BWX Technologies, Inc.
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BWXT of Ohio, Inc.
1 Mound Road
P.O. Box 3030
Miamisburg, Ohio 45343-3030
(937) 865-4020

ESC-067/01
April 19, 2001

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

ATTENTION: Robert S. Rothman

SUBJECT: Contract No. DE-AC24-97OH20044
PARCEL 4 CERCLA DOCUMENTS – FINAL

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

Dear Mr. Provencher:

Rob Rothman of your office has approved the release to USEPA, OEPA, ODH, MMCIC, the administrative record, and the Public Reading Room of the Final version of the following documents for Parcel 4:

Human Health Residual Risk Evaluation (RRE)
Ecological Risk Evaluation (ERE)
Record of Decision (ROD)
Environmental Summary (ES)

If you have any questions regarding the documents, or if additional support is needed, please contact Dave Rakel at extension 4203.

Sincerely,

JS Stapleton

Jeffrey S. Stapleton
Manager, Environmental Safeguards & Compliance

JSS/DAR:jdg

cc: Tim Fischer, USEPA, w/attachments (1-RRE, 1-ERE, 5-ROD, 1-ES)
Brian Nickel, OEPA, w/attachments (1-RRE, 1-ERE, 2-ROD, 1-ES)
Ruth Vandegrift, ODH, w/attachments (2-RRE, 2-ERE, 2-ROD, 1-ES)
John Ebersole DOE/OH, w/1 of each attachment
Torrence Tracey DOE/HQ, w/1 of each attachment
Monte Williams 1 w/1 of each attachment
Dann Bird MMCIC w/attachments (2-RRE, 2-ERE, 2-ROD, 1-ES)
Public Reading Room, w/5 of each attachment
Administrative Record, w/2 of each attachment
DCC

Residual Risk Evaluation

Parcel 4

Mound Plant
Miamisburg, OH

Final

February 2001

Department of Energy
Ohio Field Office

BWXT of Ohio, Inc.

The Mound Core Team
P.O. Box 66
Miamisburg, Ohio 45343-0066

Dr. Jeff Fisher
Ms. Cathianne Watkins
1550 Calls Creek Circle
Watkinsville, GA
30677

Dear Dr. Jeff Fisher and Ms. Cathianne Watkins:

The Core Team, consisting of the U.S. Department of Energy Miamisburg Environmental Management Project (DOE-MEMP), U.S. Environmental Protection Agency (USEPA), and the Ohio Environmental Protection Agency (OEPA), appreciates your comments on the Residual Risk Evaluation for Parcel 4. Attached are our responses.

Should the responses to comments require additional detail, please contact Rob Rothman at (937) 865-3823 and we will gladly arrange a meeting or telephone conference.

Sincerely,

DOE/MEMP: _____
Robert S. Rothman, Remedial Project Manager

USEPA: _____
Timothy J. Fischer, Remedial Project Manager

OEPA: _____
Brian K. Nickel, Project Manager

Comments Received on the
Parcel 4 Proposed Plan and Risk Evaluations
from
Dr. Jeff Fisher and Cathianne Watkins
January 2001

General Findings in Public Review Draft (Rev 0)

Comment 1:

The level of contamination of the soil and groundwater at this parcel require restrictions on the use of this property. For example, constructing basements, using unpaved access roads, driveways and patios are not recommended. The type of industry that locates on the property is an issue. Food service and child care facilities are not recommended. The recommended institutional controls were listed (with no detail) in the document. The authors of the human health risk assessment did not present a specific opinion concerning the site, other than suggesting the risk assessment is 'conservative' and institutional controls will provide adequate protection.

Response :

The Parcel 4 RRE was conducted to evaluate human health risks associated with residual levels of contamination remaining within the area to ensure that future users of the land will not be exposed to contaminant levels that would pose unacceptable risks. The RRE was not intended to be a risk management document. The *Risk Assessment Guidance for Superfund Volume 1 Human Health Evaluation Manual (Part A)*, Section 9.1.1, Page 9-2 recommends avoiding the drawing of "risk management" conclusions within a risk assessment. The risk managers do agree that this parcel requires restrictions therefore the Record of Decision will state : "In order to maintain protection of human health and the environment at Parcel 4 in the future, the institutional controls to be adopted will ensure:

- Maintenance of industrial/commercial land use;
- Prohibition against residential use;
- Prohibition against the use of groundwater;
- Site access for federal and state agencies for the purpose of sampling and monitoring; and
- Prohibition against removal of Parcel 4 soils from the DOE Mound property (as owned in 1998) boundary without approval form the Ohio Department of Health (ODH) and the Ohio Environmental Protection Agency (OEPA)."

Comment 2:

An area of concern is off-site migration of COPCs and other materials that were removed from the risk analysis, but are known human carcinogens.

Contamination of this parcel apparently occurred from soil runoff, resuspension of dust, and atmospheric disposition of stack emissions. This parcel represents, for the most part, the 'unused' portion of Mound, but the soil is contaminated to a degree that one can argue for clean up of soil. If no clean-up of soil occurs, the current and future theoretical health risks to the immediate off-site community need to be included in this document. Discussions (or map) are needed to delineate 1) the distribution pattern of radionuclides and chemicals in the soil, and 2) the modes of transport of these radionuclides from their source to this parcel and the adjacent community since this soil contamination in this parcel is apparently not the result of work activity in this parcel.

Response:

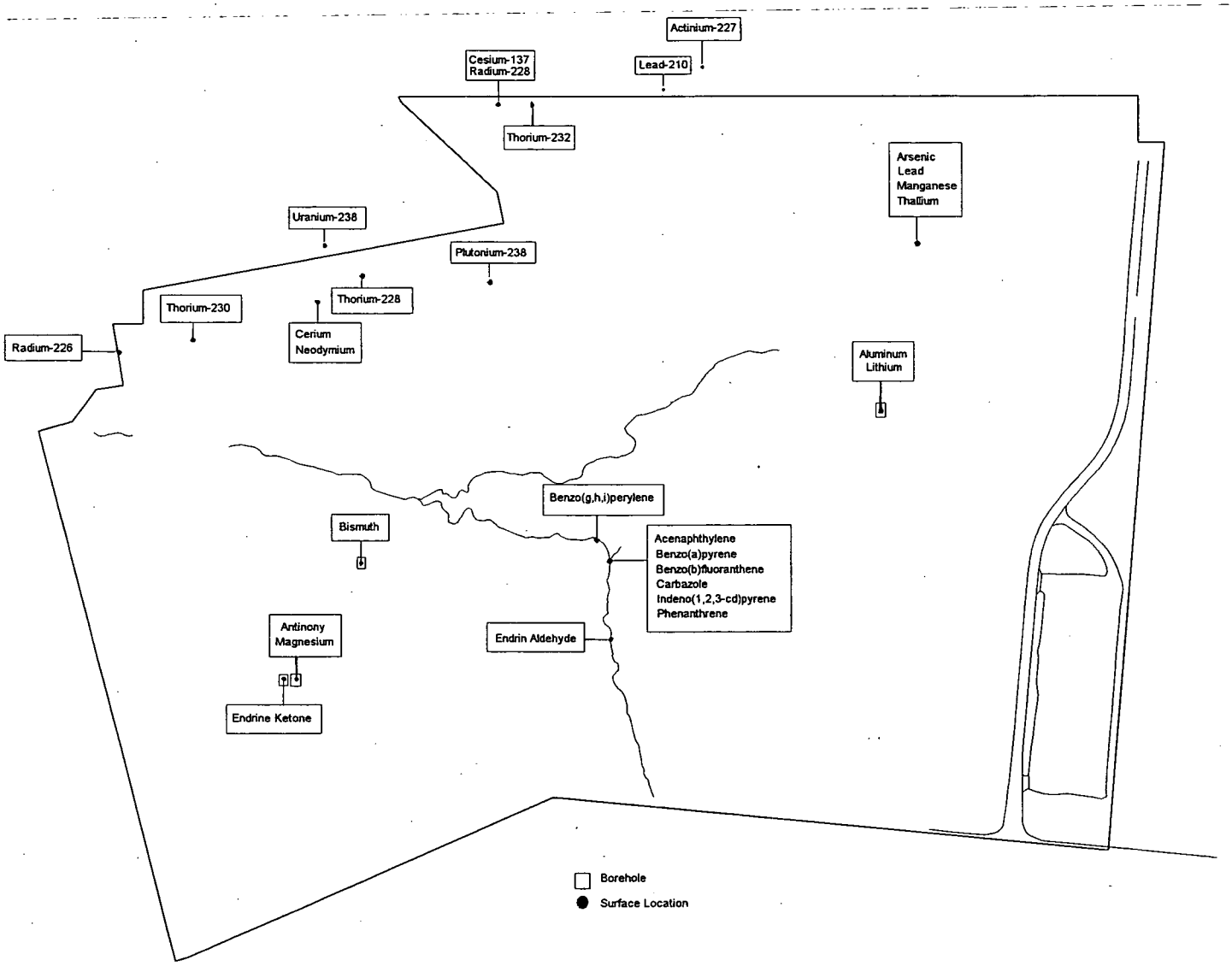
This Residual Risk Evaluation was prepared according to the Residual Risk Evaluation Methodology (RREM). This methodology focuses on the risks within the parcel . According to the Mound 2000 Work Plan, off-site risk will be addressed in the off-site or final Record of Decision and its supporting risk evaluation.

No plant operations, no spills, and no dumping activities are known to have occurred on Parcel 4. The property did receive surface runoff from the adjacent plant operations, which has potentially contaminated Parcel 4. In 1995, a drainage control system was installed along the road north (and uphill) of Parcel 4 to prevent additional surface runoff. Parcel 4 was evaluated using all available sampling data. All carcinogenic and non-carcinogenic constituents detected in Parcel 4 were evaluated in the RRE unless they screened out using the RREM screening techniques. Although the RRE does evaluate indirect exposure to contaminants that may migrate through air or groundwater, it does not evaluate off-site exposure. The purpose of the RRE is to ensure that future on-site users of the land will not be exposed to contaminant levels that pose unacceptable risks following a transfer of ownership. The evaluation of off-site risks is not covered by the RREM. Further speculation as to how contaminants came to be located in Parcel 4 media would not improve the accuracy of the RRE.

A map will be added to the Final version of the Parcel 4 RRE that shows the location of the soil COPCs maximum concentration.

Comment 3:

The community that surrounds this site deserves attention and should not be overlooked. What can Mound say to the public about health and safety for individuals that live adjacent to the site if no remedial action (clean-up) is taken? What can Mound say to the public about working on this parcel if institutional controls are instituted? Kids, pregnant women, and young adults will visit this site! What type of activity (historical or current) at the Mound is responsible for the hand-full chemicals and radionuclides that are driving this parcel risk assessment?



Locations Of Maximum Observed Value For COPCs That Did Not Screen Out of Parcel 4 RRE

Response:

The community that surrounds the Mound facility should be protected, however the evaluation of off-site risks is not covered by the RRE. The purpose of the RRE is to assess potential health risks associated with residual levels of contamination remaining within a parcel prior to its release for future use. The future use scenarios specified by the RRE (i.e. construction worker, site employee) assume that adult workers will be chronically exposed to residual contamination in soil, groundwater, and air. Since the RRE used reasonable maximum exposure (RME) assumptions, actual risk levels for site employees and construction workers are not likely to exceed the levels presented in the RRE. Furthermore, the use of institutional controls limiting exposures to soil and groundwater are planned to ensure that on-site conditions are protective of future receptors.

Given the projected industrial/commercial future use for the site, it is unlikely that children and pregnant visitors would be chronically exposed to on-site contaminants. If exposures to children and pregnant visitors were to occur, those exposures are expected to be brief in duration and below any incremental cancer or adverse effect levels as modeled by the construction worker and site employee scenarios within the Parcel 4 Residual Risk Evaluation . Much lower for instance than a construction worker who was assumed to be exposed through incidental ingestion of soil, dermal contact with soil external radiation exposure, inhalation of airborne dust and vapors, ground water ingestion, dermal contact with ground water and inhalation of vapors released by ground water while showering. If on-site conditions are protective of the highly exposed construction worker, it is anticipated that on-site conditions would be protective of occasional site visitors. Pregnant employees are restricted from access to radiological work areas, and currently there are no radiological work areas in Parcel 4. Radiation levels on Parcel 4 are well below levels that would require workplace restrictions for pregnant women. The restrictions on development and use of the property (some of which specifically prohibit "children under eighteen years of age") are listed in detail in the Quit Claim Deed which is Appendix A of this Record of Decision.

Current and future risk due to antimony in groundwater was estimated using the maximum concentration detected. For chromium, it was assumed that all chromium detected was present in the most toxic, hexavalent state. Hexavalent chromium is not naturally occurring and requires strong oxidizing conditions to persist. Assuming that contaminants are present at the maximum concentration detected and assuming that contaminants are present only in their most toxic form is likely to result in an overestimation of actual risk levels.

Although the focus of this evaluation is Parcel 4, the offsite population has not been forgotten. Mound's effluent monitoring and environmental surveillance continues, is reported to the public via the Annual Site Environmental Monitoring Report and other means, and will continue until the end of the Exit

Project. The effluent monitoring program focuses on releases from the site, i.e., stack and wastewater discharges. The environmental surveillance program involves sample collection and analysis of ambient air, regional water supplies, sediments, onsite and offsite groundwater, and foodstuffs.

Screening Level Ecological Risk Assessment Parcel 4

Comment 4:

The ecological risk assessment was easier to read, generally. Did Mound formally sample for the two species, the Indiana bat and the eastern massasauga rattlesnake? If not, why? Succinct statements needs to be included about the strength of the data concerning a census of what does live on this site. If historical data is available, are there any trends? How will future use of the site effect the current population of wildlife? Development of the site means removal of several species. What are the species that will be affected by development? Are wildlife contaminated with chemicals or radionuclides, from this site, that is, is there any data on the measurement of these materials in carcasses?

Response:

No formal sampling for the Indiana bat and the eastern massasauga was conducted. The habitat required by the Indiana bat was not found to be present and no eastern massasauga specimens were collected during the comprehensive 1992-1993 OU9 Ecological Characterization study. Careful examination of all habitats on Parcel 4 in March 2000 revealed minor changes in certain habitat categories related to succession of the plant communities. However, no significant physical changes have occurred since completion of the Operable Unit 9, Ecological Characterization study. For this reason, it is assumed that the Indiana bat and the eastern massasauga do not occur on or in the vicinity of Parcel 4.

Evaluating trends in species populations, impacts of development on wildlife, and tissue analysis are beyond the scope of a Screening Level Ecological Risk Assessment (SLERA) for a variety of reasons. First, a SLERA focuses on the potential for adverse effects on wildlife from chemical stressors, not physical or biological stressors. Second, impacts of future developmental actions have been addressed in the Environmental Assessment: Disposition of Mound Plant's South Property (DOE/EA-1239 June 1999). Third, community analysis and tissue bioassays are typically performed in a baseline Ecological Risk Assessment, using the results of the SLERA to focus quantitative field studies on those contaminants that pose a potential for adverse effects on specific wildlife species.

Comment 6:

Screening potential constituents of potential concern for surface soil samples less than 2 inches in depth only invalidates this pathway. This surface soil exposure issues for wildlife that do not live in soil is the same issue with humans. Granted, the expected disturbance of soil and potential exposure is expected to be with the surface layer of soil, but for this site, with industrial development and a construction worker scenario, removal or relocation of soil is expected. When this occurs, deep soil is brought to the surface and is a potential source for surface soil exposure. Re-accomplish the ecological analysis using 'deep' surface soil.

Response:

Samples collected within the 0 – to 2 **-feet** depth below ground surface were evaluated in the SLERA.

Specific Findings

Comment 1:

The ecological and human health documents are incorrect when referring to hazard index values as 'risk' projections. Only the cancer calculations are risk projections based on a slope or dose-response. There are no dose-response analyses for non-cancer human health effects or the ecological effects using a LOAEL or NOAEL approach with uncertainty factors. Please correct this technical deficiency in the documents. Nothing can be inferred in terms of risk from a HI value greater than 1.0 (other than segregating chemicals or radionuclides in terms of mode of action). So, a HI value of 1.1, 10 or 100 is very deceptive to interpret, unless the toxicology data and uncertainty factors used to derive a toxicity factor are evaluated. Bench mark dose response values are needed for noncancer 'risk' projections.

Response:

We agree that hazard index values are not "risk" projections. However, the text improvements requested will not impact the remedy selected for this parcel. These improvements will be applied to the next parcel. We also agree that the interpretation of HI values greater than 1 is complex and deceptive to interpret (see RAGS Part A, Section 8.2.2, page 8-14). Segregation of hazard indices requires identification of the major effects of each chemical, including those seen at higher doses than the critical effect (e.g. the chemical may cause liver damage at a dose of 100 mg/kg-day and neurotoxicity at a dose of 250 mg/kg-day). Major effect catagories include neurotoxicity, developmental toxicity, reproductive toxicity, immmunotoxicity, and adverse effects by target organ. Although higher exposure levels may be required to produce adverse health effects other than the critical effect, the reference dose can be used as the toxicity value for each effect category as a conservative and simplifying step. If

the segregation is not carefully done, an underestimation of true hazard could result.

Comment 2:

Add an appendix to the Residual Risk Evaluation Parcel 4 document with the statistically derived background concentrations (mean, range, n, and standard deviation) for chemicals and radionuclides.

Response:

The background values used in the Parcel 4 RRE were taken from the Mound 2000 RREM Appendix A. The soil background values were established in the *Operable Unit 9 Background Soils Investigation Soil Chemistry Report* (September 1994). The groundwater background values were established in the *Operable Unit 9 Hydrogeologic Investigation Groundwater Sweeps Report* (April 1995). Since the background values were not recalculated and were published along with the RREM, these values will not be repeated in this RRE. Mound stakeholders were provided with an opportunity to critically evaluate the background values when the public review draft of the RREM was issued. A citation referring the reader to Appendix A of the RREM will be added to the Parcel 4 RRE.

Comment 3:

The updated RBGV calculations were very helpful. This presents a systemic problem for future risk assessments because citation of prior outdated risk guidance documents is not appropriate. Please create a RBGV document for the public that is current for the two worker scenarios and can be cited in future risk assessments.

Response:

Thank you for the positive feed back. We are aware of the challenge of maintaining up-to-date values for the site. There are a few options in discussion – one is the approach you have suggested.

Comment 4:

SOIL: Table 5.19, total residual risk for parcel 4, summary table, (no page number) of the Residual Risk Evaluation Parcel 4 document. This sums it up! Technically, combining the cancer calculations for chemicals and radionuclides makes no sense. Combining rads and chemicals make sense only if the mechanism of action of the chemical is thought to be genotoxic by production of hydroxy radicals or direct alkylation of DNA. However, given the lumping of these data, the theoretical excess cancer risks are 1.0 in 10,000 from exposure to contaminated soil for the site employee and 3.3 in 100,000 for construction worker for parcel 4. Future use of water as a drinking source presents

unacceptable risks. However, there are drinking water standards in place (ARARs) to set acceptable standards, both on site and off site. This is not true for soil. The calculations in this document will be used to determine the acceptability of the soil in parcel 4.

Is the USEPA and OEPA using total residual risk or incremental risk (total residual risk- background risk)? The reality is that parcel 4 imposes excess theoretical cancer risks above background and is borderline in terms of acceptability as it stands. If only total residual risk is required, then remove the incremental risk calculations. These calculations do not add information to the document. If incremental risk is used to establish soil safety criteria, then a public review of the adequacy of the background levels is needed. I do not believe that the public critically evaluated these data. The set point of 1e-4 to 1e-6 for excess cancer risks is misinterpreted or ill defined in the document. The site is the entire Mound faculty (and the off-site locations which is another issue).

If the theoretical cancer risks for soil at parcel 4 are at 6.5e-5 for incremental risk or 1.1e-4 for total residual risk, then what is the probability that the entire Mound facility will meet the criterion of 1e-4 to 1e-6, given that this is the 'cleanest' portion of the site? A near zero probability is probably the answer. Antimony in water and low level radionuclides in soil are driving the health concerns. Can 'hot spot' removal of soil help in reducing the calculated health risks for soil at parcel 4 and can treatment of water for the site be considered? Is the current thinking to write-off the water supply and not deal with it as eluded to in the institutional controls?

Response:

The commentor makes a good point, technically the summation of cancer calculations for chemical and radionuclides is conservative. Cancer slope factors are defined differently for radionuclide and non-radionuclides. The document *Radiation Risk Assessment at CERCLA Sites: Q&A* (EPA540/R199/006, December, 1999) states:

"Excess cancer risk from both radionuclides and chemical carcinogens should be summed to provide an estimate of the combined risk presented by all carcinogenic contaminants as specified in OSWER directive 9200.4-18 (1997). An exception would be cases in which a person reasonably can not be exposed to both chemical and radiological carcinogens...

In the absence of additional information, it is reasonable to assume that excess cancer risks are additive for purposes of evaluating the total incremental cancer risk associated with a contaminated site."

These risks were summed to allow risk management decisions to be made on cumulative effects that might be missed if the risks were evaluated individually. The presentation of total, background, and incremental risk follows the RREM.

Risk management decisions focus on site related risks which are represented in the incremental sections. Carcinogenic risk results were compared to the acceptable risk range of 10^{-4} to 10^{-6} (increase in cancer risk of one human in ten thousand to one human in one million) as specified by the National Contingency Plan.

Comment 5:

Provide a list of authors and their affiliations on the 1st page of the documents.

Response:

The number of contributors to these reports is large; the number of organizations participating in the development of these documents is large. Because of this and the fact that the documents represent the positions of US EPA, DOE, and OEPA concerning the site, we have chosen not to provide a list of authors and affiliations.

The Mound Core Team
P.O. Box 66
Miamisburg, Ohio 45343-0066

Mr. Peter Townsend
Hydro-Log
PO Box 555
Yellow Springs, Ohio 45387

Dear Mr. Townsend:

The Core Team, consisting of the U.S. Department of Energy Miamisburg Environmental Management Project (DOE-MEMP), U.S. Environmental Protection Agency (USEPA), and the Ohio Environmental Protection Agency (OEPA), appreciates your comments on the Proposed Plan for Parcel 4. Attached are our responses.

Should the responses to comments require additional detail, please contact Rob Rothman at (937) 865-3823 and we will gladly arrange a meeting or telephone conference.

Sincerely,

DOE/MEMP: Robert S. Rothman, Remedial Project Manager

USEPA Timothy J. Fischer, Remedial Project Manager

OEPA Brian K. Nickel, Project Manager

Comments Received on the
Parcel 4 Proposed Plan and Risk Evaluations
from
Peter Townsend
January 2001

The Proposed Plan for Parcel 4 contains three areas of concern. These are: 1) groundwater protection and groundwater monitoring in the Buried Valley Aquifer (BVA) downflow from Parcel 4 is not considered, 2) the source of groundwater contaminants is not considered, and 3) the source of groundwater contaminants is most likely airborne fallout from Mound Lab emissions. This study implies that other off-site areas, particularly to the east, west, and north of Mound Labs would have considerable heavy metal and radionuclide fallout, and should receive similar groundwater investigations.

Concerns:

1) The Proposed Plan for Parcel 4 protects future groundwater use within Parcel 4 through deed restrictions, which will prevent future Parcel 4 landowners from installing wells. The groundwater flow regime for Parcel 4 is shown on a map on page 8 in Appendix B of the *Residual Risk Evaluation, Parcel 4*. The groundwater flow map is presented on page 2 of these comments. This map shows that the groundwater flow from Parcel 4 descends from the east and northern boundaries, and enters the Buried Valley Aquifer (BVA). In the BVA are the groundwater supply wells for the Mound Laboratory, also downflow from Parcel 4. The Hazard Index (HI) for groundwater within Parcel 4 is above 1, and has resulted in the decision to impose deed restrictions, eliminating future land owners from installing wells on their property. There should be a discussion in the Proposed Plan for Parcel 4 about the impact of the groundwater flow from parcel 4 into the BVA, and the possible impact on the Mound Water Supply Wells. Also, there should be provisions for monitoring groundwater descending from Parcel 4 into the BVA, to look for possible migration of contaminated groundwater from Parcel 4 into the BVA and the Mound Water Supply Wells.

Response:

There may be some misinterpretation of the Parcel 4 RRE results. The groundwater data are not solely from Parcel 4. Groundwater quality data from wells across the site; i.e, located on and near (including the Mound Plant process areas) Parcel 4 were used to calculate the current and future potential impact of measured chemicals of concern (COCs) at the closest existing groundwater receptor, the Mound water supply wells (see

Appendix B of the RRE). As discussed in the Parcel 4 RRE, the calculated unacceptable HI for the current groundwater scenario is driven largely by the result of a few suspect antimony concentrations measured nearly a decade ago in the production wells. The future groundwater scenario is driven largely by total chromium, assumed to be hexavalent chromium. There is no indication that groundwater COC concentrations beneath Parcel 4 have significantly contributed to the elevated HI.

There is an additional source of uncertainty surrounding the groundwater measurements used in the RRE. The sampling method itself is believed to produce turbid samples which would yield results for measurements of metals that are not representative of the groundwater. Such results would be biased high. (*1999 Comparative Well Study*, unpublished) The new micro purge, low flow sampling is being implemented for the groundwater sampling network. The micro purge, low flow sampling will provide more consistency and reduce the uncertainty. We will share the results of this effort as they become available.

Also, Mound's environmental surveillance program will continue after Parcel 4 is transferred. The on-site groundwater monitoring program will continue. The Operable Unit One groundwater treatment and its monitoring will continue. The production wells will be monitored for Safe Drinking Water Act compliance until the site transitions to city water. In addition, monitoring as a part of Post Closure Stewardship will be developed in detail prior to the final parcel transfer.

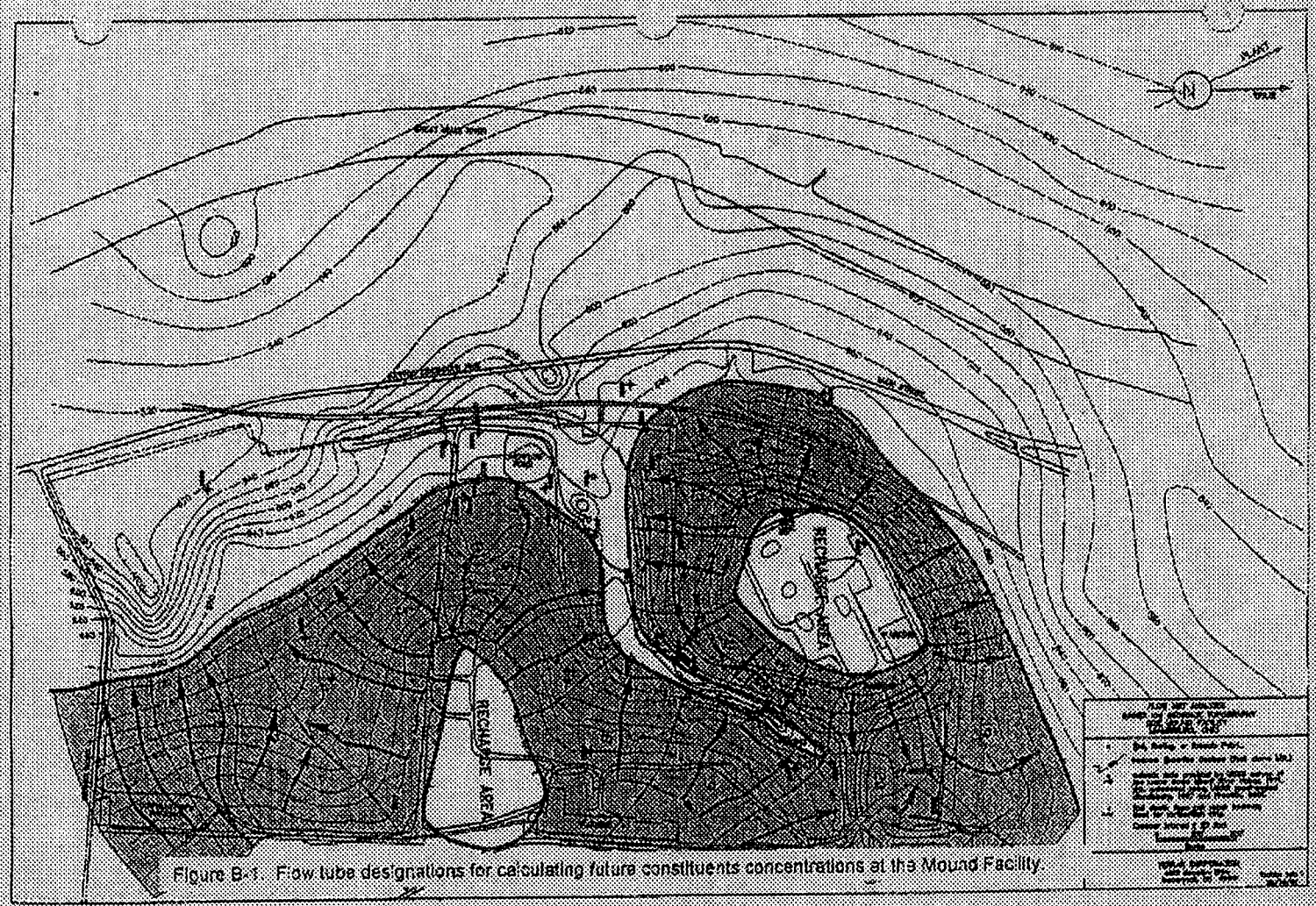


Figure B-1. Flow tube designations for calculating future constituents concentrations at the Mound Facility.

2) Parcel 4 was a farm purchased by Mound Laboratories in 1981. The public has been informed that Parcel 4 was never used by Mound Labs to store or handle any chemicals, wastes, or metals. However, groundwater tests reported in the *Residual Risk Evaluation, Parcel 4* document show that a large number of heavy metals and radionuclides occur in the groundwater at Parcel 4. Metals found in groundwater at Parcel 4 are shown on the attached page. This page is Table 2.9 from the *Residual Risk Evaluation, Parcel 4.*

Table 2.9 shows a number of metals present, in many samples, that would not normally occur in such high amounts. For example, chromium was detected in 78 of 120 tests at concentrations up to 7,400 times higher than expected background concentration; copper was detected in 81 of 117 tests at concentrations up to 430 times higher than expected background concentration; and nickel was detected in 82 of 120 tests at concentrations up to 330 times higher than expected background concentration. Table 2.8 in the *Residual Risk Evaluation, Parcel 4* document, page 5, shows radionuclides present in a number of samples at levels several times higher than expected background values.

An interesting and important question is where did these metals and radionuclides come from? How did they get in the groundwater at this site? These are not materials that would come from farming or other land use from before Mound purchased the property. If Mound never used this property, then how did these contaminants arrive? Most of this property is not downhill from Mound, so these materials could not have washed off the Mound. The only reasonable mode of arrival is from airborne fallout.

Figure 1 of these comments, shown on page 6, is a contour map of average annual air concentration of Pu^{238} for 1997. Figure 1 is contoured in increments of 1×10^{-18} uCi/mL from 1 to 10, and above 10, contours are omitted and raw data values are presented because air concentrations at Mound are so high that contours near the lab would be too close together.

Figure 1 shows that Pu^{238} air concentrations drop off rapidly away from the Mound Laboratory, but note on Figure 1 that Parcel 4, located in the southern 1/3 of the Mound Property, receives considerable Pu^{238} fallout as indicated by this contour map. Note also that the Pu^{238} contaminant plume extends beyond the Mound Plant in all directions, but most notably to the north and west, into areas of Miamisburg that adjoin Mound facility. Figure 1 strongly shows off-site airborne emissions of Pu^{238}.

Figure 2 shows the number of air monitoring stations in place from 1992 to 1998. Table 1 lists air monitoring station numbers and gives data values for 1996 and 1997 Pu^{238} levels at each station.

Table 3.9 Initial Identification of Future Groundwater Constituents of Potential Concern for the Construction Worker Scenario
(Maximum Detected Concentration Compared to Background and Mound Guideline Values)

Chemical	Minimum Concentration in Bedrock Wells	Maximum Concentration in Bedrock Wells	Units	Detection Frequency in Bedrock Wells	95 Percent UCL	Concentration Used for Screening	Background Value	Construction Worker Risk-Based SV	Reference	COPC?
Inorganics										
Aluminum	25.3	31500.00	ug/L	107/ 115	6840.30	31500.00	37.523	18000.00	a, d	YES
Ammonia**	110	37500.00	ug/L	54/ 61	403.90	37500.00	182			NO.5
Antimony	0.35	41.60	ug/L	31/ 122	2.82	41.60	0.578	4.10	a	YES
Arsenic**	0.3	933.50	ug/L	36/ 114	91.80	933.00	32.997	3.10	a	YES
Barium	17.5	329.00	ug/L	112/ 114	130.00	329.00	335.209	210.00	a	NO.5
Beryllium**	0.03	2.30	ug/L	41/ 123	0.47	2.30		0.00	c	YES
Bismuth**	0.9	364.00	ug/L	33/ 103	23.28	364.00				YES
Boron**	110	110.00	ug/L	1/ 2	NC	110.00		500.00	a, d	NO.3
Cadmium	0.34	13.10	ug/L	31/ 124	0.75	13.10		3.10	a	YES
Calcium	316	1510000.00	ug/L	164/ 164	199000.00	1510000.00	111110.664			NO.4
Chloride**	8100	17700000.00	ug/L	74/ 74	908000.00	17700000.00	103823			NO.5
Chromium*	0.27	44800.00	ug/L	78/ 120	3010.00	44800.00	6.076	30.00	a, d	YES
Cobalt**	0.31	295.00	ug/L	46/ 113	18.50	295.00	1.032	600.00	a, d	NO.5
Copper	0.38	514.00	ug/L	81/ 117	26.80	514.00	3.167	400.00	a, d	YES
Cyanide**	3.5	14.20	ug/L	3/ 43	4790.00	14.20		200.00	a	NO.3
Dissolved Solids	499000	32500000.00	ug/L	47/ 47	2480.00	32500000.00				NO.5
Fluoride**	150	2900.00	ug/L	57/ 58	678.00	2400.00	419			NO.5
Iron	0.154	192000.00	ug/L	131/ 163	45400.00	192000.00	4064.888			NO.5
Lead**	0.4	32.00	ug/L	55/ 125	4.96	32.00	20.03			YES
Lithium	8.8	4280.00	ug/L	87/ 102	323.50	4280.00	55.7			YES
Magnesium	26.9	719000.00	ug/L	163/ 165	77300.00	719000.00	40428.111			NO.4
Manganese	0.037	3835.00	ug/L	155/ 165	737.00	3835.00	329.168	31.00	a	YES
Mercury**	0.1	1.40	ug/L	3/ 123	0.04	1.40		3.10	a	NO.3
Molybdenum	0.79	476.00	ug/L	31/ 98	32.50	476.00	5.397	50.00	a, d	YES
Nickel	1.3	11600.00	ug/L	83/ 120	749.00	11600.00	34.937	200.00	a	YES
Phosphate**	60	10100.00	ug/L	31/ 41	782.00	10100.00	231			NO.5
Potassium	2.12	214000.00	ug/L	158/ 164	15200.00	214000.00	4461.663			NO.4
Selenium	1.3	7.00	ug/L	16/ 112	1.78	7.00		50.00	a, d	NO.3
Silicon**	3230	12300.00	ug/L	6/ 6	NC	12300.00				NO.4
Silver	0.72	25.60	ug/L	7/ 115	1.26	25.60		51.00	a	NO.5
Sodium	88.3	7270000.00	ug/L	162/ 162	340000.00	7270000.00	62423.363			NO.4
Sulfate	3000	456000.00	ug/L	73/ 78	305.00	456000.00				NO.4
Thallium	3.1	6.90	ug/L	8/ 107	4.44	6.90		2.80	a, d	YES
Tin	1.4	357.20	ug/L	27/ 100	34.90	357.20	34.382	8000.00	a, d	NO.3
Vanadium	0.15	277.00	ug/L	63/ 115	33.00	277.00	11.1	21.00	a	YES
Zinc	1.4	398.00	ug/L	98/ 117	47.10	398.00	119.6	3000.00	a	NO.5

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

Chemical	Minimum Concentration	Maximum Concentration	Units	Detection Frequency	95 Percent UCL	Concentration Used for Screening and EPC	Background Value	COPC for RBS
Inorganics								
Antimony	2.6	40.20	ug/L	1-30	85.06	40.20	0.[illegible]	YES
Cadmium	4.4	7.70	ug/L	6-17	1.91	3.81	[illegible]	YES
Copper	1.6	109.00	ug/L	29-32	77.76	109.00	11.67	YES
Lead	2.4	46.00	ug/L	5-33	7.28	7.28	10.05	NO
Radionuclides								
Strontium-90	0.46	1.41	pCi/L	1-10	NC	0.56	[illegible]	YES
Plutonium-239/240	0.01	2.00	pCi/L	5-30	4.87	2.00	0.125	YES
Thorium-228	0.0	2.17	pCi/L	18-35	164.00	2.17	0.779	YES
Thorium-230	0.01	1.97	pCi/L	31-32	1.44	1.44	[illegible]	YES
Tritium	110.00	7200.00	pCi/L	113-128	861.00	861.00	1485.47	NO
Uranium-234	0.20	8.14	pCi/L	35-48	NC	8.14	1.98	YES
Uranium-238	0.13	8.21	pCi/L	41-48	6.47	6.47	0.888	NO

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

Figure 1. 1997 average Plutonium 238 concentration in the air around the Mound Plant (10E-18uCi/mL)

Background subtracted from the data.

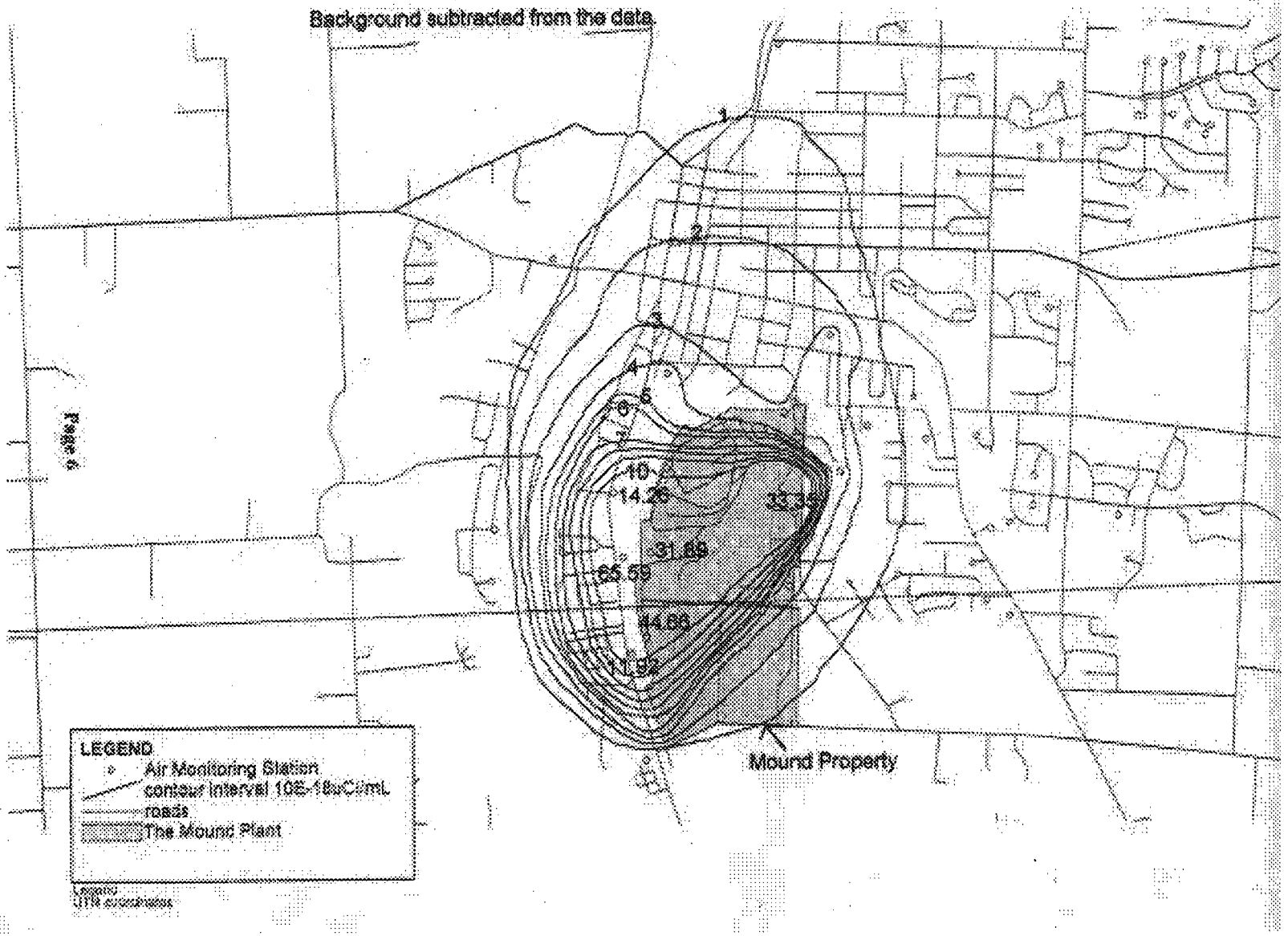


Figure 3 of these comments is a contour map of average annual air concentration of Pu^{238} for 1996. Figure 3 is contoured in increments of 1×10^{-18} uCi/mL from 1 to 10, and above 10 contours are omitted and raw data values are presented, because air concentrations at Mound are so high that contours near the lab are too close together. Figure 3 shows that air dispersion of the heavy metal and radionuclide Pu^{238} extends into Miamisburg, as was also shown in Figure 1.

Figures 1 and 3 both show that the heavy metal Pu^{238} was dispersed through the air, off-site from Mound Lab into the surrounding area. Miamisburg, especially north, east, and to a lesser extent west of Mound, received airborne fallout of heavy metals and radionuclides from Mound.

Mound Lab emitted relatively little Pu^{238} in 1997 compared to earlier years. The year 1997 was chosen for this illustration not because of the high Pu^{238} airborne emissions, but because by 1997 Mound Lab had a relatively thorough air monitoring system in place. Figure 4 shows a graph of annual Pu^{238} air emissions from Mound Lab for 1960 - 1998. Table 2 gives data that were graphed to construct Figure 4. Note that Pu^{238} emissions for most years are not even seen on this plot because most years emissions of Pu^{238} from Mound were relatively small compared to the huge emissions in 1960, and relatively large emissions from 1965 to 1970. If we were to scale Figures 1 and 3 up to the higher emissions during the 1960's and assume that non-radioactive heavy metals were also emitted from Mound Labs, then we can easily account for the presence of both radionuclides and heavy metals in elevate concentrations in the groundwater of Parcel 4.

Response:

The assertion that the potential source of elevated metals in the groundwater associated with Parcel 4 is the result of air deposition is interesting. The concentrations of metals and radionuclides listed in Table 2.9 are from groundwater monitoring across the Mound Plant (See Appendix B of the RRE). Most of the highest values are from the bedrock monitoring wells located north of Parcel 4, in the main process areas. If air deposition was the main source of elevated groundwater metals, a very significant overall increase in soil metals concentrations throughout the entire Mound site would have been detected. It has not. Also, an increasing trend in groundwater metals concentrations in all shallow monitoring wells should have emerged if the contamination was distributed by air and has migrated to the deeper monitoring wells. No such trends have been observed.

Figure 2. Location of air monitoring stations July 1992 to May 1998

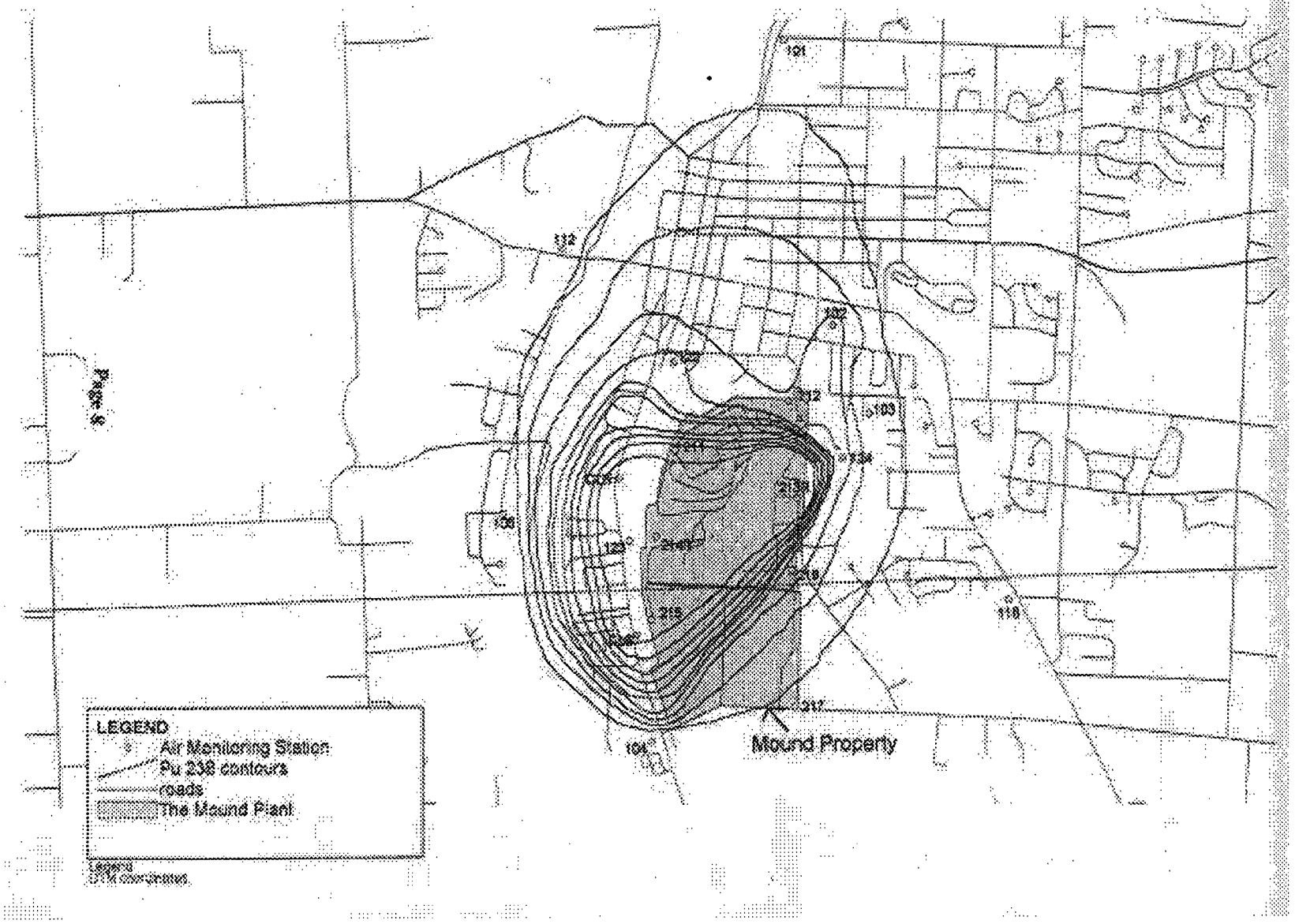


Figure 3. 1996 average Plutonium 238 concentration in the air around the Mound Plant (10E-18uCi/mL).

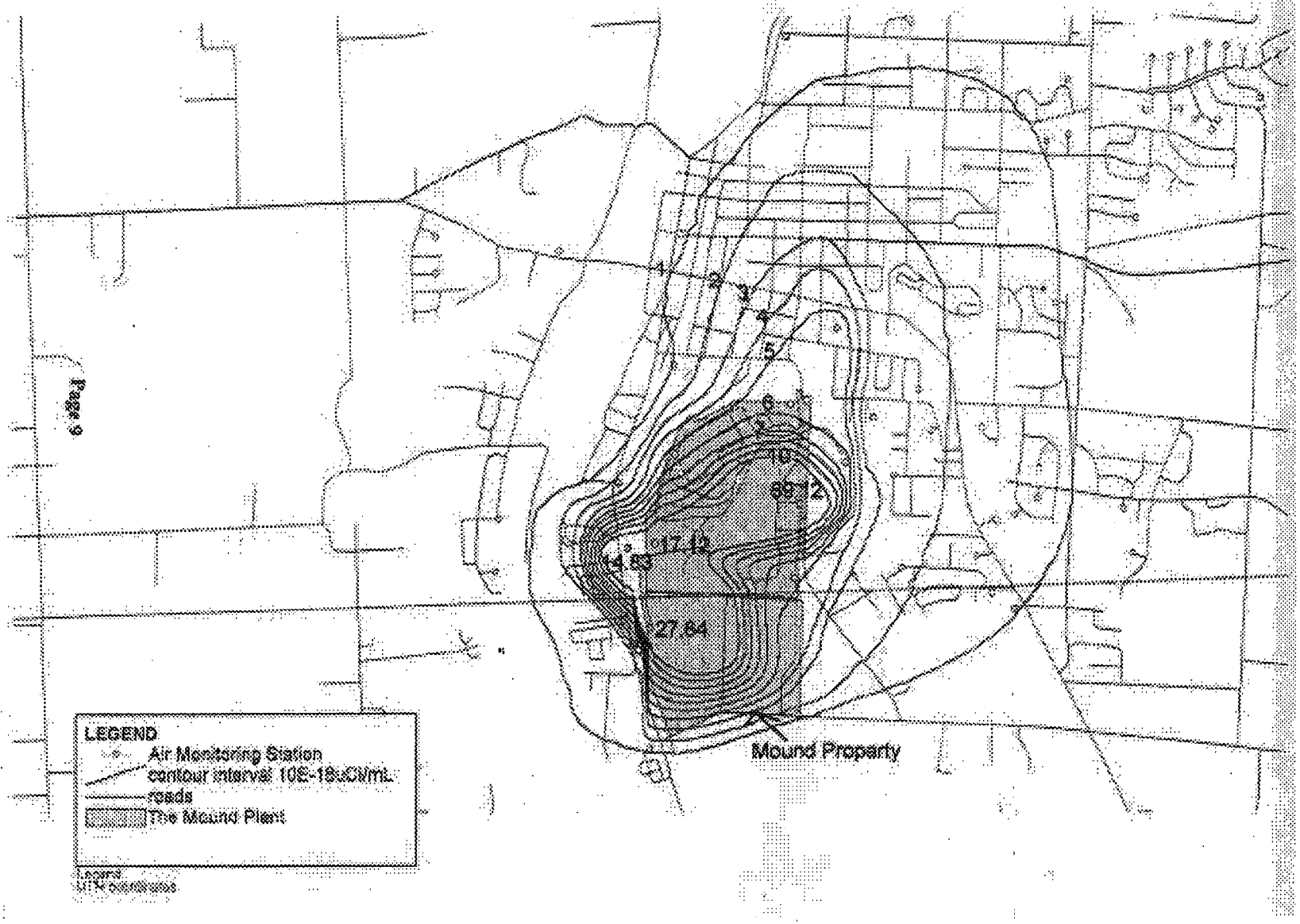


TABLE 1.

AVERAGE PLUTONIUM 238 CONCENTRATIONS (10^{-18} uCi/mL) IN THE AIR AT INDIVIDUAL AIR MONITORING STATIONS.
1996 AND 1997

Offsite air monitoring stations	1996 Pu^{238} concentrations in air.	1997 Pu^{238} concentrations in air.
101	0.23	0.44
102	5.86	3.26
103	2.32	1.38
104	1.22	0.76
105	0.19	0.45
112	0.13	0.37
118	1.18	0.27
122	1.07	4.33
123	14.83	65.58
124	6.45	3.98
CLN	2.26	14.26
CLS	3.91	11.92
Onsite air monitoring stations		
211	5.42	9.31
212	5.76	3.02
213R	85.12	33.35
214R	17.12	31.89
215	27.64	44.86
216	5.03	3.54
217	1.43	0.8

1996 and 1997 background levels subtracted from the data.

Data taken from 1996 and 1997 Annual Site Environmental Reports pages 4-12 and 5-4 respectively.

1/17/01

Figure 4 - Graph of Pu 238 air emissions from Mound Lab, 1960-1998.

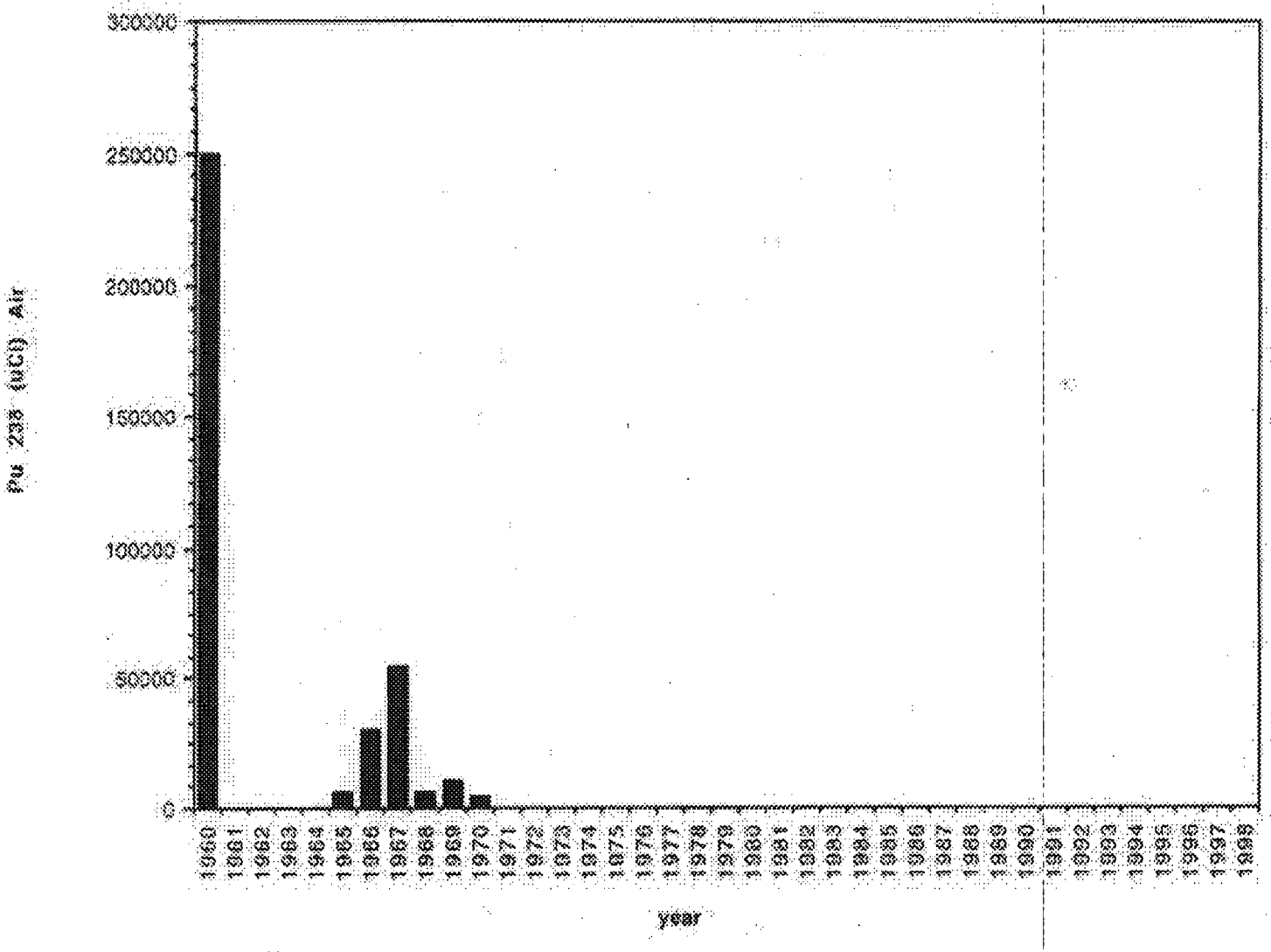


TABLE 2

year	Pu 238 Air (µCi)
1960	258,125
1961	160
1962	140
1963	108
1964	252
1965	5,863
1966	30,442
1967	54,347
1968	5,720
1969	10,544
1970	4,342
1971	401
1972	74
1973	84
1974	26
1975	29
1976	15
1977	13
1978	14
1979	12
1980	15
1981	8
1982	21
1983	4
1984	7
1985	5
1986	6
1987	5
1988	5
1989	4
1990	18
1991	15
1992	6
1993	12
1994	15
1995	9
1996	7
1997	45
1998	15

Annual Plutonium 238 releases to the air from the Mound Plant

Plutonium emission figures for 1960 to 1989 were found in the Remedial Investigation/Feasibility study, Operable Unit 2, site wide work Plan, Mound, May 91 DOE, Section 2, page 6. Plutonium emission figures for 1990 through 1998 were found in the yearly Annual Site Environmental Reports 1990 through 1998.

3) It appears that the source of the elevated radionuclides and heavy metals in the groundwater at Parcel 4 is air emission from Mound Lab. Therefore, levels of heavy metals and radionuclides in the groundwater in Miamisburg adjacent to Mound Labs are probably elevated and of environmental concern. Groundwater studies similar to Parcel 4 should occur in Miamisburg.

Response:

As discussed above, the results listed in Table 2.9 are from bedrock monitoring wells from across the entire Mound Plant. Many wells with the elevated levels of heavy metals are located in or just down gradient of the process areas north of Parcel 4 (see Appendix B of the RRE). Additional investigation is underway as discussed earlier.

There is an offsite groundwater monitoring program at Mound. It's objectives are to assure local residents and communities that their drinking water has not been adversely impacted by plant activities and to provide an early warning of impacts due to continuing environmental restoration activities. This program consists of the collection and analysis of samples from production wells, private wells, regional drinking water supplies, and BVA monitoring wells. Samples are analyzed for radionuclides, inorganic substances, and VOCs. The details of the program and its results are available in the Annual Environmental Monitoring Report. In 1999, the average tritium concentrations ranged from 0.05nCi/L to 0.53 nCi/L (with the MCL = 20nCi/L). Many results for other radionuclides were comparable to background levels; average concentrations were less than 2.9% of the respective dose standard.

The Mound Core Team
P.O. Box 66
Miamisburg, Ohio 45343-0066

Rev. Dr. Velma M. Shearer
124 Chestnut Street
#210
Englewood, Ohio
45322

Dear Rev. Dr. Shearer:

The Core Team, consisting of the U.S. Department of Energy Miamisburg Environmental Management Project (DOE-MEMP), U.S. Environmental Protection Agency (USEPA), and the Ohio Environmental Protection Agency (OEPA), appreciates your comments on the Proposed Plan for Parcel 4. Attached are our responses.

Should the responses to comments require additional detail, please contact Rob Rothman at (937) 865-3823 and we will gladly arrange a meeting or telephone conference.

Sincerely,

DOE/MEMP: _____
Robert S. Rothman, Remedial Project Manager

USEPA: _____
Timothy J. Fischer, Remedial Project Manager

OEPA: _____
Brian K. Nickel, Project Manager

Comments Received on the
Parcel 4 Proposed Plan and Risk Evaluations
from
Rev. Dr. Velma M. Shearer
January 2001

Concerns:

1. The drainage from PRS 419, the drainage pipe along the western boundary of the Mound Site and which ends within Parcel 4, before draining by open concrete ditch across City Park property to the Great Miami River.

   It has been stated that the effluent which drains through the pipeline is run-off from the overflow ponds to the north, and this is monitored at Outfall 002 daily for gross alpha (and tritium) and biweekly from 24 hour composite samples for Pu 238, Pu 239/240, U 233/234, U 238, Th 228, Th 230, and Th 232. Will this effluent become the source of water for the future pond as shown within the drawings for future development of parcel 4? Or, if the effluent is routed permanently through the open concrete ditch to the Great Miami River, it should be monitored and released only to meet recreational standards rather than industrial standards. Add to the recreational standard a factor of 10 for children under 15 years of age, since children are much more susceptible to carcinogens than adults. This is not considered in the Proposed Plan, but is, in reality, located on the edge of Parcel 4.

Response:

The effluent from PRS 419 (Drainage Outflow Reroute) does come from the site's drainage system. This system includes the Retention Basins, the Overflow Pond, Outfall 002, the drainage ditch that separates the two hills that comprise the site, and the Asphalt-lined Pond. The effluent at Outfall 002 is regulated by the site's National Pollutant Discharge Elimination System (NPDES) permit. Sampling for radionuclides is not required by the NPDES permit; however flow-proportional samples are collected from Outfall 002 and are analyzed for tritium and isotopes of plutonium, uranium, and thorium. Samples are collected daily during the work week. Three 24-hour samples are collected on Tuesdays, Wednesdays, and Thursdays. One 96-hour sample is collected each Monday. Samples are analyzed four times a week for tritium. Two-week composite samples are analyzed for isotopes of plutonium and uranium. The two-week composite samples are also analyzed for isotopes of thorium. The results of these measurements are reported in the Annual Site Environmental Monitoring Report. According to MMCIC's current

plans, this effluent will not be the source of water for the future pond planned for Parcel 4.

The second part of your concern addresses the standards employed in monitoring this effluent (industrial vs. recreational). These are scenarios for calculating risk. Standards with different bases are applied to this effluent. The nonradioactive constituents in this effluent are monitored and regulated by the NPDES permit limits. The radioactive constituents are compared to Derived Concentration Guides (DCGs). These are the concentrations that would result in a 50-year committed effective dose equivalent of 100 mrem. DCGs are listed in DOE Order 5400.5 and are based on recommendations in Publications 26 and 30 of the International Commission on Radiological Protection. The DCGs for water are based on the conservative assumption that the water is used as drinking water; clearly not the case for this effluent. The average radionuclide concentrations at Outfall 002 during 1999 were:

Radionuclide	Average Concentration MicroCurie/mL	Average as a percent Of DOE DCG
H-3	2.14E-6	0.11
Pu-238	4.82E-10	1.21
Pu-239	4.45E-12	0.015
U-233,234	5.15E-10	0.1
Th-228	5.3E-11	0.01
Th-230	2.6E-11	0.009
Th-232	3.67E-12	0.007

2. The total and incremental carcinogenic and non-carcinogenic risks exceed the acceptable risk range for the future construction worker and the future site employee due to potential exposure groundwater.

Though the estimates for future exposures are biased high, yet considerable PRS cleanup is yet to take place across the site, and must be included in the calculations. For example, a number of PRSs exist which can contribute potential exposure through the movement of the groundwater to the Buried Valley Aquifer: the Pu 238 and Th contaminated soils disposed at the disposal area known as Rader's Hill, the sampling locations I8, I9, J8 and J9 in the region of Building 21 and upgradient areas east of this site, and the Thorium 230 samples taken very near to the Parcel 4 north boundary and which exceeded the 3.0 pCi/g industrial site limit. Though a barrier may delay some of the transport, we must keep in mind that Pu 238 can attach to colloids and move with the colloids in water, and that the Th 230 could be in a water soluble form and thus move with the groundwater flow. (See the following

published papers which give examples of radionuclide transport by natural organic matter from its original deposition to other areas.)

a) A. B. Kersting, D.W. Efurd, D. L. Finnegan, D. J. Rokop, D. K. Smith and J. L. Thompson, "Migration of Plutonium in Ground Water at the Nevada Test Site", *Nature*, Vol. 397, 7 January 1999, 58-59.

b) John F. McCarthy, William E. Sanford, and Paige L. Stafford, "Lanthanide Field Tracers Demonstrate Enhanced Transport of Transuranic Radionuclides by Natural Organic Matter", *Environmental Science & Technology*, Vol. 32, No. 24, December 15, 1998, A-F.

c) Richard C. Marty, Deborah Bennett, and Philip Thullen, "Mechanisms of Plutonium Transport in a Shallow Aquifer in Mortandad Canyon, Los Alamos National Laboratory, New Mexico", *Environmental Science and Technology*, Vol. 31, No. 7, 1997, 2020-2027.

Since the existent potable water source wells on the Mound site are not to be used as a water resource for the newly established industries in Parcel 4, and since the most likely source of potable water for Parcel 4 industrial use will be the Miamisburg City water wells which also draw from the same Buried Valley Aquifer, and since the Miamisburg wells are sufficiently close to the Parcel 4 perimeter, the question remains as to how long before these wells also will be of concern. The Miamisburg City water wells are already known to contain 300 pCi/L of tritium.

Response:

The references listed point out that movement of radionuclides in the subsurface is possible by colloidal transport or through complexation with naturally occurring organic matter. Although this is a possible avenue of migration for elements with normally high affinities to soil (i.e. thorium & plutonium), it does not appear to be a predominant transport mechanism at Mound. For example, if thorium or plutonium were present in the groundwater and migrating in significant concentrations as colloids or organic complexes, samples from monitoring wells directly down-gradient of disposal sites containing these contaminants should consistently show measurable concentrations above background. Such trends have not appeared in over a decade of extensive groundwater monitoring. Although details of the groundwater monitoring program to be implemented as part of the Stewardship efforts at the Mound are yet to be established, correctly placed "sentinel" wells near disposal areas containing radionuclides will help confirm that these contaminants remain immobile. Parcel 4 contains

no disposal areas, providing further assurance that colloidal transport or organic complexation of radionuclides is not a potential long-term liability at this site.

The last paragraph of the comment expresses concern for the potential migration of contaminants from Parcel 4 to the current Miamisburg wellfield. In 1995, the DOE completed a detailed numeric groundwater model of the Great Miami River Buried Valley Aquifer (*Operable Unit 9, Determination of Potential Pathways from Source Areas Adjacent and Within the Buried Valley Aquifer via Ground Water Flow Modeling and Particle Tracking. Technical Memorandum,* Final, September 1995). This model substantiated that the Miamisburg wellfield zone of capture is strongly influenced and limited by recharge from the Great Miami River. Due to this recharge, the position of the Miamisburg wellfield nearly a mile up-gradient of Parcel 4 and the groundwater capture zone created by the Mound production wells, the potential for adverse contaminant impact is remote.

3. The cumulative Cancer Risks for all carcinogenic contaminants do not appear to include Cr(VI) (Hexavalent Chromium) and Sb (Antimony). Cr(VI) is a confirmed human carcinogen; Sb is a questionable carcinogen with experimental carcinogenic data. Both of these chemicals should be included the Cancer Risk calculations. The Cancer Risk totals, hopefully, includes both radiological and hazardous contaminants in the total calculations.

Response:

In general, we total risk for both radioactive and non-radioactive carcinogens.

The *Mound 2000 Residual Risk Evaluation Methodology* (RREM) indicates that the process of evaluating residual risk starts with a list of constituents that includes every compound detected in a given media. These constituents are then screened using criteria established by the RREM to determine which constituents are carried through the RRE. Using the constituent screening methods put forth in the RREM, antimony was retained as a constituent of potential concern (COPC) for groundwater and soil greater than 2 feet below land surface (bls), but not for soil 0-2 feet bls. The level of antimony detected in soil 0-2 feet bls was lower than the screening guideline value. Therefore, antimony was not carried through the RRE calculations for this media. The non-carcinogenic effects of antimony in soil greater than 2 feet bls and groundwater were evaluated in the RRE.

Antimony has not undergone a complete evaluation under US EPA's Integrated Risk Information System (IRIS) program for evidence of human carcinogenic potential. Therefore, the carcinogenic potential of antimony could not be evaluated. However, according to U.S. EPA , multimedia antimony exposures (exposures that occur outside the workplace) are essentially negligible by comparison to occupational exposures where discrete clinical health effects have been observed (*Ambient Water Quality Criteria Document for Antimony*. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Air Quality Planning and Standards, Washington, DC. EPA 440/5-80-020).Therefore, incidental exposures to antimony are not likely to cause unacceptable levels of risk.

Total chromium was evaluated in site media and was conservatively assumed to be present in the hexavalent state. Using the constituent screening methods specified by the RREM, Chromium VI was not retained as a COPC in current groundwater, soil 0-2 feet bls or soil greater than 2 feet bls. In all three instances, chromium was detected at levels below the Chromium VI guideline values. Chromium VI was carried through the screening process for Future Groundwater in both the Construction Worker and Site Employee scenarios. For the ingestion pathway, IRIS does not provide a cancer slope factor for Chromium VI due to lack of evidence. IRIS does provide an inhalation cancer slope factor for Chromium VI. Metals in general were removed from the inhalation pathway since they do not readily volatilize from water while showering. Hence, Chromium VI was removed from consideration as a carcinogen because the pathway (inhalation) to the receptors (Construction Worker, Site Employee) did not exist. A copy of the ATSDR factsheet for chromium is enclosed.

4. Are emergency plans in place for an unforeseen overflow of the holding ponds in case of a heavy rainfall, especially if, for example, during a time when serious remediations are taking place, e.g., of PRS 66? How would such an overflow effect the 419 pipeline and its exit at the Parcel 4 border?

Response :

Contingency plans exist for managing the Overflow Pond in the case of a release and for stormwater management/erosion control during remediation activities. In the event of a (suspected) release, a gate just upstream of the Retention Basins is closed; this diverts the drainage to the Overflow Pond. This pond has approximately four million gallon capacity

and can hold approximately two weeks of the site's water effluent if there is no rain. If the Overflow Pond should exceed its capacity, the overflow travels to the west from the southern corner of the pond, crosses the road, and pools on the DOE property. The overflow from the pond would not enter the drainage reroute (PRS 419).

Stormwater management/erosion control measures for remediation projects are designed specifically for each project. Heavy rainfall on site during remediation activities has always been a prime concern. Note that during remediation of the canal, OEPA recommended additional controls for potential run on flows. These were constructed upgradient of the project. Additionally, the project was constructed and managed in a manner that considered rainfall and as a result there were no unplanned releases during the extensive remediation process. Recall that the reason for the cleanup of the canal was a storm event washing contamination off site, and the site was reminded of this to emphasize the importance of stormwater controls during remediation of the canal. OEPA was very pleased with the result. It is our intent to see that the proper controls are placed during all remediation activities, and in particular PRS 66. The site has already been talking about controls such as those to prevent run on into the disturbed soil areas, and using the excavation itself to contain any storm flows that come in contact with disturbed earth. Then the water can be removed under controlled conditions (tested, pumped for appropriate disposal, etc). This method has been used in some of the removals on this and other sites and works well.

5. A cost of approximately $5000 annually is proposed for the maintenance of deed restrictions, Institutional Controls and maintenance for the total former Mound site. Who will be funding any needed monitoring of water, soils, and air on Parcel 4? Certainly an additional amount should be provided annually for a basic environmental monitoring program.

Response:

The $5,000 per year as referenced is the annual estimated cost for maintaining the Institutional Controls for Parcel 4 (i.e. deed restrictions) and performing the effectiveness reviews for US EPA and OEPA as described in the Proposed Plan. The selected remedy for Parcel 4 does not include monitoring of water, soils, or air on Parcel 4. However, as the Exit Project continues, DOE will continue its environmental surveillance program. This program and its results are described in the Annual Site Environmental Monitoring Report. Any monitoring of the site after DOE completes its mission would be part of Post Closure Stewardship and may be included in the site-wide Proposed Plan and Record of Decision. As a

member of the Post Closure Stewardship Committee, you know these discussions are just beginning.

6. Where will a Data Base be established, and who will maintain all records? This could become part of the Stewardship Program, however, an additional dimension specific to Parcel 4 would need to be added.

Response:

If the contents of the Data Base are the results of monitoring discussed in Comment 5, the Stewardship Program is the appropriate vehicle to address the question. DOE will retain responsibility for and ownership of the information in the current data base (Mound Environmental Information Management System or MEIMS) and the Geographic Information System.

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ACRONYMS AND ABBREVIATIONS

ATSDR	Agency for Toxic Substances Disease Registry
ARAR	Applicable or Relevant and Appropriate Requirement
BVA	Great Miami Buried Valley Aquifer
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPCs	constituents of potential concern
CSF	cancer slope factor
DOE	Department of Energy
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
FFA	Federal Facilities Agreement
GV	Guideline Values
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
IRIS	Integrated Risk Information System
LOAEL	lowest observed adverse effects level
MEIMS	Mound Environmental Information and Management System
MMCIC	Miamisburg Mound Community Improvement Corporation
NCEA	National Center for Environmental Assessment
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ND	Not detected
NOAEL	no observed adverse effect level
Ohio EPA	Ohio Environmental Protection Agency
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyls
ppm	parts per million
PRS	Potential Release Site
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RAGS	Risk Assessment Guidance for Superfund
RfD	reference dose factor
RfC	reference concentration factor
RME	reasonable maximum exposure
RRE	residual risk evaluation
RREM	residual risk evaluation methodology
SVOCs	semi-volatile organic compounds
TPH	total petroleum hydrocarbon
UCL	upper confidence limit
UTL	upper tolerance limit
VOCs	volatile organic compounds

Parcel 4 Human Health Residual Risk Evaluation

Executive Summary

This report was prepared using the Mound 2000 Residual Risk Evaluation Methodology [(RREM) DOE 1997a] to quantify the potential for cancer and other non-cancer health effects from long-term, low-level exposures to site-related contaminants in Parcel 4. A Residual Risk Evaluation (RRE) quantifies human health risks associated with residual levels of contamination remaining within an area to ensure that future users of the land will not be exposed to contaminant levels that would pose unacceptable risks. In the future, Parcel 4 may be used for commercial or industrial land use. Total risk, background risk, and incremental risk were calculated for current and future exposure scenarios for a construction worker and a site employee working in Parcel 4. Potential exposure to contaminants originating outside Parcel 4 that may reach receptors in the parcel are termed potential cumulative exposures. Potential cumulative risk was calculated for current and future exposure to groundwater and air.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Overall Summary of Risks

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

bls = below land surface

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

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

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

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

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

1.0 INTRODUCTION

The U.S. Department of Energy's (DOE) Mound Plant is located on a 306-acre parcel of land within the City of Miamisburg, Ohio, about 10 miles southwest of Dayton, Ohio. Figure 1.1 shows the vicinity of the Mound Plant. The plant is located approximately 2,000 feet east of the Great Miami River and partially overlies the Great Miami Buried Valley Aquifer (BVA). Since 1948, Mound has operated as a research, development, and production facility in support of DOE's weapons and energy programs. Mound's past weapons program mission included process development, production engineering, manufacturing, and surveillance of detonators, explosives, and nuclear components. Mound's current mission is to support DOE's efforts in environmental management and to transition the site, in cooperation with the City of Miamisburg, from a cold-war weapons production facility to commercial or industrial use.

