Miamisburg Closure Project

Parcel 9 Residual Risk Evaluation

Mound Plant
Miamisburg, OH

FINAL

June 2011

Department of Energy
Ohio Field Office

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RPT-2185.00-001

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Acronyms and Abbreviations

ABS	dermal absorption factor
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
CDI	chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIDARS	Chemical Information Database and Applicable Regulatory Standards
COPC	constituents of potential concern
CSF	cancer slope factor
CSM	conceptual site model
DOE	U.S. Department of Energy
ELCR	excess lifetime cancer risk
EPC	exposure point concentrations
HEAST	Health Effects Assessment Summary Tables
HI	hazard Index
HQ	hazard quotient
IC	institutional controls
IRIS	Integrated Risk Information System
LOAEL	lowest-observable-adverse-effect-level
MCP	Miamisburg Closure Project
mg/kg-day	milligrams per kilogram per day
MMCIC	Miamisburg Mound Community Improvement Corporation
NCEA	National Center for Environmental Assessment
NCP	National Oil & Hazardous Substances Pollution Contingency Plan
ND	not detected
NOAEL	no-observable-adverse-effect-level
OEPA	Ohio Environmental Protection Agency
OSC	on-scene coordinator
OU	operable unit
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PCE	perchloroethane (aka tetrachloroethane)
pCi	picocurie
PEF	particulate emission factor
PPRTV	provisional peer-reviewed toxicity values
PRS	potential release site

QAPP	quality assurance project plan
QA/QC	quality assurance/quality control
RAGS	Risk Assessment Guidance for Superfund
RAIS	Risk Assessment Information System
RBGV	risk-based guideline value
RESRAD	residual radiation
RfC	reference concentration factors
RfD	reference dose factor
RME	reasonable maximum exposure
RRE	residual risk evaluation
RREM	residual risk evaluation methodology
Se	gamma-shielding factor
SEEPRO	Site Environmental Evaluation for Projects
SF	slope factor
SRC	site-related constituents
SVOC	semi-volatile organic compound
TCDD	tetrachlorodibenzo-p-dioxin
TCE	trichloroethene
TEF	toxicity equivalence factors
THI	target hazard index
TIC	tentatively identified compound
TRL	target risk level
UCL	upper confidence limit
USEPA	U.S. Environmental Protection Agency
UTL	upper tolerance limit
VOC	volatile organic compound
WHO	World Health Organization
WTS	Waste Transfer System
XRF	X-ray fluorescence

EXECUTIVE SUMMARY

The Miamisburg Closure Project (MCP) Parcel 9 Residual Risk Evaluation (RRE) addresses the remaining portions of the U.S. Department of Energy (DOE) Mound Plant to be transferred to the Miamisburg Mound Community Improvement Corporation (MMCIC). Parcel 9 includes Operable Unit 1 (OU1) and the Former Rail Loadout Area (formerly Potential Release Site [PRS] 441). The Parcel 9 RRE 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 9. The Parcel 9 RRE quantifies human health risk associated with residual levels of contaminants remaining in the area to ensure that future users are not exposed to contaminant levels posing unacceptable risks.

The anticipated future use of Parcel 9 is industrial; therefore, the total, background, and incremental risks are calculated for current exposure scenarios for a construction worker and site worker working within the Parcel 9 boundary. These risks have been compared to the National Oil & Hazardous Substances Pollution Contingency Plan (NCP) (USEPA 1990) acceptable risk range of 1×10^{-4} to 1×10^{-6} for carcinogenic risk (corresponding to an increased cancer risk of 1 in 10,000 to 1 in 1 million) as well as the Ohio Environmental Protection Agency's (OEPA's) target risk goal of 1×10^{-5} (OEPA 2009). Non-carcinogenic hazards were also compared to the U.S. Environmental Protection Agency (USEPA) and OEPA target hazard goal of 1.0 (USEPA 1990; OEPA 2009). Total risk for both the construction worker and site worker scenarios slightly exceed the OEPA target risk goal, supporting the use and enforcement of the institutional controls (ICs) as part of the final remedy.

The Parcel 9 RRE does not include groundwater as a media of concern because groundwater exposure at the MCP is not a complete pathway. MCP was connected to the City of Miamisburg municipal water service on May 1, 2005. Since then, potable water at MCP has been provided by the City of Miamisburg. Provision of potable water via the Miamisburg municipal water infrastructure is the anticipated method for receipt and use of potable water for the foreseeable future.

The surface water pathway is complete, but it is an insignificant pathway, as there are no flowing surface water bodies on the site and surface water is only present following precipitation events. As a result, surface water is not included as a media of concern for site or construction workers in the Parcel 9 RRE.

To quantify future residual soil risk at Parcel 9, it was assumed that no degradation of the contaminants of potential concern (COPCs) would occur over time; therefore, current and future residual soil risks are assumed to be equivalent. There are four complete exposure routes through which a receptor may be exposed to COPCs in soil: oral (ingestion), dermal contact, inhalation of dust, and/or external exposure to ionizing radiation. Residual risks for the

construction worker and site worker resulting from soil exposure at Parcel 9 are summarized below and presented in Table ES.1.

Construction Worker. The principal carcinogenic risk driver for the Parcel 9 construction worker is external exposure to radium-228, responsible for 47% of the total risk. Benzo(a)pyrene also contributes 29% of the total risk. In evaluating incremental risks for the construction worker scenario, the computed total risks using verification sample data from Parcel 9 were compared with the risks resulting from site-specific background concentrations. The computed total residual risk of 1.3×10^{-5} exceeds the OEPA target risk goal of 1×10^{-5}, and the background comparison reveals the incremental carcinogenic risk for the construction worker is equal to the total residual risk.

The total residual hazard due to soil exposure for the construction worker is 0.49, which is below the OEPA target hazard goal of 1. The primary driver for the hazard index (HI) is incidental ingestion of polychlorinated biphenyls (PCBs), specifically Aroclor-1248 (62% of the total HI). The incremental hazard level for the construction worker scenario is 0.49, as there are no background concentrations for the organic chemicals identified as COPCs.

Site Worker. The principal carcinogenic risk driver for the Parcel 9 site worker is dermal absorption of benzo(a)pyrene, which accounts for 45% of the total risk. Radium-228 is also responsible for 36% of the total risk. In evaluating incremental risks for the site worker scenario, the computed total residual risks using Parcel 9 verification sample data were compared with the risks resulting from site-specific background concentrations. The computed residual risk of 1.7×10^{-5} exceeds the OEPA target risk goal of 1×10^{-5}, and the background comparison reveals the incremental carcinogenic risk of $1.6 \times 10^{-5}$for the site worker is nearly equal to the total residual risk.

The total residual hazard due to soil exposure for the site worker is 0.039 which is below the OEPA target hazard goal of 1. The primary driver for the hazard index is incidental ingestion of PCBs, specifically Aroclor-1248 (76% of the total HI).

Table ES.1 - Overall Summary of Risks and Hazards at Parcel 9

Exposure Scenario	Risk Type	Excess Lifetime Cancer Risk (ELCR) for Carcinogenic Effects	Hazard Index (HI) for Non-Carcinogenic Effects
Construction Worker	Total Residual	1.3×10^{-5}	0.49
	Background	7.3×10^{-7}	0.0
	Incremental	1.3×10^{-5}	0.49
Site Worker	Total Residual	1.7×10^{-5}	0.039
	Background	5.0×10^{-7}	0.0
	Incremental	1.6×10^{-5}	0.039

1.0 INTRODUCTION

The Mound Plant is located approximately 10 miles southwest of Dayton, Ohio, in Montgomery County, within the City of Miamisburg as shown in Figure 1.1. The plant is located approximately 2,000 feet east of the Great Miami River and partially overlies the Great Miami Buried Valley Aquifer. At one time, the Mound Plant occupied approximately 306 acres and approximately 130 buildings with a total of 1.4 million square feet of floor space. Since 1999, approximately 178.35 acres have been transferred to the Miamisburg Mound Community Involvement Corporation (MMCIC). Parcel 9 consists of approximately 23.2 acres of land. The location of Parcel 9 is illustrated in Figure 1.2.

Beginning in 1948, Mound operated as a research, development, and production facility in support of the Department of Energy's (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. In 1989, the U.S. Environmental Protection Agency (USEPA) placed Mound on the National Priorities List due to volatile organic compounds (VOCs) detected in the groundwater. Mound's 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 industrial use.

During past operations at the Mound facility, hazardous materials have been released. During subsequent facility investigations, over 400 potential release sites (PRSs) were identified. Since contamination at Mound occurred at discrete PRSs rather than being widespread across the site, a new decision-making process was formulated for the Miamisburg Closure Project (MCP), which is known as the Mound 2000 Process. The Mound 2000 Process is consistent with the Federal Facilities Agreement signed by DOE, the 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) (USEPA 1990).

1.1 Purpose of Residual Risk Evaluation

This report was developed using the *Mound 2000 Residual Risk Evaluation Methodology* (RREM) (DOE 1997a) to quantify the potential carcinogenic and non-cancer health effects from chronic low-level exposure to site-related contaminants in Parcel 9. A residual risk evaluation (RRE) assesses human health risks associated with residual levels of contamination remaining within an area to ensure that future land users will not be exposed to contaminant levels that would pose unacceptable risks. The RRE results will be used in conjunction with the applicable or relevant and appropriate requirements (ARARs) to determine the need for additional site remediation or to demonstrate that the parcel is ready for release and economic development.

The objective of the Parcel 9 RRE is to assess risks associated with residual contamination after cleanup activities have been completed. Although the RRE method was developed specifically for use at Mound, the method is consistent with USEPA Risk Assessment Guidance for Superfund (RAGS) Part A (USEPA 1989) to ensure that future land users will not be exposed to contaminant levels that would pose unacceptable risks.

1.2 Scope of the Parcel 9 RRE

The Parcel 9 RRE was completed using the Mound 2000 RREM (DOE 1997a) and includes an evaluation of human health risk for residual contamination at Parcel 9. Since the anticipated future land use is commercial/industrial, exposure scenarios were selected to represent reasonable maximum exposures (RMEs) in a commercial/industrial setting. Residual contaminants in Parcel 9 were evaluated for two potential exposure scenarios[1]: (1) construction workers, who may be directly exposed to surface (0–2 ft below ground surface [bgs]) and subsurface (all depths below 2 ft bgs) soil over a period of 5 years, and (2) site workers, such as office workers, who may be exposed to surface soil (0–2 ft bgs) over a period of 25 years.

The Parcel 9 RRE does not include groundwater as a media of concern as exposure to groundwater at the MCP is an incomplete exposure pathway. The MCP was connected to the City of Miamisburg municipal water service on May 1, 2005. Since then, potable water at MCP has been provided by the City of Miamisburg. Provision of potable water via the Miamisburg municipal water infrastructure is the anticipated method for receipt and use of potable water for the foreseeable future.

The Parcel 9 RRE does not include surface water as a media of concern because the exposure pathway for construction workers and site workers is considered complete but insignificant, as the only surface water at Parcel 9 is ephemeral.

Exposure parameters for the construction worker and site worker scenarios are site-specific adaptations of the USEPA default exposure scenarios presented in RAGS Part A (USEPA 1989). These parameters are documented in Table 1 of the Mound 2000 RREM (DOE 1997a) and are based on RME assumptions. The RME exposure assumptions are conservative estimates for exposure and, therefore, are protective of human health risks from residual contamination.

Parcel 9 residual risks for the construction worker and site worker scenarios were calculated as total, background, and incremental risk. Total risk was calculated using exposure point concentrations (EPCs) calculated for each COPC. EPCs for the Parcel 9 RRE were defined as the lower of either the maximum detected concentration or the 95% upper confidence limit of the arithmetic mean (95% upper confidence limit [UCL]) for constituents with greater than 30% detected data or the 70th percentile of the data set for constituents with fewer than 30% detected data. This approach is in line with current USEPA guidance (USEPA 2010a). Similarly, background risk was calculated based on the lower of the maximum detected concentration or the 95% UCL of the Mound background data set. Incremental risk is defined as the difference

1. Exposure for the two scenarios assumes workers are directly contacting residual material and no improvements or covers have been placed at the site, providing a very conservative assessment of potential risks or hazards.

between total and background risks and was used to assess the increase in risk above background levels due to Mound Plant operations.

1.3 Report Organization

The RRE provides a framework for evaluating potential human health risks associated with residual contamination. The report consists of the following five sections:

- *Identification of contaminants to be evaluated.* Describes the methods used to obtain and compile the Parcel 9 data and identify the COPCs evaluated in the RRE.
- *Exposure assessment.* Identifies exposure scenarios assessed in the RRE, summarizes the pathways though which exposure to residual contamination may occur for each scenario, and presents intake assumptions used to quantify exposure.
- *Toxicity assessment.* Presents EPCs, intake equations, and toxicological reference values.
- *Risk characterization.* Exposure assessment information is combined with the toxicity assessment to characterize and quantify human health risks from residual contamination.
- *Uncertainty evaluation.* Discusses the sources of uncertainty inherent to risk assessment as well as those affecting the Parcel 9 RRE and the potential effect on risk characterization.

Figure 1.1 Vicinity Map

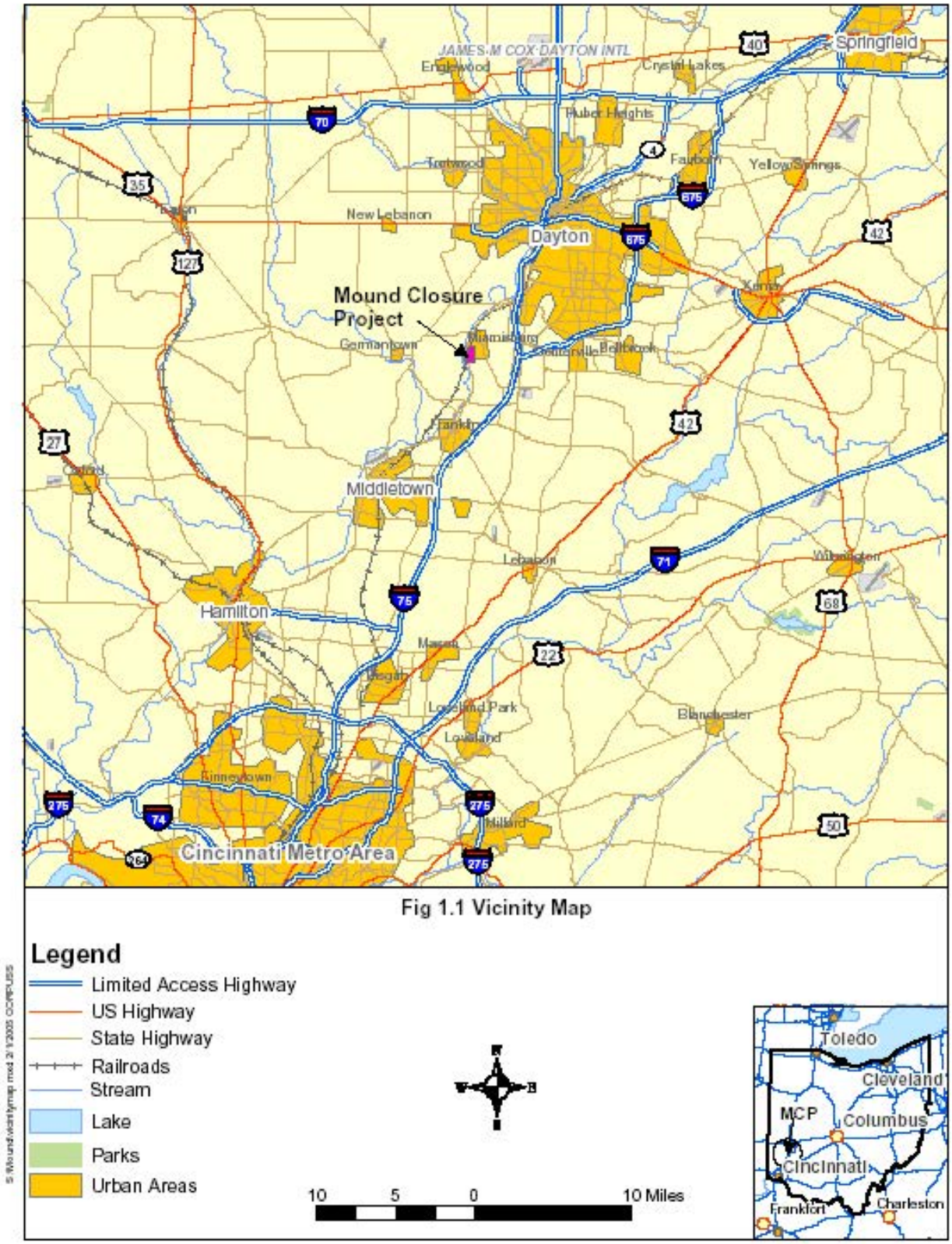
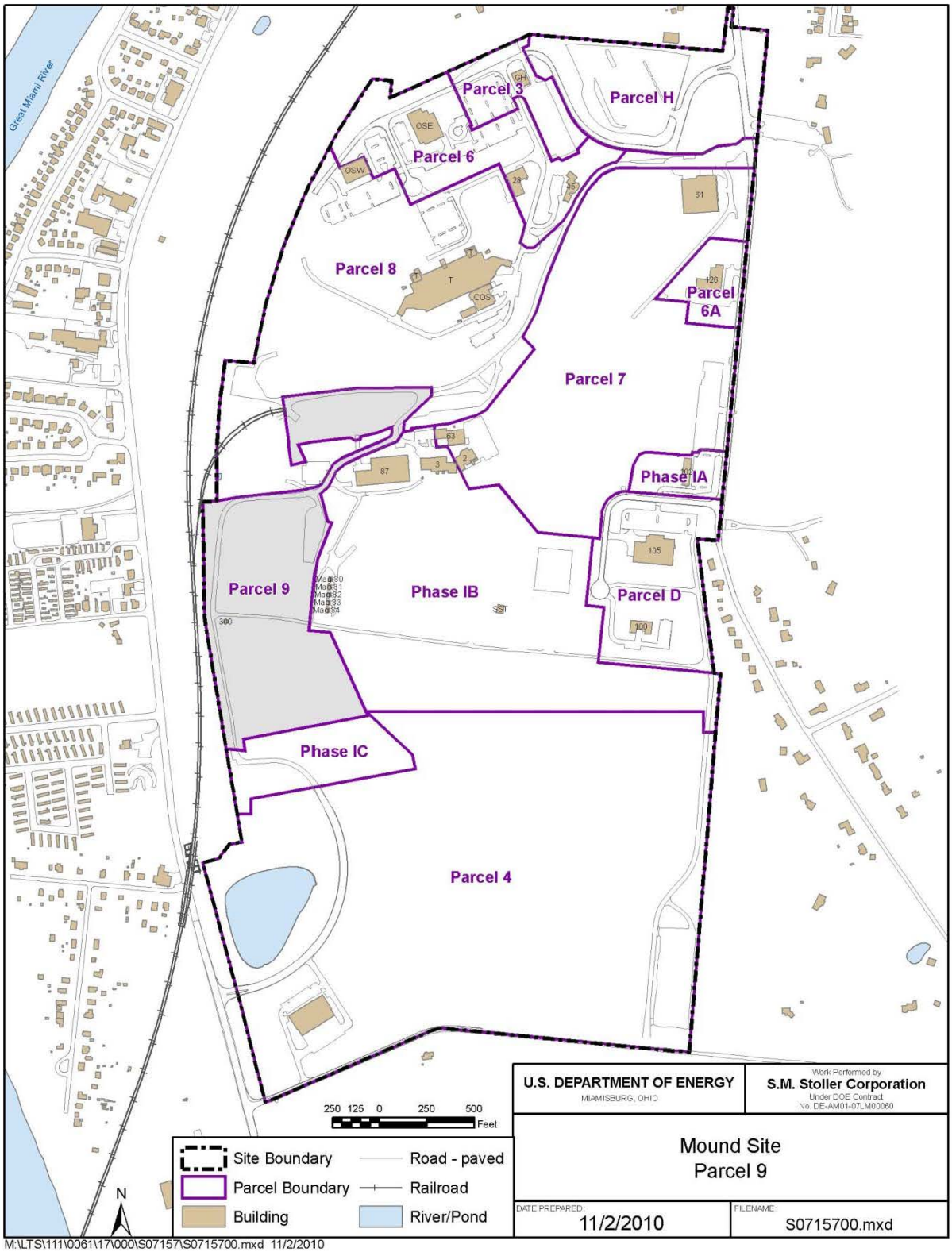


Fig 1.1 Vicinity Map

Figure 1.2 Parcel 9 Site Map



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 constituents detected in Parcel 9 and then eliminating constituents based on the screening criteria established in the RREM (DOE 1997a).

Sample data were compiled from the Site Environmental Evaluation for Projects (SEEPRO) database for use in the Parcel 9 RRE. Newer data were used to supplement older data except when older data were representative of materials removed from the parcel. In this case, the older data no longer represented site conditions and were not used in the RRE. Sample 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 this event, data from the commercial analytical laboratory were used to take advantage of the greater precision available from the commercial analytical laboratory.

Soil data used in the Parcel 9 RRE collected prior to the Mound 2000 Process (DOE 1999) are documented in the following reports:

- *Operable Unit 3 Miscellaneous Sites Limited Field Investigation Report, Volumes 1, 2, and 3* (DOE 1993a). The purpose of this investigation was to address areas noted in previous surveys but not thought to endanger human health or the environment.
- *Operable Unit 5 New Property Extended Phase I Field Investigation Report* (DOE 1995a). The purpose of this investigation was to augment previous reconnaissance surveys with surface and subsurface sampling, groundwater sampling, and sediment sampling in ephemeral streams.
- *Operable Unit 5 Remedial Investigation Report* (DOE 1996). This report identifies the nature and extent of contamination in groundwater, surface water, soils, and sediment in Operable Unit 5.
- *Operable Unit 5 Operational Area Phase I Investigation Area 22* (DOE 1995b). The purpose of this investigation was to present results of the radiological and soil gas reconnaissance surveys conducted in Area 22 as part of the larger OU5 Phase I investigation and identify potential areas of radiological and chemical contamination. It provided a qualitative screen that can be used to determine a strategy for directing additional investigations.
- *Operable Unit 5 Operational Area Phase I Investigation Area 13* (DOE 1995c). The purpose of this investigation was to present results of the radiological and soil gas reconnaissance surveys conducted in Area 13 as part of the larger OU5 Phase I investigation and identify potential areas of radiological and chemical contamination. It provides a qualitative screen that can be used to determine a strategy for directing additional investigations.
- *Reconnaissance Sampling Report Decontamination and Decommissioning Areas* (DOE 1992). The purpose of this sampling campaign was to characterize the non-radioactive hazardous contaminant in the soil areas that were included in the

Decontamination & Decommissioning (D&D) Program as of 1989. Some onsite analyses for plutonium-238 and thorium-232 were also reported.

- *Operable Unit 9 Site Scoping Report, Volume 3 - Radiological Site Survey* (DOE 1993b). This report was a compendium of existing data.
- *Work Plan for Environmental Restoration of the DOE Mound Site, the Mound 2000 Approach* (DOE 1999). In the Mound 2000 Process, radionuclide and chemical contaminants were studied on a PRS basis. Radiological and chemical information is available in the applicable PRS on-scene coordinator (OSC) reports. A total of 40 identified PRSs were located in Parcel 9 as described in Appendix A of this report.
- *Haul Road Hot Spot* (DOE 2009). During a walkover survey of the haul road used for hauling soil from the remediation site to the rail load out area, a section was found to have elevated readings. The contaminant was determined to be U-238 under approximately 1 foot of fill. This area was remediated and verified. Verification results were reported in the Final PRS 441 OSC report (DOE 2009). The locations were all within the Parcel 9 footprint and, therefore, included in the Parcel 9 RRE.
- *Test Fire Parking Lot Data* (DOE 2009). During the final remediation of the eastern portions of PRS 441 (the Rail Spur), an area of contamination was identified and removed from the Test Fire Parking Lot. This area extended into a small portion of Parcel 8 in the area of the parking lot just east of PRS 441. Fifteen soil samples were collected and analyzed offsite via alpha spectroscopy. Contaminants included Th-232, U-238, and Ra-226. Final verification sampling was conducted in accordance with the Mound 2000 Process (DOE 1999). All verification sample results were below risk-based cleanup objectives. Verification results were reported in the Final PRS 441 OSC report (DOE 2009). Because these results were collected after the remediation was completed, they were not included in assessment of Parcel 8 in the Parcel 6, 7, and 8 RRE (DOE 2007). However, because verification sample results were below cleanup objectives and the area represents a small portion of Parcel 8, the Parcel 6, 7, and 8 RRE (DOE 2007) was not revised. Instead, this data was included in the Parcel 9 RRE.

Soil data can be divided into three types: (1) data obtained through commercial analytical laboratory analysis, (2) data obtained through screening techniques conducted in a DOE laboratory, and (3) data obtained through screening techniques conducted in the field.

Analytical laboratory data are obtained using strict methods and are subjected to exacting quality control procedures. These data are of the highest quality and are quantitative. The laboratory screening data are considered to be of lower quality because sample preparation does not occur, and the measuring instruments are less precise and generally have higher detection limits. The field screening techniques are the least accurate due to instrument limitations and the effects of ambient conditions on field measurements. Due to these limitations, field screening data were not used in risk and hazard calculations for the Parcel 9 RRE.

Although data obtained using X-ray fluorescence (XRF) is considered quantitative data,

Other radiochemical analysis are superior in quality to XRF and have been used instead of XRF results in risk and hazard calculations for the Parcel 9 RRE.

Where historical samples have been removed through excavation they are marked removed in the data set based on post excavation topographical civil surveys. Given that the excavation contours are developed by interpolation between surveyed points on a grid system, the contour may not precisely indicate the actual bottom of the excavation between the surveyed points but rather assigns a value to the entire grid of "dug at least this far" with the understanding the actual surface is irregular. Any sample point not clearly at or above the final excavation contours as developed by the survey grid is retained by the site in the data set. This is a conservative approach and does not take into account the typical non-linear bottom surface of the excavation or the radiation surveys conducted as part of the verification process. Sample locations residing within this error margin in defining the excavation bottom, have most likely been cleaned up based on the surveys but remain within the interpolated contours, thus leaving a measured sample point in the data set. This method ensures that no data is removed from analysis unless it is certain that the point has been removed.

Based on the above, several elevated samples (although U qualified) are present in the dataset but are believed to be removed based on field observations and walkover surveys conducted as part of the verification process. These walkovers indicated that the historically elevated sample locations were not detected during area walkovers. This process would have identified the presence of hot spots left unexcavated. In addition, Oak Ridge Institute for Science and Education (ORISE) also conducted independent confirmation of the project remediation process and end state results. In addition, data qualified as rejected were not used in this risk assessment, per RAGS Part A (USEPA 1989), as an ‘R’ validation flag indicates data are unusable due to quality control issues. Blind field duplicate samples were used in the data quality assessment but were not included in the calculation of the EPCs. Trip blanks were also excluded from risk calculations as they are intended to assess sample collection methodology and are not representative of site conditions.

2.1 Data Quality Assessment

Samples collected after 1993 were analyzed according to the methods outlined in the Operable Unit 9 Quality Assurance Project Plan (QAPP) (DOE 1993c).Since some of the data used to characterize residual contaminant concentrations in Parcel 9 were collected prior to 1993, not all data used in the risk assessment have undergone QA/QC evaluation and data validation in accordance with the requirements described in the OU9 QAPP (DOE 1993c).

2.2 Environmental Media Considered and Data Availability

Data used to characterize the residual contamination at Parcel 9 are discussed in Section 2.0 of this document. Samples were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), inorganic compounds, anions, dioxins, furans, polychlorinated biphenyls (PCBs), pesticides, explosives, and radionuclides. Environmental media included in this evaluation consisted of surface soil (0–2 ft bgs) and subsurface soil (>2 ft bgs).

2.3 Data Analysis

Each analyte in Parcel 9 that was detected was examined to determine the extent to which receptors would be exposed. If the data contained at least eight detected results and at least 30% of the data were detected, a 95% UCL was computed for that analyte as the EPC. If fewer than 30% of the data were detected or if fewer than eight values were detected, the lesser of the 70th percentile or the maximum detected value was used as the EPC. The 70th percentile was computed using the detected values and the detection limits for undetected data points. The 95% UCLs were computed using USEPA's ProUCL software (USEPA 2010a). ProUCL runs a series of diagnostics and goodness-of-fit tests on the data to determine the appropriate UCL to use for the analyte. ProUCL is also capable of appropriately handling data sets with undetected data using Kaplan-Meier methodology. The recommended UCL was used as the EPC unless the UCL using the H-statistic for lognormal data was recommended. ProUCL recommends using a bootstrapped UCL in place of the H-UCL, so the BCa bootstrap UCL was used as the EPC when the H-statistic UCL was recommended. If ProUCL recommended more than one UCL, the largest of the recommended UCLs was used as the EPC.

2.4 Data Screening Process

Prior to performing data screening, the units of measure for each constituent (inorganic chemicals, organic compounds, and radionuclides) were assigned consistent units of measure. All inorganic chemicals and organic compounds were converted to mg/kg when needed and all radionuclide results were converted to pCi/g as necessary. Sample results were then sorted by depth and divided into two data sets: (1) the site worker exposure scenario (0-2 ft bgs) and (2) the construction worker exposure scenario (all soil depths).

All constituents detected in at least one soil sample are listed in the constituent summary tables (Tables 2.1 and 2.2), which include the frequency of detection, maximum detected concentrations, range of detection limits, and the rationale to include/exclude a constituent from further consideration as a COPC in this RRE. Data screening was performed in accordance with Mound 2000 RREM guidance (DOE 1997a) as outlined in the following sections.

2.4.1 Background Comparison

Site-specific background values for Parcel 9 are presented in Appendix A of the Mound 2000 RREM guidance (DOE 1997a). These background values are based on the *Operable Unit 9 Background Soils Investigation Soil Chemistry Report* (DOE 1994). Background values represent the 95% Upper Tolerance Limit (95% UTL) concentrations of the background data set.

To complete background comparisons, the maximum concentration for each constituent detected in at least one sample in each data set was compared to the site-specific 95% UTL background value. However, in cases where the maximum concentration was greater than the 95% UCL of the mean generated from the data set, an additional comparison of the 95% UCL to the background value was also performed. If the 95% UCL was less than the maximum detected concentration, then the 95% UCL was used in the background comparison, per the

Mound 2000 RREM (DOE 1997a). The contaminant was retained for evaluation in the RRE if (1) the maximum concentration (or 95% UCL if less than the maximum concentration) was greater than or equal to the background level, or (2) no background value was available. If these conditions were not met, the constituent was not considered further in the RRE.

2.4.2 Risk-Based Guideline Values Comparison

Those constituents in each data set with concentrations greater than background values or which had no background values were then compared to Risk-Based Guideline Values (RBGVs). RBGVs are media- and scenario-specific contaminant concentrations calculated using a specific human health target risk or hazard. In keeping with USEPA *de minimus* risk levels, the RBGVs for the Mound facility correspond to a target risk of 1×10^{-6} for carcinogens and a hazard quotient (HQ) of 1. RBGVs calculated with a 1×10^{-6} risk level represent media-specific carcinogen concentrations corresponding to a 1–in-1-million probability of increased risk of developing cancer over a lifetime, due to exposure through all significant exposure routes (USEPA 1991a). RBGVs calculated with an HQ of 1 represent media-specific non-carcinogen concentrations below which it is unlikely a person (including sensitive populations) will develop adverse health effects due to exposure through all significant exposure routes (USEPA 1991a).

The original RBGVs referenced in the Mound 2000 RREM (DOE 1997a) were updated in 2007 in Appendix B of the Mound Parcel 6, 7, and 8 RRE, to reflect updated toxicity information and updated computational guidance issued since 1997 (DOE 2007). These updated RBGVs were used for constituent screening in the Parcel 9 RRE. Appendix B of this document provides RBGVs.

The acceptable risk range outlined in the NCP is 1×10^{-4} to 1×10^{-6} (USEPA 1990), and the OEPA target risk goal is 1×10^{-5} (OEPA 2009). Therefore, carcinogen screening against RBGVs with a target risk of 1×10^{-6} is conservative and protective. To account for the possibility of exposure to more than one non-carcinogenic constituent, COPCs were screened against $1/10^{th}$ the RBGV, as outlined in the Mound 2000 RREM (DOE 1997a). Carcinogens with maximum concentrations or activities exceeding their RBGVs and non-carcinogens with maximum concentrations exceeding $1/10^{th}$ their RBGVs were retained for evaluation in the RRE, as were those constituents with no established RBGV. In those cases where a constituent had both carcinogenic and non-carcinogenic effects, the lower of the carcinogenic RBGV or the $1/10^{th}$ non-carcinogenic RBGV was used for screening purposes. Those constituents with maximum concentrations below their respective RBGVs were not considered further in the RRE.

Some radionuclide RBGVs have a “+D” designation, indicating the RBGV includes contributions from the radionuclide’s short-lived decay products (daughters). This designation assumes secular equilibrium with the parent nuclide under normal environmental conditions (see Appendix C). Where available, these RBGVs were used in the screening process.

2.4.3 Frequency of Detection

Those constituents in each data set exhibiting maximum detected concentrations either above their respective background values and RBGVs or which did not have background values and/or

RBGVs were then screened based on their frequency of detection. Per RAGS Part A (USEPA 1989), constituents detected infrequently may not be site-related due to various sampling or analytical problems or other issues. Therefore, constituents detected infrequently, at low-level concentrations, and which are not site process-related were removed from consideration in the RRE. Infrequent detection is defined as 5% or less for an individual constituent, for a data set consisting of at least 20 samples (i.e., 1/20 samples). If the data set consists of less than 20 samples, frequency of detection was not used to remove constituents from consideration in the RRE.

2.4.4 Essential Human Nutrients

Constituents remaining in each data set after screening based on background values, RBGVs, and frequency of detection were then screened as essential nutrients. Essential nutrients are those compounds that are not associated with adverse health effects at background or near-background concentrations. The essential nutrients include: calcium, iron, magnesium, potassium, and sodium, per RAGS Part A (USEPA 1989). These constituents were removed from consideration as COPCs if they exhibited concentrations at or slightly above background levels, because, at these concentrations, they are not expected to result in toxic responses.

