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RCRA Facility Investigation – Remedial Investigation/ Corrective Measures Study – Feasibility Study Report for the Rocky Flats Environmental Technology Site Appendix A – Comprehensive Risk Assessment

Volume 9 of 15
Risk Assessment for the Wind Blown Area Exposure Unit

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ACRONYMS AND ABBREVIATIONS

AEU	Aquatic Exposure Unit
AI	Adequate Intake
BAF	bioaccumulation factor
bgs	below ground surface
BZ	Buffer Zone
CAD/ROD	Corrective Action Decision/Record of Decision
CD	compact disc
CDPHE	Colorado Department of Public Health and Environment
CMS	Corrective Measures Study
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
CSF	cancer slope factors
cy	cubic yards
DOE	U.S. Department of Energy
DQA	data quality assessment
DQO	data quality objective
DRI	dietary reference intake
ECOI	ecological contaminant of interest
ECOPC	ecological contaminant of potential concern
EcoSSL	ecological soil screening level
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	Ecological Risk Assessment
ESL	ecological screening level

EU	Exposure Unit
HHRA	Human Health Risk Assessment
HI	Hazard Index
HRR	Historical Release Report
HQ	hazard quotient
IA	Industrial Area
IAEU	Industrial Area Exposure Unit
IAG	Interagency Agreement
IHSS	Individual Hazardous Substance Site
LOAEL	lowest observed adverse effect level
LOEC	lowest effects concentration
LWNEU	Lower Walnut Drainage Exposure Unit
LWOEU	Lower Woman Drainage Exposure Unit
MDC	maximum detected concentration
mg	milligram
mg/day	milligram per day
mg/kg	milligram per kilogram
mg/kg/BW/day	milligram per kilogram receptor body weight per day
mrem	millirem
msl	mean sea level
N/A	not applicable or not available
NFAA	No Further Accelerated Action
NOAEL	no observed adverse effect level
NOEC	no observed effect concentration
OU	Operable Unit

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PAC	Potential Area of Concern
PCB	polychlorinated biphenyl
PCOC	potential contaminant of concern
PMJM	Preble's meadow jumping mouse
PRG	preliminary remediation goal
QAPjP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
RDA	recommended daily allowance
RDI	recommended daily intake
RFCA	Rocky Flats Cleanup Agreement
RfD	reference doses
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
SCM	site conceptual model
tESL	threshold ESL
TRV	toxicity reference value
UBC	Under Building Contamination
UCL	upper confidence limit
UL	upper limit daily intake
UT	uncertain toxicity
UTL	upper tolerance limit
UWNEU	Upper Walnut Drainage Exposure Unit
UWOEU	Upper Woman Drainage Exposure Unit

VOC	volatile organic compound
WBEU	Wind Blown Area Exposure Unit
WRV	wildlife refuge visitor
WRW	wildlife refuge worker

EXECUTIVE SUMMARY

This report presents the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) for the 715-acre Wind Blown Area Exposure Unit (EU) (WBEU) at the Rocky Flats Environmental Technology Site (RFETS). The purpose of this report is to assess potential risks to human health and ecological receptors posed by exposure to contaminants of concern (COCs) and ecological contaminants of potential concern (ECOPCs) remaining at the WBEU after completion of accelerated actions at RFETS.

Results of the risk characterization for the HHRA indicate that excess lifetime chemical and radionuclide cancer risk for the wildlife refuge worker (WRW) and the wildlife refuge visitor (WRV) in the WBEU is at or below U.S. Environmental Protection Agency (EPA)-acceptable risk range (i.e., within or below a 1E-04 to 1E-06). Hazard Indices (HIs) were found to be well below 1, indicating that no significant noncarcinogenic health effects are expected for the WRW or the WRV in the WBEU. Radiation doses were estimated to be less than 1 millirem (mrem), which is well below the radiation dose limit of 25 mrem. Arsenic and plutonium-239/240 were selected as COCs for surface soil/surface sediment. No COCs were selected for subsurface soil/subsurface sediment.

Risks were calculated for arsenic and plutonium-239/240 using a tiered approach. For the WRW, the estimated total excess lifetime chemical cancer risk from arsenic in surface soil/surface sediment at the WBEU is 2E-06, based on both the Tier 1 and Tier 2 EPCs. The estimated noncarcinogenic Hazard Index (HI) is 0.02, based on the Tier 1 EPC, and 0.01 based on the Tier 2 EPC. The estimated total excess lifetime radionuclide cancer risk to the WRW is 2E-06 based on the Tier 1 EPC and 8E-07 based on the Tier 2 EPC.

For the WRV, estimated total excess lifetime chemical cancer risk based on the Tier 1 EPC at the WBEU is 2E-06; the risk based on the Tier 2 EPC is 1E-06. The estimated noncarcinogenic HI is 0.01 based on both the Tier 1 and Tier 2 EPCs. The estimated total excess lifetime radionuclide cancer risk to the WRV is 1E-06, based on the Tier 1EPC, and 5E-07 based on the Tier 2 EPC.

Although arsenic was selected as a COC and was evaluated quantitatively in the HHRA, it has not been directly associated with historical Individual Hazardous Substance Sites (IHSSs) in the WBEU, but elevated concentrations are likely due to natural variation. Background concentrations of arsenic in the surface soil/surface sediment at RFETS range from 0.27 to 9.6 milligram per kilogram (mg/kg). Therefore, under similar exposure conditions as those evaluated for the WBEU, background risks from arsenic in surface soil/surface sediment would be 70 to 80 percent of that estimated for the WBEU, or approximately 1.4E-06 to 1.5E-06.

Overall, no significant risks to survival, growth, and reproduction are predicted for the wildlife receptors evaluated in the WBEU. In the ERA, ECOPCs in surface soil were identified for non-Preble's jumping mouse (PMJM) and PMJM receptors. ECOPCs for selected populations of non-PMJM receptors included chromium, manganese, nickel, silver, thallium, tin, bis(2-ethylhexyl)phthalate, endrin, and total polychlorinated biphenyls (PCBs). No ECOPCs were identified in subsurface soil. The assessment of risk to the PMJM is addressed in the Upper Walnut Drainage Exposure Unit (UWNEU) and Lower Woman Drainage Exposure Unit (LWOEU) because habitat for PMJM within the WBEU is a small subset of the larger PMJM habitat areas in these two adjacent EUs.

The ECOPC/receptor pairs were evaluated in the risk characterization using a range of EPCs, exposure scenarios, and toxicity reference values (TRVs) to give a range of risk estimates. Overall, no significant risks to ecological receptors that may use the WBEU are predicted.

In addition, the high species diversity and continued use of the site by numerous vertebrate species verify that habitat quality for these species remains acceptable and the ecosystem functions are being maintained. Data collected on wildlife abundance and diversity indicate that wildlife populations are stable and species richness remains high during remediation activities at RFETS, including wildlife using the WBEU.

1.0 WIND BLOWN AREA EXPOSURE UNIT

This volume of the Comprehensive Risk Assessment (CRA) presents the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) for the Wind Blown Area Exposure Unit (EU) (WBEU) at the Rocky Flats Environmental Technology Site (RFETS) (Figure 1.1).

The HHRA and ERA methods and selection of receptors are described in detail in the Final CRA Work Plan and Methodology (DOE 2005a), hereafter referred to as the CRA Methodology. A summary of the risk assessment methods, including updates made in consultation with the regulatory agencies, are summarized in Appendix A, Volume 2, Section 2.0 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation (RI)/Corrective Measures Study (CMS)-Feasibility Study (FS) Report (hereafter referred to as the RI/FS Report). The anticipated future land use of RFETS is a wildlife refuge. Consequently, two human receptors, a wildlife refuge worker (WRW) and a wildlife refuge visitor (WRV), are evaluated in this risk assessment consistent with this land use. A variety of representative terrestrial and aquatic receptors are evaluated in the ERA including the Preble's meadow jumping mouse (PMJM), a federally listed threatened species present at the RFETS.

1.1 Wind Blown Area Exposure Unit Description

This section provides a brief description of the WBEU, including its location at RFETS, historical activities in the area, topography, surface water features, vegetation, and ecological resources. A more detailed description of these features and additional information regarding the geology, hydrology, and soil types at RFETS is included in Section 2.0, Physical Characteristics of the Study Area, of the RI/FS Report.

The Historical Release Report (HRR) and its annual updates provide descriptions of known or suspected releases of hazardous substances that occurred at RFETS (DOE 2005b). The original HRR (DOE 1992a) organized these known or suspected historical sources of contamination as Individual Hazardous Substance Sites (IHSSs), Potential Areas of Concern (PACs), or Under Building Contamination (UBC) sites (hereafter collectively referred to as historical IHSSs). Individual historical IHSSs and groups of historical IHSSs were also designated as Operable Units (OUs). Over the course of cleanup under the 1991 Interagency Agreement (IAG) and the 1996 Rocky Flats Cleanup Agreement (RFCA), the U.S. Department of Energy (DOE) has thoroughly investigated and characterized contamination associated with these historical IHSSs. Historical IHSSs have been dispositioned through appropriate remedial actions or by determining that No Further Accelerated Action (NFAA) is required, pursuant to the applicable IAG and RFCA requirements. Some OUs have also been dispositioned in accordance with an OU-specific Corrective Action Decision/Record of Decision (CAD/ROD).

A more detailed description of the regulatory agreements and the investigation and cleanup history under these agreements is contained in Section 1.0 of the RI/FS Report Section 1.4.3 of the RI/FS Report describes the accelerated action process, and the

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disposition of all historic IHSSs at RFETs is summarized in Table 1.4 of the RI/FS Report. The 2005 Annual Update to the HRR (DOE 2005b) provides for each IHSS a description of the potential contaminant releases and any interim response to the releases; identification of potential contaminants based on process knowledge and site data; data collection activities; accelerated action activities (if any); and the basis for recommending NFAA.

Several IHSSs exist within the WBEU (Table 1.1 and Figure 1.2). All the IHSSs have regulatory agency-approved NFAAs, as documented in the Annual Updates to the HRR (Table 1.1). Several of these IHSSs required accelerated action. Approximately 200 cubic yards of contaminated material were removed from Trench T-2 (IHSS 109). The excavated soil was treated by low-temperature thermal desorption and returned to the trench as "clean" backfill. Approximately 5,000 cubic yards of material were removed from Trenches T-3 (IHSS 110) and T-4 (IHSS 111.1), followed by thermal desorption processing of the material. The processed material was returned to Trench T-3 enveloped in a geotextile fabric. Approximately 420 cubic yards (cy) of contaminated material were removed from Trenches T-6 (IHSS 111.3) and T-8 (IHSS 111.5). A surface soil hot spot was removed from Trench T-7 (IHSS 111.6). At the 903 Pad (IHSS 112), 20,213 cy of radionuclide contaminated-soil and 4,467 cy of asphalt were removed. Another 49,800 cy of radionuclide-contaminated soil were removed from the 903 Lip Area (IHSS 155). At the East Firing Range (PAC SW-1602), 520 cy of metal-contaminated soil were removed. All other IHSSs in the WBEU were dispositioned as NFAA based on characterization results.

1.1.1 Exposure Unit Characteristics and Location

The 715-acre WBEU is located in the east-central portion of RFETS (Figure 1.1) and contains several distinguishing features:

- The WBEU is located within the Buffer Zone (BZ) OU, and its western boundary is adjacent to the areas that were used historically for operation of RFETS.
- The WBEU includes a portion of the Woman Creek Drainage that is east of the Industrial Area (IA) and south of the east access road, as well as small portions of the Walnut Creek Drainage that are north of the east access road and immediately east of the IA. Runoff from other areas of the WBEU flows to the east and off site via ephemeral drainages.
- The 903 Pad and 903 Lip Area IHSSs are located in the western portion of the WBEU, where plutonium and americium were released into surface soil as a result of storing contaminated liquids in drums that leaked over time. Wind erosion resulted in migration of this contamination to the east. These IHSSs have been remediated through accelerated actions.

The WBEU is bounded by the Lower Woman Drainage EU (LWOEU) and Upper Woman Drainage EU (UWOEU) to the south, the Industrial Area EU (IAEU) to the west, the Upper Walnut Drainage EU (UWNEU), Lower Walnut Drainage EU (LWNEU) to the northwest, and Indiana Street to the east.

1.1.2 Topography and Surface Water Hydrology

A recent aerial photograph of the WBEU is shown in Figure 1.3. The WBEU is an upland area between the valleys of Woman Creek and Walnut Creek. Natural surface water drainage in the WBEU is generally to the east toward Great Western Reservoir and Standley Lake. In areas along the northern and southern boundaries of the WBEU, runoff flows north into Walnut Creek or south into Woman Creek before flowing east into Great Western Reservoir or Standley Lake, respectively. Elevations in the WBEU range from 5,980 feet above mean sea level (msl) at the western boundary near the 903 Pad to 5,670 feet msl where Badger Gulch and Mower Ditch intersect Indiana Street.

Surface water features in the WBEU include Badger Gulch and Kestrel Gulch (Figures 1.2 and 1.3), which drain from the northeastern part of the WBEU into Great Western Reservoir, located approximately one third of a mile east of the site. The WBEU also includes a short segment of Woman Creek where it flows around the north end of Pond C-2. Mower Ditch, a diversion from Woman Creek, flows along the southern boundary of the WBEU, approaching it and crossing it in a few places near the southeast corner of the EU.

1.1.3 Flora and Fauna

The WBEU predominantly comprises grassland vegetation. The major components are mesic mixed grasslands and xeric grasslands (Figure 1.4). The mesic mixed grassland is distinguished at RFETS by plant species such as western wheatgrass (*Agropyron smithii*), blue grama (*Bouteloua gracilis*), side-oats grama (*Bouteloua curtipendula*), prairie junegrass (*Koeleria pyramidata*), Canada bluegrass (*Poa compressa*), Kentucky bluegrass (*Poa pratensis*), green needlegrass (*Stipa virigula*), and little bluestem (*Andropogon scoparius*). Xeric grasslands in the WBEU are primarily xeric needle and thread grass (*Stipa comata*) prairie with some xeric tallgrass prairie. Large reclaimed areas resulting from recent remediation activities and pavement removal are found in the western portion of the EU (Figure 1.4). Small areas of wetland and riparian woodland exist along Woman Creek and hill-side seeps.

Grasslands are important to wildlife, and grassland conditions on the eastern side of RFETS including WBEU are generally good. However, weeds have degraded grasslands in some areas (PTI 1997). Weed control, erosion control, and reclamation activities that are ongoing within the WBEU will continue to promote native grasslands at RFETS (Nelson 2005).

Numerous animal species have been observed at RFETS, and the more common of these are expected to be present in the WBEU. Common large-and medium-sized mammals include the mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), coyote (*Canis latrans*), desert cottontail (*Sylvilagus audubonii*), and prairie dog (*Cynomys ludovicianus*). The most common reptile observed at RFETS is the western

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prairie rattlesnake (*Crotalis viridus*). Eastern short-horned lizards (*Phrynosoma douglassii brevirostra*) are also found in the xeric grasslands within the EU. Common bird species include the meadow lark (*Sturnella neglecta*) and vesper sparrow (*Pooecetes gramineus*). The most common small mammal species include deer mice (*Peromyscus maniculatus*), prairie voles (*Microtus ochrogaster*), and different species of pocket mice, including the plains pocket mouse (*Perognathus flavescens*), silky pocket mouse (*Perognathus flavus*), and hispid pocket mouse (*Chaetodipus hispidus*).

The PMJM is a federally listed threatened species found at RFETS. The preferred habitat for the PMJM is the riparian corridors bordering streams, ponds, and wetlands at RFETS with an adjacent thin band of upland grasslands. PMJM habitat occurs along the lower reach of Lower Woman Creek along Mower Ditch in the southeastern portion of the WBEU and along the northwestern edge of the EU bordering the South Walnut Creek drainage (Figure 1.5). No PMJM have ever been captured within the boundaries of SEEU and because viable habitat for PMJM within this EU is a small subset of two larger PMJM patches in adjacent EUs, assessment of risk to the PMJM will be addressed in the UWNEU and the LWOEU, as appropriate (see Figure 1.6).

More information on the plant communities and animal species that exist within RFETS and the methodology of creating site-wide PMJM habitat patches is provided in Section 2.0 of the RI/FS Report.

1.1.4 Data Description

Data have been collected at RFETS under regulatory agency-approved Work Plans, Sampling and Analysis Plans (SAPs), and Quality Assurance Project Plans (QAPjPs) to meet data quality objectives (DQOs) and appropriate U.S. Environmental Protection Agency (EPA) and Colorado Department of Public Health and Environment (CDPHE) guidance. Surface soil, subsurface soil, sediment, surface water, and groundwater samples were collected from the WBEU. Surface soil/surface sediment, subsurface soil/subsurface sediment, surface soil, and subsurface soil are the media evaluated in the HHRA and ERA (Table 1.2). The sampling locations for these media are shown in Figures 1.6 and 1.7, and data summaries for detected analytes in each medium are provided in Tables 1.3 through 1.6. Potential contaminants of concern (PCOCs) and ecological contaminants of interest (ECOIs) that were analyzed for but not detected, or were detected in less than 5 percent of the samples, are presented in Attachment 1. Detection limits are compared to preliminary remediation goals (PRGs) and ecological screening levels (ESLs), and are discussed in Attachment 1 (Tables A1.1 through A1.4). Only data from June 1991 to the present are used in the CRA because these data meet the approved analytical quality assurance/quality control (QA/QC) requirements.

In accordance with the CRA Methodology, only data collected on or after June 28, 1991, and data for subsurface soil and subsurface sediment samples with a start depth less than or equal to 8 feet below ground surface (bgs) are used in the CRA. Subsurface soil and subsurface sediment data are limited to this depth because it is not anticipated that the WRW or burrowing animals will dig to deeper depths. A detailed description of data storage and processing methods is provided in Appendix A, Volume 2 of the RI/FS

Report. The CRA analytical data set for the WBEU is provided on a compact disc (CD) presented in Attachment 4. The CD in Attachment 5 includes the data used in the CRA as well as data not considered useable based on criteria presented in Appendix A, Volume 2 of the RI/FS Report.

The sampling data used for the WBEU HHRA and ERA are as follows:

- Combined surface soil/surface sediment data (HHRA);
- Combined subsurface soil/subsurface sediment data (HHRA);
- Surface soil data (ERA); and
- Subsurface soil data (ERA).

The data for these media are briefly described below.

In addition, because ECOPCs were identified for soil in this EU, surface water data were used in the ERA as part of the overall intake of ECOPCs by ecological receptor. The surface water data used in the ERA are summarized in Table 8.4. Surface water and sediment are assessed for ecological receptors on an aquatic exposure unit (AEU) basis in Appendix A, Volume 15 of the RI/FS Report. An assessment of the surface water, groundwater-to-surface water, and volatilization pathways for human health are presented in Appendix A, Volume 2 of the RI/FS Report.

Surface Soil/Surface Sediment

The combined surface soil/surface sediment data set for the WBEU consists of up to 347 samples that were analyzed for inorganics (160 samples), organics (107 samples), and radionuclides (347 samples) (Table 1.2). The data include sediment samples collected to depths down to 0.5 feet bgs. The sampling locations for surface soil and surface sediment are shown in Figure 1.6. Surface soil/surface sediment samples were collected in the WBEU for several months from July 1991 through October 1994 and then again for several months from February 1998 through January 2005. The samples collected in 2004 were located on a 30-acre grid, as described in CRA SAP Addendum #04-01 (DOE 2004). For the grid sampling, five individual samples were collected from each 30-acre cell, one from each quadrant and one in the center, as described in the addendum (DOE 2004). Most of the evenly spaced surface soil sampling locations in Figure 1.6 represent the 30-acre grid samples.

The data summary for detected analytes in surface soil/surface sediment for the WBEU is presented in Table 1.3. Detected analytes included representatives from the inorganics, organics, and radionuclides analyte groups. A summary of analytes that were not detected or were detected in less than 5 percent of the surface soil/surface sediment samples in the WBEU is presented and discussed in Attachment 1.

Subsurface Soil/Subsurface Sediment

The combined subsurface soil/subsurface sediment data set for the WBEU consists of up to 580 samples that were analyzed for organics (580 samples), inorganics (314 samples), and radionuclides (417 samples) (Table 1.2). The data include subsurface sediment samples with a starting depth less than or equal to 8 feet bgs and an ending depth below 0.5 feet. The sampling locations for subsurface soil and subsurface sediment are shown in Figure 1.7. Subsurface soil/subsurface sediment samples were collected in the WBEU for several months from August 1991 through May 1995 and in May 1997. Samples were again collected for several months from February 1998 through April 2000 and from January 2002 through March 2005.

The data summary for subsurface soil/subsurface sediment in the WBEU is presented in Table 1.4. Detected analytes included representatives from the inorganics, organics, and radionuclides analyte groups. A summary of analytes that were not detected, or were detected in less than 5 percent of the subsurface soil/subsurface sediment samples is presented and discussed in Attachment 1.

Surface Soil

Data meeting the CRA requirements are available for up to 335 surface soil samples collected in the WBEU that were analyzed for inorganics (151 samples), organics (98 samples), and radionuclides (335 samples) (Table 1.2). The surface soil sampling locations for the WBEU are shown in Figure 1.6. Surface soil samples were collected in the WBEU for several months from July 1991 through October 1994 and again for several months from February 1998 through January 2005. For the grid sampling, five individual surface soil samples were collected and composited from each 30-acre cell, one from each quadrant, and one in the center, as described in the CRA SAP Addendum #04-01 (DOE 2004).

The data summary for detected analytes in WBEU surface soil is presented in Table 1.5. Radionuclides, organics, and inorganics were detected in WBEU surface soil samples. A summary of analytes that were not detected, or were detected in less than 5 percent of the surface soil samples is presented and discussed in Attachment 1.

Subsurface Soil

The subsurface soil data set for the WBEU consists of up to 579 samples that were analyzed for organics (579 samples), inorganics (313 samples), and radionuclides (414 samples) (Table 1.2). Subsurface soil sampling locations are shown in Figure 1.7. Subsurface soil samples used in the CRA are defined in the CRA Methodology as soil samples with a starting depth less than or equal to 8 feet bgs and an ending depth below 0.5 feet. Subsurface soil samples were collected in the WBEU for several months from August 1991 through May 1995 and for several months from February 1998 through April 2000. Subsurface soil sampling was again performed for several months from January 2002 through March 2005.

The data summary for detected analytes in subsurface soil for the WBEU is presented in Table 1.6. Subsurface soil samples were analyzed for inorganics, organics, and radionuclides, and representatives from all three analyte groups were detected. A summary of analytes that were not detected, or were detected in less than 5 percent of the subsurface soil samples is presented and discussed in Attachment 1.

1.2 Data Adequacy

A data adequacy assessment was performed to determine whether the available data set discussed in the previous section is adequate for risk assessment purposes. The data adequacy assessment rules are presented in the CRA Methodology, and a detailed data adequacy assessment for the data used in the CRA is presented in Appendix A, Volume 2 of the RI/FS Report. The adequacy of the data was assessed by examining the number of available samples for each analyte group in each medium for use in the CRA, the spatial and temporal representativeness of the data, as well as information on potential historical sources of contamination, migration pathways, and the concentration levels in the media. The assessment concludes that the data are adequate for the purposes of the CRA.

1.3 Data Quality Assessment

A data quality assessment (DQA) of the WBEU data was conducted to determine whether the data were of sufficient quality for risk assessment use. The DQA is presented in Attachment 2, and an evaluation of the entire RFETS data set is presented in Appendix A, Volume 2 of the RI/FS Report. The quality of the laboratory results were evaluated for compliance with the CRA Methodology data quality objectives (DQOs) through an overall review of precision accuracy representativeness, completeness, and comparability (PARCC) parameters. This review was concluded that the data are of sufficient quality for use in this CRA and the CRA DQOs have been met.

2.0 SELECTION OF HUMAN HEALTH CONTAMINANTS OF CONCERN

The human health contaminant of concern (COC) screening process is described in Section 4.4 of the CRA Methodology and summarized in Appendix A, Volume 2 of the RI/FS Report (Section 2.2).

The human health COC selection process was conducted for surface soil/surface sediment and subsurface soil/subsurface sediment in the WBEU. Results of the COC selection process are summarized below.

2.1 Contaminant of Concern Selection for Surface Soil/Surface Sediment

Detected PCOCs in surface soil/surface sediment samples (Table 1.3) are screened in accordance with the CRA Methodology to identify the COCs.

2.1.1 Surface Soil/Surface Sediment Cation/Anion and Essential Nutrient Screen

The major cations and anions that do not have toxicological factors are eliminated from assessments in surface soil/surface sediment in accordance with the CRA Methodology.

The essential nutrient screen for analytes detected in surface soil/surface sediment is presented in Table 2.1. The screen includes PCOCs that are essential for human health and do not have toxicity criteria available. Table 2.1 shows the maximum detected concentrations (MDCs) for essential nutrients, daily intake estimates based on the MDCs, and dietary reference intakes (DRIs). The DRIs are identified in the table as recommended daily allowances (RDAs), recommended daily intakes (RDIs), adequate intakes (AIs), and upper limit daily intakes (ULs). The estimated daily maximum intakes based on the nutrients' MDCs and a surface soil/surface sediment ingestion rate of 100 milligrams per day (mg/day) are less than the DRIs. Therefore, these PCOCs were not further evaluated as COCs for surface soil/surface sediment.

2.1.2 Surface Soil/Surface Sediment Preliminary Remediation Goal Screen

Table 2.2 compares MDCs and upper confidence limits (UCLs) to the WRW PRGs for each PCOC. If the MDC and the UCL are greater than the PRG, the PCOC is retained for further screening; otherwise, it is not further evaluated. Arsenic, cesium-137, plutonium-239/240, and radium-228 were retained as PCOCs.

PRGs were not available for several PCOCs in surface soil/surface sediment. Analytes without PRGs are listed in Table 2.2, and their effect on the conclusions of the risk assessment results is discussed in the uncertainty section (Section 6.0).

2.1.3 Surface Soil/Surface Sediment Detection Frequency Screen

Arsenic was detected in more than 5 percent of surface soil/surface sediment samples and, therefore, was retained for further evaluation in the COC screen (Table 1.3). A detection frequency screen was not performed for cesium-137, plutonium-239/240, and radium-228 in surface soil/surface sediment because all reported values for radionuclides are considered detects.

2.1.4 Surface Soil/Surface Sediment Background Analysis

Results of the background statistical comparison for arsenic, cesium-137, plutonium-239/240, and radium-228 are presented in Table 2.3 and discussed in Attachment 3. Box plots for arsenic, cesium-137, plutonium-239/240, and radium-228 (both WBEU and background) are provided in Attachment 3. Arsenic and plutonium-239/240 and radium-228 were statistically greater than background at the 0.1 significance level, and are evaluated further in the professional judgment section.

2.1.5 Surface Soil/Surface Sediment Professional Judgment Evaluation

Based on the weight of available evidence evaluated by professional judgment, PCOCs will either be included for further evaluation as COCs or excluded as COCs. The professional judgment evaluation takes into account process knowledge, spatial trends, and pattern recognition. As discussed in Section 1.2 and Attachment 2, the sample results are adequate for use in the professional judgment because they are of sufficient quality for use in the CRA.

Based on the weight of evidence described in Attachment 3, radium-228 in surface soil/surface sediment in the WBEU is not considered a COC because the weight of evidence supports the conclusion that radium-228 concentrations in surface soil/surface sediment in the WBEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations.

Arsenic and plutonium-239/240 are considered COCs in surface soil/surface sediment and are further evaluated in Section s 3.0 through 5.0.

2.2 Contaminant of Concern Selection for Subsurface Soil/Subsurface Sediment

Detected PCOCs in subsurface soil/subsurface sediment samples (Table 1.4) are screened in accordance with the CRA Methodology to identify COCs.

2.2.1 Subsurface Soil/Subsurface Sediment Cation/Anion and Essential Nutrient Screen

The major cations and anions that do not have toxicological factors are eliminated from assessments in subsurface soil/subsurface sediment in accordance with the CRA Methodology. Sulfide was the only cation/anion detected in subsurface soil/subsurface sediment. The effect of eliminating sulfide as a PCOC on the conclusions of the risk assessment is discussed in the uncertainty section (Section 6.0).

Essential nutrients without toxicity criteria that were detected in subsurface soil/subsurface sediment in the WBEU are compared to DRIs in Table 2.4. The estimated daily maximum intakes for these PCOCs, based on the nutrients' MDCs and a subsurface soil/subsurface sediment ingestion rate of 100 milligrams per day (mg/day), are less than the DRIs. Therefore, these PCOCs were not further evaluated as COCs for subsurface soil/subsurface sediment.

2.2.2 Subsurface Soil/Subsurface Sediment Preliminary Remediation Goal Screen

The PRG screen for detected analytes in subsurface soil/subsurface sediment is presented in Table 2.5. Radium-228 was the only PCOC with both an MDC and a UCL that exceeded the PRG. Therefore, radium-228 is retained for further evaluation as a PCOC.

PRGs are not available for several PCOCs in subsurface soil/subsurface sediment. Analytes without PRGs are listed in Table 2.5, and their effect on the conclusions of the risk assessment is discussed in the uncertainty section (Section 6.0).

2.2.3 Subsurface Soil/Subsurface Sediment Detection Frequency Screen

The detection frequency screen is not performed for radium-228 in subsurface soil/subsurface sediment because all reported values for radionuclides are considered detects.

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2.2.4 Subsurface Soil/Subsurface Sediment Background Analysis

Results of the background statistical comparison for radium-228 is presented in Table 2.3 and discussed in Attachment 3. Box plots for radium-228 (both WBEU and background) are provided in Attachment 3. Radium-228 concentrations were not statistically greater than background at the 0.1 significance level; therefore, it is not evaluated further.

2.2.5 Subsurface Soil/Subsurface Sediment Professional Judgment Evaluation

The professional judgment step was not performed for subsurface soil/subsurface sediment because no PCOCs were retained following the background analysis.

2.3 Contaminant of Concern Selection Summary

A summary of the results of the COC screening process is presented in Table 2.6. In surface soil/surface sediment, arsenic and plutonium-239/240 were selected as COCs in the WBEU and are further evaluated quantitatively. No analytes were selected as COCs in subsurface soil/subsurface sediment in the WBEU.

3.0 HUMAN HEALTH EXPOSURE ASSESSMENT

The site conceptual model (SCM), presented in Figure 2.1 of the CRA Methodology and is discussed in Appendix A, Volume 2 of the RI/FS Report, provides an overview of potential human exposures at RFETS for reasonably anticipated land use. Two types of receptors, the WRW and WRV were selected for quantitative evaluation based on the SCM. Exposure point concentrations (EPCs) were calculated for the COCs identified, and chemical intakes were estimated using the EPCs for the WRW and WRV receptors.

Tier 1 and Tier 2 EPCs were calculated for the two COCs, arsenic and plutonium-239/240, in surface soil/surface sediment for the WBEU. Tier 1 EPCs are based on the upper confidence limits of the arithmetic mean concentration for the EU data set and Tier 2 EPCs are calculated using a spatially weighted averaging approach. The methodology for these calculations is provided in Appendix A, Volume 2 of the RI/FS Report. Figure 3.1 shows the 30-acre grid used to calculate the Tier 2 EPCs. Table 3.1 presents the Tier 1 and Tier 2 EPCs for the WBEU.

Chemical intakes for WRW and WRV exposure pathways were quantified for arsenic and plutonium-239/240 using the exposure factors listed in Tables 3.2 through 3.5. Additional information on the estimation of chemical intake is presented in Appendix A, Volume 2 of the RI/FS Report and in the CRA Methodology.

4.0 HUMAN HEALTH TOXICITY ASSESSMENT

Toxicity criteria are used in the risk calculations in Section 5.0. Tables 4.1 through 4.4 present the toxicity criteria (cancer slope factors [CSFs], reference doses [RfDs], dermal absorption factors, and dose conversion factors) for COCs at the WBEU. Toxicity criteria are presented for the oral, inhalation, and external exposure pathways. The dermal exposure pathway is not evaluated for inorganic chemicals and radionuclides (DOE 2004a). Additional information on the human health toxicity assessment is presented in Appendix A, Volume 2 of the RI/FS Report and in the CRA Methodology.

5.0 HUMAN HEALTH RISK CHARACTERIZATION

Information from the exposure assessment and the toxicity assessment is integrated in this section to characterize risk and radiation dose to the WRW and WRV receptors. Quantitative risks for cancer and noncancer effects were estimated using the toxicity factors presented in the Toxicity Assessment (Section 4.0) and pathway-specific intakes defined in the Exposure Assessment (Section 3.0). Details of the risk characterization methods are provided in the CRA Methodology and summarized in Appendix A, Volume 2 of the RI/FS Report.

5.1 Wildlife Refuge Worker

This section presents the risk characterization for exposure to COCs at the WBEU. The WRW receptor was evaluated for exposure to arsenic and plutonium-239/240 in surface soil/surface sediment. The risk estimates for exposure to arsenic and plutonium-239/240 are summarized in Tables 5.1 and 5.2, respectively, while Attachment 4 contains the risk calculation tables.

5.1.1 Surface Soil/Surface Sediment

The WRW is evaluated for exposure to arsenic and plutonium-239/240 in surface soil/surface sediment by ingestion, inhalation, and external exposure (for radiological COCs only). The estimated excess lifetime cancer risks and noncancer hazards for Tier 1 and Tier 2 EPCs are calculated and summarized in Tables 5.1 and 5.5. The estimated radiation cancer risks and doses for Tier 1 and Tier 2 EPCs are calculated and summarized in Tables 5.2 and 5.6.

Risk Characterization Results Based on Tier 1 Exposure Point Concentrations

<u>Chemical Cancer Risks</u>

The total chemical cancer risk for potential exposure to surface soil/surface sediment by the WRW, based on the Tier 1 EPC, is 2E-06 (Table 5.1). The primary risk driver is arsenic, which comprises 100 percent of the total chemical cancer risk. The risk is predominantly from the ingestion exposure route.

The relationship of the arsenic risk in the WBEU to that for background soil concentrations is presented in the uncertainty section (Section 6.0).

<u>Chemical Noncancer Hazards</u>

The noncancer Hazard Index (HI) for potential exposure to surface soil/surface sediment by the WRW, based on the Tier 1 EPC is 0.02 (Table 5.1). Arsenic is the sole contributor to the HI and the hazard is entirely from the ingestion exposure route.

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Radionuclide Cancer Risks

The total radionuclide cancer risk for potential exposure to surface soil/surface sediment by the WRW, based on the Tier 1 EPC, is 2E-06 (Table 5.2). The primary risk driver is plutonium-239/240, which comprises 100 percent of the total radionuclide cancer risk. The risk is predominantly from the inhalation exposure route.

Radiation Dose

The total radiation dose estimate for potential exposure to surface soil/surface sediment by the WRW, based on the Tier 1 EPC, is 3.4E-01 millirem (mrem) (Table 5.2). Plutonium-239/240 is the sole contributor to the dose. The dose is predominantly from the ingestion exposure route.

Uncertainties associated with the dose estimate for plutonium-239/240 are further discussed in the uncertainty section (Section 6.0).

Risk Characterization Results Based on Tier 2 Exposure Point Concentrations

Chemical Cancer Risks

The total chemical cancer risk for potential exposure to surface soil/surface sediment by the WRW, based on the Tier 2 EPC, is 2E-06 (Table 5.1). The primary risk driver is arsenic, which comprises 100 percent of the total chemical cancer risk. The risk is predominantly from the ingestion exposure route.

The relationship of the arsenic risk in the WBEU to that for background soil concentrations is presented in the uncertainty section (Section 6.0).

Chemical Noncancer Hazards

The noncancer HI for potential exposure to surface soil/surface sediment by the WRW, based on the Tier 2 EPC is 0.01 (Table 5.1). Arsenic is the sole contributor to the HI, and the hazard is entirely from the ingestion exposure route.

Radionuclide Cancer Risks

The total radionuclide cancer risk for potential exposure to surface soil/surface sediment by the WRW, based on the Tier 2 EPC, is 8E-07 (Table 5.2). The primary risk driver is plutonium-239/240, which comprises 100 percent of the total radionuclide cancer risk. The risk is predominantly from the inhalation exposure route.

Radiation Dose

The total radiation dose estimate for potential exposure to surface soil/surface sediment by the WRW, based on the Tier 2 EPC, is 1.6E-01 mrem (Table 5.2). Plutonium-239/240 is the sole contributor to the dose. The dose is predominantly from the ingestion exposure route.

Uncertainties associated with the dose estimate for plutonium-239/240 are further discussed in the uncertainty section (Section 6.0).

5.1.2 Subsurface Soil/Subsurface Sediment

No COCs were identified in subsurface soil/subsurface sediment. Therefore, it is not necessary to perform a risk characterization for subsurface soil/subsurface sediment in the WBEU.

5.1.3 Wildlife Refuge Worker Total Risk and Hazards

Risk estimates are summed across media to develop an estimate for the total risk to a receptor. This approach is followed only if the COCs in different media exhibit comparable health effects. For the WBEU, arsenic and plutonium-239/240 were selected as COCs for surface soil/surface sediment only. Total risk and hazards are summarized in Tables 5.5 and 5.6. The surface soil/surface sediment risk estimates for the WRW results in an estimated total chemical cancer risk of 2E-06 for both Tier 1 and Tier 2 EPCs and a total radionuclide cancer risk of 2E-06, based on a Tier 1 EPC, and 8E-07, based on a Tier 2 EPC. The non-cancer HI for the WRW is estimated to be 0.02, based on a Tier 1 EPC, and 0.01, based on a Tier 2 EPC. Because arsenic and plutonium-239/240 were selected as COCs in only one medium, cumulative risks from exposure to multimedia are not calculated for the WBEU.

5.2 Wildlife Refuge Visitor

This section presents the results of the risk characterization for potential exposure of the WRV receptor to arsenic and plutonium-239/240 in surface soil/surface sediment at the WBEU. Exposure to subsurface soil/subsurface sediment is not evaluated for the WRV. The risk estimates for exposure to arsenic and plutonium-239/240 are summarized in Tables 5.3 and 5.4, respectively, while Attachment 4 contains the risk calculation tables.

5.2.1 Surface Soil/Surface Sediment

The WRV is evaluated for exposure to arsenic and plutonium-239/240 in surface soil/surface sediment by ingestion, inhalation, and external exposure (for radiological COCs only). The estimated excess lifetime cancer risks and noncancer hazards for Tier 1 and Tier 2 EPCs are calculated and summarized in Tables 5.3 and 5.5. The estimated radiation cancer risks and doses for Tier 1 and Tier 2 EPCs are calculated and summarized in Tables 5.4 and 5.6.

Risk Characterization Results Based on Tier 1 Exposure Point Concentrations

<u>Chemical Cancer Risks</u>

The total chemical cancer risk for potential exposure to surface soil/surface sediment by the WRV, based on the Tier 1 EPC, is 2E-06 (Table 5.3). The primary risk driver is arsenic, which comprises 100 percent of the total chemical cancer risk. The risk is predominantly from the ingestion exposure route.

The relationship of the arsenic risk in the WBEU to that for background soil concentrations is presented in the uncertainty section (Section 6.0).

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Chemical Noncancer Hazards

The noncancer HI for potential exposure to surface soil/surface sediment by the WRV, based on the Tier 1 EPC, is 0.01 (Table 5.3). Arsenic is the sole contributor to the HI and the hazard is entirely from the ingestion exposure route.

Radionuclide Cancer Risks

The total radionuclide cancer risk for potential exposure to surface soil/surface sediment by the WRV, based on the Tier 1 EPC, is 1E-06 (Table 5.4). The primary risk driver is plutonium-239/240, which comprises 100 percent of the total radionuclide cancer risk. The risk is predominantly from the ingestion exposure route.

Radiation Dose

The total radiation dose estimate for potential exposure to surface soil/surface sediment by the WRV, based on the Tier 1 EPC, is 7.2E-02 mrem for an adult and 2.2E-01 mrem for a child (Table 5.4). Plutonium-239/240 is the sole contributor to the dose. The dose is predominantly from the ingestion exposure route.

Uncertainties associated with the dose estimate for plutonium-239/240 are further discussed in the uncertainty section (Section 6.0).

Risk Characterization Results Based on Tier 2 Exposure Point Concentrations

Chemical Cancer Risks

The total chemical cancer risk for potential exposure to surface soil/surface sediment by the WRV, based on the Tier 2 EPC, is 1E-06 (Table 5.3). The primary risk driver is arsenic, which comprises 100 percent of the total chemical cancer risk. The risk is predominantly from the ingestion exposure route.

The relationship of the arsenic risk in the WBEU to that for background soil concentrations is presented in the uncertainty section (Section 6.0).

Chemical Noncancer Hazards

The noncancer HI for potential exposure to surface soil/surface sediment by the WRV, based on the Tier 2 EPC, is 0.01 (Table 5.3). Arsenic is the sole contributor to the HI and the hazard is entirely from the ingestion exposure route.

Radionuclide Cancer Risks

The total radionuclide cancer risk for potential exposure to surface soil/surface sediment by the WRV, based on the Tier 2 EPC, is 5E-07 (Table 5.4). The primary risk driver is plutonium-239/240, which comprises 100 percent of the total radionuclide cancer risk. The risk is predominantly from the ingestion exposure route; however, the inhalation exposure route also has a significant contribution.

Radiation Dose

The total radiation dose estimate for potential exposure to surface soil/surface sediment by the WRV, based on the Tier 2 EPC, is 3.5E-02 mrem for an adult and 1.0E-01 mrem for a child (Table 5.4). Plutonium-239/240 is the sole contributor to the dose. The dose is predominantly from the ingestion exposure route.

Uncertainties associated with the dose estimate for plutonium-239/240 are further discussed in the uncertainty section (Section 6.0).

5.3 Summary

Risks to the WRW and WRV were evaluated for potential exposure to arsenic and plutonium-239/240 in surface soil/surface sediment at the WBEU. The chemical cancer risks and noncancer hazards are summarized in Table 5.5, and the radionuclide cancer risks are summarized in Table 5.6.

The results of the Tier 1 and Tier 2 risk characterizations indicate that estimated chemical and radionuclide risks for the WRW and WRV are at the low end or are below the target risk range for COCs exhibiting carcinogenic effects (i.e., 1×10^{-6} to $1x\ 10^{-4}$) (Tables 5.5 and 5.6). The Tier 1 and Tier 2 total HI estimates for arsenic are well below 1, indicating that no significant noncarcinogenic health effects are expected for the WRW or the WRV in the WBEU (Table 5.5).

Radiation dose associated with exposure to plutonium-239/240 in surface soil/surface sediment at the WBEU was evaluated. The results of the Tier 1 and Tier 2 dose assessments indicate that estimated doses are less than 1 mrem (Tables 5.2 and 5.4), which is well below the radiation dose limit of 25 mrem.

6.0 UNCERTAINTIES ASSOCIATED WITH THE HUMAN HEALTH RISK ASSESSMENT

There are various types of uncertainties associated with steps of an HHRA. General uncertainties common to the EUs are discussed in Appendix A, Volume 2 of the RI/FS Report. Uncertainties specific to the EU are described below.

6.1 Uncertainties Associated with the Data

Data adequacy for this CRA is evaluated and discussed in Appendix A, Volume 2 of the RI/FS Report. Although there are some uncertainties associated with the sampling and analyses conducted for surface soil/surface sediment and subsurface soil/subsurface sediment at the WBEU, data are considered adequate for the characterization of risk at the EU. The environmental samples for the WBEU were collected from 1991 through 2005. The CRA sampling and analysis requirements for the BZ (DOE 2004a, 2004b) specify the minimum sampling density requirement for surface soil/surface sediment is one five-sample composite for every 30-acre grid cell. For most of the WBEU, this sampling density is exceeded because there are up to 324 surface soil/surface sediment samples for the entire 715-acre EU.

Another source of uncertainty in the data is the relationship of detection limits to the PRGs for analytes eliminated as COCs because they were either not detected or had a low detection frequency (i.e., less than 5 percent). The detection limits were appropriate for the analytical methods used, and this is examined in greater detail in Attachment 1.

6.2 Uncertainties Associated with Screening Values

The COC screening analyses used RFETS-specific PRGs based on a WRW scenario. The assumptions used in the development of these values were conservative. For example, it was assumed that a future WRW will consume 100 milligram (mg) of surface soil/surface sediment for 230 days per year for a period of 18.7 years. In addition, a WRW is assumed to be dermally exposed and to inhale surface soil and surface sediment particles in the air. These assumptions are likely to over-estimate actual exposures to surface soil/surface sediment for WRWs in the WBEU because a WRW will not spend 100 percent of his or her time in this area. Exposure to subsurface soil and subsurface sediment is assumed to occur 20 days per year. The WRW PRGs for subsurface soil/subsurface sediment also are expected to conservatively estimate potential exposures because it is unlikely a WRW will excavate extensively in the WBEU.

6.2.1 Uncertainties Associated with Potential Contaminants of Concern without Preliminary Remediation Goals

PCOCs for the WBEU for which PRGs are not available are listed in Table 6.1.

Uncertainties associated with the lack of PRGs for analytes listed in Table 6.1 are considered small. The listed cations/anions and inorganics are not usually included in HHRAs because they are not expected to result in significant human health impacts. Many of the listed organics have a low detection frequency and, therefore, are not expected to affect the results of the HHRA. Radionuclide PRGs are available for all detected individual radionuclides. Therefore, the lack of PRGs for the gross alpha and gross beta activities is not expected to affect the results of the HHRA.

6.3 Uncertainties Associated with Eliminating Potential Contaminants of Concern Based on Professional Judgment

Radium-228 in surface soil/surface sediment was eliminated as a COC based on professional judgment. There is no identified source or pattern of release in the WBEU, and the slightly elevated median value of radium-228 in the WBEU is most likely due to natural variation. The weight of evidence presented in Attachment 3, Section 4.0 supports the conclusion that concentrations of radium-228 are naturally occurring and not due to site activities. Uncertainty associated with the elimination of this chemical as a COC is low.

6.4 Uncertainties Associated with Calculation of Risk

The Tier 1 UCL for the WBEU surface soil/surface sediment arsenic data is 5.50 mg/kg, and the excess lifetime cancer risks are estimated to be 2.1E-06 for the WRW (Table 5.1) and 1.9E-06 for the WRV (Table 5.3). The background UCL for surface soil/surface sediment arsenic data is 4.03 mg/kg (Appendix A, Volume 2 of the RI/FS Report), which results in a background excess lifetime cancer risk of 1.5E-06. Risks associated with typical arsenic background levels in soils are equal to approximately 70 to 80 percent of the WBEU risk estimates. Therefore, potential risks from arsenic associated with site-related activities in the WBEU may be over-estimated.

6.5 Uncertainties Associated with Calculation of Radiation Dose from Plutonium-239/240 in Surface Soil/Surface Sediment

Radiation dose may be over-estimated or under-estimated based on the radiation dose assessment methodology. Uncertainties associated with the soil/sediment concentrations, exposure scenarios, exposure pathways, exposure factors, and dose conversion factors exist. All factors are conservatively estimated so that radiation dose would tend toward being over-estimated.

6.6 Uncertainties Evaluation Summary

Evaluation of the uncertainties associated with the data and the COC screening processes indicates there is reasonable confidence in the conclusions of the WBEU risk characterization.

7.0 IDENTIFICATION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN

The ECOPC identification process streamlines the ecological risk characterization for each EU by focusing the assessment on ECOIs that are present in the WBEU. ECOIs are defined as any chemical detected in the WBEU and are assessed for surface soils and subsurface soils. ECOIs for sediments and surface water are assessed in Appendix A, Volume 15 of the RI/FS Report. The ECOPC process is described in the CRA Methodology and additional details are provided in Appendix A, Volume 2 of the RI/FS Report. A detailed discussion of the SCM, including the receptors of concern, exposure pathways, and endpoints used in the ERA for the WBEU, are also provided in Appendix A, Volume 2 of the RI/FS Report. The ECOPC process is described in the CRA Methodology and additional details are provided in Appendix A, Volume 2 of the RI/FS Report.

The process is based on the SCM presented in the CRA Methodology and described in detail in Appendix A, Volume 2 of the RI/FS Report. The SCM presents the pathways of potential exposure from documented historical source areas (IHSSs and PACs) to the receptors of concern. The most significant exposure pathways for ecological receptors at the WBEU are the ingestion of plant, invertebrate, or animal tissue that could have accumulated ECOIs from the source areas through direct uptake or dietary routes, as well as the direct ingestion of potentially contaminated media. For terrestrial plants and invertebrates, the most significant exposure pathway is direct contact with potentially contaminated soils.

The receptors of concern that were selected for assessment are listed in Table 7.1, and discussed in detail in Appendix A, Volume 2 of the RI/FS Report, and include representative birds and mammals in addition to the general plant and terrestrial invertebrate communities. The receptors were selected based on several criteria, including their potential to be found in the various habitats present within the WBEU, their potential to come into contact with ECOIs, and the amount of life history and behavioral information available.

The ECOPC process consists of two separate evaluations, one for the PMJM receptor and one for non-PMJM receptors. The ECOPC identification process for the PMJM is conducted separately from non-PMJM receptors because the PMJM is a federally listed threatened species under the Endangered Species Act (63 FR 26517). The assessment of risk to the PMJM is addressed in the UWNEU and LWOEU because habitat for PMJM within the WBEU is a small subset of the larger PMJM habitat areas in these two adjacent EUs (Figure 1.5).

7.1 Data Used in the Ecological Risk Assessment

The following WBEU data are used in the CRA:

- A total of 335 surface soil samples were collected in the WBEU and analyzed for inorganics (151 samples) and organics (98 samples) (Table 1.2) and radionuclides (335 samples).
- A total of 579 subsurface soil samples were collected and analyzed for inorganics (313 samples) and organics (579 samples) (Table 1.2) and radionuclides (414 samples).

A data summary is provided in Table 1.5 for surface soil and Table 1.6 for subsurface soil.

Sediment and surface water data for the WBEU were collected (Table 1.2) and are evaluated for the ERA in Appendix A, Volume 15 of the RI/FS Report. Surface water data are also as part of the drinking water exposure pathway that is evaluated in the risk characterization.

7.2 Identification of Surface Soil Ecological Contaminants of Potential Concern

ECOPCs for surface soil were identified for non-PMJM and PMJM receptors in accordance with the sequence presented in the CRA Methodology.

7.2.1 Comparison with No Observed Adverse Effect Level Ecological Screening Levels

In the first step of the ECOPC identification process, the MDCs of ECOIs in surface soil were compared to receptor-specific no observed adverse effect level (NOAEL) ESLs. NOAEL ESLs for surface soil were developed in the CRA Methodology for three receptor groups: terrestrial vertebrates, terrestrial invertebrates, and terrestrial plants.

Non-PMJM Receptors

The NOAEL ESLs for non-PMJM receptors are compared to MDCs in surface soil in Table 7.1. The results of the NOAEL ESL screening analyses for all receptor types are summarized in Table 7.2. Analytes with a "Yes" in any of the "Exceedance" columns in Table 7.2 are evaluated further.

NOAEL ESLs were not available for several ECOI/receptor pairs (Tables 7.1 and 7.2). These ECOI/receptor pairs are discussed as ECOIs with uncertain toxicity (UT) in Section 10.0 along with the potential impacts to the risk assessment.

PMJM Receptors

No screening was conducted for PMJM receptors in the WBEU.

7.2.2 Surface Soil Frequency of Detection Evaluation

The ECOPC identification process for non-PMJM receptors involves an evaluation of detection frequency for each ECOI retained after the NOAEL screening step. If the detection frequency is less than 5 percent, then population-level risks are considered highly unlikely and the ECOI is not further evaluated. Di-n-butylphthalate was the only ECOI detected in surface soil at the WBEU that was retained after the NOAEL ESL screening step and had a detection frequency less than 5 percent.

Di-n-butylphthalate was detected in 1 of 85 surface soil samples in the WBEU. Figure 7.1 shows the sampling locations and detections. It is unlikely that population-level risks would be predicted based on one isolated detection of di-n-butylphthalate.

7.2.3 Surface Soil Background Comparisons

The ECOIs retained after the NOAEL ESL screening and the detection frequency evaluation were then compared to site-specific background concentrations where available. The background comparison is discussed in Attachment 3. The statistical methods used for the background comparison are summarized in Appendix A, Volume 2 of the RI/FS Report.

Non-PMJM Receptors

The results of the background comparisons for the non-PMJM receptors are presented in Table 7.3. The analytes listed as being retained as ECOIs in Table 7.3 are evaluated further using upper-bound EPCs in the following section.

PMJM Receptors

No screening for PMJM receptors was conducted for WBEU.

7.2.4 Exposure Point Concentration Comparisons to Threshold Ecological Screening Levels

The ECOIs retained after completion of all previous evaluations for non-PMJM receptors are then compared to threshold ESLs (tESLs) using EPCs specific to small and large

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home-range receptors. The calculation of EPCs is described in Appendix A, Volume 2 of the RI/FS Report.

Statistical concentrations for each ECOI retained for the tESL screen are presented in Table 7.4. The EPC for small home-range receptors is the 95 percent UCL of the 90th percentile (upper tolerance limit [UTL]), or the MDC in the event that the UTL is greater than the MDC. The EPC for large home-range receptors is the UCL, or the MDC in the event that the UCL is greater than the MDC.

Small home-range receptors include terrestrial plants, terrestrial invertebrates, mourning dove, American kestrel, deer mouse, and black-tailed prairie dog. These receptors are evaluated by comparing the small home-range EPC (UTL) for each ECOI to the limiting (or lowest) small home-range receptor tESL (if available). In the event that tESLs are not available, the limiting NOAEL ESL is used in accordance with the CRA Methodology.

Large home-range receptors, such as coyote and mule deer, are evaluated by comparing the large home-range EPC (UCL) for each ECOI to the limiting large home-range receptor tESL (if available).. In the event that tESLs are not available, the limiting NOAEL ESL is used in accordance with the CRA Methodology.

The EPC comparison to limiting tESLs for small and large home-range receptors is presented in Table 7.5. Analytes that exceed the limiting tESLs are further evaluated by comparing them to the receptor-specific tESLs (if available) to identify receptors of potential concern. Analytes exceeding the limiting tESLs for small home-range receptors are compared to receptor-specific tESLs in Table 7.6, and analytes exceeding limiting tESLs for large home-range receptors are compared to receptor-specific tESLs in Table 7.7.

Chemicals that exceed any tESLs (if available) are assessed in the professional judgment evaluation. Any analyte/receptor pairs that are retained through professional judgment are identified as ECOPCs and are carried forward in the risk characterization.

7.2.5 Surface Soil Professional Judgment Evaluation

Non-PMJM Receptors

Based on the weight-of-evidence, professional judgment described in Attachment 3, aluminum, barium, boron, lithium, and molybdenum in surface soil at the WBEU were not considered ECOPCs for non-PMJM receptors and, therefore, are not further evaluated quantitatively.

Chromium, manganese, nickel, silver, thallium, tin, bis(2-ethylhexyl)phthalate, endrin, and total PCBs were identified as ECOPCs and retained for further evaluation in the risk characterization.

PMJM Receptors

No screening was conducted for PMJM receptors in WBEU.

7.2.6 Summary of Surface Soil Ecological Contaminants of Potential Concern

The ECOPC screening process for surface soil is summarized below.

Non-PMJM Receptors

Inorganic, organic, and radionuclide surface soil ECOIs for non-PMJM receptors in the WBEU were eliminated from further consideration as ECOPCs based on one of the following: 1) the MDC of the ECOI was less than the lowest ESL; 2) no ESLs were available (these ECOIs are discussed in Section 10.0); 3) the concentration of the ECOI in WBEU surface soils was not statistically greater than background surface soils; 4) the upper-bound EPC did not exceed the limiting tESL; or 5) the weight-of-evidence, professional judgment evaluation indicated that the ECOI was not a site-related contaminant of potential concern. Chemicals that were retained are identified as ECOPCs.

A summary of the ECOPC screening process for non-PMJM receptors is presented in Table 7.8. Receptors of potential concern for each ECOPC are also presented. The ECOPC/receptor pairs are evaluated further in Section 8.0 (Ecological Exposure Assessment), Section 9.0 (Ecological Toxicity Assessment), and Section 10.0 (Ecological Risk Characterization).

PMJM Receptors

No ECOPCs were identified for PMJM receptors in the WBEU.

7.3 Identification of Subsurface Soil Ecological Contaminants of Potential Concern

Subsurface soil sampling locations for soil collected at a starting depth of 0.5 to 8 feet bgs in the WBEU are identified in Figure 1.7. A data summary for subsurface soil less than 8 feet deep is presented in Table 1.6.

7.3.1 Comparison to No Observed Adverse Effect Level Ecological Screening Levels

The CRA Methodology indicates subsurface soil is evaluated for those ECOIs that have greater concentrations in subsurface soil than in surface soil. As a conservative screening step, subsurface soil is evaluated for all EUs regardless of the presence/absence of a change in concentrations from surface soil and subsurface soil. The MDCs of ECOIs in subsurface soil were compared to NOAEL ESLs for burrowing receptors (Table 7.9). ECOIs with MDCs greater than the NOAEL ESL for the prairie dog are further evaluated in the ECOPC identification process.

NOAEL ESLs are not available for some analytes, and these are identified as "N/A" in Table 7.9. These constituents are considered ECOIs with UT and are discussed in the uncertainty analysis (Section 10.0).

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7.3.2 Subsurface Soil Detection Frequency Evaluation

The ECOPC identification process for burrowing receptors involves an evaluation of detection frequency for each ECOI retained after the NOAEL ESL screening step. If the detection frequency is less than 5 percent, population-level risks are considered highly unlikely and the ECOI is not further evaluated. The detection frequencies for chemicals in subsurface soil are presented in Table 1.6. None of the chemicals in subsurface soil at the WBEU that were retained after the NOAEL ESL screening step had a detection frequency of less than 5 percent. Therefore, no ECOIs were eliminated from further evaluation based on low detection frequencies for subsurface soil in the WBEU.

7.3.3 Subsurface Soil Background Comparison

The ECOIs retained after the ESL screening and detection frequency evaluation were compared to site-specific background concentrations where available. The background comparison was conducted in the same manner as that for surface soil non-PMJM receptors using statistical comparisons.

Analyses were conducted to assess whether ECOPC concentrations in WBEU subsurface soil is statistically greater than those in sitewide background surface soil at the 0.1 level of significance.

The results of the statistical comparisons of the WBEU data to background data indicate that site concentrations of only antimony in WBEU subsurface soil are statistically greater than background concentrations. The results are summarized in Table 7.10.

7.3.4 Exposure Point Concentration Comparisons to Threshold Ecological Screening Levels

ECOIs retained after all previous evaluations for burrowing receptors are compared to tESLs using EPCs specific to small home-range receptors. The calculation of EPCs is described in Appendix A, Volume 2 of the RI/FS Report.

Because only antimony was retained following the background analysis step, statistical concentrations for antimony are presented in Table 7.11. The EPC comparison to tESLs for burrowing receptors is presented in Table 7.12. The subsurface soil UTL for antimony is lower than the tESL for the prairie dog receptor; therefore, it was not further evaluated.

7.3.5 Subsurface Soil Professional Judgment

No further screening was conducted for burrowing receptors because all ECOIs have been eliminated in the previous screening steps.

7.3.6 Summary of Subsurface Soil Ecological Contaminants of Potential Concern

All subsurface soil ECOIs for burrowing receptors in the WBEU were eliminated from further consideration as ECOPCs based on one of the following: 1) the MDC of the ECOI was less than NOAEL ESL for the burrowing receptor; 2) no ESLs were available (these ECOIs are discussed in Section 10.0); 3) the concentration of the ECOI in WBEU subsurface soils was not statistically greater than background subsurface soils; or 4) the upper-bound EPC was less than the tESL. The results of the subsurface soil ECOPC identification process for burrowing receptors are summarized in Table 7.13.

7.4 Summary of Ecological Contaminants of Potential Concern

ECOIs in surface and subsurface soil in the WBEU were evaluated in the ECOPC identification process for non-PMJM receptors and burrowing receptors. Chromium, manganese, nickel, silver, thallium, tin, bis(2-ethylhexyl)phthalate, endrin, and total PCBs were identified as ECOPCs for selected non-PMJM receptors (Table 7.8). No chemicals were identified as ECOPCs for the burrowing receptor (Table 7.13). No other ECOIs were retained past the professional judgment step of the ECOPC identification process for any other receptor group (non-PMJM receptors, PMJM receptors, or burrowing receptors).

8.0 ECOLOGICAL EXPOSURE ASSESSMENT

The ECOPC identification process defined the steps necessary to identify those chemicals that could not reliably be removed from further consideration in the ERA process. The list of ECOPC/receptor pairs of potential concern (Table 8.1) represents those media, chemicals, and receptors in the WBEU that require further assessment. The characterization of risk defines a range of potential exposures to site receptors from the ECOPCs and a parallel evaluation of the potential toxicity of each of the ECOPCs as well as the uncertainties associated with the risk characterization. This section provides the estimation of potential exposure to surface soil ECOPCs for the receptors identified in Section 7.0 and Table 8.1. Details of the two exposure models, concentration-based exposure and dosage-based exposure, are presented in Appendix A, Volume 2 of the RI/FS Report.

8.1 Exposure Point Concentrations

Surface soil EPCs for all non-PMJM receptors were calculated using both Tier 1 and Tier 2 methods as described in Appendix A, Volume 2 of the RI/FS Report. The 30-acre grid used for the Tier 2 calculations is shown in Figure 8.1. The Tier 1 and Tier 2 UTLs and UCLs are presented in Table 8.2. The methodology for the calculation of Tier 2 statistics is provided in Appendix A, Volume 2 of the RI/FS Report.

Surface water EPCs consisted of values that corresponded to the soil EPCs (only for the soil ECOPCs) being used and are used to estimate the total exposure via the surface water ingestion pathway. For example, if the soil EPC statistic was the UCL, then the UCL concentration in surface water (total values only) was calculated as described for soils and was selected as the EPC. Surface water EPCs for all ECOPCs are presented in Table 8.3. All surface water data are provided on CD in Attachment 6.

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8.2 Receptor-Specific Exposure Parameters

Receptor-specific exposure factors are needed to estimate exposure to ECOPCs for each representative species. These include body weight; food, water, and media ingestion rates; and diet composition and respective proportion of each dietary component. Daily rates for intake of forage, prey, water, and incidental ingestion of soils were developed in the CRA Methodology and are presented in Table 8.4 for the receptors of potential concern carried forward in the ERA for the WBEU.

8.3 Bioaccumulation Factors

The measurement or estimation of concentrations of ECOPCs in wildlife food is necessary to evaluate how much of a receptor's exposure is via food versus direct uptake of contaminated media. Conservative BAFs were identified in the CRA Methodology (DOE 2004a). These BAFs are either simple ratios between chemical concentrations in biota and soil or are based on quantitative relationships such as linear, logarithmic, or exponential equations. The values reported in the CRA Methodology are used as the BAFs for purposes of risk estimation.

8.4 Intake and Exposure Estimates

Intake and exposure estimates were completed for each ECOPC/receptor pair identified in Table 8.1. The estimates use the default exposure parameters and BAFs presented in Appendix B of the CRA Methodology and described in the previous subsection. These intake calculations represent conservative estimates of food tissue concentrations calculated from the range of upper-bound EPCs including the Tier 1 and Tier 2 UTLs and UCLs.

Non-PMJM Receptors

The intake and exposure estimates for ECOPC/non-PMJM receptor pairs are presented in Attachment 4. A summary of the exposure estimates is presented in Table 8.5.

- Chromium – Exposure estimates for American kestrel, mourning dove (herbivore and insectivore), and deer mouse (insectivore);
- Manganese – Exposure estimates for the deer mouse (herbivore);
- Nickel – Exposure estimates for mourning dove (insectivore), deer mouse (herbivore and insectivore), and coyote (generalist and insectivore);
- Tin – Exposure estimates for American kestrel, mourning dove (herbivore and insectivore), and deer mouse (insectivore);
- Bis(2-ethylhexyl)phthalate – Exposure estimates for the mourning dove (insectivore);
- Endrin – Exposure estimates for the American kestrel and mourning dove (insectivore); and

- Total PCBs – Exposure estimates for the American kestrel and mourning dove (insectivore).

PMJM Receptors

No ECOPC/PMJM receptor pairs were identified in Section 7. No further evaluations were conducted.

9.0 ECOLOGICAL TOXICITY ASSESSMENT

Exposure to wildlife receptors was estimated for representative species of functional groups based on taxonomy and feeding behavior in Section 8.0 in the form of a daily rate of intake for each ECOPC/receptor pair. To estimate risk, soil concentrations (plants and invertebrate exposure) and calculated intakes (birds and mammals) must then be compared to the toxicological properties of each ECOPC. The laboratory-based toxicity benchmarks are termed toxicity reference values (TRVs) and are of several basic types. The NOAEL and no observed effect concentration (NOEC) TRVs are intake rates or soil concentrations below which no ecologically significant effects are expected. The NOAEL and NOEC TRVs were used to calculate the NOAEL ESLs employed in screening steps of the ECOPC identification process to eliminate chemicals that have no potential to cause risk to the representative receptors. The lowest observed adverse effects level (LOAEL) TRV is a concentration above which the potential for some ecologically significant adverse effect could be elevated. The threshold TRVs represent the hypothetical dose at which the response for a group of exposed organisms may first begin to be significantly greater than the response for unexposed receptors and is calculated as the geometric mean of the NOAEL and LOAEL. Threshold TRVs were calculated based on specific data quality rules for use in the ECOPC identification process for a small subset of ECOIs in the CRA Methodology.

TRVs for ECOPCs identified for WBEU were obtained from the CRA Methodology. The pertinent TRVs for the WBEU are presented for terrestrial plants and invertebrates in Table 9.1 and for birds and mammals in Table 9.2.

10.0 ECOLOGICAL RISK CHARACTERIZATION

Risk characterization includes risk estimation and risk description. Details of these components are described in the CRA Methodology and Appendix A, Volume 2 of the RI/FS Report. Predicted risks should be viewed in terms of the potential for the assumptions used in the risk characterization to occur in nature, the uncertainties associated with the assumptions, and in the potential for effects on the population of receptors that could inhabit the WBEU.

Potential risks to terrestrial plants, invertebrates, birds, and mammals are evaluated using a hazard quotient (HQ) approach. An HQ is the ratio of the estimated exposure of a receptor to a TRV that is associated with a known level of toxicity, either a no effect level (NOAEL or NOEC) or an effect level (LOAEL or lowest effects concentration [LOEC]):

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HQ = Exposure / TRV

As described in Section 8.0, the units used for exposure and TRV depend upon the type of receptor evaluated. For plants and invertebrates, exposures and TRVs are expressed as concentrations (mg/kg soil). For birds and mammals, exposures and TRVs are expressed as ingested doses (mg/kg/BW/day). In general, if the NOAEL-based HQ is less than 1, then no adverse effects are predicted. If the LOAEL-based HQ is less than 1 but the NOAEL-based HQ is above 1, then some adverse effects are possible, but it is expected that the magnitude and frequency of the effects will usually be low (assuming the magnitude and severity of the response at the LOAEL are not large and the endpoint of the LOAEL accurately reflects the assessment endpoints for that receptor). If the LOAEL-based HQ is greater than or equal to 1, the risk of an adverse effect is of potential concern, with the probability and/or severity of effect tending to increase as the value of the HQ increases.

When interpreting HQ results for non-PMJM ecological receptors, it is important to remember that the assessment endpoint to non-PMJM receptors is based on the sustainability of exposed populations, and risks to some individuals in a population may be acceptable if the population is expected to remain healthy and stable.

HQs were calculated for each ECOPC/receptor pair based on the exposures estimated and TRVs presented in the preceding sections. Risks are discussed and presented to put the assumptions of the risk predictions into a context that can be used to make risk management decisions.

10.1 Chemical Risk Characterization

Chemical risk characterization uses quantitative methods to evaluate potential risks to ecological receptors. In this risk assessment, the quantitative method used to characterize chemical risk is the HQ approach. As noted above, HQs are usually interpreted as follows:

HQ Values		**Interpretation of HQ Results**
NOAEL-based	**LOAEL-based**	
≤ 1	≤ 1	Minimal or no risk
> 1	≤ 1	Low level risk[a]
> 1	> 1	Potentially significant risk

[a] Assuming magnitude and severity of response at LOAEL are relatively small and based on endpoints appropriate for the assessment endpoint of the receptor considered.

One potential limitation of the HQ approach is that calculated HQ values may sometimes be uncertain due to simplifications and assumptions in the underlying exposure and toxicity data used to derive the HQs. Where possible, this risk assessment provides information on three potential sources of uncertainty, described below.

- **EPCs.** Because surface soil sampling programs in the EU sometimes tended to focus on areas of potential contamination (IHSS/PAC/UBCs), EPCs calculated using the Tier 1 approach (which assumes that all samples are randomly spread across the EU and are weighted equally) may tend to yield an EPC that is biased high. For this reason, a Tier 2 area-weighting approach was used to derive additional EPCs that help compensate for this potential bias. HQs were always calculated based on both Tier 1 and Tier 2 EPCs for non-PMJM receptors.

- **BAFs.** For wildlife receptors, concentrations of contaminants in dietary items were estimated from surface soil using uptake equations. When the uptake equation was based on a simple linear model (e.g., $C_{tissue} = BAF * C_{soil}$), the default exposure scenario used a high-end estimate of the BAF (the 90th percentile BAF). However, the use of high-end BAFs may tend to overestimate tissue concentrations in some dietary items. To estimate more typical tissue concentrations, where necessary, an alternative exposure scenario calculated total chemical intake using a 50th percentile (median) BAF and HQs were calculated. The use of the median BAF is consistent with the approach used in the ecological soil screening level (EcoSSL) guidance (EPA 2005).

- **TRVs.** The CRA Methodology used an established hierarchy to identify the most appropriate default TRVs for use in the ECOPC selection. However, in some instances, the default TRV selected may be overly conservative with regard to characterizing population-level risks. The determination of whether the default TRVs are thought to yield overly conservative estimates of risk is addressed in the uncertainty sections below on a chemical-by-chemical basis. When an alternative TRV is identified, the chemical-specific uncertainty sections provide a discussion of why the alternative TRV is thought to be appropriate to provide an alternative estimate of toxicity (e.g., endpoint relevance, species relevance, data quality, chemical form, etc.), and HQs were calculated using both default and alternative TRVs where necessary.

The influences of each of these uncertainties on the calculated HQs were evaluated both alone and in concert in the risk description for each chemical. Uncertainties related to the BAFs, TRVs, and background risk are presented for each chemical in Attachment 5. Where uncertainties were deemed to be high, Attachment 5 provided alternative BAFs and/or TRVs as appropriate based on the results of the uncertainty assessment.

HQs calculated using the default BAFs and with the Tier 1 and Tier 2 EPCs are provided in Table 10.1 for each ECOPC/receptor pair. Where no LOAEL HQs exceed 1 using the default exposure and toxicity values, no further HQs were calculated regardless of the results of the uncertainty analysis. Because the default HQs are generally the most

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conservative risk estimations, if low risk is estimated using these values then further reductions of conservatism would only serve to reduce risk estimates further.

For non-PMJM receptors, where LOAEL HQs greater than 1 are calculated using default assumptions, and the uncertainty analysis indicated that alternative BAFs and/or TRVs would be beneficial to reduce uncertainty and conservatism, alternative HQs are presented in Table 10.1 as appropriate.

The selection of which EPC (e.g., UTL or UCL) is of primary importance will depend upon the type of receptor and the relative home-range size. Only the UTL EPC is provided in Table 10.1 for small home-range receptors, and only the UCL is provided for large home-range receptors.

All calculated exposure estimates and HQ values are also provided in Attachment 4. These include the default and alternative HQs and are calculated using a range of EPCs. The results for each ECOPC are discussed in more detail below.

The risk description incorporates results of the risk estimates along with the uncertainties associated with the risk estimations and other lines of evidence to evaluate potential chemical effects on ecological receptors in the WBEU following accelerated actions. Information considered in the risk description includes receptor groups potentially affected, type of TRV exceeded (e.g., NOAEL versus LOAEL), relation of EU concentrations to other criteria such as EPA EcoSSLs, and risk above background conditions. In addition, other site-specific and regional factors are considered such as the use of a given ECOPC within the EU related to historical RFETS activities, comparison of ECOPC concentrations within the WBEU to the rest of the RFETS site as it relates to background, and/or comparison to regional background concentrations.

10.1.1 Chromium

Chromium HQs for the terrestrial plants, terrestrial invertebrates, American kestrel, mourning dove (herbivore and insectivore), and deer mouse (insectivore) are presented in Table 10.1. Figure 10.1 shows the spatial distribution of chromium in relation to the lowest ESL and also presents the data used in the calculation of the Tier 2 EPCs.

HQs Calculated to Characterize Uncertainty

Uncertainties related to the default HQ calculations provided in Table 10.1 are discussed in detail in Attachment 5. Uncertainties related to BAFs, TRVs, and background risks are presented.

For non-PMJM receptors, because only the terrestrial plant, terrestrial invertebrate, and mourning dove (insectivore) receptors had LOAEL HQs greater than 1 using the default exposure assumptions, alternative HQs were only calculated for those receptors. Those alternative HQs are presented in Table 10.1

However, care should be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors regardless of whether alternative HQs are provided.

Chromium Risk Description

Chromium was identified as an ECOPC for terrestrial plants, terrestrial invertebrates, American kestrel, mourning dove (herbivore and insectivore), and deer mouse (insectivore) receptors. Alternative HQs were calculated for the terrestrial plant, terrestrial invertebrate, and mourning dove (insectivore) receptors using alternative TRVs for plants and invertebrates and a median soil-to-invertebrate BAF for the mourning dove (insectivore). Information on the historical use and a summary of site data and background data are provided in Attachment 3.

Terrestrial Plants and Invertebrates

For terrestrial plants, HQs were greater than 1 using the default ESL. The UTL HQ equaled 31, indicating that risks could not be considered to be minimal. Because no default LOEC value was available, it is uncertain whether risks have the potential to be significant based on the default HQ calculations.

The uncertainty assessment discussed the low confidence placed in the chromium ESL for terrestrial plants and provided an alternative NOEC and LOEC value. The alternative NOEC had an HQ greater than 1, while no HQs greater than 1 were calculated using the alternative LOEC. As discussed in the uncertainty analysis, the alternative LOEC is representative of a concentration at which soybean roots had a 30 percent reduction in shoot weight.

The default ESL is less than all site-specific background concentrations. HQs greater than 1 were calculated using UTL background concentration (HQ = 17).

The low confidence placed in the ESL and the lack of exceedance of any effects-based TRVs, and the conservatisms noted in the default ESL, all indicate that the potential for risk to terrestrial plant populations in the WBEU from exposure to chromium in surface soils is likely to be low.

For terrestrial invertebrates, HQs greater than 1 were calculated using the default ESL indicating that risks could not be considered to be minimal. Because no default LOEC value was available, it is uncertain whether risks have the potential to be significant based on the default HQ calculations.

The uncertainty assessment indicated that the default ESL is less than all site-specific background concentrations. HQs greater than 1 were calculated using UTL background concentration (HQ = 42).

The maximum HQ calculated using the alternative LOEC, identified in the uncertainty analysis, equaled 0.9. The alternative LOEC is representative of a concentration at which soybean roots had a 30 percent reduction in earthworm growth.

The low confidence placed in the ESL, the lack of exceedance of any effects-based TRVs indicates that the potential for risk to terrestrial invertebrate populations in the WBEU from exposure to chromium in surface soils is likely to be low.

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Non-PMJM Receptors – Small Home-Range

NOAEL HQs using default risk models were greater than 1 for the American kestrel, mourning dove (herbivore and insectivore), and deer mouse (insectivore) (chromium VI TRV only). All LOAEL HQs were less than 1 for all receptors except the mourning dove (insectivore). Risks to populations of the American kestrel, mourning dove (herbivore), and deer mouse (insectivore) from exposure to chromium are likely to be low. Risks to the mourning dove (insectivore) using the default HQ calculations may potentially be significant and require further evaluation.

Table 10.2 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL, threshold, and LOAEL TRVs were used in the HQ calculations. Chromium samples were available from 37 grid cells (Figure 10.1). NOAEL and LOAEL HQs greater than 1 were calculated in 100 percent of the grid cells, while no LOAEL HQs greater than 5 were calculated in any grid cell for the most sensitive receptor (mourning dove [insectivore]). The results of the grid-cell analysis indicate that the average exposure to sub-populations of mourning dove (insectivore) results in low to moderate risk from exposure to chromium.

The uncertainty analysis indicated that exposure to the mourning dove (insectivore) was likely to be overestimated based on the use of upper-bound BAFs. Table 10.1 presents HQs calculated using the identical model and TRVs as used in the default but with a median BAF rather than the conservative 90th percentile BAF. The mourning dove (insectivore) had NOAEL HQs greater than or equal to 1 and LOAEL HQs less than 1. These results provide a less conservative measure of potential intake and support the conclusions reached using the default HQ calculation. In addition, background risk evaluations also indicated similar HQs for the mourning dove (insectivore) using the default HQ calculations. The combined lines of evidence suggest the overestimation of risk using the default HQ calculations. Risks are, therefore, expected to be low to populations of the mourning dove (insectivore).

10.1.2 Manganese

Manganese HQs for the terrestrial plants and deer mouse (herbivore) receptors are presented in Table 10.1. Figure 10.2 shows the spatial distribution of manganese in relation to the lowest ESL and also presents the data used in the calculation of the Tier 2 EPCs.

HQs Calculated to Characterize Uncertainty

Uncertainties related to the default HQ calculations provided in Table 10.1 are discussed in detail in Attachment 5. Uncertainties related to BAFs, TRVs, and background risks are presented.

For non-PMJM receptors, no receptors had LOAEL HQs greater than 1 using the default exposure assumptions and no alternative HQs were calculated.

Care should, however, be taken to review the chemical specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors regardless of whether alternative HQs are provided.

Manganese Risk Description

Manganese was identified as an ECOPC for the deer mouse (herbivore) receptor only. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

Non-PMJM Receptors – Small Home-Range

NOAEL HQs calculated using the Tier 1 EPC were equal to 1 for the deer mouse (herbivore) for the UTL. The Tier 2 UTL NOAEL HQ was less than 1. All LOAEL HQs for the deer mouse (herbivore) were less than 1. Risks to populations of non-PMJM receptors from exposure to manganese in WBEU surface soils are, therefore, considered to be low.

Uncertainties associated with background risks, BAFs, and TRVs used in the default HQ calculations are discussed in Attachment 5. No significant uncertainties were identified, and no alternative HQ calculations were recommended.

Table 10.2 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Manganese samples were available from 37 grid cells (Figure 10.2). NOAEL HQs greater than 1 were calculated in only 8 percent of grid cells for the most sensitive receptor (deer mouse [herbivore]). No LOAEL HQs greater than 1 were calculated in any grid cell. The results of the grid-cell analysis indicate that the average exposure to sub-populations of deer mouse (herbivore) results in low risk from exposure to manganese.

10.1.3 Nickel

Nickel HQs for the mourning dove (insectivore), deer mouse (herbivore and insectivore), and coyote (generalist and insectivore) are presented in Table 10.1. Figure 10.3 shows the spatial distribution of nickel in relation to the lowest ESL and also presents the data used in the calculation of the Tier 2 EPCs.

HQs Calculated to Characterize Uncertainty

Uncertainties related to the default HQ calculations provided in Table 10.1 are discussed in detail in Attachment 5. Uncertainties related to BAFs, TRVs, and background risks are presented.

For non-PMJM receptors, only the deer mouse (insectivore) receptor had LOAEL HQs greater than 1, indicating that risks based on the default assumptions could have the potential to be significant. However, the uncertainty analysis presented in Attachment 5 indicated that there were considerable uncertainties and conservatisms in the nickel risk calculations based on both upper-bound BAFs and TRVs. For this reason, alternative

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HQs were calculated for the deer mouse (insectivore) using both median BAFs and the alternative TRVs presented in the uncertainty analysis. The resulting HQs are presented in Table 10.1

Although risks to all receptors except the deer mouse (insectivore) were determined to be low using the more conservative default HQs, care should be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors regardless of whether alternative HQs are provided.

Nickel – Risk Description

Nickel was identified as an ECOPC for the mourning dove (insectivore), deer mouse (herbivore and insectivore), and coyote (generalist and insectivore). Information on the historical use and a summary of site data and background data are provided in Attachment 3.

Non-PMJM Receptors – Small Home-Range

For the non-PMJM receptors, NOAEL HQs were greater than 1 for the mourning dove (insectivore), deer mouse (insectivore), and coyote (generalist and insectivore) under the default exposure/TRV scenarios (Table 10.1). Threshold HQs were also greater than 1 for the mourning dove under default exposure/TRV scenarios. LOAEL HQs for all non-PMJM receptors (except deer mouse [insectivore]) were, however, less than or equal to 1 under the default exposure scenario. The deer mouse (insectivore) had LOAEL HQs greater than 1 under the default exposure scenarios (ranging up to 6), indicating that potentially significant risks are predicted under the default exposure scenario. Risks to the mourning dove (insectivore), deer mouse (herbivore), and coyote (generalist and insectivore) are all likely to be low because no LOAEL HQs greater than 1 were calculated using the default BAFs and TRVs prescribed by the CRA Methodology. Risks to the deer mouse (insectivore) require more evaluation based on the results of the uncertainty analysis.

Table 10.2 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Nickel samples were available from 37 grid cells (Figure 10.3). NOAEL HQs greater than 10 were calculated in 100 percent of the grid cells. LOAEL HQs greater than 1 but less than 5 were also calculated in 97 percent of grid cells and between 5 and 10 in 3 percent of grid cells for the most sensitive receptor (deer mouse [insectivore]). The results of the grid-cell analysis indicate that risks from average exposure to sub-populations of insectivorous small mammals may potentially be significant and also requires further evaluation.