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

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

This report was developed using the Mound 2000 Residual Risk Evaluation Methodology (RREM) (DOE 1997a) to quantify the potential for cancer and other non-cancer health effects from long-term, low-level exposures to site-related contaminants in Parcel 4. A Residual Risk Evaluation (RRE) assesses human health risks associated with residual levels of contamination remaining within an area to ensure that future users of the land will not be exposed to contaminant levels that would pose unacceptable risks. The RRE

results will be used, together with Applicable or Relevant and Appropriate Requirements (ARARs), to determine the need for additional site remediation or to demonstrate that Parcel 4 is ready for public use.

1.1 Purpose of Residual Risk Evaluation

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

1.2 Scope of the Parcel 4 RRE

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

The Parcel 4 residual risk evaluation included an assessment of total, background, and incremental risk. Total risk was calculated using the total concentration of identified constituents of potential concern (COPCs) detected in Parcel 4. Background risk was based on background levels of the COPCs and incremental risk was calculated using the difference between total and background levels. Incremental risk can be used to assess the increase in risk above background levels due to contaminant releases from past Mound Plant operations.

1.3 Organization of Report

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

The RREM consists of five elements, including:

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

The following sections describe each of these elements in more detail starting with Section 2.0, Data Compilation and Evaluation, which describes the methods used to compile Parcel 4 data and identify contaminants to be evaluated in the RRE. Section 3.0, Exposure Assessment, summarizes both the pathways through which hazardous substances may reach potential receptors and intake assumptions that will be used to quantify exposure. In Section 4.0, Toxicity Assessment, exposure point concentrations, intake equations and toxicological reference values are presented. Information from the exposure assessment is combined with information from the toxicity assessment to characterize human health risks in Section 5.0, Risk Characterization. Section 6.0, Uncertainty in the Risk Assessment, presents some of the sources of uncertainty inherent in risk assessments and in the RRE. Section 7.0, References, contains a list of all documents cited in this report.

2.0 DATA COMPILATION AND EVALUATION

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

All available sampling data were compiled for use in the Parcel 4 RRE. Newer data were used to supplement, rather than supercede older data, except when older data described materials that had subsequently been removed from the area. In this case, the older data no longer represent site conditions and

were, therefore, not used in the RRE. Sampling data obtained from the Mound Soil Screening Facility were used except in the case where a sample was split and analyzed by both the Mound Soil Screening Facility and a commercial analytical laboratory. In such cases, the value from the commercial analytical laboratory was used to take advantage of the greater precision available from the commercial analytical laboratory. When a given sample was analyzed using both alpha and gamma spectroscopy methods, the more sensitive alpha spectroscopy results were used to characterize the sample.

Parcel 4 Data Set Components:

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

2.1 Data Quality Assessment

Samples were collected and analyzed according to the methods outlined in the Operable Unit (OU) 9 Quality Assurance Project Plan (QAPP) (DOE 1993a) and the OU5 QAPP (DOE 1993b). Since some of

the data used to characterize residual contaminant concentration in Parcel 4 were collected prior to 1993, not all data used in the risk assessment have undergone Quality Assurance/Quality Control (QA/QC) evaluation and data validation in accordance with the requirements described in the OU9 QAPP (DOE 1993a).

2.2 Environmental Media Considered and Data Availability

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

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

2.3 Data Analysis

For each constituent detected in Parcel 4 soils and current groundwater from the production wells, the 95% upper confidence limit of the mean (UCL) was calculated to estimate the concentration that receptors in the area may be exposed to. This is known as the Exposure Point Concentration or EPC. For future groundwater, modeled values were used as the EPC. The Flow Tube model used to predict future contaminant groundwater concentrations is described in Appendix B. The 95% UCL was calculated in accordance with the Mound 2000 RREM (DOE 1997a), Gilbert's *Statistical Methods for Environmental*

Pollution Monitoring (Gilbert 1987), and the *Supplemental Guidance to RAGS: Calculating the Concentration Term* (EPA, 1992a). Before calculating the 95% UCL, the distribution of the data set was determined. If data were found to be normally distributed, the EPC was calculated as the 95% UCL of the arithmetic mean of the data, using the Student's t-statistic (EPA 1992a). If the data were found to be log normally distributed, the EPC was calculated as the 95% UCL using the H-statistic (EPA 1992a). The 95% UCL on the arithmetic mean for normal data sets were calculated as follows:

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

Where:

UCL= upper confidence limit,
t = t statistic (Table A2, Gilbert, 1987),
s = standard deviation, and
n = number of observation in the data set

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

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

Where:

UCL = upper confidence limit,
e = constant (base of the natural log, equal to 2718)
Mean=mean of the transformed data
s = standard deviation of the transformed data
H = H statistic (e.g., from table published in Gilbert 1987),
n = number of observations in the data set

If the 95% UCL exceeded the maximum value observed in the sampling results , the maximum value was used as the EPC for that constituent (whether the data were normally or log normally distributed). For both chemical and radiological constituents, "not detected" (ND, qualified as U or UJ) results were treated as one-half the limit of detection and included in the calculations of the mean and 95% UCL values. Samples reported as ND or zero with no detection limit were not utilized in calculating a 95% UCL.

Blind field duplicates were collected to assess variability in the sampling process. Duplicate samples were used in the data quality assessment but were not included in the calculation of the exposure point concentrations. If a data set had less than twenty observations (n<20), the maximum detected concentration was used as the EPC. For radionuclides, zero or negative results with no detection limits were excluded from the data set. Data qualified as "J", or estimated values at concentrations less than the detection limit, were evaluated as half the detection limit. For "J" data, which was greater than the detection limit or reported without the sample detection limit, the value was used as reported Data flagged with an "R", meaning rejected, were not used in calculating the EPC.

2.4 Data Screening Process

All constituents that were detected one or more times were listed in constituent summary tables and sorted by media and depth where they were detected. Soil data were also sorted by depth. The constituent screening methods described below were then used to generate a final list of constituents of potential concern (COPCs). The constituent summary tables also provide maximum detected concentrations, the range of contaminant detection limits, the frequency of detection, and the decision and rationale to include or exclude a constituent from further consideration in the RRE. The following section describes how COPCs were selected.

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

2.4.1 Screening Constituents Based on Background

Site-specific background concentrations described as the 95% Upper Tolerance Limit (UTL) of the background sample results for each constituent were calculated for Mound Plant soil and groundwater, and are presented in the Mound 2000 RREM (DOE 1997a). Constituents with a maximum detected concentration exceeding their level in background were identified as initial COPCs and carried to the next screening step of the RRE. Constituents with maximum concentrations less than their background concentration were not carried though the RRE. If no background value was available for a particular constituent (e.g., many organic compounds), the constituent was carried through to the next screening step

of the RRE. These background concentrations were also used to quantify background risk.

For initial COPCs with a 95% UCL of the arithmetic mean less than the maximum detected value, the 95% UCL was compared to background to determine whether the 95% UCL was below background. If the 95% UCL was below the background value for the constituent, the constituent was not identified as a COPC in the RRE. Eliminating these constituents is consistent with the Mound 2000 RREM and focuses the RRE on constituents detected above background.

2.4.2 Screening Constituents Based on Guideline Values

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

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

A 1×10^{-6} risk level represents an incremental increase of one human in a million of developing cancer as a result of exposure to the GV concentration. A Hazard Quotient of one indicates that from an exposure at or below the given concentration, no adverse effects to humans are expected. Since the acceptable risk level for carcinogenic constituents specified in the NCP is a range of 1×10^{-4} to 1×10^{-6} (1 human in 10,000 to 1 human in a million), screening COPCs against the whole GV is protective. The target

threshold for non-carcinogenic constituents is a Hazard Index (HI) of less than or equal to one. The GV values were calculated for a HI of one. To account for the possibility of more than one non-carcinogenic constituent, COPCs were screened using 1/10 the GV. Carcinogenic or radioactive constituents that exceed their GVs and non-carcinogenic constituents that exceed one-tenth of their GV were carried to the next step of the RRE.

2.4.3 Screening Constituents Based on Frequency of Detection

Constituents detected at concentrations above Mound background levels and above applicable GVs were next evaluated for their frequency of detection. Frequency of detection was evaluated as the number of detections divided by the total number of samples analyzed for a constituent. Infrequent detection was defined as five percent or less. This is equivalent to one detect in 20 samples. If there were an insufficient number of samples (e.g. less than 20) to determine whether the frequency of detection is five percent or less, the contaminant was not eliminated on the basis of frequency of detection.

2.4.4 Screening Constituents Based on Essential Human Nutrients

According to RAGS Part A (EPA 1989): "Chemicals that are (1) essential human nutrients, (2) present at low concentrations (i.e., only slightly elevated above naturally occurring levels), and (3) toxic only at very high doses (i.e., much higher than those that could be associated with contact at the site) need not be considered further in the quantitative risk assessment." Inorganic analytes meeting this description were not carried through the RRE. Calcium, chloride, iron, magnesium, potassium, and sodium are considered essential nutrients to humans. These compounds were detected in the Parcel 4 area at levels below or slightly elevated above background and are toxic only at very high doses. Concentrations of these compounds in on-site media would not be expected to result in intakes associated with a toxic response. Therefore, these compounds were eliminated as COPCs for the Parcel 4 area.

2.4.5 Additional Screening Procedures

In accordance with the RREM, additional screening procedures also were used to evaluate Parcel 4 area constituents. For example, in accordance with EPA's Functional Guideline for Organics (EPA 1988) if a blank contains measurable levels of a common laboratory contaminant, then the associated sample results were considered as positive results only if the concentration in the samples exceeded ten times the concentration in the blank. If the concentration of a common laboratory contaminant was less than ten times the blank concentration, the constituent was considered to be an artifact of laboratory handling and was not included in the RRE. Common laboratory contaminants include acetone, 2-butanone, methylene chloride, toluene, and phthalate esters.

2.4.6 Screening Procedures for Future Groundwater

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

3.0 EXPOSURE ASSESSMENT

The goal of the RRE exposure assessment is to estimate the type and magnitude of contaminant exposures that may occur under current and future conditions with the area being used for industrial/commercial purposes. The information gathered in the exposure assessment is integrated with toxicity information to characterize potential risks associated with exposure to residual contamination in the Parcel 4 area.

3.1 Characterization of Exposure Setting

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

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

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

3.2 Identifying Exposure Pathways

Although many exposure pathways are possible, the RRE focuses on those pathways that are likely to occur and are likely to contribute significantly to the overall risk. When identifying exposure pathways

it is important to keep in mind the four elements of an exposure pathway. An exposure pathway consists of: (1) a source of chemical releases, (2) a transport media, (3) a point of potential human contact with the contaminant or contaminated media, and (4) an exposure route (e.g. ingestion). If any of these elements is missing or eliminated, the pathway will be incomplete and exposure will not occur.

A pictorial representation of the exposure pathways identified for potential receptors is included in a conceptual site model for the Parcel 4 (Figure 3.1). The conceptual site model summarizes the pathways that hazardous substances may take to reach potential receptors. Exposure assumptions used to evaluate potential exposure pathways were drawn from the Mound Plant *Risk-Based Guideline Values* (DOE 1997c) and the Mound 2000 RREM (DOE 1997a). Exposure assumptions used to quantify contaminant exposures are summarized in Table 3.1.

3.3 Identifying Exposure Scenarios

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

3.3.1 Construction Worker Scenario

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

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

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

Current and future exposure scenarios for the construction worker are identical except for groundwater. In order to estimate the future contaminant concentrations in groundwater, the modeled future estimated concentration of contaminants detected in the bedrock aquifer were added to current contaminant concentrations in the Mound Plant production wells. Exposure pathways evaluated for the construction worker for both current and future scenarios, include:

- incidental ingestion of soil at or below land surface;
- external exposure to ionizing radiation from radionuclides in soil at or below land surface;
- inhalation of airborne contaminated dust;
- inhalation of volatile emissions from soil;
- ingestion of contaminated groundwater as drinking water;
- inhalation of volatile contaminants from groundwater while showering at work;
- dermal contact with soil at or below land surface; and
- dermal contact with contaminated groundwater while showering at work.

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

3.3.2 Site Employee Scenario

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

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

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

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

3.4 Exposure Point Concentrations

Exposure point concentrations (EPC) are the concentrations of contaminants available to human receptors at the point of contact. The EPC for soil and current groundwater used in the RRE was calculated as the 95% UCL of the arithmetic mean of the data, using the Student's t-statistic. If the data were found to be lognormally distributed, the EPC estimate was calculated as the 95% UCL using the H-statistic (EPA 1992a).

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

3.5 Human Intake Equations And Assumptions

This section presents the exposure equations and assumptions used to derive contaminant-specific intake estimates for the populations and exposure pathways evaluated in the risk assessment. The use of the intake equations presented in this section is in accordance with methods presented by EPA in Risk Assessment Guidance for Superfund (RAGS) Part A (EPA 1989) and the RREM presented in Mound 2000 (DOE 1997a). Exposure assumptions have been developed to represent high-end RME conditions. Exposure

assumptions for each of the potential receptors, and corresponding guidance or rationale used in this assessment are presented in Table 3.1.

For chemicals, exposure generally refers to the intake (e.g., inhalation, ingestion, dermal exposure) of the chemical, expressed in units of mg/kg-day. Toxicity values for chemicals are generally expressed in these terms; therefore, the product of the intake estimate with the toxicity value yields a risk value. There is a fundamental difference between exposures to chemical contaminants as compared to radionuclide contaminants. Radionuclides can have deleterious effects on humans without being taken into the body. Radiation exposure can result from exposure to gamma and x-ray emitting radionuclides that are external to the receptor.

The approach used to estimate intake for chemical contaminants largely applies to radionuclides. However, there are a few key differences in the methods. For example, in addition to the ingestion, inhalation, and direct contact pathways considered for chemical contaminants, external exposure to penetrating radiation was also evaluated for radionuclides. Equations for estimating the intake of radionuclides have been modified by omitting the body weight and averaging time from the denominator. The slope factors for radionuclides are expressed as the average risk per unit intake or exposure for an individual in a stationary population; therefore, radionuclide intakes and slope factors are not expressed as a function of body weight and time.

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

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

3.5.1 Soil Exposure Pathways

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

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

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

Where:

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

Radionuclide intake estimates for the soil via incidental ingestion was estimated by means of the following equation:

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

Where:

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

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

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

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

Where:

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

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

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

Where:

C_{so}	=	Contaminant concentration in soil (mg/kg)
IR_{air}	=	Inhalation rate (m^3/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
PEF	=	Particulate emission factor (4.28×10^9 m^3/kg, EPA default value)
BW	=	Body weight (kg)
AT	=	Averaging time for cancer and non-cancer effects (days)

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

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

Where:

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

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

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

3.5.2 Groundwater Exposure Pathways

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

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

Where:

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

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

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

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

Where:

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

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

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

Where:

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

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

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

Where:

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

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

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

Where:

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

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

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

Where:

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

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

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

Where:

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

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

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

Where:

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

4.0 TOXICITY ASSESSMENT

The objectives of the toxicity assessment are to identify and select toxicological values for use in estimating the significance of the exposure and to evaluate potential adverse effects associated with exposure to compounds detected in Parcel 4. The RRE for the Parcel 4 area evaluated chronic exposures. The RRE utilized methods recommended by EPA for evaluating human cancer effects resulting from exposure to the COPCs. Toxicity criteria used in the RRE were obtained from the most current update of the EPA Integrated Risk Information System (IRIS) or, if the information was not available in IRIS, the EPA Health Effects Assessment Summary Tables (HEAST). IRIS is an electronic database containing the most current descriptive and quantitative EPA regulatory information on chemical and radiological constituents. Constituent files maintained in IRIS contain information related to non-carcinogenic and carcinogenic health effects of constituents. HEAST is a published reference, updated periodically by EPA. HEAST contains slope factors needed to evaluate the carcinogenicity of radionuclides. Table 4.1 presents a summary of toxicological criteria used along with the chemical-specific characteristics used to estimate dermal absorbed dose and the concentrations present in vapors or dust.

In assessing the potential for non-cancer health effects, EPA assumes that there is a threshold below which no adverse toxic effects are expected. For example, a toxic threshold would exist if a substance had no toxic effect at a certain level of exposure, but did have a toxic effect at a higher level. EPA derives and publishes reference doses (RfDs) and reference concentrations (RfCs) for use in evaluating adverse non-carcinogenic effects. These are estimates (with uncertainty spanning an order of magnitude or greater) of daily human exposures, including sensitive sub-populations, that may go without appreciable deleterious effects during a lifetime (EPA 1989). EPA derives RfDs and RfCs for humans, based on estimates of the no-observable-adverse-effect-level (NOAEL) or lowest-observable-adverse-effect-level (LOAEL) observed in test organisms. EPA classifies all radionuclides as carcinogens and the process of carcinogenesis is generally thought to be a phenomenon without a threshold for effect (EPA 1989). The basis for this presumption is that an extremely low level of exposure to some carcinogens may result in chromosomal or enzyme changes leading to uncontrolled cellular proliferation, or cancer. EPA does not therefore, estimate an effect threshold for carcinogenic chemicals. EPA uses a two-part evaluation for carcinogens. First the constituent is assigned a weight-of-evidence classification based on both epidemiological evidence of carcinogenic effects and laboratory tests conducted with animals. Then a cancer slope factor (CSF), is calculated. The HEAST lists ingestion, inhalation, and external exposure CSF for radionuclides in the units

of picocuries (pCi). Ingestion and inhalation slope factors are central estimates in a linear model of the age-averaged, lifetime-attributable radiation cancer incidence (fatal and nonfatal) risk per unit of activity inhaled or ingested. The slope factor is a plausible upper-bound estimate of the slope of the dose-response curve in the low dose range. In risk assessment, the cancer slope factor is used to estimate the excess lifetime probability of a carcinogenic effect occurring in exposed receptors.

4.1 Toxicity Values for Evaluating the Dermal Pathway

Toxicological reference values are available only for the oral and inhalation pathways, and the majority of these values are based on intake (i.e., administered dose) rather than an absorbed dose. Because the intake equation for the dermal contact pathway calculates absorbed dose (by incorporating a dermal absorption factor or a permeability coefficient), it is necessary to convert the administered dose toxicity value to an absorbed dose toxicity value in order to calculate risk. For non-carcinogens, the administered dose toxicity value (i.e., the RfD) was multiplied by the gastrointestinal absorption factor. For carcinogens, the slope factor was divided by the gastrointestinal absorption factor. For the Parcel 4 RRE oral administered-dose, EPA recommended compound-specific gastrointestinal absorption factors used for adjusting toxicity values were only available for PAHs.

5.0 RISK CHARACTERIZATION

This section presents the risk characterization for the Parcel 4 area. In risk characterization, information from the exposure assessment (Section 3) is combined with information from a toxicity assessment (Section 4) to characterize human health risks.

5.1 Risk Characterization Methods

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

The RRE reports the incremental risk, total risk, and risk from background for each contaminant evaluated in Parcel 4 Area. The incremental risk is the risk posed by site-related contamination above the risk posed by background environmental levels. Background risk is the risk resulting from sources other than the Mound-related residual contamination. Site-specific background values are provided in the Mound 2000 RREM (DOE 1997a). The Mound 2000 background values that correspond to the Parcel 4 COPCs were used as the EPCs to determine background risk. Total risk is the sum of the background and incremental risk. This risk characterization presents a separate evaluation of non-carcinogenic and carcinogenic effects. The assessment distinguishes cancer from non-cancer effects because organisms typically respond differently following exposure to carcinogenic or non-carcinogenic agents. Quantification methods for cancer and non-cancer effects are discussed separately in the following sections.

5.1.1 Quantification of Carcinogenic Risk

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

COPC. To derive an estimate of risk, the cancer slope factor was multiplied by the estimated chronic daily intake experienced by the exposed individual:

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

Where:

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

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

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

Where:

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

5.1.2 Quantification of Non-carcinogenic Risk

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

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

Where:

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

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

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

Where:

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

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

5.2 Risk Characterization Results

The following sections present the risk characterization results for the Parcel 4 by potential receptor. Risk estimates for individual soil COPCs for all scenarios and pathways are presented in Tables 5.1 through 5.6. Tables 5.1 through 5.3 present soil risk estimates based on construction worker exposure parameters, and Tables 5.4 through 5.6 present soil risk estimates based on site employee exposure parameters. Total risk was calculated using the total concentration of the COPCs detected in Parcel 4. Background risk was based on background levels of the COPCs and incremental risk was calculated using the difference between total and background levels. Incremental risk can be used to assess the increase in risk above background levels due to Mound Plant operations. Tables 5.19 through 5.21 present summaries of the risk results for all scenarios and media for exposure pathways assessed in the RRE.

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

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

5.2.1 Construction Worker Risk Results

Soil

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

Current Groundwater

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

Future Groundwater

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

Air

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

5.2.2 Site Employee Risk Results

Surface Soil

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

Current Groundwater

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

Future Groundwater

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

Air

Potential cumulative carcinogenic risk due to site employee exposure to contaminants in air was 9.9×10^{-7}, which is slightly less than the acceptable risk range. None of the COPCs identified in air have non-carcinogenic risk criteria so a HI was not calculated for exposure to contaminants in air.

5.2.3 Overall Summary of Risk Results

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

6.0 UNCERTAINTY IN THE RISK ASSESSMENT

In the following section, an evaluation is presented of the sources of uncertainty in the Parcel 4 area RRE and the relative influence of these sources on the results of the evaluation. Uncertainty is inherent in the selection of input parameters and in every step of the risk assessment process. Risk assessment of contaminated sites must not be viewed as yielding single value, invariant results. Rather, the results of risk assessment are estimates that span a range of possible values, and which must be understood only in light of the assumptions and methods used in the evaluation.

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

6.1 Uncertainty in Analytical Data

Uncertainty is introduced to the RRE when sample locations are selected and when samples are collected and analyzed. In the RRE, the long-term exposure concentrations were upper estimates of site concentrations (e.g., maximum detect or 95% UCL); therefore, a conservative bias to overestimate potential exposure has been incorporated into the risk estimates. The uncertainty associated with the statistical analysis of environmental data is low, with little introduction of bias.

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

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

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

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

To estimate future risk in the BVA, the EPC in the production wells was added to the flow tube modeled maximum detected concentration found in the bedrock wells. The flow tube model includes an assumption that the maximum concentration of a constituent detected in each of the twenty bedrock flow tubes impacts the BVA in the future. Natural physical and chemical processes such as dilution, dispersion,

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

6.2 Uncertainty in Exposure Assessment

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

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

Another source of uncertainty in the Parcel 4 RRE involves external exposure to gamma-emitting radionuclides. External exposure refers to the irradiation of tissues by radiation emitted by radionuclides located outside the body either dispersed in air, on skin surfaces, or deposited on ground surfaces. Gamma and x-rays are the most penetrating of the emitted radiation and comprise the primary contribution to radiation dose from external exposures. The calculation of risk from external radiation exposure assumes

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

6.3 Uncertainties Related to Toxicity Information

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

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

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

The derivation of reference doses involves the use of animal studies. Uncertainty factors ranging from 1 to 1,000 are incorporated into the reference dose to provide an extra level of health protection. The factors used depend on the type of study from which the value has been derived (e.g., animal or human, chronic or acute, study design). The scientific basis for this practice is somewhat subjective. In general,

high uncertainty factors are meant to bias the results conservatively so that exposures at the reference dose level will not result in adverse health effects.

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

There are some chemicals for which no toxicity value exists and for which little information is available. Therefore, a quantitative risk estimate cannot be calculated for these chemicals. For example, several of the COPCs identified in Parcel 4 could not be quantified for lack of EPA-approved toxicity values. The lack of toxicity information for some chemicals contributes to the underestimation of risks.

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

6.4 Uncertainties in Risk Characterization

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

6.5 Conclusion

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

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

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Screening Guideline Value	Reference	Rationale for Contaminant Deletion or Selection
Metals												
7429-90-5	Aluminum	363	21400.00	mg/kg	B409	65-65	12700	21400.00	19000.00	21000.00	b, f	YES
7440-36-0	Antimony	0.27	42.20	mg/kg	MND33-0103	20-48	12.6	42.20		8.50	a	YES
7440-38-2	Arsenic	1.7	17.10	mg/kg		65-65	6.99	17.10	8.60	6.40	a	YES
7440-39-3	Barium	2	133.00	mg/kg	CH	65-65	86.5	133.00	180.00	1500.00	b	NO:2,3
13966-02-4	Beryllium	0.12	0.94	mg/kg	CH	50-65	0.66	0.94	1.30	0.70	c	NO:2
14733-03-0	Bismuth	0.76	70.40	mg/kg	CJ	48-51	73.3	70.40				YES
7440-43-9	Cadmium	0.31	7.70	mg/kg	MND33-0103	14-65	1.02	7.70	2.10	21.00	a	NO:3
7440-70-2	Calcium	812	175000.00	mg/kg	NPS1	65-65	108000	175000.00	310000.00			NO:2
	Cerium	23.60	50.90	mg/kg		8-8	NC	50.90				YES
7440-47-3	Chromium	1	30.50	mg/kg	MND33-0103	65-65	17.9	30.50	20.00	64.00	a	NO:3
10198-40-0	Cobalt	0.37	14.40	mg/kg	B409	65-65	12.0	14.40	19.00			NO:2
7440-50-8	Copper	1.4	27.50	mg/kg		65-65	17.5	27.50	26.00	790.00	a, f	NO:3
57-12-5	Cyanide	0.12	0.38	mg/kg	MND33-0103	8-65	0.31	0.38		430.00	a	NO:3
7439-89-6	Iron	1300	40500.00	mg/kg		65-65	22100	40500.00	35000.00			NO:4
15067-28-4	Lead	2	255.00	mg/kg		65-65	20.6	255.00	48.00			YES
7439-93-2	Lithium	2.7	41.40	mg/kg	B409	45-46	17.6	41.40	26.00			YES
7439-95-4	Magnesium	583	68800.00	mg/kg	MND33-0103	65-65	21700	68800.00	40000.00			YES
7439-96-5	Manganese	42.3	5240.00	mg/kg		65-65	1010	5240.00	1400.00	2700.00	b	YES
7439-97-6	Mercury	0.14	0.42	mg/kg	NPS6	4-65	0.07	0.42		6.40	b	NO:3
7439-98-7	Molybdenum	0.56	15.70	mg/kg		45-46	9.52	15.70	27.00			NO:2
	Neodymium	16.5	33.40	mg/kg		7-8	NC	33.40				YES
7440-02-0	Nickel	2.8	26.20	mg/kg	CJ	62-65	22.0	26.20	32.00	430.00	a	NO:2,3
13966-00-2	Potassium	157	4320.00	mg/kg	B409	60-65	2530	4320.00	1900.00			NO:4
7782-49-2	Selenium	0.29	2.20	mg/kg	CJ	10-65	0.54	2.20		110.00	a, f	NO:3
7440-22-4	Silver	0.35	17.00	mg/kg	MND33-0103	9-65	1.88	17.00	1.70	110.00	a	NO:3
13966-32-0	Sodium	26.7	865.00	mg/kg		50-65	410	865.00	240.00			NO:4
14913-50-9	Thallium	0.35	2.10	mg/kg		11-50	0.66	2.10	0.46	1.70	a, f	YES
7440-31-5	Tin	1.6	41.10	mg/kg		7-52	6.9	41.10	20.00	13000.00	a, f	NO:3
7440-62-2	Vanadium	0.45	37.00	mg/kg	B409	63-65	34.9	37.00	25.00	150.00	a	NO:3
7440-66-6	Zinc	4.1	1310.00	mg/kg		65-65	65.5	1310.00	140.00	6400.00	a	NO:3

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

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

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

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Screening Guideline Value	Reference	Rationale for Contaminant Deletion or Selection
Pesticides/PCBs												
72-54-8	4,4'-DDD	0.4	6.60	ug/kg	B409	2-64	2.6	6.60	4.20			NO:1
72-55-9	4,4'-DDE	0.25	3.50	ug/kg	MND22-4101	6-64	2.07	3.50	4.30	9000.00	d	NO:2,3
50-29-3	4,4'-DDT	0.19	0.48	ug/kg		4-65	2.69	0.48	13.00	9000.00	c	NO:2,3
309-00-2	Aldrin	0.074	0.35	ug/kg	B401	6-64	1.26	0.35		180.00	c, f	NO:3
5103-71-9	Alpha Chlordane	0.044	3.50	ug/kg		6-65	1.97	3.50		8500.00	c, f	NO:3
319-86-8	Delta-BHC	0.08	5.30	ug/kg	MND22-4101	3-65	1.64	5.30				NO:1
60-57-1	Dieldrin	0.31	1.20	ug/kg		4-65	2.17	1.20		185.00	c	NO:3
33213-65-9	Endosulfan I	0.051	0.27	ug/kg	B407	3-63	1.81	0.27		130000.00	a, f	NO:1
33213-65-9	Endosulfan II	0.053	7.10	ug/kg	MND22-4001	5-65	2.41	7.10		130000.00	a, f	NO:3
1031-07-8	Endosulfan Sulfate	0.13	0.56	ug/kg	MND22-4101	2-65	3.35	0.56				NO:1
7421-93-4	Endrin Aldehyde	0.28	0.93	ug/kg	MND22-4102	4-60	3.34	0.93				YES
53494-70-5	Endrin Ketone	0.24	0.86	ug/kg		4-65	3.43	0.86				YES
5103-74-2	Gamma Chlordane	0.058	0.93	ug/kg	MND22-4003	2-65	1.85	0.93		8500.00	c, f	NO:1
58-89-9	Gamma-BHC (Lindane)	0.065	0.095	ug/kg	MND22-4101	2-65	1.26	0.10		2300.00	d, f	NO:1
1024-57-3	Heptachlor	0.056	1.20	ug/kg		7-65	1.17	1.20		660.00	d, f	NO:3
1024-57-3	Heptachlor Epoxide	0.072	0.94	ug/kg	MND22-4102	6-65	1.79	0.94		280.00	a, f	NO:3
72-43-5	Methoxychlor	0.13	0.95	ug/kg	MND22-4101	4-63	23.2	0.95	30.00			NO:2
Explosives												
99-65-0	1,3-Dinitrobenzene	0.098	0.098	mg/kg	B405	1-41	0.89	0.10				NO:1
118-96-7	2,4,6-Trinitrotoluene	0.20	0.20	mg/kg	B405	1-41	0.86	0.20				NO:1
	Tetryl	0.29	0.29	mg/kg		1-41	1.34	0.29				NO:1

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

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Screening Guideline Value	Reference	Rationale for Contaminant Deletion or Selection
Radionuclides												
AC-227DA	Actinium-227	0.13	2.01	pCi/g		14-130	0.23	2.01		1.00	e	YES
14596-10-2	Americium-241	0.05	0.21	pCi/g		5-188	0.13	0.21		4.95	e	NO:1
10045-97-3	Cesium-137	0.06	0.90	pCi/g		130-188	0.36	0.90	0.42	0.46	e	YES
10198-40-0	Cobalt-60	0.04	0.90	pCi/g		3-188	0.05	0.90		0.10	e	NO:1
14255-04-0	Lead-210	0.38	3.35	pCi/g		94-117	1.76	3.35		1.65	e, f	YES
13994-20-2	Neptunium-237	0.023	0.067	pCi/g	#613	6-8	NC	0.07		1.50	e, f	NO:3
13981-16-3	Plutonium-238	0.013	55.40	pCi/g		142-480	87	55.40	0.13	5.50	e	YES
PU-239/240	Plutonium-239	0.01	0.011	pCi/g		3-10	NC	0.01	0.18	5.50	e	NO:2,3
PU-239/240	Plutonium-239/240	0.0039	0.21	pCi/g		18-63	0.02	0.21	0.18	5.50	e	NO:3
13982-10-0	Plutonium-242	0.0102	0.01	pCi/g	GJ	1-31	0.02	0.01				NO:1
13966-00-2	Potassium-40	10.5	34.46	pCi/g	B405	56-67	22.6	34.46	37.00			NO:2
13982-63-3	Radium-226	0.39	3.26	pCi/g		137-180	1.34	3.26	2.00	0.14	e	YES
	Radium-228	0.636	2.57	pCi/g		10-10	NC	2.57		0.10	e, f	YES
10098-97-2	Strontium-90	0.158	2.77	pCi/g	B405	4-37	1.07	2.77	0.72	3.00	e	NO:3
14274-82-9	Thorium-228	0.195	1.79	pCi/g		66-80	1.07	1.79	1.50	0.16	e	YES
14269-63-7	Thorium-230	0.15	2.69	pCi/g		79-178	3.57	2.69	1.90		g	YES
7440-29-1	Thorium-232	0.037	5.60	pCi/g	S1049	184-491	0.83	5.60	1.40	0.10	e, f	YES
10028-17-8	Tritium	0.066	3.00	pCi/g		7-64	0.88	3.00	1.60	23500.00	e	NO:3
13966-29-5	Uranium-234	0.33	1.17	pCi/g	B406	56-65	0.77	1.17	1.10	37.50	e	NO:3
15117-96-1	Uranium-235	0.019	0.20	pCi/g	B406	46-51	0.09	0.20	0.11	3.35	e	NO:3
24678-82-8	Uranium-238	0.32	1.95	pCi/g		110-115	1.08	1.95	1.20	0.12	e	YES

a= 1/10th HI for ingestion
b= 1/10th HI for ingestion + inhalation
c= 10^{-6} cancer risk for ingestion + inhalation
d= 10^{-6} cancer risk for ingestion
e= 10^{-6} cancer risk for ingestion + inhalation + external
f= Calculated values based on procedures in Mound's approved Risk-Based Guidance Values, Final Rev. 4, March 1997 and updated toxicity criteria
g= Guideline Value was removed(under Core Team review)

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

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

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

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

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

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Screening Guidance Values	Reference	Rationale for Contaminant Deletion or Selection
Metals												
7429-90-5	Aluminum	1680	21400	mg/kg	B409	22-22	8570.00	21400	19000.00	190000.00	b, f	YES
7440-36-0	Antimony	26.1	42.2	mg/kg	MND33-0103	8-21	367.00	42.20		82.00	a	NO 3
7440-38-2	Arsenic	3.90	11.80	mg/kg	B406	22-22	7.00	11.80	8.60	61.00	a	NO 3
7440-39-3	Barium	12.4	111.00	mg/kg		22-22	58.30	111.00	180.00	14000.00	b	NO 2,3
13966-02-4	Beryllium	0.12	0.85	mg/kg		21-22	0.70	0.85	1.30	1.30	c	NO 2,3
14733-03-0	Bismuth	0.76	28.50	mg/kg	CJ	12-14	NC	28.50				YES
7440-43-9	Cadmium	0.31	7.70	mg/kg	MND33-0103	11-22	40.10	7.70	2.10	200.00	a	NO 3
7440-70-2	Calcium	812	150000.00	mg/kg		22-22	662000.00	150000.00	310000.00			NO 2
7440-47-3	Chromium	1.7	30.50	mg/kg	MND33-0103	22-22	26.70	30.50	20.00	1000.00 610	a	NO 3
10198-40-0	Cobalt	1.4	14.40	mg/kg	B409	22-22	10.80	14.40	19.00			NO 2
7440-50-8	Copper	3.4	21.70	mg/kg		22-22	18.10	21.70	26.00	7600.00	a, f	NO 2,3
57-12-5	Cyanide	0.12	0.38	mg/kg	MND33-0103	8-22	0.35	0.38		4100.00	a	NO 3
7439-89-6	Iron	2790	28800.00	mg/kg		22-22	17600.00	28800.00	35000.00			NO 2
15067-28-4	Lead	5.4	32.00	mg/kg	B401	22-22	19.20	32.00	48.00			NO 2
7439-93-2	Lithium	2.7	27.30	mg/kg	B409	12-13	NC	27.30	26.00			YES
7439-95-4	Magnesium	583	68800.00	mg/kg	MND33-0103	22-22	110000.00	68800.00	40000.00			NO 4
7439-96-5	Manganese	116	1250.00	mg/kg	MND22-4101	22-22	722.00	1250.00	1400.00	15000.00	b	NO 2,3
7439-97-6	Mercury	0.14	0.14	mg/kg		1-22	0.07	0.14		61.00	b	NO 1
7439-98-7	Molybdenum	0.56	6.20	mg/kg	B409	13-13	NC	6.20	27.00			NO 2
7440-02-0	Nickel	2.8	25.80	mg/kg		21-22	30.10	25.80	32.00	4100.00	a	NO 2,3
13966-00-2	Potassium	270	3550.00	mg/kg	B409	22-22	1650.00	3550.00	1900.00			NO 4
7440-22-4	Silver	12	17.00	mg/kg	MND33-0103	8-22	149.00	17.00	1.70	1000.00	a	NO 3
13966-32-0	Sodium	26.7	530.00	mg/kg	MND22-4101	21-22	407.00	530.00	240.00			NO 4
14913-50-9	Thallium	0.43	0.44	mg/kg		8-22	0.89	0.44	0.46	16.00	a, f	NO 2,3
7440-31-5	Tin	2.6	4.80	mg/kg	MND22-4102	3-14	NC	4.80	20.00			NO 2
7440-62-2	Vanadium	0.75	37.00	mg/kg	B409	22-22	33.20	37.00	25.00	1400.00	a	NO 3
7440-66-6	Zinc	6.7	74.10	mg/kg		22-22	45.50	74.10	140.00	61000.00	a	NO 2,3
Semi-Volatile Organic Compounds												
120-82-1	1,2,4-Trichlorobenzene	33	33	ug/kg	MND33-0104	1-15	NC	33.00		2040000.00	b, f	NO 3
95-57-8	2-Chlorophenol	38	38	ug/kg	MND33-0104	1-15	NC	38.00		10200000.00	a, f	NO 3
91-57-6	2-Methylnaphthalene	63	63	ug/kg	B401	1-15	NC	63.00				YES
59-50-7	4-Chloro-3-methylphenol	7	7	ug/kg	MND33-0104	1-15	NC	7.00				YES
56-55-3	Benzo(a)anthracene	58	58	ug/kg	B401	1-15	NC	58.00		7800.00	d	NO 3
50-32-8	Benzo(a)pyrene	51	51	ug/kg	B401	1-15	NC	51.00		780.00	d	NO 3
205-99-2	Benzo(b)fluoranthene	37	98	ug/kg	B401	4-15	NC	98.00		7800.00	d	NO 3
207-08-9	Benzo(k)fluoranthene	65	170	ug/kg	B401	4-15	NC	170.00		78000.00	d	NO 3
65-85-0	Benzoic Acid	12	12	ug/kg	MND33-0104	1-15	NC	12.00		820000000.00	a	NO 3
218-01-9	Chrysene	78	78	ug/kg	B401	1-15	NC	78.00		780000.00	a	NO 3
84-74-2	Di-n-butyl Phthalate	25	68	ug/kg		3-15	NC	68.00		20000000.00	a	NO 3
206-44-0	Fluoranthene	39	110	ug/kg	B401	4-15	NC	110.00		8200000.00	a	NO 3
85-01-8	Phenanthrene	78	78	ug/kg	B401	1-15	NC	78.00				YES
108-95-2	Phenol	23	23	ug/kg	MND33-0104	1-15	NC	23.00		120000000.00	a	NO 3
129-00-0	Pyrene	25	120	ug/kg	MND33-0103	7-15	NC	120.00		6100000.00	a	NO 3
Volatile Organic Compounds												
67-64-1	Acetone	13	17	ug/kg	MND22-4101	2-22	7.16	17.00		20000000.00	a	NO 3
75-09-2	Methylene Chloride	6	14	ug/kg		7-22	9.54	14.00		100000.00	d	NO 3
108-88-3	Toluene	2	2	ug/kg		1-22	3.12	2.00		25000.00	b	NO 1

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

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

a - 1/10th HI for ingestion
b - 1/10th HI for ingestion + inhalation
c - 10^{-6} cancer risk for ingestion + inhalation
d - 10^{-6} cancer risk for ingestion
e - 10^{-6} cancer risk for ingestion + inhalation + external
f - Calculated values based on procedures in Mound's approved Risk-Based Guidance Values, Final Rev. 4, March 1997 and updated toxicity criteria
g - Guideline Value was removed (under Core Team review)

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

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

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

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

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

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

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

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

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

a 1/10th HI for ingestion + inhalation + dermal

b 1/10th HI for ingestion

c 10^{-6} cancer risk for ingestion

d 10^{-6} cancer risk for ingestion + dermal + inhalation

e 10^{-6} cancer risk for ingestion + inhalation + external

f New Risk-Based Guideline Values calculated according to Mound GV 3/97 methodology

The calculations for updated GVs are presented in Appendix C.

NO:1 - <5% Detects

NO:2 - <Background Value

NO:3 - < Risk-Based Guideline Value

NO:2,3 - <Background and Risk-Based Guideline Value

NO:4 - Essential Nutrient

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

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

UCL = Upper Confidence Limit

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

NO = Background Value

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

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

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

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

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

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

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

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

Table 2.8 Final Identification of Current Groundwater Constituents of Potential Concern for the Site Employee Scenario

(Exposure Point Concentration Compared to Background Values)

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

UCL = Upper Confidence Limit

EPC = minimum of 95% UCL or maximum detected concentration

NO = Background Value

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

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

Chemical	Minimum Concentration In Bedrock Wells	Maximum Concentration In Bedrock Wells	Units	Detection Frequency In Bedrock Wells	95 Percent UCL	Concentration Used for Screening	Background Value	Construction Worker Risk-Based GV	Reference	COPC?
Inorganics										
Aluminum	20.1	31500.00	ug/L	107/ 115	6840.00	31500.00	37.523	10000.00	a, d	YES
Ammonia**	110	37500.00	ug/L	34/ 61	403.00	37500.00	162			NO 5
Antimony	0.35	41.60	ug/L	21/ 122	2.82	41.60	0.578	4.10	a	YES
Arsenic**	0.3	933.00	ug/L	26/ 114	11.80	933.00	32.997	3.10	a	YES
Barium	17.5	329.00	ug/L	112/ 114	130.00	329.00	310.209	710.00	a	NO 3
Beryllium**	0.03	2.30	ug/L	41/ 115	0.47	2.30		0.07	c	YES
Bismuth**	0.9	264.00	ug/L	23/ 103	23.20	264.00				YES
Boron**	110	110.00	ug/L	1/ 2	NC	110.00		900.00	a, d	NO 3
Cadmium	0.34	13.10	ug/L	11/ 123	0.75	13.10		5.10	a	YES
Calcium	116	1510000.00	ug/L	163/ 164	199000.00	1510000.00	111110.664			NO 4
Chloride**	8100	17700000.00	ug/L	74/ 74	908000.00	17700000.00	105821			NO 5
Chromium*	0.27	44800.00	ug/L	78/ 120	5010.00	44800.00	6.076	30.00	a, d	YES
Cobalt**	0.31	295.00	ug/L	46/ 115	18.50	295.00	1.032	600.00	a, d	NO 3
Copper	0.38	514.00	ug/L	81/ 117	26.80	514.00	1.167	400.00	a, d	YES
Cyanide**	5.5	14.20	ug/L	3/ 45	4790.00	14.20		200.00	a	NO 3
Dissolved Solids	499000	32500000.00	ug/L	47/ 47	2480.00	32500000.00				NO 4
Fluoride**	150	2400.00	ug/L	57/ 58	678.00	2400.00	419			NO 5
Iron	0.154	192000.00	ug/L	151/ 165	45400.00	192000.00	4064.888			NO 5
Lead**	0.4	32.00	ug/L	55/ 125	4.90	32.00	10.05			YES
Lithium	8.8	4280.00	ug/L	87/ 102	123.00	4280.00	55.7			YES
Magnesium	26.9	719000.00	ug/L	165/ 165	77500.00	719000.00	40428.111			NO 4
Manganese	0.037	3030.00	ug/L	155/ 165	737.00	3030.00	229.568	51.00	a	YES
Mercury**	0.1	1.40	ug/L	3/ 115	0.06	1.40		3.10	a	NO 1
Molybdenum	0.79	474.00	ug/L	51/ 98	32.50	474.00	5.597	50.00	a, d	YES
Nickel	1.2	11600.00	ug/L	82/ 120	749.00	11600.00	34.957	200.00	a	YES
Phosphate**	60	10100.00	ug/L	31/ 41	792.00	10100.00	231			NO 5
Potassium	2.12	214000.00	ug/L	150/ 164	15200.00	214000.00	4461.063			NO 4
Selenium	1.3	7.00	ug/L	10/ 112	1.78	7.00		50.00	a, d	NO 3
Silicon**	2230	12300.00	ug/L	6/ 6	NC	12300.00				NO 4
Silver	0.72	29.40	ug/L	7/ 115	1.24	29.40		51.00	a	NO 3
Sodium	68.2	7270000.00	ug/L	162/ 162	346000.00	7270000.00	62425.563			NO 4
Sulfate	5000	456000.00	ug/L	73/ 76	205.00	456000.00				NO 4
Thallium	3.1	6.90	ug/L	6/ 107	4.44	6.90		0.80	a,d	YES
Tin	1.4	357.20	ug/L	27/ 100	14.90	357.20	34.382	6000.00	a, d	NO 3
Vanadium	0.15	277.00	ug/L	65/ 115	33.00	277.00	17.1	71.00	a	YES
Zinc	1.4	399.00	ug/L	78/ 117	47.10	399.00	119.6	3100.00	a	NO.3

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

Chemical	Minimum Concentration In Bedrock Wells	Maximum Concentration In Bedrock Wells	Units	Detection Frequency In Bedrock Wells	95 Percent UCL	Concentration Used for Screening	Background Value	Construction Worker Risk-Based GV	Reference	COPC?
Organic Compounds										
1,1,1-Trichloroethane	0.40	7.00	ug/L	20/ 238	0.67	7.00	0.668	180.00	a,d	NO 3
1,1,2 Trichloro-1,2,2-trifluoroethane	2.20	2.20	ug/L	1/ 118	1.08	2.20		250000.00	a,d	NO 1
1,1-Dichloroethane^^	2.00	2.00	ug/L	1/ 238	0.75	2.00		950.00	a	YES
cis-1,2-Dichloroethene	0.06	17.00	ug/L	48/148	1.61	17.00	0.999	100.00	a,d	NO 3
1,2-Dichloroethene**	1.00	35.00	ug/L	13/ 38	6.61	35.00				YES
trans 1,2-Dichloroethene	0.33	10.00	ug/L	13/ 217	0.76	10.00		200.00	b	NO 3
1,3-Dichlorobenzene**	1.50	1.50	ug/L	1/ 117	3.92	1.50				NO 1
2-Butanone	3.00	65.00	ug/L	14/ 106	6.48	65.00		5300.00	a	NO 3
4-Methylphenol	12.00	61.00	ug/L	2/ 71	6.05	61.00		48.00	a	NO 1
Acetone	1.00	17.00	ug/L	25/ 81	9.19	17.00		1000.00	a	NO 3
Alpha-Chlordane**	0.01	0.069	ug/L	3/ 62	0.11	0.07				NO 1
Benzene**	2.50	2.50	ug/L	1/ 241	1.26	2.50		7.50	c	NO 1
Benzoic Acid**	1.00	890.00	ug/L	2/ 68	35.70	890.00		40000.00	a	NO 1
Bis(2-ethylhexyl)phthalate**	0.50	950.00	ug/L	16/ 72	17.20	950.00	8.41	12.00	c	NO 6
Carbon Tetrachloride**	1.50	1.50	ug/L	1/ 238	0.94	1.50		2.00	c	NO 1
Chloroform	0.50	0.70	ug/L	2/ 239	0.65	0.70	0.516			NO 1
Chloromethane**	3.40	3.40	ug/L	1/ 85	4.12	3.40				NO 1
Dibromomethane**	2.80	2.80	ug/L	1/ 182	1.01	2.80				NO 1
Dichloromethane	1.00	610.00	ug/L	41/ 239	3.28	610.00		38.00	c	YES
Di-n-butyl Phthalate**	0.50	3.00	ug/L	5/ 71	5.80	3.00		410.00	a	NO 6
Tetrachloroethene**	0.30	25.00	ug/L	55/ 247	3.37	25.00		12.00	a	YES
Toluene	0.50	8.00	ug/L	13/ 243	1.27	8.00		150.00	a	NO 3
Trichloroethene	0.44	46.00	ug/L	152/ 273	5.12	46.00		15.00	c	YES
Radionuclides										
Americium-241	0.6750	0.17	pCi/L	6/ 43	2.87	0.17	0.139	2.40	d	NO 3
Bismuth-210	0.12	0.26	pCi/L	2/ 55	7.99	0.26		110.00	d,e	NO 1
Gross Alpha**	1.03	1930.00	pCi/L	8/ 12	NC	1930.00				NO 4
Plutonium-238	0.012	1.870	pCi/L	8/ 60	0.15	1.87	0.087	2.70	d	NO 3
Plutonium-239/240	0.003	0.18	pCi/L	12/ 51	0.42	0.18	0.125	2.50	d	NO 3
Potassium-40**	129.000	258.00	pCi/L	3/ 61	133.00	258.00				NO 1
Radium-226	0.1260	39.47	pCi/L	43/ 59	2.34	39.47	0.996	2.70	d	YES
Radium-228**	1.50	1.50	pCi/L	1/ 1	NC	1.50		1.70	d,e	NO 3
Strontium-90	0.74	42.40	pCi/L	7/ 57	2.22	42.40	0.975	14.00	d	YES
Thorium-228	0.02	8.50	pCi/L	39/ 54	90.70	8.50	0.779	3.50	d	YES
Thorium-230	0.0034	4.07	pCi/L	43/ 56	0.57	4.07				YES
Thorium-232	0.0005	2.11	pCi/L	31/ 63	0.78	2.11	0.314	1.60	d,e	YES
Tritium	2.95	2816310.00	pCi/L	4440/4455	206000.00	2816310.00	1485.47	11000.00	c	YES
Uranium-233/234	0.154	0.928	pCi/L	4/ 4	NC	0.93		18.00	d	NO 3
Uranium-234	0.03	59.10	pCi/L	60/ 69	2.12	59.10	0.792	18.00	d	YES
Uranium-235	0.01	0.36	pCi/L	18/ 45	5.71	0.36	0.814	17.00	d	NO 2,3
Uranium-235/236**	0.04	0.05	pCi/L	2/ 26	0.10	0.05		17.00	d	NO 3
Uranium-238	0.03	1.34	pCi/L	57/ 75	0.51	1.34	0.688	0.60	d,e	YES

a - 1.10th HI for ingestion + inhalation + dermal
b - 1.10th HI for ingestion
c - 10^{-6} cancer risk for ingestion + inhalation + dermal
d - 10^{-6} cancer risk for ingestion
e - Risk-Based Guideline Values calculated using the methodology, equations, and parameters presented in Mound Screening GV 3.97
NC - 95% UCL not calculated: less than 20 samples in the data set
^ - Chromium conservatively assumed to be present in the hexavalent state
** - Constituent detected in bedrock well, but not in production well
- - Constituent detected in production well, not in bedrock wells, reported frequency of detection based on production wells analyses

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

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

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

UCL Upper Confidence Limit

NO 95% UCL not calculated, less than 20 samples in the data set

* Chromium conservatively assumed to be present in the hexavalent state

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

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

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

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

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

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

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

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

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

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

UCL = Upper confidence Limit

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

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

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

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

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

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

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

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

Table 3.1 (references)
Exposure Assumption References

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

Table 4.1 Toxicity Criteria and other Physical Chemical Values

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

Table 4.1 Toxicity Criteria and other Physical Chemical Values

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

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

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

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

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

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

* Toxicity criteria used to calculate risk include all daughter radionuclides

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

Constituent	EPC mg/kg	CANCER EFFECTS Route-Specific Risk Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Pesticides													
Endrin Aldehyde		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Endrin Ketone		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Metals													
Antimony		NC	NC	NA	NAP	NAP	NA	0.0E+00	0.0E+00	NA	NAP	NAP	NA
Bismuth		NC	NC	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Cerium		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Neodymium		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Thallium	0.46	NC	NC	NC	NAP	NAP	NA	2.7E-02	4.0E-05	NA	NAP	NAP	2.7E-02
SVOCs													
Acenaphthylene		NC	NC	NC	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(a)pyrene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(b)fluoranthene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(g,h,i)perylene		NC	NC	NC	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Carbazole		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Indeno(1,2,3-cd)pyrene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Phenanthrene		NC	NC	NC	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Radionuclides	EPC pCi/g												
Actinium-227		NA	NAP	NA	NAP	NA	NA	NA	NAP	NA	NAP	NA	NA
Lead-210		NA	NAP	NA	NAP	NA	NA	NA	NAP	NA	NAP	NA	NA
Plutonium-238	0.13	2.3E-08	NAP	2.1E-11	NAP	1.0E-12	2.3E-08	NA	NAP	NA	NAP	NA	NA
Radium-228*		NA	NAP	9.78-08	NAP	NA	NA	NA	NAP	NA	NAP	NA	NA
Thorium-230*	1.9	1.5E-06	NAP	2.6E-10	NAP	5.3E-06	6.8E-06	NA	NAP	NA	NAP	NA	NA
TOTAL		1.6E-06	NA	2.8E-10	NA	5.3E-06	6.8E-06	2.7E-02	4.0E-05	NA	NA	NA	2.7E-02

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

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

* Toxicity criteria used to calculate risk include all daughter radionuclides

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

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Pesticides													
Endrin Aldehyde	0.00093	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Endrin Ketone	0.00086	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Metals													
Antimony	12.60	NC	NC	NA	NAP	NAP	NA	1.5E-01	1.7E-03	NA	NAP	NAP	1.5E-01
Bismuth	70.40	NC	NC	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Cerium	50.90	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Neodymium	33.40	NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Thallium	0.20	NC	NC	NC	NAP	NAP	NA	1.2E-02	1.7E-05	NA	NAP	NAP	1.2E-02
SVOCs													
Acenaphthylene	0.243	NC	NC	NC	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(a)pyrene	0.33	8.1E-07	3.3E-07	3.3E-12	NAP	NAP	1.1E-06	NA	NA	NA	NAP	NAP	NA
Benzo(b)fluoranthene	0.439	1.1E-07	4.4E-08	4.4E-13	NAP	NAP	1.5E-07	NA	NA	NA	NAP	NAP	NA
Benzo(g,h,i)perylene	0.241	NC	NC	NC	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Carbazole	0.219	1.5E-09	4.6E-10	NA	NAP	NAP	1.9E-09	NA	NA	NA	NAP	NAP	NA
Indeno(1,2,3-cd)pyrene	0.253	6.2E-08	2.5E-08	2.6E-13	NAP	NAP	8.7E-08	NA	NA	NA	NAP	NAP	NA
Phenanthrene	0.338	NC	NC	NC	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Radionuclides	EPC pCi/g												
Actinium-227	0.64	2.4E-07	NAP	2.9E-10	NAP	2.5E-07	4.9E-07	NA	NAP	NA	NAP	NA	NA
Lead-210	1.84	1.1E-06	NAP	4.1E-11	NAP	1.1E-10	1.1E-06	NA	NAP	NA	NAP	NA	NA
Plutonium-238	75.98	1.3E-05	NAP	1.2E-08	NAP	6.1E-10	1.3E-05	NA	NAP	NA	NAP	NA	NA
Radium-228*	2.57	7.4E-07	NAP	9.7E-08	NAP	1.0E-05	1.1E-05	NA	NAP	NA	NAP	NA	NA
Thorium-230*	0.79	6.4E-07	NAP	1.1E-10	NAP	2.2E-06	2.8E-06	NA	NAP	NA	NAP	NA	NA
TOTAL		1.7E-05	4.0E-07	1.3E-08	NA	1.2E-05	3.0E-05	1.6E-01	1.7E-03	NA	NA	NA	1.6E-01

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

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

* Toxicity criteria used to calculate risk include all daughter radionuclides

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

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

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

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

* Toxicity criteria used to calculate risk include radionuclide daughters

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

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

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

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

* Toxicity criteria used to calculate risk include radionuclide daughters

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

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Pesticides											
Delta-BHC	0 004670	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Endosulfan Sulfate	0 000560	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Endrin Aldehyde	0 000930	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Endrin Ketone	0 000250	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Metals											
Bismuth	28 50	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Lithium	1 30	NA	NA	NAP	NAP	NA	3.2E-05	NA	NAP	NAP	3.2E-05
Semi-Volatile Organic Compounds											
2-Methylnaphthalene	0 063	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
4-Chloro-3-methylphenol	0 007	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Phenanthrene	0 078	NA	NA	NAP	NAP	NA	NA	NA	NAP	NAP	NA
Radionuclides	EPC pCi/g										
Actinium-227	0 24	4 7E-08	5 5E-10	NAP	4 6E-07	**5.0E-07**	NA	NA	NAP	NA	NA
Lead-210	1 76	3 7E-07	8 6E-11	NAP	4 0E-10	3.7E-07	NA	NA	NAP	NA	NA
Plutonium-238	20 27	1 9E-06	1.6E-08	NAP	8 0E-10	**1.9E-06**	NA	NA	NAP	NA	NA
Radium-228*	2 57	3 8E-07	7 3E-09	NAP	5.0E-05	**5.0E-05**	NA	NA	NAP	NA	NA
Thorium-230*	0 79	3 3E-07	5 5E-10	NAP	1.1E-05	**1.1E-05**	NA	NA	NAP	NA	NA
Uranium-238*	0 03	1.3E-08	4 5E-11	NAP	4.3E-07	4.4E-07	NA	NA	NAP	NA	NA
TOTAL		**3.0E-06**	2 5E-08	NA	**6.1E-05**	**6.5E-05**	3.2E-05	NA	NA	NA	3.2E-05

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

Numbers written as 1 0E-03 equal 1×10^{-3}

* Toxicity criteria used to calculate risk include radionuclide daughters

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

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

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

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

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

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

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

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

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

Table 5.10 Current Total Residual Groundwater Risk for Site Employee Scenario

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

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

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

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

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

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

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

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

Table 5.13 Future Total Groundwater Risk for the Construction Worker Scenario

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

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

Table 5.14 Future Background Goundwater Risk for the Construction Worker Scenario

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

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

Table 5.15 Future Incremental Groundwater Risk for the Construction Worker Scenario

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

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

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

Table 5.16 Future Total Residual Groundwater Risk for Site Employee Scenario

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

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

Table 5.17 Future Background Residual Groundwater Risk for Site Employee Scenario

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

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

Table 5.18 Future Incremental Residual Groundwater Risk for Site Employee Scenario

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

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

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

Table 5.19 Total Residual Risk for Parcel 4 Summary Table

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

bls - below land surface

NA - Not applicable

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

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

Table 5.20 Background Residual Risk for Parcel 4 Summary Table

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

bls - below land surface

NA - Not applicable

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

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

Table 5.21 Incremental Residual Risk for Parcel 4 Summary Table

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

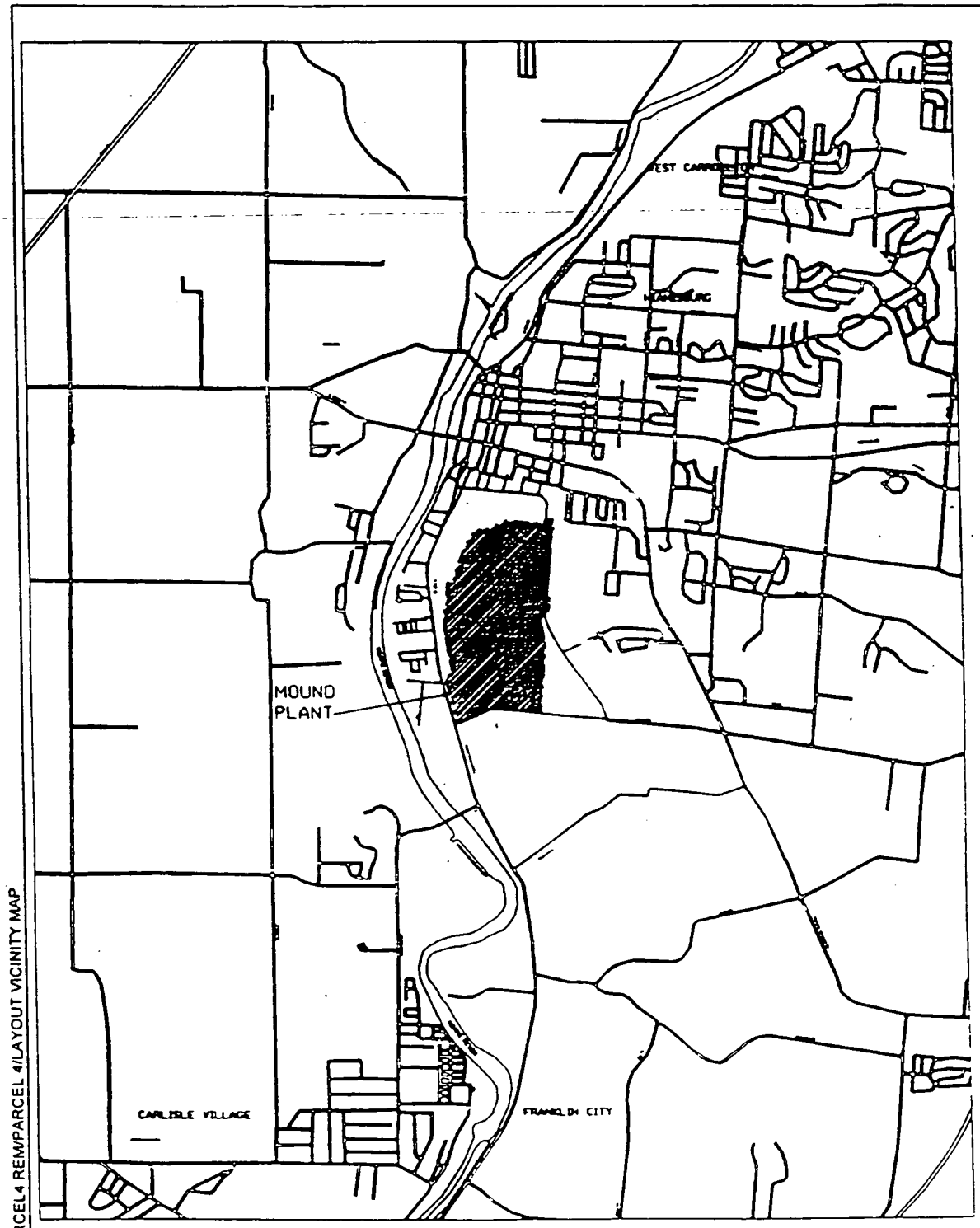
bls - below land surface

NA - Not applicable

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

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

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



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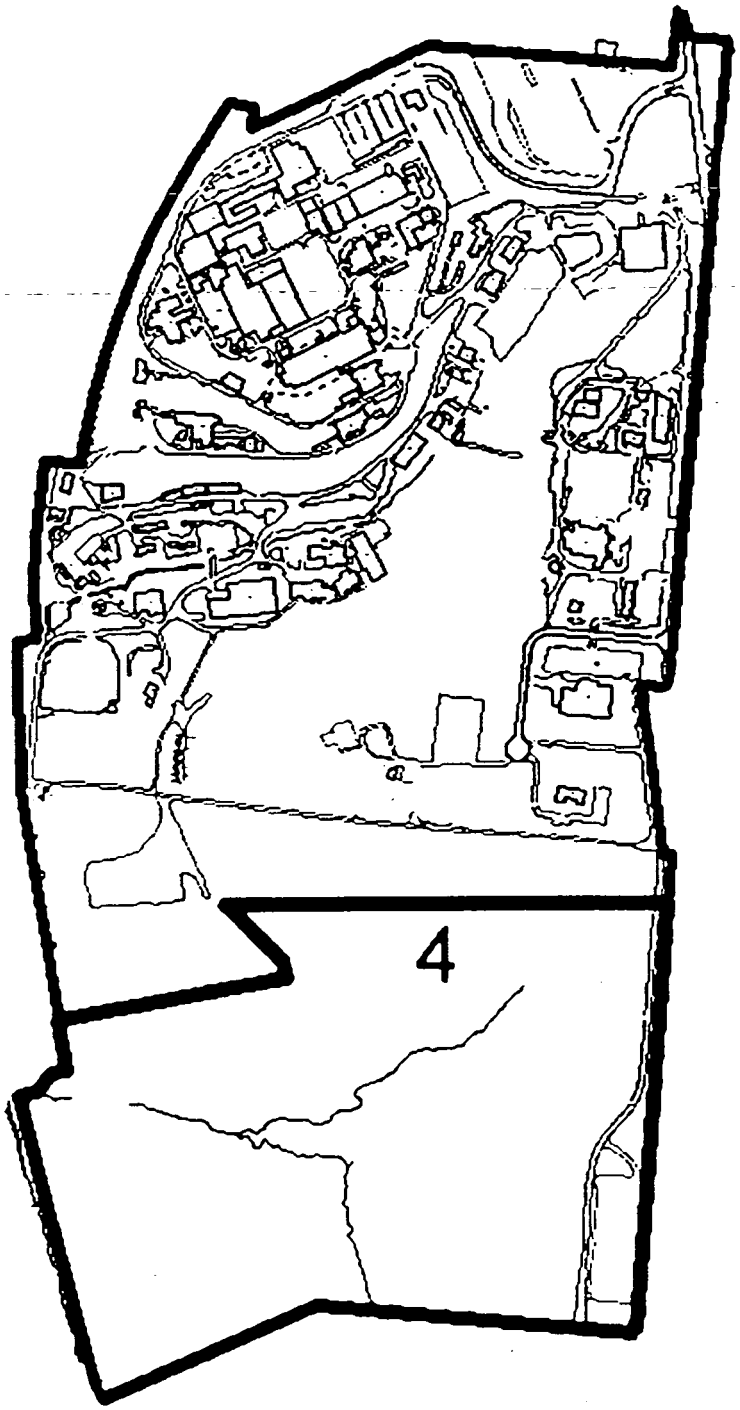
Mound Plant Parcel 4
Vicinity Area Map
Miamisburg, Ohio

Science Applications International Corporation — Columbus, OH

DRAWN BY	DATE	SCALE	PROJECT	FIGURE NO.
LMA	5-8-00	NOT SHOWN		1.1



Mound Plant Parcel 4			
Area Map			
Miamisburg, Ohio			
Science Applications International Corporation Columbus, OH			
DRAWN BY LMA	DATE 5-8-00	SCALE NOT SHOWN	FIGURE NO. 1 2

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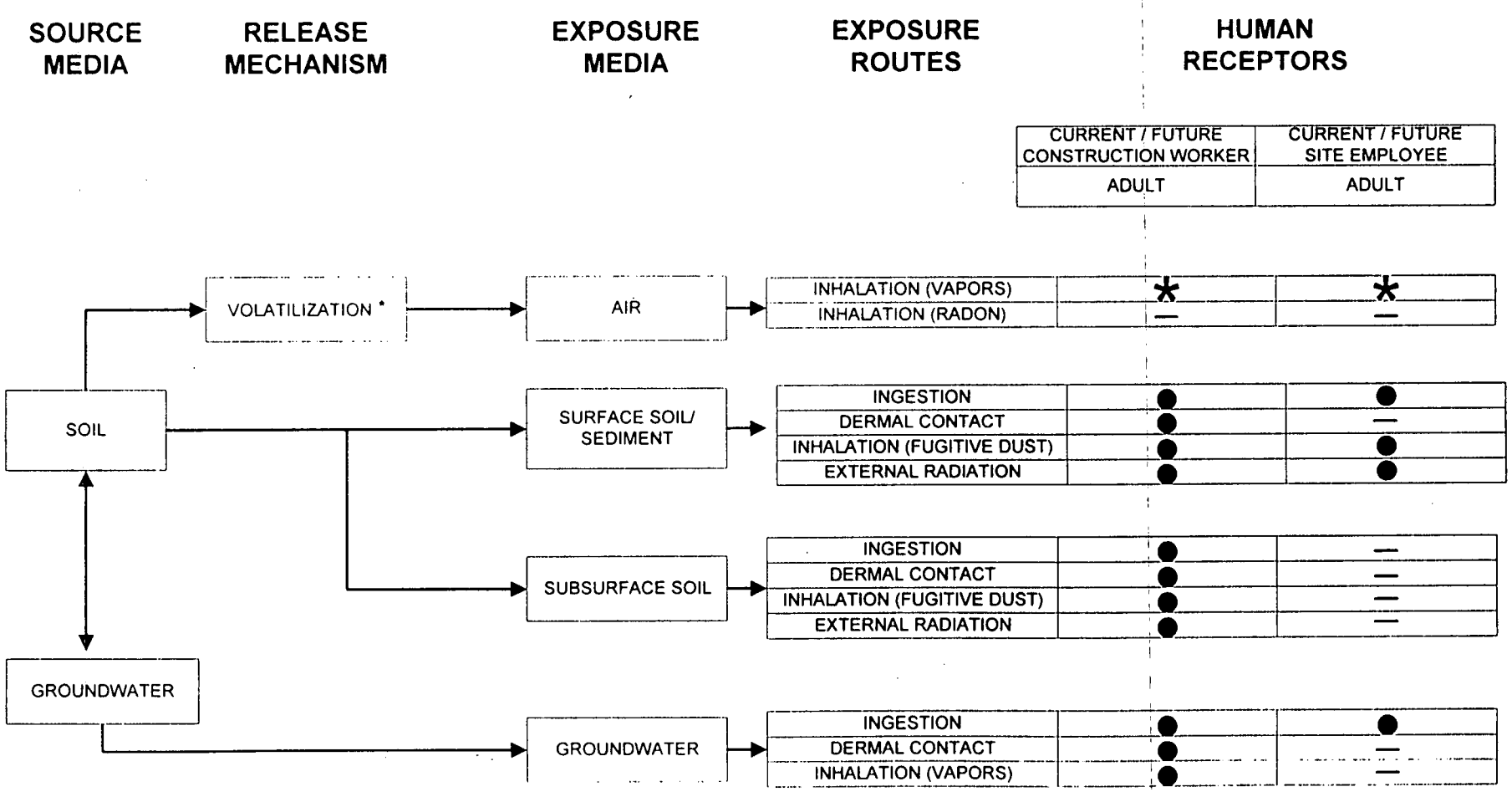

● COMPLETE PATHWAY EVALUATED QUANTITATIVELY
○ COMPLETE PATHWAY EVALUATED QUALITATIVELY
— INCOMPLETE PATHWAY, NOT EVALUATED
* NO VOLATILE COPCs IN AREA

Figure 3.1
Conceptual Site Model for the Parcel 4 RRE

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Appendix A

Evaluation of Potential Cumulative Exposure –Air

A1.1 EVALUATION OF POTENTIAL CUMULATIVE EXPOSURE – AIR

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

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

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

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

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

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

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

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

Appendix B

Methodology and Evaluation of Groundwater Exposure for Mound RRE

Potential Future Maximum Concentrations of COPCs in Groundwater

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

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

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

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

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

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

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

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

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

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

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

Antimony – An Example

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

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

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

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

12/12/00

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

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

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

Table B-3.
Contribution of Antimony Attributed to Bedrock -derived Groundwater for the Future Maximum Concentration Evaluation

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

Mound Water Use:

260000	gallons/day
94900000	gallons/year
359224970	liters/year

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

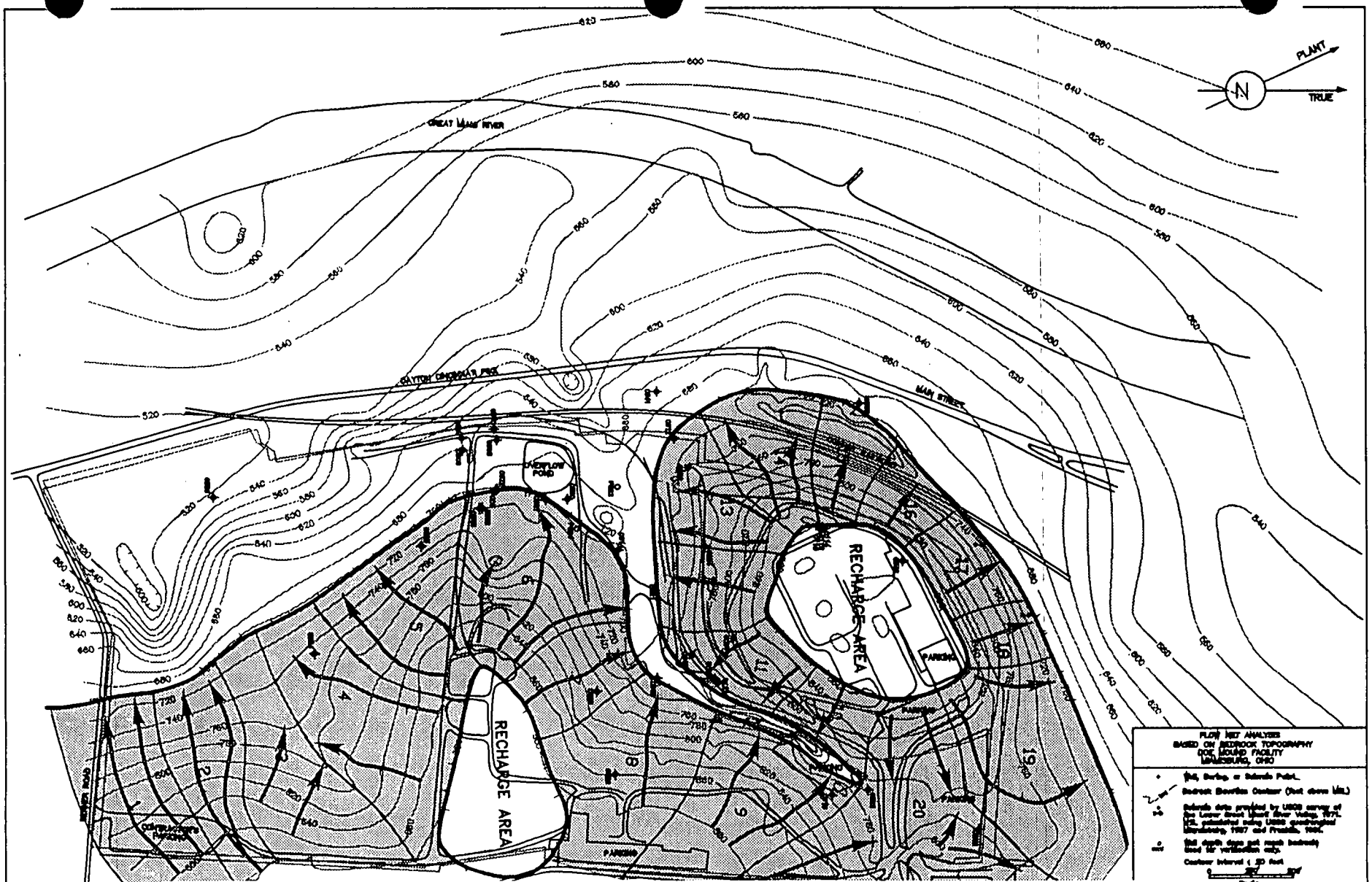

Figure B-1. Flow tube designations for calculating future constituents concentrations at the Mound Facility.