2.4.5 Additional Screening Procedures

As previously discussed, RBGVs with a “+D” designation were used in the screening process where available. The “+D” designation indicates that the slope factor accounts for risks associated with the parent radionuclide, as well as radioactive decay products with half-lives less than or equal to 6 months (USEPA 2001). Therefore, radionuclides that are part of the thorium-232, uranium-235, and uranium-238 natural decay series with half-lives less than or equal to 6 months (actinium-228, bismuth-212, bismuth-214, lead-212, lead-214, radium-224, thallium-208, and thorium-227) were removed from further consideration during COPC screening.

Given the high degree of uncertainty in both the identity and reported concentrations of Tentatively Identified Compounds (TICs), TICs were not carried through the RRE. TICs are compounds identified by instrument library search, are not quantified during analysis, and with very rare exception do not represent compounds that are regulated or that have the necessary toxicity information to support quantitative risk assessment. Among the Parcel 9 data set, relatively few TICs were reported and historical information does not suggest that any particular TIC should be considered a site-specific COPC. Table 2.1 identifies COPCs in surface and subsurface soil for the construction worker scenario in Parcel 9. Table 2.2 identifies COPCs in surface soil for the site employee in Parcel 9.

Table 2.1 – Identification of COPCs for the Construction Worker Exposure Scenario (Surface and Subsurface Soil)

Analyte	CAS Number	Minimum Concentration	Maximum Concentration	Detection Frequency	95% UCL or 70th Percentile[a]	EPC	Background Value	RBGV	COPC?[b]
Inorganics (mg/kg)									
Aluminum	7429-90-5	1.10E+03	3.20E+04	85/89	9.63E+03	9.63E+03	1.90E+04	2.08E+04	No:1
Antimony	**7440-36-0**	**1.00E+00**	**4.46E+01**	**40/77**	**1.25E+01**	**1.25E+01**	**--**	**8.52E+00**	**Yes**
Arsenic	7440-38-2	1.20E+00	3.70E+01	95/107	5.06E+00	5.06E+00	8.60E+00	1.85E+00	No:1
Barium	7440-39-3	1.02E+01	3.20E+02	85/93	4.77E+01	4.77E+01	1.80E+02	1.47E+03	No:1
Beryllium	7440-41-7	1.10E-01	1.70E+00	71/88	6.48E-01	6.48E-01	1.30E+00	4.21E+01	No:1
Bismuth	07440-69-9	5.40E-01	7.70E+01	19/65	1.83E+01	1.83E+01	3.80E+01	--	No:1
Cadmium	7440-43-9	2.20E-01	9.30E+00	48/100	1.86E+00	1.86E+00	2.10E+00	5.46E+00	No:1
Calcium	7440-70-2	1.45E+04	3.45E+05	86/90	1.13E+05	1.13E+05	3.10E+05	--	No:1
Cerium	07440-45-1	1.59E+01	1.59E+01	1/5	1.18E+01[c]	1.18E+01	--	3.85E+04	No:2
Chromium	7440-47-3	1.20E+00	1.12E+02	88/94	2.29E+01	2.29E+01	2.00E+01	3.19E+04[d]	No:2
Cobalt	7440-48-4	1.00E+00	2.07E+01	89/95	9.19E+00	9.19E+00	1.90E+01	3.83E+02	No:1
Copper	7440-50-8	3.90E+00	4.46E+02	93/99	4.85E+01	4.85E+01	2.60E+01	8.52E+02	No:2
Gadolinium	**7440-54-2**	**9.00E+01**	**9.00E+01**	**1/1**	**--**	**9.00E+01**	**--**	**--**	**Yes**
Iron	7439-89-6	1.05E+01	3.60E+04	99/103	1.89E+04	1.89E+04	3.50E+04	--	No:1
Lanthanum	**7439-91-0**	**4.60E+00**	**9.10E+00**	**4/5**	**6.02E+00[c]**	**6.02E+00**	**--**	**--**	**Yes**
Lead	7439-92-1	2.90E+00	9.61E+01	93/107	1.33E+01	1.33E+01	4.80E+01	--	No:1
Lithium	7439-93-2	1.70E+00	3.95E+01	44/58	1.53E+01	1.53E+01	2.60E+01	--	No:1
Magnesium	7439-95-4	7.18E+03	8.23E+04	86/90	3.25E+04	3.25E+04	4.00E+04	--	No:1
Manganese	7439-96-5	2.97E-01	1.32E+03	97/103	4.19E+02	4.19E+02	1.40E+03	4.85E+02	No:1
Mercury	7439-97-6	7.00E-02	1.20E+00	19/99	1.63E-01	1.63E-01	1.50E-01	5.78E+04	No:2
Molybdenum	7439-98-7	9.00E-01	2.46E+01	13/36	1.07E+01	1.07E+01	2.72E+01	1.06E+02	No:1
Nickel	7440-02-0	3.20E+00	5.08E+01	85/100	1.96E+01	1.96E+01	3.20E+01	4.26E+02	No:1
Potassium	7440-09-7	1.95E+02	1.30E+04	92/98	2.35E+03	2.35E+03	1.90E+03	--	No:4
Praseodymium	**7440-10-0**	**1.07E+01**	**1.07E+01**	**1/5**	**7.36E+00[c]**	**7.36E+00**	**--**	**--**	**Yes**
Samarium	**7440-19-9**	**5.31E+01**	**5.31E+01**	**1/5**	**1.88E+01[c]**	**1.88E+01**	**--**	**--**	**Yes**
Selenium	07782-49-2	4.70E-01	7.10E+01	11/104	1.00E+00[c]	1.00E+00	5.90E-01	1.06E+02	No:2
Silver	7440-22-4	1.60E+00	2.15E+01	54/100	7.24E+00	7.24E+00	1.70E+00	1.06E+02	No:2
Sodium	7440-23-5	9.34E+01	1.55E+03	84/100	4.35E+02	4.35E+02	2.40E+02	--	No:4
Tantalum	**7440-25-7**	**1.90E+02**	**4.02E+02**	**8/12**	**2.87E+02**	**2.87E+02**	**--**	**--**	**Yes**
Thallium	07440-28-0	2.40E-01	7.60E-01	13/99	1.40E+00[c]	7.60E-01	4.60E-01	1.41E+00	No:2

Analyte	CAS Number	Minimum Concentration	Maximum Concentration	Detection Frequency	95% UCL or 70th Percentile[a]	EPC	Background Value	RBGV	COPC?[b]
Tin	07440-31-5	1.60E+00	1.61E+01	8/36	8.60E+00[c]	8.60E+00	2.09E+01	1.28E+04	No:1
Total Cyanide	00057-12-5	1.40E-01	6.10E-01	12/52	6.10E-01[c]	6.10E-01	--	4.26E+02	No:2
Vanadium	7440-62-2	4.80E+00	5.50E+01	91/95	2.07E+01	2.07E+01	2.50E+01	2.13E+01	No:1
Zinc	7440-66-6	9.40E+00	2.74E+02	86/100	7.45E+01	7.45E+01	1.40E+02	6.39E+03	No:1
Dioxins (ug/kg)									
1,2,3,4,6,7,8-Heptachlorodibenzofuran	**67562-39-4**	**2.20E-04**	**6.30E-03**	**4/13**	**4.30E-04[c]**	**4.30E-04**	**--**	**--**	**Yes**
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	**57653-85-7**	**1.70E-03**	**1.70E-03**	**1/13**	**5.32E-04[c]**	**5.32E-04**	**--**	**--**	**Yes**
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	**19408-74-3**	**8.90E-04**	**1.80E-03**	**2/13**	**5.66E-04[c]**	**5.66E-04**	**--**	**--**	**Yes**
1,2,3,7,8-Pentachlorodibenzofuran	57117-41-6	4.20E-04	1.10E-03	2/13	4.08E-04[c]	4.08E-04	--	3.97E-02	No:2
1234678-HpCDD	**35822-46-9**	**5.20E-04**	**3.03E-02**	**5/13**	**1.46E-03[c]**	**1.46E-03**	**--**	**--**	**Yes**
1234789-HpCDF	**55673-89-7**	**6.20E-04**	**6.20E-04**	**1/13**	**4.00E-04[c]**	**4.00E-04**	**--**	**--**	**Yes**
123478-HxCDD	**39227-28-6**	**6.50E-04**	**6.50E-04**	**1/13**	**5.82E-04[c]**	**5.82E-04**	**--**	**--**	**Yes**
123478-HxCDF	**70648-26-9**	**1.80E-04**	**2.20E-03**	**3/13**	**3.98E-04[c]**	**3.98E-04**	**--**	**--**	**Yes**
123678-HxCDF	57117-44-9	5.80E-04	1.20E-03	2/13	2.88E-04[c]	2.88E-04	--	1.99E-01	No:2
2,3,4,6,7,8-Hexachlorodibenzofuran	**60851-34-5**	**1.50E-04**	**1.00E-03**	**3/13**	**5.52E-04[c]**	**5.52E-04**	**--**	**--**	**Yes**
2,3,7,8-Tetrachlorodibenzofuran	051207-31-9	3.90E-04	2.80E-03	2/13	5.80E-04[c]	5.80E-04	--	1.99E-01	No:2
2,3,7,8-Tetrachlorodibenzo-p-dioxin	001746-01-6	1.50E-03	3.00E-03	3/13	1.09E-03[c]	1.09E-03	--	1.86E-02	No:2
23478-PeCDF	57117-31-4	2.40E-04	1.50E-03	3/13	5.04E-04[c]	5.04E-04	--	3.97E-01	No:2
Octachlorodibenzofuran	39001-02-0	2.20E-04	1.03E-02	7/13	9.08E-04[c]	9.08E-04	--	1.99E+01	No:2
Octachlorodibenzo-p-dioxin	003268-87-9	2.73E-01	2.73E-01	1/13	1.72E-02[c]	1.72E-02	--	1.99E+01	No:2
Explosives (ug/kg)									
1,3-Dinitrobenzene	000099-65-0	2.00E+02	2.00E+02	1/57	1.50E+03[c]	2.00E+02	--	2.13E+03	No:2
1,3,5-Trinitrobenzene	000099-35-4	3.10E+02	3.10E+02	1/57	1.50E+03[c]	3.10E+02	--	6.39E+05	No:2
2,4-Dinitrotoluene	000121-14-2	2.00E+02	2.00E+02	1/163	5.94E+02[c]	2.00E+02	--	3.54E+03	No:2
2,6-Dinitrotoluene	000606-20-2	2.90E+02	2.90E+02	1/163	1.30E+03[c]	2.90E+02	--	3.54E+03	No:2
HMX	002691-41-0	4.10E+02	6.60E+02	2/62	2.97E+03[c]	6.60E+02	--	1.06E+06	No:2
RDX	000121-82-4	7.10E+02	6.85E+03	4/62	2.41E+03[c]	2.41E+03	--	2.71E+04	No:2
Pesticides and PCBs (ug/kg)									
4,4'-DDD	000072-54-8	9.20E-01	2.80E+00	5/100	8.33E+00[c]	2.80E+00	4.20E+03	1.24E+04	No:1
4,4'-DDE	000072-55-9	2.40E-01	1.60E+00	10/100	3.70E+00[c]	1.60E+00	4.30E+03	8.77E+03	No:1
4,4'-DDT	000050-29-3	2.20E-01	3.10E+00	9/100	9.13E+00[c]	3.10E+00	1.30E+04	8.12E+03	No:1
Aldrin	000309-00-2	1.20E-01	2.50E+00	8/100	3.13E+00[c]	2.50E+00	--	1.42E+02	No:2

Analyte	CAS Number	Minimum Concentration	Maximum Concentration	Detection Frequency	95% UCL or 70th Percentile[a]	EPC	Background Value	RBGV	COPC?[b]
alpha-BHC	000319-84-6	2.10E-01	1.10E+01	13/100	2.33E+00[c]	2.33E+00	--	4.73E+02	No:2
alpha-Chlordane	005103-71-9	1.00E-01	4.80E+00	10/99	1.07E+01[c]	4.80E+00	--	7.61E+03	No:2
Aroclor-1242	053469-21-9	3.70E+01	1.00E+03	3/610	4.00E+01[c]	4.00E+01	--	--	No:3
Aroclor-1248	**12672-29-6**	**7.10E+00**	**3.80E+04**	**307/610**	**9.60E+02**	**9.60E+02**	**--**	**--**	**Yes**
Aroclor-1254	011097-69-1	4.24E+01	2.00E+02	7/285	7.09E+01[c]	7.09E+01	5.80E+04	3.20E+02	No:1
Aroclor-1260	011096-82-5	2.54E+01	9.90E+01	4/285	7.28E+01[c]	7.28E+01	--	--	No:3
Aroclor-1262	**037324-23-5**	**4.10E+00**	**1.30E+03**	**32/325**	**4.00E+01[c]**	**4.00E+01**	**--**	**--**	**Yes**
Aroclor-1268	011100-14-4	5.60E+01	1.80E+02	5/325	3.90E+01[c]	3.90E+01	--	--	No:3
delta-BHC	000319-86-8	1.90E-01	1.90E-01	1/100	6.83E+00[c]	1.90E-01	--	--	No:3
Dieldrin	000060-57-1	9.20E-02	6.40E+00	10/100	3.73E+00[c]	3.73E+00	--	1.86E+02	No:2
Endosulfan II	033213-65-9	2.00E-01	3.50E+00	3/100	3.80E+00[c]	3.50E+00	--	--	No:3
Endosulfan sulfate	001031-07-8	1.30E-01	2.00E+00	5/100	1.83E+01[c]	2.00E+00	--	--	No:3
Endrin	000072-20-8	1.20E-01	1.60E+00	5/100	4.73E+00[c]	1.60E+00	--	6.39E+03	No:3
Endrin aldehyde	**007421-93-4**	**7.10E-01**	**4.70E+00**	**8/96**	1.72E+01[c]	**4.70E+00**	**--**	**--**	**Yes**
Endrin ketone	053494-70-5	1.50E-01	2.00E+00	5/100	1.83E+01[c]	2.00E+00	--	--	No:3
gamma-BHC (Lindane)	000058-89-9	3.30E-02	3.30E-02	1/100	3.20E+00[c]	3.30E-02	--	2.29E+03	No:2
gamma-Chlordane	005103-74-2	2.90E-01	3.50E+00	7/100	1.06E+01[c]	3.50E+00	--	7.61E+03	No:2
Heptachlor	000076-44-8	3.60E-02	2.80E-01	2/100	2.40E+00[c]	2.80E-01	--	6.62E+02	No:2
Heptachlor epoxide	001024-57-3	1.00E-01	1.10E+01	6/100	9.23E+00[c]	9.23E+00	--	2.77E+02	No:2
Methoxychlor	00072-43-5	3.10E-01	1.80E+01	7/100	9.12E+01[c]	1.80E+01	3.00E+04	1.06E+05	No:1
Semi-Volatile Organic Compounds (ug/kg)									
1,2,4-Trichlorobenzene	000120-82-1	3.00E-01	2.20E+00	17/678	5.80E+00[c]	2.20E+00	--	1.72E+05	No:2
2-Methylnaphthalene	000091-57-6	8.60E+01	1.90E+02	3/108	7.69E+02[c]	1.90E+02	--	8.52E+04	No:2
4-Methylphenol	000106-44-5	2.60E+02	2.90E+02	2/106	7.70E+02[c]	2.90E+02	--	1.06E+05	No:2
Acenaphthene	000083-32-9	2.10E+01	1.30E+03	9/108	7.49E+02[c]	7.49E+02	--	9.76E+05	No:2
Acenaphthylene	000208-96-8	2.30E+02	2.30E+02	1/108	7.59E+02[c]	2.30E+02	--	--	No:3
Anthracene	000120-12-7	3.10E+01	8.00E+02	12/109	7.40E+02[c]	7.40E+02	--	4.88E+06	No:2
Benz(a)anthracene	000056-55-3	2.90E+01	2.50E+03	26/108	3.24E+02	3.24E+02	--	3.12E+03	No:2
Benzo(a)pyrene	**000050-32-8**	**3.10E+01**	**2.30E+03**	**28/108**	**2.95E+02**	**2.95E+02**	**--**	**3.12E+02**	**Yes**
Benzo(b)fluoranthene	**000205-99-2**	**3.80E+01**	**4.90E+03**	**26/108**	**4.54E+02**	**4.54E+02**	**--**	**3.12E+03**	**Yes**
Benzo(g,h,i)perylene	**000191-24-2**	**1.00E+02**	**1.10E+03**	**16/108**	**7.20E+02[c]**	**7.20E+02**	**--**	**--**	**Yes**
Benzo(k)fluoranthene	000207-08-9	3.70E+01	4.50E+03	20/108	7.70E+02[c]	7.70E+02	--	3.12E+04	No:2

Analyte	CAS Number	Minimum Concentration	Maximum Concentration	Detection Frequency	95% UCL or 70th Percentile[a]	EPC	Background Value	RBGV	COPC?[b]
Benzoic acid	000065-85-0	3.90E+01	7.70E+02	12/90	3.60E+03[c]	7.70E+02	--	6.88E+07	No:2
Bis(2-ethylhexyl) phthalate	00117-81-7	4.80E+01	2.90E+03	44/106	4.43E+02	4.43E+02	--	1.72E+05	No:2
Butyl benzyl phthalate	000085-68-7	2.50E+01	6.70E+02	6/106	7.55E+02[c]	6.70E+02	--	3.44E+06	No:2
Carbazole	000086-74-8	1.90E+01	3.00E+02	4/66	3.90E+02[c]	3.00E+02	--	1.20E+05	No:2
Chrysene	000218-01-9	2.90E+01	4.00E+03	31/106	3.64E+02	3.64E+02	--	3.12E+05	No:2
Dibenz(a,h)anthracene	**000053-70-3**	**2.40E+01**	**1.00E+03**	**8/108**	**7.49E+02[c]**	**7.49E+02**	**--**	**3.12E+02**	**Yes**
Dibenzofuran	000132-64-9	4.00E+01	2.40E+02	4/106	**7.55E+02[c]**	2.40E+02	--	3.44E+04	No:2
Diethyl phthalate	000084-66-2	9.00E+00	1.10E+02	4/106	**7.55E+02[c]**	1.10E+02	--	1.38E+07	No:2
Dimethyl phthalate	000131-11-3	1.00E+02	1.10E+02	2/106	**7.65E+02[c]**	1.10E+02	--	2.13E+08	No:2
Di-n-butyl phthalate	000084-74-2	3.90E+01	6.70E+02	17/106	**7.45E+02[c]**	6.70E+02	--	1.72E+06	No:2
Di-n-octyl phthalate	000117-84-0	9.00E+00	3.00E+02	7/106	**7.65E+02[c]**	3.00E+02	--	8.52E+05	No:2
Fluoranthene	00206-44-0	6.00E+00	5.60E+03	34/108	4.97E+02	4.97E+02	--	6.51E+05	No:2
Fluorene	000086-73-7	6.40E+01	3.90E+02	4/108	7.59E+02[c]	3.90E+02	--	6.51E+05	No:2
Indeno(1,2,3-cd)pyrene	000193-39-5	4.60E+01	1.30E+03	19/108	7.19E+02[c]	7.19E+02	--	3.12E+03	No:2
N-Nitrosodi-n-propylamine	000621-64-7	5.10E+01	5.10E+01	1/106	7.70E+02[c]	5.10E+01	--	3.44E+02	No:2
N-Nitrosodiphenylamine	000086-30-6	6.60E+01	1.10E+02	2/106	7.55E+02[c]	1.10E+02	--	3.44E+05	No:2
Phenanthrene	**000085-01-8**	**2.70E+01**	**3.90E+03**	**30/108**	**3.72E+02**	**3.72E+02**	**--**	**--**	**Yes**
Phenol	000108-95-2	9.00E+01	1.20E+02	3/106	7.65E+02[c]	1.20E+02	--	5.16E+06	No:2
Phenol, 4-chloro-2-(phenylmethyl)	**120-32-1**	**1.10E+02**	**2.00E+02**	**4/19**	6.38E+02[c]	2.00E+02	**--**	**--**	**Yes**
Pyrene	00129-00-0	3.00E+00	6.10E+03	36/108	5.02E+02	5.02E+02	--	4.88E+05	No:2
Volatile Organic Compounds (ug/kg)									
1,1,1-Trichloroethane	000071-55-6	3.40E-01	2.10E+02	14/758	5.80E+00[c]	5.80E+00	--	6.84E+05	No:2
1,1,2-Trichloro-1,1,2-trifluoroethane	000076-13-1	7.40E-01	1.80E+01	17/608	5.70E+00[c]	5.70E+00	--	6.93E+06	No:2
1,1-Dichloroethane	000075-34-3	3.90E+00	5.20E+00	2/757	5.80E+00[c]	5.20E+00	--	1.93E+05	No:2
1,1-Dichloroethene	000075-34-3	1.00E+00	3.03E+04	73/864	5.80E+00[c]	5.80E+00	--	4.20E+04	No:2
1,2-Dibromo-3-chloropropane	000096-12-8	7.00E+00	7.00E+00	1/572	1.10E+01[c]	7.00E+00	--	7.28E+02	No:2
1,2-Dichlorobenzene	000095-50-1	3.90E-01	3.20E+01	23/679	5.80E+00[c]	5.80E+00	--	2.86E+05	No:2
1,2-Dichloroethane	000107-06-2	4.80E-01	1.50E+01	3/757	5.70E+00[c]	5.70E+00	--	3.45E+03	No:2
1,2-Dichloropropane	000078-87-5	4.80E-01	2.00E+00	5/757	5.80E+00[c]	2.00E+00	--	2.08E+03	No:2
1,3-Dichlorobenzene	000541-73-1	3.90E-01	1.70E+00	8/678	5.80E+00[c]	1.70E+00	--	5.16E+05	No:2
1,4-Dichlorobenzene	000106-46-7	4.30E-01	4.20E+00	12/678	5.80E+00[c]	4.20E+00	--	1.00E+05	No:2
2-Butanone	000078-93-3	2.00E+00	7.20E+01	30/754	2.20E+01[c]	2.20E+01	--	6.65E+06	No:2

Analyte	CAS Number	Minimum Concentration	Maximum Concentration	Detection Frequency	95% UCL or 70th Percentile[a]	EPC	Background Value	RBGV	COPC?[b]
2-Hexanone	000591-78-6	2.00E+00	1.70E+01	3/755	2.20E+01[c]	1.70E+01	--	--	No:3
4-Methyl-2-Pentanone	000108-10-1	1.00E+00	1.30E+02	10/755	2.20E+01[c]	2.20E+01	--	1.47E+06	No:2
Acetone	000067-64-1	2.00E+00	5.30E+02	140/755	2.20E+01[c]	2.20E+01	--	1.92E+07	No:2
Ammonia	**07664-41-7**	**1.40E+01**	**2.70E+01**	**2/13**	**2.00E+03[c]**	**2.70E+01**	**--**	**--**	**Yes**
Benzene	000071-43-2	4.60E-01	1.40E+03	78/872	5.80E+00[c]	5.80E+00	--	6.46E+03	No:2
Carbon disulfide	000075-15-0	4.00E-01	4.30E+01	83/755	5.80E+00[c]	5.80E+00	--	1.16E+05	No:2
Carbon tetrachloride	000056-23-5	1.00E+00	5.80E+02	32/866	5.80E+00[c]	5.80E+00	--	2.44E+03	No:2
Chlorobenzene	000108-90-7	1.60E+00	3.00E+00	3/757	5.80E+00[c]	3.00E+00	--	4.85E+04	No:2
Chloroform	**000067-66-3**	**1.60E-01**	**3.67E+03**	**211/866**	**3.13E+01**	**3.13E+01**	**--**	**2.56E+03**	**Yes**
Chloromethane	000074-87-3	6.90E-01	6.90E-01	1/757	1.10E+01[c]	6.90E-01	--	1.59E+04	No:2
cis-1,2-Dichloroethene	000156-59-2	4.30E-01	2.01E+05	157/672	5.80E+00[c]	5.80E+00	--	2.13E+05	No:2
Cyclohexane	000110-82-7	5.00E-01	6.40E-01	3/583	5.80E+00[c]	6.40E-01	--	--	No:3
Ethylbenzene	000100-41-4	2.80E-01	7.50E+03	83/871	5.80E+00[c]	5.80E+00	--	7.80E+04	No:2
Isopropylbenzene	000098-82-8	8.00E-01	8.00E-01	1/585	5.80E+00[c]	8.00E-01	--	5.28E+04	No:2
Methyl-Cyclohexane	000108-87-2	4.00E-01	1.40E+00	29/583	5.80E+00[c]	1.40E+00	--	--	No:3
Methylene chloride	00075-09-2	8.40E-01	2.90E+03	340/757	2.01E+01	2.01E+01	--	8.25E+04	No:2
m-Xylene	000108-38-3	1.70E+01	1.70E+01	1/18	5.80E+00[c]	5.80E+00	--	2.77E+05	No:2
Naphthalene	000091-20-3	2.00E+00	1.30E+02	5/114	5.80E+00[c]	5.80E+00	--	1.79E+04	No:2
o-Xylene	000095-47-6	7.00E+00	7.00E+00	1/18	5.80E+00[c]	5.80E+00	--	4.26E+07	No:2
Styrene	000100-42-5	1.60E-01	9.00E-01	7/757	5.80E+00[c]	9.00E-01	--	1.46E+06	No:2
Tetrachloroethene	**00127-18-4**	**3.50E-01**	**2.23E+04**	**327/864**	**1.92E+02**	**1.92E+02**	**--**	**3.66E+03**	**Yes**
Toluene	00108-88-3	2.20E-01	7.16E+04	577/870	6.40E+02	6.40E+02	--	2.00E+05	No:2
Total 1,2-Dichloroethene	000540-59-0	1.00E+00	1.80E+03	50/192	6.71E+01	6.71E+01	--	1.92E+05	No:2
Total Xylenes	001330-20-7	4.00E-01	2.40E+01	31/788	5.80E+00[c]	5.80E+00	--	6.42E+04	No:2
trans-1,2-Dichloroethene	000156-60-5	3.20E-01	2.00E+03	35/672	5.80E+00[c]	5.80E+00	--	4.26E+05	No:3
Trichloroethene	**00079-01-6**	**4.20E-01**	**1.43E+05**	**378/863**	**1.28E+03**	**1.28E+03**	**--**	**4.38E+02**	**Yes**
Trichlorofluoromethane	000075-69-4	2.90E-01	5.50E+00	35/590	5.80E+00[c]	5.50E+00	--	1.30E+05	No:2
Vinyl chloride	000075-01-4	2.00E+00	2.30E+03	33/866	5.80E+00[c]	5.80E+00	--	1.07E+03	No:3
Radionuclides (pCi/g)									
Actinium-227		1.50E-01	2.29E+00	52/3883	3.59E-01[c]	3.59E-01	1.10E-01	4.56E-01	No:3
Actinium-228	14331-83-0	1.90E-01	1.79E+00	408/500	6.46E-01	6.46E-01	--	2.17E-01	No:5
Americium-241		4.00E-02	5.42E-01	78/3978	8.81E-02[c]	8.81E-02	--	6.32E+00	No:2

Analyte	CAS Number	Minimum Concentration	Maximum Concentration	Detection Frequency	95% UCL or 70th Percentile[a]	EPC	Background Value	RBGV	COPC?[b]
Beryllium-7	013966-02-4	2.20E+00	2.20E+00	1/5	4.72E-01[c]	4.72E-01	--	4.61E+00	No:2
Bismuth-210M		4.79E-02	9.10E-01	6/3168	6.35E-02[c]	6.35E-02	--	8.97E-01	No:3
Bismuth-212	14913-49-6	3.80E-01	1.76E+00	58/58	1.21E+00	1.21E+00	--	1.11E+00	No:5
Bismuth-214	14733-03-3	2.33E-01	2.50E+00	506/511	8.21E-01	8.21E-01	1.20E+00	1.31E-01	No:1
Cesium-134	13967-70-9	5.30E-02	5.30E-02	1/1	--	5.30E-02	--	1.38E-01	No:2
Cesium-137+D		**1.00E-02**	**1.50E+00**	**307/3937**	**6.00E-02[c]**	**6.00E-02**	**4.20E-01**	**3.82E-01**	**Yes**
Cobalt-60		1.00E-02	8.85E-02	35/3937	7.80E-02[c]	7.80E-02	--	7.91E-02	No:3
Lead-210+D	14255-04-0	2.16E-01	5.69E+00	1568/3840	6.69E-01	6.69E-01	1.20E+00	6.25E-01	No:1
Lead-212	15092-94-1	1.12E-01	2.00E+00	156/505	6.61E-01	6.61E-01	1.50E+00	1.79E+00	No:1
Lead-214	15067-28-4	2.20E-01	3.20E+00	498/500	8.69E-01	8.69E-01	1.20E+00	1.00E+00	No:1
Neptunium-237+D	13994-20-2	4.70E-01	4.70E-01	1/1	--	4.70E-01	--	1.10E+00	No:2
Plutonium-238		**2.90E-03**	**5.39E+01**	**697/4304**	**8.40E+00[c]**	**8.40E+00**	**1.30E-01**	**6.12E+00**	**Yes**
Plutonium-239/240		7.85E-03	1.74E+00	104/639	6.95E-02[c]	6.95E-02	1.80E-01	6.01E+00	No:2
Potassium-40	13966-00-2	9.90E-01	3.94E+01	540/558	1.44E+01	1.44E+01	3.70E+01	1.18E+00	No:1
Protactinium-231+D		6.67E-01	1.91E+00	5/3168	1.93E+00[c]	1.91E+00	--	3.91E-01	No:3
Radium-224	13233-32-4	1.04E+00	2.30E+00	13/13	1.80E+00	1.80E+00	1.50E+00	3.24E+00	No:2
Radium-226+D	13982-63-3	1.19E-01	2.80E+00	3886/3942	8.72E-01	8.72E-01	2.00E+00	1.10E-01	No:1
Radium-228+D	**15262-20-1**	**2.90E-01**	**1.31E+00**	**9/9**	**7.58E-01**	**7.58E-01**	**--**	**1.67E-01**	**Yes**
Strontium-90+D		7.18E-02	5.78E+00	9/47	4.88E-01[c]	4.88E-01	7.20E-01	9.40E+00	No:2
Thallium-208	14913-50-9	7.20E-02	5.80E-01	440/443	2.55E-01	2.55E-01	--	5.59E-02	No:5
Thorium-227	15623-47-9	7.00E-02	2.29E+00	4/7	2.07E+00[c]	2.07E+00	--	2.14E+00	No:5
Thorium-228+D	14274-82-9(+D)	2.90E-02	2.10E+00	698/719	7.57E-01	7.57E-01	1.50E+00	1.19E-01	No:1
Thorium-230+D		**8.40E-02**	**2.71E+00**	**708/3957**	**7.53E+00[c]**	**2.71E+00**	**1.90E+00**	**9.26E-02**	**Yes**
Thorium-232+D	7440-29-1	3.70E-02	2.00E+01	3648/4280	4.90E-01	4.90E-01	1.40E+00	6.90E-02	No:1
Thorium-234	15065-10-8	1.16E+00	3.60E+00	37/38	2.12E+00	2.12E+00	--	1.76E+01	No:2
Tritium	10028-17-8	1.70E-02	5.00E+01	119/119	4.57E+00	4.57E+00	1.60E+00	7.58E+03[e]	No:2
Uranium-233/234	**U-233/234**	**1.89E-01**	**1.70E+00**	**525/527**	**7.16E-01**	**7.16E-01**	**--**	**4.82E-01**	**Yes**
Uranium-234	13966-29-5	2.79E-01	1.08E+00	73/78	6.82E-01	6.82E-01	1.10E+00	1.05E+01	No:1
Uranium-235+D		1.40E-02	1.60E-01	92/544	4.00E-01[c]	1.60E-01	1.10E-01	1.54E+00	No:2
Uranium-235/236		2.77E-02	1.50E-01	88/420	8.30E-02[c]	8.30E-02	1.10E-01	3.10E-01	No:2
Uranium-238+D	**7440-61-1(+D)**	**1.80E-01**	**2.21E+00**	**2791/3240**	**6.92E-01**	**6.92E-01**	**1.20E+00**	**4.13E+00**	**Yes[f]**

Notes:
a. Unless otherwise denoted, value listed represents 95% UCL
b. COPC analyte status definitions:
Yes –retained as a COPC
No:1 –not retained as a COPC due to background concentration > lower of the maximum detected concentration or 95% UCL concentration
No:2 –not retained as a COPC due to RBGV > maximum concentration
No:3 –not retained as a COPC due to ≤5% detected
No:4 –not retained as a COPC as it is considered an essential nutrient
No:5 –not retained as a COPC as it is part of the thorium-232, uranium-235, and uranium-238 natural decay series with a half-lives less than or equal to 6 months
c. Value represents 70th percentile
d. RBGV for chromium (III)
e. RBGV for tritium (particulate)
f. Although the 95% UCL is < background, uranium-238 was retained as a COPC as it is process-related.