The uncertainty analysis discussed the potential for risks to at UCL and UTL background soil concentrations. For the deer mouse (insectivore), LOAEL HQs in background (UTL and UCL HQs = 3) are the same for those calculated for UWNEU surface soils with the exception of the Tier 1 UTL (HQ = 5). These results indicate that risks to insectivorous deer mouse populations within UWNEU are similar to those offsite. This also indicates that risk estimates to the deer mouse (insectivore) receptor using the default HQ calculation may over-predict risks to the deer mouse (insectivore) because risks are not generally expected at normal background concentrations. Attachment 3 indicates that nickel concentrations in site-specific background have an MDC of 14.0 mg/kg while the mean nickel concentration of background soils from Colorado and bordering states have a mean concentration of 18.8 mg/kg. This indicates that site-specific background surface soil concentrations are not elevated over what would be expected in the vicinity of the site.

The uncertainty analysis discussed these uncertainties and conservatisms related to both upper-bound BAFs used in the intake estimates and in the TRVs used to calculate HQs. Alternative intake rates were calculated for those receptors ingesting invertebrates in their diet. In addition, HQs were also calculated using alternative TRVs from Sample et al. (1996). No LOAEL HQs greater than 1 were calculated using the default TRVs under the alternative (median) BAF exposure scenario.

Risks to the deer mouse (insectivore) may be higher than those predicted for the other receptors. However, while the TRVs used for the NOAEL and LOAEL appear to be sound TRVs based on appropriate endpoints, the exposure models used in the assessment result in elevated risks at minimum background concentrations using those TRVs. When the upper-bound BAF for estimation of invertebrate tissue concentrations was replaced with the median value, no LOAEL HQs greater than 1 for the deer mouse (insectivore) were calculated. Similarly, when the TRVs from Sample et al. (1996) were used instead of the PRC TRVs, no HQs greater than 1 were calculated using either the NOAEL or the LOAEL TRV. The HQs were less than 1 whether the upper-bound or median BAF was used. These calculations indicate that while risks to the deer mouse (insectivore) may be greater than those predicted to the other receptors, they are over-predicted using the input parameters provided in the CRA Methodology. The lack of elevated HQs when less conservative, yet still reasonable alternative values were used, lends support to this conclusion. Therefore, risks to the deer mouse (insectivore) are likely to be low.

Non-PMJM Receptors – Large Home-Range

NOAEL HQs were greater than 1 for the coyote (generalist and insectivore) under the default exposure/TRV scenarios (Table 10.1). LOAEL HQs for both receptors were less than or equal to 1 for all exposure scenarios.

The uncertainty analysis discussed uncertainties and conservatisms related to both upper-bound BAFs used in the intake estimates and in the TRVs used to calculate HQs. However, because risks are classified as low using the more conservative default HQ calculations, no alternative HQs were calculated, and risks are likely to be low to populations of all large home-range receptors from exposure to nickel in WBEU.

10.1.4 Silver

Silver HQs for terrestrial plants are presented in Table 10.1. Figure 10.4 shows the spatial distribution of silver in relation to the terrestrial plant ESL and also presents the data used in the calculation of Tier 2 EPCs.

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HQs Calculated to Characterize Uncertainty

Uncertainties related to the default HQ calculations provided in Table 10.1 are discussed in detail in Attachment 5. Uncertainties related to BAFs, TRVs, and background risks are presented.

The terrestrial plant receptors had NOEC HQs less than or equal to 1. No LOEC TRV was available; therefore, it is unclear whether risks are low or potentially significant using only the default ESL. The uncertainty analysis did not identify any alternative toxicity information and no alterative HQs were calculated.

Silver – Risk Description

Silver was identified as an ECOPC for terrestrial plants only. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

Terrestrial Plants

NOEC HQs were equal to 1 using Tier 1 UTL, but were less than 1 when using the Tier 2 UTL. The low HQs combined with the uncertain nature of the ESL discussed in the uncertainty analysis and the lack of known releases indicate that risks to populations of terrestrial plants from silver in surface soils is low.

10.1.5 Thallium

Thallium HQs for terrestrial plants are presented in Table 10.1. Figure 10.5 shows the spatial distribution of thallium in relation to the terrestrial plant ESL and also presents the data used in the calculation of Tier 2 EPCs.

HQs Calculated to Characterize Uncertainty

Uncertainties related to the default HQ calculations provided in Table 10.1 are discussed in detail in Attachment 5. Uncertainties related to BAFs, TRVs, and background risks are presented.

The terrestrial plant receptors had NOEC HQs less than or equal to 1. No LOEC TRV was available, therefore, it is unclear whether risks are low or potentially significant using only the default ESL. The uncertainty analysis did not identify any alternative toxicity information. Therefore, no alterative HQs were calculated.

Thallium – Risk Description

Thallium was identified as an ECOPC for terrestrial plants only. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

Terrestrial Plants

NOEC HQs were equal to 2 using Tier 1 UTL, but were less than 1 when using the Tier 2 UTL. The low HQs combined with the uncertain nature of the ESL discussed in the uncertainty analysis and the lack of known releases indicate that risks to populations of terrestrial plants from thallium in surface soils is low.

10.1.6 Tin

Tin HQs for the American kestrel, mourning dove (herbivore and insectivore), and deer mouse (insectivore) are presented in Table 10.1. Figure 10.6 shows the spatial distribution of tin in relation to the lowest ESL and also presents the data used in the calculation of the Tier 2 EPCs.

HQs Calculated to Characterize Uncertainty

Uncertainties related to the default HQ calculations provided in Table 10.1 are discussed in detail in Attachment 5. Uncertainties related to BAFs, TRVs, and background risks are presented.

No alternative BAFs or TRVs were recommended in the uncertainty analysis. Therefore, no HQs based on alternative assumptions are provided in Table 10.1.

However, care should be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors regardless of whether alternative HQs are provided.

Tin – Risk Description

Tin was identified as an ECOPC for the American kestrel, mourning dove (herbivore and insectivore), and deer mouse (insectivore) receptors. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

Non-PMJM Receptors – Small Home-Range

For the non-PMJM receptors, potential risks from exposure to tin were evaluated using Tier 1 and Tier 2 UTLs. NOAEL HQs were less than or equal to 1 for the mourning dove (herbivore). NOAEL HQs were greater than 1 for the mourning dove (insectivore), American kestrel, and deer mouse (insectivore). All LOAEL HQs for all receptors were less than 1. The lack of HQs calculated when using effects-based TRVs indicates that risk to non-PMJM small home-range receptors is low.

Table 10.2 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Tin samples were available from 37 grid cells (Figure 10.6). NOAEL HQs greater than 1 were calculated in 89 percent of the grid cells, while no LOAEL HQs greater than 1 were calculated in any grid cell for the most sensitive receptor (mourning dove [insectivore]). The results of the grid-cell analysis indicate that the average exposure to sub-populations of small home-range receptors results in low risk from exposure to tin.

The uncertainty section discussed the uncertainties and likely conservatisms in the BAFs used to estimate tissue concentrations. Because no HQs greater than 1 were calculated using the LOAEL TRV and because risks may be overestimated due to uncertainties in the BAFs used, risks to non-PMJM receptor populations in the WBEU are likely to be low.

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10.1.7 Bis(2-ethylhexyl)phthalate

Bis(2-ehtylhexylphthalate) HQs for the mourning dove (insectivore) are presented in Table 10.1. Figure 10.7 shows the spatial distribution of bis(2-ethlyhexyl)phthalate in relation to the lowest ESL and also presents the data used in the calculation of the Tier 2 EPCs.

HQs Calculated to Characterize Uncertainty

Uncertainties related to the default HQ calculations provided in Table 10.1 are discussed in detail in Attachment 5. Uncertainties related to BAFs, TRVs, and background risks are presented.

No LOAEL HQs greater than 1 were calculated for any non-PMJM receptor. Therefore, no alternative HQ calculations are provided.

However, care should be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors regardless of whether alternative HQs are provided.

Bis(2-ethylhexyl)phthalate – Risk Description

There is no identified source in the WBEU of bis(2-ethylhexyl)phthalate, which was identified as an ECOPC for the mourning dove (insectivore) receptors. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

Non-PMJM Receptors – Small Home-Range

Potential risks to receptors of concern were estimated using a range of EPCs. NOAEL HQs were greater than or equal to 1 (Table 10.1). All LOAEL HQs were less than 1. Because no effects-based TRVs resulted in HQs greater than 1, risks to non-PMJM receptors are likely to be low.

Table 10.2 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Bis(2-ethylhexyl)phthalate samples were available from 34 grid cells (Figure 10.7). NOAEL HQs greater than 1 were calculated in 85 percent of the grid cells, while no grids had LOAEL HQs greater than 1 for the most sensitive receptor (mourning dove [insectivore]). The results of the grid-cell analysis indicate that the average exposure to sub-populations of small home-range receptors results in low risk from exposure to bis(2-ethylhexyl)phthalate.

These lines of evidence along with the uncertainty analysis indicated that risks to non-PMJM receptors are likely low.

10.1.8 Endrin

Endrin HQs for the American kestrel and mourning dove (insectivore) are presented in Table 10.1. Figure 10.8 shows the spatial distribution of endrin in relation to the lowest ESL and also presents the data used in the calculation of the Tier 2 EPCs.

HQs Calculated to Characterize Uncertainty

Uncertainties related to the default HQ calculations provided in Table 10.1 are discussed in detail in Attachment 5. Uncertainties related to BAFs, TRVs, and background risks are presented.

No LOAEL HQs greater than 1 were calculated for any non-PMJM receptor. Therefore, no alternative HQ calculations are provided.

However, care should be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors regardless of whether alternative HQs are provided.

Endrin – Risk Description

There is no identified source of endrin in the WBEU. Endrin was identified as an ECOPC for the American kestrel and mourning dove (insectivore) receptors. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

Non-PMJM Receptors – Small Home-Range

Potential risks to receptors of concern were estimated using a range of EPCs. NOAEL HQs were greater than 1 (Table 10.1). All LOAEL HQs were less than 1. Because no effects-based TRVs resulted in HQs greater than 1, risks to non-PMJM receptors are likely to be low.

Table 10.2 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Endrin samples were available from 34 grid cells (Figure 10.8). NOAEL HQs greater than 1 were calculated in 100 percent of the grid cells. Ninety-seven percent of the grids had LOAEL HQs less than 1, and 3 percent of the grids had LOAEL HQs between 1 and 5 for the most sensitive receptor (mourning dove [insectivore]). The results of the grid-cell analysis indicate that the average exposure to sub-populations of small home-range receptors results in low risk from exposure to endrin.

These lines of evidence along with the uncertainty analysis indicated that risks to non-PMJM receptors are likely low.

10.1.9 PCB

HQs for total PCBs for the mourning dove (insectivore) are presented in Table 10.1. Figure 10.9 shows the spatial distribution of PCB (total) in relation to the lowest ESL and also presents the data used in the calculation of the Tier 2 EPCs.

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HQs Calculated to Characterize Uncertainty

Uncertainties related to the default HQ calculations provided in Table 10.1 are discussed in detail in Attachment 5. Uncertainties related to BAFs, TRVs, and background risks are presented.

No LOAEL HQs greater than 1 were calculated for any non-PMJM receptor. Therefore, no alternative HQ calculations are provided.

However, care should be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors regardless of whether alternative HQs are provided.

PCB (Total) – Risk Description

Total PCBs were identified as an ECOPC for the mourning dove (insectivore) receptor.

Non-PMJM Receptors – Small home-range

Potential risks from exposure to total PCBs were evaluated using a range of EPCs. NOAEL HQs equal to or greater than (HQ = 3) for the mourning dove (insectivore) (Table 10.1). All LOAEL HQs were less than 1. Given the lack of LOAEL HQs greater than 1, risks to non-PMJM receptors from PCBs in surface soils in the WBEU are likely low.

Table 10.2 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. PCB (total) samples were available from 34 grid cells (Figure 10.9). NOAEL HQs greater than 1 were calculated in 85 percent of the grid cells, while no grids had LOAEL HQs greater than 1 for the most sensitive receptor (mourning dove [insectivore]). The results of the grid-cell analysis indicate that the average exposure to sub-populations of small home-range receptors indicate low risk from exposure to PCB (total).

10.2 Ecosystem Characterization

An ecological monitoring program has been underway since 1991, when baseline data on wildlife species was gathered (Ebasco 1992). The purpose of this long-term program was to monitor specific habitats to provide a sitewide database from which to monitor trends in the wildlife populations at RFETS. This type of monitoring program provides localized information that can also be used for analysis at a landscape level to monitor the population trends and general health of the RFETS ecosystem. Permanent transects through three basic habitats were run monthly for more than a decade (K-H 2002). Observations were recorded concerning the abundance, distribution, and diversity of wide-ranging wildlife species, including observations of migratory birds, raptors, coyotes, and deer. Limited data are available for small mammals in WBEU. Small mammal monitoring occurred through several tasks in the monitoring program. The Ecological Monitoring Program (DOE 1995) established permanent transects for small mammal monitoring in three habitat types; xeric grasslands, mesic grasslands, and riparian habitats. Preble's mouse studies established small mammal trapping in nearly all riparian habitats across the site (K-H 1998a, 1999a, 2000a, 2001a, 2002a).

Migratory birds were tracked during all seasons, but most notably during the breeding season. Over 8 years of bird survey data were collected on 18 permanent transects. Field observations were summarized into species richness and densities by habitat type. Habitats comprised the general categories of grasslands, woodlands, and wetlands. However, summaries in annual reports are grouped by habitat types across RFETS and not within EUs because EU boundaries were determined well after the monitoring program had begun. Additionally, wide-ranging animals may use habitat in several EUs and do not recognize EU boundaries.

Summarizing songbird surveys over the breeding season, diversity indices for RFETS for all habitats combined over 8 years of observations (1991 and 1993 to 1999) show a steady state in diversity of bird communities (K-H 2000). Among habitats, results were similar with the exception of an increasing trend in species richness and a decreasing trend in bird densities in woodland habitats. Woodland bird communities consistently show the highest diversity when compared with bird communities in wetlands and grasslands. The decreasing trend can be mostly attributed to transient species (i.e., those species not usually associated with woody cover) except for red-tailed hawk (*Buteo jamaicensis*) and American goldfinch (*Carduelis tristis*). The red-tailed hawk change in density can be attributed to a loss of nesting sites in Upper Woman Creek during the survey period. Goldfinch abundance can be heavily influenced by the availability of food sources.

A subgroup of migratory birds is neotropical migrants, which show declining populations in North America (Audubon 2005, Nature Conservancy 2005). Most of this decline is thought to be due to conversion of forest land to agriculture in the tropics, and conversion to real estate development in North America. Grassland birds that are neotropical migrants are also in decline. However, over the last 5 years on RFETS, the declining trends have not been observed and densities for this group show an increase.

Raptors, big game species, and carnivores were observed through relative abundance surveys and multi-species surveys (16 permanent transects) that provide species-specific sitewide counts. Raptors were noted on relative abundance surveys and nest sites were visited repeatedly during the nesting season to confirm nesting success. The three most common raptors at RFETS are red-tailed hawk, great horned owl (*Bubo virginianus*), and American kestrel (*Falco sparverius*) (K-H 2002). One Swainson's hawk nest in North Walnut Creek near the A-1 Pond, and one great horned owl nest was noted within South Walnut Creek (Ryon 2005). All nests typically fledged two young of each species, except kestrels, which usually fledged two to three young. Each species had a successful nesting season each year during the monitoring period from 1991 to 1999 with one exception. This exception was the loss of the red-tailed hawk nest in Upper Woman Creek (K-H 1997, 1998) due to weather. The continued presence of nesting raptors at RFETS (K-H 2002) indicate that habitat quality and protection from human disturbance have contributed to making RFETS a desirable location for raptors to reproduce. Adequate habitat provides essential seasonal requirements. RFETS is estimated to be at optimum

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population density for raptors given available habitat and territorial nature of these species (K-H 2000).

Two deer species inhabit RFETS, mule deer (*Odocoileus hemionus*) and white-tailed deer (*Odocoileus virginianus*). No white-tailed deer were present at RFETS in 1991 when monitoring began (K-H 2002). In 2000 (K-H 2001), the population of white-tailed deer was estimated to be between 10 and 15 individuals. White-tailed deer frequent WBEU but spend the majority of their time in LWOEU. Mule deer frequent all parts of RFETS (14 mi^2) year round. The RFETS population from winter counts is estimated at a mean 125 individuals (n = 7) with a density of 14 deer per square mile (K-H 2000, 2002). Winter mule deer counts have varied from 100 to 160 individuals over the monitoring period (1994 to 2000), with expected age/sex class distributions (K-H 2001). The mule deer populations from RFETS have been increasing at a steady state with good age/sex distributions (K-H 2001) over time and similar densities when compared to other "open" populations that are not hunted. This provides a good indicator that habitat quality is high and that site activities have not affected deer populations. It is unlikely that deer populations are depressed or reproduction is affected by contaminants. A recent study on actinides in deer tissue found that plutonium levels were near or below detection limits (Todd and Sattelberg 2004). This provides further support that the deer population is healthy.

Coyotes (Canis latrans) are the top mammalian predator at RFETS. They prey upon mule deer fawns and other smaller prey species. The number of coyotes using the site has been estimated at 14 to 16 individuals (K-H 2002). Through surveys across the site, coyotes have been noted having reproduction success with as many as six dens active in 1 year (Nelson 2003). Typically at RFETS, three to six coyote dens support an estimated 14 to 16 individuals at any given time (K-H 2001). No coyote dens have ever been found within the WBEU, which is likely due to the large amount of human activities associated with pond management. Coyotes have exhibited a steady population over time, indicating their prey species continue to be abundant and healthy.

The WBEU has been trapped in one location over several years (DOE 1995, K-H 2002) under the Ecological Monitoring Program. Initially (DOE 1995), a monitoring site in xeric tallgrass prairie was established for long-term monitoring. Results from these trapping efforts in spring and fall of 1993 and 1994 revealed a diverse small mammal community with a total of 8 species observed. Species densities for each species were recorded at expected and normal levels (DOE 1995, Fitzgerald et. al. 1994). More recent efforts (K-H 2001) abandoned the original robust study design and are not comparable. Although species richness and densities had decreased considerably at this xeric site, the trapping was conducted mid-summer when small mammal distributions are greatly attenuated. Most often, trapping efforts conducted in summer do not resemble the diversity revealed in other seasons. Efforts to trap Preble's mice (*Zapus hudsonius preblei*) have not been attempted in the EU due to the lack of habitat. Results of small mammal trapping from 1993 and 1994 give indications of diverse and healthy small mammal communities in xeric grasslands of the WBEU. Some relatively rare pocket mouse species (CNHP 1999) have also been captured at this site adding to species diversity and indicating native conditions expected in typical arid grasslands on the plains of eastern Colorado (Fitzgerald et al 1994).

The high species diversity and continued use of the site by numerous vertebrate species verifies that habitat quality for these species remains acceptable and that the ecosystem functions are being maintained (K-H 2000). Data collected on wildlife abundance and diversity indicate that wildlife populations are stable and species richness remains high during remediation activities at RFETS, including wildlife using WBEU.

10.3 General Uncertainty Analysis

Quantitative evaluation of ecological risks is limited by uncertainties regarding the assumptions used to predict risk and the data available for quantifying risk. These limitations are usually addressed by making estimates based on the data available or by making assumptions based on professional judgment when data are limited. Because of these assumptions and estimates, the results of the risk calculations themselves are uncertain, and it is important for risk managers and the public to view the results of the risk assessment with this in mind. Chemical-specific uncertainties are presented in Attachment 5 of this document and were discussed in terms of their potential effects on the risk characterization in the risk description section for each ECOPC. A full discussion of categories of general uncertainty that are not specific to the WBEU are presented in Appendix A, Volume 2 of the RI/FS Report. The following sections are potential sources of general uncertainty that are specific to the WBEU ERA.

10.3.1 Uncertainties Associated with Data Adequacy and Quality

Section s 1.2 and 1.3 summarize the general data adequacy and data quality for the WBEU, respectively. A more detailed discussion is presented in Attachment 2 and Appendix A, Volume 2 of the RI/FS. The data adequacy assessment indicates that the data are adequate for the CRA. Data of sufficient quality for ERA purposes were collected in surface and subsurface soils.

10.3.2 Uncertainties Associated with the Lack of Toxicity Data for Ecological Contaminant of Interest Detected at the Wind Blown Area Exposure Unit

Several ECOIs detected in the WBEU do not have adequate toxicity data for the derivation of ESLs (CRA Methodology [DOE 2004a]). These ECOIs are listed in Tables 7.1and 7.9 with a "UT" designation. Appendix B of the CRA Methodology outlines a detailed search process that was intended to provide high-quality toxicological information for a large proportion of the chemicals detected at RFETS. Although the toxicity is uncertain for those ECOIs that do not have ESLs calculated due to a lack of identified toxicity data, the overall effect on the risk assessment is small because the primary chemicals historically used at RFETS have adequate toxicity data for use in the CRA. Therefore, while the potential for risk from these ECOPCs is uncertain and will tend to underestimate the overall risk calculated, the magnitude of underestimation is likely to be low.

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ESLs and/or TRVs were not available for some receptors for the ECOPC identified in Section 7. These include terrestrial invertebrates (manganese, silver, thallium, tin, bis[2-ethylhexyl]phthalate, endrin, and PCBs), birds (silver and thallium), and mammals (silver). The risks to these ECOPC/receptor pairs is uncertain. The lack of ESLs for some receptors may tend to underestimate potential risks to ecological receptors. However, the magnitude of this underestimation is likely to be low. Available ESLs for organics show estimated ecological risks to be minimal to low for those receptors where toxicity information is available. This source of uncertainty is not expected to be significant.

10.3.3 Uncertainties Associated with Eliminating Ecological Contaminants of Interest Based on Professional Judgment

Several analytes in surface soil and subsurface soil were eliminated as ECOIs based on professional judgment. The professional judgment evaluation is intended to identify those ECOIs that have a limited potential for contamination in the WBEU. The weight-of-evidence approach indicates that there is no identified source or pattern of release in the WBEU, and the slightly elevated values of the WBEU data for these ECOIs are most likely due to natural variation. The professional judgment evaluation has little effect on the overall risk calculations because the ECOIs eliminated from further consideration are not related to site-activities in the WBEU and have very low potential to be transported from historical sources to the WBEU.

10.4 Summary of Significant Sources of Uncertainty

The preceding discussion outlined the significant sources of uncertainty in the CRA process for assessing ecological risk. While some of the general sources of uncertainty discussed tend to underestimate risk, an equal or greater number of uncertainties discussed for each ECOPC and in RI/FS Appendix A, Volume 2 indicate that risk estimations may be somewhat biased toward the overestimation of risk to a generally unknown degree.

11.0 SUMMARY AND CONCLUSIONS

A summary of the results of this CRA for human health and ecological receptors in the WBEU is presented below.

11.1 Human Health

An HHRA was performed for the WBEU for analytes identified as COCs. The COC screening analyses compared MDCs and UCLs of chemicals and radionuclides in WBEU media to PRGs for the WRW receptor. Inorganic and radionuclide analytes with UCLs greater than the PRGs were statistically compared to the background concentration data set. Inorganic and radionuclide analytes that were statistically greater than background at the 0.1 significance level, and organics with UCL concentrations greater than the PRG, were carried forward to professional judgment evaluation. Based on the COC selection process, arsenic and plutonium-239/240 were selected as COCs for surface soil/surface sediment. No COCs were selected for subsurface soil/subsurface sediment.

For the WRW, the estimated total excess lifetime chemical cancer risk from arsenic in surface soil/surface sediment at the WBEU is 2E-06, based on both the Tier 1 and Tier 2 EPCs. The estimated noncarcinogenic HI is 0.02, based on the Tier 1 EPC, and 0.01, based on the Tier 2 EPC. The estimated total excess lifetime radionuclide cancer risk to the WRW is 2E-06, based on the Tier 1 EPC, and 8E-07, based on the Tier 2 EPC.

For the WRV, estimated total excess lifetime chemical cancer risk, based on the Tier 1 EPC, at the WBEU is 2E-06; the risk based on the Tier 2 EPC is 1E-06. The estimated noncarcinogenic HI is 0.01 based on both the Tier 1 and Tier 2 EPC. The estimated total excess lifetime radionuclide cancer risk to the WRV is 1E-06, based on the Tier 1 EPC, and 5E-07, based on the Tier 2 EPC.

The results of the Tier 1 and Tier 2 dose assessments indicate that estimated doses are less than 1 mrem (Table 5.2 and Table 5.4), which are well below the radiation dose limit of 25 mrem.

Although selected as a COC for the HHRA, arsenic has not been directly associated with historical IHSSs and is likely due to natural variation. Background arsenic concentrations in the surface soil/surface sediment at RFETS range from 0.27 to 9.6 mg/kg. Therefore, under similar exposure conditions as those evaluated for the WBEU, background risks from arsenic in surface soil/surface sediment would be 70 to 80 percent of that estimated for the WBEU, or approximately 1.4E-06 to 1.5E-06.

The risk characterization for exposure of the WRW and WRV to surface soil/surface sediment indicated that the estimated cancer risks for both receptor populations were at or below the 10^{-6} to 10^{-4} risk range and that estimated HIs were well below one, indicating that significant noncancer health effects are unlikely.

11.2 Ecological Risk

No significant risks to survival, growth, and reproduction are predicted for the wildlife receptors evaluated in the WBEU (see Table 11.1). Chromium, manganese, nickel, silver, thallium, tin, bis(2-ethylhexyl)phthalate, endrin, and total PCBs were the only ECOPCs in surface soil identified for non-PMJM receptors. No ECOPCs were identified in subsurface soil. The ECOPC/receptor pairs were evaluated in the risk characterization using a range of EPCs, exposure scenarios, and TRVs to give a range of risk estimates. Overall, no significant risks to ecological receptors that may use the WBEU are predicted.

In addition, the high species diversity and continued use of the site by numerous vertebrate species verify that habitat quality for these species remains acceptable and that the ecosystem functions are being maintained (K-H 2000). Data collected on wildlife abundance and diversity indicate that wildlife populations are stable and species richness remains high during remediation activities at RFETS, including wildlife using the WBEU.

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12.0 REFERENCES

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TABLES

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Table 1.1
WBEU IHSSs

IHSS	PAC/UBC	Name	Description	Disposition
109	900-109	Trench T-2 - Ryan's Pit	The Trench T-2 site was used prior to 1968 for the disposal of sanitary sewage sludge and some flattened drums. Approximately 200 cubic yards of contaminated material was removed from the trench. The excavated soil was treated with a low temperature thermal desorption unit (TDU) and returned to the pit as "clean" backfill in September 1996.	NFAA-2002, HRR
110	NE-110	Trench T-3	Trenches T-3 through T-11 were used from 1954 to 1968 for disposal of approximately 125,000 kilograms of sewage sludge contaminated with uranium and plutonium, and approximately 300 flattened drums contaminated with uranium. Action was taken consisting of excavating approximately 5,000 cubic yards of material from Trenches T-3 and T-4, followed by thermal desorption processing of the material. The processed material was returned to Trench T-3 enveloped in a geotextile fabric.	NFAA-2002, HRR
111.1	NE-111.1	Trench T-4	Trenches T-3 through T-11 were used from 1954 to 1968 for disposal of approximately 125,000 kilograms of sewage sludge contaminated with uranium and plutonium, and approximately 300 flattened drums contaminated with uranium. Action was taken consisting of excavating approximately 5,000 cubic yards of material from Trenches T-3 and T-4, followed by thermal desorption processing of the material. The processed material was returned to Trench T-3 enveloped in a geotextile fabric. In 2004, a surface soil hot spot was identified and removed at Trench T-4.	NFAA-2003, HRR; NFAA-2005, HRR
111.2	NE-111.2	Trench T-5	Trenches T-3 through T-11 were used from 1954 to 1968 for disposal of approximately 125,000 kilograms of sewage sludge contaminated with uranium and plutonium, and approximately 300 flattened drums contaminated with uranium. No action required.	NFAA-2005, HRR
111.3	NE-111.3	Trench T-6	Trenches T-3 through T-11 were used from 1954 to 1968 for disposal of approximately 125,000 kilograms of sewage sludge contaminated with uranium and plutonium, and approximately 300 flattened drums contaminated with uranium. Removed a total of 420 cy from T-6 and T-8 per ER RSOP Notification #04-13 in 2004.	NFAA-2005, HRR
111.4	NE-111.4	Trench T-7	Trenches T-3 through T-11 were used from 1954 to 1968 for disposal of approximately 125,000 kilograms of sewage sludge contaminated with uranium and plutonium, and approximately 300 flattened drums contaminated with uranium. A surface soil hot spot was removed in 2004.	NFAA-2003, HRR; NFAA-2005, HRR
111.5	NE-111.5	Trench T-8	Trenches T-3 through T-11 were used from 1954 to 1968 for disposal of approximately 125,000 kilograms of sewage sludge contaminated with uranium and plutonium, and approximately 300 flattened drums contaminated with uranium. Removed a total of 420 cy from T-6 and T-8 per ER RSOP Notification #04-13 in 2004.	NFAA-2005, HRR
111.6	NE-111.6a	Trench T-9a	Trenches T-3 through T-11 were used from 1954 to 1968 for disposal of approximately 125,000 kilograms of sewage sludge contaminated with uranium and plutonium, and approximately 300 flattened drums contaminated with uranium. No action required.	NFAA-2005, HRR
111.6	NE-111.6b	Trench T-9b	Trenches T-3 through T-11 were used from 1954 to 1968 for disposal of approximately 125,000 kilograms of sewage sludge contaminated with uranium and plutonium, and approximately 300 flattened drums contaminated with uranium. No action required.	NFAA-2005, HRR
111.7	NE-111.7	Trench T-10	Trenches T-3 through T-11 were used from 1954 to 1968 for disposal of approximately 125,000 kilograms of sewage sludge contaminated with uranium and plutonium, and approximately 300 flattened drums contaminated with uranium. No action required.	NFAA-2005, HRR
111.8	NE-111.8	Trench T-11	Trenches T-3 through T-11 were used from 1954 to 1968 for disposal of approximately 125,000 kilograms of sewage sludge contaminated with uranium and plutonium, and approximately 300 flattened drums contaminated with uranium. No action required.	NFAA-2005, HRR

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Table 1.1
WBEU IHSSs

IHSS	PAC/UBC	Name	Description	Disposition
112	900-112	903 Pad	The 903 Pad was used from October 1958 to January 1967 for storage of radioactively contaminated oil drums. Approximately three-fourths of the drums were plutonium contaminated, while most of the balance contained uranium. Most drums contained lathe coolant oil and carbon tetrachloride. Other liquids including hydraulic oils, vacuum pump oil, trichloroethylene, perchloroethylene, silicone oils, and acetone still bottoms were also contained in the drums. Removal of all drums and wastes was completed in 1968, and the site was capped with asphalt in 1969. Removed 20,213 cy of radionuclide contaminated soil and 4467 cy of asphalt per ER RSOP Notification #02-09 in 2004.	NFAA-2005, HRR
119.2	900-119.2	East Scrap Metal Storage Area and Solvent Spill	This site was one of two areas east of former Building 881 along the southern perimeter road, which was used as a barrel storage area. The barrels contained unknown quantities and types of solvents and wastes. All barrels were removed from the site in 1972. The site was also used for scrap metal storage. No action required.	OU 1 CAD/ROD
140	900-140	Hazardous Disposal Area (IAG Name: Reactive Metal Destruction Site)	In the 1950s and 1960s, approximately 400 to 500 lb of metallic lithium were disposed on the ground surface by sprinkling with water to initiate a chemical reaction that results in the generation of lithium hydroxide plus hydrogen gas. Other reactive metals were disposed in a similar manner. No action required.	NFAA-2005, HRR
155	900-155	903 Lip Area	Plutonium redistributed from the 903 Drum Storage Site by wind and surface water was deposited in the 903 Lip Area. Soil clean-up efforts were undertaken at the Lip Site in 1976, 1978 and 1984. After the 1984 effort, the excavated area was backfilled with clean topsoil. Removed 49,800 cy of radionuclide-contaminated soil per ER RSOP Notification #03-07 and IHSS Group 900-11 IM/IRA .	NFAA-2005, HRR
183	900-183	Gas Detoxification Area	An area south of the 903 Pad was used between approximately 1963 and 1983 to detoxify various gases from lecture bottles using commercial neutralization processes. The gases consisted of nitrogen oxides, chlorine, hydrogen sulfide, sulfur tetrafluoride, methane, hydrogen fluoride and ammonia. No action required.	NFAA-2002, HRR
216.2	NE-216.2	East Spray Field	This area was used for spray evaporation of sewage treatment plant effluent. No action required.	NFAA-2003, HRR
216.3	NE-216.3	East Spray Field	This area was used for spray evaporation of sewage treatment plant effluent. No action required.	NFAA-2003, HRR
N/A	000-501	Roadway Spraying	Roadways in the BZ OU were occasionally sprayed with waste oils for dust suppression, but sometimes reverse osmosis brine solutions and footing drain water were also applied. No action required.	NFAA-2002, HRR
N/A	NE-1401	NE Buffer Zone Gas Line Break	A 12-inch high-pressure natural gas line was ruptured by a bulldozer during ditch construction in the southeast buffer zone. Approximately five million cubic feet of natural gas were released to the environment. No action required.	NFAA-2002, HRR
N/A	NE-1402	East Inner Gate PCB Spill	Oil containing PCBs leaked onto the asphalt at the east gate from a commercial truck that intended to pick up a shipment of PCB wastes from the plant. The truck left without entering the plant. No action required.	NFAA-2002, HRR
N/A	NE-1403	Gasoline Spill - Building 920 Guard Post	Approximately 1 quart of gasoline spilled from the portable generator just east of the Building 920 Guard Post. The spill was a result of a defective fuel level gauge. No action required.	NFAA-2002, HRR
N/A	NE-1412	Trench T-12 Located in OU 2 East Trenches	PAC NE-1412 (Trench T-12) was used primarily for the disposal of sanitary wastewater treatment plant sludge. Trenches T-11 and T-12 were identified during a 1993 evaluation of aerial photographs taken on April 15, 1966 and April 29, 1967. They are believed to be approximately 10 feet deep and covered with several feet of fill. The waste streams and potential contaminants are similar to those reported for the trenches in the East Trenches area. No action required.	NFAA-2003, HRR

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Table 1.1
WBEU IHSSs

IHSS	PAC/UBC	Name	Description	Disposition
N/A	NE-1413	Trench T-13 Located in OU 2 East Trenches	PAC NE-1413 (Trench T-13) was used primarily for the disposal of sanitary wastewater treatment plant sludge. No action required.	NFAA-2003, HRR
N/A	SE-1602	East Firing Range	The East Firing Range included two target areas where handgun, shotgun, and rifle bullets of various caliber, as well as depleted uranium armor-piercing bullets were fired into the hillside or into soil berms, potentially releasing antimony, arsenic, lead, and depleted uranium into the soil. Removed 520 cy of metal-contaminated soil per IHSS Group 900-11 IM/IRA.	NFAAA-2005, HRR

Table 1.2
Number of Samples Collected in Each Medium by Analyte Suite

Analyte Suite	Surface Soil/Surface Sediment[a]	Subsurface Soil/Subsurface Sediment[a]	Surface Soil[b]	Subsurface Soil[b]
Inorganic	160	314	151	313
Organic	107	580	98	579
Radionuclide	347	417	335	414

[a] Used in the HHRA.

[b] Used in the ERA.

Note: The total number of results (samples) in Tables 1.3 through 1.6 may differ from the total number of samples presented in Table 1.2 because not all analyses are necessarily performed for each sample.

Table 1.3
Summary of Detected Analytes in Surface Soil/Surface Sediment

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Inorganics (mg/kg)							
Aluminum	0.24 - 200	160	100	4,570	33,000	14,370	6,852
Ammonia	0.300	9	100	1.09	3.33	2.07	0.845
Antimony[b]	0.27 - 60	138	17.4	0.300	0.880	2.72	2.72
Arsenic	0.16 - 10	160	100	1	11	5.20	2.12
Barium	0.039 - 200	160	100	34.9	280	134	47.2
Beryllium	0.031 - 5	160	68.8	0.230	1.40	0.684	0.285
Boron	0.35 - 1.2	76	93.4	0.670	15	6.82	3.63
Cadmium	0.03 - 5	159	42.8	0.0650	2.60	0.497	0.350
Calcium	1 - 5,000	160	100	1,740	185,000	21,387	38,037
Cesium	86.4 - 1,000	66	19.7	0.680	7.40	34.4	29.8
Chromium	0.053 - 10	160	100	2.20	80.5	16.1	10.2
Cobalt	0.079 - 50	160	100	2.20	21.6	6.61	2.41
Copper	0.045 - 25	159	100	2.20	49.8	14.8	6.09
Iron	0.68 - 100	160	100	3,680	27,000	14,299	5,207
Lead	0.12 - 3	160	100	3	120	33.6	20.2
Lithium	0.17 - 100	140	92.1	4.40	33	12.2	6.20
Magnesium	1.6 - 5,000	160	100	1,100	8,270	3,142	1,297
Manganese	0.033 - 15	160	100	54	1,200	283	144
Mercury	0.0012 - 0.2	141	48.9	0.00560	0.250	0.0456	0.0350
Molybdenum	0.13 - 200	146	29.5	0.150	6.10	1.19	1.17
Nickel	0.19 - 40	160	96.9	4.40	101	14.6	10.0
Nitrate / Nitrite	0.2 - 1.8	18	88.9	0.738	3.83	2.14	0.944
Potassium	36 - 5,000	160	99.4	690	6,200	3,006	1,264
Selenium	0.24 - 5	158	21.5	0.260	0.880	0.415	0.386
Silica	2.7 - 5.3	76	100	175	1,100	596	202
Silicon[b]	0 - 100	46	100	81	2,160	1,076	694
Silver	0.055 - 10	151	23.8	0.0810	42.8	1.27	4.09
Sodium	5.7 - 5,000	160	31.3	46	492	101	71.0
Strontium	0.0061 - 200	146	100	8.90	362	47.3	46.0
Thallium	0.32 - 10	160	20	0.210	3.30	0.409	0.404
Tin	0.24 - 200	146	17.8	1.30	77.2	8.41	12.4
Titanium	0.077 - 0.2	76	100	33	603	275	129
Uranium	1.4 - 7.2	76	5.26	1.90	8	1.89	1.41
Vanadium	0.25 - 50	160	100	12.1	72	32.0	12.0
Zinc	0.2 - 20	160	100	15	216	52.8	23.7
Organics (µg/kg)							
1,1,2,2-Tetrachloroethane[b]	4.86 - 12	21	4.76	1.39	1.39	1.74	1.70
1,2,3-Trichloropropane[b]	4.86 - 5.5	13	7.69	1.47	1.47	0.583	0.267
1,2,4-Trimethylbenzene	4.86 - 5.5	13	7.69	1.44	1.44	0.574	0.261
2-Butanone	10 - 110	21	4.76	19	19	6.42	3.36
4,4'-DDE	1.7 - 38	49	6.12	4	5.80	9.41	2.20
4,6-Dinitro-2-methylphenol	130 - 3,900	88	1.14	390	390	1,002	318
Acenaphthene	33 - 780	94	6.38	45	240	186	38.5
Acetone[b]	10 - 110	21	9.52	35	71	13.8	19.1
Aldrin	2.1 - 19	49	2.04	0	0	4.80	1.12
alpha-Chlordane	80 - 190	45	2.22	0	0	47.4	11.3
Anthracene	25 - 780	94	8.51	47	330	189	40.1
Aroclor-1248	6.2 - 240	90	1.11	840	840	47.8	93.2
Aroclor-1254	4.4 - 380	90	28.9	6.80	3,000	116	321
Aroclor-1260	4.9 - 380	90	15.6	6.20	240	70.8	57.5
Benzene[b]	4.86 - 12	21	4.76	1.44	1.44	1.70	1.73
Benzo(a)anthracene	26 - 780	94	24.5	39	830	198	111
Benzo(a)pyrene	43 - 780	94	14.9	48	750	211	90.4
Benzo(b)fluoranthene	31 - 780	94	14.9	40	810	215	95.2
Benzo(g,h,i)perylene	29 - 780	94	8.51	82	240	203	59.5

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Table 1.3
Summary of Detected Analytes in Surface Soil/Surface Sediment

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Benzo(k)fluoranthene	34 - 780	94	10.6	69	740	216	91.9
Benzoic Acid	300 - 3,900	88	30.7	77	1,100	810	468
beta-BHC	1.8 - 19	49	2.04	0	0	4.76	1.08
bis(2-ethylhexyl)phthalate	71 - 780	94	14.9	49	1,400	223	153
Chlorobenzene[b]	4.86 - 12	21	4.76	2.03	2.03	1.78	1.69
Chrysene	30 - 780	94	28.7	39	790	196	109
delta-BHC	0.59 - 19	49	2.04	0	0	4.76	1.08
Dibenz(a,h)anthracene	26 - 780	94	4.26	43	92	203	68.2
Dibenzofuran	38 - 780	94	2.13	37	86	205	65.3
Dieldrin	2.9 - 38	49	4.08	4.30	5.80	10.2	3.41
Di-n-butylphthalate	22 - 780	94	6.38	39	1,000	206	106
Di-n-octylphthalate	37 - 780	94	1.06	210	210	207	61.5
Endosulfan I	2 - 19	49	2.04	0	0	4.76	1.08
Endrin	2 - 38	49	6.12	4.50	5.10	9.39	2.18
Ethylbenzene[b]	4.86 - 12	21	4.76	1.29	1.29	1.76	1.68
Fluoranthene	24 - 780	93	44.1	45	1,900	237	240
Fluorene	36 - 780	94	4.26	54	230	205	65.7
gamma-Chlordane	85 - 130	6	16.7	0	0	45.3	24.2
Heptachlor	2.5 - 19	49	2.04	0	0	4.76	1.08
Heptachlor epoxide	1.9 - 19	49	2.04	0	0	5.88	3.92
Indeno(1,2,3-cd)pyrene	24 - 780	94	9.57	72	220	203	67.2
Methoxychlor	0.91 - 190	49	6.12	3	9.40	45.5	14.5
Methylene Chloride	4.86 - 12	21	9.52	11	14	4.27	6.88
Naphthalene[b]	4.86 - 780	107	0.935	0.890	0.890	182	89.3
N-Nitroso-di-n-propylamine	24 - 780	94	1.06	400	400	210	64.8
Phenanthrene	37 - 780	94	35.1	40	1,600	216	193
Pyrene	41 - 780	94	56.4	43	1,800	221	239
Tetrachloroethene	4.86 - 12	21	4.76	1.73	1.73	1.84	1.63
Toluene[b]	4.86 - 12	21	4.76	2.26	2.26	1.88	1.62
Radionuclides (pCi/g)[c]							
Americium-241	0 - 0.261	290	N/A	0	15.6	1.81	2.42
Cesium-134	0.0271 - 0.2	35	N/A	-0.0101	0.200	0.0363	0.0537
Cesium-137	0.03 - 0.21	37	N/A	0.0500	2.01	0.781	0.565
Gross Alpha	2.2 - 56	49	N/A	-9.70	320	36.0	53.6
Gross Beta	1 - 21	56	N/A	4.95	64	33.2	8.88
Plutonium-238	0.0284 - 0.211	9	N/A	0.102	1.53	0.447	0.454
Plutonium-239/240	0 - 0.288	319	N/A	-0.00292	49	9.19	12.0
Radium-226	0.15 - 0.5	36	N/A	0.590	2.19	1.10	0.281
Radium-228	0.06 - 0.69	17	N/A	0.940	3.50	2.09	0.693
Strontium-89/90	0.04 - 0.99	17	N/A	-0.300	1.46	0.387	0.480
Uranium-233/234	0 - 0.674	204	N/A	0.119	7.96	1.11	0.792
Uranium-235	0 - 0.448	203	N/A	-0.0431	0.680	0.0802	0.0905
Uranium-238	0 - 0.438	204	N/A	0.300	3.78	1.11	0.463

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[c] All radionuclide values are considered detects.

N/A = Not applicable.

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Table 1.4
Summary of Detected Analytes in Subsurface Soil/Subsurface Sediment

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Inorganics (mg/kg)							
Aluminum	1.1 - 40	310	100	1,050	54,000	13,177	7,727
Ammonia	0.300	62	22.6	0.353	1.44	0.289	0.269
Antimony	0.16 - 12	304	15.5	0.210	350	4.58	25.5
Arsenic	0.23 - 2	310	98.1	0.820	25.9	5.20	3.12
Barium	0.03 - 40	310	99.7	9.20	838	114	99.2
Beryllium	0.03 - 1	310	80.3	0.0650	2.30	0.697	0.420
Boron	0.34 - 1.2	162	78.4	0.600	15	4.18	3.85
Cadmium	0.03 - 1.96	287	35.2	0.0520	58.7	0.864	3.86
Calcium	1.1 - 2,000	310	100	1,240	260,000	40,524	54,488
Cesium	89.5 - 200	142	64.8	0.640	21	8.70	14.1
Chromium	0.04 - 2	310	100	2.90	4,600	32.6	261
Cobalt	0.04 - 10	310	96.1	0.720	24	5.44	3.31
Copper	0.043 - 5	310	99.0	2.10	180	13.9	15.1
Iron	0.57 - 20	310	100	2,250	152,000	13,131	10,282
Lead	0.12 - 19.63	310	99.7	1.50	8,500	42.8	484
Lithium	0.17 - 20	304	93.1	1.10	44	11.0	6.70
Magnesium	1.2 - 2,000	310	99.7	364	12,200	3,161	1,622
Manganese	0.03 - 3	310	100	15.8	1,300	193	181
Mercury	0.0012 - 0.2	309	63.4	0.00150	3.40	0.0968	0.344
Molybdenum	0.13 - 40	304	50	0.140	1,970	7.97	113
Nickel	0.03 - 8	310	98.7	2.70	1,330	24.1	80.5
Nitrate / Nitrite	0.2 - 0.21	66	66.7	0.238	43.6	1.92	6.23
Phosphorus	N/A	1	100	160	160	160	0
Potassium	1.2 - 2,000	309	97.1	300	13,000	1,929	1,587
Selenium	0.18 - 49.08	310	4.84	0.230	1.50	0.380	1.39
Silica	2.6 - 5.9	162	100	174	1,200	600	226
Silicon	0 - 200	75	96	6	2,210	361	440
Silver	0.04 - 2.94	309	19.7	0.0640	219	2.16	13.6
Sodium	2.4 - 2,000	309	51.8	36.9	3,700	217	430
Strontium	0.0061 - 400	309	99.0	6.20	459	61.4	60.0
Sulfide	10 - 16.3	66	10.6	12	83.5	8.08	9.74
Thallium	0.25 - 29.45	310	34.8	0.220	10.8	0.638	1.09
Tin	0.39 - 40	303	24.8	0.570	110	7.02	11.7
Titanium	0.083 - 0.24	163	100	38.7	650	225	149
Total Petroleum Hydrocarbons	1 - 30	27	63.0	6.21	249	64.5	76.3
Uranium	1.3 - 1.9	162	29.0	1.70	19	1.80	2.21
Vanadium	0.06 - 10	310	99.7	4.60	72	28.8	14.2
Zinc	0.03 - 4	310	99.7	5.30	550	34.2	38.6
Organics (µg/kg)							
1,1,1-Trichloroethane	0.1 - 1,500	496	2.22	1	300	24.8	181
1,1,2,2-Tetrachloroethane	0.62 - 1,500	486	0.412	22	72	25.0	183
1,1,2-Trichloro-1,2,2-trifluoroethane	0.12 - 2,100	284	0.352	0.800	0.800	35.9	233
1,1-Dichloroethene	0.31 - 1,500	491	0.407	1	7	25.0	182
1,2,3-Trichlorobenzene	0.4 - 840	279	1.79	0.630	3.70	36.0	235
1,2,4-Trichlorobenzene	0.26 - 790	409	0.733	0.510	14	92.0	203
1,2,4-Trimethylbenzene	0.12 - 790	279	4.66	0.120	11.8	36.1	235
1,2-Dichlorobenzene	0.099 - 790	415	0.482	0.190	0.640	90.6	202
1,2-Dichloroethene	5 - 1,500	156	2.56	2	110	8.80	60.4
1,3,5-Trimethylbenzene	0.52 - 790	279	1.79	1.10	4.70	36.0	235
1,3-Dichlorobenzene	0.41 - 790	410	0.244	0.720	0.720	91.7	203
1,4-Dichlorobenzene	0.62 - 790	410	0.732	0.870	84	90.7	203
2-Butanone	1.7 - 11,300	467	6.00	1.70	8,100	123	765
2-Chlorophenol	10 - 3,800	249	0.402	46	46	402	2,436
2-Hexanone[b]	0.6 - 5,630	471	0.212	0.800	0.800	89.5	745
2-Methylnaphthalene	10 - 3,600	249	2.01	57	83,000	676	5,491
4-Chloro-3-methylphenol	10 - 3,800	249	0.402	37	37	660	4,754
4-Isopropyltoluene[b]	0.8 - 790	279	1.08	1.50	4.15	36.0	235
4-Methyl-2-pentanone	0.77 - 5,630	479	0.835	2	94	88.2	739
Acenaphthene	10 - 3,500	250	2.80	58	24,000	325	1,524
Acenaphthylene[b]	10 - 3,100	249	0.402	1,100	1,100	306	1,214
Acetone	1.5 - 11,300	491	33.2	2	4,890	130	769
Anthracene	10 - 2,700	250	3.60	91	8,700	270	601
Aroclor-1248	0.5 - 21,700	189	0.529	7,200	7,200	134	942
Aroclor-1254	1 - 21,700	189	13.8	9.40	5,900	156	618
Aroclor-1260	1 - 21,700	189	3.70	7.20	320	67.8	130
Benzene	0.1 - 1,500	498	0.602	0.840	14	24.6	181

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Table 1.4
Summary of Detected Analytes in Subsurface Soil/Subsurface Sediment

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Benzo(a)anthracene	10 - 2,800	249	7.23	46	7,500	286	606
Benzo(a)pyrene	10 - 4,500	249	8.84	48	11,000	346	1,024
Benzo(b)fluoranthene	10 - 3,200	249	4.02	45	7,100	430	2,475
Benzo(g,h,i)perylene	10 - 3,000	249	5.62	84	5,200	287	499
Benzo(k)fluoranthene	10 - 3,600	249	2.41	43	8,000	432	2,483
Benzoic Acid	50 - 32,000	234	5.13	43	2,300	1,996	12,402
bis(2-ethylhexyl)phthalate	10 - 8,100	250	20.8	35	71,000	702	5,091
Butylbenzylphthalate	10 - 7,400	250	13.6	35	4,900	432	2,457
Carbon Disulfide	0.31 - 3,500	491	0.204	160	160	60.6	510
Carbon Tetrachloride	0.52 - 1,500	496	3.43	1	6,200	38.9	332
Chloroform	0.1 - 1,500	492	7.11	0.680	130	25.8	182
Chrysene	10 - 3,100	250	12.4	40	11,000	321	903
cis-1,2-Dichloroethene	0.1 - 790	280	7.50	0.634	4,400	42.6	306
Dibenz(a,h)anthracene[b]	10 - 2,800	249	0.803	170	1,700	408	2,437
Dibenzofuran	10 - 4,100	249	0.402	7,000	7,000	276	491
Dicamba	1.9 - 2	5	20	2.20	2.20	17.2	8.41
Diethylphthalate	10 - 3,500	249	0.402	56	56	481	2,439
Di-n-butylphthalate	10 - 2,300	249	5.62	37	480	396	2,437
Ethylbenzene	0.1 - 1,500	498	1.20	0.780	62	24.8	181
Fluoranthene	10 - 2,600	250	10	36	18,000	331	1,184
Fluorene	10 - 3,800	250	2	98	7,100	283	522
Fluoroacetamide	0	1	100	22	22	22	0
Hexachlorobutadiene	1.4 - 790	409	0.489	16.4	310	92.6	204
Indeno(1,2,3-cd)pyrene	10 - 2,600	249	3.61	41	3,000	409	2,441
Methylene Chloride	0.33 - 1,600	498	34.5	0.830	1,500	33.0	209
Naphthalene	0.38 - 3,600	410	5.85	0.920	17,000	148	905
n-Butylbenzene	1.2 - 790	279	0.358	0.620	0.620	36.0	235
N-nitrosodiphenylamine	10 - 3,100	249	1.20	870	17,000	315	1,089
Pentachlorophenol	50 - 13,000	249	0.402	790	790	1,970	12,022
Phenanthrene	10 - 3,900	250	11.6	42	43,000	476	2,821
Phenol	10 - 3,900	252	18.7	110	2,500	488	2,430
Propylcyclopentane	0	1	100	7.20	7.20	7.20	0
Pyrene	10 - 15,000	250	14	46	36,000	563	2,893
Styrene	0.077 - 1,500	491	0.407	0.0860	1.70	24.9	182
Tetrachloroethene	0.18 - 1,500	496	24.8	0.400	72,000	433	4,694
Toluene	0.085 - 1,500	499	21.6	0.130	480	38.6	186
Trichloroethene	0.14 - 1,500	496	10.3	0.270	1,900	26.0	144
Xylene[c]	0.1 - 1,500	498	5.02	1.30	400	26.6	182
Radionuclides (pCi/g)[d]							
Americium-241	0 - 1.61	396	N/A	-6.16	410	2.92	23.8
Cesium-134	0.0325 - 0.0384	3	N/A	-0.0374	-0.0186	-0.0280	0.00940
Cesium-137	0.0334 - 0.65	82	N/A	-0.0212	0.340	0.0670	0.0637
Gross Alpha	0.83 - 20.1	139	N/A	1.02	4,100	72.6	369
Gross Beta	1.75 - 29	148	N/A	-260	137	25.1	27.4
Iodine-129	0.321 - 0.48	7	N/A	-0.648	0.125	-0.153	0.297
Nickel-59	0.3 - 0.8	7	N/A	0	0.420	0.209	0.197
Plutonium-238	0.00286 - 0.216	102	N/A	-0.0190	19.8	0.351	2.21
Plutonium-239/240	0 - 1.56	398	N/A	-0.0182	2,450	18.3	148
Plutonium-241	7.1 - 23.5	4	N/A	16.8	178	98.0	69.0
Radium-226	0.1 - 0.54	63	N/A	-0.176	1.44	0.664	0.335
Radium-228	0.118 - 1.3	65	N/A	0	2.60	1.25	0.513
Strontium-89/90	0.03 - 1.52	85	N/A	-0.630	0.830	0.193	0.214
Tritium	180 - 420	11	N/A	60	510	251	156
Uranium-233/234	0 - 1.02	391	N/A	0.0534	14	0.994	1.49
Uranium-235	0 - 0.87	391	N/A	-0.144	1.70	0.0624	0.128
Uranium-238	0 - 1.5	391	N/A	0.0279	64.0	1.31	4.36

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[c] The value for total xylene is used.

[d] All radionuclide values are considered detects.

N/A = Not applicable.

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Table 1.5
Summary of Detected Analytes in Surface Soil

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Inorganics (mg/kg)							
Aluminum	0.24 - 200	151	100	4,780	33,000	14,613	6,893
Ammonia	0.300	9	100	1.09	3.33	2.07	0.845
Antimony[b]	0.27 - 60	130	18.5	0.300	0.880	2.64	2.75
Arsenic	0.28 - 10	151	100	1	11	5.21	2.14
Barium	0.039 - 200	151	100	34.9	280	135	47.3
Beryllium	0.031 - 5	151	68.2	0.230	1.40	0.690	0.286
Boron	0.35 - 1.2	76	93.4	0.670	15	6.82	3.63
Cadmium	0.03 - 5	150	44.7	0.0650	2.60	0.496	0.351
Calcium	1 - 5,000	151	100	1,740	185,000	21,793	39,007
Cesium	200 - 1,000	57	21.1	1.50	7.40	30.6	28.4
Chromium	0.053 - 10	151	100	2.20	80.5	16.5	10.3
Cobalt	0.079 - 50	151	100	2.20	21.6	6.61	2.42
Copper	0.045 - 25	150	100	2.20	49.8	14.8	6.15
Iron	0.8 - 100	151	100	3,680	27,000	14,118	5,245
Lead	0.12 - 3	151	100	3	120	34.4	20.5
Lithium	0.17 - 100	131	92.4	4.40	33	12.4	6.26
Magnesium	1.6 - 5,000	151	100	1,100	8,270	3,142	1,294
Manganese	0.033 - 15	151	100	54	1,200	284	147
Mercury	0.0012 - 0.2	132	52.3	0.00560	0.250	0.0448	0.0357
Molybdenum	0.13 - 200	137	27.7	0.150	3	1.07	1.00
Nickel	0.19 - 40	151	96.7	4.40	101	14.6	10.3
Nitrate / Nitrite	0.200	9	100	1.60	3.83	2.63	0.748
Potassium	36 - 5000	151	100	690	6,200	3,101	1,229
Selenium	0.4 - 5	150	20	0.260	0.730	0.417	0.393
Silica	2.7 - 5.3	76	100	175	1,100	596	202
Silicon[b]	0 - 100	37	100	81	2,160	1,265	641
Silver	0.055 - 10	142	24.6	0.0810	42.8	1.30	4.22
Sodium	102 - 5000	151	27.2	46	492	97.5	67.8
Strontium	0.0061 - 200	137	100	8.90	362	46.4	46.6
Thallium	0.37 - 10	151	20.5	0.210	3.30	0.417	0.414
Tin	0.24 - 200	137	15.3	1.30	75.8	7.95	11.3
Titanium	0.077 - 0.2	76	100	33	603	275	129
Uranium	1.4 - 7.2	76	5.26	1.90	8	1.89	1.41
Vanadium	0.25 - 50	151	100	12.1	72	31.9	12.2
Zinc	0.2 - 20	151	100	15	165	51.3	18.6
Organics (µg/kg)							
1,1,2,2-Tetrachloroethane[b]	4.86 - 5.5	13	7.69	1.39	1.39	0.544	0.255
1,2,3-Trichloropropane[b]	4.86 - 5.5	13	7.69	1.47	1.47	0.583	0.267
1,2,4-Trimethylbenzene	4.86 - 5.5	13	7.69	1.44	1.44	0.574	0.261
4,4'-DDE	1.7 - 16	40	7.50	4	5.80	8.88	1.55
4,6-Dinitro-2-methylphenol	130 - 1,600	80	1.25	390	390	983	312
Acenaphthene	33 - 360	85	7.06	45	240	180	29.5
Anthracene	25 - 360	85	9.41	47	330	184	32.3
Aroclor-1248	6.2 - 240	81	1.23	840	840	46.7	98.1
Aroclor-1254	4.4 - 160	81	28.4	6.80	3,000	118	339
Aroclor-1260	4.9 - 160	81	17.3	6.20	240	65.6	57.5
Benzene[b]	4.86 - 5.5	13	7.69	1.44	1.44	0.480	0.289
Benzo(a)anthracene	26 - 360	85	27.1	39	830	193	114
Benzo(a)pyrene	43 - 360	85	16.5	48	750	207	92.4
Benzo(b)fluoranthene	31 - 360	85	16.5	40	810	212	97.7
Benzo(g,h,i)perylene	29 - 360	85	9.41	82	240	199	57.8
Benzo(k)fluoranthene	34 - 360	85	11.8	69	740	214	94.1
Benzoic Acid	300 - 1,600	80	33.8	77	1,100	772	463
bis(2-ethylhexyl)phthalate	71 - 360	85	10.6	56	510	209	83.5
Chlorobenzene[b]	4.86 - 5.5	13	7.69	2.03	2.03	0.603	0.429
Chrysene	30 - 360	85	31.8	39	790	191	112
Dibenz(a,h)anthracene	26 - 360	85	4.71	43	92	198	67.6
Dibenzofuran	38 - 360	85	2.35	37	86	201	64.5
Dieldrin	2.9 - 16	40	5	4.30	5.80	9.84	3.41
Di-n-butylphthalate	22 - 360	85	1.18	1,000	1,000	213	106

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Table 1.5
Summary of Detected Analytes in Surface Soil

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Endrin	2 - 16	40	7.50	4.50	5.10	8.87	1.51
Ethylbenzene[b]	4.86 - 5.5	13	7.69	1.29	1.29	0.580	0.214
Fluoranthene	24 - 360	84	47.6	45	1,900	239	251
Fluorene	36 - 360	85	4.71	54	230	201	64.9
Indeno(1,2,3-cd)pyrene	24 - 360	85	10.6	72	220	199	66.5
Methoxychlor	0.91 - 80	40	7.50	3	9.40	42.6	12.6
Naphthalene[b]	4.86 - 360	98	1.02	0.890	0.890	177	89.4
N-Nitroso-di-n-propylamine	24 - 360	85	1.18	400	400	206	64.2
Phenanthrene	37 - 360	85	38.8	40	1,600	214	202
Pyrene	41 - 360	85	60	43	1,800	223	249
Tetrachloroethene	4.86 - 5.5	13	7.69	1.73	1.73	0.704	0.309
Toluene[b]	4.86 - 5.5	13	7.69	2.26	2.26	0.766	0.450
Radionuclides (pCi/g)[c]							
Americium-241	0 - 0.261	279	N/A	0	15.6	1.86	2.44
Cesium-134	0.0271 - 0.1	28	N/A	-0.0101	0.100	0.0169	0.0316
Cesium-137	0.031 - 0.21	28	N/A	0.170	2.01	0.982	0.497
Gross Alpha	2.2 - 20	39	N/A	-0.980	320	38.5	58.3
Gross Beta	1 - 20	46	N/A	19	51.1	33.9	5.88
Plutonium-238	0.0284 - 0.211	9	N/A	0.102	1.53	0.447	0.454
Plutonium-239/240	0 - 0.288	307	N/A	-0.00292	49	9.44	12.1
Radium-226	0.157 - 0.5	33	N/A	0.590	1.46	1.05	0.207
Radium-228	0.11 - 0.69	13	N/A	1.35	3.50	2.16	0.602
Strontium-89/90	0.0734 - 0.4	8	N/A	0.0600	1.24	0.473	0.347
Uranium-233/234	0 - 0.674	193	N/A	0.119	7.96	1.12	0.799
Uranium-235	0 - 0.448	192	N/A	-0.0431	0.680	0.0827	0.0922
Uranium-238	0 - 0.438	193	N/A	0.351	3.78	1.12	0.454

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[c] All radionuclide values are considered detects.

N/A = Not applicable.

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Table 1.6
Summary of Detected Analytes in Subsurface Soil

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
Inorganics (mg/kg)							
Aluminum	1.2 - 40	309	100	1,050	54,000	13,189	7,737
Ammonia	0.300	62	22.6	0.353	1.44	0.289	0.269
Antimony	0.27 - 12	303	15.2	0.300	350	4.60	25.5
Arsenic	0.23 - 2	309	98.1	0.820	25.9	5.21	3.13
Barium	0.039 - 40	309	99.7	9.20	838	115	99.4
Beryllium	0.03 - 1	309	80.3	0.0650	2.30	0.697	0.421
Boron	0.34 - 1.2	162	78.4	0.600	15	4.18	3.85
Cadmium	0.047 - 1.96	286	35.0	0.0520	58.7	0.866	3.87
Calcium	1.4 - 2,000	309	100	1,240	260,000	40,641	54,538
Cesium	89.5 - 200	142	64.8	0.640	21	8.70	14.1
Chromium	0.053 - 2	309	100	2.90	4,600	32.7	261
Cobalt	0.078 - 10	309	96.1	0.720	24	5.44	3.32
Copper	0.043 - 5	309	99.0	2.10	180	13.9	15.1
Iron	0.57 - 20	309	100	2,250	152,000	13,133	10,298
Lead	0.19 - 19.63	309	99.7	1.50	8,500	42.9	484
Lithium	0.17 - 20	304	93.1	1.10	44	11.0	6.70
Magnesium	1.6 - 2,000	309	99.7	364	12,200	3,163	1,624
Manganese	0.032 - 3	309	100	15.8	1,300	193	181
Mercury	0.0012 - 0.2	308	63.6	0.00150	3.40	0.0971	0.345
Molybdenum	0.13 - 40	304	50	0.140	1,970	7.97	113
Nickel	0.19 - 8	309	98.7	2.70	1,330	24.1	80.6
Nitrate / Nitrite	0.2 - 0.21	66	66.7	0.238	43.6	1.92	6.23
Phosphorus	N/A	1	100	160	160	160	0
Potassium	34 - 2,000	308	97.1	300	13,000	1,929	1,590
Selenium	0.3 - 49.08	309	4.53	0.230	1.50	0.380	1.39
Silica	2.6 - 5.9	162	100	174	1,200	600	226
Silicon	0 - 200	75	96	6	2,210	361	440
Silver	0.055 - 2.94	308	19.8	0.0640	219	2.17	13.6
Sodium	2.4 - 2,000	308	51.6	36.9	3,700	217	430
Strontium	0.0061 - 400	309	99.0	6.20	459	61.4	60.0
Sulfide	10 - 16.3	66	10.6	12	83.5	8.08	9.74
Thallium	0.28 - 29.45	309	35.0	0.220	10.8	0.640	1.09
Tin	0.39 - 40	303	24.8	0.570	110	7.02	11.7
Titanium	0.083 - 0.24	163	100	38.7	650	225	149
Total Petroleum Hydrocarbons	1 - 30	27	63.0	6.21	249	64.5	76.3
Uranium	1.3 - 1.9	162	29.0	1.70	19	1.80	2.21
Vanadium	0.24 - 10	309	99.7	4.60	72	28.9	14.2
Zinc	0.2 - 4	309	99.7	5.30	550	34.2	38.6
Organics (µg/kg)							
1,1,1-Trichloroethane	0.1 - 1,500	495	2.22	1	300	24.8	181
1,1,2,2-Tetrachloroethane	0.62 - 1,500	485	0.412	22	72	25.1	183
1,1,2-Trichloro-1,2,2-trifluoroethane	0.12 - 2,100	284	0.352	0.800	0.800	35.9	233
1,1-Dichloroethene	0.31 - 1,500	490	0.408	1	7	25.0	182
1,2,3-Trichlorobenzene	0.4 - 840	279	1.79	0.630	3.70	36.0	235
1,2,4-Trichlorobenzene	0.26 - 790	409	0.733	0.510	14	92.0	203
1,2,4-Trimethylbenzene	0.12 - 790	279	4.66	0.120	11.8	36.1	235
1,2-Dichlorobenzene	0.099 - 790	415	0.482	0.190	0.640	90.6	202
1,2-Dichloroethene	5 - 1,500	155	2.58	2	110	8.83	60.6
1,3,5-Trimethylbenzene	0.52 - 790	279	1.79	1.10	4.70	36.0	235
1,3-Dichlorobenzene	0.41 - 790	410	0.244	0.720	0.720	91.7	203
1,4-Dichlorobenzene	0.62 - 790	410	0.732	0.870	84	90.7	203
2-Butanone	1.7 - 11,300	466	6.01	1.70	8,100	123	765
2-Chlorophenol	10 - 3,800	249	0.402	46	46	402	2,436
2-Hexanoneb	0.6 - 5,630	470	0.213	0.800	0.800	89.7	746
2-Methylnaphthalene	10 - 3,600	249	2.01	57	83.000	676	5,491
4-Chloro-3-methylphenol	10 - 3,800	249	0.402	37	37	660	4,754
4-Isopropyltolueneb	0.8 - 790	279	1.08	1.50	4.15	36.0	235
4-Methyl-2-pentanone	0.77 - 5,630	478	0.837	2	94	88.4	740
Acenaphthene	10 - 3,500	250	2.80	58	24,000	325	1,524
Acenaphthylene[b]	10 - 3,100	249	0.402	1,100	1,100	306	1,214
Acetone	1.5 - 11,300	490	33.1	2	4,890	131	770
Anthracene	10 - 2,700	250	3.60	91	8,700	270	601
Aroclor-1248	0.5 - 21,700	189	0.529	7,200	7,200	134	942
Aroclor-1254	1 - 21,700	189	13.8	9.40	5,900	156	618
Aroclor-1260	1 - 21,700	189	3.70	7.20	320	67.8	130

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Table 1.6
Summary of Detected Analytes in Subsurface Soil

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Benzene	0.1 - 1,500	497	0.604	0.840	14	24.6	181
Benzo(a)anthracene	10 - 2,800	249	7.23	46	7,500	286	606
Benzo(a)pyrene	10 - 4,500	249	8.84	48	11,000	346	1,024
Benzo(b)fluoranthene	10 - 3,200	249	4.02	45	7,100	430	2,475
Benzo(g,h,i)perylene	10 - 3,000	249	5.62	84	5,200	287	499
Benzo(k)fluoranthene	10 - 3,600	249	2.41	43	8,000	432	2,483
Benzoic Acid	50 - 32,000	234	5.13	43	2,300	1,996	12,402
bis(2-ethylhexyl)phthalate	10 - 8,100	250	20.8	35	71,000	702	5,091
Butylbenzylphthalate	10 - 7,400	250	13.6	35	4,900	432	2,457
Carbon Disulfide	0.31 - 3,500	490	0.204	160	160	60.7	510
Carbon Tetrachloride	0.52 - 1,500	495	3.43	1	6,200	38.9	332
Chloroform	0.1 - 1,500	491	7.13	0.680	130	25.8	182
Chrysene	10 - 3,100	250	12.4	40	11,000	321	903
cis-1,2-Dichloroethene	0.1 - 790	280	7.50	0.634	4,400	42.6	306
Dibenz(a,h)anthracene[b]	10 - 2,800	249	0.803	170	1,700	408	2,437
Dibenzofuran	10 - 4,100	249	0.402	7,000	7,000	276	491
Dicamba	1.9 - 2	5	20	2.20	2.20	17.2	8.41
Diethylphthalate	10 - 3,500	249	0.402	56	56	481	2,439
Di-n-butylphthalate	10 - 2,300	249	5.62	37	480	396	2,437
Ethylbenzene	0.1 - 1,500	497	1.21	0.780	62	24.8	181
Fluoranthene	10 - 2,600	250	10	36	18,000	331	1,184
Fluorene	10 - 3,800	250	2	98	7,100	283	522
Fluoroacetamide	N/A	1	100	22	22	22	0
Hexachlorobutadiene	1.4 - 790	409	0.489	16.4	310	92.6	204
Indeno(1,2,3-cd)pyrene	10 - 2,600	249	3.61	41	3,000	409	2,441
Methylene Chloride	0.33 - 1,600	497	34.4	0.830	1,500	33.1	209
Naphthalene	0.38 - 3,600	410	5.85	0.920	17,000	148	905
n-Butylbenzene	1.2 - 790	279	0.358	0.620	0.620	36.0	235
N-nitrosodiphenylamine	10 - 3,100	249	1.20	870	17,000	315	1,089
Pentachlorophenol	50 - 13,000	249	0.402	790	790	1,970	12,022
Phenanthrene	10 - 3,900	250	11.6	42	43,000	476	2,821
Phenol	10 - 3,900	252	18.7	110	2,500	488	2,430
Propylcyclopentane	0	1	100	7.20	7.20	7.20	0
Pyrene	10 - 15,000	250	14	46	36,000	563	2,893
Styrene	0.077 - 1,500	490	0.408	0.0860	1.70	25.0	182
Tetrachloroethene	0.18 - 1,500	495	24.8	0.400	72,000	434	4,699
Toluene	0.085 - 1,500	498	21.5	0.130	480	38.7	187
Trichloroethene	0.14 - 1,500	495	10.3	0.270	1,900	26.0	144
Xylene[c]	0.1 - 1,500	497	5.03	1.30	400	26.6	182
Radionuclides (pCi/g)[d]							
Americium-241	0 - 1.61	393	N/A	-6.16	410	2.94	23.9
Cesium-134	0.0325 - 0.0384	3	N/A	-0.0374	-0.0186	-0.0280	0.00940
Cesium-137	0.0334 - 0.65	82	N/A	-0.0212	0.340	0.0670	0.0637
Gross Alpha	0.83 - 20.1	136	N/A	1.02	4,100	73.7	373
Gross Beta	1.75 - 29	145	N/A	-260	137	25.4	27.6
Iodine-129	0.321 - 0.48	7	N/A	-0.648	0.125	-0.153	0.297
Nickel-59	0.3 - 0.8	7	N/A	0	0.420	0.209	0.197
Plutonium-238	0.00286 - 0.216	102	N/A	-0.0190	19.8	0.351	2.21
Plutonium-239/240	0 - 1.56	395	N/A	-0.0182	2,450	18.5	149
Plutonium-241	7.1 - 23.5	4	N/A	16.8	178	98.0	69.0
Radium-226	0.1 - 0.54	63	N/A	-0.176	1.44	0.664	0.335
Radium-228	0.118 - 1.3	65	N/A	0	2.60	1.25	0.513
Strontium-89/90	0.03 - 1.52	85	N/A	-0.630	0.830	0.193	0.214
Tritium	180 - 420	11	N/A	60	510	251	156
Uranium-233/234	0 - 1.02	388	N/A	0.0534	14	0.995	1.50
Uranium-235	0 - 0.87	388	N/A	-0.144	1.70	0.0624	0.128
Uranium-238	0 - 1.5	388	N/A	0.0279	64.0	1.32	4.38

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[c] The value for total xylene is used.

[d] All radionuclide values are considered detects.

N/A = Not applicable.

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Table 2.1
Essential Nutrient Screen for Surface Soil/Surface Sediment

Analyte	MDC (mg/kg)	Estimated Maximum Daily Intake[a] (mg/day)	RDA/RDI/AI[b] (mg/day)	UL[b] (mg/day)	Retain for PRG Screen?
Calcium	185,000	18.5	500-1,200	2,500	No
Magnesium	8,270	0.827	80-420	65-110	No
Potassium	6,200	0.62	2,000-3,500	N/A	No
Sodium	492	0.0492	500-2,400	N/A	No

[a] Based on the MDC and a 100 mg/day soil ingestion rate for a WRW.
[b] RDA/RDI/AI/UL taken from NAS 2000, 2002.
N/A = Not available.

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Table 2.2
PRG Screen for Surface Soil/Surface Sediment

Analyte	PRG[a]	MDC	MDC Exceeds PRG?	UCL[b]	UCL Exceeds PRG?	Retain for Detection Frequency Screen?
Inorganics (mg/kg)						
Aluminum	24,774	33,000	Yes	15,272	No	No
Ammonia	910,997	3.33	No	--	--	No
Antimony	44.4	0.880	No	--	--	No
Arsenic	**2.41**	**11**	**Yes**	**5.50**	**Yes**	**Yes**
Barium	2,872	280	No	--	--	No
Beryllium	100	1.40	No	--	--	No
Boron	9,477	15	No	--	--	No
Cadmium	91.4	2.60	No	--	--	No
Cesium	N/A	7.40	UT	--	--	UT
Chromium[c]	28.4	80.5	Yes	19.7	No	No
Cobalt	122	21.6	No	--	--	No
Copper	4,443	49.8	No	--	--	No
Iron	33,326	27,000	No	--	--	No
Lead	1,000	120	No	--	--	No
Lithium	2,222	33	No	--	--	No
Manganese	419	1,200	Yes	302	No	No
Mercury	32.9	0.250	No	--	--	No
Molybdenum	555	6.10	No	--	--	No
Nickel	2,222	101	No	--	--	No
Nitrate / Nitrite[d]	177,739	3.83	No	--	--	No
Selenium	555	0.880	No	--	--	No
Silica	N/A	1,100	UT	--	--	UT
Silicon	N/A	2,160	UT	--	--	UT
Silver	555	42.8	No	--	--	No
Strontium	66,652	362	No	--	--	No
Thallium	7.78	3.30	No	--	--	No
Tin	66,652	77.2	No	--	--	No
Titanium	169,568	603	No	--	--	No
Uranium	333	8	No	--	--	No
Vanadium	111	72	No	--	--	No
Zinc	33,326	216	No	--	--	No
Organics (µg/kg)						
1,1,2,2-Tetrachloroethane	10,483	1.39	No	--	--	No
1,2,3-Trichloropropane	2,079	1.47	No	--	--	No
1,2,4-Trimethylbenzene	132,620	1.44	No	--	--	No
2-Butanone	4.64E+07	19	No	--	--	No
4,4'-DDE	10,961	5.80	No	--	--	No
4,6-Dinitro-2-methylphenol	8,014	390	No	--	--	No
Acenaphthene	4.44E+06	240	No	--	--	No
Acetone	1.00E+08	71	No	--	--	No
Aldrin	176	0	No	--	--	No
alpha-Chlordane	10,261	0	No	--	--	No
Anthracene	2.22E+07	330	No	--	--	No
Aroclor-1248	1,349	840	No	--	--	No
Aroclor-1254	1,349	3,000	Yes	327	No	No
Aroclor-1260	1,349	240	No	--	--	No
Benzene	23,563	1.44	No	--	--	No
Benzo(a)anthracene	3,793	830	No	--	--	No
Benzo(a)pyrene	379	750	Yes	226	No	No
Benzo(b)fluoranthene	3,793	810	No	--	--	No
Benzo(g,h,i)perylene	N/A	240	UT	--	--	UT
Benzo(k)fluoranthene	37,927	740	No	--	--	No
Benzoic Acid	3.21E+08	1,100	No	--	--	No
beta-BHC	1,995	0	No	--	--	No
bis(2-ethylhexyl)phthalate	213,750	1,400	No	--	--	No
Chlorobenzene	666,523	2.03	No	--	--	No
Chrysene	379,269	790	No	--	--	No
delta-BHC	570	0	No	--	--	No

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Table 2.2
PRG Screen for Surface Soil/Surface Sediment

Analyte	PRG[a]	MDC	MDC Exceeds PRG?	UCL[b]	UCL Exceeds PRG?	Retain for Detection Frequency Screen?
Dibenz(a,h)anthracene	379	92	No	--	--	No
Dibenzofuran	222,174	86	No	--	--	No
Dieldrin	187	5.80	No	--	--	No
Di-n-butylphthalate	8.01E+06	1,000	No	--	--	No
Di-n-octylphthalate	3.21E+06	210	No	--	--	No
Endosulfan I	480,861	0	No	--	--	No
Endrin	24,043	5.10	No	--	--	No
Ethylbenzene	5.39E+06	1.29	No	--	--	No
Fluoranthene	2.96E+06	1,900	No	--	--	No
Fluorene	3.21E+06	230	No	--	--	No
gamma-Chlordane	10,261	0	No	--	--	No
Heptachlor	665	0	No	--	--	No
Heptachlor epoxide	329	0	No	--	--	No
Indeno(1,2,3-cd)pyrene	3,793	220	No	--	--	No
Methoxychlor	400,718	9.40	No	--	--	No
Methylene Chloride	271,792	14	No	--	--	No
Naphthalene	1.40E+06	0.890	No	--	--	No
N-Nitroso-di-n-propylamine	429	400	No	--	--	No
Phenanthrene	N/A	1,600	UT	--	--	UT
Pyrene	2.22E+06	1,800	No	--	--	No
Tetrachloroethene	6,705	1.73	No	--	--	No
Toluene	3.09E+06	2.26	No	--	--	No
Radionuclides (pCi/g)						
Americium-241	7.69	15.6	Yes	2.43	No	No
Cesium-134	0.0800	0.200	Yes	0.076	No	No
Cesium-137	**0.221**	**2.01**	**Yes**	**1.71**	**Yes**	**Yes**
Gross Alpha	N/A	320	UT	--	--	No
Gross Beta	N/A	64	UT	--	--	No
Plutonium-238	5.97	1.53	No	--	--	No
Plutonium-239/240	**9.80**	**49**	**Yes**	**12.1**	**Yes**	**Yes**
Radium-226	2.69	2.19	No	--	--	No
Radium-228	**0.111**	**3.50**	**Yes**	**2.38**	**Yes**	**Yes**
Strontium-89/90	13.2	1.46	No	--	--	No
Uranium-233/234	25.3	7.96	No	--	--	No
Uranium-235	1.05	0.680	No	--	--	No
Uranium-238	29.3	3.78	No	--	--	No

[a] The value shown is equal to the most stringent of the PRGs based on a risk of 1E-06 or an HQ of 0.1.

[b] UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL.

[c] The PRG for chromium (VI) is used.

[d] The PRG for nitrate is used.

N/A = Not available.

UT = Uncertain toxicity; no PRG available (assessed in Section 6.0).

-- = Screen not performed because analyte was eliminated from further consideration in a previous COC selection step.

Bold = Analyte retained for further consideration in the next COC selection step.

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Table 2.3
Statistical Distributions and Comparison to Background for Human Health PCOCs in WBEU[a]

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			WBEU Data Set					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1-p	Statistically Greater than Background?
Surface Soil/Surface Sediment									
Arsenic	**73**	**GAMMA**	**91.8**	**160**	**GAMMA**	**100**	**WRS**	**2.36E-08**	**Yes**
Cesium-137	105	NONPARAMETRIC	N/A	37	NONPARAMETRIC	N/A	N/A	0.206	No
Plutonium-239/240	**94**	**NONPARAMETRIC**	**N/A**	**319**	**NONPARAMETRIC**	**N/A**	**N/A**	**0**	**Yes**
Radium-228	**40**	**GAMMA**	**N/A**	**17**	**NORMAL**	**N/A**	**N/A**	**0.00727**	**Yes**
Subsurface Soil/Subsurface Sediment									
Radium-228	31	GAMMA	N/A	65	NORMAL	N/A	N/A	0.973	No

[a] EU data used for background comparisons do not include data from background locations.
N/A = Not applicable; all radionuclide values are considered detect.
Bold = Analyte retained for further consideration in the next COC selection step.
WRS = Wilcoxon Rank Sum.

Table 2.4
Essential Nutrient Screen for Subsurface Soil/Subsurface Sediment

Analyte	MDC (mg/kg)	Estimated Maximum Daily Intake[a] (mg/day)	RDA/RDI/AI[b] (mg/day)	UL[b] (mg/day)	Retain for PRG Screen?
Calcium	260,000	26.0	500-1,200	2,500	No
Magnesium	12,200	1.22	80-420	65-110	No
Potassium	13,000	1.30	2,000-3,500	N/A	No
Sodium	3,700	0.370	500-2,400	N/A	No

[a] Based on the MDC and a 100 mg/day soil ingestion rate for a WRW.