Appendix C

Calculations for Updated Screening Guidance Values

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

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

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

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

Where:

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

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

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

Where:

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

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

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

Where:

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

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

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

Not calculated for GVs because under review

Soil Guideline Values for Construction Worker at DOE Mound

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

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

Soil Guideline Values for Site Employee at DOE Mound

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

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

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

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

Slope Factors

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

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

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

RBGV= 0.11834378

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

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

Slope Factors

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

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

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

RBGV= 0.12405755

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

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

Slope Factors

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

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

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

RBGV=	0.139849944

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

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

Slope Factors

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

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

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

RBGV=	0.15363106

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

Slope Factors

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

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

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

RBGV= 0.09113537

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

Slope Factors

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

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

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

RBGV= 0.09971978

Site Employee Variables defined in table 5.1.3 p110 RBGV Report 3/97
Equations listed in Table 5.1.3 p 109 RBGV Report 3/97
Slope Factors from HEAST Table 4
For: Th-232+D Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
Th-232+D **Target Risk** 1.00E-06

Slope Factors

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

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

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

RBGV= 0.0910498

Construction Worker Varibles from Table 4.1.3 pg 93, and Equations from Table 4.1.3 page 92 RBGV Report 3/97
For: Th-232+D Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
Th-232+D **Target Risk** 1.00E-06

Slope Factors

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

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

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

RBGV= 0.09952328

Site Employee Variables defined in table 5.1.3 p110 RBGV Report 3/97
Equations listed in Table 5.1.3 p 109 RBGV Report 3/97
Slope Factors from HEAST Table 4
For: Pb-210+D Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
Pb-210+D Target Risk 1.00E-06

Slope Factors

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

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

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

RBGV= 3.166655776

Construction Worker Varibles from Table 4.1.3 pg 93, and Equations from Table 4.1.3 page 92 RBGV Report 3/97
For: Pb-210+D Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
Pb-210+D Target Risk 1.00E-06

Slope Factors

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

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

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

RBGV= 1.649759368

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

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

Slope Factors

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

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

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

RBGV= 10.66418486

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

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

Slope Factors

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

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

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

RBGV= 5.554949181

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

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

Slope Factors

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

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

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

RBGV=	1.425588724

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

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

Slope Factors

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

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

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

RBGV=	1.574053305

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

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

Slope Factors

3.00E+01	Oral Reference Dose
	Inhalation Reference Dose

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

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

RBGV= 6.13E+07

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

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

Slope Factors

3.00E+01	Oral Reference Dose
	Inhalation Reference Dose

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

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

RBGV= 6.39E+06

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

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

RfDs

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

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

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

RBGV= 2.04E+04

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

RfDs

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

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

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

RBGV= 2.13E+03

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

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

RfDs

5.00E-03	Oral Reference Dose	iris
	Inhalation Reference Dose	

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

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

RBGV= 1.02E+04

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

RfDs

5.00E-03	Oral Reference Dose
	Inhalation Reference Dose

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

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

RBGV= 1.06E+03

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

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

CSF

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

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

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

Construction Worker Variables from Table 4.1.1 pg 88-89, and Equations from Table 4.1.1 page 87 RBGV Report 3/97
For: dibenz(a,h)anthracene
dibenz(a,h Target Hazard Index 1.00E+00

CSF

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

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

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

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

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

CSF

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

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

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

Construction Worker Variables from Table 4.1.1 pg 88-89, and Equations from Table 4.1.1 page 87 RBGV Report 3/97
For: **indeno(1,2,3-cd)pyrene**
indeno(1,2 Target Hazard Index 1.00E+00

CSF

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

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

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

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

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

RfDs

4.00E-02	Oral Reference Dose	iris
	Inhalation Reference Dose	

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

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

RBGV= 8.18E+04

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

RfDs

4.00E-02	Oral Reference Dose
	Inhalation Reference Dose

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

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

RBGV= 8.52E+03

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

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

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

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

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

Where:

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

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

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

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

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

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

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

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

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

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

Where:

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

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

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

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

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

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

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

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

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

Where:

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

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

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

RBGVingestion same as above for all radionuclides

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

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

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

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

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

Not calculated for GVs because under review

Groundwater Guideline Values for Construction Worker at DOE Mound

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

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

Groundwater Guideline Values for Site Employee at DOE Mound

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

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

Appendix D

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

CLP Laboratory Data Qualifiers and their Used in the RRE

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

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

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

BWX Technologies, Inc.
a McDermott company

BWXT of Ohio, Inc.
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ESC-205/99
December 18, 1999

00-TC/12-18

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

ATTENTION: Rob Rothman (2)

SUBJECT: Contract No. DE-AC24-97OH20044
CERCLA Documents for Parcel 4

REFERENCE: Statement of Work Requirement C 7.1e -- Regulator Reports

Dear Mr. Provencher:

BWXT of Ohio has completed the following CERCLA products for public review in support of the transfer of Parcel 4: Residual Risk Evaluation, Screening Level Ecological Risk Assessment and the Proposed Plan for Parcel 4.

Pending approval from your office to release the documents to the public, copies will be placed in the CERCLA Public Reading Room for a thirty day public review period that starts December 18, 2000 through January 16, 2001. If you or members of your staff have any questions regarding the documents, or if additional support is needed, please contact Dave Rakel at extension 4203.

Sincerely,

JSStapleton

Jeffrey S. Stapleton
Manager, Environmental Safeguards & Compliance

JSS/nmg

Enclosures as stated

cc: Tim Fischer, USEPA, (2) w/attachments
Brian Nickel, OEPA, (2) w/attachments
Ruth Vandegrift, ODH, (1) w/attachments
Dewain Eckman, DOE/MEMP, (1) w/attachments
John Ebersole, DOE/OH, (1) w/attachments
Dave Rakel, BWXT of Ohio, (2) w/attachments
Dann Bird, MMCIC, (2) w/attachments
Public Reading Room, (5) w/attachments
DCC

Residual Risk Evaluation
Parcel 4

Mound Plant
Miamisburg, OH

Public Review Draft

December 2000

Department of Energy
Ohio Field Office

BWXT of Ohio, Inc.

Residual Risk Evaluation
Parcel 4

Mound Plant
Miamisburg, OH

Public Review Draft

December 2000

Department of Energy
Ohio Field Office

BWXT of Ohio, Inc.

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ACRONYMS AND ABBREVIATIONS

ATSDR	Agency for Toxic Substances Disease Registry
ARAR	Applicable or Relevant and Appropriate Requirement
BVA	Great Miami Buried Valley Aquifer
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPCs	constituents of potential concern
CSF	cancer slope factor
DOE	Department of Energy
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
FFA	Federal Facilities Agreement
GV	Guideline Values
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
IRIS	Integrated Risk Information System
LOAEL	lowest observed adverse effects level
MEIMS	Mound Environmental Information and Management System
MMCIC	Miamisburg Mound Community Improvement Corporation
NCEA	National Center for Environmental Assessment
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ND	Not detected
NOAEL	no observed adverse effect level
Ohio EPA	Ohio Environmental Protection Agency
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyls
ppm	parts per million
PRS	Potential Release Site
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RAGS	Risk Assessment Guidance for Superfund
RfD	reference dose factor
RfC	reference concentration factor
RME	reasonable maximum exposure
RRE	residual risk evaluation
RREM	residual risk evaluation methodology
SVOCs	semi-volatile organic compounds
TPH	total petroleum hydrocarbon
UCL	upper confidence limit
UTL	upper tolerance limit
VOCs	volatile organic compounds

Parcel 4 Human Health Residual Risk Evaluation

Executive Summary

This report was prepared using the Mound 2000 Residual Risk Evaluation Methodology [(RREM) DOE 1997a] to quantify the potential for cancer and other non-cancer health effects from long-term, low-level exposures to site-related contaminants in Parcel 4. A Residual Risk Evaluation (RRE) quantifies human health risks associated with residual levels of contamination remaining within an area to ensure that future users of the land will not be exposed to contaminant levels that would pose unacceptable risks. In the future, Parcel 4 may be used for commercial or industrial land use. Total risk, background risk, and incremental risk were calculated for current and future exposure scenarios for a construction worker and a site employee working in Parcel 4. Potential exposure to contaminants originating outside Parcel 4 that may reach receptors in the parcel are termed potential cumulative exposures. Potential cumulative risk was calculated for current and future exposure to groundwater and air.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Overall Summary of Risks

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

bls = below land surface

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

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

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

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

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

1.0 INTRODUCTION

The U.S. Department of Energy's (DOE) Mound Plant is located on a 306-acre parcel of land within the City of Miamisburg, Ohio, about 10 miles southwest of Dayton, Ohio. Figure 1.1 shows the vicinity of the Mound Plant. The plant is located approximately 2,000 feet east of the Great Miami River and partially overlies the Great Miami Buried Valley Aquifer (BVA). Since 1948, Mound has operated as a research, development, and production facility in support of DOE's weapons and energy programs. Mound's past weapons program mission included process development, production engineering, manufacturing, and surveillance of detonators, explosives, and nuclear components. Mound's current mission is to support DOE's efforts in environmental management and to transition the site, in cooperation with the City of Miamisburg, from a cold-war weapons production facility to commercial or industrial use.

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

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

This report was developed using the Mound 2000 Residual Risk Evaluation Methodology (RREM) (DOE 1997a) to quantify the potential for cancer and other non-cancer health effects from long-term, low-level exposures to site-related contaminants in Parcel 4. A Residual Risk Evaluation (RRE) assesses human health risks associated with residual levels of contamination remaining within an area to ensure that future

users of the land will not be exposed to contaminant levels that would pose unacceptable risks. The RRE results will be used, together with Applicable or Relevant and Appropriate Requirements (ARARs), to determine the need for additional site remediation or to demonstrate that Parcel 4 is ready for public use.

1.1 Purpose of Residual Risk Evaluation

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

1.2 Scope of the Parcel 4 RRE

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

The Parcel 4 residual risk evaluation included an assessment of total, background, and incremental risk. Total risk was calculated using the total concentration of identified constituents of potential concern (COPCs) detected in Parcel 4. Background risk was based on background levels of the COPCs and incremental risk was calculated using the difference between total and background levels. Incremental risk

can be used to assess the increase in risk above background levels due to contaminant releases from past Mound Plant operations.

1.3 Organization of Report

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

The RREM consists of five elements, including:

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

The following sections describe each of these elements in more detail starting with Section 2.0, Data Compilation and Evaluation, which describes the methods used to compile Parcel 4 data and identify contaminants to be evaluated in the RRE. Section 3.0, Exposure Assessment, summarizes both the pathways through which hazardous substances may reach potential receptors and intake assumptions that will be used to quantify exposure. In Section 4.0, Toxicity Assessment, exposure point concentrations, intake equations and toxicological reference values are presented. Information from the exposure assessment is combined with information from the toxicity assessment to characterize human health risks in Section 5.0, Risk Characterization. Section 6.0, Uncertainty in the Risk Assessment, presents some of the sources of uncertainty inherent in risk assessments and in the RRE. Section 7.0, References, contains a list of all documents cited in this report.

2.0 DATA COMPILATION AND EVALUATION

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

All available sampling data were compiled for use in the Parcel 4 RRE. Newer data were used to supplement, rather than supercede older data, except when older data described materials that had subsequently been removed from the area. In this case, the older data no longer represent site conditions and were, therefore, not used in the RRE. Sampling data obtained from the Mound Soil Screening Facility were used except in the case where a sample was split and analyzed by both the Mound Soil Screening Facility and a commercial analytical laboratory. In such cases, the value from the commercial analytical laboratory was used to take advantage of the greater precision available from the commercial analytical laboratory. When a given sample was analyzed using both alpha and gamma spectroscopy methods, the more sensitive alpha spectroscopy results were used to characterize the sample.

Parcel 4 Data Set Components:

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

2.1 Data Quality Assessment

Samples were collected and analyzed according to the methods outlined in the Operable Unit (OU) 9 Quality Assurance Project Plan (QAPP) (DOE 1993a) and the OU5 QAPP (DOE 1993b). Since some of the data used to characterize residual contaminant concentration in Parcel 4 were collected prior to 1993, not all data used in the risk assessment have undergone Quality Assurance/Quality Control (QA/QC) evaluation and data validation in accordance with the requirements described in the OU9 QAPP (DOE 1993a).

2.2 Environmental Media Considered and Data Availability

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

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

2.3 Data Analysis

For each constituent detected in Parcel 4 soils and current groundwater from the production wells, the 95% upper confidence limit of the mean (UCL) was calculated to estimate the concentration that

receptors in the area may be exposed to. This is known as the Exposure Point Concentration or EPC. For future groundwater, modeled values were used as the EPC. The Flow Tube model used to predict future contaminant groundwater concentrations is described in Appendix B. The 95% UCL was calculated in accordance with the Mound 2000 RREM (DOE 1997a), Gilbert's *Statistical Methods for Environmental Pollution Monitoring* (Gilbert 1987), and the *Supplemental Guidance to RAGS: Calculating the Concentration Term* (EPA, 1992a). Before calculating the 95% UCL, the distribution of the data set was determined. If data were found to be normally distributed, the EPC was calculated as the 95% UCL of the arithmetic mean of the data, using the Student's t-statistic (EPA 1992a). If the data were found to be log normally distributed, the EPC was calculated as the 95% UCL using the H-statistic (EPA 1992a). The 95% UCL on the arithmetic mean for normal data sets were calculated as follows:

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

Where:

UCL= upper confidence limit,
t = t statistic (Table A2, Gilbert, 1987),
s = standard deviation, and
n = number of observation in the data set

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

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

Where:

UCL = upper confidence limit,
e = constant (base of the natural log, equal to 2718)
Mean=mean of the transformed data
s = standard deviation of the transformed data
H = H statistic (e.g., from table published in Gilbert 1987),
n = number of observations in the data set

If the 95% UCL exceeded the maximum value observed in the sampling results , the maximum value was used as the EPC for that constituent (whether the data were normally or log normally distributed). For both chemical and radiological constituents, "not detected" (ND, qualified as U or UJ) results were treated as one-half the limit of detection and included in the calculations of the mean and 95% UCL values. Samples reported as ND or zero with no detection limit were not utilized in calculating a 95% UCL.

Blind field duplicates were collected to assess variability in the sampling process. Duplicate samples were used in the data quality assessment but were not included in the calculation of the exposure point concentrations. If a data set had less than twenty observations (n<20), the maximum detected concentration was used as the EPC. For radionuclides, zero or negative results with no detection limits were

excluded from the data set. Data qualified as "J", or estimated values at concentrations less than the detection limit, were evaluated as half the detection limit. For "J" data, which was greater than the detection limit or reported without the sample detection limit, the value was used as reported Data flagged with an "R", meaning rejected, were not used in calculating the EPC.

2.4 Data Screening Process

All constituents that were detected one or more times were listed in constituent summary tables and sorted by media and depth where they were detected. Soil data were also sorted by depth. The constituent screening methods described below were then used to generate a final list of constituents of potential concern (COPCs). The constituent summary tables also provide maximum detected concentrations, the range of contaminant detection limits, the frequency of detection, and the decision and rationale to include or exclude a constituent from further consideration in the RRE. The following section describes how COPCs were selected.

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

2.4.1 Screening Constituents Based on Background

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

are presented in the Mound 2000 RREM (DOE 1997a). Constituents with a maximum detected concentration exceeding their level in background were identified as initial COPCs and carried to the next screening step of the RRE. Constituents with maximum concentrations less than their background concentration were not carried though the RRE. If no background value was available for a particular constituent (e.g., many organic compounds), the constituent was carried through to the next screening step of the RRE. These background concentrations were also used to quantify background risk.

For initial COPCs with a 95% UCL of the arithmetic mean less than the maximum detected value, the 95% UCL was compared to background to determine whether the 95% UCL was below background. If the 95% UCL was below the background value for the constituent, the constituent was not identified as a COPC in the RRE. Eliminating these constituents is consistent with the Mound 2000 RREM and focuses the RRE on constituents detected above background.

2.4.2 Screening Constituents Based on Guideline Values

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

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

A $1x10^{-6}$ risk level represents an incremental increase of one human in a million of developing cancer as a result of exposure to the GV concentration. A Hazard Quotient of one indicates that from an exposure at or below the given concentration, no adverse effects to humans are expected. Since the acceptable risk level for carcinogenic constituents specified in the NCP is a range of $1x10^{-4}$ to $1x10^{-6}$ (1 human in 10,000 to 1 human in a million), screening COPCs against the whole GV is protective. The target threshold for non-carcinogenic constituents is a Hazard Index (HI) of less than or equal to one. The GV values were calculated for a HI of one. To account for the possibility of more than one non-carcinogenic constituent, COPCs were screened using 1/10 the GV. Carcinogenic or radioactive constituents that exceed their GVs and non-carcinogenic constituents that exceed one-tenth of their GV were carried to the next step of the RRE.

2.4.3 Screening Constituents Based on Frequency of Detection

Constituents detected at concentrations above Mound background levels and above applicable GVs were next evaluated for their frequency of detection. Frequency of detection was evaluated as the number of detections divided by the total number of samples analyzed for a constituent. Infrequent detection was defined as five percent or less. This is equivalent to one detect in 20 samples. If there were an insufficient number of samples (e.g. less than 20) to determine whether the frequency of detection is five percent or less, the contaminant was not eliminated on the basis of frequency of detection.

2.4.4 Screening Constituents Based on Essential Human Nutrients

According to RAGS Part A (EPA 1989): "Chemicals that are (1) essential human nutrients, (2) present at low concentrations (i.e., only slightly elevated above naturally occurring levels), and (3) toxic only at very high doses (i.e., much higher than those that could be associated with contact at the site) need not be considered further in the quantitative risk assessment." Inorganic analytes meeting this description were not carried through the RRE. Calcium, chloride, iron, magnesium, potassium, and sodium are considered essential nutrients to humans. These compounds were detected in the Parcel 4 area at levels below or slightly elevated above background and are toxic only at very high doses. Concentrations of these compounds in on-site media would not be expected to result in intakes associated with a toxic response. Therefore, these compounds were eliminated as COPCs for the Parcel 4 area.

2.4.5 Additional Screening Procedures

In accordance with the RREM, additional screening procedures also were used to evaluate Parcel 4 area constituents. For example, in accordance with EPA's Functional Guideline for Organics (EPA 1988) if a blank contains measurable levels of a common laboratory contaminant, then the associated sample results were considered as positive results only if the concentration in the samples exceeded ten times the concentration in the blank. If the concentration of a common laboratory contaminant was less than ten times the blank concentration, the constituent was considered to be an artifact of laboratory handling and was not included in the RRE. Common laboratory contaminants include acetone, 2-butanone, methylene chloride, toluene, and phthalate esters.

2.4.6 Screening Procedures for Future Groundwater

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

3.0 EXPOSURE ASSESSMENT

The goal of the RRE exposure assessment is to estimate the type and magnitude of contaminant exposures that may occur under current and future conditions with the area being used for industrial/commercial purposes. The information gathered in the exposure assessment is integrated with toxicity information to characterize potential risks associated with exposure to residual contamination in the Parcel 4 area.

3.1 Characterization of Exposure Setting

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

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

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

3.2 Identifying Exposure Pathways

Although many exposure pathways are possible, the RRE focuses on those pathways that are likely to occur and are likely to contribute significantly to the overall risk. When identifying exposure pathways

it is important to keep in mind the four elements of an exposure pathway. An exposure pathway consists of: (1) a source of chemical releases, (2) a transport media, (3) a point of potential human contact with the contaminant or contaminated media, and (4) an exposure route (e.g. ingestion). If any of these elements is missing or eliminated, the pathway will be incomplete and exposure will not occur.

A pictorial representation of the exposure pathways identified for potential receptors is included in a conceptual site model for the Parcel 4 (Figure 3.1). The conceptual site model summarizes the pathways that hazardous substances may take to reach potential receptors. Exposure assumptions used to evaluate potential exposure pathways were drawn from the Mound Plant *Risk-Based Guideline Values* (DOE 1997c) and the Mound 2000 RREM (DOE 1997a). Exposure assumptions used to quantify contaminant exposures are summarized in Table 3.1.

3.3 Identifying Exposure Scenarios

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

3.3.1 Construction Worker Scenario

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

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

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

Current and future exposure scenarios for the construction worker are identical except for groundwater. In order to estimate the future contaminant concentrations in groundwater, the modeled future estimated concentration of contaminants detected in the bedrock aquifer were added to current contaminant concentrations in the Mound Plant production wells. Exposure pathways evaluated for the construction worker for both current and future scenarios, include:

- incidental ingestion of soil at or below land surface;
- external exposure to ionizing radiation from radionuclides in soil at or below land surface;
- inhalation of airborne contaminated dust;
- inhalation of volatile emissions from soil;
- ingestion of contaminated groundwater as drinking water;
- inhalation of volatile contaminants from groundwater while showering at work;
- dermal contact with soil at or below land surface; and
- dermal contact with contaminated groundwater while showering at work.

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

3.3.2 Site Employee Scenario

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

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

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

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

3.4 Exposure Point Concentrations

Exposure point concentrations (EPC) are the concentrations of contaminants available to human receptors at the point of contact. The EPC for soil and current groundwater used in the RRE was calculated as the 95% UCL of the arithmetic mean of the data, using the Student's t-statistic. If the data were found to be lognormally distributed, the EPC estimate was calculated as the 95% UCL using the H-statistic (EPA 1992a).

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

3.5 Human Intake Equations And Assumptions

This section presents the exposure equations and assumptions used to derive contaminant-specific intake estimates for the populations and exposure pathways evaluated in the risk assessment. The use of the intake equations presented in this section is in accordance with methods presented by EPA in Risk Assessment Guidance for Superfund (RAGS) Part A (EPA 1989) and the RREM presented in Mound 2000 (DOE 1997a). Exposure assumptions have been developed to represent high-end RME conditions. Exposure

assumptions for each of the potential receptors, and corresponding guidance or rationale used in this assessment are presented in Table 3.1.

For chemicals, exposure generally refers to the intake (e.g., inhalation, ingestion, dermal exposure) of the chemical, expressed in units of mg/kg-day. Toxicity values for chemicals are generally expressed in these terms; therefore, the product of the intake estimate with the toxicity value yields a risk value. There is a fundamental difference between exposures to chemical contaminants as compared to radionuclide contaminants. Radionuclides can have deleterious effects on humans without being taken into the body. Radiation exposure can result from exposure to gamma and x-ray emitting radionuclides that are external to the receptor.

The approach used to estimate intake for chemical contaminants largely applies to radionuclides. However, there are a few key differences in the methods. For example, in addition to the ingestion, inhalation, and direct contact pathways considered for chemical contaminants, external exposure to penetrating radiation was also evaluated for radionuclides. Equations for estimating the intake of radionuclides have been modified by omitting the body weight and averaging time from the denominator. The slope factors for radionuclides are expressed as the average risk per unit intake or exposure for an individual in a stationary population; therefore, radionuclide intakes and slope factors are not expressed as a function of body weight and time.

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

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

3.5.1 Soil Exposure Pathways

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

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

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

Where:

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

Radionuclide intake estimates for the soil via incidental ingestion was estimated by means of the following equation:

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

Where:

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

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

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

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

Where:

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

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

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

Where:

C_{so}	=	Contaminant concentration in soil (mg/kg)
IR_{air}	=	Inhalation rate (m^3/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
PEF	=	Particulate emission factor (4.28×10^9 m^3/kg, EPA default value)
BW	=	Body weight (kg)
AT	=	Averaging time for cancer and non-cancer effects (days)

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

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

Where:

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

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

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

3.5.2 Groundwater Exposure Pathways

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

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

Where:

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

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

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

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

Where:

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

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

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

Where:

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

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

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

Where:

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

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

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

Where:

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

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

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

Where:

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

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

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

Where:

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

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

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

Where:

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

4.0 TOXICITY ASSESSMENT

The objectives of the toxicity assessment are to identify and select toxicological values for use in estimating the significance of the exposure and to evaluate potential adverse effects associated with exposure to compounds detected in Parcel 4. The RRE for the Parcel 4 area evaluated chronic exposures. The RRE utilized methods recommended by EPA for evaluating human cancer effects resulting from exposure to the COPCs. Toxicity criteria used in the RRE were obtained from the most current update of the EPA Integrated Risk Information System (IRIS) or, if the information was not available in IRIS, the EPA Health Effects Assessment Summary Tables (HEAST). IRIS is an electronic database containing the most current descriptive and quantitative EPA regulatory information on chemical and radiological constituents. Constituent files maintained in IRIS contain information related to non-carcinogenic and carcinogenic health effects of constituents. HEAST is a published reference, updated periodically by EPA. HEAST contains slope factors needed to evaluate the carcinogenicity of radionuclides. Table 4.1 presents a summary of toxicological criteria used along with the chemical-specific characteristics used to estimate dermal absorbed dose and the concentrations present in vapors or dust.

In assessing the potential for non-cancer health effects, EPA assumes that there is a threshold below which no adverse toxic effects are expected. For example, a toxic threshold would exist if a substance had no toxic effect at a certain level of exposure, but did have a toxic effect at a higher level. EPA derives and publishes reference doses (RfDs) and reference concentrations (RfCs) for use in evaluating adverse non-carcinogenic effects. These are estimates (with uncertainty spanning an order of magnitude or greater) of daily human exposures, including sensitive sub-populations, that may go without appreciable deleterious effects during a lifetime (EPA 1989). EPA derives RfDs and RfCs for humans, based on estimates of the no-observable-adverse-effect-level (NOAEL) or lowest-observable-adverse-effect-level (LOAEL) observed in test organisms. EPA classifies all radionuclides as carcinogens and the process of carcinogenesis is generally thought to be a phenomenon without a threshold for effect (EPA 1989). The basis for this presumption is that an extremely low level of exposure to some carcinogens may result in chromosomal or enzyme changes leading to uncontrolled cellular proliferation, or cancer. EPA does not therefore, estimate an effect threshold for carcinogenic chemicals. EPA uses a two-part evaluation for carcinogens. First the constituent is assigned a weight-of-evidence classification based on both epidemiological evidence of carcinogenic effects and laboratory tests conducted with animals. Then a cancer slope factor (CSF), is

calculated. The HEAST lists ingestion, inhalation, and external exposure CSF for radionuclides in the units of picocuries (pCi). Ingestion and inhalation slope factors are central estimates in a linear model of the age-averaged, lifetime-attributable radiation cancer incidence (fatal and nonfatal) risk per unit of activity inhaled or ingested. The slope factor is a plausible upper-bound estimate of the slope of the dose-response curve in the low dose range. In risk assessment, the cancer slope factor is used to estimate the excess lifetime probability of a carcinogenic effect occurring in exposed receptors.

4.1 Toxicity Values for Evaluating the Dermal Pathway

Toxicological reference values are available only for the oral and inhalation pathways, and the majority of these values are based on intake (i.e., administered dose) rather than an absorbed dose. Because the intake equation for the dermal contact pathway calculates absorbed dose (by incorporating a dermal absorption factor or a permeability coefficient), it is necessary to convert the administered dose toxicity value to an absorbed dose toxicity value in order to calculate risk. For non-carcinogens, the administered dose toxicity value (i.e., the RfD) was multiplied by the gastrointestinal absorption factor. For carcinogens, the slope factor was divided by the gastrointestinal absorption factor. For the Parcel 4 RRE oral administered-dose, EPA recommended compound-specific gastrointestinal absorption factors used for adjusting toxicity values were only available for PAHs.

5.0 RISK CHARACTERIZATION

This section presents the risk characterization for the Parcel 4 area. In risk characterization, information from the exposure assessment (Section 3) is combined with information from a toxicity assessment (Section 4) to characterize human health risks.

5.1 Risk Characterization Methods

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

The RRE reports the incremental risk, total risk, and risk from background for each contaminant evaluated in Parcel 4 Area. The incremental risk is the risk posed by site-related contamination above the risk posed by background environmental levels. Background risk is the risk resulting from sources other than the Mound-related residual contamination. Site-specific background values are provided in the Mound 2000 RREM (DOE 1997a). The Mound 2000 background values that correspond to the Parcel 4 COPCs were used as the EPCs to determine background risk. Total risk is the sum of the background and incremental risk. This risk characterization presents a separate evaluation of non-carcinogenic and carcinogenic effects. The assessment distinguishes cancer from non-cancer effects because organisms typically respond differently following exposure to carcinogenic or non-carcinogenic agents. Quantification methods for cancer and non-cancer effects are discussed separately in the following sections.

5.1.1 Quantification of Carcinogenic Risk

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

COPC. To derive an estimate of risk, the cancer slope factor was multiplied by the estimated chronic daily intake experienced by the exposed individual:

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

Where:

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

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

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

Where:

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

5.1.2 Quantification of Non-carcinogenic Risk

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

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

Where:

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

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

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

Where:

HI = Hazard Index

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

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

5.2 Risk Characterization Results

The following sections present the risk characterization results for the Parcel 4 by potential receptor. Risk estimates for individual soil COPCs for all scenarios and pathways are presented in Tables 5.1 through 5.6. Tables 5.1 through 5.3 present soil risk estimates based on construction worker exposure parameters, and Tables 5.4 through 5.6 present soil risk estimates based on site employee exposure parameters. Total risk was calculated using the total concentration of the COPCs detected in Parcel 4. Background risk was based on background levels of the COPCs and incremental risk was calculated using the difference between total and background levels. Incremental risk can be used to assess the increase in risk above background levels due to Mound Plant operations. Tables 5.19 through 5.21 present summaries of the risk results for all scenarios and media for exposure pathways assessed in the RRE.

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

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

5.2.1 Construction Worker Risk Results

Soil

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

Current Groundwater

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

Future Groundwater

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

Air

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

5.2.2 Site Employee Risk Results

Surface Soil

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

Current Groundwater

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

Future Groundwater

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

Air

Potential cumulative carcinogenic risk due to site employee exposure to contaminants in air was 9.9×10^{-7}, which is slightly less than the acceptable risk range. None of the COPCs identified in air have non-carcinogenic risk criteria so a HI was not calculated for exposure to contaminants in air.

5.2.3 Overall Summary of Risk Results

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

6.0 UNCERTAINTY IN THE RISK ASSESSMENT

In the following section, an evaluation is presented of the sources of uncertainty in the Parcel 4 area RRE and the relative influence of these sources on the results of the evaluation. Uncertainty is inherent in the selection of input parameters and in every step of the risk assessment process. Risk assessment of contaminated sites must not be viewed as yielding single value, invariant results. Rather, the results of risk assessment are estimates that span a range of possible values, and which must be understood only in light of the assumptions and methods used in the evaluation.

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

6.1 Uncertainty in Analytical Data

Uncertainty is introduced to the RRE when sample locations are selected and when samples are collected and analyzed. In the RRE, the long-term exposure concentrations were upper estimates of site concentrations (e.g., maximum detect or 95% UCL); therefore, a conservative bias to overestimate potential exposure has been incorporated into the risk estimates. The uncertainty associated with the statistical analysis of environmental data is low, with little introduction of bias.

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

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

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

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

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

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

6.2 Uncertainty in Exposure Assessment

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

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

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

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

6.3 Uncertainties Related to Toxicity Information

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

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

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

The derivation of reference doses involves the use of animal studies. Uncertainty factors ranging from 1 to 1,000 are incorporated into the reference dose to provide an extra level of health protection. The

factors used depend on the type of study from which the value has been derived (e.g., animal or human, chronic or acute, study design). The scientific basis for this practice is somewhat subjective. In general, high uncertainty factors are meant to bias the results conservatively so that exposures at the reference dose level will not result in adverse health effects.

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

There are some chemicals for which no toxicity value exists and for which little information is available. Therefore, a quantitative risk estimate cannot be calculated for these chemicals. For example, several of the COPCs identified in Parcel 4 could not be quantified for lack of EPA-approved toxicity values. The lack of toxicity information for some chemicals contributes to the underestimation of risks.

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

6.4 Uncertainties in Risk Characterization

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

HQs for multiple substances in this risk assessment provides a conservative estimate.

6.5 Conclusion

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

7.0 REFERENCES

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

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

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

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

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

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Screening Guideline Value	Reference	Rationale for Contaminant Deletion or Selection
Pesticides/PCBs												
72-54-8	4,4'-DDD	0.4	6.60	ug/kg	B409	2-64	2.6	6.60	4.20			NO:1
72-55-9	4,4'-DDE	0.25	3.50	ug/kg	MND22-4101	6-64	2.07	3.50	4.30	9000.00	d	NO:2,3
50-29-3	4,4'-DDT	0.19	0.48	ug/kg		4-65	2.69	0.48	13.00	9000.00	c	NO:2,3
309-00-2	Aldrin	0.074	0.35	ug/kg	B401	6-64	1.26	0.35		180.00	c, f	NO:3
5103-71-9	Alpha Chlordane	0.044	3.50	ug/kg		6-65	1.97	3.50		8500.00	c, f	NO:3
319-86-8	Delta-BHC	0.08	5.30	ug/kg	MND22-4101	3-65	1.64	5.30				NO:1
60-57-1	Dieldrin	0.31	1.20	ug/kg		4-65	2.17	1.20		185.00	c	NO:3
33213-65-9	Endosulfan I	0.051	0.27	ug/kg	B407	3-63	1.81	0.27		130000.00	a, f	NO:1
33213-65-9	Endosulfan II	0.053	7.10	ug/kg	MND22-4001	5-65	2.41	7.10		130000.00	a, f	NO:3
1031-07-8	Endosulfan Sulfate	0.13	0.56	ug/kg	MND22-4101	2-65	3.35	0.56				NO:1
7421-93-4	Endrin Aldehyde	0.28	0.93	ug/kg	MND22-4102	4-60	3.34	0.93				YES
53494-70-5	Endrin Ketone	0.24	0.86	ug/kg		4-65	3.43	0.86				YES
5103-74-2	Gamma Chlordane	0.058	0.93	ug/kg	MND22-4003	2-65	1.85	0.93		8500.00	c, f	NO:1
58-89-9	Gamma-BHC (Lindane)	0.065	0.095	ug/kg	MND22-4101	2-65	1.26	0.10		2300.00	d, f	NO:1
1024-57-3	Heptachlor	0.056	1.20	ug/kg		7-65	1.17	1.20		660.00	d, f	NO:3
1024-57-3	Heptachlor Epoxide	0.072	0.94	ug/kg	MND22-4102	6-65	1.79	0.94		280.00	a, f	NO:3
72-43-5	Methoxychlor	0.13	0.95	ug/kg	MND22-4101	4-63	23.2	0.95	30.00			NO:2
Explosives												
99-65-0	1,3-Dinitrobenzene	0.098	0.098	mg/kg	B405	1-41	0.89	0.10				NO:1
118-96-7	2,4,6-Trinitrotoluene	0.20	0.20	mg/kg	B405	1-41	0.86	0.20				NO:1
	Tetryl	0.29	0.29	mg/kg		1-41	1.34	0.29				NO:1

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

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Screening Guideline Value	Reference	Rationale for Contaminant Deletion or Selection
Radionuclides												
AC-227DA	Actinium-227	0.13	2.01	pCi/g		14-130	0.23	2.01		1.00	e	YES
14596-10-2	Americium-241	0.05	0.21	pCi/g		5-188	0.13	0.21		4.95	e	NO:1
10045-97-3	Cesium-137	0.06	0.90	pCi/g		130-188	0.36	0.90	0.42	0.46	e	YES
10198-40-0	Cobalt-60	0.04	0.90	pCi/g		3-188	0.05	0.90				NO:1
14255-04-0	Lead-210	0.38	3.35	pCi/g		94-117	1.76	3.35		1.65	e, f	YES
13994-20-2	Neptunium-237	0.023	0.067	pCi/g	#6B	6-8	NC	0.07		1.50	e, f	NO:3
13981-16-3	Plutonium-238	0.013	55.40	pCi/g		142-480	87	55.40	0.13	5.50	e	YES
PU-239/240	Plutonium-239	0.01	0.011	pCi/g		3-10	NC	0.01	0.18	5.50	e	NO:2,3
PU-239/240	Plutonium-239/240	0.0039	0.21	pCi/g		18-63	0.02	0.21	0.18	5.50	e	NO:3
13982-10-0	Plutonium-242	0.0102	0.01	pCi/g	GJ	1-31	0.02	0.01				NO:1
13966-00-2	Potassium-40	10.5	34.46	pCi/g	B405	56-67	22.6	34.46	37.00			NO:2
13982-63-3	Radium-226	0.39	3.26	pCi/g		137-180	1.34	3.26	2.00	0.14	e	YES
	Radium-228	0.636	2.57	pCi/g		10-10	NC	2.57		0.10	e, f	YES
10098-97-2	Strontium-90	0.158	2.77	pCi/g	B405	4-37	1.07	2.77	0.72	3.00	e	NO:3
14274-82-9	Thorium-228	0.195	1.79	pCi/g		66-80	1.07	1.79	1.50	0.16	e	YES
14269-63-7	Thorium-230	0.15	2.69	pCi/g		79-178	3.57	2.69	1.90		g	YES
7440-29-1	Thorium-232	0.037	5.60	pCi/g	S1049	184-491	0.83	5.60	1.40	0.10	e, f	YES
10028-17-8	Tritium	0.066	3.00	pCi/g		7-64	0.88	3.00	1.60	23500.00	e	NO:3
13966-29-5	Uranium-234	0.33	1.17	pCi/g	B406	56-65	0.77	1.17	1.10	37.50	e	NO:3
15117-96-1	Uranium-235	0.019	0.20	pCi/g	B406	46-51	0.09	0.20	0.11	3.35	e	NO:3
24678-82-8	Uranium-238	0.32	1.95	pCi/g		110-115	1.08	1.95	1.20	0.12	e	YES

a= 1/10th HI for ingestion
b= 1/10th HI for ingestion + inhalation
c= 10^{-6} cancer risk for ingestion + inhalation
d= 10^{-6} cancer risk for ingestion
e= 10^{-6} cancer risk for ingestion + inhalation + external
f= Calculated values based on procedures in Mound's approved Risk-Based Guidance Values, Final Rev. 4, March 1997 and updated toxicity criteria
g= Guideline Value was removed(under Core Team review)

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

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

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

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

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

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

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

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

a= 1/10th HI for ingestion
b= 1/10th HI for ingestion + inhalation
c= 10^{-6} cancer risk for ingestion + inhalation
d= 10^{-6} cancer risk for ingestion
e= 10^{-6} cancer risk for ingestion + inhalation + external
f= Calculated values based on procedures in Mound's approved Risk-Based Guidance Values, Final Rev. 4, March 1997 and updated toxicity criteria
g= Guideline Value was removed (under Core Team review)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

UCL= Upper Confidence Limit

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

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

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

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

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

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

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

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

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

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

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

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

UCL= Upper confidence Limit

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

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

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

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

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

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

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

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

Table 3.1 (references)
Exposure Assumption References

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

Table 4.1 Toxicity Criteria and other Physical Chemical Values

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

Table 4.1 Toxicity Criteria and other Physical Chemical Values

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

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

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

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

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

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

* Toxicity criteria used to calculate risk include all daughter radionuclides

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

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Pesticides													
Endrin Aldehyde		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Endrin Ketone		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Metals													
Antimony		NC	NC	NA	NAP	NAP	NA	0.0E+00	0.0E+00	NA	NAP	NAP	NA
Bismuth		NC	NC	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Cerium		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Neodymium		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Thallium	0.46	NC	NC	NC	NAP	NAP	NA	2.7E-02	4.0E-05	NA	NAP	NAP	2.7E-02
SVOCs													
Acenaphthylene		NC	NC	NC	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(a)pyrene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(b)fluoranthene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Benzo(g,h,i)perylene		NC	NC	NC	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Carbazole		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Indeno(1,2,3-cd)pyrene		NA	NA	NA	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Phenanthrene		NC	NC	NC	NAP	NAP	NA	NA	NA	NA	NAP	NAP	NA
Radionuclides	EPC pCi/g												
Actinium-227		NA	NAP	NA	NAP	NA	NA	NA	NAP	NA	NAP	NA	NA
Lead-210		NA	NAP	NA	NAP	NA	NA	NA	NAP	NA	NAP	NA	NA
Plutonium-238	0.13	2.3E-08	NAP	2.1E-11	NAP	1.0E-12	2.3E-08	NA	NAP	NA	NAP	NA	NA
Radium-228*		NA	NAP	9.78-08	NAP	NA	NA	NA	NAP	NA	NAP	NA	NA
Thorium-230*	1.9	1.5E-06	NAP	2.6E-10	NAP	5.3E-06	6.8E-06	NA	NAP	NA	NAP	NA	NA
TOTAL		1.6E-06	NA	2.8E-10	NA	5.3E-06	6.8E-06	2.7E-02	4.0E-05	NA	NA	NA	2.7E-02

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

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

* Toxicity criteria used to calculate risk include all daughter radionuclides

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

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

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

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

* Toxicity criteria used to calculate risk include all daughter radionuclides

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

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

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

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

* Toxicity criteria used to calculate risk include radionuclide daughters

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

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

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

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

* Toxicity criteria used to calculate risk include radionuclide daughters

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

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

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

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

* Toxicity criteria used to calculate risk include radionuclide daughters

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

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

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

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

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

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

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

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

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

Table 5.10 Current Total Residual Groundwater Risk for Site Employee Scenario

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

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

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

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

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

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

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

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

Table 5.13 Future Total Groundwater Risk for the Construction Worker Scenario

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

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

Table 5.14 Future Background Goundwater Risk for the Construction Worker Scenario

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

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

Table 5.15 Future Incremental Groundwater Risk for the Construction Worker Scenario

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

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

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

Table 5.16 Future Total Residual Groundwater Risk for Site Employee Scenario

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

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

Table 5.17 Future Background Residual Groundwater Risk for Site Employee Scenario

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

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

Table 5.18 Future Incremental Residual Groundwater Risk for Site Employee Scenario

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

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

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

Table 5.19 Total Residual Risk for Parcel 4 Summary Table

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

bls - below land surface

NA - Not applicable

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

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

Table 5.20 Background Residual Risk for Parcel 4 Summary Table

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

bls - below land surface

NA - Not applicable

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

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

Table 5.21 Incremental Residual Risk for Parcel 4 Summary Table

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

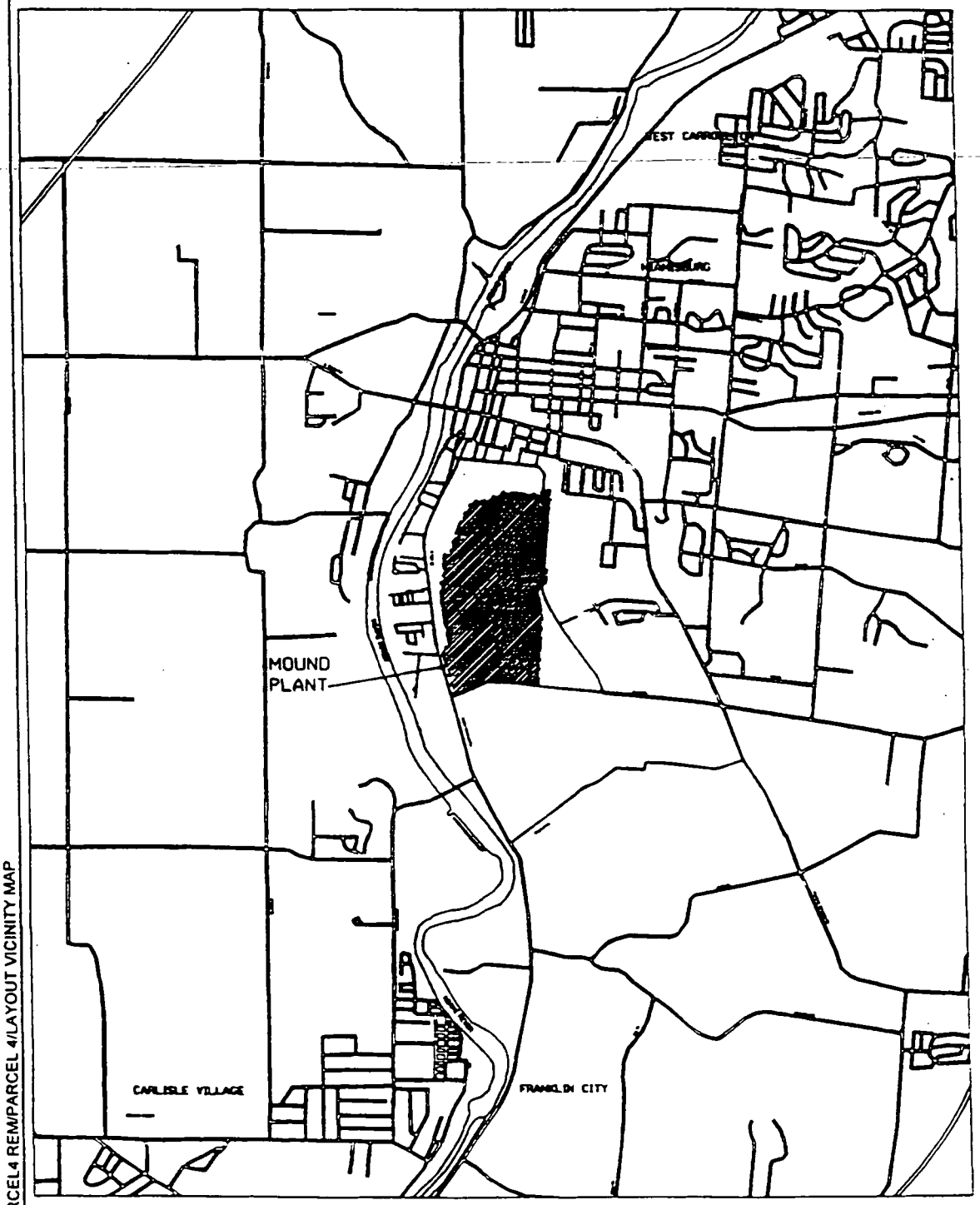
bls - below land surface

NA - Not applicable

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

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

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



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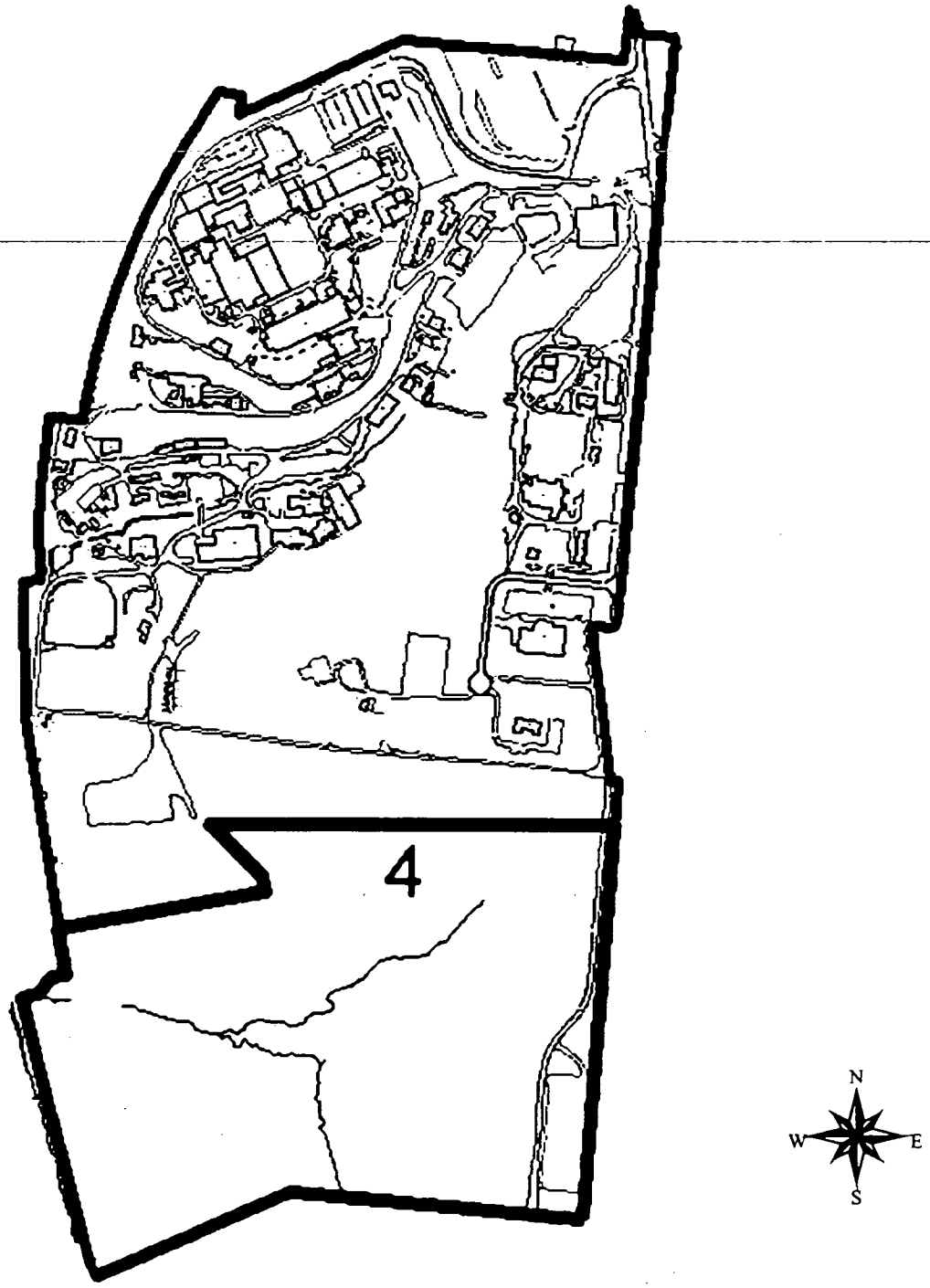
Mound Plant Parcel 4				
Vicinity Area Map				
Miamisburg, Ohio				
Science Applications International Corporation			Columbus, OH	
DRAWN BY LMA	DATE 5-8-00	SCALE NOT SHOWN	PROJECT	FIGURE NO. 1.1



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

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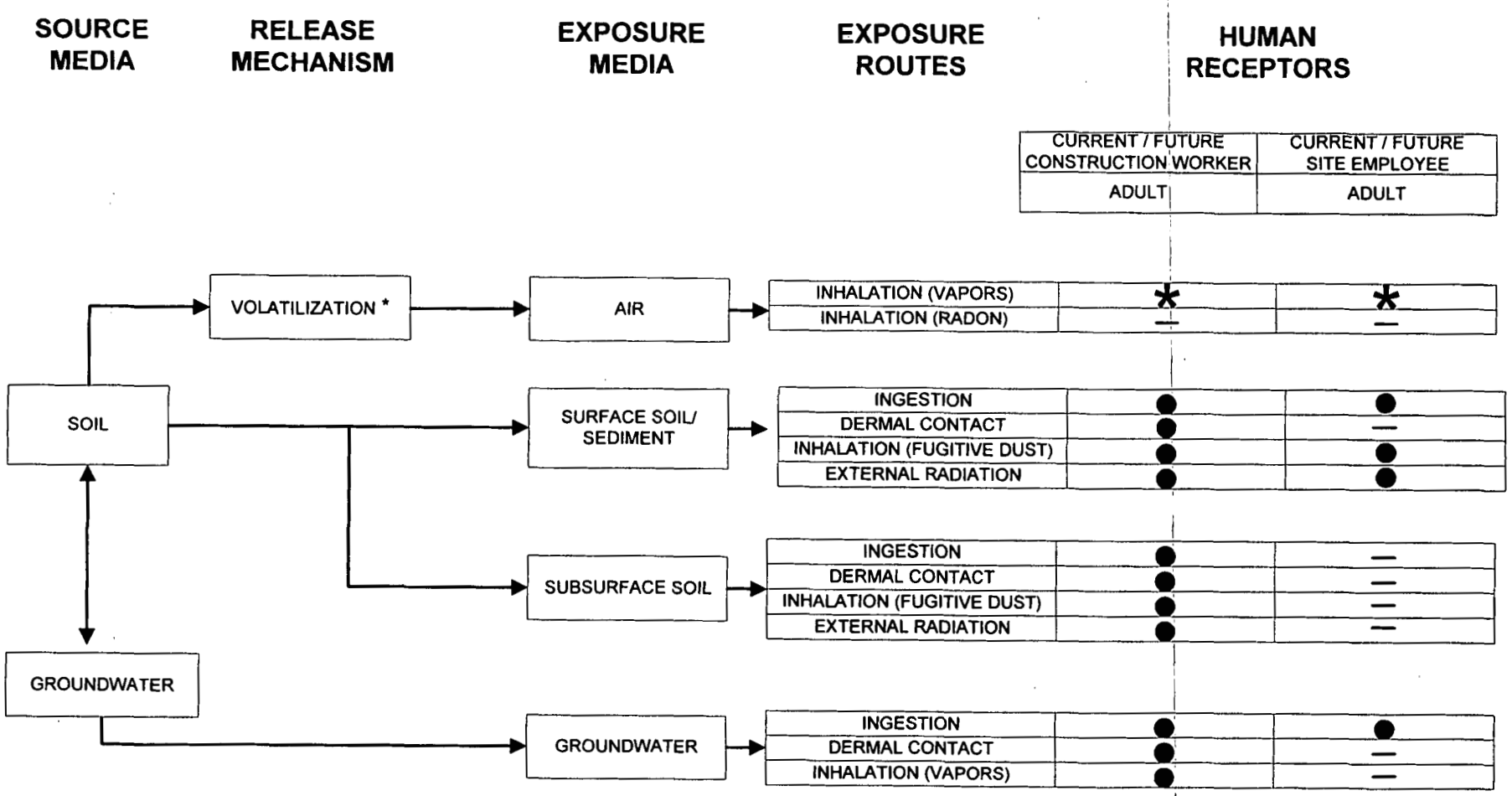

● COMPLETE PATHWAY EVALUATED QUANTITATIVELY
○ COMPLETE PATHWAY EVALUATED QUALITATIVELY
— INCOMPLETE PATHWAY, NOT EVALUATED
* NO VOLATILE COPCs IN AREA

Figure 3.1
Conceptual Site Model for the Parcel 4 RRE

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Appendix A

Evaluation of Potential Cumulative Exposure –Air

A1.1 EVALUATION OF POTENTIAL CUMULATIVE EXPOSURE – AIR

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

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

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

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

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

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

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

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

Appendix B

Methodology and Evaluation of Groundwater Exposure for Mound RRE

Potential Future Maximum Concentrations of COPCs in Groundwater

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

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

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

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

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

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

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

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

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

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

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

Antimony – An Example

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

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

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

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

12/12/00

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

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

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

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

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

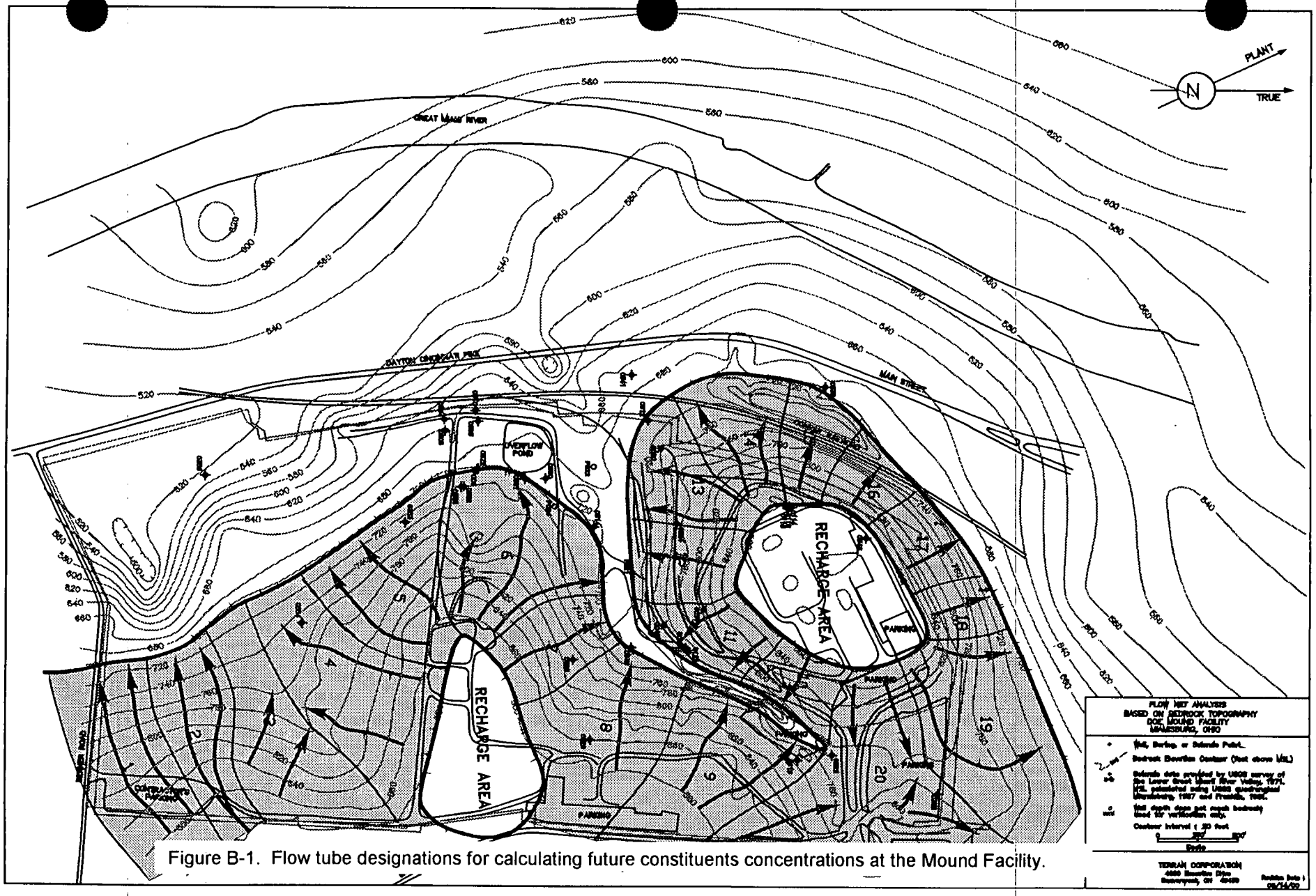

Figure B-1. Flow tube designations for calculating future constituents concentrations at the Mound Facility.

Appendix C

Calculations for Updated Screening Guidance Values

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

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

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

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

Where:

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

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

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

Where:

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

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

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

Where:

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

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

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

Not calculated for GVs because under review

Soil Guideline Values for Construction Worker at DOE Mound

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

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

Soil Guideline Values for Site Employee at DOE Mound

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

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

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

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

Slope Factors

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

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

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

RBGV= 0.11834378

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

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

Slope Factors

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

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

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

RBGV= 0.12405755

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

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

Slope Factors

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

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	25	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	50	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	17.125	yrs	25 yrs*(250days/yr/365day/yr)
Se=	0.2		
Te=	0.08	1/12	

RBGV=	0.139849944

Construction Worker Varibles from Table 4.1.3 pg 93, and Equations from Table 4.1.3 page 92 RBGV Report 3/97

For:	Th-228+D	Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
Th-228+D	**Target Risk**	1.00E-06

Slope Factors

2.31E-10	Oral Cancer Slope factor risk/pCi
9.68E-08	Inhalation Cancer slope factor risk/pCi
6.20E-06	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	5	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	480	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	3.425	yrs	5 yrs*(250days/yr/365day/yr)
Se=	0.1		
Te=	0.33	1/3= 8 hrs/24hrs	

RBGV=	0.15363106

Site Employee Variables defined in table 5.1.3 p110 RBGV Report 3/97
Equations listed in Table 5.1.3 p 109 RBGV Report 3/97
Slope Factors from HEAST Table 4
For: Ra-228+D Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
Ra-228+D Target Risk 1.00E-06

Slope Factors

4.79E-10	Oral Cancer Slope factor risk/pCi
9.78E-08	Inhalation Cancer slope factor risk/pCi
9.48E-06	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	25	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	50	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	17.125	yrs	25 yrs*(250days/yr/365day/yr)
Se=	0.2		
Te=	0.08	1/12	

RBGV= 0.09113537

Construction Worker Varibles from Table 4.1.3 pg 93, and Equations from Table 4.1.3 page 92 RBGV Report 3/97
For: Ra-228+D Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
Ra-228+D Target Risk 1.00E-06

Slope Factors

4.79E-10	Oral Cancer Slope factor risk/pCi
9.78E-08	Inhalation Cancer slope factor risk/pCi
9.48E-06	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	5	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	480	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	3.425	yrs	5 yrs*(250days/yr/365day/yr)
Se=	0.1		
Te=	0.33	1/3= 8 hrs/24hrs	

RBGV= 0.09971978

Site Employee Variables defined in table 5.1.3 p110 RBGV Report 3/97
Equations listed in Table 5.1.3 p 109 RBGV Report 3/97
Slope Factors from HEAST Table 4

For:	Th-232+D	Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
Th-232+D	**Target Risk**	1.00E-06

Slope Factors

5.12E-10	Oral Cancer Slope factor risk/pCi
1.17E-07	Inhalation Cancer slope factor risk/pCi
9.48E-06	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	25	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	50	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	17.125	yrs	25 yrs*(250days/yr/365day/yr)
Se=	0.2		
Te=	0.08	1/12	

RBGV= 0.0910498

Construction Worker Varibles from Table 4.1.3 pg 93, and Equations from Table 4.1.3 page 92 RBGV Report 3/97

For:	Th-232+D	Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
Th-232+D	**Target Risk**	1.00E-06

Slope Factors

5.12E-10	Oral Cancer Slope factor risk/pCi
1.17E-07	Inhalation Cancer slope factor risk/pCi
9.48E-06	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	5	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	480	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	3.425	yrs	5 yrs*(250days/yr/365day/yr)
Se=	0.1		
Te=	0.33	1/3= 8 hrs/24hrs	

RBGV= 0.09952328

Site Employee Variables defined in table 5.1.3 p110 RBGV Report 3/97
Equations listed in Table 5.1.3 p 109 RBGV Report 3/97
Slope Factors from HEAST Table 4

For:	**Pb-210+D**	Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,	
Pb-210+D	**Target Risk**		1.00E-06

Slope Factors

1.01E-09	Oral Cancer Slope factor risk/pCi
3.86E-09	Inhalation Cancer slope factor risk/pCi
1.45E-10	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	25	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	50	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	17.125	yrs	25 yrs*(250days/yr/365day/yr)
Se=	0.2		
Te=	0.08	1/12	

RBGV= 3.166655776

Construction Worker Varibles from Table 4.1.3 pg 93, and Equations from Table 4.1.3 page 92 RBGV Report 3/97

For:	**Pb-210+D**	Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,	
Pb-210+D	**Target Risk**		1.00E-06

Slope Factors

1.01E-09	Oral Cancer Slope factor risk/pCi
3.86E-09	Inhalation Cancer slope factor risk/pCi
1.45E-10	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	5	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	480	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	3.425	yrs	5 yrs*(250days/yr/365day/yr)
Se=	0.1		
Te=	0.33	1/3= 8 hrs/24hrs	

RBGV= 1.649759368

Site Employee Variables defined in table 5.1.3 p110 RBGV Report 3/97
Equations listed in Table 5.1.3 p 109 RBGV Report 3/97
Slope Factors from HEAST Table 4

For:	**Pu-238**	Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
Pu-238	**Target Risk**	1.00E-06

Slope Factors

3.00E-10	Oral Cancer Slope factor risk/pCi
2.70E-08	Inhalation Cancer slope factor risk/pCi
1.90E-11	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	25	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	50	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	17.125	yrs	25 yrs*(250days/yr/365day/yr)
Se=	0.2		
Te=	0.08	1/12	

RBGV=	10.66418486

Construction Worker Varibles from Table 4.1.3 pg 93, and Equations from Table 4.1.3 page 92 RBGV Report 3/97

For:	**Pu-238**	Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
Pu-238	**Target Risk**	1.00E-06

Slope Factors

3.00E-10	Oral Cancer Slope factor risk/pCi
2.70E-08	Inhalation Cancer slope factor risk/pCi
1.90E-11	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	5	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	480	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	3.425	yrs	5 yrs*(250days/yr/365day/yr)
Se=	0.1		
Te=	0.33	1/3= 8 hrs/24hrs	

RBGV=	5.554949181

Site Employee Variables defined in table 5.1.3 p110 RBGV Report 3/97
Equations listed in Table 5.1.3 p 109 RBGV Report 3/97
Slope Factors from HEAST Table 4

For:	K-40	Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
K-40	**Target Risk**	1.00E-06

Slope Factors

1.25E-11	Oral Cancer Slope factor risk/pCi
7.46E-12	Inhalation Cancer slope factor risk/pCi
6.11E-07	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=.	1.00E-06		
ED1=	25	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	50	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	17.125	yrs	25 yrs*(250days/yr/365day/yr)
Se=	0.2		
Te=	0.08	1/12	

RBGV= 1.425588724

Construction Worker Varibles from Table 4.1.3 pg 93, and Equations from Table 4.1.3 page 92 RBGV Report 3/97

For:	K-40	Risk Calculations: Soil Inhalation, Soil Ingestion, External Exposure,
K-40	**Target Risk**	1.00E-06

Slope Factors

1.25E-11	Oral Cancer Slope factor risk/pCi
7.46E-12	Inhalation Cancer slope factor risk/pCi
6.11E-07	External Cancer Slope Factor risk/yr/pCi/g

RBGV=TR/[(ED1*EF*Sfo*CF1*Irsoil) + (Sfi*CF2*IRair*(1/PEF)] + (ED2*Sfe*(1-Se)*Te)

TR=	1.00E-06		
ED1=	5	yrs	
EF=	250	days/yr	
CF1=	0.001	g/mg	
IR soil=	480	mg/day	
CF2=	1000	g/kg	
IR air=	20	m3/day	
PEF=	4.28E+09	m3/kg	
ED2=	3.425	yrs	5 yrs*(250days/yr/365day/yr)
Se=	0.1		
Te=	0.33	1/3= 8 hrs/24hrs	

RBGV= 1.574053305

Site Employee Variables defined in table 5.1.2 p1108
Equations 5.1.2 p 107 RBGV Report 3/97
Slope Factors from HEAST Table 4

For:	**Freon**	
Freon	**Target Hazard Index**	1.00E+00

Slope Factors

3.00E+01	Oral Reference Dose
	Inhalation Reference Dose

RBGV=THI*BW*365/[(EF*1/RfDo*CF1*IRsoil) + (1/RfDi*IRair*(1/PEF)]

THI=	1.00E+00	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	50	mg/day
CF2=	1000	g/kg
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg

RBGV=	6.13E+07

Construction Worker Variables from Table 4.1.2 pg 91, and Equations from Table 4.1.2 page 90 RBGV Report 3/97

For:	**Freon**	
Freon	**Target Hazard Index**	1.00E+00

Slope Factors

3.00E+01	Oral Reference Dose
	Inhalation Reference Dose

RBGV=THI*BW*365/[(EF*1/RfDo*CF1*IRsoil) + (1/RfDi*IRair*(1/PEF)]

THI=	1.00E+00	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	480	mg/day

RBGV=	6.39E+06

Site Employee Variables defined in table 5.1.2 p1108
Equations 5.1.2 p 107 RBGV Report 3/97

For: **4-trichlorobenzene**
1,2,4-trichlo Target Hazard Index 1.00E+00

RfDs

1.00E-02	Oral Reference Dose	iris
5.70E-02	Inhalation Reference Dose	heast

RBGV=THI*BW*365/[(EF*1/RfDo*CF1*IRsoil) + (1/RfDi*IRair*(1/PEF)]

THI=	1.00E+00	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	50	mg/day
CF2=	1000	g/kg
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg

RBGV=	2.04E+04

Construction Worker Variables from Table 4.1.2 pg 91, and Equations from Table 4.1.2 page 90 RBGV Report 3/97
For: **4-trichlorobenzene**
1,2,4-trichlo Target Hazard Index 1.00E+00

RfDs

1.00E-02	Oral Reference Dose
5.70E-02	Inhalation Reference Dose

RBGV=THI*BW*365/[(EF*1/RfDo*CF1*IRsoil) + (1/RfDi*IRair*(1/PEF)]

THI=	1.00E+00	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	480	mg/day
CF2=	1000	g/kg
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg

RBGV=	2.13E+03

Site Employee Variables defined in table 5.1.2 p1108
Equations 5.1.2 p 107 RBGV Report 3/97

For: **2-chlorophenol**
2-chlorophTarget Hazard Index 1.00E+00

RfDs

5.00E-03	Oral Reference Dose	iris
	Inhalation Reference Dose	

RBGV=THI*BW*365/[(EF*1/RfDo*CF1*IRsoil) + (1/RfDi*IRair*(1/PEF)]

THI=	1.00E+00	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	50	mg/day
CF2=	1000	g/kg
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg

RBGV= 1.02E+04

Construction Worker Variables from Table 4.1.2 pg 91, and Equations from Table 4.1.2 page 90 RBGV Report 3/97
For: **2-chlorophenol**
2-chlorophTarget Hazard Index 1.00E+00

RfDs

5.00E-03	Oral Reference Dose
	Inhalation Reference Dose

RBGV=THI*BW*365/[(EF*1/RfDo*CF1*IRsoil) + (1/RfDi*IRair*(1/PEF)]

THI=	1.00E+00	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	480	mg/day
CF2=	1000	g/kg
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg

RBGV= 1.06E+03

Site Employee Variables defined in table 5.1.1 p105
Equations 5.1.1 p 104 RBGV Report 3/97

For: dibenz(a,h)anthracene
dibenz(a,h Target Hazard Index 1.00E+00

CSF

7.30E+00	Oral Reference Dose	r
3.10E+00	Inhalation Reference Dose	r

RBGV=TCR*BW*365/[(EF*CSFo*CF1*IRsoil) + (CSFi*IRair*(1/PEF)]

TCR=	1.00E-06	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	50	mg/day
CF2=	1000	g/kg
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg
AT=	7.00E+01	yr
ED=	25	yr
RBGV=	7.84E-01	

Construction Worker Variables from Table 4.1.1 pg 88-89, and Equations from Table 4.1.1 page 87 RBGV Report 3/97

For: dibenz(a,h)anthracene
dibenz(a,h Target Hazard Index 1.00E+00

CSF

7.30E+00	Oral Reference Dose
3.10E+00	Inhalation Reference Dose

RBGV=TCR*BW*70*365/[(EF*5*CSFo*CF1*IRsoil) + (CSFi*IRair*(1/PEF)]

TCR	1.00E-06	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	480	mg/day
CF2=	1000	g/kg
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg
AT=	7.00E+01	yr
ED=	5	yr
RBGV=	4.08E-01	

Site Employee Variables defined in table 5.1.1 p105
Equations 5.1.1 p 104 RBGV Report 3/97

For: **indeno(1,2,3-cd)pyrene**
indeno(1,2 Target Hazard Index 1.00E+00

CSF

7.30E+00	Oral Reference Dose	r
3.10E+00	Inhalation Reference Dose	r

RBGV=TCR*BW*365/[(EF*CSFo*CF1*IRsoil) + (CSFi*IRair*(1/PEF)]

TCR=	1.00E-06	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	50	mg/day
CF2=	1000	g/kg
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg
AT=	7.00E+01	yr
ED=	25	yr
RBGV=	7.84E-01	

Construction Worker Variables from Table 4.1.1 pg 88-89, and Equations from Table 4.1.1 page 87 RBGV Report 3/97
For: **indeno(1,2,3-cd)pyrene**
indeno(1,2 Target Hazard Index 1.00E+00

CSF

7.30E+00	Oral Reference Dose
3.10E+00	Inhalation Reference Dose

RBGV=TCR*BW*70*365/[(EF*5*CSFo*CF1*IRsoil) + (CSFi*IRair*(1/PEF)]

TCR	1.00E-06	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	480	mg/day
CF2=	1000	g/kg
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg
AT=	7.00E+01	yr
ED=	5	yr
RBGV=	4.08E-01	

Site Employee Variables defined in table 5.1.2 p1108
Equations 5.1.2 p 107 RBGV Report 3/97

For: **fluorene**
fluorene **Target Hazard Index** 1.00E+00

RfDs

4.00E-02	Oral Reference Dose	iris
	Inhalation Reference Dose	

RBGV=THI*BW*365/[(EF*1/RfDo*CF1*IRsoil) + (1/RfDi*IRair*(1/PEF)]

THI=	1.00E+00	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	50	mg/day
CF2=	1000	g/kg
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg

RBGV= 8.18E+04

Construction Worker Variables from Table 4.1.2 pg 91, and Equations from Table 4.1.2 page 90 RBGV Report 3/97

For: **fluorene**
fluorene **Target Hazard Index** 1.00E+00

RfDs

4.00E-02	Oral Reference Dose
	Inhalation Reference Dose

RBGV=THI*BW*365/[(EF*1/RfDo*CF1*IRsoil) + (1/RfDi*IRair*(1/PEF)]

THI=	1.00E+00	
BW=	7.00E+01	kg
EF=	250	days/yr
CF1=	0.000001	g/mg
IR soil=	480	mg/day
CF2=	1000	g/kg
IR air=	20	m3/day
PEF=	4.28E+09	m3/kg

RBGV= 8.52E+03

The following equations were used to calculate new groundwater guideline values in accordance with the methodology presented in Risk Based Guideline Values, Mound Plant, March 1997a.