Analyte	EPC	Percent of Nondetects	Distribution	Method
Aroclor-1248	0.96	50%	Non-parametric	97.5% KM (Chebyshev) UCL
Benzo(a)pyrene	0.295	26%	Gamma	95% KM (t) UCL
Plutonium-238	8.40	16%	NA	70th Percentile
Radium-228 + D	0.758	100%	Gamma	95% Approximate Gamma UCL
Th-230 + D	2.71	18%	NA	70th Percentile
Uranium-238 + D	0.692	86%	Non-parametric	95% KM (BCA) UCL

Table 2.2 – Identification of COPCs for the Site Worker Exposure Scenario (Surface Soil)

Analyte	CAS Number	Minimum Concentration	Maximum Concentration	Detection Frequency	95% UCL or 70th Percentile[a]	EPC	Background Value	RBGV	COPC?[b]
Inorganics (mg/kg)									
Aluminum	7429-90-5	1.10E+03	3.20E+04	30/30	1.25E+04	1.25E+04	1.90E+04	1.69E+05	No:1
Antimony	7440-36-0	1.00E+00	4.46E+01	14/30	1.97E+01	1.97E+01	--	8.18E+01	No:2
Arsenic	7440-38-2	1.60E+00	7.70E+00	32/36	4.48E+00	4.48E+00	8.60E+00	2.26E+00	No:1
Barium	7440-39-3	1.02E+01	1.10E+02	30/30	5.87E+01	5.87E+01	1.80E+02	1.25E+04	No:1
Beryllium	7440-41-7	1.10E-01	1.40E+00	27/30	8.90E-01	8.90E-01	1.30E+00	3.70E+02	No:1
Bismuth	07440-69-9	3.60E-01	6.91E+01	17/22	2.64E+01	2.64E+01	3.84E+01	--	No:1
Cadmium	7440-43-9	3.50E-01	9.30E+00	20/36	2.83E+00	2.83E+00	2.10E+00	1.01E+01	No:2
Calcium	7440-70-2	4.51E+04	3.45E+05	36/36	1.24E+05	1.24E+05	3.10E+05	--	No:1
Chromium	7440-47-3	2.70E+00	4.64E+01	36/36	2.48E+01	2.48E+01	2.00E+01	3.07E+05[d]	No:2
Cobalt	7440-48-4	1.00E+00	1.30E+01	36/36	8.52E+00	8.52E+00	1.90E+01	1.93E+03	No:1
Copper	7440-50-8	3.90E+00	4.46E+02	36/36	1.05E+02	1.05E+02	2.60E+01	8.18E+03	No:2
Iron	7439-89-6	3.31E+03	3.40E+04	36/36	1.79E+04	1.79E+04	3.50E+04	--	No:1
Lanthanum	**7439-91-0**	**3.40E+00**	**4.60E+00**	**1/2**	**--**	**4.60E+00**	**--**	**--**	**Yes**
Lead	7439-92-1	2.90E+00	9.61E+01	36/36	2.71E+01	2.71E+01	4.80E+01	--	No:1
Lithium	7439-93-2	1.70E+00	3.95E+01	16/22	1.65E+01	1.65E+01	2.60E+01	--	No:1
Magnesium	7439-95-4	1.44E+04	8.23E+04	36/36	3.84E+04	3.84E+04	4.00E+04	--	No:1
Manganese	7439-96-5	1.34E+02	6.36E+02	36/36	4.07E+02	4.07E+02	1.40E+03	3.25E+03	No:1
Mercury	7439-97-6	1.30E-01	1.20E+00	8/33	2.00E-01[c]	2.00E-01	1.50E-01	5.78E+04	No:2
Molybdenum	7439-98-7	9.00E-01	2.46E+01	12/16	1.27E+01	1.27E+01	2.72E+01	1.02E+03	No:1
Nickel	7440-02-0	3.20E+00	3.15E+01	36/36	2.10E+01	2.10E+01	3.20E+01	4.09E+03	No:1
Potassium	7440-09-7	5.03E+02	1.00E+04	32/32	4.44E+03	4.44E+03	1.90E+03	--	No:4
Selenium	07782-49-2	3.80E+01	5.50E+01	3/36	1.10E+00[c]	1.10E+00	5.90E-01	1.02E+03	No:2
Silver	7440-22-4	1.60E+00	2.15E+01	28/36	8.34E+00	8.34E+00	1.70E+00	1.02E+03	No:2
Sodium	7440-23-5	9.34E+01	1.55E+03	29/36	6.94E+02	6.94E+02	2.40E+02	--	No:4
Tantalum	**7440-25-7**	**3.28E+02**	**3.28E+02**	**1/1**	**--**	**3.28E+02**	**--**	**--**	**Yes**
Thallium	07440-28-0	4.30E-01	6.90E-01	2/33	1.64E+00[c]	6.90E-01	4.60E-01	1.35E+01	No:2
Tin	07440-31-5	1.60E+00	1.61E+01	8/16	6.73E+00	6.73E+00	2.09E+01	1.23E+05	No:1
Total Cyanide	00057-12-5	1.40E-01	3.10E-01	4/23	1.20E+00[c]	3.10E-01	--	4.09E+03	No:2

Analyte	CAS Number	Minimum Concentration	Maximum Concentration	Detection Frequency	95% UCL or 70th Percentile[a]	EPC	Background Value	RBGV	COPC?[b]
Vanadium	7440-62-2	4.80E+00	4.80E+01	36/36	2.36E+01	2.36E+01	2.50E+01	2.04E+02	No:1
Zinc	7440-66-6	9.40E+00	2.74E+02	36/36	1.39E+02	1.39E+02	1.40E+02	6.13E+04	No:1
Explosives (ug/kg)									
1,3-Dinitrobenzene	000099-65-0	2.00E+02	2.00E+02	1/27	1.50E+03[c]	2.00E+02	--	2.04E+04	No:2
1,3,5-Trinitrobenzene	000099-35-4	3.10E+02	3.10E+02	1/27	1.50E+03[c]	3.10E+02	--	6.13E+06	No:2
2,4-Dinitrotoluene	000121-14-2	2.00E+02	2.00E+02	1/64	7.20E+02[c]	2.00E+02	--	2.57E+03	No:2
HMX	002691-41-0	4.10E+02	6.60E+02	2/32	3.00E+03[c]	6.60E+02	--	1.02E+07	No:2
RDX	000121-82-4	7.10E+02	6.85E+03	4/32	2.50E+03[c]	2.50E+03	--	5.20E+04	No:2
Pesticides/PCBs (ug/kg)									
4,4'-DDD	000072-54-8	9.20E-01	2.80E+00	5/37	8.20E+00[c]	2.80E+00	4.30E+03	2.38E+04	No:1
4,4'-DDE	000072-55-9	2.40E-01	1.60E+00	9/37	3.80E+00[c]	1.60E+00	4.00E+03	1.68E+04	No:1
4,4'-DDT	000050-29-3	2.20E-01	2.10E+00	6/37	8.92E+00[c]	2.10E+00	1.30E+04	9.56E+03	No:1
Aldrin	000309-00-2	1.20E-01	2.50E+00	6/37	3.22E+00[c]	2.50E+00	--	1.03E+02	No:2
alpha-BHC	000319-84-6	2.10E-01	1.10E+01	9/37	2.40E+00[c]	2.40E+00	--	9.08E+02	No:2
alpha-Chlordane	005103-71-9	1.00E-01	4.80E+00	10/37	1.04E+01[c]	4.80E+00	--	7.64E+03	No:2
Aroclor-1242	053469-21-9	3.70E+01	1.00E+03	3/547	4.00E+01[c]	4.00E+01	--	--	No:3
Aroclor-1248	**12672-29-6**	7.10E+00	3.80E+04	**305/547**	**1.07E+03**	**1.07E+03**	**--**	**--**	**Yes**
Aroclor-1254	011097-69-1	4.24E+01	6.64E+01	5/222	5.62E+01[c]	5.62E+01	5.80E+04	6.83E+02	No:1
Aroclor-1260	011096-82-5	4.46E+01	9.90E+01	3/222	4.67E+01[c]	4.67E+01	--	--	No:3
Aroclor-1262	**037324-23-5**	**4.10E+00**	**1.30E+03**	**32/325**	4.00E+01[c]	**4.00E+01**	**--**	**--**	**Yes**
Aroclor-1268	011100-14-4	5.60E+01	1.80E+02	5/325	3.90E+01[c]	3.90E+01	--	--	No:3
delta-BHC	000319-86-8	1.90E-01	1.90E-01	1/37	6.70E+00[c]	1.90E-01	--	--	No:3
Dieldrin	000060-57-1	9.20E-02	6.40E+00	9/37	3.82E+00[c]	3.82E+00	--	3.58E+02	No:2
Endosulfan II	**033213-65-9**	**2.00E-01**	**3.50E+00**	**3/37**	**4.94E+00[c]**	**3.50E+00**	**--**	**--**	**Yes**
Endosulfan sulfate	**001031-07-8**	**1.30E-01**	**2.00E+00**	**4/37**	**1.78E+01[c]**	**2.00E+00**	**--**	**--**	**Yes**
Endrin	000072-20-8	1.50E-01	1.60E+00	3/37	5.34E+00[c]	1.60E+00	--	6.13E+04	No:2
Endrin aldehyde	**007421-93-4**	**7.10E-01**	**4.70E+00**	**8/34**	**1.67E+01[c]**	**4.70E+00**	**--**	**--**	**Yes**
Endrin ketone	**053494-70-5**	**1.50E-01**	**2.00E+00**	**5/37**	**1.78E+01[c]**	**2.00E+00**	**--**	**--**	**Yes**
gamma-BHC (Lindane)	000058-89-9	3.30E-02	3.30E-02	1/37	3.54E+00[c]	3.30E-02	--	4.40E+03	No:2
gamma-Chlordane	005103-74-2	2.90E-01	3.50E+00	7/37	1.04E+01[c]	3.50E+00	--	7.64E+03	No:2
Heptachlor	000076-44-8	3.60E-02	2.80E-01	2/37	2.68E+00[c]	2.80E-01	--	1.27E+03	No:2
Heptachlor epoxide	001024-57-3	1.00E-01	4.10E-01	4/37	8.92E+00[c]	4.10E-01	--	6.29E+02	No:2

Analyte	CAS Number	Minimum Concentration	Maximum Concentration	Detection Frequency	95% UCL or 70th Percentile[a]	EPC	Background Value	RBGV	COPC?[b]
Methoxychlor	00072-43-5	3.10E-01	1.80E+01	5/37	8.93E+01[c]	1.80E+01	3.00E+04	1.02E+06	No:1
Semi-Volatile Organic Compounds (ug/kg)									
1,2,4-Trichlorobenzene	000120-82-1	3.00E-01	2.20E+00	17/604	5.70E+00[c]	2.20E+00	--	6.23E+05	No:2
2-Methylnaphthalene	000091-57-6	1.70E+02	1.90E+02	2/39	7.62E+02[c]	1.90E+02	--	8.18E+05	No:2
4-Methylphenol	000106-44-5	2.60E+02	2.60E+02	1/37	7.72E+02[c]	2.60E+02	--	1.02E+06	No:2
Acenaphthene	000083-32-9	2.10E+01	1.30E+03	8/39	7.62E+02[c]	7.62E+02	--	3.09E+06	No:2
Anthracene	000120-12-7	5.20E+01	8.00E+02	9/39	7.46E+02[c]	7.46E+02	--	1.55E+07	No:2
Benz(a)anthracene	**000056-55-3**	**5.30E+01**	**2.50E+03**	**20/39**	**5.88E+02**	**5.88E+02**	**--**	**1.98E+03**	**Yes**
Benzo(a)pyrene	**000050-32-8**	**3.10E+01**	**2.30E+03**	**24/39**	**5.34E+02**	**5.34E+02**	**--**	**1.98E+02**	**Yes**
Benzo(b)fluoranthene	**000205-99-2**	**4.70E+01**	**4.90E+03**	**20/39**	**9.82E+02**	**9.82E+02**	**--**	**1.98E+03**	**Yes**
Benzo(g,h,i)Perylene	**000191-24-2**	**1.00E+02**	**1.10E+03**	**14/39**	**3.38E+02**	**3.38E+02**	**--**	**--**	**Yes**
Benzo(k)fluoranthene	000207-08-9	3.70E+01	4.50E+03	15/39	9.33E+02	9.33E+02	--	1.98E+04	No:2
Benzoic acid	000065-85-0	8.20E+01	7.70E+02	7/34	3.51E+03[c]	7.70E+02	--	2.49E+08	No:2
Bis(2-ethylhexyl) phthalate	00117-81-7	6.90E+01	2.90E+03	19/37	7.40E+02	7.40E+02	--	1.25E+05	No:2
Butyl benzyl phthalate	000085-68-7	8.30E+01	6.70E+02	4/37	7.54E+02[c]	6.70E+02	--	1.25E+07	No:2
Carbazole	000086-74-8	1.90E+01	3.00E+02	4/22	7.05E+02[c]	3.00E+02	--	8.72E+04	No:2
Chrysene	000218-01-9	2.90E+01	4.00E+03	23/37	6.85E+02	6.85E+02	--	1.98E+05	No:2
Dibenz(a,h)anthracene	**000053-70-3**	**2.40E+01**	**1.00E+03**	**7/39**	**7.62E+02[c]**	**7.62E+02**	**--**	**1.98E+02**	**Yes**
Dibenzofuran	000132-64-9	4.00E+01	2.40E+02	4/37	7.54E+02[c]	2.40E+02	--	1.25E+05	No:2
Diethyl phthalate	000084-66-2	8.30E+01	1.10E+02	2/37	7.54E+02[c]	1.10E+02	--	4.99E+07	No:2
Dimethyl phthalate	000131-11-3	1.10E+02	1.10E+02	1/37	7.72E+02[c]	1.10E+02	--	2.04E+09	No:2
Di-n-butyl phthalate	000084-74-2	8.80E+01	6.70E+02	7/37	7.42E+02[c]	6.70E+02	--	6.23E+06	No:2
Di-n-octyl phthalate	000117-84-0	2.40E+01	1.80E+02	4/37	7.72E+02[c]	1.80E+02	--	8.18E+06	No:2
Fluoranthene	00206-44-0	5.50E+01	5.60E+03	25/39	1.14E+03	1.14E+03	--	2.06E+06	No:2
Fluorene	000086-73-7	6.40E+01	3.90E+02	4/39	7.62E+02[c]	3.90E+02	--	2.06E+06	No:2
Indeno(1,2,3-cd)pyrene	000193-39-5	4.60E+01	1.30E+03	17/39	3.56E+02	3.56E+02	--	1.98E+03	No:2
Phenanthrene	**000085-01-8**	**5.30E+01**	**3.90E+03**	**22/39**	**1.25E+03**	**1.25E+03**	**--**	**--**	**Yes**
PHENOL, 4-CHLORO-2-(PHENYLMETHYL	**120-32-1**	**1.10E+02**	**2.00E+02**	**4/14**	**6.76E+02[c]**	**2.00E+02**	**--**	**--**	**Yes**
Pyrene	00129-00-0	3.80E+01	6.10E+03	26/39	1.08E+03	1.08E+03	--	1.55E+06	No:2
Volatile Organic Compounds (ug/kg)									
1,1,1-Trichloroethane	000071-55-6	3.40E-01	2.10E+02	14/621	5.70E+00[c]	5.70E+00	--	5.72E+07	No:2
1,1,2-Trichloro-1,1,2-trifluoroethane	000076-13-1	7.40E-01	1.80E+01	16/597	5.70E+00[c]	5.70E+00	--	6.13E+09	No:2

Analyte	CAS Number	Minimum Concentration	Maximum Concentration	Detection Frequency	95% UCL or 70th Percentile[a]	EPC	Background Value	RBGV	COPC?[b]
1,1-Dichloroethane	000075-34-3	3.90E+00	5.20E+00	2/621	5.70E+00[c]	5.20E+00	--	2.04E+07	No:2
1,1-Dichloroethene	000075-34-3	1.90E+00	4.20E+00	2/621	5.70E+00[c]	4.20E+00	--	1.02E+07	No:2
1,2-Dibromo-3-chloropropane	000096-12-8	7.00E+00	7.00E+00	1/567	1.10E+01[c]	7.00E+00	--	4.09E+03	No:2
1,2-Dichlorobenzene	000095-50-1	3.90E-01	3.20E+01	23/605	5.70E+00[c]	5.70E+00	--	2.92E+00	No:3
1,2-Dichloroethane	000107-06-2	4.80E-01	1.50E+01	3/621	5.70E+00[c]	5.70E+00	--	6.29E+04	No:2
1,2-Dichloropropane	000078-87-5	4.80E-01	9.50E-01	4/621	4.73E+01[c]	9.50E-01	--	8.42E+04	No:2
1,3-Dichlorobenzene	000541-73-1	3.90E-01	1.70E+00	8/604	5.70E+00[c]	1.70E+00	--	1.87E+06	No:2
1,4-Dichlorobenzene	000106-46-7	4.30E-01	4.20E+00	12/604	5.70E+00[c]	4.20E+00	--	6.50E-02	No:3
2-Butanone	000078-93-3	2.00E+00	3.80E+01	11/620	2.30E+01[c]	2.30E+01	--	1.23E+08	No:2
4-Methyl-2-Pentanone	000108-10-1	1.00E+00	1.30E+02	3/620	2.30E+01[c]	2.30E+01	--	1.64E+07	No:2
Acetone	000067-64-1	4.40E+00	5.30E+02	123/620	2.30E+01[c]	2.30E+01	--	1.84E+08	No:2
Ammonia	**07664-41-7**	**2.70E+01**	**2.70E+01**	**1/1**	**--**	**2.70E+01**	**--**	**--**	**Yes**
Benzene	000071-43-2	4.60E-01	2.20E+01	12/653	5.70E+00[c]	5.70E+00	--	1.04E+05	No:2
Carbon Disulfide	000075-15-0	4.00E-01	4.30E+01	65/620	5.70E+00[c]	5.70E+00	--	2.04E+07	No:2
Chlorobenzene	000108-90-7	1.60E+00	1.60E+00	1/621	5.70E+00[c]	1.60E+00	--	4.09E+06	No:2
Chloroform	000067-66-3	1.60E-01	1.90E+03	105/621	5.70E+00[c]	5.70E+00	--	2.04E+06	No:2
Chloromethane	000074-87-3	6.90E-01	6.90E-01	1/621	1.10E+01[c]	6.90E-01	--	--	No:3
cis-1,2-Dichloroethene	000156-59-2	4.30E-01	1.50E+04	75/584	5.70E+00[c]	5.70E+00	--	2.04E+06	No:2
Cyclohexane	000110-82-7	5.00E-01	6.40E-01	3/583	1.10E+01[c]	6.40E-01	--	--	No:3
Ethylbenzene	000100-41-4	2.80E-01	5.00E+00	14/653	5.70E+00[c]	5.00E+00	--	2.04E+07	No:2
Isopropylbenzene	000098-82-8	8.00E-01	8.00E-01	1/580	5.70E+00[c]	8.00E-01	--	2.04E+07	No:2
methyl-Cyclohexane	000108-87-2	4.00E-01	1.40E+00	29/583	1.10E+01[c]	1.40E+00	--	--	No:3
Methylene chloride	00075-09-2	8.40E-01	2.90E+03	326/621	2.16E+01	2.16E+01	--	7.63E+05	No:2
m-Xylene	000108-38-3	1.70E+01	1.70E+01	1/17	6.00E+00[c]	6.00E+00	--	4.09E+08	No:2
Naphthalene	**000091-20-3**	**2.00E+00**	**1.30E+02**	**3/40**	**--**	**1.30E+02**	**--**	**4.38E-02**	**Yes**
o-Xylene	000095-47-6	7.00E+00	7.00E+00	1/17	6.00E+00[c]	6.00E+00	--	4.09E+08	No:2
Styrene	000100-42-5	1.60E-01	6.00E-01	3/621	5.70E+00[c]	6.00E-01	9.40E+00	4.09E+07	No:1
Tetrachloroethene	**00127-18-4**	**3.50E-01**	**1.20E+04**	**175/621**	**1.25E+02**	**1.25E+02**	**--**	**1.06E+04**	**Yes**
Toluene	00108-88-3	2.20E-01	3.00E+03	467/653	6.10E+01	6.10E+01	--	4.09E+07	No:2
Total Xylenes	001330-20-7	8.30E-01	2.40E+01	15/653	1.10E+01[c]	1.10E+01	--	4.09E+07	No:2
trans-1,2-Dichloroethene	000156-60-5	3.20E-01	4.60E+02	13/584	5.70E+00[c]	5.70E+00	--	4.09E+06	No:2
Trichloroethene	**00079-01-6**	**4.20E-01**	**5.30E+04**	**221/621**	**5.88E+02**	**5.88E+02**	**--**	**1.43E+04**	**Yes**

Analyte	CAS Number	Minimum Concentration	Maximum Concentration	Detection Frequency	95% UCL or 70th Percentile[a]	EPC	Background Value	RBGV	COPC?[b]
Trichlorofluoromethane	000075-69-4	2.90E-01	5.50E+00	35/584	5.70E+00[c]	5.50E+00	--	6.13E+07	No:2
Vinyl chloride	000075-01-4	3.20E+00	8.70E+00	2/621	5.70E+00[c]	5.70E+00	--	3.82E+03	No:2
Radionuclides (pCi/g)									
Actinium-227+D		1.50E-01	2.29E+00	32/2530	3.63E-01[c]	3.63E-01	1.10E-01	5.02E-01	No:3
Actinium-228	14331-83-0	1.90E-01	1.79E+00	383/470	6.46E-01	6.46E-01	--	2.01E-01	No:5
Americium-241		4.00E-02	5.42E-01	61/2583	9.00E-02[c]	9.00E-02	--	9.93E+00	No:2
Beryllium-7	013966-02-4	2.20E+00	2.20E+00	1/5	4.72E-01[c]	4.72E-01	--	4.28E+00	No:2
Bismuth-210M		4.85E-02	9.10E-01	4/2242	6.38E-02[c]	6.38E-02	--	8.67E-01	No:3
Bismuth-212	14913-49-6	3.80E-01	1.76E+00	56/56	1.21E+00	1.21E+00	--	1.03E+00	No:5
Bismuth-214	14733-03-3	2.33E-01	2.50E+00	472/476	8.03E-01	8.03E-01	1.20E+00	1.22E-01	No:1
Cesium-134	13967-70-9	5.30E-02	5.30E-02	1/1	--	5.30E-02	--	1.28E-01	No:2
Cesium-137+D		**1.20E-02**	**1.50E+00**	**211/2552**	**6.15E-02[c]**	**6.15E-02**	**4.20E-01**	**3.56E-01**	**Yes**
Cobalt-60		1.00E-02	8.85E-02	17/2551	7.80E-02[c]	7.80E-02	--	7.35E-02	No:3
Lead-210+D	14255-04-0	2.16E-01	5.69E+00	1004/2533	6.65E-01	6.65E-01	1.20E+00	1.19E+00	No:1
Lead-212	15092-94-1	1.12E-01	2.00E+00	474/474	6.64E-01	6.64E-01	1.50E+00	1.73E+00	No:1
Lead-214	15067-28-4	2.20E-01	3.20E+00	465/467	8.49E-01	8.49E-01	1.20E+00	9.29E-01	No:1
Neptunium-237+D	13994-20-2	4.70E-01	4.70E-01	1/1	--	4.70E-01	--	1.08E+00	No:2
Plutonium-238		**2.90E-03**	**5.39E+01**	**590/2719**	**7.95E+00[c]**	**7.95E+00**	**1.30E-01**	**1.13E+01**	**Yes**
Plutonium-239/240		8.60E-03	1.74E+00	85/540	6.92E-02[c]	6.92E-02	1.80E-01	1.11E+01	No:2
Potassium-40	13966-00-2	9.90E-01	3.94E+01	484/489	1.49E+01	1.49E+01	3.70E+01	1.12E+00	No:1
Protactinium-231+D		6.67E-01	1.91E+00	4/2243	1.90E+00[c]	1.90E+00	--	4.41E-01	No:3
Radium-224	13233-32-4	1.04E+00	2.30E+00	13/13	1.80E+00	1.80E+00	1.50E+00	5.47E+00	No:2
Radium-226+D	13982-63-3	1.19E-01	2.72E+00	2525/2552	8.11E-01	8.11E-01	2.00E+00	1.05E-01	No:1
Radium-228+D	**15262-20-1**	**2.90E-01**	**1.31E+00**	**9/9**	**7.58E-01**	**7.58E-01**	**--**	**1.76E-01**	**Yes**
Strontium-90+D		7.18E-02	6.27E-01	5/13	4.32E-01[c]	4.32E-01	7.20E-01	1.50E+01	No:1
Thallium-208	14913-50-9	7.20E-02	5.80E-01	415/418	2.55E-01	2.55E-01	--	5.18E-02	No:5
Thorium-227	15623-47-9	7.00E-02	2.29E+00	4/7	3.44E-01[c]	3.44E-01	--	2.17E+00	No:5
Thorium-228+D	14274-82-9(+D)	2.90E-02	2.10E+00	612/622	7.72E-01	7.72E-01	1.50E+00	1.14E-01	No:1
Thorium-230+D		**8.40E-02**	**2.71E+00**	**616/2560**	**7.29E+00[c]**	**2.71E+00**	**1.90E+00**	**9.58E-02**	**Yes**
Thorium-232+D	7440-29-1	3.70E-02	4.82E+00	2408/2703	5.22E-01	5.22E-01	1.40E+00	6.88E-02	No:1
Thorium-234	15065-10-8	1.16E+00	3.60E+00	34/35	2.08E+00	2.08E+00	--	2.58E+01	No:2

Analyte	CAS Number	Minimum Concentration	Maximum Concentration	Detection Frequency	95% UCL or 70th Percentile[a]	EPC	Background Value	RBGV	COPC?[b]
Tritium	10028-17-8	1.02E-01	8.68E-01	8/14	5.73E-01	5.73E-01	1.60E+00	1.45E+04[e]	No:1
Uranium-233/234	**U-233/234**	**1.89E-01**	**1.70E+00**	**495/497**	**7.14E-01**	**7.14E-01**	**--**	**5.52E-01**	**Yes**
Uranium-234	13966-29-5	3.10E-01	9.40E-01	30/30	7.01E-01	7.01E-01	1.10E+00	1.97E+01	No:1
Uranium-235+D		1.40E-02	1.30E-01	85/498	1.30E-01[c]	1.30E-01	1.10E-01	1.55E+00	No:2
Uranium-235/236		3.40E-02	1.50E-01	72/358	9.28E-02[c]	9.28E-02	--	3.32E-01	No:2
Uranium-238+D	**7440-61-1(+D)**	**1.80E-01**	**2.21E+00**	**2019/2271**	**7.07E-01**	**7.07E-01**	**1.20E+00**	**5.22E+00**	**Yes[f]**

Notes:
a. Unless otherwise denote, value listed represents 95% UCL
b. COPC analyte status definitions:
Yes –retained as a COPC
No:1 –not retained as a COPC due to background concentration > lower of the maximum detected concentration or 95% UCL concentration
No:2 –not retained as a COPC due to RBGV > maximum concentration
No:3 –not retained as a COPC due to ≤5% detected
No:4 –not retained as a COPC as it is considered an essential nutrient
No:5 –not retained as a COPC as it is part of the thorium-232, uranium-235, and uranium-238 natural decay series with a half-lives less than or equal to 6 months
c. Value represents 70th percentile
d. RBGV for chromium (III)
e. RBGV for tritium (particulate)
f. Although the 95% UCL is < background, uranium-238 was retained as a COPC as it is process-related.

Analyte	EPC	Percent of Nondetects	Distribution	Method
Aroclor-1248	1.065	56%	Non-parametric	97.5% KM (Chebyshev) UCL
Benzo(a)pyrene	534	62%	Gamma	95% KM (BCA) UCL
Plutonium-238	7.95	22%	NA	70th Percentile
Radium-228 + D	0.758	100%	Gamma	95% Approximate Gamma UCL
Th-230 + D	2.71	23%	NA	70th Percentile
Uranium-238 + D	0.707	89%	Non-parametric	95% KM (BCA) UCL

3.0 EXPOSURE ASSESSMENT

The RRE exposure assessment goal is to approximate the type and magnitude of exposures to COPCs for each exposure scenario under current conditions and reasonably anticipated future conditions. These results are combined with toxicity information presented in Section 4.0, to characterize potential risks associated with exposure to residual contamination at Parcel 9.

3.1 Characterization of Exposure Setting

Parcel 9 consists of approximately 23.2 acres and includes parts of the plant site developed as part of original plant construction. A brief discussion of the histories of the buildings and PRSs located in Parcel 9 follows. More detailed information on Parcel 9 buildings and PRSs can be found in Appendices D and A, respectively.

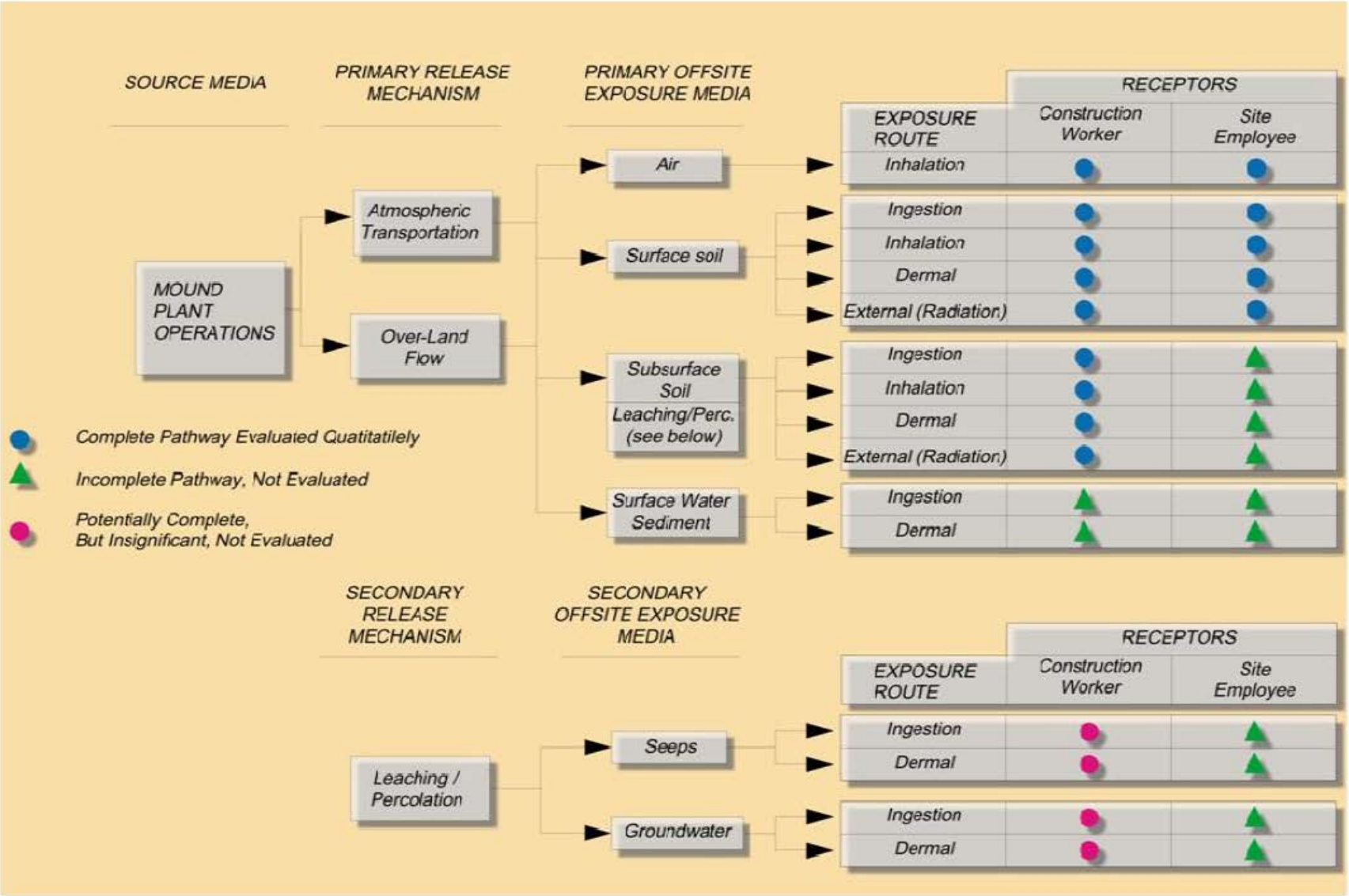
At the time of transfer, there will be no buildings or trailers in the parcel. Twenty sites of former buildings are included in the parcel. Details of current and historic buildings are provided in Appendix D. Included in the activities that once took place in Parcel 9 are development and production of energetic materials, process and blend explosives, drinking water treatment, pump house activities for fuel oil and brine water, deep water wells, air sparging/soil vapor extraction, pump and treat systems activities using an air stripper for VOCs, and storage of drums, solvents and explosives. The northern section of Parcel 9 was used to stage radioactively contaminated soils for offsite shipment via the railcars which were loaded at the site rail spur. A settling pond, sanitary waste landfill, and buried radiological waste trenches were located in the southern section of Parcel 9.

3.2 Identifying Exposure Pathways

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, inhalation, or dermal contact). If any of these elements is missing or eliminated, the pathway is considered incomplete and exposure cannot occur.

A pictorial representation of the exposure pathways identified for potential receptors is included in the Conceptual Site Model (CSM) for the Parcel 9 RRE (Figure 3.1). The CSM summarizes the pathways that residual contamination may take to reach potential receptors. Exposure assumptions used to evaluate potential exposure pathways were drawn from the Mound Plant Risk-Based Guideline Values guidance (DOE 1997b) and the RREM (DOE 1997a). Exposure assumptions used to quantify COPC exposures for the construction worker and site worker scenarios are summarized in Table 3.1.

Figure 3.1 – Conceptual Site Model for the Parcel 9 RRE



3.3 Identifying Exposure Scenarios

Residual contamination in Parcel 9 was evaluated for two potential use scenarios: construction workers and site workers. It was assumed that construction workers would routinely be exposed to surface and subsurface soil and that site workers would be exposed to surface soil. The evaluation of risk associated with exposure to residual contamination at Parcel 9 for both receptors is intended to assess whether commercial/industrial redevelopment can be safety conducted in the area.

3.3.1 Construction Worker Scenario

As the intended future land use is commercial, it is likely that construction activities will occur to place improvements at Parcel 9. During construction activities, workers could be exposed to residual contamination in surface and subsurface soil. As outlined in the Mound 2000 RREM, construction workers were assumed to be adult workers weighing 70 kg, working 8 hours per day, 250 days per year over a 5-year exposure period (DOE 1997a). These exposure factors were used to evaluate both carcinogenic and noncarcinogenic effects from exposure to residual levels of Parcel 9 contaminants.