[b] RDA/RDI/AI/UL taken from NAS 2000, 2002.

N/A = Not available.

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Table 2.5
PRG Screen for Subsurface Soil/Subsurface Sediment

Analyte	PRG[a]	MDC	MDC Exceeds PRG?	UCL[b]	UCL Exceeds PRG?	Retain for Detection Frequency Screen?
Inorganics (mg/kg)						
Aluminum	284,902	54,000	No	--	--	No
Ammonia	1.05E+07	1.44	No	--	--	No
Antimony	511	350	No	--	--	No
Arsenic	27.7	25.9	No	--	--	No
Barium	33,033	838	No	--	--	No
Beryllium	1,151	2.30	No	--	--	No
Boron	108,980	15	No	--	--	No
Cadmium	1,051	58.7	No	--	--	No
Cesium	N/A	21	UT	--	--	UT
Chromium[c]	327	4,600	Yes	97.2	No	No
Cobalt	1,401	24	No	--	--	No
Copper	51,100	180	No	--	--	No
Iron	383,250	152,000	No	--	--	No
Lead	1,000	8,500	Yes	163	No	No
Lithium	25,550	44	No	--	--	No
Manganese	4,815	1,300	No	--	--	No
Mercury	379	3.40	No	--	--	No
Molybdenum	6,388	1,970	No	--	--	No
Nickel	25,550	1,330	No	--	--	No
Nitrate / Nitrite[d]	2.04E+06	43.6	No	--	--	No
Phosphorus	N/A	160	UT	--	--	UT
Selenium	6,388	1.50	No	--	--	No
Silica	N/A	1,200	UT	--	--	UT
Silicon	N/A	2,210	UT	--	--	UT
Silver	6,388	219	No	--	--	No
Strontium	766,500	459	No	--	--	No
Thallium	89.4	10.8	No	--	--	No
Tin	766,500	110	No	--	--	No
Titanium	1.95E+06	650	No	--	--	No
Total Petroleum Hydrocarbons	N/A	249	UT	--	--	UT
Uranium	3,833	19	No	--	--	No
Vanadium	1,278	72	No	--	--	No
Zinc	383,250	550	No	--	--	No
Organics (µg/kg)						
1,1,1-Trichloroethane	1.06E+08	300	No	--	--	No
1,1,2,2-Tetrachloroethane	120,551	72	No	--	--	No
1,1,2-Trichloro-1,2,2-trifluoroethane	2.74E+10	0.800	No	--	--	No
1,1-Dichloroethene	199,706	7	No	--	--	No
1,2,3-Trichlorobenzene	N/A	3.70	UT	--	--	UT
1,2,4-Trichlorobenzene	1.74E+06	14	No	--	--	No
1,2,4-Trimethylbenzene	1.53E+06	11.8	No	--	--	No
1,2-Dichlorobenzene	3.32E+07	0.640	No	--	--	No
1,2-Dichloroethene	1.15E+07	110	No	--	--	No
1,3,5-Trimethylbenzene	1.31E+06	4.70	No	--	--	No
1,3-Dichlorobenzene	3.83E+07	0.720	No	--	--	No
1,4-Dichlorobenzene	1.05E+06	84	No	--	--	No
2-Butanone	5.33E+08	8,100	No	--	--	No
2-Chlorophenol	6.39E+06	46	No	--	--	No
2-Hexanone	N/A	0.800	UT	--	--	UT
2-Methylnaphthalene	3.69E+06	83,000	No	--	--	No
4-Chloro-3-methylphenol	N/A	37	UT	--	--	UT
4-Isopropyltoluene	N/A	4.15	UT	--	--	UT
4-Methyl-2-pentanone	9.57E+08	94	No	--	--	No
Acenaphthene	5.10E+07	24,000	No	--	--	No
Acenaphthylene	N/A	1,100	UT	--	--	UT
Acetone	1.15E+09	4,890	No	--	--	No
Anthracene	2.55E+08	8,700	No	--	--	No
Aroclor-1248	15,514	7,200	No	--	--	No
Aroclor-1254	15,514	5,900	No	--	--	No
Aroclor-1260	15,514	320	No	--	--	No
Benzene	270,977	14	No	--	--	No
Benzo(a)anthracene	43,616	7,500	No	--	--	No
Benzo(a)pyrene	4,357	11,000	Yes	628	No	No
Benzo(b)fluoranthene	43,616	7,100	No	--	--	No
Benzo(g,h,i)perylene	N/A	5,200	UT	--	--	UT

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Table 2.5
PRG Screen for Subsurface Soil/Subsurface Sediment

Analyte	PRG[a]	MDC	MDC Exceeds PRG?	UCL[b]	UCL Exceeds PRG?	Retain for Detection Frequency Screen?
Benzo(k)fluoranthene	436,159	8,000	No	--	--	No
Benzoic Acid	3.69E+09	2,300	No	--	--	No
bis(2-ethylhexyl)phthalate	2.46E+06	71,000	No	--	--	No
Butylbenzylphthalate	1.84E+08	4,900	No	--	--	No
Carbon Disulfide	1.88E+07	160	No	--	--	No
Carbon Tetrachloride	97,124	6,200	No	--	--	No
Chloroform	90,270	130	No	--	--	No
Chrysene	4.36E+06	11,000	No	--	--	No
cis-1,2-Dichloroethene	1.28E+07	4,400	No	--	--	No
Dibenz(a,h)anthracene	4,362	1,700	No	--	--	No
Dibenzofuran	2.56E+06	7,000	No	--	--	No
Dicamba	2.76E+07	2.20	No	--	--	No
Diethylphthalate	7.37E+08	56	No	--	--	No
Di-n-butylphthalate	9.22E+07	480	No	--	--	No
Ethylbenzene	6.19E+07	62	No	--	--	No
Fluoranthene	3.40E+07	18,000	No	--	--	No
Fluorene	3.69E+07	7,100	No	--	--	No
Fluoroacetamide	N/A	22	UT	--	--	UT
Hexachlorobutadiene	255,500	310	No	--	--	No
Indeno(1,2,3-cd)pyrene	43,616	3,000	No	--	--	No
Methylene Chloride	3.13E+06	1,500	No	--	--	No
Naphthalene	1.61E+07	17,000	No	--	--	No
n-Butylbenzene	N/A	0.620	UT	--	--	UT
N-nitrosodiphenylamine	7.04E+06	17,000	No	--	--	No
Pentachlorophenol	202,777	790	No	--	--	No
Phenanthrene	N/A	43,000	UT	--	--	UT
Phenol	2.76E+08	2,500	No	--	--	No
Propylcyclopentane	N/A	7.20	UT	--	--	UT
Pyrene	2.55E+07	36,000	No	--	--	No
Styrene	1.59E+08	1.70	No	--	--	No
Tetrachloroethene	77,111	72,000	No	--	--	No
Toluene	3.56E+07	480	No	--	--	No
Trichloroethene	20,354	1,900	No	--	--	No
Xylene[e]	1.22E+07	400	No	--	--	No
Radionuclides (pCi/g)						
Americium-241	88.4	410	Yes	8.13	No	No
Cesium-134	0.910	-0.0186	No	--	--	No
Cesium-137	2.54	0.340	No	--	--	No
Gross Alpha	N/A	4,100	UT	--	--	No
Gross Beta	N/A	137	UT	--	--	No
Iodine-129	90.3	0.125	No	--	--	No
Nickel-59	36,397	0.420	No	--	--	No
Plutonium-238	68.7	19.8	No	--	--	No
Plutonium-239/240	112	2,450	Yes	50.7	No	No
Plutonium-241	5,981	178	No	--	--	No
Radium-226	31	1.44	No	--	--	No
Radium-228	**1.28**	**2.60**	**Yes**	**1.35**	**Yes**	**Yes**
Strontium-89/90	152	0.830	No	--	--	No
Tritium	288,449	510	No	--	--	No
Uranium-233/234	291	14	No	--	--	No
Uranium-235	12.1	1.70	No	--	--	No
Uranium-238	337	64.0	No	--	--	No

[a] The value shown is equal to the most stringent of the PRGs based on a risk of 1E-06 or an HQ of 0.1.
[b] UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL.
[c] The PRG for chromium (VI) is used.
[d] The PRG for nitrate is used.
[e] The PRG for total xylene is used.
N/A = Not available.
UT = Uncertain toxicity; no PRG available (assessed in Section 6.0).
-- = Screen not performed because analyte was eliminated from further consideration in a previous COC selection step.
Bold = Analyte retained for further consideration in the next COC selection step.

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Table 2.6
Summary of the COC Selection Process

Analyte	MDC Exceeds PRG?	UCL Exceeds PRG?	Detection Frequency > 5%?[a]	Exceeds 30X the PRG?	Exceeds Background?	Professional Judgment-Retain?	Retain as COC?
Surface Soil/Surface Sediment							
Aluminum	Yes	No	--	--	--	--	No
Arsenic	**Yes**	**Yes**	**Yes**	**N/A**	**Yes**	**Yes**	**Yes**
Chromium	Yes	No	--	--	--	--	No
Manganese	Yes	No	--	--	--	--	No
Aroclor-1254	Yes	No	--	--	--	--	No
Benzo(a)pyrene	Yes	No	--	--	--	--	No
Americium-241	Yes	No	--	--	--	--	No
Cesium-134	Yes	No	--	--	--	--	No
Cesium-137	Yes	Yes	N/A	--	No	--	No
Plutonium-239/240	**Yes**	**Yes**	**N/A**	**--**	**Yes**	**Yes**	**Yes**
Radium-228	Yes	Yes	N/A	--	Yes	No	No
Subsurface Soil/ Subsurface Sediment							
Chromium	Yes	No	--	--	--	--	No
Lead	Yes	No	--	--	--	--	No
Benzo(a)pyrene	Yes	No	--	--	--	--	No
Americium-241	Yes	No	--	--	--	--	No
Plutonium-239/240	Yes	No	--	--	--	--	No
Radium-228	Yes	Yes	N/A	N/A	No	--	No

[a] All radionuclide values are considered detects.

N/A = Not applicable.

-- = Screen not performed because analyte was eliminated from further consideration in a previous COC selection step.

Bold = Analyte retained as a COC for risk characterization.

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Table 3.1
Exposure Point Concentrations

Analyte	Unit	MDC[a]	UCL Value[b]	UCL Type[c]	Distribution[d]	EPC[e]
Tier 1						
Surface Soil/Surface Sediment						
Arsenic	mg/kg	11	5.50	95% Approximate Gamma UCL	GAMMA	5.50
Plutonium-239/240	pCi/g	49	12.1	95% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	12.1
Tier 2						
Surface Soil/Surface Sediment						
Arsenic	mg/kg	6.87	4.22	95% Student's-t UCL	NORMAL	4.22
Plutonium-239/240	pCi/g	19.81	5.82	95% Student's-t UCL	NORMAL	5.82

[a] The MDC for Tier 1 is the maximum detected concentration of all samples and the MDC for Tier 2 is the maximum of the average concentration of the samples in each of the 30-acre grids in the EU.

[b] UCL = upper confidence limit.

[c] The Tier 1 UCL type is recommended by ProUCL.

[d] The Tier 1 distribution is recommended by ProUCL.

[e] The UCL is used as the EPC, unless the UCL exceeds the MDC, then the MDC is used for the EPC.

Table 3.2

Chemical Exposure Factors Used in Surface Soil/Surface Sediment Intake Calculations for the Wildlife Refuge Worker

Exposure Route/Exposure Factor	Abbreviation	Value	Units	Source
Ingestion				
CI = (Cs x IRwss x EFwss x EDw x CF_3) / (BW x [ATc_wss or ATn_wss]b)				
Chemical Intake	CI	chemical-specific	mg/kg-day	calculated
Chemical concentration in soil	Cs	chemical-specific	mg/kg	Tier 1 or 2 EPC
Ingestion Rate of soil/sediment	IRwss	100	mg/day	EPA et al. 2002
Exposure Frequency	EFwss	230	days/year	EPA et al. 2002
Exposure Duration	EDw	18.7	yr	EPA et al. 2002
Conversion Factor	CF_3	1.00E-06	kg/mg	1 kg = 1.0E6 mg
Adult Body Weight	BW	70	kg	EPA 1991
Averaging Time-Carcinogenic	ATc_wss	25,550	day	calculated
Averaging Time-Noncarcinogenic	ATnc_wss	6,826	day	calculated
Outdoor Inhalation of Suspended Particulates				
CI = (Cs x IRawss x EFwss x EDw x ETwss x ETFo x MLF) / (BW x [ATc_wss or ATn_wss][b])				
Chemical Intake	CI	chemical-specific	mg/kg-day	calculated
Chemical concentration in soil	Cs	chemical-specific	mg/kg	Tier 1 or 2 EPC
Inhalation Rate	IRawss	1.3	m^3/hr	EPA et al. 2002
Exposure Frequency	EFwss	230	days/year	EPA et al. 2002
Exposure Duration	EDw	18.7	yr	EPA et al. 2002
Exposure Time	ETwss	8	hr/day	EPA et al. 2002
Exposure Time Fraction, outdoor	ETFo	0.5	--	EPA et al. 2002
Mass loading, (PM 10) for inhalation[a]	MLF	6.70E-08	kg/m^3	EPA et al. 2002
Adult Body Weight	BW	70	kg	EPA 1991
Averaging Time-Carcinogenic	ATc_wss	25,550	day	calculated
Averaging Time-Noncarcinogenic	ATnc_wss	6,826	day	calculated
Indoor Inhalation of Suspended Particulates				
CI = (Cs x IRawss x EFwss x EDw x ETwss x ETFi x DFi x MLF) / (BW x [ATc_wss or ATn_wss][b])				
Chemical Intake	CI	chemical-specific	mg/kg-day	calculated
Chemical concentration in soil	Cs	chemical-specific	mg/kg	Tier 1 or 2 EPC
Inhalation Rate	IRawss	1.3	m^3/hr	EPA et al. 2002
Exposure Frequency	EFwss	230	days/year	EPA et al. 2002
Exposure Duration	EDw	18.7	yr	EPA et al. 2002
Exposure Time	ETwss	8	hr/day	EPA et al. 2002
Exposure Time Fraction, indoor	ETFi	0.5	--	EPA et al. 2002
Dilution Factor, indoor inhalation	DFi	0.7	--	EPA et al. 2002
Mass Loading, (PM 10) for inhalation	MLF	6.70E-08	kg/m^3	EPA et al. 2002[a]
Adult Body Weight	BW	70	kg/m3	EPA 1991
Averaging Time-Carcinogenic	ATc_wss	25,550	day	calculated
Averaging Time-Noncarcinogenic	ATnc_wss	6,826	day	calculated

[a] The mass loading value is the 95th percentile of the estimated mass loading distribution estimated in the RSALs Task 3 Report (EPA et al. 2002).

[b] Carcinogenic or noncarcinogenic averaging times (Atc and Atnc, respectively) are used in equations, depending on whether carcinogenic or noncarcinogenic intakes are being calculated.

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Table 3.3

Radionuclide Exposure Factors Used in Surface Soil/Surface Sediment Intake Calculations for the Wildlife Refuge Worker

Exposure Route/Exposure Factor	Abbreviation	Value	Units	Source
Ingestion				
RI = Cs x IRwss x EFwss x EDw x CF_1				
Radionuclide Intake	RI	radionuclide-specific	pCi	calculated
Radionuclide concentration in soil	Cs	radionuclide-specific	pCi/g	Tier 1 or 2 EPC
Ingestion Rate of soil/sediment	IRwss	100	mg/day	EPA et al. 2002
Exposure Frequency	EFwss	230	days/year	EPA et al. 2002
Exposure Duration	EDw	18.7	yr	EPA et al. 2002
Conversion factor	CF_1	0.001	g/mg	1 g = 1000 mg
Outdoor Inhalation of Suspended Particulates				
RI = Cs x IRawss x EFwss x EDw x ETwss x ETFo x MLF x CF_2				
Radionuclide Intake	RI	radionuclide-specific	pCi	calculated
Radionuclide concentration in soil	Cs	radionuclide-specific	pCi/g	Tier 1 or 2 EPC
Inhalation Rate	Irawss	1.3	m^3/hr	EPA et al. 2002
Exposure Frequency	EFwss	230	days/year	EPA et al. 2002
Exposure Duration	EDw	18.7	yr	EPA et al. 2002
Exposure Time	ETwss	8	hr/day	EPA et al. 2002
Exposure Time Fraction, outdoor	ETFo	0.5	--	EPA et al. 2002
Mass loading, (PM 10) for inhalation[a]	MLF	6.70E-08	kg/m^3	EPA et al. 2002
Conversion factor	CF_2	1000	g/kg	1000 g = 1 kg
Indoor Inhalation of Suspended Particulates				
RI = Cs x IRawss x EFwss x EDw x ETwss x ETFi x DFi x MLF x CF_2				
Radionuclide Intake	RI	radionuclide-specific	pCi	calculated
Chemical concentration in soil	Cs	radionuclide-specific	pCi/g	Tier 1 or 2 EPC
Inhalation Rate	Irawss	1.3	m^3/hr	EPA et al. 2002
Exposure Frequency	EFwss	230	days/year	EPA et al. 2002
Exposure Duration	EDw	18.7	yr	EPA et al. 2002
Exposure Time	ETwss	8	hr/day	EPA et al. 2002
Exposure Time Fraction, indoor	ETFi	0.5	--	EPA et al. 2002
Dilution Factor, indoor inhalation	DFi	0.7	--	EPA et al. 2002
Mass Loading, (PM 10) for inhalation	MLF	6.70E-08	kg/m^3	EPA et al. 2002[a]
Conversion factor	CF_2	1000	g/kg	1000 g = 1 kg
Outdoor External Radiation Exposure				
RE = Cs x Te_A x Te_Do x EDw x ACF x GSFo				
Radionuclide Exposure	RE	radionuclide-specific	(pCi-yr)/g	calculated
Radionuclide concentration in soil	Cs	radionuclide-specific	pCi/g	Tier 1 or 2 EPC
Gamma exposure factor (annual) surface soil	Te_A	0.630	--	EFwss / 365 day/yr
Gamma exposure factor (daily) outdoor	Te_Do	0.167	--	ETwss x ETFo / 24 hr/day
Exposure Duration	EDw	18.7	yr	EPA et al. 2002
Area Correction Factor	ACF	0.9	--	EPA et al. 2002
Gamma Shielding Factor (1-SE) outdoor	GSFo	1	--	EPA et al. 2002
Indoor External Radiation Exposure				
RE = Cs x Te_A x Te_Di x EDw x ACF x GSFi				
Radionuclide Exposure	RE	radionuclide-specific	(pCi-yr)/g	calculated
Radionuclide concentration in soil	Cs	radionuclide-specific	pCi/g	EPC
Gamma exposure factor (annual) surface soil	Te_A	0.630	--	EFwss / 365 day/yr
Gamma exposure factor (daily) outdoor	Te_Di	0.167	--	ETwss x ETFi / 24 hr/day
Exposure Duration	EDw	18.7	yr	EPA et al. 2002
Area Correction Factor	ACF	0.9	--	EPA et al. 2002
Gamma Shielding Factor (1-SE) outdoor	GSFi	0.4	--	EPA et al. 2002

Table 3.3

Radionuclide Exposure Factors Used in Surface Soil/Surface Sediment Intake Calculations for the Wildlife Refuge Worker

Exposure Route/Exposure Factor	Abbreviation	Value	Units	Source

[a] The mass loading value is the 95th percentile of the estimated mass loading distribution estimated in the RSALs Task 3 Report (EPA et al. 2002).

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Table 3.4

Chemical Exposure Factors Used in Surface Soil/Surface Sediment Intake Calculations for the Wildlife Refuge Visitor

Exposure Route/Exposure Factor	Abbreviation	Value	Units	Source
Ingestion				
CI = (Cs x IRagevss x EFvss x CF_3) / [Atc_vss or Atnc][a] **where, IRageav = ((IRvss x EDav) / BW) + ((IRcvss x EDcv) / BWc)**				
Chemical Intake	CI	chemical-specific	mg/kg-day	calculated
Chemical concentration in soil	Cs	chemical-specific	mg/kg	Tier 1 or 2 EPC
Age-adjusted Soil Ingestion Rate for chemicals	IRagevss	57	mg-yr/kg-day	calculated
Exposure Frequency	EFvss	100	days/year	EPA et al. 2002[b]
Exposure Duration - adult	EDav	24	yr	EPA et al. 2002
Exposure Duration - child	EDcv	6	yr	EPA et al. 2002
Conversion Factor	CF_3	1.00E-06	kg/mg	1 kg = 1.0E6 mg
Soil Ingestion Rate - adult	IRvss	50	mg/day	EPA et al. 2002
Soil Ingestion Rate - child	IRcvss	100	mg/day	EPA et al. 2002
Adult Body Weight	BW	70	kg	EPA 1991
Child Body Weight	BWc	15	kg	EPA 1991
Averaging Time-Carcinogenic	ATc_vss	25,550	day	calculated
Averaging Time-Noncarcinogenic	ATn_vss	8,760	day	calculated
Averaging Time-Noncarcinogenic (child)	ATn_c_vss	2,190	day	calculated
Averaging Time-Noncarcinogenic (child+adult)	ATnc	10,950	day	calculated
Outdoor Inhalation of Suspended Particulates				
CI = (Cs x IRa_agevss x EFvss x MLF) / [Atc_vss or Atnc][a] **where, IRa_agevss = (((Ira_vss x EDav) / BW) + ((IRa_cvss x EDcv) / BWc)) x ET**				
Chemical Intake	NRI	chemical-specific	mg/kg-day	calculated
Chemical concentration in soil	Cs	chemical-specific	mg/kg	EPC
Age-averaged Inhalation Rate for chemicals	IRa_agevss	3.7	m^3-yr/kg-day	EPA et al. 2002[b]
Exposure Frequency	EFvss	100	days/year	EPA et al. 2002[b]
Mass loading, (PM 10) for inhalation	MLF	6.70E-08	kg/m^3	EPA et al. 2002[c]
Exposure Duration - adult	EDav	24	yr	EPA et al. 2002
Exposure Duration - child	EDcv	6	yr	EPA et al. 2002
Adult Body Weight	BW	70	kg	EPA 1991
Child Body Weight	BWc	15	kg	EPA 1991
Air Inhalation Rate - adult	IRavss	2.4	m^3/hr	EPA et al. 2002
Air Inhalation Rate - child	IRa_cvss	1.6	m^3/hr	EPA et al. 2002
Exposure Time	ET	2.5	hr/day	EPA et al. 2002[b]
Averaging Time-Carcinogenic	ATc_vss	25,550	day	calculated
Averaging Time-Noncarcinogenic	ATn_vss	8,760	day	calculated
Averaging Time-Noncarcinogenic (child)	ATn_c_vss	2,190	day	calculated
Averaging Time-Noncarcinogenic (child+adult)	ATnc	10,950	day	calculated

[a] Carcinogenic or noncarcinogenic averaging times (Atc and Atnc, respectively) are used in equations, depending on whether carcinogenic or

[b] Value is 95th percentile of visitation frequency for open space users (Jefferson County 1996).

[c] The mass loading value is the 95th percentile of the estimated mass loadding distribution estimated in the RSALs Task 3 Report (EPA et al. 2002).

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Table 3.5

Radionuclide Exposure Factors Used in Surface Soil/Surface Sediment Intake Calculations for the Wildlife Refuge Visitor

Exposure Route/Exposure Factor	Abbreviation	Value	Units	Source
Ingestion				
RI = Cs x IRagevss_r x EFvss x (EDav + EDcv) x CF_1				
Radionuclide Intake	RI	chemical-specific	pCi	calculated
Radionuclide concentration in soil	Cs	chemical-specific	pCi/g	Tier 1 or 2 EPC
Age-adjusted Soil Ingestion Rate for radionuclides	IRagevss_r	60	mg/day	EPA et al. 2002
Exposure Frequency	EFvss	100	days/year	EPA et al. 2002[a]
Exposure Duration - adult	EDav	24	yr	EPA et al. 2002
Exposure Duration - child	EDcv	6	yr	EPA et al. 2002
Conversion factor	CF_1	0.001	g/mg	1 g = 1000 mg
Outdoor Inhalation of Suspended Particulates				
RI = Cs x IRa_agevss_r x EFvss x (EDav + EDcv) x ETvss x MLF x CF_2				
Radionuclide Intake	RI	chemical-specific	pCi	calculated
Radionuclide concentration in soil	Cs	chemical-specific	pCi/g	EPC
Age-averaged Inhalation Rate for radionuclides	IRa_agevss_r	2.2	m^3/hr	Tier 1 or 2 EPC
Exposure Frequency	EFvss	100	days/year	EPA et al. 2002[a]
Exposure Duration - adult	EDav	24	yr	EPA et al. 2002
Exposure Duration - child	EDcv	6	yr	EPA et al. 2002
Exposure Time	ETvss	2.5	hr/day	EPA et al. 2002[b]
Mass loading, (PM 10) for inhalation	MLF	6.70E-08	kg/m^3	EPA et al. 2002[c]
Conversion factor	CF_2	1000	g/kg	1000 g = 1 kg
Outdoor External Radiation Exposure				
RE = Cs x Te_Av x Te_Dv x (EDav + EDcv) x ACF x GSFo				
Radionuclide Exposure	RE	chemical-specific	(pCi-yr)/g	calculated
Radionuclide concentration in soil	Cs	chemical-specific	pCi/g	EPC
Gamma exposure factor (annual) surface soil	Te_Av	0.274	--	EFv / 365 day/yr
Gamma exposure factor (daily) outdoor	Te_Dv	0.104	--	ETv / 24 hr/day
Exposure Duration - adult	EDav	24	yr	EPA et al. 2002
Exposure Duration - child	EDcv	6	yr	EPA et al. 2002
Area Correction Factor	ACF	0.9	--	EPA et al. 2002
Gamma Shielding Factor (1-SE) outdoor	GSFo	1	--	EPA et al. 2002

[a] Value is 95th percentile of visitation frequency for open space users (Jefferson County 1996).

[b] Value is 50th percentile of time spent for open space users (Jefferson County 1996).

[c] The mass loading value is the 95th percentile of the estimated mass loadding distribution estimated in the RSALs Task 3 Report (EPA et al. 2002).

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Table 4.1
Chemical Cancer Slope Factors, Weight of Evidence, and Target Organs for COCs

Contaminant of Concern	CAS Number	Oral Slope Factor (mg/kg-day)$^{-1}$	Source	Dermal Slope Factor (mg/kg-day)$^{-1}$	Source	Inhalation Slope Factor (mg/kg-day)$^{-1}$	Source	Weight of Evidence[a]	Dermal Absorption Fraction[b]	Target Organ/Cancer	Source
Arsenic	7440-38-2	1.50E+00	I	N/A	N/A	1.51E+01	I	A	3.00E-02	Skin, lungs	I

[a] See Table 5.1 in the CRA Methodology (DOE 2005) for definitions of Weight of Evidence classifications.

[b] Dermal ABS from EPA 2001.

I - IRIS (EPA 2004a).

N/A - Not available or not applicable.

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Table 4.2
Chemical Non-Cancer Reference Doses, Target Organs, and Effects for COCs

Contaminant of Concern	CAS Number	Oral RfD (mg/kg-day)	Source	Dermal RfD (mg/kg-day)	Source	Inhalation RfD (mg/kg-day)	Source	Dermal Absorption Fraction[a]	Target Organ/Effect	Source
Arsenic	7440-38-2	3.00E-04	I	N/A	N/A	N/A	N/A	3.00E-02	Hyperpigmentation, keratosis and vascular complications	I

[a] Dermal ABS from EPA 2001.
A = Heast Alternate.
I = IRIS (EPA 2004).
N/A - Not available or not applicable.

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Table 4.3
Radionuclide Cancer Slope Factors for COCs

Contaminant of Concern	CAS Number	Adult (age 18-65) Soil Oral Slope Factor[a] (risk/pCi)	Source	Age-Adjusted Soil Oral Slope Factor[b] (risk/pCi)	Source	Inhalation Slope Factor (risk/pCi)	Source	External Slope Factor (risk/yr)/(pCi/g)	Source
Plutonium-239[c]	15117-48-3	1.21E-10	R	2.76E-10	H	3.33E-08	H	2.00E-10	H

[a] Used for the WRW receptor.

[b] Used for the WRV receptor.

[c] Pu-239 is used for Pu-239/240.

H = Values from HEAST for Radionuclides (EPA 2001a).
R = Values Derived for RSALS (EPA et al. 2002).

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Table 4.4
Radionuclide Dose Conversion Factors for COCs

Contaminant of Concern	Oral Dose Conversion Factor[a] (mrem/pCi)	Inhalation Dose Conversion Factor[a] (mrem/pCi)	External Dose Conversion Factor[b] (mrem/yr)/(pCi/g)
Plutonium-239 (Adult)[c]	9.30E-04	0.190	2.95E-04
Plutonium-239 (Child)[c]	0.00160	0.290	2.95E-04

[a] ICRP Publication 72, 1996.

[b] Federal Guidance Report 12, EPA 402-R-93-081, September 1993.

[c] Pu-239 is used for Pu-239/240.

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Table 5.1
Summary of Chemical Cancer Risks and Non-Cancer Hazards for the Wildlife Refuge Worker

EPC/Medium/ Contaminant of Concern	Chemical Cancer Risk					Non-Cancer Hazard Quotient				
	Ingestion	Inhalation	Dermal	Exposure Routes Total	Percent Contribution to Risk	Ingestion	Inhalation	Dermal	Exposure Routes Total	Percent Contribution to Hazard Index
Tier 1										
Surface Soil/Surface Sediment										
Arsenic	1.98E-06	1.18E-07	--	2.10E-06	100%	0.016	NC	NC	0.0165	100%
Surface Soil/Surface Sediment Total:				**2.10E-06**	**100%**				**0.0165**	**100%**
Tier 1 WRW Total:				**2.E-06**					**0.02**	
Tier 2										
Surface Soil/Surface Sediment										
Arsenic	1.52E-06	9.08E-08	--	1.61E-06	100%	0.013	NC	NC	0.0127	100%
Surface Soil/Surface Sediment Total:				**1.61E-06**	**100%**				**0.0127**	**100%**
Tier 2 WRW Total:				**2.E-06**					**0.01**	

-- = Exposure route is not complete because no COCs identified or exposure route was identified as insignificant in the CRA Methodology.
NC = Not calculated, noncancer toxicity criteria were not available.

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Table 5.2
Summary of Radionuclide Cancer Risks and Doses for the Wildlife Refuge Worker

EPC/Medium/ Contaminant of Concern	Radiation Cancer Risk			Exposure Routes Total	Percent Contribution to Risk	Radiation Dose			Exposure Routes Total	Percent Contribution to Dose
	Ingestion	Inhalation	External			Ingestion	Inhalation	External		
Tier 1										
Surface Soil/Surface Sediment										
Plutonium-239/240	6.31E-07	1.03E-06	6.00E-09	1.67E-06	100%	0.281	0.058	5.55E-04	0.339	100%
			Surface Soil/Surface Sediment Total:	**1.67E-06**	**100%**				**0.339**	**100%**
			Tier 1 WRW Total:	**2.E-06**					**3.4E-01**	
Tier 2										
Surface Soil/Surface Sediment										
Plutonium-239/240	3.03E-07	4.94E-07	2.88E-09	8.00E-07	100%	0.135	0.028	2.67E-04	0.163	100%
			Surface Soil/Surface Sediment Total:	**8.00E-07**	**100%**				**0.163**	**100%**
			Tier 2 WRW Total:	**8.E-07**					**1.6E-01**	

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Table 5.3
Summary of Chemical Cancer Risks and Non-Cancer Hazards for the Wildlife Refuge Visitor

EPC/Medium/ Contaminant of Concern	Chemical Cancer Risk					Non-Cancer Hazard Quotient				
	Ingestion	Inhalation	Dermal	Exposure Routes Total	Percent Contribution to Risk	Ingestion	Inhalation	Dermal	Exposure Routes Total	Percent Contribution to Hazard Index
Tier 1										
Surface Soil/Surface Sediment										
Arsenic	1.84E-06	7.96E-08	--	1.92E-06	100%	0.010	NC	NC	0.010	100%
Surface Soil/Surface Sediment Total:				**1.92E-06**	**100%**				**0.010**	**100%**
Tier 1 WRV Total:				**2.E-06**					**0.01**	
Tier 2										
Surface Soil/Surface Sediment										
Arsenic	1.42E-06	6.11E-08	--	1.48E-06	100%	0.007	NC	NC	0.0073	100%
Surface Soil/Surface Sediment Total:				**1.48E-06**	**100%**				**0.0073**	**100%**
Tier 2 WRV Total:				**1.E-06**					**0.01**	

-- = Exposure route is not complete because no COCs identified or exposure route was identified as insignificant in the CRA Methodology.
NC = Not calculated, noncancer toxicity criteria were not available.

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Table 5.4

Summary of Radionuclide Cancer Risks and Doses for the Wildlife Refuge Visitor

EPC/Medium/ Contaminant of Concern	Radiation Cancer Risk					Adult Radiation Dose (mrem)					Child Radiation Dose (mrem)				
	Ingestion	Inhalation	External	Exposure Routes Total	Percent Contribution to Risk	Ingestion	Inhalation	External	Exposure Routes Total	Percent Contribution to Dose	Ingestion	Inhalation	External	Exposure Routes Total	Percent Contribution to Dose
Tier 1															
Surface Soil/Surface Sediment															
Plutonium-239/240	6.02E-07	4.46E-07	1.87E-09	1.05E-06	100%	0.059	0.013	1.04E-04	0.072	100%	0.203	0.014	1.04E-04	0.217	100%
Surface Soil/Surface Sediment Total:				1.05E-06	100%				0.072	100%				0.217	100%
Tier 1 WRV Total:				1E-06					7.2E-02					2.2E-01	
Tier 2															
Surface Soil/Surface Sediment															
Plutonium-239/240	2.89E-07	2.14E-07	8.97E-10	5.04E-07	100%	0.028	0.006	5.02E-05	0.03	100%	0.098	0.007	5.02E-05	0.104	100%
Surface Soil/Surface Sediment Total:				5.04E-07	100%				0.03	100%				0.104	100%
Tier 2 WRV Total:				5E-07					3.5E-02					1.0E-01	

Table 5.5

Summary of Chemical Risk Characterization Results

Exposure Scenario/EPC/Medium	Estimated Excess Lifetime Cancer Risk	Major Contributors to Chemical Cancer Risk	Estimated Non-Cancer Hazard Index	Major Contributors to Hazard Index
Wildlife Refuge Worker (WRW)				
Tier 1 EPC				
Surface Soil/Surface Sediment	2E-06	Arsenic (100%)	0.02	Arsenic (100%)
Tier 2 EPC				
Surface Soil/Surface Sediment	2E-06	Arsenic (100%)	0.01	Arsenic (100%)
Wildlife Refuge Visitor (WRV)				
Tier 1 EPC				
Surface Soil/Surface Sediment	2E-06	Arsenic (100%)	0.01	Arsenic (100%)
Tier 2 EPC				
Surface Soil/Surface Sediment	1E-06	Arsenic (100%)	0.01	Arsenic (100%)

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Table 5.6
Summary of Radionuclide Risk Characterization Results

Exposure Scenario/EPC/Medium	Estimated Excess Lifetime Cancer Risk	Major Contributors to Radiation Cancer Risk
Wildlife Refuge Worker		
Tier 1 EPC		
Surface Soil/Surface Sediment	2E-06	Plutonium-239/240 (100%)
Tier 2 EPC		
Surface Soil/Surface Sediment	8E-07	Plutonium-239/240 (100%)
Wildlife Refuge Visitor		
Tier 1 EPC		
Surface Soil/Surface Sediment	1E-06	Plutonium-239/240 (100%)
Tier 2 EPC		
Surface Soil/Surface Sediment	5E-07	Plutonium-239/240 (100%)

Table 6.1
Detected PCOCs without PRGs in Each Medium by Analyte Suite[a]

PCOC	Surface Soil/Surface Sediment	Subsurface Soil/Subsurface Sediment
Cations/Anions		
Sulfide	N/A	X
Inorganics		
Cesium	X	X
Phosphorus	N/A	X
Silica	X	X
Silicon	X[b]	X
Total Petroleum Hydrocarbons	N/A	X
Organics		
1,2,3-Trichlorobenzene	N/A	X
2-Hexanone	N/A	X[b]
4-Chloro-3-methylphenol	N/A	X
4-Isopropyltoluene	N/A	X[b]
Acenaphthylene	N/A	X[b]
Benzo(g,h,i)perylene	X	X
Fluoroacetamide	N/A	X
n-Butylbenzene	N/A	X
Phenanthrene	X	X
Propylcyclopentane	N/A	X
Radionuclides		
Gross alpha	X	X
Gross beta	X	X

[a] Does not include essential nutrients. Essential nutrients without PRGs were evaluated by comparing estimated intakes to recommended intakes.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

N/A = Not Applicable. Analyte not detected or not analyzed.

X = indicates PRG is unavailable.

Table 7.1

Comparison of MDCs in Surface Soil to NOAEL ESLs for Terrestrial Plants, Invertebrates and Vertebrates (Non-PMJM)

ECOI	MDC	Terrestrial Plants		Terrestrial Invertebrates		Mourning Dove Herbivore		Mourning Dove Insectivore		American Kestrel		Deer Mouse Herbivore		Deer Mouse Insectivore		Mule Deer		Prairie Dog		Coyote Carnivore		Coyote Generalist		Coyote Insectivore		Terrestrial Receptor[a]		Most Sensitive Receptor	Retain for Further Analysis?
		NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	Results	
Inorganics (mg/kg)																													
Aluminum	33,000	50	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Terrestrial Plants	Yes
Ammonia	3.33	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7,316	No	586	No	37,008	No	26,723	No	2,247	No	2,311	No	2,539	No	N/A	N/A	Deer Mouse Insectivore	No
Antimony	0.880	5	No	78	No	N/A	N/A	N/A	N/A	N/A	N/A	10	No	0.90	No	58	No	19	No	138	No	13	No	3.85	No	N/A	N/A	Deer Mouse Insectivore	No
Arsenic	11	10	Yes	60	No	20	No	164	No	1,028	No	2.57	Yes	51	No	13	No	9.35	Yes	709	No	341	No	293	No	N/A	N/A	Deer Mouse Herbivore	Yes
Barium	280	500	No	330	No	159	Yes	357	No	1,317	No	930	No	4,427	No	4,766	No	3,224	No	24,896	No	19,838	No	18,369	No	N/A	N/A	Morning Dove Herbivore	Yes
Beryllium	1.40	10	No	40	No	N/A	N/A	N/A	N/A	N/A	N/A	160	No	6.82	No	896	No	211	No	1,072	No	103	No	29	No	N/A	N/A	Deer Mouse Insectivore	No
Boron	15	0.5	Yes	N/A	N/A	30	No	115	No	167	No	62	No	422	No	314	No	237	No	929	No	6,070	No	1,816	No	N/A	N/A	Terrestrial Plants	Yes
Cadmium	2.60	32	No	140	No	28	No	0.71	Yes	15	No	60	No	1.56	Yes	723	No	198	No	1,360	No	51	No	10	No	N/A	N/A	Morning Dove Insectivore	Yes
Calcium	185,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Cesium	7.40	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Chromium[b]	80.5	1	Yes	0.4	Yes	25	Yes	1.34	Yes	14	Yes	281	No	16	Yes	1,461	No	703	No	4,173	No	250	No	69	Yes	N/A	N/A	Terrestrial Invertebrates	Yes
Cobalt	21.6	13	Yes	N/A	N/A	278	No	87	No	440	No	1,476	No	363	No	7,902	No	2,461	No	3,785	No	2,492	No	1,519	No	N/A	N/A	Terrestrial Plants	Yes
Copper	49.8	100	No	50	No	29	Yes	8.25	Yes	164	No	295	No	605	No	4,119	No	838	No	5,459	No	3,000	No	4,641	No	N/A	N/A	Morning Dove Insectivore	Yes
Iron	27,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Lead	120	110	Yes	1,700	No	50	Yes	12	Yes	96	Yes	1,344	No	242	No	9,798	No	1,850	No	8,927	No	3,066	No	1,393	No	N/A	N/A	Morning Dove Insectivore	Yes
Lithium	33	2	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,882	No	610	No	10,173	No	3,178	No	18,431	No	5,608	No	2,560	No	N/A	N/A	Terrestrial Plants	Yes
Magnesium	8,270	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Manganese	1,200	500	Yes	N/A	N/A	1,032	Yes	2,631	No	9,917	No	486	Yes	4,080	No	2,506	No	1,519	No	14,051	No	10,939	No	19,115	No	N/A	N/A	Deer Mouse Hervibore	Yes
Mercury	0.250	0.3	No	0.1	Yes	0.20	Yes	1.00E-04	Yes	1.57	No	0.44	No	0.18	Yes	7.56	No	3.15	No	8.18	No	8.49	No	37	No	N/A	N/A	Morning Dove Insectivore	Yes
Molybdenum	3	2	Yes	N/A	N/A	44	No	7.0	No	77	No	8.68	No	1.90	Yes	44	No	27	No	275	No	29	No	8.18	No	N/A	N/A	Deer Mouse Insectivore	Yes
Nickel	101	30	Yes	200	No	44	Yes	1.2	Yes	13	Yes	16	Yes	0.43	Yes	124	No	38	Yes	91	Yes	6.02	Yes	1.86	Yes	N/A	N/A	Deer Mouse Insectivore	Yes
Nitrate / Nitrite[c]	3.83	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4,478	No	7,647	No	22,660	No	16,233	No	32,879	No	32,190	No	32,879	No	N/A	N/A	Deer Mouse Herbivore	No
Potassium	6,200	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Selenium	0.730	1	No	70	No	1.61	No	1.0	No	8.48	No	0.87	No	0.75	No	3.82	No	2.80	No	32	No	12	No	5.39	No	N/A	N/A	Deer Mouse Insectivore	No
Silica	1,100	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Silicon	2,160	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Silver	42.8	2	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Terrestrial Plants	Yes
Sodium	492	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Strontium	362	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	940	No	13,578	No	4,702	No	3,519	No	584,444	No	144,904	No	57,298	No	N/A	N/A	Deer Mouse Herbivore	No
Thallium	3.30	1	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	180	No	7.24	No	1,039	No	204	No	212	No	82	No	31	No	N/A	N/A	Terrestrial Plants	Yes
Tin	75.8	50	Yes	N/A	N/A	26	Yes	2.9	Yes	19	Yes	45	Yes	3.77	Yes	242	No	81	No	70	Yes	36	Yes	16	Yes	N/A	N/A	Morning Dove Insectivore	Yes
Titanium	603	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Uranium	8	5	Yes	N/A	N/A	685	No	446	No	2,792	No	970	No	569	No	5,472	No	1,226	No	7,299	No	3,106	No	2,272	No	N/A	N/A	Terrestrial Plants	Yes
Vanadium	72	2	Yes	N/A	N/A	503	No	274	No	1,514	No	64	Yes	30	Yes	358	No	84	No	341	No	164	No	121	No	N/A	N/A	Terrestrial Plants	Yes
Zinc	165	50	Yes	200	No	109	Yes	0.6	Yes	113	Yes	171	No	5.29	Yes	2,772	No	1,174	No	16,489	No	3,887	No	431	No	N/A	N/A	Morning Dove Insectivore	Yes
Organics (µg/kg)																													
1,1,2,2-Tetrachloroethane	1.39	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.32E+06	No	60,701	No	6.70E+06	No	4.70E+06	No	253,233	No	255,398	No	262,963	No	N/A	N/A	Deer Mouse Insectivore	No
1,2,3-Trichloropropane	1.47	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	330,027	No	13,883	No	1.67E+06	No	1.17E+06	No	58,642	No	58,965	No	60,144	No	N/A	N/A	Deer Mouse Insectivore	No
1,2,4-Trimethylbenzene	1.44	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
4,4'-DDE	5.80	N/A	N/A	N/A	N/A	366	No	8.0	No	22	No	15,484	No	517	No	78,493	No	54,420	No	2,530	No	2,449	No	2,240	No	N/A	N/A	Morning Dove Insectivore	No
4,6-Dinitro-2-methylphenol	390	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	12,483	No	560	No	63,246	No	44,283	No	2,345	No	2,363	No	2,427	No	N/A	N/A	Deer Mouse Insectivore	No
Acenaphthene	240	20,000	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Terrestrial Plants	No
Anthracene	330	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Benzene	1.44	500	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	307,359	No	14,934	No	1.56E+06	No	1.10E+06	No	61,785	No	62,438	No	64,693	No	N/A	N/A	Terrestrial Plants	No
Benzo(a)anthracene	830	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Benzo(a)pyrene	750	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	336,625	No	631	Yes	2.41E+06	No	502,521	No	3,062	No	2,971	No	2,756	No	N/A	N/A	Deer Mouse Insectivore	Yes
Benzo(b)fluoranthene	810	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Benzo(g,h,i)perylene	240	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Benzo(k)fluoranthene	740	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Benzoic Acid	1,100	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
bis(2-ethylhexyl)phthalate	510	N/A	N/A	N/A	N/A	19,547	No	137	Yes	398	Yes	960,345	No	8,071	No	4.93E+06	No	2.76E+06	No	42,305	No	40,167	No	34,967	No	N/A	N/A	Morning Dove Insectivore	Yes
Chlorobenzene	2.03	N/A	N/A	40,000	No	N/A	N/A	N/A	N/A	N/A	N/A	117,455	No	4,750	No	595,322	No	413,812	No	20,175	No	20,258	No	20,576	No	N/A	N/A	Deer Mouse Insectivore	No
Chrysene	790	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Dibenz(a,h)anthracene	92	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Dibenzofuran	86	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	707,000	No	21,200	No	3.59E+06	No	2.44E+06	No	93,800	No	93,200	No	91,800	No	N/A	N/A	Deer Mouse Insectivore	No
Dieldrin	5.80	N/A	N/A	N/A	N/A	178	No	10	No	26	No	81	No	7.40	No	411	No	301	No	34	No	33	No	32	No	N/A	N/A	Deer Mouse Insectivore	No
Di-n-butylphthalate	1,000	200,000	No	N/A	N/A	989	Yes	16	Yes	42	Yes	1.21E+07	No	281,236	No	6.13E+07	No	4.06E+07	No	1.29E+06	No	1.27E+06	No	1.22E+06	No	N/A	N/A	Morning Dove Insectivore	Yes
Endrin	5.10	N/A	N/A	N/A	N/A	106	No	1.4	Yes	3.74	Yes	2,462	No	46	No	12,536	No	8,060	No	215	No	210	No	197	No	N/A	N/A	Morning Dove Insectivore	Yes
Ethylbenzene	1.29	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Fluoranthene	1,900	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Fluorene	230	200,000	No	30,000	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Terrestrial Invertebrates	No
Indeno(1,2,3-cd)pyrene	220	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Methoxychlor	9.40	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	70,467	No	1,226	No	358,904	No	228,896	No	5,840	No	5,695	No	5,313	No	N/A	N/A	Deer Mouse Insectivore	No
Naphthalene	0.890	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8.08E+06	No	27,048	No	5.57E+07	No	1.60E+07	No	104,269	No	107,146	No	117,177	No	N/A	N/A	Deer Mouse Insectivore	No
N-Nitroso-di-n-propylamine	400	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Phenanthrene	1,600	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Pyrene	1,800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Tetrachloroethene	1.73	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20,713	No	763	No	105,023	No	72,494	No	3,285	No	3,288	No	3,307	No	N/A	N/A	Deer Mouse Insectivore	No
Toluene	2.26	200,000	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	346,579	No	14,416	No	1.76E+06	No	1.22E+06	No	60,990	No	61,301	No	62,452	No	N/A	N/A	Deer Mouse Insectivore	No
Total PCB	3,365	40,000	No	N/A	N/A	1,141	Yes	172	Yes	882	Yes	11,892	No	1,244	Yes	61,287	No	37,963	No	3,320	Yes	5,190	No	3,681	No	N/A	N/A	Mourning Dove Insectivore	Yes
Radionuclides (pCi/g)																													
Americium-241	15.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,890	No	Terrestrial Receptor	No
Cesium-134	0.100	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Cesium-137	2.01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	21	No	Terrestrial Receptor	No
Gross Alpha	320	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Gross Beta	51.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Plutonium-238	1.53	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Plutonium-239/240	49	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6,110	No	Terrestrial Receptor	No
Radium-226	1.46	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	50.6	No	Terrestrial Receptor	No
Radium-228	3.50	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	43.9	No	Terrestrial Receptor	No
Strontium-89/90	1.24	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22.5	No	Terrestrial Receptor	No
Uranium-233/234	7.96	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4,980	No	Terrestrial Receptor	No
Uranium-235	0.680	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,770	No	Terrestrial Receptor	No
Uranium-238	3.78	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,580	No	Terrestrial Receptor	No

[a] Radionuclide ESLs are not receptor-specific. They are considered protective of all terrestrial ecological species.

[b] The ESLs for chromium were developed using available toxicity data based on chromium (III) (birds) and chromium (VI) (plants, invertebrates, and mammals).

[c] The ESL for nitrate is used

N/A = Indicates no ESL was available for that ECOI/receptor pair.

UT = Uncertain toxicity; no ESL available (assessed in Section 10.0).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

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Table 7.2
Summary of Non-PMJM NOAEL ESL Screening Results for Surface Soil in the WBEU

Analyte	Terrestrial Vertebrate Exceedance?	Terrestrial Invertebrate Exceedance?	Terrestrial Plant Exceedance?
Inorganics			
Aluminum	UT	UT	**Yes**
Ammonia	No	UT	UT
Antimony	No	No	No
Arsenic	**Yes**	No	**Yes**
Barium	**Yes**	No	No
Beryllium	No	No	No
Boron	No	UT	**Yes**
Cadmium	**Yes**	No	No
Calcium	UT	UT	UT
Cesium	UT	UT	UT
Chromium	**Yes**	**Yes**	**Yes**
Cobalt	No	UT	**Yes**
Copper	**Yes**	No	No
Iron	UT	UT	UT
Lead	**Yes**	No	**Yes**
Lithium	No	UT	**Yes**
Magnesium	UT	UT	UT
Manganese	**Yes**	UT	**Yes**
Mercury	**Yes**	**Yes**	No
Molybdenum	**Yes**	UT	**Yes**
Nickel	**Yes**	No	**Yes**
Nitrate / Nitrite	No	UT	UT
Potassium	UT	UT	UT
Selenium	No	No	No
Silica	UT	UT	UT
Silicon	UT	UT	UT
Silver	UT	UT	**Yes**
Sodium	UT	UT	UT
Strontium	No	UT	UT
Thallium	No	UT	**Yes**
Tin	**Yes**	UT	**Yes**
Titanium	UT	UT	UT
Uranium	No	UT	**Yes**
Vanadium	**Yes**	UT	**Yes**
Zinc	**Yes**	No	**Yes**
Organics			
1,1,2,2-Tetrachloroethane	No	UT	UT
1,2,3-Trichloropropane	No	UT	UT
1,2,4-Trimethylbenzene	UT	UT	UT
4,4'-DDE	No	UT	UT
4,6-Dinitro-2-methylphenol	No	UT	UT
Acenaphthene	UT	UT	No
Anthracene	UT	UT	UT
Benzene	No	UT	No
Benzo(a)anthracene	UT	UT	UT
Benzo(a)pyrene	**Yes**	UT	UT

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Table 7.2
Summary of Non-PMJM NOAEL ESL Screening Results for Surface Soil in the WBEU

Analyte	Terrestrial Vertebrate Exceedance?	Terrestrial Invertebrate Exceedance?	Terrestrial Plant Exceedance?
Benzo(b)fluoranthene	UT	UT	UT
Benzo(g,h,i)perylene	UT	UT	UT
Benzo(k)fluoranthene	UT	UT	UT
Benzoic Acid	UT	UT	UT
bis(2-ethylhexyl)phthalate	**Yes**	UT	UT
Chlorobenzene	No	No	UT
Chrysene	UT	UT	UT
Di-n-butylphthalate	**Yes**	UT	No
Dibenz(a,h)anthracene	UT	UT	UT
Dibenzofuran	No	UT	UT
Dieldrin	No	UT	UT
Endrin	**Yes**	UT	UT
Ethylbenzene	UT	UT	UT
Fluoranthene	UT	UT	UT
Fluorene	UT	No	No
Indeno(1,2,3-cd)pyrene	UT	UT	UT
Methoxychlor	No	UT	UT
N-Nitroso-di-n-propylamine	UT	UT	UT
Naphthalene	No	UT	UT
Phenanthrene	UT	UT	UT
Pyrene	UT	UT	UT
Tetrachloroethene	No	UT	UT
Toluene	No	UT	No
Total PCB	**Yes**	UT	No

UT = Uncertain toxicity; no ESL available (assessed in Section 10).
Bold = Analyte retained for further consideration in the next ECOPC selection step.

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Table 7.3

Statistical Distributions and Comparison to Background for WBEU Surface Soil (Non-PMJM)

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			WBEU Data Set (excluding background samples)					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Retain as ECOI?
Aluminum	**20**	**NORMAL**	**100**	**151**	**GAMMA**	**100**	**WRS**	**0.003**	**Yes**
Arsenic	20	NORMAL	100	151	GAMMA	100	WRS	0.961	No
Barium	**20**	**NORMAL**	**100**	**151**	**NON-PARAMETRIC**	**100**	**WRS**	**5.22E-05**	**Yes**
Boron	**N/A**	**N/A**	**N/A**	**76**	**NON-PARAMETRIC**	**93**	**N/A**	**N/A**	**Yes[a]**
Cadmium	20	NON-PARAMETRIC	65	150	NON-PARAMETRIC	45	WRS	0.991	No
Chromium	**20**	**NORMAL**	**100**	**151**	**NON-PARAMETRIC**	**100**	**WRS**	**0.001**	**Yes**
Cobalt	20	NORMAL	100	151	NORMAL	100	t-Test_N	0.879	No
Copper	20	NON-PARAMETRIC	100	150	NON-PARAMETRIC	100	WRS	0.159	No
Lead	20	NORMAL	100	151	NON-PARAMETRIC	100	WRS	0.610	No
Lithium	**20**	**NORMAL**	**100**	**131**	**GAMMA**	**92**	**WRS**	**1.55E-04**	**Yes**
Manganese	**20**	**NORMAL**	**100**	**151**	**NON-PARAMETRIC**	**100**	**WRS**	**0.091**	**Yes**
Mercury	20	NON-PARAMETRIC	40	132	NON-PARAMETRIC	52	WRS	1.000	No
Molybdenum	**20**	**NORMAL**	**0**	**137**	**NON-PARAMETRIC**	**28**	**N/A**	**N/A**	**Yes[a]**
Nickel	**20**	**NORMAL**	**100**	**151**	**LOGNORMAL**	**97**	**WRS**	**1.31E-04**	**Yes**
Silver	**20**	**NORMAL**	**0**	**142**	**NON-PARAMETRIC**	**25**	**N/A**	**N/A**	**Yes[a]**
Thallium	**14**	**NORMAL**	**0**	**151**	**NON-PARAMETRIC**	**21**	**N/A**	**N/A**	**Yes[a]**
Tin	**20**	**NORMAL**	**0**	**137**	**NON-PARAMETRIC**	**15**	**N/A**	**N/A**	**Yes[a]**
Uranium	**N/A**	**N/A**	**N/A**	**76**	**NON-PARAMETRIC**	**5**	**N/A**	**N/A**	**Yes[a]**
Vanadium	20	NORMAL	100	151	LOGNORMAL	100	WRS	0.161	No
Zinc	20	NORMAL	100	151	NON-PARAMETRIC	100	WRS	0.420	No

[a] Statistical comparisons to background cannot be performed. The analyte is retained as an ECOI for further evaluation.

-- = Screen not performed because ECOI was eliminated from further consideration by a previous step.

N/A = Not applicable. Site and/or background detection frequency less than 20%.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

WRS = Wilcoxon Rank Sum.

t-Test_N = Student's t-test using normal data.

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Table 7.4

Statistical Concentrations in WBEU Surface Soil (Non-PMJM)[a]

Analyte	Units	Total Samples	UCL Recommended by ProUCL	Distribution Recommended by ProUCL	Mean Detected Concentration	Median Detected Concentraiton	75th percentile	95th percentile	UCL	UTL	MDC
Inorganics											
Aluminum	mg/kg	151	95% Approximate Gamma UCL	GAMMA	14,613	13,000	17,950	29,500	15,549	28,000	33,000
Barium	mg/kg	151	95% Student's-t UCL	NON-PARAMETRIC	135	125	156	230	142	230	280
Boron	mg/kg	76	95% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	6.82	6.10	9.43	13.3	8.64	13.0	15.0
Chromium	mg/kg	151	95% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	16.5	14.1	17.9	32.0	20.2	31.0	80.5
Lithium	mg/kg	131	95% Approximate Gamma UCL	GAMMA	12.4	11.4	15.4	23.9	13.4	23.3	33.0
Manganese	mg/kg	151	95% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	284	262	325	508	336	490	1,200
Molybdenum	mg/kg	137	97.5% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	1.07	0.540	2.25	2.51	1.61	2.50	3.00
Nickel	mg/kg	151	95% Student's-t UCL	LOGNORMAL	14.6	12.8	16.9	22.8	16.0	25.6	101
Silver	mg/kg	142	97.5% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	1.30	0.550	1.15	2.84	3.51	2.60	42.8
Thallium	mg/kg	151	95% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	0.417	0.250	0.498	1.20	0.564	1.10	3.30
Tin	mg/kg	137	97.5% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	7.95	1.40	12.0	32.5	14.0	31.0	75.8
Uranium	mg/kg	76	95% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	1.89	0.825	3.00	3.60	2.60	3.60	8.00
Organics											
Benzo(a)pyrene	µg/kg	85	95% Student's-t UCL	NON-PARAMETRIC	207	180	205	395	224	395	750
bis(2-ethylhexyl)phthalate	µg/kg	85	95% Student's-t UCL	NON-PARAMETRIC	209	180	200	395	224	395	510
Endrin	µg/kg	40	95% Student's-t UCL	NON-PARAMETRIC	8.87	9.00	10.0	10.0	9.27	10.5	10.5
Total PCBs	µg/kg	81	97.5% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	184	170	190	380	449	380	3,365

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

MDC = maximum detected concentration or in some cases, maximum proxy result.

UCL = 95% upper confidence limit on the mean, unless the MDC<UCL, then the MDC is used as the UCL.

UTL = 95% upper confidence limit on the 90th percentile value, unless the MDC<UTL then the MDC is used as the UTL.

Table 7.5

Upper-Bound Exposure Point Concentration Comparison to Limiting ESLs in the WNEU Surface Soil (Non-PMJM)

	Small Home Range Receptors			Large Home Range Receptors		
Analyte	EPC (95UTL)	Limiting ESL[a]	EPC>ESL?	EPC (95UCL)	Limiting ESL[b]	EPC>ESL?
Inorganics (mg/kg)						
Aluminum	28,000	50	Yes	15,549	N/A	N/A
Barium	230	222	Yes	142	4,766	No
Boron	13.0	0.5	Yes	8.64	314	No
Chromium[c]	31.0	0.4	Yes	20.2	68.5	No
Lithium	23.3	2	Yes	13.4	2,560	No
Manganese	490	486	Yes	336	2,510	No
Molybdenum	2.50	1.9	Yes	1.61	8.18	No
Nickel	25.6	0.43	Yes	16.0	1.86	Yes
Silver	2.60	2	Yes	3.51	N/A	N/A
Thallium	1.10	1	Yes	0.564	53.3	No
Tin	31.0	2.9	Yes	14.0	16	No
Uranium	3.60	5	No	2.60	2,270	No
Organics (µg/kg)						
Benzo(a)pyrene	395	3,160	No	224	13,800	No
bis(2-ethylhexyl)phthalate	395	137	Yes	224	35,000	No
Endrin	10.5	1.4	Yes	9.27	197	No
Total PCB	380	172	Yes	449	1,244	No

[a]Threshold ESL (if available) for the plant, invertebrate, deer mouse, prarie dog, dove, or kestrel receptors.

[b]Threshold ESL (if available) for the coyote and mule deer receptors.

[c] The ESLs for chromium were developed using available toxicity data based on chromium (III) (birds) and chromium (VI) (plants, invertebrates, and mammals).

N/A = Not applicable; ESL not available (assessed in Section 10).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.6
Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Small Home Range Receptors for Surface Soil (Non-PMJM)

Analyte	Small Home Range Receptor 95th UTL	Receptor-Specific ESLs[a]							
		Terrestrial Invertebrate	Terrestrial Plant	American Kestrel	Mourning Dove (herbivore)	Mourning Dove (insectivore)	Deer Mouse (herbivore)	Deer Mouse (Insectivore)	Prairie Dog
Inorganics (mg/kg)									
Aluminum	27,400	**50**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Barium	230	500	330	1,860	**222**	506	930	4,430	3,220
Boron	13	N/A	**0.5**	167	30.3	115	62.1	422	237
Chromium	31	**0.4**	**1**	**14.2**	**24.6**	**1.34**	281	**15.9**	703
Lithium	23.3	N/A	**2**	N/A	N/A	N/A	1,880	610	3,180
Manganese	490	N/A	500	9,920	1,030	2,630	**486**	4,080	1,519
Molybdenum	2.50	N/A	**2**	76.7	44.4	6.97	8.68	**1.9**	27.1
Nickel	25.6	200	30	89.9	320	**7.84**	**16.4**	**0.43**	38.3
Silver	2.60	N/A	**2**	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	1.10	N/A	**1**	N/A	N/A	N/A	312	12.5	350
Tin	31	N/A	50	**19**	**26.1**	**2.9**	45	**3.77**	80.6
Organics (µg/kg)									
bis(2-ethylhexyl)phthalate	395	N/A	N/A	398	19,547	**137**	960,345	8,071	2,759,555
Endrin	10.5	N/A	N/A	**3.74**	106	**1.4**	2,460	45.5	8,060
Total PCB	380	N/A	40,000	886	1,140	**172**	17,000	1,610	53,200

[a]Threshold ESL (if available)

N/A = Not applicable; ESL not available (assessed in Section 10).

Bold = Receptors of potential concern.

Table 7.7
Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Large Home-Range Receptors in the WBEU Surface Soil

Analyte	Large Home Range Receptor 95th UCL	Receptor-Specific ESLs[a]			
		Mule Deer	Coyote (carnivore)	Coyote (generalist)	Coyote (insectivore)
Inorganics (mg/kg)					
Nickel	16.0	124	90.9	**6.02**	**1.86**

[a] Threshold ESL (if available)

N/A = Not applicable; ESL not available.

Bold = Receptors of potential concern.

Table 7.8
Summary of ECOPC Screening Steps for Surface Soil in the WBEU for Non-PMJM Receptors

Analyte	Exceed Any NOAEL ESL?	Detection Frequency >5%?	Exceed Background?[a]	Upper-Bound EPC > Limiting ESL?	Professional Judgment - Retain?	ECOPC?	Receptor(s) of Potential Concern
Inorganics							
Aluminum	Yes	Yes	Yes	Yes	No	No	--
Ammonia	No	--	--	--	--	No	--
Antimony	No	--	--	--	--	No	--
Arsenic	Yes	Yes	No	--	--	No	--
Barium	Yes	Yes	Yes	Yes	No	No	--
Beryllium	No	--	--	--	--	No	--
Boron	Yes	Yes	N/A	Yes	No	No	--
Cadmium	Yes	Yes	No	--	--	No	--
Calcium	UT	--	--	--	--	No	--
Cesium	UT	--	--	--	--	No	--
Chromium	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Terrestrial plant Terrestrial invertebrate American kestrel Mourning dove (herbivore) Mourning dove (insectivore) Deer mouse (insectivore)**
Cobalt	Yes	Yes	No	--	--	No	--
Copper	Yes	Yes	No	--	--	No	--
Iron	UT	--	--	--	--	No	--
Lead	Yes	Yes	No	--	--	No	--
Lithium	Yes	Yes	Yes	Yes	No	No	--
Magnesium	UT	--	--	--	--	No	--
Manganese	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Deer mouse (herbivore)**
Mercury	Yes	Yes	No	--	--	No	--
Molybdenum	Yes	Yes	N/A	Yes	No	No	--
Nickel	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Mourning dove (insectivore) Deer mouse (herbivore) Deer mouse (insectivore) Coyote (generalist) Coyote (insectivore)**
Nitrate / Nitrite	No	--	--	--	--	No	--
Potassium	UT	--	--	--	--	No	--
Selenium	No	--	--	--	--	No	--
Silica	UT	--	--	--	--	No	--
Silicon	UT	--	--	--	--	No	--
Silver	**Yes**	**Yes**	**N/A**	**Yes**	**Yes**	**Yes**	**Terrestrial plant**
Sodium	UT	--	--	--	--	No	--
Strontium	No	--	--	--	--	No	--
Thallium	**Yes**	**Yes**	**N/A**	**Yes**	**Yes**	**Yes**	**Terrestrial plant**
Tin	**Yes**	**Yes**	**N/A**	**Yes**	**Yes**	**Yes**	**American kestrel Mourning dove (herbivore) Mourning dove (insectivore) Deer mouse (insectivore)**
Titanium	UT	--	--	--	--	No	--
Uranium	Yes	Yes	N/A	No	--	No	--
Vanadium	Yes	Yes	No	--	--	No	--
Zinc	Yes	Yes	No	--	--	No	--
Organics							
1,1,2,2-Tetrachloroethane	No	--	--	--	--	No	--
1,2,3-Trichloropropane	No	--	--	--	--	No	--
1,2,4-Trimethylbenzene	UT	--	--	--	--	No	--
4,4'-DDE	No	--	--	--	--	No	--
4,6-Dinitro-2-methylphenol	No	--	--	--	--	No	--
Acenaphthene	No	--	--	--	--	No	--
Anthracene	UT	--	--	--	--	No	--
Benzene	No	--	--	--	--	No	--
Benzo(a)anthracene	UT	--	--	--	--	No	--
Benzo(a)pyrene	Yes	Yes	N/A	No	--	No	--
Benzo(b)fluoranthene	UT	--	--	--	--	No	--
Benzo(g,h,i)perylene	UT	--	--	--	--	No	--
Benzo(k)fluoranthene	UT	--	--	--	--	No	--
Benzoic Acid	UT	--	--	--	--	No	--
bis(2-ethylhexyl)phthalate	**Yes**	**Yes**	**N/A**	**Yes**	**Yes**	**Yes**	**Mourning dove (insectivore)**
Chlorobenzene	No	--	--	--	--	No	--
Chrysene	No	--	--	--	--	No	--

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Table 7.8
Summary of ECOPC Screening Steps for Surface Soil in the WBEU for Non-PMJM Receptors

Analyte	Exceed Any NOAEL ESL?	Detection Frequency >5%?	Exceed Background?[a]	Upper-Bound EPC > Limiting ESL?	Professional Judgment - Retain?	ECOPC?	Receptor(s) of Potential Concern
Di-n-butylphthalate	Yes	No	--	--	--	No	--
Dibenz(a,h)anthracene	UT	--	--	--	--	No	--
Dibenzofuran	No	--	--	--	--	No	--
Dieldrin	No	--	--	--	--	No	--
Endrin	**Yes**	**Yes**	**N/A**	**Yes**	**Yes**	**Yes**	**American kestrel Mourning dove (insectivore)**
Ethylbenzene	UT	--	--	--	--	No	--
Fluoranthene	UT	--	--	--	--	No	--
Fluorene	No	--	--	--	--	No	--
Indeno(1,2,3-cd)pyrene	UT	--	--	--	--	No	--
Methoxychlor	No	--	--	--	--	No	--
N-Nitroso-di-n-propylamine	UT	--	--	--	--	No	--
Naphthalene	No	--	--	--	--	No	--
Phenanthrene	UT	--	--	--	--	No	--
Pyrene	UT	--	--	--	--	No	--
Tetrachloroethene	No	--	--	--	--	No	--
Toluene	No	--	--	--	--	No	--
Total PCB	**Yes**	**Yes**	**N/A**	**Yes**	**Yes**	**Yes**	**Mourning dove (insectivore)**
Radionuclides							
Americium-241	No	--	--	--	--	No	--
Cesium-134	UT	--	--	--	--	No	--
Cesium-137	No	--	--	--	--	No	--
Gross Alpha	UT	--	--	--	--	No	--
Gross Beta	UT	--	--	--	--	No	--
Plutonium-238	UT	--	--	--	--	No	--
Plutonium-239/240	No	--	--	--	--	No	--
Radium-226	No	--	--	--	--	No	--
Radium-228	No	--	--	--	--	No	--
Strontium-89/90	No	--	--	--	--	No	--
Uranium-233/234	No	--	--	--	--	No	--
Uranium-235	No	--	--	--	--	No	--
Uranium-238	No	--	--	--	--	No	--

[a] Based on results of statistical analysis at the 0.1 level of significance.

-- = Screen not preformed because analyet was eliminated from further consideration in a previous ECOPC screening step.

N/A - Not applicable; background comparison could not be conducted.

Bold = Analyte retained as an ECOPC for risk characterization.

UT = Uncertain toxicity; no ESL available (assessed in Section 10.0).

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Table 7.9
Comparison of MDCs in WBEU Subsurface Soil to NOAEL ESLs for Burrowing Receptors

Analyte	MDC	Prairie Dog NOAEL ESL	MDC>NOAEL ESL?
Inorganics (mg/kg)			
Aluminum	54,000	N/A	UT
Ammonia	1.44	26,723	No
Antimony	350	18.7	**Yes**
Arsenic	25.93	9.35	**Yes**
Barium	838	3,224	No
Beryllium	2.3	211	No
Boron	15	237	No
Cadmium	58.7	198	No
Calcium	260,000	N/A	UT
Cesium	21	N/A	UT
Chromium[a]	4,600	703	**Yes**
Cobalt	24	2,461	No
Copper	180	838	No
Iron	152,000	N/A	UT
Lead	8,500	1,850	**Yes**
Lithium	44	3,178	No
Magnesium	12,200	N/A	UT
Manganese	1,300	1,519	No
Mercury	3.4	3.15	**Yes**
Molybdenum	1,970	27.1	**Yes**
Nickel	1,330	38.3	**Yes**
Nitrate / Nitrite[b]	43.6	16,233	No
Phosphorus	160	N/A	UT
Potassium	13,000	N/A	UT
Selenium	1.5	2.80	No
Silica	1,200	N/A	UT
Silicon	2,210	N/A	UT
Silver	219	N/A	UT
Sodium	3,700	N/A	UT
Strontium	459	3,519	No
Sulfide	83.5	N/A	UT
Thallium	10.8	204	No
Tin	110	80.6	**Yes**
Titanium	650	N/A	UT
Total Petroleum Hydrocarbons	249	N/A	UT
Uranium	19	1,226	No
Vanadium	72	83.5	No
Zinc	550	1,174	No
Organics (ug/kg)			
1,1,1-Trichloroethane	300	4.85E+07	No
1,1,2,2-Tetrachloroethane	72	4.70E+06	No
1,1,2-Trichloro-1,2,2-trifluoroethane	0.8	N/A	UT
1,1-Dichloroethene	7	1.28E+06	No
1,2,3-Trichlorobenzene	3.7	N/A	UT
1,2,4-Trichlorobenzene	14	94,484	No
1,2,4-Trimethylbenzene	11.8	N/A	UT
1,2-Dichlorobenzene	0.64	N/A	UT
1,2-Dichloroethene	110	1.87E+06	No

DEN/E032005011.XLS

Table 7.9

Comparison of MDCs in WBEU Subsurface Soil to NOAEL ESLs for Burrowing Receptors

Analyte	MDC	Prairie Dog NOAEL ESL	MDC> NOAEL ESL?
1,3,5-Trimethylbenzene	4.7	855,709	No
1,3-Dichlorobenzene	0.72	N/A	UT
1,4-Dichlorobenzene	84	5.93E+06	No
2-Butanone	8100	4.94E+07	No
2-Chlorophenol	46	21,598	No
2-Hexanone	0.8	N/A	UT
2-Methylnaphthalene	83,000	319,121	No
4-Chloro-3-methylphenol	37	N/A	UT
4-Isopropyltoluene	4.15	N/A	UT
4-Methyl-2-pentanone	94	859,131	No
Acenaphthene	24,000	N/A	UT
Acenaphthylene	1,100	N/A	UT
Acetone	4,890	247,687	No
Anthracene	8,700	N/A	UT
Benzene	14	1.10E+06	No
Benzo(a)anthracene	7,500	N/A	UT
Benzo(a)pyrene	11,000	502,521	No
Benzo(b)fluoranthene	7,100	N/A	UT
Benzo(g,h,i)perylene	5,200	N/A	UT
Benzo(k)fluoranthene	8,000	N/A	UT
Benzoic Acid	2,300	N/A	UT
bis(2-ethylhexyl)phthalate	71,000	2.76E+06	No
Butylbenzylphthalate	4,900	3.37E+06	No
Carbon Disulfide	160	410,941	No
Carbon Tetrachloride	6,200	736,154	No
Chloroform	130	560,030	No
Chrysene	11,000	N/A	UT
cis-1,2-Dichloroethene	4,400	132,702	No
Dibenz(a,h)anthracene	1,700	N/A	UT
Dibenzofuran	7,000	2.44E+06	No
Dicamba	2.2	129,003	No
Diethylphthalate	56	2.21E+08	No
Di-n-butylphthalate	480	4.06E+07	No
Ethylbenzene	62	N/A	UT
Fluoranthene	18,000	N/A	UT
Fluorene	7,100	N/A	UT
Fluoroacetamide	22	N/A	UT
Hexachlorobutadiene	310	150,894	No
Indeno(1,2,3-cd)pyrene	3,000	N/A	UT
Methylene Chloride	1,500	209,560	No
Naphthalene	17,000	1.60E+07	No
n-Butylbenzene	0.62	N/A	UT
N-nitrosodiphenylamine	17,000	2.15E+06	No
Pentachlorophenol	790	18,373	No
Phenanthrene	43,000	N/A	UT
Phenol	2,500	1.49E+06	No
Propylcyclopentane	7.2	N/A	UT
Pyrene	36,000	N/A	UT
Styrene	1.7	1.53E+06	No

Table 7.9
Comparison of MDCs in WBEU Subsurface Soil to NOAEL ESLs for Burrowing Receptors

Analyte	MDC	Prairie Dog NOAEL ESL	MDC> NOAEL ESL?
Tetrachloroethene	72,000	72,494	No
Toluene	480	1.22E+06	No
Total PCB	5,900	37,963	No
Trichloroethene	1,900	32,424	No
Xylene	400	111,663	No
Radionuclides (pCi/g)			
Americium-241	410	3,890	No
Cesium-134	-0.0186	N/A	UT
Cesium-137	0.3398	20.8	No
Gross Alpha	4100	N/A	UT
Gross Beta	137.1	N/A	UT
Iodine-129	0.125	N/A	UT
Nickel-59	0.42	N/A	UT
Plutonium-238	19.84	N/A	UT
Plutonium-239/240	2450	6,110	No
Plutonium-241	178	N/A	UT
Radium-226	1.44	50.6	No
Radium-228	2.6	43.9	No
Strontium-89/90	0.83	22.5	No
Tritium	510	174,000	No
Uranium-233/234	14	4,980	No
Uranium-235	1.7	2,770	No
Uranium-238	63.99	1,580	No

[a] The ESLs for chromium were developed using available toxicity data based on chromium (III) (birds) and chromium (VI) (plants, invertebrates, and mammals).

[b] The ESL for nitrate was used.

N/A = No ESL available for the ECOI/receptor pair.

UT = Uncertain toxicity; no ESL available (assessed in Section 10.0).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

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Table 7.10
Statistical Distributions and Comparison to Background for WBEU Subsurface Soil

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			WBEU Data Set (excluding background samples)					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Retain as ECOI?
Antimony	**28**	**NON-PARAMETRIC**	**7.14**	**303**	**NON-PARAMETRIC**	**15.2**	**N/A**	**N/A**	**Yes[a]**
Arsenic	45	NON-PARAMETRIC	93.3	309	GAMMA	98.1	WRS	0.280	No
Chromium	45	GAMMA	100	309	NON-PARAMETRIC	100	WRS	0.859	No
Lead	45	GAMMA	100	309	NON-PARAMETRIC	99.7	WRS	1.000	No
Mercury	41	NON-PARAMETRIC	29.3	308	NON-PARAMETRIC	63.6	WRS	1.000	No
Molybdenum	45	NON-PARAMETRIC	66.7	304	NON-PARAMETRIC	50	WRS	1.00	No
Nickel	44	GAMMA	100	309	NON-PARAMETRIC	98.7	WRS	0.995	No
Tin	41	NON-PARAMETRIC	36.6	303	NON-PARAMETRIC	24.8	WRS	1.000	No

[a] Statistical comparisons to background cannot be performed. The analyte is retained as an ECOI for further evaluation.

N/A = Not applicable. Site and/or background detection frequency less than 20%.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

WRS = Wilcoxon Rank Sum.

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Table 7.11
Statistical Concentrations in Subsurface Soil in the WBEU

Analyte	Units	Total Samples	UCL Recommended by ProUCL	Distribution Recommended by ProUCL	Mean Detected Concentration	Median Detected Concentration	75th percentile	95th percentile	UCL	UTL	MDC
Antimony	mg/kg	303	97.5% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	4.60	0.730	3.23	6.59	13.7	5.90	350

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.
MDC = maximum detected concentration or in some cases, maximum proxy result.
UCL = 95% upper confidence limit on the mean, unless the MDC<UCL, then the MDC is used as the UCL.

Table 7.12

Upper-Bound Exposure Point Concentration Comparison to tESLs in the WBEU Subsurface Soil

Analyte	Burrowing Receptors		
	EPC (95UTL)	tESL[a]	EPC>ESL?
Inorganics (mg/kg)			
Antimony	5.9	18.7	No

[a] Threshold ESL (if available) for the prairie dog receptor.

N/A = Not applicable; ESL not available.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.13
Summary of ECOPC Screening Steps for Subsurface Soil

Analyte	Exceed Any NOAEL ESL	Frequency of Detection >5%	Exceeds Background?	Upper Bound EPC > Limiting ESL?	Professional Judgment - Retain?	Retain as ECOPC?
Inorganics						
Aluminum	UT	--	--	--	--	No
Ammonia	No	--	--	--	--	No
Antimony	Yes	Yes	N/A	No	--	No
Arsenic	Yes	Yes	No	--	--	No
Barium	No	--	--	--	--	No
Beryllium	No	--	--	--	--	No
Boron	No	--	--	--	--	No
Cadmium	No	--	--	--	--	No
Calcium	UT	--	--	--	--	No
Cesium	UT	--	--	--	--	No
Chromium	Yes	Yes	No	--	--	No
Cobalt	No	--	--	--	--	No
Copper	No	--	--	--	--	No
Iron	UT	--	--	--	--	No
Lead	Yes	Yes	No	--	--	No
Lithium	No	--	--	--	--	No
Magnesium	UT	--	--	--	--	No
Manganese	No	--	--	--	--	No
Mercury	Yes	Yes	No	--	--	No
Molybdenum	Yes	Yes	No	--	--	No
Nickel	Yes	Yes	No	--	--	No
Nitrate / Nitrite	No	--	--	--	--	No
Phosphorus	UT	--	--	--	--	No
Potassium	UT	--	--	--	--	No
Selenium	No	--	--	--	--	No
Silica	UT	--	--	--	--	No
Silicon	UT	--	--	--	--	No
Silver	UT	--	--	--	--	No
Sodium	UT	--	--	--	--	No
Strontium	No	--	--	--	--	No
Sulfide	UT	--	--	--	--	No
Thallium	No	--	--	--	--	No
Tin	Yes	Yes	No	--	--	No
Titanium	UT	--	--	--	--	No
Uranium	No	--	--	--	--	No
Vanadium	No	--	--	--	--	No
Zinc	No	--	--	--	--	No
Organics						
1,1,1-Trichloroethane	No	--	--	--	--	No
1,1,2,2-Tetrachloroethane	No	--	--	--	--	No
1,1,2-Trichloro-1,2,2-trifluoroethane	UT	--	--	--	--	No
1,1-Dichloroethene	No	--	--	--	--	No
1,2,3-Trichlorobenzene	UT	--	--	--	--	No
1,2,4-Trichlorobenzene	No	--	--	--	--	No
1,2,4-Trimethylbenzene	UT	--	--	--	--	No
1,2-Dichlorobenzene	UT	--	--	--	--	No
1,2-Dichloroethene	No	--	--	--	--	No
1,3,5-Trimethylbenzene	No	--	--	--	--	No
1,3-Dichlorobenzene	UT	--	--	--	--	No
1,4-Dichlorobenzene	No	--	--	--	--	No
2-Butanone	No	--	--	--	--	No
2-Chlorophenol	No	--	--	--	--	No
2-Hexanone	UT	--	--	--	--	No
2-Methylnaphthalene	No	--	--	--	--	No

Table 7.13
Summary of ECOPC Screening Steps for Subsurface Soil

Analyte	Exceed Any NOAEL ESL	Frequency of Detection >5%	Exceeds Background?	Upper Bound EPC > Limiting ESL?	Professional Judgment - Retain?	Retain as ECOPC?
4-Chloro-3-methylphenol	UT	--	--	--	--	No
4-Isopropyltoluene	UT	--	--	--	--	No
4-Methyl-2-pentanone	No	--	--	--	--	No
Acenaphthene	UT	--	--	--	--	No
Acenaphthylene	UT	--	--	--	--	No
Acetone	No	--	--	--	--	No
Anthracene	UT	--	--	--	--	No
Benzene	No	--	--	--	--	No
Benzo(a)anthracene	UT	--	--	--	--	No
Benzo(a)pyrene	No	--	--	--	--	No
Benzo(b)fluoranthene	UT	--	--	--	--	No
Benzo(g,h,i)perylene	UT	--	--	--	--	No
Benzo(k)fluoranthene	UT	--	--	--	--	No
Benzoic Acid	UT	--	--	--	--	No
bis(2-ethylhexyl)phthalate	No	--	--	--	--	No
Butylbenzylphthalate	No	--	--	--	--	No
Carbon Disulfide	No	--	--	--	--	No
Carbon Tetrachloride	No	--	--	--	--	No
Chloroform	No	--	--	--	--	No
Chrysene	UT	--	--	--	--	No
cis-1,2-Dichloroethene	No	--	--	--	--	No
Dibenz(a,h)anthracene	UT	--	--	--	--	No
Dibenzofuran	No	--	--	--	--	No
Dicamba	No	--	--	--	--	No
Diethylphthalate	No	--	--	--	--	No
Di-n-butylphthalate	No	--	--	--	--	No
Ethylbenzene	UT	--	--	--	--	No
Fluoranthene	UT	--	--	--	--	No
Fluorene	UT	--	--	--	--	No
Fluoroacetamide	UT	--	--	--	--	No
Hexachlorobutadiene	No	--	--	--	--	No
Indeno(1,2,3-cd)pyrene	UT	--	--	--	--	No
Methylene Chloride	No	--	--	--	--	No
Naphthalene	No	--	--	--	--	No
n-Butylbenzene	UT	--	--	--	--	No
N-nitrosodiphenylamine	No	--	--	--	--	No
Pentachlorophenol	No	--	--	--	--	No
Phenanthrene	UT	--	--	--	--	No
Phenol	No	--	--	--	--	No
Propylcyclopentane	UT	--	--	--	--	No
Pyrene	UT	--	--	--	--	No
Styrene	No	--	--	--	--	No
Tetrachloroethene	No	--	--	--	--	No
Toluene	No	--	--	--	--	No
Total PCB	No	--	--	--	--	No
Trichloroethene	No	--	--	--	--	No
Xylene	No	--	--	--	--	No

[a] Based on results of statistical analysis at the 0.1 level of significance.
-- = Screen not preformed because analyet was eliminated from further consideration in a previous ECOPC screening step.
N/A - Not applicable; background comparison could not be conducted.
UT = Uncertain toxicity; no ESL available (assessed in Section 10.0).