The equations are generally the same for construction worker and site employee scenarios. Input parameters differ. The construction worker includes ingestion and shower exposure while the site employee only includes groundwater ingestion.

Water Cancer Risk Based Guideline Values (RBGV) are calculated by the following equation for Chemicals- Nonradiological

$$\text{RBGVTotal (mg/L)} = \frac{1}{1/\text{RBGVingestion} + 1/\text{RBGVinhalation} + 1/\text{RBGVdermal}}$$

$$\text{RBGVingestion (mg/L)} = \frac{\text{TCR*AT*BW}}{\text{IRw*EF*ED*CSFo}}$$

Where:

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	1.00E-06	1.00E-06
BW=	Body Weight	70 kg	70 kg
EF=	Exposure Frequency	250 days/yr	250 days/yr
ED=	Exposure Duration	25 yr	5 yr
CSFo=	Oral Cancer Slope Factor	chemical specific	chemical specific
AT=	Averaging time	70 yr	70 yr
IRw=	Ingestion Rate Water	1 L/day	1 L/day

$$\text{RBGVinhalation (mg/L)} = \frac{\text{TCR*BW*AT}}{\text{K*IRair*EF*ET*ED*(1/24)*CSFi}}$$

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	NA	1.00E-06
BW=	Body Weight	NA	70 kg
AT=	Averaging time	NA	70 yr
CSFi=	Inhalation Cancer Slope Factor	NA	chemical specific
IR air=	Inhalation Rate Air	NA	20 m3/day
K=	Volatilization Factor	NA	0.5 l/m^3
ET=	Exposure Time	NA	0.167 hrs/day
EF=	Exposure Frequency	NA	250 days/yr
AT=	Averaging time	NA	70 yr
ED=	Exposure Duration	NA	5 yr

$$\text{RBGVdermal (mg/L) Organics} = \frac{\text{TCR*BW*AT}}{\text{2*Kp*EF*EV*0.001*(CSFa)*SSAa*ED*(6*T*tevent)/3.1412)}^{1/2}}$$

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	NA	1.00E-06
BW=	Body Weight	NA	70 kg
AT=	Averaging time	NA	70 yr
Kp=	Permeability Constant	NA	chemical specific
CSFa=	Dermal Cancer Slope Factor	NA	chemical specific
SSA=	Skin Surface Area	NA	19,400 cm^2
EV=	Events per day	NA	1 per day
EF=	Exposure Frequency	NA	250 days/yr
AT=	Averaging time	NA	70 yr
ED=	Exposure Duration	NA	5 yr
T=	Lag Time	NA	chemical specific
tevent	Exposure time	NA	chemical specific

$$\text{RBGVdermal (mg/L) Inorganics} = \frac{\text{TCR*BW*AT}}{\text{Kp*EF*EV*0.001*t event*(CSFa)*SSAa*ED}}$$

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	NA	1.00E-06
BW=	Body Weight	NA	70 kg
AT=	Averaging time	NA	70 yr
Kp=	Permeability Constant	NA	chemical specific
CSFa=	Dermal Cancer Slope Factor	NA	chemical specific
SSA=	Skin Surface Area	NA	19,400 cm^2
EV=	Events per day	NA	1 per day
EF=	Exposure Frequency	NA	250 days/yr
AT=	Averaging time	NA	70 yr
ED=	Exposure Duration	NA	5 yr
tevent	Exposure time	NA	chemical specific

Water Non-Cancer Risk Based Guideline Values (RBGV) are calculated by the following equation for Nonradiological Chemicals.

$$\text{RBGVTotal (mg/L)} = \frac{1}{1/\text{RBGVingestion} + 1/\text{RBGVinhalation} + 1/\text{RBGVdermal}}$$

$$\text{RBGVingestion (mg/L)} = \frac{\text{THI*AT*BW}}{\text{IRw*EF*ED*(1/RfDo)}}$$

Where:

		Site Employee	Construction Worker
THI=	Target Hazard Index	1	1
BW=	Body Weight	70 kg	70 kg
EF=	Exposure Frequency	250 days/yr	250 days/yr
ED=	Exposure Duration	25 yr	5 yr
RfDo=	Oral Reference Dose Factor	chemical specific	chemical specific
AT=	Averaging time	25 yr	5 yr
IRw=	Ingestion Rate Water	1 L/day	1 L/day

$$\text{RBGVinhalation (mg/L)} = \frac{\text{THI*BW*AT}}{\text{K*IRair*EF*ET*ED*(1/24)*(1/RfDi)}}$$

		Site Employee	Construction Worker
THI=	Target Hazard Index	NA	1
BW=	Body Weight	NA	70 kg
AT=	Averaging time	NA	70 yr
RfDi=	Inhalation Reference Dose Factor	NA	chemical specific
IR air=	Inhalation Rate Air	NA	20 m3/day
K=	Volatilization Factor	NA	0.5 l/m^3
ET=	Exposure Time	NA	0.167 hrs/day
EF=	Exposure Frequency	NA	250 days/yr
AT=	Averaging time	NA	5 yr
ED=	Exposure Duration	NA	5 yr

$$\text{RBGVdermal (mg/L) Organics} = \frac{\text{THI*BW*AT}}{\text{2*Kp*EF*EV*0.001*(1/RfDa)*SSAa*ED*(6*T*tevent/3.1412)}^{1/2}}$$

		Site Employee	Construction Worker
THI=	Target Hazard Index	NA	1
BW=	Body Weight	NA	70 kg
AT=	Averaging time	NA	70 yr
Kp=	Permeability Constant	NA	chemical specific
RfDa=	Dermal Reference Dose Factor	NA	chemical specific
SSA=	Skin Surface Area	NA	19,400 cm^2
EV=	Events per day	NA	1 per day
EF=	Exposure Frequency	NA	250 days/yr
AT=	Averaging time	NA	70 yr
ED=	Exposure Duration	NA	5 yr
T=	Lag Time	NA	chemical specific
tevent	Exposure time	NA	chemical specific

$$\text{RBGVdermal (mg/L) Inorganics} = \frac{\text{THI*BW*AT}}{\text{Kp*EF*EV*0.001*t event*(1/RfDa)*SSAa*ED}}$$

		Site Employee	Construction Worker
THI=	Target Hazard Index	NA	1
BW=	Body Weight	NA	70 kg
AT=	Averaging time	NA	70 yr
Kp=	Permeability Constant	NA	chemical specific
RfDa=	Dermal Reference Dose Factor	NA	chemical specific
SSA=	Skin Surface Area	NA	19,400 cm^2
EV=	Events per day	NA	1 per day
EF=	Exposure Frequency	NA	250 days/yr
AT=	Averaging time	NA	70 yr
ED=	Exposure Duration	NA	5 yr
tevent	Exposure time	NA	chemical specific

Water Cancer Risk Based Guideline Values (RBGV) are calculated by the following equation for Radiolnuclides

$$\text{RBGVingestion (pCi/L)} = \frac{\text{TCR}}{\text{IRw*EF*ED*CSFo}}$$

Where:

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	1.00E-06	1.00E-06
EF=	Exposure Frequency	250 days/yr	250 days/yr
ED=	Exposure Duration	25 yr	5 yr
CSFo=	Oral Cancer Slope Factor	chemical specific	chemical specific
IRw=	Ingestion Rate Water	1 L/day	1 L/day

For tritium dermal and inhalation pathways are also evaluated for water and total tritium is calculated as follows

$$\text{RBGVTotal (mg/L)} = \frac{1}{1/\text{RBGVingestion} + 1/\text{RBGVinhalation} + 1/\text{RBGVdermal}}$$

RBGVingestion same as above for all radionuclides

$$\text{RBGV tritium inhalation (pCi/L)} = \frac{\text{TCR}}{\text{IRa*EF*ED*ETs*CF1*CFt*M*CSFi}}$$

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	NA	1.00E-06
EF=	Exposure Frequency	NA	250 days/yr
CF1=	Conversion Factor mass of water	NA	1/1000 L/g
CFt=	Conversion Factor for time	NA	1/24 day/hrs
ETs=	Exposure Time shower	NA	.167 hr/day
ED=	Exposure Duration	NA	5 yr
M=	Air Mass conc of water in shower	NA	66.96 g/m^3
CSFi=	Inhalation Cancer Slope Factor	NA	chemical specific
IRa=	Ingestion Rate Air	NA	20 m^3hr/day

$$\text{RBGVdermal (pCimg/L) tritium} = \frac{\text{TCR}}{\text{Kp*EF*1000*ETs*(CSFa)*SSA*ED}}$$

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	NA	1.00E-06
Kp=	Permeability Constant	NA	1.50E-05
CSFa=	Dermal Cancer Slope Factor	NA	chemical specific
SSA=	Skin Surface Area	NA	19,400 cm^2
EF=	Exposure Frequency	NA	250 days/yr
ETs=	Exposure Time shower	NA	.167 hr/day
ED=	Exposure Duration	NA	5 yr

Constituent	TOXICITY VALUES FOR GROUNDWATER GVS						
	RfD (mg/kg/day)			CSF (kg-day/mg)			
	Oral	Adjusted	Inhalation	Oral	Adjusted	Inhalation	
Organics	RfDo	RfDa	RfDi	CSFo	CSFa	CSFi	
1,1,1,2-Tetrachloroethane	3.0E-02	3.00E-02	3.0E-02	2.6E-02	2.60E-02	2.6E-02	
1,1,2,2-Tetrachloroethane	6.0E-02	6.00E-02	6.0E-02	2.0E-01	2.00E-01	2.0E-01	
1,1,1-Trichloroethane	3.5E-02	3.50E-02	2.9E-01	NA	NA	NA	
1,1,2-Trichloro-1,2,2trifluoroethane	3.00E+01	3.00E+01	8.57E+00	NA	NA	NA	
cis-1,2-Dichloroethylene	1.0E-02	1.00E-02	2.3E-01	---	---	---	
Inorganics							
Aluminum	1.0E+00	1.00E+00	1.4E-03	---	---	---	
Boron	9.0E-02	9.00E-02	5.7E-03	---	---	---	
Chromium (VI)	3.0E-03	3.00E-03	2.9E-05	---	---	4.2E+01	
Cobalt	6.0E-02	6.00E-02	5.7E-06	---	---	---	
Copper	4.0E-02	4.00E-02	2.9E-04	---	---	---	
Molybdenum	5.0E-03	5.00E-03	1.4E-03	---	---	---	
Selenium	5.0E-03	5.00E-03	5.7E-05	---	---	---	
Thallium and compounds (as thallium	8.0E-05	8.00E-05	2.9E-05	---	---	---	
Tin	6.0E-01	6.00E-01		---	---	---	
Radionuclides							External
Americium-241	NA	NA	NA	3.28E-10		3.85E-08	4.59E-09
Bismuth-210	NA	NA	NA	7.29E-12		5.12E-11	0.00E+00
Radium-228+D	NA	NA	NA	4.79E-10		9.78E-08	9.48E-06
Strontium-85	NA	NA	NA	1.40E-12		1.14E-12	1.54E-06
Strontium-90	NA	NA	NA	4.09E-11		5.94E-11	0.00E+00
Thorium-227	NA	NA	NA	4.04E-11		4.31E-09	1.70E-07
Thorium-228 +D	NA	NA	NA	2.31E-10		9.68E-08	6.20E-06
Thorium-230 ***	NA	NA	NA	1.34E-09		2.38E-08	6.74E-06
Thorium-232 +D	NA	NA	NA	5.12E-10		1.17E-07	9.48E-06
Uranium-238 +D	NA	NA	NA	1.43E-09		5.08E-08	7.01E-06

Not calculated for GVs because under review

Groundwater Guideline Values for Construction Worker at DOE Mound

Constituent	GV	CANCER EFFECTS					NON-CANCER EFFECTS				
		Route-Specific RRSs (mg/L)			Weight Of Evidence	Cancer GW GV (TRC-06)	Route-Specific RRSs (mg/L)			Non-Cancer GW GVs mg/L	Non-Cancer 1/10 GW GVs mg/L
		Oral	Dermal	Inhalation			Oral	Dermal	Inhalation		
		(RRSo)c	(RRSd)c	(RRSi)c		RRSc	(RRSo)nc	(RRSd)nc	(RRSi)nc		
Inorganics (mg/L)											
Aluminum	1.0E+01	---	---	NA	NA	---	1.0E+02	5.3E+03	---	1.0E+02	1.0E+01
Boron	9.0E-01	---	---	NA	NA	---	9.2E+00	4.7E+02	---	9.0E+00	9.0E-01
Chromium (VI)	3.0E-02	---	---	NA	A	---	3.1E-01	1.6E+01	---	3.0E-01	3.0E-02
Cobalt	6.0E-01	---	---	NA	NA	---	6.1E+00	3.2E+02	---	6.0E+00	6.0E-01
Copper	4.0E-01	---	---	NA	D	---	4.1E+00	2.1E+02	---	4.0E+00	4.0E-01
Molybdenum	5.0E-02	---	---	NA	NA	---	5.1E-01	2.6E+01	---	5.0E-01	5.0E-02
Selenium	5.0E-02	---	---	NA	D	---	5.1E-01	2.6E+01	---	5.0E-01	5.0E-02
Thallium and compounds (as thallium	8.0E-04	---	---	NA	NA	---	8.2E-03	4.2E-01	---	8.0E-03	8.0E-04
Tin	6.0E+00	---	---	NA	NA	---	6.1E+01	3.2E+03	---	6.0E+01	6.0E+00
Organics (mg/L)											
1,1,1,2-Tetrachloroethane	5.1E-02	5.5E-02	---	7.9E-01	C	5.1E-02	3.1E+00	---	4.4E+01	2.9E+00	2.9E-01
1,1,2,2-Tetrachloroethane	3.0E-03	7.2E-03	5.3E-03	1.0E-01	D	3.0E-03	6.1E+00	4.5E+00	8.8E+01	2.5E+00	2.5E-01
1,1,1-Trichloroethane	1.8E-01	NA	NA	NA	D	NA	3.6E+00	3.6E+00	4.3E+02	1.8E+00	1.8E-01
1,1,2-Trichloro-1,2,2trifluoroethane	2.5E+02	NA	NA	NA		NA	3.1E+03	---	1.3E+04	2.5E+03	2.5E+02
cis-1,2-Dichloroethylene	1.0E-01	---	---	---	D	---	1.0E+00	---	---	1.0E+00	1.0E-01
Radionuclides (pCi/L)											
Americium-241	2.4E+00	2.4E+00	NA	NA		2.4E+00	NA	NA	NA		
Bismuth-210	1.1E+02	1.1E+02	NA	NA		1.1E+02	NA	NA	NA		
Radium-228+D	1.7E+00	1.7E+00	NA	NA		1.7E+00	NA	NA	NA		
Strontium-85	5.7E+02	5.7E+02	NA	NA		5.7E+02	NA	NA	NA		
Strontium-90	1.4E+01	1.4E+01	NA	NA		1.4E+01	NA	NA	NA		
Thorium-227	2.0E+01	2.0E+01	NA	NA		2.0E+01	NA	NA	NA		
Thorium-228+D	3.5E+00	3.5E+00	NA	NA		3.5E+00	NA	NA	NA		
Thorium-230+D	6.0E-01	6.0E-01	NA	NA		6.0E-01	NA	NA	NA		
Thorium-232+D	1.6E+00	1.6E+00	NA	NA		1.6E+00	NA	NA	NA		
Uranium-238+D	5.6E-01	5.6E-01	NA	NA		5.6E-01	NA	NA	NA		

mg/kg	milligrams/kilograms
NA	Not applicable
RRS	Risk Reduction Standard

Groundwater Guideline Values for Site Employee at DOE Mound

Constituent	GV	CANCER EFFECTS					NON-CANCER EFFECTS				
		Route-Specific RRSs (mg/L)				Cancer	Route-Specific RRSs (mg/L)			Non-Cancer	1/10
		Oral	Dermal	Inhalation	Weight Of Evidence	GW GV (TRC-06)	Oral	Dermal	Inhalation	W RRE GV mg/L	HI mg/L
Organics (mg.L)		(MSCo)c	(MSCd)c	(MSCi)c			(MSCo)nc	(MSCd)nc	(MSCi)nc		
1,1,1,2-Tetrachloroethane	1.1E-02	1.1E-02	NA	NA	C	1.1E-02	3.1E+00	NA	NA	3.1E+00	3.1E-01
1,1,2,2-Tetrachloroethane	1.4E-03	1.4E-03	NA	NA	D	1.4E-03	6.1E+00	NA	NA	6.1E+00	6.1E-01
1,1,1-Trichloroethane	3.6E-01	NA	NA	NA	D	NA	3.6E+00	NA	NA	3.6E+00	3.6E-01
1,1,2-Trichloro-1,2,2trifluoroethane	3.1E+02	NA	NA	NA		NA	3.1E+03	NA	NA	3.1E+03	3.1E+02
cis-1,2-Dichloroethylene	1.0E-01	---	NA	NA	D	---	1.0E+00	NA	NA	1.0E+00	1.0E-01
Inorganics (mg/L)											
Aluminum	1.0E+01	---	NA	NA	NA	---	1.0E+02	NA	NA	1.0E+02	1.0E+01
Boron	9.2E-01	---	NA	NA	NA	---	9.2E+00	NA	NA	9.2E+00	9.2E-01
Chromium (VI)	3.1E-02	---	NA	NA	A	---	3.1E-01	NA	NA	3.1E-01	3.1E-02
Cobalt	6.1E-01	---	NA	NA	NA	---	6.1E+00	NA	NA	6.1E+00	6.1E-01
Copper	4.1E-01	---	NA	NA	D	---	4.1E+00	NA	NA	4.1E+00	4.1E-01
Molybdenum	5.1E-02	---	NA	NA	NA	---	5.1E-01	NA	NA	5.1E-01	5.1E-02
Selenium	5.1E-02	---	NA	NA	D	---	5.1E-01	NA	NA	5.1E-01	5.1E-02
Thallium and compounds (as thallium chlorid	8.2E-04	---	NA	NA	NA	---	8.2E-03	NA	NA	8.2E-03	8.2E-04
Tin	6.1E+00	---	NA	NA	NA	---	6.1E+01	NA	NA	6.1E+01	6.1E+00
Radionuclides (pCi/L)											
Americium-241	4.9E-01	4.9E-01	NA	NA		4.9E-01	NA	NA	NA	NA	
Bismuth-210	2.2E+01	2.2E+01	NA	NA		2.2E+01	NA	NA	NA	NA	
Radium-228+D	3.3E-01	3.3E-01	NA	NA		3.3E-01	NA	NA	NA	NA	
Strontium-85	1.1E+02	1.1E+02	NA	NA		1.1E+02	NA	NA	NA	NA	
Strontium-90	3.9E+00	3.9E+00	NA	NA		3.9E+00	NA	NA	NA	NA	
Thorium-227	4.0E+00	4.0E+00	NA	NA		4.0E+00	NA	NA	NA	NA	
Thorium-228 +D	6.9E-01	6.9E-01	NA	NA		6.9E-01	NA	NA	NA	NA	
Thorium-230+D	1.2E-01	1.2E-01	NA	NA		1.2E-01	NA	NA	NA	NA	
Thorium-232 +D	3.1E-01	3.1E-01	NA	NA		3.1E-01	NA	NA	NA	NA	
Uranium-238 +D	1.1E-01	1.1E-01	NA	NA		1.1E-01	NA	NA	NA	NA	

mg/kg milligrams/kilograms
NA Not applicable
RRS Risk-Reduction Standard

Appendix D

Parcel 4 Database (Provided on CD provided with this report)

CLP Laboratory Data Qualifiers and their Used in the RRE

Inorganic Chemical Data	Definition	Included in RRE?
B	Reported value is <CRDL[a], but >IDL[b].	Yes
U	Compound was analyzed for but not detected.	Yes, 1/2 SQL[c]
E	Value is estimated due to matrix interference.	Yes
N	Spiked sample not within control limits.	Yes
J	Value is an estimated quantity.	Yes[d]
R	Quality control indicates that data is unusable.	No

Organic Chemical Data	Definition	Included in RRE?
U	Compound was analyzed for but not detected.	Yes, 1/2 SQL[c]
J	Value is estimated, spectral identification criteria are met but the value is <CRDL.	Yes[d]
B	Analyte found in associated blank as well as in sample.	Yes[e]
E	Concentration exceeds calibration range of GC/MS[d] instrument.	Yes
D	Compound identified in an analysis at a secondary dilution factor	Yes

a. CRDL means contract required detection limits
b. IDL means instrument detection limits
c. "U" qualified data, result was recorded as 1/2 the detection limit.
d. "J" qualified data with results less than the detection limit, recorded as 1/2 the detction limit.
e. "B" qualified organic results. If blank sample contained a common lab contaminant, result considered positive only if concentration exceeded 10x the amount detected in the blank. If blank sample contained a constituent that is not a common lab contaminant, result considered positive only if concentration exceeded 5X the amount detected in the blank.

Dave,
As requested, we are forwarding what I've been able to document from our comments on the Parcel 4 RRE. As noted on the attached, the comments represent only those that were derived from the text section of the RRE. The comments on the tables and appendices are work in progress. I'm hoping to have them completed by Monday. I'll start on documenting Proposed Plan comments for Parcel 4 after the RRE comments have been completed.
If you have any questions, my telephone number is 937-285-6066

From: "Jane Odell" <jane.odell@epa.state.oh.us>
To: MNDCONT.MNDPO(RAKEDA),MNDCONT.SMTP("hallie.j.seraz...
Date: 12/1/00 12:40pm
Subject: PARTIAL COMMENTS ON PARCEL 4 RRE

Dave,
As requested, we are forwarding what I've been able to document from our commen
If you have any questions, my telephone number is 937-285-6066

CC: "Brian Nickel" <Brian.Nickel@epa.state.oh.us>, "La...

General Comments

1. The Parcel 4/5 Boundary results provided to Ohio EPA in the form of Soil Analysis Reports (SAR) do not match the Parcel 4/5 Boundary results presented in the data set used in this Residual Risk Evaluation (RRE). Please indicate the reason for the discrepancy and the resulting action.

2. The data set representing Parcel 4 sent to Ohio EPA by Bob Hocks on November 17 has 2,020 blank entries and three "0" entries in the detection limit column. The data set provided with this RRE has 3,888 blank entries and 2,023 "0" entries in the detection limit column. Please reconcile this difference.

3. For any occurrence of the term "target risk range", please discontinue the use of the word "target" and replace it with the word "acceptable"

4. There is a discrepancy between the number of years that the data set encompasses. This discrepancy first appears in the Executive Summary on page ix. The first paragraph on this page indicates the data spans 16 years, but the second paragraph mentions 12 years. Please determine the correct amount of time and use one value throughout the document.

Specific Comments

1. Table of Contents - Please ensure the page numbering in the next version to ensure sections can be found on the page numbers listed.

2. List of Tables - The table name in this listing should match the table in the body of the document.

3. Acronyms and Abbreviations - Remove the word "and" from the HEAST acronym.

4. Executive Summary -
Introduce the intended land use (Industrial) within the first paragraph to account for use of the construction worker and site employee scenarios.

   In the third paragraph on page v, define the acronym "M&O". Remove the last sentence, pertaining to Release Block H, in the third paragraph.

   In the fourth paragraph on page v, third sentence, place the word "risk" after the term "non-cancer".

4. Executive Summary - continued

   On the first line of page vi, where the risk range of 10-4 to 10-6 is referenced, provide a description of what that means (increase in cancer risk of one human in ten thousand to one human in one million).

In the third paragraph on page vi, third sentence, add the word "risk" after the word "cumulative".

In the third paragraph on page vi, fourth sentence, remove the word "all". It is known that the results from the Safe Drinking Water Act testing are not included in the calculation of risk.

In the first paragraph on page vii, fifth sentence, change the non-cancer incremental risk number from "1.3" to "1.4".

In the third paragraph on page vii, sixth sentence, change the non-cancer background risk from "0.015" to "0.014".

In the fourth paragraph on page vii, second sentence, add the word "worker" after "construction".

In the second paragraph on page viii, last sentence, the "4.0 x 106" should be "4.0 x 10-6".

In the third paragraph on page viii, second to the last sentence, the "9.9 x 10-7" should be "9.8 x 10-7".

Within the Overall Summary of Risks table on page ix, account for the rounding problems that lead to discrepancies between the risk summary tables and within the table itself (Current Construction Worker HI values).

Delete the last sentence in the first paragraph on page ix dealing with the expected incremental risk.

In the second paragraph on page ix, second sentence, define "EPC".

The discussion regarding uncertainties and the "conservative nature" of the ground water model needs to be summarized and balanced with the fact that the model is conservative by design due to the lack of characterization

4. <u>Executive Summary - continued</u>

In the second paragraph on page x, third sentence from the bottom, change "MIEMS" to "MEIMS"

In the last paragraph on page x, first sentence, change the "maximum detected" term to 95% Upper Control Limit (UCL).

5. <u>Page 1, Section 1.0 Introduction</u> -

In the second paragraph, fourth sentence, remove the word "gravel".

Take out the word "may" within the first sentence of the third paragraph.

6. Page 2, Section 1.2 Scope of the Parcel 4 RRE - Reiterate the intended land use (Industrial) in this section.

7. Page 4, Section 2.0 Data Compilation and Evaluation -

In the last paragraph, last sentence, add the term " more sensitive" in front of "alpha spectroscopy results".

Provide the appropriate reference for the projects listed in the Parcel 4 Data Set Components

Provide an explanation regarding the removal of the Miami-Erie Canal 1974 Plutonium Study from the data set components.

Confirm the usage of the results from the sampling of the Canal Trailer Site.

8. Page 5, Section 2.2 Environmental Media Considered and Data Availability - In the first paragraph, second to the last sentence, add "bodies (i.e., ponds, streams)" after "surface water". Add the following text to end of the first paragraph in this section:

> However, some seeps are continuously present on Parcel 4. These seeps are defined as surface water for purposes of quantifying human health exposure. Due to the ephemeral nature of potential surface water exposures, USEPA has concluded in RAGS that "In general, use sediment monitoring data to estimate exposure concentrations. Sediment monitoring data can be expected to provide better temporal representativeness than surface water concentrations". Since RAGs suggests that risk from surface water can be approximated by risk from sediment, which is treated the same as soil, exposure to contaminants in seeps is accounted for within the direct soil exposure pathway.

9. Page 6, Section 2.3 Data Analysis -

In the first paragraph, first sentence, add " and current ground water" after "Parcel 4 soils". Remove the third sentence. Add a comma after "For future ground water" in the fourth sentence

The seventh sentence in this first paragraph indicates that the distribution of the data set is determined prior to the calculation of the 95% UCL. Is this statement accurate?

In the second to the last line on page 6, change the " $\bar{x}$ " to "mean".

10. Page 7, Section 2.3 Data Analysis - Remove the last sentence of the first paragraph regarding ND or zero samples. The sentence is repeated in the second paragraph.

11. Page 7, Section 2.4 Data Screening Process - Add text to this section to clarify what constituents were retained from the first screening process and hence appear on the second table.

12. Page 8, Section 2.4.1 Screening Constituents Based on Background - The statement regarding "negative risk" used in the second paragraph must be further defined for the reader or removed.

13. Page 9, Section 2.4.2 Screening Constituents Based on Guideline Values -

    In the first paragraph, third sentence from the bottom, remove the "+D" from Actinium-227 and add Cesium-137, Lead-210, Radium-226 and Thorium-227 and 228 to the list of daughter guideline values.

    In the second paragraph, first sentence, add the word "human" after the term " increase of one".

14. Page 9, Section 2.4.3 Screening Constituents Based on Frequency of Detection - Clarify this discussion by including the calculation is based on number of positive detects divided by the number of samples taken.

15. Page 10, Section 2.4.6 Screening Procedures for Future Ground Water - In the second sentence from the last on the page, replace the term "maximum concentration" with "95% UCL".

16. Page 11, Section 3.0 Exposure Assessment - Remove the reference to recreational and future residential use in the first sentence.

17. Page 11, Section 3.1 Characterization of Exposure Setting -

    In the second paragraph, first sentence, remove the word "gravel".

    In the second paragraph, third sentence, remove the term "but no continuously running

surface water" and replace it with "and some continuously flowing seeps".

In the last partial paragraph, first sentence, add PRS 419 to the PRS list.

18. Page 12, Section 3.3 Identifying Exposure Scenarios - Remove the word "the' from in front of "Parcel 4" in the first sentence. In the third sentence, change "soil" to "soil/sediment".

19. Page 13, Section3.3.1 Construction Worker Scenario -

In the middle of the first paragraph, the reference used (EPA 1999) regarding the use of dermal default values appears to be incorrect.

Provide a reference for the statement used in the fourth sentence from the end of the first paragraph regarding dermal toxicity data existence.

20. Page 14, Section 3.3.2 Site Employee Scenario - Explain why dermal contact with soil is not an exposure pathway.

21. Page 14, Section 3.4 Exposure Point Concentrations - Is the distribution of the data tested prior to the 95% UCL calculation. Change the "RME" acronym in the last sentence on this page to "EPC".

22. Page 17, Section 3.5.1 Soil Exposure Pathways - Place the "=" in the first complete equation on this page after "(pCi/g-yr).

23. Page 18, Section 3.5.2 Ground Water Exposure Pathways -In the first full sentence from the bottom of the page, change "maximum detected" to 95% UCL.

24. Page 19, Section 3.5.2 Ground Water Exposure Pathways - In the second equation on the page, move the "ED" from the denominator to the numerator.

25. Page 20, Section 3.5.2 Ground Water Exposure Pathways - In the first paragraph, the word permeability is spelled wrong.

26. Page 24, Section 4.1 Toxicity Values for Evaluating the Dermal Pathway - Explain and clarify whether or not tox values are available for other COPCs for this site. Were PAHs the only COPCs addressed dermally? Why not metals, etc...

27. Page 25, Section 5.0 Risk Characterization - In the second sentence on this page, add a comma after the term "In risk characterization".

28. Page 26, Section 5.1.1 Quantification of Carcinogenic Risk - In the equation on the middle of the page, change the word "RiskT" to "Riskt".

29. Page 27, Section 5.1.2 Quantification of Non-carcinogenic Risk - In the equation on the page, change the term "i-1" to "i=1".

30. Page 27, Section 5.2 Risk Characterization Results - In the third sentence, change the term "5.4 and 5.6" to "5.4 through 5.6".

---

31. Page 28, Section 5.2 Risk Characterization Results -

Remove the first sentence on this page and provide an updated assessment on how ground water exposure was quantified.

In the third sentence on the page, change the table reference from "5.15" to "5.18".

Define the significance of the 10-6 risk level. Explain that the point of departure is at the 10-6 risk level.

32. Page 28, Section 5.2.1 Construction Worker Risk Results - Under the Current Ground Water discussion, in the first sentence, change the table reference from "2.8" to "2.6".

33. Page 29, Section 5.2.1 Construction Worker Risk Results - Under the Future Ground Water discussion, in the last sentence, remove the word "residual" after "Background" and change the "8.6 X 10-6" to "9.3 X 10-5 ".

34. Page 30, Section 5.2.2 Site Employee Risk Results -

Under the Surface Soil discussion, the first full sentence on the page needs to be examined for accuracy.

Under the Current Ground Water discussion, second sentence, change the word "soil" to "current ground water". Second to the last sentence, add uranium-234 and change the word "inhalation" to "ingestion".

35. Page 32, Section 6.1 Uncertainty in Analytical Data -

First paragraph, delete the last sentence that reads "This is unlikely given the extent of sampling conducted".

Second paragraph, second sentence. Explain why there is a potential bias to the EPC for a constituent.

36. Page 33, Section 6.1 Uncertainty in Analytical Data -

Delete the first sentence on this page dealing with processes conducted involving antimony.

First paragraph, third sentence from the end of the paragraph, correct the spelling of MEIMS. In the last sentence in the first paragraph, delete "Despite this, " and start the sentence with "The maximum concentration...". Add to the end of this sentence ... due to 95% UCL concentration value being greater than the maximum concentration value.\

After the second paragraph, include a table which compares the EPC, min/max and associated risk estimates with and without the May 6, 1991 antimony data points.

In the third paragraph, first sentence, reword as follows, "To estimate future risk in the BVA , the 95% UCL concentration in the production wells..."

In the third paragraph, last full sentence on the page, delete the sentence and replace it with "The model does not take into account chemical and physical processes such as dilution, dispersion and adsorption which may reduce contaminant levels by the time it reaches the BVA". Delete the next sentence and replace it with "As a result of this methodology, the Future EPC concentration is biased high and conservative. Then add text regarding the lack of characterization to balance these statements. In addition, add "To reduce uncertainty, better characterization of ground water may be necessary".

Add the following as the last paragraph in this section:

> It was also agreed through the implementation of Mound 2000, source removal and the RREM that extensive characterization of the bedrock ground water was not needed due to the following: 1. A restriction on the use of the aquifer would be implemented; 2. The ground water yield from the bedrock is low (i.e. one gallon per minute); and 3. Characterization and remediation of a fractured bedrock is technically difficult and costly. Contaminants in the bedrock may be higher or more wide spread than currently known due to the limited characterization. It is important to recognize the uncertainties of the assumptions, but it is also important to maintain the conservative nature of the assumptions due to the reasons described in the above text.

37. Page 34, Section 6.2 Uncertainty in Exposure Assessment -

In the first paragraph, second sentence from the bottom, correct the spelling of "judgment".

In the second paragraph, add to the second sentence, " in the near future". Add to the last sentence, "but appropriate because the production wells are located in a productive portion of the BVA and could be used in the future as a water resource".

38. Page 36, Section 6.5 Conclusion - The conclusion should be based on risk estimates provided in the text and should not restate the uncertainties involve with the process. Conclusions should summerize the risk estimates exceeding the 10-6 point of departure and risk drivers.

The suggested wording for this section is as follows: The risk exceeds the acceptable risk range and is primarily driven by the conservative ground water analysis. Risk due to soil and air contaminants is within acceptable risk range for industrial/commercial reuse.

39.

Dave,

Can you begin our marathon RRE and PP comment session here at Ohio EPA at 9:30 on Monday, November 27?

Also, All newly calculated guideline values for SOIL in the Parcel 4 RRE need to be supported with data. We have the data for the ground water newly calculated guideline values in Appendix C. These soil values are footnoted in the soil tables as "f".

Jane

Jane

From: "Jane Odell" <jane.odell@epa.state.oh.us>
To: MNDCONT.MNDPO(RAKEDA)
Date: 11/21/00 11:11am
Subject: Monday RRE and Proposed Plan Comment Session

Dave,

Can you begin our marathon RRE and PP comment session here at Ohio EPA at 9:30

Also, All newly calculated guideline values for SOIL in the Parcel 4 RRE need t

Jane

Jane

CC: "Laurie Eggert" <laurie.eggert@epa.state.oh.us>

And another thing..... The background number used on Table 2.1 of the Parcel 4 RRE for U238 is incorrect. The value listed is .96 pCi/g the background level should be 1.2 pCi/g. Also, it looks like the Th232 guideline values on Table 2.1 and 2.3 table need to be updated.
Jane

From: "Jane Odell" <jane.odell@epa.state.oh.us>
To: MNDCONT.MNDPO(RAKEDA)
Date: 11/20/00 2:59pm
Subject: Re: Soil Background Levels for Pesticides/PCB -Reply

And another thing..... The background number used on Table 2.1 of the Parcel
Jane

>>> David Rakel <RAKEDA@doe-md.gov> 11/20/00 02:39PM >>>
Jane,

I see what you mean. I'm having a copy of the OU9 Soils Chemistry Report pulled from records.

Dave

>>> "Jane Odell" <jane.odell@epa.state.oh.us> 11/20/00 11:40am >>>
Dave,
Table A-4 in the RREM lists background values for Pesticides/PCBs in mg/kg. However, Table V.2 on Page 5-14 of the OU9 Background Soil Investigation: Soil Chemistry Report Rev. 2 lists the same background values but the units are ug/kg. Based on the levels, the ug/kg units appear to be correct. This was one of our comments on the Most Commonly Used Guideline Value Document (August 15, 2000) In the Parcel 4 RRE tables representing soil, the values were used as mg/kg and further converted to ug/kg. We believe that the levels were already ug/kg as noted in Table V.2 and should not have been converted. Let me know what you find out.

Thanks,
Jane

Dave,
Table A-4 in the RREM lists background values for Pesticides/PCBs in mg/kg. However, Table V.2 on Page 5-14 of the OU9 Background Soil Investigation: Soil Chemistry Report Rev. 2 lists the same background values but the units are ug/kg. Based on the levels, the ug/kg units appear to be correct. This was one of our comments on the Most Commonly Used Guideline Value Document (August 15, 2000) In the Parcel 4 RRE tables representing soil, the values were used as mg/kg and further converted to ug/kg. We believe that the levels were already ug/kg as noted in Table V.2 and should not have been converted. Let me know what you find out.

Thanks,
Jane

From: "Jane Odell" <jane.odell@epa.state.oh.us>
To: MNDCONT.MNDPO(RAKEDA)
Date: 11/20/00 11:40am
Subject: Soil Background Levels for Pesticides/PCB

Dave,
Table A-4 in the RREM lists background values for Pesticides/PCBs in mg/kg. Ho

Thanks,
Jane

CC: "Brian Nickel" <Brian.Nickel@epa.state.oh.us>

General

For clarification purposes, we suggest the following be placed in the *NOTES* sec

> The risk based guideline values do not represent or consider any risk fro soil leaching to ground water.
>
> Radionuclides labeled with a ▒D▒ indicate that some/all daughters are inc risk calculation. See the Mound Risk-Based Guideline Values, March 1997 source for a list of included daughters.
>
> The definition of ▒NA▒ and ▒ND▒ used in the background column. For those values such as Cobalt60, that did not have a value computed due to the la non-detects in the sample set, label and define these as NC.

Radionuclides

Indicate the reference source for Lead210+D is the Technical Position Report in Block H.

Provide the Ohio EPA with the data behind the calculation for the Protactinium2 construction worker/employee scenario. This value has not been reviewed/verif EPA.

Change the Thorium230 10-6 guideline value for the construction worker scenario calculated for the HH Building Action Memorandum. The Thorium230 site employee should be recalculated to reflect the daughters and current slope factor.

The Uranium238 value(s) should reflect the Uranium daughters group paper with a the NOTES: section on when to use the value with daughters and when to use the daughters.

Contaminant

The Pesticides/PCBs background values are assumed to be in mg/kg in the Most Co Used Guideline Values tables. In the OU9 Background Soil Investigation: Soil C Report on Page 5-14, the values are in ug/kg. Please reconcile.

The value for Xylene in the HI, construction worker/employee column should be 4 not 43,000 mg/kg.

The value for 4,4 DDT in the HI, construction worker/employee column should be not 100 mg/kg.

From: "Jane Odell" <jane.odell@epa.state.oh.us>
To: MNDCONT.MNDPO(RAKEDA,KRUEJW,HOCKRJ,GENEJC,ARTHKM),...
Date: 8/15/00 10:48am
Subject: Ohio EPAs Comments on the Most Commonly Used Guideline Values

Please find attached, Ohio EPAs comments on the Most Commonly Used Guideline Va
Thanks, Jane O'Dell

CC: MNDCONT.SMTP("Kathy.Fox@epa.state.oh.us","Brian.Ni...

Please find attached, Ohio EPAs comments on the Most Commonly Used Guideline Values for Soil/Sediment dated June 2000. If you have any questions regarding the comments, please email me or call me at 937-285-6066.
Thanks, Jane O'Dell

From: "Jane Odell" <jane.odell@epa.state.oh.us>
To: MNDCONT.MNDPO(HOCKRJ),MNDCONT.SMTP("tuckerrob@us-d...
Date: 11/17/00 1:03pm
Subject: RRE Teleconference Meeting Notes

Please find enclosed a summary of the responses to the comment responses we dis
Thanks, Jane

CC: "Anthony Campbell" <Anthony.Campbell@epa.state.oh....

Response to Ohio EPA Preliminary Comments on the Parcel 3 RRE Revision 4

From:	Hallie Serazin, SAIC
Sent:	Tuesday, November 07, 2000 10:01 AM
To:	David Rakel, BWXT, Jane O'Dell, Ohio EPA
Cc:	Brian.Nickel@epa.state.oh.us; laurie.eggert@epa.state.oh.us; Robert.Rothman@ohio.doe.gov
Subject:	Parcel 3/4 Ground Water Risk

The following comments were received from Jane O'Dell on Tuesday, November 7th and responses to the comments were discussed during a conference call held on Thursday, November 9th. The following memo documents responses given to the initial set of comments as well as any supplemental comments received via e-mail since our discussion on November 9th.

1. There are numerous comments from our review of Revision 3 of Parcel 3 RRE that have not been addressed. Specific Comments 2, 4, 5, 7, 8, 12, 13, 14 and 17 have not been addressed or an answer provided. A copy of the comments is attached.

Of the 9 specific comments called out here, only comments 8 and 12 were not addressed. Given the editorial nature of comments 8 and 12, these revisions called for by these comments are not likely to affect the overall meaning of the report. Each of the comments has been repeated below along with actions taken to address the comment or discussion of the issue from the November 9th conference call.

Ohio EPA Response to Comment Response:
To ensure that there is no question as to whether a comment and/or response has been addressed, I would like to request that all actions/responses/comments are documented. This document/email format we are presently using is acceptable. This was agreed upon in our teleconference of 11/16/00.

Ohio EPA Comment 2: Page 4, Section 2.0 Data Compilation and Evaluation - Provide a brief description of the MEIMS database. Add MEIMS to the Acronyms and Abbreviations list at the beginning of the document.

MEIMS has been added to the acronym list for both Parcel 3 and Parcel 4 RRE reports. MEIMS is defined on page 38 in the Parcel 3 RRE and on page "x" of the Executive Summary of the Parcel 4 RRE. During the November 9th conference call Ohio EPA requested that the acronym also be defined in Section 2.0. This addition will be made to the next version of the RRE.

Ohio EPA Response to Comment Response:
O.K. Please describe things that are not familiar to the public at their first introduction within a document.

Ohio EPA Comment 4: Page 7, Section 2.3 Data Analysis - Please add an explanation on the use of 'B' and 'E' qualified data.

The issue of where, and how, to explain data qualifiers was discussed prior to issuance of Revision 4 of the Parcel 3 RRE. It was agreed that an explanation of the data qualifiers would be

included with the data set and provided with report in an electronic format. An explanation of lab qualifiers was included with the electronic version of the data set provided with both RRE reports.

Ohio EPA Response to Comment Response:
O.K. When this agreement was made, it was in response to the comment of including qualifiers within the summary tables. We had previously agreed to remove the qualifier from the summary tables. Hallie stated that this has been completed.

Ohio EPA Comment 5: Page 7, Section 2.4 Data Screening Process - The fourth sentence references that the summary tables provide the Arange of contaminant detection limits@. Should this be changed to the range of detection or detection limits?

The 4th sentence of section of the RRE reports dealing with the "Data Screening Process" reads:

"The constituent summary tables also provide maximum detected concentrations, the range of contaminant detection limits, the frequency of detection and the decision and rationale to include or exclude a constituent from further consideration in the RRE."

Since the table lists the minimum and maximum concentration detected it does provide the range of detection limits. It is unclear how the meaning of this sentence would be changes if Arange of contaminant detection limits@ were changed to "the range of detection or detection limits".

Ohio EPA Response to Comment Response:
Agreed.

Ohio EPA Comment 7: Page 8, Section 2.4.2 Screening Constituents Based on Guideline Values - Change the word calculated to recalculated in the last sentence in the second paragraph. Make the last sentence in the second paragraph two sentences by placing a period (.) after GV and before The about 11 words from the bottom of the paragraph.

New GV were calculated, not recalculated. These calculations are provided in Appendix C. Since this text has been modified the second revision is no longer needed.

Ohio EPA Response to Comment Response:
O.K. Please provide the same documentation that appears in Parcel 4 Appendix C in the Parcel 3 RRE.

Ohio EPA Comment 8: Page 17, Section 3.4 Exposure Point Concentrations - Change the acronym RME used in the last sentence of the first paragraph to EPC.

The acronym will be revised as suggested.

Ohio EPA Response to Comment Response:
Thanks.

Ohio EPA Comment 12: Page 28, Section 5.0 Risk Characterization - Place a comma after Aln risk characterization@ in the second sentence of the first paragraph.

As suggested, a comma will be added to the 1st sentence of Section 5

Ohio EPA Response to Comment Response:
Thanks.

Ohio EPA Comment 13: Table 2.1, Identification of Current and Future Soil Constituents - Please add to the minimum and maximum concentration columns, a descriptor for the lab qualifier. Add text to the Ae@ footnote to direct the reader to Appendix C for selected updated guideline values. Use the thorium^{230} plus daughters guideline value for screening thorium^{230} concentrations. There are approximately 59 additional samples for metals between revision 2 and revision 3. Please explain the difference. The 95% UCL for plutonium^{238} looks too high (67.20 pCi/g). Please verify the value.

Since lab qualifiers have been defined with the data set, no explanation is needed on Table 2.1. Footnote "e" on the Parcel 4 RRE Table 2.1 and footnote "f" on the Parcel 3 RRE Table 2.1 will be modified to direct the reader to Appendix C.

Ohio EPA Response to Comment Response:
Thanks

The issue of which GVs to use for thorium^{230} and thorium^{232} was discussed during the November 9th conference call. Given the current uncertainty regarding the GVs for thorium it was agreed that the column would be left blank

As discussed in the teleconference of 11/16/00, Thorium 232 +D will be used in the Site Employee Scenario for soil and will replace the without daughter value presently used in both Parcel 3 and 4 RREs. Bob Hocks is to forward this value to Hallie.

The Parcel 3 soil data set has remained the same for versions 2, 3 and 4 of the Parcel 3 RRE. However, at the direction of Ohio EPA, the subsurface soil interval included in risk calculations has been expanded. The earlier versions of the RRE considered subsurface soil to be soil 0 to 10 feet below land surface based on the belief that even if the soil were disturbed by construction activities this would be the interval of soil most likely to be available for direct contact. At a meeting held at Mound on December 2, 1999, Ohio EPA directed us to include all subsurface soil data regardless of the depth at which it was collected. This change in policy accounts for the additional 59 metal samples between versions 2 and 3.

O.K.

The 95% UCL value for plutonium^{238} is a result of the required assumption that distributions are lognormal unless they are shown to be normal. Plutonium^{238} has less than 50% detects and would normally have defaulted to a non-parametric UCL but since the distribution was assumed to be log normal, the log normal 95% UCL was used.

I (Jane) asked for a reference for this "required assumption". Bob Tucker indicated it was in the Mound 2000 document. I asked for the specific reference (action item for Bob T). Bob also indicated that Brian Nickel had previously requested that data should be assumed to be lognormal. This issue will be discussed with Laurie Eggert and Brian Nickel (action item for Jane).

Ohio EPA Comment 14: Table 2.2, Identification of Current and Future Soil Constituents... - Please add to the minimum and maximum concentration columns, a descriptor for the lab qualifier. Add text to the Ae@ footnote to direct the reader to Appendix C for selected updated guideline values. Update both the thorium$^{230\&232}$ guideline values for screening concentrations.

Since lab qualifiers have been defined with the data set, no explanation is needed on Table 2.2. Footnote "e" on the Parcel 4 RRE Table 2.1 and footnote "f" on the Parcel 3 RRE Table 2.1 will be modified to direct the reader to Appendix C. See discussion above regarding GVs for thorium^{230} and thorium^{232}.

Ohio EPA Response to Comment Response:
Discussed in a previous response.

Ohio EPA Comment 17: Table 2.2, Identification of Current and Future Soil Constituents... - Please add to the minimum and maximum concentration columns, a descriptor for the lab qualifier. Add text to the Ae@ footnote to direct the reader to Appendix C for selected updated guideline values. Update both the thorium$^{230\&232}$ guideline values for screening concentrations.

Appendix C will be modified to say where the values are used.

Ohio EPA Response to Comment Response:
Discussed in a previous response

2. Please provide a table of current groundwater results that include the raw data for each sample. The table provided includes only the value used for the calculation of risk. We are interested in ensuring that the frequency of detect calculation is accurate. We are also interested in the lab qualifiers for this data.

This comment was expanded in an e-mail received from Jane O'Dell on November 13th. These comments are included below:

> I have rechecked the data that I originally flagged as creating discrepancy in the RRE summary tables. I'm still having problems reconciling this data. Within the data set, there is a column labeled "PREFIX". I'm assuming since the column either has a less than sign (<) or it is blank, that the column is used to determine if a result is greater than the detection limit. There are several examples of data that indicates the less than sign, but the result is greater than the given detection limit. There is also an example of a detection limit greater than a result, yet the column is blank. Below are a few of the examples.

Current Ground Water Data

Analyte	Prefix	Result	Detlim	
Aluminum	<	6.55	4.10	(multiple cases)
Vanadium	<	5.15	2.0	(multiple cases)
Chloroform	<	0.6	.5	
Th228		.0085	.017	

These are just a few that I've listed, please let us know why this occurred in the data table.

Response: The electronic copy of the data set provided with the report includes a field for insertion of "<" to indicate the non-detects or "U". However, the data set provided with the report did not include a field with J, B or other lab qualifiers if they exist. The data set has been

modified to capture other data qualifiers.

For metals and chloroform the reason there is a < designation is that a result may be considered to be non-detect due to data validation rather than being strictly less than detection limit. This could be due to contamination in blanks and other QA samples. The thorium^{228} value is the result of a rule we were asked to implement that indicated that if the reported radiological value was less than the detection limit, regardless of qualifier, we were to use half the detection limit as the result.

Ohio EPA Response to Comment Response:
The data set provided with the additional qualifiers will be reviewed.

3. The current ground water data provided does not match up exactly to the summary tables. There are numerous cases of the minimum/maximum concentration not matching (Aluminum, Selenium, Vanadium, Th228, etc.) the data provided. There are also problems with the detection frequency (Aluminum, Vanadium, Chloroform) matching. In the case of Chloroform, this miscalculation caused the chemical to be screened out based on frequency of detect when it should have been carried through. We have spot-checked this data and found problems, someone from your shop should review all of the data to ensure that the summary tables match the data set.

Response: A comparison of the data set submitted in electronic format with the RRE reports to the data reported on the screening tables for current groundwater was conducted. The minimum values detected on the screening table are the minimum detected values. For "U" qualified data, when ½ the SQL was used to estimate the contaminant concentration, these values do not appear in the table. Results for aluminum, vanadium, selenium, thorium-228, and chloroform were compared to the screening table and the findings were consistent with the reported values for minimum, maximum and frequency of detection.

Ohio EPA Response to Comment Response:
The data set provided with the additional qualifiers will be reviewed.

4. Strontium^{85} in current ground water was screened out due to a short half-life. A short half-life is not one of the screening mechanisms.

Response: The strontium^{85} values are the same as those reported for Release Blocks D and H. The short half-life rational as a screening mechanism was used in the earlier approved release blocks to eliminate this as a COPCs, therefore, based on precedence it was used in this version of screening. If this is incorrect, it can be modified.

Ohio EPA Response to Comment Response:
Even though the short half-life rational was used as a screening mechanism in Release Blocks D and H, we prefer to follow the RREM stated screening mechanisms. It was agreed to remove the short half-life screening mechanisms.

5. We had agreed to use the new Thorium 230 guideline values in the RREs.
The old soil values of 44 pCi/g (construction worker) and 81 pCi/g (site employee) are used in the RREs. The Th 232 soil value for the site employee is incorrect at 92 pCi/g.

Response: The issue of which GVs to use for thorium^{230} and thorium^{232} was discussed during the November 9th conference call. Given the current uncertainty regarding the GVs for thorium it was agreed that the column would be left blank.

Ohio EPA Response to Comment Response:
Discussed in a previous response.

6. There are guideline values being used in Revision 4 of Parcel 3 RRE that were not used in Revision 3 and we are unsure of where these values are referenced. They are the guideline values on Table 2.5 that are footnoted as "e" and on Table 2.7 footnoted as "d". Please provide the reference to the guideline values.

Response: Appendix C for Parcel 3 has the tables where these values were calculated for the Revision 4. New groundwater GVs had not been calculated for many COPCs for Revison 3. Additionally, only the construction worker GV table was included in the Appendix C. Site employee GV's will be included with the next version of the Parcel 3 RRE report

Ohio EPA Response to Comment Response:
Ohio EPA is currently reviewing the calculations of the above mentioned guideline values.

7. As previously discussed, we would like to have Matt Justice sit down with Brent Huntsman to review the data and analysis of the future ground water results. Please provide dates as to when Brent would be available for this meeting.

Response: A meeting between Matt Justice (Ohio EPA) and Brent Huntsman (Teran) was held on November 8, 2000.

Ohio EPA Response to Comment Response:
Agreed

11/9/00

Comments rec'd via e-mail from Jane O'Dell 11/7/00

Comments apply to Parcel 3/4 groundwater.

See Parcel 4 Binder.

Comments discussed 11/9/00 conference call.

Dave,
By now I'm sure you're aware of the discrepancy between the Parcel 4/5 Boundary Soil Analysis Reports and the Parcel 4/5 Boundary data used in the Parcel 4 RRE. This email is a request for an explanation (once determined) as to the reason for the discrepancy. Karen Arthur has given us a preliminary explanation, but she wasn't sure about the details.
Thanks, Jane

Response via e-mail 11/29/00

BWX Technologies, Inc.
a McDermott company

BWXT of Ohio, Inc.
1 Mound Road
P.O. Box 3030
Miamisburg, Ohio 45343-3030
(937) 865-4020

ESC-164/00
October 26, 2000

00-TC/10-26

Mr. Richard B. Provencher, Director
Miamisburg Environmental Management Project
U.S. Department of Energy
P.O. Box 66
Miamisburg, OH 45343-0066

ATTENTION: Dewain Eckman

SUBJECT: Contract No. DE-AC24-97OH20044
PARCEL 4 RESIDUAL RISK EVALUATION - DRAFT

REFERENCE: Statement of Work Requirement C 7.1d -- Regulator Data Requests

Dear Mr. Provencher:

Attached is the Draft (Revision 2) Residual Risk Evaluation for Parcel 4. The release of this document to USEPA, OEPA, ODH for review concurrent with DOE has been authorized by Rob Rothman of MEMP.

If you or members of your staff have any questions regarding the document, or if additional support is needed, please contact Dave Rakel at extension 4203.

Sincerely,

JSStapleton

Jeffrey S. Stapleton
Manager, Environmental Safeguards & Compliance

JSS/nmg

Enclosures as stated

cc: Tim Fischer, USEPA, (2) w/attachments
Dave Meredith, TechLaw, (1) w/attachments
Brian Nickel, OEPA, (2) w/attachments
Ruth Vandegrift, ODH, (1) w/attachments
Rob Rothman, MEMP, (2) w/attachments
John Krueger, BWXT of Ohio, (1) w/attachments
Monte Williams, BWXT of Ohio, (1) w/attachments
DCC

bc: J. Stapleton
N. Grice (file)
F. Hertweck
D. Rakel

Science Applications International Corporation
An Employee-Owned Company

October 25, 2000

David Rakel. Ph.D.
Babcock & Wilcox of Ohio, Inc.
1 Mound Road
P.O. Box 3030
Miamisburg, OH 45343-3030

RE: Parcel 4 Draft Revision 2 Residual Risk Evaluation Report

Dear Dr. Rakel,

Science Applications International Corporation (SAIC) is pleased to submit to Babcock and Wilcox of Ohio, Inc. fifteen bound copy of the Draft Revision 2, Parcel 4 Residual Risk Evaluation Report. This report was prepared using the Mound 2000 Residual Risk Evaluation Methodology to quantify the potential for cancer and other non-cancer health effects from long-term, low-level exposures to site-related contaminants in Parcel 4. Residual risks were calculated for total risk, background risk and incremental risk for a current and future adult construction worker and a current and future adult site employee. In addition this report contains updated cumulative risks from contaminants in current and future groundwater. Potential cumulative exposure to contaminants in air were not re-calculated but were brought forward from the Release Block H RRE and Technical Position Paper for Release Block H. Preliminary comments from the Ohio EPA were addressed in this revision.

Please call me if you have any questions on this submittal, or the electronic files that were sent on Friday.

Sincerely,

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

Hallie J. Serazin

Hallie J Serazin
Environmental Scientist

Enclosure
cc: Vincent Krivda w/o enclosure

4900 Blazer Pkwy., Dublin, Ohio 43017 (614) 793-7600 • Fax: (614) 793-7620

RESIDUAL RISK EVALUATION
MOUND PLANT PARCEL 4

DRAFT (Revision 2)

Mound Plant
Miamisburg, Ohio

Prepared for:
U.S. Department of Energy

Managed by:
BWXT of Ohio

October 25, 2000

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ACRONYMS AND ABBREVIATIONS

ATSDR	Agency for Toxic Substances Disease Registry
ARAR	Applicable or Relevant and Appropriate
BVA	Great Miami Buried Valley Aquifer
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPCs	constituents of potential concern
CSF	cancer slope factor
DOE	Department of Energy
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
FFA	Federal Facilities Agreement
GV	Guideline Values
HEAST	Health Effects and Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
IRIS	Integrated Risk Information System
LOAEL	lowest observed adverse effects level
MEIMS	Mound Environmental Information and Management System
MMCIC	Miamisburg Mound Community Improvement Corporation
NCEA	National Center for Environmental Assessment
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ND	Not detected
NOAEL	no observed adverse effect level
Ohio EPA	Ohio Environmental Protection Agency
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyls
ppm	parts per million
PRS	Potential Release Site
QAPP	quality assurance project plan
QA/QC	Quality Assurance/Quality Control
RAGS	Risk Assessment Guidance for Superfund
RfD	reference dose factor
RfC	reference concentration factor
RME	reasonable maximum exposure
RRE	residual risk evaluation
RREM	residual risk evaluation methodology
SVOCs	semi-volatile organic compounds
TPH	total petroleum hydrocarbon
UCL	upper confidence limit
VOCs	volatile organic compounds

Parcel 4 Human Health Residual Risk Evaluation

Executive Summary

This report was prepared using the Mound 2000 Residual Risk Evaluation Methodology [(RREM) DOE 1997a] to quantify the potential for cancer and other non-cancer health effects from long-term, low-level exposures to site-related contaminants in Parcel 4. A Residual Risk Evaluation (RRE) quantifies human health risks associated with residual levels of contamination remaining within an area to ensure that future users of the land will not be exposed to contaminant levels that would pose unacceptable risks. Total risk, background risk and incremental risk were calculated for current and future exposure scenarios for a construction worker and a site employee working in Parcel 4. Potential exposure to contaminants originating outside Parcel 4 that may reach receptors in the parcel are termed potential cumulative exposures. Potential cumulative risk was calculated for current and future exposure to groundwater and air.

To quantify future residual soil risk it was assumed that no degradation of the COPCs would occur over time, therefore, current and future residual soil risks are the same. Current groundwater exposures were estimated using data collected from the Mound Plant Production Wells up through the year 2000, including approximately 12 years worth of data. The Mound Plant Production wells are finished in the Great Miami Buried Valley Aquifer (BVA). The concentration of contaminants in future groundwater were estimated using a model that assumes all contaminants currently detected in the bedrock aquifer of the Mound Plant property migrate to the BVA.

The terms "Release Blocks" and "Parcel" are both used in this report to designate portions of the Mound property to be evaluated for transfer. To streamline the transfer process, the Mound property was initially divided into 19 "release blocks", which are contiguous tracts of property designated for release. RREs must be completed before the transfer of a release block can be completed. RRE reports have been completed for Release Blocks D and H. When the M&O contract for Mound oversight changed hands in 1997 the release blocks were reconfigured into 10 "Parcels" to shorten the schedule for site transfer. Release Block H forms the eastern boundary of Parcel 4.

Constituents of potential concern (COPCs) in Parcel 4 soil for the construction worker scenario are identified in Table 2.2. Total, background and incremental residual risk for the construction worker exposed to Parcel 4 soil is presented in Tables 5.1, 5.2 and 5.3, respectively. Total, background and incremental residual non-cancer for a construction worker exposed to soil are all below the target risk threshold of 1. Total residual cancer risk for a construction worker exposed to soil in Parcel 4 is 2.0×10^{-5}, which falls within

the target or acceptable risk range of 10^{-4} to 10^{-6}. Background residual cancer risk from soil for a construction worker in Parcel 4 was 2.3×10^{-8}. Since background risk to a construction worker was three orders of magnitude lower than total risk, incremental residual cancer risk is essentially equivalent to total residual risk. Incremental residual cancer risk for the construction worker exposed to soil was 2.0×10^{-5}.

Constituents of potential concern (COPCs) in Parcel 4 surface soil for the site employee scenario are identified in Table 2.4. Total, background and incremental residual risk for the site employee scenario exposed to Parcel 4 surface soil is presented in Tables 5.4, 5.5 and 5.6, respectively. Total, background and incremental residual non-cancer for a site employee exposed to surface soil are all well below the target risk threshold of 1 for non-carcinogenic risk. Total and incremental residual cancer risk from surface soil for a site employee in Parcel 4 is 2.3×10^{-5}, which falls within the target or acceptable risk range of 10^{-4} to 10^{-6}. Background residual risk from soil for a construction worker in Parcel 4 was 2.6×10^{-7}.

Potential exposure to contaminants originating from outside Parcel 4 that may reach receptors in the parcel are termed potential cumulative exposures. Potential cumulative risk was calculated for current and future exposure to groundwater and air. The approach used to estimate potential cumulative for air is the same method as was used for Release Blocks D and H. Current groundwater risk was assessed using all groundwater data available from the Mound Production wells. Potential cumulative risk from air and groundwater are reported in the Parcel 4 summary tables at the end of this Executive Summary.

Potential cumulative risk was assessed for both current and future exposure to groundwater. Current groundwater exposures were estimated using data collected from the Mound Plant Production Wells (well numbers 271 and 076) up through the year 2000 including approximately 12 years worth of data. The Mound Plant Production wells are finished in the Great Miami Buried Valley Aquifer (BVA). The concentration of contaminants in future groundwater were estimated using a model that assumes all contaminants currently detected in the Bedrock Aquifer of the Mound Plant property migrate to the BVA. Contaminant concentrations detected in the Bedrock Aquifer were added to the current contaminant concentrations detected in the Mound Plant Production Wells to estimate potential future exposures. Information on the derivation of future contaminant concentrations in groundwater is presented in Appendix B.

For the construction worker scenario antimony, cadmium, and copper were identified as COPCs in current groundwater (Table 2.6). Total, background and incremental residual risk for a construction worker exposed to current groundwater are presented in Table 5.7, 5.8 and 5.9, respectively.

Total residual cancer risk from current groundwater for the construction worker scenario is 1.6×10^{-6}, due entirely to cadmium. This risk level falls within the target or acceptable risk range of 10^{-4} to 10^{-6}. Since

the background concentration of cadmium in groundwater has not been quantified, background risk for a construction worker could not be quantified. Therefore, incremental residual cancer risk from current groundwater for a construction worker was 1.6x 10^{-6} which falls within the target risk range for carcinogens. Total residual non-cancer risk from current groundwater for a construction worker is 1.4, which exceeds the target risk threshold of 1 for non-carcinogenic risk. The largest contributor to this risk is antimony. Background residual non-cancer risk from current groundwater for a construction worker is 0.017. Incremental non-cancer risk for this receptor is 1.3 which, again, is largely due to antimony. The maximum concentration of antimony detected in the production wells was used to describe current groundwater to ensure that the actual risk from groundwater ingestion is not underestimated. However, these results were collected on May 6th 1991 using an uncertain analytical procedure. Uncertainty surrounding the concentration of antimony used in the current groundwater calculations is discussed further below.

For the site employee scenario antimony, cadmium, copper, actinium-227, plutonium-239/240, thorium-228 and uranium-234 were identified as COPCs in current groundwater (Table 2.8). Total, background and incremental residual risk for a site employee exposed to current groundwater are presented in Table 5.10, 5.11 and 5.12, respectively.

Total residual cancer risk from current groundwater for a site employee 1.1×10^{-5}. Background and incremental residual cancer risk from current groundwater for a site employee is 3.3×10^{-6} and 8.0×10^{-6}, respectively. All three of these risk levels falls within the target or acceptable risk range of 10^{-4} to 10^{-6}. Total residual non-cancer risk from current groundwater for a site employee is 1.1, which exceeds the target risk threshold of 1 for non-carcinogenic risk. The largest contributor to this risk is antimony. Background residual non-cancer risk from current groundwater for a site employee is 0.015. Incremental residual non-cancer risk from current groundwater for a site employee is and 1.1 which, again, is largely due to antimony. The maximum concentration of antimony detected in the production wells was used to describe current groundwater to ensure that the actual risk from groundwater ingestion is not underestimated. However, these results were collected on May 6th 1991 using an uncertain analytical procedure. Uncertainty surrounding the concentration of antimony used in the current groundwater calculations is discussed further below.

Final COPCs for future groundwater for the construction worker are identified in Table 2.10. Total, background and incremental risks for the construction are presented in Tables 5.13, 5.14 and 5.15, respectively. Total residual non-carcinogenic risk from future groundwater for the construction worker is 26. Background residual non-carcinogenic risk from future groundwater for the construction worker scenario is 11 and increment residual non-carcinogenic risk from future groundwater is 14. The total, background and incremental non-cancer risk for the construction worker all exceed the target Hazard Index (HI) of 1. Future total and incremental carcinogenic residual risk from groundwater for the construction worker scenario is

$1.4x10^{-2}$, which exceeds the target risk range for carcinogens. Background residual carcinogenic risk from future groundwater for the construction worker scenario is $9.3x10^{-5}$, which falls within the target risk range.

Final COPCs for future groundwater for the site employee are identified in Table 2.12. Total, background and incremental risks for the construction are presented in Tables 5.16, 5.17 and 5.18, respectively. Future total and incremental non-carcinogenic residual risk from groundwater for the site employee scenario were 5.5 and 5.3, respectively. Both these values exceed the target HI of 1. Future background non-carcinogenic residual risks in groundwater for the site employee is 0.21, which does not exceed target Hazard Index of 1. Future total and incremental carcinogenic residual risk from groundwater for the site employee scenario was $5.2x10^{-5}$ and $4.8x10^{-5}$, respectively. Total and incremental carcinogenic risk associated with exposure to groundwater falls within the target risk range of 10^{-4} to 10^{-6} for the site employee scenario. Background carcinogenic residual risk from groundwater for the site employee scenario was $4.0x10^{6}$, which also falls within the target risk range of 10^{-4} to 10^{-6}.

Airborne contaminant concentrations were measured at the Mound Facility in 1994 while various site restoration activities (DOE, 1994) were ongoing. This method assumes both current and future exposure to air. Both radiological and non-radiological data were collected. Since several soil-disturbing activities were going on during data collection it is assumed that the measured air concentrations represent an upper-bound air concentration. Information on the derivation of these values is presented in Appendix A. Incremental cumulative carcinogenic risk due to exposure to contaminants in air was $2.1x10^{-7}$, for the construction worker, and $9.9x10^{-7}$ for the site employee. In both scenarios, the result is less than the target risk range. None of the COPCs identified in air have non-carcinogenic risk criteria so a HI was not calculated for exposure to contaminants in air.

Overall total, background, and incremental cancer and non-cancer risks are presented in the following table. The risk values in the table are the addition of all of the media and associated pathways for the construction worker and site employee scenarios. Total and incremental non-carcinogenic risks exceed target criteria for the future construction worker and future site employee due to potential exposure to groundwater. Overall carcinogenic risks associated with exposure to soil, current groundwater, and air fall within the target risk range of 10^{-4} to 10^{-6} for both potential receptors, but future groundwater risks to construction worker exceeds target risk levels.

Overall Summary of Risks

Scenario and Receptor	Overall Risk Types	Total Non-carcinogen Risk HI	Total Excess Lifetime Cancer Risk
Current Construction Worker	Total	1.4	$2.2x10^{-5}$
	Background	0.017	$3.1x10^{-8}$
	Incremental	1.3	$2.2x10^{-5}$
Future Construction Worker	Total	26	$1.4x10^{-2}$
	Background	11	$9.3x10^{-5}$
	Incremental	14	$1.4x10^{-2}$
Current Site Employee	Total	1.1	$3.5x10^{-5}$
	Background	0.015	$3.5x10^{-6}$
	Incremental	1.1	$3.2x10^{-5}$
Future Site Employee	Total	5.5	$7.6x10^{-5}$
	Background	0.21	$4.6x10^{-6}$
	Incremental	5.3	$7.2x10^{-5}$

The incremental non-carcinogenic risk exceeds the standard (HI=1) for the four scenarios listed in the Overall Summary of Risks Table. The incremental excess lifetime cancer risk exceeds the acceptable risk range (10^{-4} to 10^{-6}) for the Future Construction Worker Scenario ($1.4x10^{-2}$). These exceedances are driven by the conservative nature of the groundwater analysis. Specifically, using the maximum detected value (a single measurement) from a data set that spans sixteen years as the concentration representing a contaminant of potential concern and assuming contaminants are present only in their most toxic form overestimate the risk. Details are provided in Section 6, Uncertainties. Based on this conservative methodology, the expected incremental residual risk from Parcel 3 is within the acceptable range.

Data for the RRE was collected over a 12-year period and analytical detection limits and methods have changed. This has resulted in current lower detection limits and presents uncertainty in the data by adding potential bias to the EPC for a constituent. For groundwater, the historical and current groundwater data were used to estimate the exposure point concentration. Uncertainty is introduced because the analytical

results for constituents in the groundwater, collected over a 12-year time period, may not meet the Data Quality Objectives (DQOs) currently in place for data collection at Mound. Antimony is an example of this type of uncertainty. The long time frame also means that contaminants detected in the Production Wells and bedrock wells may have degraded. For example, 12 years is equivalent to one half-life for tritium. The concentration of tritium in groundwater is reduced by half every 12 years.