Construction workers were not expected to have regular contact with surface water or groundwater. Regular contact with both surface soil (0–2 ft bgs) and subsurface soil (>2 ft bgs) was assumed to occur through the following exposure routes:

- incidental ingestion of soil,
- inhalation of fugitive dust and volatile emissions from soil,
- dermal contact with soil, and
- external exposure to ionizing radiation.

Additional exposure parameters used to evaluate these pathways and their references are listed in Table 3.1.

3.3.2 Site Worker Scenario

Although exposure to residual contamination for site workers will vary depending on the type of work performed (e.g., groundkeeper vs. office worker), it is reasonable to assume that exposure may occur under normal work conditions. Site workers are not expected to involve direct work with site soils. Exposure routes evaluated for the site worker are the same as those evaluated for the construction worker except that the site worker is assumed to perform the majority of his or her work indoors and therefore have less direct contact with site soils. Site workers were assumed to be adult workers weighing 70 kg, working 8 hours per day, 250 days per year over a 25-year exposure period (DOE 1997a). These exposure factors were used to evaluate potential carcinogenic and noncarcinogenic effects from contact with residual Parcel 9 contaminant concentrations.

Site workers were not expected to have regular contact with surface water, groundwater, or subsurface soil (>2 ft bgs). Regular contact with surface soil (0–2 ft bgs) was assumed to ensure the assessment is protective. The following exposure routes were examined for the assessment:

- incidental ingestion of soil,
- inhalation of fugitive dust and volatile emissions from soil,
- dermal contact with soil, and
- external exposure to ionizing radiation.

Additional exposure parameters used to evaluate these pathways and their references are listed in Table 3.1.

3.4 Exposure Point Concentrations

Exposure point concentrations (EPCs) are the concentrations of contaminants available to human receptors at the point of contact. The EPCs for soil data used in the RRE were calculated as outlined in Section 2.3 and include either 95% UCL estimates of the mean, 70th percentiles of the data set, or maximum concentrations for individual constituents. Surface soil data (0–2 ft bgs) were used to calculate EPCs for the site worker, as site workers are expected to perform the majority of their work indoors and, thus, have limited contact with soil and little to no contact with subsurface soil. Construction workers were assumed to be exposed to both surface (0–2 ft bgs) and subsurface (>2 ft bgs) soil as part of their job duties. As a result, EPCs for the construction worker incorporate both surface and subsurface soil concentrations.

In accordance with USEPA guidance for assessing dioxin/furans and polycyclic or Polynuclear Aromatic Hydrocarbons (PAHs), EPCs for these two groups of chemicals were developed using toxicity equivalence factors (TEFs). TEFs are applied to groups of chemicals that exhibit similar toxicological properties but differ in their degree of toxicity (USEPA 2010b). The USEPA National Center for Environmental Assessment (NCEA) has assigned TEFs to seven PAHs relative to benzo(a)pyrene (USEPA 1993), and the World Health Organization (WHO) updated dioxin and furan TEFs in 2005 relative to 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) (Van den Berg et al. 2006). These TEFs were used in the calculation of EPCs for these groups of chemicals by multiplying each individual chemical's EPC by its applicable TEF and then summing the concentrations to obtain a single weighted concentration for benzo(a)pyrene or 2,3,7,8-TCDD. Although some individual PAHs and dioxins/furans did not meet the screening criteria to be included as COPCs, they were included in the calculation of weighted benzo(a)pyrene and 2,3,7,8-TCDD EPCs in order to conservatively estimate potential exposure to these two groups of carcinogenic compounds.

3.5 Human Intake Equations and Assumptions

The exposure assumptions presented in the previous section were used with the intake equations presented in this section. This approach is in accordance with RAGS Part A (USEPA

1989) and the Mound 2000 RREM (DOE 1997a). Human intake assumptions for each exposure scenario were developed to represent RME conditions.

A fundamental difference exists in the measurement of exposures from chemical constituents (inorganic and organic) versus radiological constituents. Exposure to chemicals generally refers to the mass intake of each COPC through each exposure route (ingestion, inhalation, or dermal contact), expressed in units of milligrams per kilogram of body weight, per day (mg/kg-day). Radionuclide intake is typically expressed in units of activity (usually in picocuries [pCi]) rather than in mass. In addition, dose has a different meaning for radionuclides than for chemicals since adverse health effects may result from exposure to ionizing radiation. For radionuclides, dose is equal to the energy imparted to a unit mass of human tissue.

Ingestion, inhalation, and dermal contact intakes were expressed as the amount of chemical at the exchange boundary (e.g., intestines, lungs, or skin) that is available for absorption. These intakes are not equivalent to the absorbed dose, which is the amount of chemical actually absorbed into the blood stream. Dermal doses are expressed as estimates of absorbed doses. Toxicity values used to calculate risk have been adjusted to account for this difference; however, this discrepancy is a source of uncertainty when comparing or combining dermal doses with intakes from other exposure routes. Assessment of dermal risks was performed using the methodologies presented in the *Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment* (hereafter referred to as RAGS Part E) (USEPA 2004).

The approach used to estimate intake for chemicals largely applies to radionuclides. However, there are a few key differences in the methods. For example, ingestion and inhalation were assessed for both chemicals and radionuclides, but dermal contact was only considered for chemicals, and external radiation was only considered for radionuclides. Equations for estimating the intake of radionuclides were modified by omitting the body weight and averaging time from the denominator. This approach is in keeping with standard USEPA practice (USEPA 1989), and it is performed because radiation exposure assessments do not end with the calculation of intake, but use dose conversion factors to estimate dose equivalents to specified organs.

Exposure to soil through incidental ingestion was evaluated for both the construction worker and site worker exposure scenarios. Intakes for the chemical constituents through the incidental ingestion pathway were calculated using the following equation:

$$\text{Intake}\left(\frac{\text{mg}}{\text{kg}\cdot\text{day}}\right) = \frac{C \times IR \times FI \times EF \times ED \times CF}{BW \times AT} \qquad (1)$$

Where:

C	=	chemical concentration in soil (EPC) (mg/kg)
IR	=	ingestion rate (mg/day)
FI	=	fraction ingested from contaminated source (1.0; unitless)
EF	=	exposure frequency (days/yr)

ED	=	exposure duration (years)
CF	=	conversion factor (10^{-6} kg/mg)
BW	=	body weight (kg)
AT	=	averaging time (days).

Radionuclide intake for the incidental ingestion pathway was calculated using the following equation:

$$\text{Intake (pCi)} = C \times IR \times FI \times EF \times ED \times CF \tag{2}$$

Where:

C	=	radiological activity in soil (EPC) (pCi/g)
IR	=	ingestion rate (mg/day)
FI	=	fraction ingested from contaminated source (1.0; unitless)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (years)
CF	=	conversion factor (10^{-3} g/mg).

Dermal exposure to soil was assumed to occur simultaneously with incidental ingestion exposure and was evaluated for both the construction worker and site worker exposure scenarios for those chemicals with dermal absorption values available. The dermal pathway was not assessed for VOCs or inorganic compounds in accordance with RAGS Part E (USEPA 2004). VOCs are not assessed, as these compounds would volatilize from soil on skin and should be accounted for through the inhalation pathway; inorganic compounds are not assessed (with the exception of arsenic and cadmium) as there are not enough data to extrapolate reasonable default values (USEPA 2004). Chemical intakes for the soil pathway via dermal exposure were calculated using the following equations:

$$\text{Intake}\left(\frac{\text{mg}}{\text{kg-day}}\right) = \frac{DA_{event} \times EF \times ED \times EV \times SA}{BW \times AT} \tag{3}$$

Where:

DA_{event}	=	chemical-specific absorbed dose per event (mg/cm^2-event) (see below)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (years)
EV	=	event frequency (events/day)
SA	=	skin surface area (cm^2)
BW	=	body weight (kg)
AT	=	averaging time (days).

$$DA_{event}\left(\frac{mg}{cm^2\text{-event}}\right) = C \times CF \times AF \times ABS_d \quad (4)$$

Where:

C	=	chemical concentration in soil (EPC) (mg/kg)
CF	=	conversion factor (10^{-6} kg/mg)
AF	=	adherence factor of soil to skin (mg/kg)
ABS_d	=	dermal absorption factor (unitless).

Unlike the other exposure routes, the external radiation exposure term is defined as a radionuclide concentration in soil that a receptor could be exposed to for a specific exposure duration. External radiation was evaluated for both the construction worker and site worker scenarios. The exposure term is adjusted for exposure time and shielding. Default shielding factors of 10% and 20% were assumed for the construction worker and site worker scenarios, respectively. A higher shielding factor was assumed for the site worker to account for shielding provided by working indoors. These factors provide for a conservative estimate of external radiation exposure. Exposure to external radiation from radionuclides in soil was calculated using the following equation:

$$\text{Intake}\left(\frac{pCi\text{-}yr}{g}\right) = C \times ED \times T_e \times (1 - S_e) \quad (5)$$

Where:

C	=	radionuclide activity in soil (EPC) (pCi/g)
ED	=	exposure duration (years)
T_e	=	gamma exposure time factor (unitless)
S_e	=	gamma shielding factor (unitless).

Inhalation of fugitive dust and vapors emitted from soil was evaluated for the construction worker and site worker. Vapor inhalation is only applicable to VOCs. The remaining chemical COPCs were assessed via the fugitive dust pathway only. Intake of chemicals through inhalation was calculated using the following equation:

$$\text{Intake}\left(\frac{mg}{kg\text{-}day}\right) = \frac{C \times \left(\frac{1}{VF} + \frac{1}{PEF}\right) \times IR_{air} \times ET \times EF \times ED}{BW \times AT} \quad (6)$$

Where:

C	=	chemical concentration in soil (EPC) (mg/kg)
VF	=	soil-to-air volatilization factor (m^3/kg)
PEF	=	particulate emission factor (m^3/kg)
IR_{air}	=	inhalation rate (m^3/hr)
ET	=	exposure time (hrs/day)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (years)

BW = body weight (kg)
AT = averaging time (days).

Radium-226 is the only radionuclide COPC identified at Parcel 9 that is volatile enough that its vapor was considered for inhalation. The remaining radionuclide COPCs were assessed via the fugitive dust pathway only. The intake equation for radionuclides via inhalation of fugitive dust and vapor (if applicable) was estimated using the following equation:

$$Intake\ (pCi) = C \times \left(\frac{1}{VF} + \frac{1}{PEF}\right) \times CF \times ET \times EF \times ED \times IR_{air} \quad (7)$$

Where:

C = radiological activity in soil (EPC) (pCi/g)
VF = soil-to-air volatilization factor (m^3/kg)
PEF = particulate emission factor (m^3/kg)
CF = conversion factor (1,000 g/kg)
ET = exposure time (hrs/day)
EF = exposure frequency (days/yr)
ED = exposure duration (years)
IR_{air} = inhalation rate (m^3/hr).

The particulate emission factor (PEF) relates the concentration of the constituent in soil to the concentration of respirable particles in the air from fugitive dust emissions resulting from wind erosion. The USEPA's *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* default value of 1.36 x 10^9 m^3/kg was used to represent a surface with unlimited erosion potential (USEPA 2002).

Table 3.1 Exposure Assumptions for the Parcel 9 RRE

Variable	Definition	Units	Construction Worker[a]	Site Worker[b]	Reference[c]
Incidental ingestion of soil					
C	COPC concentration in soil	mg/kg	chemical-specific	chemical-specific	
		pCi/g	radionuclide-specific	radionuclide-specific	
IR	Daily soil ingestion rate	mg/d	480	50	1
FI	Fraction ingested	unitless	1.0	1.0	3
EF	Exposure frequency	d/yr	250	250	2
ED	Exposure duration	yr	5	25	1, 2
BW	Body weight	kg	70	70	3
AT	Averaging time (carcinogens)	days	25550	25550	3
	Averaging time (non-carcinogens)	days	1825	9125	3
CF	Conversion factor (chemicals)	kg/mg	1.00E-06	1.00E-06	
	Conversion factor (radionuclides)	g/mg	1.00E-03	1.00E-03	
Dermal exposure to soil					
DA_{event}	Chemical-specific absorbed dose per event	mg/cm2-event	calculated	calculated	

Variable	Definition	Units	Construction Worker[a]	Site Worker[b]	Reference[c]
EF	Exposure frequency	d/yr	250	250	2
ED	Exposure duration	yr	5	25	1, 2
EV	Event frequency	events/d	1	1	4
SA	Skin surface area	cm^2	5700	5700	4
BW	Body weight	kg	70	70	3
AT	Averaging time (carcinogens)	days	25550	25550	3
	Averaging time (non-carcinogens)	days	1825	9125	3
C	COPC concentration in soil	mg/kg	chemical-specific	chemical-specific	
CF	Conversion factor	kg/mg	1.00E-06	1.00E-06	
AF	Adherence factor of soil to skin	mg/cm^2	0.2	0.2	4
ABS_d	Dermal absorption factor	unitless	chemical-specific	chemical-specific	4
Inhalation of vapors and fugitive dust					
C	COPC concentration in soil	mg/kg	chemical-specific	chemical-specific	
		pCi/g	radionuclide-specific	radionuclide-specific	
VF	Soil-to-air volatilization factor	m^3/kg	chemical- and radionuclide-specific	chemical- and radionuclide-specific	2
PEF	Particulate emission factor	m^3/kg	1.36E+09	1.36E+09	2
IR_{air}	Daily inhalation rate	m^3/hr	0.83	0.83	3
ET	Exposure time	hr/day	8	8	1
EF	Exposure frequency	d/yr	250	250	2
ED	Exposure duration	yr	5	25	1, 2
BW	Body weight	kg	70	70	3
AT	Averaging time (carcinogens)	days	25550	25550	3
	Averaging time (non-carcinogens)	days	1825	9125	3
CF	Conversion factor (radionuclides)	g/kg	1.00E+03	1.00E+03	
External exposure from soil					
C	COPC concentration in soil	pCi/g	radionuclide-specific	radionuclide-specific	
S_e	Gamma shielding factor	unitless	0.1	0.2	5
T_e	Gamma exposure time factor	unitless	0.33	0.08	5
ED	Exposure duration	yr	5	25	1, 2
EF	Exposure frequency	d/yr	250	250	2

Notes:
a. Construction worker scenario applies to surface and subsurface soil (all depths).
b. Site worker scenario applies to surface soil (0–2 ft bgs).
c. References:

1 USEPA Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Supplemental Guidance, "Standard Default Exposure Factors" (USEPA 1991b)
2 USEPA Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (USEPA 2002)
3 USEPA Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Part A (USEPA 1989)
4 USEPA Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Part E (USEPA 2004)
5 Mound 2000 Residual Risk Evaluation Methodology (DOE 1997a).

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 at Parcel 9. The Parcel 9 RRE evaluated exposures using methods recommended in the Mound 2000 RREM (DOE 1997a) and USEPA RAGS guidance (USEPA 1989, 1991b, and 2004) for evaluating human cancer and non-cancer health effects resulting from exposure to residual contamination.

Toxicity criteria used in the Parcel 9 RRE were obtained from the most current update of the USEPA's Integrated Risk Information System (IRIS). IRIS is an electronic database containing the most current descriptive and quantitative USEPA regulatory information related to carcinogenic and non-carcinogenic health effects of chemical compounds (USEPA 2010c). If information was not available in IRIS, the USEPA's Office of Research and Development provisional peer-reviewed toxicity values (PPRTVs) (USEPA 2010d) were consulted. Because the PPRTV database is no longer publically accessible, these values were accessed using DOE's Risk Assessment Information System (RAIS) (http://rais.ornl.gov/) (DOE 2010). In addition, the USEPA's Health Effects Assessment Summary Tables (HEAST) (USEPA 2001) and OEPA's Chemical Information Database and Applicable Regulatory Standards (CIDARS) database (http://www.epa.ohio.gov/derr/rules/guidance.aspx) (OEPA 2010) were also used to determine toxicity values. RAIS was last updated in October 2010 and the CIDARS database was last updated in August 2010. Toxicological reference values for trichloroethylene are based on California EPA values as accepted by OEPA (OEPA 2010). Table 4.1 presents a summary of toxicological criteria used along with the chemical-specific characteristics used to estimate residual risk.

In assessing the potential for non-cancer health effects, USEPA assumes a threshold exists below which no adverse toxic effects are expected. For example, a toxic threshold would exist if a substance had no toxic effect at a low level of exposure but did have a toxic effect at a higher level. USEPA derives and publishes reference dose factors (RfDs) and reference concentration factors (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 subpopulations, that may go without appreciable harmful effects during a lifetime (USEPA 1989). USEPA derives RfDs and RfCs for humans based on estimates of the no-observable-adverse-effect-level (NOAEL) or the lowest-observable-adverse-effect-level (LOAEL) in test organisms.

Carcinogenesis, however, is without a threshold for effect (USEPA 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. Therefore, USEPA does not estimate an effect threshold (i.e., LOAEL or NOAEL) 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 is calculated. The slope factor is a plausible upper-bound estimate of the slope of the dose-response curve in the low dose range. In risk assessment, the slope factor is used to estimate the excess lifetime cancer risk (ELCR) of a carcinogenic effect occurring in exposed receptor populations.

4.1 Toxicity Values for Evaluating the Dermal Pathway

Toxicological reference values are generally only available 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. The effects of the dermal pathway cannot be quantified where a dermal absorption factor is not available. Because the intake equation for the dermal contact pathway calculates absorbed dose by incorporating a dermal absorption factor, it is necessary to convert the administered dose toxicity value to an absorbed dose toxicity value in order to calculate dermal risk. For the Parcel 9 RRE, oral toxicity values were adjusted using COPC-specific gastrointestinal absorption factors when those factors were less than 0.5 (USEPA 2004). In accordance with RAGS Part E, for non-carcinogens, the oral administered dose toxicity value (oral RfD) was multiplied by the gastrointestinal absorption factor; for carcinogens, the oral slope factor was divided by the gastrointestinal absorption factor (2004). Exhibits 3-4 and 4-1 in RAGS Part E list the dermal absorption values and gastrointestinal adjustment factors, respectively, used in this assessment (2004).

Table 4.1 Toxicity Values and Chemical Specific Parameters

Chemical	Non-Cancer					Cancer							Dermal Exposure Parameters		
	Oral		Dermal	Inhalation		Oral		Dermal	Inhalation		External Radiation		% Absorbed		Dermal Absorption Fraction
	RfD_o (mg/kg/day)	Ref.[a]	Adjusted RfD_d[b] (mg/kg/day)	RfD_i[c] (mg/kg/day)	Ref.[a]	SF_o $(mg/kg/day)^{-1}$	Ref.[a]	SF_d[d] $(mg/kg/day)^{-1}$	SF_i[e] $(mg/kg/day)^{-1}$	Ref.[a]	SF_e (risk/y per pCi/g)	Ref.[a]	ABS_{GI} (unitless)	Ref.[a]	D_{ABS}
Inorganic Chemicals															
Antimony	4.00E-04	1	6.00E-05	NA		NA		NA	NA		NA		0.15	7	NA
Bismuth	NA		NA	NA		NA		NA	NA		NA		1	7	NA
Cadmium	1.00E-03	1	2.50E-05	2.86E-06	5	NA		NA	6.30E+00	1	NA		0.025	7	0.001
Gadolinium	NA		NA	NA		NA		NA	NA		NA		1	7	NA
Lanthanum	NA		NA	NA		NA		NA	NA		NA		1	7	NA
Praseodymium	NA		NA	NA		NA		NA	NA		NA		1	7	NA
Samarium	NA		NA	NA		NA		NA	NA		NA		1	7	NA
Tantalum	NA		NA	NA		NA		NA	NA		NA		1	7	NA
Dioxins															
2,3,7,8-TCDD	1.00E-09	5	1.00E-09	1.14E-08	6	1.30E+05	6	1.30E+05	1.33E+05	6	NA		1	7	0.03
Pesticides and PCBs															
Endrin aldehyde	NA		NA	NA		NA		NA	NA		NA		1	7	0.1
Endrin ketone	NA		NA	NA		NA		NA	NA		NA		1	7	0.1
Endosulfan II	NA		NA	NA		NA		NA	NA		NA		1	7	0.1
Endosulfan Sulfate	NA		NA	NA		NA		NA	NA		NA		1	7	0.1
Aroclor – 1248[f]	2.00E-05	1	2.00E-05	NA		2.00E+00	1	2.00E+00	2.00E+00	6	NA		1	7	0.14
Aroclor – 1262[f]	2.00E-05	1	2.00E-05	NA		2.00E+00	1	2.00E+00	2.00E+00	6	NA		1	7	0.14
SVOCs															
Benzo(a)pyrene	NA		NA	NA		7.30E+00	1	7.30E+00	3.85E+00	6	NA		1	7	0.13
Benzo(g,h,i)Perylene	NA		NA	NA		NA		NA	NA		NA		NA		0.1
Phenanthrene	NA		NA	NA		NA		NA	NA		NA		NA		0.1
4-Chloro-2-phenylmethyl phenol	NA		NA	NA		NA		NA	NA		NA		NA		0.1
VOCs															
Ammonia	3.00E+01	2	3.00E+01	2.86E-02	1	NA		NA	NA		NA		1	7	NA
Chloroform	1.00E-02	1	1.00E-02	2.79E-02	5	3.10E-02	6	3.10E-02	8.05E-02	1	NA		1	7	NA
Naphthalene	2.00E-02	1	2.00E-02	8.57E-04	1	NA		NA	1.19E-01	6	NA		1	7	NA
Tetrachloroethene (PCE)	1.00E-02	1	1.00E-02	7.74E-02	5	5.40E-01	6	5.40E-01	2.07E-02	6	NA		1	7	NA
Trichloroethene (TCE)	5.00E-01	3	5.00E-01	1.71E-01	3	1.30E-02	3	1.30E-02	7.00E-03	3	NA		1	7	NA
Radionuclides															
Cesium-137+D	NA		NA	NA		4.33E-11	2	NA	1.19E-11	2	2.54E-06	2	1	7	NA
Plutonium-238	NA		NA	NA		2.72E-10	2	NA	3.36E-08	2	7.22E-11	2	0.0005	7	NA
Radium-228+D	NA		NA	NA		2.29E-09	2	NA	5.23E-09	2	4.53E-06	2	0.2	7	NA
Thorium-230+D	NA		NA	NA		2.02E-10	2	NA	2.85E-08	2	8.19E-10	2	0.0005	7	NA
Uranium 233/234	NA		NA	NA		1.60E-10	2	NA	1.16E-08	2	9.82E-10	2	0.02	7	NA
Uranium-238+D	NA		NA	NA		2.10E-10	2	NA	9.35E-09	2	1.14E-07	2	0.02	7	NA

ABS = dermal absorption factor
NA = not available or not applicable
SF = slope factor

Notes:

a. References:

1 USEPA IRIS database (USEPA 2010c)
2 USEPA HEAST (USEPA 2001)
3 OEPA CIDARS (OEPA 2010)
4 USEPA PPRTVs (USEPA 2010d)
5 ATSDR (ATSDR 2009)
6 California EPA (CalEPA 2010)
7 USEPA RAGS Part E (USEPA 2004)

b. Dermal RfD = RfD_o * ABS_{GI}
c. Inhalation RfD = (RfC * 20 m^3/day) / 70 kg
d. Dermal SF = SF_o / ABS_{GI}
e. Inhalation SF = (UR * 70 kg * 1000 µg/mg) / 20 m^3day
f. Toxicity values for PCBs (high risk) used since none available for Aroclor-1248 and -1262.

5.0 RISK CHARACTERIZATION

The objective of risk characterization is to determine if exposure to COPCs could result in adverse health effects when receptors are exposed over an extended period. USEPA risk characterization integrates the exposure and toxicity assessments by taking estimates of intake or dose and applying individual chemical/radiochemical toxicity values. This process provides quantitative probabilities which are used to evaluate the potential for adverse effects to exposed populations.

5.1 Risk Characterization Methodology

The Parcel 9 RRE quantifies total, background, and incremental risk for each COPC evaluated for each exposure scenario. Total risk for each exposure scenario was calculated using the verification data acquired from Parcel 9; EPCs for the residual levels are identified in Tables 2.1 and 2.2 for each COPC retained for quantitative risk assessment. Background risk was calculated based on the 95% UTL for each constituent with determined background levels; these were acquired from the Mound background data set (or the maximum value if no 95% UTL was available) (DOE 1994) and accounts for the risk resulting from naturally occurring levels of constituents or from anthropogenic sources other than those being measured in Parcel 9. Background risks are presented in Tables 5.2 and 5.5. Incremental risk is the difference between total and background risk levels and has been used in this report to assess the increase in risk above background levels. Incremental risk for each exposure scenario is presented in Tables 5.3 and 5.6 and provides the definitive measure when considering if residual levels found at Parcel 9 may pose risks or hazards to potential receptors.

The Parcel 9 risk characterization also presents a separate evaluation of non-carcinogenic and carcinogenic effects. The assessment distinguishes cancer from non-cancer effects because receptors respond differently following exposure to carcinogenic or non-carcinogenic agents. Quantification methods for cancer and non-cancer effects are discussed in the following sections.

5.1.1 Quantification of Carcinogenic Risk

Cancer risks are expressed as the probability that a receptor will develop cancer over a lifetime of exposure to individual chemicals or multiple chemicals (e.g., 1 in 1,000,000). Cancer risks are expressed in terms of excess lifetime cancer risk (ELCR) and are computed for individual COPCs and for all COPCs. The procedure used for computing Parcel 9 carcinogenic risks is in keeping with RAGS Part A (USEPA 1989). Carcinogenic slope factors for each exposure pathway were identified as outlined in Section 4.0 of this document. To derive an estimate of risk, each slope factor was multiplied by the estimated chronic daily intake (CDI) of the exposed individual:

$$\text{Risk} = CDI \times SF \tag{8}$$

Where:

Risk	=	a unitless probability of an individual developing cancer from exposure to a COPC
CDI	=	chronic daily intake averaged over 70 years (mg/kg-day)
SF	=	cancer slope factor (95% upper-bound estimate of the slope of the dose-response curve) $(mg/kg\text{-}day)^{-1}$.

To evaluate the risk of simultaneous exposure to multiple COPCs with carcinogenic effects, the risk estimates for each COPC were summed to provide an overall estimate of total carcinogenic risk (USEPA 1989):

$$ELCR = \sum_{i=1}^{n} Risk_i \tag{9}$$

Where:

ELCR	=	combined excess lifetime cancer risk from simultaneous exposure to all carcinogenic COPCs
$Risk_i$	=	risk estimate for the ith chemical of n COPCs under evaluation.

As previously discussed, USEPA has established a target risk range of 10^{-6} to 10^{-4}, and OEPA has adopted a cumulative ELCR goal of 10^{-5} for all receptors and land uses (OEPA 2009). The OEPA ELCR goal is intended to be used as the level of acceptable excess cancer risk, while recognizing the need to retain flexibility during evaluation of future actions.

5.1.2 Quantification of Non-Carcinogenic Risk

Non-carcinogenic risk is a measure of the likelihood that a receptor may develop non-cancer health effects (e.g., kidney disease), due to long-term exposure to a given chemical or groups of chemicals. The USEPA standard practice for evaluating exposure to non-carcinogenic compounds includes experimental determinations of a no-observable-adverse-effect-level (NOAEL) which are then applied to receptor through pre-established intake rates, to establish an acceptable human dose (i.e., an acceptable daily intake or reference dose [RfD]). The RfD is then compared to the daily intake of the exposed population to obtain a measure of concern for adverse non-carcinogenic effects:

$$HQ = \frac{CDI}{RfD} \tag{10}$$

Where:

HQ	=	hazard quotient representing potential for adverse non-carcinogenic effects from exposure to a COPC (unitless)

CDI	=	chronic daily intake averaged over an established period (mg/kg body weight per day)
RfD	=	reference dose (acceptable daily intake for chronic exposure) (mg/kg body weight per day).

To evaluate simultaneous exposure to multiple COPCs with non-carcinogenic effects, the HQs for each COPC were summed to obtain the hazard index (HI).

$$HI = \sum_{i=1}^{n} HQ_i \tag{11}$$

Where:

HI	=	hazard index representing potential for adverse non-carcinogenic effects from exposure to all non-carcinogenic COPCs
HQ_i	=	hazard quotient for the ith chemical of n COPCs under evaluation.

For non-carcinogenic effects, USEPA and OEPA have set the target HI of 1 (OEPA 2009). If the HI is greater than 1, there is the potential for adverse health effects at site-specific exposure concentrations. In cases where the HQ for individual substances is less than 1 but multiple 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 various adverse health effects. In cases where individual HQs exceed 1, this step is not necessary.

5.2 Risk Characterization Results

Risk and hazard estimates for individual soil COPCs for all scenarios and pathways are presented in Tables 5.1 through 5.6. Tables 5.1 through 5.3 present risk and hazard estimates for the construction worker, and Tables 5.4 through 5.6 present risk and hazard estimates for the site worker. Background risks were calculated using background levels for those constituents identified as COPCs during the screening process, and incremental risks were calculated by determining the differences between total and background risks. Incremental risk provides a site-specific measure of the increased risk above background levels due to measured concentrations of constituents in Parcel 9.

5.2.1 Construction Worker Risk Results

Tables 5.1 through 5.3 present total residual, background, and incremental risk for the construction worker scenario, respectively. Inorganic COPCs included antimony, gadolinium, lanthanum, praseodymium, samarium, and tantalum. Organic COPCs included 2,3,7,8-TCDD, ammonia, Aroclor-1248, Aroclor-1262, benzo(a)pyrene, benzo(g,h,i)perylene, chloroform, endrin aldehyde, phenanthrene, 4-chloro-2-phenylmethylphenol, tetrachloroethene (PCE), and trichloroethene (TCE). Radionuclide COPCs included cesium-137+D, plutonium-238, radium-228+D, thorium-230+D, uranium-233/234, and uranium-238+D.

The principal carcinogenic risk driver for the Parcel 9 construction worker is radium-228, responsible for 47% of the total risk, and the primary exposure route is through external exposure. Benzo(a)pyrene also contributes 29% of the total risk. In evaluating incremental risks for the construction worker scenario, the computed total risks using verification sample data from Parcel 9 were compared with the risks resulting from site-specific background concentrations. The computed total residual risk of 1.3×10^{-5} falls within the USEPA's acceptable risk range of 1×10^{-4} to 1×10^{-6}, but exceeds the OEPA target risk goal of 1×10^{-5}. The background comparison reveals the incremental carcinogenic risk for the construction worker is equal to the total residual risk.

The total residual hazard due to soil exposure for the construction worker is 0.49 and is below the USEPA and OEPA target hazard goal of 1. The primary driver for the hazard index is incidental ingestion of polychlorinated biphenyls (PCBs), specifically Aroclor-1248 (62% of the total HI). The incremental hazard level for the construction worker scenario is 0.49, as there are no background concentrations for the organic chemicals identified as COPCs.

5.2.2 Site Worker Risk Results

Tables 5.4 through 5.6 present total residual, background, and incremental risk for the site worker scenario, respectively. Inorganic COPCs included lanthanum and tantalum. Organic COPCs included ammonia, Aroclor-1248, Aroclor-1262, benzo(a)pyrene, benzo(g,h,i)perylene, 4-chloro-2-phenylmethol phenol, endrin aldehyde, endrin ketone, endosulfan II, endosulfan sulfate, naphthalene, phenanthrene, PCE, and TCE. Radionuclide COPCs included cesium-137+D, plutonium-238, radium-228+D, thorium-230+D, uranium-233/234, and uranium-238+D. The principal carcinogenic risk driver for the Parcel 9 site worker is benzo(a)pyrene with the primary exposure route through dermal absorption, which accounts for 45% of the total risk. Radium-228 is also responsible for 36% of the total risk. In evaluating incremental risks for the site worker scenario, the computed total residual risks using Parcel 9 verification sample data were compared with the risks resulting from site-specific background concentrations. The computed residual risk of 1.7×10^{-5} falls within the USEPA's acceptable risk range of 1×10^{-4} to 1×10^{-6}, but exceeds the OEPA target risk goal of 1×10^{-5}. The background comparison reveals the incremental carcinogenic risk of 1.6×10^{-5} for the site worker is nearly equal to the total residual risk.

The total residual hazard due to soil exposure for the site worker is 0.039, which is below the USEPA and OEPA target hazard goal of 1. The primary driver for the hazard index is incidental ingestion of PCBs, specifically Aroclor-1248 (76% of the total HI).

5.2.3 Overall Summary of Risk Results

Overall total residual, background, and incremental cancer risks and non-cancer hazards are presented in Tables 5.1 through 5.6. The values in the tables are the sum of all the media and applicable pathways for the construction worker and site worker. The carcinogenic risks for both receptors exceeded the OEPA target risk goal of 1×10^{-5} for carcinogenic risks but fell within the USEPA's acceptable risk range of 1×10^{-4} to 1×10^{-6}. The hazard index for both scenarios was below the USEPA and OEPA target hazard goal of 1.0.