Table 8.1
Summary of ECOPC/Receptor Pairs

ECOPC	Receptors of Potential Concern
Surface Soil	
Chromium	Terrestrial plant Terrestrial invertebrate American kestrel Mourning dove (herbivore) Mourning dove (insectivore) Deer mouse (insectivore)
Manganese	Deer mouse (herbivore)
Nickel	Mourning dove (insectivore) Deer mouse (herbivore) Deer mouse (insectivore) Coyote (generalist) Coyote (insectivore)
Silver	Terrestrial plant
Thallium	Terrestrial plant
Tin	American kestrel Mourning dove (herbivore) Mourning dove (insectivore) Deer mouse (insectivore)
Bis(2-ethylhexyl)phthalate	Mourning dove (insectivore)
Endrin	American kestrel Mourning dove (insectivore)
Total PCBs	Mourning dove (insectivore)

Table 8.2
Surface Soil Exposure Point Concentrations for Non-PMJM Receptors

ECOPC	Tier I Exposure Point Concentrations (mg/kg)		Tier II Exposure Point Concentrations (mg/kg)	
	UTL	UCL	UTL	UCL
Inorganics				
Chromium	31	20.2	14.6	13.7
Manganese	490	336	344	319
Nickel	25.6	16.0	12.9	12
Silver	2.6	3.51	1.42	1.17
Thallium	1.1	0.556	0.328	0.387
Tin	31.0	14.0	15.7	13.8
Organics				
Bis(2-ethylhexyl)phthalate	0.395	0.224	0.2	0.188
Endrin	0.0105	0.0093	0.01	0.0097
Total PCBs	0.38	0.449	0.216	0.2

Table 8.3
Surface Water Exposure Point Concentrations

ECOPC	UTL	UCL
Inorganics (mg/L)		
Chromium	0.019	0.006
Manganese	0.19	0.093
Nickel	0.012	0.008
Silver	0.048	0.02
Tin	0.068	0.047
Thallium	N/A	
Organics (µg/L)		
Bis(2-ethylhexyl)phthalate	N/A	
Endrin	N/A	
Total PCs	N/A	

N/A = No available.

Table 8.4
Receptor-Specific Input Parameters

Receptor	Body Weight (kg)	Body Weight Reference	Percentage of Diet: Plant Tissue	Percentage of Diet: Invertebrate Tissue	Percentage of Diet: Bird or Mammal Tissue	Dietary Reference	Food Ingestion Rate ($kg/kg\ BW\ day^{-1}$)	Ingestion Rate Reference	Water Ingestion Rate ($L/kg\ BW\ day^{-1}$)	Ingestion Rate Reference	Percentage of Diet as Soil	Soil Ingestion Reference
Non-Wildlife Terrestrial Receptors												
Terrestrial Plants	N/A											
Terrestrial Invertebrates	N/A											
Vertebrate Receptors - Birds												
American kestrel	0.116	Brown and Amadon (1968) - Average value	0	20	80	Generalized Diet from several studies presented in the Watershed ERA DOE (1996)	0.092	Kolpin et al. (1980)	0.12	EPA (1993) - Estimated using model for all birds - Calder and Braun (1983)	5	Assumed value based on conservative estimates for carnivores
Mourning Dove (herbivore)	0.113	Average of adult values from CalEPA (2004) Online Database	100	0	0	Cowan (1952)	0.23	EPA (2003)	0.12	EPA (1993) - Estimated using model for all birds - Calder and Braun (1983)	9.3	Beyer et al. (1994) - Wild turkey used as a surrogate.
Mourning Dove (insectivore)	0.113	Average of adult values from CalEPA (2004) Online Database	0	100	0	Generalized Diet	0.23	EPA (2003)	0.12	EPA (1993) - Estimated using model for all birds - Calder and Braun (1983)	9.3	Beyer et al. (1994) - Wild turkey used as a surrogate.
Vertebrate Receptors - Mammals												
Deer Mouse (herbivore)	0.0187	Flake (1973)	100	0	0	Generalized Diet	0.111	Cronin and Bradley (1988)	0.19	Ross (1930); Dice (1922) as cited in EPA (1993).	2	Beyer et al. (1994)
Deer Mouse (insectivore)	0.0187	Flake (1973)	0	100	0	Generalized Diet	0.065	Cronin and Bradley (1988)	0.19	Ross (1930); Dice (1922) as cited in USEPA 1993.	2	Beyer et al. (1994)
Coyote (generalist)	12.75	Bekoff (1977) - Average of male and female weights	0	25	75	Generalized Diet	0.015	Gier (1975)	0.08	EPA (1993) - Estimated using model for all mammals - Calder and Braun (1983)	5	Beyer et al. (1994) - High end estimate for Red Fox
Coyote (insectivore)	12.75	Bekoff (1977) - Average of male and female weights	0	100	0	Generalized Diet	0.015	Gier (1975)	0.08	EPA (1993) - Estimated using model for all mammals - Calder and Braun (1983)	2.8	Beyer et al. (1994) - Red Fox

Receptor parameters for all receptors with the exception of the prairie dog and mourning dove were taken from the Watershed Risk Assessment (DOE 1996) and referenced to the original source.

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Table 8.4
Receptor-Specific Input Parameters

Receptor	Body Weight (kg)	Body Weight Reference	Percentage of Diet				Food Ingestion Rate (kg/kg BW day⁻¹)	Ingestion Rate Reference	Water Ingestion Rate (L/kg BW day⁻¹)	Ingestion Rate Reference	Percentage of Diet as Soil	Soil Ingestion Reference
			Plant Tissue	Invertebrate Tissue	Bird or Mammal Tissue	Dietary Reference						

All receptor parameters are estimates of central tendency except where noted.

All values are presented in a dry weight basis.

N/A = Not available.

Table 8.5
Receptor Specific Intake Estimates

	Intake Estimates (mg/kg BW day)					
	Plant Tissue	Invertebrate Tissue	Mammal Tissue	Soil	Surface Water	Total
Default Exposure Estimates						
Chromium						
Mourning Dove - Herbivore						
Tier 1 UTL	0.599	N/A	N/A	0.663	0.00228	1.26
Tier 2 UTL	0.282	N/A	N/A	0.312	0.00228	0.597
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	22.5	N/A	0.663	0.00228	23.2
Tier 2 UTL	N/A	10.6	N/A	0.312	0.00228	10.9
American Kestrel						
Tier 1 UTL	N/A	1.80	0.204	0.143	0.00228	2.15
Tier 2 UTL	N/A	0.849	0.118	0.0672	0.00228	1.04
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	6.37	N/A	0.0403	0.00361	6.42
Tier 2 UTL	N/A	3.00	N/A	0.0190	0.00361	3.02
Manganese						
Deer Mouse - Herbivore						
Tier 1 UTL	12.7	N/A	N/A	1.09	0.0361	13.9
Tier 2 UTL	8.94	N/A	N/A	0.764	0.0361	9.73
Nickel						
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	27.9	N/A	0.548	0.00144	28.4
Tier 2 UTL	N/A	14.0	N/A	0.276	0.00144	14.3
Deer Mouse - Herbivore						
Tier 1 UTL	0.136	N/A	N/A	0.0568	0.00228	0.195
Tier 2 UTL	0.0813	N/A	N/A	0.0286	0.00228	0.112
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	7.87	N/A	0.0333	0.00228	7.91
Tier 2 UTL	N/A	3.97	N/A	0.0168	0.00228	3.99
Coyote - Generalist						
Tier 1 UCL	NA	0.282	0.0319	0.0119	6.40E-04	0.326
Tier 2 UCL	NA	0.213	0.0280	0.00900	6.40E-04	0.250
Coyote - Insectivore						
Tier 1 UCL	NA	1.13	NA	0.00668	6.40E-04	1.14
Tier 2 UCL	NA	0.851	NA	0.00504	6.40E-04	0.857
Tin						
Mourning Dove - Herbivore						
Tier 1 UTL	0.214	N/A	N/A	0.663	0.00816	0.885
Tier 2 UTL	0.108	N/A	N/A	0.336	0.00816	0.452
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	7.13	N/A	0.663	0.00816	7.80
Tier 2 UTL	N/A	3.61	N/A	0.336	0.00816	3.95
American Kestrel						
Tier 1 UTL	N/A	0.570	0.479	0.143	0.00816	1.20
Tier 2 UTL	N/A	0.289	0.243	0.0722	0.00816	0.612
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	2.02	N/A	0.0403	0.0129	2.07
Tier 2 UTL	N/A	1.02	N/A	0.0204	0.0129	1.05
Bis(2-ethylhexyl)phthalate						
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	3.17	N/A	0.00845	N/A	3.18
Tier 2 UTL	N/A	1.61	N/A	0.00428	N/A	1.61
Endrin						
Mourning Dove - Insectivore						
Tier 1 UTL	NA	0.0751	NA	2.25E-04	N/A	0.0753
Tier 2 UTL	NA	0.0715	NA	2.14E-04	N/A	0.0717
American Kestrel						
Tier 1 UTL	NA	0.00601	0.0220	4.83E-05	N/A	0.0281
Tier 2 UTL	NA	0.00572	0.0210	4.60E-05	N/A	0.0267

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Table 8.5
Receptor Specific Intake Estimates

	Intake Estimates (mg/kg BW day)					
	Plant Tissue	Invertebrate Tissue	Mammal Tissue	Soil	Surface Water	Total
Default Exposure Estimates						
PCB (Total)						
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	0.252	N/A	0.00813	N/A	0.261
Tier 2 UTL	N/A	0.117	N/A	0.00462	N/A	0.122
Alterative Exposure Estimates						
Chromium						
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	2.18	N/A	0.663	0.00228	2.85
Tier 2 UTL	N/A	1.03	N/A	0.312	0.00228	1.34
Nickel						
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	1.76	N/A	0.0333	0.00228	1.80
Tier 2 UTL	N/A	0.888	N/A	0.0168	0.00228	0.907

N/A = Not applicable.

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Table 9.1
TRVs for Terrestrial Plant and Invertebrate Receptors

ECOPC	Soil Concentration (mg/kg)	Endpoint	Effect Measured/Observed	Reference	Notes
Terrestrial Plants					
Chromium	1	Screening ESL	Value was not based on any specific study.	Efroymson et al. 1997a	Low confidence in value.
Silver	2	Screening ESL	Value based on unspecified effects.	Efroymson et al. 1997a	Low confidence in value.
Thallium	1	Screening ESL	Value based on unspecified effects.	Efroymson et al. 1997a	Low confidence in value.
Terrestrial Invertebrates					
Chromium	0.4	Screening ESL	Value based on lowest concentration tested and then adjusted by an uncertainty factor of 5.	Efroymson et al. 1997b	Low confidence in value.

Table 9.2
TRVs for Terrestrial Vertebrate Receptors

ECOPC	NOAEL (mg/kg day)	NOAEL Endpoint	Lowest Bounded LOAEL (mg/kg day)	LOAEL Endpoint	TRV Source	Uncertainty Factor	Final NOAEL (mg/kg day)	Threshold (mg/kg day)	Rationale For Calculation	TRV Confidence
Birds										
Chromium (III)	1	No effect on black duckling survival	5	Reduction in black duckling survival	Sample et al. (1996)	1	1	N/A	Threshold was not calculated.	High
Chromium (VI)	*No Values Available*									N/A
Nickel	1.38	No increase in tremors or toe and leg joint edema	55.26	Increase in tremors and toe and knee joint edema in mallard	PRC (1994)	1	1.38	8.7	The nature of the effect is not likely to cause a significant effect on growth, reproduction or survival. Thus, the data satisfy the requirements described in the text for calculating a threshold.	High
Tin (Butyltins)	0.73	No change in Japanese quail growth and reproduction	18.34	Decrease in Japanese quail reproduction	PRC (1994)	1	0.73	N/A	Threshold was not calculated.	High
bis(2-ethylhexyl)phthalate	1.1	No reproductive effects in ringed doves	214	Increase in European starling body weight.	Sample et al. (1996)/O'Shea and Stafford (1980)	1	1.1	N/A	Threshold was not calculated.	NOAEL High/LOAEL Low
Endrin	0.01	NOAEL estimated from LOAEL	0.1	Decrease in hatchling success and egg production in screech owls	Sample et al. (1996)	1	0.01	N/A	NOAEL was estimated from the LOAEL.	High
Total PCBs	0.09	NOAEL was estimated from LOAEL	1.27	Decrease in egg hatchability	PRC (1994)	1	0.09	N/A	NOAEL was estimated from LOAEL	High
Mammals										
Chromium (III)	2,737	No effects on rat reproduction and life span	N/A	No effects at the highest study dose	Sample et al. (1996)	1	2,737	N/A	No LOAEL was presented.	High
Chromium (VI)	3.28	No effects on rat body weight or food consumption	13.14	Increased mortality in rats	Sample et al. (1996)	1	3.28	N/A	Threshold was not calculated.	High

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Table 9.2
TRVs for Terrestrial Vertebrate Receptors

ECOPC	NOAEL (mg/kg day)	NOAEL Endpoint	Lowest Bounded LOAEL (mg/kg day)	LOAEL Endpoint	TRV Source	Uncertainty Factor	Final NOAEL (mg/kg day)	Threshold (mg/kg day)	Rationale For Calculation	TRV Confidence
Manganese	13.7	No change in mouse testicle weight	159.1	Decrease in mouse testicle weight	PRC (1994)	1	13.7	NA	The original paper was not reviewed. Not enough information was available to calculate the threshold TRV.	High
Nickel	0.133	NOAEL was estimated from LOAEL	1.33	Increase in pup mortality in rats	PRC (1994)	1	0.133	N/A	NOAEL was estimated from LOAEL	High
Tin (Butyltins)	0.25	No systemic effects	15	Midrange of effects less than mortality	PRC (1994)	1	0.25	N/A	Threshold was not calculated.	High

TRV Confidence:
N/A = No TRV has been identified or the TRV has been deemed unacceptable for use in ECOPC selection.
Low = TRVs that have data for only one species looking at one endpoint (non-mortality) and from one primary literature source.
Moderate = TRVs that have multiple primary literature sources looking at one endpoint (non-mortality or mortality) but with only one species evaluated.
Good = For TRVs that have either multiple species with one endpoint from multiple studies or those TRVs with multiple species and multiple endpoints from only one study.
High = For TRVs that have multiple study sources looking at multiple endpoints and more than one species.
Very High = All EcoSSLs (EPA 2003a) will be assigned this level of confidence by default.

Table 10.1
Hazard Quotient Summary For Non-PMJM Receptors

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs) Based on Default TRVs	Hazard Quotients (HQs) Based on Alternate TRVs (Uncertainty Analysis)
Chromium	Terrestrial Plant	Default	Tier 1	***NOEC*** UTL = 31	***NOEC*** UTL = 3 ***LOEC*** UTL = 1
			Tier 2	***NOEC*** UTL = 15	***NOEC*** UTL = 1 ***LOEC*** UTL = 0.5
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
	Terrestrial Invertebrate	Default	Tier 1	***NOEC*** UTL = 78	***NOEC*** N/A ***LOEC*** UTL = 0.9
			Tier 2	***NOEC*** UTL = 37	***NOEC*** N/A ***LOEC*** UTL = 0.4
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
	American kestrel	Default	Tier 1	***NOAEL*** UTL = 2 ***LOAEL*** UTL = 0.4	Not Calculated
			Tier 2	***NOAEL*** UTL = 1 ***LOAEL*** UTL = 0.2	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
	Mourning Dove (Herbivore)	Default	Tier 1	***NOAEL*** UTL = 1.3 ***LOAEL*** UTL = 0.3	Not Calculated
			Tier 2	***NOAEL*** UTL = 0.6 ***LOAEL*** UTL = 0.1	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
	Mourning Dove (Insectivore)	Default	Tier 1	***NOAEL*** UTL = 23 ***LOAEL*** UTL = 5	Not Calculated
			Tier 2	***NOAEL*** UTL = 11 ***LOAEL*** UTL = 2	Not Calculated
		Alternate	Tier 1	***NOAEL*** UTL = 3 ***LOAEL*** UTL = 0.6	Not Calculated
			Tier 2	***NOAEL*** UTL = 1 ***LOAEL*** UTL = 0.3	Not Calculated

Table 10.1
Hazard Quotient Summary For Non-PMJM Receptors

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs)	
				Based on Default TRVs	Based on Alternate TRVs (Uncertainty Analysis)
Chromium	Deer Mouse (Insectivore)	Default Chromium (VI)	Tier 1	*NOAEL* UTL = 2 *LOAEL* UTL = 0.5	Not Calculated
			Tier 2	*NOAEL* UTL = 0.9 *LOAEL* UTL = 0.2	Not Calculated
		Default Chromium (III)	Tier 1	*NOAEL* UTL = 0.002 *LOAEL* N/A	Not Calculated
			Tier 2	*NOAEL* UTL = 0.001 *LOAEL* N/A	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated

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Table 10.1
Hazard Quotient Summary For Non-PMJM Receptors

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs) Based on Default TRVs	Hazard Quotients (HQs) Based on Alternate TRVs (Uncertainty Analysis)
Manganese	Deer Mouse (Herbivore)	Default	Tier 1	*NOAEL* UTL = 1 *LOAEL* UTL = 0.09	Not Calculated
			Tier 2	*NOAEL* UTL = 0.7 *LOAEL* UTL = 0.6	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated

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Table 10.1
Hazard Quotient Summary For Non-PMJM Receptors

<table>
<tr><th rowspan="2">ECOPC</th><th rowspan="2">Receptor</th><th rowspan="2">BAF</th><th rowspan="2">EPC</th><th colspan="2">Hazard Quotients (HQs)</th></tr>
<tr><th>Based on Default TRVs</th><th>Based on Alternate TRVs (Uncertainty Analysis)</th></tr>
<tr><td rowspan="22">Nickel</td><td rowspan="4">Mourning Dove (Insectivore)</td><td rowspan="2">Default</td><td>Tier 1</td><td>NOAEL
UTL = 21
Threshold
UTL = 3
LOAEL
UTL = 0.5</td><td>Not Calculated</td></tr>
<tr><td>Tier 2</td><td>NOAEL
UTL = 10
Threshold
UTL = 2
LOAEL
UTL = 0.3</td><td>Not Calculated</td></tr>
<tr><td rowspan="2">Alternate</td><td>Tier 1</td><td>Not Calculated</td><td>Not Calculated</td></tr>
<tr><td>Tier 2</td><td>Not Calculated</td><td>Not Calculated</td></tr>
<tr><td rowspan="4">Deer Mouse (Herbivore)</td><td rowspan="2">Default</td><td>Tier 1</td><td>NOAEL
UTL = 1
LOAEL
UTL = 0.1</td><td>Not Calculated</td></tr>
<tr><td>Tier 2</td><td>NOAEL
UTL = 0.8
LOAEL
UTL = 0.1</td><td>Not Calculated</td></tr>
<tr><td rowspan="2">Alternate</td><td>Tier 1</td><td>Not Calculated</td><td>Not Calculated</td></tr>
<tr><td>Tier 2</td><td>Not Calculated</td><td>Not Calculated</td></tr>
<tr><td rowspan="4">Deer Mouse (Insectivore)</td><td rowspan="2">Default</td><td>Tier 1</td><td>NOAEL
UTL = 59
LOAEL
UTL = 6</td><td>NOAEL
UTL = 0.2
LOAEL
UTL = 0.1</td></tr>
<tr><td>Tier 2</td><td>NOAEL
UTL = 30
LOAEL
UTL = 3</td><td>NOAEL
UTL = 0.1
LOAEL
UTL = 0.05</td></tr>
<tr><td rowspan="2">Alternate</td><td>Tier 1</td><td>NOAEL
UTL = 14
LOAEL
UTL = 1</td><td>NOAEL
UTL = 0.04
LOAEL
UTL = 0.02</td></tr>
<tr><td>Tier 2</td><td>NOAEL
UTL = 7
LOAEL
UTL = 0.7</td><td>NOAEL
UTL = 0.02
LOAEL
UTL = 0.01</td></tr>
<tr><td rowspan="4">Coyote (Generalist)</td><td rowspan="2">Default</td><td>Tier 1</td><td>NOAEL
UTL = 4
LOAEL
UTL = 0.4</td><td>Not Calculated</td></tr>
<tr><td>Tier 2</td><td>NOAEL
UTL = 2
LOAEL
UTL = 0.2</td><td>Not Calculated</td></tr>
<tr><td rowspan="2">Alternate</td><td>Tier 1</td><td>Not Calculated</td><td>Not Calculated</td></tr>
<tr><td>Tier 2</td><td>Not Calculated</td><td>Not Calculated</td></tr>
<tr><td>Coyote (Insectivore)</td><td>Default</td><td>Tier 1</td><td>NOAEL
UTL = 14
LOAEL
UTL = 1</td><td>Not Calculated</td></tr>
</table>

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Table 10.1
Hazard Quotient Summary For Non-PMJM Receptors

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs)	
				Based on Default TRVs	Based on Alternate TRVs (Uncertainty Analysis)
Nickel	Coyote (Insectivore)	Default	Tier 2	***NOAEL*** UTL = 7 ***LOAEL*** UTL = 0.7	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated

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Table 10.1
Hazard Quotient Summary For Non-PMJM Receptors

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs)	
				Based on Default TRVs	Based on Alternate TRVs (Uncertainty Analysis)
Silver	Terrestrial Plant	Default	Tier 1	*ESL* UTL = 1	Not Calculated
			Tier 2	*ESL* UTL = 0.7	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated

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Table 10.1
Hazard Quotient Summary For Non-PMJM Receptors

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs)	
				Based on Default TRVs	Based on Alternate TRVs (Uncertainty Analysis)
Thallium	Terrestrial Plant	Default	Tier 1	*ESL* UTL = 1	Not Calculated
			Tier 2	*ESL* UTL = 0.3	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated

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Table 10.1
Hazard Quotient Summary For Non-PMJM Receptors

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs)	
				Based on Default TRVs	Based on Alternate TRVs (Uncertainty Analysis)
Tin	American kestrel	Default	Tier 1	*NOAEL* UTL = 2 *LOAEL* UTL = 0.1	Not Calculated
			Tier 2	*NOAEL* UTL = 0.8 *LOAEL* UTL = 0.03	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
	Mourning Dove (Herbivore)	Default	Tier 1	*NOAEL* UTL = 1 *LOAEL* UTL = 0.05	Not Calculated
			Tier 2	*NOAEL* UTL = 0.6 *LOAEL* UTL = 0.02	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
	Mourning Dove (Insectivore)	Default	Tier 1	*NOAEL* UTL = 11 *LOAEL* UTL = 0.4	Not Calculated
			Tier 2	*NOAEL* UTL = 5 *LOAEL* UTL = 0.2	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
	Deer Mouse (Insectivore)	Default	Tier 1	*NOAEL* UTL = 8 *LOAEL* UTL = 0.1	Not Calculated
			Tier 2	*NOAEL* UTL = 4 *LOAEL* UTL = 0.07	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated

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Table 10.1
Hazard Quotient Summary For Non-PMJM Receptors

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs)	
				Based on Default TRVs	Based on Alternate TRVs (Uncertainty Analysis)
Bis(2-ethylhexyl)phthalate	Mourning Dove (Insectivore)	Default	Tier 1	*NOAEL* UTL = 3 *LOAEL* UTL = 0.01	Not Calculated
			Tier 2	*NOAEL* UTL = 1 *LOAEL* UTL = 0.008	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated

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Table 10.1
Hazard Quotient Summary For Non-PMJM Receptors

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs) Based on Default TRVs	Hazard Quotients (HQs) Based on Alternate TRVs (Uncertainty Analysis)
Endrin	American kestrel	Default	Tier 1	*NOAEL* UTL = 3 *LOAEL* UTL = 0.3	Not Calculated
			Tier 2	*NOAEL* UTL = 3 *LOAEL* UTL = 0.3	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
	Mourning Dove (Insectivore)	Default	Tier 1	*NOAEL* UTL = 8 *LOAEL* UTL = 0.8	Not Calculated
			Tier 2	*NOAEL* UTL = 7 *LOAEL* UTL = 0.7	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated

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Table 10.1
Hazard Quotient Summary For Non-PMJM Receptors

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs)	
				Based on Default TRVs	Based on Alternate TRVs (Uncertainty Analysis)
Total PCB	Mourning Dove (Insectivore)	Default	Tier 1	*NOAEL* UTL = 3 *LOAEL* UTL = 0.2	Not Calculated
			Tier 2	*NOAEL* UTL = 1 *LOAEL* UTL = 0.1	Not Calculated
		Alternate	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated

Shaded cells represent default HQ calculations based on exposure and toxicity models specifically identified in the CRA Methodology.

All HQ Calculations are provided in Attachment 4.

Discussion of the chemical-specific uncertainties are provided in Attachment 5.

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Table 10.2
Tier 2 Grid Cell Hazard Quotients for Surface Soil in the WBEU

ECOPC	Most Sensitive Receptor	Number of Grid Cells	Percent of Tier 2 Grid Means							
			NOAEL TRV				LOAEL TRV			
			HQ <1	HQ >1 <5	HQ > 5 <10	HQ > 10	HQ <1	HQ > 1 <5	HQ > 5 <10	HQ > 10
Inorganics										
Chromium	Mourning Dove - Insectivore	37	0	0	51	49	0	100	0	0
Manganese	Deer Mouse - Herbivore	37	92	8	0	0	100	0	0	0
Nickel	Deer Mouse - Insectivore	37	0	0	0	100	0	97	3	0
Tin	Mourning Dove - Insectivore	37	11	62	16	11	100	0	0	0
Organics										
Bis(2-ethylhexyl)phthalate	Mourning Dove - Insectivore	34	15	85	0	0	100	0	0	0
Endrin	Mourning Dove - Insectivore	34	0	6	91	3	97	3	0	0
Total PCBs	Mourning Dove - Insectivore	34	15	85	0	0	100	0	0	0

N/A = No value available

The limiting receptor is chosen as the receptor with the lowest ESL.

Table 11.1
Summary of Risk Characterization Results for the WBEU

Analyte	Ecological Receptors	Result of Risk Characterization	Risk Description Conclusion
Surface Soil - Non-PMJM Receptors			
Chromium	Terrestrial plants	Screening ESL HQs>1 for all EPCs. Alternate NOEC HQs >1 for all EPCs Alternate LOEC HQs <1 for all EPCs.	Low Risk
	Terrestrial invertebrate	Screening ESL HQs>1 for all EPCs. Alternate LOEC HQs <1 for all EPCs.	Low Risk
	American kestrel	NOAEL HQs >= 1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	Mourning dove (herbivore)	NOAEL HQs <1 to >1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	Mourning dove (insectivore)	NOAEL HQs > 1 for default exposures and TRVs. LOAEL HQs >1 for default exposures and TRVs. NOAEL HQs >=1 for alternative exposures and default TRVs. LOAEL HQ < 1 for all alternative exposures.	Low Risk
	Deer mouse (herbivore)	Not an ECOPC.	Not an ECOPC.
	Deer mouse (Insectivore)	NOAEL HQs <1 to >1 for default exposures and Cr VI TRV. LOAEL HQs < 1 for default exposures and Cr VI TRV. All HQs <1 for default exposures and Cr III TRV.	Low Risk
	Prairie dog	Not an ECOPC.	Not an ECOPC.
	Coyote (carnivore)	Not an ECOPC.	Not an ECOPC.
	Coyote (generalist)	Not an ECOPC.	Not an ECOPC.
	Coyote (insectivore)	Not an ECOPC.	Not an ECOPC.
	Mule Deer	Not an ECOPC.	Not an ECOPC.
Manganese	Terrestrial plants	Not an ECOPC.	Not an ECOPC.
	Terrestrial invertebrate	Not an ECOPC[a].	ECOPC of Uncertain Risk
	American kestrel	Not an ECOPC.	Not an ECOPC.
	Mourning dove (herbivore)	Not an ECOPC	Not an ECOPC
	Mourning dove (insectivore)	Not an ECOPC	Not an ECOPC
	Deer mouse (herbivore)	NOAEL HQ <= 1 for default exposures. LOAEL HQs <1for default exposures.	Low Risk
	Deer mouse (Insectivore)	Not an ECOPC.	Not an ECOPC.
	Prairie dog	Not an ECOPC.	Not an ECOPC.
	Coyote (carnivore)	Not an ECOPC.	Not an ECOPC.
	Coyote (generalist)	Not an ECOPC.	Not an ECOPC.
	Coyote (insectivore)	Not an ECOPC.	Not an ECOPC.
	Mule Deer	Not an ECOPC.	Not an ECOPC.

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Table 11.1
Summary of Risk Characterization Results for the WBEU

Analyte	Ecological Receptors	Result of Risk Characterization	Risk Description Conclusion
Nickel	Terrestrial plants	Not an ECOPC.	Not an ECOPC.
	Terrestrial invertebrate	Not an ECOPC.	Not an ECOPC.
	American kestrel	Not an ECOPC.	Not an ECOPC.
	Mourning dove (herbivore)	Not an ECOPC.	Not an ECOPC.
	Mourning dove (insectivore)	NOAEL HQs > 1 for default exposures and TRVs. Threshold HQs >1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	Deer mouse (herbivore)	NOAEL HQs <= 1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	Deer mouse (insectivore)	NOAEL HQs > 1 for default exposures and TRVs. LOAEL HQs >1 for default exposures and TRVs. All HQs < 1 for default exposures and alternative TRVs. All HQs < 1 for alternative exposures and alternative TRVs.	Low Risk
	Prairie dog	Not an ECOPC.	Not an ECOPC.
	Coyote (carnivore)	Not an ECOPC.	Not an ECOPC.
	Coyote (generalist)	NOAEL HQs >1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	Coyote (insectivore)	NOAEL HQs >1 for default exposures and TRVs. LOAEL HQs <=1 for default exposures and TRVs.	Low Risk
	Mule Deer	Not an ECOPC.	Not an ECOPC.
Silver	Terrestrial plants	Tier 1 UTL = 1 using ESL Tier 2 UTL < 1 using ESL	Low Risk
	Terrestrial invertebrate	Not an ECOPC[a].	ECOPC of Uncertain Risk
	American kestrel	Not an ECOPC[a].	ECOPC of Uncertain Risk
	Mourning dove (herbivore)	Not an ECOPC[a].	ECOPC of Uncertain Risk
	Mourning dove (insectivore)	Not an ECOPC[a].	ECOPC of Uncertain Risk
	Deer mouse (herbivore)	Not an ECOPC[a].	ECOPC of Uncertain Risk
	Deer mouse (insectivore)	Not an ECOPC[a].	ECOPC of Uncertain Risk
	Prairie dog	Not an ECOPC[a].	ECOPC of Uncertain Risk
	Coyote (carnivore)	Not an ECOPC[a].	ECOPC of Uncertain Risk
	Coyote (generalist)	Not an ECOPC[a].	ECOPC of Uncertain Risk
	Coyote (insectivore)	Not an ECOPC[a].	ECOPC of Uncertain Risk
	Mule Deer	Not an ECOPC[a].	ECOPC of Uncertain Risk

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Table 11.1
Summary of Risk Characterization Results for the WBEU

Analyte	Ecological Receptors	Result of Risk Characterization	Risk Description Conclusion
Thallium	Terrestrial plants	Tier 1 UTL = 1 using ESL Tier 2 UTL < 1 using ESL	Low Risk
	Terrestrial invertebrate	Not an ECOPC[a].	ECOPC of Uncertain Risk
	American kestrel	Not an ECOPC[a].	ECOPC of Uncertain Risk
	Mourning dove (herbivore)	Not an ECOPC[a].	ECOPC of Uncertain Risk
	Mourning dove (insectivore)	Not an ECOPC[a].	ECOPC of Uncertain Risk
	Deer mouse (herbivore)	Not an ECOPC.	Not an ECOPC.
	Deer mouse (insectivore)	Not an ECOPC.	Not an ECOPC.
	Prairie dog	Not an ECOPC.	Not an ECOPC.
	Coyote (carnivore)	Not an ECOPC.	Not an ECOPC.
	Coyote (generalist)	Not an ECOPC.	Not an ECOPC.
	Coyote (insectivore)	Not an ECOPC.	Not an ECOPC.
	Mule Deer	Not an ECOPC.	Not an ECOPC.
Tin	Terrestrial plants	Not an ECOPC.	Not an ECOPC.
	Terrestrial invertebrate	Not an ECOPC[a].	ECOPC of Uncertain Risk
	American kestrel	NOAEL HQ <> 1 for default exposures LOAEL HQs < 1 for default exposures.	Low Risk
	Mourning dove (herbivore)	NOAEL HQs <= 1 for default exposures. LOAEL HQs < 1 for default exposures.	Low Risk
	Mourning dove (insectivore)	NOAEL HQs >= 1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	Deer mouse (herbivore)	Not an ECOPC.	Not an ECOPC.
	Deer mouse (insectivore)	NOAEL HQs > 1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs	Low Risk
	Prairie dog	Not an ECOPC.	Not an ECOPC.
	Coyote (carnivore)	Not an ECOPC.	Not an ECOPC.
	Coyote (generalist)	Not an ECOPC.	Not an ECOPC.
	Coyote (insectivore)	Not an ECOPC.	Not an ECOPC.
	Mule Deer	Not an ECOPC.	Not an ECOPC.
Bis(2-ethylhexyl)phthalate	Terrestrial plants	Not an ECOPC[a].	ECOPC of Uncertain Risk
	Terrestrial invertebrate	Not an ECOPC[a].	ECOPC of Uncertain Risk
	American kestrel	Not an ECOPC	Not an ECOPC
	Mourning dove (herbivore)	Not an ECOPC.	Not an ECOPC.
	Mourning dove (insectivore)	NOAEL HQs >= 1 for default exposure and TRVs. LOAEL HQs < 1 for default exposure and TRVs.	Low Risk
	Deer mouse (herbivore)	Not an ECOPC.	Not an ECOPC.
	Deer mouse (Insectivore)	Not an ECOPC.	Not an ECOPC.
	Prairie dog	Not an ECOPC.	Not an ECOPC.
	Coyote (carnivore)	Not an ECOPC.	Not an ECOPC.
	Coyote (generalist)	Not an ECOPC.	Not an ECOPC.
	Coyote (insectivore)	Not an ECOPC.	Not an ECOPC.
	Mule Deer	Not an ECOPC.	Not an ECOPC.

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Table 11.1
Summary of Risk Characterization Results for the WBEU

Analyte	Ecological Receptors	Result of Risk Characterization	Risk Description Conclusion
Endrin	Terrestrial plants	Not an ECOPC[a].	ECOPC of Uncertain Risk
	Terrestrial invertebrate	Not an ECOPC[a].	ECOPC of Uncertain Risk
	American kestrel	NOAEL HQs > 1 for default exposure and TRVs. LOAEL HQs <1 for default exposure and TRVs.	Low Risk
	Mourning dove (herbivore)	Not an ECOPC.	Not an ECOPC.
	Mourning dove (insectivore)	NOAEL HQs > 1 for default exposure and TRVs. LOAEL HQs <1 for default exposure and TRVs.	Low Risk
	Deer mouse (herbivore)	Not an ECOPC.	Not an ECOPC.
	Deer mouse (Insectivore)	Not an ECOPC.	Not an ECOPC.
	Prairie dog	Not an ECOPC.	Not an ECOPC.
	Coyote (carnivore)	Not an ECOPC.	Not an ECOPC.
	Coyote (generalist)	Not an ECOPC.	Not an ECOPC.
	Coyote (insectivore)	Not an ECOPC.	Not an ECOPC.
	Mule Deer	Not an ECOPC.	Not an ECOPC.
Total PCBs	Terrestrial plants	Not an ECOPC.	Not an ECOPC.
	Terrestrial invertebrate	Not an ECOPC[a].	ECOPC of Uncertain Risk
	American kestrel	Not an ECOPC	Not an ECOPC.
	Mourning dove (herbivore)	Not an ECOPC.	Not an ECOPC.
	Mourning dove (insectivore)	NOAEL HQs > 1 for default exposure and TRVs. LOAEL HQs <1 for default exposure and TRVs.	Low Risk
	Deer mouse (herbivore)	Not an ECOPC.	Not an ECOPC.
	Deer mouse (Insectivore)	Not an ECOPC.	Not an ECOPC.
	Prairie dog	Not an ECOPC.	Not an ECOPC.
	Coyote (carnivore)	Not an ECOPC.	Not an ECOPC.
	Coyote (generalist)	Not an ECOPC.	Not an ECOPC.
	Coyote (insectivore)	Not an ECOPC.	Not an ECOPC.
	Mule Deer	Not an ECOPC.	Not an ECOPC.
Surface Soil - PMJM Receptors			
None	The small areas of PMJM habitat located within the WBEU were evaluated in the UWNEU and LWOEU.		
Subsurface Soil			
None	Prairie dog	No ECOPCs.	No ECOPCs.

[a]No ESL was available for the receptor. Risks to this receptor are uncertain and discussed in Section 10.

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FIGURES

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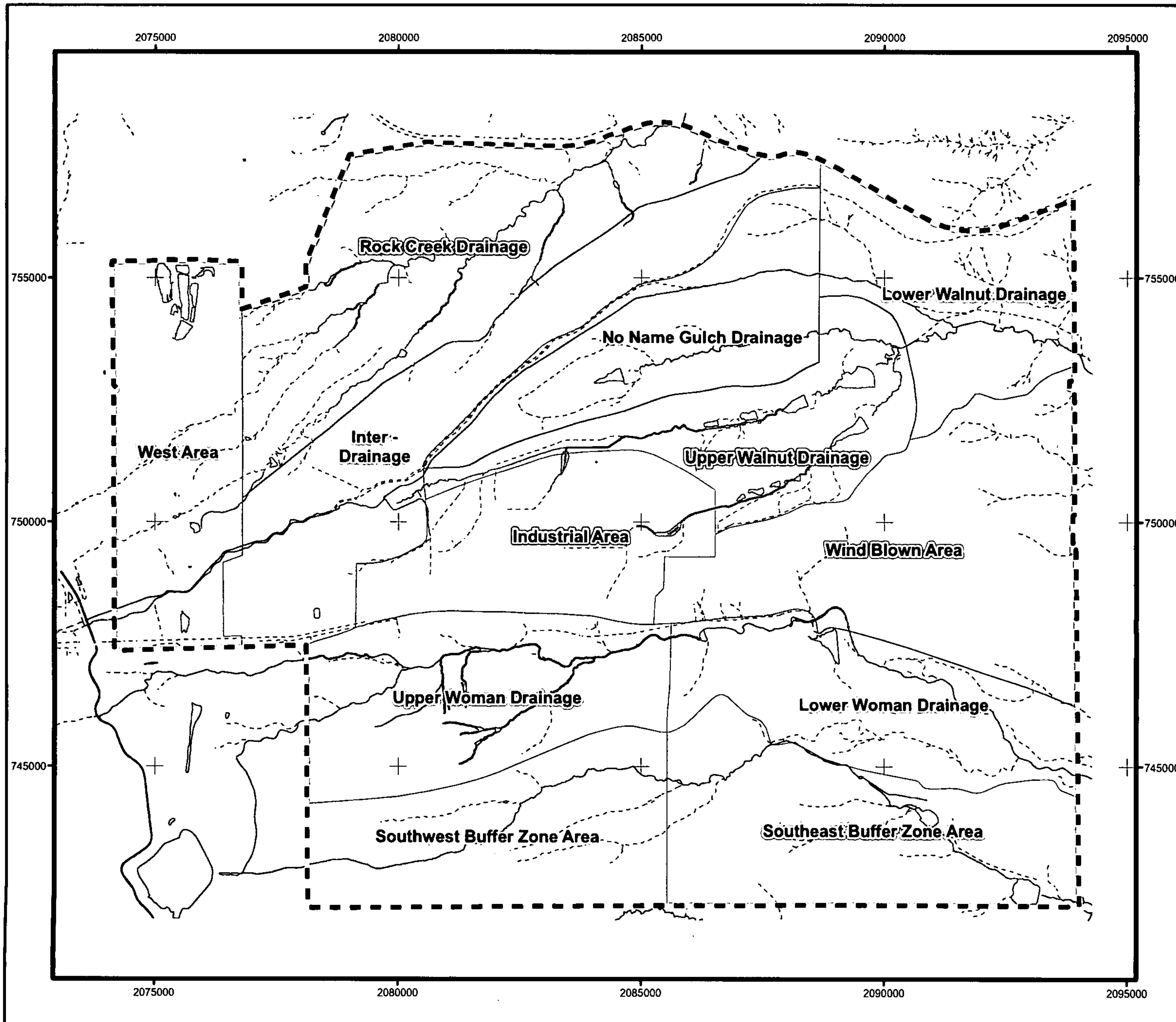

Figure 1.1
Rocky Flats Environmental Technology Site
Exposure Units

KEY

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W E
S

0 1,500 3,000 Feet

Scale 1:36,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Rocky Flats Environmental Technology Site

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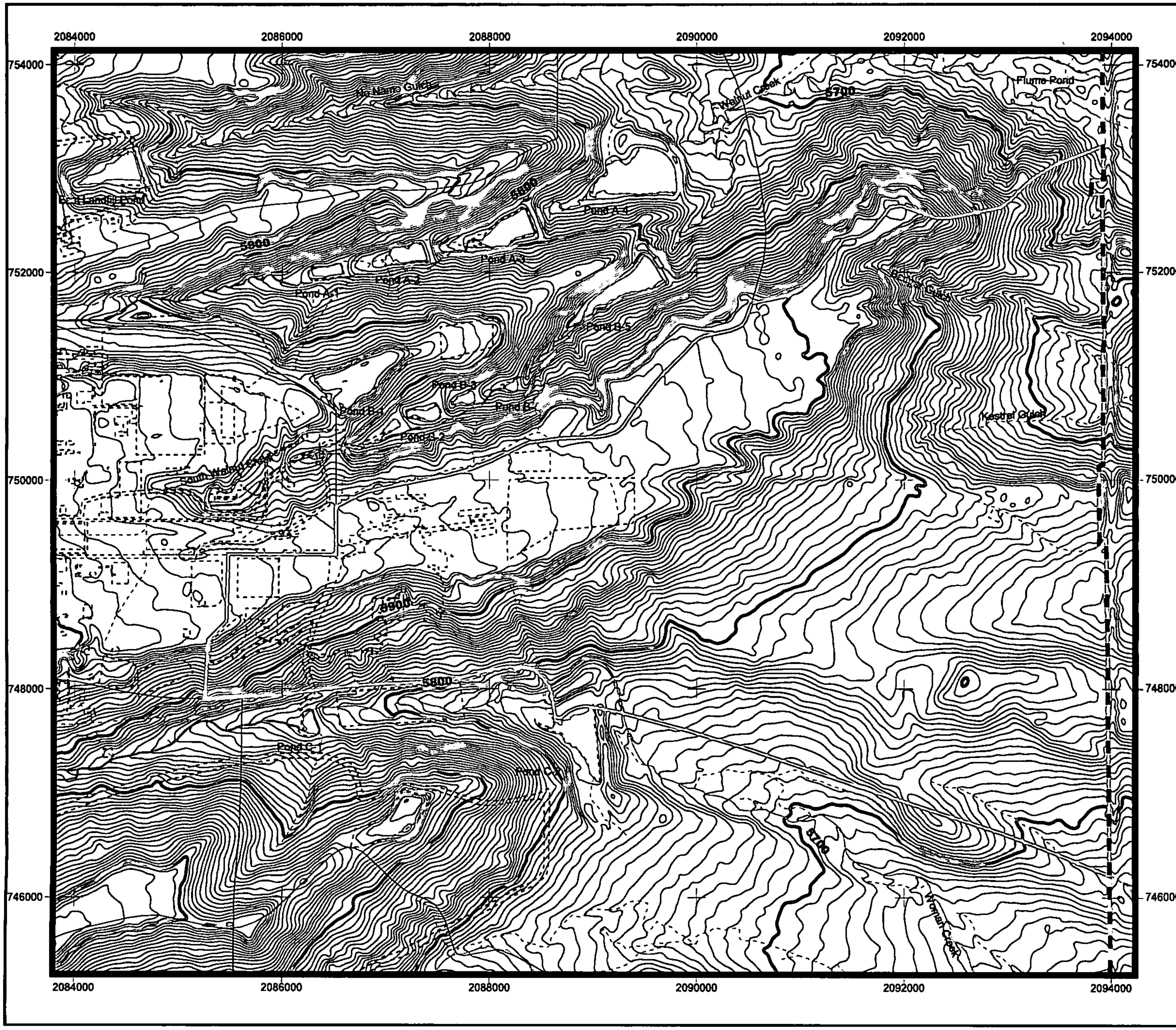

Figure 1.2
Topography and Historical IHSS Locations in the Wind Blown Area Exposure Unit

KEY

- Wind Blown Area EU
- Historical IHSS/PAC
- Topographic contour interval = 5 ft.

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W
E
S

0 700 1400 Feet

Scale 1:16800

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental
Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section1\WindBlownArea.apr

Figure 1.3
Aerial Photograph of the Wind Blown Area Exposure Unit
July 2005

KEY

Wind Blown Area EU

Standard Map Features

Exposure unit boundary
Pond
Site boundary
Perennial stream
Intermittent stream
Ephemeral stream

N W E S

0 700 1400 Feet

Scale 1:16800

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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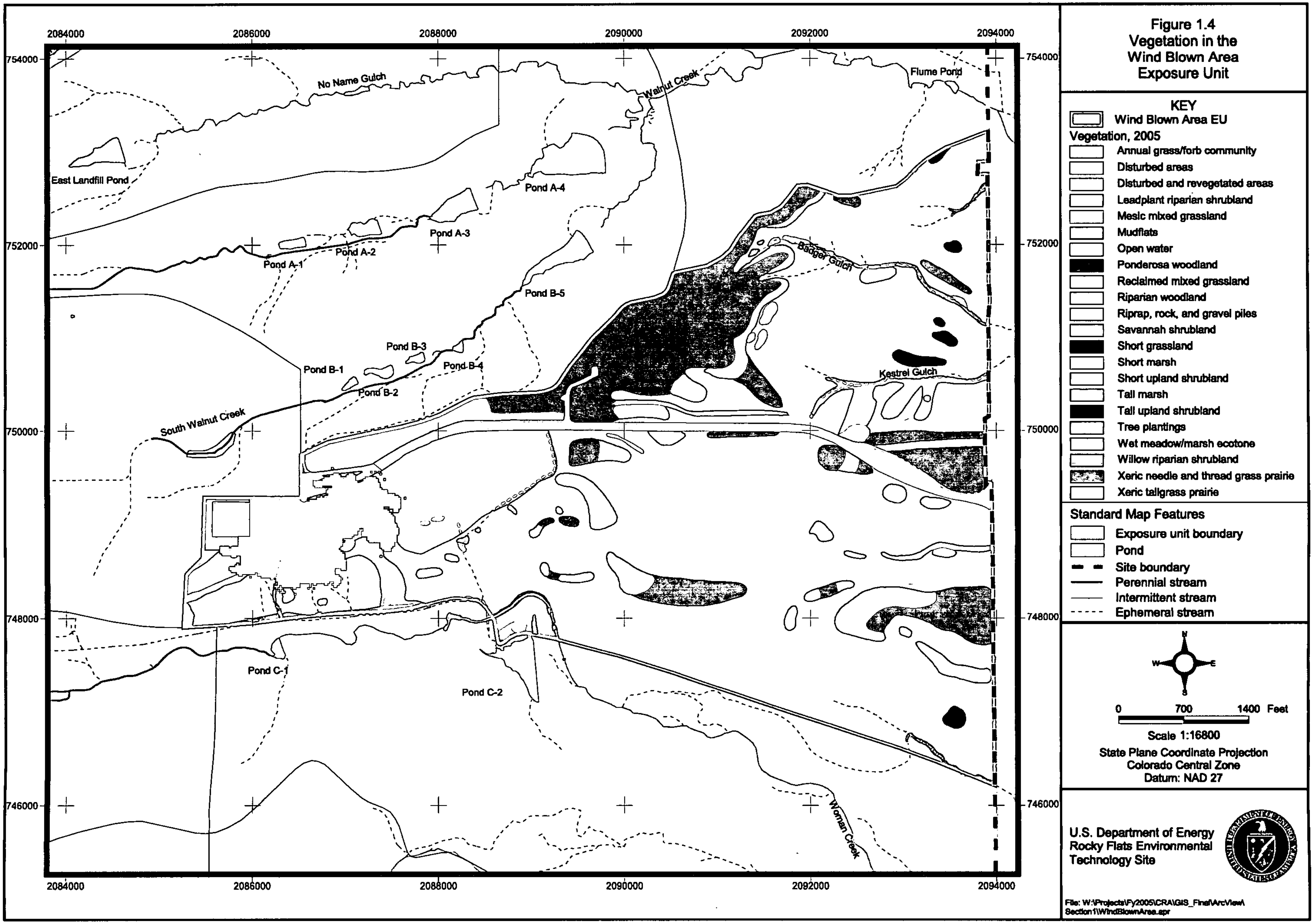

Figure 1.4
Vegetation in the
Wind Blown Area
Exposure Unit

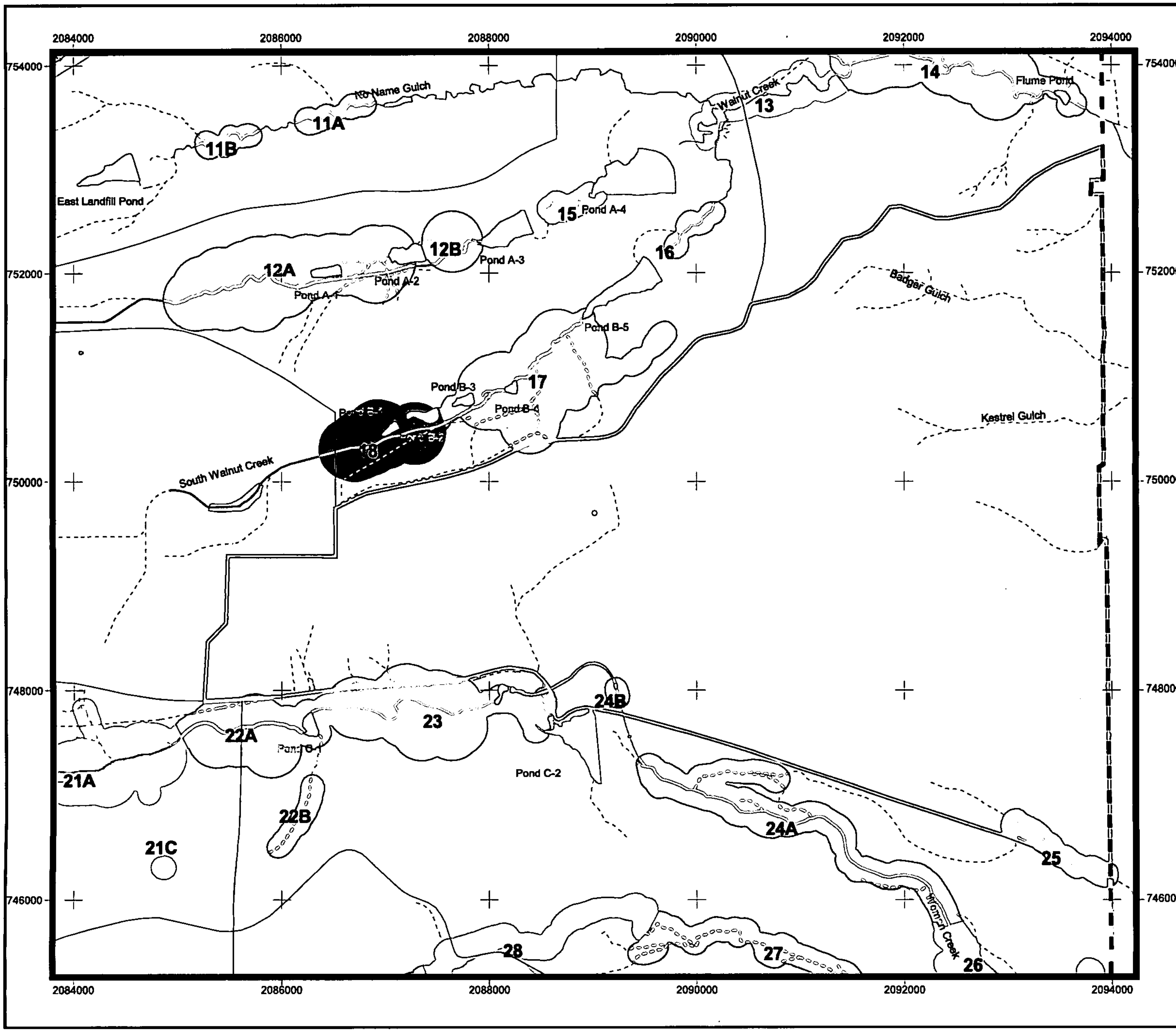

Figure 1.5
Preble's Meadow Jumping Mouse Habitat and Surface Soil Sample Locations in the Wind Blown Area Exposure Unit

KEY

- Surface soil sample location
- Wind Blown Area EU
- PMJM habitat patch
- 1 PMJM habitat patch ID

Note: Not all analyte groups were analyzed at every sample location.

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N W E S

0 700 1400 Feet

Scale 1:16800

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section1\WindBlownArea.apr

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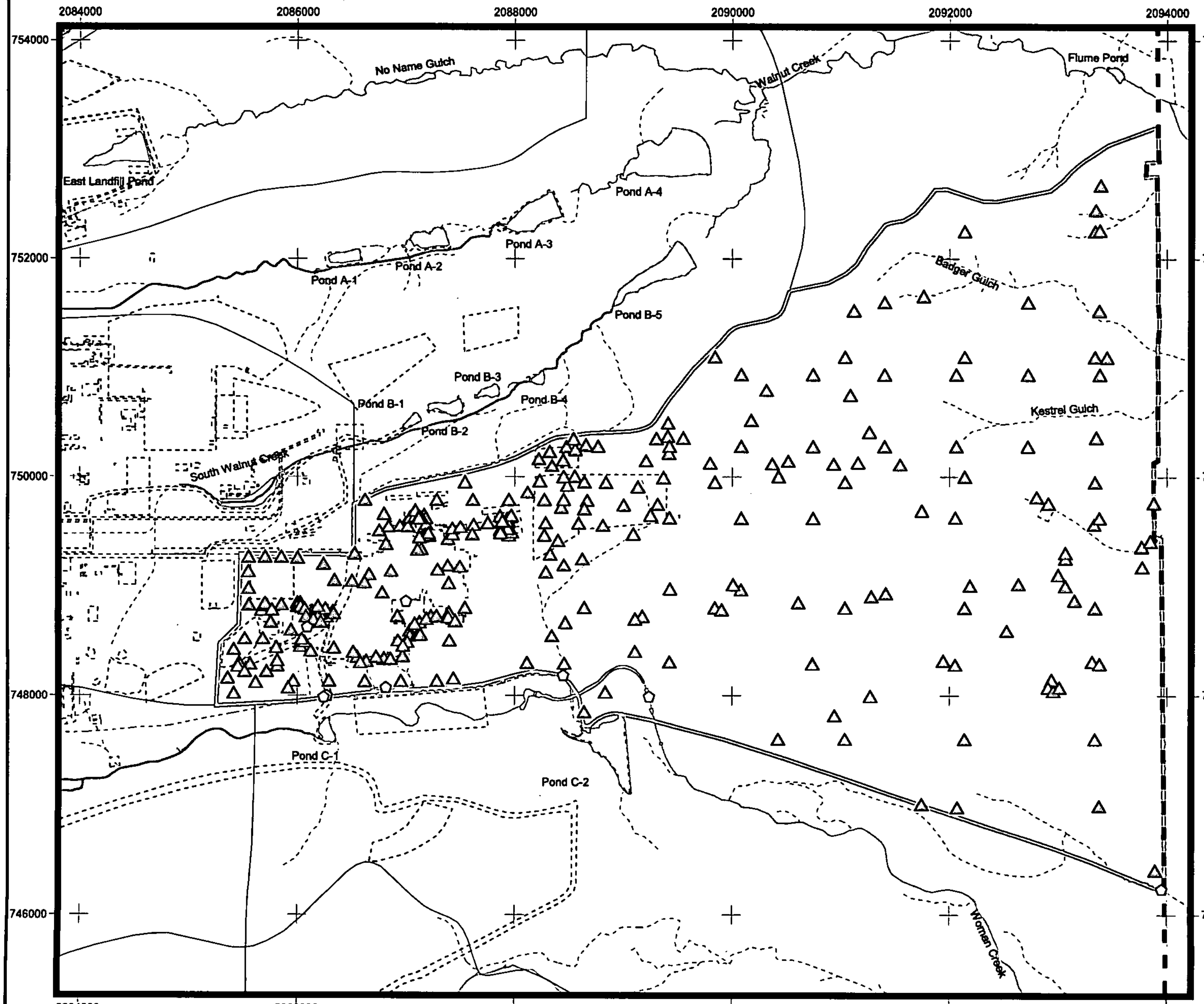

Figure 1.6
Wind Blown Area Exposure Unit Surface Soil and Surface Sediment Sample Locations

KEY

Sample location
- Surface sediment sample location
- Surface soil sample location

(Background locations shown in red)
- Surface sediment sample location
- Surface soil sample location
- Wind Blown Area EU
- Historical IHSS/PAC

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N W E S

0 700 1400 Feet

Scale 1:16800

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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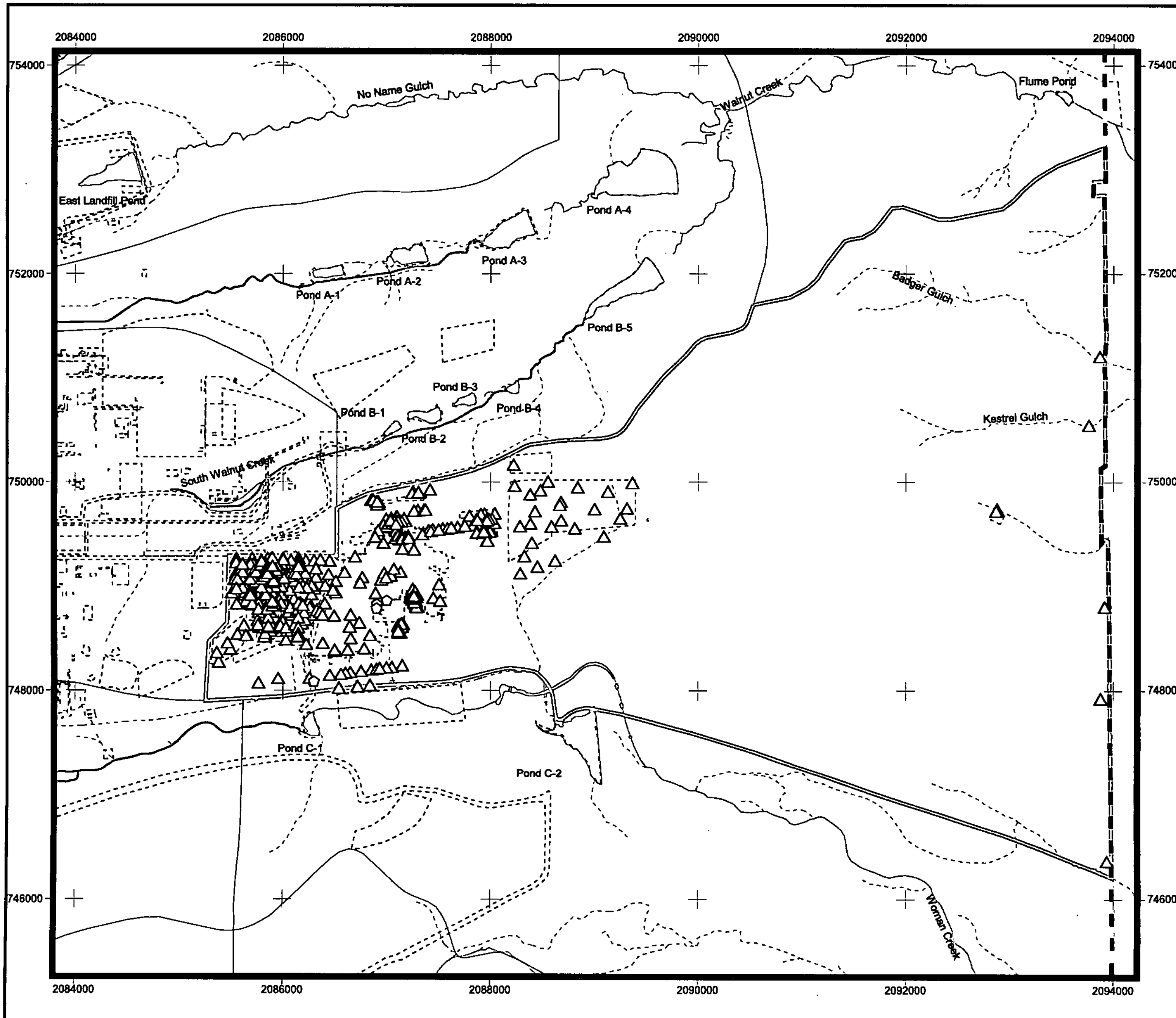

Figure 1.7
Wind Blown Area Exposure Unit Subsurface Soil and Subsurface Sediment Sample Locations

KEY

Sample location
- Subsurface sediment sample location
- Subsurface soil sample location

(Background locations shown in red)
- Subsurface sediment sample location
- Subsurface soil sample location
- Wind Blown Area EU
- Historical IHSS/PAC

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N W E S

0 700 1400 Feet

Scale 1:16800

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section1\WindBlownArea.apr

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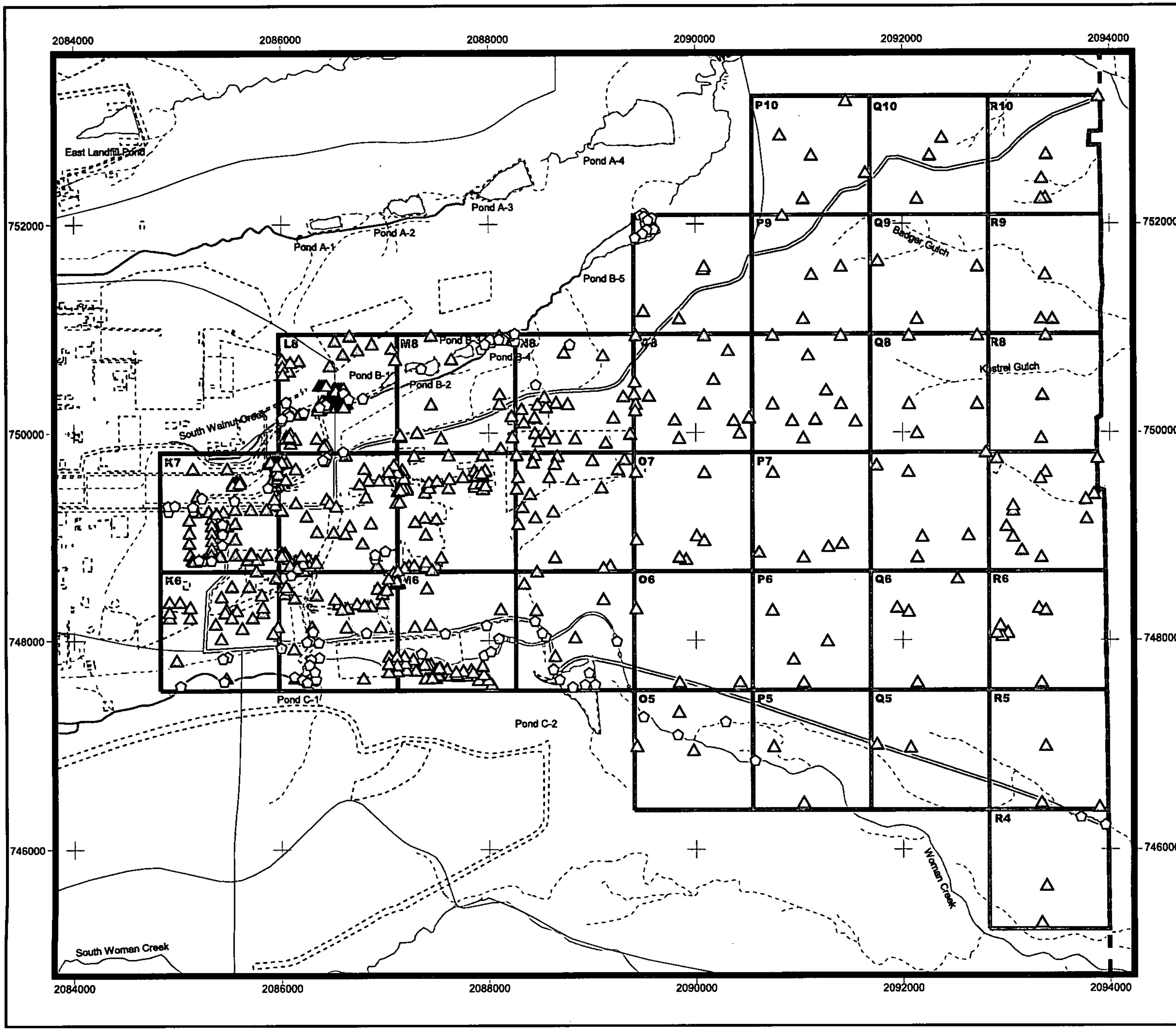

Figure 3.1
Tier 2 EPC 30-acre Grids with Surface Soil and Surface Sediment Sample Locations

KEY

- Surface sediment sample location
- Surface soil sample location
- Wind Blown Area EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W E
S

0 700 1400 Feet

Scale 1:16800

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section3\WindBlownArea.apr

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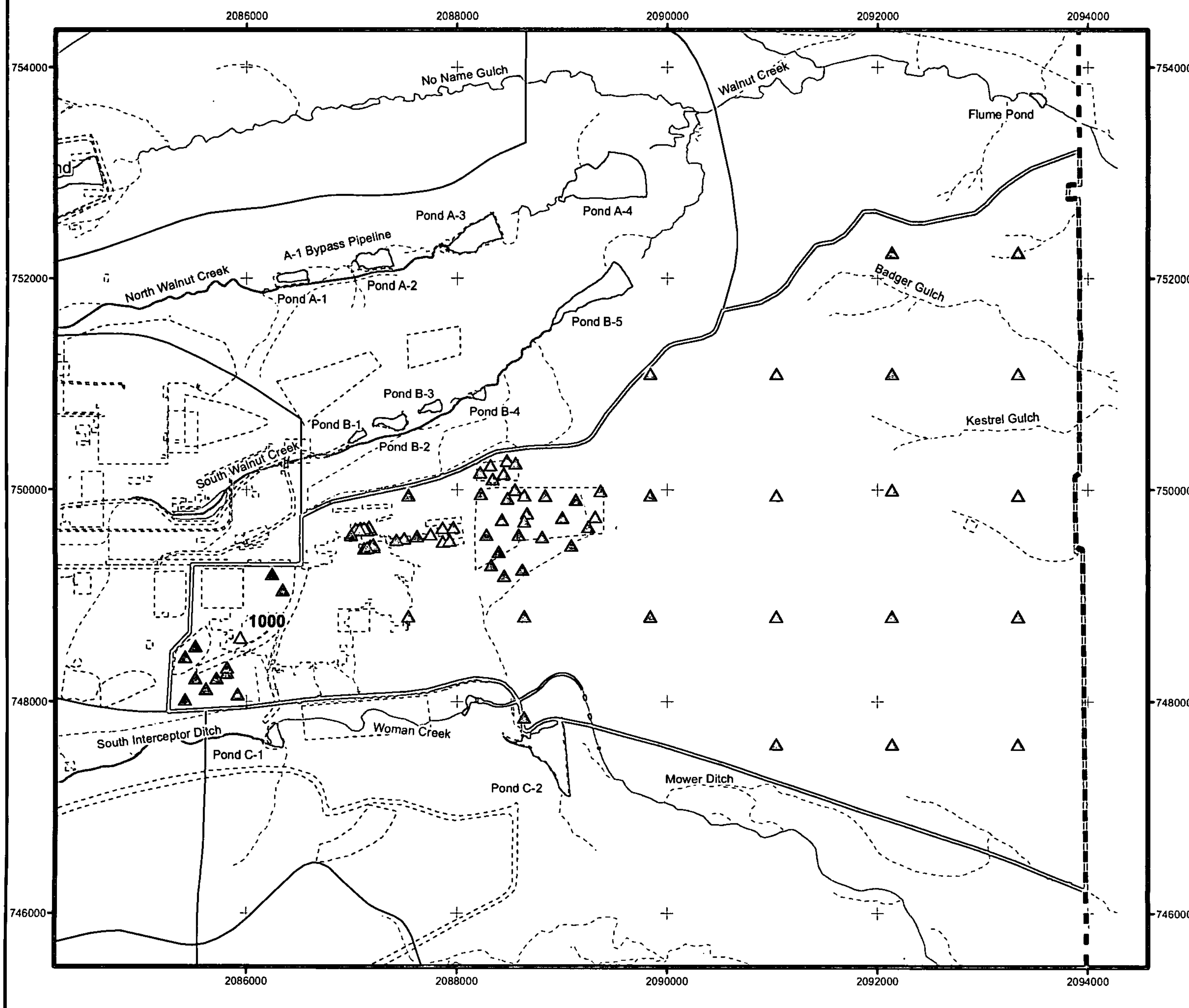

Figure 7.1
Wind Blown Area EU
Surface Soil Results
for Di-n-butylphthalate

KEY

Sample location
Detect
Nondetect
Wind Blown Area EU
Historical IHSS/PAC

CRA Methodology ESL = 15.87 ug/kg

Standard Map Features
Exposure unit boundary
Pond
Site boundary
Perennial stream
Intermittent stream
Ephemeral stream

N W E S

0 700 1,400 Feet
Scale 1:16,800
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Rocky Flats Environmental
Technology Site

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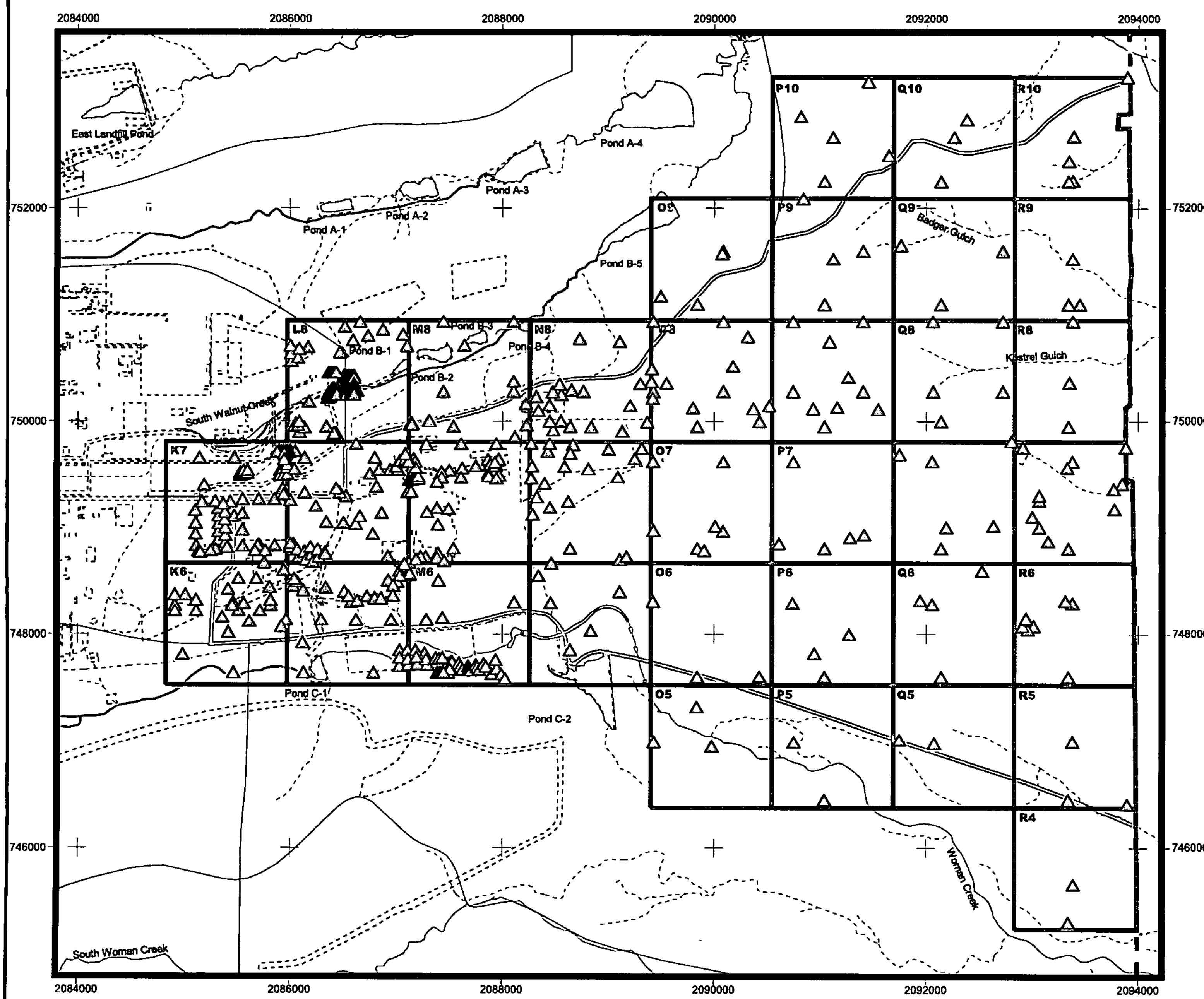

Figure 8.1
Tier 2 EPC 30-acre Grids
with Surface Soil
Sample Locations

KEY

- Surface soil sample location
- Wind Blown Area EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N W E S

0 700 1400 Feet

Scale 1:16800

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Rocky Flats Environmental
Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section8\WindBlownArea.apr

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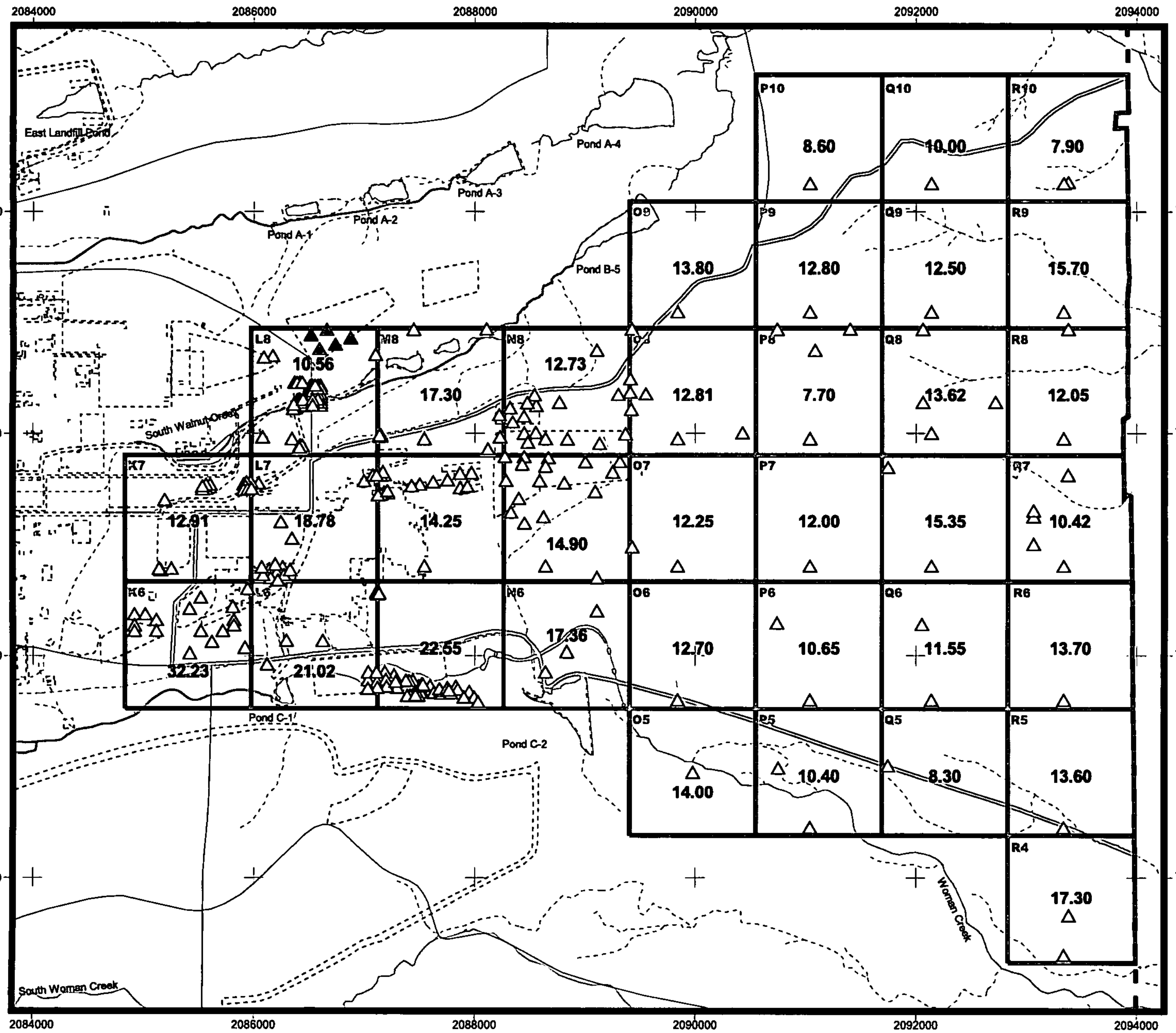

Figure 10.1
Wind Blown Area Exposure Unit
Sample-by-Sample
Comparison to the Limiting ESL -
Chromium

KEY

Surface soil sample location
- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Nondetect
- Wind Blown Area EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 1.34 mg/kg
Receptor: Mourning Dove (Insectivore)
95th UCL background: 12.3 mg/kg
Maximum background concentration: 16.9 mg/kg