None of the processes conducted at the Mound facility involved the use of antimony so, no process knowledge exists to suggest that antimony might be present in current or historical groundwater, yet antimony was detected in 5 out of 29 analyses of groundwater collected from the two production wells. The highest concentrations of antimony detected (38.2 μg/L and 40.2 μg/L) were both collected on May 6th, 1991. Since both elevated results were collected on the same date the possibility of sample contamination exists. May 6th 1991 precedes development of the Mound Quality Assurance Project Plan (DOE 1993a) by two years, so it is doubtful that the elevated antimony results meet the Mound DQOs. The Mound Environmental Information and Management System (MEIMS) database specifies the procedure used for antimony analysis as an "unknown CLP method" and the results were lab qualified as "B". When applied to inorganic compounds, like antimony, the "B" lab qualifier means that the reported value is greater than the instrument detection limit but less than the contract required detection limit. The next highest detection of antimony (14.4μg/L) was detected in April 7th, 1994 and antimony has not been detected in the BVA since. In addition to the monitoring data reported in MIEMS, monitoring of the production wells is conducted in accordance with the Safe Drinking Water Act (SDWA). The SDWA data for production well groundwater shows antimony at the detection limit of 0.6 μg/L. Despite this, the maximum concentration of antimony detected in the production wells (40.2 μg/L) was used to describe the current groundwater concentration.

Given the age, elevated detection limits, and uncertain analytical procedure used for the May 6th 1991 analyses, plus results of subsequent analysis that shows antimony at much lower levels, it seems highly unlikely that the concentration used to describe the current concentration of antimony in groundwater is accurate. The maximum concentration of antimony detected in the production wells was used to describe current groundwater to ensure that the actual risk from groundwater ingestion is not underestimated. However, this approach may result in an overestimation of actual current risk. Elimination of the questionable May 6th results would lower the estimated current total risk due to antimony from an HI of 1.1 for the construction worker down to an HI of 0.4 which is well below the target risk threshold.

To estimate future maximum constituent concentrations in the BVA the maximum detected concentration in the production wells was added to the flow tube modeled maximum detected concentration

found in the bedrock wells. The flow tube model includes an assumption that the maximum concentration of a constituent detected in each of the twenty bedrock flow tubes impacts the BVA in the future. Natural physical and chemical processes such as dilution, dispersion, adsorption, and soil properties are ignored when establishing future estimated concentrations by this method. It is possible that the soil and the bedrock layer would inhibit most of the groundwater sampled in the bedrock wells to ever migrate into the BVA. As a result of this methodology, the future EPC concentration is biased high and the future groundwater concentrations are overstated.

Furthermore, the Parcel 4 RRE assumed that future site users would utilize the production wells for potable water supplies. The Miamisburg Mound Community Improvement Corporation (MMCIC) intends to tap future site-users into the municipal water supply system, therefore exposure to bedrock or BVA groundwater is unlikely. Using the production well and bedrock well data to estimate future risk is a conservative estimate of future risk.

1.0 INTRODUCTION

The U.S. Department of Energy's (DOE) Mound Plant is located on a 306-acre parcel of land within the City of Miamisburg, Ohio, about 10 miles southwest of Dayton, Ohio. Figure 1.1 shows the vicinity of the Mound Plant. The plant is located approximately 2,000 feet east of the Great Miami River and partially overlies the Great Miami Buried Valley Aquifer (BVA). Since 1948, Mound has operated as a research, development and production facility in support of DOE's weapons and energy programs. Mound's past weapons program mission included process development, production engineering, manufacturing, and surveillance of detonators, explosives, and nuclear components. Mound's current mission is to support DOE's efforts in environmental management and to transition the site, in cooperation with the City of Miamisburg, from a cold-war production facility to commercial or industrial use.

Parcel 4, the subject of this report, consists of 95.2 acres located immediatelysouth of Operable Unit (OU) 5, the Mound Plant Production Area. A map of the Parcel 4 is included as Figure 1.2. Prior to DOE's purchase of Parcel 4 in 1981, the land had been in use for agricultural purposes. Parcel 4 remains undeveloped with the exception of a construction gate, a gravel road from Benner Road and gravel-surface parking area, a contractor storage area, and an above ground power line running approximately north-south through the center of the property.

During past operations at the Mound facility the release of hazardous waste may have occurred. Subsequent facility investigations have identified over 400 potential release sites (PRSs). Since contamination at the Mound Plant occurs at discrete PRSs rather than being widespread across the site, a new decision-making process was formulated for Mound. The new process is known formally as the "removal site evaluation process" and informally as the "Mound 2000 process". The Mound 2000 process is consistent with the Federal Facilities Agreement (FFA) signed by DOE, the U. S. Environmental Protection Agency (EPA) and the Ohio Environmental Protection Agency (Ohio EPA), in accordance with the Comprehensive Environmental Response, Compensation, and Liabilities Act (CERCLA) as defined in the National Contingency Plan [(NCP) EPA 1989].

This report was developed using the Mound 2000 Residual Risk Evaluation Methodology (RREM) (DOE 1997a) to quantify the potential for cancer and other non-cancer health effects from long-term, low-level exposures to site-related contaminants in Parcel 4. A Residual Risk Evaluation (RRE) assesses human

health risks associated with residual levels of contamination remaining within an area to ensure that future users of the land will not be exposed to contaminant levels that would pose unacceptable risks. The RRE results will be used, together with Applicable or Relevant and Appropriate Requirements (ARARs), to determine the need for additional site remediation or to demonstrate that Parcel 4 is ready for public use.

1.1 Purpose of Residual Risk Evaluation

The objective of the Parcel 4 RRE is to assess risks associated with residual levels of contamination that exist after completion of the removal action. Although the RRE method was developed specifically for use at Mound, the method is consistent with the CERCLA baseline risk assessment method to ensure that future users of the land will not be exposed to contaminant levels that would pose unacceptable risks.

1.2 Scope of the Parcel 4 RRE

The RRE for Parcel 4 includes an evaluation of human health risk for potential residual contamination in the area. A remedial investigation of Parcel 4, also known as the Mound Plant New Property, was completed in February 1996. The results of this investigation were presented in the *Operable Unit 5 New Property Remedial Investigation Report* (DOE 1996). Since commercial/industrial use of Parcel 4 is anticipated, receptor scenarios were selected to represent reasonable maximum exposure (RME) conditions for a commercial/industrial setting. Residual contaminants in Parcel 4 were evaluated for two potential receptor groups: construction workers, who may be exposed to surface and subsurface soil, groundwater and air for up to five years and site employees, such as office workers, who may be exposed to surface soil, groundwater and air for up to 25 years. The construction worker and site employee were assumed to utilize groundwater from the Mound Plant Production Wells (Wells 271 and 076) for their potable water supply while at work. Exposure assumptions for the construction worker and site employee scenarios are site-specific adaptations of the standard scenarios presented in EPA's Risk Assessment Guidance for Superfund (RAGS), Part A (EPA 1989). These assumptions are documented in Table 1 in the Mound 2000 RREM (DOE 1997a) and are based on a RME assumptions. RME exposure assumptions are conservative and are therefore, not likely to underestimate residual risk.

The Parcel 4 residual risks evaluation included an assessment of total, background and incremental risk. Total risk was calculated using the total concentration of identified constituents of potential concern

(COPCs) detected in Parcel 4. Background risk was based on background levels of the COPCs and incremental risk was calculated using the difference between total and background levels. Incremental risk can be used to assess the increase in risk above background levels due to contaminant releases from past Mound Plant operations.

1.3 Organization of Report

The RREM provides a framework for evaluating potential human health risks associated with residual levels of contamination. Although the RREM is similar to a traditional CERCLA baseline risk assessment, it serves a different purpose and, therefore, is not identical.

The RREM consists of five elements, including:

- identification of the contaminants to be evaluated,
- exposure assessment,
- toxicity assessment,
- risk characterization, and
- evaluation of potential cumulative risks.

The following sections describe each of these elements in more detail starting with Section 2.0, Data Compilation and Evaluation, which describes the methods used to compile Parcel 4 data and identify contaminants to be evaluated in the RRE. Section 3.0, Exposure Assessment, summarizes the pathways through which hazardous substances may reach potential receptors and intake assumptions that will be used to quantify exposure. In Section 4.0, Toxicity Assessment, exposure point concentrations, intake equations and toxicological reference values are presented. Information from the exposure assessment is combined with information from the toxicity assessment to characterize human health risks in Section 5.0, Risk Characterization. Section 6.0, Uncertainties, presents some of the sources of uncertainty inherent in risk assessments and in the RRE. Section 7.0, References, contains a list of all documents cited in this report.

2.0 DATA COMPILATION AND EVALUATION

Identification of contaminants to be carried through the RRE calculations is a multi-step process beginning with the identification of all contaminants detected in the area and then eliminating contaminants based upon a set of established screening criteria described in the RREM.

All available sampling data were compiled for use in the Parcel 4 RRE. Newer data were used to supplement, rather than supercede older data except when older data described materials that had subsequently been removed from the area. In this case, the older data no longer represent site conditions and were, therefore, not used in the RRE. Sampling data obtained from the Mound Soil Screening Facility were used except in the case where a sample was split and analyzed by both the Mound Soil Screening Facility and a commercial analytical laboratory. In such cases, the value from the commercial analytical laboratory was used to take advantage of the greater precision available from the commercial analytical laboratory. When a given sample was analyzed using both alpha and gamma spectroscopy methods the alpha spectroscopy results were used to characterize the sample.

Parcel 4 Data Set Components:

Project Code	Description	Reference	Comment
34896	New Property	Operable Unit 5 Remedial Investigation Report, Final, Rev 0, February 1996	
SWSD	Surface Water and Sediment	Operable Unit 9 Surface Water and Sediment Investigation Report, Technical Memo, Rev 2, September 1996	
RSS	Radiological Site Survey – OU9 Site Scoping Report	Operable Unit 9 Site Scoping report Volume 3; Radiological Site Survey, Final, June 1993	
SCRDATA	Mound Plant Screening Data	Not published	
SGCSP	Regional Soils Investigation	Operable Unit 9 Further Assessment Soil Gas Confirmation Sampling, Final, Rev 0, May 1996	
04-2768	New Property Extended Phase	OU 9 Regional Soils Investigation Report, Final, Rev 2, August 1995	
34897	Operable Unit 3 LFI	Operable Unit 5 Remedial Investigation Report, Final, Rev 0, February 1996 Or Operable Unit 5 New Property Extended Phase I Field Report, Final,	

		Rev 0, July 1995	
MND33	WD Building Soil Characterization	Operable Unit 3 Miscellaneous Sites Limited Field Investigation Report, Final, Rev 0 July 1993	
WDSOIL	BVA Mound Production Well Sampling Bedrock aquifer monitoring well sampling		Ecotek
Groundwater	1994 Site Restoration activities	Compiled from the MEIMS database and reported in Release Blocks H and D	
		RRS reports.	
Air		Mound Site Environmental Report for Calendar Year 1994, MLM-3814, (DOE 1994)	

2.1 Data Quality Assessment

Samples were collected and analyzed according to the methods outlined in the Operable Unit (OU) 9 Quality Assurance Project Plan (QAPP) (DOE 1993a) and the OU5 QAPP (DOE 1993b). Since some of the data used to characterize residual contaminant concentration in Parcel 4 were collected prior to 1993, not all data used in the risk assessment have undergone Quality Assurance/Quality Control (QA/QC) evaluation and data validation in accordance with the requirements described in the OU9 QAPP (DOE 1993a).

2.2 Environmental Media Considered and Data Availability

Field investigations conducted for Parcel 4 are listed above. Samples were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), inorganic compounds, common anions, polychlorinated biphenyls, and radionuclides. Environmental media evaluated include surface soil (0-2 ft below land surface), subsurface soil (>2 feet below land surface), sediment, groundwater and air. Parcel 4 does contain surface drainage ways but no persistent surface water. Since ditch sediments are typically dry, sediment data was evaluated with the surface soil data.

Current groundwater exposures were estimated using data collected from the Mound Plant Production Wells (Wells 271 and 076), which are finished in the BVA. The concentration of constituents in future groundwater was estimated using a flow tube model that assumes all contaminants currently detected in the Bedrock Aquifer of the Mound Plant property migrate to the BVA. Future estimated modeled contaminant

concentrations in the Bedrock Aquifer were added to the current maximum contaminant concentrations detected in the Mound Plant Production Wells. This method is described in more detail in Appendix B. The approach used to estimate potential cumulative risk from exposure to air is the same method as was used for Release Blocks D and H. Potential cumulative risks due to contaminants released to the air are discussed in more detail in Appendix A.

2.3 Data Analysis

For each constituent detected in Parcel 4 soils the 95% upper confidence limit of the mean (UCL) was calculated to estimate the concentration that receptors in the area may be exposed to. This is known as the Exposure Point Concentration or EPC. In groundwater, the 95% UCL was also calculated to estimate the current concentration that receptors may be exposed to. For future groundwater modeled values were used as the EPC. The Flow Tube model used to predict future contaminant concentrations is described in Appendix B. The 95% UCL was calculated in accordance with the Mound 2000 RREM (DOE 1997a), Gilbert's *Statistical Methods for Environmental Pollution Monitoring* (Gilbert 1987), and the*Supplemental Guidance to RAGS: Calculating the Concentration Term* (EPA, 1992a). Before calculating the 95% UCL the distribution of the data set was determined. If data were found to be normally distributed, the EPC was calculated as the 95% UCL of the arithmetic mean of the data, using the Student's t-statistic (EPA 1992a). If the data were found to be log normally distributed, the EPC was calculated as the 95% UCL using the H-statistic (EPA 1992a). The 95% UCL on the arithmetic mean for normal data sets were calculated as follows:

$$95\%\ UCL = Mean + t(s/n^{1/2})$$

Where:

UCL= upper confidence limit,
t = t statistic (Table A2, Gilbert, 1987),
s = standard deviation, and
n = number of observation in the data set

The 95% UCL equation of the arithmetic mean for log normal data sets were calculated as follows:

$$95\%\ UCL = e^{Mean + 0.5\ s2\ + H(s/(n-1)\ 1/2)}$$

Where:

UCL = upper confidence limit,
e = constant (base of the natural log, equal to 2718
$\bar{x}$= mean of the transformed data
s = standard deviation of the transformed data

H = H statistic (e.g., from table published in Gilbert 1987),
n = number of observations in the data set

If the 95% UCL exceeded the maximum value observed in the sampling results, the maximum value was used as the EPC for that constituent (whether the data were normally or log normally distributed). For both chemical and radiological constituents, "not detected" (ND, qualified as U or UJ) results were treated as one-half the limit of detection and included in the calculations of the mean and 95% UCL values. Samples reported as ND or zero with no detection limit were not utilized in calculating a 95% UCL.

Blind field duplicates were collected to assess variability in the sampling process. Duplicate samples were used in the data quality assessment but were not included in the calculation of the exposure point concentrations. If a data set had less than twenty observations (n<20) the maximum detected concentration was used as the EPC. For radionuclides, zero or negative results with no detection limits were excluded from the data set. Data qualified as "J", or estimated values at concentrations less than the detection limit, were evaluated as half the detection limit. For "J" data, which was greater than the detection limit or reported without the sample detection limit, the value was used as reported. Samples reported as ND or zero with no detection limit were not utilized in calculating a 95% UCL. Data flagged with an"R", meaning rejected, were not used in calculating the EPC.

2.4 Data Screening Process

All constituents that were detected one or more times were listed in constituent summary tables and sorted by media and depth where they were detected. Soil data was also sorted by depth. The constituent screening methods described below were then used to generate a final list of constituents of potential concern (COPCs). The constituent summary tables also provide maximum detected concentrations, the range of contaminant detection limits, the frequency of detection and the decision and rationale to include or exclude a constituent from further consideration in the RRE. The following section describes how COPCs were selected.

To make the COPC selection process easier to understand the COPC selection tables have been broken into two tables. The first table identifies initial COPCs by comparing the maximum concentration detected in a given media to background values and Mound Guideline Values (GVs) for the given receptor. The second table identifies final COPCs by comparing the exposure point concentrations for the initial COPCs to background values. Tables 2.1 and 2.2 identify the COPCs in soil for the construction worker

scenario and Tables 2.3 and 2.4 identify COPCs for the site employee scenario. Tables 2.5 and 2.6 identify the COPCs in current groundwater for the construction worker scenario and Table 2.7 and 2.8 identify COPCs in current groundwater for the site employee scenario. Tables 2.9 and 2.10 identify the COPCs in future groundwater for the construction worker scenario and Tables 2.11 and 2.12 identify the COPCs in future groundwater for the site employee scenario.

2.4.1 Screening Constituents Based on Background

Site-specific background concentrations described as the 95% Upper Tolerance Limit (UTL) of the background sample results for each constituent were calculated for Mound Plant soil and groundwater, and are presented in the Mound 2000 RREM (DOE 1997a). Constituents with a maximum detected concentration exceeding their level in background were identified as initial COPCs and carried to the next screening step of the RRE. Constituents with maximum concentrations less than their background concentration were not carried though the RRE. If no background value was available for a particular constituent (e.g., many organic compounds), the constituent was carried through to the next screening step of the RRE. These background concentrations were also used to quantify background risk.

For initial COPCs with a 95% UCL of the arithmetic mean less than the maximum detected value, the 95% UCL was compared to background to determine whether the 95% UCL was below background. If the 95% UCL was below the background value for the constituent, the constituent was not identified as a COPC in the RRE. Including constituents whose 95% UCL is less than background would cause that the incremental risk to be a "negative" risk. Eliminating these constituents is consistent with the Mound 2000 RREM and focuses the RRE on constituents detected above background.

2.4.2 Screening Constituents Based on Guideline Values

Soil and groundwater constituents with maximum detected concentrations greater than background concentration were compared to risk-based Guideline Values (GVs) for the Mound Facility (DOE 1997c). GVs are media-specific concentrations of constituents that correspond to specific human health risk levels for specified exposure scenarios. GVs were developed for construction worker and site employee scenarios (see DOE 1997c for the detailed derivation of GVs). Construction worker and site employee GVs, were used to screen detected constituents as COPCs to be retained for the quantitative risk assessment for each of the identified receptors.

The GVs used to screen COPCs were developed specifically for Mound, and were approved by the DOE, the U.S. EPA, and Ohio EPA. The GVs correspond to the 1.0×10^{-6} risk level for carcinogens and radionuclides, and to a Hazard Quotient (HQ) of one for each non-carcinogenic constituent. Some of the radionuclide GVs are designated as +D to indicate that cancer risk estimates and GVs include contributions from the radionuclide's short-lived decay products, or daughters. These calculations assumed equal activity concentrations (i.e. secular equilibrium) with the principal or parent nuclide in the environment. For Parcel 4 +D GVs were used for actinium-227+D neptunium-237, radium-228, strontium-90 uranium-235 and uranium-238. When GVs were unavailable they were calculated using the Mound GV methodology (DOE 1997c) due to updated toxicity criteria or lack of a previously calculated GV. The calculations for these updated GVs are provided in Appendix C.

A 1×10^{-6}-risk level represents an incremental increase of one in a million of developing cancer as a result of exposure to the GV concentration. A Hazard Quotient of one indicates that from an exposure at or below the given concentration, no adverse effects to humans are expected. Since the target risk level for carcinogenic constituents specified in the NCP is a range of 1×10^{-4} to 1×10^{-6} (1 in 10,000 to 1 in a million), screening COPCs against the whole GV is protective. The target threshold for non-carcinogenic constituents is a Hazard Index (HI) of less than or equal to one. The GV values were calculated for a HI of one. To account for the possibility of more than one non-carcinogenic constituent, COPCs were screenedusing 1/10 the GV. Carcinogenic or radioactive constituents that exceed their GVs and non-carcinogenic constituents that exceed one-tenth of their GV were carried to the next step of the RRE.

2.4.3 Screening Constituents Based on Frequency of Detection

Constituents detected at concentrations above Mound background levels and above applicable GVs were next evaluated for their frequency of detection. Infrequent detection was defined asfive percent or less. This is equivalent to one detect in 20 samples. If there were an insufficient number of samples (e.g. less than 20) to determine whether the frequency of detection is five percent or less, the contaminant was not eliminated on the basis of frequency of detection.

2.4.4 Screening Constituents Based on Essential Human Nutrients

According to RAGS Part A (EPA 1989): "Chemicals that are (1) essential human nutrients, (2) present at low concentrations (i.e., only slightly elevated above naturally occurring levels), and (3) toxic only at very high doses (i.e., much higher than those that could be associated with contact at the site) need not be

considered further in the quantitative risk assessment." Inorganic analytes meeting this description were not carried through the RRE. Calcium, chloride, iron, magnesium, potassium, and sodium are considered essential nutrients to humans. These compounds were detected in the Parcel 4 area at levels below or slightly elevated above background and are toxic only at very high doses. Concentrations of these compounds in on-site media would not be expected to result in intakes associated with a toxic response. Therefore, these compounds were eliminated as COPCs for the Parcel 4 area.

2.4.5 Additional Screening Procedures

In accordance with the RREM, additional screening procedures also were used to evaluate Parcel 4 area constituents. For example, in accordance with EPA's Functional Guideline for Organics (EPA 1988) if a blank contains measurable levels of a common laboratory contaminant, then the associated sample results were considered as positive results only if the concentration in the samples exceeded ten times the concentration in the blank. If the concentration of a common laboratory contaminant was less than ten times the blank concentration, the constituent was considered to be an artifact of laboratory handling and was not included in the RRE. Common laboratory contaminants include acetone, 2-butanone, methylene chloride, toluene and phthalate esters.

2.4.6 Screening Procedures for Future Groundwater

To estimate the future concentration of COPCs in groundwater the flow tube model was applied to bedrock well data based on the maximum concentration detected. This procedure is discussed in detail in Appendix B. In accordance with the RREM, an initial screen was necessary to determine which constituents were to be carried through the flow tube model. All constituents detected in the bedrock wells were screened for frequency of detection as well as a comparison to the background and GV values. Those constituents that exceeded these criteria were retained for flow tube modeling. In addition, those constituents that were COPCs in the current groundwater RRE were retained for flow tube modeling. To obtain a final estimated future groundwater concentration for each COPC the maximum concentrations detected in a given bedrock flow tube was added to the maximum concentration detected in the production wells. The estimated future maximum constituent concentrations in the BVA are presented in Appendix B.

3.0 EXPOSURE ASSESSMENT

The goal of the RRE exposure assessment is to estimate the type and magnitude of contaminant exposures that may occur under current conditions with the area being used for recreational purposes and in the future assuming that the area is developed for residential use. The information gathered in the exposure assessment is integrated with toxicity information to characterize potential risks associated with exposure to residual contamination in the Parcel 4 area.

3.1 Characterization of Exposure Setting

Parcel 4 consists of 95.2 acres located immediately south of Operable Unit (OU) 5, the Mound Plant Production Area. On August 26, 1981 the DOE purchased an additional 124 acres of land contiguous with and south of the original 182 acres at Mound Plant. The new property was bounded by the Mound Plant to the north, private property to the east, Benner Road to the south and the Miami Erie Canal to the west. The land had been in use for agricultural purposes. Following purchase of the property in 1981, DOE razed a two-story brick house, a barn, a frame tool shed and an outhouse and disposed some farm implements and discarded appliances left by the previous owner. A farm fence was put up around the perimeter of the new property. In 1999 the north property line of this area was shifted slightly to the south to exclude an area of known contamination south of an east-west road running along the southern boundary of the Mound Plant production area. The remaining 95.2 acres is now called Parcel 4.

Parcel 4 remains undeveloped with the exception of a construction gate, a gravel road from Benner Road and gravel-surface parking area, a contractor storage area, and an above ground power line running approximately north-south through the center of the property. Topographically the land can be described as gently rolling in the southwest with steeply sloped bluffs in the northwest where Parcel 4 abuts to the Mound Plant production area. There are natural drainage channels within Parcel 4 but no continuously running surface water. An archaeological survey of Parcel 4 was conducted in 1987. Two sites of archaeological interest were discovered, however, neither was regarded as being eligibility for the National Register, and no further work was recommended at either location (Riordan 1987)

PRS 306, 314 and 406 are located in Parcel 4. PRS 306 is a ground water seep located along the eastside of Parcel 4 approximately mid-way between the northern and southern boundaries. PRS 314 is an

area that contained farm debris and was the location of potential oil releases from previous farm operations. PRS 406 is a tongue-shaped area of potential radiological contamination in thenorthern end of Parcel 4 and on the Mound Plant property. PRS 406 was investigated and a surface water interceptor ditch was installed in August and September 1995. The *Operable Unit 5 New Property Remedial Investigation Report*(RIR) (DOE 1996) concluded that no further assessment was needed for Parcel 4.

3.2 Identifying Exposure Pathways

Although many exposure pathways are possible, the RRE focuses on those pathways that are likely to occur and are likely to contribute significantly to the overall risk. When identifying exposure pathways it is important to keep in mind the four elements of an exposure pathway. An exposure pathway consists of: (1) a source of chemical releases, (2) a transport media, (3) a point of potential human contact with the contaminant or contaminated media, and (4) an exposure route (e.g. ingestion). If any of these elements is missing or eliminated, the pathway will be incomplete and exposure will not occur.

A pictorial representation of the exposure pathways identified for potential receptors are included in as conceptual site model for the Parcel 4 (Figure 3.1). The conceptual site model summarizes the pathways that hazardous substances may take to reach potential receptors. Exposure assumptions used to evaluate potential exposure pathways were drawn from the Mound Plant *Risk-Based Guideline Values* (DOE 1997c) and the Mound 2000 RREM (DOE 1997a). Exposure assumptions used to quantify contaminant exposures are summarized in Table 3.1.

3.3 Identifying Exposure Scenarios

Residual contamination in the Parcel 4 was evaluated for two potential use scenarios. Residual contamination in the Parcel 4 area was evaluated for adult construction workers and adult site employees. It was assumed that construction workers and site employees could potentially be exposed to soil, groundwater and air. The evaluation of risk associated with exposure to residual contamination in the Parcel 4 area for these receptors will indicate whether economic redevelopment can be safely conducted in the area.

3.3.1 Construction Worker Scenario

Since it is reasonable to assume that construction activities could occur within the Parcel 4 area, adult

construction workers were identified as potential receptors. During construction activities these receptors could be exposed to residual contamination present in soil at or below the land surface. Potential exposure pathways include incidental soil ingestion, dermal contact, external radiation exposure, and inhalation of airborne dust and vapors. Although the possibility of dermal exposure to surface and subsurface soil does exist for a construction worker, quantification of risk from this route of exposure requires both a chemical-specific skin absorption value and dermal toxicity value. Of the COPCs identified for Parcel 4, chemical-specific skin absorption factors are currently available for only benzo(a)pyrene and other polycyclic aromatic hydrocarbons (PAHs). The use of dermal default absorption values for inorganic compounds is currently not recommended by EPA (EPA 1999). For many chemicals, including most of the Parcel 4 COPCs, scientifically defensible data does not exist to derive a dermal toxicity value or for making an adjustment of on oral cancer slope factor (CSF) or reference dose (RfD) to estimate a dermal toxicity value. Without these critical input parameters, risk due to dermal exposure to soil cannot be quantified. However, EPA recommendations for the adjustment of toxicity factors for PAHs were used. The exclusion of inorganic compounds and radionuclides from this pathway is expected to have a minimal impact on the final risk-based calculations because human exposure to these compounds in soil is generally driven by other pathways of exposure, such as external exposure or incidental ingestion.

It was also assumed that construction workers would use BVA groundwater for drinking water supply and for showering. Exposure pathways include ingestion and inhalation of vapors and dermal contact with groundwater while showering. Construction workers were assumed to be on the property 8 hours per day, 250 days per year over a 5-year period. Since construction workers are assumed to be adults, a body weight of 70-kilogram was used to assess exposure to chemical contaminants.

Current and future exposure scenarios for the construction worker scenario are identical except for groundwater. In order to estimate the future contaminant concentrations in groundwater, the modeled future estimated concentration of contaminants detected in the bedrock aquifer were added to current contaminant concentrations in the Mound Plant Production wells. Exposure pathways evaluated for the construction worker for both current and future scenarios, include:

- incidental ingestion of soil at or below land surface;
- external exposure to ionizing radiation from radionuclides in soil at or below land surface;
- inhalation of airborne contaminated dust;
- inhalation of volatile emissions from soil;
- ingestion of contaminated groundwater as drinking water;
- inhalation of volatile contaminants from groundwater while showering at work;

- dermal contact with soil at or below land surface; and
- dermal contact with contaminated groundwater while showering at work.

The parameters used to evaluate these pathways and their references are provided in Table 3.1.

3.3.2 Site Employee Scenario

Although exposures will vary depending on the type of work performed, it is reasonable to assume that a site employee at Parcel 4 will be exposed to residual contamination left on the property. The exposure routes evaluated for the site employee are similar to those evaluated for the construction worker except the site employee is assumed to work indoors and therefore have less exposure to site soil. Potential soil exposure pathways include incidental soil ingestion, external radiation exposures and inhalation of airborne dust and vapors. Site employees were assumed to use BVA groundwater for potable supply, but are not expected to shower at work. Site employees were assumed to be on the property 8 hours per day, 250 days per year over a 25-year period. Since site employees were assumed to be adults, a body weight of 70-kilogram was used to assess exposure to chemical contaminants. The exposure pathways evaluated for the future site employee include:

- incidental ingestion of soil 0-2 feet below land surface;
- external exposure to ionizing radiation from radionuclides in soil 0-2 feet below land surface;
- inhalation of airborne contaminated dust;
- inhalation of volatile emissions from soil;
- ingestion of contaminated groundwater as drinking water;

The parameters used to evaluate these pathways and their references are provided in Table 3.1.

3.4 Exposure Point Concentrations

Exposure point concentrations (EPC) are the concentrations of contaminants available to human receptors at the point of contact. The EPC for soil and current groundwater used in the RRE was calculated as the 95% UCL of the arithmetic mean of the data, using the Student's t-statistic. If the data were found to be log
normally distributed, the RME estimate was calculated as the 95% UCL using the H-statistic (EPA 1992a).

Only surface soil data (0-2 feet below land surface) were used to calculate the EPC for the site employee. Site employees are assumed to spend most of their time indoors and have limited contact with surface soil. Construction workers were assumed to be exposed to both surface and subsurface soil. Therefore, the EPC for the construction worker was calculated using soil sample data collected at any depth.

3.5 Human Intake Equations And Assumptions

This section presents the exposure equations and assumptions used to derive contaminant-specific intake estimates for the populations and exposure pathways evaluated in the risk assessment. The use of the intake equations presented in this section is in accordance with methods presented by EPA in RAGS Part A (EPA 1989) and the RREM presented in Mound 2000 (DOE 1997a). Exposure assumptions have been developed to represent high-end RME conditions. Exposure assumptions for each of the potential receptors, and corresponding guidance or rationale used in this assessment are presented in Table 3.1.

For chemicals, exposure generally refers to the intake (e.g., inhalation, ingestion, dermal exposure) of the chemical, expressed in units of mg/kg-day. Toxicity values for chemicals are generally expressed in these terms; therefore, the product of the intake estimate with the toxicity value yields a risk value. There is a fundamental difference between exposures to chemical contaminants as compared to radionuclide contaminants. Radionuclides can have deleterious effects on humans without being taken into the body. Radiation exposure can result from exposure to gamma and x-ray emitting radionuclides that are external to the receptor.

The approach used to estimate intake for chemical contaminants largely applies to radionuclides. However, there are a few key differences in the methods. For example, in addition to the ingestion, inhalation, and direct contact pathways considered for chemical contaminants, external exposure to penetrating radiation was also evaluated for radionuclides. Equations for estimating the intake of radionuclides have been modified by omitting the body weight and averaging time from the denominator. The slope factors for radionuclides are expressed as the average risk per unit intake or exposure for an individual in a stationary population; therefore, radionuclide intakes and slope factors are not expressed as a function of body weight and time.

Another key difference in the method used to assess radiological risk is the inclusion of short-lived decay products, or daughter products, for radionuclides designated with the suffix +D. The calculation of risk for radioactive decay chain products assumed equal activity concentrations (i.e. secular equilibrium) with the

principal or parent nuclide in the environment. Risk calculations for decay chain products were assessed by summing the ingestion, inhalation, and external slope factors for the parent radionuclide and decay members of continuous decay chains (EPA 2000).

Chemical intakes from oral and inhalation exposure are expressed as the amount of chemical at the exchange boundary (e.g., skin, lungs, intestine) that is available for absorption. These intakes are not equivalent to the absorbed dose (the amount of chemical actually absorbed into the blood stream). Dermal doses are expressed as estimates of absorbed dose. The toxicological reference values used to calculate risk have been adjusted to account for this difference; however, this discrepancy is a source of uncertainty when comparing or combining dermal doses with intakes from other exposure routes.

3.5.1 Soil Exposure Pathways

Exposure to soil through incidental ingestion was evaluated for construction workers and site employees under current and future land use scenarios. Intake estimates for the chemical contaminants in the soil ingestion pathway were estimated by means of the following equation:

$$\text{Intake (mg / kg – day)} = \frac{C_{SO} \times IR \times EF \times ED \times CF}{BW \times AT}$$

Where:

C_{SO}	=	Contaminant concentration in soil (mg/kg)
IR	=	Ingestion rate (mg/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
CF	=	Conversion factor (10^{-6} kg/mg)
BW	=	Body weight (kg)
AT	=	Averaging time for cancer and non-cancer effects (days)

Radionuclide intake estimates for the soil via incidental ingestion was estimated by means of the following equation:

$$\text{Intake (pCi)} = C_{SO} \times IR \times EF \times ED \times CF$$

Where:

C_{SO}	=	Radiological activity in soil (pCi/g)
IR	=	Ingestion rate (mg/day)

EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
CF	=	Conversion factor (10^{-3} g/mg)

Unlike inhalation and ingestion exposure to soil, the external radiation exposure term is defined as an equivalent radionuclide concentration in soil that an onsite receptor would be exposed to for a particular duration. This exposure term is adjusted for exposure time and shielding. For the Parcel 4 area RRE a default-shielding factor of 20% for the site employee and 10% for the construction worker scenarios were assumed. These assumptions provide for a conservative estimate of external radiation exposure.

The intake equation for radionuclide contaminants via the external exposure pathway was estimated using the following equation:

$$IR_{ext}\ (pCi/g\text{-}yr) = Cso \times ED_{ex} \times (1\text{-}Se) \times Te$$

Where:

IR_{ext}	=	External exposure contact rate (pCi-yr/g)
Cso	=	Radiological activity of soil (pCi/g)
ED_{ex}	=	Exposure Duration x 0.685 (days worked/days in a year= 250/365) (year)
Se	=	Gamma Shielding Factor (unitless)
Te	=	Gamma Exposure Time Factor (unitless)

Intake of soil (fugitive dust) via inhalation was evaluated for construction workers and site employees under current and future use scenarios. The intake equation for chemical contaminants by this means is provided below:

$$\text{Intake (mg / kg – day)} = \frac{C_{so} \times IR_{air} \times EF \times ED}{PEF \times BW \times AT}$$

Where:

C_{so}	=	Contaminant concentration in soil (mg/kg)
IR_{air}	=	Inhalation rate (m^3/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
PEF	=	Particulate emission factor (4.28×10^9 m^3/kg, EPA default value)
BW	=	Body weight (kg)

AT = Averaging time for cancer and non-cancer effects (days)

The intake equation for radionuclide contaminants via inhalation of fugitive dust was estimated using the following equation:

$$\text{Intake (pCi)} = \frac{C_{so} \times IR_{air} \times EF \times ED \times CF}{PEF}$$

Where:

C_{SO} = Radiological activity in soil (pCi/g)

IR_{air} = Inhalation rate (m^3/day)

EF = Exposure frequency (days/year)

ED = Exposure duration (years)

CF = Conversion factor (1000 g/kg)

PEF = Particulate emission factor (4.28×10^9 m^3/kg, EPA default value)

The PEF relates the concentration of the contaminant in soil to the concentration of respirable particles in the air from fugitive dust emissions. These emissions result from wind erosion. The default value of 4.28×10^9 m^3/kg was taken from Risk-Based Guideline Values (DOE 1997c).

Volatilization of chemical contaminants from soils may result in exposures via inhalation for construction workers and site employees; however, no volatile COPCs were identified in the Parcel 4 area. Therefore, this pathway was not evaluated for chemical constituents.

3.5.2 Groundwater Exposure Pathways

Intake from the ingestion of groundwater was evaluated for construction workers and site employees under current and future use scenarios. The current concentration of contaminants in groundwater was derived from concentrations detected in the Mound Plant Production wells. The future concentration of contaminants in groundwater assumes that all contaminants detected in the bedrock wells will migrate to the BVA and be withdrawn at the Mound Plant Production wells. Historical and current bedrock well contamination was screened and modeled to predict future contribution to the BVA from bedrock using a Flow Tube Model. This future bedrock estimated concentration was then added to the maximum detected contaminant concentrations in the Mound Plant Production Wells to provide the estimated future contaminant concentrations in groundwater used to calculate future groundwater risk. The discussion of the Flow Tube

Model and future bedrock estimated concentrations and total future estimated groundwater concentrations are presented in Appendix B. Risk was then calculated for current and future intake of groundwater under the construction worker and site employee scenarios. The following equation was used to estimate current and future intake of chemical COPCS from the ingestion of groundwater as a drinking water source for both the construction worker and the site employee:

$$\text{Constituent Intake (mg / kg – d)} = \frac{C_W \times IR_W \times EF \times ED}{BW \times AT}$$

Where:

C_W	=	constituent concentration in water (mg/L)
IR_W	=	ingestion rate (L/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days)

In addition to groundwater ingestion the construction worker was assumed to shower at work. While showering, workers were assumed to have dermal exposure to contaminants in groundwater and to inhale volatile contaminants while showering. The dermal absorbed dose from dermal contact withconstituents in groundwater was calculated as follows:

$$\text{Constituent DAD (mg / kg – d)} = \frac{DA_{event} \times EV \times EF \times SA \times ED}{BW \times AT}$$

Where:

DAD	=	dermal absorbed dose (mg/kg-day)
DA_{event}	=	absorbed dose per event in water (mg/cm^2-event)
EV	=	events per day (day^{-1})
EF	=	exposure frequency (days/year)
SA	=	surface area of skin exposed (cm^2)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days)

For inorganics, DA_{event} (mg/cm^2-event) was calculated as follows:

$$DA_{event} = K_p \times C_W \times t_{event} \times 10^{-3}\ L/cm^3$$

Where:

DA_{event}	=	absorbed dose per event in water (mg/cm^2-event)
K_p	=	chemical-specific permeability coefficient (cm/hr)
C_w	=	concentration of chemical in water (mg/L)
t_{event}	=	duration of event (hr/event)

For organics, DA_{event} (mg/cm^2-event) was calculated as follows:

$$DA_{event} = 2 \times K_p \times C_w\, 10^{-3}\, L/cm^3 \times (6 \times T \times t_{event}/л)^{1/2}$$

Where:

DA_{event}	=	absorbed dose per event in water (mg/cm^2-event)
K_p	=	permeability coefficient from water (constituent-specific, cm/hr)
C_w	=	concentration of chemical in water ($mg/cm^3 = 10^{-3}$ mg/L)
t_{event}	=	duration of event (hr/event)
T	=	lag time (hour)
л	=	constant (3.14159)

Constituent-specific permiability coefficient values (K_p) and the formula for the calculation of K_p was taken from Chapter 5 of *Dermal Exposure Assessment: Principles and Applications* (EPA 1992b). If a K_p was not found, it was calculated using the following formula:

$$\log(PC) = -2.72 + 0.71 \log(K_{o/w}) - 0.0061\, MW$$

Where:

log PC	=	log of the constituent-specific permeability coefficient
$K_{o/w}$	=	octanol/water coefficient (constituent-specific)
MW	=	molecular weight (g/mole)

The following equation was used to calculate the intake of radionuclides from dermal contact with water:

$$Intake(pCi) = C_w x SA x K_p x EF x ED x ET_s x 1000 x \frac{L}{m^3}$$

Where:

C_w	=	concentration of contaminant in water (pCi/L)
SA	=	surface area of skin exposed (cm^2)
K_p	=	chemical-specific permeability constant (cm/hr)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
ETs	=	duration of event (hours/day)

The following equation will be used in the RRE to calculate chemical contaminant intake from inhalation during showering:

$$Intake\ (m\ /kg - d) = \frac{C_w\ x\ K\ x\ IR_{air}\ x\ EF\ x\ ED\ x\ ET\ x\ CF}{BW\ x\ AT}$$

Where:

C_w	=	contaminant concentration in water (mg/L)
K	=	volatilization factor (L/m^3)
IR_{air}	=	inhalation rate (m^3/d)
EF	=	exposure frequency (d/yr.)
ED	=	exposure duration (yr.)
ET	=	exposure time (hr/d)
CF	=	conversion factor (1d/24 hr)
BW	=	body weight (kg)
AT	=	averaging time (yr x 365 d/yr.)

Tritium is the only radionuclide present at the Mound Plant that is volatile enough that its vapor needs to be considered for the inhalation pathway. The following equation was used to calculate tritium intake from inhalation during showering:

$$Intake(pCi)=C_w x IR_{air} x EF x ED x M_{total} x ET_s x \frac{L}{1000g}$$

Where:

C_w	=	Tritium concentration in water (pCi/L)
IR_{air}	=	inhalation rate (m^3/d)

EF	=	exposure frequency (d/yr)
ED	=	exposure duration (y)
M_{Total}	=	airborne mass concentration of water in shower (66.96 g/m^3, HAZWRAP, 1995)
ET_S	=	shower duration (hr/d)

4.0 TOXICITY ASSESSMENT

The objectives of the toxicity assessment are to identify and select toxicological values for use in estimating the significance of the exposure and to evaluate potential adverse effects associated with exposure to compounds detected in Parcel 4. The RRE for the Parcel 4 area evaluated chronic exposures. The RRE utilized methods recommended by EPA for evaluating human cancer effects resulting from exposure to the COPCs. Toxicity criteria used in the RRE were obtained from the most current update of the EPA Integrated Risk Information System (IRIS) or, if the information was not available in IRIS, the EPA Health Effects Assessment Summary Tables (HEAST). IRIS is an electronic database containing the most current descriptive and quantitative EPA regulatory information on chemical and radiological constituents. Constituent files maintained in IRIS contain information related to non-carcinogenic and carcinogenic health effects of constituents. HEAST is a published reference, updated periodically by EPA. HEAST contains slope factors needed to evaluate the carcinogenicity of radionuclides. Table 4.1 presents a summary of toxicological criteria used along with the chemical-specific characteristics used to estimate dermal absorbed dose and the concentrations present in vapors or dust.

In assessing the potential for non-cancer health effects, EPA assumes that there is a threshold below which no adverse toxic effects are expected. For example, a toxic threshold would exist if a substance had no toxic effect at a certain level of exposure, but did have a toxic effect at a higher level. EPA derives and publishes reference doses (RfDs) and reference concentrations (RfCs) for use in evaluating adverse non-carcinogenic effects. These are estimates (with uncertainty spanning an order of magnitude or greater) of daily human exposures, including sensitive sub-populations, that may go without appreciable deleterious effects during a lifetime (EPA 1989). EPA derives RfDs and RfCs for humans, based on estimates of the no-observable-adverse-effect-level (NOAEL) or lowest-observable-adverse-effect-level (LOAEL) observed in test organisms. EPA classifies all radionuclides as carcinogens and the process of carcinogenesis is generally thought to be a phenomenon without a threshold for effect (EPA 1989). The basis for this presumption is that an extremely low level of exposure to some carcinogens may result in chromosomal or enzyme changes leading to uncontrolled cellular proliferation, or cancer. EPA does not therefore, estimate an effect threshold for carcinogenic chemicals. EPA uses a two-part evaluation for carcinogens. First the constituent is assigned a weight-of-evidence classification based on both epidemiological evidence of carcinogenic effects and laboratory tests conducted with animals. Then a cancer slope factor (CSF), is calculated. The HEAST lists

ingestion, inhalation, and external exposure CSF for radionuclides in the units of picocuries (pCi). Ingestion and inhalation slope factors are central estimates in a linear model of the age-averaged, lifetime-attributable radiation cancer incidence (fatal and nonfatal) risk per unit of activity inhaled or ingested. The slope factor is a plausible upper-bound estimate of the slope of the dose-response curve in the low dose range. In risk assessment, the cancer slope factor is used to estimate the excess lifetime probability of a carcinogenic effect occurring in exposed receptors.

4.1 Toxicity Values for Evaluating the Dermal Pathway

Toxicological reference values are available only for the oral and inhalation pathways and the majority of these values are based on intake (i.e., administered dose) rather than an absorbed dose. Because the intake equation for the dermal contact pathway calculates absorbed dose (by incorporating a dermal absorption factor or a permeability coefficient), it is necessary to convert the administered dose toxicity value to an absorbed dose toxicity value in order to calculate risk. For non-carcinogens, the administered dose toxicity value (i.e., the RfD) was multiplied by the gastrointestinal absorption factor. For carcinogens, the slope factor was divided by the gastrointestinal absorption factor. For the Parcel 4 RRE oral administered-dose EPA recommended compound-specific gastrointestinal absorption factors used for adjusting toxicity values were only available for PAHs.

5.0 RISK CHARACTERIZATION

This section presents the risk characterization for the Parcel 4 area. In risk characterization information from the exposure assessment (Section 3) is combined with information from a toxicity assessment (Section 4) to characterize human health risks.

5.1 Risk Characterization Methods

Risk characterization integrates the exposure and toxicity assessments by comparing estimates of intake or dose with appropriate toxicity values. This in turn provides an indication of the potential for adverse effects to exposed receptors. The objective of the risk characterization is to determine if exposure to contaminants associated with the site poses risks that exceed EPA target levels for human health effects. The results of the risk assessment may thus support the determination of site release or the need for site remediation.

The RRE reports the incremental risk, total risk, and risk from background for each contaminant evaluated in Parcel 4 Area. The incremental risk is the risk posed by site-related contamination above the risk posed by background environmental levels. Background risk is the risk resulting from sources other than the Mound-related residual contamination. Site-specific background values are provided in the Mound 2000 RREM (DOE 1997a). The Mound 2000 background values that correspond to the Parcel 4 COPCs were used as the EPCs to determine background risk. Total risk is the sum of the background and incremental risk. This risk characterization presents a separate evaluation of non-carcinogenic and carcinogenic effects. The assessment distinguishes cancer from non-cancer effects because organisms typically respond differently following exposure to carcinogenic or non-carcinogenic agents. Quantification methods for cancer and non-cancer effects are discussed separately in the following sections.

5.1.1 Quantification of Carcinogenic Risk

Cancer risks are probabilistic estimates of the excess (incremental) lifetime cancer risk for an individual specifically attributable to long term exposure to site-related chemicals. The procedure for calculating risk associated with exposure to carcinogenic compounds has been established by EPA (EPA 1989). A non- threshold, dose-response model was used to calculate a cancer slope (potency) factor for each

COPC. To derive an estimate of risk, the cancer slope factor was multiplied by the estimated chronic daily intake experienced by the exposed individual:

$$\text{Risk} = \text{CDI} \times \text{CSF}$$

Where:

Risk	=	High end estimate of the excess lifetime cancer risk to an individual (unitless probability)
CDI	=	Chronic daily intake averaged over an established period (mg/kg body weight/day)
CSF	=	Cancer slope factor (95% upper-bound estimate of the slope of the dose-response curve) expressed as (mg/kg body weight/day)$^{-1}$.

To evaluate the risk of exposure to more than one carcinogenic COPC, the risk estimates for each COPC were summed to provide an overall estimate of total carcinogenic risk (EPA 1989).

$$Risk_t = \sum_{i=1}^{n} Risk_i$$

Where:

$Risk_T$	=	The combined excess lifetime cancer risk across chemical carcinogens
$Risk_i$	=	The risk estimate for the ith chemical of n chemicals under evaluation.

5.1.2 Quantification of Non-carcinogenic Risk

The traditionally accepted practice of evaluating exposure to non-carcinogenic compounds has been to experimentally determine a NOAEL and to divide this by a safety factor to establish an acceptable human dose, for example, acceptable daily intake or RfD. The RfD is then compared to the average daily intake experienced by the exposed population to obtain a measure of concern for adverse non-carcinogenic effects:

$$\text{HQ} = \text{Intake/RfD}$$

Where:

HQ	=	Hazard Quotient: potential for adverse non-carcinogenic effects
Intake	=	Average daily intake for subchronic or chronic exposure (mg/kg body weight/day)

RfD = Acceptable intake for subchronic or chronic exposure (mg/kg body weight/day).

To evaluate exposure to multiple non-carcinogenic COPCs the HQs for all COPCs were summed to obtain the Hazard Index (HI).

$$HI = \sum_{i-1}^{n} HQ$$

Where:

HI = Hazard Index

HQ_i = Hazard Quotient for the ith chemical of n chemicals under evaluation.

EPA has established target risk levels for use in determining the need for site remediation. For non-carcinogenic effects, EPA has set the target HQ at one. If the HQ is >1, there is the potential for adverse health effects at the given exposure/dose level, but the HQ value is not an indication of the severity of the effects. For multiple non-carcinogens, the HQs for all of the chemicals under evaluation are summed resulting in the HI. If the HI is > 1, the potential also exists for adverse health effects resulting from exposure to mixtures of chemicals. In cases where the HQ for individual substances is below 1 yet several HQs sum to greater than 1, EPA recommends segregating the compounds into groups with like or common toxicological effects and re-evaluating the potential for the various adverse health effects. In cases where HQs for individual substances are greater than 1, this step is not necessary or useful.

5.2 Risk Characterization Results

The following sections present the risk characterization results for the Parcel 4 by potential receptor. Risk estimates for individual soil COPCs for all scenarios and pathways are presented in Tables 5.1through 5.6. Tables 5.1 through 5.3 present soil risk estimates based on construction worker exposure parameters, and Tables 5.4 and 5.6 present soil risk estimates based on site employee exposure parameters. Total risk was calculated using the total concentration of the COPCs detected in Parcel 4. Background risk was based on background levels of the COPCs and incremental risk was calculated using the difference between total and background levels. Incremental risk can be used to assess the increase inrisk above background levels due to Mound Plant operations. Tables 5.19 through 5.21 present summaries of the risk results for all scenarios and media for exposure pathways assessed in the RRE.

Residual risk due to exposure to groundwater was assessed using the original database and method as presented in the RRE for Parcel H (DOE 1997b) and updated and combined with current data for both current and future RRE of groundwater. Appendix B presents the methodology for calculation and values of the future groundwater COPCs. Risks due to exposure to current and future groundwater are presented in Tables 5.7 through 5.15. In the summary Tables 5.19 through 5.21, risk estimates that are at or above the non-cancer HI of 1 and the cancer target risk level of 10^{-6} are bolded.

5.2.1 Construction Worker Risk Results

Soil

Final COPCs for soil for the construction worker are identified in Table 2.2. Tables 5.1 through 5.3 present total, background, and incremental risk for a construction worker in Parcel 4, respectively. Total residual non-carcinogenic risk for a construction worker due to COPCs in soil was 0.25, which is below the target HQ of one. Most of this risk (0.20 or 83%) is due to antimony. Background and incremental residual non-carcinogenic risk for a construction worker due to COPCs in soil also fell below the target HQ of one. Total and incremental residual cancer risk from soil for a construction worker in Parcel 4 is 2.0×10^{-5}, which falls within the target risk range of 10^{-4} to 10^{-6}. Background residual risk from soil for a construction worker in Parcel 4 was 2.3×10^{-8} and is based only on background concentrations of plutonium-238. Incidental soil ingestion is the exposure pathway that contributes most significantly to residual cancer risk. Incidental soil ingestion contributes 80% of the total residual cancer risk for a construction worker in Parcel 4 soil.

Current Groundwater

Final COPCs for current groundwater for the construction worker are identified in Table 2.8. Total, background and incremental risk for a construction worker exposed to current groundwater is presented in Tables 5.7 through 5.9. Total and incremental non-carcinogenic residual risk from current groundwater for the construction worker is 1.4 and 1.3, respectively. These values exceed the target HI of 1. Antimony is responsible for 79% of the current groundwater non-carcinogenic risk. Current background non-carcinogenic residual risk for the construction worker due to exposure to groundwater is 0.017, which does not exceed target non-carcinogenic risk. Current total and incremental carcinogenic risks associated with exposure to groundwater is 1.6×10^{-6}, which falls within the target risk range of 10^{-4} to 10^{-6}. Cadmium is responsible for 100% of carcinogenic risk via the inhalation pathway.

Future Groundwater

Final COPCs for future groundwater for the construction worker are identified in Table 2.10. Total, background and incremental risks for the construction are presented in Tables 5.13, 5.14 and 5.15, respectively. Total residual non-carcinogenic risk from future groundwater for the construction worker was 26. Background residual non-carcinogenic risk from future groundwater for the construction worker scenario was 11 and increment residual non-carcinogenic risk from future groundwater was 14. Total, background and incremental non-cancer risk for the construction worker exceed the target Hazard Index (HI) of 1. Future total and incremental carcinogenic residual risk from groundwater for the construction worker scenario was 1.4×10^{-2}, which exceeds the target risk range for carcinogens. Background residual carcinogenic risk from future groundwater for the construction worker scenario was 8.6×10^{-6}, which falls within the target risk range.

Air

Potential cumulative carcinogenic risk due to exposure to contaminants in air was 2.1×10^{-7}, which is less than the target risk range. None of the COPCs identified in air have non-carcinogenic risk criteria so a HI was not calculated for exposure to contaminants in air.

5.2.2 Site Employee Risk Results

Surface Soil

Final COPCs for surface soil for the site employee are identified in Table 2.4. Total, background and incremental residual soil risk for a site employee in Parcel 4 is presented in Tables 5.4, 5.5 and 5.6, respectively. Total residual non-cancer risk for a site employee exposed to surface soil in Parcel 4 is 0.00066, which is well below the target HQ of one. Background and incremental residual non-cancer risk for a site employee exposed to surface soil in Parcel 4 is also well below the target HQ of 1. Total and incremental residual cancer risk from surface soil for a site employee in Parcel 4 is 2.3×10^{-5}, which falls within the target risk range of 10^{-4} to 10^{-6}. Background residual cancer risk from surface soil for a site employee in Parcel 4

is 2.6×10^{-7}. Incidental surface soil ingestion is the exposure pathway that contributes 70% to residual cancer risk for the site employee from Parcel 4.

Current Groundwater

Final COPCs for current groundwater for the site employee are identified in Table 2.10. Total, background and incremental residual soil risk for a site employee in Parcel 4 is presented in Tables 5.10,5.11 and 5.12, respectively. Total and incremental non-carcinogenic residual risk from current groundwater for the site employee scenario is 1.1, which exceeds the target HI of 1. Antimony via the ingestion pathway is responsible for 89% of the non-carcinogenic risk. Current background non-carcinogenic residual risk for the site employee due to exposure to groundwater does not exceed target non-carcinogenic risk. Total and incremental carcinogenic risks for site employees exposed to current groundwateris 1.1×10^{-5} and 8.0×10^{-6}, respectively. These values fall within the target risk range of 10^{-4} to 10^{-6}. Actinium-227, plutonium-239/240 and thorium-228 contribute equally to the carcinogenic risk via the inhalation pathway. Current background cancer risk to the site employee presents a risk of 3.3×10^{-6}, which is within the target cancer risk range.

Future Groundwater

Final COPCs for future groundwater for the site employee are identified in Table 2.12. Total, background and incremental risks for the site employee are presented in Tables 5.16, 5.17 and 5.18, respectively. Future total and incremental non-carcinogenic residual risk from groundwater for the site employee scenario were 5.5 and 5.3, respectively. Both these values exceed the target HI of 1. Future background non-carcinogenic residual risks in groundwater for the site employee is 0.21, which does not exceed target Hazard Index of 1. Future total and incremental carcinogenic residual risk from groundwater for the site employee scenario is 5.2×10^{-5} and 4.8×10^{-5}, respectively. Total and incremental carcinogenic risk associated with exposure to groundwater falls within the target risk range of 10^{-4} to 10^{-6} for the site employee scenario. Background carcinogenic residual risk from groundwater for the site employee scenario was 4.0×10^{-6}, which also falls within the target risk range of 10^{-4} to 10^{-6}.

Air

Potential cumulative carcinogenic risk due to site employee exposure to contaminants in air was 9.9×10^{-7}, which is slightly less than the target risk range. None of the COPCs identified in air have non-carcinogenic risk criteria so a HI was not calculated for exposure to contaminants in air.

5.2.3 Overall Summary of Risk Results

An overall summary of total, background, and incremental cancer and non-cancer risks are presented in a table included with the Executive Summary and in Tables 5.19 through 5.21. The values in the tables are the sum of all of the media and associated pathways for the construction worker and site employee scenarios. Total and incremental non-carcinogenic risks exceed target criteria for the current and future construction worker and site employee scenarios largely due to potential exposures to groundwater.

6.0 UNCERTAINTY IN THE RISK ASSESSMENT

In the following section, an evaluation is presented of the sources of uncertainty in the Parcel 4 area RRE and the relative influence of these sources on the results of the evaluation. Uncertainty is inherent in the selection of input parameters and in every step of the risk assessment process. Risk assessment of contaminated sites must not be viewed as yielding single value, invariant results. Rather, the results of risk assessment are estimates that span a range of possible values, and which must be understood only in light of the assumptions and methods used in the evaluation.

The results of the RRE are presented in terms of the potential for adverse effects based upon a number of conservative assumptions. The tendency to be conservative is an effort to err toward protecting health. Uncertainty can be found at all phases in the risk assessment: in the analytical data, the exposure assessment, the toxicity assessment, and the risk characterization. Where uncertainty does exist, the RRE uses conservative assumptions to ensure that the outcome will be protective.

6.1 Uncertainty in Analytical Data

Uncertainty is introduced to the RRE when sample locations are selected and when samples are collected and analyzed. In the RRE, the long-term exposure concentrations were upper estimates of site concentrations (e.g., maximum detect or 95% UCL); therefore, a conservative bias to overestimate potential exposure has been incorporated into the risk estimates. The uncertainty associated with the statistical analysis of environmental data is low, with little introduction of bias. However, it is possible that contaminated areas of Parcel 4 were not sampled. This is unlikely given the extent of sampling conducted.

Data for the RRE was collected over a 12-year period and analytical detection limits and methods have changed. This has resulted in current lower detection limits and presents uncertainty in the data by adding potential bias to the EPC for a constituent. For groundwater, the historical and current groundwater data were collected and used to develop the EPC by a conservative approach and model presented in Mound 2000 RREM. Uncertainty is introduced because the analytical results for constituents in the groundwater, collected over a 12-year time period, may not meet the DQOs currently in place for data collection at Mound. Antimony is an example of this type of uncertainty. The long time frame also means that contaminants detected in the Production Wells and bedrock wells may have degraded. For example, 12 years is equivalent to one half-life for tritium. The concentration of tritium in groundwater is reduced by half every 12 years.

None of the processes conducted at the Mound facility involved the use of antimony so, no process knowledge exists to suggest that antimony might be present in current or historical groundwater, yet antimony was detected in 5 out of 29 analyses of groundwater collected from the two production wells. The highest concentrations of antimony detected (38.2 μg/L and 40.2 μg/L) were both collected on May 6th, 1991. Since both elevated results were collected on the same date the possibility of sample contamination exists. May 6th 1991 precedes development of the Mound Quality Assurance Project Plan (DOE 1993a) by two years, so it is doubtful that these antimony results meet the data quality objectives currently in place at Mound. The MIEMS database specifies the procedure used for antimony analysis as an "unknown CLP method" and the results were lab qualified as "B". When applied to inorganic compounds, like antimony, the "B" lab qualifier means that the reported value is greater than the instrument detection limit but less than the contract required detection limit. The next highest detection of antimony (14.4 μg/L) was detected in April 7th, 1994 and antimony has not been detected in the BVA since. In addition to the monitoring data reported in MIEMS, monitoring of the production wells is conducted in accordance with the Safe Drinking Water Act (SDWA). The SDWA data for production well groundwater shows antimony at the detection limit of 0.6μg/L. Despite this, the maximum concentration of antimony detected in the production wells (40.2 μg/L) was used to describe the current groundwater concentration.

Given the age, elevated detection limits, and uncertain analytical procedure used for the May 6th 1991 analyses, plus results of subsequent analysis that shows antimony at much lower levels, it seems highly unlikely that the concentration used to describe the current concentration of antimony in groundwater is accurate. The maximum concentration of antimony detected in the production wells was used to describe current groundwater to ensure that the actual risk from groundwater ingestion is not underestimated. However, this approach may result in an overestimation of actual current risk. Elimination of the questionable May 6th results would lower the estimated current total risk due to antimony from an HI of 1.1 for the construction worker down to an HI of 0.4 which is well below the target risk threshold.

To estimate future maximum constituent concentrations in the BVA the maximum detected concentration in the production wells was added to the flow tube modeled maximum detected concentration found in the bedrock wells. The flow tube model includes an assumption that the maximum concentration of a constituent detected in each of the twenty bedrock flow tubes impacts the BVA in the future. Natural physical and chemical processes such as dilution, dispersion, adsorption, and soil properties are ignored when establishing future estimated concentrations by this method. It is possible that the soil andthe bedrock layer

would inhibit most of the groundwater sampled in the bedrock wells to ever migrate into the BVA. As a result of this methodology, the future EPC concentration is biased high and the future groundwater concentrations are overstated.

6.2 Uncertainty in Exposure Assessment

Exposure assessment may introduce considerable uncertainty in the risk assessment process. The RREM presents exposure and intake calculations based on EPA procedures that were used in the Parcel 4 RRE. Exposure assumption values were also used to develop site-specific risk-based guideline values for the Mound Plant which were approved by DOE, Ohio EPA and EPA. Exposure assumptions are based on best professional judgement regarding potential land use, assumptions concerning contaminant fate and transport, and receptor behavior. Uncertainty associated with the exposure assumptions used in the risk assessment is low to moderate, and most likely overestimates the actual risks.

One of the exposure assumptions used in the Parcel 4 RRE is that future site users would utilize the production wells for potable water supplies. The MMCIC intends to tap future site users into the municipal water supply system, therefore exposure to bedrock or BVA groundwater is unlikely. Using the production well and bedrock well data to estimate future risk is a conservative estimate of future risk.

Another source of uncertainty in the Parcel 4 RRE involves external exposure to gamma-emitting radionuclides. External exposure refers to the irradiation of tissues by radiation emitted by radionuclides located outside the body either dispersed in air, on skin surfaces, or deposited on ground surfaces. Gamma and x-rays are the most penetrating of the emitted radiation and comprise the primary contribution to radiation dose from external exposures. The calculation of risk from external radiation exposure assumes that any gamma-emitting radionuclide in soil is uniformly distributed in soil. The calculation of external radiation exposure risk includes a gamma-shielding factor (S_e) to account for attenuation of radiation by structures, terrain or engineered barriers. S_e is expressed as a fractional value between 0 and 1, representing the possible risk reduction range from 0% to 100% due to shielding. For the Parcel 4 RRE a default value of 0.2 or 20% shielding for the site employee and 0.1 or 10% shielding for the construction worker scenarios was used in the risk calculations.

6.3 Uncertainties Related to Toxicity Information

Although EPA approved toxicity values were used for the RRE a significant amount of uncertainty may surround these values. Identification of the sources of this uncertainty enables the risk assessor to establish the degree of confidence associated with the toxicity measures.

Uncertainty is inherent within the toxicity assessment and is primarily due to differences in study design, species, sex, routes of exposure, or dose-response relationships. A major source of uncertainty involves using toxicity values based on experimental studies that substantially differ from typical human exposure scenarios. The derivation of the toxicity values must take into account such differences as 1) using dose-response information from animal studies to predict effects in humans, 2) extrapolating dose-response information from high-dose studies to predict adverse health effects from low doses, 3) using data from short-term studies to predict chronic effects, and 4) extrapolating from uniform animal populations to variable human populations.

The cancer slope factors, in particular, are based on studies that may differ greatly from realistic situations. Experimental cancer bioassays typically expose animals to very high levels of chemicals (i.e., the maximum tolerated dose) for their entire lifetime. After appropriate studies have been identified, the slope factor is calculated as the upper 95th percent confidence limit of the slope of the dose-response curve. This introduces conservatism into the risk assessment. In addition, carcinogens are assumed to be human carcinogens regardless of EPA's weight-of-evidence classification.

The derivation of reference doses involves the use of animal studies. Uncertainty factors ranging from 1 to 1,000 are incorporated into the reference dose to provide an extra level of health protection. The factors used depend on the type of study from which the value has been derived (e.g., animal or human, chronic or acute, study design). The scientific basis for this practice is somewhat subjective. In general, high uncertainty factors are meant to bias the results conservatively so that exposures at the reference dose level will not result in adverse health effects.

Toxicity values derived from oral administered dose studies have been converted to absorbed dose toxicity values for use in evaluating the dermal contact pathway. This is considered a more accurate approach than using unadjusted oral toxicity values for the dermal pathway. Uncertainty is introduced in the

use of the gastrointestinal absorption factors. Limited information is available on the gastrointestinal absorption of some analytes and many have no information at all. In addition, no adjustments have been made for the medium of exposure (e.g., when the medium of exposure in the site differs from the medium of exposure assumed by the toxicity value). The uncertainty associated with using the absorbed dose toxicity values for the dermal pathway is moderate and the bias unknown.

There are some chemicals for which no toxicity value exists and for which little information is available. Therefore, a quantitative risk estimate cannot be calculated for these chemicals. For example, several of the COPCs identified in Parcel 4 could not be quantified for lack of EPA-approved toxicity values. The lack of toxicity information for some chemicals contributes to the underestimation of risks.

Cancer and non-cancer risks are summed in the risk characterization process (separately for carcinogens and non-carcinogens) to estimate potential risks associated with the simultaneous exposure to multiple chemicals. In the case of carcinogens, this gives carcinogens with a class B or class C weight-of-evidence the same weight as carcinogens with a class A weight-of-evidence. It also equally weights slope factors derived from animal data with those derived from human data. Uncertainties in the combined risks are also compounded because RfDs and cancer slope factors do not have equal accuracy or levels of confidence and are not based on the same severity of effect.

6.4 Uncertainties In Risk Characterization

Uncertainties in any phase of the risk analysis are reflected in the risk estimates. Some uncertainty is associated with the summation of risks and HQs for multiple chemical contaminants. As stated in RAGS (EPA 1989), "The assumption of dose additivity ignores possible synergisms or antagonisms among chemicals, and assumes similarity in mechanisms of action and metabolism." However, summing risks and HQs for multiple substances in this risk assessment provides a conservative estimate.

6.5 Conclusion

The exceedances of the acceptable risk range are driven by the conservative groundwater analysis. Specifically, using the maximum detected value (the result of a single measurement) from a data set that spans sixteen years as the concentration representing a contaminant of potential concern and assuming chromium is present entirely as Chromium VI overestimate the risk. Based on this conservative methodology, the expected incremental risk from Parcel 3 is within the acceptable risk range.