Table 5.1 Total Risk from Soil Exposure for a Construction Worker in Parcel 9

COPC	EPC	Cancer Effects					Non-Cancer Effects			
		Route-Specific Risk				Chemical ELCR[a]	Route-Specific HQs			Chemical HI[b]
		Ingestion	Dermal	Inhalation (Dust + VOCs)	External Exposure		Ingestion	Dermal	Inhalation (Dust + VOCs)	
Inorganic Chemicals (mg/kg)										
Antimony	1.2E+01	NA	NA	NA	NA	NA	1.5E-01	NA	NA	1.5E-01
Gadolinium	9.0E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lanthanum	6.0E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA
Praseodymium	7.4E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA
Samarium	1.9E+01	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tantalum	2.9E+02	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dioxins and Dibenzofurans (mg/kg)										
2,3,7,8-TCDD[c]	5.1E-06	2.2E-07	1.6E-08	2.3E-12	NA	2.4E-07	2.4E-02	1.7E-03	2.1E-08	2.6E-02
Pesticides and PCBs (mg/kg)										
Endrin aldehyde	4.7E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1248	9.6E-01	6.4E-07	2.1E-07	6.6E-12	NA	8.6E-07	2.3E-01	7.5E-02	NA	3.0E-01
Aroclor-1262	4.0E-02	2.7E-08	8.9E-09	2.7E-13	NA	3.6E-08	9.4E-03	3.1E-03	NA	1.3E-02
SVOCs (mg/kg)										
Benzo(a)pyrene[d]	1.2E+00	2.9E-06	9.1E-07	1.6E-11	NA	3.9E-06	NA	NA	NA	NA
Benzo(g,h,i)perylene	7.2E-01	NA	NA	NA	NA	0.0E+00	NA	NA	NA	NA
Phenanthrene	3.7E-01	NA	NA	NA	NA	0.0E+00	NA	NA	NA	NA
4-Chloro-2-phenylmethylphenol	2.0E-01	NA	NA	NA	NA	0.0E+00	NA	NA	NA	NA
VOCs (mg/kg)										
Ammonia	2.7E-02	NA	NA	NA	NA	NA	4.2E-09	NA	4.5E-11	4.3E-09
Chloroform	3.1E-02	3.3E-10	NA	4.3E-09	NA	4.6E-09	1.5E-05	NA	2.5E-05	4.0E-05
Tetrachloroethene	1.9E-01	3.5E-08	NA	5.8E-09	NA	4.1E-08	9.0E-05	NA	5.1E-05	1.4E-04
Trichloroethene	1.3E+00	5.6E-09	NA	1.6E-08	NA	2.2E-08	1.2E-05	NA	1.9E-04	2.0E-04
Radionuclides (pCi/g)										
Cesium-137+D	6.0E-02	1.6E-09	NA	4.4E-15	4.8E-11	1.6E-09	NA	NA	NA	0.0E+00
Plutonium-238	8.4E+00	1.4E-06	NA	1.7E-09	9.1E-10	1.4E-06	NA	NA	NA	0.0E+00
Radium-228+D	7.6E-01	1.0E-06	NA	2.4E-11	5.2E-06	6.2E-06	NA	NA	NA	0.0E+00
Thorium-230+D	2.7E+00	3.3E-07	NA	4.7E-10	3.3E-09	3.3E-07	NA	NA	NA	0.0E+00

COPC	EPC	Cancer Effects					Non-Cancer Effects			
		Route-Specific Risk				Chemical ELCR[a]	Route-Specific HQs			Chemical HI[b]
		Ingestion	Dermal	Inhalation (Dust + VOCs)	External Exposure		Ingestion	Dermal	Inhalation (Dust + VOCs)	
Uranium-233/234	7.2E-01	6.9E-08	NA	5.1E-11	1.1E-09	7.0E-08	NA	NA	NA	0.0E+00
Uranium-238+D	6.9E-01	8.7E-08	NA	4.0E-11	1.2E-07	2.1E-07	NA	NA	NA	0.0E+00
Cumulative Values:		6.8E-06	1.1E-06	2.8E-08	5.3E-06	**1.3E-05**	4.1E-01	8.0E-02	2.6E-04	**4.9E-01**
% Contribution:		51%	9%	0%	40%		84%	16%	0%	

NA = risk or hazard not calculated due to absence of toxicity data.

Notes:

a. Chemical ELCR is total risk summed across all four routes of exposure.

b. Chemical HI is total hazard summed across all three routes of exposure; external exposure not included in hazard calculations as it only applies to carcinogenic radionuclides.

c. 2,3,7,8-TCDD risks calculated with a weighted 2,3,7,8-TCDD EPC using 2005 WHO TEFs for dioxins and dioxin-like compounds (Van den Berg et al. 2006).

d. Benzo(a)pyrene risks calculated with a weighted benzo(a)pyrene EPC using NCEA TEFs for the following PAHs: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene (USEPA 1993).

Table 5.2 Background Risk from Soil Exposure for a Construction Worker in Parcel 9

COPC	EPC	Cancer Effects					Non-Cancer Effects			
		Route-Specific Risk				Chemical ELCR[a]	Route-Specific HQs			Chemical HI[b]
		Ingestion	Dermal	Inhalation (Dust + VOCs)	External Exposure		Ingestion	Dermal	Inhalation (Dust + VOCs)	
Inorganic Chemicals (mg/kg)										
Antimony	0.0E+00	NA	NA	NA	NA	NA	0.0E+00	NA	NA	0.0E+00
Gadolinium	0.0E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lanthanum	0.0E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA
Praseodymium	0.0E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA
Samarium	0.0E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tantalum	0.0E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dioxins and Dibenzofurans (mg/kg)										
2,3,7,8-TCDD[c]	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Pesticides and PCBs (mg/kg)										
Endrin aldehyde	0.0E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1248	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	NA	0.0E+00
Aroclor-1262	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	NA	0.0E+00
SVOCs (mg/kg)										
Benzo(a)pyrene[d]	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	0.0E+00	NA	NA	NA	NA
Benzo(g,h,i)perylene	0.0E+00	NA	NA	NA	NA	0.0E+00	NA	NA	NA	NA
Phenanthrene	0.0E+00	NA	NA	NA	NA	0.0E+00	NA	NA	NA	NA
4-Chloro-2-phenylmethylphenol	0.0E+00	NA	NA	NA	NA	0.0E+00	NA	NA	NA	NA
VOCs (mg/kg)										
Ammonia	0.0E+00	NA	NA	NA	NA	NA	0.0E+00	NA	0.0E+00	0.0E+00
Chloroform	0.0E+00	0.0E+00	NA	0.0E+00	NA	0.0E+00	0.0E+00	NA	0.0E+00	0.0E+00
Tetrachloroethene	0.0E+00	0.0E+00	NA	0.0E+00	NA	0.0E+00	0.0E+00	NA	0.0E+00	0.0E+00
Trichloroethene	0.0E+00	0.0E+00	NA	0.0E+00	NA	0.0E+00	0.0E+00	NA	0.0E+00	0.0E+00
Radionuclides (pCi/g)										
Cesium-137+D	4.2E-01	1.1E-08	NA	3.1E-14	3.4E-10	1.1E-08	NA	NA	NA	0.0E+00
Plutonium-238	1.3E-01	2.1E-08	NA	2.7E-11	1.4E-11	2.1E-08	NA	NA	NA	0.0E+00
Radium-228+D	0.0E+00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	NA	NA	NA	0.0E+00
Thorium-230+D	1.9E+00	2.3E-07	NA	3.3E-10	2.3E-09	2.3E-07	NA	NA	NA	0.0E+00

COPC	EPC	Cancer Effects					Non-Cancer Effects			
		Route-Specific Risk				Chemical ELCR[a]	Route-Specific HQs			Chemical HI[b]
		Ingestion	Dermal	Inhalation (Dust + VOCs)	External Exposure		Ingestion	Dermal	Inhalation (Dust + VOCs)	
Uranium-233/234	1.1E+00	1.1E-07	NA	7.8E-11	1.6E-09	1.1E-07	NA	NA	NA	0.0E+00
Uranium-238+D	1.2E+00	1.5E-07	NA	6.9E-11	2.1E-07	3.6E-07	NA	NA	NA	0.0E+00
Cumulative Values:		5.2E-07	0.0E+00	5.1E-10	2.1E-07	**7.3E-07**	0.0E+00	0.0E+00	0.0E+00	**0.0E+00**
% Contribution:		71%	0%	0%	29%		0%	0%	0%	

NA = risk or hazard not calculated due to absence of toxicity data.

Notes:

a. Chemical ELCR is total risk summed across all four routes of exposure.

b. Chemical HI is total hazard summed across all three routes of exposure; external exposure not included in hazard calculations as it only applies to carcinogenic radionuclides.

c. 2,3,7,8-TCDD risks calculated with a weighted 2,3,7,8-TCDD EPC using 2005 WHO TEFs for dioxins and dioxin-like compounds (Van den Berg et al. 2006).

d. Benzo(a)pyrene risks calculated with a weighted benzo(a)pyrene EPC using NCEA TEFs for the following PAHs: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene (USEPA 1993).

Table 5.3 Incremental Risk from Soil Exposure for a Construction Worker in Parcel 9

COPC	Cancer Effects					Non-Cancer Effects			
	Route-Specific Risk				Chemical ELCR[a]	Route-Specific HQs			Chemical HI[b]
	Ingestion	Dermal	Inhalation (Dust + VOCs)	External Exposure		Ingestion	Dermal	Inhalation (Dust + VOCs)	
Inorganic Chemicals (mg/kg)									
Antimony	NA	NA	NA	NA	NA	1.5E-01	NA	NA	1.5E-01
Gadolinium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lanthanum	NA	NA	NA	NA	NA	NA	NA	NA	NA
Praseodymium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Samarium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tantalum	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dioxins and Dibenzofurans (mg/kg)									
2,3,7,8-TCDD[c]	2.2E-07	1.6E-08	2.3E-12	NA	2.4E-07	2.4E-02	1.7E-03	2.1E-08	2.6E-02
Pesticides and PCBs (mg/kg)									
Endrin aldehyde	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1248	6.4E-07	2.1E-07	6.6E-12	NA	8.6E-07	2.3E-01	7.5E-02	NA	3.0E-01
Aroclor-1262	2.7E-08	8.9E-09	2.7E-13	NA	3.6E-08	9.4E-03	3.1E-03	NA	1.3E-02
SVOCs (mg/kg)									
Benzo(a)pyrene[d]	2.9E-06	9.1E-07	1.6E-11	NA	3.9E-06	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	0.0E+00	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	0.0E+00	NA	NA	NA	NA
4-Chloro-2-phenylmethylphenol	NA	NA	NA	NA	0.0E+00	NA	NA	NA	NA
VOCs (mg/kg)									
Ammonia	NA	NA	NA	NA	NA	4.2E-09	NA	4.5E-11	4.3E-09
Chloroform	3.3E-10	NA	4.3E-09	NA	4.6E-09	1.5E-05	NA	2.5E-05	4.0E-05
Tetrachloroethene	3.5E-08	NA	5.8E-09	NA	4.1E-08	9.0E-05	NA	5.1E-05	1.4E-04
Trichloroethene	5.6E-09	NA	1.6E-08	NA	2.2E-08	1.2E-05	NA	1.9E-04	2.0E-04
Radionuclides (pCi/g)									
Cesium-137+D	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	NA	NA	NA	0.0E+00
Plutonium-238	1.3E-06	NA	1.7E-09	9.0E-10	1.4E-06	NA	NA	NA	0.0E+00
Radium-228+D	1.0E-06	NA	2.4E-11	5.2E-06	6.2E-06	NA	NA	NA	0.0E+00

COPC	Cancer Effects					Non-Cancer Effects			
	Route-Specific Risk				Chemical ELCR[a]	Route-Specific HQs			Chemical HI[b]
	Ingestion	Dermal	Inhalation (Dust + VOCs)	External Exposure		Ingestion	Dermal	Inhalation (Dust + VOCs)	
Thorium-230+D	9.8E-08	NA	1.4E-10	1.0E-09	9.9E-08	NA	NA	NA	0.0E+00
Uranium-233/234	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	NA	NA	NA	0.0E+00
Uranium-238+D	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	NA	NA	NA	0.0E+00
Cumulative Values:	6.4E-06	1.1E-06	2.8E-08	5.2E-06	**1.3E-05**	4.1E-01	8.0E-02	2.6E-04	**4.9E-01**
% Contribution:	50%	9%	0%	41%		0%	0%	0%	

NA = risk or hazard not calculated due to absence of toxicity data.

Notes:

a. Chemical ELCR is total risk summed across all four routes of exposure.

b. Chemical HI is total hazard summed across all three routes of exposure; external exposure not included in hazard calculations as it only applies to carcinogenic radionuclides.

c. 2,3,7,8-TCDD risks calculated with a weighted 2,3,7,8-TCDD EPC using 2005 WHO TEFs for dioxins and dioxin-like compounds (Van den Berg et al. 2006).

d. Benzo(a)pyrene risks calculated with a weighted benzo(a)pyrene EPC using NCEA TEFs for the following PAHs: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene (USEPA 1993).

Table 5.4 Total Risk from Soil Exposure for a Site Worker in Parcel 9

COPC	EPC	Cancer Effects					Non-Cancer Effects			
		Route-Specific Risk				Chemical ELCR[a]	Route-Specific HQs			Chemical HI[b]
		Ingestion	Dermal	Inhalation (Dust + VOC)	External Exposure		Ingestion HQ	Dermal HQ	Inhalation HQ	
Inorganic Chemicals (mg/kg)										
Lanthanum	4.6E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tantalum	3.3E+02	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pesticides and PCBs (mg/kg)										
Endosulfan II	3.5E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endosulfan sulfate	2.0E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endrin aldehyde	4.7E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endrin ketone	2.0E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1248	1.1E+00	3.7E-07	1.2E-06	3.7E-11	NA	1.6E-06	2.6E-02	3.3E-03	NA	3.0E-02
Aroclor-1262	4.0E-02	1.4E-08	4.5E-08	1.4E-12	NA	5.9E-08	9.8E-04	1.2E-04	NA	1.1E-03
SVOCs (mg/kg)										
Benzo(a)pyrene[c]	1.5E+00	1.9E-06	5.7E-06	9.9E-11	NA	7.6E-06	NA	NA	NA	NA
Benzo(g,h,i)perylene	3.4E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	1.3E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloro-2-phenylmethylphenol	2.0E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA
VOCs (mg/kg)										
Ammonia	2.7E-02	NA	NA	NA	NA	NA	4.4E-10	NA	4.5E-11	4.9E-10
Naphthalene	1.3E-01	NA	NA	3.0E-07	NA	3.0E-07	3.2E-06	NA	8.2E-03	8.2E-03
Tetrachloroethene	1.3E-01	1.2E-08	NA	1.9E-08	NA	3.1E-08	6.1E-06	NA	3.3E-05	3.9E-05
Trichloroethene	5.9E-01	1.3E-09	NA	3.7E-08	NA	3.8E-08	5.8E-07	NA	8.6E-05	8.7E-05
Radionuclides (pCi/g)										
Cesium-137+D	6.2E-02	8.3E-10	NA	2.2E-14	5.2E-11	8.8E-10	NA	NA	NA	0.0E+00
Plutonium-238	8.0E+00	6.8E-07	NA	8.2E-09	9.2E-10	6.8E-07	NA	NA	NA	0.0E+00
Radium-228+D	7.6E-01	5.4E-07	NA	1.2E-10	5.5E-06	6.0E-06	NA	NA	NA	0.0E+00
Thorium-230+D	2.7E+00	1.7E-07	NA	2.4E-09	3.6E-09	1.8E-07	NA	NA	NA	0.0E+00
Uranium-233/234	7.1E-01	3.6E-08	NA	2.5E-10	1.1E-09	3.7E-08	NA	NA	NA	0.0E+00
Uranium-238+D	7.1E-01	4.6E-08	NA	2.0E-10	1.3E-07	1.8E-07	NA	NA	NA	0.0E+00

COPC	EPC	Cancer Effects					Non-Cancer Effects			
		Route-Specific Risk				Chemical ELCR[a]	Route-Specific HQs			Chemical HI[b]
		Ingestion	Dermal	Inhalation (Dust + VOC)	External Exposure		Ingestion HQ	Dermal HQ	Inhalation HQ	
Cumulative Values:		3.8E-06	6.9E-06	3.7E-07	5.6E-06	**1.7E-05**	2.7E-02	3.5E-03	8.4E-03	**3.9E-02**
% Contribution:		23%	41%	2%	34%		70%	9%	21%	

NA = risk or hazard not calculated due to absence of toxicity data.

Notes:

a. Chemical ELCR is total risk summed across all four routes of exposure.

b. Chemical HI is total hazard summed across all three routes of exposure; external exposure not included in hazard calculations as it only applies to carcinogenic radionuclides.

c. Benzo(a)pyrene risks calculated with a weighted benzo(a)pyrene EPC using NCEA TEFs for the following PAHs: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene (USEPA 1993).

Table 5.5 Background Risk from Soil Exposure for a Site Worker in Parcel 9

COPC	EPC	Cancer Risk					Non-Cancer Risk			
		Route-Specific Risk				Chemical ELCR[a]	Route-Specific HQs			Chemical HI[b]
		Ingestion	Dermal	Inhalation (Dust + VOCs)	External Exposure		Ingestion HQ	Dermal HQ	Inhalation HQ	
Inorganic Chemicals (mg/kg)										
Lanthanum	0.0E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tantalum	0.0E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pesticides and PCBs (mg/kg)										
Endosulfan II	1.9E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endosulfan sulfate	0.0E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endrin aldehyde	0.0E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endrin ketone	0.0E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1248	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	0.0E+00	0.00E+00	0.00E+00	NA	0.0E+00
Aroclor-1262	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	0.0E+00	0.00E+00	0.00E+00	NA	0.0E+00
SVOCs (mg/kg)										
Benzo(a)pyrene[c]	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	0.0E+00	NA	NA	NA	NA
Benzo(g,h,i)perylene	0.0E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	0.0E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloro-2-phenylmethylphenol	0.0E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA
VOCs (mg/kg)										
Ammonia	0.0E+00	NA	NA	NA	NA	NA	0.00E+00	NA	0.00E+00	0.0E+00
Naphthalene	0.0E+00	NA	NA	0.0E+00	NA	0.0E+00	0.00E+00	NA	0.00E+00	0.0E+00
Tetrachloroethene	0.0E+00	0.0E+00	NA	0.0E+00	NA	0.0E+00	0.00E+00	NA	0.00E+00	0.0E+00
Trichloroethene	0.0E+00	0.0E+00	NA	0.0E+00	NA	0.0E+00	0.00E+00	NA	0.00E+00	0.0E+00
Radionuclides (pCi/g)										
Cesium-137+D	4.2E-01	1.1E-08	NA	3.1E-14	3.4E-10	1.1E-08	NA	NA	NA	0.0E+00
Plutonium-238	1.3E-01	1.1E-08	NA	1.3E-10	1.5E-11	1.1E-08	NA	NA	NA	0.0E+00
Radium-228+D	0.0E+00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	NA	NA	NA	0.0E+00
Thorium-230+D	1.9E+00	1.2E-07	NA	1.7E-09	2.5E-09	1.2E-07	NA	NA	NA	0.0E+00
Uranium-233/234	1.1E+00	5.5E-08	NA	3.9E-10	1.7E-09	5.7E-08	NA	NA	NA	0.0E+00

COPC	EPC	Cancer Risk					Non-Cancer Risk			
		Route-Specific Risk				Chemical ELCR[a]	Route-Specific HQs			Chemical HI[b]
		Ingestion	Dermal	Inhalation (Dust + VOCs)	External Exposure		Ingestion HQ	Dermal HQ	Inhalation HQ	
Uranium-238+D	1.2E+00	7.9E-08	NA	3.4E-10	2.2E-07	3.0E-07	NA	NA	NA	0.0E+00
Cumulative Values:		2.8E-07	0.0E+00	2.5E-09	2.2E-07	**5.0E-07**	0.0E+00	0.0E+00	0.0E+00	**0.0E+00**
% Contribution:		55%	0%	1%	45%		0%	0%	0%	

NA = risk or hazard not calculated due to absence of toxicity data.

Notes:

a. Chemical ELCR is total risk summed across all four routes of exposure.

b. Chemical HI is total hazard summed across all three routes of exposure; external exposure not included in hazard calculations as it only applies to carcinogenic radionuclides.

c. Benzo(a)pyrene risks calculated with a weighted benzo(a)pyrene EPC using NCEA TEFs for the following PAHs: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene (USEPA 1993).

Table 5.6 Incremental Risk from Soil Exposure for a Site Worker in Parcel 9

COPC	Cancer Effects					Non-Cancer Effects			
	Route-Specific Risk				Chemical ELCR[a]	Route-Specific HQs			Chemical HI[b]
	Ingestion	Dermal	Inhalation (Dust + VOCs)	External Exposure		Ingestion	Dermal	Inhalation (Dust + VOCs)	
Inorganic Chemicals (mg/kg)									
Lanthanum	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tantalum	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pesticides and PCBs (mg/kg)									
Endosulfan II	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endosulfan sulfate	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endrin aldehyde	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endrin ketone	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1248	3.7E-07	1.2E-06	3.7E-11	NA	1.6E-06	2.6E-02	3.3E-03	NA	3.0E-02
Aroclor-1262	1.4E-08	4.5E-08	1.4E-12	NA	5.9E-08	9.8E-04	1.2E-04	NA	1.1E-03
SVOCs (mg/kg)									
Benzo(a)pyrene[c]	1.9E-06	5.7E-06	9.9E-11	NA	7.6E-06	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloro-2-phenylmethylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA
VOCs (mg/kg)									
Ammonia	NA	NA	NA	NA	NA	4.4E-10	NA	4.5E-11	4.9E-10
Naphthalene	NA	NA	3.0E-07	NA	3.0E-07	3.2E-06	NA	8.2E-03	8.2E-03
Tetrachloroethene	1.2E-08	NA	1.9E-08	NA	3.1E-08	6.1E-06	NA	3.3E-05	3.9E-05
Trichloroethene	1.3E-09	NA	3.7E-08	NA	3.8E-08	5.8E-07	NA	8.6E-05	8.7E-05
Radionuclides (pCi/g)									
Cesium-137+D	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	NA	NA	NA	0.0E+00
Plutonium-238	6.6E-07	NA	8.1E-09	9.0E-10	6.7E-07	NA	NA	NA	0.0E+00
Radium-228+D	5.4E-07	NA	1.2E-10	5.5E-06	6.0E-06	NA	NA	NA	0.0E+00
Thorium-230+D	5.1E-08	NA	7.1E-10	1.1E-09	5.3E-08	NA	NA	NA	0.0E+00
Uranium-233/234	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	NA	NA	NA	0.0E+00

COPC	Cancer Effects					Non-Cancer Effects			
	Route-Specific Risk				Chemical ELCR[a]	Route-Specific HQs			Chemical HI[b]
	Ingestion	Dermal	Inhalation (Dust + VOCs)	External Exposure		Ingestion	Dermal	Inhalation (Dust + VOCs)	
Uranium-238+D	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	NA	NA	NA	0.0E+00
Cumulative Values:	3.6E-06	6.9E-06	3.7E-07	5.5E-06	**1.6E-05**	2.7E-02	3.5E-03	8.4E-03	**3.9E-02**
% Contribution:	22%	42%	2%	34%		70%	9%	21%	

NA = risk or hazard not calculated due to absence of toxicity data.

Notes:

a. Chemical ELCR is total risk summed across all four routes of exposure.

b. Chemical HI is total hazard summed across all three routes of exposure; external exposure not included in hazard calculations as it only applies to carcinogenic radionuclides.

c. Benzo(a)pyrene risks calculated with a weighted benzo(a)pyrene EPC using NCEA TEFs for the following PAHs: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene (USEPA 1993).

6.0 UNCERTAINTY IN THE RISK ASSESSMENT

The following section presents an evaluation of the sources of uncertainty affecting the Parcel 9 RRE and the relative influence of these uncertainties on the results of the evaluation. Human health risk screening evaluations are subject to uncertainty in data evaluation and COPC identification, exposure evaluation, and toxicity evaluation. Risk estimates span a range of possible values and should be interpreted only in light of the assumptions and methods used in the evaluation. Where uncertainty does exist, the RRE uses conservative assumptions to ensure that the resulting values will be protective of human health.

6.1 Uncertainty in Analytical Data

Uncertainty is associated with sample location selection as well as sample collection and analysis. For the Parcel 9 RRE, the EPCs utilized in risk and hazard calculations were either the maximum detected concentration, 95% UCL estimate of the mean, or 70th percentile of the data set as outlined in Section 2.3. Use of maximum concentrations and/or 95% UCLs is a conservative method of computing risk and hazard values, and the method likely overestimates potential exposure. One uncertainty associated with the COPC identification process is the possibility that a chemical may be inappropriately identified as a COPC when it is not. Conversely, a chemical may excluded as a COPC for the quantitative assessment, when it should have been retained. For example, background concentrations may not be representative of all subunits of Parcel 9 as it is possible: (1) uncontaminated areas are underrepresented in the data set, or (2) the background data set was not large enough to generate representative 95% Upper Tolerance Limits (UTLs).

Environmental samples comprising the data set used in this RRE were collected over a 17-year period. During this period, analytical detection limits have likely decreased due to advances in analytical methods and instrumentation, resulting in potential biases in the data set. In some cases, historical results may have been considered non-detects; however, because more modern methods may have lower detection limits, historical non-detects may have been detections using newer methods. Because COPCs were screened in part on their frequency of detection, the effect of having non-detected data with elevated detection limits introduces uncertainty in correctly identifying COPCs.

Other uncertainties may include errors in sampling, laboratory analysis, and data analysis. To minimize these, the Parcel 9 data set has undergone multiple quality control reviews to ensure site-related results reflect their sample locations, and reported concentrations do not reflect analytical error. In addition, the number of samples collected from Parcel 9 is very large, which ensures any errors are minimized by the breadth of the sample size. In addition, detections above instrument detection limits, but below contract required detection were used in the risk-screening evaluations, and non-detects whose detection limit was above background were retained for quantitative assessment. These factors combined serve to minimize the effect of these uncertainties.

6.2 Uncertainty in Exposure Assessment

6.2.1 Exposure Duration and Frequency

The current and reasonably foreseeable future land use for Parcel 9 is industrial. To the degree the current exposure scenarios do not account for all possible work-related activities, both the construction and site worker scenarios are extremely conservative in terms of the exposure durations and exposure times to individual receptors and, as such, are at a minimum protective of other activities and at a maximum may overestimate risk. To illustrate, the site worker receptor is on-site for 8 hours per day, 250 days per year, over a period of 25 years. The construction worker assumes the receptor is onsite for 8 hours per day, 250 days per year, over a period of 5 years (DOE 1997a). As a result, both exposure scenarios evaluated at Parcel 9 are certainly conservative and any activities not incorporated by the scenario conditions are assumed to be accounted for in the extended exposure duration and frequency. As a result, the impact of this element is considered very low.

A number of assumptions are made relative to exposure pathways, including input parameters, completeness of a given pathway, the contaminated media to which an individual may be exposed, and intake rates for different routes of exposure. In the absence of site-specific data, the exposure assumptions used were consistent with default values (USEPA 1991a). Typically, the exposure assumptions represent upper bound estimates for exposure frequency and time, in an effort to ensure protectiveness. However, when several upper-bound values are combined to estimate exposure for any one pathway, the resulting risk estimate is impacted by compounding conservatism, resulting in risk estimates that are at or above the likely exposure scenarios. This combination of factors tends to overestimate risks and is considered to have a moderate effect on the Parcel 9 RRE.

6.2.2 Exposure to Radiation

Another source of uncertainty in the Parcel 9 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. The calculation of risk from external radiation exposure assumes that any gamma-emitting radionuclide in soil is uniformly distributed. The calculation of external radiation exposure risk includes a gamma-shielding factor to account for attenuation of radiation by structures, terrain, or engineered barriers, 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 9 RRE, a default value of 0.2 or 20% shielding for the site worker and 0.1 or 10% shielding for the construction worker scenarios was used in the risk calculations. The gamma-shielding values are conservative assumptions but are consistent with values previously used in the calculation of the RBGVs. A typical default value is 0.5 (Yu et al. 2001), which implies that indoor levels of external radiation are 50% lower than outdoor levels, which will likely be conservative for situations involving low to moderate energy emitters. The gamma-shielding factors used for the Parcel 9 RRE (0.2 for the site worker, 0.1 for the construction worker) assume less shielding and are more conservative than the RESRAD default value of 0.5.

Because radium-228 (a beta emitting radionuclide) accounts for the majority of the risk in both scenarios, this is considered to have little to no effect on the Parcel 9 RRE.

6.2.3 Exposure Point Concentrations

Potential risk and exposure from a single location or area with relatively high COPC concentrations may be overestimated if a representative sitewide value is used. The use of the maximum detected concentration for the EPC overestimates the exposure to contamination because receptors are not consistently exposed to the maximum detected concentration across the site. Because the primary risk drivers at Parcel 9 (radium-228, benzo(a)pyrene, and Aroclor-1248) were assessed using EPCs reflecting the 95% UCL of a large data set, the use of maximum detected concentrations as EPCs is considered to have a low impact on the Parcel 9 RRE.

Additionally, risks for dioxins and dioxin-like compounds as well as PAHs were calculated using weighted EPCs for 2,3,7,8-TCDD and benzo(a)pyrene. The use of TEFs for dioxins and dioxin-like compounds was originally intended to estimate exposure through food ingestion (Van den Berg et al. 2006). TEFs for PAHs were developed through animal studies, which may not be entirely representative of the toxicity of each PAH in humans because of this extrapolation (USEPA 1993). However, the use of TEFs is recommended by the USEPA in assessing risks due to dioxins, dioxin-like compounds, and PAHs (USEPA 2010b). Constituents falling into these two categories initially removed from consideration during COPC screening were included in TEF calculations for 2,3,7,8-TCDD and benzo(a)pyrene to be conservatively protective and address some uncertainty due to pathway and organism extrapolation for each set of TEFs. Therefore, the effect of the use of TEFs is considered to have a low impact on the Parcel 9 RRE.

6.2.4 Background Comparisons

Prior to comparing the maximum detected concentration for each constituent to the 95% UTL of the background data set, the maximum detected concentration was compared to the 95% UCL of the mean developed from verification data at Parcel 9. If the maximum concentration was greater than the 95% UCL, the 95% UCL was compared to background instead of the maximum concentration, as outlined in the Mound 2000 RREM (DOE 1997a). The site-specific background values are based on the *Operable Unit 9 Background Soils Investigation Soil Chemistry Report* (DOE 1994) and represent the 95% UTL concentrations of the background data set. The UTL is designed to be compared to a maximum value as it is a measure of the maximum concentration of the background data set. However, the 95% UCLs developed for each constituent are a measure of the mean and are intended to represent the average concentration of a constituent across the area sampled. Therefore, comparing the 95% UCL for each constituent to 95% UTL background values may remove COPCs from further consideration during screening when they should actually be retained. The comparison of the 95% UCL to background is considered to have a medium impact on the Parcel 9 RRE.

6.3 Uncertainty Related to Toxicity Information

A significant amount of uncertainty may surround toxicity values (reference doses [RfDs] and cancer slope factors [CSFs]) used to derive the risk screening estimates. Uncertainties were identified in four areas with respect to the toxicity values: (1) extrapolation from other animals to humans, (2) inter-individual variability in the human population, (3) the derivation of RfDs and CSFs, and (4) the chemical form of the COPC.

6.3.1 Extrapolation from Animals to Humans

The CSFs and RfDs are often determined by extrapolation from animal data to humans—a method which may result in uncertainties in toxicity values because differences exist in chemical absorption, metabolism, excretion, and toxic responses between animals and humans. Differences in body weight, body surface area, and pharmacokinetic relationships between animals and humans are taken into account to address these uncertainties in the dose-response relationship. However, conservatism is usually incorporated in each of these steps through the use of modifying and uncertainty factors, resulting in the overestimation of potential risk.

6.3.2 Individual Variability in the Human Population

For non-carcinogenic effects, the degree of variability in human physical characteristics is important both in determining the risks that can be expected at low exposures and in defining the NOAEL. The NOAEL uncertainty factor approach incorporates a 10-fold factor to reflect individual variability within the human population that can contribute to uncertainty in the risk evaluation; this factor of 10 is generally considered to result in a conservative estimate of risk to non-carcinogenic COPCs.

6.3.3 Derivation of RfDs and CSFs

The RfDs and CSFs for different chemicals are derived from experiments conducted by different laboratories that may have different accuracy and precision, which could lead to an over- or underestimation of the risk. The uncertainty associated with the toxicity factors for noncarcinogens is measured by the uncertainty factor, the modifying factor, and the confidence level. For carcinogens, the weight of evidence classification indicates the likelihood that a contaminant is a human carcinogen. Toxicity values with high uncertainties may change as new information is evaluated.

6.3.4 Chemical Form of the COPC

COPCs may be bound to the environment matrix and not available for absorption into the human body. However, it is assumed that the COPCs are bioavailable. This assumption can lead to an overestimation of the total risk but adds conservatism to risk and hazard estimates.

6.4 Uncertainty in Risk Characterization

Some uncertainty is associated with the summation of risks and HQs for multiple chemical constituents. Quantifying total excess cancer risk requires calculation of risks associated with exposure to individual carcinogens and summing risks associated with simultaneous exposure to several carcinogens for the same human receptor. 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 weighs slope factors derived from animal data with those derived from human data.

For noncarcinogens, the effects of exposure to multiple chemicals are generally not known, while the assumption of dose additivity ignores possible synergistic or antagonistic effects among chemicals and assumes similarity in mechanisms of action and metabolism (USEPA 1989), resulting in either an overestimation or underestimation of the potential risk. Additionally, RfDs used in the risk calculations typically are not based on the same endpoints with respect to severity, effects, or target organs. Therefore, the potential for non-carcinogenic effects may be overestimated for individual COPCs that act by different mechanisms and on different target organs but are addressed additively. Unlike carcinogenic effects, noncarcinogenic effects are not expressed as a probability. Instead, adverse effects caused by noncarcinogens are expressed as the ratio of the CDI to the RfD or RfC, termed the hazard quotient (HQ), when both values are based on similar exposure periods. The hazard index (HI) represents the total of the HQs of all COPCs in all pathways, media, and routes to which the receptor is exposed.