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N W E S

0 700 1400 Feet

Scale 1:16800

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section10\WindBlownArea.apr

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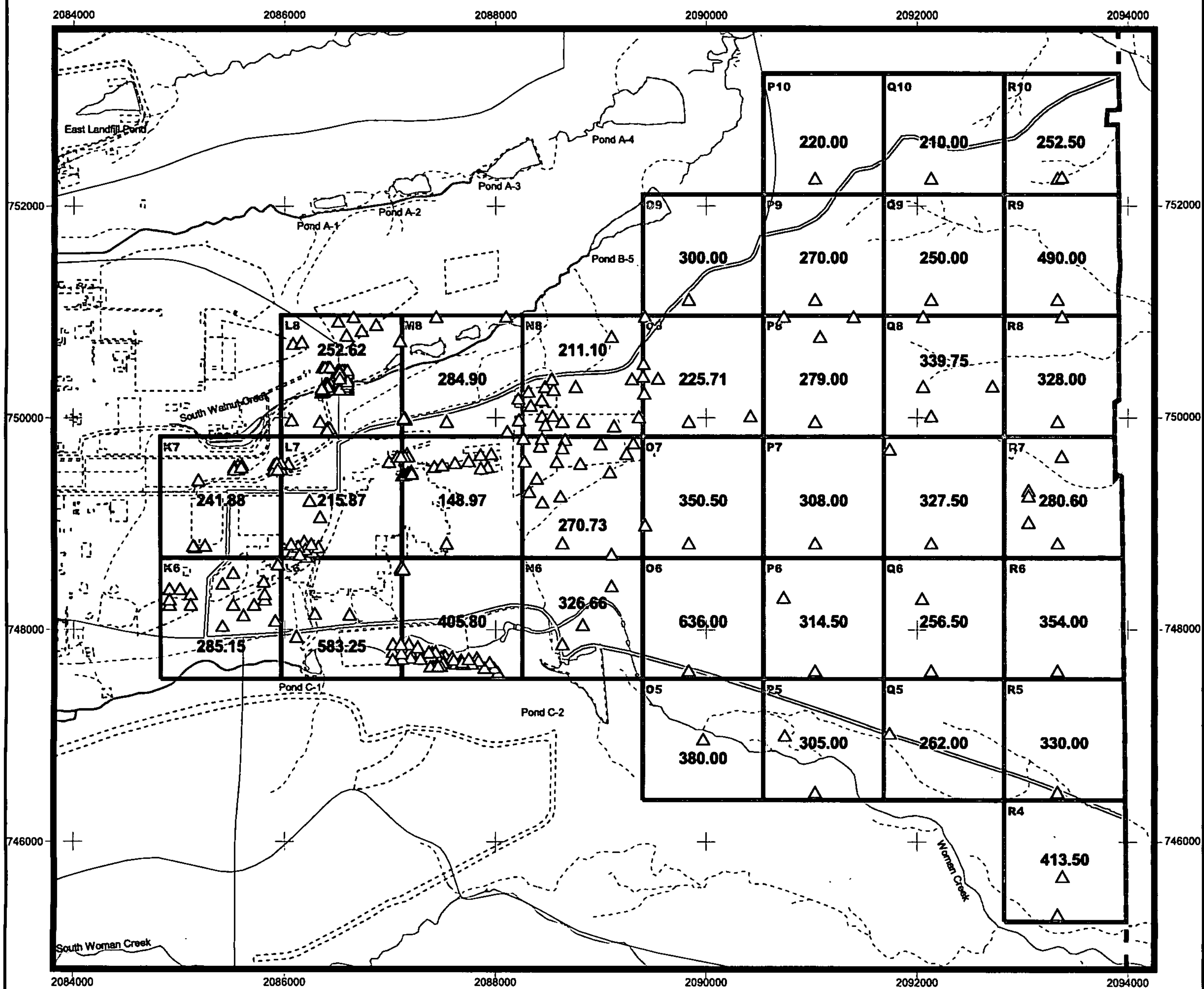

Figure 10.2
Wind Blown Area Exposure Unit
Sample-by-Sample
Comparison to the Limiting ESL -
Manganese

KEY

Surface soil sample location
- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Nondetect
- Wind Blown Area EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 486 mg/kg
Receptor: Deer Mouse (Herbivore)
95th UCL background: 262 mg/kg
Maximum background concentration: 357 mg/kg

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W E
S

0 700 1400 Feet

Scale 1:16800
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Rocky Flats Environmental
Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section10\WindBlownArea.apr

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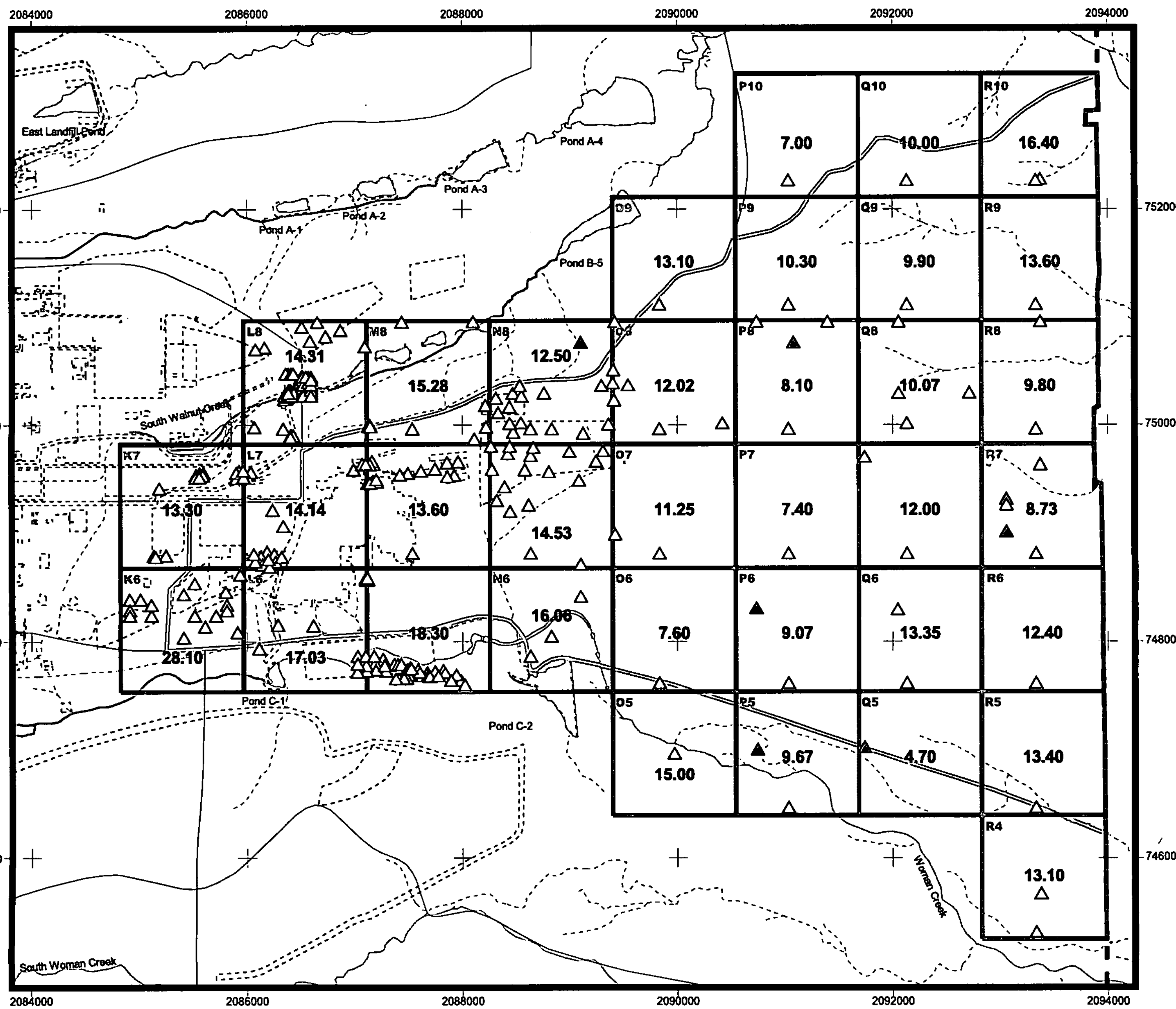

Figure 10.3
Wind Blown Area Exposure Unit Sample-by-Sample Comparison to the Limiting ESL - Nickel

KEY

Surface soil sample location

- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Nondetect
- Wind Blown Area EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 0.431 mg/kg
Receptor: Deer Mouse (Insectivore)
95th UCL background: 10.6 mg/kg
Maximum background concentration: 14 mg/kg

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N W E S

0 700 1400 Feet

Scale 1:16800

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section10\WindBlownArea.apr

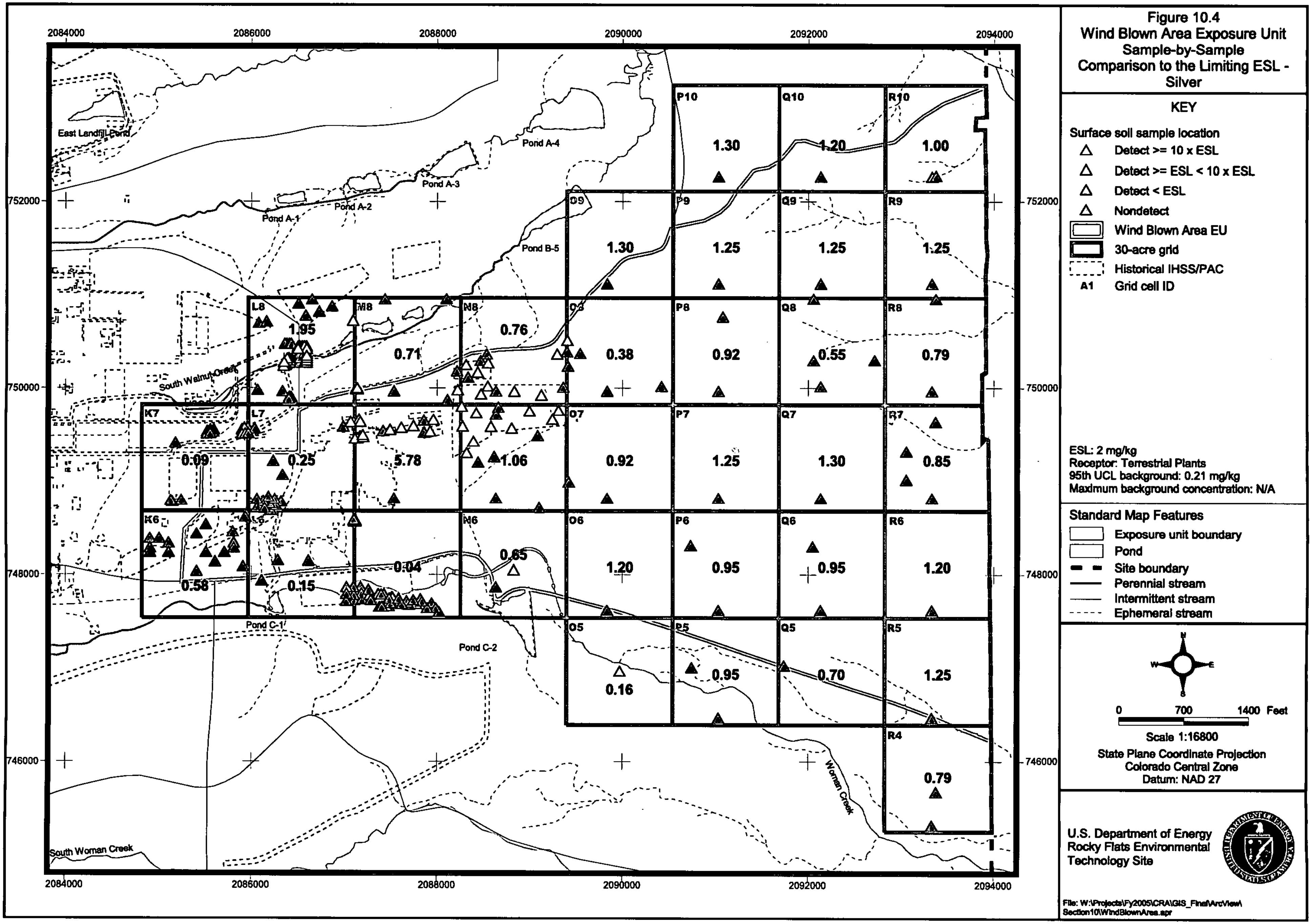

Figure 10.4
Wind Blown Area Exposure Unit
Sample-by-Sample
Comparison to the Limiting ESL -
Silver

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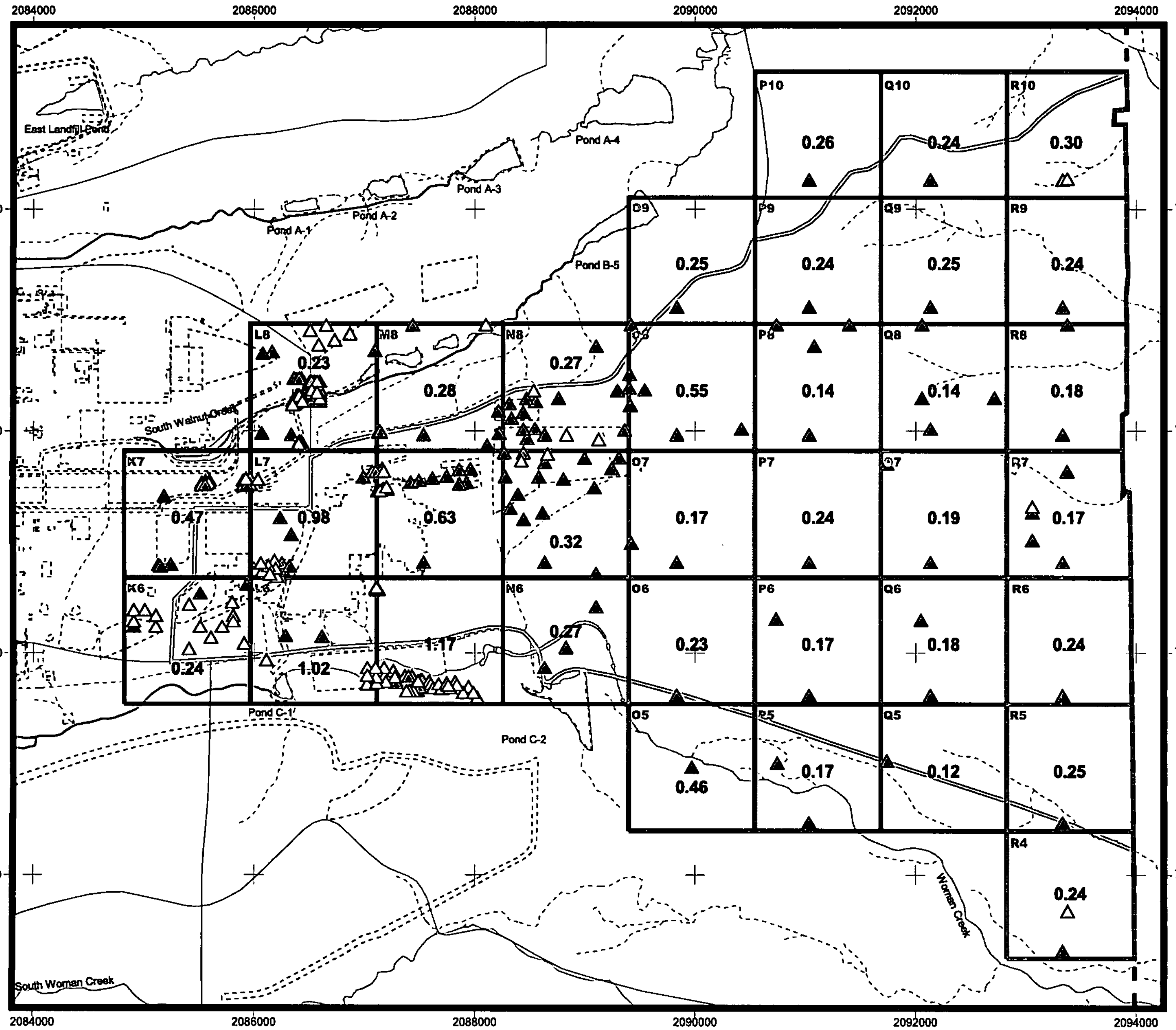

Figure 10.5
Wind Blown Area Exposure Unit
Sample-by-Sample
Comparison to the Limiting ESL -
Thallium

KEY

Surface soil sample location
- △ Detect >= 10 x ESL
- △ Detect >= ESL < 10 x ESL
- △ Detect < ESL
- △ Nondetect
- Wind Blown Area EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 1 mg/kg
Receptor: Terrestrial Plants
95th UCL background: 0.421 mg/kg
Maximum background concentration: N/A

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N W E S

0 700 1400 Feet

Scale 1:16800

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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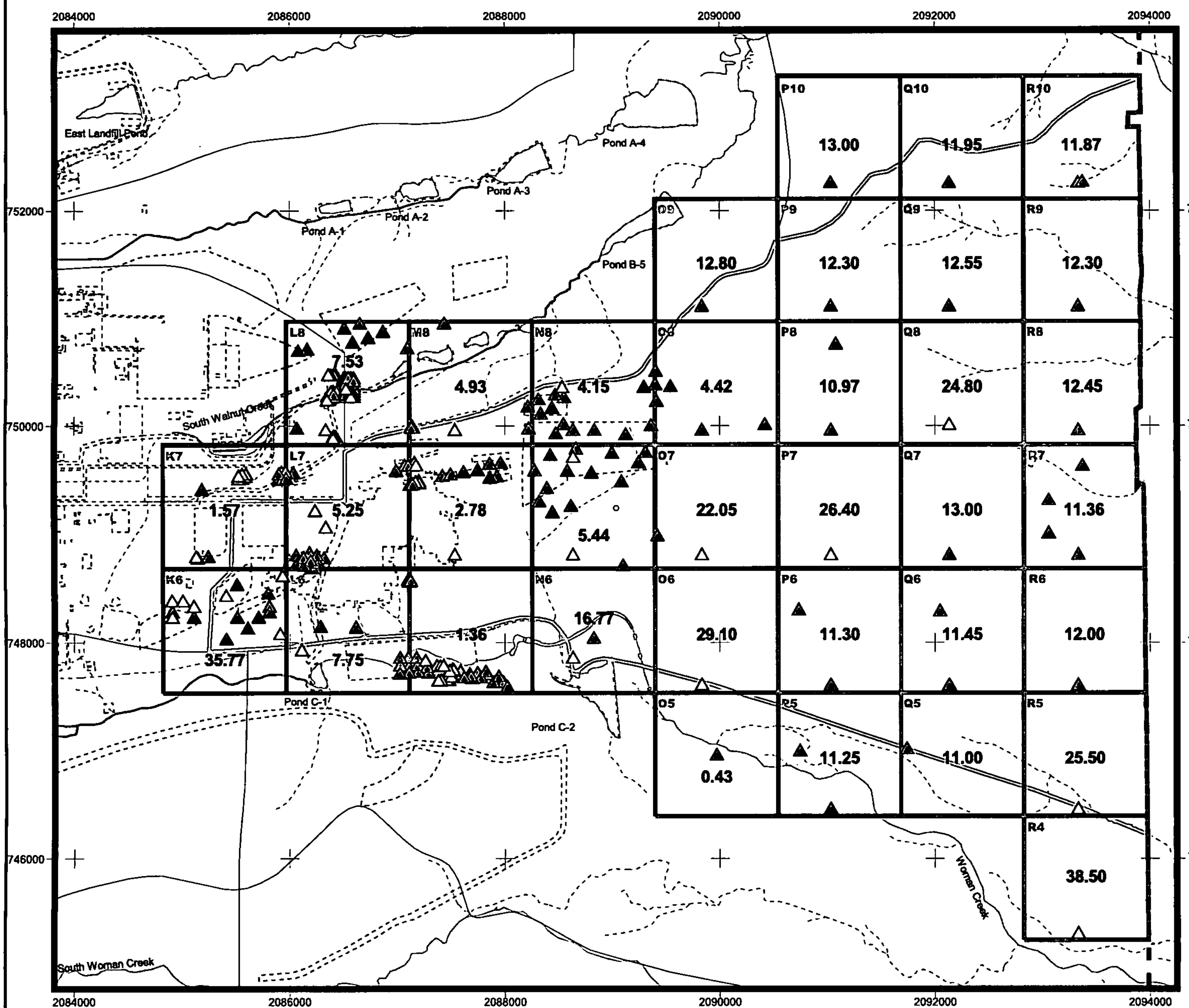
Figure 10.6
Wind Blown Area Exposure Unit Sample-by-Sample Comparison to the Limiting ESL - Tin



KEY

Surface soil sample location
- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Nondetect
- Wind Blown Area EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 2.9 mg/kg
Receptor: Mourning Dove (Insectivore)
95th UCL background: 2.22 mg/kg
Maximum background concentration: N/A

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N E S W

0 700 1400 Feet

Scale 1:16800

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section10\WindBlownArea.apr

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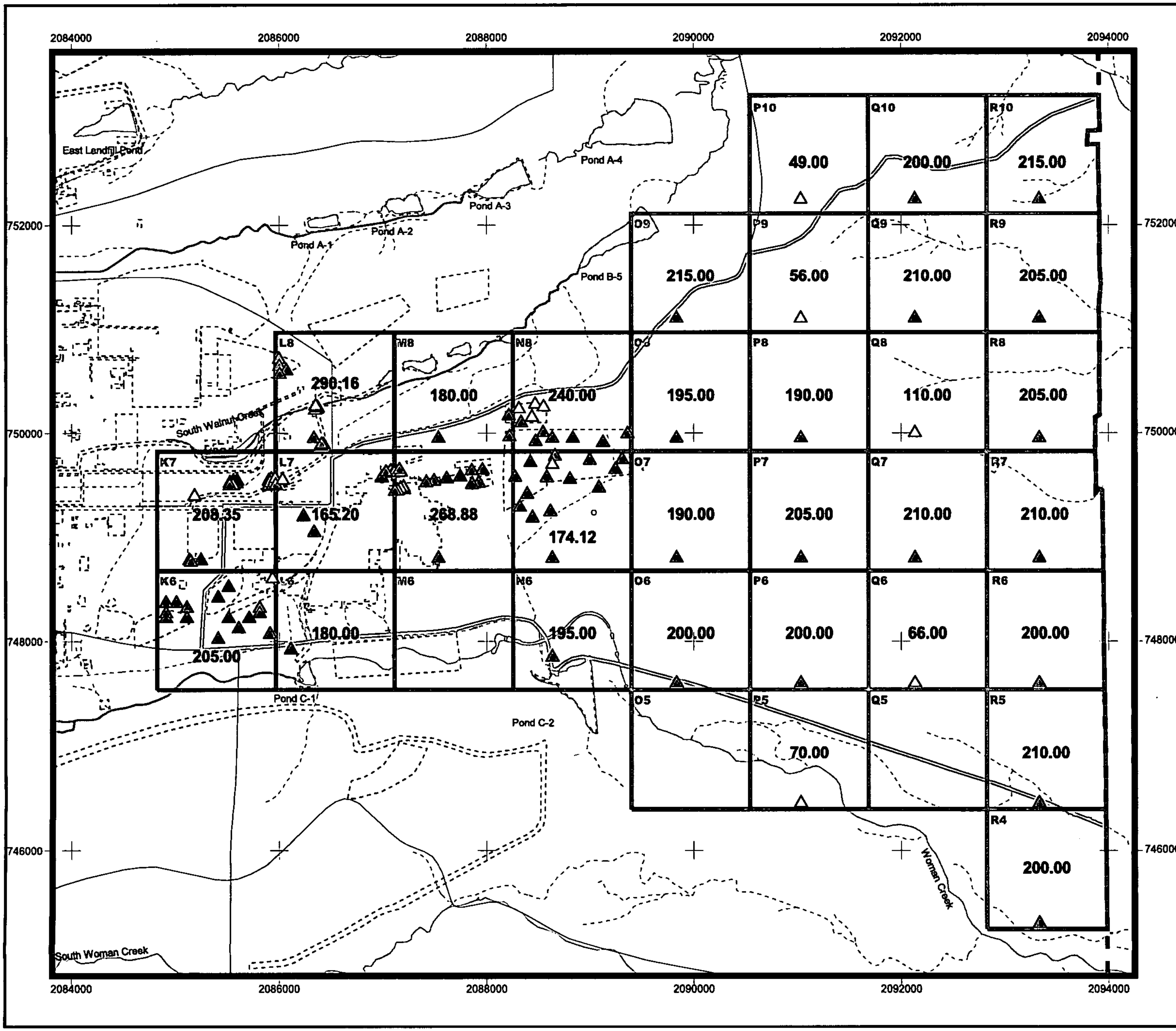

Figure 10.7
Wind Blown Area Exposure Unit Sample-by-Sample Comparison to the Limiting ESL - Bis(2-ethylhexyl)phthalate

KEY

Surface soil sample location
- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Nondetect
- Wind Blown Area EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 137 ug/kg
Receptor: Mourning Dove (Insectivore)
95th UCL background: N/A
Maximum background concentration: N/A

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W E
S

0 700 1400 Feet

Scale 1:16800

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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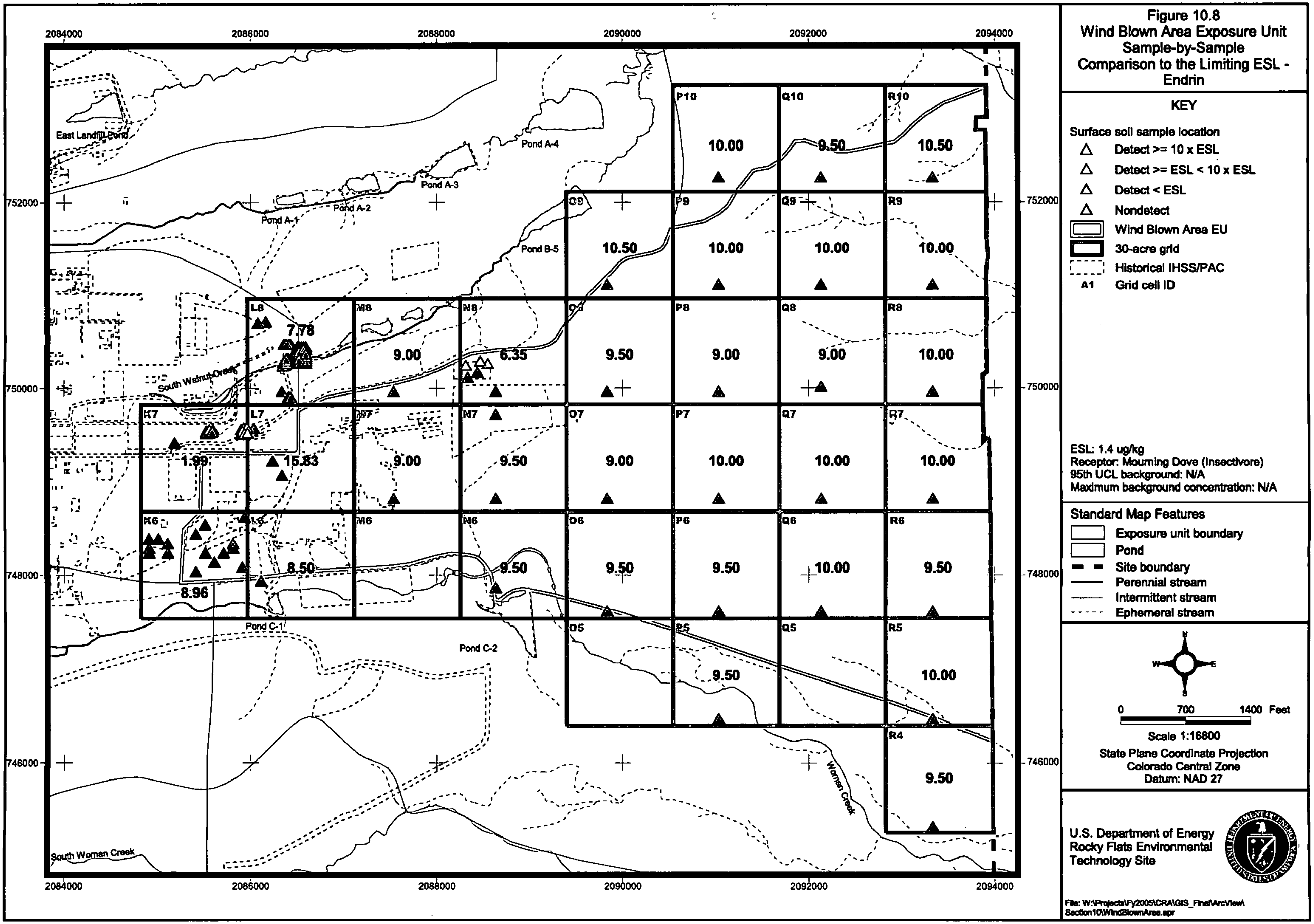
Figure 10.8
Wind Blown Area Exposure Unit
Sample-by-Sample
Comparison to the Limiting ESL -
Endrin
KEY
Surface soil sample location
Detect >= 10 x ESL
Detect >= ESL < 10 x ESL
Detect < ESL
Nondetect
Wind Blown Area EU
30-acre grid
Historical IHSS/PAC
A1 Grid cell ID
ESL: 1.4 ug/kg
Receptor: Mourning Dove (Insectivore)
95th UCL background: N/A
Maximum background concentration: N/A
Standard Map Features
Exposure unit boundary
Pond
Site boundary
Perennial stream
Intermittent stream
Ephemeral stream
0 700 1400 Feet
Scale 1:16800
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27
U.S. Department of Energy
Rocky Flats Environmental
Technology Site
File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section10\WindBlownArea.apr
2084000
2086000
2088000
2090000
2092000
2094000
752000
750000
748000
746000
East Landfill Pond
Pond A-4
Pond A-3
Pond A-2
Pond A-1
Pond B-5
South Walnut Creek
Pond C-1
Pond C-2
Woman Creek
South Woman Creek
P10
10.00
Q10
9.50
R10
10.50
O9
10.50
P9
10.00
Q9
10.00
R9
10.00
L8
7.78
M8
9.00
N8
6.35
O8
9.50
P8
9.00
Q8
9.00
R8
10.00
K7
1.99
L7
15.83
M7
9.00
N7
9.50
O7
9.00
P7
10.00
Q7
10.00
R7
10.00
K6
8.96
L6
8.50
M6
N6
9.50
O6
9.50
P6
9.50
Q6
10.00
R6
9.50
O5
P5
9.50
Q5
R5
10.00
R4
9.50

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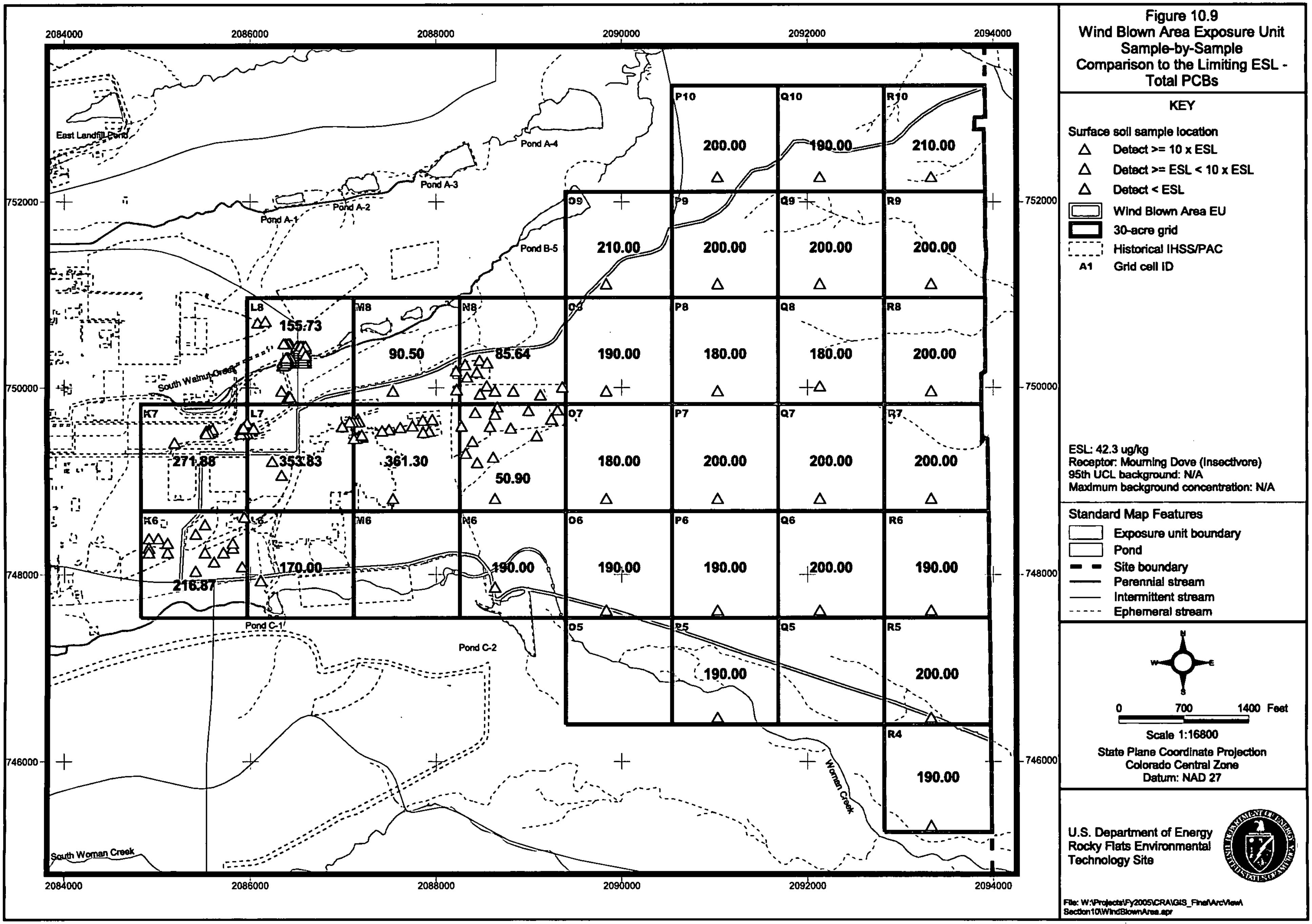

Figure 10.9
Wind Blown Area Exposure Unit
Sample-by-Sample
Comparison to the Limiting ESL -
Total PCBs

COMPREHENSIVE RISK ASSESSMENT

WIND BLOWN AREA EXPOSURE UNIT

VOLUME 9: ATTACHMENT 1

Detection Limit Screen

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ACRONYMS AND ABBREVIATIONS

µg/kg	microgram per kilogram
ERA	Ecological Risk Assessment
ESL	ecological screening level
EU	Exposure Unit
HHRA	Human Health Risk Assessment
mg/kg	milligram per kilogram
N/A	not available or not applicable
NOAEL	no observed adverse effect level
PRG	preliminary remediation goal
UT	unknown toxicity
WBEU	Wind Blown Area Exposure Unit
WRW	wildlife refuge worker

1.0 EVALUATION OF DETECTION LIMITS FOR NONDETECTED ANALYTES AND ANALYTES DETECTED IN LESS THAN 5 PERCENT OF SAMPLES IN THE WIND BLOWN AREA EXPOSURE UNIT

The detection limits for analytes that are either not detected or detected in less than 5 percent of the samples collected from the media used in the Human Health Risk Assessment (HHRA) or the Ecological Risk Assessment (ERA) are reviewed in this attachment. The detection limits for surface soil/surface sediment and subsurface soil/subsurface sediment samples are compared to human health preliminary remediation goals (PRGs) for the wildlife refuge worker (WRW). The detection limits for media evaluated in the ERA are compared to the minimum ecological screening level (ESL) for a variety of ecological receptors (surface soil) and the prairie dog no observed effect level (NOAEL) ESL (subsurface soil). The results of these comparisons are presented in Tables A1.1 through A1.4.

Nondetects, analytes detected in less than 5 percent of samples, and the reported detection limits (referred to as "reported result" in the following sections of this attachment) are listed in these tables for each medium in the Wind Blown Area Exposure Unit (EU) (WBEU) and compared to medium-specific human health PRGs for the WRW and ESLs for a variety of ecological receptors. Maximum reported results that exceed the respective PRGs and ESLs are noted and discussed.

Analytes that were not detected in any samples collected in each media are referred to as nondetected analytes. The nondetected chemicals are reported in this attachment at the lowest level at which the chemical may be accurately and reproducibly quantified, taking into account the sample characteristics, sample collection, sample preparation, and analytical adjustments.

1.1 Comparison of Maximum Reported Results for Nondetected Analytes and Analytes Detected in Less than 5 percent of Samples to Preliminary Remediation Goals

1.1.1 Surface Soil/Surface Sediment

The maximum reported results for two analytes detected in less than 5 percent of samples (dibenz(a,h)anthracene and n-nitroso-di-n-propylamine) in surface soil/surface sediment are greater than the PRG (Table A1.1). Therefore, there is some uncertainty associated with the reported results for these analytes in the WBEU.

The minimum reported results for both analytes were below their respective PRGs. The maximum reported result for dibenz(a,h)anthracene was just over 2 times the PRG and the maximum reported result for n-nitroso-di-n-propylamine was just under two times the PRG. The slight exceedance of the PRG by the maximum reported results for these 2 analytes is not expected to have significant impacts on the results of the risk assessment.

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PRGs were not available for several nondetected organics in surface soil/surface sediment (Table A1.1). Because PRGs were available for most of the nondetected organics in surface soil/surface sediment, and the maximum reported results for most of these analytes were lower than the PRGs, the lack of PRGs for less than half of the organics is unlikely to have a significant effect on the results of the risk assessment.

1.1.2 Subsurface Soil/Subsurface Sediment

The maximum reported results for 12 nondetected analytes and five analytes detected in less than 5 percent of samples (benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, PCB-1248, and pentachlorophenol) in subsurface soil/subsurface sediment are greater than the PRG (Table A1.2). For n-nitrosodiethylamine and n-nitrosodimethylamine, the minimum reported results also exceeded the PRG. Therefore, there is some uncertainty associated with the reported results for these analytes in subsurface soil/ subsurface sediment in the WBEU.

For n-nitrosodiethylamine, the maximum reported result was approximately 32 times the PRG. For 1,2-dibromoethane, dibenz(a,h)anthracene, n-nitrosodimethylamine, and n-nitroso-di-n-propylamine, the maximum reported results were between 10 and 20 times the PRG. The remaining 12 analytes had maximum reported results that were less than 5 times the PRG.

PRGs were not available for several nondetected organic analytes and organic analytes detected in less than 5 percent of samples in subsurface soil/subsurface sediment (Table A1.2). Because PRGs were available for most of the nondetected organics and organics detected in less than 5 percent of samples in subsurface soil/subsurface sediment, and the maximum reported results for most of these analytes were lower than the PRGs, the lack of PRGs for less than half of the organics is unlikely to have a significant effect on the results of the risk assessment.

1.2 Comparison of Maximum Reported Results for Nondetected Analytes and Analytes Detected in Less than 5 percent of Samples to Ecological Screening Levels

1.2.1 Surface Soil

In surface soil in the WBEU, the maximum reported results for 16 nondetected analytes and three analytes detected in less than 5 percent of samples (4,6-dinitro-2-methylphenol, di-n-butylphthalate, and PCB-1248) exceeded their respective ESLs (Table A1.3). For 10 of these 19 analytes, the minimum reported results also exceeded the ESL. Therefore, there is some uncertainty associated with the reported results for nondetected analytes in surface soil in the WBEU.

The maximum reported results for hexachlorobenzene, di-n-butylphthalate, pentachlorophenol, 2,4-dinitrotoluene, 4,6-dinitro-2-methylphenol, and endrin ketone were approximately 107, 52, 34, 26, 19, and 15 times the PRG, respectively. The remaining 13 analytes had maximum reported results that were less than 10 times the PRG.

ESLs were unavailable for less than half of the nondetected organics and organics detected in less than 5 percent of surface soil samples (Table A1.3). Because ESLs were available for most of the nondetected organics and organics detected in less than 5 percent of surface soil samples and the maximum reported results for these analytes were much lower than the ESLs, the lack of ESLs for less than half of the organics is unlikely to have a significant effect on the results of the risk assessment.

1.2.2 Subsurface Soil

The maximum reported result for six nondetected analytes and three analytes detected in less than 5 percent of samples (selenium, 2-chlorophenol, and pentachlorophenol) in subsurface soil exceeded their respective ESL (Table A1.4). Therefore, there is some uncertainty associated with the reported results for nondetected analytes in subsurface soil in the WBEU.

The minimum reported results for all nine of these analytes were below their respective ESLs. The maximum reported results for 2,4-dinitrotoluene, pentachlorophenol, and selenium were approximately 32, 21, and 18 times the PRG, respectively. The remaining six analytes had maximum reported results that were less than 10 times the PRG.

ESLs were unavailable for less than half of the nondetected organics and organics detected in less than 5 percent of subsurface soil samples (Table A1.4). Because ESLs were available for most of the nondetected organics and organics detected in less than 5 percent of subsurface soil samples and the maximum reported results for these analytes were much lower than the ESLs, the lack of ESLs for less than half of the analytes is unlikely to have a significant effect on the results of the risk assessment.

TABLES

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Table A1.1
Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Soil/Surface Sediment

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result[a] > PRG?
Inorganic (mg/kg)				
Chromium (VI)	0.96 - 1.2	4	28.4	No
Organic (ug/kg)				
1,1,1,2-Tetrachloroethane	1.151 - 1.303	13	91,018	No
1,1,1-Trichloroethane	1.022 - 12	21	9.18E+06	No
1,1,2,2-Tetrachloroethane[b]	0.899 - 12	20	10,483	No
1,1,2-Trichloro-1,2,2-trifluoroethane	0.911 - 1.031	13	2.38E+09	No
1,1,2-Trichloroethane	0.865 - 12	21	28,022	No
1,1-Dichloroethane	0.918 - 12	21	2.72E+06	No
1,1-Dichloroethene	1.379 - 12	21	17,366	No
1,1-Dichloropropene	1.171 - 1.326	13	N/A	UT
1,2,3-Trichlorobenzene	0.653 - 0.739	13	N/A	UT
1,2,4-Trichlorobenzene	0.904 - 820	107	151,360	No
1,2-Dibromo-3-chloropropane	1.679 - 1.901	13	2,968	No
1,2-Dibromoethane	0.766 - 0.867	13	35.1	No
1,2-Dichlorobenzene	0.682 - 780	99	2.89E+06	No
1,2-Dichloroethane	0.93 - 12	21	13,270	No
1,2-Dichloroethene	5 - 12	8	999,783	No
1,2-Dichloropropane	0.799 - 12	21	38,427	No
1,3,5-Trimethylbenzene	0.908 - 1.027	13	114,340	No
1,3-Dichlorobenzene	0.951 - 820	107	3.33E+06	No
1,3-Dichloropropane	0.54 - 0.612	13	N/A	UT
1,4-Dichlorobenzene	1.031 - 780	99	91,315	No
2,2-Dichloropropane	0.945 - 1.07	13	N/A	UT
2,4,5-Trichlorophenol	340 - 3,900	89	8.01E+06	No
2,4,6-Trichlorophenol	340 - 820	89	272,055	No
2,4-Dichlorophenol	340 - 820	89	240,431	No
2,4-Dimethylphenol	340 - 820	89	1.60E+06	No
2,4-Dinitrophenol	1,600 - 4,100	88	160,287	No
2,4-Dinitrotoluene	340 - 820	94	160,287	No
2,6-Dinitrotoluene	340 - 820	94	80,144	No
2-Butanone[b]	9.288 - 24	20	4.64E+07	No
2-Chloronaphthalene	340 - 820	94	6.41E+06	No
2-Chlorophenol	340 - 820	89	555,435	No
2-Chlorotoluene	1.47 - 1.663	13	2.22E+06	No
2-Hexanone	7.439 - 24	21	N/A	UT
2-Methylnaphthalene	340 - 820	94	320,574	No
2-Methylphenol	340 - 820	89	4.01E+06	No
2-Nitroaniline	1,600 - 4,100	94	192,137	No
2-Nitrophenol	340 - 820	89	N/A	UT
3,3'-Dichlorobenzidine	670 - 1,600	94	6,667	No
3-Nitroaniline	1,600 - 4,100	91	N/A	UT
4,4'-DDD	9.1 - 38	49	15,528	No
4,4'-DDT	9.1 - 38	49	10,927	No
4,6-Dinitro-2-methylphenol[b]	1,600 - 4,100	87	8,014	No
4-Bromophenyl-phenylether	340 - 820	94	N/A	UT
4-Chloro-3-methylphenol	340 - 1,600	89	N/A	UT
4-Chloroaniline	340 - 1,600	94	320,574	No

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Table A1.1
Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Soil/Surface Sediment

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result[a] > PRG?
4-Chlorophenyl-phenyl ether	340 - 820	94	N/A	UT
4-Chlorotoluene	0.861 - 0.975	13	N/A	UT
4-Isopropyltoluene	1.012 - 1.146	13	N/A	UT
4-Methyl-2-pentanone	6.288 - 24	21	8.32E+07	No
4-Methylphenol	340 - 820	89	400,718	No
4-Nitroaniline	1,600 - 4,100	93	207,917	No
4-Nitrophenol	1,600 - 4,100	89	641,148	No
Acenaphthylene	340 - 780	94	N/A	UT
Aldrin[b]	8.1 - 19	48	176	No
alpha-BHC	8.1 - 19	49	570	No
alpha-Chlordane[b]	80 - 190	44	10,261	No
Aroclor-1016	34 - 730	90	1,349	No
Aroclor-1221	34 - 730	90	1,349	No
Aroclor-1232	34 - 730	90	1,349	No
Aroclor-1242	34 - 730	90	1,349	No
Aroclor-1248[b]	34 - 730	89	1,349	No
Benzene[b]	0.759 - 12	20	23,563	No
Benzyl Alcohol	340 - 1,600	89	2.40E+07	No
beta-BHC[b]	8.1 - 19	48	1,995	No
beta-Chlordane	81 - 190	39	10,261	No
bis(2-Chloroethoxy) methane	340 - 820	94	N/A	UT
bis(2-Chloroethyl) ether	340 - 820	94	3,767	No
bis(2-Chloroisopropyl) ether	340 - 820	93	59,301	No
Bromobenzene	1.016 - 1.15	13	N/A	UT
Bromochloromethane	1.082 - 1.225	13	N/A	UT
Bromodichloromethane	0.637 - 12	21	67,070	No
Bromoform	1.033 - 12	21	419,858	No
Bromomethane	1.483 - 24	21	20,959	No
Butylbenzylphthalate	340 - 820	94	1.60E+07	No
Carbon Disulfide	2.568 - 12	21	1.64E+06	No
Carbon Tetrachloride	1.091 - 12	21	8,446	No
Chlordane	91 - 98	4	10,261	No
Chlorobenzene[b]	0.918 - 12	20	666,523	No
Chloroethane	3.615 - 24	21	1.43E+06	No
Chloroform	0.83 - 12	21	7,850	No
Chloromethane	1.297 - 24	20	115,077	No
cis-1,2-Dichloroethene	0.984 - 1.114	13	1.11E+06	No
cis-1,3-Dichloropropene	0.81 - 12	21	19,432	No
delta-BHC[b]	8.1 - 19	48	570	No
Dibenz(a,h)anthracene[b]	**340 - 820**	**90**	**379**	**Yes**
Dibenzofuran[b]	340 - 820	92	222,174	No
Dibromochloromethane	0.676 - 12	21	49,504	No
Dibromomethane	0.706 - 0.799	13	N/A	UT
Dichlorodifluoromethane	1.763 - 1.996	13	229,820	No
Dieldrin[b]	9.1 - 47	47	187	No
Diethylphthalate	340 - 840	94	6.41E+07	No
Dimethylphthalate	340 - 820	94	8.01E+08	No
Di-n-octylphthalate[b]	340 - 820	93	3.21E+06	No

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Table A1.1

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Soil/Surface Sediment

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result[a] > PRG?
Endosulfan I[b]	8.1 - 19	48	480,861	No
Endosulfan II	9.1 - 38	49	480,861	No
Endosulfan sulfate	9.1 - 38	49	480,861	No
Endrin aldehyde	9.1 - 9.8	4	24,043	No
Endrin ketone	16 - 38	45	33,326	No
Ethylbenzene[b]	0.987 - 12	20	5.39E+06	No
Fluorene[b]	340 - 820	90	3.21E+06	No
gamma-BHC (Lindane)	8.1 - 19	49	2,771	No
Heptachlor[b]	8.1 - 19	48	665	No
Heptachlor epoxide[b]	8.1 - 38	48	329	No
Hexachlorobenzene	340 - 820	94	1,870	No
Hexachlorobutadiene	1.151 - 820	107	22,217	No
Hexachlorocyclopentadiene	340 - 840	94	380,452	No
Hexachloroethane	340 - 820	94	111,087	No
Isophorone	340 - 820	94	3.16E+06	No
Isopropylbenzene	1.201 - 1.359	13	32,680	No
Naphthalene[b]	0.765 - 820	106	1.40E+06	No
n-Butylbenzene	0.958 - 1.084	13	N/A	UT
Nitrobenzene	340 - 820	89	43,246	No
N-Nitroso-di-n-propylamine[b]	**340 - 820**	**93**	**429**	**Yes**
N-nitrosodiphenylamine	340 - 820	94	612,250	No
n-Propylbenzene	1.066 - 1.206	13	N/A	UT
Pentachlorophenol	1,600 - 4,100	89	17,633	No
Phenol	340 - 820	89	2.40E+07	No
Pyridine	730 - 820	8	N/A	UT
sec-Butylbenzene	1.01 - 1.144	13	N/A	UT
Styrene	0.97 - 12	21	1.38E+07	No
tert-Butylbenzene	1.055 - 1.195	13	N/A	UT
Tetrachloroethene[b]	1.176 - 12	20	6,705	No
Toluene[b]	1.217 - 12	20	3.09E+06	No
Toxaphene	160 - 980	49	2,720	No
trans-1,2-Dichloroethene	1.291 - 1.461	13	287,340	No
trans-1,3-Dichloropropene	0.866 - 12	21	20,820	No
Trichloroethene	0.614 - 12	21	1,770	No
Trichlorofluoromethane	1.208 - 1.367	13	1.51E+06	No
Vinyl acetate	11 - 24	8	2.65E+06	No
Vinyl Chloride	2.723 - 24	21	2,169	No
Xylene[c]	2.419 - 12	21	1.06E+06	No

[a] Value is the maximum reported result for nondetected analytes.

[b] Analyte has a detection frequency of less than 5 percent.

[c] The PRG for total xylene is used.

N/A = Not available or not applicable.

UT = Uncertain toxicity.

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Table A1.2

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Subsurface Soil/Subsurface Sediment

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result[a] > PRG?
Inorganic (mg/kg)				
Cyanide	0.0442 - 0.64	67	25,550	No
Selenium[b]	0.2 - 49.0798	295	6,388	No
Organic (ug/kg)				
1,1,1,2-Tetrachloroethane	0.497 - 5,500	279	1.05E+06	No
1,1,1-Trichloroethane[b]	0.778 - 5,500	485	1.06E+08	No
1,1,2,2-Tetrachloroethane[b]	0.522 - 5,500	484	120,551	No
1,1,2-Trichloro-1,2,2-trifluoroethane[b]	0.888 - 5,500	283	2.74E+10	No
1,1,2-Trichloroethane	0.497 - 5,500	496	322,253	No
1,1-Dichloroethane	0.507 - 5,500	491	3.12E+07	No
1,1-Dichloroethene[b]	0.632 - 5,500	489	199,706	No
1,1-Dichloropropene	1.013 - 5,500	279	N/A	UT
1,2,3-Trichlorobenzene[b]	0.637 - 5,500	274	N/A	UT
1,2,3-Trichloropropane	0.938 - 5,500	279	23,910	No
1,2,4,5-Tetrachlorobenzene	340 - 3,600	53	276,495	No
1,2,4-Trichlorobenzene[b]	0.753 - 3,600	406	1.74E+06	No
1,2,4-Trimethylbenzene[b]	0.586 - 5,500	266	1.53E+06	No
1,2-Dibromo-3-chloropropane	1.355 - 5,500	279	34,137	No
1,2-Dibromoethane	**0.497 - 5,500**	**279**	**403**	**Yes**
1,2-Dichlorobenzene[b]	0.497 - 3,600	413	3.32E+07	No
1,2-Dichloroethane	0.517 - 5,500	489	152,603	No
1,2-Dichloroethene	5 - 1,500	152	1.15E+07	No
1,2-Dichloropropane	0.497 - 5,500	491	441,907	No
1,2-Diphenylhydrazine	340 - 3,600	53	43,021	No
1,3,5-Trimethylbenzene[b]	0.53 - 5,500	274	1.31E+06	No
1,3-Dichlorobenzene[b]	0.5 - 3,600	409	3.83E+07	No
1,3-Dichloropropane	0.497 - 5,500	279	N/A	UT
1,4-Dichlorobenzene[b]	0.924 - 3,600	407	1.05E+06	No
1,4-Dioxane	103 - 114	5	4.35E+06	No
2,2-Dichloropropane	0.72 - 5,500	279	N/A	UT
2,4,5-T	21 - 22	5	9.22E+06	No
2,4,5-TP (Silvex)	21 - 22	5	1.95E+06	No
2,4,5-Trichlorophenol	330 - 77,000	249	9.22E+07	No
2,4,6-Trichlorophenol	330 - 77,000	249	3.13E+06	No
2,4-D	83 - 87	5	9.22E+06	No
2,4-DB	83 - 87	5	7.37E+06	No
2,4-Dichlorophenol	330 - 77,000	249	2.76E+06	No
2,4-Dimethylphenol	330 - 77,000	249	1.84E+07	No
2,4-Dinitrophenol	1,600 - 380,000	249	1.84E+06	No
2,4-Dinitrotoluene	330 - 77,000	249	1.84E+06	No
2,6-Dinitrotoluene	330 - 77,000	249	921,651	No
2-Chloroethyl vinyl ether	10 - 1,600	59	N/A	UT
2-Chloronaphthalene	330 - 77,000	249	7.37E+07	No
2-Chlorophenol	330 - 77,000	248	6.39E+06	No
2-Chlorotoluene	0.528 - 5,500	279	2.56E+07	No
2-Hexanone[b]	5 - 22,000	470	N/A	UT
2-Methyl-1-propanol	103 - 114	5	3.83E+08	No

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Table A1.2

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Subsurface Soil/Subsurface Sediment

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result[a] > PRG?
2-Methylnaphthalene[b]	330 - 3,900	244	3.69E+06	No
2-Methylphenol	330 - 77,000	254	4.61E+07	No
2-Nitroaniline	360 - 380,000	249	2.21E+06	No
2-Nitrophenol	330 - 77,000	249	N/A	UT
3 & 4-methyl phenol	1,010 - 1,080	5	N/A	UT
3,3'-Dichlorobenzidine	**680 - 150,000**	**240**	**76,667**	**Yes**
3-Nitroaniline	380 - 380,000	243	N/A	UT
4,4'-DDD	3.6 - 1,190	81	178,570	No
4,4'-DDE	3.6 - 430	81	126,049	No
4,4'-DDT	3.6 - 1,270	81	125,658	No
4,6-Dinitro-2-methylphenol	**1600 - 380,000**	**249**	**92,165**	**Yes**
4-Bromophenyl-phenylether	330 - 77,000	249	N/A	UT
4-Chloro-3-methylphenol[b]	330 - 150,000	248	N/A	UT
4-Chloroaniline	330 - 150,000	249	3.69E+06	No
4-Chlorophenyl-phenyl ether	330 - 77,000	249	N/A	UT
4-Chlorotoluene	0.837 - 5,500	279	N/A	UT
4-Isopropyltoluene[b]	0.609 - 5,500	276	N/A	UT
4-Methyl-2-pentanone[b]	5 - 22,000	475	9.57E+08	No
4-Methylphenol	330 - 77,000	249	4.61E+06	No
4-Nitroaniline	1600 - 380,000	245	2.39E+06	No
4-Nitrophenol	390 - 380,000	249	7.37E+06	No
Acenaphthene[b]	330 - 3,900	243	5.10E+07	No
Acenaphthylene[b]	330 - 38,000	248	N/A	UT
Acetonitrile	103 - 114	5	N/A	UT
Aldrin	1.8 - 430	81	2,024	No
alpha-BHC	1.8 - 318	81	6,555	No
alpha-Chlordane	1.8 - 1,700	76	117,997	No
Anthracene[b]	330 - 3,900	241	2.55E+08	No
Aroclor-1016	**33 - 21,700**	**189**	**15,514**	**Yes**
Aroclor-1221	**33 - 21,700**	**189**	**15,514**	**Yes**
Aroclor-1232	**33 - 21,700**	**189**	**15,514**	**Yes**
Aroclor-1242	**33 - 21,700**	**189**	**15,514**	**Yes**
Aroclor-1248[b]	**33 - 21,700**	**188**	**15,514**	**Yes**
Aroclor-1260[b]	21 - 3,400	182	15,514	No
Benzene[b]	0.497 - 5,500	495	270,977	No
Benzo(b)fluoranthene[b]	**330 - 77,000**	**239**	**43,616**	**Yes**
Benzo(k)fluoranthene[b]	330 - 77,000	243	436,159	No
Benzyl Alcohol	330 - 150,000	249	2.76E+08	No
beta-BHC	1.8 - 637	81	22,942	No
beta-Chlordane	1.8 - 1,700	76	117,997	No
bis(2-Chloroethoxy) methane	330 - 77,000	249	N/A	UT
bis(2-Chloroethyl) ether	**330 - 77,000**	**249**	**43,315**	**Yes**
bis(2-Chloroisopropyl) ether	330 - 77,000	246	681,967	No
Bromobenzene	0.497 - 5,500	279	N/A	UT
Bromochloromethane	0.497 - 5,500	279	N/A	UT
Bromodichloromethane	0.497 - 5,500	491	771,304	No
Bromoform	0.594 - 5,500	485	4.83E+06	No
Bromomethane	0.963 - 5,500	486	241,033	No
Carbon Disulfide[b]	0.888 - 15,000	490	1.88E+07	No

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Table A1.2

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Subsurface Soil/Subsurface Sediment

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result[a] > PRG?
Carbon Tetrachloride[b]	0.849 - 5,500	479	97,124	No
Chlordane	290 - 1,510	5	117,997	No
Chlorobenzene	0.497 - 5,500	496	7.67E+06	No
Chloroethane	1.08 - 5,500	488	1.65E+07	No
Chloromethane	1.006 - 5,500	486	1.32E+06	No
cis-1,3-Dichloropropene	0.497 - 5,500	491	223,462	No
Dalapon	42 - 44	5	2.76E+07	No
delta-BHC	1.8 - 952	81	6,555	No
Dibenz(a,h)anthracene[b]	**330 - 77,000**	**247**	**4,362**	**Yes**
Dibenzofuran[b]	330 - 3,900	248	2.56E+06	No
Dibromochloromethane	0.497 - 5,500	491	569,296	No
Dibromomethane	0.497 - 5,500	279	N/A	UT
Dichlorodifluoromethane	1.719 - 5,500	279	2.64E+06	No
Dichloroprop	83 - 87	5	N/A	UT
Dieldrin	3.6 - 340	81	2,151	No
Diethylphthalate[b]	340 - 77,000	248	7.37E+08	No
Dimethylphthalate	330 - 77,000	249	9.22E+09	No
Di-n-octylphthalate	330 - 77,000	249	3.69E+07	No
Dinoseb	12 - 13	5	921,651	No
Endosulfan I	1.8 - 222	81	5.53E+06	No
Endosulfan II	3.6 - 430	80	5.53E+06	No
Endosulfan sulfate	3.6 - 7,140	81	5.53E+06	No
Endrin	3.6 - 637	81	276,495	No
Endrin aldehyde	3.6 - 2,460	9	276,495	No
Endrin ketone	3.6 - 340	76	383,250	No
Ether	52.3 - 57	3	2.56E+08	No
ethyl acetate	51.3 - 57	5	1.15E+09	No
Ethylbenzene[b]	0.497 - 5,500	492	6.19E+07	No
Fluorene[b]	330 - 3,900	245	3.69E+07	No
gamma-BHC (Lindane)	1.8 - 430	81	31,864	No
Heptachlor	1.8 - 318	81	7,647	No
Heptachlor epoxide	1.8 - 857	81	3,782	No
Hexachlorobenzene	**330 - 77,000**	**249**	**21,508**	**Yes**
Hexachlorobutadiene[b]	0.639 - 3,600	407	255,500	No
Hexachlorocyclopentadiene	340 - 77,000	249	4.38E+06	No
Hexachloroethane	330 - 77,000	249	1.28E+06	No
Indeno(1,2,3-cd)pyrene[b]	**330 - 77,000**	**240**	**43,616**	**Yes**
Isophorone	330 - 77,000	249	3.63E+07	No
Isopropylbenzene	0.497 - 5,500	279	375,823	No
MCPA	8,300 - 8,700	5	460,825	No
MCPP	8,300 - 8,700	5	921,651	No
Methoxychlor	18 - 19,100	81	4.61E+06	No
n-Butanol	103 - 114	5	N/A	UT
n-Butylbenzene[b]	0.705 - 5,500	278	N/A	UT
Nitrobenzene	330 - 77,000	254	497,333	No
N-Nitrosodiethylamine	**680 - 7,300**	**53**	**229**	**Yes**
N-Nitrosodimethylamine	**680 - 7,300**	**53**	**675**	**Yes**
N-Nitrosodi-n-butylamine	340 - 3,600	53	5,977	No
N-Nitroso-di-n-propylamine	**330 - 77,000**	**249**	**4,929**	**Yes**

Table A1.2

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Subsurface Soil/Subsurface Sediment

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result[a] > PRG?
N-nitrosodiphenylamine[b]	330 - 3,900	246	7.04E+06	No
n-Propylbenzene	0.664 - 5,500	279	N/A	UT
o-Xylene	6.000	1	1.22E+07	No
Pentachlorobenzene	340 - 3,600	53	737,321	No
Pentachlorophenol[b]	**1,600 - 380,000**	**248**	**202,777**	**Yes**
Pyridine	680 - 77,000	35	N/A	UT
sec-Butylbenzene	0.613 - 5,500	279	N/A	UT
Styrene[b]	0.545 - 5,500	489	1.59E+08	No
tert-Butylbenzene	0.709 - 5,500	279	N/A	UT
Toxaphene	86 - 27,000	81	31,284	No
trans-1,2-Dichloroethene	0.732 - 2,800	335	3.30E+06	No
trans-1,3-Dichloropropene	0.497 - 5,500	487	239,434	No
Trichlorofluoromethane	1.173 - 5,500	284	1.74E+07	No
Vinyl acetate	6 - 7,800	195	3.04E+07	No
Vinyl Chloride	0.98 - 5,500	491	24,948	No

[a] Value is the maximum reported result for nondetected analytes.

[b] Analyte has a detection frequency of less than 5 percent.

N/A = Not available or not applicable.

UT = Uncertain toxicity.

Table A1.3

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Soil

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Results[a] > ESL?
Inorganic (mg/kg)				
Chromium (VI)[c]	0.96 - 1.2	4	1.34	No
Organic (ug/kg)				
1,1,1,2-Tetrachloroethane	1.151 - 1.303	13	N/A	UT
1,1,1-Trichloroethane	1.022 - 1.156	13	551,453	No
1,1,2-Trichloro-1,2,2-trifluoroethane	0.911 - 1.031	13	N/A	UT
1,1,2-Trichloroethane	0.865 - 0.979	13	N/A	UT
1,1-Dichloroethane	0.918 - 1.039	13	3,121	No
1,1-Dichloroethene	1.379 - 1.561	13	16,909	No
1,1-Dichloropropene	1.171 - 1.326	13	N/A	UT
1,2,3-Trichlorobenzene	0.653 - 0.739	13	N/A	UT
1,2,4-Trichlorobenzene	**0.904 - 820**	**98**	**777**	**Yes**
1,2-Dibromo-3-chloropropane	1.679 - 1.901	13	N/A	UT
1,2-Dibromoethane	0.766 - 0.867	13	N/A	UT
1,2-Dichlorobenzene	0.682 - 430	90	N/A	UT
1,2-Dichloroethane	0.93 - 1.053	13	2,764	No
1,2-Dichloropropane	0.799 - 0.904	13	49,910	No
1,3,5-Trimethylbenzene	0.908 - 1.027	13	7,598	No
1,3-Dichlorobenzene	0.951 - 820	98	N/A	UT
1,3-Dichloropropane	0.54 - 0.612	13	N/A	UT
1,4-Dichlorobenzene	1.031 - 430	90	20,000	No
2,2-Dichloropropane	0.945 - 1.07	13	N/A	UT
2,4,5-Trichlorophenol	340 - 2,100	80	4,000	No
2,4,6-Trichlorophenol	**340 - 820**	**80**	**161**	**Yes**
2,4-Dichlorophenol	340 - 820	80	2,744	No
2,4-Dimethylphenol	340 - 820	80	N/A	UT
2,4-Dinitrophenol	1,600 - 4,100	80	20,000	No
2,4-Dinitrotoluene	**340 - 820**	**85**	**32.1**	**Yes**
2,6-Dinitrotoluene	340 - 820	85	6,186	No
2-Butanone	9.288 - 10.51	13	1.07E+06	No
2-Chloronaphthalene	340 - 820	85	N/A	UT
2-Chlorophenol	**340 - 820**	**80**	**281**	**Yes**
2-Chlorotoluene	1.47 - 1.663	13	N/A	UT
2-Hexanone	7.439 - 8.42	13	N/A	UT
2-Methylnaphthalene	340 - 820	85	2,769	No
2-Methylphenol	340 - 820	80	123,842	No
2-Nitroaniline	1,600 - 4,100	85	5,659	No
2-Nitrophenol	340 - 820	80	N/A	UT
3,3'-Dichlorobenzidine	670 - 1,600	85	N/A	UT
3-Nitroaniline	1,600 - 4,100	82	N/A	UT
4,4'-DDD	9.1 - 21	40	13,726	No
4,4'-DDT	**9.1 - 22**	**40**	**1.20**	**Yes**
4,6-Dinitro-2-methylphenol[b]	**1,600 - 4,100**	**79**	**560**	**Yes**
4-Bromophenyl-phenylether	340 - 820	85	N/A	UT
4-Chloro-3-methylphenol	340 - 1,600	80	N/A	UT
4-Chloroaniline	**340 - 1,600**	**85**	**716**	**Yes**
4-Chlorophenyl-phenyl ether	340 - 820	85	N/A	UT
4-Chlorotoluene	0.861 - 0.975	13	N/A	UT
4-Isopropyltoluene	1.012 - 1.146	13	N/A	UT
4-Methyl-2-pentanone	6.288 - 7.117	13	14,630	No

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Table A1.3
Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Soil

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Results[a] > ESL?
4-Methylphenol	340 - 820	80	N/A	UT
4-Nitroaniline	1,600 - 4,100	85	41,050	No
4-Nitrophenol	1,600 - 4,100	80	7,000	No
Acenaphthylene	340 - 430	85	N/A	UT
Acetone	11.37 - 12.86	13	6,182	No
Aldrin	8.1 - 14	40	47.0	No
alpha-BHC	8.1 - 10	40	18,662	No
alpha-Chlordane	80 - 100	36	289	No
Aroclor-1016	**34 - 730**	**81**	**172**	**Yes**
Aroclor-1221	**34 - 730**	**81**	**172**	**Yes**
Aroclor-1232	**34 - 730**	**81**	**172**	**Yes**
Aroclor-1242	**34 - 730**	**81**	**172**	**Yes**
Aroclor-1248[b]	**34 - 730**	**80**	**172**	**Yes**
Benzyl Alcohol	340 - 1,600	80	4,403	No
beta-BHC	8.1 - 10	40	207	No
beta-Chlordane	81 - 100	36	289	No
bis(2-Chloroethoxy) methane	340 - 820	85	N/A	UT
bis(2-Chloroethyl) ether	340 - 820	85	N/A	UT
bis(2-Chloroisopropyl) ether	340 - 820	85	N/A	UT
Bromobenzene	1.016 - 1.15	13	N/A	UT
Bromochloromethane	1.082 - 1.225	13	N/A	UT
Bromodichloromethane	0.637 - 0.721	13	5,750	No
Bromoform	1.033 - 1.169	13	2,855	No
Bromomethane	1.483 - 1.679	13	N/A	UT
Butylbenzylphthalate	340 - 820	85	24,155	No
Carbon Disulfide	2.568 - 2.906	13	5,676	No
Carbon Tetrachloride	1.091 - 1.235	13	8,906	No
Chlordane	91 - 98	4	289	No
Chloroethane	3.615 - 4.092	13	N/A	UT
Chloroform	0.83 - 0.94	13	8,655	No
Chloromethane	1.297 - 1.468	13	N/A	UT
cis-1,2-Dichloroethene	0.984 - 1.114	13	1,814	No
cis-1,3-Dichloropropene	0.81 - 0.917	13	2,800	No
delta-BHC	8.1 - 10	40	25.9	No
Dibenz(a,h)anthracene[b]	340 - 820	81	N/A	UT
Dibenzofuran[b]	340 - 820	83	21,200	No
Dibromochloromethane	0.676 - 0.765	13	5,730	No
Dibromomethane	0.706 - 0.799	13	N/A	UT
Dichlorodifluoromethane	1.763 - 1.996	13	855	No
Diethylphthalate	340 - 840	85	100,000	No
Dimethylphthalate	340 - 820	85	200,000	No
Di-n-butylphthalate[b]	**340 - 820**	**84**	**15.9**	**Yes**
Di-n-octylphthalate	340 - 820	85	731,367	No
Endosulfan I	8.1 - 10	40	80.1	No
Endosulfan II	9.1 - 29	40	80.1	No
Endosulfan sulfate	9.1 - 26	40	80.1	No
Endrin aldehyde	**9.1 - 9.8**	**4**	**1.40**	**Yes**
Endrin ketone	**16 - 21**	**36**	**1.40**	**Yes**
Fluorene[b]	340 - 820	81	30,000	No
gamma-BHC (Lindane)	8.1 - 10	40	25.9	No

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Table A1.3

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Soil

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Results[a] ≥ ESL?
Heptachlor	8.1 - 10	40	63.3	No
Heptachlor epoxide	8.1 - 38	40	64.0	No
Hexachlorobenzene	**340 - 820**	**85**	**7.73**	**Yes**
Hexachlorobutadiene	**1.151 - 820**	**98**	**431**	**Yes**
Hexachlorocyclopentadiene	340 - 840	85	5,518	No
Hexachloroethane	**340 - 820**	**85**	**366**	**Yes**
Isophorone	340 - 820	85	N/A	UT
Isopropylbenzene	1.201 - 1.359	13	N/A	UT
Methylene Chloride	1.038 - 1.175	13	3,399	No
Naphthalene[b]	0.765 - 820	97	27,048	No
n-Butylbenzene	0.958 - 1.084	13	N/A	UT
Nitrobenzene	340 - 820	80	40,000	No
N-Nitroso-di-n-propylamine[b]	340 - 820	84	N/A	UT
N-nitrosodiphenylamine	340 - 820	85	20,000	No
n-Propylbenzene	1.066 - 1.206	13	N/A	UT
Pentachlorophenol	**1,600 - 4,100**	**80**	**122**	**Yes**
Phenol	340 - 820	80	23,090	No
Pyridine	730 - 820	8	N/A	UT
sec-Butylbenzene	1.01 - 1.144	13	N/A	UT
Styrene	0.97 - 1.097	13	16,408	No
tert-Butylbenzene	1.055 - 1.195	13	N/A	UT
Toxaphene	160 - 980	40	3,756	No
trans-1,2-Dichloroethene	1.291 - 1.461	13	25,617	No
trans-1,3-Dichloropropene	0.866 - 0.981	13	2,800	No
Trichloroethene	0.614 - 0.695	13	389	No
Trichlorofluoromethane	1.208 - 1.367	13	N/A	UT
Vinyl Chloride	2.723 - 3.083	13	97.7	No
Xylene[d]	2.419 - 2.739	13	1,140	No

[a] Value is the maximum reported result for nondetected analytes.

[b] Analyte has a detection frequency of less than 5 percent.

[c] The ESL for chromium (VI) is used.

[d] The ESL for total xylene is used.

N/A = Not available or not applicable.

UT = Uncertain toxicity.

Table A1.4

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Subsurface Soil

Analyte	Range of Reported Results	Total Number of Results	Prairie Dog NOAEL ESL	Maximum Reported Result[a] > ESL?
Inorganic (mg/kg)				
Cyanide	0.0442 - 0.64	67	2,200	No
Selenium[b]	**0.2 - 49.0798**	**295**	**2.80**	**Yes**
Organic (ug/kg)				
1,1,1,2-Tetrachloroethane	0.497 - 5,500	279	N/A	UT
1,1,1-Trichloroethane[b]	0.778 - 5,500	484	4.85E+07	No
1,1,2,2-Tetrachloroethane[b]	0.522 - 5,500	483	4.70E+06	No
1,1,2-Trichloro-1,2,2-trifluoroethane[b]	0.888 - 5,500	283	N/A	UT
1,1,2-Trichloroethane	0.497 - 5,500	495	N/A	UT
1,1-Dichloroethane	0.507 - 5,500	490	215,360	No
1,1-Dichloroethene[b]	0.632 - 5,500	488	1.28E+06	No
1,1-Dichloropropene	1.013 - 5,500	279	N/A	UT
1,2,3-Trichlorobenzene[b]	0.637 - 5,500	274	N/A	UT
1,2,3-Trichloropropane	0.938 - 5,500	279	1.17E+06	No
1,2,4,5-Tetrachlorobenzene	340 - 3,600	53	N/A	UT
1,2,4-Trichlorobenzene[b]	0.753 - 3,600	406	94,484	No
1,2,4-Trimethylbenzene[b]	0.586 - 5,500	266	N/A	UT
1,2-Dibromo-3-chloropropane	1.355 - 5,500	279	N/A	UT
1,2-Dibromoethane	0.497 - 5,500	279	N/A	UT
1,2-Dichlorobenzene[b]	0.497 - 3,600	413	N/A	UT
1,2-Dichloroethane	0.517 - 5,500	488	2.00E+06	No
1,2-Dichloroethene[b]	5 - 1,500	151	1.87E+06	No
1,2-Dichloropropane	0.497 - 5,500	490	3.92E+06	No
1,2-Diphenylhydrazine	340 - 3,600	53	N/A	UT
1,3,5-Trimethylbenzene[b]	0.53 - 5,500	274	855,709	No
1,3-Dichlorobenzene[b]	0.5 - 3,600	409	N/A	UT
1,3-Dichloropropane	0.497 - 5,500	279	N/A	UT
1,4-Dichlorobenzene[b]	0.924 - 3,600	407	5.93E+06	No
1,4-Dioxane	103 - 114	5	719,409	No
2,2-Dichloropropane	0.72 - 5,500	279	N/A	UT
2,4,5-T	21 - 22	5	16,560	No
2,4,5-TP (Silvex)	21 - 22	5	N/A	UT
2,4,5-Trichlorophenol	330 - 77,000	249	N/A	UT
2,4,6-Trichlorophenol	**330 - 77,000**	**249**	**17,263**	**Yes**
2,4-D	83 - 87	5	N/A	UT
2,4-DB	83 - 87	5	47,561	No
2,4-Dichlorophenol	330 - 77,000	249	249,324	No
2,4-Dimethylphenol	330 - 77,000	249	N/A	UT
2,4-Dinitrophenol	1,600 - 380,000	249	4.90E+06	No
2,4-Dinitrotoluene	**330 - 77,000**	**249**	**2,473**	**Yes**
2,6-Dinitrotoluene	330 - 77,000	249	477,309	No
2-Chloroethyl vinyl ether	10 - 1,600	59	N/A	UT
2-Chloronaphthalene	330 - 77,000	249	N/A	UT

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Table A1.4

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Subsurface Soil

Analyte	Range of Reported Results	Total Number of Results	Prairie Dog NOAEL ESL	Maximum Reported Result[a] > ESL?
2-Chlorophenol[b]	**330 - 77,000**	**248**	**21,598**	**Yes**
2-Chlorotoluene	0.528 - 5,500	279	N/A	UT
2-Hexanone[b]	5 - 22,000	469	N/A	UT
2-Methyl-1-propanol	103 - 114	5	N/A	UT
2-Methylnaphthalene[b]	330 - 3,900	244	319,121	No
2-Methylphenol	330 - 77,000	254	9.26E+06	No
2-Nitroaniline	360 - 380,000	249	418,475	No
2-Nitrophenol	330 - 77,000	249	N/A	UT
3 & 4-methyl phenol	1,010 - 1,080	5	N/A	UT
3,3'-Dichlorobenzidine	680 - 150,000	240	N/A	UT
3-Nitroaniline	380 - 380,000	243	N/A	UT
4,4'-DDD	3.6 - 1,190	81	6.19E+06	No
4,4'-DDE	3.6 - 430	81	54,420	No
4,4'-DDT	3.6 - 1,270	81	175,708	No
4,6-Dinitro-2-methylphenol	**1600 - 380,000**	**249**	**44,283**	**Yes**
4-Bromophenyl-phenylether	330 - 77,000	249	N/A	UT
4-Chloro-3-methylphenol[b]	330 - 150,000	248	N/A	UT
4-Chloroaniline	**330 - 150,000**	**249**	**48,856**	**Yes**
4-Chlorophenyl-phenyl ether	330 - 77,000	249	N/A	UT
4-Chlorotoluene	0.837 - 5,500	279	N/A	UT
4-Isopropyltoluene[b]	0.609 - 5,500	276	N/A	UT
4-Methyl-2-pentanone[b]	5 - 22,000	474	859,131	No
4-Methylphenol	330 - 77,000	249	N/A	UT
4-Nitroaniline	1,600 - 380,000	245	2.62E+06	No
4-Nitrophenol	390 - 380,000	249	1.02E+06	No
Acenaphthene[b]	330 - 3,900	243	N/A	UT
Acenaphthylene[b]	330 - 38,000	248	N/A	UT
Acetonitrile	103 - 114	5	N/A	UT
Aldrin	1.8 - 430	81	11,282	No
alpha-BHC	1.8 - 318	81	2.47E+06	No
alpha-Chlordane	1.8 - 1,700	76	472,808	No
Anthracene[b]	330 - 3,900	241	N/A	UT
Aroclor-1016	33 - 21,700	189	37,963	No
Aroclor-1221	33 - 21,700	189	37,963	No
Aroclor-1232	33 - 21,700	189	37,963	No
Aroclor-1242	33 - 21,700	189	37,963	No
Aroclor-1248[b]	33 - 21,700	188	37,963	No
Aroclor-1260[b]	21 - 3,400	182	37,963	No
Benzene[b]	0.497 - 5,500	494	1.10E+06	No
Benzo(b)fluoranthene[b]	330 - 77,000	239	N/A	UT
Benzo(k)fluoranthene[b]	330 - 77,000	243	N/A	UT
Benzyl Alcohol	330 - 150,000	249	253,015	No
beta-BHC	1.8 - 637	81	27,399	No

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Table A1.4

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Subsurface Soil

Analyte	Range of Reported Results	Total Number of Results	Prairie Dog NOAEL ESL	Maximum Reported Result[a] > ESL?
beta-Chlordane	1.8 - 1,700	76	472,808	No
bis(2-Chloroethoxy) methane	330 - 77,000	249	N/A	UT
bis(2-Chloroethyl) ether	330 - 77,000	249	N/A	UT
bis(2-Chloroisopropyl) ether	330 - 77,000	246	N/A	UT
Bromobenzene	0.497 - 5,500	279	N/A	UT
Bromochloromethane	0.497 - 5,500	279	N/A	UT
Bromodichloromethane	0.497 - 5,500	490	381,135	No
Bromoform	0.594 - 5,500	484	198,571	No
Bromomethane	0.963 - 5,500	485	N/A	UT
Carbon Disulfide[b]	0.888 - 15,000	489	410,941	No
Carbon Tetrachloride[b]	0.849 - 5,500	478	736,154	No
Chlordane	290 - 1,510	5	472,808	No
Chlorobenzene	0.497 - 5,500	495	413,812	No
Chloroethane	1.08 - 5,500	487	N/A	UT
Chloromethane	1.006 - 5,500	485	N/A	UT
cis-1,3-Dichloropropene	0.497 - 5,500	490	222,413	No
Dalapon	42 - 44	5	N/A	UT
delta-BHC	1.8 - 952	81	3,425	No
Dibenz(a,h)anthracene[b]	330 - 77,000	247	N/A	UT
Dibenzofuran[b]	330 - 3,900	248	2.44E+06	No
Dibromochloromethane	0.497 - 5,500	490	389,064	No
Dibromomethane	0.497 - 5,500	279	N/A	UT
Dichlorodifluoromethane	1.719 - 5,500	279	59,980	No
Dichloroprop	83 - 87	5	N/A	UT
Dieldrin	**3.6 - 340**	**81**	**301**	**Yes**
Diethylphthalate[b]	340 - 77,000	248	2.21E+08	No
Dimethylphthalate	330 - 77,000	249	1.35E+07	No
Di-n-octylphthalate	330 - 77,000	249	2.58E+08	No
Dinoseb	12 - 13	5	N/A	UT
Endosulfan I	1.8 - 222	81	8,726	No
Endosulfan II	3.6 - 430	80	8,726	No
Endosulfan sulfate	3.6 - 7,140	81	8,726	No
Endrin	3.6 - 637	81	8,060	No
Endrin aldehyde	3.6 - 2,460	9	8,060	No
Endrin ketone	3.6 - 340	76	8,060	No
Ether	52.3 - 57	3	1.68E+06	No
ethyl acetate	51.3 - 57	5	3.14E+06	No
Ethylbenzene[b]	0.497 - 5,500	491	N/A	UT
Fluorene[b]	330 - 3,900	245	N/A	UT
gamma-BHC (Lindane)	1.8 - 430	81	3,425	No
Heptachlor	1.8 - 318	81	12,359	No
Heptachlor epoxide	1.8 - 857	81	9,121	No
Hexachlorobenzene	330 - 77,000	249	190,142	No

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Table A1.4

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Subsurface Soil

Analyte	Range of Reported Results	Total Number of Results	Prairie Dog NOAEL ESL	Maximum Reported Result[a] > ESL?
Hexachlorobutadiene[b]	0.639 - 3,600	407	150,894	No
Hexachlorocyclopentadiene	340 - 77,000	249	799,679	No
Hexachloroethane	**330 - 77,000**	**249**	**45,656**	**Yes**
Indeno(1,2,3-cd)pyrene[b]	330 - 77,000	240	N/A	UT
Isophorone	330 - 77,000	249	N/A	UT
Isopropylbenzene	0.497 - 5,500	279	N/A	UT
MCPA	8300 - 8,700	5	N/A	UT
MCPP	8300 - 8,700	5	N/A	UT
Methoxychlor	18 - 19,100	81	228,896	No
n-Butanol	103 - 114	5	N/A	UT
n-Butylbenzene[b]	0.705 - 5,500	278	N/A	UT
Nitrobenzene	330 - 77,000	254	N/A	UT
N-Nitrosodiethylamine	680 - 7,300	53	N/A	UT
N-Nitrosodimethylamine	680 - 7,300	53	N/A	UT
N-Nitrosodi-n-butylamine	340 - 3,600	53	N/A	UT
N-Nitroso-di-n-propylamine	330 - 77,000	249	N/A	UT
N-nitrosodiphenylamine[b]	330 - 3,900	246	2.15E+06	No
n-Propylbenzene	0.664 - 5,500	279	N/A	UT
o-Xylene	6.000	1	111,663	No
Pentachlorobenzene	340 - 3,600	53	68,375	No
Pentachlorophenol[b]	**1,600 - 380,000**	**248**	**18,373**	**Yes**
Pyridine	680 - 77,000	35	N/A	UT
sec-Butylbenzene	0.613 - 5,500	279	N/A	UT
Styrene[b]	0.545 - 5,500	488	1.53E+06	No
tert-Butylbenzene	0.709 - 5,500	279	N/A	UT
Toxaphene	86 - 27,000	81	909,313	No
trans-1,2-Dichloroethene	0.732 - 2,800	335	1.87E+06	No
trans-1,3-Dichloropropene	0.497 - 5,500	486	222,413	No
Trichlorofluoromethane	1.173 - 5,500	284	N/A	UT
Vinyl acetate	6 - 7,800	195	730,903	No
Vinyl Chloride	0.98 - 5,500	490	6,494	No

[a] Value is the maximum reported result for nondetected analytes.