7.0 REFERENCES

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Table 2.1 Initial Identification of Soil Constituents of Potential Concern for the Construction Worker in Parcel 4. (Maximum Detected Concentration Compared to Background and Mound Guidance Values)

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Screening Guideline Value	Reference	Rationale for Contaminant Deletion or Selection
Metals												
7429-90-5	Aluminum	363	21400.00	mg/kg	B409	65-65	12700	21400.00	19000.00	21000.00	f, b	YES
7440-36-0	Antimony	0.27	42.20	mg/kg	MND33-0103	20-48	12.6	42.20		8.50	a	YES
7440-38-2	Arsenic	1.7	17.10	mg/kg		65-65	6.99	17.10	8.60	6.40	a	YES
7440-39-3	Barium	2	133.00	mg/kg	CH	65-65	86.5	133.00	180.00	1500.00	b	NO:2,3
13966-02-4	Beryllium	0.12	0.94	mg/kg	CH	50-65	0.66	0.94	1.30	0.70	c	NO:2
14733-03-0	Bismuth	0.76	70.40	mg/kg	CJ	48-51	73.3	70.40				YES
7440-43-9	Cadmium	0.31	7.70	mg/kg	MND33-0103	14-65	1.02	7.70	2.10	21.00	a	NO:3
7440-70-2	Calcium	812	175000.00	mg/kg	NPS1	65-65	108000	175000.00	310000.00			NO:2
	Cerium	24	50.90	mg/kg		8-8	NC	50.90				YES
7440-47-3	Chromium	1	30.50	mg/kg	MND33-0103	65-65	17.9	30.50	20.00	110.00	a	NO:3
10198-40-0	Cobalt	0.37	14.40	mg/kg	B409	65-65	12	14.40	19.00			NO:2
7440-50-8	Copper	1.4	27.50	mg/kg		65-65	17.5	27.50	26.00	790.00	a, f	NO:3
57-12-5	Cyanide	0.12	0.38	mg/kg	MND33-0103	8-65	0.31	0.38		430.00	a	NO:3
7439-89-6	Iron	1300	40500.00	mg/kg		65-65	22100	40500.00	35000.00			NO:4
15067-28-4	Lead	2	255.00	mg/kg		65-65	20.6	255.00	48.00			YES
7439-93-2	Lithium	2.7	41.40	mg/kg	B409	45-46	17.6	41.40	26.00			YES
7439-95-4	Magnesium	583	68800.00	mg/kg	MND33-0103	65-65	21700	68800.00	40000.00			YES
7439-96-5	Manganese	42.3	5240.00	mg/kg		65-65	1010	5240.00	1400.00	2700.00	b	YES
7439-97-6	Mercury	0.14	0.42	mg/kg	NPS6	4-65	0.07	0.42		6.40	b	NO:3
7439-98-7	Molybdenum	0.56	15.70	mg/kg		45-46	9.52	15.70	27.00			NO:2
	Neodymium	17	33.40	mg/kg		7-8	NC	33.40				YES
7440-02-0	Nickel	2.8	26.20	mg/kg	CJ	62-65	22	26.20	32.00	430.00	a	NO:2,3
13966-00-2	Potassium	157	4320.00	mg/kg	B409	60-65	2530	4320.00	1900.00			NO:4
7782-49-2	Selenium	0.29	2.20	mg/kg	CJ	10-65	0.54	2.20		110.00	f,a	NO:3
7440-22-4	Silver	0	17.00	mg/kg	MND33-0103	9-65	1.88	17.00	1.70	110.00	a	NO:3
13966-32-0	Sodium	26.7	865.00	mg/kg		34-41	410	865.00	240.00			NO:4
14913-50-9	Thallium	0.35	2.10	mg/kg		11-50	0.66	2.10	0.46	1.70	f,a	YES
7440-31-5	Tin	1.6	41.10	mg/kg		7-52	6.9	41.10	20.00	13000.00	f, a	NO:3
7440-62-2	Vanadium	0.45	37.00	mg/kg	B409	63-65	34.9	37.00	25.00	150.00	a	NO:3
7440-66-6	Zinc	4.1	1310.00	mg/kg		65-65	65.5	1310.00	140.00	6400.00	a	NO:3

Table 2.1 Initial Identification of Soil Constituents of Potential Concern for the Construction Worker in Parcel 4. (Maximum Detected Concentration Compared to Background and Mound Guidance Values)

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Screening Guideline Value	Reference	Rationale for Contaminant Deletion or Selection
Semi-Volatile Organic Compounds												
120-82-1	1,2,4-Trichlorobenzene	33	33.00	ug/kg	MND33-0104	1-58	239	33.00		213000.00	f, b	NO:1
95-57-8	2-Chlorophenol	38	38.00	ug/kg	MND33-0104	1-58	238	38.00		1064.58	f, a	NO:1
91-57-6	2-Methylnaphthalene	63	110.00	ug/kg		2-58	238	110.00				NO:1
59-50-7	4-Chloro-3-methylphenol	7	7.00	ug/kg	MND33-0104	1-58	263	7.00				NO:1
	Acenaphthene	42	120.00	ug/kg		2-58	252	120.00				NO:1
	Acenaphthylene	**50**	**690.00**	**ug/kg**		**4-58**	**243**	**690.00**				**YES**
	Anthracene	50	690.00	ug/kg		7-58	243	690.00		6400000.00	a	NO:3
56-55-3	Benzo(a)anthracene	58	2800.00	ug/kg		10-58	325	2800.00		4100.00	d	NO:3
50-32-8	**Benzo(a)pyrene**	**40**	**2500.00**	**ug/kg**		**11-58**	**330**	**2500.00**		**410.00**	**d**	**YES**
205-99-2	**Benzo(b)fluoranthene**	**35**	**4800.00**	**ug/kg**		**21-58**	**439**	**4800.00**		**4100.00**	**d**	**YES**
191-24-2	**Benzo(g,h,i)perylene**	**47**	**250.00**	**ug/kg**		**8-58**	**241**	**250.00**				**YES**
207-08-9	Benzo(k)fluoranthene	58	8600.00	ug/kg		19-58	524	8600.00		41000.00	d	NO:3
65-85-0	Benzoic Acid	12	86.00	ug/kg		5-55	1710	86.00		85000000.00	a	NO:3
117-81-7	Bis(2-ethylhexyl)phthalate	34	340.00	ug/kg	B401	11-58	241	340.00		215000.00	d	NO:3
	Carbazole	**41**	**420.00**	**ug/kg**		**4-50**	**219**	**420.00**				**YES**
218-01-9	Chrysene	43	2400.00	ug/kg		12-58	321	2400.00		410000.00	d	NO:3
84-74-2	Di-n-butyl Phthalate	25	420.00	ug/kg	NPS5	8-58	252	420.00		2100000.00	a	NO:3
117-84-0	Di-n-octyl Phthalate	47	130.00	ug/kg	B408	3-58	240	130.00		430000.00	a	NO:3
	Dibenz(a,h)anthracene	46	130.00	ug/kg		4-58	240	130.00		408.33	f, c	NO:3
	Dibenzofuran	42	250.00	ug/kg		2-58	243	250.00				NO:1
206-44-0	Fluoranthene	39	5000.00	ug/kg		21-58	433	5000.00		850000.00	a	NO:3
	Fluorene	50	460.00	ug/kg		5-58	246	460.00		8516666.67	f,a	NO:3
	Indeno(1,2,3-cd)pyrene	**67**	**850.00**	**ug/kg**		**8-58**	**253**	**850.00**		**408.33**	**f, c**	**YES**
	Naphthalene	200	200.00	ug/kg		1-58	237	200.00				NO:1
85-01-8	**Phenanthrene**	**78**	**3700.00**	**ug/kg**		**10-58**	**338**	**3700.00**				**YES**
108-95-2	Phenol	23	23.00	ug/kg	MND33-0104	1-58	243	23.00		13000000.00	a	NO:1
129-00-0	Pyrene	25	3300.00	ug/kg		21-58	371	3300.00		640000.00	a	NO:3
Volatile Organic Compounds												
78-93-3	2-Butanone	8.5	8.50	ug/kg	NPS3	1-65	6.11	8.50		930000.00	b	NO:1
67-64-1	Acetone	12	55.00	ug/kg		9-65	10.3	55.00		2100000.00	a	NO:3
56-23-5	Carbon Tetrachloride	9.6	9.60	ug/kg	NPS3	1-65	3.74	9.60		12000.00	c	NO:1
100-41-4	Ethylbenzene	2.1	2.10	ug/kg	NPS3	1-65	3.61	2.10		50.00	b	NO:1
	Hexane	4	10.00	ug/kg		2-53	6.24	10.00		9100.00	b	NO:1
75-09-2	Methylene Chloride	6	97.00	ug/kg	NPS3	10-65	10.9	97.00		100000.00	b	NO:3
108-88-3	Toluene	1	4.70	ug/kg	NPS3	3-65	3.66	4.70		25000.00	b	NO:1
	Xylenes, Total	2	2.10	ug/kg		1-65	3.61	2.10		43000000.00	a	NO:1

Table 2.1 Initial Identification of Soil Constituents of Potential Concern for the Construction Worker in Parcel 4. (Maximum Detected Concentration Compared to Background and Mound Guidance Values)

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Screening Guideline Value	Reference	Rationale for Contaminant Deletion or Selection
Pesticides/PCBs												
72-54-8	4,4'-DDD	0.4	6.60	ug/kg	B409	2-64	2.6	6.60	4200.00			NO:1
72-55-9	4,4'-DDE	0.25	3.50	ug/kg	MND22-4101	6-64	2.07	3.50	4300.00	9000.00	d	NO:2,3
50-29-3	4,4'-DDT	0.19	0.48	ug/kg		4-65	2.69	0.48	13000.00	9000.00	c	NO:2,3
309-00-2	Aldrin	0.074	0.35	ug/kg	B401	6-64	1.26	0.35		640.00	f,a	NO:3
5103-71-9	Alpha Chlordane	0.044	3.50	ug/kg		6-65	1.97	3.50		8500.00	f,c	NO:3
319-86-8	Delta-BHC	0.08	5.30	ug/kg	MND22-4101	3-65	1.64	5.30				NO:1
60-57-1	Dieldrin	1.20	1.20	ug/kg		4-65	2.17	1.20		185.00	c	NO:3
33213-65-9	Endosulfan I	0.051	0.27	ug/kg	B407	3-63	1.81	0.27		130000.00	f,a	NO:1
33213-65-9	Endosulfan II	0.053	7.10	ug/kg	MND22-4001	5-65	2.41	7.10		130000.00	f,a	NO:3
1031-07-8	Endosulfan Sulfate	0.13	0.56	ug/kg	MND22-4101	2-65	3.35	0.56				NO:1
7421-93-4	**Endrin Aldehyde**	**0.28**	**0.93**	**ug/kg**	**MND22-4102**	**4-60**	**3.34**	**0.93**				**YES**
53494-70-5	**Endrin Ketone**	**0.24**	**0.86**	**ug/kg**		**4-65**	**3.43**	**0.86**				**YES**
5103-74-2	Gamma Chlordane	0.058	0.93	ug/kg	MND22-4003	2-65	1.85	0.93		8500.00	f,c	NO:1
58-89-9	Gamma-BHC (Lindane)	0.065	0.10	ug/kg	MND22-4101	2-65	1.26	0.10		2300.00	f,d	NO:1
1024-57-3	Heptachlor	0.056	1.20	ug/kg		7-65	1.17	1.20		660.00	f,d	NO:3
1024-57-3	Heptachlor Epoxide	0.072	0.94	ug/kg	MND22-4102	6-65	1.79	0.94		280.00	f,a	NO:3
72-43-5	Methoxychlor	0.13	0.95	ug/kg	MND22-4101	4-63	23.2	0.95	30000.00			NO:2
								0.00				
Explosives								0.00				
99-65-0	1,3-Dinitrobenzene	0.098	0.10	mg/kg	B405	1-39	0.87	0.10		2.10	f,a	NO:1
118-96-7	2,4,6-Trinitrotoluene	0.2	0.20	mg/kg	B405	1-39	0.84	0.20		11.00	f,a	NO:1
	Tetryl	0.29	0.29	mg/kg	?	1-39	1.35	0.29				NO:1

Table 2.1 Initial Identification of Soil Constituents of Potential Concern for the Construction Worker in Parcel 4. (Maximum Detected Concentration Compared to Background and Mound Guidance Values)

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Screening Guideline Value	Reference	Rationale for Contaminant Deletion or Selection
Radionuclides												
AC-227DA	Actinium-227	0.13	3.02	pCi/g		63-153	0.64	3.02		1.00	e	YES
14596-10-2	Americium-241	0.23	0.23	pCi/g		11-187	0.14	0.23		4.95	e	NO:3
10045-97-3	Cesium-137	0.90	0.90	pCi/g		126-188	0.36	0.90	0.42	0.46	e	YES
10198-40-0	Cobalt-60	0.16	0.16	pCi/g		9-188	0.06	0.16		0.10	e	NO:1
14255-04-0	Lead-210	0.38	3.70	pCi/g		89-117	1.84	3.70		1.60	f,e	YES
13994-20-2	Neptunium-237	0.023	0.01	pCi/g	#6B	6-8	NC	0.01		1.50	f,e	NO:3
13981-16-3	Plutonium-238	0.01	76.11	pCi/g		156-480	111	76.11	0.13	5.50	e	YES
PU-239/240	Plutonium-239	0.01	0.01	pCi/g		3-10	NC	0.01	0.18	5.50	e	NO:2,3
PU-239/240	Plutonium-239/240	0.00667	0.21	pCi/g		18-63	0.02	0.21	0.18	5.50	e	NO:3
13982-10-0	Plutonium-242	0.0102	0.01	pCi/g	GJ	1-31	0.02	0.01		5.60	f,e	NO:1
13966-00-2	Potassium-40	10.5	34.46	pCi/g	B405	55-66	22.6	34.46	37.00	1.60	f,e	NO:2
13982-63-3	Radium-226	0.39	3.64	pCi/g		147-179	1.53	3.64	2.00	0.14	e	YES
	Radium-228	1	2.57	pCi/g		9-9	NC	2.57		0.28	f,e	YES
10098-97-2	Strontium-90	0.158	2.77	pCi/g	B405	4-37	1.07	2.77	0.72	3.00	e	NO:3
14274-82-9	Thorium-228	0.195	1.79	pCi/g		66-80	1.07	1.79	1.50	0.16	e	YES
14269-63-7	Thorium-230	27.17	27.17	pCi/g		86-178	4.61	27.17	1.90	44.00	e	NO:3
7440-29-1	Thorium-232	0.037	5.60	pCi/g	S1049	182-491	0.84	5.60	1.40	50.00	e	NO:3
10028-17-8	Tritium	3.00	3.00	pCi/g		7-64	0.88	3.00	1.60	23500.00	e	NO:3
13966-29-5	Uranium-234	1.17	1.17	pCi/g	B406	56-65	0.77	1.17	1.10	37.50	e	NO:3
15117-96-1	Uranium-235	0.019	0.20	pCi/g	B406	51-59	0.1	0.20	0.11	3.35	e	NO:3
24678-82-8	Uranium-238	1.95	1.95	pCi/g		109-114	1.08	1.95	0.96	11.00	e	NO:3

a= 1/10th HI for ingestion
b= 1/10th HI for ingestion + inhalation
c= cancer risk for ingestion + inhalation
d= cancer risk for ingestion
e= cancer risk for ingestion + inhalation + external
f= Calculated values based on procedures in Mound's approved Risk-Based Guidance Values, Final Rev. 4, March 1997 and updated toxicity criteria

NO:1 - <5% Detects
NO:2 - <Background
NO:3 - < Screening Toxicity Value
NO:2,3 - <Background,Screening Toxicity
NO:4 - Essential Human Nutrient

Table 2.2 Final Identification of Soil Constituents of Potential Concern for the Construction Worker in Parcel 4. (Exposure Point Concentration Compared to Background and Mound Guidance Values)

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Rationale for Contaminant Deletion or Selection
Metals										
7429-90-5	Aluminum	363	21400.00	mg/kg	B409	65-65	12700	12700.00	19000.00	NO
7440-36-0	Antimony	0.27	42.20	mg/kg	MND33-0103	20-48	12.6	12.60		YES
7440-38-2	Arsenic	1.7	17.10	mg/kg		65-65	6.99	6.99	8.60	NO
14733-03-0	Bismuth	0.76	70.40	mg/kg	CJ	48-51	73.3	70.40		YES
	Cerium	24	50.90	mg/kg		8-8	NC	50.90		YES
15067-28-4	Lead	2	255.00	mg/kg		65-65	20.6	20.60	48.00	NO
7439-93-2	Lithium	2.7	41.40	mg/kg	B409	45-46	17.6	17.60	26.00	NO
7439-95-4	Magnesium	583	68800.00	mg/kg	MND33-0103	65-65	21700	21700.00	40000.00	NO
7439-96-5	Manganese	42.3	5240.00	mg/kg		65-65	1010	1010.00	1400.00	NO
	Neodymium	17	33.40	mg/kg		7-8	NC	33.40		YES
14913-50-9	Thallium	0.35	2.10	mg/kg		11-50	0.66	0.66	0.46	YES
Semi-Volatile Organic Compounds										
	Acenaphthylene	50	690.00	ug/kg		4-58	243	243.00		YES
50-32-8	Benzo(a)pyrene	40	2500.00	ug/kg		11-58	330	330.00		YES
205-99-2	Benzo(b)fluoranthene	35	4800.00	ug/kg		21-58	439	439.00		YES
191-24-2	Benzo(g,h,i)perylene	47	250.00	ug/kg		8-58	241	241.00		YES
	Carbazole	41	420.00	ug/kg		4-50	219	219.00		YES
	Indeno(1,2,3-cd)pyrene	67	850.00	ug/kg		8-58	253	253.00		YES
85-01-8	Phenanthrene	78	3700.00	ug/kg		10-58	338	338.00		YES
Pesticides/PCBs										
7421-93-4	Endrin Aldehyde	0.28	0.93	ug/kg	MND22-4102	4-60	3.34	0.93		YES
53494-70-5	Endrin Ketone	0.24	0.86	ug/kg		4-65	3.43	0.86		YES

Table 2.2 Final Identification of Soil Constituents of Potential Concern for the Construction Worker in Parcel 4.
(Exposure Point Concentration Compared to Background and Mound Guidance Values)

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Rationale for Contaminant Deletion or Selection
Radionuclides										
AC-227DA	Actinium-227	0.13	3.02	pCi/g		63-153	0.64	0.64		YES
10045-97-3	Cesium-137	0	0.90	pCi/g		126-188	0.36	0.36	0.42	NO
14255-04-0	Lead-210	0.38	3.70	pCi/g		89-117	1.84	1.84		YES
13981-16-3	Plutonium-238	0.01	76.11	pCi/g		156-480	111	76.11	0.13	YES
13982-63-3	Radium-226	0.39	3.64	pCi/g		147-179	1.53	1.53	2.00	NO
	Radium-228	1	2.57	pCi/g		9-9	NC	2.57		YES
14274-82-9	Thorium-228	0.195	1.79	pCi/g		66-80	1.07	1.07	1.50	NO

a= 1/10th HI for ingestion
b= 1/10th HI for ingestion + inhalation
c= cancer risk for ingestion + inhalation
d= cancer risk for ingestion
e= cancer risk for ingestion + inhalation + external
f= Calculated values based on procedures in Mound's approved Risk-Based Guidance Values, Final Rev. 4, March 1997 and updated toxicity criteria

NO:1 - <5% Detects
NO:2 - <Background
NO:3 - < Screening Toxicity Value
NO:2,3 - <Background,Screening Toxicity
NO:4 - Essential Human Nutrient

Table 2.3 Initial Identification of Surface Soil Constituents of Potential Concern for the Site Employee in Parcel 4. (Maximum Detected Concentration Compared to Background and Mound Guidance Values)

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Screening Guidance Values	Reference	Rationale for Contaminant Deletion or Selection
Metals												
7429-90-5	Aluminum	1680	21400	mg/kg	B409	22-22	8570.00	21400	19000.00	190000.00	f, b	YES
7440-36-0	Antimony	26.1	42	mg/kg	MND33-0103	8-21	367.00	42.20		82.00	a	NO:3
7440-38-2	Arsenic	3.90	11.8	mg/kg	B406	22-22	7.00	11.8	8.60	61.00	a	YES
7440-39-3	Barium	12.4	111.00	mg/kg		22-22	58.30	111.00	180.00	14000.00	b	NO:2,3
13966-02-4	Beryllium	0.12	0.85	mg/kg		21-22	0.70	0.85	1.30	1.30	c	NO:2,3
14733-03-0	Bismuth	0.76	28.50	mg/kg	CJ	12-14	NC	28.50				YES
7440-43-9	Cadmium	0.31	7.70	mg/kg	MND33-0103	11-22	40.10	7.70	2.10	200.00	a	NO:3
7440-70-2	Calcium	812	150000.00	mg/kg		22-22	662000.00	150000.00	310000.00			NO:2
7440-47-3	Chromium	1.7	30.50	mg/kg	MND33-0103	22-22	26.70	30.50	20.00	1000.00	a	NO:3
10198-40-0	Cobalt	1.4	14.40	mg/kg	B409	22-22	10.80	14.40	19.00			NO:2
7440-50-8	Copper	3.4	21.70	mg/kg		22-22	18.10	21.70	26.00	7600.00	a, f	NO:2,3
57-12-5	Cyanide	0.12	0.38	mg/kg	MND33-0103	8-22	0.35	0.38		4100.00	a	NO:3
7439-89-6	Iron	2790	28800.00	mg/kg		22-22	17600.00	28800.00	35000.00			NO:2
15067-28-4	Lead	5	32.00	mg/kg	B401	22-22	19.20	32.00	48.00			NO:2
7439-93-2	Lithium	2.7	27.30	mg/kg	B409	12-13	26.80	27.30	26.00			YES
7439-95-4	Magnesium	583	6800.00	mg/kg	MND33-0103	22-22	110000.00	6800.00	40000.00			NO:2
7439-96-5	Manganese	116	1250.00	mg/kg	MND22-4101	22-22	722.00	1250.00	1400.00	15000.00	b	NO:2,3
7439-97-6	Mercury	0.14	0.14	mg/kg		1-22	0.07	0.14		61.00	b	NO:1
7439-98-7	Molybdenum	0.56	6.20	mg/kg	B409	13-13	NC	6.20	27.00			NO:2
7440-02-0	Nickel	2.8	25.80	mg/kg		21-22	30.10	25.80	32.00	4100.00	a	NO:2,3
13966-00-2	Potassium	270	3550.00	mg/kg	B409	22-22	1650.00	3550.00	1900.00			NO:4
7440-22-4	Silver	12	17.00	mg/kg	MND33-0103	8-22	149.00	17.00	1.70	1000.00	a	NO:3
13966-32-0	Sodium	26.7	530.00	mg/kg	MND22-4101	21-22	407.00	530.00	240.00			NO:4
14913-50-9	Thallium	0	0.44	mg/kg		8-22	0.89	0.44	0.46	16.00	f,a	NO:2,3
7440-31-5	Tin	2.6	4.80	mg/kg	MND22-4102	3-14	6.48	4.80	20.00			NO:2
7440-62-2	Vanadium	0.75	37.00	mg/kg	B409	22-22	33.20	37.00	25.00	1400.00	a	NO:3
7440-66-6	Zinc	6.7	74.10	mg/kg		22-22	45.50	74.10	140.00	61000.00	a	NO:2,3

Table 2.3 Initial Identification of Surface Soil Constituents of Potential Concern for the Site Employee in Parcel 4.
(Maximum Detected Concentration Compared to Background and Mound Guidance Values)

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Screening Guidance Values	Reference	Rationale for Contaminant Deletion or Selection
Semi-Volatile Organic Compounds												
120-82-1	1,2,4-Trichlorobenzene	33	33	ug/kg	MND33-0104	1-15	NC	33.00		2040000.00	f, b	NO:3
95-57-8	2-Chlorophenol	38	38	ug/kg	MND33-0104	1-15	NC	38.00		1022000.00	f, a	NO:3
91-57-6	2-Methylnaphthalene	63	63	ug/kg	B401	1-15	NC	63.00				YES
59-50-7	4-Chloro-3-methylphenol	7	7	ug/kg	MND33-0104	1-15	NC	7.00				YES
56-55-3	Benzo(a)anthracene	58	58	ug/kg	B401	1-15	NC	58.00		78000.00	d	NO:3
50-32-8	Benzo(a)pyrene	51	51	ug/kg	B401	1-15	NC	51.00		780.00	d	NO:3
205-99-2	Benzo(b)fluoranthene	37	98	ug/kg	B401	4-15	NC	98.00		7800.00	d	NO:3
207-08-9	Benzo(k)fluoranthene	65	170	ug/kg	B401	4-15	NC	170.00		78000.00	d	NO:3
65-85-0	Benzoic Acid	12	12	ug/kg	MND33-0104	1-15	NC	12.00		820000000.00	a	NO:3
218-01-9	Chrysene	78	78	ug/kg	B401	1-15	NC	78.00		780000.00	a	NO:3
84-74-2	Di-n-butyl Phthalate	25	68	ug/kg		3-15	NC	68.00		20000000.00	a	NO:3
206-44-0	Fluoranthene	39	110	ug/kg	B401	4-15	NC	110.00		8200000.00	a	NO:3
85-01-8	Phenanthrene	78	78	ug/kg	B401	1-15	NC	78.00				YES
108-95-2	Phenol	23	23	ug/kg	MND33-0104	1-15	NC	23.00		120000000.00	a	NO:3
129-00-0	Pyrene	25	120	ug/kg	MND33-0103	7-15	NC	120.00		6100000.00	a	NO:3
Volatile Organic Compounds												
67-64-1	Acetone	13	17	ug/kg	MND22-4101	2-22	7.16	17.00		20000000.00	a	NO:3
75-09-2	Methylene Chloride	6	14	ug/kg		7-22	9.54	14.00		100000.00	d	NO:3
108-88-3	Toluene	2	2	ug/kg		1-22	3.12	2.00		25000.00	b	NO:1
Pesticides/PCBs												
72-54-8	4,4'-DDD	0.4	660.00	ug/kg	B409	2-21	4.04	660.00	4200.00			NO:2
72-55-9	4,4'-DDE	0.25	3.50	ug/kg	MND22-4101	3-22	2.36	3.50	4300.00	17000.00	d	NO:2,3
50-29-3	4,4'-DDT	0.19	0.25	ug/kg	B406	3-22	5.46	0.25	13000.00	17000.00	c	NO:2,3
309-00-2	Aldrin	0.35	0.35	ug/kg	B401	6-22	2.38	0.35		340.00	f, c	NO:3
5103-71-9	Alpha Chlordane	1.10	1.10	ug/kg	MND22-4003	3-22	6.87	1.10		16000.00	f, c	NO:3
319-86-8	Delta-BHC	0.08	5.3	ug/kg	MND22-4101	3-22	4.67	5.3				YES
60-57-1	Dieldrin	0.96	0.96	ug/kg	MND22-4003	1-22	1.95	0.96		360.00	c	NO:1
33213-65-9	Endosulfan I	0.27	0.27	ug/kg	B407	3-22	6.11	0.27		1200000.00	f, a	NO:3
33213-65-9	Endosulfan II	7.10	7.10	ug/kg	MND22-4001	4-22	4.45	7.10		1200000.00	f, a	NO:3
1031-07-8	Endosulfan Sulfate	0.13	0.56	ug/kg	MND22-4101	2-22	10.20	0.56				YES
7421-93-4	Endrin Aldehyde	0.28	0.93	ug/kg	MND22-4102	3-22	9.30	0.93				YES
53494-70-5	Endrin Ketone	0.24	0.25	ug/kg	B407	2-22	10.10	0.25				YES
5103-74-2	Gamma Chlordane	0.058	0.93	ug/kg	MND22-4003	2-22	5.92	0.93		16000.00	f, c	NO:3
58-89-9	Gamma-BHC (Lindane)	0.065	0.10	ug/kg	MND22-4101	2-22	2.05	0.10		4400.00	f, d	NO:3
1024-57-3	Heptachlor	0.056	0.32	ug/kg	MND22-4102	3-22	1.62	0.32		1300.00	f, c	NO:3
1024-57-3	Heptachlor Epoxide	0.072	0.94	ug/kg	MND22-4102	4-22	7.05	0.94		630.00	f, c	NO:3
72-43-5	Methoxychlor	0.13	0.95	ug/kg	MND22-4101	4-22	204.00	0.95	30000.00			NO:2

Table 2.3 Initial Identification of Surface Soil Constituents of Potential Concern for the Site Employee in Parcel 4.
(Maximum Detected Concentration Compared to Background and Mound Guidance Values)

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Screening Guidance Values	Reference	Rationale for Contaminant Deletion or Selection
Explosives												
99-65-0	1,3-Dinitrobenzene	0.10	0.10	mg/kg	B405	1-7	NC	0.10		20.00	f, a	NO:3
118-96-7	2,4,6-Trinitrotoluene	0.2	0.20	mg/kg	B405	1-7	NC	0.20		100.00	f, a	NO:3
Radionuclides												
AC-227	Actinium-227	0.13	3.02	pCi/g		63-123	0.82	3.02		1.10	e	YES
14596-10-2	Americium-241	0.26	0.26	pCi/g		11-136	0.10	0.26		9.20	e	NO:3
10045-97-3	Cesium-137	0.90	0.90	pCi/g		115-137	0.38	0.90	0.42	0.42	e	YES
10198-40-0	Cobalt-60	0.16	0.16	pCi/g		9-137	0.05	0.16		0.09	e	YES
14255-04-0	Lead-210	0.38	3.70	pCi/g		89-117	1.84	3.70		3.20	f, e	YES
13994-20-2	Neptunium-237	0.023	0.067	pCi/g	#6B	4-6	0.11	0.067		1.60	f, e	YES
13981-16-3	Plutonium-238	76.11	76.11	pCi/g		102-358	26.40	76.11	0.13	11.00	e	YES
PU-239/240	Plutonium-239	0.01	0.02	pCi/g	CANAL NW	3-5	0.01	0.02	0.18	10.00	e	NO:2,3
PU-239/240	Plutonium-239/240	0.00667	0.19	pCi/g		14-37	0.02	0.19	0.18	10.00	e	NO:3
13966-00-2	Potassium-40	13	34.46	pCi/g	B405	23-23	24.20	34.46	37.00			NO:2
13982-63-3	Radium-226	3.64	3.64	pCi/g		105-130	1.64	3.64	2.00	0.13	e	YES
	Radium-228	1	2.57	pCi/g		9-9	NC	2.57		0.26	f, e	YES
10098-97-2	Strontium-90	0.158	2.10	pCi/g	#4B	2-14	NC	2.10	0.72	57.00	e	NO:3
14274-82-9	Thorium-228	1.66	1.66	pCi/g	B405	38-40	1.03	1.66	1.50	0.16	e	YES
14269-63-7	Thorium-230	0.316	27.17	pCi/g		48-138	5.51	27.17	1.90	81.00	e	NO:3
7440-29-1	Thorium-232	0.037	5.60	pCi/g	S1049	139-369	0.74	5.60	1.40	92.00	e	NO:3
13966-29-5	Uranium-234	1	1.17	pCi/g	B406	20-25	0.86	1.17	1.10	70.00	e	YES
15117-96-1	Uranium-235	0.2	0.2	pCi/g	B406	29-32	0.11	0.2	0.11	3.10	e	YES
24678-82-8	Uranium-238	2	2	pCi/g		71-74	1.24	1.95	0.96	11.00	f,e	NO:3

a= 1/10th HI for ingestion
b= 1/10th HI for ingestion + inhalation
c= cancer risk for ingestion + inhalation
d= cancer risk for ingestion
e= cancer risk for ingestion + inhalation + external
f= Calculated values based on procedures in Mound's approved Risk-Based Guidance Values, Final Rev. 4, March 1997 and updated toxicity criteria

NO:1 - <5% Detects
NO:2 - <Background
NO:3 - < Screening Toxicity Value
NO:2,3 - <Background,Screening Toxicity
NO:4 - Essential Human Nutrient

Table 2.4 Final Identification of Surface Soil Constituents of Potential Concern for the Site Employee in Parcel 4. (Exposure Point Concentration Compared to Background Values)

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Rationale for Contaminant Deletion or Selection
Metals										
7429-90-5	Aluminum	1680	21400	mg/kg	B409	22-22	8570.00	8570.00	19000.00	NO
7440-38-2	Arsenic	3.90	11.8	mg/kg	B406	22-22	7.00	7.00	8.60	NO
14733-03-0	Bismuth	0.76	28.50	mg/kg	CJ	12-14	NC	28.50		YES
7439-93-2	Lithium	2.7	27.30	mg/kg	B409	12-13	26.80	26.80	26.00	YES
Semi-Volatile Organic Compounds										
91-57-6	2-Methylnaphthalene	63	63	ug/kg	B401	1-15	NC	63.00		YES
59-50-7	4-Chloro-3-methylphenol	7	7	ug/kg	MND33-0104	1-15	NC	7.00		YES
85-01-8	Phenanthrene	78	78	ug/kg	B401	1-15	NC	78.00		YES
Pesticides/PCBs										
319-86-8	Delta-BHC	0.08	5.3	ug/kg	MND22-4101	3-22	4.67	4.67		YES
1031-07-8	Endosulfan Sulfate	0.13	0.56	ug/kg	MND22-4101	2-22	10.20	0.56		YES
7421-93-4	Endrin Aldehyde	0.28	0.93	ug/kg	MND22-4102	3-22	9.30	0.93		YES
53494-70-5	Endrin Ketone	0.24	0.25	ug/kg	B407	2-22	10.10	0.25		YES
Radionuclides										
AC-227	Actinium-227	0.13	3.02	pCi/g		63-123	0.82	0.82		YES
10045-97-3	Cesium-137	0.90	0.90	pCi/g		115-137	0.38	0.38	0.42	NO
10198-40-0	Cobalt-60	0.16	0.16	pCi/g		9-137	0.05	0.05		YES
14255-04-0	Lead-210	0.38	3.70	pCi/g		89-117	1.84	1.84		YES
13994-20-2	Neptunium-237	0.023	0.067	pCi/g	#6B	4-6	0.11	0.11		YES

Table 2.4 Final Identification of Surface Soil Constituents of Potential Concern for the Site Employee in Parcel 4.
(Exposure Point Concentration Compared to Background Values)

CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	95% UCL	Concentration Used for Screening	Background Value	Rationale for Contaminant Deletion or Selection
Radionuclides (continued)										
13981-16-3	Plutonium-238	76.11	76.11	pCi/g		102-358	26.40	26.40	0.13	YES
PU-239/240	Plutonium-239	0.01	0.02	pCi/g	CANAL NW	3-5	0.01	0.01	0.18	NO
PU-239/240	Plutonium-239/240	0.00667	0.19	pCi/g		14-37	0.02	0.02	0.18	NO
13966-00-2	Potassium-40	13	34.46	pCi/g	B405	23-23	24.20	24.20	37.00	NO
13982-63-3	Radium-226	3.64	3.64	pCi/g		105-130	1.64	1.64	2.00	NO
	Radium-228	1	2.57	pCi/g		9-9	NC	2.57		YES
10098-97-2	Strontium-90	0.158	2.10	pCi/g	#4B	2-14	NC	2.10	0.72	YES
14274-82-9	Thorium-228	1.66	1.66	pCi/g	B405	38-40	1.03	1.03	1.50	NO
14269-63-7	Thorium-230	0.316	27.17	pCi/g		48-138	5.51	5.51	1.90	YES
7440-29-1	Thorium-232	0.037	5.60	pCi/g	S1049	139-369	0.74	0.74	1.40	NO
13966-29-5	Uranium-234	1	1.17	pCi/g	B406	20-25	0.86	0.86	1.10	NO
15117-96-1	Uranium-235	0.2	0.2	pCi/g	B406	29-32	0.11	0.11	0.11	YES
24678-82-8	Uranium-238	2	2	pCi/g		71-74	1.24	1.24	0.96	YES

a= 1/10th HI for ingestion
b= 1/10th HI for ingestion + inhalation
c= cancer risk for ingestion + inhalation
d= cancer risk for ingestion
e= cancer risk for ingestion + inhalation + external
f= Calculated values based on procedures in Mound's approved Risk-Based Guidance Values, Final Rev. 4, March 1997 and updated toxicity criteria

NO:1 - <5% Detects
NO:2 - <Background
NO:3 - < Screening Toxicity Value
NO:2,3 - <Background,Screening Toxicity
NO:4 - Essential Human Nutrient

Table 2.5 Initial Identification of Current Groundwater Constituents of Potential Concern for the Construction Worker Scenario
(Maximum Detected Values Compared to Background and Screening Guidance Values)

Chemical	Minimum Concentration	Maximum Concentration	Units	Detection Frequency	Concentration Used for Screening and Risk	Background Value	Construction Worker Risk-Based GV	Reference Risk-Based GV	Initial COPC
Inorganics									
Aluminum	67.91	148.00	ug/L	7-29	148.00	37.523	10200	a, e	NO:3
Antimony	2.8	40.20	ug/L	5-29	40.20	0.578	4.1	a	YES
Barium	75	115.00	ug/L	27-29	115.00	310.209	710	a	NO:2,3
Cadmium	4.6	7.70	ug/L	6-32	7.70		5.1	a	YES
Calcium	94300	126000.00	ug/L	33-33	126000.00	111110.664	0		YES
Chromium	18.3	24.91	ug/L	6-32	24.91	6.076	10000	a	NO:3
Copper	1.6	593.00	ug/L	22-32	593.00	1.167	409	a,e	YES
Iron	18.8	1890.00	ug/L	14-31	1890.00	4064.888	0		NO:2
Lithium	2.9	2.90	ug/L	4-10	2.90	55.7	0		NO:2
Magnesium	29100	39600.00	ug/L	32-32	39600.00	40428.111	0		NO:2
Manganese	2.8	224.00	ug/L	30-32	224.00	229.568	51	a	NO:2
Molybdenum	1.6	2.70	ug/L	5-10	2.70	5.597	0		NO:2
Nickel	2.1	27.10	ug/L	5-32	27.10	34.957	200	a	NO:2,3
Potassium	2390	3761.00	ug/L	27-33	3761.00	4461.063	0		NO:2
Selenium	1.5	1.50	ug/L	1-32	1.50		0		NO:1
Silver	16.9	24.20	ug/L	6-29	24.20		51	a	NO:3
Sodium	46600	84200.00	ug/L	32-32	84200.00	62425.563	0		NO:4
Thallium	2.4	2.40	ug/L	1-29	2.40		0		NO:1
Tin	8.7	8.70	ug/L	1-10	8.70	34.382	0		NO:2
Vanadium	3.9	14.60	ug/L	12-29	14.60	17.1	71	a	NO:2,3
Zinc	4.5	57.70	ug/L	10-32	57.70	119.6	3100	a	NO:2,3
Volatile Organic Compounds									
1,1,1-trichloroethane	0.30	3.30	ug/L	79-193	3.30	0.668	169.00	a, e	NO:3
1,1,2 trichloro-1,2,2-trifluoroethane	2.00	34.00	ug/L	13-18	34.00		303000.00	a, e	NO:3
1,1-Dichloroethane	2.50	3.50	ug/L	2-191	3.50		950.00	a	NO:1
1,1-Dichloroethene	1.70	1.70	ug/L	1-193	1.70				NO:1
1,2-cis-Dichloroethene	0.47	4.00	ug/L	103-159	4.00	0.999	102.00	b, e	NO:3
1,2-trans-Dichloroethene	0.50	3.00	ug/L	8-195	3.00		200.00	b	NO:1
1,3-cis-Dichloropropene	0.50	1.20	ug/L	2-195	1.20				NO:1
2-Butanone	7.00	41.00	ug/L	3-12	41.00		5300.00	a	NO:3
Acetone	1.00	12.00	ug/L	6-12	12.00		1000.00	a	NO:3
Bromodichloromethane	2.20	3.70	ug/L	2-193	3.70		4.50	c	NO:1
Chloroform	0.50	5.40	ug/L	9-197	5.40	0.516			NO:1
Dichloromethane	3.00	13.00	ug/L	8-195	13.00		38.00	c	NO:1
Ethylbenzene	0.50	0.60	ug/L	2-197	0.60		69.00	a	NO:1
Tetrachloroethane	0.15	2.20	ug/L	109-196	2.20		12.00	c	NO:3
Toluene	0.60	1.50	ug/L	4-197	1.50		16000.00	a	NO:1
Trichloroethene	0.47	5.90	ug/L	176-197	5.90		15.00	c	NO:3
Trichlorofluoromethane	2.20	2.50	ug/L	2-188	2.50		22000.00	a	NO:1
Xylenes, Total	0.60	3.60	ug/L	8-190	3.60		20000.00	b	NO:1

Table 2.5 Initial Identification of Current Groundwater Constituents of Potential Concern for the Construction Worker Scenario (Maximum Detected Values Compared to Background and Screening Guidance Values)

Chemical	Minimum Concentration	Maximum Concentration	Units	Detection Frequency	Concentration Used for Screening and Risk	Background Value	Construction Worker Risk-Based GV	Reference Risk-Based GV	Initial COPC
Radionuclides									
Actinium-227	0.50	0.50	pCi/L	1-10	0.50		1.30	c	NO:3
Americium-241	0.03	0.03	pCi/L	1-9	0.03	0.139	2.40	c	NO:2,3
Bismuth-210	0.11	0.39	pCi/L	2-19	0.39		110.00	c, e	NO:3
Plutonium-238	0.01	0.25	pCi/L	8-48	0.25	0.087	2.70	c	NO:3
Plutonium-239/240	0.002	2.00	pCi/L	6-20	2.00	0.125	2.50	c	NO:3
Radium-226	0.10	0.52	pCi/L	6-19	0.52	0.996	2.70	c	NO:2,3
Strontium-85	25.00	25.00	pCi/L	1-2	25.00				NO:5
Strontium-90	0.50	0.50	pCi/L	3-19	0.50	0.975	14.00	c	NO:2,3
Thorium-227	0.01	0.10	pCi/L	8-14	0.10		19.80	c, e	NO:3
Thorium-228	0.01	2.17	pCi/L	14-35	2.17	0.779	3.50	c	NO:3
Thorium-230	0.01	1.99	pCi/L	11-32	1.99		21.00	c	NO:3
Thorium-232	0.0025	0.10	pCi/L	8-33	0.10	0.314	24.00	c	NO:2,3
Tritium	110.00	7200.00	pCi/L	112-128	7200.00	1485.47	11000.00	d	NO:3
Uranium-233/234	0.17	0.36	pCi/L	30-30	0.36		18.00	c	NO:3
Uranium-234	0.20	8.14	pCi/L	14-19	8.14	0.792	18.00	c	NO:3
Uranium-235	0.10	2.30	pCi/L	23-43	2.30	0.814	17.00	c	NO:3
Uranium-238	0.13	8.25	pCi/L	41-48	8.25	0.688	13.00	c	NO:3

NC= 95% UCL not calculated, less than 20 samples in the data set.

a= 1/10th HI for ingestion + inhalation + dermal
b= 1/10th HI for ingestion
c= cancer risk for ingestion
d= cancer risk for ingestion + inhalation + external
e= New Risk-Based Guideline Values calculated according to Mound GV 3/97 methodology

NO:1 - <5% Detects
NO:2 - <Background Value
NO:3 - < Risk-Based Guideline Value
NO:2,3 - <Background and Risk-Based Guideline Value
NO:4 - Essential Nutrient
NO:5 - Low detected, low frequency, short half life

Table 2.6 Final Identification of Current Groundwater Constituents of Potential Concern for the Construction Worker Scenario (Exposure Point Concentration Compared to Background Values)

Chemical	Minimum Concentration	Maximum Concentration	Units	Detection Frequency	95 Percent UCL	Concentration Used for Screening and Risk	Background Value	COPC for RRE
Inorganics								
Antimony	2.8	40.20	ug/L	5-29	80.30	40.20	0.578	YES
Cadmium	4.6	7.70	ug/L	6-32	5.25	5.25		YES
Calcium	94300	126000.00	ug/L	33-33	109000.00	109000.00	111110.664	NO
Copper	1.6	593.00	ug/L	22-32	57.40	57.40	1.167	YES

NO <Background Value
NC= 95% UCL not calculated, less than 20 samples in the data set.

Table 2.7 Initial Identification of Current Groundwater Constituents of Potential Concern for the Site Employee Scenario (Maximum Detected Values Compared to Background and Screening Guidance Values)

Chemical	Minimum Concentration	Maximum Concentration	Units	Detection Frequency	Concentration Used for Screening and Risk	Background Value	Site Employee Risk-Based GV	Reference Risk-Based GV	Initial COPC
Inorganics									
Aluminum	67.91	148.00	ug/L	7-29	148.00	37.523	10200.00	a,d	NO:3
Antimony	2.8	40.20	ug/L	5-29	40.20	0.578	4.10	a	YES
Barium	75	115.00	ug/L	27-29	115.00	310.209	720.00	a	NO:2,3
Cadmium	4.6	7.70	ug/L	6-32	7.70		5.10	a	YES
Calcium	94300	126000.00	ug/L	33-33	126000.00	111110.664			NO:4
Chromium	18.3	24.91	ug/L	6-32	24.91	6.076	51.00	b	NO:3
Copper	1.6	593.00	ug/L	22-32	593.00	1.167	409.00	a, d	YES
Iron	18.8	1890.00	ug/L	14-31	1890.00	4064.888			NO:2
Lithium	2.9	2.90	ug/L	4-10	2.90	55.7			NO:2
Magnesium	29100	39600.00	ug/L	32-32	39600.00	40428.111			NO:2
Manganese	2.8	224.00	ug/L	30-32	224.00	229.568	51.00	a	NO:2
Molybdenum	1.6	2.70	ug/L	5-10	2.70	5.597			NO:2
Nickel	2.1	27.10	ug/L	5-32	27.10	34.957	200.00	a	NO:2,3
Potassium	2390	3761.00	ug/L	27-33	3761.00	4461.063			NO:2
Selenium	1.5	1.50	ug/L	1-32	1.50				NO:1
Silver	16.9	24.20	ug/L	6-29	24.20		51.00	a	NO:3
Sodium	46600	84200.00	ug/L	32-32	84200.00	62425.563			NO:4
Thallium	2.4	2.40	ug/L	1-29	2.40				NO:1
Tin	8.7	8.70	ug/L	1-10	8.70	34.382			NO:2
Vanadium	3.9	14.60	ug/L	12-29	14.60	17.1	72.00	a	NO:2,3
Zinc	4.5	57.70	ug/L	10-32	57.70	119.6	3100.00	a	NO:2,3
Volatile Organic Compounds									
1,1,1-trichloroethane	0.30	3.30	ug/L	79-193	3.30	0.668	307.00	a, d	NO:3
1,1,2 trichloro-1,2,2-trifluoroethane	2.00	34.00	ug/L	13-18	34.00		307000.00	a, d	NO:3
1,1-Dichloroethane	2.50	3.50	ug/L	2-191	3.50		1000.00	a	NO:1
1,1-Dichloroethene	1.70	1.70	ug/L	1-193	1.70				NO:1
1,2-cis-Dichloroethene	0.47	4.00	ug/L	103-159	4.00	0.999	102.00	a, d	NO:3
1,2-trans-Dichloroethene	0.50	3.00	ug/L	8-195	3.00		200.00	a	NO:1
1,3-cis-Dichloropropene	0.50	1.20	ug/L	2-195	1.20				NO:1
2-Butanone	7.00	41.00	ug/L	3-12	41.00		6100.00	a	NO:3
Acetone	1.00	12.00	ug/L	6-12	12.00		1000.00	a	NO:3
Bromodichloromethane	2.20	3.70	ug/L	2-193	3.70		4.60	c	NO:1
Chloroform	0.50	5.40	ug/L	9-197	5.40	0.516			NO:1
Dichloromethane	3.00	13.00	ug/L	8-195	13.00		38.00	c	NO:1
Ethylbenzene	0.50	0.60	ug/L	2-197	0.60		1000.00	a	NO:1
Tetrachloroethane	0.15	2.20	ug/L	109-196	2.20		100.00	a	NO:3
Toluene	0.60	1.50	ug/L	4-197	1.50		2000.00	a	NO:1
Trichloroethene	0.47	5.90	ug/L	176-197	5.90		26.00	c	NO:3
Trichlorofluoromethane	2.20	2.50	ug/L	2-188	2.50		3100.00	a	NO:1
Xylenes, Total	0.60	3.60	ug/L	8-190	3.60		20000.00	a	NO:1

Table 2.7 Initial Identification of Current Groundwater Constituents of Potential Concern for the Site Employee Scenario (Maximum Detected Values Compared to Background and Screening Guidance Values)

Chemical	Minimum Concentration	Maximum Concentration	Units	Detection Frequency	Concentration Used for Screening and Risk	Background Value	Site Employee Risk-Based GV	Reference Risk-Based GV	Initial COPC
Radionuclides									
Actinium-227	0.50	0.50	pCi/L	1-10	0.50		0.26	c	YES
Americium-241	0.03	0.03	pCi/L	1-9	0.03	0.139	0.49	c	NO:2,3
Bismuth-210	0.11	0.39	pCi/L	2-19	0.39		2.19	a, d	NO:3
Plutonium-238	0.01	0.25	pCi/L	8-48	0.25	0.087	0.54	c	NO:3
Plutonium-239/240	0.00	2.00	pCi/L	6-20	2.00	0.125	0.51	c	YES
Radium-226	0.10	0.52	pCi/L	6-19	0.52	0.996	0.54	c	NO:2,3
Strontium-85	25.00	25.00	pCi/L	1-2	25.00				NO:5
Strontium-90	0.50	0.50	pCi/L	3-19	0.50	0.975	2.90	c	NO:2,3
Thorium-227	0.01	0.10	pCi/L	8-14	0.10		3.96	a, d	NO:3
Thorium-228	0.01	2.17	pCi/L	14-35	2.17	0.779	0.69	c	YES
Thorium-230	0.01	1.99	pCi/L	11-32	1.99		4.30	c	NO:3
Thorium-232	0.00	0.10	pCi/L	8-33	0.10	0.314	4.90	c	NO:2,3
Tritium	110.00	7200.00	pCi/L	112-128	7200.00	1485.47	2200.00	c	YES
Uranium-233/234	0.17	0.36	pCi/L	30-30	0.36		3.60	c	NO:3
Uranium-234	0.20	8.14	pCi/L	14-19	8.14	0.792	3.60	c	YES
Uranium-235	0.10	2.30	pCi/L	23-43	2.30	0.814	3.40	c	NO:3
Uranium-238	0.13	8.25	pCi/L	41-48	8.25	0.688	2.60	c	YES

a= 1/10th HI for ingestion
b= 1/10th HI for ingestion of Cr VI
c= cancer risk for ingestion
d= New Risk-Based Guideline Values calculated according to Mound GV 3/97 methodology

NC= 95% UCL not calculated, less than 20 samples in the data set.

NO:1 - <5% Detects
NO:2 - <Background Value
NO:3 - < Risk-Based Guideline Value
NO:2,3 - <Background and Risk-Based Guideline Value
NO:4 - Essential Nutrient
NO:5 - short half life, one detect

Table 2.8 Final Identification of Current Groundwater Constituents of Potential Concern for the Site Employee Scenario (Exposure Point Concentration Compared to Background Values)

Chemical	Minimum Concentration	Maximum Concentration	Units	Detection Frequency	95 Percent UCL	Concentration Used for Screening and Risk	Background Value	COPC for RRE
Inorganics								
Antimony	2.8	40.20	ug/L	5-29	80.30	40.20	0.578	YES
Cadmium	4.6	7.70	ug/L	6-32	5.25	5.25		YES
Copper	1.6	593.00	ug/L	22-32	57.40	57.40	1.167	YES
Radionuclides								
Actinium-227	0.50	0.50	pCi/L	1-10	NC	0.50		YES
Plutonium-239/240	0.00	2.00	pCi/L	6-20	8.87	2.00	0.125	YES
Thorium-228	0.01	2.17	pCi/L	14-35	105.00	2.17	0.779	YES
Tritium	110.00	7200.00	pCi/L	112-128	861.00	861.00	1485.47	NO
Uranium-234	0.20	8.14	pCi/L	14-19	NC	8.14	0.792	YES
Uranium-238	0.13	8.25	pCi/L	41-48	0.47	0.47	0.688	NO

NO <Background Value
NC= 95% UCL not calculated, less than 20 samples in the data set.

Table 2.9 Initial Identification of Future Groundwater Constituents of Potential Concern for the Construction Worker Scenario (Maximum Detected Concentration Compared to Background and Mound Guideline Values)

Chemical	Minimum Concentration In Bedrock Wells	Maximum Concentration In Bedrock Wells	Units	Detection Frequency In Bedrock Wells	95 Percent UCL	Concentration Used for Screening	Background Value	Construction Worker Risk-Based GV	Reference Risk-Based GV	COPC?
Inorganics										
Aluminum	3.5	31500.00	ug/L	107/ 115	6840.00	31500.00	37.523	1.0E+04	a, d	YES
Ammonia**	100	37500.00	ug/L	34/ 61	4.03	37500.00	162			NO:4
Antimony	0.22	41.60	ug/L	21/ 122	2.82	41.60	0.578	4.1	a	YES
Arsenic**	0.3	933.00	ug/L	26/ 114	11.80	933.00	37.295	3.1	a	YES
Barium	17.5	329.00	ug/L	112/ 114	130.00	329.00	310.209	710	a	NO:3
Beryllium**	0.02	2.30	ug/L	41/ 115	0.47	2.30		6.60E-02	c	YES
Bismuth**	0.09	264.00	ug/L	23/ 103	23.20	264.00				YES
Boron**	100	110.00	ug/L	1/ 2	0.00	110.00		900	a, d	NO:3
Cadmium	0.1	13.10	ug/L	11/ 124	0.75	13.10		5.1	a	YES
Calcium	116	1510000.00	ug/L	164/ 164	199000.00	1510000.00	111110.664	0		NO:4
Chloride**	8100	17700000.00	ug/L	74/ 74	908.00	17700000.00	105821			NO:4
Chromium	0.15	44800.00	ug/L	78/ 120	5010.00	44800.00	6.076	51	a*	YES
Cobalt**	0.18	295.00	ug/L	46/ 115	18.50	295.00	1.032	600	a, d	NO:3
Copper	0.3	514.00	ug/L	81/ 117	26.80	514.00	1.167	400	a, d	YES
Cyanide**	5	14.20	ug/L	3/ 45	4.79	14.20	na	200	a	NO:2,3
Dissolved Solids	499000	32500000.00	ug/L	47/ 47	2480.00	32500000.00				NO:4
Fluoride**	100	2400.00	ug/L	57/ 58	0.68	2400.00	419			YES
Iron	0.154	192000.00	ug/L	151/ 165	45400.00	192000.00	4064.888	0		NO:4
Lead**	0.4	32.00	ug/L	55/ 125	4.90	32.00	10.05			YES
Lithium	2.6	4280.00	ug/L	87/ 102	123.00	4280.00	55.7	0		YES
Magnesium	26.9	719000.00	ug/L	165/ 165	77500.00	719000.00	40428.111	0		NO:4
Manganese	0.037	3030.00	ug/L	155/ 165	737.00	3030.00	229.568	51	a	YES
Mercury**	0.1	1.40	ug/L	3/ 115	0.06	1.40		3.1	a	NO:1
Molybdenum	0.79	474.00	ug/L	51/ 98	32.50	474.00	5.597	50	a, d	YES
Nickel	1.1	6600.00	ug/L	82/ 120	749.00	6600.00	34.957	200	a	YES
Phosphate**	20	10100.00	ug/L	31/ 41	0.79	10100.00	231			NO:4
Potassium	2.12	214000.00	ug/L	150/ 164	15200.00	214000.00	4461.063	0		NO:4
Selenium	0.7	100.00	ug/L	10/ 112	1.78	100.00		50	a, d	YES
Silicon**	2230	3280.00	ug/L	6/ 6	17000.00	3280.00				NO:4
Silver	0.2	29.40	ug/L	7/ 115	1.24	29.40		51	a	NO:3
Sodium	68.2	7270000.00	ug/L	162/ 162	346000.00	7270000.00	62425.563	0		NO:4
Sulfate	5000	456000.00	ug/L	73/ 76	205.00	456000.00		0		NO:4
Thallium	0.9	22.00	ug/L	6/ 107	4.44	22.00		0		YES
Tin	0.92	357.20	ug/L	27/ 100	14.90	357.20	34.382	6000	a, d	NO:3
Vanadium	0.15	277.00	ug/L	65/ 115	33.00	277.00	17.1	71	a	YES
Zinc	0.5	399.00	ug/L	78/ 117	47.10	399.00	119.6	3100	a	NO:3

Table 2.9 Initial Identification of Future Groundwater Constituents of Potential Concern for the Construction Worker Scenario (Maximum Detected Concentration Compared to Background and Mound Guideline Values)

Chemical	Minimum Concentration In Bedrock Wells	Maximum Concentration In Bedrock Wells	Units	Detection Frequency In Bedrock Wells	95 Percent UCL	Concentration Used for Screening	Background Value	Construction Worker Risk-Based GV	Reference Risk-Based GV	COPC?
Volatiles & Organic Compounds										
1,1,1-trichloroethane	0.30	7.00	ug/L	20/ 238	0.67	7.00	0.668			YES
1,1,2 trichloro-1,2,2-trifluoroethane	1.00	2.20	ug/L	1/ 118	1.08	2.20				NO:1
1,1-Dichloroethane^^	0.50	2.00	ug/L	1/ 238	0.75	2.00		950.00	a	NO:1
1,1-Dichloroethene	0.20	1.30	ug/L	0/ 238	0.00	1.30				NO:1
1,2-cis-Dichloroethene	0.12	17.00	ug/L	48/ 148	1.61	17.00	0.999			YES
1,2-Dichloroethane**	0.30	0.30	ug/L	0/ 240	0.00	0.30		2.90	c	NO:1
1,2-Dichloroethene**	1.00	35.00	ug/L	13/ 38	6.61	35.00				YES
1,2-Dichloropropane**	0.40	0.40	ug/L	0/ 238	0.00	0.40				NO:1
1,2-trans-Dichloroethene	0.50	10.00	ug/L	13/ 217	0.76	10.00		200.00	b	NO:3
1,3-cis-Dichloropropene	0.50	1.00	ug/L	0/ 229	0.00	1.00				NO:1
1,3-Dichlorobenzene**	0.40	3.20	ug/L	1/ 147	3.92	3.20				NO:1
1,4-Dichlorobenzene**	0.30	2.40	ug/L	0/ 148	0.00	2.40				NO:1
2-Butanone	2.00	65.00	ug/L	14/ 106	6.48	65.00		5300.00	a	NO:3
4-Methylphenol	10.00	61.00	ug/L	2/ 71	6.05	61.00				NO:1
Acetone	1.00	28.00	ug/L	25/ 81	9.19	28.00		1000.00	a	NO:3
Alpha Chlordane**	0.01	0.069	ug/L	3/ 62	0.11	0.07				NO:1
Benzene**	0.20	2.50	ug/L	1/ 241	1.26	2.50		7.50	c	NO:1
Benzoic Acid**	1.00	990.00	ug/L	2/ 68	35.70	990.00		9.90	c	NO:1
Bis(2-ethylhexyl)phthalate**	1.00	950.00	ug/L	16/ 72	17.20	950.00	8.41	12.00	c	NO:6
Carbon Tetrachloride**	0.50	1.50	ug/L	1/ 238	0.94	1.50		2.00	c	NO:1
Chloroform	0.50	0.70	ug/L	2/ 239	0.65	0.70	0.516			NO:1
Chloromethane**	0.50	3.40	ug/L	1/ 85	4.12	3.40				NO:1
Dibromomethane**	1.00	3.00	ug/L	1/ 182	1.01	3.00				NO:1
Dichloromethane	0.50	3.40	ug/L	41/ 239	3.28	3.40		38.00	c	NO:3
Di-n-butyl Phthalate**	0.60	11.00	ug/L	5/ 71	5.80	11.00		410.00	a	NO:6
Endosulfan Sulfate**	0.02	2.20	ug/L	0/ 59	0.00	2.20				NO:1
Tetrachloroethene**	0.30	25.00	ug/L	55/ 247	3.37	25.00		12.00	a	YES
Toluene	0.20	8.00	ug/L	13/ 243	1.27	8.00		1500.00	a	NO:3
Trichloroethene	1.20	46.00	ug/L	152/ 273	5.12	46.00		15.00	c	YES

Table 2.9 Initial Identification of Future Groundwater Constituents of Potential Concern for the Construction Worker Scenario (Maximum Detected Concentration Compared to Background and Mound Guideline Values)

Chemical	Minimum Concentration In Bedrock Wells	Maximum Concentration In Bedrock Wells	Units	Detection Frequency In Bedrock Wells	95 Percent UCL	Concentration Used for Screening	Background Value	Construction Worker Risk-Based GV	Reference Risk-Based GV	COPC?
Radionuclides										
Americium-241	0.0045	30.90	pCi/L	6/ 43	2.87	30.90	0.139	2.40	d	YES
Bismuth-210	0.12	20.00	pCi/L	2/ 55	7.99	20.00			d	NO:1
Cesium-137	1.65	51.30	pCi/L	0/ 54	0.00	51.30				NO:1
Cobalt-60	1.22	30.40	pCi/L	0/ 54	0.00	30.40				NO:1
Gross Alpha**	0.45	1930.00	pCi/L	8/ 12	158000.00	1930.00				NO:4
Plutonium-238	0.012	0.236	pCi/L	8/ 60	0.15	0.24	0.087	2.70	d	NO:3
Plutonium-239/240	0.020	1.00	pCi/L	12/ 51	0.42	1.00	0.125	2.50	d	NO:3
Potassium-40**	0.100	800.00	pCi/L	3/ 61	133.00	800.00				NO:1
Radium-226	0.1260	39.47	pCi/L	43/ 59	2.34	39.47	0.996	2.70	d	YES
Radium-228**	1.50	1.50	pCi/L	1/ 1	0.00	1.50				NO:5
Strontium-90	0.39	42.40	pCi/L	7/ 57	2.22	42.40	0.975	14.00	d	YES
Thorium-228	0.02	2440.00	pCi/L	39/ 54	90.70	2440.00	0.779	3.50	d	YES
Thorium-230	0.0044	4.07	pCi/L	43/ 56	0.57	4.07		21.00	d	NO:3
Thorium-232	0.0006	2.11	pCi/L	31/ 63	0.78	2.11	0.314	24.00	d	NO:3
Tritium	421.00	2816310.00	pCi/L	4440/4455	206000.00	2816310.00	1485.47	11000.00	c	YES
Uranium-233/234	0.154	0.928	pCi/L	4/ 4	61.90	0.93		18.00	d	NO:3
Uranium-234	0.03	67.10	pCi/L	60/ 69	2.12	67.10	0.792	18.00	d	YES
Uranium-235	0.02	50.30	pCi/L	18/ 45	5.71	50.30	0.814	17.00	d	YES
Uranium-235/236**	0.04	1.00	pCi/L	2/ 26	0.10	1.00		17.00	d	NO:3
Uranium-238	0.00	1.34	pCi/L	57/ 75	0.51	1.34	0.688	13.00	d	NO:3

a= 1/10th HI for ingestion + inhalation + dermal
b= 1/10th HI for ingestion
c= cancer risk for ingestion+ inhalation+dermal
d= cancer risk for ingestion
e= Risk-Based Guideline Values calculated using the methodology, equations, and parameters presented in Mound Screening GV 3/97
NC= 95% UCL not calculated, less than 20 samples in the data set.
**RED = Constituent detected in bedrock well, but not in production well
^^Green = Constituent detected in production well, not in bedrock wells; reported frequency of detection based on production wells analyses

NO:1 - <5% Detects
NO:2 - <Background Value
NO:3 - < Risk-Based Guideline Value
NO:2,3 - <Background and Risk-Based Guideline Value
NO:4 - Essential Nutrient or General Quality Parameter

NO:5 - Low detected, low frequency, short half life
NO:6 - Common laboratory contaminant (EPA, 1998)

Table 2.10 Final Identification of Future Groundwater Constituents of Potential Concern for the Construction Worker Scenario
(Exposure Point Concentration Compared to Background Values)

Chemical	Minimum Concentration In Bedrock Wells	Maximum Concentration In Bedrock Wells	Units	Detection Frequency In Bedrock Wells	95 Percent UCL	Concentration Used for Screening	Background Value	COPC?
Inorganics								
Aluminum	3.5	31500.00	ug/L	107/ 115	6840.00	6840.00	37.523	YES
Antimony	0.22	41.60	ug/L	21/ 122	2.82	2.82	0.578	YES
Arsenic**	0.3	933.00	ug/L	26/ 114	11.80	11.80	37.295	NO
Beryllium**	0.02	2.30	ug/L	41/ 115	0.47	0.47		YES
Bismuth**	0.09	264.00	ug/L	23/ 103	23.20	23.20		YES
Cadmium	0.1	13.10	ug/L	11/ 124	0.75	0.75		YES
Chromium	0.15	44800.00	ug/L	78/ 120	5010.00	5010.00	6.076	YES
Copper	0.3	514.00	ug/L	81/ 117	26.80	26.80	1.167	YES
Fluoride**	100	2400.00	ug/L	57/ 58	0.68	0.68	419	NO
Lead**	0.4	32.00	ug/L	55/ 125	4.90	4.90	10.05	NO
Lithium	2.6	4280.00	ug/L	87/ 102	123.00	123.00	55.7	YES
Manganese	0.037	3030.00	ug/L	155/ 165	737.00	737.00	229.568	YES
Molybdenum	0.79	474.00	ug/L	51/ 98	32.50	32.50	5.597	YES
Nickel	1.1	6600.00	ug/L	82/ 120	749.00	749.00	34.957	YES
Selenium	0.7	100.00	ug/L	10/ 112	1.78	1.78		YES
Thallium	0.9	22.00	ug/L	6/ 107	4.44	4.44		YES
Vanadium	0.15	277.00	ug/L	65/ 115	33.00	33.00	17.1	YES
Volatiles & Organic Compounds								
1,1,1-trichloroethane	0.30	7.00	ug/L	20/ 238	0.67	0.67	0.668	NO
1,2-cis-Dichloroethene	0.12	17.00	ug/L	48/ 148	1.61	1.61	0.999	YES
1,2-Dichloroethene**	1.00	35.00	ug/L	13/ 38	6.61	6.61		YES
Tetrachloroethene**	0.30	25.00	ug/L	55/ 247	3.37	3.37		YES
Trichloroethene	1.20	46.00	ug/L	152/ 273	5.12	5.12		YES
Americium-241	0.0045	30.90	pCi/L	6/ 43	2.87	2.87	0.139	YES
Radium-226	0.1260	39.47	pCi/L	43/ 59	2.34	2.34	0.996	YES
Strontium-90	0.39	42.40	pCi/L	7/ 57	2.22	2.22	0.975	YES
Thorium-228	0.02	2440.00	pCi/L	39/ 54	90.70	90.70	0.779	YES
Tritium	421.00	2816310.00	pCi/L	4440/4455	206000.00	206000.00	1485.47	YES
Uranium-234	0.03	67.10	pCi/L	60/ 69	2.12	2.12	0.792	YES
Uranium-235	0.02	50.30	pCi/L	18/ 45	5.71	5.71	0.814	YES

a= 1/10th HI for ingestion + inhalation + dermal
b= 1/10th HI for ingestion
c= cancer risk for ingestion+ inhalation+dermal
d= cancer risk for ingestion
e= Risk-Based Guideline Values calculated using the methodology, equations, and parameters presented in Mound Screening GV 3/97
NC= 95% UCL not calculated, less than 20 samples in the data set.
**RED = Constituent detected in bedrock well, but not in production well
^^Green = Constituent detected in production well, not in bedrock wells; reported frequency of detection based on production wells analyses

NO:1 - <5% Detects
NO:2 - <Background Value
NO:3 - < Risk-Based Guideline Value
NO:2,3 - <Background and Risk-Based Guideline Value
NO:4 - Essential Nutrient or General Quality Parameter

NO:5 - Low detected, low frequency, short half life
NO:6 - Common laboratory contaminant (EPA, 1998)

Table 2.11 Initial Identification of Future Groundwater Constituents of Potential Concern for the Site Employee Scenario (Maximum Detected Concentration Compared to Background and Mound Guideline Values)

Chemical	Minimum Concentration In Bedrock Wells	Maximum Concentration In Bedrock Wells	Units	Detection Frequency In Bedrock Wells	95 Percent UCL	Concentration Used for Screening	Background Value	Site Employee Risk-Based GV	Reference Risk Based GV	COPC?
Inorganics										
Aluminum	3.5	31500.00	ug/L	107/ 115	6840.00	31500.00	37.523			YES
Ammonia**	100	37500.00	ug/L	34/ 61	4.03	37500.00	162			NO:4
Antimony	0.22	41.60	ug/L	21/ 122	2.82	41.60	0.578	4.10	a	YES
Arsenic**	0.3	933.00	ug/L	26/ 114	11.80	933.00	37.295	3.10	a	YES
Barium	17.5	329.00	ug/L	112/ 114	130.00	329.00	310.209	720.00	a	NO:3
Beryllium**	0.02	2.30	ug/L	41/ 115	0.47	2.30	na	6.70E-02	c	NO:2
Bismuth**	0.09	264.00	ug/L	23/ 103	23.20	264.00	na			NO:2
Boron**	100	110.00	ug/L	1/ 2	0.00	110.00	na			NO:2
Cadmium	0.1	13.10	ug/L	11/ 124	0.75	13.10	na	5.10	a	NO:2
Calcium	116	1510000.00	ug/L	164/ 164	199000.00	1510000.00	111110.664			NO:4
Chloride**	8100	17700000.00	ug/L	74/ 74	908.00	17700000.00	105821			NO:4
Chromium	0.15	44800.00	ug/L	78/ 120	5010.00	44800.00	6.076	51.00	b	YES
Cobalt**	0.18	295.00	ug/L	46/ 115	18.50	295.00	1.032			YES
Copper	0.3	514.00	ug/L	81/ 117	26.80	514.00	1.167			YES
Cyanide**	5	14.20	ug/L	3/ 45	4.79	14.20	na	200.00	a	NO:2,3
Dissolved Solids	499000	32500000.00	ug/L	47/ 47	2480.00	32500000.00				NO:4
Fluoride**	100	2400.00	ug/L	57/ 58	0.68	2400.00	419			YES
Iron	0.154	192000.00	ug/L	151/ 165	45400.00	192000.00	4064.888			NO:4
Lead**	0.4	32.00	ug/L	55/ 125	4.90	32.00	10.05			YES
Lithium	2.6	4280.00	ug/L	87/ 102	123.00	4280.00	55.7			YES
Magnesium	26.9	719000.00	ug/L	165/ 165	77500.00	719000.00	40428.111			NO:4
Manganese	0.037	3030.00	ug/L	155/ 165	737.00	3030.00	229.568	51.00	a	YES
Mercury**	0.1	1.40	ug/L	3/ 115	0.06	1.40	na	3.10	a	NO:1
Molybdenum	0.79	474.00	ug/L	51/ 98	32.50	474.00	5.597			YES
Nickel	1.1	6600.00	ug/L	82/ 120	749.00	6600.00	34.957	200.00	a	YES
Phosphate**	20	10100.00	ug/L	31/ 41	0.79	10100.00	231			NO:4
Potassium	2.12	214000.00	ug/L	150/ 164	15200.00	214000.00	4461.063			NO:4
Selenium	0.7	100.00	ug/L	10/ 112	1.78	100.00	na			NO:2
Silicon**	2230	3280.00	ug/L	6/ 6	17000.00	3280.00	na			NO:4
Silver	0.2	29.40	ug/L	7/ 115	1.24	29.40	na	51.00	a	NO:2,3
Sodium	68.2	7270000.00	ug/L	162/ 162	346000.00	7270000.00	62425.563			NO:4
Sulfate	5000	456000.00	ug/L	73/ 76	205.00	456000.00		0		NO:4
Thallium	0.9	22.00	ug/L	6/ 107	4.44	22.00	na			NO:2
Tin	0.92	357.20	ug/L	27/ 100	14.90	357.20	34.382			YES
Vanadium	0.15	277.00	ug/L	65/ 115	33.00	277.00	17.1	72.00	a	YES
Zinc	0.5	399.00	ug/L	78/ 117	47.10	399.00	119.6	3100.00	a	NO:3

Table 2.11 Initial Identification of Future Groundwater Constituents of Potential Concern for the Site Employee Scenario (Maximum Detected Concentration Compared to Background and Mound Guideline Values)

Chemical	Minimum Concentration In Bedrock Wells	Maximum Concentration In Bedrock Wells	Units	Detection Frequency In Bedrock Wells	95 Percent UCL	Concentration Used for Screening	Background Value	Site Employee Risk-Based GV	Reference Risk Based GV	COPC?
Volatiles & Organic Compounds										
1,1,1-trichloroethane	0.30	7.00	ug/L	20/ 238	0.67	7.00	0.668			YES
1,1,2 trichloro-1,2,2-trifluoroethane	1.00	2.20	ug/L	1/ 118	1.08	2.20				NO:1
1,1-Dichloroethane^^	0.50	2.00	ug/L	1/ 238	0.75	2.00		1000.00	a	NO:1
1,1-Dichloroethene	0.50	1.30	ug/L	0/ 238	0.00	1.30				NO:1
1,2-cis-Dichloroethene	0.12	17.00	ug/L	48/ 148	1.61	17.00	0.999		a	YES
1,2-Dichloroethane**	0.30	0.30	ug/L	0/ 240	0.00	0.30		3.10		NO:1
1,2-Dichloroethene**	1.00	35.00	ug/L	13/ 38	6.61	35.00				YES
1,2-Dichloropropane**	0.40	0.40	ug/L	0/ 238	0.00	0.40				NO:1
1,2-trans-Dichloroethene	0.50	10.00	ug/L	13/ 217	0.76	10.00		200.00	a	NO:3
1,3-cis-Dichloropropene	0.50	1.00	ug/L	0/ 229	0.00	1.00				NO:1
1,3-Dichlorobenzene**	0.40	3.20	ug/L	1/ 147	3.92	3.20				NO:1
1,4-Dichlorobenzene**	0.30	2.40	ug/L	0/ 148	0.00	2.40				NO:1
2-Butanone	2.00	65.00	ug/L	14/ 106	6.48	65.00		6100.00	a	NO:3
4-Methylphenol	10.00	61.00	ug/L	2/ 71	6.05	61.00				NO:1
Acetone	1.00	28.00	ug/L	25/ 81	9.19	28.00		1000.00	a	NO:3
Alpha Chlordane**	0.01	0.069	ug/L	3/ 62	0.11	0.07				NO:1
Benzene**	0.20	2.50	ug/L	1/ 241	1.26	2.50		9.90	c	NO:1
Benzoic Acid**	1.00	990.00	ug/L	2/ 68	35.70	990.00				NO:1
Bis(2-ethylhexyl)phthalate**	1.00	950.00	ug/L	16/ 72	17.20	950.00	8.41	20.00	c	NO:6
Carbon Tetrachloride**	0.50	1.50	ug/L	1/ 238	0.94	1.50		2.20	c	NO:1
Chloroform	0.50	0.70	ug/L	2/ 239	0.65	0.70	0.516			NO:1
Chloromethane**	0.50	3.40	ug/L	1/ 85	4.12	3.40				NO:1
Dibromomethane**	1.00	3.00	ug/L	1/ 182	1.01	3.00				NO:1
Dichloromethane	0.50	3.40	ug/L	41/ 239	3.28	3.40		38.00	c	NO:3
Di-n-butyl Phthalate**	0.60	11.00	ug/L	5/ 71	5.80	11.00		1000.00	a	NO:6
Endosulfan Sulfate**	0.02	2.20	ug/L	0/ 59	0.00	2.20				NO:1
Tetrachloroethene**	3.00	25.00	ug/L	55/ 247	3.37	25.00		100.00	a	NO:3
Toluene	0.20	8.00	ug/L	13/ 243	1.27	8.00		2000.00	a	NO:3
Trichloroethene	1.20	46.00	ug/L	152/ 273	5.12	46.00		26.00	c	YES

Table 2.11 Initial Identification of Future Groundwater Constituents of Potential Concern for the Site Employee Scenario (Maximum Detected Concentration Compared to Background and Mound Guideline Values)

Chemical	Minimum Concentration In Bedrock Wells	Maximum Concentration In Bedrock Wells	Units	Detection Frequency In Bedrock Wells	95 Percent UCL	Concentration Used for Screening	Background Value	Site Employee Risk-Based GV	Reference Risk Based GV	COPC?
Americium-241	0.0045	30.90	pCi/L	6/ 43	2.87	30.90	0.139	0.49	c	YES
Bismuth-210	0.12	20.00	pCi/L	2/ 55	7.99	20.00				NO:1
Cesium-137	1.65	51.30	pCi/L	0/ 54	0.00	51.30				NO:1
Cobalt-60	1.22	30.40	pCi/L	0/ 54	0.00	30.40				NO:1
Gross Alpha**	0.45	1930.00	pCi/L	8/ 12	158000.00	1930.00				NO:4
Plutonium-238	0.012	0.236	pCi/L	8/ 60	0.15	0.24	0.087	0.54	c	NO:3
Plutonium-239/240	0.020	1.00	pCi/L	12/ 51	0.42	1.00	0.125	0.51	c	YES
Potassium-40**	0.100	800.00	pCi/L	3/ 61	133.00	800.00				NO:1
Radium-226	0.1260	39.47	pCi/L	43/ 59	2.34	39.47	0.996	0.54	c	YES
Radium-228**	1.500	1.50	pCi/L	1/ 1	0.00	1.50				NO:5
Strontium-90	0.39	42.40	pCi/L	7/ 57	2.22	42.40	0.975	2.90	c	YES
Thorium-228	0.02	2440.00	pCi/L	39/ 54	90.70	2440.00	0.779	0.69	c	YES
Thorium-230	0.0044	4.07	pCi/L	43/ 56	0.57	4.07		4.30	c	NO:3
Thorium-232	0.0006	2.11	pCi/L	31/ 63	0.78	2.11	0.314	4.90	c	NO:3
Tritium	421.00	2816310.00	pCi/L	4440/4455	206000.00	2816310.00	1485.47	2200.00	c	YES
Uranium-233/234	0.154	0.928	pCi/L	4/ 4	61.90	0.93		3.60	c	NO:3
Uranium-234	0.03	67.10	pCi/L	60/ 69	2.12	67.10	0.792	3.60	c	YES
Uranium-235	0.02	50.30	pCi/L	18/ 45	5.71	50.30	0.814	3.40	c	YES
Uranium-235/236**	0.04	1.00	pCi/L	2/ 26	0.10	1.00		3.40	c	NO:3
Uranium-238	0.00	1.34	pCi/L	57/ 75	0.51	1.34	0.688	2.60	c	NO:3

a= 1/10th HI for ingestion
b= 1/10th HI for ingestion of Cr VI
c= cancer risk for ingestion

NC= 95% UCL not calculated, less than 20 samples in the data set.
**RED = Constituent detected in bedrock well, but not in production well
^^Green = Constituent detected in production well, not in bedrock wells; reported frequency of detection based on production wells analyses

NO:1 - <5% Detects
NO:2 - <Background Value
NO:3 - < Risk-Based Guideline Value
NO:2,3 - <Background and Risk-Based Guideline Value
NO:4 - Essential Nutrient or General Quality Parameter
NO:5 - Low detected, low frequency, short half life
NO:6 - Common laboratory contaminant (EPA, 1998)

Table 2.12 Final Identification of Future Groundwater Constituents of Potential Concern for the Site Employee Scenario (Exposure Point Concentration Compared to Background Values)

Chemical	Minimum Concentration In Bedrock Wells	Maximum Concentration In Bedrock Wells	Units	Detection Frequency In Bedrock Wells	95 Percent UCL	Concentration Used for Screening	Background Value	COPC?
Inorganics								
Aluminum	3.5	31500.00	ug/L	107/ 115	6840.00	6840.00	37.523	YES
Antimony	0.22	41.60	ug/L	21/ 122	2.82	2.82	0.578	YES
Arsenic**	0.3	933.00	ug/L	26/ 114	11.80	11.80	37.295	NO
Chromium	0.15	44800.00	ug/L	78/ 120	5010.00	5010.00	6.076	YES
Cobalt**	0.18	295.00	ug/L	46/ 115	18.50	18.50	1.032	YES
Copper	0.3	514.00	ug/L	81/ 117	26.80	26.80	1.167	YES
Fluoride**	100	2400.00	ug/L	57/ 58	0.68	0.68	419	NO
Lead**	0.4	32.00	ug/L	55/ 125	4.90	4.90	10.05	NO
Lithium	2.6	4280.00	ug/L	87/ 102	123.00	123.00	55.7	YES
Manganese	0.037	3030.00	ug/L	155/ 165	737.00	737.00	229.568	YES
Molybdenum	0.79	474.00	ug/L	51/ 98	32.50	32.50	5.597	YES
Nickel	1.1	6600.00	ug/L	82/ 120	749.00	749.00	34.957	YES
Tin	0.92	357.20	ug/L	27/ 100	14.90	14.90	34.382	NO
Vanadium	0.15	277.00	ug/L	65/ 115	33.00	33.00	17.1	YES
Volatiles & Organic Compounds								
1,1,1-trichloroethane	0.30	7.00	ug/L	20/ 238	0.67	0.67	0.668	NO
1,2-cis-Dichloroethene	0.12	17.00	ug/L	48/ 148	1.61	1.61	0.999	YES
1,2-Dichloroethene**	1.00	35.00	ug/L	13/ 38	6.61	6.61		YES
Trichloroethene	1.20	46.00	ug/L	152/ 273	5.12	5.12		YES
Americium-241	0.0045	30.90	pCi/L	6/ 43	2.87	2.87	0.139	YES
Plutonium-239/240	0.020	1.00	pCi/L	12/ 51	0.42	0.42	0.125	YES
Radium-226	0.1260	39.47	pCi/L	43/ 59	2.34	2.34	0.996	YES
Strontium-90	0.39	42.40	pCi/L	7/ 57	2.22	2.22	0.975	YES
Thorium-228	0.02	2440.00	pCi/L	39/ 54	90.70	90.70	0.779	YES
Tritium	421.00	12816310.00	pCi/L	4440/4455	206000.00	206000.00	1485.47	YES
Uranium-234	0.03	67.10	pCi/L	60/ 69	2.12	2.12	0.792	YES
Uranium-235	0.02	50.30	pCi/L	18/ 45	5.71	5.71	0.814	YES

a= 1/10th HI for ingestion
b= 1/10th HI for ingestion of Cr VI
c= cancer risk for ingestion

NC= 95% UCL not calculated, less than 20 samples in the data set.
**RED = Constituent detected in bedrock well, but not in production well
^^Green = Constituent detected in production well, not in bedrock wells; reported frequency of detection based on production wells analyses

NO:1 - <5% Detects
NO:2 - <Background Value
NO:3 - < Risk-Based Guideline Value
NO:2,3 - <Background and Risk-Based Guideline Value
NO:4 - Essential Nutrient or General Quality Parameter
NO:5 - Low detected, low frequency, short half life
NO:6 - Common laboratory contaminant (EPA, 1998)

Table 3.1 Exposure Assumptions for Site Employee and Construction Worker Scenarios in Parcel 4

Parameter	Units	Construction Worker Adult	Site-Employee Adult	Reference
Medium/pathway				
Surface soil (0 - 2 ft.) & Sediment				
Incidental ingestion				
Soil ingestion rate	mg/day	480	50	a
Exposure frequency	days/year	250	250	b
Exposure duration	years	5	25	c
Body weight	kg	70	70	d
Carcinogen averaging time	days	25550	25550	e
Noncarcinogen averaging time	days	1825	9125	e
Conversion Factor	kg/mg	1.00E-06	1.00E-06	
Inhalation of VOCs and dust				
Inhalation rate	m^3/day	20	20	f
Exposure frequency	days/year	250	250	b
Exposure duration	years	5	25	c
Body weight	kg	70	70	d
Carcinogen averaging time	days	25550	25550	e
Noncarcinogen averaging time	days	1825	9125	e
Conversion Factor	days/hour	0.042	0.042	
Air Exchange Rate	air changes/hour	N/A	0.45	h
Surface/Subsurface soil (0 - 10 ft.)				
Incidental ingestion				
Soil ingestion rate	mg/day	480	50	a
Exposure frequency	days/year	250	250	b
Exposure duration	years	5	25	c
Body weight	kg	70	70	d
Carcinogen averaging time	days	25550	25550	e
Noncarcinogen averaging time	days	1825	9125	e
Conversion Factor	kg/mg	$1x10^{-6}$	$1x10^{-6}$	
Inhalation of VOCs and dust				
Inhalation rate	m^3/day	20	20	f
Exposure frequency	days/year	250	250	b
Exposure time	hours/day	8	8	g
Exposure duration	years	5	25	c
Body weight	kg	70	70	d
Carcinogen averaging time	days	25550	25550	e
Noncarcinogen averaging time	days	1825	9125	e
Particle Emissions Factor	m^3/kg	4.28×10^9	4.28×10^9	
Conversion Factor	g/kg	1000	1000	
Conversion Factor	days/hour	0.042	0.042	
External Exposure				
Soil to skin adherence factor	mg/cm2	0.3	-	k
Gamma Shielding Factor		0.1	0.2	
Gamma Exposure Time Factor		1/3	1/12	
Exposure Duration 2	years	5 x 0.685	25 x 0.685	c
Exposure Frequency	day/year	250	250	b

Table 3.1 Exposure Assumptions for Site Employee and Construction Worker Scenarios in Parcel 4

Parameter	Units	Construction Worker Adult	Site-Employee Adult	Reference
Groundwater				
Drinking water ingestion				
Drinking water ingestion rate	L/day	1	1	i
Exposure frequency	days/year	250	250	b
Exposure time	years	5	25	g
Body weight	kg	70	70	d
Carcinogen averaging time	days	25550	25550	e
Noncarcinogen averaging time	days	1825	9125	e
Dermal contact while showering				
Skin surface area available for contact	cm^2	19400	NA	j
Exposure time	hr/day	0.167	NA	g
Exposure frequency	days/year	250	NA	b
Exposure duration	years	5	NA	c
Body weight	kg	70	NA	d
Carcinogen averaging time	days	25550	NA	e
Noncarcinogen averaging time	days	1825	NA	e
Conversion factor	L/cm^3	0.001	NA	
Inhalation of VOCs while showering				
Inhalation rate	m^3/day	20	NA	f
Exposure time	hr/day	0	NA	g
Exposure frequency	days/year	250	NA	b
Exposure duration	years	5	NA	c
Body weight	kg	70	NA	d
Carcinogen averaging time	days	25550	NA	e
Noncarcinogen averaging time	days	1825	NA	e

Table 3.1 (references)
Exposure Assumption References

a	Soil ingestion rate	Risk-Based Guideline Values, Mound Plant, Miamisburg, Ohio. (DOE 1997c) and RAGS Part A (EPA 1989)
b	Exposure frequency	Risk-Based Guideline Values, Mound Plant, Miamisburg, Ohio. (DOE 1997c) and RAGS Part A (EPA 1989)
c	Exposure duration	Exposure duration for the construction worker and site employee is based on Risk-Based Guideline Values, Mound Plant, Miamisburg, Ohio. (DOE 1997c) and RAGS Part A (EPA 1989)
d	Body weight	Risk-Based Guideline Values, Mound Plant, Miamisburg, Ohio. (DOE 1997c) and RAGS Part A (EPA 1989).
e	Averaging time	Carcinogenic averaging time = 70 yrs * 365 days/year. Non-carcinogenic averaging time = exposure duration (yrs) * 365 days/year.
f	Inhalation rate	Risk-Based Guideline Values, Mound Plant, Miamisburg, Ohio. (DOE 1997c) and EFH Volume I, Table 1-2.
g	Exposure time	Risk-Based Guideline Values, Mound Plant, Miamisburg, Ohio. (DOE 1997c) and RAGS Part A (EPA 1989)
h	Air exchange rate	Volume of residential homes, EFH, Volume III, Table 17-3. 50th percentile air exchange rate of 0.45 air changes per hour, EFH, Volume III, Table 17-10 (EPA 1997).
i	Drinking water ingestion	Risk-Based Guideline Values, Mound Plant, Miamisburg, Ohio.(DOE 1997c) and RAGS Part A (EPA 1989).
j	Skin surface available for contact	Risk-Based Guideline Values, Mound Plant, Miamisburg, Ohio. (DOE 1997c) and RAGS Part A (EPA 1989).
k	Soil to skin adherence Factor	Dermal Guidance from Mark Johnson, USEPA Region 5 January 2000.