7.0 REFERENCES

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Appendix A
Potential Release Site Information

PRS DESCRIPTION	Contaminant	Initial Core Team Decision	Closeout document and decision	Comment period
PRS-8: Site Sanitary Landfill (Waste Storage and Disposal Sites Release Block I) Potential Release Sites (PRSs) 8, 9, 10, 11, 12 include the historical landfill site and historical disposal site of plant waste materials, including general trash and liquid waste in an area of the site commonly referred to as Area B.		NFA	Recommendation signed 3/4/96	3/18/96 – 4/1/96
PRS-9: Area 18, Site Sanitary Landfill Cover (Waste Storage and Disposal Sites Release Block I). Potential Release Sites(PRSs) 8, 9, I0, 11, 12 included the historical landfill site and historical disposal site of plant waste materials, including general trash and liquid waste in an area of the site commonly referred to as Area B.		NFA	Recommendation signed 3/4/96	3/18/96 – 4/1/96
PRS-10: Site Sanitary Landfill (Waste Storage and Disposal Sites Release Block I). Potential Release Sites (PRSs) 8, 9, I0, 11, 12 included the historical landfill site and historical disposal site of plant waste materials, including general trash and liquid waste in an area of the site commonly referred to as Area B.		NFA	Recommendation signed 3/4/96	3/18/96 – 4/1/96
PRS-11: Site Sanitary Landfill (Waste Storage and Disposal Sites Release Block I). Potential Release Sites (PRSs) 8, 9, IO, 11 , 12 included the historical landfill site and historical disposal site of plant waste materials, including general trash and liquid waste in an area of the site commonly referred to as Area B. Based on the discovery of thorium contamination commingled with drum remnants at PRS 11.		NFA	OSC signed 11/26/03	12/5/03 – 1/4/04
PRS-12: Site Sanitary Landfill (Waste Storage and Disposal Sites Release Block I). Potential Release Sites (PRSs) 8, 9, 10, 11, 12 included the historical landfill site and historical disposal site of plant waste materials, including general trash and liquid waste in an area of the site commonly referred to as Area B.		NFA	Recommendation signed 3/4/96	3/18/96 – 4/1/96
PRS-13: Trash Incinerator (Former Treatment Site). Potential Release Site (PRS) 13 was identified as a trash incinerator was part of an overall open burning process employed from 1948-1970 in the old burn area, which was part of OU 1.		NFA	Recommendation signed 12/18/96	2/22/97 – 4/3/97
PRS-14: Area C, Waste Storage Area (Drum Staging Area and Chemical Waste Storage). Historical use as a drum storage area for staging chemical waste prior to off-site disposal.		NFA	Recommendation signed 5/8/96	6/19/96 – 7/17/96
PRS-21: Building 1, Leach Pit (Area 1). The RCRA PRSs 21, 22, 25, 26, 27, and 29, otherwise known as wastewater transfer structures, were identified as Potential Release Sites because of the concern that residual volatile organic compounds from past operations associated with Buildings 1 & 27 remained in/on the structures.		NFA	Recommendation signed 11/16/00	5/10/01 – 6/10/01
PRS-22: Building 1 Explosives Waste Water Settling Basin (Tank 200). The RCRA PRSs 21, 22, 25, 26, 27, and 29, otherwise known as wastewater transfer structures, were identified as Potential Release Sites because of the concern that residual volatile organic		NFA	Recommendation signed 11/16/00	5/10/01 – 6/10/01

PRS DESCRIPTION	Contaminant	Initial Core Team Decision	Closeout document and decision	Comment period
compounds from past operations associated with Buildings1 & 27 remained in/on the structures.				
PRS-23: Building 43 Explosives Waste Water Settling Basin (Tank 201). PRS 23 was identified as a concrete tank (Tank 201) that was installed in 1969 to filter and settle-out explosive elements from a planned explosive, production process slated to be housed in Building 43.		NFA	Recommendation signed 12/18/96	2/27/97 – 4/3/97
PRS-24: Building 43 Solvent Storage Tank (Tank 221) was identified as a solvent storage tank (Tank 221) that was constructed to store acetone or alcohol solvents for use in Building 43. The proposed use of Building 43, to purify explosive materials, never took place. The tank was never used and was removed in 1990.		NFA	Recommendation signed 12/18/96	2/27/97 – 4/3/97
PRS-25: Building 27 (unlined) Leach Pit (Area 1) was taken out of service in 1985. The RCRA PRSs 21, 22, 25, 26, 27, and 29, otherwise known as wastewater transfer structures, were identified as PRSs because of the concern that residual volatile organic compounds from past operations associated with Buildings 1 & 27 remained in/on the structures.		NFA	Recommendation signed 11/16/00	5/10/01 – 6/10/01
PRS-26: Building 27 Concrete Flume (Tank 217) use was discontinued in 1991. The RCRA PRSs 21, 22, 25, 26, 27, and 29, otherwise known as wastewater transfer structures, were identified as PRSs because of the concern that residual volatile organic compounds from past operations associated with Buildings 1 & 27 remained in/on the structures.		NFA	Recommendation signed 11/16/00	5/10/01 – 6/10/01
PRS-27: Building 27 Settling Sump (Tank 218). The RCRA PRSs 21, 22, 25, 26, 27, and 29, otherwise known as wastewater transfer structures, were identified as PRSs because of the concern that residual volatile organic compounds from past operations associated with Buildings 1 & 27 remained in/on the structures.		NFA	Recommendation signed 11/16/00	5/10/01 – 6/10/01
PRS-28: Building 27 Solvent/Drum Storage Area (Pad). It was an asphalt pad used for the temporary storage of past process solvent waste, and was presently used for storage of acetone.		NFA	Recommendation signed 6/19/01	5/8/02 – 6/8/02
PRS-29: Building 27 Filtration System. The RCRA PRSs 21, 22, 25, 26, 27, and 29, otherwise known as wastewater transfer structures, were identified as PRSs because of the concern that residual volatile organic compounds from past operations associated with Buildings 1 & 27 remained in/on the structures.		NFA	Recommendation signed 11/16/00	5/10/01 – 6/10/01
PRS-30: Building 27 Diesel Fuel Storage Tank (Tank 213) (AKA Bldg. 27 Propane Tank). Potential Release Site (PRS) 30 was the site north of Building 27 where a propane tank was located. This tank was mistakenly listed as a PRS because it was incorrectly listed as an underground fuel oil tank by Mound Plant Underground Storage Tank (UST) Plan.		NFA	Recommendation signed 3/18/97	6/17/97 – 7/18/97
PRS-33: Underground Sanitary Sewer Line		NFA	Recommendation signed	12/4/02 – 1/3/03

PRS DESCRIPTION	Contaminant	Initial Core Team Decision	Closeout document and decision	Comment period
GI4 EAST. Potential Release Sites (PRSs) 31-36, 125 and 270 were identified as PRSs as a result of breaks and/or separations in Mound's sanitary sewer lines, identified during 1982 video survey of the lines.			11/26/02	
PRS-34: Underground Sanitary Sewer Line GI4 WEST. Potential Release Sites (PRSs) 31-36, 125 and 270 were identified as PRSs as a result of breaks and/or PRS-41: Area 3, Thorium Drum Storage and Re-drumming Area. Potential Release Site (PRS) 41 was located on the western portion of the site (Figure I).		NFA	Recommendation signed 11/26/02	12/4/02 – 1/3/03
PRS-59: Contaminated Soil Box Storage Area. PRS 59 was identified as a storage area for boxes containing plutonium-contaminated soil during a USEPA 1988 preliminary Review Visual Site Inspection		NFA	Recommendation signed 5/13/97	7/15/97 – 8/17/97
PRS-67: Plant Drainage Ditch. Potential Release Site (PRS) 67 was an open, unlined channel that flowed above ground through the central part of the facility from Building 22 to the retention basins on the western plant boundary. Only a portion of this PRS is located within Parcel 9. The ditch carried surface run-off from both the Main Hill and SM/PP Hill areas and the asphalt lined pond (removed) that drained into the ditch through culvert (removed), emerging behind Building 22. From that point the open ditch falls 40 feet over a length of 1,800 feet.		NFA	OSC signed 1/10/06	N/A
PRS-69: Overflow Pond and outflow pipe were a PRS due to the presence of plutonium-238 contamination, site sanitary landfill leachate, effluent from the plant drainage system, and storm water runoff. The overflow pond was located near the southwest corner of the original plant property. Operating continuously since 1979, the pond had a capacity of 5 million gallons.		NFA	OSC signed 1/12/06	N/A
PRS-71: Building 85 Waste Solvent Tank (Tank 136). Historical process knowledge indicated that this PRS, which was a below grade tank located adjacent to Building 85, was never used.		NFA	Recommendation signed 3/4/96	3/18/96 – 4/1/96
PRS-75: Railroad Siding (Historical Railroad Spur Area) soils area in the vicinity of the railway siding, created due to its use as a radioactive drum storage, loading, unloading, and repackaging area. Multiple soil samples taken from the PRS 75 area had recorded concentrations of thorium-232 and plutonium-238 in excess of guideline criteria.	Th-232 Pu-238 Ra-226 U-238	RA	OSC signed 1/29/05	N/A
PRS 81: Drilling Mud Drum Storage Areas (three locations, two within Parcel 9). These areas were designated a PRS due to suspected barium contamination from borehole cuttings that were stored in drums. The areas were used from 1987-1989.		NFA	Recommendation signed 5/8/96	5/15/96 – 6/17/96
PRS 176: Area 14, Radioactive Waste Line Break. In 1974, the soils associated with the Waste Transfer System (WTS) leaks (PRS-176) were remediated. In the mid 1980s, the WTS line, the two holding tanks, and Building 43 were removed.		NFA	Recommendation signed 12/17/96	1/9/97 - 2/13/97
PRS 282: Spoils Disposal Area, Construction		FA	Recommendation signed	1/22/03 – 2/20/03

PRS DESCRIPTION	Contaminant	Initial Core Team Decision	Closeout document and decision	Comment period
Spoils Area.			1/7/03	
PRS-300: Area 19, Underground Waste Transfer Line. This PRS was identified based on the fact that a pair of lines (waste transfer system) had been installed to transfer plutonium-238 contaminated waste solutions from the Special Metallurgical (SM) Building to the Waste Disposal (WD) Building. The PRS consisted of the WTS lines and the soil surrounding them from the SM area to the WD Building, a distance of approximately 2,600 feet.		NFA	Recommendation signed 12/17/96	1/9/97 – 2/13/97
PRS 346: Elevated Soil Gas Location was soil PRS located in the southern sector of the original Mound Plant. No radioactive or hazardous waste generating processes or activities were known to have occurred. These soils locations were identified as PRSs due to qualitative hydrocarbon detections found during the PETREX soil gas portion of OU5, Non Area of Concern investigation.		NFA	Recommendation signed 11/20/96	12/19/96 – 1/23/97
PRS 354: Elevated Soil Gas Location was identified due to a single elevated radiological detection of plutonium found during the Mound Soil Screening Analysis performed as part of the June 1994 OU5, Operational Area Phase I Investigation.		NFA	Recommendation signed 2/19/97	5/8/97 – 6/16/97
PRS 357: A sampling location in the driveway area northwest of Bldg 67, between the main access road and the access roads leading to Bldg 67 and the sewage disposal plant parking lots. This soil location was identified as a PRS due to qualitative hydrocarbon detections found during the PETREX soil gas portion of the OM, Non Area of Concern Investigation. No radioactive or hazardous waste generating processes or activities are known to have occurred at these PRSs.		NFA	Recommendation signed 11/20/96	12/10/96 – 1/23/97
PRS 358: Located along the railroad siding near Bldg 24. Elevated Soil Gas Location was identified due to elevated levels of organic chemicals detected by the qualitative PETREX survey during the OU5, Non-AOC Investigation.		NFA	Recommendation signed 12/18/96	2/27/97 – 4/3/97
PRS 359: Elevated Soil Gas Location		NFA	Recommendation signed 11/20/96	12/19/96 – 1/23/97
PRS 361: Elevated Soil Gas Location		NFA	Recommendation signed 11/20/96	12/19/96 – 1/23/97
PRS 409: The site of a former chemical (Stoddard Solvent) concrete pad staging area. This area was encountered and remediated during the installation of a storm water drainage pipe in 1996. Contamination soils area located in Release Block I, OU1, just west of the site sanitary landfill. This area was identified September 23, 1996, by the contractor installing the OU4 canal re-route drainage pipe.	Stoddard Solvent	RA	Recommendation signed 1/11/05	8/25/05 – 9/24/05
PRS 410: Based on a surface (8" below grade) soil stain and odor (thought to be diesel fuel) encountered during the removal and replacement of a storm water drainage pipe. The stained soil was sampled for total petroleum hydrocarbons (TPH) and found to contain 198 parts per million (ppm) (vs. 105 ppm Bureau of Underground Storage Tank	TPH	FA	Recommendation signed 12/1/04	12/9/04 – 1/9/05

PRS DESCRIPTION	Contaminant	Initial Core Team Decision	Closeout document and decision	Comment period
Regulations criteria). All stained soil was removed, the utility project completed, and the area backfilled with clean gravel. The area was subsequently paved with asphalt.				
PRS 414: South Area Groundwater and Soil Evaluation.		Retired	Recommendation signed 12/2/04	12/9/04 – 1/8/05
PRS 418: Overflow Pond South Inlet		NFA	Recommendation signed 6/22/01	8/9/00 – 9/14/00
PRS 419: Drainage Outflow Reroute. The reroute extends for a length of approximately 4,500 feet proceeding south from its entrance near the concrete sealed "twin 60s" before exiting the Mound Plant property and emptying into the Great Miami River.		NFA	Recommendation signed 11/17/99	1/19/00 – 2/17/00
PRS 441: Soil Staging Area and Expansion. The soil staging area and expansion area are located near the rail spur, north of the overflow pond. This area had been used for the staging and loading of contaminated soils and debris awaiting shipment offsite. Includes the soil staging area, rail siding (including a segment formerly part of PRS 75), and a segment of the site drainage ditch (formerly part of PRS 67). The siding had been used for loading and unloading packaged materials and packaged wastes for the polonium, thorium, and plutonium projects during the 1950s, 60s, and 70s.	Th-232 Pu-238 Ra-226 U-238	RA	OSC signed 12/1/09	NA

Appendix B
Risk-Based Guideline Values for Construction Worker and Site Worker Exposure Scenarios

B.1 Introduction

This appendix presents the RBGVs developed for the MCP Parcel 9 RRE. The RBGVs are media-specific concentrations of constituents that correspond to specific, human health risk levels for specified exposure scenarios and were used to screen COPCs. The RBGVs were developed for the construction worker and the site worker exposure scenarios using the equations and exposure assumptions presented in the Mound Plant RBGV guidance (DOE 1997b). Since toxicological reference values and computational guidance relevant to the calculation of RBGVs have been updated since release of the Mound RBGV guidance in 1997, the Mound Facility RBGVs were updated for the Parcel 6, 7, and 8 RRE. The updated RBGVs presented in Appendix B of the Parcel 6, 7, and 8 RRE (DOE 2007) were used in the Parcel 9 RRE.

B.2 Development of Risk-Based Guideline Values

The RBGVs used to screen site-related constituents (SRCs) were developed specifically for Mound, following methods approved by the DOE, USEPA, and OEPA (DOE 1997b). The RBGVs correspond to the target risk level (TRL) of 1×10^{-6} for carcinogenic constituents and radionuclides, and to a target hazard index (THI) of 1 for each non-carcinogen constituent. A 1×10^{-6} risk level represents an incremental increase of one chance in 1 million of developing cancer as a result of exposure to the RBGV concentration. Since the target risk range for carcinogenic constituents specified in the National Contingency Plan is 1×10^{-4} to 1×10^{-6} and the OEPA TRL is 1×10^{-5}, screening SRCs against RBGVs calculated with a TRL of 1×10^{-6} is protective. The RBGVs for non-carcinogenic constituents were calculated for an HI of 1. When both non-carcinogenic and carcinogenic endpoints were calculated for a constituent, the lowest (more conservative) value was used as the RBGV. To account for the possibility of more than one non-carcinogenic constituent, SRCs were screened using 1/10 the RBGV for non-carcinogenic constituents. Carcinogenic or radioactive constituents that exceed their RBGVs and non-carcinogenic constituents that exceed one-tenth of their RBGV were carried to the next step, COPC selection.

Exposure media evaluated for the Parcel 9 RBGVs were based on the Mound RBGV guidance and included soil. Reasons for excluding the air, surface water, and groundwater pathways are discussed in Section 1.0 of the Parcel 9 RRE. Receptors for the Parcel 9 RBGVs included construction worker and site employee, and exposure was assumed to be complete through the incidental ingestion, dermal absorption, inhalation, and external radiation exposure pathways.

The following equation was used to derive the RBGVs for carcinogens:

$$RBGVcancer = \frac{TRL}{(Intake_{ing} \times CSF_o) + (Intake_{inh} \times CSF_{inh}) + (Intake_d \times CSF_d)}$$

(B-1)

Where:

TRL	=	target risk level (risk)
$Intake_{ing}$	=	media-specific intake for ingestion pathway (mg/kg-day)
CSF_o	=	oral cancer slope factor for constituent i [$(mg/kg\text{-}day)^{-1}$]
$Intake_{inh}$	=	media-specific intake for inhalation pathway (mg/kg-day)
CSF_{inh}	=	inhalation cancer slope factor for constituent i [$(mg/kg\text{-}day)^{-1}$]
$Intake_d$	=	media-specific intake (i.e., absorbed dose) for dermal pathway (mg/kg-day)
CSF_d	=	dermal cancer slope factor for constituent i [$(mg/kg\text{-}day)^{-1}$].

The following equation was used to derive the RBGVs for non-carcinogens:

$$RBGVcancer = \frac{THI}{(Intake_{ing}/RfD_o) + (Intake_{inh}/RfD_{inh}) + (Intake_d/RfD_d)}$$

(B-2)

Where:

THI	=	target hazard index (unitless)
$Intake_{ing}$	=	media-specific intake for ingestion pathway (including food where appropriate) (mg/kg-day)
RfD_o	=	oral chronic reference dose for constituent i (mg/kg-day)
$Intake_{inh}$	=	media-specific intake for inhalation pathway (mg/kg-day)
RfD_{inh}	=	inhalation chronic reference dose factor for constituent i (mg/kg-day)
$Intake_d$	=	media-specific intake (i.e., absorbed dose) for dermal pathway (mg/kg-day)
RfD_d	=	dermal chronic reference dose factor for constituent i (mg/kg-day).

Dermal exposure to COPCs present in soil was not assessed by the original RBGV document but was included as a complete, significant exposure pathway for the Parcel 9 RRE. Evaluation of the dermal exposure pathway follows guidance presented in USEPA's "Supplemental Guidance for Dermal Risk Assessment," RAGS Part E (USEPA 2004).

B.3 Exceptions and Updates for RBGVs

Exposure assumptions used for the RBGV updates were similar to those presented in the RBGV guidance with a few exceptions. The particle emission factors were replaced based on updated guidance from the *Soil Screening Guidance: User's Guide* (EPA 1996). Additional assumptions regarding chemical-specific dermal absorption factors and gastrointestinal factors were taken from USEPA's RAGS Part E (USEPA 2004).

B.4 Toxicity Values and Chemical Specific Parameters

RBGVs were calculated using USEPA-approved toxicity criteria from the Integrated Risk Information System (IRIS) database (USEPA 2010c) and Health Effects Assessment Summary table (HEAST) (USEPA 2001). IRIS is an electronic database (maintained online at http://www.epa.gov/iris/index.html) containing the most current descriptive and quantitative EPA regulatory information related to non-carcinogenic and carcinogenic health effects of chemical constituents. HEAST is a published reference, updated periodically by EPA. It contains toxicity information and values for constituents from health effects documents and profiles. Toxicological reference values used to calculate the RBGVs are presented in Table 3.1 of the Parcel 6, 7, and 8 RRE (DOE 2007). In addition to IRIS and HEAST, toxicity information was obtained from RAGS Part E (USEPA 2004) and NCEA (USEPA 1993).

B.5 Risk-Based Guideline Values

The RBGVs are presented in Tables B.1 and B.2.

Table B.1 RBGVs for Construction Worker Exposure to Soil

SRC	CAS Number	Carcinogenic GV (TR = 1 x 10^{-6})	1/10th Non-Carcinogenic GV (THI = 1.0)	RBGV	Endpoint[a]
Metals		**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	
Actinium	7440-34-8	- - -	- - -	- - -	
Aluminum	7429-90-5	- - -	2.08E+04	2.08E+04	b
Antimony	7440-36-0	- - -	8.52E+00	8.52E+00	b
Arsenic	7440-38-2	1.85E+00	5.96E+00	1.85E+00	a
Barium	7440-39-3	- - -	1.47E+03	1.47E+03	b
Beryllium	7440-41-7	1.12E+04	4.21E+01	4.21E+01	b
Bismuth	7440-69-9	- - -	- - -	- - -	
Boron	7440-42-8	- - -	4.25E+03	4.25E+03	b
Cadmium	7440-43-9s	1.50E+04	5.46E+00	5.46E+00	b
Calcium	7440-70-2	- - -	- - -	- - -	
Cerium	7440-45-1	- - -	3.85E+04	3.85E+04	b
Chromium	7440-47-3	- - -	- - -	- - -	
Chromium III	16065-83-1	- - -	3.19E+04	3.19E+04	b
Chromium VI	18540-29-9	3.26E+02	6.12E+01	6.12E+01	b
Cobalt	7440-48-4	9.64E+03	3.83E+02	3.83E+02	b
Copper	7440-50-8	- - -	8.52E+02	8.52E+02	b
Cyanide	57-12-5	- - -	4.26E+02	4.26E+02	b
Dypsprosium	7429-91-6	- - -	- - -	- - -	
Erbium	7440-52-0	- - -	- - -	- - -	
Europium	7440-53-1	- - -	- - -	- - -	
Gadolinium	7440-54-2	- - -	- - -	- - -	
Holmium	7440-60-0	- - -	- - -	- - -	
Iron	7439-89-6	- - -	- - -	- - -	
Lanthanum	7439-91-0	- - -	- - -	- - -	
Lead	7439-92-1	- - -	- - -	- - -	
Lithium	7439-93-2	- - -	- - -	- - -	
Lutetium	7439-94-3	- - -	- - -	- - -	
Magnesium	7439-95-4	- - -	- - -	- - -	
Manganese	7439-96-5s	- - -	4.85E+02	4.85E+02	b
Mercury	7439-97-6	- - -	5.78E+04	5.78E+04	b
Molybdenum	7439-98-7	- - -	1.06E+02	1.06E+02	b
Neodymium	7440-00-8	- - -	- - -	- - -	
Nickel	7440-02-0	- - -	4.26E+02	4.26E+02	b
Nitrate	14797-55-8	- - -	3.41E+04	3.41E+04	b
Nitrite	14797-65-0	- - -	2.13E+03	2.13E+03	b
Osmium	7440-04-2	- - -	- - -	- - -	
Potassium	7440-09-7	- - -	- - -	- - -	
Praseodymium	7440-10-0	- - -	- - -	- - -	
Rubidium	7440-17-7	- - -	- - -	- - -	
Samarium	7440-19-9	- - -	- - -	- - -	
Selenium	7782-49-2	- - -	1.06E+02	1.06E+02	b
Silicon	7440-21-3	- - -	- - -	- - -	
Silver	7440-22-4	- - -	1.06E+02	1.06E+02	b
Sodium	7440-23-5	- - -	- - -	- - -	
Strontium	7440-24-6	- - -	1.28E+04	1.28E+04	b
Tantalum	7440-25-7	- - -	- - -	- - -	
Terbium	7440-27-9	- - -	- - -	- - -	
Thallium	7440-28-0	- - -	1.41E+00	1.41E+00	b
Tin	7440-31-5	- - -	1.28E+04	1.28E+04	b
Titanium	7440-32-6	- - -	8.39E+04	8.39E+04	b

SRC	CAS Number	Carcinogenic GV (TR = 1 x 10^{-6})	1/10th Non-Carcinogenic GV (THI = 1.0)	RBGV	Endpoint[a]
Uranium	7440-61-1	- - -	4.26E+00	4.26E+00	b
Vanadium	7440-62-2	- - -	2.13E+01	2.13E+01	b
Ytterbium	7440-64-4	- - -	- - -	- - -	
Zinc	7440-66-6	- - -	6.39E+03	6.39E+03	b
Zirconium	7440-67-7	- - -	- - -	- - -	
BTEX Compounds		**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	
Ethylbenzene	100-41-4	7.80E+01	4.76E+02	7.80E+01	a
Xylenes, Total	1330-20-7	- - -	6.42E+01	6.42E+01	b
Dioxins/Dibenzofurans		**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	
1,2,3,4,6,7,8-HpCDD	35822-46-9	- - -	- - -	- - -	
1,2,3,4,6,7,8-HpCDF	67562-39-4	- - -	- - -	- - -	
1,2,3,4,7,8,9-HpCDF	55673-89-7	- - -	- - -	- - -	
1,2,3,4,7,8-HxCDD	39227-28-6	- - -	- - -	- - -	
1,2,3,4,7,8-HxCDF	70648-26-9	- - -	- - -	- - -	
1,2,3,5,7,8-HxCDF	57117-44-9	- - -	- - -	- - -	
1,2,3,6,7,8-HxCDD	57653-85-7	- - -	- - -	- - -	
1,2,3,6,7,8-HxCDF	55684-94-1	1.99E-04	- - -	1.99E-04	a
1,2,3,7,8,9-HxCDD	19408-74-3	4.81E-04	- - -	4.81E-04	a
1,2,3,7,8,9-HxCDF	72918-21-9	- - -	- - -	- - -	
1,2,3,7,8-PeCDD	40321-76-4	- - -	- - -	- - -	
1,2,3,7,8-PeCDF	57117-41-6	3.97E-05	- - -	3.97E-05	a
2,3,4,6,7,8-HxCDF	60851-34-5	- - -	- - -	- - -	
2,3,4,7,8-PeCDF	57117-31-4	3.97E-04	- - -	3.97E-04	a
2,3,7,8-TCDD	1746-01-6	1.86E-05	- - -	1.86E-05	a
2,3,7,8-TCDF	51207-31-9	1.99E-04	- - -	1.99E-04	a
HpCDD	37871-00-4	1.99E-03	- - -	1.99E-03	a
HpCDF	38998-75-3	1.99E-03	- - -	1.99E-03	a
HxCDD	34465-46-8	1.99E-04	- - -	1.99E-04	a
OCDD	3268-87-9	1.99E-02	- - -	1.99E-02	a
OCDF	39001-02-0	1.99E-02	- - -	1.99E-02	a
PeCDD	36088-22-9	3.97E-05	- - -	3.97E-05	a
PeCDF	30402-15-4	- - -	- - -	- - -	
TCDD, Total	41903-57-5	- - -	- - -	- - -	
TCDF	30402-14-3	- - -	- - -	- - -	
Explosives		**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	
1,3,5-Trinitrobenzene	99-35-4	- - -	6.39E+02	6.39E+02	b
1,3-Dinitrobenzene	99-65-0	- - -	2.13E+00	2.13E+00	b
2,4,6-Trinitrotoluene	118-96-7	9.94E+01	1.06E+01	1.06E+01	b
2,4-Dinitrotoluene	121-14-2	3.54E+00	3.44E+01	3.54E+00	a
2,6-Dinitrotoluene	606-20-2	3.54E+00	1.72E+01	3.54E+00	a
2-Amino-4,6-Dinitrotoluene	35572-78-2	- - -	- - -	- - -	
HMX	2691-41-0	- - -	1.06E+03	1.06E+03	b
Nitrobenzene	98-95-3	- - -	8.60E+00	8.60E+00	b
Nitroglycerin	55-63-0	- - -	- - -	- - -	
PETN	78-11-5	- - -	- - -	- - -	
RDX	121-82-4	2.71E+01	6.39E+01	2.71E+01	a
Tetryl	479-45-8	- - -	2.13E+02	2.13E+02	b
Pesticides and/or PCBs		**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	
4,4'-DDD	72-54-8	1.24E+01	- - -	1.24E+01	a
4,4'-DDE	72-55-9	8.77E+00	- - -	8.77E+00	a
4,4'-DDT	50-29-3	8.12E+00	9.86E+00	8.12E+00	a
Aldrin	309-00-2	1.42E-01	5.16E-01	1.42E-01	a
Alpha Chlordane	5103-71-9	7.61E+00	9.52E+00	7.61E+00	a
Alpha-BHC	319-84-6	4.73E-01	1.06E+01	4.73E-01	a
Aroclor-1016	12674-11-2	3.20E+01	1.12E+00	1.12E+00	b
Aroclor-1221	11104-28-2	- - -	- - -	- - -	
Aroclor-1232	11141-16-5	- - -	- - -	- - -	

SRC	CAS Number	Carcinogenic GV (TR = 1 x 10^{-6})	1/10th Non-Carcinogenic GV (THI = 1.0)	RBGV	Endpoint[a]
Aroclor-1242	53469-21-9	- - -	- - -	- - -	
Aroclor-1248	12672-29-6	- - -	- - -	- - -	
Aroclor-1254	11097-69-1	1.12E+00	3.20E-01	3.20E-01	b
Aroclor-1260	11096-82-5	- - -	- - -	- - -	
Beta-BHC	319-85-7	1.66E+00	4.26E+00	1.66E+00	a
Chlordane	57-74-9	7.61E+00	9.52E+00	7.61E+00	a
Delta-BHC	319-86-8	- - -	- - -	- - -	
Dieldrin	60-57-1	1.86E-01	1.06E+00	1.86E-01	a
Endosulfan I	959-98-8	- - -	- - -	- - -	
Endosulfan II	33213-65-9	- - -	- - -	- - -	
Endosulfan Sulfate	1031-07-8	- - -	- - -	- - -	
Endrin	72-20-8	- - -	6.39E+00	6.39E+00	b
Endrin Aldehyde	7421-93-4	- - -	- - -	- - -	
Endrin Ketone	53494-70-5	- - -	- - -	- - -	
Gamma Chlordane	5103-74-2	7.61E+00	9.52E+00	7.61E+00	a
Gamma-BHC (Lindane)	58-89-9	2.29E+00	6.39E+00	2.29E+00	a
Heptachlor	76-44-8	6.62E-01	1.06E+01	6.62E-01	a
Heptachlor Epoxide	1024-57-3	3.28E-01	2.77E-01	2.77E-01	b
Methoxychlor	72-43-5	- - -	1.06E+02	1.06E+02	b
Polychlorinated Biphenyls (PCBs)	1336-36-3	1.49E+00	4.26E-01	4.26E-01	b
Toxaphene	8001-35-2	2.71E+00	- - -	2.71E+00	a
Semi-Volatile Organics		**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	
1,2,4-Trichlorobenzene	120-82-1	- - -	1.72E+02	1.72E+02	b
1,2-Dichlorobenzene	95-50-1	- - -	1.55E+03	1.55E+03	b
1,2-Diphenylhydrazine	122-66-7	3.01E+00	- - -	3.01E+00	a
1,3-Dichlorobenzene	541-73-1	- - -	5.16E+02	5.16E+02	b
1,4-Dichlorobenzene	106-46-7	1.00E+02	5.16E+02	1.00E+02	a
2,2'-oxybis(1-chloropropane)	108-60-1	4.26E+01	8.52E+02	4.26E+01	a
2,4,5-Trichlorophenol	95-95-4	- - -	1.72E+03	1.72E+03	b
2,4,6-Trichlorophenol	88-06-2	2.19E+02	1.72E+00	1.72E+00	b
2,4-Dichlorophenol	120-83-2	- - -	5.05E+01	5.05E+01	b
2,4-Dimethylphenol	105-67-9	- - -	3.44E+02	3.44E+02	b
2,4-Dinitrophenol	51-28-5	- - -	3.44E+01	3.44E+01	b
2,4-Dinitrotoluene	121-14-2	3.54E+00	3.44E+01	3.54E+00	a
2,6-Dinitrotoluene	606-20-2	3.54E+00	1.72E+01	3.54E+00	a
2-Benzyl-4-Chlorophenol	120-32-1	- - -	- - -	- - -	
2-Chloronaphthalene	91-58-7	- - -	1.70E+03	1.70E+03	b
2-Chlorophenol	95-57-8	- - -	8.60E+01	8.60E+01	b
2-Methylnaphthalene	91-57-6	- - -	8.52E+01	8.52E+01	b
2-Methylphenol	95-48-7	- - -	1.06E+03	1.06E+03	b
2-Nitroaniline	88-74-4	- - -	6.37E+01	6.37E+01	b
2-Nitrophenol	88-75-5	- - -	- - -	- - -	
3,3'-Dichlorobenzidine	91-94-1	5.35E+00	- - -	5.35E+00	a
3-Nitroaniline	99-09-2	1.15E+02	5.16E+00	5.16E+00	b
4,6-Dinitro-o-Cresol	534-52-1	- - -	1.72E+00	1.72E+00	b
4-Bromophenyl-phenyl Ether	101-55-3	- - -	- - -	- - -	
4-Chloro-3-Methylphenol	59-50-7	- - -	- - -	- - -	
4-Chloroaniline	106-47-8	- - -	6.88E+01	6.88E+01	b
4-Chlorophenyl-Phenylether	7005-72-3	- - -	- - -	- - -	
4-Methylphenol	106-44-5	- - -	1.06E+02	1.06E+02	b
4-Nitroaniline	100-01-6	1.15E+02	5.16E+01	5.16E+01	b
4-Nitrophenol	100-02-7	- - -	- - -	- - -	
Acenaphthene	83-32-9	- - -	9.76E+02	9.76E+02	b
Acenaphthylene	208-96-8	- - -	- - -	- - -	
Anthracene	120-12-7	- - -	4.88E+03	4.88E+03	b
Benzidine	92-87-5	1.05E-02	5.16E+01	1.05E-02	a
Benzo(a)anthracene	56-55-3	3.12E+00	- - -	3.12E+00	a