[b] Analyte has a detection frequency of less than 5 percent.

N/A = Not available or not applicable.

UT = Uncertain toxicity.

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COMPREHENSIVE RISK ASSESSMENT

WIND BLOWN AREA EXPOSURE UNIT

VOLUME 9: ATTACHMENT 2

Data Quality Assessment

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ACRONYMS AND ABBREVIATIONS

AA	atomic absorption
AI	adequate intake
ASD	Analytical Services Division
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
CRDL	contract required detection limit
DER	duplicate error ratio
DQA	Data Quality Assessment
DQO	data quality objective
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ICP	inductively couple plasma
IDL	instrument detection limit
LCS	laboratory control sample
MDA	minimum detectable activity
MDL	method detection limit
MS	matrix spike
MSA	method of standard additions
MSD	matrix spike duplicate
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
QC	quality control

RDL	required detection limit
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
RPD	relative percent difference
SDP	standard data package
SOW	Statement of Work
SVOC	semi-volatile organic compound
SWD	Soil Water Database
TCLP	Toxicity Characteristic Leaching Procedure
TIC	tentatively identified compound
V&V	verification and validation
VOC	volatile organic compound
WBEU	Windblown Area Exposure Unit

EXECUTIVE SUMMARY

This document provides an assessment of the quality of the data used in the Windblown Area Exposure Unit (WBEU) Comprehensive Risk Assessment (CRA). This Data Quality Assessment (DQA) focuses on all elements of quality control (QC) including both laboratory and sample-specific QC data.

Depending on the matrix and analyte group, anywhere from 85 to 100 percent of the WBEU data have been verified and/or validated by a validator from the Analytical Services Division (ASD) at the Rocky Flats Environmental Technology Site (RFETS) (or from an outside subcontractor) using verification and validation (V&V) guidelines for each analytical method developed for RFETS. V&V data are identified in the RFETS Soil Water Database (SWD) by a data qualifier flag and reason code(s) that provide an explanation for the qualifier flag. All rejected data have been removed from the data set used in the CRA because the validator has determined the data are unusable. The remaining V&V data have associated qualifier flags indicating that the data are valid, estimated, or undetected and are used in the CRA. Of the WBEU V&V data, approximately 12 percent was qualified as estimated and/or undetected. Approximately 3 percent of the data reported as detected by the laboratory were qualified as undetected due to blank contamination. Data qualified as estimated or undetected are a result of various minor laboratory noncompliance issues that are insufficient to render the data unusable.

A review of the WBEU V&V data indicates that the data meet the data quality objectives (DQOs) outlined in the Final CRA Work Plan and Methodology (K-H 2004), hereafter referred to as the CRA Methodology. A review of the most common observations found in the V&V data determined that a minimal amount, less than 1 percent, of the non-V&V data may have been qualified if a review had been performed. Based on this DQA, data for the WBEU are of sufficient quality for use in the CRA.

1.0 INTRODUCTION

The Windblown Area Exposure Unit (WBEU) Comprehensive Risk Assessment (CRA) for the Rocky Flats Environmental Technology Site (RFETS) has been prepared in accordance with the Final CRA Work Plan and Methodology (K-H 2004), hereafter referred to as the CRA Methodology (K-H 2004). The CRA Methodology was developed jointly with the regulatory agencies using the consultative process and was approved by the agencies on September 28, 2004. Consistent with the CRA Methodology, data quality was assessed using a standard precision, accuracy, representativeness, completeness, and comparability (PARCC) parameter analysis (EPA 2002). Both laboratory and field quality control (QC) were evaluated for the WBEU data set.

Although many of the elements of QC that are reviewed in this document affect more than one PARCC parameter, their major impact on data quality is described below:

- Precision, as a measure of agreement among replicate measurements, is determined quantitatively based on the results of replicate laboratory measurements. Precision of the laboratory data was verified through review of:
  - Relative percent differences (RPDs) for laboratory control samples (LCSs) and LCS duplicates compared to the acceptable ranges (analytical precision);
  - RPDs (nonradionuclides) and duplicate error ratios (DERs) (radionuclides) for field sample and field duplicates compared to the acceptable ranges[1] (field precision);
  - RPDs for matrix spike (MS) and matrix spike duplicates (MSDs) compared to acceptable control ranges (matrix precision); and
  - RPDs for primary and secondary column analyses (analytical precision).
- Accuracy, as a measure of the distortion of a measurement process that causes error in measuring the true value, is determined quantitatively based on the analysis of samples with a known concentration. Accuracy of the laboratory data was verified through review of:
  - LCS data, calibration verification data, internal standard data, and instrument tune parameters (laboratory accuracy), and
  - Surrogate recoveries, MSs, and sample preparation (sample-specific accuracy).
- Representativeness of the data was verified through review of:

[1] The CRA Methodology states that the overall precision of the data is considered adequate if the RPD between the target and duplicate, at concentrations five times the reporting limit (RL), is less than 35 percent for solids and 20 percent for liquids. The precision adequacy requirement for radiological contaminants is a DER less than 1.96.

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  - Laboratory blank data;
  - Sample preservation/storage;
  - Adherence to sample holding times;
  - Documentation issues;
  - Contract noncompliance issues; and
  - Laboratory activities affecting ability to properly identify compounds.

- Completeness is a data adequacy criterion and is addressed in Appendix A, Volume 2 of the Remedial Investigation/Feasibility Study (RI/FS) Report. It refers to the spatial and temporal distribution of the data and their adequacy for estimating exposure point concentrations (EPCs) for the CRA.

- Comparability of the data was verified through evaluation of:
  - Analytical procedures, and whether they were standard U.S. Environmental Protection Agency (EPA)- and RFETS-approved procedures;
  - Instrument types and maintenance, sample preparation techniques, and standard units for reporting; and
  - MS and surrogate samples, ensuring accuracy within acceptable ranges.

2.0 ANALYTICAL DATA

Approximately 214,600 specific analytical records exist in the WBEU CRA data set, some 91 percent of which (195,609 records) have undergone V&V. The fraction of the data that was verified and/or validated is shown in Table A2.1 by analyte group and matrix. These data were reviewed by validators, and their observations and comments are captured in the Soil Water Database (SWD). All of the data that have been flagged due to V&V findings (except "R"-flagged data) and data that have no flags as a result of V&V are used in the WBEU CRA. The small amount of data that has not undergone V&V is used as provided by the laboratories. The most common errors found during V&V such as transcription errors, calculation errors, and excluded records that were later added by the validator were reviewed to determine the possible effect on non-V&V data. Assuming that the percentage of data qualified as a result of these issues is representative of similar observations in the non-V&V data, less than 1 percent of the entire WBEU data set is at risk for such unacknowledged and, therefore, uncorrected errors.

Data V&V involves an in-depth review of the data packages from the laboratory to assess compliance with contract requirements. In general, data validation includes all of the activities of verification, as well as additional QC checks and review of some raw laboratory instrument data and calculations. After V&V, a data qualifier flag and/or reason code(s) are assigned to the data record (Tables A2.2 and A2.3). The reason codes provide an explanation for the qualifier flag, thereby making it possible to determine which of the PARCC parameters is affected by the observation (Table A2.4). Qualifier flags are discussed in this Data Quality Assessment (DQA) as those V&V flags that note issues in the data. V&V flags "V," "V1," and "1" represent data that were reviewed by validators, but no issues were observed. Eighty-five percent of the V&V data falls into this category. Additional qualifier flags such as "A," "E," and "Z" were also applied. These validation qualifiers are notations that do not indicate estimation or a change in the status of detection. The data are valid and useable as reported by the laboratory. Three percent of the V&V data are represented by these additional qualifier flags. The specific definitions of these additional V&V flags are presented in Table A2.2. Data with noted issues are presented in Table A2.5 and discussed in detail in Section 3.0.

V&V qualifier flags are not specifically addressed in this data assessment, but rather the reason codes associated with the qualifier flags for each analytical record are summarized and evaluated. This approach was chosen because the validator's specific observations (reason codes), and not the qualifier flags, provide the best descriptors of the data quality.

V&V data records contain a field with V&V reason codes (5, 18/52, 200, 99/101/701, and so forth), or the field is null. These reason codes represent observations related to assessment of precision, accuracy, and representativeness. For example, the reason code 110 definition (see Table A2.3) is "LCS recovery criteria were not met," which is an observation related to data accuracy.

Multiple reason codes were routinely applied to a specific sample method/matrix/analyte combination. Therefore, it was necessary to parse out the individual codes to create a table that included a unique record identifier and the associated parsed data V&V reason code (5, 18, 52, 200, 99, 101, 701, and so forth). With this information and the data V&V reason code definitions, the data validator's observations related to this data set can be re-created for each analytical record.

To summarize the reason codes in a logical manner for presentation, it was first necessary to group the reason codes that have slightly different definitions but convey the same meaning. A standardized definition was then applied to the individual reason codes within the group. The grouped reason codes were also assigned a QC category (for example, blanks, calibration, and holding time) and the affected PARCC parameter (Table A2.4). The reason codes were then summarized for each medium and analyte group within each QC category, applying the standardized definition to the summarized codes. The summary is presented in Table A2.5.

Rejected data (data qualifier flag "R"), consisting of approximately 3 percent of all V&V data, have been removed from the data used in the WBEU CRA because the validator has determined the data to be unusable. The fraction of the data that was rejected during validation and/or verification is shown in Table A2.6 by analyte group and matrix.

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Finally, evaluating the RPD (DER for radionuclides) between a target sample and the associated field duplicate is not a QC parameter performed during V&V, but is still an important analysis when determining data precision. Because this analysis was not performed during V&V, the target sample/field duplicate RPD and DER calculations were performed separately and are presented in Table A2.7 as the number of exceedances per analyte group/matrix combination. Only those analyte group/matrix combinations having records that met the criteria for calculating an RPD or DER are presented. RPDs and DERs for target sample/field duplicate analyte pairs where one or both of the results are less than five times the RL are not calculated as outlined in the CRA Methodology.

3.0 FINDINGS

V&V observations affecting the CRA data set are summarized by analyte group/matrix/QC category/V&V observation in Table A2.5. The detected and nondetected results are summarized separately to give the reader a better idea of the impact on data usability. Only those issues observed in notable percentages (generally greater than 5 percent) of the data are discussed below in further detail. RPDs (DERs for radionuclides) presented in Table A2.7 are only discussed below when RPD (DER for radionuclides) exceedances of control criteria are greater than 10 percent for any give analyte group/matrix combination. Instances of elevated rates (greater than 10 percent) of rejected data are also discussed below.

3.1 Herbicides – Soil

Calibration, documentation, holding time, internal standard, sample preparation, surrogate, and other issues resulted in data V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified due to continuing calibration verification issues. While the importance of this QC parameter should not be overlooked, it is also important to note that the data were qualified as usable, although estimated.

3.2 Herbicides – Water

Documentation and surrogate issues resulted in data V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified due to transcription errors. Transcription errors have no impact on data quality as all issues have previously been evaluated and corrected.

3.3 Metals – Soil

Blank, calculation error, calibration, documentation, holding time, instrument setup, LCS, matrix, sensitivity, and other observations resulted in data V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified due to low LCS and pre-digestion MS recoveries and expired instrument detection limit (IDL) studies. While the importance of these QC parameters should not be overlooked, it is also important to note that the data were qualified as usable, although estimated.

3.4 Metals – Water

Blank, calculation error, calibration, documentation, holding time, instrument setup, LCS, matrix, sample preparation, sensitivity, and other observations resulted in V&V qualifications associated with this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified due to blank contamination. While the importance of blank analyses should not be overlooked, it is also important to note that the data were qualified as usable, although estimated.

3.5 Polychlorinated Biphenyls – Soil

Calibration, confirmation, documentation, holding time, sample preparation, surrogate, and other issues resulted in data V&V observations related to this analyte group/matrix combination. The percentage of observations is low with few exceptions. While the importance of QC parameters such as continuing calibration verifications, surrogate analyses, and proper sample preservation should not be overlooked, it is also important to note that the data associated with these observations were qualified as usable, although estimated.

3.6 Polychlorinated Biphenyls – Water

Documentation issues resulted in data V&V observations related to this analyte group/matrix combination. The percentage of all observations is low and within method expectations.

3.7 Pesticides – Soil

Calculation error, calibration, confirmation, documentation, holding time, internal standard, sample preparation, surrogate, and other issues resulted in data V&V observations related to this analyte group/matrix combination. The percentage of observations is low, with the exception of those records qualified because the allowed sample holding time was exceeded. While the importance of observing the allowed sample holding time should not be overlooked, it is also important to note that the data were not flagged as though the holding time was grossly exceeded, as was the practice where applicable, and the data were qualified as usable, although estimated.

3.8 Pesticides – Water

Calibration and documentation issues resulted in V&V qualification related to this analyte group/matrix combination. The percentage of all observations is low and within method expectations.

3.9 Radionuclides – Soil

Blank, calculation error, calibration, documentation, holding time, instrument setup, LCS, matrix, sample preparation, sensitivity, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with few exceptions. Insufficient documentation indicates that a complete V&V evaluation may not have been performed, but it is important to note that the data were qualified as usable, although estimated. Validator-calculated minimum detectable activities (MDAs) have no effect on data quality as all issues have previously been evaluated and corrected. Those observations noting omissions or errors in a portion of the data package also have no impact on data usability. All omissions and/or errors were noted in portions of the data package not required for validation. While the importance of continuing calibration verifications should not be overlooked, it is also important to note that the data were qualified as usable, although estimated. The majority of those records qualified as directing the data user to the hard-copy validation report for further explanation of the observation were flagged as estimated. The CRA is performed with this uncertainty in mind; therefore, no other effort was made to identify the observations. Finally, although almost 11 percent of the target sample/field duplicate analyte pairs exceeded RPD criteria, it is important to note that the majority of exceedances were noted at one location. This is more indicative of the matrix at a particular location, than an overall precision issue.

3.10 Radionuclides – Water

Blank, calculation error, calibration, documentation, holding time, instrument setup, LCS, matrix, sample preparation, sensitivity, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with few exceptions. Insufficient documentation indicates that a complete V&V evaluation may not have been performed, but it is important to note that the data were qualified as usable, although estimated. Validator-calculated MDAs have no effect on data quality as all issues have previously been evaluated and corrected. While the importance of blank analyses continuing calibration verifications should not be overlooked, it is also important to note that the data associated with these observations were qualified as usable, although estimated.

3.11 Semi-Volatile Organic Compounds – Soil

Blank, calibration, documentation, holding time, internal standard, matrix, sample preparation, surrogate, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of all observations is low and within method expectations.

3.12 Semi-Volatile Organic Compounds – Water

Blank, calibration, documentation, holding time, instrument setup, internal standard, LCS, matrix, sample preparation, surrogate, and other issues resulted in V&V

observations related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified due to transcription errors. Transcription errors have no impact on data quality as all issues have previously been evaluated and corrected.

3.13 Volatile Organic Compounds – Soil

Blank, calculation error, calibration, documentation, holding time, internal standard, LCS, matrix, sample preparation, surrogate, and other issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified due to omissions or errors in a portion of the data package. The quality of the data, however, is not impacted as all omissions and/or errors were noted in portions of the data package not required for validation.

3.14 Volatile Organic Compounds – Water

Blank, calculation error, calibration, confirmation, documentation, holding time, instrument setup, internal standard, LCS, matrix, sample preparation, sensitivity, surrogate, and other issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of observations is low with few exceptions. Transcription errors have no impact on data quality as all issues have previously been evaluated and corrected. The omissions or errors noted in the data package also do not impact data quality as the omitted data was not required for V&V. While the importance of observing allowed sample holding times and proper instrument setup should not be overlooked, it is important to note that the data were qualified as usable, although estimated.

3.15 Wet Chemistry Parameters – Soil

Blank, calculation error, documentation, holding time, LCS, matrix, and other issues resulted in V&V observations related to this analyte group/matrix combination. While the percentage of several of the observations is high, it is important to note that this analyte group contains numerous general chemistry parameters having little or no impact on site characterization.

3.16 Wet Chemistry Parameters – Water

Blank, calculation error, calibration, documentation, holding time, LCS, matrix, sample preparation, and other issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of all observations is low and within method expectations.

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4.0 CONCLUSIONS

The quality of the laboratory results were evaluated for compliance with the CRA Methodology data quality objectives (DQOs) through an overall review of PARCC parameters.

Of the data used in the WBEU CRA, approximately 91 percent underwent the V&V process. Of that 91 percent, 85 percent was qualified as having no QC issues, and approximately 12 percent was qualified as estimated or undetected (Table A2.8). The remaining 3 percent of the V&V data are made up of records qualified with additional flags indicating acceptable data such as "A," "E," or "P." Less than 3 percent of the data reported as detected by the laboratory were flagged as undetected by the validators due to blank contamination (Table A2.9). Data qualified as estimated or undetected indicate some issues with PARCC parameters, but not to a degree sufficient to mark the data unusable. Less than 3 percent of the entire data set was rejected during the V&V process (Table A2.6).

Although many of the elements of QC that are reviewed in this document affect more than one PARCC parameter, the general discussion below summarizes the data quality per the validation reason codes affecting each specific PARCC parameter. Several V&V reason codes have no real impact on data quality because they represent issues that were noted but corrected, or represent observations related to missing documentation that was not required for data assessment. Approximately 21 percent of the WBEU V&V data was flagged with these "Other" V&V observations.

- Precision, as a measure of agreement among replicate measurements, is determined quantitatively based on the results of replicate laboratory measurements.

  Of the V&V data, approximately 2 percent was noted for observations related to precision. Of that 2 percent, 99 percent was qualified for issues related to sample matrices. Result confirmation and instrument setup observations make up the other 1 percent. No LCS or instrument sensitivity issues related to precision were noted.

  RPDs and DERs for target sample/field duplicate pairs were found to be acceptable for all analyte group/matrix combinations. Overall, the method precision was found to be generally acceptable.

- Accuracy is a measure of the distortion of a measurement process that causes error in the true value.

  Of the V&V data, 32 percent was noted for accuracy-related observations. Of that 32 percent, 79 percent was noted for laboratory practice-related observations, while sample-specific accuracy observations make up the other 21 percent. Although the percentage of data with noted accuracy issues is slightly elevated, it is important to note that most of the data flagged with these accuracy-related observations are also flagged as estimated and the CRA is performed with this uncertainty in mind.

Accuracy was generally acceptable with infrequent performance outside QC limits.

- Representativeness of the data was verified.

  Of the V&V data, approximately 32 percent was noted for observations related to representativeness. Of that 32 percent, 63 percent was qualified for blank observations, 25 percent for failure to observe allowed holding times, 3 percent for documentation issues, 1 percent for instrument sensitivity issues, and approximately 6 percent for sample preparation observations. Instrument setup, LCS, matrix, and other observations make up the other 2 percent of the data qualified for observations related to sample representativeness.

  Reportable levels of target analytes were not routinely detected in the laboratory blanks greater than the laboratory reporting limits except for relatively isolated incidences. Samples were generally stored and preserved properly. Overall, these elements of QC exceedances are indicative of normal laboratory operations and have little impact on the sample data as reported.

  Sample data are representative of the site conditions at the time of sample collection.

- Comparability of the data was reviewed and no systematic errors were noted.

  - The use of standard EPA- and RFETS-approved analytical procedures;

  - Instrument types and maintenance, sample preparation techniques, and standard units for reporting; and

  - Evaluation of MS and surrogate samples, ensuring accuracy within acceptable ranges.

  Examination of these parameters did not show any systematic issues with comparability.

- Completeness, as defined in the CRA Methodology, is addressed in Appendix A, Volume 2 of the RI/FS Report.

  Another indication of completeness that is sometimes used is a measure of the number of valid measurements obtained in relation to the total number of measurements planned.

  Because less than 3 percent of the overall data were rejected, the use of non-V&V data for the WBEU CRA does not contribute to any completeness issues.

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This review concludes that the PARCC of the data are generally acceptable and the CRA objectives have been met.

5.0 REFERENCES

K-H, 2004. Final Comprehensive Risk Assessment Work Plan and Methodology, Environmental Restoration, Rocky Flats Environmental Technology Site, Golden, Colorado. September.

EPA, 2002. Guidance for Quality Assurance Project Plans. EPA QA/G-5, EPA/240/R-02/009. Office of Environmental Information, Washington, D.C. December.

TABLES

Table A2.1
CRA Data V&V Summary

Analyte Group	Matrix	Total No. of V&V Records	Total No. of CRA Records	Percent V&V (%)
Dioxins and Furans	WATER	56	56	100
Herbicide	SOIL	349	388	89.9
Herbicide	WATER	95	96	99.0
Metal	SOIL	12,381	13,569	91.2
Metal	WATER	38,884	41,148	94.5
PCB	SOIL	1,882	1,953	96.4
PCB	WATER	455	462	98.5
Pesticide	SOIL	2,688	2,937	91.5
Pesticide	WATER	1,377	1,399	98.4
Radionuclide	SOIL	3,541	4,159	85.1
Radionuclide	WATER	9,345	10,838	86.2
SVOC	SOIL	18,490	20,976	88.1
SVOC	WATER	7,226	7,699	93.9
VOC	SOIL	25,407	26,406	96.2
VOC	WATER	67,249	75,972	88.5
Wet Chem	SOIL	481	554	86.8
Wet Chem	WATER	5,703	6,020	94.7
	Total	**195,609**	**214,632**	**91.14%**

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Table A2.2
V&V Qualifier Flag Definitions

Validation Qualifier Code	Description
1	QC data from a data package – Verification
A	Data acceptable with qualifications
B	Compound was found in BLK and sample
C	Calibration
E	Associated value exceeds calibration range; dilute and reanalyze
J	Estimated quantity – Validation
J1	Estimated quantity – Verification
JB	Organic method blank contamination – Validation
JB1	Organic method blank contamination – Verification
N	Historical – Validators asked not to validate this
NJ	Associated value is presumptively estimated
NJ1	Value presumptively estimated – Verification
P	Systematic error
R	Data unusable – Validation
R1	Data unusable – Verification
S	Matrix spike
U	Analyzed, not detected at/above method detection limit
U1	Analyzed, not detect at/above method detection limit – Verification
UJ	Associated value is considered estimated at an elevated detection
UJ1	Estimated at elevated level – Verification
V	No problems with the data – Validation
V1	No problems with the data – Verification
Y	Analytical results in validation process
Z	Validation was not requested or could not be performed

Table A2.3
V&V Reason Code Definitions

Validation Reason Code	Description
***	Unknown code from RFEDS
1	Holding times were exceeded
2	Holding times were grossly exceeded
3	Initial calibration correlation coefficient <0.995
4	Calibration verification criteria were not met
5	CRDL check sample recovery criteria were not met
6	Incorrect calibration of instrument
7	Analyte values > IDL were found in the blanks
8	Negative bias was indicated in the blanks
9	Interference indicated in the ICP interference check sample
10	Laboratory control sample recovery criteria were not met
11	Duplicate sample precision criteria were not met
12	Predigestion matrix spike criteria were not met (+/- 25 percent)
13	Predigestion matrix spike criteria were not met (<30 percent)
14	Post-digestion matrix spike recovery criteria were not met
15	MSA was required but not performed
16	MSA calibration correlation coefficient <0.995
17	Serial dilution criteria not met
18	Documentation was not provided
19	Calibration verification criteria not met
20	AA duplicate injection precision criteria were not met
21	Reagent blanks exceeded MDA
22	Tracer contamination
23	Improper aliquot size
24	Sample aliquot not taken quantitatively
25	Primary standard had exceeded expiration date
26	No raw data submitted by the laboratory
27	Recovery criteria were not met
28	Duplicate analysis was not performed
29	Verification criteria were not met
30	Replicate precision criteria were not met
31	Replicate analysis was not performed
32	Laboratory control samples >+/- 3 sigma
33	Laboratory control samples >+/- 2 sigma and <+/- 3 sigma
35	Transformed spectral index external ST criteria were not met
36	MDA exceeded the RDL
37	Sample exceeded efficiency curve weight limit
38	Excessive solids on planchet
39	Tune criteria not met
40	Organics initial calibration criteria were not met

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Table A2.3
V&V Reason Code Definitions

Validation Reason Code	Description
41	Organics continuing calibration criteria were not met
42	Surrogates were outside criteria
43	Internal standards outside criteria
44	No mass spectra were provided
45	Results were not confirmed
47	Percent breakdown exceeded 20 percent
48	Linear range of instrument was exceeded
49	Method blank contamination
51	Nonverifiable laboratory results and/or unsubmitted data
52	Transcription error
53	Calculation error
54	Incorrect reported activity or MDA
55	Result exceeds linear range; serial dilution value reported
56	IDL changed due to significant figure discrepancy
57	Percent solids < 30 percent
58	Percent solids < 10 percent
59	Blank activity exceeded RDL
60	Blank recovery criteria were not met
61	Replicate recovery criteria were not met
62	LCS relative percent error criteria not met
63	LCS expected value not submitted/verifiable
64	Nontraceable/noncertified standard was used
67	Sample results not submitted/verifiable
68	Frequency of quality control samples not met
69	Samples not distilled
70	Resolution criteria not met
71	Unit conversion of results
72	Calibration counting statistics not met
73	Daily instrument performance assessment not performed
74	LCS data not submitted
75	Blank data not submitted
76	Instrument gain and/or efficiency not submitted
77	Detector efficiency criteria not met
78	MDAs were calculated by reviewer
79	Result obtained through dilution
80	Spurious counts of unknown origin
81	Repeat count outside of 3 sigma counting error
82	Sample results were not corrected for decay
83	Sample results were not included on Data Summary Table
84	Key fields wrong

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Table A2.3
V&V Reason Code Definitions

Validation Reason Code	Description
85	Record added by QLI
86	Results considered qualitative not quantitative
87	Laboratory did no analysis for this record
88	Blank corrected results
89	Sample analysis was not requested
90	Sample result was not validated due to reanalysis
91	Unit conversion; QC sample activity/uncertainty/MDA
99	See hard copy for further explanation
101	Holding times were exceeded (attributed to laboratory problem)
102	Holding times were grossly exceeded (attribute to laboratory problem)
103	Calibration correlation coefficient does not meet requirement
104	Calibration verification recovery criteria were not met
105	Low-level check sample recovery criteria were not met
106	Calibration did not contain minimum number of standards
107	Analyte detected but < RDL in calibration blank verification
109	Interference indicated in the ICP interference check sample
110	Laboratory control sample recovery criteria were not met
111	Laboratory duplicate sample precision criteria were not met
112	Predigestion matrix spike criteria were not met (+/- 25 percent)
113	Predigestion matrix spike recovery is <30 percent
114	Post-digestion matrix spike criteria were not met
115	MSA was required but not performed
116	MSA calibration correlation coefficient <0.995
117	Serial dilution percent D criteria not met
123	Improper aliquot size
128	Laboratory duplicate was not analyzed
129	Verification criteria for frequency or sequence were not met
130	Replicate precision criteria were not met
131	Confirmation percent difference criteria not met
132	Laboratory control samples >+/- 3 sigma
136	MDA exceeded the RDL
139	Tune criteria not met
140	Requirements for independent calibration verification were not met
141	Continuing calibration verification criteria were not met
142	Surrogates were outside criteria
143	Internal standards outside criteria
145	Results were not confirmed
147	Percent breakdown exceeded 20 percent
148	Linear range of measurement system was exceeded
149	Method, preparation, or reagent blank contamination > RDL

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Table A2.3
V&V Reason Code Definitions

Validation Reason Code	Description
150	Unknown carrier volume
152	Reported data do not agree with raw data
153	Calculation error
155	Original result exceeds linear range; serial dilution value reported
159	Magnitude of calibration verification blank result exceeded the RDL
164	Standard traceability or certification requirements not met
166	Carrier aliquot nonverifiable
168	QC sample frequency does not meet requirements
170	Resolution criteria not met
172	Calibration counting statistics not met
174	LCS data not submitted
175	Blank data not submitted
177	Detector efficiency criteria not met
188	Blank corrected results
199	See hard copy for further explanation
201	Preservation requirements not met by the laboratory
205	Unobtainable omissions or errors on SDP (required for databases)
206	Analyses were not requested according to the SOW
207	Sample pretreatment or sample preparation method is incorrect
211	Poor cleanup recovery
212	Instrument detection limit was not provided
213	Instrument detection limit is > the associated RDL
214	IDL is older than 3 months from date of analysis
215	Blank results were not reported to the IDL/MDL
216	Post-digestion spike recoveries outside of 85-115 percent criteria
217	Post-digestion spike recoveries were < 10 percent
218	Sample COC was not verifiable (attributed to laboratory)
219	Standards have expired or are not valid
220	TCLP sample percent solids < 0.5 percent
222	TCLP particle size was not performed
224	Incomplete TCLP extraction data
225	Insufficient TCLP extraction time
226	TIC misidentification
227	No documentation regarding deviations from methods or SOW
228	Calibration recoveries affecting data quality have not been met
229	Element not analyzed in ICP interference check sample
230	QC sample/analyte (e.g., spike, duplicate, LCS) not analyzed
231	MS/MSD criteria not met
232	Control limits not assigned correctly
233	Sample matrix QC does not represent samples analyzed

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Table A2.3
V&V Reason Code Definitions

Validation Reason Code	Description
234	QC sample does not meet method requirement
235	Duplicate sample control limits do not pass
236	LCS control limits do not pass
237	Preparation blank control limits do not pass
238	Blank correction was not performed
239	Winsorized mean plus standard deviation of the same not calculated or calculated wrong
240	Sample preparations for soil/sludge/sediment were not homog/aliq properly
241	No micro PPT or electroplating data available
242	Tracer requirements were not met
243	Standard values were not calculated correctly (LCS, tracer, standards)
244	Standard or tracer is not NIST traceable
245	Energy calibration criteria not met
246	Background calibration criteria were not met
247	Sample or control analysis not chemically separated from each other
248	Single combined TCLP result was not repeated for sample with both mis+nonm
249	Result qualified due to blank contamination
250	Incorrect analysis sequence
251	Misidentified target compounds
252	Result is suspect DU
701	Holding times were exceeded (not attributed to laboratory)
702	Holding times were grossly exceeded (not attributed to laboratory)
703	Samples were not preserved properly in the field (not attributed to laboratory)
801	Missing deliverables (required for data assessment)
802	Missing deliverables (not required for data assessment)
803	Omissions or errors on SDP deliverables (required for data assessment)
804	Omissions or errors on SDP deliverables (not required for data assessment
805	Information missing from case narrative
806	Site samples not used for sample matrix QC
807	Original documentation not provided
808	Incorrect or incomplete DRC
809	Non-site samples reported with site samples
810	EDD does not match hard copy; EDD may be resubmitted

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Table A2.4
Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
188, 88	Blank corrected results	Blanks	Representativeness
238	Blank correction was not performed	Blanks	Representativeness
175, 75	Blank data not submitted	Blanks	Representativeness
60	Blank recovery criteria were not met	Blanks	Representativeness
215	Blank results were not reported to the IDL/MDL	Blanks	Representativeness
107, 159	Calibration verification blank contamination	Blanks	Representativeness
149, 21, 237, 249, 49, 59, 7	Method, preparation, or reagent blank contamination	Blanks	Representativeness
8	Negative bias indicated in the blanks	Blanks	Representativeness
153, 53	Calculation error	Calculation Errors	Other
232	Control limits not assigned correctly	Calculation Errors	Other
246	Background calibration criteria were not met	Calibration	Accuracy
103, 3	Calibration correlation coefficient did not meet requirements	Calibration	Accuracy
172, 72	Calibration counting statistics did not meet criteria	Calibration	Accuracy
106	Calibration did not contain minimum number of standards	Calibration	Accuracy
228	Calibration requirements affecting data quality have not been met	Calibration	Accuracy
104, 141, 19, 29, 4, 40, 41	Continuing calibration verification criteria were not met	Calibration	Accuracy
245	Energy calibration criteria not met	Calibration	Accuracy
6	Incorrect calibration of instrument	Calibration	Accuracy
148, 48	Result exceeded linear range of measurement system	Calibration	Accuracy
155, 55	Original result exceeded linear range, serial dilution value reported	Calibration	Accuracy
140	Requirements for independent calibration verification were not met	Calibration	Accuracy
129	Frequency or sequencing verification criteria not met	Calibration	Accuracy
131	Confirmation percent difference criteria not met	Confirmation	Precision
145, 45	Results were not confirmed	Confirmation	Precision
18	Sufficient documentation not provided by the laboratory	Documentation issues	Representativeness
705	Electronic qualifiers were applied from validation report by hand	Documentation issues	Other
805	Information missing from case narrative	Documentation issues	Other
84	Key data field incorrect	Documentation issues	Other
802	Missing deliverables (not required for validation)	Documentation issues	Other
801	Missing deliverables (required for validation)	Documentation issues	Representativeness
227	No documentation regarding deviations from methods or SOW	Documentation issues	Other
44	No mass spectra were provided	Documentation issues	Representativeness
241	No micro pipette or electroplating data available	Documentation issues	Other
26	No raw data submitted by the laboratory	Documentation issues	Representativeness

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Table A2.4
Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
804	Omissions or errors in SDP (not required for validation)	Documentation issues	Other
803	Omissions or errors in SDP (required for validation)	Documentation issues	Representativeness
807	Original documentation not provided	Documentation issues	Other
85	Record added by the validator	Documentation issues	Other
152	Reported data do not agree with raw data	Documentation issues	Other
89	Sample analysis was not requested	Documentation issues	Other
218	Sample COC was not verifiable (attributed to laboratory)	Documentation issues	Representativeness
704	Sample COC was not verifiable (not attributed to laboratory)	Documentation issues	Representativeness
83	Sample results were not included on Data Summary Table	Documentation issues	Other
52	Transcription error	Documentation issues	Other
205	Unobtainable omissions or errors on SDP (required for data assessment)	Documentation issues	Representativeness
1, 101, 701	Holding times were exceeded	Holding times	Representativeness
2, 102, 702	Holding times were grossly exceeded	Holding times	Representativeness
251	Misidentified target compounds	Identification errors	Representativeness
70	Resolution criteria not met	Identification errors	Representativeness
226	TIC misidentification	Identification errors	Representativeness
143, 43	Internal standards did not meet criteria	Internal standards	Accuracy
5	CRDL check sample recovery criteria were not met	LCS	Accuracy
33	LCS > ± 2 sigma and < ± 3 sigma	LCS	Accuracy
10, 110, 236	LCS recovery criteria were not met	LCS	Accuracy
132, 32	Laboratory control samples > ± 3 sigma	LCS	Accuracy
174, 74	LCS data not submitted	LCS	Representativeness
63	Expected LCS value not submitted/verifiable	LCS	Representativeness
62	LCS relative percent error criteria not met	LCS	Accuracy
105	Low-level check sample recovery criteria were not met	LCS	Accuracy
230	QC sample/analyte (e.g., spike, duplicate, LCS) not analyzed	LCS	Representativeness
28	Duplicate analysis was not performed	Matrices	Precision
11, 235	Duplicate sample precision criteria were not met	Matrices	Precision
111	LCS/LCSD precision criteria were not met	Matrices	Precision
128	Laboratory duplicate was not analyzed	Matrices	Precision
231	MS/MSD criteria not met	Matrices	Precision
116, 16	MSA calibration correlation coefficient <0.995	Matrices	Accuracy
115, 15	MSA was required but not performed	Matrices	Representativeness
58	Sample contained < 10 percent solid material	Matrices	Representativeness
57	Sample contained < 30 percent solid material	Matrices	Representativeness
217	Post-digestion spike recoveries were < 10%	Matrices	Accuracy
14, 114, 216	Post-digestion matrix spike criteria were not met	Matrices	Accuracy
113, 13	Predigestion matrix spike recovery is <30%	Matrices	Accuracy

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Table A2.4

Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
112, 12	Predigestion matrix spike recovery criteria were not met	Matrices	Accuracy
27	Recovery criteria were not met	Matrices	Accuracy
31	Replicate analysis was not performed	Matrices	Precision
130, 30	Replicate precision criteria were not met	Matrices	Precision
61	Replicate recovery criteria were not met	Matrices	Accuracy
233	Sample matrix QC does not represent samples analyzed	Matrices	Representativeness
117, 17	Serial dilution criteria not met	Matrices	Accuracy
806	Site samples not used for sample matrix QC	Matrices	Representativeness
810	EDD does not match hard copy; EDD may be resubmitted	Other	Other
214	IDL is older than 3 months from date of analysis	Other	Accuracy
250	Incorrect analysis sequence	Other	Representativeness
808	Incorrect or incomplete DRC	Other	Representativeness
212	Instrument detection limit was not provided	Other	Other
87	Laboratory did no analysis for this record	Other	Other
809	Nonsite samples reported with Site samples	Other	Other
64	Nontraceable/noncertified standard was used	Other	Accuracy
51	Nonverifiable laboratory results and/or unsubmitted data	Other	Representativeness
211	Poor cleanup recovery	Other	Accuracy
25	Primary standard had exceeded expiration date	Other	Accuracy
234	QC sample does not meet method requirement	Other	Representativeness
168, 68	QC sample frequency does not meet requirements	Other	Representativeness
252	Result is suspect due to dilution	Other	Other
79	Result obtained through dilution	Other	Other
37	Sample exceeded efficiency curve weight limit	Other	Accuracy
247	Sample or control analyses not chemically separated from each other	Other	Representativeness
90	Sample result was not validated due to re-analysis	Other	Other
67	Sample results not submitted/verifiable	Other	Representativeness
199, 99	See hard copy for further explanation	Other	Other
248	Single combined TCLP results was not reported for sample with both mis+nonm	Other	Accuracy
80	Spurious counts of unknown origin	Other	Representativeness
244	Standard or tracer is not NIST traceable	Other	Accuracy
164	Standard traceability or certification requirements not met	Other	Accuracy
219	Standards have expired or are not valid	Other	Accuracy
243	Standard values were not calculated correctly (LCS, tracer, standards)	Other	Other
22	Tracer contamination	Other	Accuracy
242	Tracer requirements were not met	Other	Accuracy
71	Unit conversion of results	Other	Other

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Table A2.4
Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
239	Winsorized mean+standard deviation of the same not calculated or calculated wrong	Other	Other
38	Excessive solids on planchet	Sample preparation	Accuracy
123, 23	Improper aliquot size	Sample preparation	Accuracy
224	Incomplete TCLP extraction data	Sample preparation	Representativeness
225	Insufficient TCLP extraction time	Sample preparation	Representativeness
201	Preservation requirements not met by the laboratory	Sample preparation	Representativeness
24	Sample aliquot not taken quantitatively	Sample preparation	Accuracy
240	Sample preparation for soil/sludge/ sediment were not homog/aliq properly	Sample preparation	Representativeness
207	Sample pretreatment or preparation method is incorrect	Sample preparation	Representativeness
69	Samples not distilled	Sample preparation	Representativeness
703	Samples were not preserved properly in the field	Sample preparation	Representativeness
222	TCLP particle size was not performed	Sample preparation	Representativeness
220	TCLP sample percent solids < 0.5 percent	Sample preparation	Representativeness
56	IDL changed due to significant figure discrepancy	Sensitivity	Representativeness
54	Incorrect reported activity or MDA	Sensitivity	Other
213	Instrument detection limit > the associated RDL	Sensitivity	Representativeness
136, 36	MDA exceeded the RDL	Sensitivity	Representativeness
78	MDA was calculated by reviewer	Sensitivity	Other
81	Repeat count outside of 3 sigma counting error	Sensitivity	Precision
86	Results considered qualitative not quantitative	Sensitivity	Accuracy
82	Sample results were not corrected for decay	Sensitivity	Other
91	Unit conversion, QC sample activity uncertainty/MDA	Sensitivity	Representativeness
142, 42	Surrogates were outside criteria	Surrogate	Accuracy
20	AA duplicate injection precision criteria were not met	Instrument Set-up	Precision
73	Daily instrument performance assessment not performed	Instrument Set-up	Accuracy
177, 77	Detector efficiency criteria not met	Instrument Set-up	Accuracy
229	Element not analyzed in ICP interference check sample	Instrument Set-up	Representativeness
76	Instrument gain and/or efficiency not submitted	Instrument Set-up	Representativeness
109, 9	Interference indicated in the ICP interference check sample	Instrument Set-up	Accuracy
147, 47	Percent breakdown exceeded 20 percent	Instrument Set-up	Representativeness
170	Resolution criteria not met	Instrument Set-up	Representativeness
35	Transformed spectral index external site criteria were not met	Instrument Set-up	Representativeness
139, 39	Tune criteria not met	Instrument Set-up	Accuracy
206	Analysis was not requested according to SOW	Unknown	Other
166	Carrier aliquot nonverifiable	Unknown	Representativeness
150	Unknown carrier volume	Unknown	Representativeness

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Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Herbicide	SOIL	Calibration	Continuing calibration verification criteria were not met	No	28	349	8.02
Herbicide	SOIL	Documentation Issues	Record added by the validator	No	3	349	0.86
Herbicide	SOIL	Holding Times	Holding times were exceeded	No	13	349	3.72
Herbicide	SOIL	Internal Standards	Internal standards did not meet criteria	No	2	349	0.57
Herbicide	SOIL	Other	Sample results were not validated due to re-analysis	No	3	349	0.86
Herbicide	SOIL	Other	See hard copy for further explanation	No	1	349	0.29
Herbicide	SOIL	Sample Preparation	Samples were not properly preserved in the field	No	15	349	4.30
Herbicide	SOIL	Surrogates	Surrogate recovery criteria were not met	No	2	349	0.57
Herbicide	WATER	Documentation Issues	Transcription error	No	15	95	15.79
Herbicide	WATER	Surrogates	Surrogate recovery criteria were not met	No	1	95	1.05
Metal	SOIL	Blanks	Calibration verification blank contamination	No	542	12,381	4.38
Metal	SOIL	Blanks	Calibration verification blank contamination	Yes	204	12,381	1.65
Metal	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	117	12,381	0.94
Metal	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	28	12,381	0.23
Metal	SOIL	Blanks	Negative bias indicated in the blanks	No	34	12,381	0.27
Metal	SOIL	Blanks	Negative bias indicated in the blanks	Yes	60	12,381	0.48
Metal	SOIL	Calculation Errors	Control limits not assigned correctly	No	126	12,381	1.02
Metal	SOIL	Calculation Errors	Control limits not assigned correctly	Yes	381	12,381	3.08
Metal	SOIL	Calibration	Calibration correlation coefficient did not meet requirements	No	2	12,381	0.02
Metal	SOIL	Calibration	Calibration correlation coefficient did not meet requirements	Yes	8	12,381	0.06
Metal	SOIL	Calibration	Continuing calibration verification criteria were not met	No	12	12,381	0.10
Metal	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	1	12,381	0.01
Metal	SOIL	Documentation Issues	Key data fields incorrect	No	103	12,381	0.83
Metal	SOIL	Documentation Issues	Key data fields incorrect	Yes	217	12,381	1.75
Metal	SOIL	Documentation Issues	Missing deliverables (not required for validation)	No	3	12,381	0.02
Metal	SOIL	Documentation Issues	Missing deliverables (not required for validation)	Yes	20	12,381	0.16
Metal	SOIL	Documentation Issues	Omissions or errors in data package (not required for validation)	No	75	12,381	0.61
Metal	SOIL	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	229	12,381	1.85
Metal	SOIL	Documentation Issues	Record added by the validator	No	18	12,381	0.15
Metal	SOIL	Documentation Issues	Record added by the validator	Yes	74	12,381	0.60
Metal	SOIL	Documentation Issues	Transcription error	No	94	12,381	0.76
Metal	SOIL	Documentation Issues	Transcription error	Yes	181	12,381	1.46
Metal	SOIL	Holding Times	Holding times were exceeded	No	18	12,381	0.15
Metal	SOIL	Holding Times	Holding times were grossly exceeded	Yes	1	12,381	0.01
Metal	SOIL	Instrument Set-up	Interference was indicated in the interference check sample	No	51	12,381	0.41
Metal	SOIL	Instrument Set-up	Interference was indicated in the interference check sample	Yes	84	12,381	0.68
Metal	SOIL	LCS	CRDL check sample recovery criteria were not met	No	96	12,381	0.78
Metal	SOIL	LCS	CRDL check sample recovery criteria were not met	Yes	146	12,381	1.18

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Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Metal	SOIL	LCS	LCS recovery criteria were not met	No	309	12,381	2.50
Metal	SOIL	LCS	LCS recovery criteria were not met	Yes	744	12,381	6.01
Metal	SOIL	LCS	Low level check sample recovery criteria were not met	No	437	12,381	3.53
Metal	SOIL	LCS	Low level check sample recovery criteria were not met	Yes	456	12,381	3.68
Metal	SOIL	Matrices	Duplicate sample precision criteria were not met	No	26	12,381	0.21
Metal	SOIL	Matrices	Duplicate sample precision criteria were not met	Yes	296	12,381	2.39
Metal	SOIL	Matrices	LCS/LCSD precision criteria were not met	No	2	12,381	0.02
Metal	SOIL	Matrices	LCS/LCSD precision criteria were not met	Yes	114	12,381	0.92
Metal	SOIL	Matrices	MSA calibration correlation coefficient < 0.995	Yes	2	12,381	0.02
Metal	SOIL	Matrices	Post-digestion MS did not meet control criteria	No	79	12,381	0.64
Metal	SOIL	Matrices	Post-digestion MS did not meet control criteria	Yes	60	12,381	0.48
Metal	SOIL	Matrices	Predigestion MS recovery criteria were not met	No	401	12,381	3.24
Metal	SOIL	Matrices	Predigestion MS recovery criteria were not met	Yes	1,091	12,381	8.81
Metal	SOIL	Matrices	Predigestion MS recovery was < 30 percent	Yes	30	12,381	0.24
Metal	SOIL	Matrices	Serial dilution criteria were not met	No	1	12,381	0.01
Metal	SOIL	Matrices	Serial dilution criteria were not met	Yes	270	12,381	2.18
Metal	SOIL	Other	IDL is older than 3 months from date of analysis	No	484	12,381	3.91
Metal	SOIL	Other	IDL is older than 3 months from date of analysis	Yes	1,591	12,381	12.85
Metal	SOIL	Other	Result obtained through dilution	Yes	7	12,381	0.06
Metal	SOIL	Other	See hard copy for further explanation	No	143	12,381	1.15
Metal	SOIL	Other	See hard copy for further explanation	Yes	501	12,381	4.05
Metal	SOIL	Sensitivity	IDL changed due to a significant figure discrepancy	No	3	12,381	0.02
Metal	WATER	Blanks	Calibration verification blank contamination	No	1,007	38,884	2.59
Metal	WATER	Blanks	Calibration verification blank contamination	Yes	158	38,884	0.41
Metal	WATER	Blanks	Method, preparation, or reagent blank contamination	No	2,980	38,884	7.66
Metal	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	177	38,884	0.46
Metal	WATER	Blanks	Negative bias indicated in the blanks	No	479	38,884	1.23
Metal	WATER	Blanks	Negative bias indicated in the blanks	Yes	319	38,884	0.82
Metal	WATER	Calculation Errors	Control limits not assigned correctly	No	45	38,884	0.12
Metal	WATER	Calculation Errors	Control limits not assigned correctly	Yes	39	38,884	0.10
Metal	WATER	Calibration	Calibration correlation coefficient did not meet requirements	No	114	38,884	0.29
Metal	WATER	Calibration	Calibration correlation coefficient did not meet requirements	Yes	45	38,884	0.12
Metal	WATER	Calibration	Continuing calibration verification criteria were not met	No	21	38,884	0.05
Metal	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	33	38,884	0.08
Metal	WATER	Documentation Issues	Electronic qualifiers were applied from validation report by hand	No	18	38,884	0.05
Metal	WATER	Documentation Issues	Electronic qualifiers were applied from validation report by hand	Yes	11	38,884	0.03
Metal	WATER	Documentation Issues	Information missing from case narrative	No	24	38,884	0.06
Metal	WATER	Documentation Issues	Information missing from case narrative	Yes	23	38,884	0.06

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Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Metal	WATER	Documentation Issues	Key data fields incorrect	No	70	38,884	0.18
Metal	WATER	Documentation Issues	Key data fields incorrect	Yes	10	38,884	0.03
Metal	WATER	Documentation Issues	Missing deliverables (not required for validation)	No	321	38,884	0.83
Metal	WATER	Documentation Issues	Missing deliverables (not required for validation)	Yes	184	38,884	0.47
Metal	WATER	Documentation Issues	Missing deliverables (required for validation)	No	130	38,884	0.33
Metal	WATER	Documentation Issues	Missing deliverables (required for validation)	Yes	132	38,884	0.34
Metal	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	742	38,884	1.91
Metal	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	973	38,884	2.50
Metal	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	No	13	38,884	0.03
Metal	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	Yes	3	38,884	0.01
Metal	WATER	Documentation Issues	Record added by the validator	No	34	38,884	0.09
Metal	WATER	Documentation Issues	Record added by the validator	Yes	20	38,884	0.05
Metal	WATER	Documentation Issues	Transcription error	No	1,657	38,884	4.26
Metal	WATER	Documentation Issues	Transcription error	Yes	563	38,884	1.45
Metal	WATER	Holding Times	Holding times were exceeded	No	25	38,884	0.06
Metal	WATER	Holding Times	Holding times were exceeded	Yes	4	38,884	0.01
Metal	WATER	Instrument Set-up	AA duplicate injection precision criteria were not met	No	4	38,884	0.01
Metal	WATER	Instrument Set-up	Interference was indicated in the interference check sample	No	91	38,884	0.23
Metal	WATER	Instrument Set-up	Interference was indicated in the interference check sample	Yes	145	38,884	0.37
Metal	WATER	LCS	CRDL check sample recovery criteria were not met	No	164	38,884	0.42
Metal	WATER	LCS	CRDL check sample recovery criteria were not met	Yes	137	38,884	0.35
Metal	WATER	LCS	LCS data not submitted by the laboratory	No	1	38,884	0.00
Metal	WATER	LCS	LCS recovery criteria were not met	No	50	38,884	0.13
Metal	WATER	LCS	LCS recovery criteria were not met	Yes	42	38,884	0.11
Metal	WATER	LCS	Low level check sample recovery criteria were not met	No	213	38,884	0.55
Metal	WATER	LCS	Low level check sample recovery criteria were not met	Yes	189	38,884	0.49
Metal	WATER	LCS	QC sample/analyte (e.g. spike, duplicate, LCS) was not analyzed	No	85	38,884	0.22
Metal	WATER	LCS	QC sample/analyte (e.g. spike, duplicate, LCS) was not analyzed	Yes	63	38,884	0.16
Metal	WATER	Matrices	Duplicate sample precision criteria were not met	No	34	38,884	0.09
Metal	WATER	Matrices	Duplicate sample precision criteria were not met	Yes	243	38,884	0.62
Metal	WATER	Matrices	LCS/LCSD precision criteria were not met	No	54	38,884	0.14
Metal	WATER	Matrices	LCS/LCSD precision criteria were not met	Yes	56	38,884	0.14
Metal	WATER	Matrices	MSA calibration correlation coefficient < 0.995	No	1	38,884	0.00
Metal	WATER	Matrices	MSA calibration correlation coefficient < 0.995	Yes	6	38,884	0.02
Metal	WATER	Matrices	Post-digestion MS did not meet control criteria	No	342	38,884	0.88
Metal	WATER	Matrices	Post-digestion MS did not meet control criteria	Yes	88	38,884	0.23
Metal	WATER	Matrices	Predigestion MS recovery criteria were not met	No	378	38,884	0.97
Metal	WATER	Matrices	Predigestion MS recovery criteria were not met	Yes	534	38,884	1.37

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Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Metal	WATER	Matrices	Predigestion MS recovery was < 30 percent	Yes	11	38,884	0.03
Metal	WATER	Matrices	Recovery criteria were not met	Yes	7	38,884	0.02
Metal	WATER	Matrices	Serial dilution criteria were not met	No	24	38,884	0.06
Metal	WATER	Matrices	Serial dilution criteria were not met	Yes	615	38,884	1.58
Metal	WATER	Matrices	Site samples were not used for sample matrix QC	No	1	38,884	0.00
Metal	WATER	Other	Analysis was not requested according to the statement of work	No	1	38,884	0.00
Metal	WATER	Other	IDL is older than 3 months from date of analysis	No	385	38,884	0.99
Metal	WATER	Other	IDL is older than 3 months from date of analysis	Yes	398	38,884	1.02
Metal	WATER	Other	Incorrect analysis sequence	No	5	38,884	0.01
Metal	WATER	Other	Incorrect analysis sequence	Yes	7	38,884	0.02
Metal	WATER	Other	QC sample frequency does not meet method requirements	No	1	38,884	0.00
Metal	WATER	Other	Result obtained through dilution	No	2	38,884	0.01
Metal	WATER	Other	Result obtained through dilution	Yes	22	38,884	0.06
Metal	WATER	Other	See hard copy for further explanation	No	41	38,884	0.11
Metal	WATER	Other	See hard copy for further explanation	Yes	46	38,884	0.12
Metal	WATER	Sample Preparation	Samples were not properly preserved in the field	No	266	38,884	0.68
Metal	WATER	Sample Preparation	Samples were not properly preserved in the field	Yes	396	38,884	1.02
Metal	WATER	Sensitivity	IDL changed due to a significant figure discrepancy	No	124	38,884	0.32
PCB	SOIL	Calibration	Continuing calibration verification criteria were not met	No	112	1,882	5.95
PCB	SOIL	Confirmation	Confirmation percent difference criteria not met	No	1	1,882	0.05
PCB	SOIL	Confirmation	Confirmation percent difference criteria not met	Yes	5	1,882	0.27
PCB	SOIL	Documentation Issues	Missing deliverables (not required for validation)	No	14	1,882	0.74
PCB	SOIL	Documentation Issues	Transcription error	No	21	1,882	1.12
PCB	SOIL	Documentation Issues	Transcription error	Yes	2	1,882	0.11
PCB	SOIL	Holding Times	Holding times were exceeded	No	75	1,882	3.99
PCB	SOIL	Holding Times	Holding times were exceeded	Yes	2	1,882	0.11
PCB	SOIL	Other	See hard copy for further explanation	Yes	1	1,882	0.05
PCB	SOIL	Sample Preparation	Samples were not properly preserved in the field	No	134	1,882	7.12
PCB	SOIL	Sample Preparation	Samples were not properly preserved in the field	Yes	6	1,882	0.32
PCB	SOIL	Surrogates	Surrogate recovery criteria were not met	No	130	1,882	6.91
PCB	SOIL	Surrogates	Surrogate recovery criteria were not met	Yes	10	1,882	0.53
PCB	WATER	Documentation Issues	Key data fields incorrect	No	7	455	1.54
PCB	WATER	Documentation Issues	Transcription error	No	21	455	4.62
Pesticide	SOIL	Calculation Errors	Calculation error	No	8	2,688	0.30
Pesticide	SOIL	Calibration	Continuing calibration verification criteria were not met	No	18	2,688	0.67
Pesticide	SOIL	Calibration	Independent calibration verification criteria not met	No	12	2,688	0.45
Pesticide	SOIL	Confirmation	Confirmation percent difference criteria not met	Yes	3	2,688	0.11
Pesticide	SOIL	Documentation Issues	Record added by the validator	No	3	2,688	0.11

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Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Pesticide	SOIL	Documentation Issues	Transcription error	No	43	2,688	1.60
Pesticide	SOIL	Holding Times	Holding times were exceeded	No	225	2,688	8.37
Pesticide	SOIL	Internal Standards	Internal standards did not meet criteria	No	2	2,688	0.07
Pesticide	SOIL	Other	Sample results were not validated due to re-analysis	No	3	2,688	0.11
Pesticide	SOIL	Other	See hard copy for further explanation	No	4	2,688	0.15
Pesticide	SOIL	Sample Preparation	Samples were not properly preserved in the field	No	15	2,688	0.56
Pesticide	SOIL	Surrogates	Surrogate recovery criteria were not met	No	139	2,688	5.17
Pesticide	SOIL	Surrogates	Surrogate recovery criteria were not met	Yes	11	2,688	0.41
Pesticide	WATER	Calibration	Continuing calibration verification criteria were not met	No	7	1,377	0.51
Pesticide	WATER	Documentation Issues	Key data fields incorrect	No	20	1,377	1.45
Pesticide	WATER	Documentation Issues	Transcription error	No	1	1,377	0.07
Radionuclide	SOIL	Blanks	Blank recovery criteria were not met	Yes	54	3,541	1.52
Radionuclide	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	6	3,541	0.17
Radionuclide	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	119	3,541	3.36
Radionuclide	SOIL	Calculation Errors	Calculation error	No	2	3,541	0.06
Radionuclide	SOIL	Calculation Errors	Calculation error	Yes	15	3,541	0.42
Radionuclide	SOIL	Calibration	Continuing calibration verification criteria were not met	No	3	3,541	0.08
Radionuclide	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	222	3,541	6.27
Radionuclide	SOIL	Calibration	Frequency or sequencing verification criteria not met	Yes	4	3,541	0.11
Radionuclide	SOIL	Documentation Issues	Information missing from case narrative	No	3	3,541	0.08
Radionuclide	SOIL	Documentation Issues	Information missing from case narrative	Yes	2	3,541	0.06
Radionuclide	SOIL	Documentation Issues	Key data fields incorrect	Yes	52	3,541	1.47
Radionuclide	SOIL	Documentation Issues	Missing deliverables (required for validation)	No	11	3,541	0.31
Radionuclide	SOIL	Documentation Issues	Missing deliverables (required for validation)	Yes	30	3,541	0.85
Radionuclide	SOIL	Documentation Issues	Omissions or errors in data package (not required for validation)	No	70	3,541	1.98
Radionuclide	SOIL	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	229	3,541	6.47
Radionuclide	SOIL	Documentation Issues	Omissions or errors in data package (required for validation)	No	53	3,541	1.50
Radionuclide	SOIL	Documentation Issues	Omissions or errors in data package (required for validation)	Yes	122	3,541	3.45
Radionuclide	SOIL	Documentation Issues	Record added by the validator	Yes	48	3,541	1.36
Radionuclide	SOIL	Documentation Issues	Results were not included on Data Summary Table	No	11	3,541	0.31
Radionuclide	SOIL	Documentation Issues	Results were not included on Data Summary Table	Yes	11	3,541	0.31
Radionuclide	SOIL	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	254	3,541	7.17
Radionuclide	SOIL	Documentation Issues	Transcription error	No	17	3,541	0.48
Radionuclide	SOIL	Documentation Issues	Transcription error	Yes	140	3,541	3.95
Radionuclide	SOIL	Holding Times	Holding times were grossly exceeded	Yes	3	3,541	0.08
Radionuclide	SOIL	Instrument Set-up	Detector efficiency did not meet requirements	Yes	19	3,541	0.54
Radionuclide	SOIL	Instrument Set-up	Instrument gain and/or efficiency not submitted	No	11	3,541	0.31
Radionuclide	SOIL	Instrument Set-up	Resolution criteria were not met	No	3	3,541	0.08

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Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Radionuclide	SOIL	Instrument Set-up	Resolution criteria were not met	Yes	8	3,541	0.23
Radionuclide	SOIL	LCS	Lab control samples >+/- 2 sigma and <+/- 3 sigma	No	2	3,541	0.06
Radionuclide	SOIL	LCS	Lab control samples >+/- 2 sigma and <+/- 3 sigma	Yes	15	3,541	0.42
Radionuclide	SOIL	LCS	LCS data not submitted by the laboratory	Yes	23	3,541	0.65
Radionuclide	SOIL	LCS	LCS recovery > +/- 3 sigma	Yes	149	3,541	4.21
Radionuclide	SOIL	LCS	LCS recovery criteria were not met	No	1	3,541	0.03
Radionuclide	SOIL	LCS	LCS recovery criteria were not met	Yes	30	3,541	0.85
Radionuclide	SOIL	LCS	LCS relative percent error criteria not met	No	1	3,541	0.03
Radionuclide	SOIL	LCS	LCS relative percent error criteria not met	Yes	126	3,541	3.56
Radionuclide	SOIL	Matrices	Duplicate sample precision criteria were not met	Yes	1	3,541	0.03
Radionuclide	SOIL	Matrices	Recovery criteria were not met	Yes	38	3,541	1.07
Radionuclide	SOIL	Matrices	Replicate analysis was not performed	No	6	3,541	0.17
Radionuclide	SOIL	Matrices	Replicate analysis was not performed	Yes	4	3,541	0.11
Radionuclide	SOIL	Matrices	Replicate precision criteria were not met	No	2	3,541	0.06
Radionuclide	SOIL	Matrices	Replicate precision criteria were not met	Yes	198	3,541	5.59
Radionuclide	SOIL	Matrices	Replicate recovery criteria were not met	No	2	3,541	0.06
Radionuclide	SOIL	Matrices	Replicate recovery criteria were not met	Yes	36	3,541	1.02
Radionuclide	SOIL	Other	Lab results not verified due to unsubmitted data	Yes	134	3,541	3.78
Radionuclide	SOIL	Other	QC sample does not meet method requirements	No	17	3,541	0.48
Radionuclide	SOIL	Other	QC sample does not meet method requirements	Yes	55	3,541	1.55
Radionuclide	SOIL	Other	Sample exceeded efficiency curve weight limit	Yes	3	3,541	0.08
Radionuclide	SOIL	Other	See hard copy for further explanation	No	26	3,541	0.73
Radionuclide	SOIL	Other	See hard copy for further explanation	Yes	201	3,541	5.68
Radionuclide	SOIL	Other	Tracer requirements were not met	No	22	3,541	0.62
Radionuclide	SOIL	Other	Tracer requirements were not met	Yes	70	3,541	1.98
Radionuclide	SOIL	Sample Preparation	Samples were not properly preserved in the field	No	3	3,541	0.08
Radionuclide	SOIL	Sample Preparation	Samples were not properly preserved in the field	Yes	2	3,541	0.06
Radionuclide	SOIL	Sensitivity	Incorrect reported activity or MDA	No	10	3,541	0.28
Radionuclide	SOIL	Sensitivity	Incorrect reported activity or MDA	Yes	1	3,541	0.03
Radionuclide	SOIL	Sensitivity	MDA exceeded the RDL	No	2	3,541	0.06
Radionuclide	SOIL	Sensitivity	MDA exceeded the RDL	Yes	67	3,541	1.89
Radionuclide	SOIL	Sensitivity	MDA was calculated by reviewer	Yes	796	3,541	22.48
Radionuclide	SOIL	Sensitivity	Results considered qualitative not quantitative	No	12	3,541	0.34
Radionuclide	SOIL	Sensitivity	Results considered qualitative not quantitative	Yes	22	3,541	0.62
Radionuclide	WATER	Blanks	Blank recovery criteria were not met	No	9	9,345	0.10
Radionuclide	WATER	Blanks	Blank recovery criteria were not met	Yes	78	9,345	0.83
Radionuclide	WATER	Blanks	Method, preparation, or reagent blank contamination	No	100	9,345	1.07
Radionuclide	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	625	9,345	6.69

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Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Radionuclide	WATER	Calculation Errors	Calculation error	No	17	9,345	0.18
Radionuclide	WATER	Calculation Errors	Calculation error	Yes	35	9,345	0.37
Radionuclide	WATER	Calibration	Calibration counting statistics did not meet criteria	No	39	9,345	0.42
Radionuclide	WATER	Calibration	Calibration counting statistics did not meet criteria	Yes	1	9,345	0.01
Radionuclide	WATER	Calibration	Continuing calibration verification criteria were not met	No	109	9,345	1.17
Radionuclide	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	878	9,345	9.40
Radionuclide	WATER	Documentation Issues	Information missing from case narrative	No	2	9,345	0.02
Radionuclide	WATER	Documentation Issues	Information missing from case narrative	Yes	8	9,345	0.09
Radionuclide	WATER	Documentation Issues	Missing deliverables (required for validation)	No	17	9,345	0.18
Radionuclide	WATER	Documentation Issues	Missing deliverables (required for validation)	Yes	21	9,345	0.22
Radionuclide	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	50	9,345	0.54
Radionuclide	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	97	9,345	1.04
Radionuclide	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	No	3	9,345	0.03
Radionuclide	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	Yes	5	9,345	0.05
Radionuclide	WATER	Documentation Issues	Record added by the validator	Yes	43	9,345	0.46
Radionuclide	WATER	Documentation Issues	Sufficient documentation not provided by the laboratory	No	7	9,345	0.07
Radionuclide	WATER	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	806	9,345	8.62
Radionuclide	WATER	Documentation Issues	Transcription error	No	360	9,345	3.85
Radionuclide	WATER	Documentation Issues	Transcription error	Yes	362	9,345	3.87
Radionuclide	WATER	Holding Times	Holding times were exceeded	No	6	9,345	0.06
Radionuclide	WATER	Holding Times	Holding times were exceeded	Yes	12	9,345	0.13
Radionuclide	WATER	Holding Times	Holding times were grossly exceeded	Yes	1	9,345	0.01
Radionuclide	WATER	Instrument Set-up	Resolution criteria were not met	No	9	9,345	0.10
Radionuclide	WATER	Instrument Set-up	Resolution criteria were not met	Yes	79	9,345	0.85
Radionuclide	WATER	Instrument Set-up	Transformed spectral index external site criteria were not met	No	9	9,345	0.10
Radionuclide	WATER	Instrument Set-up	Transformed spectral index external site criteria were not met	Yes	2	9,345	0.02
Radionuclide	WATER	LCS	Expected LCS value not submitted/verifiable	No	19	9,345	0.20
Radionuclide	WATER	LCS	Expected LCS value not submitted/verifiable	Yes	93	9,345	1.00
Radionuclide	WATER	LCS	LCS data not submitted by the laboratory	Yes	3	9,345	0.03
Radionuclide	WATER	LCS	LCS recovery > +/- 3 sigma	No	120	9,345	1.28
Radionuclide	WATER	LCS	LCS recovery > +/- 3 sigma	Yes	306	9,345	3.27
Radionuclide	WATER	LCS	LCS recovery criteria were not met	No	12	9,345	0.13
Radionuclide	WATER	LCS	LCS recovery criteria were not met	Yes	50	9,345	0.54
Radionuclide	WATER	LCS	LCS relative percent error criteria not met	No	23	9,345	0.25
Radionuclide	WATER	LCS	LCS relative percent error criteria not met	Yes	303	9,345	3.24
Radionuclide	WATER	Matrices	Duplicate sample precision criteria were not met	Yes	6	9,345	0.06
Radionuclide	WATER	Matrices	Recovery criteria were not met	No	16	9,345	0.17
Radionuclide	WATER	Matrices	Recovery criteria were not met	Yes	91	9,345	0.97

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Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Radionuclide	WATER	Matrices	Replicate analysis was not performed	No	43	9,345	0.46
Radionuclide	WATER	Matrices	Replicate analysis was not performed	Yes	193	9,345	2.07
Radionuclide	WATER	Matrices	Replicate precision criteria were not met	No	54	9,345	0.58
Radionuclide	WATER	Matrices	Replicate precision criteria were not met	Yes	448	9,345	4.79
Radionuclide	WATER	Matrices	Replicate recovery criteria were not met	No	8	9,345	0.09
Radionuclide	WATER	Matrices	Replicate recovery criteria were not met	Yes	51	9,345	0.55
Radionuclide	WATER	Other	Lab results not verified due to unsubmitted data	No	1	9,345	0.01
Radionuclide	WATER	Other	Lab results not verified due to unsubmitted data	Yes	2	9,345	0.02
Radionuclide	WATER	Other	QC sample does not meet method requirements	No	43	9,345	0.46
Radionuclide	WATER	Other	QC sample does not meet method requirements	Yes	61	9,345	0.65
Radionuclide	WATER	Other	Sample exceeded efficiency curve weight limit	Yes	5	9,345	0.05
Radionuclide	WATER	Other	Sample results not submitted/verifiable	Yes	1	9,345	0.01
Radionuclide	WATER	Other	Sample results were not validated due to re-analysis	No	1	9,345	0.01
Radionuclide	WATER	Other	Sample results were not validated due to re-analysis	Yes	4	9,345	0.04
Radionuclide	WATER	Other	See hard copy for further explanation	No	30	9,345	0.32
Radionuclide	WATER	Other	See hard copy for further explanation	Yes	344	9,345	3.68
Radionuclide	WATER	Other	Tracer requirements were not met	No	47	9,345	0.50
Radionuclide	WATER	Other	Tracer requirements were not met	Yes	88	9,345	0.94
Radionuclide	WATER	Sample Preparation	Improper aliquot size	No	1	9,345	0.01
Radionuclide	WATER	Sample Preparation	Improper aliquot size	Yes	27	9,345	0.29
Radionuclide	WATER	Sample Preparation	Samples were not properly preserved in the field	No	7	9,345	0.07
Radionuclide	WATER	Sample Preparation	Samples were not properly preserved in the field	Yes	9	9,345	0.10
Radionuclide	WATER	Sensitivity	Incorrect reported activity or MDA	No	6	9,345	0.06
Radionuclide	WATER	Sensitivity	Incorrect reported activity or MDA	Yes	47	9,345	0.50
Radionuclide	WATER	Sensitivity	MDA exceeded the RDL	No	31	9,345	0.33
Radionuclide	WATER	Sensitivity	MDA exceeded the RDL	Yes	284	9,345	3.04
Radionuclide	WATER	Sensitivity	MDA was calculated by reviewer	No	36	9,345	0.39
Radionuclide	WATER	Sensitivity	MDA was calculated by reviewer	Yes	1,790	9,345	19.15
SVOC	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	13	18,490	0.07
SVOC	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	13	18,490	0.07
SVOC	SOIL	Calibration	Continuing calibration verification criteria were not met	No	111	18,490	0.60
SVOC	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	17	18,490	0.09
SVOC	SOIL	Calibration	Independent calibration verification criteria not met	No	26	18,490	0.14
SVOC	SOIL	Documentation Issues	Missing deliverables (not required for validation)	No	23	18,490	0.12
SVOC	SOIL	Documentation Issues	Missing deliverables (not required for validation)	Yes	1	18,490	0.01
SVOC	SOIL	Documentation Issues	No mass spectra were provided	Yes	1	18,490	0.01
SVOC	SOIL	Documentation Issues	Omissions or errors in data package (not required for validation)	No	90	18,490	0.49
SVOC	SOIL	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	6	18,490	0.03

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Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
SVOC	SOIL	Documentation Issues	Omissions or errors in data package (required for validation)	No	3	18,490	0.02
SVOC	SOIL	Documentation Issues	Record added by the validator	No	177	18,490	0.96
SVOC	SOIL	Documentation Issues	Transcription error	No	3	18,490	0.02
SVOC	SOIL	Holding Times	Holding times were exceeded	No	178	18,490	0.96
SVOC	SOIL	Holding Times	Holding times were exceeded	Yes	19	18,490	0.10
SVOC	SOIL	Internal Standards	Internal standards did not meet criteria	No	145	18,490	0.78
SVOC	SOIL	Internal Standards	Internal standards did not meet criteria	Yes	42	18,490	0.23
SVOC	SOIL	Matrices	MS/MSD precision criteria were not met	No	4	18,490	0.02
SVOC	SOIL	Other	Sample results were not validated due to re-analysis	No	167	18,490	0.90
SVOC	SOIL	Other	Sample results were not validated due to re-analysis	Yes	4	18,490	0.02
SVOC	SOIL	Other	See hard copy for further explanation	No	58	18,490	0.31
SVOC	SOIL	Other	See hard copy for further explanation	Yes	1	18,490	0.01
SVOC	SOIL	Sample Preparation	Samples were not properly preserved in the field	No	861	18,490	4.66
SVOC	SOIL	Surrogates	Surrogate recovery criteria were not met	No	102	18,490	0.55
SVOC	SOIL	Surrogates	Surrogate recovery criteria were not met	Yes	18	18,490	0.10
SVOC	WATER	Blanks	Method, preparation, or reagent blank contamination	No	11	7,226	0.15
SVOC	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	5	7,226	0.07
SVOC	WATER	Calibration	Continuing calibration verification criteria were not met	No	108	7,226	1.49
SVOC	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	9	7,226	0.12
SVOC	WATER	Calibration	Independent calibration verification criteria not met	No	28	7,226	0.39
SVOC	WATER	Documentation Issues	Information missing from case narrative	No	9	7,226	0.12
SVOC	WATER	Documentation Issues	Key data fields incorrect	No	3	7,226	0.04
SVOC	WATER	Documentation Issues	Missing deliverables (not required for validation)	No	81	7,226	1.12
SVOC	WATER	Documentation Issues	Missing deliverables (required for validation)	No	12	7,226	0.17
SVOC	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	308	7,226	4.26
SVOC	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	4	7,226	0.06
SVOC	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	No	3	7,226	0.04
SVOC	WATER	Documentation Issues	Original documentation not provided	No	3	7,226	0.04
SVOC	WATER	Documentation Issues	Transcription error	No	622	7,226	8.61
SVOC	WATER	Documentation Issues	Transcription error	Yes	5	7,226	0.07
SVOC	WATER	Holding Times	Holding times were exceeded	No	303	7,226	4.19
SVOC	WATER	Holding Times	Holding times were exceeded	Yes	3	7,226	0.04
SVOC	WATER	Instrument Set-up	Instrument tune criteria were not met	No	186	7,226	2.57
SVOC	WATER	Instrument Set-up	Instrument tune criteria were not met	Yes	1	7,226	0.01
SVOC	WATER	Internal Standards	Internal standards did not meet criteria	No	16	7,226	0.22
SVOC	WATER	LCS	LCS recovery criteria were not met	No	125	7,226	1.73
SVOC	WATER	LCS	LCS recovery criteria were not met	Yes	2	7,226	0.03
SVOC	WATER	Matrices	MS/MSD precision criteria were not met	No	5	7,226	0.07

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Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
SVOC	WATER	Other	Sample results were not validated due to re-analysis	No	27	7,226	0.37
SVOC	WATER	Other	Sample results were not validated due to re-analysis	Yes	2	7,226	0.03
SVOC	WATER	Other	See hard copy for further explanation	No	31	7,226	0.43
SVOC	WATER	Other	See hard copy for further explanation	Yes	4	7,226	0.06
SVOC	WATER	Sample Preparation	Preservation requirements were not met by the laboratory	No	9	7,226	0.12
SVOC	WATER	Sample Preparation	Samples were not properly preserved in the field	No	79	7,226	1.09
SVOC	WATER	Sample Preparation	Samples were not properly preserved in the field	Yes	1	7,226	0.01
SVOC	WATER	Surrogates	Surrogate recovery criteria were not met	No	55	7,226	0.76
VOC	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	166	25,407	0.65
VOC	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	162	25,407	0.64
VOC	SOIL	Calculation Errors	Calculation error	No	32	25,407	0.13
VOC	SOIL	Calculation Errors	Calculation error	Yes	2	25,407	0.01
VOC	SOIL	Calibration	Continuing calibration verification criteria were not met	No	554	25,407	2.18
VOC	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	42	25,407	0.17
VOC	SOIL	Calibration	Independent calibration verification criteria not met	No	81	25,407	0.32
VOC	SOIL	Calibration	Independent calibration verification criteria not met	Yes	4	25,407	0.02
VOC	SOIL	Calibration	Original result exceeded linear range, serial dilution value reported	Yes	1	25,407	0.00
VOC	SOIL	Documentation Issues	Key data fields incorrect	No	30	25,407	0.12
VOC	SOIL	Documentation Issues	Key data fields incorrect	Yes	1	25,407	0.00
VOC	SOIL	Documentation Issues	Missing deliverables (not required for validation)	No	479	25,407	1.89
VOC	SOIL	Documentation Issues	Missing deliverables (not required for validation)	Yes	5	25,407	0.02
VOC	SOIL	Documentation Issues	Omissions or errors in data package (not required for validation)	No	1,918	25,407	7.55
VOC	SOIL	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	50	25,407	0.20
VOC	SOIL	Documentation Issues	Omissions or errors in data package (required for validation)	No	61	25,407	0.24
VOC	SOIL	Documentation Issues	Record added by the validator	No	12	25,407	0.05
VOC	SOIL	Documentation Issues	Transcription error	No	228	25,407	0.90
VOC	SOIL	Documentation Issues	Transcription error	Yes	8	25,407	0.03
VOC	SOIL	Holding Times	Holding times were exceeded	No	82	25,407	0.32
VOC	SOIL	Internal Standards	Internal standards did not meet criteria	No	336	25,407	1.32
VOC	SOIL	Internal Standards	Internal standards did not meet criteria	Yes	16	25,407	0.06
VOC	SOIL	LCS	LCS recovery criteria were not met	No	7	25,407	0.03
VOC	SOIL	LCS	LCS recovery criteria were not met	Yes	4	25,407	0.02
VOC	SOIL	Matrices	MS/MSD precision criteria were not met	No	30	25,407	0.12
VOC	SOIL	Matrices	MS/MSD precision criteria were not met	Yes	4	25,407	0.02
VOC	SOIL	Matrices	Percent solids < 30 percent	Yes	5	25,407	0.02
VOC	SOIL	Other	Sample results were not validated due to re-analysis	No	43	25,407	0.17
VOC	SOIL	Other	Sample results were not validated due to re-analysis	Yes	3	25,407	0.01
VOC	SOIL	Other	See hard copy for further explanation	No	4	25,407	0.02

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Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
VOC	SOIL	Sample Preparation	Samples were not properly preserved in the field	No	262	25,407	1.03
VOC	SOIL	Sample Preparation	Samples were not properly preserved in the field	Yes	6	25,407	0.02
VOC	SOIL	Surrogates	Surrogate recovery criteria were not met	No	233	25,407	0.92
VOC	SOIL	Surrogates	Surrogate recovery criteria were not met	Yes	18	25,407	0.07
VOC	WATER	Blanks	Method, preparation, or reagent blank contamination	No	203	67,249	0.30
VOC	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	80	67,249	0.12
VOC	WATER	Calculation Errors	Calculation error	Yes	7	67,249	0.01
VOC	WATER	Calibration	Continuing calibration verification criteria were not met	No	821	67,249	1.22
VOC	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	140	67,249	0.21
VOC	WATER	Calibration	Independent calibration verification criteria not met	No	43	67,249	0.06
VOC	WATER	Calibration	Independent calibration verification criteria not met	Yes	16	67,249	0.02
VOC	WATER	Calibration	Original result exceeded linear range, serial dilution value reported	Yes	140	67,249	0.21
VOC	WATER	Calibration	Result exceeded linear range of measurement system	Yes	106	67,249	0.16
VOC	WATER	Confirmation	Results were not confirmed	No	8	67,249	0.01
VOC	WATER	Confirmation	Results were not confirmed	Yes	3	67,249	0.00
VOC	WATER	Documentation Issues	Information missing from case narrative	No	162	67,249	0.24
VOC	WATER	Documentation Issues	Information missing from case narrative	Yes	3	67,249	0.00
VOC	WATER	Documentation Issues	Key data fields incorrect	No	48	67,249	0.07
VOC	WATER	Documentation Issues	Key data fields incorrect	Yes	5	67,249	0.01
VOC	WATER	Documentation Issues	Missing deliverables (not required for validation)	No	1,398	67,249	2.08
VOC	WATER	Documentation Issues	Missing deliverables (not required for validation)	Yes	78	67,249	0.12
VOC	WATER	Documentation Issues	Missing deliverables (required for validation)	No	175	67,249	0.26
VOC	WATER	Documentation Issues	Missing deliverables (required for validation)	Yes	21	67,249	0.03
VOC	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	5,307	67,249	7.89
VOC	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	354	67,249	0.53
VOC	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	No	48	67,249	0.07
VOC	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	Yes	6	67,249	0.01
VOC	WATER	Documentation Issues	Original documentation not provided	No	54	67,249	0.08
VOC	WATER	Documentation Issues	Original documentation not provided	Yes	2	67,249	0.00
VOC	WATER	Documentation Issues	Record added by the validator	No	64	67,249	0.10
VOC	WATER	Documentation Issues	Record added by the validator	Yes	6	67,249	0.01
VOC	WATER	Documentation Issues	Sample analysis was not requested	No	2	67,249	0.00
VOC	WATER	Documentation Issues	Transcription error	No	10,761	67,249	16.00
VOC	WATER	Documentation Issues	Transcription error	Yes	1,293	67,249	1.92
VOC	WATER	Holding Times	Holding times were exceeded	No	3,888	67,249	5.78
VOC	WATER	Holding Times	Holding times were exceeded	Yes	127	67,249	0.19
VOC	WATER	Holding Times	Holding times were grossly exceeded	No	1	67,249	0.00
VOC	WATER	Holding Times	Holding times were grossly exceeded	Yes	46	67,249	0.07

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Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
VOC	WATER	Instrument Set-up	Instrument tune criteria were not met	No	3,196	67,249	4.75
VOC	WATER	Instrument Set-up	Instrument tune criteria were not met	Yes	216	67,249	0.32
VOC	WATER	Internal Standards	Internal standards did not meet criteria	No	141	67,249	0.21
VOC	WATER	Internal Standards	Internal standards did not meet criteria	Yes	16	67,249	0.02
VOC	WATER	LCS	LCS recovery criteria were not met	No	1,377	67,249	2.05
VOC	WATER	LCS	LCS recovery criteria were not met	Yes	153	67,249	0.23
VOC	WATER	Matrices	MS/MSD precision criteria were not met	No	101	67,249	0.15
VOC	WATER	Matrices	MS/MSD precision criteria were not met	Yes	16	67,249	0.02
VOC	WATER	Other	Sample results were not validated due to re-analysis	No	541	67,249	0.80
VOC	WATER	Other	Sample results were not validated due to re-analysis	Yes	256	67,249	0.38
VOC	WATER	Other	See hard copy for further explanation	No	554	67,249	0.82
VOC	WATER	Other	See hard copy for further explanation	Yes	154	67,249	0.23
VOC	WATER	Sample Preparation	Preservation requirements were not met by the laboratory	No	143	67,249	0.21
VOC	WATER	Sample Preparation	Preservation requirements were not met by the laboratory	Yes	4	67,249	0.01
VOC	WATER	Sample Preparation	Samples were not properly preserved in the field	No	1,363	67,249	2.03
VOC	WATER	Sample Preparation	Samples were not properly preserved in the field	Yes	93	67,249	0.14
VOC	WATER	Sensitivity	Instrument detection limit > the associated RDL	No	3	67,249	0.00
VOC	WATER	Surrogates	Surrogate recovery criteria were not met	No	810	67,249	1.20
VOC	WATER	Surrogates	Surrogate recovery criteria were not met	Yes	177	67,249	0.26
Wet Chem	SOIL	Blanks	Calibration verification blank contamination	Yes	74	481	15.38
Wet Chem	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	2	481	0.42
Wet Chem	SOIL	Calculation Errors	Control limits not assigned correctly	Yes	17	481	3.53
Wet Chem	SOIL	Documentation Issues	Key data fields incorrect	Yes	3	481	0.62
Wet Chem	SOIL	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	10	481	2.08
Wet Chem	SOIL	Documentation Issues	Record added by the validator	Yes	1	481	0.21
Wet Chem	SOIL	Holding Times	Holding times were exceeded	No	2	481	0.42
Wet Chem	SOIL	Holding Times	Holding times were exceeded	Yes	4	481	0.83
Wet Chem	SOIL	LCS	LCS recovery criteria were not met	Yes	68	481	14.14
Wet Chem	SOIL	Matrices	Duplicate sample precision criteria were not met	No	5	481	1.04
Wet Chem	SOIL	Matrices	Predigestion MS recovery criteria were not met	No	24	481	4.99
Wet Chem	SOIL	Matrices	Predigestion MS recovery criteria were not met	Yes	79	481	16.42
Wet Chem	SOIL	Matrices	Predigestion MS recovery was < 30 percent	Yes	112	481	23.28
Wet Chem	SOIL	Other	IDL is older than 3 months from date of analysis	Yes	69	481	14.35
Wet Chem	SOIL	Other	See hard copy for further explanation	No	11	481	2.29
Wet Chem	WATER	Blanks	Calibration verification blank contamination	No	2	5,703	0.04
Wet Chem	WATER	Blanks	Method, preparation, or reagent blank contamination	No	48	5,703	0.84
Wet Chem	WATER	Blanks	Negative bias indicated in the blanks	No	43	5,703	0.75
Wet Chem	WATER	Blanks	Negative bias indicated in the blanks	Yes	27	5,703	0.47

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Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Wet Chem	WATER	Calculation Errors	Control limits not assigned correctly	Yes	2	5,703	0.04
Wet Chem	WATER	Calibration	Calibration correlation coefficient did not meet requirements	Yes	17	5,703	0.30
Wet Chem	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	5	5,703	0.09
Wet Chem	WATER	Calibration	Result exceeded linear range of measurement system	Yes	2	5,703	0.04
Wet Chem	WATER	Documentation Issues	Missing deliverables (not required for validation)	Yes	11	5,703	0.19
Wet Chem	WATER	Documentation Issues	Missing deliverables (required for validation)	Yes	10	5,703	0.18
Wet Chem	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	55	5,703	0.96
Wet Chem	WATER	Documentation Issues	Record added by the validator	No	15	5,703	0.26
Wet Chem	WATER	Documentation Issues	Record added by the validator	Yes	13	5,703	0.23
Wet Chem	WATER	Documentation Issues	Transcription error	No	90	5,703	1.58
Wet Chem	WATER	Documentation Issues	Transcription error	Yes	344	5,703	6.03
Wet Chem	WATER	Holding Times	Holding times were exceeded	No	31	5,703	0.54
Wet Chem	WATER	Holding Times	Holding times were exceeded	Yes	49	5,703	0.86
Wet Chem	WATER	Holding Times	Holding times were grossly exceeded	No	41	5,703	0.72
Wet Chem	WATER	Holding Times	Holding times were grossly exceeded	Yes	32	5,703	0.56
Wet Chem	WATER	LCS	LCS recovery criteria were not met	No	2	5,703	0.04
Wet Chem	WATER	Matrices	Duplicate sample precision criteria were not met	No	2	5,703	0.04
Wet Chem	WATER	Matrices	Duplicate sample precision criteria were not met	Yes	9	5,703	0.16
Wet Chem	WATER	Matrices	LCS/LCSD precision criteria were not met	Yes	6	5,703	0.11
Wet Chem	WATER	Matrices	Predigestion MS recovery criteria were not met	No	52	5,703	0.91
Wet Chem	WATER	Matrices	Predigestion MS recovery criteria were not met	Yes	175	5,703	3.07
Wet Chem	WATER	Matrices	Predigestion MS recovery was < 30 percent	Yes	1	5,703	0.02
Wet Chem	WATER	Matrices	Site samples were not used for sample matrix QC	Yes	1	5,703	0.02
Wet Chem	WATER	Other	Lab results not verified due to unsubmitted data	No	2	5,703	0.04
Wet Chem	WATER	Other	Lab results not verified due to unsubmitted data	Yes	45	5,703	0.79
Wet Chem	WATER	Other	QC sample frequency does not meet method requirements	Yes	2	5,703	0.04
Wet Chem	WATER	Other	See hard copy for further explanation	No	1	5,703	0.02
Wet Chem	WATER	Other	See hard copy for further explanation	Yes	27	5,703	0.47
Wet Chem	WATER	Sample Preparation	Preservation requirements were not met by the laboratory	No	1	5,703	0.02
Wet Chem	WATER	Sample Preparation	Preservation requirements were not met by the laboratory	Yes	9	5,703	0.16
Wet Chem	WATER	Sample Preparation	Sample pretreatment or preparation method was incorrect	Yes	2	5,703	0.04
Wet Chem	WATER	Sample Preparation	Samples were not properly preserved in the field	Yes	19	5,703	0.33

Table A2.6
Summary of Data Rejected During V&V

Analyte Group	Matrix	Total No. of Rejected Records	Total No. of Records	Percent Rejected (%)
Dioxins and Furans	WATER	0	56	0
Herbicide	SOIL	7	599	1.17
Herbicide	WATER	2	118	1.69
Metal	SOIL	380	23,768	1.60
Metal	WATER	846	47,428	1.78
PCB	SOIL	7	3,108	0.225
PCB	WATER	0	581	0
Pesticide	SOIL	32	5,800	0.552
Pesticide	WATER	0	1,764	0
Radionuclide	SOIL	881	45,895	1.92
Radionuclide	WATER	841	12,380	6.79
SVOC	SOIL	667	31,146	2.14
SVOC	WATER	237	8,495	2.79
VOC	SOIL	1,823	55,136	3.31
VOC	WATER	2,984	84,190	3.54
Wet Chem	SOIL	21	1,293	1.62
Wet Chem	WATER	113	7,201	1.57
	Total	**8,841**	**328,958**	**2.69**

Table A2.7
Summary of RPDs/DERs of Field Duplicate Analyte Pairs

Analyte Group	Matrix	No. of Duplicates Failing RPD/DER Criteria	Total No. of Duplicate Pairs	Percent Failure (%)	Field Duplicate Frequency (%)
Herbicide	SOIL	0	24	0.00	6.19
Metal	SOIL	106	1,135	9.34	8.36
Metal	WATER	76	2,703	2.81	6.57
PCB	SOIL	0	161	0.00	8.24
Pesticide	SOIL	0	263	0.00	8.95
Radionuclide	SOIL	50	462	10.82	11.11
Radionuclide	WATER	15	818	1.83	7.55
SVOC	SOIL	6	1,461	0.41	6.97
SVOC	WATER	17	663	2.56	8.61
VOC	SOIL	54	1,801	3.00	6.82
VOC	WATER	544	6,298	8.64	8.29
Wet Chem	SOIL	0	50	0.00	9.03
Wet Chem	WATER	11	417	2.64	6.93

Table A2.8
Summary of Data Estimated or Undetected Due to V&V Determinations

Analyte Group	Matrix	No. of CRA Data Records Qualified	Total No. of V&V CRA Records	Detect?	Percent Qualified (%)
Herbicide	SOIL	43	349	No	12.32
Herbicide	WATER	1	95	No	1.05
Metal	SOIL	2,962	12,381	Yes	23.92
Metal	SOIL	1,636	12,381	No	13.21
Metal	WATER	5,637	38,884	No	14.50
Metal	WATER	2,494	38,884	Yes	6.41
PCB	SOIL	5	1,882	Yes	0.27
PCB	SOIL	193	1,882	No	10.26
Pesticide	SOIL	264	2,688	No	9.82
Pesticide	SOIL	3	2,688	Yes	0.11
Pesticide	WATER	7	1,377	No	0.51
Radionuclide	SOIL	28	3,541	No	0.79
Radionuclide	SOIL	127	3,541	Yes	3.59
Radionuclide	WATER	173	9,345	Yes	1.85
Radionuclide	WATER	46	9,345	No	0.49
SVOC	SOIL	46	18,490	Yes	0.25
SVOC	SOIL	435	18,490	No	2.35
SVOC	WATER	15	7,226	Yes	0.21
SVOC	WATER	569	7,226	No	7.87
VOC	SOIL	185	25,407	Yes	0.73
VOC	SOIL	989	25,407	No	3.89
VOC	WATER	7,006	67,249	No	10.42
VOC	WATER	640	67,249	Yes	0.95
Wet Chem	SOIL	237	481	Yes	49.27
Wet Chem	SOIL	32	481	No	6.65
Wet Chem	WATER	351	5,703	Yes	6.15
Wet Chem	WATER	188	5,703	No	3.30
	Total	**24,312**	**195,609**		**12.43%**

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Table A2.9
Summary of Data Qualified as Undetected Due to Blank Contamination

Analyte Group	Matrix	No. of CRA Records Qualified as Undetected	Total No. of CRA Records with Detected Results[a]	Percent Qualified as Undetected
Metal	SOIL	289	9,304	3.11
Metal	WATER	597	16,993	3.51
PCB	SOIL	1	75	1.33
Radionuclide	SOIL	1	2,975	0.03
VOC	SOIL	16	746	2.14
VOC	WATER	9	4,568	0.20
	Total	**913**	**34,661**	**2.63%**

[a] As determined by the laboratory prior to V&V.