Table 4.1 Toxicity Criteria and other Physical Chemical Values

Constituent	RfD (mg/kg/day) Oral RfDo		Adjusted RfDa	Inhalation RfDi		CSF (kg-day/mg) Oral CSFo		Adjusted CSFa	Inhalation CSFi		CSFex	GI Factor		Kp(cm/hr)	T (hr)		Dermal Absorption Abs	
Volatile Organic Compounds (VOCs)																		
1,1,1-trichloroethane	3.50E-02	a	2.70E-02	2.90E-01	a	NA		NA	NA		NA	0.90	d	0.017	0.570	e	NA	
1,1,2-trichloro-1,2,2trifluoroeth	3.00E+01	b	2.40E+01	8.60E+00	c	NA		NA	NA		NA	0.80	d	0.009		e	NA	
1,2-cis-Dichlorethene	1.00E-02	c	1.00E-02	NA		NA		NA	NA		NA	1.00	d	0.010	0.340	e	NA	
1,2-Dichloroethene	9.00E-03	b	NA	NA		NA		NA	NA		NA	1.00	d	0.010	0.340	e	NA	
Alpha Chlordane	NA		NA	NA		NA		NA	NA		NA	0.50	d	0.046	28.000	e	NA	
Carbon Tetrachloride	7.00E-04	b	4.55E-04	5.70E-04	a	1.30E-01	b	2.00E-01	5.25E-02	b	NA	0.65	d	0.022	0.760	e	NA	
Chloroform	1.00E-02	b	2.00E-03	8.60E-05	a	6.10E-03	b	3.05E-02	8.05E-02	b	NA	0.20	d	0.009	0.470	e	NA	
Semivolatile Organic Compounds (SVOCs)																		
2-Methylnaphthalene	NA		NA	NA		NA		NA	NA		NA	NA					NA	
4-Chloro-3-methylphenol	NA		NA	NA		NA		NA	NA		NA	NA					NA	
Acenaphthylene	NA		NA	NA		NA		NA	NA		NA	0.31	d				0.10	d
Benzo(a)pyrene	NA		NA	NA		7.3E+00		7.30E+00	3.10E+00		NA	0.89	f				0.13	f
Benzo(b)fluoranthene	NA		NA	NA		7.3E-01		7.30E-01	3.10E-01		NA	0.89	f				0.13	f
Benzo(g,h,i)perylene	NA		NA	NA		NA		NA	NA		NA	0.89	f				0.13	f
Carbazole	NA		NA	NA		2.0E-02		2.00E-02	NA		NA	0.70	d				0.10	d
Indeno(1,2,3-cd)pyrene	NA		NA	NA		7.3E-01		7.30E-01	3.10E-01		NA	0.89	f				0.13	f
Phenanthrene	NA		NA	NA		NA		NA	NA		NA	0.73	d				0.10	d
Pesticides																		
Delta-BHC	NA		NA	NA		NA		NA	NA		NA	NA					NA	
Endosulfan Sulfate	NA		NA	NA		NA		NA	NA		NA	NA					NA	
Endrin Aldehyde	NA		NA	NA		NA		NA	NA		NA	NA					NA	
Endrin Ketone	NA		NA	NA		NA		NA	NA		NA	NA					NA	
Metals																		
Aluminum	1.00E+00	a	1.00E-01	1.40E-03	a	NA		NA	NA		NA	0.10	d	0.001		e		
Antimony	4.00E-04	b	8.00E-06	NA		NA		NA	NA		NA	0.02	d	0.001		e	0.0010	d
Beryllium	2.00E-03	b	2.00E-05	5.71E-03	b	4.30E+00	b	NA	8.40E+00	b	NA	0.01	d	0.001		e		
Bismuth	NA		NA	NA		NA		NA	NA		NA	NA		0.001		e	NA	
Boron	9.00E-02	b	8.10E-03	5.71E-03	c	NA		NA	NA		NA	0.09	d	0.001		e		
Cadmium	5.00E-04	b	5.00E-06	5.70E-05	a	NA		NA	6.30E+00	b	NA	0.01	d	0.001		e		
Cerium	NA		NA	NA		NA		NA	NA		NA	NA					NA	
Chromium VI	3.00E-03	b	6.00E-05	NA		NA		NA	4.10E+01	c	NA	0.02	d	0.001		e		
Cobalt	6.00E+02	a	4.80E+01	NA		NA		NA	NA		NA	0.08	d	0.001		e		
Copper	4.00E-02	a	1.20E-02	NA		NA		NA	NA		NA	0.30	d	0.001		e		
Lead	NA		NA	NA		NA		NA	NA		NA	0.15	d	0.001		e		
Lithium	NA		NA	NA		NA		NA	NA		NA	NA		0.001		e	NA	
Manganese	2.40E-02	b	9.60E-04	1.43E-05	b	NA		NA	NA		NA	0.04	d	0.001		e		
Molybdenum	5.00E-03	c	1.90E-03	NA		NA		NA	NA		NA	0.38	d	0.001		e		
Neodymium	NA		NA	NA		NA		NA	NA		NA	NA					NA	
Nickel	2.00E-02	b	5.40E-03	NA		NA		NA	NA		NA	0.27	d	0.001		e		
Selenium	5.00E-03	b	2.20E-03	NA		NA		NA	NA		NA	0.44	d	0.001		e		
Thallium	8.00E-05	b	1.20E-05	NA		NA		NA	NA		NA	0.15	d	0.001		e	0.0010	
Tin	6.00E-01	c	6.00E-02	NA		NA		NA	NA		NA	0.10	d	0.001		e		

Table 4.1 Toxicity Criteria and other Physical Chemical Values

Constituent	RfD (mg/kg/day) Oral RfDo	Adjusted RfDa	Inhalation RfDi	CSF (kg-day/mg) Oral CSFo		Adjusted CSFa	Inhalation CSFi		CSFex		GI Factor		Kp(cm/hr)	T (hr)	Dermal Absorption Abs
Radionuclides															
Actinium-227+D	NA	NA	NA	6.26E-10	c	NA	7.87E-08	c	9.30E-07	c	NA*		NA		
Bismuth-210	NA	NA	NA	7.29E-12	c	NA	5.12E-11	c	0.00E+00	c	NA*		NA		
Cobalt-60	NA	NA	NA	1.89E-11	c	NA	6.88E-11	c	9.76E-06	c					
Lead-210	NA	NA	NA	6.75E-10	c	NA	1.67E-09	c	1.12E-10	c					
Neptunium-237+D	NA	NA	NA	3.00E-10	c	NA	3.45E-08	c	4.62E-07	c					
Plutonium-238	NA	NA	NA	2.95E-10	c	NA	2.74E-08	c	1.94E-11	c	NA*		NA		
Plutonium-239/240	NA	NA	NA	3.16E-10	c	NA	2.78E-08	c	1.26E-11	c	NA*		NA		
Radium-226	NA	NA	NA	2.96E-10	c	NA	2.75E-09	c	6.74E-06	c	NA*		NA		
Radium-228+D	NA	NA	NA	2.48E-10	c	NA	9.94E-10	c	3.28E-06	c					
Strontium-90+D	NA	NA	NA	5.59E-11	c	NA	6.93E-11	c	0.00E+00	c					
Thorium-227	NA	NA	NA	4.04E-11	c	NA	4.31E-09	c	1.74E-07	c	NA*		NA		
Thorium-228+D	NA	NA	NA	2.31E-10	c	NA	9.68E-08	c	6.20E-06	c	NA*		NA		
Tritium	NA	NA	NA	7.15E-14	c	7.15E-14	9.59E-14	c	0.00E+00	c	1.00	c	1.50E-05		
Uranium-234	NA	NA	NA	4.44E-11	c	NA	1.40E-08	c	2.14E-11	c	NA*		NA		
Uranium-235+D	NA	NA	NA	4.70E-11	c	NA	1.30E-08	c	1.72E-11	c	NA*		NA		
Uranium-238	NA	NA	NA	4.27E-11	c	NA	1.24E-08	c	1.50E-11	c	NA*		NA		

NA= Not Available
a=NCEA
b= IRIS
c=HEAST
d=values compiled by ORNL, DOE-OR/ERD site and presented on RAIS web page.
e=Dermal Exposure Assessment Principles and Applications, 1992, EPA/600/8-91/011B for Kp and lag time
f=values provided by Mark Johnson USEPA for the Draft Dermal Risk Assessment Guidance for RAGS
NA* HEAST does not recommend adjusting CSFo for dermal

Table 5.1 Total Residual Risk for a Construction Worker Exposed to Soil in Parcel 4

Constituent	EPC mg/kg	CANCER EFFECTS Route-Specific Risk Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Pesticides													
Endrin Aldehyde	0.00093	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Endrin Ketone	0.00086	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Metals													
Antimony	12.60	NC	NC	NA	NAP	NAP	0.0E+00	1.5E-01	1.7E-03	NA	NAP	NAP	1.5E-01
Bismuth	70.40	NC	NC	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Cerium	50.90	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Neodymium	33.40	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Thallium	0.66	NC	NC	NC	NAP	NAP	0.0E+00	3.9E-02	5.8E-05	NA	NAP	NAP	3.9E-02
SVOCs													
Acenaphthylene	0.243	NC	NA	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(a)pyrene	0.33	8.1E-07	3.3E-07	3.3E-12	NAP	NAP	**1.1E-06**	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(b)fluoranthene	0.439	1.1E-07	4.4E-08	4.4E-13	NAP	NAP	1.5E-07	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(g,h,i)perylene	0.241	NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Carbazole	0.219	1.5E-09	4.6E-10	NA	NAP	NAP	1.9E-09	NA	NA	NA	NAP	NAP	0.0E+00
Indeno(1,2,3-cd)pyrene	0.253	6.2E-08	2.5E-08	2.6E-13	NAP	NAP	8.7E-08	NA	NA	NA	NAP	NAP	0.0E+00
Phenanthrene	0.338	NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Radionuclides	EPC pCi/g												
Actinium-227	0.64	2.4E-07	NAP	2.9E-10	NAP	2.5E-07	4.9E-07	NA	NAP	NA	NAP	NA	0.0E+00
Lead-210	1.84	1.1E-06	NAP	4.1E-11	NAP	1.1E-10	**1.1E-06**	NA	NAP	NA	NAP	NA	0.0E+00
Plutonium-238	76.11	1.3E-05	NAP	1.2E-08	NAP	6.1E-10	**1.3E-05**	NA	NAP	NA	NAP	NA	0.0E+00
Radium-228	2.57	3.8E-07	NAP	1.5E-11	NAP	3.5E-06	**3.9E-06**	NA	NAP	NA	NAP	NA	0.0E+00
TOTAL		**1.6E-05**	4.0E-07	1.3E-08	0.0E+00	**3.7E-06**	**2.0E-05**	1.9E-01	1.7E-03	0.0E+00	0.0E+00	0.0E+00	1.9E-01

EPC	Exposure point concentration
mg/kg	Milligram per kilogram.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
pCi/g	Picocuries per gram
VOCs	Volatile organic compounds.

Numbers written as 1.0E-03 equal 1×10^{-3}.

Table 5.1 Total Residual Risk for a Construction Worker Exposed to Soil in Parcel 4

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Pesticides													
Endrin Aldehyde	0.00093	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Endrin Ketone	0.00086	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Metals													
Antimony	12.60	NC	NC	NA	NAP	NAP	0.0E+00	1.5E-01	5.5E-02	NA	NAP	NAP	2.0E-01
Bismuth	70.40	NC	NC	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Cerium	50.90	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Neodymium	33.40	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Thallium	0.66	NC	NC	NC	NAP	NAP	0.0E+00	3.9E-02	0.0E+00	NA	NAP	NAP	3.9E-02
SVOCs													
Acenaphthylene	0.243	NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(a)pyrene	0.33	8.1E-07	NC	3.3E-12	NAP	NAP	8.1E-07	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(b)fluoranthene	0.439	1.1E-07	NC	4.4E-13	NAP	NAP	1.1E-07	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(g,h,i)perylene	0.241	NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Carbazole	0.219	1.5E-09	NC	NA	NAP	NAP	1.5E-09	NA	NA	NA	NAP	NAP	0.0E+00
Indeno(1,2,3-cd)pyrene	0.253	6.2E-08	NC	2.6E-13	NAP	NAP	6.2E-08	NA	NA	NA	NAP	NAP	0.0E+00
Phenanthrene	0.338	NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Radionuclides	EPC pCi/g												
Actinium-227	0.64	2.4E-07	NAP	2.9E-10	NAP	2.5E-07	4.9E-07	NA	NAP	NA	NAP	NA	0.0E+00
Lead-210	1.84	1.1E-06	NAP	4.1E-11	NAP	1.1E-10	**1.1E-06**	NA	NAP	NA	NAP	NA	0.0E+00
Plutonium-238	76.11	1.3E-05	NAP	1.2E-08	NAP	6.1E-10	**1.3E-05**	NA	NAP	NA	NAP	NA	0.0E+00
Radium-228	2.57	3.8E-07	NAP	1.5E-11	NAP	3.5E-06	**3.9E-06**	NA	NAP	NA	NAP	NA	0.0E+00
TOTAL		**1.6E-05**	0.0E+00	1.3E-08	0.0E+00	**3.7E-06**	**2.0E-05**	1.9E-01	5.5E-02	0.0E+00	0.0E+00	0.0E+00	2.4E-01

EPC Exposure point concentration
mg/kg Milligram per kilogram.
NA Not available; insufficient toxicity data.
NAP Not applicable pathway; not a VOC.
pCi/g Picocuries per gram
VOCs Volatile organic compounds.

Numbers written as 1.0E-03 equal 1×10^{-3}.

Table 5.2 Background Residual Risk for a Construction Worker Exposed to Soil in Parcel 4

Constituent	EPC mg/kg	CANCER EFFECTS Route-Specific Risk Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Pesticides													
Endrin Aldehyde		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Endrin Ketone		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Metals													
Antimony		NC	NC	NA	NAP	NAP	0.0E+00	0.0E+00	0.0E+00	NA	NAP	NAP	0.0E+00
Bismuth		NC	NC	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Cerium		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Neodymium		NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Thallium	0.46	NC	NC	NC	NAP	NAP	0.0E+00	2.7E-02	4.0E-05	NA	NAP	NAP	2.7E-02
SVOCs													
Acenaphthylene		NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(a)pyrene		0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(b)fluoranthene		0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(g,h,i)perylene		NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Carbazole		0.0E+00	0.0E+00	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Indeno(1,2,3-cd)pyrene		0.0E+00	0.0E+00	0.0E+00	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Phenanthrene		NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Radionuclides	EPC pCi/g												
Actinium-227		0.0E+00	NAP	0.0E+00	NAP	0.0E+00	0.0E+00	NA	NAP	NA	NAP	NA	0.0E+00
Lead-210		0.0E+00	NAP	0.0E+00	NAP	0.0E+00	0.0E+00	NA	NAP	NA	NAP	NA	0.0E+00
Plutonium-238	0.13	2.3E-08	NAP	2.1E-11	NAP	1.0E-12	2.3E-08	NA	NAP	NA	NAP	NA	0.0E+00
Radium-228		0.0E+00	NAP	0.0E+00	NAP	0.0E+00	0.0E+00	NA	NAP	NA	NAP	NA	0.0E+00
TOTAL		2.3E-08	0.0E+00	2.1E-11	0.0E+00	1.0E-12	2.3E-08	2.7E-02	4.0E-05	0.0E+00	0.0E+00	0.0E+00	2.7E-02

EPC Exposure point concentration
mg/kg Milligram per kilogram.
NA *Not available; insufficient toxicity data.*
NAP Not applicable pathway; not a VOC.
pCi/g Picocuries per gram
VOCs Volatile organic compounds.

Numbers written as 1.0E-03 equal 1×10^{-3}.

Table 5.3 Incremental Residual Risk for a Construction Worker Exposed to Soil in Parcel 4

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Pesticides													
Endrin Aldehyde	0.00093	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Endrin Ketone	0.00086	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Metals													
Antimony	12.60	NC	NC	NA	NAP	NAP	0.0E+00	1.5E-01	1.7E-03	NA	NAP	NAP	1.5E-01
Bismuth	70.40	NC	NC	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Cerium	50.90	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Neodymium	33.40	NA	NA	NA	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Thallium	0.20	NC	NC	NC	NAP	NAP	0.0E+00	1.2E-02	1.7E-05	NA	NAP	NAP	1.2E-02
SVOCs													
Acenaphthylene	0.243	NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(a)pyrene	0.33	8.1E-07	3.3E-07	3.3E-12	NAP	NAP	**1.1E-06**	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(b)fluoranthene	0.439	1.1E-07	4.4E-08	4.4E-13	NAP	NAP	1.5E-07	NA	NA	NA	NAP	NAP	0.0E+00
Benzo(g,h,i)perylene	0.241	NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Carbazole	0.219	1.5E-09	4.6E-10	NA	NAP	NAP	1.9E-09	NA	NA	NA	NAP	NAP	0.0E+00
Indeno(1,2,3-cd)pyrene	0.253	6.2E-08	2.5E-08	2.6E-13	NAP	NAP	8.7E-08	NA	NA	NA	NAP	NAP	0.0E+00
Phenanthrene	0.338	NC	NC	NC	NAP	NAP	0.0E+00	NA	NA	NA	NAP	NAP	0.0E+00
Radionuclides	EPC pCi/g												
Actinium-227	0.64	2.4E-07	NAP	2.9E-10	NAP	2.5E-07	4.9E-07	NA	NAP	NA	NAP	NA	0.0E+00
Lead-210	1.84	1.1E-06	NAP	4.1E-11	NAP	1.1E-10	**1.1E-06**	NA	NAP	NA	NAP	NA	0.0E+00
Plutonium-238	75.98	1.3E-05	NAP	1.2E-08	NAP	6.1E-10	**1.3E-05**	NA	NAP	NA	NAP	NA	0.0E+00
Radium-228	2.57	3.8E-07	NAP	1.5E-11	NAP	3.5E-06	**3.9E-06**	NA	NAP	NA	NAP	NA	0.0E+00
TOTAL		**1.6E-05**	4.0E-07	1.3E-08	0.0E+00	**3.7E-06**	**2.0E-05**	1.6E-01	1.7E-03	0.0E+00	0.0E+00	0.0E+00	1.6E-01

EPC Exposure point concentration
mg/kg Milligram per kilogram.
NA Not available; insufficient toxicity data.
NAP Not applicable pathway; not a VOC.
pCi/g Picocuries per gram
VOCs Volatile organic compounds.

Numbers written as 1.0E-03 equal 1×10^{-3}.

Table 5.4 Total Residual Risk for a Site Employee Exposed to Surface Soil in Parcel 4

Constituent	EPC mg/kg	CANCER EFFECTS: Route-Specific Risk: Oral	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Pesticides											
Delta-BHC	0.004670	NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
Endosulfan Sulfate	0.000560	NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
Endrin Aldehyde	0.000930	NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
Endrin Ketone	0.000250	NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
Metals											
Bismuth	28.50	NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
Lithium	26.80	NA	NA	NAP	NAP	0.0E+00	6.6E-04	NA	NAP	NAP	6.6E-04
Semi-Volatile Organic Compounds											
2-Methylnaphthalene	0.063	NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
4-Chloro-3-methylphenol	0.007	NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
Phenanthrene	0.078	NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
Radionuclides	**EPC pCi/g**										
Actinium-227	0.82	1.6E-07	1.9E-09	NAP	1.6E-06	**1.7E-06**	NA	NA	NAP	NA	0.0E+00
Cobalt-60	0.05	3.0E-10	1.0E-13	NAP	1.0E-06	**1.0E-06**	NA	NA	NAP	NA	0.0E+00
Lead-210	1.84	3.9E-07	9.0E-11	NAP	4.2E-10	3.9E-07	NA	NA	NAP	NA	0.0E+00
Neptunium-237	0.11	1.0E-08	1.1E-10	NAP	1.0E-07	1.1E-07	NA	NA	NAP	NA	0.0E+00
Plutonium-238	26.40	2.4E-06	2.1E-08	NAP	1.0E-09	**2.5E-06**	NA	NA	NAP	NA	0.0E+00
Radium-228	2.57	2.0E-07	7.5E-11	NAP	1.7E-05	**1.7E-05**	NA	NA	NAP	NA	0.0E+00
Strontium-90	2.10	3.7E-08	4.3E-12	NAP	0.0E+00	3.7E-08	NA	NA	NAP	NA	0.0E+00
Thorium-230	5.51	6.5E-08	2.8E-09	NAP	4.9E-10	6.8E-08	NA	NA	NAP	NA	0.0E+00
Uranium-235	0.11	1.6E-09	4.2E-11	NAP	6.0E-08	6.1E-08	NA	NA	NAP	NA	0.0E+00
Uranium-238	1.24	2.4E-08	4.5E-10	NAP	1.7E-07	1.9E-07	NA	NA	NAP	NA	0.0E+00
TOTAL		**3.3E-06**	2.7E-08	0.0E+00	**2.0E-05**	**2.3E-05**	6.6E-04	0.0E+00	0.0E+00	0.0E+00	6.6E-04

EPC	Exposure point concentration
mg/kg	Milligram per kilogram.
NA	Not available; insufficient toxicity data.
NAP	Not an applicable pathway.
pCi/g	Picocuries per gram
VOCs	Volatile organic compounds.

Numbers written as 1.0E-03 equal 1×10^{-3}.

Table 5.5 Background Residual Risk for a Site Employee Exposed to Surface Soil in Parcel 4

Constituent	EPC mg/kg	CANCER EFFECTS					NON-CANCER EFFECTS				
		Route-Specific Risk				Cancer Risk Total	Route-Specific HQ				Non-Cancer HI Total
		Oral	Inhalation Dust	Inhalation VOCs	External		Oral	Inhalation Dust	Inhalation VOCs	External	
Pesticides											
Delta-BHC		NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
Endosulfan Sulfate		NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
Endrin Aldehyde		NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
Endrin Ketone		NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
Metals											
Bismuth		NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
Lithium	26	NA	NA	NAP	NAP	0.0E+00	6.4E-04	NA	NAP	NAP	6.4E-04
Semi-Volatile Organic Compounds											
2-Methylnaphthalene		NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
4-Chloro-3-methylphenol		NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
Phenanthrene		NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
Radionuclides	EPC pCi/g										
Actinium-227		0.0E+00	0.0E+00	NAP	0.0E+00	0.0E+00	NA	NA	NAP	NA	0.0E+00
Cobalt-60		0.0E+00	0.0E+00	NAP	0.0E+00	0.0E+00	NA	NA	NAP	NA	0.0E+00
Lead-210		0.0E+00	0.0E+00	NAP	0.0E+00	0.0E+00	NA	NA	NAP	NA	0.0E+00
Neptunium-237		0.0E+00	0.0E+00	NAP	0.0E+00	0.0E+00	NA	NA	NAP	NA	0.0E+00
Plutonium-238	0.13	1.2E-08	1.0E-10	NAP	5.1E-12	1.2E-08	NA	NA	NAP	NA	0.0E+00
Radium-228		0.0E+00	0.0E+00	NAP	0.0E+00	0.0E+00	NA	NA	NAP	NA	0.0E+00
Strontium-90	0.72	1.3E-08	1.5E-12	NAP	0.0E+00	1.3E-08	NA	NA	NAP	NA	0.0E+00
Thorium-230	1.90	2.2E-08	9.5E-10	NAP	1.7E-10	2.3E-08	NA	NA	NAP	NA	0.0E+00
Uranium-235	0.11	1.6E-09	4.2E-11	NAP	6.0E-08	6.1E-08	NA	NA	NAP	NA	0.0E+00
Uranium-238	0.96	1.9E-08	3.5E-10	NAP	1.3E-07	1.5E-07	NA	NA	NAP	NA	0.0E+00
TOTAL		6.7E-08	1.4E-09	0.0E+00	1.9E-07	2.6E-07	6.4E-04	0.0E+00	0.0E+00	0.0E+00	6.4E-04

EPC Exposure point concentration
mg/kg Milligram per kilogram.
NA Not available; insufficient toxicity data.
NAP Not an applicable pathway.
pCi/g Picocuries per gram
VOCs Volatile organic compounds.
Numbers written as 1.0E-03 equal 1×10^{-3}.

Table 5.6 Incremental Residual Risk for a Site Employee Exposed to Surface Soil in Parcel 4

Constituent	EPC mg/kg	CANCER EFFECTS Route-Specific Risk Oral	Inhalation Dust	Inhalation VOCs	External	Cancer Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	Inhalation Dust	Inhalation VOCs	External	Non-Cancer HI Total
Pesticides											
Delta-BHC	0.004670	NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
Endosulfan Sulfate	0.000560	NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
Endrin Aldehyde	0.000930	NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
Endrin Ketone	0.000250	NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
Metals											
Bismuth	28.50	NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
Lithium	0.80	NA	NA	NAP	NAP	0.0E+00	2.0E-05	NA	NAP	NAP	2.0E-05
Semi-Volatile Organic Compounds											
2-Methylnaphthalene	0.063	NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
4-Chloro-3-methylphenol	0.007	NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
Phenanthrene	0.078	NA	NA	NAP	NAP	0.0E+00	NA	NA	NAP	NAP	0.0E+00
Radionuclides	EPC pCi/g										
Actinium-227	0.82	1.6E-07	1.9E-09	NAP	1.6E-06	**1.7E-06**	NA	NA	NAP	NA	0.0E+00
Cobalt-60	0.05	3.0E-10	1.0E-13	NAP	1.0E-06	**1.0E-06**	NA	NA	NAP	NA	0.0E+00
Lead-210	1.84	3.9E-07	9.0E-11	NAP	4.2E-10	3.9E-07	NA	NA	NAP	NA	0.0E+00
Neptunium-237	0.11	1.0E-08	1.1E-10	NAP	1.0E-07	1.1E-07	NA	NA	NAP	NA	0.0E+00
Plutonium-238	26.27	2.4E-06	2.1E-08	NAP	1.0E-09	**2.4E-06**	NA	NA	NAP	NA	0.0E+00
Radium-228	2.57	2.0E-07	7.5E-11	NAP	1.7E-05	**1.7E-05**	NA	NA	NAP	NA	0.0E+00
Strontium-90	1.38	2.4E-08	2.8E-12	NAP	0.0E+00	2.4E-08	NA	NA	NAP	NA	0.0E+00
Thorium-230	3.61	4.2E-08	1.8E-09	NAP	3.2E-10	4.4E-08	NA	NA	NAP	NA	0.0E+00
Uranium-235	0.00	0.0E+00	0.0E+00	NAP	0.0E+00	0.0E+00	NA	NA	NAP	NA	0.0E+00
Uranium-238	0.28	5.4E-09	1.0E-10	NAP	3.8E-08	4.3E-08	NA	NA	NAP	NA	0.0E+00
TOTAL		**3.3E-06**	2.5E-08	0.0E+00	**2.0E-05**	**2.3E-05**	2.0E-05	0.0E+00	0.0E+00	0.0E+00	2.0E-05

EPC Exposure point concentration
mg/kg Milligram per kilogram.
NA Not available; insufficient toxicity data.
NAP Not an applicable pathway.
pCi/g Picocuries per gram
VOCs Volatile organic compounds.

Numbers written as 1.0E-03 equal 1×10^{-3}.

Table 5.7 Current Total Residual Groundwater Risk for the Construction Worker Scenario

Constituent	Total EPC	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation $VOC_{(shower)}$	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation VOCs	Non-Cancer HI Total
Metals	**mg/L**								
Antimony	0.0402	NA	NA	NA	0.0E+00	9.8E-01	1.6E-01	NA	**1.1E+00**
Cadmium	0.00525	NA	NA	1.6E-06	**1.6E-06**	1.0E-01	3.3E-02	6.3E-02	2.0E-01
Copper	0.0574	NA	NA	NA	0.0E+00	1.4E-02	1.5E-04	NA	1.4E-02
TOTAL		0.0E+00	0.0E+00	**1.6E-06**	**1.6E-06**	**1.1E+00**	1.9E-01	6.3E-02	**1.4E+00**

mg/L	Milligram per liter.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
NC	Not a suspected carcinogen.
pCi/L	Picocuries per liter.
VOCs	Volatile organic compounds.

Table 5.8 Current Background Residual Groundwater Risk for the Construction Worker Scenario

Constituent	Total EPC	CANCER EFFECTS Route-Specific Risk Oral	Dermal	Inhalation $VOC_{(shower)}$	Cancer Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	Dermal	Inhalation VOCs	Non-Cancer HI Total
Metals	**mg/L**								
Antimony	0.000578	NA	NA	NA	0.0E+00	1.4E-02	2.3E-03	NA	1.6E-02
Cadmium		NA	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Copper	0.001167	NA	NA	NA	0.0E+00	2.9E-04	3.1E-06	NA	2.9E-04
TOTAL		0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.4E-02	2.3E-03	0.0E+00	1.7E-02

mg/L	Milligram per liter.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
NC	Not a suspected carcinogen.
pCi/L	Picocuries per liter.
VOCs	Volatile organic compounds.

Table 5.9 Current Incremental Residual Groundwater Risk for the Construction Worker Scenario

Constituent	Total EPC	CANCER EFFECTS: Route-Specific Risk: Oral	Dermal	Inhalation $VOC_{(shower)}$	Cancer Risk Total	NON-CANCER EFFECTS: Route-Specific HQ: Oral	Dermal	Inhalation VOCs	Non-Cancer HI Total
Metals	**mg/L**								
Antimony	0.039622	NA	NA	NA	0.0E+00	9.7E-01	1.6E-01	NA	**1.1E+00**
Cadmium	0.00525	NA	NA	1.6E-06	**1.6E-06**	1.0E-01	3.3E-02	6.3E-02	2.0E-01
Copper	0.056233	NA	NA	NA	0.0E+00	1.4E-02	1.5E-04	NA	1.4E-02
TOTAL		0.0E+00	0.0E+00	1.6E-06	**1.6E-06**	**1.1E+00**	1.9E-01	6.3E-02	**1.3E+00**

mg/L	Milligram per liter.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
NC	Not a suspected carcinogen.
pCi/L	Picocuries per liter.
VOCs	Volatile organic compounds.

Table 5.10 Current Total Residual Groundwater Risk for Site Employee Scenario

Constituent	Total EPC	CANCER EFFECTS Route-Specific Risk Oral	CANCER EFFECTS Route-Specific Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	NON-CANCER EFFECTS Non-Cancer HI Total
Metals	**mg/L**				
Antimony	0.0402	NA	0.0E+00	9.8E-01	**9.8E-01**
Cadmium	0.00525	NA	0.0E+00	1.0E-01	1.0E-01
Copper	0.0574	NA	0.0E+00	1.4E-02	1.4E-02
Radionuclides	**pCi/L**				
Actinium-227	0.5	2.0E-06	2.0E-06	NAP	NAP
Plutonium-239/240	2	4.0E-06	4.0E-06	NAP	NAP
Thorium-228	2.17	3.1E-06	3.1E-06	NAP	NAP
Uranium-234	8.14	2.3E-06	2.3E-06	NAP	NAP
TOTAL		**1.1E-05**	**1.1E-05**	**1.1E+00**	**1.1E+00**

mg/L	Milligram per liter.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
NC	Not a suspected carcinogen.
pCi/L	Picocuries per liter.
VOCs	Volatile organic compounds.

Table 5.11 Current Background Residual Groundwater Risk for the Site Employee Scenario

Constituent	Total EPC	CANCER EFFECTS Route-Specific Risk Oral	CANCER EFFECTS Route-Specific Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	NON-CANCER EFFECTS Non-Cancer HI Total
Metals	**mg/L**				
Antimony	0.000578	NA	0.0E+00	1.4E-02	1.4E-02
Cadmium		NA	0.0E+00	0.0E+00	0.0E+00
Copper	0.001167	NA	0.0E+00	2.9E-04	2.9E-04
Radionuclides	**pCi/L**				
Actinium-227		0.0E+00	0.0E+00	NAP	NAP
Plutonium-239/240	0.996	2.0E-06	2.0E-06	NAP	NAP
Thorium-228	0.779	1.1E-06	1.1E-06	NAP	NAP
Uranium-234	0.792	2.2E-07	2.2E-07	NAP	NAP
TOTAL		**3.3E-06**	**3.3E-06**	1.4E-02	1.4E-02

mg/L	Milligram per liter.
NA	Not available.
NAP	Not applicable pathway; not a VOC.
NC	Not a suspected carcinogen.
pCi/L	Picocuries per liter.
VOCs	Volatile organic compounds.

Table 5.12 Current Incremental Residual Groundwater Risk for the Site Employee Scenario

Constituent	Total EPC	CANCER EFFECTS Route-Specific Risk Oral	CANCER EFFECTS Route-Specific Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	NON-CANCER EFFECTS Non-Cancer HI Total
Metals	**mg/L**				
Antimony	0.039622	NA	0.0E+00	9.7E-01	**9.7E-01**
Cadmium	0.00525	NA	0.0E+00	1.0E-01	1.0E-01
Copper	0.056233	NA	0.0E+00	1.4E-02	1.4E-02
Radionuclides	**pCi/L**				
Actinium-227	0.5	2.0E-06	**2.0E-06**	NAP	NAP
Plutonium-239/240	1.004	2.0E-06	**2.0E-06**	NAP	NAP
Thorium-228	1.391	2.0E-06	**2.0E-06**	NAP	NAP
Uranium-234	7.348	2.0E-06	2.0E-06	NAP	NAP
TOTAL		**8.0E-06**	**8.0E-06**	**1.1E+00**	**1.1E+00**

mg/L	Milligram per liter.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
NC	Not a suspected carcinogen.
pCi/L	Picocuries per liter.
VOCs	Volatile organic compounds.

Table 5.13 Future Total Groundwater Risk for the Construction Worker Scenario

Constituent	Total EPC mg/L	CANCER EFFECTS Route-Specific Risk Oral	Dermal	Inhalation $VOC_{(shower)}$	Cancer Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	Dermal	Inhalation VOCs	Non-Cancer HI Total
VOCs									
1,2-cis-dichloroethene	0.0042	NA	NA	NA	0.0E+00	4.1E-03	5.3E-04	NA	4.6E-03
1,2-Dichloroethene	0.0095	NA	NA	NA	0.0E+00	1.0E-02	1.3E-03	NA	1.2E-02
Dichloromethane	0.0278	1.5E-07	2.4E-08	2.2E-09	1.7E-07	4.5E-03	7.4E-04	2.2E-05	5.3E-03
Tetrachloroethene	0.0028	1.0E-07	4.4E-07	2.7E-10	5.5E-07	2.7E-03	1.2E-02	1.7E-05	1.5E-02
Trichloroethene	0.0075	5.8E-08	4.6E-08	2.2E-09	1.1E-07	1.2E-02	9.8E-03	8.5E-04	2.3E-02
Inorganics									
Aluminum	2.1356	NA	NA	NA	0.0E+00	2.1E-02	NA	1.0E+00	1.1E+00
Antimony	3.2921	NA	NA	NA	0.0E+00	8.1E+01	1.7E+00	NA	**8.2E+01**
Beryllium	0.0002	NA	NA	8.2E-08	8.2E-08	9.8E-04	4.5E-06	2.4E-02	2.5E-02
Bismuth	0.0098	NA	NA	NA	0.0E+00	NA	NA	NA	0.0E+00
Cadmium	0.0087	NA	NA	2.7E-06	**2.7E-06**	1.7E-01	2.2E-02	NA	1.9E-01
Chromium VI	0.9626	NA	NA	1.4E-02	**1.4E-02**	3.1E+00	4.1E-01	NA	3.5E+00
Cobalt	0.0080	NA	NA	NA	0.0E+00	1.3E-03	NA	NA	**1.3E-03**
Copper	0.6069	NA	NA	NA	0.0E+00	1.6E-01	NA	NA	1.6E-01
Lithium	0.1195	NA	NA	NA	0.0E+00	5.8E-02	NA	NA	5.8E-02
Manganese	0.3817	NA	NA	NA	0.0E+00	1.6E-01	1.3E-02	1.9E+01	**1.9E+01**
Molybdenum	0.0151	NA	NA	NA	0.0E+00	3.0E-02	NA	NA	3.0E-02
Nickel	0.2011	NA	NA	NA	0.0E+00	9.8E-02	8.0E-03	NA	1.1E-01
Selenium	0.0022	NA	NA	NA	0.0E+00	4.3E-03	1.7E-05	NA	4.3E-03
Thallium	0.0045	NA	NA	NA	0.0E+00	5.5E-01	1.8E-03	NA	**5.5E-01**
Tin	0.0205	NA	NA	NA	0.0E+00	3.3E-04	NA	NA	**3.3E-04**
Vanadium	0.0252	NA	NA	NA	0.0E+00	3.5E-02	4.4E-03	NA	4.0E-02

Table 5.13 Future Total Groundwater Risk for the Construction Worker Scenario

Constituent	Total EPC mg/L	CANCER EFFECTS Route-Specific Risk Oral	Dermal	Inhalation $VOC_{(shower)}$	Cancer Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	Dermal	Inhalation VOCs	Non-Cancer HI Total
VOCs									
1,2-cis-dichloroethene	0.0047	NA	NA	NA	0.0E+00	4.6E-03	5.9E-04	NA	5.2E-03
1,2-Dichloroethene	0.0023	NA	NA	NA	0.0E+00	2.5E-03	3.2E-04	NA	2.8E-03
Dichloromethane	0.0278	1.5E-07	2.4E-08	2.2E-09	1.7E-07	4.5E-03	7.4E-04	2.2E-05	5.3E-03
Tetrachloroethene	0.0028	1.0E-07	4.4E-07	2.7E-10	5.5E-07	2.7E-03	1.2E-02	1.7E-05	1.5E-02
Trichloroethene	0.0075	5.8E-08	4.6E-08	2.2E-09	1.1E-07	1.2E-02	9.8E-03	8.5E-04	2.3E-02
Inorganics									
Aluminum	2.1356	NA	NA	NA	0.0E+00	2.1E-02	NA	1.0E+00	1.1E+00
Antimony	0.0436	NA	NA	NA	0.0E+00	1.1E+00	2.3E-02	NA	**1.1E+00**
Beryllium	0.0002	NA	NA	8.2E-08	8.2E-08	9.8E-04	4.5E-06	2.4E-02	2.5E-02
Bismuth	0.0098	NA	NA	NA	0.0E+00	NA	NA	NA	0.0E+00
Cadmium	0.0087	NA	NA	2.7E-06	**2.7E-06**	1.7E-01	2.2E-02	NA	1.9E-01
Chromium VI	0.9626	NA	NA	1.4E-02	**1.4E-02**	3.1E+00	4.1E-01	NA	3.5E+00
Cobalt	0.0080	NA	NA	NA	0.0E+00	1.3E-03	NA	NA	**1.3E-03**
Copper	0.6069	NA	NA	NA	0.0E+00	1.6E-01	NA	NA	1.6E-01
Lithium	0.1195	NA	NA	NA	0.0E+00	5.8E-02	NA	NA	5.8E-02
Manganese	0.3817	NA	NA	NA	0.0E+00	1.6E-01	1.3E-02	1.9E+01	**1.9E+01**
Molybdenum	0.0151	NA	NA	NA	0.0E+00	3.0E-02	NA	NA	3.0E-02
Nickel	0.2011	NA	NA	NA	0.0E+00	9.8E-02	8.0E-03	NA	1.1E-01
Selenium	0.0022	NA	NA	NA	0.0E+00	4.3E-03	1.7E-05	NA	4.3E-03
Thallium	0.0045	NA	NA	NA	0.0E+00	5.5E-01	1.8E-03	NA	**5.5E-01**
Vanadium	0.0252	NA	NA	NA	0.0E+00	3.5E-02	4.4E-03	NA	4.0E-02

Table 5.13 Future Total Groundwater Risk for the Construction Worker Scenario

Constituent	Total	CANCER EFFECTS Route-Specific Risk Oral	Dermal	Inhalation $VOC_{(shower)}$	Cancer Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	Dermal	Inhalation VOCs	Non-Cancer HI Total
Radionuclides	pCi/L								
Americium-241	1.8956	7.8E-07	NA	NAP	7.8E-07	NAP	NAP	NAP	NAP
Plutonium-239/240	2.0914	8.3E-07	NA	NAP	8.3E-07	NAP	NAP	NAP	NAP
Radium-226	1.6902	3.5E-13	NA	NAP	3.5E-13	NA	NAP	NAP	NAP
Strontium-90	1.3177	6.7E-08	NA	NAP	6.7E-08	NAP	NAP	NAP	NAP
Thorium-228	2.5351	2.0E-07	NA	NAP	2.0E-07	NAP	NAP	NAP	NAP
Tritium	73145.3956	6.5E-06	3.2E-04	8.2E-08	**3.2E-04**	NAP	NAP	NAP	NAP
Uranium-234	8.7303	4.8E-07	NA	NAP	4.8E-07	NAP	NAP	NAP	NAP
Uranium-235	5.0326	2.8E-07	NA	NAP	2.8E-07	NAP	NAP	NAP	NAP
TOTAL		**9.5E-06**	**3.2E-04**	**1.4E-02**	**1.4E-02**	**5.5E+00**	**5.0E-01**	**2.0E+01**	**2.6E+01**

mg/L Milligram per liter.
NA Not available; insufficient toxicity data.
NAP Not applicable pathway; not a VOC.
NC Not a suspected carcinogen.
pCi/L Picocuries per liter.
VOCs Volatile organic compounds.

Table 5.14 Future Background Goundwater Risk for the Construction Worker Scenario

Constituent	Total EPC mg/L	CANCER EFFECTS Route-Specific Risk Oral	Dermal	Inhalation $VOC_{(shower)}$	Cancer Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	Dermal	Inhalation VOCs	Non-Cancer HI Total
VOCs									
1,2-cis-Dichloroethene	0.000575	NA	NA	NA	NA	5.6E-04	7.2E-05	NA	6.3E-04
1,2-Dichloroethene		NA	NA	NA	NA	0.0E+00	0.0E+00	NA	0.0E+00
Dichloromethane		0.0E+00	0.0E+00	0.0E+00	NA	NA	0.0E+00	0.0E+00	NA
Tetrachloroethene		NA	NA	NA	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Trichloroethene		NA	NA	NA	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Inorganics									
Aluminum	0.037523	NA	NA	NA	NA	3.7E-04	NA	1.8E-02	1.9E-02
Antimony	0.000578	NA	NA	NA	NA	1.4E-02	3.1E-04	NA	1.4E-02
Beryllium		NA	NA	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	NA
Bismuth		NA	NA	NA	NA	NA	NA	NA	0.0E+00
Cadmium		NA	NA	NA	NA	0.0E+00	0.0E+00	NA	0.0E+00
Chromium VI	0.006076	NA	NA	8.6E-05	**8.6E-05**	2.0E-02	2.6E-03	NA	2.2E-02
Cobalt	0.001032	NA	NA	NA	0.0E+00	1.7E-04	NA	NA	1.7E-04
Copper	0.001167	NA	NA	NA	NA	3.1E-04	NA	NA	3.1E-04
Lithium	0.055707	NA	NA	NA	NA	2.7E-02	NA	NA	NA
Manganese	0.229568	NA	NA	NA	NA	9.4E-02	7.6E-03	1.1E+01	**1.1E+01**
Molybdenum	0.005597	NA	NA	NA	NA	1.1E-02	NA	NA	1.1E-02
Nickel	0.034957	NA	NA	NA	NA	1.7E-02	1.4E-03	NA	1.8E-02
Selenium		NA	NA	NA	NA	NA	NA	NA	NA
Thallium		NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	0.017076	NA	NA	NA	NA	2.4E-02	3.0E-03	NA	2.7E-02

Table 5.14 Future Background Goundwater Risk for the Construction Worker Scenario

Constituent	Total	CANCER EFFECTS Route-Specific Risk Oral	Dermal	Inhalation $VOC_{(shower)}$	Cancer Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	Dermal	Inhalation VOCs	Non-Cancer HI Total
Radionuclides	pCi/L								
Americium-241	0.139	5.7E-08	NA	NAP	NA	NAP	NAP	NAP	NAP
Plutonium-239/240	0.125	4.9E-08	NA	NAP	4.9E-08	NAP	NAP	NAP	NAP
Radium-226	0.996	3.7E-07	NA	NAP	NA	NAP	NAP	NAP	NAP
Strontium-90	0.975	5.0E-08	NA	NAP	5.0E-08	NAP	NAP	NAP	NAP
Thorium-228	0.779	6.1E-08	NA	NAP	6.1E-08	NAP	NAP	NAP	NAP
Tritium	1485.473	1.3E-07	6.5E-06	1.7E-09	6.6E-06	NAP	NAP	NAP	NAP
Uranium-234	0.792	4.4E-08	NA	NAP	4.4E-08	NAP	NAP	NAP	NAP
Uranium-235	0.814	4.6E-08	NA	NAP	4.6E-08	NAP	NAP	NAP	NAP
TOTAL		**8.1E-07**	**6.5E-06**	**8.6E-05**	**9.3E-05**	**2.1E-01**	1.5E-02	**1.1E+01**	**1.1E+01**

mg/L	Milligram per liter.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
NC	Not a suspected carcinogen.
pCi/L	Picocuries per liter.
VOCs	Volatile organic compounds.

Table 5.15 Future Incremental Groundwater Risk for the Construction Worker Scenario

Constituent	Total EPC mg/L	CANCER EFFECTS Route-Specific Risk Oral	Dermal	Inhalation $VOC_{(shower)}$	Cancer Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	Dermal	Inhalation VOCs	Non-Cancer HI Total
VOCs									
1,2-cis-dichloroethene	0.0041	NA	NA	NA	NA	4.0E-03	5.2E-04	NA	4.6E-03
1,2-Dichloroethene	0.0023	NA	NA	NA	NA	2.5E-03	3.2E-04	NA	2.8E-03
Dichloromethane	0.0278	1.5E-07	2.4E-08	2.2E-09	NA	4.5E-03	7.4E-04	2.2E-05	5.3E-03
Tetrachloroethene	0.0028	1.0E-07	4.4E-07	2.7E-10	5.5E-07	2.7E-03	1.2E-02	1.7E-05	1.5E-02
Trichloroethene	0.0075	5.8E-08	4.6E-08	2.2E-09	1.1E-07	1.2E-02	9.8E-03	8.5E-04	2.3E-02
Inorganics									
Aluminum	2.0981	NA	NA	NA	NA	2.1E-02	NA	1.0E+00	1.0E+00
Antimony	0.0430	NA	NA	NA	NA	1.1E+00	2.3E-02	NA	**1.1E+00**
Beryllium	0.0002	NA	NA	8.2E-08	NA	9.8E-04	4.5E-06	2.4E-02	NA
Bismuth	0.0098	NA	NA	NA	0.0E+00	NA	NA	NA	0.0E+00
Cadmium	0.0087	NA	NA	2.7E-06	2.7E-06	1.7E-01	2.2E-02	NA	1.9E-01
Chromium VI	0.9565	NA	NA	1.4E-02	1.4E-02	3.1E+00	4.0E-01	NA	3.5E+00
Cobalt	0.0070	NA	NA	NA	0.0E+00	1.1E-03	NA	NA	1.1E-03
Copper	0.6057	NA	NA	NA	NA	1.6E-01	NA	NA	1.6E-01
Lithium	0.0638	NA	NA	NA	NA	3.1E-02	NA	NA	NA
Manganese	0.1521	NA	NA	NA	NA	6.2E-02	5.0E-03	7.4E+00	**7.5E+00**
Molybdenum	0.0095	NA	NA	NA	NA	1.9E-02	NA	NA	1.9E-02
Nickel	0.1661	NA	NA	NA	NA	8.1E-02	6.6E-03	NA	8.8E-02
Selenium	0.0022	NA	NA	NA	NA	4.3E-03	1.7E-05	NA	4.3E-03
Thallium	0.0045	NA	NA	NA	NA	5.5E-01	1.8E-03	NA	5.5E-01
Vanadium	0.0081	NA	NA	NA	NA	1.1E-02	1.4E-03	NA	1.3E-02

Table 5.15 Future Incremental Groundwater Risk for the Construction Worker Scenario

Constituent	Total	CANCER EFFECTS Route-Specific Risk Oral	Dermal	Inhalation $VOC_{(shower)}$	Cancer Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	Dermal	Inhalation VOCs	Non-Cancer HI Total
Radionuclides	pCi/L								
Americium-241	1.7566	7.2E-07	NA	NAP	7.2E-07	NAP	NAP	NAP	NAP
Plutonium-239/240	1.9664	7.8E-07	NA	NAP	7.8E-07	NAP	NAP	NAP	NAP
Radium-226	0.6942	2.6E-07	NA	NAP	2.6E-07	NAP	NAP	NAP	NAP
Strontium-90	0.3427	1.8E-08	NA	NAP	1.8E-08	NAP	NAP	NAP	NAP
Thorium-228	1.7561	1.4E-07	NA	NAP	1.4E-07	NAP	NAP	NAP	NAP
Tritium	71659.9226	6.4E-06	3.1E-04	8.0E-08	3.2E-04	NAP	NAP	NAP	NAP
Uranium-234	7.9383	4.4E-07	NA	NAP	4.4E-07	NAP	NAP	NAP	NAP
Uranium-235	4.2186	2.4E-07	NA	NAP	2.4E-07	NAP	NAP	NAP	NAP
TOTAL		**9.3E-06**	**3.1E-04**	**1.4E-02**	**1.4E-02**	**5.3E+00**	**4.9E-01**	**8.5E+00**	**1.4E+01**

mg/L Milligram per liter.
NA Not available; insufficient toxicity data.
NAP Not applicable pathway; not a VOC.
NC Not a suspected carcinogen.
pCi/L Picocuries per liter.
VOCs Volatile organic compounds.

Table 5.16 Future Total Residual Groundwater Risk for Site Employee Scenario

Constituent	Total EPC mg/L	CANCER EFFECTS Route-Specific Risk Oral	Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	Non-Cancer HI Total
VOCs					
1,2-cis-dichloroethene	0.0047	NA	0.0E+00	4.6E-03	4.6E-03
1,2-Dichloroethene	0.0023	NA	0.0E+00	2.5E-03	2.5E-03
Dichloromethane	0.0278	7.3E-07	7.3E-07	4.5E-03	4.5E-03
Tetrachloroethene	0.0028	5.1E-07	5.1E-07	2.7E-03	2.7E-03
Trichloroethene	0.0075	2.9E-07	2.9E-07	1.2E-02	1.2E-02
Metals					
Aluminum	2.1356	NA	0.0E+00	2.1E-02	2.1E-02
Antimony	0.0436	NA	0.0E+00	1.1E+00	**1.1E+00**
Beryllium	0.0002	NA	0.0E+00	9.8E-04	9.8E-04
Bismuth	0.0098	NA	0.0E+00	NA	0.0E+00
Cadmium	0.0087	NA	0.0E+00	1.7E-01	1.7E-01
Chromium VI	0.9626	NA	0.0E+00	3.1E+00	**3.1E+00**
Cobalt	0.0080	NA	0.0E+00	1.3E-03	1.3E-03
Copper	0.6069	NA	0.0E+00	1.6E-01	1.6E-01
Lithium	0.1195	NA	0.0E+00	5.8E-02	5.8E-02
Manganese	0.3817	NA	0.0E+00	1.6E-01	1.6E-01
Molybdenum	0.0151	NA	0.0E+00	3.0E-02	3.0E-02
Nickel	0.2011	NA	0.0E+00	9.8E-02	9.8E-02
Selenium	0.0022	NA	0.0E+00	4.3E-03	4.3E-03
Thallium	0.0045	NA	0.0E+00	5.5E-01	5.5E-01
Vanadium	0.0252	NA	0.0E+00	3.5E-02	3.5E-02

Table 5.16 Future Total Residual Groundwater Risk for Site Employee Scenario

Constituent	Total	CANCER EFFECTS Route-Specific Risk Oral	Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	Non-Cancer HI Total
Radionuclides	pCi/L				
Actinium-227	0.5000	2.0E-06	**2.0E-06**	NA	NA
Americium-241	1.8956	3.9E-06	**3.9E-06**	NA	NA
Plutonium-239/240	2.0914	4.1E-06	**4.1E-06**	NA	NA
Radium-226	1.6902	3.1E-06	**3.1E-06**	NA	NA
Strontium-90	1.3177	3.4E-07	3.4E-07	NA	NA
Thorium-228	2.5351	1.0E-06	**1.0E-06**	NA	NA
Tritium	73145.3956	3.3E-05	**3.3E-05**	NA	NA
Uranium-234	8.7303	2.4E-06	**2.4E-06**	NA	NA
Uranium-235	5.0326	1.4E-06	**1.4E-06**	NA	NA
TOTAL		**5.2E-05**	**5.2E-05**	**5.5E+00**	**5.5E+00**

mg/L	Milligram per liter.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
NC	Not a suspected carcinogen.
pCi/L	Picocuries per liter.
VOCs	Volatile organic compounds.

Table 5.17 Future Background Residual Groundwater Risk for Site Employee Scenario

Constituent	Total EPC mg/L	CANCER EFFECTS Route-Specific Risk Oral	Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	Non-Cancer HI Total
VOCs					
1,2-cis-dichloroethene	0.000575	NA	0.0E+00	5.6E-04	5.6E-04
1,2-Dichloroethene		NA	0.0E+00	0.0E+00	0.0E+00
Dichloromethane		0.0E+00	0.0E+00	0.0E+00	0.0E+00
Tetrachloroethene		0.0E+00	0.0E+00	0.0E+00	0.0E+00
Trichloroethene		0.0E+00	0.0E+00	0.0E+00	0.0E+00
		0.0E+00	0.0E+00	0.0E+00	0.0E+00
Metals					
Aluminum	0.037523				
Antimony	0.000578	NA	0.0E+00	1.4E-02	1.4E-02
Beryllium		NA	0.0E+00	0.0E+00	0.0E+00
Bismuth		NA	0.0E+00	NA	0.0E+00
Cadmium		NA	0.0E+00	0.0E+00	0.0E+00
Chromium VI	0.006076	NA	0.0E+00	2.0E-02	2.0E-02
Cobalt	0.001032	NA	0.0E+00	1.7E-04	1.7E-04
Copper	0.001167	NA	0.0E+00	3.1E-04	3.1E-04
Lithium	0.055707	NA	0.0E+00	2.7E-02	2.7E-02
Manganese	0.229568	NA	0.0E+00	9.4E-02	9.4E-02
Molybdenum	0.005597	NA	0.0E+00	1.1E-02	1.1E-02
Nickel	0.034957	NA	0.0E+00	1.7E-02	1.7E-02
Selenium		NA	0.0E+00	0.0E+00	0.0E+00
Thallium		NA	0.0E+00	0.0E+00	0.0E+00
Vanadium	0.017076	NA	0.0E+00	2.4E-02	2.4E-02

Table 5.17 Future Background Residual Groundwater Risk for Site Employee Scenario

Constituent	Total	CANCER EFFECTS Route-Specific Risk Oral	Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	Non-Cancer HI Total
Radionuclides	pCi/L				
Actinium-227		0.0E+00	0.0E+00	NA	NA
Americium-241	0.139	2.8E-07	2.8E-07	NA	NA
Plutonium-239/240	0.125	2.5E-07	2.5E-07	NA	NA
Radium-226	0.996	1.8E-06	**1.8E-06**	NA	NA
Strontium-90	0.975	2.5E-07	2.5E-07	NA	NA
Thorium-228	0.779	3.1E-07	3.1E-07	NA	NA
Tritium	1485.473	6.6E-07	6.6E-07	NA	NA
Uranium-234	0.792	2.2E-07	2.2E-07	NA	NA
Uranium-235	0.814	2.3E-07	2.3E-07	NA	NA
TOTAL		**4.0E-06**	**4.0E-06**	**2.1E-01**	**2.1E-01**

mg/L	Milligram per liter.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
NC	Not a suspected carcinogen.
pCi/L	Picocuries per liter.
VOCs	Volatile organic compounds.

Table 5.18 Future Incremental Residual Groundwater Risk for Site Employee Scenario

Constituent	Total EPC mg/L	CANCER EFFECTS Route-Specific Risk Oral	Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	Non-Cancer HI Total
VOCs					
1,2-cis-dichloroethene	0.0041	NA	0.0E+00	4.0E-03	4.0E-03
1,2-Dichloroethene	0.0023	NA	0.0E+00	2.5E-03	2.5E-03
Dichloromethane	0.0278	7.3E-07	7.3E-07	4.5E-03	4.5E-03
Tetrachloroethene	0.0028	5.1E-07	5.1E-07	2.7E-03	2.7E-03
Trichloroethene	0.0075	2.9E-07	2.9E-07	1.2E-02	1.2E-02
Metals					
Aluminum	2.098077	NA	0.0E+00	2.1E-02	2.1E-02
Antimony	0.043022	NA	0.0E+00	1.1E+00	**1.1E+00**
Beryllium	0.000200	NA	0.0E+00	9.8E-04	9.8E-04
Bismuth	0.009800	NA	0.0E+00	NA	0.0E+00
Cadmium	0.008700	NA	0.0E+00	1.7E-01	1.7E-01
Chromium VI	0.956524	NA	0.0E+00	3.1E+00	**3.1E+00**
Cobalt	0.006968	NA	0.0E+00	1.1E-03	1.1E-03
Copper	0.605733	NA	0.0E+00	1.6E-01	1.6E-01
Lithium	0.063793	NA	0.0E+00	3.1E-02	3.1E-02
Manganese	0.152132	NA	0.0E+00	6.2E-02	6.2E-02
Molybdenum	0.009503	NA	0.0E+00	1.9E-02	1.9E-02
Nickel	0.166143	NA	0.0E+00	8.1E-02	8.1E-02
Selenium	0.002200	NA	0.0E+00	4.3E-03	4.3E-03
Thallium	0.004500	NA	0.0E+00	5.5E-01	5.5E-01
Vanadium	0.008124	NA	0.0E+00	1.1E-02	1.1E-02

Table 5.18 Future Incremental Residual Groundwater Risk for Site Employee Scenario

Constituent	Total	CANCER EFFECTS Route-Specific Risk Oral	Risk Total	NON-CANCER EFFECTS Route-Specific HQ Oral	Non-Cancer HI Total
Radionuclides	pCi/L				
Actinium-227	0.500000	2.0E-06	**2.0E-06**	NAP	NAP
Americium-241	1.756600	3.6E-06	**3.6E-06**	NAP	NAP
Plutonium-239/240	1.966400	3.9E-06	**3.9E-06**	NAP	NAP
Radium-226	0.694200	1.3E-06	**1.3E-06**	NAP	NAP
Strontium-90	0.342700	8.8E-08	8.8E-08	NAP	NAP
Thorium-228	1.756100	6.9E-07	6.9E-07	NAP	NAP
Tritium	71659.922600	3.2E-05	**3.2E-05**	NAP	NAP
Uranium-234	7.938300	2.2E-06	**2.2E-06**	NAP	NAP
Uranium-235	4.218600	1.2E-06	**1.2E-06**	NAP	NAP
TOTAL		**4.8E-05**	**4.8E-05**	**5.3E+00**	**5.3E+00**

mg/L	Milligram per liter.
NA	Not available; insufficient toxicity data.
NAP	Not applicable pathway; not a VOC.
NC	Not a suspected carcinogen.
pCi/L	Picocuries per liter.
VOCs	Volatile organic compounds.

Table 5.19 Total Residual Risk for Parcel 4 Summary Table

Scenario and Receptor	Media	Constituents	Pathway	Total Noncarcinogen Risk HI	Total Carcinogenic Risk ELCR
Construction Worker Scenario	Soil (all sample depths)	Chemical and Radiological	Ingestion	1.9E-01	**1.6E-05**
			Dermal Contact	5.5E-02	0.0E+00
			Inhalation of Dust	0.0E+00	1.3E-08
			Inhalation of VOCs	0.0E+00	0.0E+00
			External	0.0E+00	**3.7E-06**
		Soil Total Risk		2.5E-01	**2.0E-05**
	Groundwater (Current)	Chemical and Radiological	Ingestion	**1.1E+00**	0.0E+00
			Dermal Contact	1.9E-01	0.0E+00
			Inhalation While Showering	6.3E-02	**1.6E-06**
		Current Groundwater Total Risk		**1.4E+00**	**1.6E-06**
	Groundwater (Future)	Chemical and Radiological	Ingestion	**5.5E+00**	**9.5E-06**
			Dermal Contact	5.0E-01	**3.2E-04**
			Inhalation While Showering	**2.0E+01**	**1.4E-02**
		Future Groundwater Total Risk		**2.6E+01**	**1.4E-02**
	Air*	Radiological	Inhalation	NA	2.1E-07
		Air Total Risk		NA	2.1E-07
	Cumulative Total Current Risk			**1.4E+00**	**2.2E-05**
	Cumulative Total Future Risk			**2.6E+01**	**1.4E-02**
Site Employee Scenario	Soil (0-2 ft bls)	Chemical and Radiological	Ingestion	6.6E-04	3.3E-06
			Inhalation of Dust	NA	2.7E-08
			Inhalation of VOCs	0.0E+00	0.0E+00
			External	NA	2.0E-05
		Soil Total Risk		6.6E-04	**2.3E-05**
	Groundwater (Current)	Chemical and Radiological	Ingestion	**1.1E+00**	**1.1E-05**
		Current Groundwater Total Risk		**1.1E+00**	**1.1E-05**
	Groundwater (Future)	Chemical and Radiological	Ingestion	**5.5E+00**	**5.2E-05**
		Future Groundwater Total Risk		**5.5E+00**	**5.2E-05**
	Air*	Radiological	Inhalation	NA	1.0E-06
		Air Total Risk		NA	1.0E-06
	Cumulative Total Current Risk			**1.1E+00**	**3.5E-05**
	Cumulative Total Future Risk			**5.5E+00**	**7.6E-05**

NA - Not applicable

*RRE values for air were brought forward from the Technical Position Report for Release Blocks D and H. (DOE 1999).