SRC	CAS Number	Carcinogenic GV (TR = 1 x 10^{-6})	1/10th Non-Carcinogenic GV (THI = 1.0)	RBGV	Endpoint[a]
Benzo(a)pyrene	50-32-8	3.12E-01	- - -	3.12E-01	a
Benzo(b)fluoranthene	205-99-2	3.12E+00	- - -	3.12E+00	a
Benzo(g,h,i)perylene	191-24-2	- - -	- - -	- - -	
Benzo(k)fluoranthene	207-08-9	3.12E+01	- - -	3.12E+01	a
Benzoic Acid	65-85-0	- - -	6.88E+04	6.88E+04	b
Benzyl Alcohol	100-51-6	- - -	5.16E+03	5.16E+03	b
Bis(2-chloroethoxy)methane	111-91-1	- - -	- - -	- - -	
Bis(2-chloroethyl)ether	111-44-4	2.19E+00	- - -	2.19E+00	a
Bis(2-ethylhexyl)phthalate	117-81-7	1.72E+02	3.44E+02	1.72E+02	a
Butyl Benzyl Phthalate	85-68-7	- - -	3.44E+03	3.44E+03	b
Carbazole	86-74-8	1.20E+02	- - -	1.20E+02	a
Chrysene	218-01-9	3.12E+02	- - -	3.12E+02	a
Di-n-butyl Phthalate	84-74-2	- - -	1.72E+03	1.72E+03	b
Di-n-octyl Phthalate	117-84-0	- - -	8.52E+02	8.52E+02	b
Dibenz(a,h)anthracene	53-70-3	3.12E-01	- - -	3.12E-01	a
Dibenzofuran	132-64-9	- - -	3.44E+01	3.44E+01	b
Dichloromethane	75-09-02	- - -	- - -	- - -	
Diethyl Phthalate	84-66-2	- - -	1.38E+04	1.38E+04	b
Dimethyl Phthalate	131-11-3	- - -	2.13E+05	2.13E+05	b
Fluoranthene	206-44-0	- - -	6.51E+02	6.51E+02	b
Fluorene	86-73-7	- - -	6.51E+02	6.51E+02	b
Hexachlorobenzene	118-74-1	1.51E+00	1.38E+01	1.51E+00	a
Hexachlorobutadiene	87-68-3	3.09E+01	5.16E+00	5.16E+00	b
Hexachlorocyclopentadiene	77-47-4	- - -	1.03E+02	1.03E+02	b
Hexachloroethane	67-72-1	1.72E+02	1.72E+01	1.72E+01	b
Indeno(1,2,3-cd)pyrene	193-39-5	3.12E+00	- - -	3.12E+00	a
Isophorone	78-59-1	2.54E+03	3.44E+03	2.54E+03	a
N-Nitroso-di-n-propylamine	621-64-7	3.44E-01	- - -	3.44E-01	a
N-Nitrosodimethylamine	62-75-9	4.72E-02	1.38E-01	4.72E-02	a
N-Nitrosodiphenylamine	86-30-6	4.92E+02	3.44E+02	3.44E+02	b
Naphthalene	91-20-3	- - -	3.44E+02	3.44E+02	b
Nitrobenzene	98-95-3	- - -	8.60E+00	8.60E+00	b
Pentachlorophenol	87-86-5	1.56E+01	4.01E+02	1.56E+01	a
Phenanthrene	85-01-8	- - -	- - -	- - -	
Phenol	108-95-2	- - -	5.16E+03	5.16E+03	b
Pyrene	129-00-0	- - -	4.88E+02	4.88E+02	b
Pyridine	110-86-1	- - -	1.72E+01	1.72E+01	b
Tributyl phosphate	126-73-8	2.62E+02	3.44E+03	2.62E+02	a
Volatile Organics		**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	
1,1,1,2-Tetrachloroethane	630-20-6	2.73E+01	6.39E+02	2.73E+01	a
1,1,1-Trichloroethane	71-55-6	- - -	6.84E+02	6.84E+02	b
1,1,2,2-Tetrachloroethane	79-34-5	3.50E+00	1.28E+03	3.50E+00	a
1,1,2-Trichloro-1,2,2-Trifluoroethane (FREON-113)	76-13-1	- - -	6.93E+03	6.93E+03	b
1,1,2-Trichloroethane	79-00-5	8.19E+00	8.52E+01	8.19E+00	a
1,1-Dichloroethane	75-34-3	- - -	1.93E+02	1.93E+02	b
1,1-Dichloroethene	75-35-4	- - -	4.20E+01	4.20E+01	b
1,1-Dichloropropene	563-58-6	- - -	- - -	- - -	
1,2,3-Trichlorobenzene	87-61-6	- - -	- - -	- - -	
1,2,3-Trichloropropane	96-18-4	1.49E+00	1.06E+00	1.06E+00	b
1,2,4-Trichlorobenzene	120-82-1	- - -	1.91E+01	1.91E+01	b
1,2,4-Trimethylbenzene	95-63-6	- - -	1.71E+01	1.71E+01	b
1,2-Dibromo-3-Chloropropane	96-12-8	2.12E+00	7.28E-01	7.28E-01	b
1,2-Dichlorobenzene	95-50-1	- - -	2.86E+02	2.86E+02	b
1,2-Dichloroethane	107-06-2	3.45E+00	3.48E+00	3.45E+00	a
1,2-Dichloroethene	540-59-0	- - -	1.92E+02	1.92E+02	b
1,2-Dichloropropane	78-87-5	4.38E+01	2.08E+00	2.08E+00	b

SRC	CAS Number	Carcinogenic GV (TR = 1 x 10^{-6})	1/10th Non-Carcinogenic GV (THI = 1.0)	RBGV	Endpoint[a]
1,2-Diethylbenzene	135-01-3	- - -	- - -	- - -	
1,2-cis-Dichloroethene	156-59-2	- - -	2.13E+02	2.13E+02	b
1,2-trans-Dichloroethene	156-60-5	- - -	4.26E+02	4.26E+02	b
1,3,5-Trimethylbenzene	108-67-8	- - -	6.90E+00	6.90E+00	b
1,3-Dichlorobenzene	541-73-1	- - -	5.16E+02	5.16E+02	b
1,3-Dichloropropane	142-28-9	- - -	4.26E+02	4.26E+02	b
1,3-Diethylbenzene	141-93-5	- - -	- - -	- - -	
1,3-cis-Dichloropropene	10061-01-5	- - -	- - -	- - -	
1,3-trans-Dichloropropene	10061-02-6	- - -	- - -	- - -	
1,4-Dichlorobenzene	106-46-7	2.97E+01	3.86E+02	2.97E+01	a
1,4-Diethylbenzene	105-05-5	- - -	- - -	- - -	
1-Chlorohexane	544-10-5	- - -	- - -	- - -	
2,2'-oxybis(1-chloropropane)	108-60-1	2.19E+01	8.52E+02	2.19E+01	a
2,2-Dichloropropane	594-20-7	- - -	- - -	- - -	
2-Butanone	78-93-3	- - -	6.65E+03	6.65E+03	b
2-Chloroethylvinylether	110-75-8	- - -	- - -	- - -	
2-Chlorotoluene	95-49-8	- - -	4.26E+02	4.26E+02	b
2-Hexanone	591-78-6	- - -	- - -	- - -	
4-Chlorotoluene	106-43-4	- - -	- - -	- - -	
4-Methyl-2-pentanone	108-10-1	- - -	1.47E+03	1.47E+03	b
Acetone	67-64-1	- - -	1.92E+04	1.92E+04	b
Acetonitrile	75-05-8	- - -	2.00E+02	2.00E+02	b
Acrylonitrile	107-13-1	1.82E+00	2.34E+00	1.82E+00	a
Benzene	71-43-2	6.46E+00	1.08E+01	6.46E+00	a
Benzyl Chloride	100-44-7	1.75E+01	- - -	1.75E+01	a
Bromobenzene (Phenyl bromide, Monobromobenzene)	108-86-1	- - -	9.01E+00	9.01E+00	b
Bromochloromethane	74-97-5	- - -	- - -	- - -	
Bromodichloromethane	75-27-4	4.81E+01	4.26E+02	4.81E+01	a
Bromoform	75-25-2	3.77E+02	4.26E+02	3.77E+02	a
Bromomethane	74-83-9	- - -	1.26E+00	1.26E+00	b
Carbon Disulfide	75-15-0	- - -	1.16E+02	1.16E+02	b
Carbon Tetrachloride	56-23-5	2.44E+00	1.49E+01	2.44E+00	a
Chlorobenzene	108-90-7	- - -	4.85E+01	4.85E+01	b
Chloroethane	75-00-3	1.03E+03	1.57E+03	1.03E+03	a
Chloroform (Trichloromethane)	67-66-3	2.56E+00	1.89E+01	2.56E+00	a
Chloromethane	74-87-3	- - -	1.59E+01	1.59E+01	b
Chlorotoluene	25168-05-2	- - -	- - -	- - -	
Dibromochloromethane	124-48-1	3.55E+01	4.26E+02	3.55E+01	a
Dibromomethane	74-95-3	- - -	2.13E+02	2.13E+02	b
Dichlorodifluoromethane	75-71-8	- - -	3.19E+01	3.19E+01	b
Dichloromethane (Methylene Chloride)	75-09-2	8.25E+01	5.77E+02	8.25E+01	a
Ethylbenzene	100-41-4	7.80E+01	4.76E+02	7.80E+01	a
Ethylene Dibromide (1,2-Dibromoethane)	106-93-4	2.59E-01	1.14E+01	2.59E-01	a
Freon	76-13-1	- - -	6.93E+03	6.93E+03	b
Fluorobenzene	462-06-6	- - -	- - -	- - -	
Hexachlorobutadiene	87-68-3	3.09E+01	5.16E+00	5.16E+00	b
Hexane	110-54-3	- - -	4.08E+01	4.08E+01	b
Iodomethane	74-88-4	- - -	- - -	- - -	
Isopropyl Benzene	98-82-8	- - -	5.28E+01	5.28E+01	b
Naphthalene	91-20-3	- - -	1.79E+01	1.79E+01	b
O-Chloroflurobenzene	348-51-6	- - -	- - -	- - -	
Phenyl Bromide	108-86-1	- - -	9.01E+00	9.01E+00	b
Styrene	100-42-5	- - -	1.46E+03	1.46E+03	b
Tetrachloroethene	127-18-4	3.66E+00	1.52E+01	3.66E+00	a
Toluene	108-88-3	- - -	2.00E+02	2.00E+02	b

SRC	CAS Number	Carcinogenic GV (TR = 1 x 10^{-6})	1/10th Non-Carcinogenic GV (THI = 1.0)	RBGV	Endpoint[a]
Total VOCs	TVOC	- - -	- - -	- - -	
Trichloroethene	79-01-6	4.38E-01	4.49E+00	4.38E-01	a
Trichlorofluoromethane	75-69-4	- - -	1.30E+02	1.30E+02	b
Vinyl Acetate	108-05-4	- - -	1.39E+02	1.39E+02	b
Vinyl Chloride	75-01-4	1.07E+00	1.20E+01	1.07E+00	a
Xylenes, Total	1330-20-7	- - -	6.42E+01	6.42E+01	b
m-Xylene	108-38-3	- - -	4.26E+04	4.26E+04	b
mp-Xylene	mp-Xylene	- - -	- - -	2.77E+02	b
n-Butylbenzene	104-51-8	- - -	- - -	- - -	
n-propylbenzene	103-65-1	- - -	- - -	- - -	
o-Xylene	95-47-6	- - -	4.26E+04	4.26E+04	b
p-Isopropyltoluene	99-87-6	- - -	- - -	- - -	
p-Xylene	106-42-3	- - -	- - -	- - -	
sec-Butylbenzene	135-98-8	- - -	- - -	- - -	
tert-Butylbenzene	98-06-6	- - -	- - -	- - -	
Radiological		**pCi/g**		**pCi/g**	
Actinium	7440-34-8	- - -	- - -	- - -	
Actinium-227	14952-40-0	4.37E+00	- - -	4.37E+00	a
Actinium-227 +D	14952-40-0(+D)	4.56E-01	- - -	4.56E-01	a
Actinium-227 long-lived decay	14952-40-0L	4.56E-01	- - -	4.56E-01	a
Actinium-228	14331-83-0	2.17E-01	- - -	2.17E-01	a
Americium-241	14596-10-2	6.32E+00	- - -	6.32E+00	a
Antimony-124	14683-10-4	1.10E-01	- - -	1.10E-01	a
Antimony-125	14234-35-6	5.41E-01	- - -	5.41E-01	a
Antimony-125+D	14234-35-6(+D)	5.41E-01	- - -	5.41E-01	a
Barium-133	13981-41-4	6.79E-01	- - -	6.79E-01	a
Barium-133m	13981-41-4m	4.88E+00	- - -	4.88E+00	a
Barium-140	14798-08-4	1.25E+00	- - -	1.25E+00	a
Beryllium-7	13966-02-4	4.61E+00	- - -	4.61E+00	a
Bismuth-207	13982-38-2	1.39E-01	- - -	1.39E-01	a
Bismuth-210	14331-79-4	5.52E+01	- - -	5.52E+01	a
Bismuth-210m	14331-79-4m	8.97E-01	- - -	8.97E-01	a
Bismuth-211	15229-37-5	5.23E+00	- - -	5.23E+00	a
Bismuth-212	14913-49-6	1.11E+00	- - -	1.11E+00	a
Bismuth-214	14733-03-0	1.31E-01	- - -	1.31E-01	a
Cerium-139	CE-139	- - -	- - -	- - -	
Cerium-141	13967-74-3	4.18E+00	- - -	4.18E+00	a
Cerium-144	14762-78-8	8.91E+00	- - -	8.91E+00	a
Cerium-144+D	14762-78-8(+D)	3.23E+00	- - -	3.23E+00	a
Cesium-134	13967-70-9	1.38E-01	- - -	1.38E-01	a
Cesium-134m	13967-70-9m	1.96E+01	- - -	1.96E+01	a
Cesium-137	10045-97-3	3.77E+01	- - -	3.77E+01	a
Cesium-137 +D	10045-97-3(+D)	3.82E-01	- - -	3.82E-01	a
Cesium-137 long-lived decay	10045-97-3L	3.82E-01	- - -	3.82E-01	a
Chromium-51	14392-02-0	7.72E+00	- - -	7.72E+00	a
Cobalt-57	13981-50-5	2.76E+00	- - -	2.76E+00	a
Cobalt-58	13981-38-9	2.19E-01	- - -	2.19E-01	a
Cobalt-58m	13981-38-9m	4.78E+03	- - -	4.78E+03	a
Cobalt-60	10198-40-0	7.91E-02	- - -	7.91E-02	a
Cobalt-60m	10198-40-0m	5.28E+01	- - -	5.28E+01	a
Europium-152	14683-23-9	1.85E-01	- - -	1.85E-01	a
Europium-152m	14683-23-9m	7.36E-01	- - -	7.36E-01	a
Europium-154	15585-10-1	1.68E-01	- - -	1.68E-01	a
Europium-155	14391-16-3	7.73E+00	- - -	7.73E+00	a
Iodine-131	24267-56-9	- - -	- - -	- - -	
Iridium-192	12154-84-6	- - -	- - -	- - -	
Iron-59	14596-12-4	1.68E-01	- - -	1.68E-01	a

SRC	CAS Number	Carcinogenic GV (TR = 1 x 10^{-6})	1/10th Non-Carcinogenic GV (THI = 1.0)	RBGV	Endpoint[a]
Lanthanum-140	13981-28-7	8.54E-02	- - -	8.54E-02	a
Lead-210	14255-04-0	9.05E-01	- - -	9.05E-01	a
Lead-210+D	14255-04-0(+D)	6.25E-01	- - -	6.25E-01	a
Lead-210 long-lived decay	14255-04-0L	6.25E-01	- - -	6.25E-01	a
Lead-212	15092-94-1	1.79E+00	- - -	1.79E+00	a
Lead-214	15067-28-4	1.00E+00	- - -	1.00E+00	a
Manganese-54	13966-31-9	2.53E-01	- - -	2.53E-01	a
Mercury-203	13982-78-0	1.06E+00	- - -	1.06E+00	a
Neptunium-237	13994-20-2	7.04E+00	- - -	7.04E+00	a
Neptunium-237+D	13994-20-2(+D)	1.10E+00	- - -	1.10E+00	a
Niobium-95	13967-76-5	2.78E-01	- - -	2.78E-01	a
Niobium-95m	13967-76-5m	4.13E+00	- - -	4.13E+00	a
Plutonium-238	13981-16-3	6.12E+00	- - -	6.12E+00	a
Plutonium-238/239	PU-238/239	6.03E+00	- - -	6.03E+00	a
Plutonium-239	15117-48-3	6.03E+00	- - -	6.03E+00	a
Plutonium-239/240	14119-33-6	6.01E+00	- - -	6.01E+00	a
Plutonium-241	14119-32-5	5.06E+02	- - -	5.06E+02	a
Plutonium-242	13982-10-0	6.33E+00	- - -	6.33E+00	a
Polonium-210	13981-52-7	2.09E+00	- - -	2.09E+00	a
Potassium-40	13966-00-2	1.18E+00	- - -	1.18E+00	a
Protactinium-231	14331-85-2	2.73E+00	- - -	2.73E+00	a
Protactinium-231+D	14331-85-2D	3.91E-01	- - -	3.91E-01	a
Protactinium-231 long-lived decay	14331-85-2L	3.91E-01	- - -	3.91E-01	a
Protactinium-233	13981-14-1	1.31E+00	- - -	1.31E+00	a
Protactinium-234	15100-28-4	1.13E-01	- - -	1.13E-01	a
Protactinium-234m	15100-28-4m	1.43E+01	- - -	1.43E+01	a
Radium-223	15623-45-7	1.21E+00	- - -	1.21E+00	a
Radium-224	13233-32-4	3.24E+00	- - -	3.24E+00	a
Radium-225	13981-53-8	5.91E+00	- - -	5.91E+00	a
Radium-226	13982-63-3	2.17E+00	- - -	2.17E+00	a
Radium-226+D	13982-63-3(+D)	1.10E-01	- - -	1.10E-01	a
Radium-226 long-lived decay	13982-63-3L	9.37E-02	- - -	9.37E-02	a
Radium-228	15262-20-1	7.31E-01	- - -	7.31E-01	a
Radium-228+D	15262-20-1(+D)	1.67E-01	- - -	1.67E-01	a
Radium-228 long-lived decay	15262-20-1L	6.96E-02	- - -	6.96E-02	a
Ruthenium-103	13968-53-1	4.80E-01	- - -	4.80E-01	a
Ruthenium-106	13967-48-1	1.40E+01	- - -	1.40E+01	a
Ruthenium-106+D	13967-48-1(+D)	9.49E-01	- - -	9.49E-01	a
Scandium-46	13967-63-0	1.02E-01	- - -	1.02E-01	a
Silver	7440-22-4	- - -	- - -	- - -	
Silver-108m	14391-65-2m	1.37E-01	- - -	1.37E-01	a
Sodium-22	13966-32-0	9.53E-02	- - -	9.53E-02	a
Strontium-85	13967-73-2	4.46E-01	- - -	4.46E-01	a
Strontium-85m	13967-73-2m	1.20E+00	- - -	1.20E+00	a
Strontium-89	14158-27-1	3.55E+01	- - -	3.55E+01	a
Strontium-90	10098-97-2	1.80E+01	- - -	1.80E+01	a
Strontium-90+D	10098-97-2(+D)	9.40E+00	- - -	9.40E+00	a
Thallium-208	14913-50-9	5.59E-02	- - -	5.59E-02	a
Thorium-227	15623-47-9	2.14E+00	- - -	2.14E+00	a
Thorium-228	14274-82-9	5.58E+00	- - -	5.58E+00	a
Thorium-228+D	14274-82-9(+D)	1.19E-01	- - -	1.19E-01	a
Thorium-228 long-lived decay	14274-82-9L	1.19E-01	- - -	1.19E-01	a
Thorium-229	15594-54-4	1.90E+00	- - -	1.90E+00	a
Thorium-229+D	15594-54-4(+D)	5.09E-01	- - -	5.09E-01	a
Thorium-229 long-lived decay	15594-54-4L	5.09E-01	- - -	5.09E-01	a
Thorium-230	14269-63-7	8.19E+00	- - -	8.19E+00	a

SRC	CAS Number	Carcinogenic GV (TR = 1 x 10^{-6})	1/10th Non-Carcinogenic GV (THI = 1.0)	RBGV	Endpoint[a]
Thorium-230 D+	14269-63-7D	9.26E-02	- - -	9.26E-02	a
Thorium-230 long-lived decay	14269-63-7L	9.26E-02	- - -	9.26E-02	a
Thorium-232	7440-29-1	7.20E+00	- - -	7.20E+00	a
Thorium-232 D+	7440-29-1D	6.90E-02	- - -	6.90E-02	a
Thorium-232 long-lived decay	7440-29-1L	6.90E-02	- - -	6.90E-02	a
Thorium-234	15065-10-8	1.76E+01	- - -	1.76E+01	a
Tin-113	13966-06-8	3.59E+01	- - -	3.59E+01	a
Tin-126	15832-50-5	6.96E+00	- - -	6.96E+00	a
Tritium (particulate)	10028-17-8p	7.58E+03	- - -	7.58E+03	a
Tritium (water)	10028-17-8w	1.80E+04	- - -	1.80E+04	a
Uranium-232	14158-29-3	2.90E+00	- - -	2.90E+00	a
Uranium-233	13968-55-3	1.03E+01	- - -	1.03E+01	a
Uranium-233 long-lived decay	13968-55-3L	4.85E-01	- - -	4.85E-01	a
Uranium-233/234	U-233/234	4.82E-01	- - -	4.82E-01	a
Uranium-234	13966-29-5	1.05E+01	- - -	1.05E+01	a
Uranium-235	15117-96-1	1.61E+00	- - -	1.61E+00	a
Uranium-235+D	15117-96-1(+D)	1.54E+00	- - -	1.54E+00	a
Uranium-235 long-lived decay	15117-96-1L	3.12E-01	- - -	3.12E-01	a
Uranium-235/236	U-235/236	3.10E-01	- - -	3.10E-01	a
Uranium-238	7440-61-1	1.16E+01	- - -	1.16E+01	a
Uranium-238+D	7440-61-1(+D)	4.13E+00	- - -	4.13E+00	a
Uranium-238 long-lived decay	7440-61-1L	8.98E-02	- - -	8.98E-02	a
Yttrium-88	7440-65-5	- - -	- - -	- - -	
Zinc-65	13982-39-3	3.48E-01	- - -	3.48E-01	a
Zirconium-95	13967-71-0	2.89E-01	- - -	2.89E-01	a

Notes:

a. Endpoint indicates whether the RBGV listed is based on the carcinogenic or non-carcinogenic screening value,

a = Carcinogenic

b = Non-carcinogenic.

Table B.2 RBGVs for Site Worker Exposure to Soil

SRC	CAS Number	Carcinogenic GV (TR = 1 x 10^{-6})	1/10th Non-Carcinogenic GV (THI = 1.0)	RBGV	Endpoint[a]
Metals		**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	
Actinium	7440-34-8	- - -	- - -	- - -	
Aluminum	7429-90-5	- - -	1.69E+05	1.69E+05	b
Antimony	7440-36-0	- - -	8.18E+01	8.18E+01	b
Arsenic	7440-38-2	2.26E+00	3.64E+01	2.26E+00	a
Barium	7440-39-3	- - -	1.25E+04	1.25E+04	b
Beryllium	7440-41-7	2.25E+03	3.70E+02	3.70E+02	b
Bismuth	7440-69-9	- - -	- - -	- - -	
Boron	7440-42-8	- - -	4.05E+04	4.05E+04	b
Cadmium	7440-43-9s	3.00E+03	1.01E+01	1.01E+01	b
Calcium	7440-70-2	- - -	- - -	- - -	
Cerium	7440-45-1	- - -	3.85E+04	3.85E+04	b
Chromium	7440-47-3	- - -	- - -	- - -	
Chromium III	16065-83-1	- - -	3.07E+05	3.07E+05	b
Chromium VI	18540-29-9	6.51E+01	4.34E+02	6.51E+01	a
Cobalt	7440-48-4	1.93E+03	1.98E+03	1.93E+03	a
Copper	7440-50-8	- - -	8.18E+03	8.18E+03	b
Cyanide	57-12-5	- - -	4.09E+03	4.09E+03	b
Dypsprosium	7429-91-6	- - -	- - -	- - -	
Erbium	7440-52-0	- - -	- - -	- - -	
Europium	7440-53-1	- - -	- - -	- - -	
Gadolinium	7440-54-2	- - -	- - -	- - -	
Holmium	7440-60-0	- - -	- - -	- - -	
Iron	7439-89-6	- - -	- - -	- - -	
Lanthanum	7439-91-0	- - -	- - -	- - -	
Lead	7439-92-1	- - -	- - -	- - -	
Lithium	7439-93-2	- - -	- - -	- - -	
Lutetium	7439-94-3	- - -	- - -	- - -	
Magnesium	7439-95-4	- - -	- - -	- - -	
Manganese	7439-96-5s	- - -	3.25E+03	3.25E+03	b
Mercury	7439-97-6	- - -	5.78E+04	5.78E+04	b
Molybdenum	7439-98-7	- - -	1.02E+03	1.02E+03	b
Neodymium	7440-00-8	- - -	- - -	- - -	
Nickel	7440-02-0	- - -	4.09E+03	4.09E+03	b
Nitrate	14797-55-8	- - -	3.27E+05	3.27E+05	b
Nitrite	14797-65-0	- - -	2.04E+04	2.04E+04	b
Osmium	7440-04-2	- - -	- - -	- - -	
Potassium	7440-09-7	- - -	- - -	- - -	
Praseodymium	7440-10-0	- - -	- - -	- - -	
Rubidium	7440-17-7	- - -	- - -	- - -	
Samarium	7440-19-9	- - -	- - -	- - -	
Selenium	7782-49-2	- - -	1.02E+03	1.02E+03	b
Silicon	7440-21-3	- - -	- - -	- - -	
Silver	7440-22-4	- - -	1.02E+03	1.02E+03	b
Sodium	7440-23-5	- - -	- - -	- - -	
Strontium	7440-24-6	- - -	1.23E+05	1.23E+05	b
Tantalum	7440-25-7	- - -	- - -	- - -	
Terbium	7440-27-9	- - -	- - -	- - -	
Thallium	7440-28-0	- - -	1.35E+01	1.35E+01	b
Tin	7440-31-5	- - -	1.23E+05	1.23E+05	b
Titanium	7440-32-6	- - -	7.17E+05	7.17E+05	b
Uranium	7440-61-1	- - -	4.09E+01	4.09E+01	b
Vanadium	7440-62-2	- - -	2.04E+02	2.04E+02	b
Ytterbium	7440-64-4	- - -	- - -	- - -	
Zinc	7440-66-6	- - -	6.13E+04	6.13E+04	b

SRC	CAS Number	Carcinogenic GV (TR = 1 x 10^{-6})	1/10th Non-Carcinogenic GV (THI = 1.0)	RBGV	Endpoint[a]
Zirconium	7440-67-7	- - -	- - -	- - -	
BTEX Compounds		**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	
Ethylbenzene	100-41-4	- - -	2.04E+04	2.04E+04	b
Xylenes, Total	1330-20-7	- - -	4.09E+04	4.09E+04	b
Dioxins/Dibenzofurans		**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	
1,2,3,4,6,7,8-HpCDD	35822-46-9	- - -	- - -	- - -	
1,2,3,4,6,7,8-HpCDF	67562-39-4	- - -	- - -	- - -	
1,2,3,4,7,8,9-HpCDF	55673-89-7	- - -	- - -	- - -	
1,2,3,4,7,8-HxCDD	39227-28-6	- - -	- - -	- - -	
1,2,3,4,7,8-HxCDF	70648-26-9	- - -	- - -	- - -	
1,2,3,5,7,8-HxCDF	57117-44-9	- - -	- - -	- - -	
1,2,3,6,7,8-HxCDD	57653-85-7	- - -	- - -	- - -	
1,2,3,6,7,8-HxCDF	55684-94-1	3.81E-04	- - -	3.81E-04	a
1,2,3,7,8,9-HxCDD	19408-74-3	9.23E-04	- - -	9.23E-04	a
1,2,3,7,8,9-HxCDF	72918-21-9	- - -	- - -	- - -	
1,2,3,7,8-PeCDD	40321-76-4	- - -	- - -	- - -	
1,2,3,7,8-PeCDF	57117-41-6	7.63E-05	- - -	7.63E-05	a
2,3,4,6,7,8-HxCDF	60851-34-5	- - -	- - -	- - -	
2,3,4,7,8-PeCDF	57117-31-4	7.63E-04	- - -	7.63E-04	a
2,3,7,8-TCDD	1746-01-6	2.27E-05	- - -	2.27E-05	a
2,3,7,8-TCDF	51207-31-9	3.81E-04	- - -	3.81E-04	a
HpCDD	37871-00-4	3.81E-03	- - -	3.81E-03	a
HpCDF	38998-75-3	3.81E-03	- - -	3.81E-03	a
HxCDD	34465-46-8	3.81E-04	- - -	3.81E-04	a
OCDD	3268-87-9	3.81E-02	- - -	3.81E-02	a
OCDF	39001-02-0	3.81E-02	- - -	3.81E-02	a
PeCDD	36088-22-9	7.63E-05	- - -	7.63E-05	a
PeCDF	30402-15-4	- - -	- - -	- - -	
TCDD, Total	41903-57-5	- - -	- - -	- - -	
TCDF	30402-14-3	- - -	- - -	- - -	
Explosives		**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	
1,3,5-Trinitrobenzene	99-35-4	- - -	6.13E+03	6.13E+03	b
1,3-Dinitrobenzene	99-65-0	- - -	2.04E+01	2.04E+01	b
2,4,6-Trinitrotoluene	118-96-7	1.91E+02	1.02E+02	1.02E+02	b
2,4-Dinitrotoluene	121-14-2	2.57E+00	1.25E+02	2.57E+00	a
2,6-Dinitrotoluene	606-20-2	2.57E+00	6.23E+01	2.57E+00	a
2-Amino-4,6-Dinitrotoluene	35572-78-2	- - -	- - -	- - -	
HMX	2691-41-0	- - -	1.02E+04	1.02E+04	b
Nitrobenzene	98-95-3	- - -	3.12E+01	3.12E+01	b
Nitroglycerin	55-63-0	- - -	- - -	- - -	
PETN	78-11-5	- - -	- - -	- - -	
RDX	121-82-4	5.20E+01	6.13E+02	5.20E+01	a
Tetryl	479-45-8	- - -	2.04E+03	2.04E+03	b
Pesticides and/or PCBs		**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	
4,4'-DDD	72-54-8	2.38E+01	- - -	2.38E+01	a
4,4'-DDE	72-55-9	1.68E+01	- - -	1.68E+01	a
4,4'-DDT	50-29-3	9.56E+00	5.81E+01	9.56E+00	a
Aldrin	309-00-2	1.03E-01	1.87E+00	1.03E-01	a
Alpha Chlordane	5103-71-9	7.64E+00	4.77E+01	7.64E+00	a
Alpha-BHC	319-84-6	9.08E-01	1.02E+02	9.08E-01	a
Aroclor-1016	12674-11-2	1.95E+01	3.41E+00	3.41E+00	b
Aroclor-1221	11104-28-2	- - -	- - -	- - -	
Aroclor-1232	11141-16-5	- - -	- - -	- - -	
Aroclor-1242	53469-21-9	- - -	- - -	- - -	
Aroclor-1248	12672-29-6	- - -	- - -	- - -	
Aroclor-1254	11097-69-1	6.83E-01	9.75E-01	6.83E-01	a
Aroclor-1260	11096-82-5	- - -	- - -	- - -	

SRC	CAS Number	Carcinogenic GV (TR = 1 x 10^{-6})	1/10th Non-Carcinogenic GV (THI = 1.0)	RBGV	Endpoint[a]
Beta-BHC	319-85-7	3.18E+00	4.09E+01	3.18E+00	a
Chlordane	57-74-9	7.64E+00	4.77E+01	7.64E+00	a
Delta-BHC	319-86-8	- - -	- - -	- - -	
Dieldrin	60-57-1	3.58E-01	1.02E+01	3.58E-01	a
Endosulfan I	959-98-8	- - -	- - -	- - -	
Endosulfan II	33213-65-9	- - -	- - -	- - -	
Endosulfan Sulfate	1031-07-8	- - -	- - -	- - -	
Endrin	72-20-8	- - -	6.13E+01	6.13E+01	b
Endrin Aldehyde	7421-93-4	- - -	- - -	- - -	
Endrin Ketone	53494-70-5	- - -	- - -	- - -	
Gamma Chlordane	5103-74-2	7.64E+00	4.77E+01	7.64E+00	a
Gamma-BHC (Lindane)	58-89-9	4.40E+00	6.13E+01	4.40E+00	a
Heptachlor	76-44-8	1.27E+00	1.02E+02	1.27E+00	a
Heptachlor Epoxide	1024-57-3	6.29E-01	2.66E+00	6.29E-01	a
Methoxychlor	72-43-5	- - -	1.02E+03	1.02E+03	b
Polychlorinated Biphenyls (PCBs)	1336-36-3	2.86E+00	4.09E+00	2.86E+00	a
Toxaphene	8001-35-2	5.20E+00	- - -	5.20E+00	a
Semi-Volatile Organics		**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	
1,2,4-Trichlorobenzene	120-82-1	- - -	6.23E+02	6.23E+02	b
1,2-Dichlorobenzene	95-50-1	- - -	2.92E-03	2.92E-03	b
1,2-Diphenylhydrazine	122-66-7	2.18E+00	- - -	2.18E+00	a
1,3-Dichlorobenzene	541-73-1	- - -	1.87E+03	1.87E+03	b
1,4-Dichlorobenzene	106-46-7	7.27E+01	1.87E+03	7.27E+01	a
2,2'-oxybis(1-chloropropane)	108-60-1	8.17E+01	8.18E+03	8.17E+01	a
2,4,5-Trichlorophenol	95-95-4	- - -	6.23E+03	6.23E+03	b
2,4,6-Trichlorophenol	88-06-2	1.59E+02	6.23E+00	6.23E+00	b
2,4-Dichlorophenol	120-83-2	- - -	1.74E+02	1.74E+02	b
2,4-Dimethylphenol	105-67-9	- - -	1.25E+03	1.25E+03	b
2,4-Dinitrophenol	51-28-5	- - -	1.25E+02	1.25E+02	b
2,4-Dinitrotoluene	121-14-2	2.57E+00	1.25E+02	2.57E+00	a
2,6-Dinitrotoluene	606-20-2	2.57E+00	6.23E+01	2.57E+00	a
2-Benzyl-4-Chlorophenol	120-32-1	- - -	- - -	- - -	
2-Chloronaphthalene	91-58-7	- - -	1.64E+04	1.64E+04	b
2-Chlorophenol	95-57-8	- - -	3.12E+02	3.12E+02	b
2-Methylnaphthalene	91-57-6	- - -	8.18E+02	8.18E+02	b
2-Methylphenol	95-48-7	- - -	1.02E+04	1.02E+04	b
2-Nitroaniline	88-74-4	- - -	5.95E+02	5.95E+02	b
2-Nitrophenol	88-75-5	- - -	- - -	- - -	
3,3'-Dichlorobenzidine	91-94-1	3.88E+00	- - -	3.88E+00	a
3-Nitroaniline	99-09-2	8.31E+01	1.87E+01	1.87E+01	b
4,6-Dinitro-o-Cresol	534-52-1	- - -	6.23E+00	6.23E+00	b
4-Bromophenyl-phenyl Ether	101-55-3	- - -	- - -	- - -	
4-Chloro-3-Methylphenol	59-50-7	- - -	- - -	- - -	
4-Chloroaniline	106-47-8	- - -	2.49E+02	2.49E+02	b
4-Chlorophenyl-Phenylether	7005-72-3	- - -	- - -	- - -	
4-Methylphenol	106-44-5	- - -	1.02E+03	1.02E+03	b
4-Nitroaniline	100-01-6	8.31E+01	1.87E+02	8.31E+01	a
4-Nitrophenol	100-02-7	- - -	- - -	- - -	
Acenaphthene	83-32-9	- - -	3.09E+03	3.09E+03	b
Acenaphthylene	208-96-8	- - -	- - -	- - -	
Anthracene	120-12-7	- - -	1.55E+04	1.55E+04	b
Benzidine	92-87-5	7.59E-03	1.87E+02	7.59E-03	a
Benzo(a)anthracene	56-55-3	1.98E+00	- - -	1.98E+00	a
Benzo(a)pyrene	50-32-8	1.98E-01	- - -	1.98E-01	a
Benzo(b)fluoranthene	205-99-2	1.98E+00	- - -	1.98E+00	a
Benzo(g,h,i)perylene	191-24-2	- - -	- - -	- - -	