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COMPREHENSIVE RISK ASSESSMENT

WIND BLOWN AREA EXPOSURE UNIT

VOLUME 9: ATTACHMENT 3

Statistical Analyses and Professional Judgment

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ACRONYMS AND ABBREVIATIONS

AL	action level
CDH	Colorado Department of Health
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
DOE	U.S. Department of Energy
ECOI	ecological contaminant of interest
EcoSSL	Ecological Soil Screening Level
ECOPC	ecological contaminant of potential concern
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	Ecological Risk Assessment
ESL	ecological screening level
EU	Exposure Unit
HHRA	Human Health Risk Assessment
IAEU	Industrial Area Exposure Unit
IHSS	Individual Hazardous Substance Site
µg/kg	microgram per kilogram
MDC	maximum detected concentration
mg/kg	milligrams per kilogram
N/A	Not Applicable
NCP	National Contingency Plan
NFA	No Further Action
NOAEL	no observed adverse effect level

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PCB	polychlorinated biphenyl
pCi/g	picocuries per gram
PCOC	potential contaminant of concern
PMJM	Preble's meadow jumping mouse
PRG	preliminary remediation goal
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
RLCR	Reconnaissance-Level Characterization Reports
tESL	threshold ESL
UCL	upper confidence limit
UTL	upper tolerance limit
WBEU	Wind Blown Area Exposure Unit
WRS	Wilcoxon Rank Sum
WRW	wildlife refuge worker

1.0 INTRODUCTION

This attachment presents the results for the statistical analyses and professional judgment evaluation used to select human health contaminants of concern (COCs) as part of the Human Health Risk Assessment (HHRA) and ecological contaminants of potential concern (ECOPCs) as part of the Ecological Risk Assessment (ERA) for the Wind Blown Area Exposure Unit (EU) (WBEU) at the Rocky Flats Environmental Technology Site (RFETS). The methods used to perform the statistical analysis and to develop the professional judgment sections are described in Appendix A, Volume 2, Section 2 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation/Corrective Measures Study (CMS)-Feasibility Study (RI/FS) Report (hereafter referred to as the RI/FS Report).

2.0 RESULTS OF STATISTICAL COMPARISONS TO BACKGROUND FOR THE WIND BLOWN AREA EXPOSURE UNIT

The results of the statistical background comparisons for inorganic and radionuclide potential contaminants of concern (PCOCs) and ecological contaminants of interest (ECOIs) in surface soil/surface sediment, subsurface soil/subsurface sediment, surface soil, and subsurface soil samples collected from the WBEU are presented in this section. Box plots are provided for analytes that were carried forward into the statistical comparison step and are presented in Figures A3.2.1 to A3.2.26.[1] The box plots display several reference points: 1) the line inside the box is the median; 2) the lower edge of the box is the 25th percentile; 3) the upper edge of the box is the 75th percentile; 4) the upper lines (called whiskers) are drawn to the greatest value that is less than or equal to 1.5 times the inter-quartile range (the interquartile range is between the 75th and 25th percentiles); 5) the lower whiskers are drawn to the lowest value that is greater than or equal to 1.5 times the inter-quartile range; and 6) solid circles are data points greater or less than the whiskers.

ECOIs for surface soil (Preble's meadow jumping mouse [PMJM] receptor) and PCOCs with concentrations that are statistically greater than background (or those where background comparisons were not performed) are carried through to the professional judgment step of the COC/ECOPC selection processes. There are no PMJM habitats within the WBEU. Therefore, no ECOIs for surface soil PMJM are evaluated in this document. ECOIs (for non-PMJM receptors) with concentrations in the WBEU that are statistically greater than background (or those where background comparisons were not

[1] Statistical background comparisons are not performed for analytes if: 1) the background concentrations are non-detections; 2) background data are unavailable; 3) the analyte has low detection frequency in the WBEU or background data set (less than 20 percent); or 4) the analyte is an organic compound. Box plots are not provided for these analytes. However, these analytes are carried forward into the professional judgment evaluation.

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performed) are carried through to the upper-bound exposure point concentration (EPC) – threshold ecological screening level (tESL) comparison step of the ECOPC selection processes.

PCOCs and ECOIs with concentrations that are not statistically greater than background are not identified as COCs/ECOPCs and are not evaluated further.

2.1 Surface Soil/Surface Sediment Data Used in the HHRA

For the WBEU surface soil/surface sediment data set, the maximum detected concentrations (MDCs) and upper confidence limits on the mean (UCLs) for arsenic, cesium-137, plutonium-239/240, and radium-228 exceed the wildlife refuge worker (WRW) preliminary remediation goals (PRGs) for the WBEU data set. These PCOCs were carried forward into the statistical background comparison step.

The WBEU MDC for aluminum, chromium, manganese, benzo(a)pyrene, Aroclor-1254, Americium-241, and cesium-134 exceed the PRG, but the UCL for the WBEU data set does not exceed the PRG, and these analytes were not evaluated further. The WBEU MDCs for all other PCOCs do not exceed the PRGs and were not further evaluated.

The results of the statistical comparison of the WBEU surface soil/surface sediment data to background data for the PCOCs are presented in Table A3.2.1 and the summary statistics for background and WBEU surface soil/surface sediment data are shown in Table A3.2.2.

The results of the statistical comparisons of the WBEU surface soil/surface sediment data to background data indicate the following:

Analytes Statistically Greater than Background at the 0.1 Significance Level

- Arsenic
- Plutonium-239/240
- Radium-228

Analytes Not Statistically Greater than Background at the 0.1 Significance Level

- Cesium-137

Background Comparison Not Performed[1]

- None

2.2 Subsurface Soil/Subsurface Sediment Data Used in the HHRA

For the WBEU subsurface soil/subsurface sediment data set, the MDCs and UCLs on the mean for radium-228 exceed the WRW PRGs for the WBEU data set, and this PCOC was carried forward into the statistical background comparison step.

The WBEU MDC for chromium, lead, benzo(a)pyrene, americium-241, and plutonium-239/240 exceed the PRG, but the UCL for the WBEU data set does not exceed the PRG, and these analytes were not further evaluated. The WBEU MDCs for all other PCOCs do not exceed the PRGs and were not further evaluated.

The results of the statistical comparison of the WBEU subsurface soil/subsurface sediment data to background data for radium-228 are presented in Table A3.2.3, and the summary statistics for background and WBEU surface soil/surface sediment data are shown in Table A3.2.4.

The results of the statistical comparisons of the WBEU surface soil/surface sediment data to background data indicate the following:

Analytes Statistically Greater than Background at the 0.1 Significance Level

- None

Analytes Not Statistically Greater than Background at the 0.1 Significance Level

- Radium-228

Background Comparison Not Performed[1]

- None

2.3 Surface Soil Data Used In the ERA (Non-PMJM)

For the ECOIs in surface soil, the MDCs for aluminum, arsenic, barium, boron, cadmium, chromium, cobalt, copper, lead, lithium, manganese, mercury, molybdenum, nickel, silver, thallium, tin, uranium, vanadium, and zinc exceed a non-PMJM (ESL), and these ECOIs were carried forward into the statistical background comparison step. The MDCs for benzo(a)pyrene, bis(2-ethylhexyl)phthalate, endrin, and polychlorinated biphenyl total PCB also exceed a non-PMJM ESL. The MDC for di-n-butylphthalate exceeded a non-PMJM ESL, but because the detection frequency of this organic compound was less than 1 percent, di-n-butylphthalate was eliminated from further evaluation and was not carried forward into the background comparison step.

The results of the statistical comparison of the WBEU surface soil data to background data are presented in Table A3.2.5, and the summary statistics for background and WBEU surface soil data are shown in Table A3.2.6.

The results of the statistical comparisons of the WBEU surface soil to background data indicate the following:

Analytes Statistically Greater than Background at the 0.1 Significance Level

- Aluminum

- Barium

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- Chromium
- Lithium
- Manganese
- Nickel

Analytes Not Statistically Greater than Background at the 0.1 Significance Level

- Arsenic
- Cadmium
- Cobalt
- Copper
- Lead
- Mercury
- Vanadium
- Zinc

Background Comparison Not Performed[1]

- Boron
- Molybdenum
- Silver
- Thallium
- Tin
- Uranium

2.4 Surface Soil Data Used in the ERA (PMJM)

There are no PMJM habitats within WBEU.

2.5 Subsurface Soil Data Used in the ERA

For the ECOIs in subsurface soil, the MDCs for antimony, arsenic, chromium, lead, mercury, molybdenum, nickel, and tin exceed the prairie dog ESL and were carried forward into the statistical background comparison step. The MDCs for all other ECOIs do not exceed the prairie dog ecological screening level (ESL). The results of the statistical comparison of the WBEU subsurface soil data to background data are presented in Table A3.2.7 and the summary statistics for background and WBEU subsurface soil data are shown in Table A3.2.8.

The results of the statistical comparisons of the surface soil data to background data indicate the following:

Analytes Statistically Greater than Background at the 0.1 Significance Level

- None

Analytes Not Statistically Greater than Background at the 0.1 Significance Level

- Arsenic
- Chromium
- Lead
- Mercury
- Molybdenum
- Nickel
- Tin

Background Comparison Not Performed[1]

- Antimony

3.0 UPPER-BOUND EXPOSURE POINT CONCENTRATION COMPARISON TO LIMITING ECOLOGICAL SCREENING LEVELS

ECOIs in surface soil and subsurface soil with concentrations that are statistically greater than background, or background comparisons were not performed, are evaluated further by comparing the WBEU EPCs to the tESLs. The EPCs are the 95 percent UCLs of the 90th percentile [upper tolerance limit (UTL)] for small home-range receptors, the UCL for large home-range receptors, or the MDC in the event that the UCL or UTL is greater than the MDC.

3.1 ECOIs in Surface Soil

Of the sixteen ECOIs in surface soil for non-PMJM (aluminum, barium, boron, chromium, lithium, manganese, molybdenum, nickel, silver, thallium, tin, uranium, benzo[a]pyrene, bis[2-ethylhexyl]phthalate, endrin, and PCB [total]), only uranium and benzo[a]pyrene were eliminated from further consideration because their EPCs are not greater than the limiting tESLs.

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Fourteen ECOIs (aluminum, barium, boron, chromium, lithium, manganese, molybdenum, nickel, silver, thallium, and tin, along with three organics, bis[2-ethylhexyl]phthalate, endrin, and PCB [total]), have EPCs greater than the limiting tESLs and are evaluated in the professional judgment evaluation screening step (Section 4.0).

3.2 ECOIs in Subsurface Soil

A background comparison analysis could not be performed for antimony concentrations in subsurface soil at WBEU and this ECOI was evaluated further by comparing the WBEU EPC for antimony to the limiting tESLs. Antimony does not have an EPC greater than the limiting tESL; thus antimony in subsurface soil at WBEU is not carried forward into the professional judgment evaluation screening step.

4.0 PROFESSIONAL JUDGMENT

This section presents the results of the professional judgment step of the COC and ECOPC selection processes for the HHRA and ERA, respectively. Based on the weight of evidence evaluated in the professional judgment step, PCOCs and ECOIs are either included for further evaluation as COCs/ECOPCs in the risk characterization step, or excluded from further evaluation.

The professional judgment evaluation takes into account the following lines of evidence: process knowledge, spatial trends, pattern recognition[2], comparison to RFETS background and regional background data sets (see Table A3.4.1 for a summary of regional background data)[3], and risk potential. For PCOCs or ECOIs where the process knowledge and/or spatial trends indicate that the presence of the analyte in the EU may be a result of historical site-related activities, the professional judgment discussion

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[2] The pattern recognition evaluation includes the use of probability plots. If two or more distinct populations are evident in the probability plot, this suggests that one or more local releases may have occurred. Conversely, if only one distinct low-concentration population is defined, likely representing a background population, a local release may or may not have occurred. Similar to all statistical methods, the probability plot has limitations in cases where there is inadequate sampling and the magnitude of the release is relatively small. Thus, the absence of two clear populations in the probability plots is consistent with, but not definitive proof of, the hypothesis that no releases have occurred. However, if a release has occurred within the sampled area and has been included in the samples, then the elemental concentrations associated with that release are either within the background concentration range or the entire sampled population represents a release, a highly unlikely probability.

[3] The regional background data set for Colorado and the bordering states was extracted from data for the western United States (Shacklette and Boerngen 1984), and is composed of data from Colorado as well as Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming. Although the Colorado and bordering states background data set is not specific to Colorado's Front Range, it is useful for the professional judgment evaluation in the absence of a robust data set for the Front Range. Colorado's Front Range has highly variable terrain that changes elevation over short distances. Consequently, numerous soil types and geologic materials are present at RFETS, and the data set for Colorado and bordering states may be more representative of these variable soil types.

includes only two of the lines of evidence listed above, and it is concluded that these analytes are COCs/ECOPCs and are carried forward into risk characterization. For the other PCOCs and ECOIs that are evaluated in the professional judgment step, each of the lines of evidence listed above are included in the discussion.

For metals, Appendix A, Volume 2, Attachment 8 of the RI/FS Report provides the details of the process knowledge and spatial trend evaluations. The conclusions from these evaluations are noted in this attachment.

The following PCOCs/ECOIs are evaluated further in the professional judgment step for RCEU:

- Surface soil/surface sediment (HHRA)
  - Arsenic
  - Plutonium-239/240
  - Radium-228
- Subsurface soil/subsurface sediment (HHRA)
  - None
- Surface soil for non-PMJM receptors (ERA)
  - Aluminum
  - Barium
  - Boron
  - Chromium
  - Lithium
  - Manganese
  - Molybdenum
  - Nickel
  - Silver
  - Thallium
  - Tin
  - bis(2-Ethylhexyl)phthalate
  - Endrin
  - Total PCBs
- Subsurface soil (ERA)
  - None

The following sections provide the professional judgment evaluations, by analyte and by medium, for the PCOCs/ECOIs listed above.

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4.1 Aluminum

Aluminum has an EPC in surface soil (for non-PMJM receptors) greater than the tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if aluminum should be retained for risk characterization are summarized below.

4.1.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, because there was a large inventory of aluminum and it was present in waste generated during former RFETS operations, aluminum may be present in RFETS soil as a result of historical site-related activities. However, these historic source areas are remote from the WBEU.

4.1.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that aluminum concentrations in WBEU surface soil reflect variations in naturally occurring aluminum.

4.1.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log-transformed data set for aluminum in surface soil within the WBEU (Figure A3.4.1) is a classical, fully defined, single background population. This background population has a crude "S" shape formed by low concentrations asymptotically tailing off to a low concentration, essentially a straight line forming the majority of the background population, and an upper concentration trend asymptotically tailing off to a high concentration. The lower concentration trend is commonly the detection limit but, in this case, probably represents an approach to a lower limit (about 0.5 percent aluminum). The upper concentration trend is usually a saturation concentration (in this case, 3.2 to 3.3 percent aluminum).

4.1.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Aluminum was detected in 100 percent of the 151 surface soil samples collected in the WBEU. Aluminum concentrations in surface soil samples at the WBEU range from 4,780 to 33,000 milligrams per kilogram (mg/kg), with a mean concentration of 14,613 mg/kg and a standard deviation of 6,893 mg/kg. Aluminum concentrations in the background data set range from 4,050 to 17,100 mg/kg, with a mean concentration of 10,203 mg/kg and a standard deviation of 3,256 mg/kg (Table A3.2.6) The concentrations of aluminum in surface soil samples at the WBEU are elevated compared to background, but the data populations overlap.

Aluminum concentrations in WBEU surface soil are well within aluminum background concentrations in soils of Colorado and the bordering states, which range from 5,000 to 100,000 mg/kg, with a mean concentration of 50,800 mg/kg and a standard deviation of 23,500 mg/kg (Table A3.4.1).

4.1.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The MDC for aluminum in the WBEU (33,000 mg/kg) exceeds the no observed adverse effect level (NOAEL) ESL for only one receptor group, terrestrial plants (50 mg/kg). However, U.S. Environmental Protection Agency (EPA) Ecological Soil Screening Level (EcoSSL) guidance (EPA 2003) for aluminum recommends that aluminum should not be considered an ECOPC for soils at sites where the soil pH exceeds 5.5 due to its limited bioavailability in non-acidic soils. The average pH value for RFETS surface soils is 8.2. Therefore, aluminum concentrations in WBEU surface soil are unlikely to result in risk concerns for wildlife populations.

4.1.6 Conclusion

The weight of evidence presented above shows that aluminum concentrations in WBEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; a spatial distribution that suggests aluminum is naturally occurring; a probability plot that suggests the presence of a single population, which is also indicative of background conditions; WBEU aluminum concentrations that are well within regional background levels; and WBEU concentrations that are unlikely to result in risk concerns for wildlife populations. Aluminum is not considered an ECOPC in surface soil for the WBEU and, therefore, is not further evaluated quantitatively.

4.2 Arsenic

Arsenic has concentrations statistically greater than background in surface soil/surface sediment and was carried forward to the professional judgment step. The lines of evidence used to determine if arsenic should be retained as a COC for risk characterization are summarized below.

4.2.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates that arsenic cannot be eliminated as a PCOC in WBEU soil due to the presence of the Individual Hazardous Substance Site (IHSS) SE-1602 in the WBEU, a former firing range.

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4.2.2 Evaluation of Spatial Trends

Surface Soil/Surface Sediment

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, arsenic in surface soil/surface sediment cannot be eliminated as a COC in the WBEU because elevated concentrations of arsenic are located near historical IHSSs and will be evaluated in the risk characterization for the WBEU.

4.2.3 Conclusion

The weight of evidence presented above shows that arsenic concentrations in WBEU surface soil/surface sediment may be associated with past site activities and cannot be eliminated as a COC. Therefore, arsenic is carried forward into risk characterization.

4.3 Barium

Barium has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if barium should be retained for risk characterization are summarized below.

4.3.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates that barium is unlikely to be present in RFETS soil as a result of historical site-related activities.

4.3.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that barium concentrations in WBEU surface soil reflect variations in naturally occurring barium.

4.3.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for barium in surface soil (Figure A3.4.2) indicates the presence of a single background population.

4.3.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Barium concentrations in WBEU surface soil range from 34.9 to 280 mg/kg, with a mean concentration of 135 mg/kg and a standard deviation of 47.3 mg/kg. Barium concentrations in the background data set range from 45.7 to 134.0 mg/kg, with a mean concentration of 102.0 and a standard deviation of 19.4 mg/kg (Table A3.2.6). The concentrations of barium in surface soil samples at the WBEU are slightly elevated compared to background, but the data populations do overlap considerably.

Barium concentrations in WBEU surface soil are well within the range for background concentrations of barium in soils of Colorado and the bordering states, which range from 100.0 to 3,000 mg/kg, with mean concentration of 642 mg/kg and a standard deviation of 330 mg/kg (Table A3.4.1).

4.3.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for barium in the WBEU (230 mg/kg) exceeds the NOAEL ESL of only one receptor group, the herbivorous mourning dove (159 mg/kg). The ESL is not below the range of background concentrations and is, therefore, likely to be overly conservative for use in screening level risk assessments.

4.3.6 Conclusion

The weight of evidence presented above shows that barium concentrations in WBEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; the spatial distribution analysis that suggests barium is naturally occurring; and the pattern recognition analysis that indicates the presence of a single background population within WBEU surface soil. In addition, barium concentrations within WBEU are well within regional background levels. Therefore, barium is not considered an ECOPC in surface soil for the WBEU and is not further evaluated quantitatively.

4.4 Bis(2-ethylhexyl)phthalate

Bis(2-ethylhexyl)phthalate has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if bis(2-ethylhexyl)phthalate should be retained for risk characterization are summarized below.

4.4.1 Summary of Process Knowledge

There are no documented historical source areas present in the WBEU, and no documented operations or activities that occurred in the WBEU involving the use of bis(2-ethylhexyl)phthalate (Colorado Department of Health [CDH] 1992; U.S. Department of Energy [DOE] 1992; DOE 1995). Therefore, the potential for bis(2-ethylhexyl)phthalate to be present in WBEU surface soil as a result of historical site-related activities is unlikely.

4.4.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

Bis(2-ethylhexyl)phthalate was detected in 11 percent of the WBEU surface soil samples. The detections are estimated values, and most results are below the reported detection limits of 330 to 480 micrograms per kilogram (μg/kg). However, the bis(2-ethylhexyl)phthalate MDC of 580 μg/kg was above the upper detection limit. As shown in Figure A3.4.3, there are two locations near an historical IHSS that have concentration of bis(2-ethylhexyl)phthalate greater than 3 times the ESL.

4.4.3 Conclusion

Although there are no documented historical source areas of bis(2-ethylhexyl)phthalate present in the WBEU and the EPA considers bis(2-ethylhexyl)phthalate, along with other phthalate esters, to be common laboratory contaminants, a decision could not be made whether the elevated concentration in the samples collected from the WBEU is significantly elevated compared to background because the background comparison is not performed for organics. Because the bis(2-ethylhexyl)phthalate MDC of 510 μg/kg exceeded two NOAEL ESL, insectivorous mourning dove (137 μg/kg) and American kestrel (398 μg/kg), and the UTL of 395 μg/kg exceeded the NOAEL ESL for insectivorous mourning dove (137 μg/kg), as a conservative measure, bis(2-ethylhexyl)phthalate was identified as an ECOPC and carried forward into risk characterization.

4.5 Boron

Boron has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if boron should be retained for risk characterization are summarized below.

4.5.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates boron is unlikely to be present in RFETS soil as a result of historical site-related activities.

4.5.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that boron concentrations in WBEU surface soil reflect variations in naturally occurring boron.

4.5.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for boron in surface soil (Figure A3.4.4) indicates the presence of a single background population.

4.5.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

The reported range for boron in surface soil within Colorado and the bordering states is 20 to 150 mg/kg, with a mean concentration of 27.9 mg/kg and a standard deviation of 19.7 mg/kg (Table A3.4.1). Boron concentrations reported in surface soil samples at the WBEU range from 0.67 to 15.0 mg/kg, with a mean concentration of 6.82 mg/kg and a standard deviation of 3.63 mg/kg (Table A3.2.6). The range of concentrations of boron in surface soil is well within the lower range for background concentrations for boron in soils of Colorado and the bordering states.

4.5.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for boron in the WBEU (13.0 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (0.5 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 30 to 6,070 mg/kg. Site-specific background data for boron were not available, but the MDC did not exceed the low end (20 mg/kg) of the background range presented in Shacklette and Boerngen (1984). This indicates the terrestrial plant NOAEL ESL (0.5 mg/kg) is well below expected background concentrations, and because risks are not typically expected at background concentrations, boron concentrations are not likely to be indicative of site-related risk to the terrestrial plant community in the WBEU. Kabata-Pendias and Pendias (1992) indicate that soil with boron concentrations equal to 0.3 mg/kg is critically deficient in boron, and effects on plant reproduction would be expected. Additionally, the summary of boron toxicity in Efroymson et al. (1997) notes that the source of the 0.5-mg/kg NOAEL ESL indicates boron was toxic when added at 0.5 mg/kg to soil, but gives no indication of the boron concentration in the baseline soil before addition. The confidence placed by Efroymson et al. (1997) was low. Because no NOAEL ESLs other than the terrestrial plant NOAEL ESL are exceeded by the MDC, boron is unlikely to present a risk to terrestrial receptor populations in the WBEU.

4.5.6 Conclusion

The weight of evidence presented above shows that boron concentrations in WBEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; a spatial distribution that suggests boron is naturally occurring; and a probability plot that suggests the presence of a single population, which is also indicative of background conditions. In addition, WBEU boron concentrations are well within regional background levels and WBEU concentrations are unlikely to result in risk concerns for wildlife populations. Boron is not considered an ECOPC in surface soil for the WBEU and, therefore, is not further evaluated quantitatively.

4.6 Chromium

Chromium has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if chromium should be retained for risk characterization are summarized below.

4.6.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for chromium to have been released into RFETS soil because of the moderate chromium metal inventory and the presence of chromium in waste generated during former operations. Spills of chromium-contaminated wastes have also occurred at RFETS. Based on process knowledge, chromium may be present in RFETS soil as a result of historical site-related activities.

4.6.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis shows the concentrations of chromium at levels three times the background MDC at several locations in the WBEU that are near historical IHSSs.

4.6.3 Conclusion

The weight of evidence presented above shows that chromium concentrations in WBEU surface soil (non-PMJM) may be a result of historical site-related activities based on process knowledge and the spatial distribution analysis. Therefore, based on this line of evidence, chromium in surface soil is considered an ECOPC and is evaluated in the risk characterization.

4.7 Endrin

Endrin has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if endrin should be retained for risk characterization are summarized below.

4.7.1 Summary of Process Knowledge

There are no documented operations or activities that occurred in the WBEU involving the use of endrin (CDH 1992; DOE 1992; DOE 1995). Therefore, the potential for endrin to be present in WBEU surface soil as a result of historical site-related activities is unlikely.

4.7.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

Endrin is not a naturally occurring compound and a background comparison can not be performed. Endrin was detected in only 8 percent of the 40 surface soil samples collected within the WBEU. Endrin concentrations ranged from 4.50 to 5.10 µg/kg. The three locations where endrin concentrations were greater than 3 times the ESL were clustered together near an IHSS (Figure A3.4.5). Therefore endrin cannot be eliminated as an ECOPC.

4.7.3 Conclusion

Due to the elevated concentrations of endrin at three locations within the WBEU located near historical IHSSs, endrin was identified as an ECOPC and carried forward into risk characterization.

4.8 Lithium

Lithium has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if lithium should be retained for risk characterization are summarized below.

4.8.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for lithium to have been released into RFETS soil because of the moderate lithium metal inventory and presence of lithium in waste generated during former operations. However, these sources of historic use are remote from the WBEU. Therefore, lithium may be present in RFETS soil as a result of historical site-related activities.

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4.8.2 Evaluation of Spatial Trends

Surface Soil (non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that lithium concentrations in WBEU surface soil reflect variations in naturally occurring lithium.

4.8.3 Pattern Recognition

Surface Soil (non-PMJM)

The probability plot for lithium concentrations suggests the presence of a single population, which indicates background conditions (Figure A3.4.6).

4.8.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Lithium concentrations in surface soil samples at the WBEU range from 4.40 to 33.0 mg/kg, with a mean concentration of 12.4 mg/kg and a standard deviation of 6.26 mg/kg. Lithium concentrations in the background data set range from 4.80 to 11.6 mg/kg, with a mean concentration of 7.66 mg/kg and a standard deviation of 1.89 mg/kg (Table A3.2.6). The concentrations of lithium in surface soil samples at the WBEU are slightly elevated compared to background, but the data populations do overlap.

Lithium concentrations reported in surface soil samples at the WBEU are well within the range for lithium in soils of Colorado and the bordering states (5 to 130 mg/kg, with mean concentration of 25.3 mg/kg and a standard deviation of 14.4 mg/kg) (Table A3.4.1).

4.8.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for lithium in the WBEU (23.3 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (2 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 610 to 18,431 mg/kg. The ESL for terrestrial plants is lower than all detected background concentrations. Because risks to ecological receptors are not expected at background concentrations, the terrestrial plant ESL may be overly-conservative.

4.8.6 Conclusion

The weight of evidence presented above shows that lithium concentrations in WBEU surface soil (non-PMJM receptors) have a spatial distribution indicative of naturally occurring lithium; a probability plot that suggests the presence of a single population, which is also indicative of background conditions; and WBEU concentrations that are well within regional background levels. Lithium is not considered an ECOPC in surface soil for the WBEU and, therefore, is not further evaluated quantitatively.

4.9 Manganese

Manganese has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and was carried forward to the professional judgment step. The lines of evidence used to determine if manganese should be retained for risk characterization are summarized below.

4.9.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates manganese is unlikely to be present in RFETS soil as a result of historical site-related activities.

4.9.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that manganese concentrations in some locations within the WBEU exceed the ESL and background, but are at levels less than 3 times the minimum ESL. However, because these locations are near historical IHSSs, manganese in surface soil within the WBEU cannot be eliminated as an ECOPC and is evaluated in the risk characterization.

4.9.3 Conclusion

The weight of evidence presented above shows that manganese concentrations in WBEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge. However, the spatial distribution analysis indicates that elevated manganese concentrations within the WBEU are located near historical IHSSs. Therefore, manganese in surface soil (non-PMJM) was identified as an ECOPC and carried forward into risk characterization.

4.10 Molybdenum

Molybdenum had an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if molybdenum should be retained for risk characterization are summarized below.

4.10.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates molybdenum is unlikely to be present in RFETS soil as a result of historical site-related activities.

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4.10.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that molybdenum concentrations in WBEU surface soil reflect variations in naturally occurring molybdenum.

4.10.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plots for molybdenum contain a large proportion of multiple detection limits, resulting in a set of variably spaced and horizontal sample trends ("stair-steps") as shown in Figure A3.4.7a. This condition is created by the limited molybdenum concentration range in the WBEU surface soils. A background population line inappropriately estimates the background population because of the large number of detection limit samples (Figure A3.4.7b). Eliminating the nondetect molybdenum concentrations (102 analyses) results in a reasonable background population estimate based on 38 analyses with detectable molybdenum concentrations in this EU (Figure A3.4.7c). Therefore, the molybdenum concentrations in surface soils in this EU represent a single background population.

4.10.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

The reported range for molybdenum in surface soil within Colorado and the bordering states is 3 to 7 mg/kg, with a mean concentration of 1.59 mg/kg and a standard deviation of 0.522 mg/kg (Table A3.4.1). Molybdenum concentrations reported in surface soil samples at the WBEU range from 0.150 to 3.0 mg/kg, with a mean concentration of 1.07 mg/kg and a standard deviation of 1.00 mg/kg (Table A3.2.6). The range of concentrations of molybdenum in surface soil is below the range for molybdenum in soils of Colorado and the bordering states.

4.10.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for molybdenum in the WBEU (2.50 mg/kg) exceeds the NOAEL ESL for two receptor groups: terrestrial plants (2.0 mg/kg) and insectivorous deer mouse (1.90 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 7.0 to 275.0 mg/kg. Only the ESL for terrestrial plants is within the range of background concentrations. It is, therefore, likely to be overly conservative. None of the remaining ESLs are within the range of background concentrations and are not likely to be overly conservative for use in screening level risk assessments.

4.10.6 Conclusion

The weight of evidence presented above shows that molybdenum concentrations in WBEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge, a spatial distribution that suggests molybdenum is naturally occurring, a probability plot that suggests the presence of a single population which is also indicative of background conditions, and WBEU concentrations that are well within regional background levels. Molybdenum is not considered an ECOPC in surface soil for the WBEU and, therefore, is not further evaluated quantitatively.

4.11 Nickel

Nickel had an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if nickel should be retained for risk characterization are summarized below.

4.11.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for nickel to have been released into RFETS soil because of the moderate nickel metal inventory and presence of nickel in waste generated during former operations. Based on process knowledge, nickel may be present in RFETS soil as a result of historical site-related activities.

4.11.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that nickel in surface soil cannot be eliminated as an ECOPC for the WBEU and is evaluated in the risk characterization.

4.11.3 Conclusion

The weight of evidence presented above shows that nickel concentrations in surface soil within WBEU may be a result of historical site-related activities based on process knowledge. The spatial distribution analysis indicates that elevated nickel concentrations within the WBEU are located near historical IHSSs. Therefore, nickel in surface soil (non-PMJM) was identified as an ECOPC and carried forward into risk characterization.

4.12 Total PCBs

Total PCBs has an EPC in surface soil (for non-PMJM receptors) greater than the tESL and, therefore, was carried forward to the professional judgment step. A decision could not be made whether concentrations in samples collected from EU are significantly elevated versus background because the background comparison is not performed for organics. The lines of evidence used to determine if total PCBs should be retained for risk characterization are summarized below.

4.12.1 Summary of Process Knowledge

There are no documented operations or activities that occurred in the WBEU involving the use of total PCBs (CDH 1992; DOE 1992; DOE 1995). Therefore, the potential for total PCBs to be present in WBEU surface soil as a result of historical site-related activities is unlikely.

4.12.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

Total PCBs was detected in 32 percent of the 81 surface samples collected from the WBEU, with a concentration range of 20.1 μg/kg to 3,365 μg/kg, a mean concentration of 184.0 μg/kg, and a standard deviation of 382 μg/kg . Samples with concentrations 3 times the ESL of 42 μg/kg are located near a historical IHSS (Figure A3.4.8). Therefore, based on this line of evidence, total PCBs cannot be eliminated as an ECOPC.

4.12.3 Conclusion

Total PCB in surface soil concentrations is being carried forward into the ecological non-PMJM risk characterization as an ECOPC because of elevated concentrations (greater than 3 times the ESL) in surface soil samples collected near historical IHSSs.

4.13 Plutonium-239/240

Plutonium-239/240 has concentrations statistically greater than background in surface soil/surface sediment and was carried forward to the professional judgment step. The lines of evidence used to determine if plutonium-239/240 should be retained for risk characterization are summarized below.

4.13.1 Summary of Process Knowledge

Components for nuclear weapons were fabricated in a large industrial complex at RFETS from plutonium, uranium, and metals such as beryllium and stainless steel. Other activities of RFETS included purification of plutonium (DOE 1998).

4.13.2 Evaluation of Spatial Trends

Surface Soil/Surface Sediment

Plutonium-239/240 was detected in all of the 319 surface soil/surface sediment samples collected from the WBEU with activities ranging from -0.003 to 49.0 pCi/g with a mean activity of 9.19 pCi/g and a standard deviation of 12 pCi/g. Samples with concentrations 3 times the WRW PRG of 29.4 pCi/g are located near historical IHSSs (Figure A3.4.9). Therefore, plutonium-239/240 cannot be eliminated as a COC.

4.13.3 Conclusion

Plutonium-239/240 in surface soil/surface sediment is being carried forward into the risk characterization as a COC because elevated concentrations (greater than 3 times the ESL) in surface soil/surface sediment samples collected near historical IHSSs.

4.14 Radium-228

Radium-228 has concentrations statistically greater than background in surface soil/surface sediment and was carried forward to the professional judgment step. The lines of evidence used to determine if radium-228 should be retained for risk characterization are summarized below.

4.14.1 Summary of Process Knowledge

The ChemRisk Task 1 Report did not identify radium-228 as a radionuclide used at RFETS (CDH 1991) and no radium-228 waste was reported to have been generated. It is unlikely that radium-228 is present in soil at RFETS as a result of historical site-related activities.

4.14.2 Evaluation of Spatial Trends

Surface Soil/Surface Sediment

As shown in Figure A3.4.10, radium-228 concentrations exceed the PRG of 0.111 picocuries per gram (pCi/g) at locations throughout the WBEU. There are no locations where the radium-228 concentration exceeds the background MDC. Thus, it appears that radium-228 concentrations in WBEU surface soil reflect variations in naturally occurring radium-228.

4.14.3 Pattern Recognition

Surface Soil/Surface Sediment

The probability plot for radium-228 concentrations suggests a single population, which is indicative of background conditions (Figure A3.4.11).

4.14.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil/Surface Sediment

Radium-228 concentrations in surface soil/surface sediment samples at the WBEU range from 0.94 to 3.50 pCi/g, with a mean concentration of 2.09 pCi/g and a standard deviation of 0.693 pCi/g. The radium-228 concentrations in the background data set range from 0.200 to 4.10 pCi/g, with a mean concentration of 1.60 pCi/g and a standard deviation of 0.799 pCi/g (Table A3.2.2). The range of concentrations of radium-228 in the WBEU and background samples considerably overlaps and the means are similar.

Furthermore, radium-228 detections in WBEU surface soil/surface sediment are all below the background MDC.

4.14.5 Risk Potential for HHRA

The radium-228 UCL for surface soil/surface sediment is 2.38 pCi/g. The PRG is 0.111 pCi/g, with all of the detections greater than the PRG. Because the PRG is based on an excess carcinogenic risk of 1E-06, the cancer risk based on the UCL concentration is less than 2E-05 and is well within the National Contingency Plan risk range of 1E-06 to 1E-04. Because the radium-228 concentrations appear to be naturally occurring, the excess cancer risks to the WRW from exposure to radium-228 in surface soil/surface sediment in the WBEU is similar to background risk.

4.14.6 Conclusion

The weight of evidence presented above shows that radium-228 concentrations in WBEU surface soil/surface sediment are not likely to be a result of historical site-related activities based on process knowledge; a spatial distribution indicative of naturally occurring radium-228; and a probability plot that suggests the presence of a single population, which is also indicative of background conditions. The WBEU radium-228 concentrations are unlikely to result in risks to humans significantly above background risks. Radium-228 is not considered a COC in surface soil/surface sediment in WBEU and, therefore, is not further evaluated quantitatively.

4.15 Silver

Silver has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if silver should be retained for risk characterization are summarized below.

4.15.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates that silver was used in small quantities at the site and waste was generated from both laboratory and process buildings. Based on process knowledge, silver was present in the metals inventory, silver waste at the site and, therefore, silver may be present in RFETS soil as a result of historical site-related activities.

4.15.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, WBEU surface soil samples have concentrations of silver greater than the minimum ESL and the background MDC at locations near historical IHSSs. Therefore, based on this line of evidence, silver in surface soil cannot be eliminated as an ECOPC for the WBEU and will be evaluated in the risk characterization.

4.15.3 Conclusion

The weight of evidence presented above shows that silver concentrations in WBEU surface soil (non-PMJM) may be a result of historical site-related activities based on process knowledge. However, the spatial distribution analysis indicates that elevated silver concentrations within the WBEU are located near historical IHSSs. Therefore, based on this line of evidence, silver in surface soil is considered an ECOPC and is evaluated in the risk characterization.

4.16 Thallium

Thallium has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if thallium should be retained for risk characterization are summarized below.

4.16.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates that thallium was used in small quantities at the site, thallium waste was generated from both laboratory and process buildings, and thallium compounds were identified in the ChemRisk reports but were not carried forward as a material of concern (CDH 1991). Based on process knowledge, thallium is not likely to be present at WBEU soil as a result of historical site-related activities.

4.16.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, thallium in surface soil cannot be eliminated as an ECOPC for the WBEU, and as a conservative measure is evaluated in the risk characterization because concentrations above background were located near historical IHSSs.

4.16.3 Conclusion

The weight of evidence presented above shows that thallium concentrations in WBEU surface soil (non-PMJM) are not likely to be a result of historical site-related activities based on process knowledge. However, the spatial distribution analysis indicates that elevated thallium concentrations within the WBEU are located near historical IHSSs. Therefore, based on this line of evidence, thallium in surface soil is considered an ECOPC and is evaluated in the risk characterization.

4.17 Tin

Tin has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if tin should be retained for risk characterization are summarized below.

4.17.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, based on process knowledge, tin was present in the metals inventory and may be present in RFETS soil as a result of historical site-related activities.

4.17.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the MDC and EPC for tin exceed the minimum ESL in surface soil locations within WBEU. Therefore, based on this line of evidence, tin in surface soil cannot be eliminated as an ECOPC for the WBEU and is carried into the risk characterization.

4.17.3 Conclusion

The weight of evidence presented above shows that tin concentrations in WBEU surface soil (non-PMJM) may be a result of historical site-related activities based on process knowledge. The spatial distribution analysis indicates that elevated tin concentrations are located within the WBEU. Therefore, based on this line of evidence, tin in surface soil is considered an ECOPC and is evaluated in the risk characterization.

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TABLES

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Table A3.2.1
Statistical Distribution and Comparison to Background for WBEU Surface Soil/Surface Sediment

Analyte	Statistical Distribution Testing Results						Background Comparison Test Result		
	Background Data Set			WBEU Data Set (excluding background samples)			Test	1 - p	Statistically Greater than Background?
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)			
Arsenic	**73**	**GAMMA**	**92**	**160**	**GAMMA**	**100**	**WRS**	**2.36E-08**	**Yes**
Cesium-137	105	NONPARAMETRIC	100	37	NONPARAMETRIC	100	WRS	0.206	No
Plutonium-239/240	**94**	**NONPARAMETRIC**	**100**	**319**	**NONPARAMETRIC**	**100**	**WRS**	**0**	**Yes**
Radium-228	**40**	**GAMMA**	**100**	**17**	**NORMAL**	**100**	**WRS**	**0.00727**	**Yes**

WRS = Wilcoxon Rank Sum.

Bold = Analyte retained for further consideration in the next COC selection step.

Table A3.2.2

Summary Statistics for Background and WBEU Surface Soil/Surface Sediment[a]

Analyte	Units	Background					WBEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Arsenic	mg/kg	73	0.270	9.60	3.42	2.55	160	1.00	11.0	5.20	2.12
Cesium-137	pCi/g	105	-0.027	1.80	0.692	0.492	37	0.050	2.01	0.781	0.565
Plutonium-239/240	pCi/g	94	-0.010	0.350	0.032	0.039	319	-0.003	49.0	9.19	12.0
Radium-228	pCi/g	40	0.200	4.10	1.60	0.799	17	0.940	3.50	2.09	0.693

[a] Statistics are computed using one-half of the report values for nondetects.

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Table A3.2.3
Statistical Distribution and Comparison to Background for WBEU Subsurface Soil/Subsurface Sediment

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			WBEU Data Set (excluding background samples)			Test	1 - p	Statistically Greater than Background?
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)			
Radium-228	31	GAMMA	100	65	NORMAL	100	WRS	0.973	No

WRS = Wilcoxon Rank Sum.

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Table A3.2.4
Summary Statistics for Background and WBEU Suburface Soil/Subsurface Sediment[a]

Analyte	Units	Background Data Set					WBEU Data Set (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Radium-228	pCi/g	31	1.00	2.10	1.45	0.320	65	0	2.60	1.25	0.513

[a] Statistics are computed using one-half of the report values for nondetects.

Table A3.2.5
Statistical Distribution and Comparison to Background for WBEU Surface Soil

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			WBEU Data Set (excluding background samples)			Test	1 - p	Statistically Greater than Background?
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)			
Aluminum	**20**	**NORMAL**	**100**	**151**	**GAMMA**	**100**	**WRS**	**0.00263**	**Yes**
Arsenic	20	NORMAL	100	151	GAMMA	100	WRS	0.961	No
Barium	**20**	**NORMAL**	**100**	**151**	**NONPARAMETRIC**	**100**	**WRS**	**5.22E-05**	**Yes**
Boron	**N/A**	**N/A**	**N/A**	**76**	**NONPARAMETRIC**	**93**	**N/A**	**N/A**	**N/A**
Cadmium	20	NONPARAMETRIC	65	150	NONPARAMETRIC	45	WRS	0.991	No
Chromium	**20**	**NORMAL**	**100**	**151**	**NONPARAMETRIC**	**100**	**WRS**	**0.00141**	**Yes**
Cobalt	20	NORMAL	100	151	NORMAL	100	t-Test_N	0.879	No
Copper	20	NONPARAMETRIC	100	150	NONPARAMETRIC	100	WRS	0.159	No
Lead	20	NORMAL	100	151	NONPARAMETRIC	100	WRS	0.610	No
Lithium	**20**	**NORMAL**	**100**	**131**	**GAMMA**	**92**	**WRS**	**1.55E-04**	**Yes**
Manganese	**20**	**NORMAL**	**100**	**151**	**NONPARAMETRIC**	**100**	**WRS**	**0.0911**	**Yes**
Mercury	20	NONPARAMETRIC	40	132	NONPARAMETRIC	52	WRS	1.000	No
Molybdenum	**20**	**NORMAL**	**0**	**137**	**NONPARAMETRIC**	**28**	**N/A**	**N/A**	**N/A**
Nickel	**20**	**NORMAL**	**100**	**151**	**LOGNORMAL**	**97**	**WRS**	**1.31E-04**	**Yes**
Silver	**20**	**NORMAL**	**0**	**142**	**NONPARAMETRIC**	**25**	**N/A**	**N/A**	**N/A**
Thallium	**14**	**NORMAL**	**0**	**151**	**NONPARAMETRIC**	**21**	**N/A**	**N/A**	**N/A**
Tin	**20**	**NORMAL**	**0**	**137**	**NONPARAMETRIC**	**15**	**N/A**	**N/A**	**N/A**
Uranium	**N/A**	**N/A**	**N/A**	**76**	**NONPARAMETRIC**	**5**	**N/A**	**N/A**	**N/A**
Vanadium	20	NORMAL	100	151	LOGNORMAL	100	WRS	0.161	No
Zinc	20	NORMAL	100	151	NONPARAMETRIC	100	WRS	0.420	No

WRS = Wilcoxon Rank Sum.

t-Test_N = Student's t-test using normal data.

N/A = not applicable; site and/or background detection frequency less than 20%.

Bold = indicate ECOIs retained for further consideration in the upper-bound EPC comparison step.

Table A3.2.6
Summary Statistics For WBEU Surface Soil[a]

Analyte	Units	Background					WBEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Aluminum	mg/kg	20	4,050	17,100	10,203	3,256	151	4,780	33,000	14,613	6,893
Arsenic	mg/kg	20	2.30	9.60	6.09	2.00	151	1.00	11.0	5.21	2.14
Barium	mg/kg	20	45.7	134	102	19.4	151	34.9	280	135	47.3
Boron	mg/kg	N/A	N/A	N/A	N/A	N/A	76	0.670	15.0	6.82	3.63
Cadmium	mg/kg	20	0.670	2.30	0.708	0.455	150	0.065	2.60	0.496	0.351
Chromium	mg/kg	20	5.50	16.9	11.2	2.78	151	2.20	80.5	16.5	10.3
Cobalt	mg/kg	20	3.40	11.2	7.27	1.79	151	2.20	21.6	6.61	2.42
Copper	mg/kg	20	5.20	16.0	13.0	2.58	150	2.20	49.8	14.8	6.15
Lead	mg/kg	20	8.60	53.3	33.5	10.5	151	3.00	120	34.4	20.5
Lithium	mg/kg	20	4.80	11.6	7.66	1.89	131	4.40	33.0	12.4	6.26
Manganese	mg/kg	20	129	357	237	63.9	151	54.0	1,200	284	147
Mercury	mg/kg	20	0.090	0.120	0.072	0.031	132	0.006	0.250	0.045	0.036
Molybdenum	mg/kg	20	ND	ND	0.573	0.184	137	0.150	3.00	1.07	1.00
Nickel	mg/kg	20	3.80	14.0	9.60	2.59	151	4.40	101	14.6	10.3
Silver	mg/kg	20	ND	ND	0.207	0.007	142	0.081	42.8	1.30	4.22
Thallium	mg/kg	14	ND	ND	0.414	0.015	151	0.210	3.30	0.417	0.414
Tin	mg/kg	20	ND	ND	2.06	0.410	137	1.30	75.8	7.95	11.3
Uranium	mg/kg	N/A	N/A	N/A	N/A	N/A	76	1.90	8.00	1.89	1.41
Vanadium	mg/kg	20	10.8	45.8	27.7	7.68	151	12.1	72.0	31.9	12.2
Zinc	mg/kg	20	21.1	75.9	49.8	12.2	151	15.0	165	51.3	18.6
Benzo(a)pyrene	ug/kg	N/A	N/A	N/A	N/A	N/A	85	48.0	750	207	92.4
bis(2-ethylhexyl)phthalate	ug/kg	N/A	N/A	N/A	N/A	N/A	85	56.0	510	209	83.5
Endrin	ug/kg	N/A	N/A	N/A	N/A	N/A	40	4.50	5.10	8.87	1.51
Total PCBs	ug/kg	N/A	N/A	N/A	N/A	N/A	81	20.1	3,365	184	382

[a] Statistics are computed using one-half of the report values for nondetects.

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Table A3.2.7
Statistical Distribution and Comparison to Background for WBEU Subsurface Soil

Analyte	Statistical Distribution Testing Results: Background Data Set: Total Samples	Background Data Set: Distribution Recommended by ProUCL	Background Data Set: Detects (%)	WBEU Data Set (excluding background samples): Total Samples	WBEU Data Set: Distribution Recommended by ProUCL	WBEU Data Set: Detects (%)	Background Comparison Test Results: Test	1 - p	Statistically Greater than Background?
Antimony	**28**	**NONPARAMETRIC**	**7.14**	**303**	**NONPARAMETRIC**	**15.2**	**N/A**	**N/A**	**N/A**
Arsenic	45	NONPARAMETRIC	93.3	309	GAMMA	98.1	WRS	0.280	No
Chromium	45	GAMMA	100	309	NONPARAMETRIC	100	WRS	0.859	No
Lead	45	GAMMA	100	309	NONPARAMETRIC	99.7	WRS	1.000	No
Mercury	41	NONPARAMETRIC	29.3	308	NONPARAMETRIC	63.6	WRS	1.000	No
Molybdenum	45	NONPARAMETRIC	66.7	304	NONPARAMETRIC	50	WRS	1.00	No
Nickel	44	GAMMA	100	309	NONPARAMETRIC	98.7	WRS	0.995	No
Tin	41	NONPARAMETRIC	36.6	303	NONPARAMETRIC	24.8	WRS	1.000	No

WRS = Wilcoxon Rank Sum.

Bold = indicate ECOIs retained for further consideration in the upper-bound EPC comparison step.

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Table A3.2.8
Summary Statistics For WBEU Subsurface Soil[a]

Analyte	Units	Background					WBEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Antimony	mg/kg	28	2.90	8.20	4.21	2.78	303	0.300	350	4.60	25.5
Arsenic	mg/kg	45	1.70	41.8	5.48	6.02	309	0.820	25.9	5.21	3.13
Chromium	mg/kg	45	5.80	69.6	18.4	11.9	309	2.90	4,600	32.7	261
Lead	mg/kg	45	4.20	25.8	13.9	6.31	309	1.50	8,500	42.9	484
Mercury	mg/kg	41	0.190	0.640	0.155	0.166	308	0.002	3.40	0.097	0.345
Molybdenum	mg/kg	45	3.50	41.0	13.5	7.80	304	0.140	1,970	7.97	113
Nickel	mg/kg	44	4.30	54.2	20.9	11.1	309	2.70	1,330	24.1	80.6
Tin	mg/kg	41	25.7	441	86.0	134	303	0.570	110	7.02	11.7

[a] Statistics are computed using one-half of the report values for nondetects.

Table A3.4.1
Summary of Element Concentrations in Colorado and Bordering States Surface Soil[a]

Analyte	Total Number of Results	Detection Frequency (%)	Range of Detected Values (mg/kg)	Average (mg/kg)[b]	Standard Deviation (mg/kg)[b]
Aluminum	303	100	5,000 - 100,000	50,800	23,500
Antimony	84	15.5	1.038 - 2.531	0.647	0.378
Arsenic	307	99.3	1.224 - 97	6.9	7.64
Barium	342	100	100 - 3,000	642	330
Beryllium	342	36	1 - 7	0.991	0.876
Boron	342	66.7	20 - 150	27.9	19.7
Bromine	85	50.6	0.5038 - 3.522	0.681	0.599
Calcium	342	100	0.055 - 32	3.09	4.13
Carbon	85	100	0.3 - 10	2.18	1.92
Cerium	291	16.2	150 - 300	90	38.4
Chromium	342	100	3 - 500	48.2	41
Cobalt	342	88.6	3 - 30	8.09	5.03
Copper	342	100	2 - 200	23.1	17.7
Fluorine	264	97.3	10 - 1,900	394	261
Gallium	340	99.1	5 - 50	18.3	8.9
Germanium	85	100	0.5777 - 2.146	1.18	0.316
Iodine	85	78.8	0.516 - 3.487	1.07	0.708
Iron	342	100	3,000 - 100,000	21,100	13,500
Lanthanum	341	66.3	30 - 200	39.8	28.8
Lead	342	92.7	10 - 700	24.8	41.5
Lithium	307	100	5 - 130	25.3	14.4
Magnesium	341	100	300 - 50,000	8,630	6,400
Manganese	342	100	70 - 2,000	414	272
Mercury	309	99	0.01 - 4.6	0.0768	0.276
Molybdenum	340	3.53	3 - 7	1.59	0.522
Neodymium	256	22.7	70 - 300	47.1	31.7
Nickel	342	96.5	5 - 700	18.8	39.8
Niobium	335	63.3	10 - 100	11.4	8.68
Phosphorus	249	100	40 - 4,497	399	397
Potassium	341	100	1,900 - 63,000	18,900	6,980
Rubidium	85	100	35 - 140	75.8	25
Scandium	342	85.1	5 - 30	8.64	4.69
Selenium	309	80.6	0.1023 - 4.3183	0.349	0.415
Silicon	85	100	149,340 - 413,260	302,000	61,500
Sodium	335	100	500 - 70,000	10,400	6,260
Strontium	342	100	10 - 2,000	243	212
Sulfur	85	16.5	816 - 47,760	1,250	5,300
Thallium	76	100	2.45 - 20.79	9.71	3.54
Tin	85	96.5	0.117 - 5.001	1.15	0.772
Titanium	342	100	500 - 7,000	2,290	1,350
Uranium	85	100	1.11 - 5.98	2.87	0.883
Vanadium	342	100	7 - 300	73	41.7
Ytterbium	330	99.1	1 - 20	3.33	2.06
Yttrium	342	98	10 - 150	26.9	18.1
Zinc	330	100	10 - 2,080	72.4	159
Zirconium	342	100	30 - 1,500	220	157

[a] Based on data from Shacklette and Boerngen 1984 for the states of Colorado, Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming.

[b] One-half the detection limit used as proxy value for nondetects in computation of the mean and standard deviation.

FIGURES

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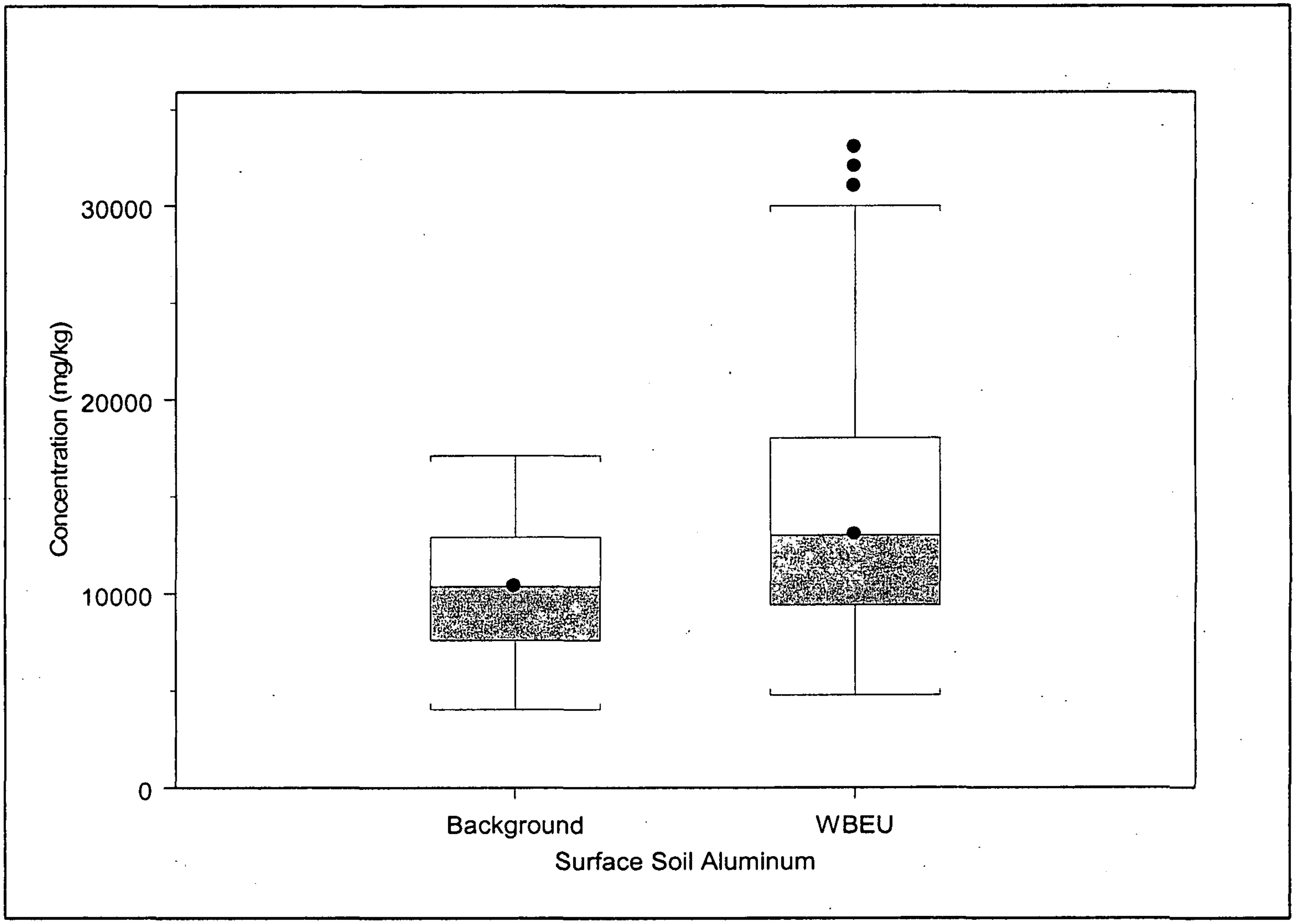
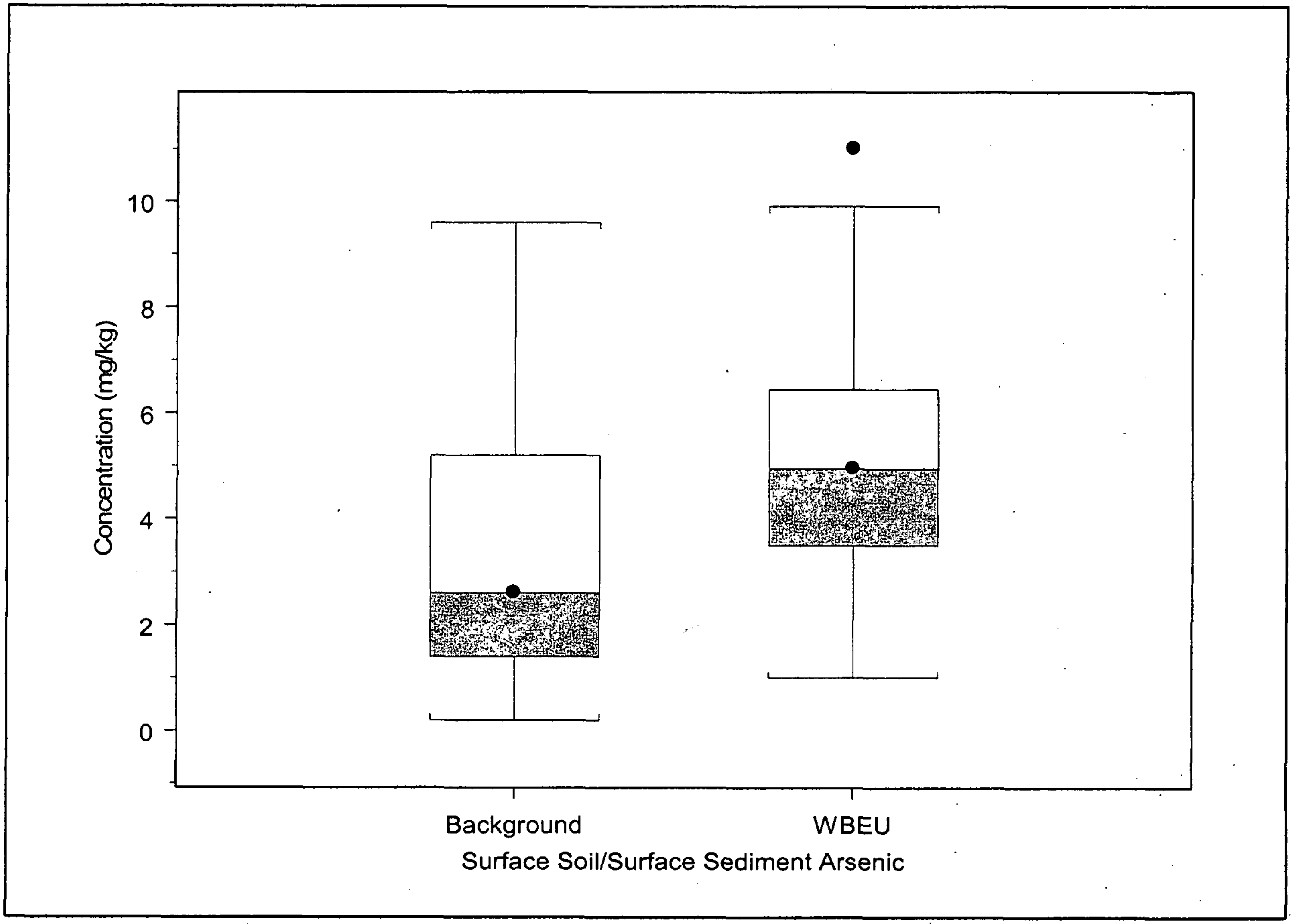
Figure [illegible].2.1
WBEU Surface Soil Box Plots for Aluminum



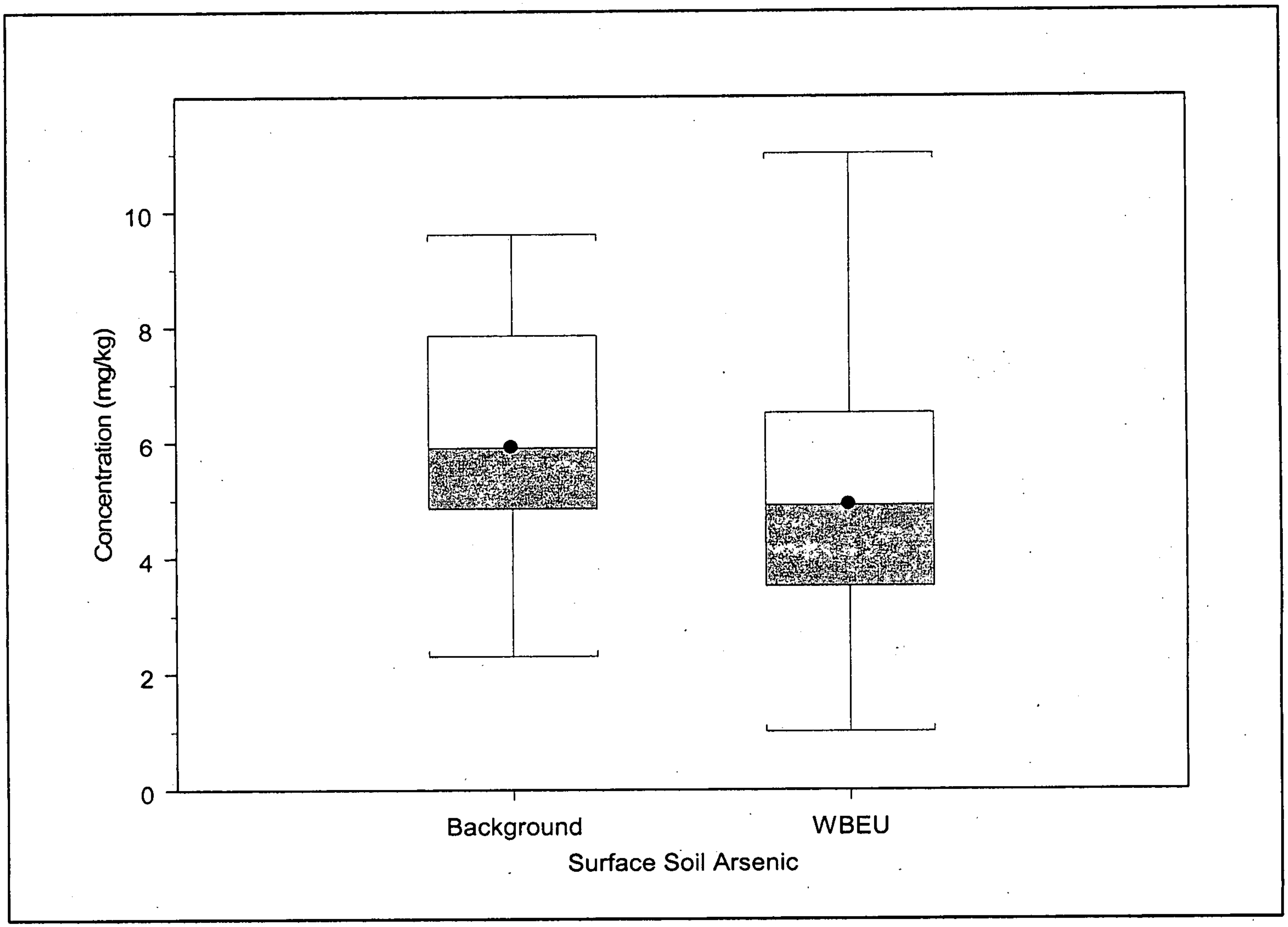
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figur[illegible]3.2.2
WBEU Surface Soil/Surface Sediment Box Plots for Arsenic



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

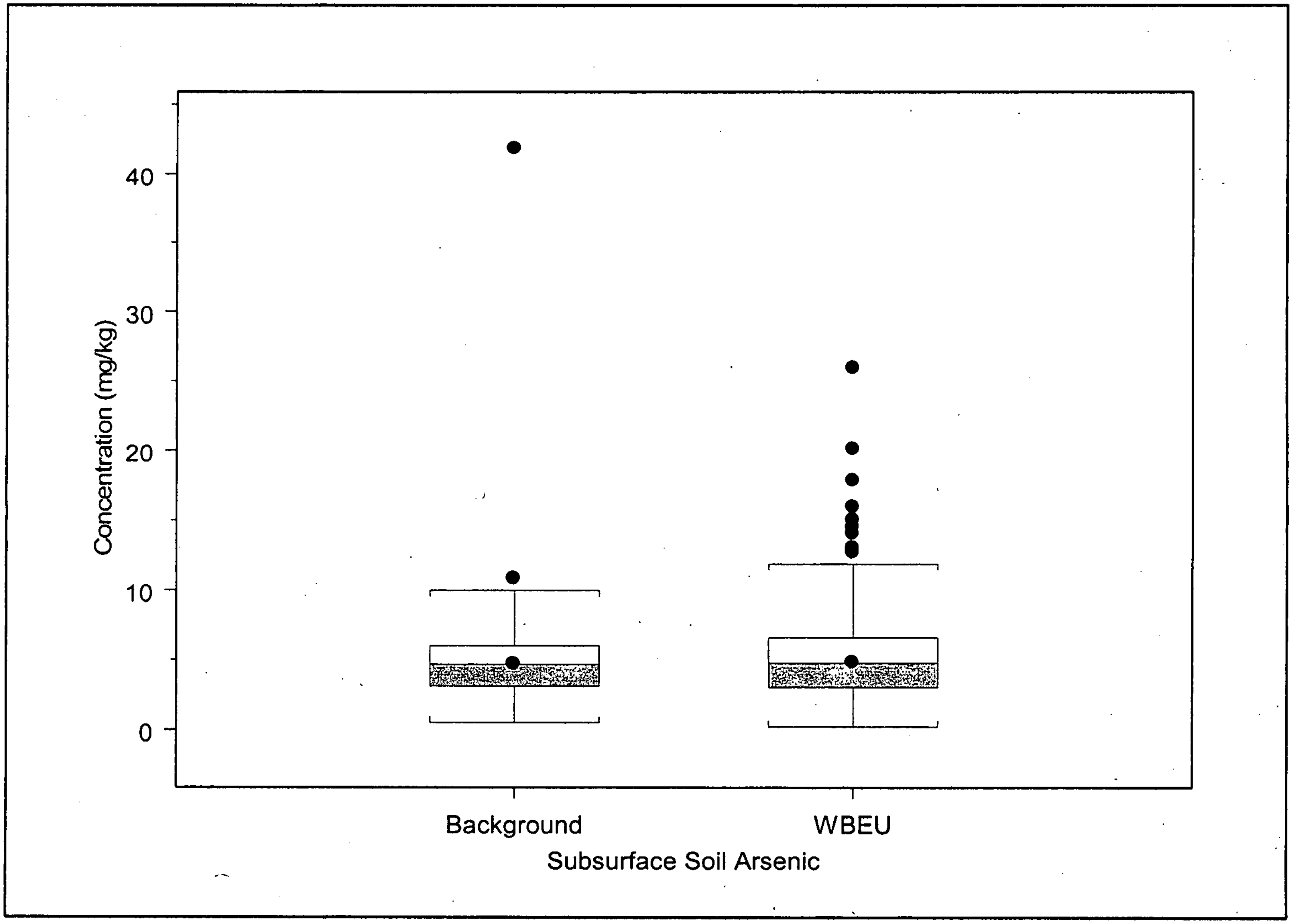
Figur[illegible]3.2.3
WBEU Surface Soil Box Plots for Arsenic



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

223

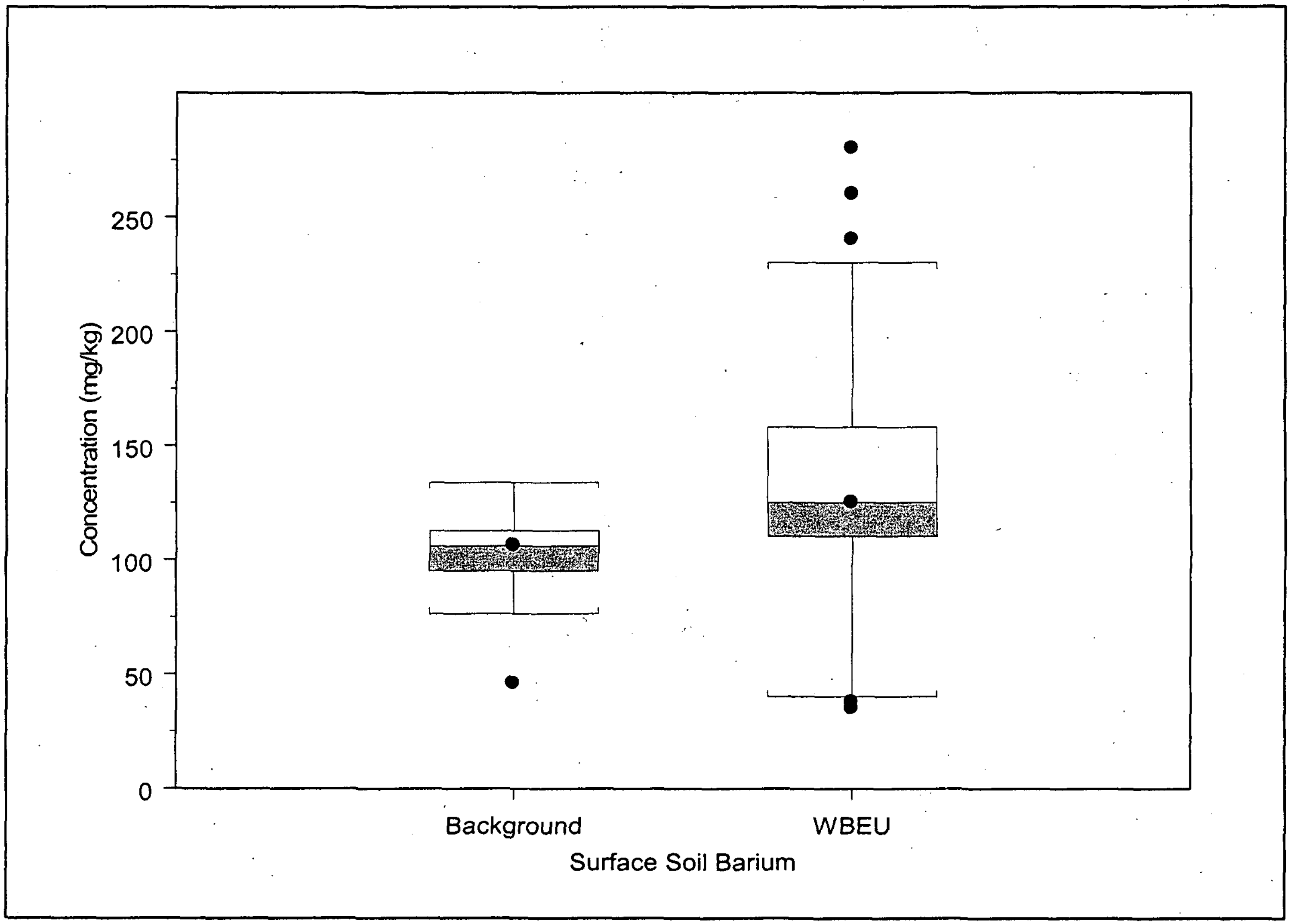
Figure A3.2.4
WBEU Subsurface Soil Box Plots for Arsenic