Numbers written as 1.0E-03 equal $1x10^{-3}$

Table 5.20 Background Residual Risk for Parcel 4 Summary Table

Scenario and Receptor	Media	Constituents	Pathway	Total Noncarcinogen Risk HI	Total Carcinogenic Risk ELCR
Construction Worker Scenario	Soil (all sample depths)	Chemical and Radiological	Ingestion	2.7E-02	2.3E-08
			Dermal Contact	4.0E-05	0.0E+00
			Inhalation of Dust	0.0E+00	2.1E-11
			Inhalation of VOCs	0.0E+00	0.0E+00
			External	0.0E+00	1.0E-12
		Soil Total Risk		2.7E-02	2.3E-08
	Groundwater (Current)	Chemical and Radiological	Ingestion	1.4E-02	0.0E+00
			Dermal Contact	2.4E-03	0.0E+00
			Inhalation While Showering	0.0E+00	0.0E+00
		Current Groundwater Total Risk		1.7E-02	0.0E+00
	Groundwater (Future)	Chemical and Radiological	Ingestion	2.1E-01	8.1E-07
			Dermal Contact	1.5E-02	**6.5E-06**
			Inhalation While Showering	**1.1E+01**	**8.6E-05**
		Future Groundwater Total Risk		**1.1E+01**	**9.3E-05**
	Air*	Radiological	Inhalation	NA	7.7E-09
		Air Total Risk		NA	7.7E-09
	Cumulative Background Current Risk			1.7E-02	3.1E-08
	Cumulative Background Future Risk			**1.1E+01**	**9.3E-05**
Site Employee Scenario	Soil (0-2 ft bls)	Chemical and Radiological	Ingestion	6.4E-04	6.7E-08
			Inhalation of Dust	NA	1.4E-09
			Inhalation of VOCs	NA	0.0E+00
			External	NA	1.9E-07
		Soil Total Risk		6.4E-04	2.6E-07
	Groundwater (Current)	Chemical and Radiological	Ingestion	1.4E-02	**3.3E-06**
		Current Groundwater Total Risk		1.4E-02	**3.3E-06**
	Groundwater (Future)	Chemical and Radiological	Ingestion	2.1E-01	**4.0E-06**
		Future Groundwater Total Risk		2.1E-01	**4.0E-06**
	Air*	Radiological	Inhalation	NA	3.9E-08
		Air Total Risk		NA	3.9E-08
	Cumulative Background Current Risk			1.5E-02	**3.6E-06**
	Cumulative Background Future Risk			2.1E-01	**4.3E-06**

NA - Not applicable

*RRE values for air were brought forward from the Technical Position Report for Release Blocks D and H. (DOE 1999).

Numbers written as 1.0E-03 equal $1x10^{-3}$

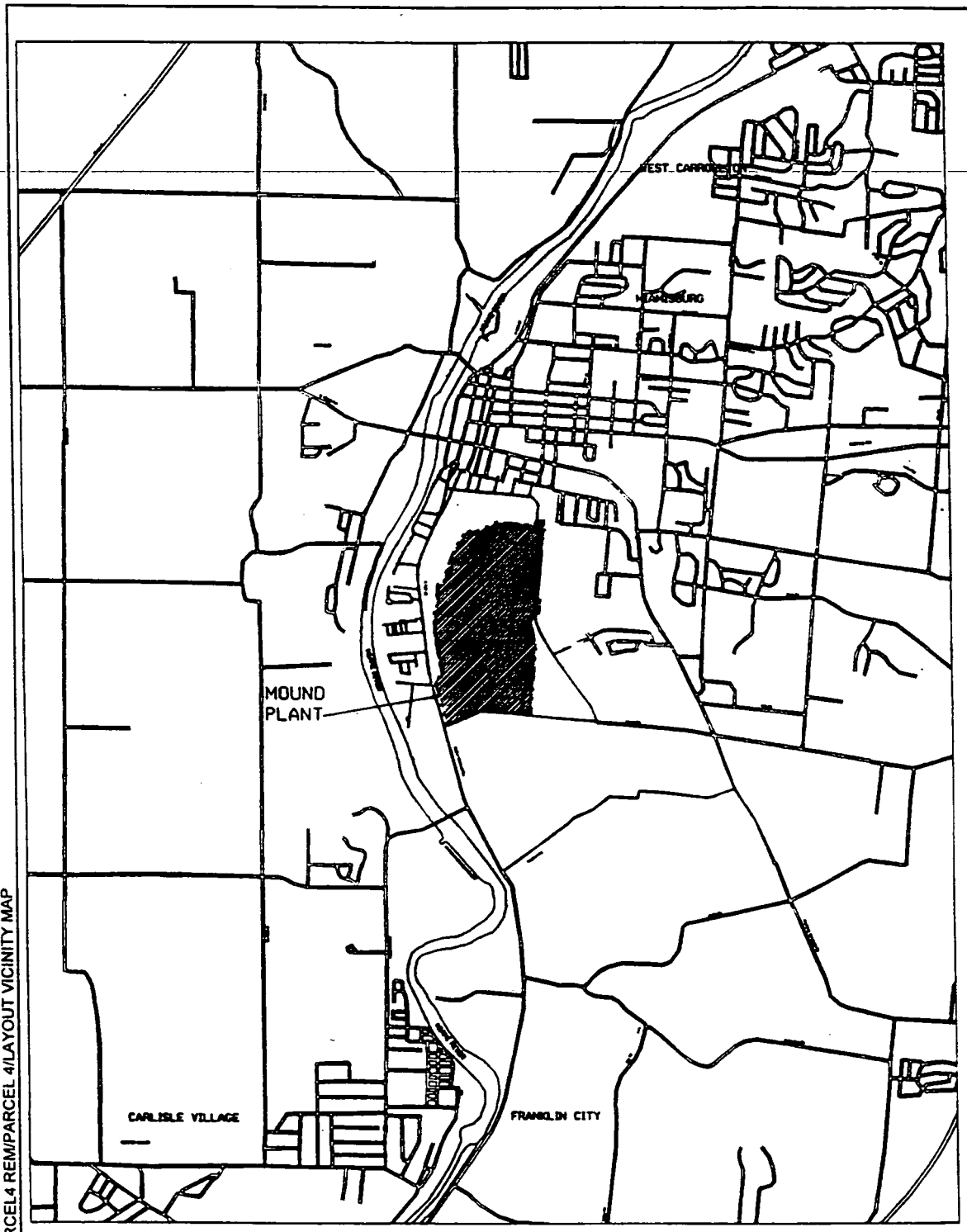
Table 5.21 Incremental Residual Risk for Parcel 4 Summary Table

Scenario and Receptor	Media	Constituents	Pathway	Total Noncarcinogen Risk HI	Total Carcinogenic Risk ELCR
Construction Worker Scenario	Soil (all sample depths)	Chemical and Radiological	Ingestion	1.6E-01	**1.6E-05**
			Dermal Contact	1.7E-03	4.0E-07
			Inhalation of Dust	0.0E+00	1.3E-08
			Inhalation of VOCs	NA	0.0E+00
			External	0.0E+00	**3.7E-06**
		Soil Total Risk		1.6E-01	**2.0E-05**
	Groundwater (Current)	Chemical and Radiological	Ingestion	**1.1E+00**	**0.0E+00**
			Dermal Contact	1.9E-01	0.0E+00
			Inhalation While Showering	6.3E-02	**1.6E-06**
		Current Groundwater Total Risk		**1.3E+00**	**1.6E-06**
	Groundwater (Future)	Chemical and Radiological	Ingestion	**5.3E+00**	**9.3E-06**
			Dermal Contact	4.9E-01	**3.1E-04**
			Inhalation While Showering	**8.5E+00**	**1.4E-02**
		Future Groundwater Total Risk		**1.4E+01**	**1.4E-02**
	Air*	Radiological	Inhalation	NA	2.0E-07
		Air Total Risk		NA	2.0E-07
	Cumulative Incremental Current Risk			**1.5E+00**	**2.2E-05**
	Cumulative Incremental Future Risk			**1.4E+01**	**1.4E-02**
Site Employee Scenario	Soil (0-2 ft bls)	Chemical and Radiological	Ingestion	2.0E-05	**3.3E-06**
			Inhalation of Dust	NA	2.5E-08
			Inhalation of VOCs	NA	0.0E+00
			External	NA	**2.0E-05**
		Soil Total Risk		2.0E-05	**2.3E-05**
	Groundwater (Current)	Chemical and Radiological	Ingestion	**1.1E+00**	**8.0E-06**
		Current Groundwater Total Risk		**1.1E+00**	**8.0E-06**
	Groundwater (Future)	Chemical and Radiological	Ingestion	**5.3E+00**	**4.8E-05**
		Future Groundwater Total Risk		**5.3E+00**	**4.8E-05**
	Air*	Radiological	Inhalation	NA	9.9E-07
		Air Total Risk		NA	9.9E-07
	Cumulative Incremental Current Risk			**1.1E+00**	**3.2E-05**
	Cumulative Incremental Future Risk			**5.3E+00**	**7.2E-05**

NA - Not applicable

*RRE values for air were brought forward from the Technical Position Report for Release Blocks D and H. (DOE 1999).

Numbers written as 1.0E-03 equal $1x10^{-3}$



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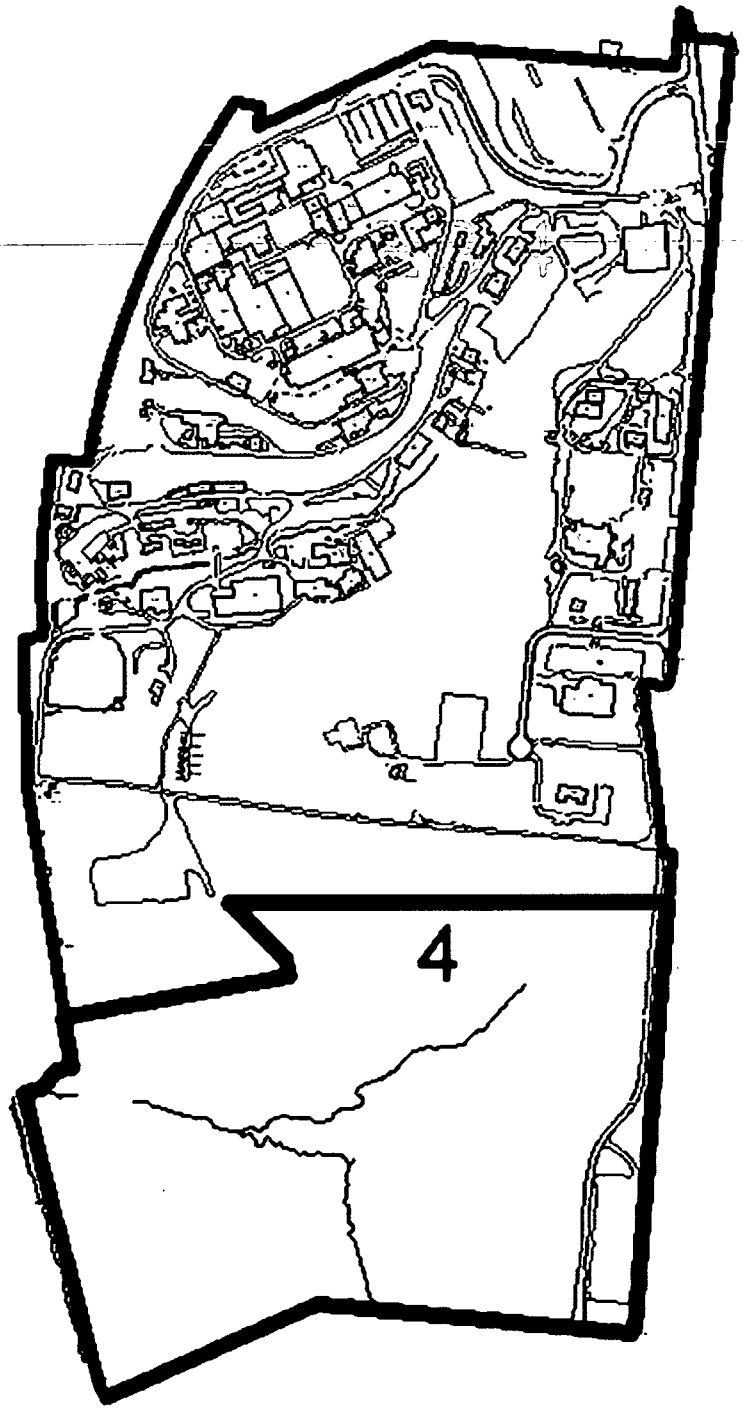
Mound Plant Parcel 4				
Vicinity Area Map				
Miamisburg, Ohio				
Science Applications International Corporation			Columbus, OH	
DRAWN BY LMA	DATE 5-8-00	SCALE NOT SHOWN	PROJECT	FIGURE NO. 1.1



Mound Plant Parcel 4			
Area Map			
Miamisburg, Ohio			
Science Applications International Corporation Columbus, OH			
DRAWN BY LMA	DATE 5-8-00	SCALE NOT SHOWN	FIGURE NO. 1.2

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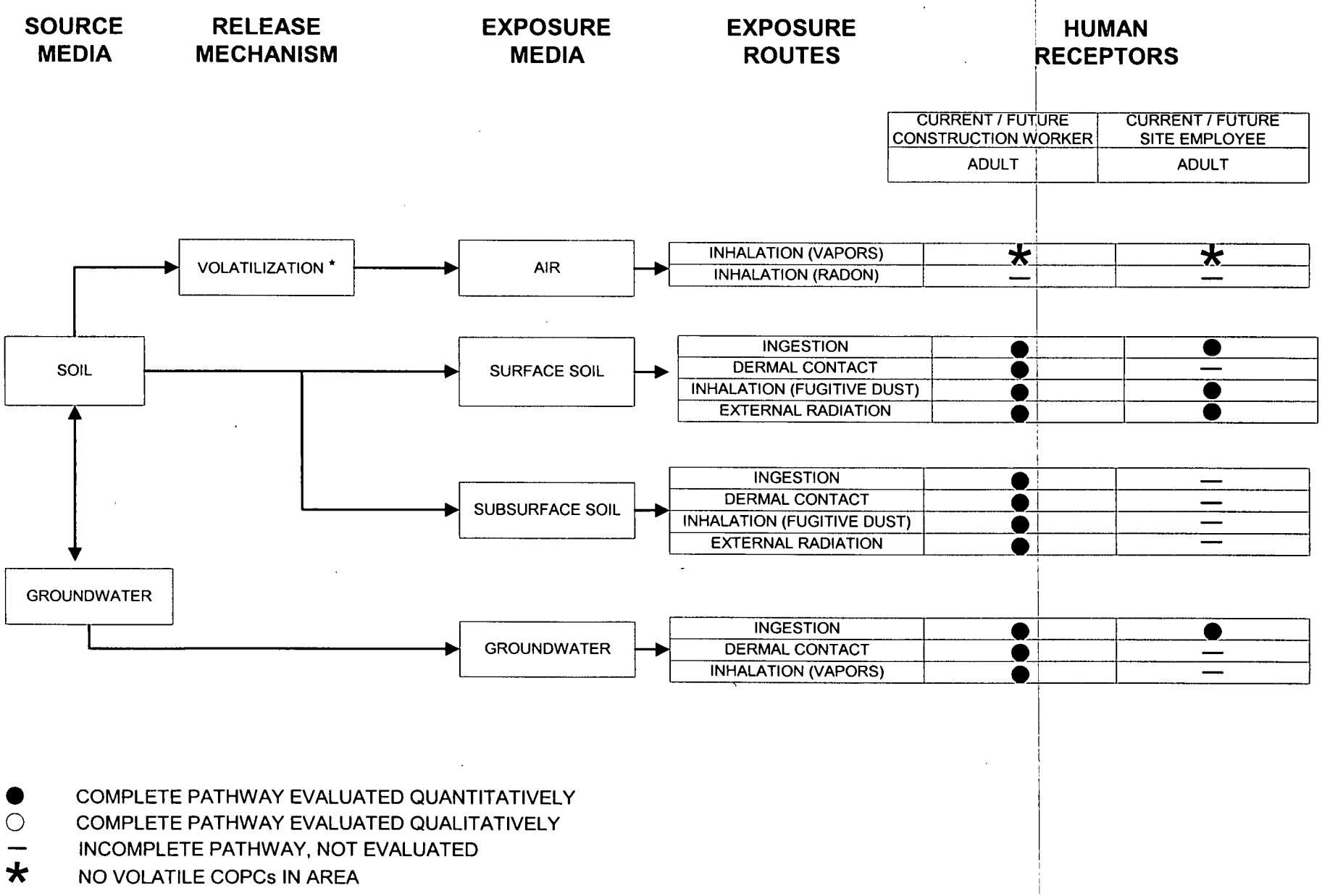

● COMPLETE PATHWAY EVALUATED QUANTITATIVELY
○ COMPLETE PATHWAY EVALUATED QUALITATIVELY
— INCOMPLETE PATHWAY, NOT EVALUATED
* NO VOLATILE COPCs IN AREA

Figure 3.1
Conceptual Site Model for the Parcel 4 RRE

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A1.1 EVALUATION OF POTENTIAL CUMULATIVE EXPOSURE – AIR

Potential exposure to contaminants originating from outside Release Block 3 that may reach a receptor in the release block are termed potential cumulative exposures. This appendix presents potential cumulative exposures that may come from air.

Airborne contaminant concentrations were measured at the Mound Facility in 1994 during various site restoration activities (DOE, 1994). Both radiological and non-radiological data were collected. It is assumed that the measured concentrations would represent an upper-bound air concentration. These data are shown in Table A1-1. Risks due to inhalation of the radionuclides by construction workers and site employees were calculated and are also presented in Table A1-1.

The calculated risks attributable to the potential upper-bound exposure of airborne contaminants would total 2.0E-07 for the construction worker and 9.8E-07 for the site employee. Note that the potential exposures and associated risks are based on the assumption of long-term consumption of this upper-bound concentration that was measured during site restoration activities.

Table A1-1 Concentration of Radionuclides in Air in 1994 (EG&G Mound Applied Technologies- Mound Site Environmental Report for Calendar Year 1994, pg. 4-15 to 4-17) MLM-3814

Radionuclide	Maximum Concentration* (μCi/mL)	Risks to Construction Worker*	Risks to Site Employees**
Tritium oxide (H-3)	7.54 ± 4.61E-12	1.8E-08	9.0E-08
Plutonium-238	259.65 ± 289.58E-18	1.75E-07	8.8E-07
Plutonium-239/240	3.50 ±2.75E-18	2.5E-09	1.2E-08
Total		2.0E-07	9.8E-07

* Error limits are estimates of the standard error of the estimated means at the 95% confidence level. Values given are from the location on the site with the highest concentration (based on the average of two or more samples).

** Calculated risks assumed that the maximum concentration shown here was the C_{air} value needed for the calculation of risk by inhalation for construction workers and site employees.

Potential Future Maximum Concentrations of COPCs in Groundwater

This Appendix describes the steps completed to estimate the potential future concentration of contaminants in the Mound Plant Production Wells. In summary, very conservative estimates of future contaminant concentrations were developed by assuming all contaminants currently detected in the Bedrock Aquifer of the Mound Property would migrate to the Buried Valley Aquifer (BVA), from which the Mound Plant Production Wells withdraw potable water for Mound facility use. The calculated potential bedrock contaminant concentrations were then added to the current contaminant concentrations in the Mound Plant Production Wells to obtain the estimated future contaminant concentrations.

The techniques used to forecast future contaminant concentrations were purposely designed to represent the most conservative (worst-case) future scenario possible. This overly conservative approach assures no significant chemical of concern would be prematurely removed from the risk evaluation process. If particular constituent concentrations were initially found to be unacceptable in the overall risk evaluations, efforts would then be focused on calculating a more realistic value at the production wells to assess their true potential impact. The steps completed to develop this initial "model" of the future contaminant concentrations in the Mound Plant Production Wells are summarized as follows.

1. Using established groundwater flow net analysis techniques, a topographic map of the bedrock surface underlying the Mound facility was used to create 20 evaluation areas of similar size termed "flow tubes." Ground water flow within the Bedrock Aquifer was assumed to generally follow the topography of the bedrock surface. The flow tubes were delineated based on drainage patterns suggested by the bedrock topographic map (see Figure B-1). Within each flow tube it is assumed ground water flows in the same general direction, on a slope of the same general gradient. Based on topography and gradient, ground water from the majority of these flow tubes will eventually flow into the BVA. Although several of the flow tubes do not appear to contribute to the BVA directly, they were considered to contribute to the BVA to make the future scenario as conservative as possible.

2. All contaminant concentration data from bedrock wells currently maintained or archived in the MEIMS database were examined for each flow tube. The maximum concentration of each analyte for any of the bedrock wells or selected bedrock seeps was assumed to be representative of the contamination within the flow tube. This maximum concentration was multiplied by the volume of water per unit time that flows within each flow tube in order to determine the mass of each contaminant that could be contributed to the BVA production wells.

3. The total flow of each tube was determined by measuring the width and the gradient of the flow tube from the bedrock topographic map. These were multiplied by the assumed thickness of the bedrock aquifer (40 feet), and by the assumed hydraulic conductivity (0.1 feet/day). The product of these values is the volume of ground water flow per flow tube per unit time.

4. The maximum concentration of each analyte from each flow tube was applied to the total flow of each tube to determine a potential mass of contaminant entering the BVA per year per flow tube.

5. The contaminant mass from each flow tube was summed to provide the total potential mass of each contaminant contributed by the bedrock aquifer to the BVA per year.

6. The total mass of each contaminant was divided by an assumed Mound Plant water use of 260,000 gallons per day (94,900,000 gallons per year) to obtain the theoretical concentration of the bedrock contribution for all bedrock contaminants. Therefore, the very conservative assumption is made that the masses of contaminants that enter the BVA from the bedrock contribute to the production wells without any dilution or degradation.

7. This theoretical concentration was added to the current concentration of contaminants observed in the Mound Plant Production wells to obtain the theoretical worst-case future ground water concentration.

This approach represents the most conservative scenario possible using currently available ground water data. A more realistic estimate of the future ground water concentrations would require consideration of dilution and degradation of contaminants within the bedrock and the BVA aquifers, quantification of the actual amounts of bedrock water intercepted by the Mound production wells and replacement of the maximum contaminant concentrations with more representative values.

Table B-1 lists all contaminants of potential concern detected in either a bedrock well, seep or a Mound Plant Production well, their respective concentrations, and the calculated combined estimated future maximum concentration.

Antimony – An Example

The wells and seeps selected to best represent the water quality of the consolidated lithologic units beneath the Mound are summarized in Table B-2. Upon review of the data in the MEIMS database for these monitoring locations, antimony was detected in the bedrock monitoring wells and seeps in 21 out of 122 analyses for this parameter. All designated wells and seeps were assigned to specific flow tubes. The highest concentration measured in each monitoring well or seep within a flow tube was used to calculate a potential annual contribution of antimony to the groundwater. Table B-3 summarizes the water volume and concentrations used to project antimony loading to the Mound production wells.

As shown in Table B-1, the calculated COPC concentration obtained from the flow tube model is added to the existing concentration measured in the production wells. It is this potential future maximum constituent concentration which is the RRE modeling process.

Table B-1
Estimated Future Maximum Constituent Concentrations in the BVA
Bedrock Flow Tube Model Results

Constituents in Production and Bedrock Wells & Seeps	Bedrk. Contribution to BVA (mg/L or pCi/L)	Current Production Well Concentration (mg/L or pCi/L)	Est. Future Max. Conc. (mg/L or pCi/L)
1,2-cis-Dichloroethene	0.0007	0.0040	0.0047
1,2-Dichloroethene	0.0023		0.0023
Aluminum	1.9876	0.1480	2.1356
Americium-241	1.8656	0.0300	1.8956
Antimony	0.0034	0.0402	0.0436
Beryllium	0.0002		0.0002
Bismuth	0.0098		0.0098
Cadmium	0.0010	0.0077	0.0087
Chromium	0.9377	0.0249	0.9626
Cobalt	0.0080		0.0080
Copper	0.0139	0.5930	0.6069
Dichloromethane	0.0148	0.0130	0.0278
Lithium	0.1166	0.0029	0.1195
Manganese	0.1577	0.2240	0.3817
Molybdenum	0.0124	0.0027	0.0151
Nickel	0.1740	0.0271	0.2011
Plutonium-239/240	0.0914	2.0000	2.0914
Radium-226	1.1702	0.5200	1.6902
Selenium	0.0007	0.0015	0.0022
Stronium-90	0.8177	0.5000	1.3177
Tetrachloroethene	0.0006	0.0022	0.0028
Thallium	0.0021	0.0024	0.0045
Thorium-228	0.3651	2.1700	2.5351
Tin	0.0051	0.0087	0.0138
Trichloroethene	0.0016	0.0059	0.0075
Tritium	65945.3956	7200.0000	73145.3956
Uranium-234	0.5903	8.1400	8.7303
Uranium-235	2.7326	2.3000	5.0326
Vanadium	0.0106	0.0146	0.0252

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Table B-2 Locations and Details of Water Quality Monitoring Sites Used in Bedrock Flow Tube Calculations						
Well / Seep I.D.	**Parcel**	**Flow Tube**	**Well Depth (feet)**	**Screen Length (feet)**	**Depth into Bedrock (feet)**	**Comments**
Bedrock Monitoring Wells						
0034 (a)	8	11	20.61	3	7.5	Abandoned - Historical Data Only. Use in Flow Tube 11
0035 (a)	8	12	20+	2	6.0	Abandoned - Historical Data Only. Use in Flow Tube 12
~~0112~~	~~7~~	~~11~~	~~36.70~~	~~10~~	~~13.0~~	~~Use in Flow Tube 11~~
0113	6	Recharge Area	55.72	3 (upper) 3 (lower)	56.5	Use in Flow Tube 15. At top of recharge area.
0114	8	Recharge Area	51.31	3 (upper) 3 (lower)	39.5	Use in Flow Tube 15. At top of recharge area.
0115	8	15	40.25	10	27.5	Use in Flow Tube 15. At top of recharge area.
0116	8	Recharge Area	81.95	10	69.5	Use in Flow Tube 15. At top of recharge area.
0117	8	12	18.10	10	15.0	Use in Flow Tube 12
0120	8	12	32.86	10	28.5	Use in Flow Tube 12
0227 (a)	8	13	35.29	2	3.0	Abandoned - Historical Data Only. Use in Flow Tube 13
0242 (a)	8	12	15.36	2	11.5	Abandoned - Historical Data Only. Use in Flow Tube 12
0312	8	13	34.50	10	6.5	Use in Flow Tube 13
0318	7	9	31.07	10	17.0	Use in Flow Tube 9
0322	7	20	56.27	10	12.5	Use in Flow Tube 20
0323	8	13	17.53	5	8.0	Use in Flow Tube 13
0324	8	13	19.82	5	19.0	Use in Flow Tube 13
0325	7	7	31.93	10	26.0	Use in Flow Tube 7
0326	7	8	35.06	10	19.0	Use in Flow Tube 8
0332	MMCIC	20	31.56	10	19.0	Use in Flow Tube 20
0335	Off Site	15	54.51	5	33.0	Use in Flow Tube 15. In discharge area
0351	MMCIC	4	21.39	10	16.7	Use in Flow Tube 4. At top of recharge area.
0354	4	4	26.06	10	11.5	Use in Flow Tube 4.
0372	8	6	64.16	10	12.0	Use in Flow Tube 6
0380	8	6	63.08	10	28.0	Use in Flow Tube 6. At base of Flow Tube in discharge area
0381	8	6	39.59	10	12.0	Use in Flow Tube 6
0382	8	6	37.25	10	17.8	Use in Flow Tube 6
0399	4	3	34.93	10	29.0	Use in Flow Tube 3
0411	5	5	39.70	10	24.0	Use in Flow Tube 5
P004	8	6	64.51	10	12.4	Use in Flow Tube 6
P021	7	12	33.08	5	8.0	Use in Flow Tube 12
P024	9	6	42.58	5	5.0	Use in Flow Tube 6

Table B-2 (continued) Locations and Details of Water Quality Monitoring Sites Used in Bedrock Flow Tube Calculations						
Well / Seep I.D.	**Parcel**	**Flow Tube**	**Well Depth (feet)**	**Screen Length (feet)**	**Depth into Bedrock (feet)**	**Comments**
Interface Monitoring Wells - Partially Screened into Bedrock						
0314	8	6	45.47	10	6.5	Use in Flow Tube 6. At base of Flow Tube in discharge area
0353	8	5	22.12	5	2.0	Use in Flow Tube 5, although very shallow
Bedrock Seeps with Annual Flow						
601	8	14	NA	NA	NA	Use in Flow Tube 14
607	3	18	NA	NA	NA	Use in Flow Tube 18
a - abandoned						

Table B-3. Contribution of Antimony Attributed to Bedrock -derived Groundwater for the Future Maximum Concentration Evaluation			
Flow Tube (#)	**Flow Tube Discharge (liters/yr)**	**Parameter Max. Conc. (mg/L)**	**Annual Bdrk Contribution (mg)**
1	**3158986**	**0.0067**	**21165**
2	**2622525**	**0.0067**	**17571**
3	2986588	0.0067	20010
4	3497913	0.0018	6296
5	5926541	0.0076	45042
6	5179894	0.0076	39367
7	4577574	0.00075	3433
8	5311033	0.002	10622
9	3438297	0.016	55013
10	**4286151**	**0.016**	**68578**
11	3020572	0.0023	6947
12	4278420	0.00062	2653
13	3684327	0.0176	64844
14	1624763	0.0302	49068
15	3136537	0.0062	19447
16	**3742041**	**0.0062**	**23201**
17	**8624724**	**0.0416**	**358788**
18	5031433	0.0416	209308
19	**4424896**	**0.0416**	**184076**
20	1925159	0.0058	11166
Averages	4098873	0.0132785	60830
Totals	81977457		***1216595***

Mound Water Use:

260000	gallons/day
94900000	gallons/year
359224970	liters/year

Projected Antimony contribution from bedrock to the BVA: 0.003387 mg/L

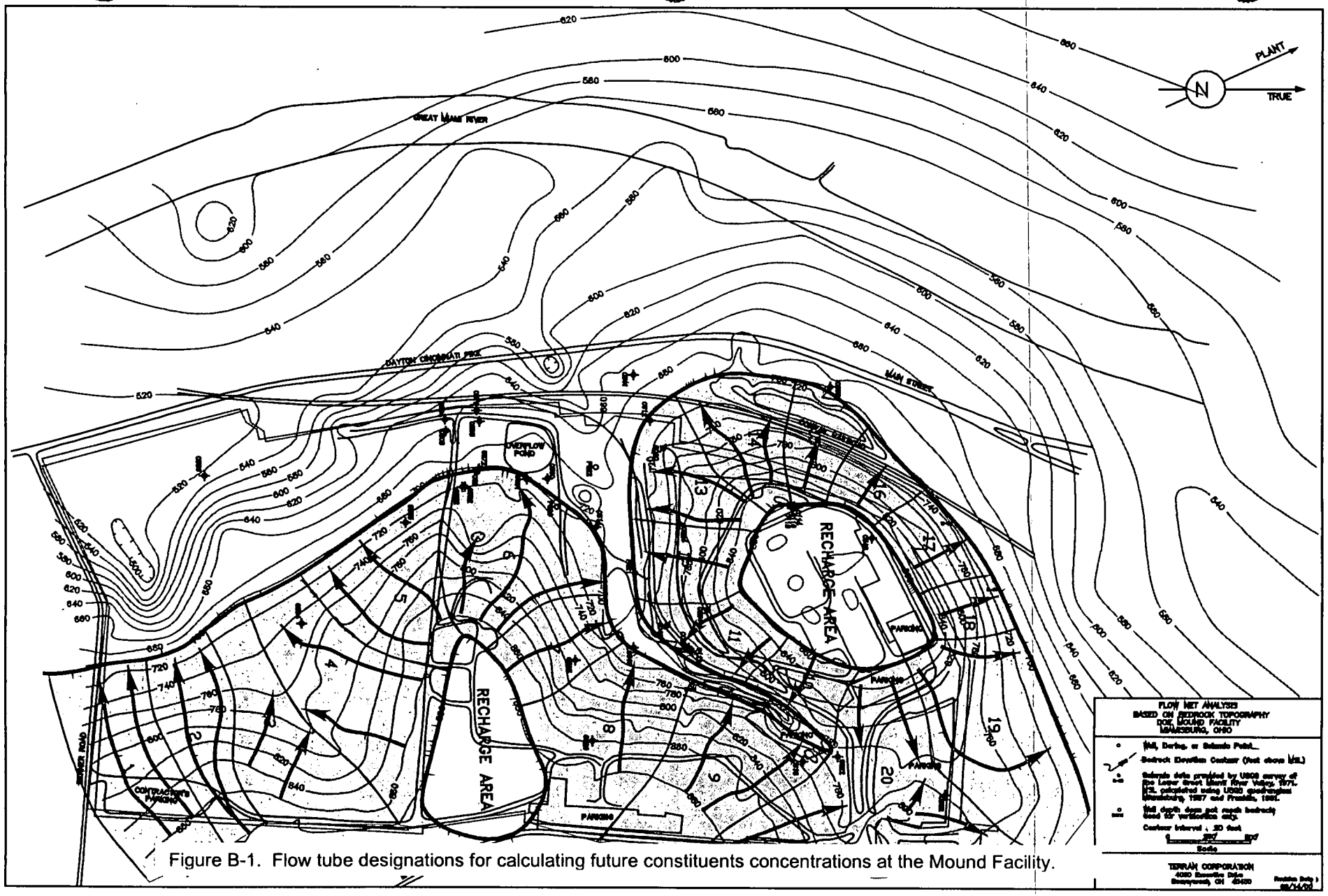

Figure B-1. Flow tube designations for calculating future constituents concentrations at the Mound Facility.

The following equations were used to calculate new groundwater guideline values in accordance with the methodology presented in Risk Based Guideline Values, Mound Plant, March 1997a.

The equations are generally the same for construction worker and site employee scenarios. Input parameters differ. The construction worker includes ingestion and shower exposure while the site employee only includes groundwater ingestion.

Water Cancer Risk Based Guideline Values (RBGV) are calculated by the following equation for Chemicals- Nonradiological

$$\text{RBGVTotal (mg/L)} = \frac{1}{1/\text{RBGVingestion} + 1/\text{RBGVinhalation} + 1/\text{RBGVdermal}}$$

$$\text{RBGVingestion (mg/L)} = \frac{\text{TCR*AT*BW}}{\text{IRw*EF*ED*CSFo}}$$

Where:

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	1.00E-06	1.00E-06
BW=	Body Weight	70 kg	70 kg
EF=	Exposure Frequency	250 days/yr	250 days/yr
ED=	Exposure Duration	NA	5 yr
CSFo=	Oral Cancer Slope Factor	chemical specific	chemical specific
AT=	Averaging time	70 yr	70 yr
IRw=	Ingestion Rate Water	1 L/day	1 L/day

$$\text{RBGVinhalation (mg/L)} = \frac{\text{TCR*BW*AT}}{\text{K*IRair*EF*ET*ED*(1/24)*CSFi}}$$

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	NA	1.00E-06
BW=	Body Weight	NA	70 kg
AT=	Averaging time	NA	70 yr
CSFi=	Inhalation Cancer Slope Factor	NA	chemical specific
IR air=	Inhalation Rate Air	NA	20 m3/day
K=	Volatilization Factor	NA	0.5 l/m^3
ET=	Exposure Time	NA	0.167 hrs/day
EF=	Exposure Frequency	NA	250 days/yr
AT=	Averaging time	NA	70 yr
ED=	Exposure Duration	NA	5 yr

$$\text{RBGVdermal (mg/L) Organics} = \frac{\text{TCR*BW*AT}}{\text{2*Kp*EF*EV*0.001*(CSFa)*SSAa*ED*(6*T*tevent)/3.1412)}^{1/2}}$$

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	NA	1.00E-06
BW=	Body Weight	NA	70 kg
AT=	Averaging time	NA	70 yr
Kp=	Permeability Constant	NA	chemical specific
CSFa=	Dermal Cancer Slope Factor	NA	chemical specific
SSA=	Skin Surface Area	NA	19,400 cm^2
EV=	Events per day	NA	1 per day
EF=	Exposure Frequency	NA	250 days/yr
AT=	Averaging time	NA	70 yr
ED=	Exposure Duration	NA	5 yr
T=	Lag Time	NA	chemical specific
tevent	Exposure time	NA	chemical specific

$$\text{RBGVdermal (mg/L) Inorganics} = \frac{\text{TCR*BW*AT}}{\text{Kp*EF*EV*0.001*t event*(CSFa)*SSAa*ED}}$$

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	NA	1.00E-06
BW=	Body Weight	NA	70 kg
AT=	Averaging time	NA	70 yr
Kp=	Permeability Constant	NA	chemical specific
CSFa=	Dermal Cancer Slope Factor	NA	chemical specific
SSA=	Skin Surface Area	NA	19,400 cm^2
EV=	Events per day	NA	1 per day
EF=	Exposure Frequency	NA	250 days/yr
AT=	Averaging time	NA	70 yr
ED=	Exposure Duration	NA	5 yr
tevent	Exposure time	NA	chemical specific

Water Non-Cancer Risk Based Guideline Values (RBGV) are calculated by the following equation for Nonradiological Chemicals.

$$\text{RBGVTotal (mg/L)} = \frac{1}{1/\text{RBGVingestion} + 1/\text{RBGVinhalation} + 1/\text{RBGVdermal}}$$

$$\text{RBGVingestion (mg/L)} = \frac{\text{THI*AT*BW}}{\text{IRw*EF*ED*(1/RfDo)}}$$

Where:

		Site Employee	Construction Worker
THI=	Target Hazard Index	1	1
BW=	Body Weight	70 kg	70 kg
EF=	Exposure Frequency	250 days/yr	250 days/yr
ED=	Exposure Duration	NA	5 yr
RfDo=	Oral Reference Dose Factor	chemical specific	chemical specific
AT=	Averaging time	25 yr	5 yr
IRw=	Ingestion Rate Water	1 L/day	1 L/day

$$\text{RBGVinhalation (mg/L)} = \frac{\text{THI*BW*AT}}{\text{K*IRair*EF*ET*ED*(1/24)*(1/RfDi)}}$$

		Site Employee	Construction Worker
THI=	Target Hazard Index	NA	1
BW=	Body Weight	NA	70 kg
AT=	Averaging time	NA	70 yr
RfDi=	Inhalation Reference Dose Factor	NA	chemical specific
IR air=	Inhalation Rate Air	NA	20 m3/day
K=	Volatilization Factor	NA	0.5 l/m^3
ET=	Exposure Time	NA	0.167 hrs/day
EF=	Exposure Frequency	NA	250 days/yr
AT=	Averaging time	NA	5 yr
ED=	Exposure Duration	NA	5 yr

$$\text{RBGVdermal (mg/L) Organics} = \frac{\text{THI*BW*AT}}{2\text{*Kp*EF*EV*0.001*(1/RfDa)*SSAa*ED*(6*T*tevent/3.1412)}^{1/2}}$$

		Site Employee	Construction Worker
THI=	Target Hazard Index	NA	1
BW=	Body Weight	NA	70 kg
AT=	Averaging time	NA	70 yr
Kp=	Permeability Constant	NA	chemical specific
RfDa=	Dermal Reference Dose Factor	NA	chemical specific
SSA=	Skin Surface Area	NA	19,400 cm^2
EV=	Events per day	NA	1 per day
EF=	Exposure Frequency	NA	250 days/yr
AT=	Averaging time	NA	70 yr
ED=	Exposure Duration	NA	5 yr
T=	Lag Time	NA	chemical specific
tevent	Exposure time	NA	chemical specific

$$\text{RBGVdermal (mg/L) Inorganics} = \frac{\text{THI*BW*AT}}{\text{Kp*EF*EV*0.001*t event*(1/RfDa)*SSAa*ED}}$$

		Site Employee	Construction Worker
THI=	Target Hazard Index	NA	1
BW=	Body Weight	NA	70 kg
AT=	Averaging time	NA	70 yr
Kp=	Permeability Constant	NA	chemical specific
RfDa=	Dermal Reference Dose Factor	NA	chemical specific
SSA=	Skin Surface Area	NA	19,400 cm^2
EV=	Events per day	NA	1 per day
EF=	Exposure Frequency	NA	250 days/yr
AT=	Averaging time	NA	70 yr
ED=	Exposure Duration	NA	5 yr
tevent	Exposure time	NA	chemical specific

Water Cancer Risk Based Guideline Values (RBGV) are calculated by the following equation for Radiolnuclides

$$\text{RBGVingestion (pCi/L)} = \frac{\text{TCR}}{\text{IRw*EF*ED*CSFo}}$$

Where:

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	1.00E-06	1.00E-06
EF=	Exposure Frequency	250 days/yr	250 days/yr
ED=	Exposure Duration	NA	5 yr
CSFo=	Oral Cancer Slope Factor	chemical specific	chemical specific
IRw=	Ingestion Rate Water	1 L/day	1 L/day

For tritium dermal and inhalation pathways are also evaluated for water and total tritium is calculated as follows

$$\text{RBGVTotal (mg/L)} = \frac{1}{\text{1/RBGVingestion + 1/RBGVinhalation + 1/RBGVdermal}}$$

RBGVingestion same as above for all radionuclides

$$\text{RBGV tritium inhalation (pCi/L)} = \frac{\text{TCR}}{\text{IRa*EF*ED*ETs*CF1*CFt*M*CSFi}}$$

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	NA	1.00E-06
EF=	Exposure Frequency	NA	250 days/yr
CF1=	Conversion Factor mass of water	NA	1/1000 L/g
CFt=	Conversion Factor for time	NA	1/24 day/hrs
ETs=	Exposure Time shower	NA	.167 hr/day
ED=	Exposure Duration	NA	5 yr
M=	Air Mass conc of water in shower	NA	66.96 g/m^3
CSFi=	Inhalation Cancer Slope Factor	NA	chemical specific
IRa=	Ingestion Rate Air	NA	20 m^3hr/day

$$\text{RBGVdermal (pCimg/L) tritium} = \frac{\text{TCR}}{\text{Kp*EF*0.001*ETs*(CSFa)*SSA*ED}}$$

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	NA	1.00E-06
Kp=	Permeability Constant	NA	chemical specific
CSFa=	Dermal Cancer Slope Factor	NA	chemical specific
SSA=	Skin Surface Area	NA	19,400 cm^2
EF=	Exposure Frequency	NA	250 days/yr
ETs=	Exposure Time shower	NA	.167 hr/day
ED=	Exposure Duration	NA	5 yr

Groundwater Guidance Values for Site Employee at DOE Mound

Constituent	RRE GV Screen mg/l	CANCER EFFECTS Route-Specific RRSs (mg/L) Oral	Dermal	Inhalation	Weight Of Evidence	Cancer GW GV (TRC-06)	NON-CANCER EFFECTS Route-Specific RRSs (mg/L) Oral	Dermal	Inhalation	Non-Cancer GW RRE GV mg/L	1/10 HI mg/L
Organics		(MSCo)c	(MSCd)c	(MSCi)c			(MSCo)nc	(MSCd)nc	(MSCi)nc		
1,1,1,2-Tetrachloroethane	1.1E-02	1.1E-02	NA	NA	C	1.1E-02	3.1E+00	NA	NA	3.1E+00	3.1E-01
1,1,1-Trichloroethane	2.0E+00	---	NA	NA	D	---	2.0E+01	NA	NA	2.0E+01	2.0E+00
1,1,2,2-Tetrachloroethane	1.4E-03	1.4E-03	NA	NA	D	1.4E-03	3.1E+01	NA	NA	3.1E+01	3.1E+00
1,1,2-Trichloro-1,2,2trifluoroethane	3.1E+02	NA	NA	NA		NA	3.1E+03	NA	NA	3.1E+03	3.1E+02
cis-1,2-Dichloroethylene	1.0E-01	---	NA	NA	D	---	1.0E+00	NA	NA	1.0E+00	1.0E-01
Tetrachloroethylene[h]	5.5E-03	5.5E-03	NA	NA	NA	5.5E-03	1.0E+00	NA	NA	1.0E+00	1.0E-01
trans-1,2Dichloroethylene	2.0E-01	---	NA	NA	D	---	2.0E+00	NA	NA	2.0E+00	2.0E-01
Trichloroethylene[h]	2.6E-02	2.6E-02	NA	NA		2.6E-02	6.1E-01	NA	NA	6.1E-01	6.1E-02
Inorganics	0.0E+00										
Aluminum	1.0E+01	---	NA	NA	NA	---	1.0E+02	NA	NA	1.0E+02	1.0E+01
Ammonia	NA	---	NA	NA	NA	---	---	NA	NA	---	#VALUE!
Antimony	4.1E-03	---	NA	NA	NA	---	4.1E-02	NA	NA	4.1E-02	4.1E-03
Arsenic[e]	1.9E-04	1.9E-04	NA	NA	A	1.9E-04	3.1E-02	NA	NA	3.1E-02	3.1E-03
Barium	7.2E-01	---	NA	NA	D	---	7.2E+00	NA	NA	7.2E+00	7.2E-01
Beryllium	2.0E-02	---	NA	NA	B1	---	2.0E-01	NA	NA	2.0E-01	2.0E-02
Boron	9.2E-01	---	NA	NA	NA	---	9.2E+00	NA	NA	9.2E+00	9.2E-01
Cadmium	5.1E-03	---	NA	NA	B1	---	5.1E-02	NA	NA	5.1E-02	5.1E-03
Chromium (III) (total chromium)	1.5E+01	---	NA	NA	NA	---	1.5E+02	NA	NA	1.5E+02	1.5E+01
Chromium (VI)	3.1E-02	---	NA	NA	A	---	3.1E-01	NA	NA	3.1E-01	3.1E-02
Cobalt	6.1E-01	---	NA	NA	NA	---	6.1E+00	NA	NA	6.1E+00	6.1E-01
Copper	4.1E-01	---	NA	NA	D	---	4.1E+00	NA	NA	4.1E+00	4.1E-01
Cyanide	2.0E-01	---	NA	NA	D	---	2.0E+00	NA	NA	2.0E+00	2.0E-01
Fluorine (soluble fluoride)	6.1E-01	---	NA	NA	NA	---	6.1E+00	NA	NA	6.1E+00	6.1E-01
Lead (inorganic)	NA	---	NA	NA	B2	---	---	NA	NA	---	#VALUE!
Manganese	4.8E-01	---	NA	NA	D	---	4.8E+00	NA	NA	4.8E+00	4.8E-01
Molybdenum	5.1E-02	---	NA	NA	NA	---	5.1E-01	NA	NA	5.1E-01	5.1E-02
Nickel and compounds	2.0E-01	---	NA	NA	A	---	2.0E+00	NA	NA	2.0E+00	2.0E-01
Selenium	5.1E-02	---	NA	NA	D	---	5.1E-01	NA	NA	5.1E-01	5.1E-02
Silver	5.1E-02	---	NA	NA	D	---	5.1E-01	NA	NA	5.1E-01	5.1E-02
Thallium and compounds (as thallium chlori	8.2E-04	---	NA	NA	NA	---	8.2E-03	NA	NA	8.2E-03	8.2E-04
Vanadium	7.2E-02	---	NA	NA	NA	---	7.2E-01	NA	NA	7.2E-01	7.2E-02
Zinc	3.1E+00	---	NA	NA	D	---	3.1E+01	NA	NA	3.1E+01	3.1E+00

Groundwater Guidance Values for Site Employee at DOE Mound

Constituent	RRE GV Screen mg/l	CANCER EFFECTS Route-Specific RRSs (mg/L) Oral	Dermal	Inhalation	Weight Of Evidence	Cancer GW GV (TRC-06)	NON-CANCER EFFECTS Route-Specific RRSs (mg/L) Oral	Dermal	Inhalation	Non-Cancer GW RRE GV mg/L	1/10 HI mg/L
Radionuclides											
Americium-241	4.9E-01	4.9E-01	NA	NA		4.9E-01	NAP	NAP	NAP	NAP	
Bismuth-210	2.2E+01	2.2E+01	NA	NA		2.2E+01	NAP	NAP	NAP	NAP	
Radium-226	5.4E-01	5.4E-01	NA	NA		5.4E-01	NAP	NAP	NAP	NAP	
Strontium-90	3.9E+00	3.9E+00	NA	NA		3.9E+00	NAP	NAP	NAP	NAP	
Thorium-228 +D	6.9E-01	6.9E-01	NA	NA		6.9E-01	NAP	NAP	NAP	NAP	
Tritium	2.2E+03	2.2E+03	NA	NA		2.2E+03	NAP	NAP	NAP	NAP	
Uranium-234	3.6E+00	3.6E+00	NA	NA		3.6E+00	NAP	NAP	NAP	NAP	
Uranium-235 +D	3.4E+00	3.4E+00	NA	NA		3.4E+00	NAP	NAP	NAP	NAP	

*

mg/kg

NA

NAP

NC

RRS

VOCs

***

Groundwater Guidance Values for Construction Worker at DOE Mound

Constituent	RRE GW-GV mg/l	CANCER EFFECTS: Route-Specific RRSs (mg/L) Oral	Dermal	Inhalation	Weight Of Evidence	Cancer GW GV (TRC-06)	NON-CANCER EFFECTS: Route-Specific RRSs (mg/L) Oral	Dermal	Inhalation	Non-Cancer GW GVs mg/L	Non-Cancer 1/10 GW GVs mg/L
		(MSCo)c	(MSCd)c	(MSCi)c		RRSc	(MSCo)nc	(MSCd)nc	(MSCi)nc		
Inorganics											
Aluminum	1.0E+01	---	---	NA	NA	---	1.0E+02	5.3E+03	---	1.0E+02	1.0E+01
Ammonia	---	---	---	NA	NA	---	---	---	---	---	---
Antimony	4.0E-03	---	---	NA	NA	---	4.1E-02	2.1E+00	---	4.0E-02	4.0E-03
Arsenic[e]	9.5E-04	9.5E-04	2.9E-01	NA	A	9.5E-04	3.1E-02	1.6E+00	---	3.0E-02	3.0E-03
Barium	7.0E-01	---	---	NA	D	---	7.2E+00	3.7E+02	---	7.0E+00	7.0E-01
Beryllium	2.0E-02	---	---	NA	B1	---	2.0E-01	1.1E+01	---	2.0E-01	2.0E-02
Boron	9.0E-01	---	---	NA	NA	---	9.2E+00	4.7E+02	---	9.0E+00	9.0E-01
Cadmium	5.0E-03	---	---	NA	B1	---	5.1E-02	2.6E+00	---	5.0E-02	5.0E-03
Chromium (III) (total chromium)	1.5E+01	---	---	NA	NA	---	1.5E+02	7.9E+03	---	1.5E+02	1.5E+01
Chromium (VI)	3.0E-02	---	---	NA	A	---	3.1E-01	1.6E+01	---	3.0E-01	3.0E-02
Cobalt	6.0E-01	---	---	NA	NA	---	6.1E+00	3.2E+02	---	6.0E+00	6.0E-01
Copper	4.0E-01	---	---	NA	D	---	4.1E+00	2.1E+02	---	4.0E+00	4.0E-01
Cyanide	2.0E-01	---	---	NA	D	---	2.0E+00	1.1E+02	---	2.0E+00	2.0E-01
Fluorine (soluble fluoride)	8.3E-03	---	---	NA	NA	---	6.1E+00	3.2E+02	8.4E-02	8.3E-02	8.3E-03
Lead (inorganic)	---	---	---	NA	B2	---	---	---	---	---	#VALUE!
Manganese	4.7E-01	---	---	NA	D	---	4.8E+00	2.5E+02	---	4.7E+00	4.7E-01
Molybdenum	5.0E-02	---	---	NA	NA	---	5.1E-01	2.6E+01	---	5.0E-01	5.0E-02
Nickel and compounds	2.0E-01	---	---	NA	A	---	2.0E+00	1.1E+02	---	2.0E+00	2.0E-01
Selenium	5.0E-02	---	---	NA	D	---	5.1E-01	2.6E+01	---	5.0E-01	5.0E-02
Silver	5.0E-02	---	---	NA	D	---	5.1E-01	2.6E+01	---	5.0E-01	5.0E-02
Thallium and compounds (as thallium	8.0E-04	---	---	NA	NA	---	8.2E-03	4.2E-01	---	8.0E-03	8.0E-04
Tin	6.0E+00	---	---	NA	NA	---	6.1E+01	3.2E+03	---	6.0E+01	6.0E+00
Vanadium	7.1E-02	---	---	NA	NA	---	7.2E-01	1.4E+02	---	7.1E-01	7.1E-02
Zinc	3.1E+00	---	---	NA	D	---	3.1E+01	7.9E+03	---	3.1E+01	3.1E+00
Organics											
1,1,1,2-Tetrachloroethane	5.1E-02	5.5E-02	---	7.9E-01	C	5.1E-02	3.1E+00	---	---	3.1E+00	3.1E-01
1,1,1-Trichloroethane	1.0E+00	---	---	---	D	---	2.0E+01	2.0E+01	4.2E+02	1.0E+01	1.0E+00
1,1,2,2-Tetrachloroethane	3.0E-03	7.2E-03	5.3E-03	1.0E-01	D	3.0E-03	3.1E+01	2.3E+01	---	1.3E+01	1.3E+00
1,1,2-Trichloro-1,2,2trifluoroethane	2.5E+02	NA	NA	NA		NA	3.1E+03	---	1.3E+04	2.5E+03	2.5E+02
cis-1,2-Dichloroethylene	1.0E-01	---	---	---	D	---	1.0E+00	---	---	1.0E+00	1.0E-01
Tetrachloroethylene[h]	2.7E-02	2.8E-02	---	1.0E+01	NA	2.7E-02	1.0E+00	---	1.1E+02	1.0E+00	1.0E-01
trans-1,2Dichloroethylene	1.7E-01	---	---	---	D	---	2.0E+00	9.9E+00	3.3E+02	1.7E+00	1.7E-01
Trichloroethylene[h]	3.3E-02	1.3E-01	1.5E-01	3.5E+00	W/DRAWI	6.9E-02	6.1E-01	7.2E-01	---	3.3E-01	3.3E-02

Groundwater Guidance Values for Construction Worker at DOE Mound

Constituent	RRE GW-GV mg/l	CANCER EFFECTS: Route-Specific RRSs (mg/L) Oral	Dermal	Inhalation	Weight Of Evidence	Cancer GW GV (TRC-06)	NON-CANCER EFFECTS: Route-Specific RRSs (mg/L) Oral	Dermal	Inhalation	Non-Cancer GW GVs mg/L	Non-Cancer 1/10 GW GVs mg/L
Radionuclides											
Americium-241	2.4E+00	2.4E+00	NA	NAP		2.4E+00	NAP	NAP	NAP		
Bismuth-210	1.1E+02	1.1E+02	NA	NAP		1.1E+02	NAP	NAP	NAP		
Radium-226	2.7E+00	2.7E+00	NA	NAP		2.7E+00	NAP	NAP	NAP		
Strontium-90	2.0E+01	2.0E+01	NA	NAP		2.0E+01	NAP	NAP	NAP		
Thorium-228+D	3.5E+00	3.5E+00	NA	NAP		**3.5E+00**	NAP	NAP	NAP		
Tritium	1.1E+04	1.1E+04	2.3E+02	1.6E-03		**1.1E+04**	NAP	NAP	NAP		
Uranium-234	1.8E+01	1.8E+01	NA	NAP		1.8E+01	NAP	NAP	NAP		
Uranium-235	1.8E+01	1.8E+01	NA	NAP		1.8E+01	NAP	NAP	NAP		

•

mg/kg

NA

NAP

NC

RRS

VOCs

•••

The following equations were used to calculate new soil guideline values in accordance with the methodology presented in Risk Based Guideline Values, Mound Plant, March 1997a.

The equations are the same for construction worker and site employee scenarios, only the input parameters to the equations are different.

Soil Cancer Risk Based Guideline Values (RBGV) are calculated by the following equation for Chemicals- Nonradiological

$$\text{RBGV (mg/kg)} = \frac{TCR \times BW \times AT \times 365}{EF \times ED\ [(CSFo \times CF1 \times IRsoil) + (CSFi \times IRair \times (1/PEF + 1/VF)]}$$

Where:

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	1.00E-06	1.00E-06
BW=	Body Weight	70 kg	70 kg
EF=	Exposure Frequency	250 days/yr	250 days/yr
CSFo=	Oral Cancer Slope Factor	chemical specific	chemical specific
CF1=	Conversion Factor	0.000001 g/mg	0.000001 g/mg
IR soil=	Ingestion Rate Soil	50 mg/day	480 mg/day
CSFi=	Inhalation Cancer Slope Factor	chemical specific	chemical specific
CF2=	Conversion Factor	1000 g/kg	1000 g/kg
IR air=	Inhalation Rate Air	20 m3/day	20 m3/day
PEF=	Particulate Emissions Factor	4.28E+09 m3/kg	4.28E+09 m3/kg
VF=	Volatilization Factor	chemical specific	chemical specific
AT=	Averaging time	70 yr	70 yr
ED=	Exposure Duration	25 yr	5 yr

Soil Cancer Risk Based Guideline Values (RBGV) are calculated by the following equation for Radiological Constituents

$$\text{RBGV (pCi/g)} = \frac{TCR}{\{EF \times ED1 \times [(CSFo \times CF1 \times IRsoil) + (CSFi \times CF2 \times IRair \times (1/PEF + 1/VF))]\} + (ED2 \times CSFex \times (1-Se) \times Te)}$$

Where:

		Site Employee	Construction Worker
TCR=	Target Cancer Risk	1.00E-06	1.00E-06
BW=	Body Weight	70 kg	70 kg
ED1=	Exposure Duration	25 yr	5 yr
EF=	Exposure Frequency	250 days/yr	250 days/yr
CSFo=	Oral Cancer Slope Factor	chemical specific	chemical specific
CF1=	Conversion Factor	1000 mg/g	1000 g/kg
IR soil=	Ingestion Rate Soil	50 mg/day	480 mg/day
CSFi=	Inhalation Cancer Slope Factor	chemical specific	chemical specific
CF2=	Conversion Factor	1000 g/kg	1000 g/kg
IR air=	Inhalation Rate Air	20 m3/day	20 m3/day
PEF=	Particulate Emissions Factor	4.28E+09 m3/kg	4.28E+09 m3/kg
VF=	Volatilization Factor	chemical specific	chemical specific
ED2=	External Duration Factor	25 x 250/365 yr	5 x 250/365 yr
CSFex=	External Cancer Slope Factor	chemical specific	chemical specific
Se=	Gamma Shielding Factor	0.2 unitless	0.1 unitless
Te=	Gamma Exposure Time Factor	2/24 unitless	8/24 unitless

Soil Non-cancer Risk Based Guideline Values (RBGV) are calculated by the following equation for Nonradiological Chemicals

$$\text{RBGV (mg/kg)} = \frac{THI \times BW \times AT \times 365}{EF \times ED\ [(1/RfDo) \times CF1 \times IRsoil) + ((1/RfDi) \times IRair \times (1/PEF + 1/VF)]}$$

Where:

		Site Employee	Construction Worker
THI=	Target Hazard Index	1 unitless	1 unitless
BW=	Body Weight	70 kg	70 kg
ED=	Exposure Duration	25 yr	5 yr
EF=	Exposure Frequency	250 days/yr	250 days/yr
RfDo=	Oral Reference Dose Factor	chemical specific	chemical specific
CF1=	Conversion Factor	0.000001 g/mg	0.000001 g/mg
IR soil=	Ingestion Rate Soil	50 mg/day	480 mg/day
RfDi=	Inhalation Reference Dose Factor	chemical specific	chemical specific
CF2=	Conversion Factor	1000 g/kg	1000 g/kg
IR air=	Inhalation Rate Air	20 m3/day	20 m3/day
PEF=	Particulate Emissions Factor	4.28E+09 m3/kg	4.28E+09 m3/kg
VF=	Volatilization Factor	chemical specific	chemical specific
AT=	Averaging time	25 yr	5 yr

Soil Guidance Values for Construction Worker at DOE Mound

Constituent	VF (m^3/kg)		CANCER EFFECTS Route-Specific RRSs (mg/kg) Oral (RRSo)c	Inhalation (RRSi)c	Cancer Effects PRG RRSc	NON-CANCER EFFECTS Route-Specific RRSs (mg/kg) Oral (RRSo)nc	Inhalation (RRSi)nc	Non-Cancer Effects PRG RRSnc	1/10 HI	Minimum RRS (mg/kg)
VOCs										
Benzene	19000	2.5E+00	1.0E+02	7.1E+00	6.6E+00	NA	2.5E+01	2.5E+01	2.5E+00	7
Ethylbenzene	21000	6.7E+02	NC	NC	NC	2.1E+04	9.7E+03	6.7E+03	6.7E+02	11000
Styrene	16750	1.6E+03	NA	NA	NA	4.3E+04	2.5E+04	1.6E+04	1.6E+03	24000
Toluene	23000	2.5E+02	NC	NC	NC	4.3E+04	2.6E+03	2.5E+03	2.5E+02	5400
Xylenes	18000	4.2E+02	NC	NC	NC	4.3E+05	4.2E+03	4.2E+03	4.2E+02	4157
PAHs										
Acenaphthene		1.3E+03	NC	NC	NC	1.3E+04	NA	1.3E+04	1.3E+03	32000
Acenaphthylene		NA	NC	NC	NC	NA	NA	NA	NA	16000
Anthracene		6.4E+03	NC	NC	NC	6.4E+04	NA	6.4E+04	6.4E+03	160000
Benzo(a)anthracene		4.0E+00	4.1E+00	4.6E+02	4.0E+00	NA	NA	NA	NA	4
Benzo(b)fluoranthene		4.1E+00	4.1E+00	9.8E+02	4.1E+00	NA	NA	NA	NA	4
Benzo(k)fluoranthene		4.1E+01	4.1E+01	1.6E+05	4.1E+01	NA	NA	NA	NA	760
Benzo(g,h,i)perylene		NA	NC	NC	NC	NA	NA	NA	NA	16000
Benzo(a)pyrene		4.1E-01	4.1E-01	1.4E+02	4.1E-01	NA	NA	NA	NA	0
Carbazole		1.5E+02	1.5E+02	NA	1.5E+02	NA	NA	NA	NA	
4-Chloro-3-methylphenol		NA	NA	NA	NA	NA	NA	NA	NA	
Chrysene		4.1E+02	4.1E+02	8.0E+04	4.1E+02	6.4E+03	NA	6.4E+03	6.4E+02	7600
Dibenzo(a,h)anthracene		4.1E-01	4.1E-01	3.3E+03	4.1E-01	NA	NA	NA	NA	0
Fluoranthene		8.5E+02	NC	NC	NC	8.5E+03	NA	8.5E+03	8.5E+02	21000
Fluorene		8.5E+02	NC	NC	NC	8.5E+03	NA	8.5E+03	8.5E+02	21000
Indeno(1,2,3-cd)pyrene		4.1E+00	4.1E+00	2.0E+04	4.1E+00	NA	NA	NA	NA	4
2-methylnaphthalene		NA	NA	NA	NA	NA	NA	NA	NA	
4-Methylphenol		9.1E+01	NA	NA	NA	1.1E+03	6.2E+03	9.1E+02	9.1E+01	2200
Naphthalene		3.0E+01	NC	NC	NC	4.3E+03	3.2E+02	3.0E+02	3.0E+01	720
Phenanthrene		NA	NC	NC	NC	NA	NA	NA	NA	16000
Pesticides										
Delta-BHC		NA	NA	NA	NA	NA	NA	NA	NA	
Endosulfan Sulfate		NA	NA	NA	NA	NA	NA	NA	NA	
Endrin Aldehyde		NA	NA	NA	NA	NA	NA	NA	NA	
Endrin Ketone		NA	NA	NA	NA	NA	NA	NA	NA	

Soil Guidance Values for Construction Worker at DOE Mound

Constituent	VF (m^3/kg)		CANCER EFFECTS Route-Specific RRSs (mg/kg) Oral	CANCER EFFECTS Route-Specific RRSs (mg/kg) Inhalation	CANCER EFFECTS Cancer Effects PRG	NON-CANCER EFFECTS Route-Specific RRSs (mg/kg) Oral	NON-CANCER EFFECTS Route-Specific RRSs (mg/kg) Inhalation	NON-CANCER EFFECTS Non-Cancer Effects PRG	1/10 HI	Minimum RRS (mg/kg)
Metals										
Aluminium		2.1E+04	NA	NA	NA	2.1E+05	3.1E+07	2.1E+05	2.1E+04	
Antimony		8.5E+00	NC	NC	NC	8.5E+01	NA	8.5E+01	8.5E+00	85
Arsenic		2.0E+00	2.0E+00	2.0E+04	2.0E+00	6.4E+01	NA	6.4E+01	6.4E+00	2
Barium		1.5E+03	NC	NC	NC	1.5E+04	3.1E+06	1.5E+04	1.5E+03	14000
Beryllium		4.2E+01	NC	3.6E+04	3.6E+04	4.3E+02	1.2E+05	4.2E+02	4.2E+01	400
Bismuth		NA	NA	NA	NA	NA	NA	NA	NA	
Cadmium		1.1E+01	NAP	4.9E+04	4.9E+04	1.1E+02	1.2E+06	1.1E+02	1.1E+01	106
Chromium*		2.1E+04	NC	NC	NC	2.1E+05	NA	2.1E+05	2.1E+04	200000
Cobalt		1.2E+03	NC	NC	NC	1.3E+04	1.2E+05	1.2E+04	1.2E+03	11000
Copper		7.9E+02	NC	NC	NC	7.9E+03	NA	7.9E+03	7.9E+02	7400
Cyanide (total)		4.3E+02	NC	NC	NC	4.3E+03	NA	4.3E+03	4.3E+02	4000
Lead		NA	NAP	NAP	NAP	NA	NA	NA	NA	NA
Lithium		NA	NA	NA	NA	NA	NA	NA	NA	
Mercury	3108	6.4E+00	NC	NC	NC	6.4E+01	1.9E+06	6.4E+01	6.4E+00	64
Nickel		4.3E+02	NAP	NAP	NAP	4.3E+03	NA	4.3E+03	4.3E+02	4000
Selenium		1.1E+02	NC	NC	NC	1.1E+03	NA	1.1E+03	1.1E+02	990
Silver		1.1E+02	NC	NC	NC	1.1E+03	NA	1.1E+03	1.1E+02	990
Thallium		1.7E+00	NC	NC	NC	1.7E+01	NA	1.7E+01	1.7E+00	17
Tin		1.3E+04	NA	NA	NA	1.3E+05	NA	1.3E+05	1.3E+04	
Vanadium		1.5E+02	NC	NC	NC	1.5E+03	NA	1.5E+03	1.5E+02	1400
Zinc		6.4E+03	NC	NC	NC	6.4E+04	NA	6.4E+04	6.4E+03	60000

*	All detected chromium is conservatively assumed to be chromium VI.
mg/kg	Milligram per kilogram.
NA	Not available; insufficient toxicity data.
NAP	Not applicable; carcinogenic only via the inhalation route.
NC	Not a suspected carcinogen.
RRS	Risk Reduction Standard for soil (mg/kg).
VOCs	Volatile organic compounds.

Soil Guidance Values for Site Emplpyee at DOE Mound

Constituent	VF (m^3/kg)		CANCER EFFECTS Route-Specific RRSs (mg/kg) Oral (RRSo)c	Inhalation (RRSi)c	Cancer Effects PRG RRSc	NON-CANCER EFFECTS Route-Specific RRSs (mg/kg) Oral (RRSo)nc	Inhalation (RRSi)nc	Non-Cancer Effects PRG RRSnc	1/10 HI	Minimum RRS (mg/kg)
VOCs										
Benzene	2862	1.4E+00	2.0E+02	1.4E+00	1.4E+00	NA	2.5E+01	2.5E+01	2.5E+00	1
Ethylbenzene	6572	9.3E+02	NC	NC	NC	2.0E+05	9.7E+03	9.3E+03	9.3E+02	11000
Styrene	16750	2.3E+03	NA	NA	NA	4.1E+05	2.5E+04	2.3E+04	2.3E+03	24000
Toluene	4696	2.6E+02	NC	NC	NC	4.1E+05	2.6E+03	2.6E+03	2.6E+02	5400
Xylenes	7469	4.2E+02	NC	NC	NC	4.1E+06	4.2E+03	4.2E+03	4.2E+02	4194
PAHs										
Acenaphthene		1.2E+04	NC	NC	NC	1.2E+05	NA	1.2E+05	1.2E+04	32000
Acenaphthylene		NA	NC	NC	NC	NA	NA	NA	NA	16000
Anthracene		6.1E+04	NC	NC	NC	6.1E+05	NA	6.1E+05	6.1E+04	160000
Benzo(a)anthracene		7.2E+00	7.8E+00	9.3E+01	7.2E+00	NA	NA	NA	NA	7
Benzo(b)fluoranthene		7.5E+00	7.8E+00	2.0E+02	7.5E+00	NA	NA	NA	NA	8
Benzo(k)fluoranthene		7.8E+01	7.8E+01	3.1E+04	7.8E+01	NA	NA	NA	NA	760
Benzo(g,h,i)perylene		NA	NC	NC	NC	NA	NA	NA	NA	16000
Benzo(a)pyrene		7.6E-01	7.8E-01	2.8E+01	7.6E-01	NA	NA	NA	NA	1
Carbazole		2.9E+02	2.9E+02	NA	2.9E+02	NA	NA	NA	NA	
4-Chloro-3-methylphenol		NA	NA	NA	NA	NA	NA	NA	NA	
Chrysene		7.5E+02	7.8E+02	1.6E+04	7.5E+02	6.1E+04	NA	6.1E+04	6.1E+03	7600
Dibenzo(a,h)anthracene		7.8E-01	7.8E-01	6.6E+02	7.8E-01	NA	NA	NA	NA	1
Fluoranthene		8.2E+03	NC	NC	NC	8.2E+04	NA	8.2E+04	8.2E+03	21000
Fluorene		8.2E+03	NC	NC	NC	8.2E+04	NA	8.2E+04	8.2E+03	21000
Indeno(1,2,3-cd)pyrene		7.8E+00	7.8E+00	NC	7.8E+00	NA	NA	NA	NA	8
2-methylnaphthalene		NA	NA	NA	NA	NA	NA	NA	NA	
4-Methylphenol		3.9E+02	NA	NA	NA	1.0E+04	6.2E+03	3.9E+03	3.9E+02	2200
Naphthalene		3.2E+01	NC	NC	NC	4.1E+04	3.2E+02	3.2E+02	3.2E+01	720
Phenanthrene		NA	NC	NC	NC	NA	NA	NA	NA	16000
Pesticides										
Delta-BHC		NA	NA	NA	NA	NA	NA	NA	NA	
Endosulfan Sulfate		NA	NA	NA	NA	NA	NA	NA	NA	
Endrin Aldehyde		NA	NA	NA	NA	NA	NA	NA	NA	
Endrin Ketone		NA	NA	NA	NA	NA	NA	NA	NA	

Soil Guidance Values for Site Emplpyee at DOE Mound

Constituent	VF (m^3/kg)		CANCER EFFECTS Route-Specific RRSs (mg/kg) Oral	Inhalation	Cancer Effects PRG	NON-CANCER EFFECTS Route-Specific RRSs (mg/kg) Oral	Inhalation	Non-Cancer Effects PRG	1/10 HI	Minimum RRS (mg/kg)
Metals										
Aluminium		1.9E+05	NA	NA	NA	2.0E+06	3.1E+07	1.9E+06	1.9E+05	
Antimony		8.2E+01	NC	NC	NC	8.2E+02	NA	8.2E+02	8.2E+01	818
Arsenic		3.8E+00	3.8E+00	4.1E+03	3.8E+00	6.1E+02	NA	6.1E+02	6.1E+01	4
Barium		1.4E+04	NC	NC	NC	1.4E+05	3.1E+06	1.4E+05	1.4E+04	14000
Beryllium		4.0E+02	NC	7.3E+03	7.3E+03	4.1E+03	1.2E+05	4.0E+03	4.0E+02	400
Bismuth		NA	NA	NA	NA	NA	NA	NA	NA	
Cadmium		1.0E+02	NAP	9.7E+03	9.7E+03	1.0E+03	1.2E+06	1.0E+03	1.0E+02	1021
Chromium*		2.0E+05	NC	NC	NC	2.0E+06	NA	2.0E+06	2.0E+05	200000
Cobalt		6.2E+03	NC	NC	NC	1.2E+05	1.2E+05	6.2E+04	6.2E+03	11000
Copper		7.6E+03	NC	NC	NC	7.6E+04	NA	7.6E+04	7.6E+03	7400
Cyanide (total)		4.1E+03	NC	NC	NC	4.1E+04	NA	4.1E+04	4.1E+03	4000
Lead		NA	NAP	NAP	NAP	NA	NA	NA	NA	NA
Lithium		NA	NA	NA	NA	NA	NA	NA	NA	
Mercury	3108	6.1E+01	NC	NC	NC	6.1E+02	1.9E+06	6.1E+02	6.1E+01	613
Nickel		4.1E+03	NAP	NAP	NAP	4.1E+04	NA	4.1E+04	4.1E+03	4000
Selenium		1.0E+03	NC	NC	NC	1.0E+04	NA	1.0E+04	1.0E+03	990
Silver		1.0E+03	NC	NC	NC	1.0E+04	NA	1.0E+04	1.0E+03	990
Thallium		1.6E+01	NC	NC	NC	1.6E+02	NA	1.6E+02	1.6E+01	164
Tin		1.2E+05	NA	NA	NA	1.2E+06	NA	1.2E+06	1.2E+05	
Vanadium		1.4E+03	NC	NC	NC	1.4E+04	NA	1.4E+04	1.4E+03	1400
Zinc		6.1E+04	NC	NC	NC	6.1E+05	NA	6.1E+05	6.1E+04	60000

*	All detected chromium is conservatively assumed to be chromium VI.
mg/kg	Milligram per kilogram.
NA	Not available; insufficient toxicity data.
NAP	Not applicable; carcinogenic only via the inhalation route.
NC	Not a suspected carcinogen.
RRS	Risk Reduction Standard for soil (mg/kg).
VOCs	Volatile organic compounds.