SRC	CAS Number	Carcinogenic GV (TR = 1 x 10^{-6})	1/10th Non-Carcinogenic GV (THI = 1.0)	RBGV	Endpoint[a]
Benzo(k)fluoranthene	207-08-9	1.98E+01	- - -	1.98E+01	a
Benzoic Acid	65-85-0	- - -	2.49E+05	2.49E+05	b
Benzyl Alcohol	100-51-6	- - -	1.87E+04	1.87E+04	b
Bis(2-chloroethoxy)methane	111-91-1	- - -	- - -	- - -	
Bis(2-chloroethyl)ether	111-44-4	1.59E+00	- - -	1.59E+00	a
Bis(2-ethylhexyl)phthalate	117-81-7	1.25E+02	1.25E+03	1.25E+02	a
Butyl Benzyl Phthalate	85-68-7	- - -	1.25E+04	1.25E+04	b
Carbazole	86-74-8	8.72E+01	- - -	8.72E+01	a
Chrysene	218-01-9	1.98E+02	- - -	1.98E+02	a
Di-n-butyl Phthalate	84-74-2	- - -	6.23E+03	6.23E+03	b
Di-n-octyl Phthalate	117-84-0	- - -	8.18E+03	8.18E+03	b
Dibenz(a,h)anthracene	53-70-3	1.98E-01	- - -	1.98E-01	a
Dibenzofuran	132-64-9	- - -	1.25E+02	1.25E+02	b
Dichloromethane	75-09-02	- - -	- - -	- - -	
Diethyl Phthalate	84-66-2	- - -	4.99E+04	4.99E+04	b
Dimethyl Phthalate	131-11-3	- - -	2.04E+06	2.04E+06	b
Fluoranthene	206-44-0	- - -	2.06E+03	2.06E+03	b
Fluorene	86-73-7	- - -	2.06E+03	2.06E+03	b
Hexachlorobenzene	118-74-1	1.09E+00	4.99E+01	1.09E+00	a
Hexachlorobutadiene	87-68-3	2.24E+01	1.87E+01	1.87E+01	b
Hexachlorocyclopentadiene	77-47-4	- - -	3.70E+02	3.70E+02	b
Hexachloroethane	67-72-1	1.25E+02	6.23E+01	6.23E+01	b
Indeno(1,2,3-cd)pyrene	193-39-5	1.98E+00	- - -	1.98E+00	a
Isophorone	78-59-1	1.84E+03	1.25E+04	1.84E+03	a
N-Nitroso-di-n-propylamine	621-64-7	2.49E-01	- - -	2.49E-01	a
N-Nitrosodimethylamine	62-75-9	3.42E-02	4.99E-01	3.42E-02	a
N-Nitrosodiphenylamine	86-30-6	3.56E+02	1.25E+03	3.56E+02	a
Naphthalene	91-20-3	- - -	1.24E+03	1.24E+03	b
Nitrobenzene	98-95-3	- - -	3.12E+01	3.12E+01	b
Pentachlorophenol	87-86-5	7.12E+00	9.15E+02	7.12E+00	a
Phenanthrene	85-01-8	- - -	- - -	- - -	
Phenol	108-95-2	- - -	1.87E+04	1.87E+04	b
Pyrene	129-00-0	- - -	1.55E+03	1.55E+03	b
Pyridine	110-86-1	- - -	6.23E+01	6.23E+01	b
Tributyl phosphate	126-73-8	1.90E+02	1.25E+04	1.90E+02	a
Volatile Organics		**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	
1,1,1,2-Tetrachloroethane	630-20-6	2.20E+02	6.13E+03	2.20E+02	a
1,1,1-Trichloroethane	71-55-6	- - -	5.72E+04	5.72E+04	b
1,1,2,2-Tetrachloroethane	79-34-5	2.86E+01	1.23E+04	2.86E+01	a
1,1,2-Trichloro-1,2,2-Trifluoroethane (FREON-113)	76-13-1	- - -	6.13E+06	6.13E+06	b
1,1,2-Trichloroethane	79-00-5	1.00E+02	8.18E+02	1.00E+02	a
1,1-Dichloroethane	75-34-3	- - -	2.04E+04	2.04E+04	b
1,1-Dichloroethene	75-35-4	- - -	1.02E+04	1.02E+04	b
1,1-Dichloropropene	563-58-6	- - -	- - -	- - -	
1,2,3-Trichlorobenzene	87-61-6	- - -	- - -	- - -	
1,2,3-Trichloropropane	96-18-4	2.86E+00	1.23E+03	2.86E+00	a
1,2,4-Trichlorobenzene	120-82-1	- - -	5.11E-05	5.11E-05	b
1,2,4-Trimethylbenzene	95-63-6	- - -	1.02E+04	1.02E+04	b
1,2-Dibromo-3-Chloropropane	96-12-8	4.09E+00	- - -	4.09E+00	a
1,2-Dichlorobenzene	95-50-1	- - -	2.92E-03	2.92E-03	b
1,2-Dichloroethane	107-06-2	6.29E+01	4.09E+03	6.29E+01	a
1,2-Dichloroethene	540-59-0	- - -	1.84E+03	1.84E+03	b
1,2-Dichloropropane	78-87-5	8.42E+01	- - -	8.42E+01	a
1,2-Diethylbenzene	135-01-3	- - -	- - -	- - -	
1,2-cis-Dichloroethene	156-59-2	- - -	2.04E+03	2.04E+03	b

SRC	CAS Number	Carcinogenic GV (TR = 1 x 10^{-6})	1/10th Non-Carcinogenic GV (THI = 1.0)	RBGV	Endpoint[a]
1,2-trans-Dichloroethene	156-60-5	- - -	4.09E+03	4.09E+03	b
1,3,5-Trimethylbenzene	108-67-8	- - -	1.02E+04	1.02E+04	b
1,3-Dichlorobenzene	541-73-1	- - -	1.87E+03	1.87E+03	b
1,3-Dichloropropane	142-28-9	- - -	4.09E+03	4.09E+03	b
1,3-Diethylbenzene	141-93-5	- - -	- - -	- - -	
1,3-cis-Dichloropropene	10061-01-5	- - -	- - -	- - -	
1,3-trans-Dichloropropene	10061-02-6	- - -	- - -	- - -	
1,4-Dichlorobenzene	106-46-7	6.50E-05	1.18E-02	6.50E-05	a
1,4-Diethylbenzene	105-05-5	- - -	- - -	- - -	
1-Chlorohexane	544-10-5	- - -	- - -	- - -	
2,2'-oxybis(1-chloropropane)	108-60-1	8.18E+01	8.18E+03	8.18E+01	a
2,2-Dichloropropane	594-20-7	- - -	- - -	- - -	
2-Butanone	78-93-3	- - -	1.23E+05	1.23E+05	b
2-Chloroethylvinylether	110-75-8	- - -	- - -	- - -	
2-Chlorotoluene	95-49-8	- - -	4.09E+03	4.09E+03	b
2-Hexanone	591-78-6	- - -	- - -	- - -	
4-Chlorotoluene	106-43-4	- - -	- - -	- - -	
4-Methyl-2-pentanone	108-10-1	- - -	1.64E+04	1.64E+04	b
Acetone	67-64-1	- - -	1.84E+05	1.84E+05	b
Acetonitrile	75-05-8	- - -	- - -	- - -	
Acrylonitrile	107-13-1	1.06E+01	2.04E+02	1.06E+01	a
Benzene	71-43-2	1.04E+02	8.18E+02	1.04E+02	a
Benzyl Chloride	100-44-7	3.37E+01	- - -	3.37E+01	a
Bromobenzene (Phenyl bromide, Monobromobenzene)	108-86-1	- - -	4.09E+03	4.09E+03	b
Bromochloromethane	74-97-5	- - -	- - -	- - -	
Bromodichloromethane	75-27-4	9.23E+01	4.09E+03	9.23E+01	a
Bromoform	75-25-2	7.24E+02	4.09E+03	7.24E+02	a
Bromomethane	74-83-9	- - -	2.86E+02	2.86E+02	b
Carbon Disulfide	75-15-0	- - -	2.04E+04	2.04E+04	b
Carbon Tetrachloride	56-23-5	4.40E+01	1.43E+02	4.40E+01	a
Chlorobenzene	108-90-7	- - -	4.09E+03	4.09E+03	b
Chloroethane	75-00-3	1.97E+03	8.18E+04	1.97E+03	a
Chloroform (Trichloromethane)	67-66-3	- - -	2.04E+03	2.04E+03	b
Chloromethane	74-87-3	- - -	- - -	- - -	
Chlorotoluene	25168-05-2	- - -	- - -	- - -	
Dibromochloromethane	124-48-1	6.81E+01	4.09E+03	6.81E+01	a
Dibromomethane	74-95-3	- - -	2.04E+03	2.04E+03	b
Dichlorodifluoromethane	75-71-8	- - -	4.09E+04	4.09E+04	b
Dichloromethane (Methylene Chloride)	75-09-2	7.63E+02	1.23E+04	7.63E+02	a
Ethylbenzene	100-41-4	- - -	2.04E+04	2.04E+04	b
Ethylene Dibromide (1,2-Dibromoethane)	106-93-4	2.86E+00	1.84E+03	2.86E+00	a
Freon	76-13-1	- - -	6.13E+06	6.13E+06	b
Fluorobenzene	462-06-6	- - -	- - -	- - -	
Hexachlorobutadiene	87-68-3	2.24E+01	1.87E+01	1.87E+01	b
Hexane	110-54-3	- - -	2.25E+06	2.25E+06	b
Iodomethane	74-88-4	- - -	- - -	- - -	
Isopropyl Benzene	98-82-8	- - -	2.04E+04	2.04E+04	b
Naphthalene	91-20-3	- - -	4.38E-05	4.38E-05	b
O-Chloroflurobenzene	348-51-6	- - -	- - -	- - -	
Phenyl Bromide	108-86-1	- - -	4.09E+03	4.09E+03	b
Styrene	100-42-5	- - -	4.09E+04	4.09E+04	b
Tetrachloroethene	127-18-4	1.06E+01	2.04E+03	1.06E+01	a
Toluene	108-88-3	- - -	4.09E+04	4.09E+04	b

SRC	CAS Number	Carcinogenic GV (TR = 1 x 10^{-6})	1/10th Non-Carcinogenic GV (THI = 1.0)	RBGV	Endpoint[a]
Total VOCs	TVOC	- - -	- - -	- - -	
Trichloroethene	79-01-6	1.43E+01	6.13E+01	1.43E+01	a
Trichlorofluoromethane	75-69-4	- - -	6.13E+04	6.13E+04	b
Vinyl Acetate	108-05-4	- - -	2.04E+05	2.04E+05	b
Vinyl Chloride	75-01-4	3.82E+00	6.13E+02	3.82E+00	a
Xylenes, Total	1330-20-7	- - -	4.09E+04	4.09E+04	b
m-Xylene	108-38-3	- - -	4.09E+05	4.09E+05	b
mp-Xylene	mp-Xylene	- - -	- - -	2.79E+02	b
n-Butylbenzene	104-51-8	- - -	- - -	- - -	
n-propylbenzene	103-65-1	- - -	- - -	- - -	
o-Xylene	95-47-6	- - -	4.09E+05	4.09E+05	b
p-Isopropyltoluene	99-87-6	- - -	- - -	- - -	
p-Xylene	106-42-3	- - -	- - -	- - -	
sec-Butylbenzene	135-98-8	- - -	- - -	- - -	
tert-Butylbenzene	98-06-6	- - -	- - -	- - -	
Radiological		**pCi/g**		**pCi/g**	
Actinium	7440-34-8	- - -	- - -	- - -	
Actinium-227	14952-40-0	7.49E+00	- - -	7.49E+00	a
Actinium-227 +D	14952-40-0(+D)	5.02E-01	- - -	5.02E-01	a
Actinium-227 long-lived decay	14952-40-0L	5.02E-01	- - -	5.02E-01	a
Actinium-228	14331-83-0	2.01E-01	- - -	2.01E-01	a
Americium-241	14596-10-2	9.93E+00	- - -	9.93E+00	a
Antimony-124	14683-10-4	1.03E-01	- - -	1.03E-01	a
Antimony-125	14234-35-6	5.03E-01	- - -	5.03E-01	a
Antimony-125+D	14234-35-6(+D)	5.03E-01	- - -	5.03E-01	a
Barium-133	13981-41-4	6.32E-01	- - -	6.32E-01	a
Barium-133m	13981-41-4m	4.59E+00	- - -	4.59E+00	a
Barium-140	14798-08-4	1.18E+00	- - -	1.18E+00	a
Beryllium-7	13966-02-4	4.28E+00	- - -	4.28E+00	a
Bismuth-207	13982-38-2	1.29E-01	- - -	1.29E-01	a
Bismuth-210	14331-79-4	9.07E+01	- - -	9.07E+01	a
Bismuth-210m	BI-210M	8.67E-01	- - -	8.67E-01	a
Bismuth-211	15229-37-5	4.85E+00	- - -	4.85E+00	a
Bismuth-212	14913-49-6	1.03E+00	- - -	1.03E+00	a
Bismuth-214	14733-03-0	1.22E-01	- - -	1.22E-01	a
Cerium-139	CE-139	- - -	- - -	- - -	
Cerium-141	13967-74-3	3.95E+00	- - -	3.95E+00	a
Cerium-144	14762-78-8	1.15E+01	- - -	1.15E+01	a
Cerium-144+D	14762-78-8(+D)	3.34E+00	- - -	3.34E+00	a
Cesium-134	13967-70-9	1.28E-01	- - -	1.28E-01	a
Cesium-134m	13967-70-9m	1.82E+01	- - -	1.82E+01	a
Cesium-137	10045-97-3	7.08E+01	- - -	7.08E+01	a
Cesium-137 +D	10045-97-3(+D)	3.56E-01	- - -	3.56E-01	a
Cesium-137 long-lived decay	10045-97-3L	3.56E-01	- - -	3.56E-01	a
Chromium-51	14392-02-0	7.18E+00	- - -	7.18E+00	a
Cobalt-57	13981-50-5	2.56E+00	- - -	2.56E+00	a
Cobalt-58	13981-38-9	2.04E-01	- - -	2.04E-01	a
Cobalt-58m	13981-38-9m	9.13E+03	- - -	9.13E+03	a
Cobalt-60	10198-40-0	7.35E-02	- - -	7.35E-02	a
Cobalt-60m	10198-40-0m	4.90E+01	- - -	4.90E+01	a
Europium-152	14683-23-9	1.72E-01	- - -	1.72E-01	a
Europium-152m	14683-23-9m	6.85E-01	- - -	6.85E-01	a
Europium-154	15585-10-1	1.56E-01	- - -	1.56E-01	a
Europium-155	14391-16-3	7.27E+00	- - -	7.27E+00	a
Iodine-131	24267-56-9	- - -	- - -	- - -	
Iridium-192	12154-84-6	- - -	- - -	- - -	

SRC	CAS Number	Carcinogenic GV (TR = 1 x 10^{-6})	1/10th Non-Carcinogenic GV (THI = 1.0)	RBGV	Endpoint[a]
Iron-59	14596-12-4	1.56E-01	- - -	1.56E-01	a
Lanthanum-140	13981-28-7	7.93E-02	- - -	7.93E-02	a
Lead-210	14255-04-0	1.73E+00	- - -	1.73E+00	a
Lead-210+D	14255-04-0(+D)	1.19E+00	- - -	1.19E+00	a
Lead-210 long-lived decay	14255-04-0L	1.19E+00	- - -	1.19E+00	a
Lead-212	15092-94-1	1.73E+00	- - -	1.73E+00	a
Lead-214	15067-28-4	9.29E-01	- - -	9.29E-01	a
Manganese-54	13966-31-9	2.34E-01	- - -	2.34E-01	a
Mercury-203	13982-78-0	9.87E-01	- - -	9.87E-01	a
Neptunium-237	13994-20-2	9.43E+00	- - -	9.43E+00	a
Neptunium-237+D	13994-20-2(+D)	1.08E+00	- - -	1.08E+00	a
Niobium-95	13967-76-5	2.58E-01	- - -	2.58E-01	a
Niobium-95m	13967-76-5m	3.88E+00	- - -	3.88E+00	a
Plutonium-238	13981-16-3	1.13E+01	- - -	1.13E+01	a
Plutonium-238/239	PU-238/239	1.12E+01	- - -	1.12E+01	a
Plutonium-239	15117-48-3	1.12E+01	- - -	1.12E+01	a
Plutonium-239/240	PU-239/240	1.11E+01	- - -	1.11E+01	a
Plutonium-241	14119-32-5	9.40E+02	- - -	9.40E+02	a
Plutonium-242	13982-10-0	1.17E+01	- - -	1.17E+01	a
Polonium-210	13981-52-7	4.00E+00	- - -	4.00E+00	a
Potassium-40	13966-00-2	1.12E+00	- - -	1.12E+00	a
Protactinium-231	14331-85-2	3.66E+00	- - -	3.66E+00	a
Protactinium-231+D	14331-85-2D	4.41E-01	- - -	4.41E-01	a
Protactinium-231 long-lived decay	14331-85-2L	4.41E-01	- - -	4.41E-01	a
Protactinium-233	13981-14-1	1.22E+00	- - -	1.22E+00	a
Protactinium-234	15100-28-4	1.05E-01	- - -	1.05E-01	a
Protactinium-234m	15100-28-4m	1.33E+01	- - -	1.33E+01	a
Radium-223	15623-45-7	1.47E+00	- - -	1.47E+00	a
Radium-224	13233-32-4	5.47E+00	- - -	5.47E+00	a
Radium-225	13981-53-8	1.07E+01	- - -	1.07E+01	a
Radium-226	13982-63-3	3.94E+00	- - -	3.94E+00	a
Radium-226+D	13982-63-3(+D)	1.05E-01	- - -	1.05E-01	a
Radium-226 long-lived decay	13982-63-3L	9.64E-02	- - -	9.64E-02	a
Radium-228	15262-20-1	1.40E+00	- - -	1.40E+00	a
Radium-228+D	15262-20-1(+D)	1.76E-01	- - -	1.76E-01	a
Radium-228 long-lived decay	15262-20-1L	6.92E-02	- - -	6.92E-02	a
Ruthenium-103	13968-53-1	4.47E-01	- - -	4.47E-01	a
Ruthenium-106	13967-48-1	2.69E+01	- - -	2.69E+01	a
Ruthenium-106+D	13967-48-1(+D)	9.12E-01	- - -	9.12E-01	a
Scandium-46	13967-63-0	9.47E-02	- - -	9.47E-02	a
Silver	7440-22-4	- - -	- - -	- - -	
Silver-108m	14391-65-2m	1.27E-01	- - -	1.27E-01	a
Sodium-22	13966-32-0	8.85E-02	- - -	8.85E-02	a
Strontium-85	13967-73-2	4.14E-01	- - -	4.14E-01	a
Strontium-85m	13967-73-2m	1.11E+00	- - -	1.11E+00	a
Strontium-89	14158-27-1	5.34E+01	- - -	5.34E+01	a
Strontium-90	10098-97-2	3.42E+01	- - -	3.42E+01	a
Strontium-90+D	10098-97-2(+D)	1.50E+01	- - -	1.50E+01	a
Thallium-208	14913-50-9	5.18E-02	- - -	5.18E-02	a
Thorium-227	15623-47-9	2.17E+00	- - -	2.17E+00	a
Thorium-228	14274-82-9	9.18E+00	- - -	9.18E+00	a
Thorium-228+D	14274-82-9(+D)	1.14E-01	- - -	1.14E-01	a
Thorium-228 long-lived decay	14274-82-9L	1.14E-01	- - -	1.14E-01	a
Thorium-229	15594-54-4	2.39E+00	- - -	2.39E+00	a
Thorium-229+D	15594-54-4(+D)	5.86E-01	- - -	5.86E-01	a
Thorium-229 long-lived decay	15594-54-4L	5.86E-01	- - -	5.86E-01	a

SRC	CAS Number	Carcinogenic GV (TR = 1 x 10^{-6})	1/10th Non-Carcinogenic GV (THI = 1.0)	RBGV	Endpoint[a]
Thorium-230	14269-63-7	1.50E+01	- - -	1.50E+01	a
Thorium-230 D+	14269-63-7(+D)	9.58E-02	- - -	9.58E-02	a
Thorium-230 long-lived decay	14269-63-7L	9.58E-02	- - -	9.58E-02	a
Thorium-232	7440-29-1	1.30E+01	- - -	1.30E+01	a
Thorium-232 +D	7440-29-1(+D)	6.88E-02	- - -	6.88E-02	a
Thorium-232 long-lived decay	7440-29-1L	6.88E-02	- - -	6.88E-02	a
Thorium-234	15065-10-8	2.58E+01	- - -	2.58E+01	a
Tin-113	13966-06-8	3.85E+01	- - -	3.85E+01	a
Tin-126	15832-50-5	7.62E+00	- - -	7.62E+00	a
Tritium (particulate)	10028-17-8p	1.45E+04	- - -	1.45E+04	a
Tritium (water)	10028-17-8w	3.46E+04	- - -	3.46E+04	a
Uranium-232	14158-29-3	5.50E+00	- - -	5.50E+00	a
Uranium-233	13968-55-3	1.92E+01	- - -	1.92E+01	a
Uranium-233 long-lived decay	13968-55-3L	5.69E-01	- - -	5.69E-01	a
Uranium-233/234	U-233/234	5.52E-01	- - -	5.52E-01	a
Uranium-234	13966-29-5	1.97E+01	- - -	1.97E+01	a
Uranium-235	15117-96-1	1.62E+00	- - -	1.62E+00	a
Uranium-235+D	15117-96-1(+D)	1.55E+00	- - -	1.55E+00	a
Uranium-235 long-lived decay	15117-96-1L	3.43E-01	- - -	3.43E-01	a
Uranium-235/236	U-235/236	3.32E-01	- - -	3.32E-01	a
Uranium-238	7440-61-1	2.19E+01	- - -	2.19E+01	a
Uranium-238+D	7440-61-1(+D)	5.22E+00	- - -	5.22E+00	a
Uranium-238 long-lived decay	7440-61-1L	9.36E-02	- - -	9.36E-02	a
Yttrium-88	7440-65-5	- - -	- - -	- - -	
Zinc-65	13982-39-3	3.24E-01	- - -	3.24E-01	a
Zirconium-95	13967-71-0	2.68E-01	- - -	2.68E-01	a

Notes:

a. Endpoint indicates whether the RBGV listed is based on the carcinogenic or non-carcinogenic screening value,

a = Carcinogenic

b = Non-carcinogenic.

Appendix C
Demonstration of Secular Equilibrium

Secular Equilibrium

Several of the radionuclides of interest at Mound are part of the naturally occurring decay chains. The naturally occurring decay chains are the uranium-238 chain, the uranium-235 chain, and the thorium-232 chain. The risk assessment was based on the EPCs for each of the members of the decay series that were long lived (i.e., half-life greater than 6 months). This includes the following progeny for each decay chain:

U-238
- U-234
- Th-230
- Ra-226
- Pb-210

U-235
- Pa-231
- Ac-227

Th-232
- Ra-228
- Th-228

The risk analysis did not assume secular equilibrium of these long-lived progeny; instead, the appropriate EPCs in the media of interest were used directly in the calculations of the risk assessment.

Secular equilibrium was assumed between the long-lived progeny and their associated short-lived progeny with half-lives of 6 months or less. The associated slope factors with the +D designation were used to represent these short-lived progeny in the analysis. Secular equilibrium for these short-lived progeny can be assumed, since equilibrium is generally obtained after seven half-lives of the short-lived progeny. For example, U-238+D represents the following progeny:

U-238 + D = U-238 + Th-234 + Pa-234m + Pa-234

The longer of the short-lived progeny is Th-234 with a half-life of 24 days. Secular equilibrium will be obtained for the short-lived progeny of U-238 in approximately 168 days. Considering that natural decay chain radionuclides have been present since the beginning of time, these short-lived progeny are in secular equilibrium. The same process can be used to justify each of the long-lived progeny in the U-235 and Th-232 decay chains and their associated short-lived progeny. For example, in the uranium-238 decay series:

U-238 + D = U-238 + Th-234 + Pa-234m + Pa-234
- U-234
- Th-230
- Ra-226 + D = Ra-226 + Rn-222 + Po-218 + Pb-214 + Po-214
- Pb-210 + D = Pb-210 + Bi-210 + Po-210

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Appendix D
Parcel 9 Building Information

Buildings Located in Parcel 9

Building 1 and Building 106: Building 1 was a one-story, 986-square-foot concrete block structure, with a sheet metal addition (Bldg 106) on one side. The roof was of built-up membrane coal tar and asphalt. The building had electrical service of 240 V and central steam. Building 1 was constructed in 1958. It consisted of four heavy-walled rooms, plus a small office area with a window air conditioner. The facility had been used to support the same program since construction. Research and testing activities involving energetic materials were conducted in the building. In the past, the building was used for processing and blending of explosive powders. More recently, it was used for packaging of energetic materials.

Building 24: The facility was constructed for the purpose of treating raw well water and had been used for the same purpose since construction. The facility was a concrete block structure built with slab-on-grade floor with built up membrane roof. The facility contained two large-capacity (100,000-gallon) zeolite-softening beds plus the chemicals and injection equipment for chlorination and rust inhibition. The building also contained two high-capacity booster pumps to distribute the treated water.

Building 27 and S-6: The explosive materials laboratory and testing facility was a two-story, 5,300-square-foot, reinforced concrete, slab-on-grade structure with a built-up membrane (asphalt) roof. The south wall had frangible panels. The second floor contained a lavatory and a locker room. The first floor contained laboratories, an office, storage, and explosive bays. The building was serviced by sanitary and storm water service lines and a fire sprinkler water main. Electric service of Building 27 was constructed in 1969. The building had been used for the same purpose since construction. Research and testing activities using energetic materials have occurred in the building. Research, development, and testing activities using radioactive materials have not occurred in Shed 6 (S6). Shed 6 occupied 35 square-feet and was removed in 2002.

Building 42: The pyrotechnics and thermite production facility was a two-story, 2,892-square-foot combination reinforced concrete and concrete block slab-on-grade structure, which had a built-up membrane (coal tar) roof. The first floor of the structure (approximately 2,000 square feet) housed assembly cells, an electronic equipment room, lavatory, laboratory, office, storage, and a janitor‘s closet. The second floor (approximately 200 square feet) was known as the penthouse. The second floor had an outside access stairway and the floor contained mechanical equipment. The building was serviced by central steam for heat and chilled water, and electrical service of 240 V. Building 42 was constructed in1970. The building had been used for the same purpose since construction. Component testing and assembly of pyrotechnics and energetic materials have occurred in the building. The assembly rooms had steel blast shields or steel blast cells. The interior assembly rooms contained distribution systems for nitrogen, argon, and high-pressure air.

Building 43: This building was a one-story, 1,516 square-foot, reinforced concrete structure. The roof was of built-up membrane (asphalt). The building had been serviced with electrical service of 240 V, central steam, and chilled water. Building 43 was constructed in 1971. The facility had been used for the same purpose since construction. Research and development activities involving thermite had been conducted in the building.

Building 67: This building was a one-story, 3,787-square-foot structure. Built slab-on-grade, it was a concrete-covered, polystyrene foam building with a metal roof. The building previously served as office space for energetic materials support staff. The building contains open office space with relocatable partitions, a lavatory, storage closets for office supplies and records, and a mechanical room with exterior entrance. There was interstitial space between the ceiling and the roof for utility duct work. The building was serviced by central steam for heat and chilled water, and electrical service of 240 V. Building 67 was constructed in 1983. Mound personnel familiar with its construction indicated that approximately 15 feet of the site was removed and replaced with select fill prior to construction because of possible contamination involving a classified hazardous material. Records were not available to indicate whether or not all of the contamination had been removed. The building had been used for the same purpose since construction. The building was not contaminated with any radioactive, energetic, or asbestos-containing building materials.

Building 74: This building was a one-story, 400-square-foot, slab-on-grade structure. The facility was a manufactured Butler Building with metal arched walls and roof. The building was serviced by central steam for heat, an exhaust fan, and electrical service of 120 V. Building 74 was constructed in 1984. The building was used for the same purpose since construction until activities were discontinued.

Building 85: This building was constructed in 1989. It was built as a Class I powder processing facility, with a high bay area, 3-foot thick reinforced concrete wall and ceiling, and an explosion-proof electrical system. The building had never been used.

Building 300: The building housed the OUI pump and treat system using an air stripper for VOCs. It had been used for the same purpose since construction. The building was a prefabricated metal structure built with slab-on-grade. The facility was not supplied with utilities other than 480-V, three-phase power to run the system and provide electric space heat.

Building 301: The building housed the OU1 air sparging/soil vapor extraction process. It had been used for the same purpose since construction. The facility was a prefabricated metal structure on skids. The facility was not supplied with utilities other than 480-V, three-phase power to run the system and provide electric heat.

Building 301A: The facility housed a gas chromatograph to analyze gases removed in the air sparging/soil vapor extraction process in Building 300. Building 301A was a converted prefabricated guard post building with electrical service.

Magazine 52: This structure was a single compartment unit. This magazine was a reinforced concrete box structure classified as a non-standard, earth-covered magazine. Size of the compartment area was fewer than 200 square feet. Magazine 52 was constructed in 1970, and demolished in 1999. The magazine had been used for the same purpose since construction. The magazine was used for the storage of energetic materials.

Magazine 64: This magazine was constructed in 1974. The building had been used for the same purpose since construction. A known use was storage of energetic materials and components had occurred.

Building PH: This building originally housed fuel oil pumps to supply the power house with fuel from a nearby tank (now demolished). When the facility no longer served its original design intent, the pumps were removed. It then housed a steam line condensate pump and was used for miscellaneous storage of powerhouse supplies and some contractor supplies. It now houses a steam condensate pump. The environmental appraisal showed that the building contains asbestos. The building is a concrete block structure with built-up membrane roof and slab-on-grade flooring. The facility had central steam heat, a window unit air conditioner, and 480-V three-phase power. The brine line for the Building 24 zeolite softening bed recharge passed through Building PH. No research, development, or production activities using radioactive or energetic materials have occurred in the building.

Old Oil Storage Tank 5: This tank is an above-ground, 315,000-gallon fuel oil tank.

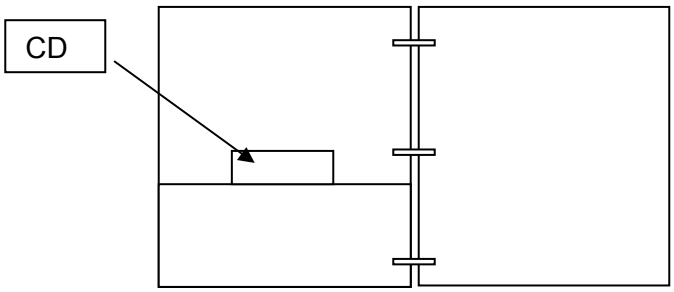
Trailers 1 and 16: These trailers are used as an office and break room.

Well House (WH)-1: The building, since its initial construction, had covered the well and housed a pump to help supply water to the Mound facility. WH-1, a well house, was a slab-on-grade floor with concrete block wells and a metal roof. The facility was not supplied with utilities other than 480-V, three-phase power to run the water well pump and an electric space heater.

WH 2: The building covered a well and pump that helped furnish water to the Mound facility. It had been used for the same purpose since construction. WH-2, a well house, was a concrete slab-on-grade with masonry exterior walls and a built-up membrane roof. The facility had no utilities other than 480-V, three-phase power to run the water well pump and an electric space heater. A propane-fueled, standby, direct-drive engine was hooked to the pump to provide power during electrical power outages.

WH-3: This building covered a well and pump that provided plant water supply to the Mound facility. It had been used for the same purpose since construction. WH-3, a well house, was a concrete slab-on-grade floor with masonry exterior walls and a built-up membrane roof. The facility had no utilities other than 480-V, three-phase power to run the water well pump and an electric space heater. There was a propane-fueled, direct-drive engine to provide standby power during electrical power outages.

Appendix E
Parcel 9 Data Set (Included on CD-ROM)

Envelope with CD

Included Inside Front Cover