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

224

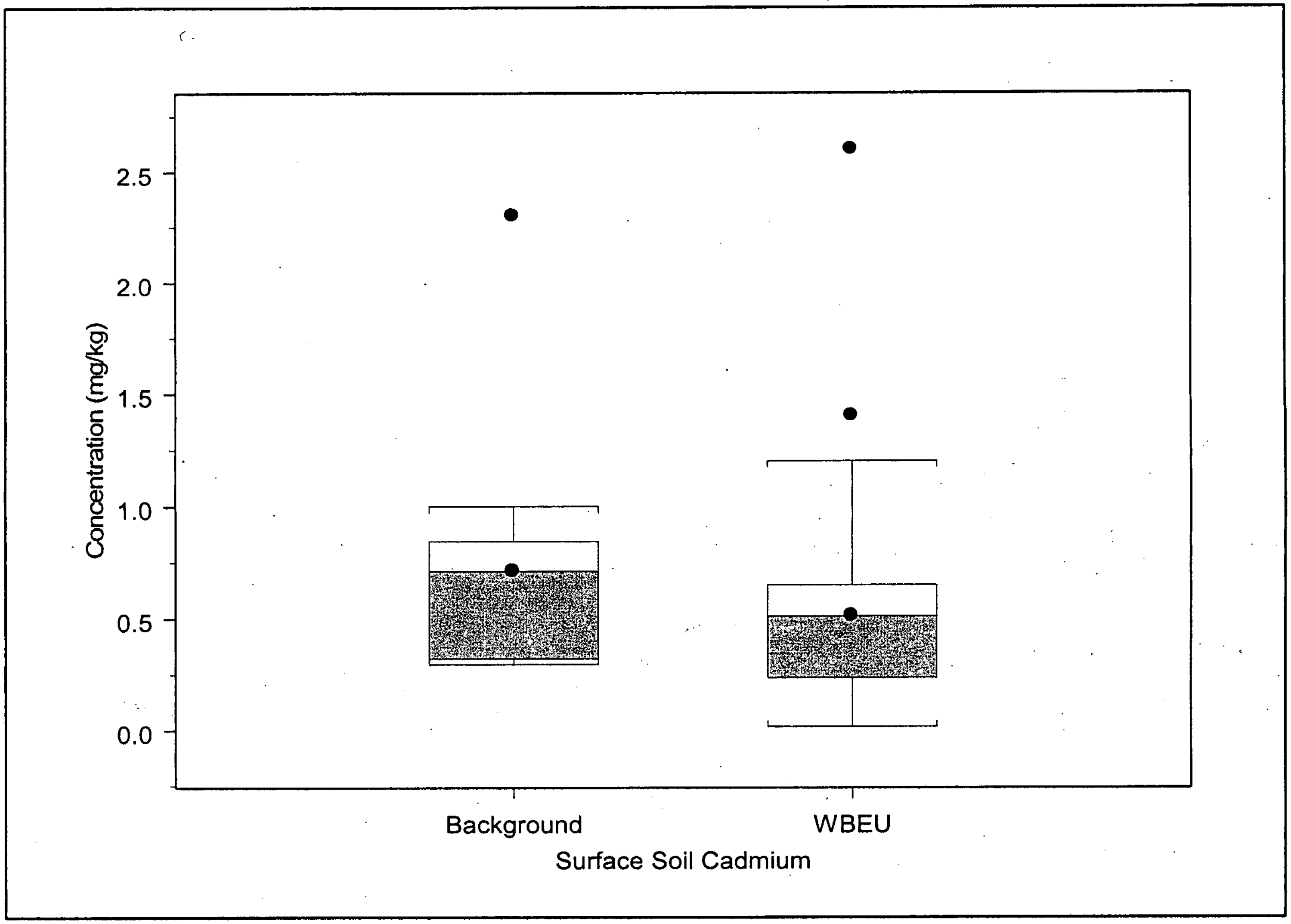
Figure [illegible].2.5
WBEU Surface Soil Box Plots for Barium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

225

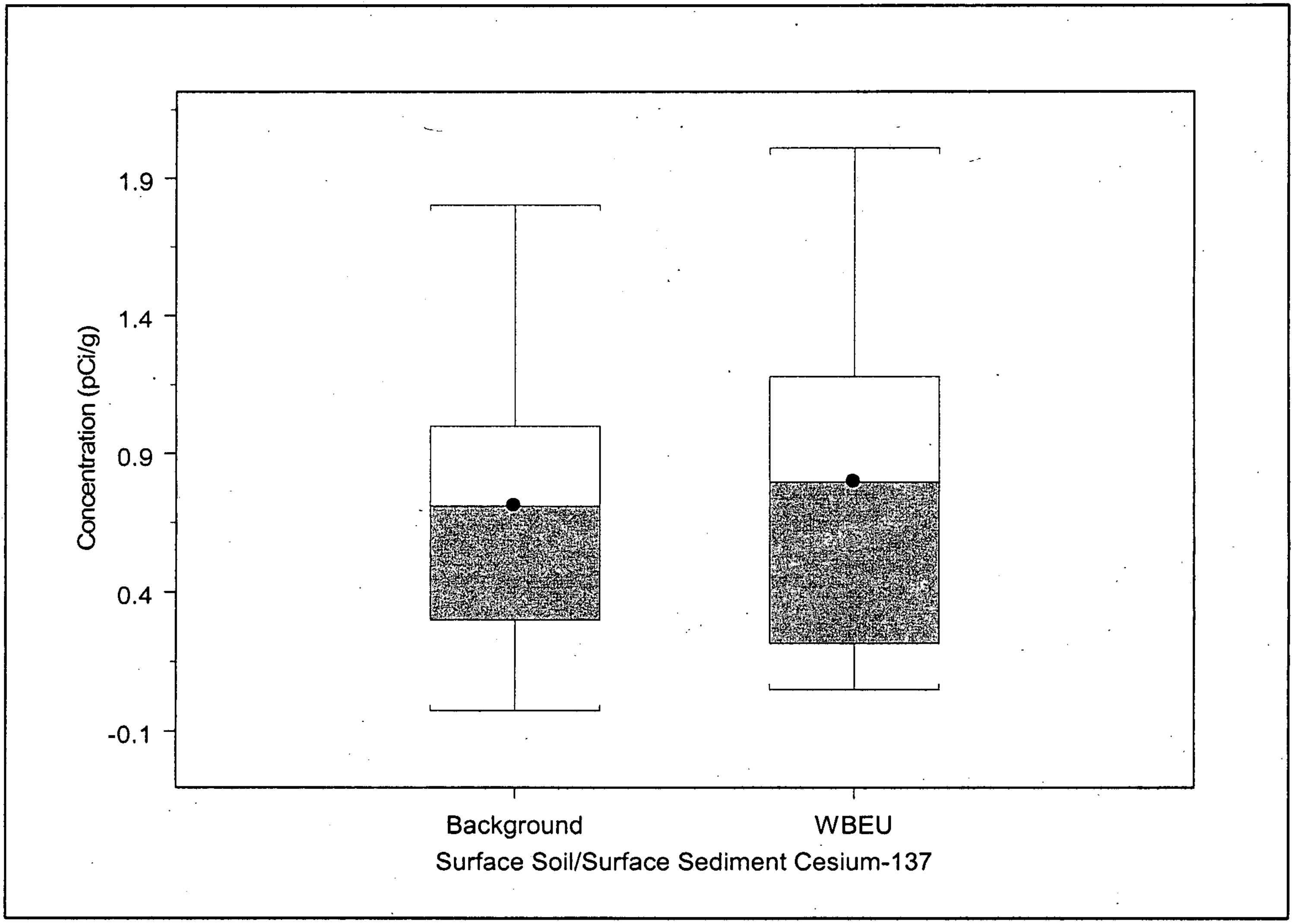
Figure [illegible].2.6
WBEU Surface Soil Box Plots for Cadmium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

278

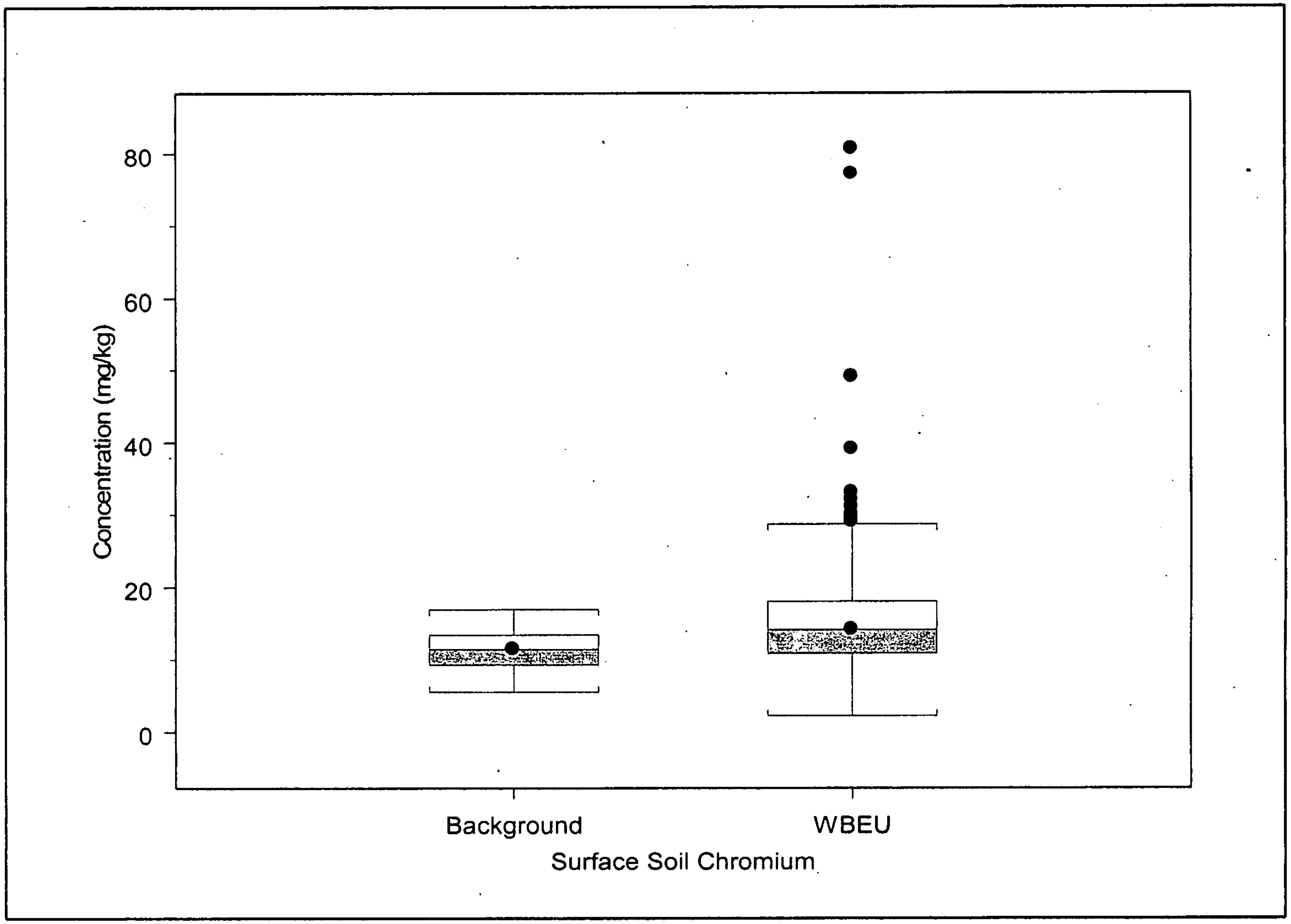
Figure [illegible].2.7
WBEU Surface Soil/Surface Sediment Box Plots for Cesium-137



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

227

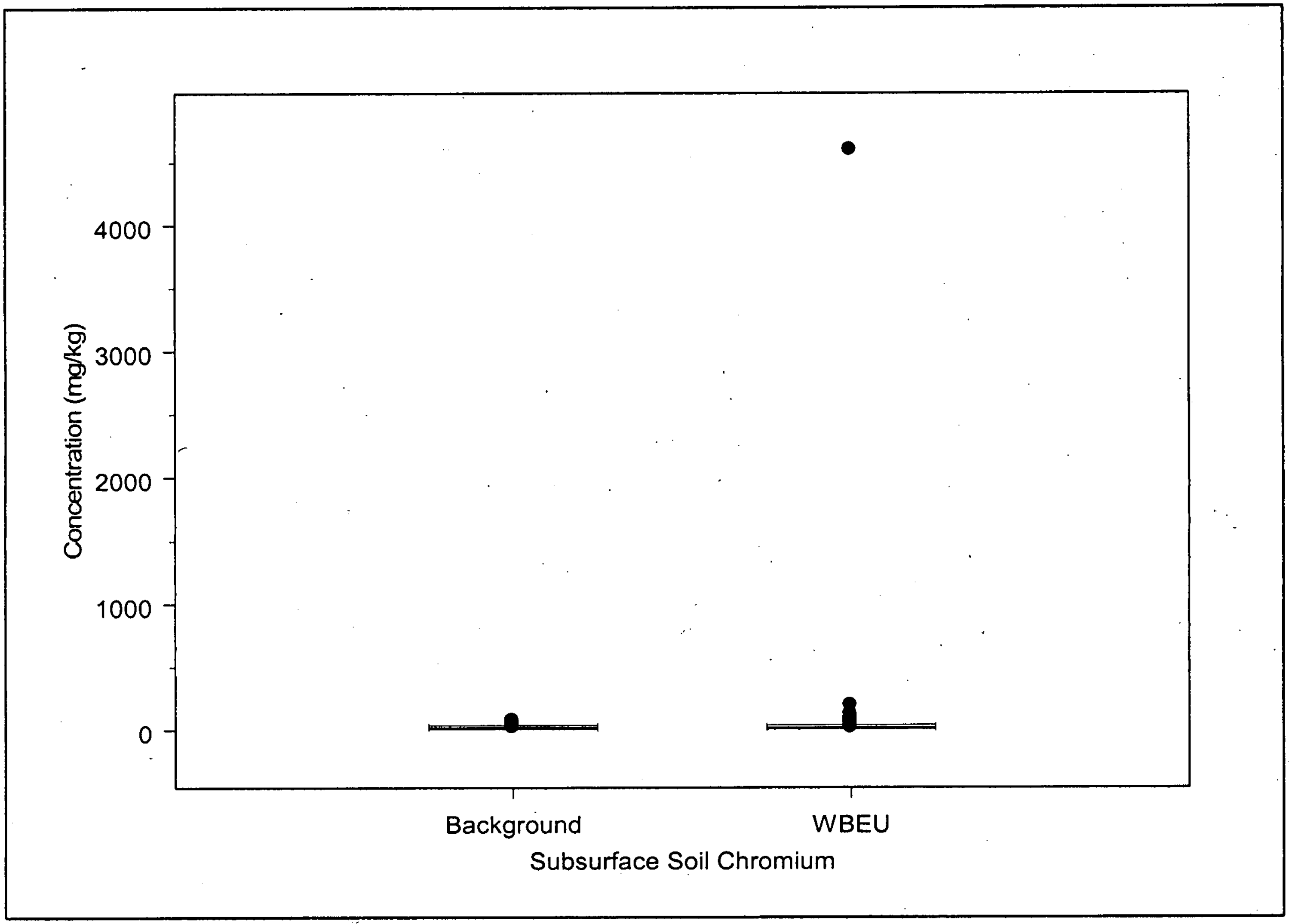
Figure [illegible].2.8
WBEU Surface Soil Box Plots for Chromium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

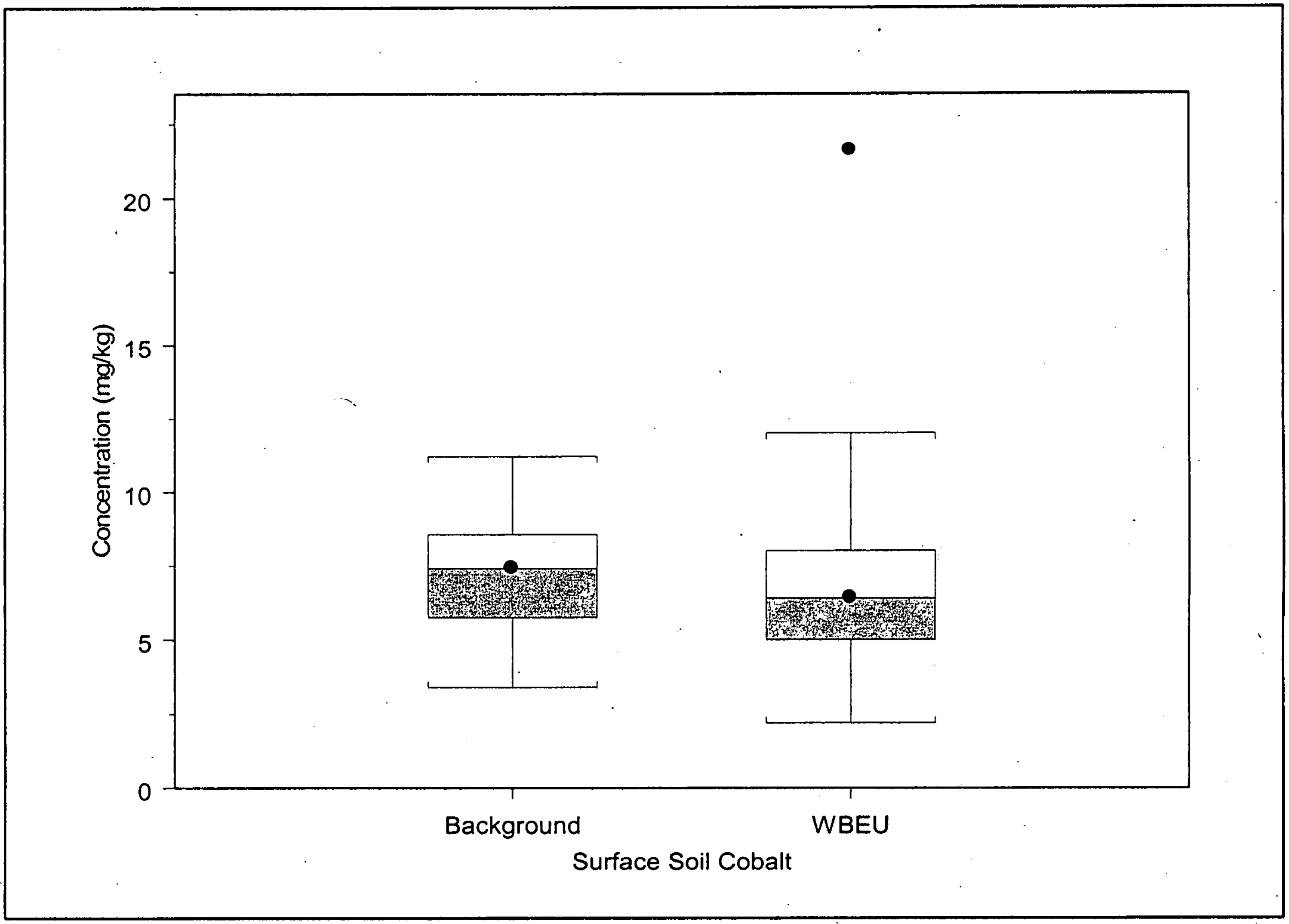
228

Figure [illegible].2.9
WBEU Subsurface Soil Box Plots for Chromium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

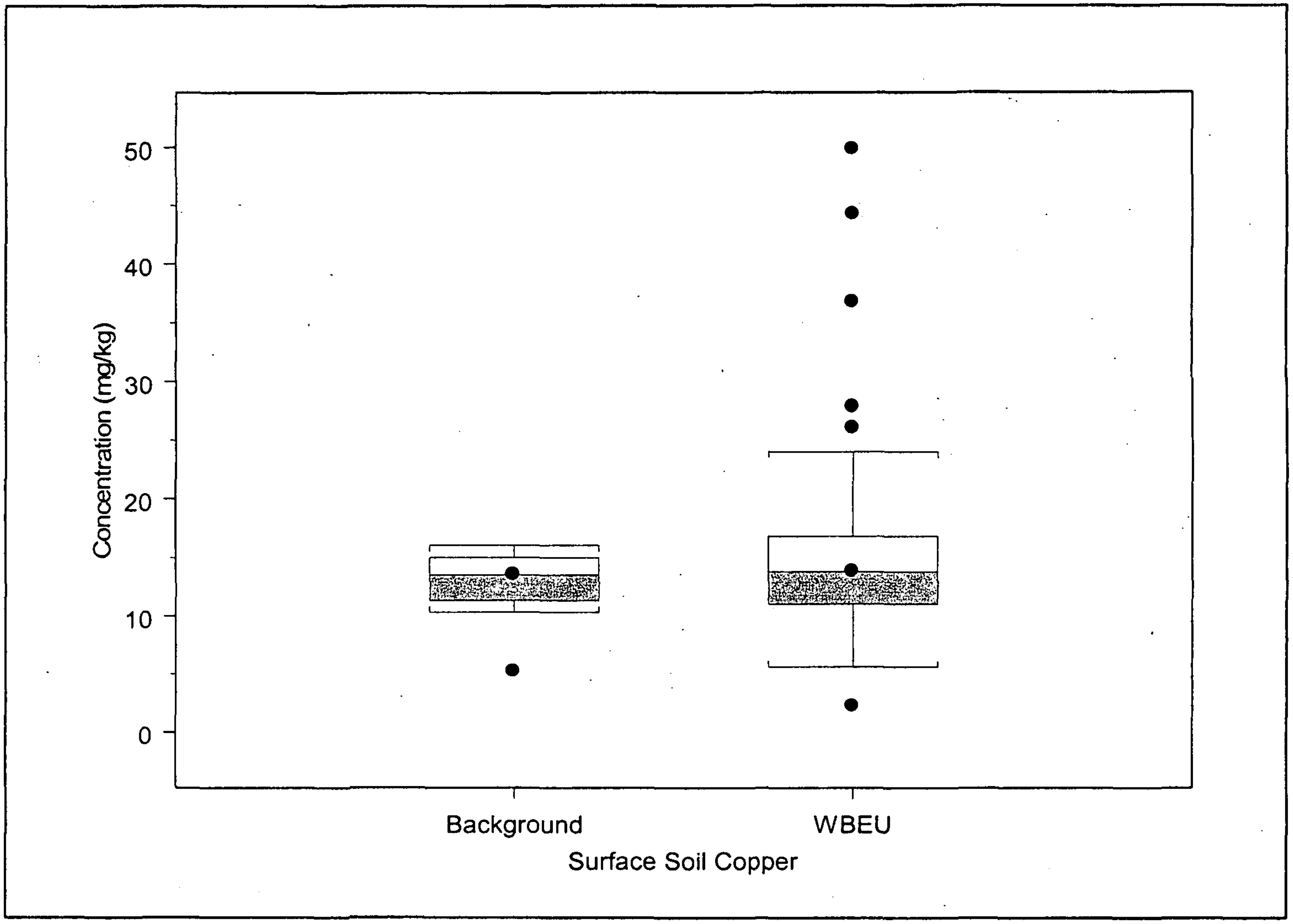
Figure [illegible].2.10
WBEU Surface Soil Box Plots for Cobalt



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

230

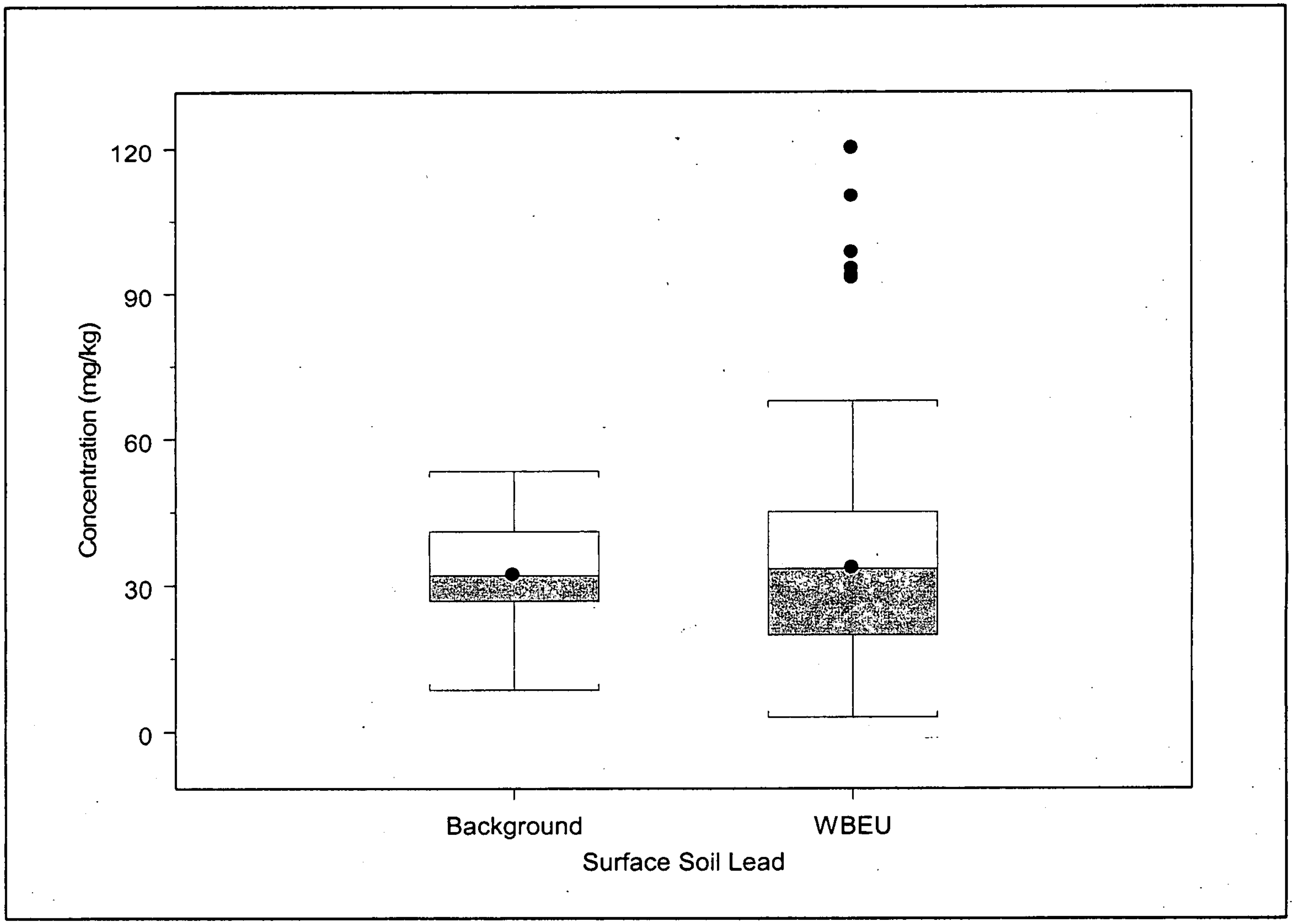
Figure [illegible].2.11
WBEU Surface Soil Box Plots for Copper



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

231

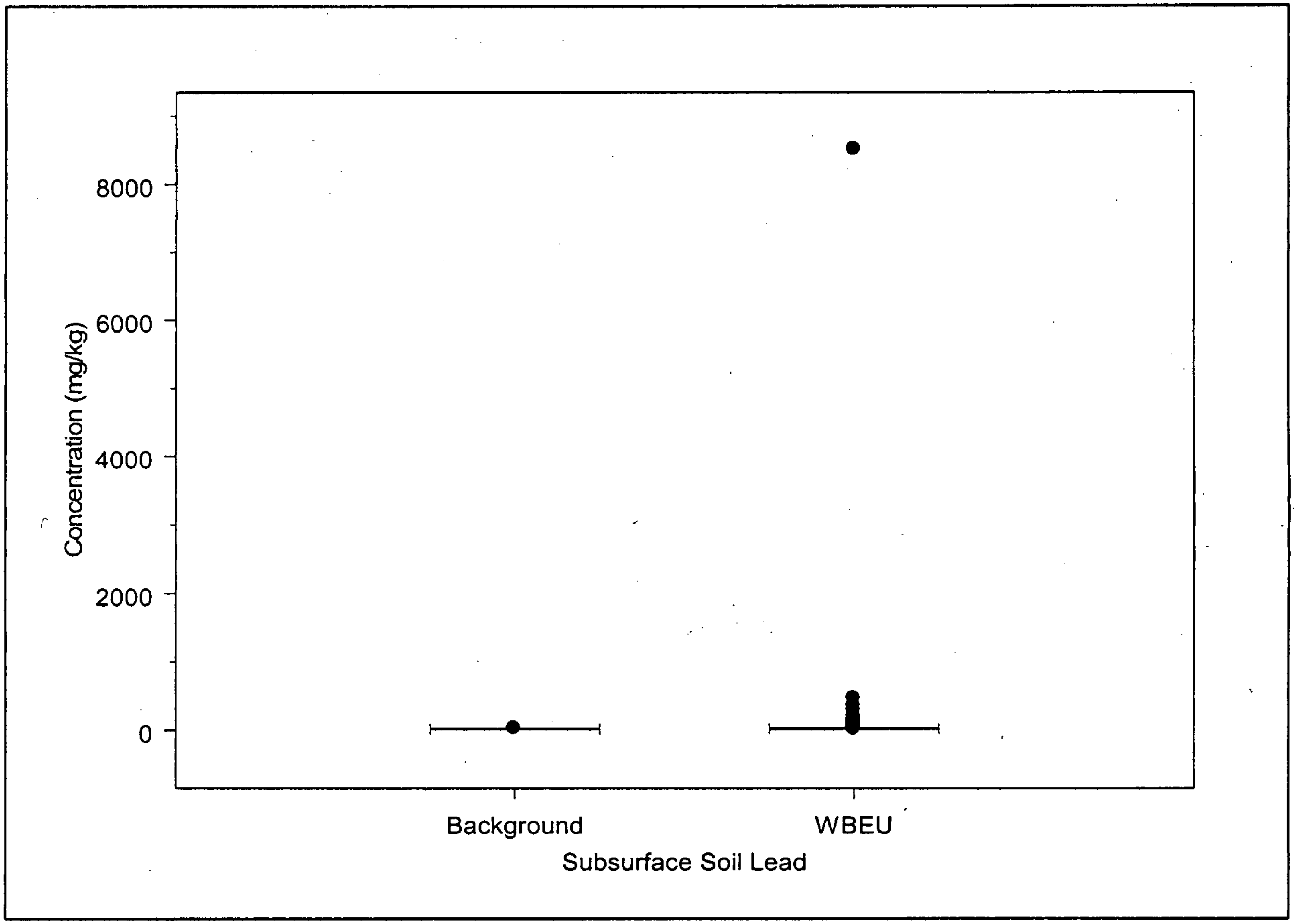
Figure [illegible].2.12
WBEU Surface Soil Box Plots for Lead



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

232

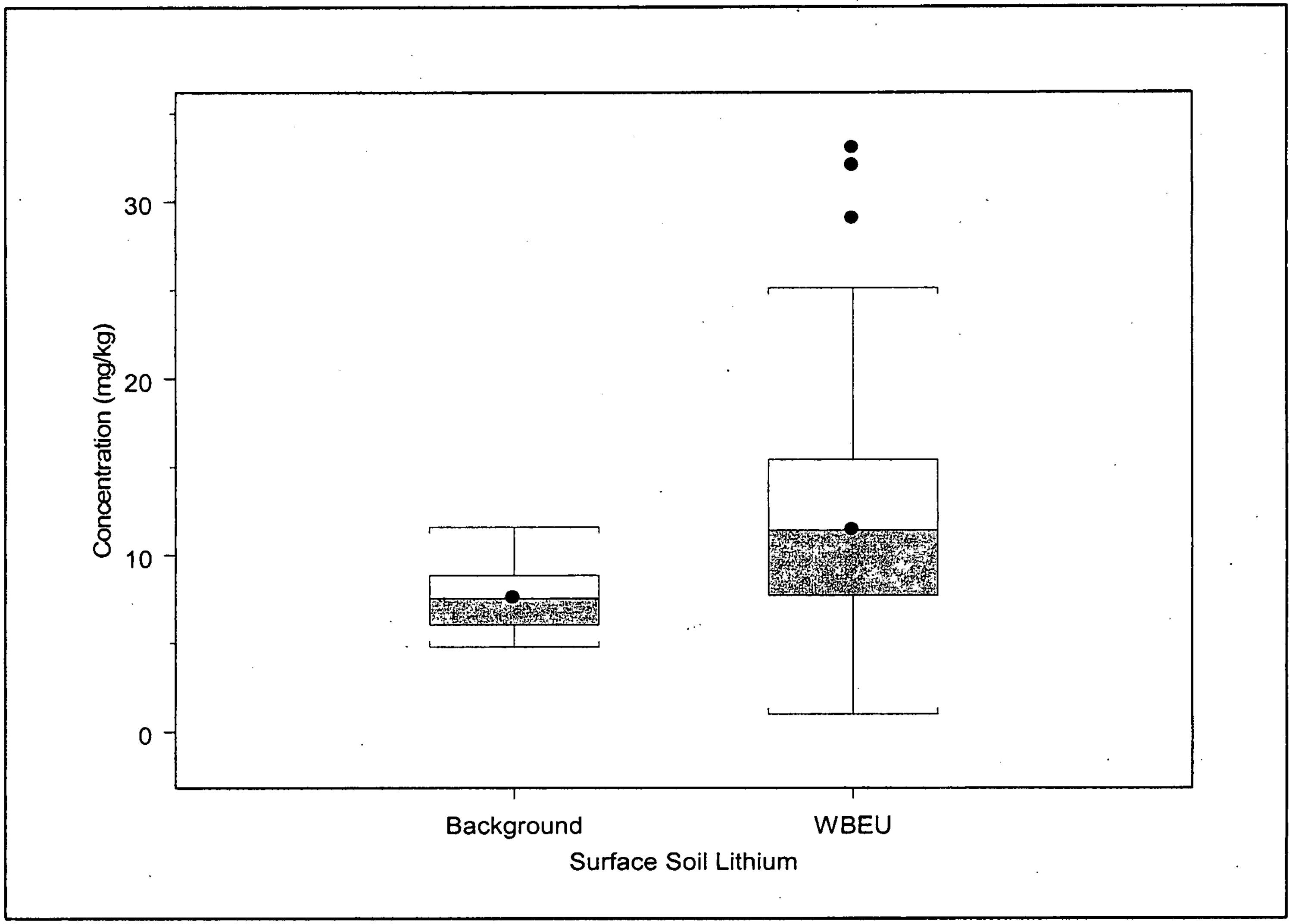
Figure [illegible].2.13
WBEU Subsurface Soil Box Plots for Lead



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

233

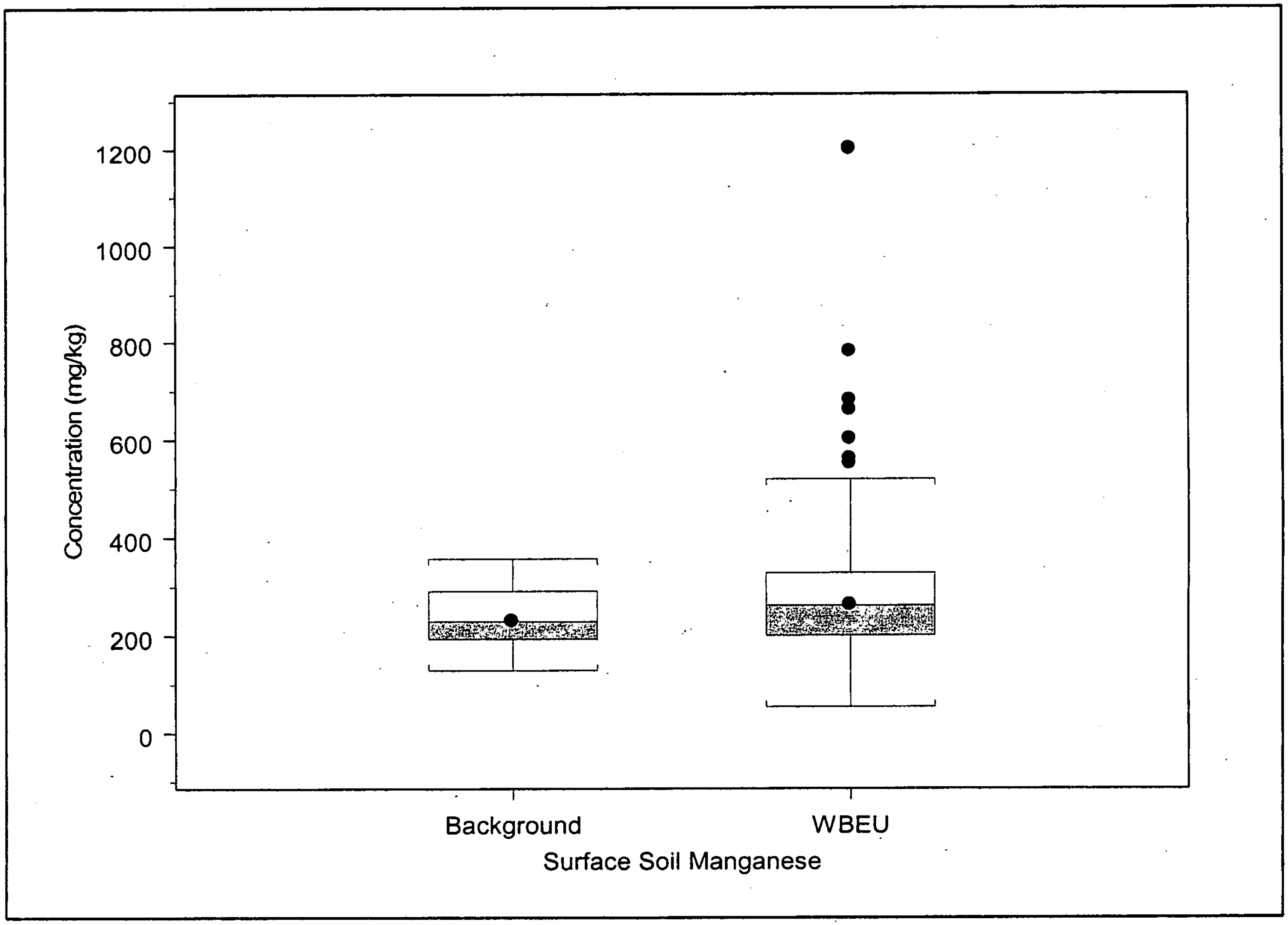
Figure .2.14
WBEU Surface Soil Box Plots for Lithium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

234

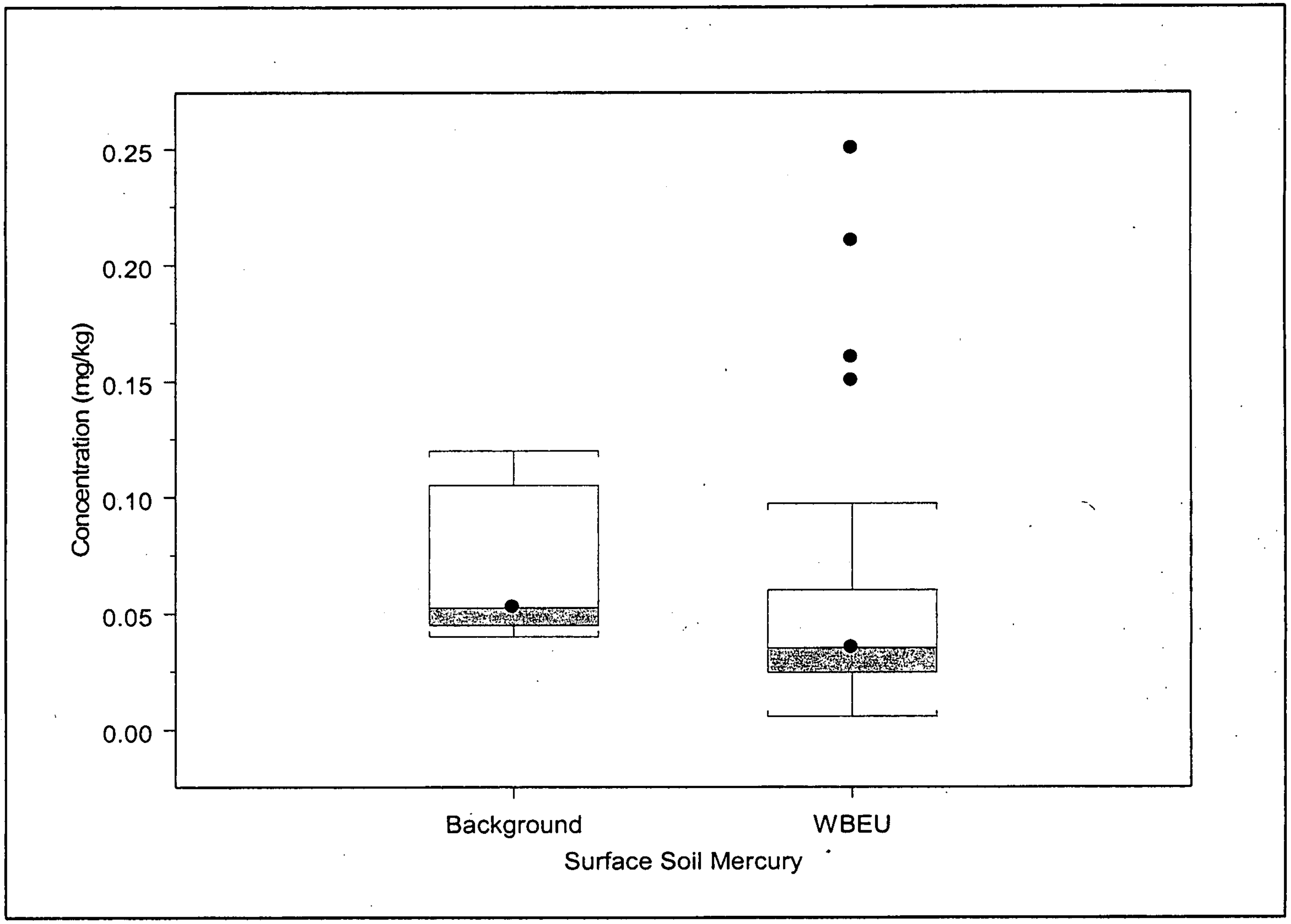
Figure [illegible].2.15
WBEU Surface Soil Box Plots for Manganese



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

235

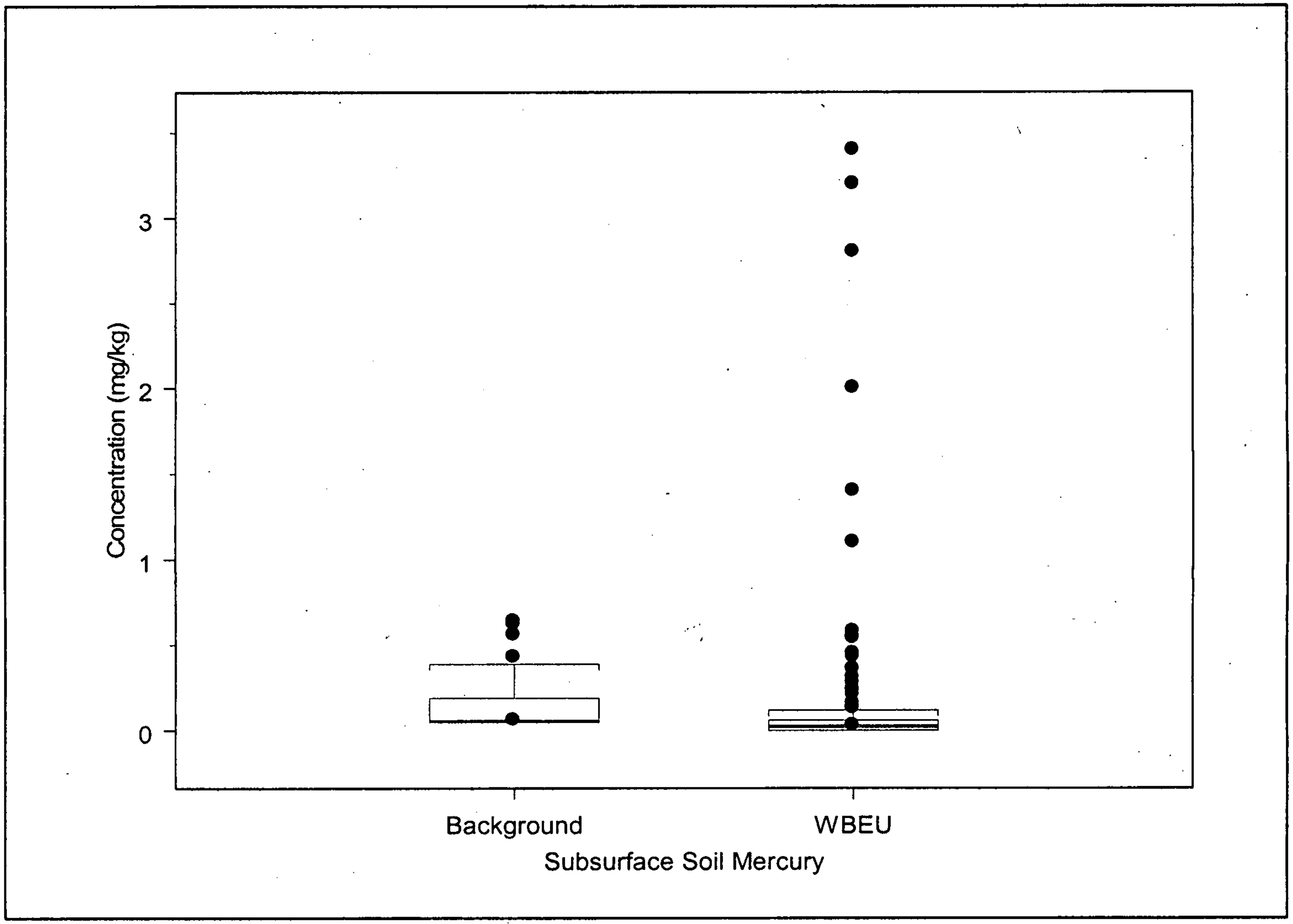
Figure [illegible].2.16
WBEU Surface Soil Box Plots for Mercury



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

236

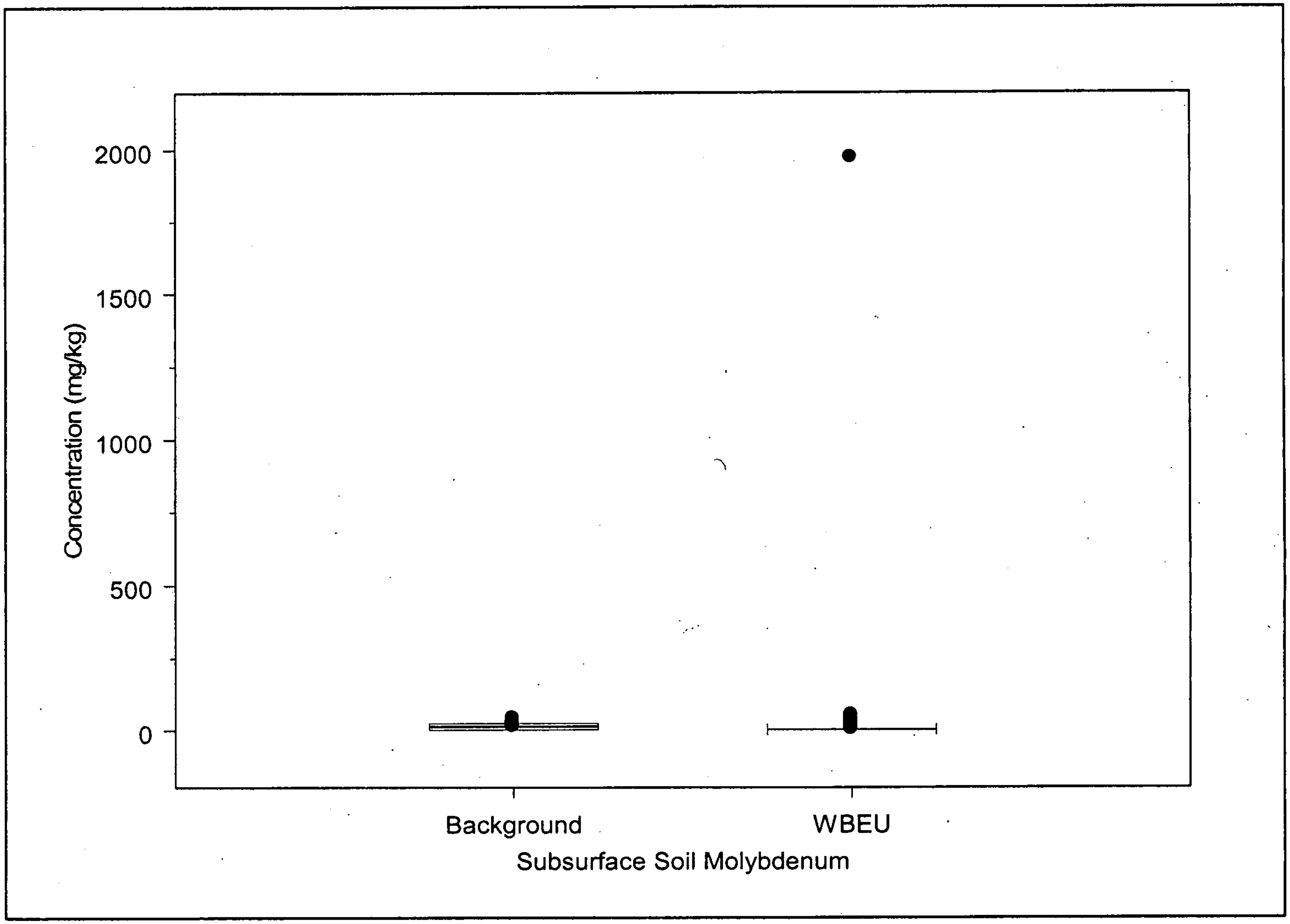
Figure [illegible].2.17
WBEU Subsurface Soil Box Plots for Mercury



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

237

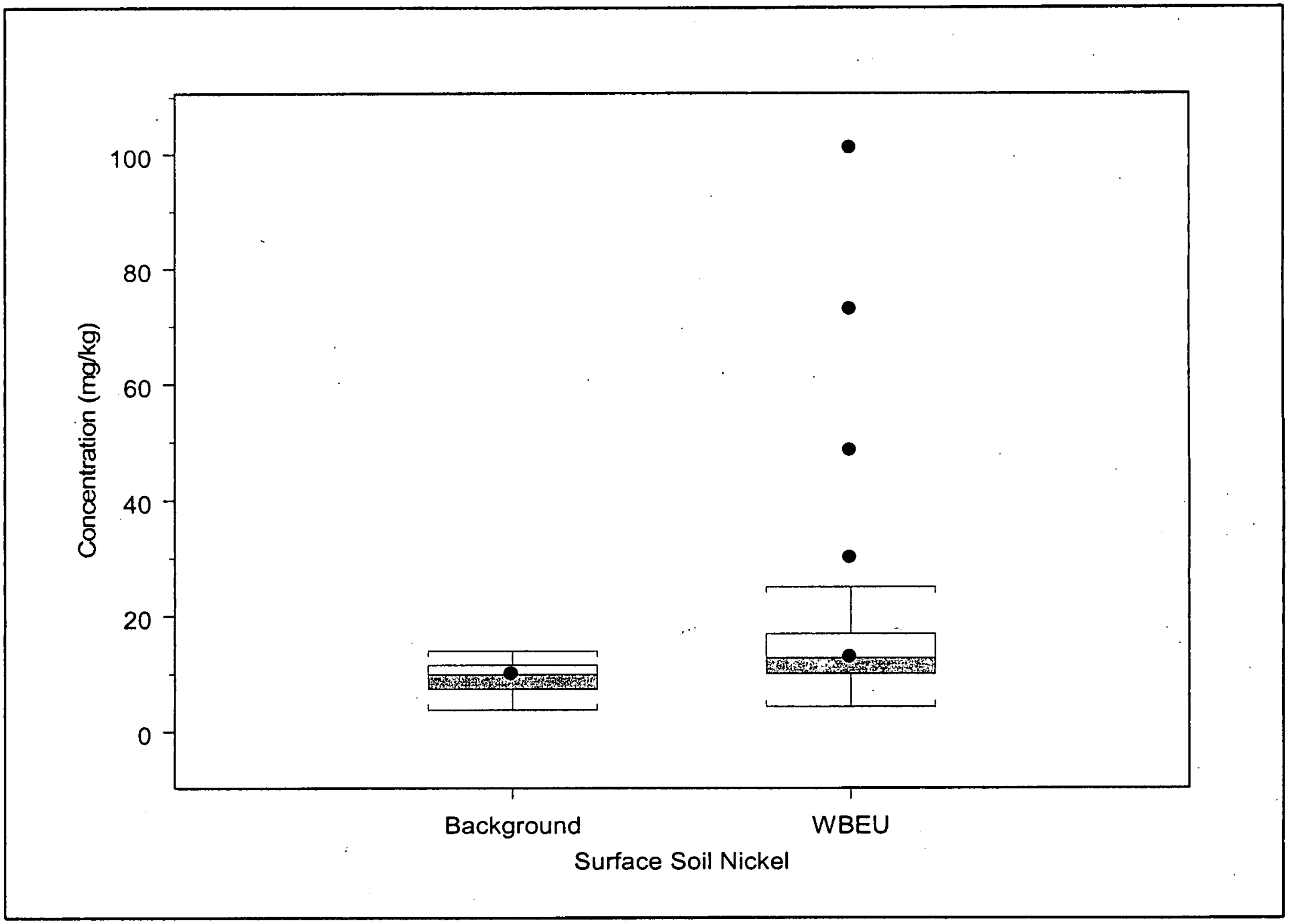
Figure .2.18
WBEU Subsurface Soil Box Plots for Molybdenum



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

238

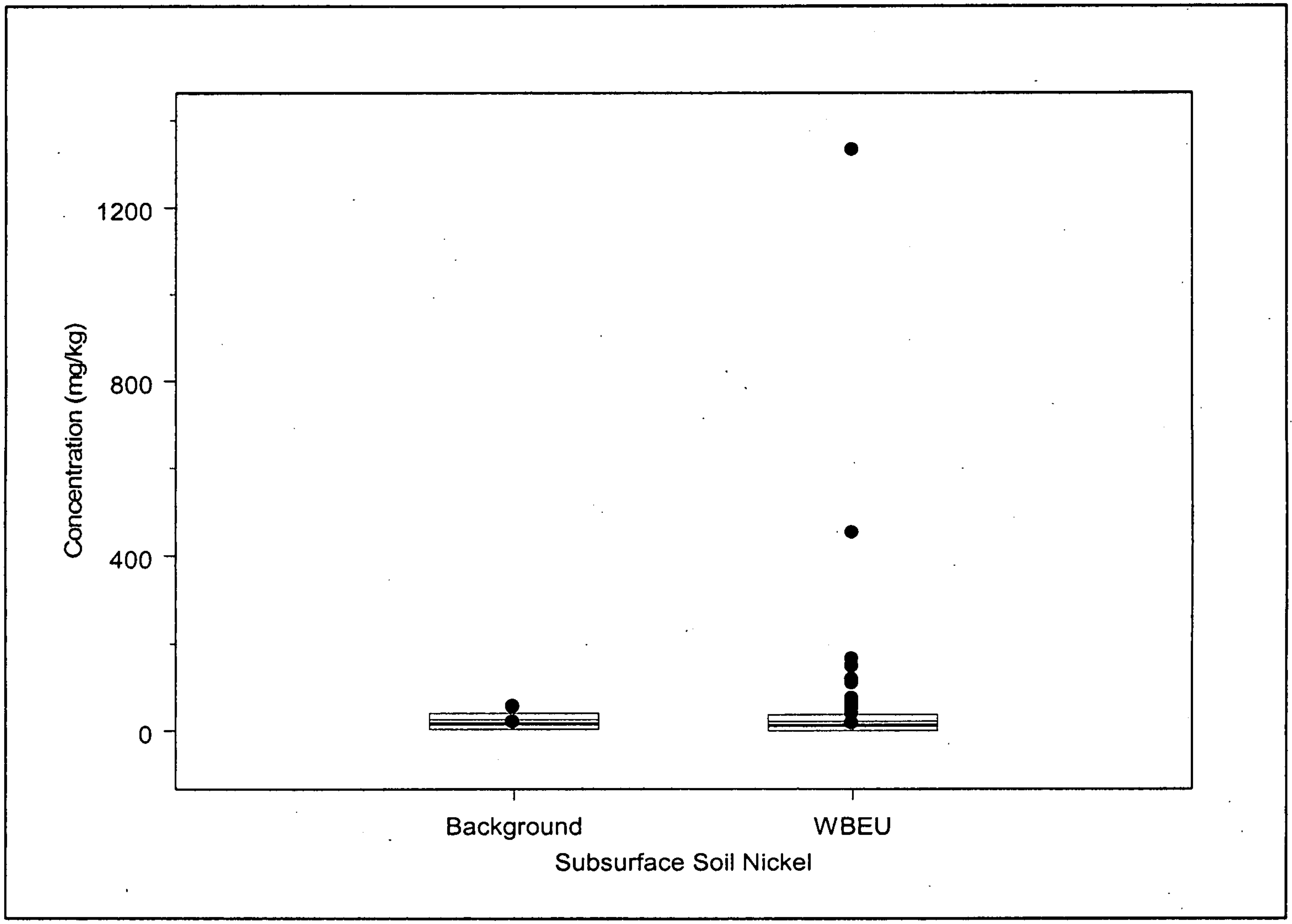
Figur[illegible].2.19
WBEU Surface Soil Box Plots for Nickel



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

239

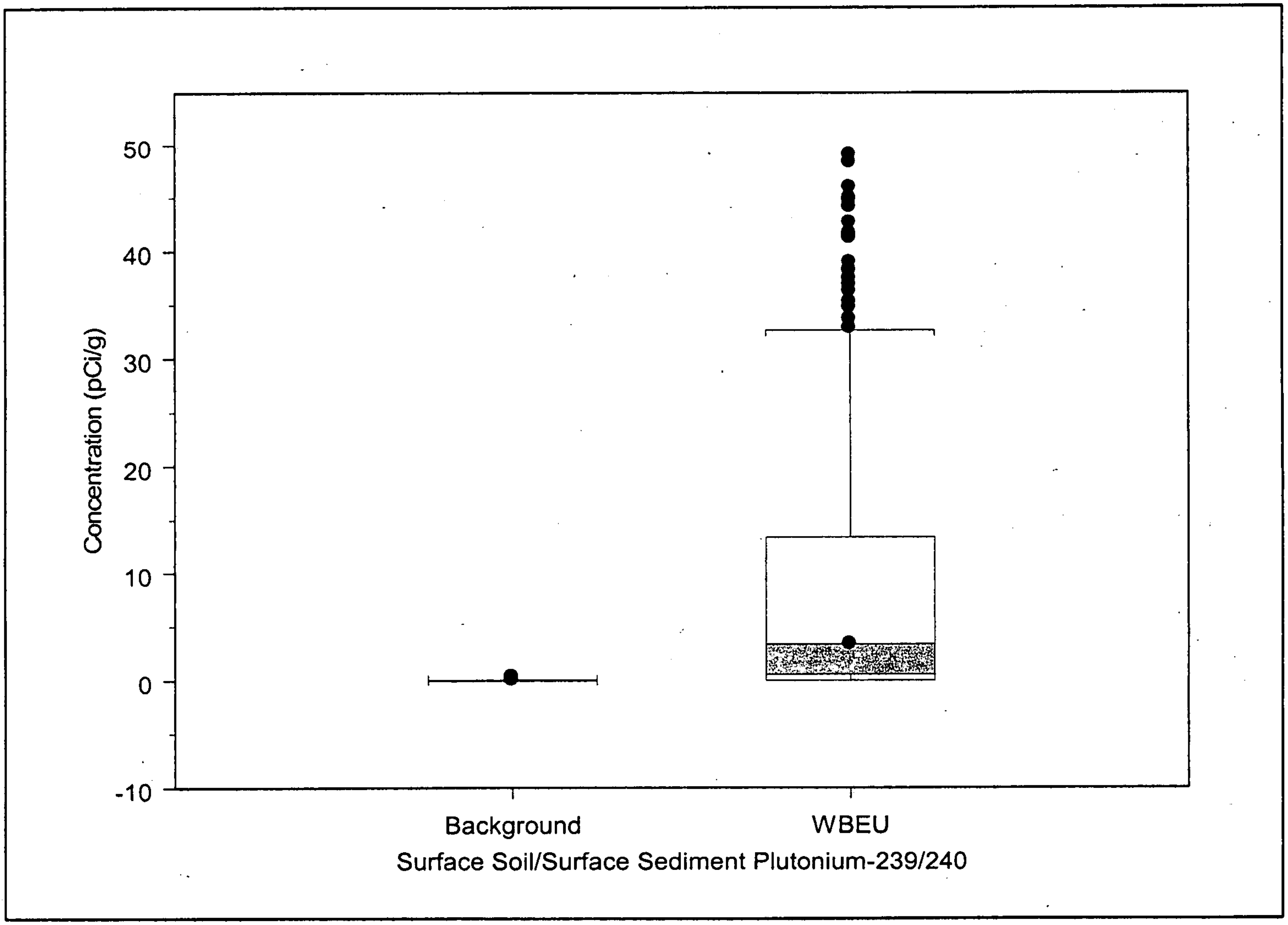
Figure [illegible].2.20
WBEU Subsurface Soil Box Plots for Nickel



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

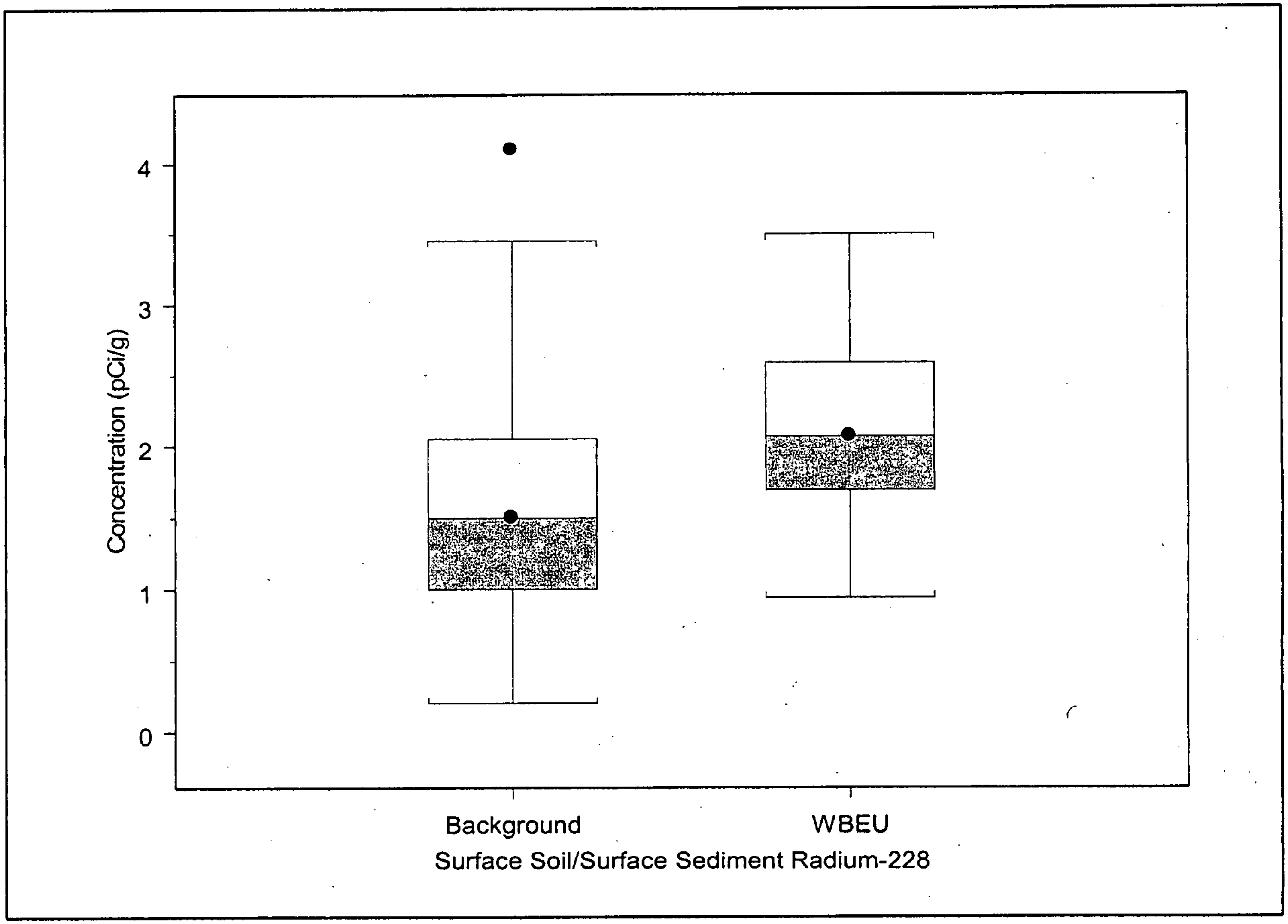
240

Figure [illegible].2.21
WBEU Surface Soil/Surface Sediment Box Plots for Plutonium-239/240



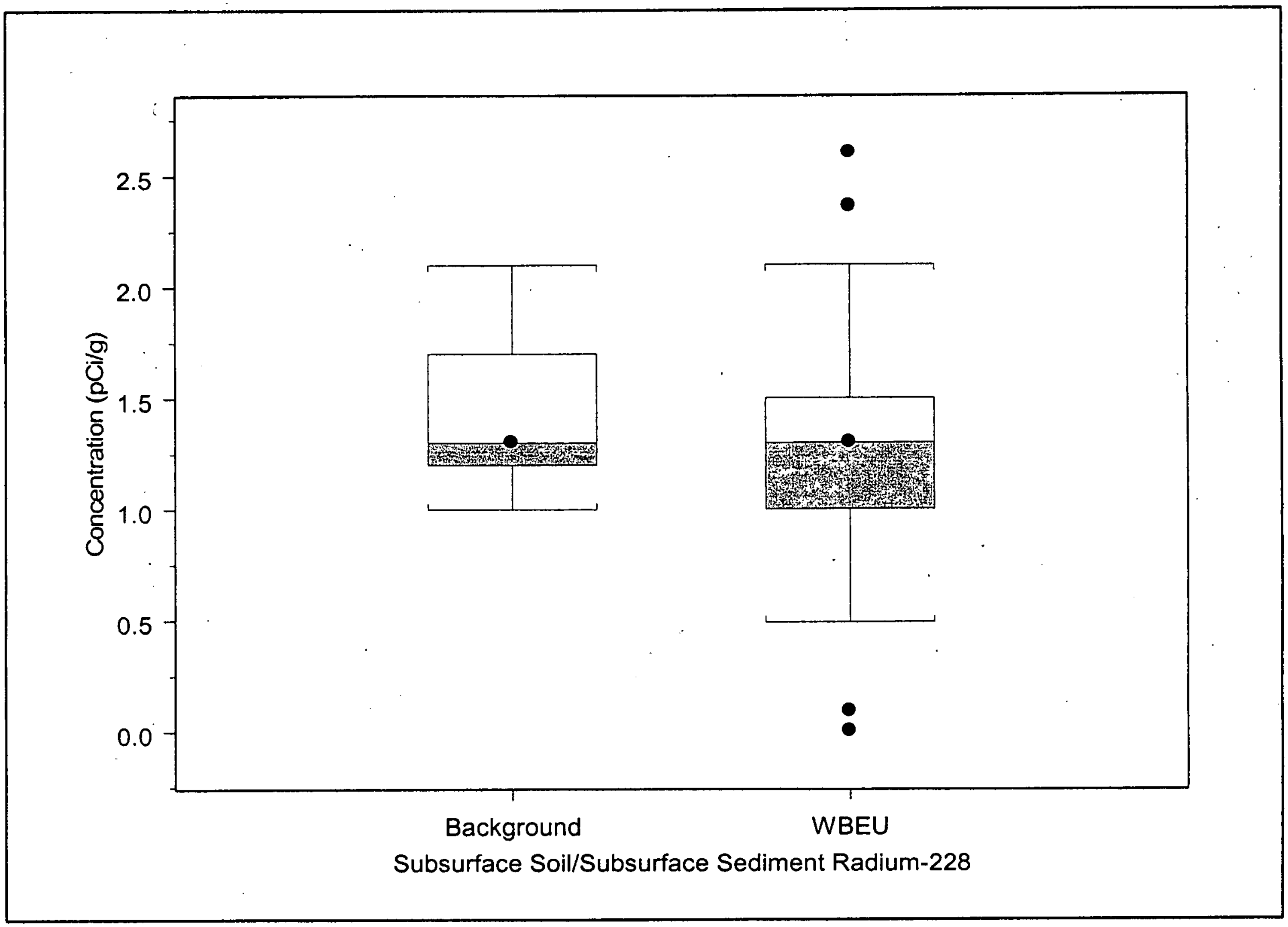
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.22
WBEU Surface Soil/Surface Sediment Box Plots for Radium-228



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

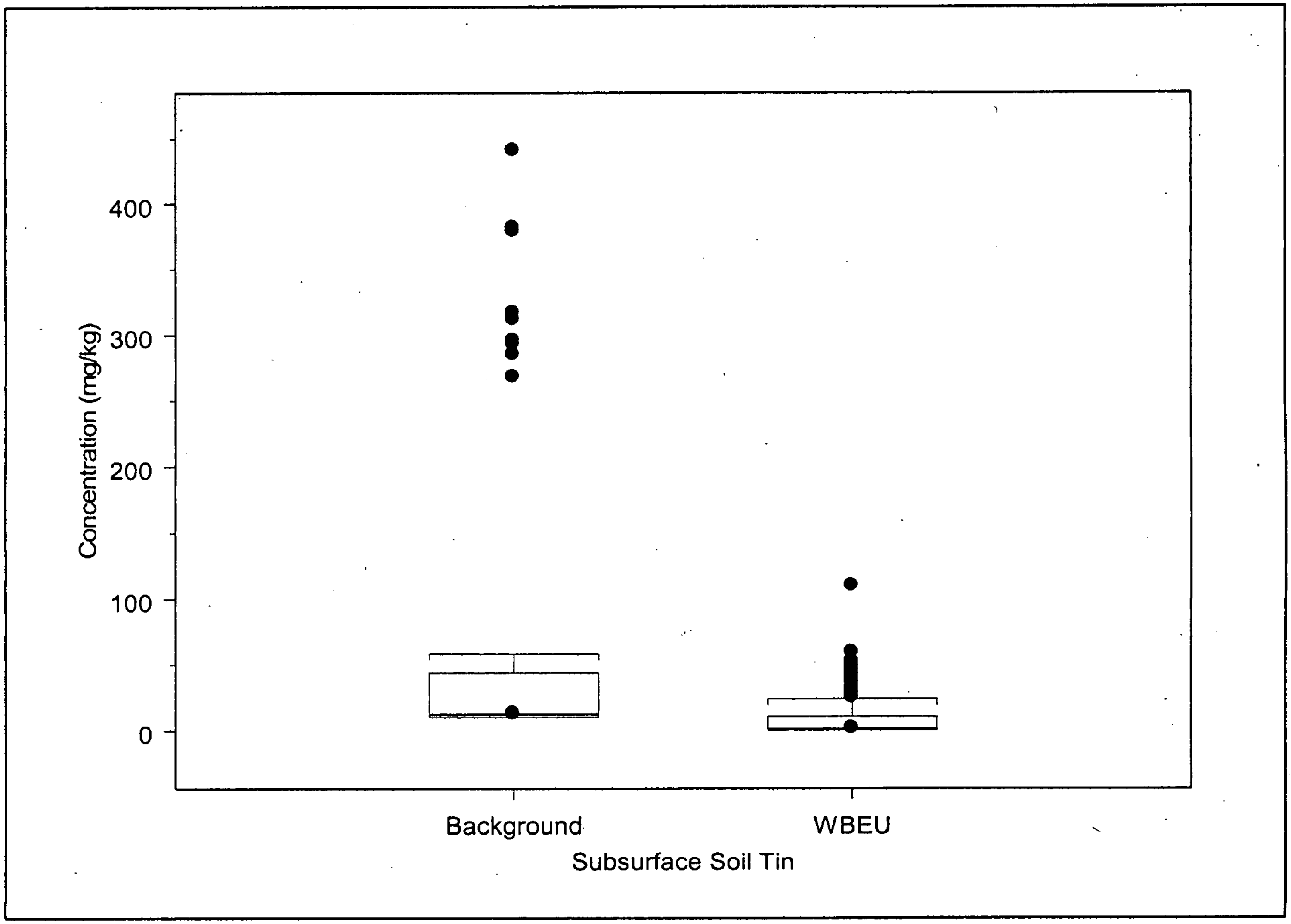
Figure .2.23
WBEU Subsurface Soil/Subsurface Sediment Box Plots for Radium-228



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

243

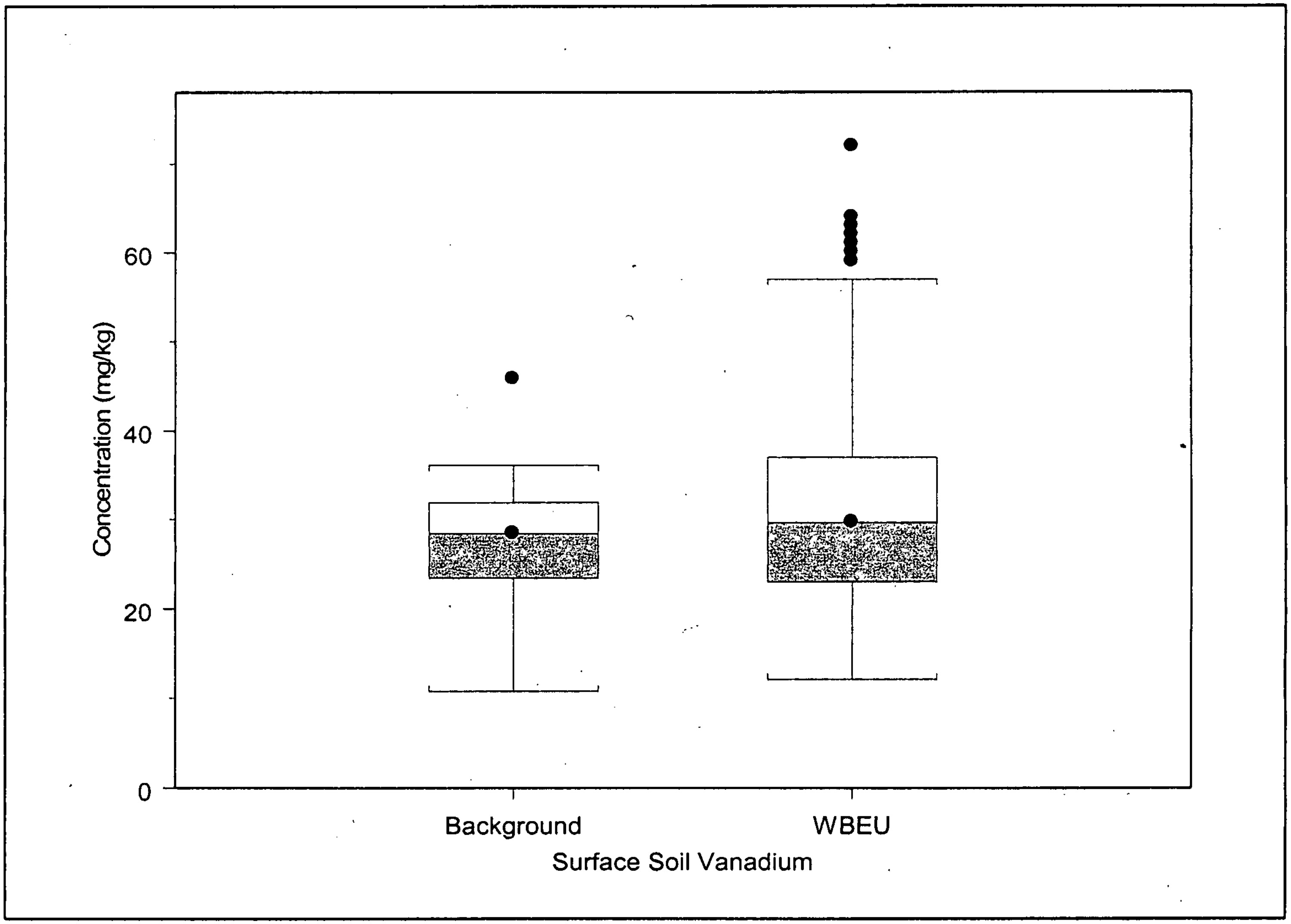
Figure .2.24
WBEU Subsurface Soil Box Plots for Tin



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

244

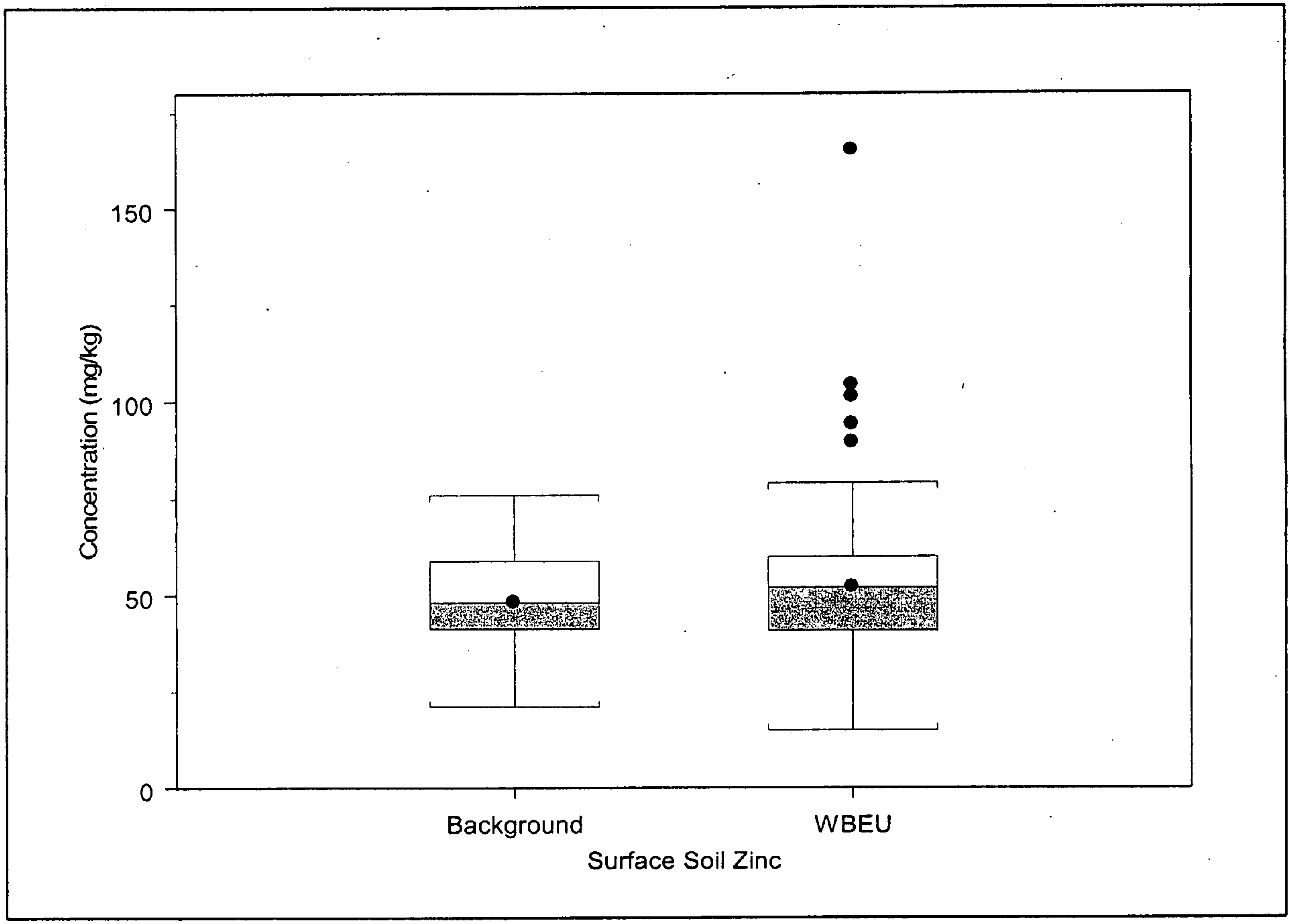
Figure [illegible].2.25
WBEU Surface Soil Box Plots for Vanadium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

245

Figure [illegible].2.26
WBEU Surface Soil Box Plots for Zinc



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

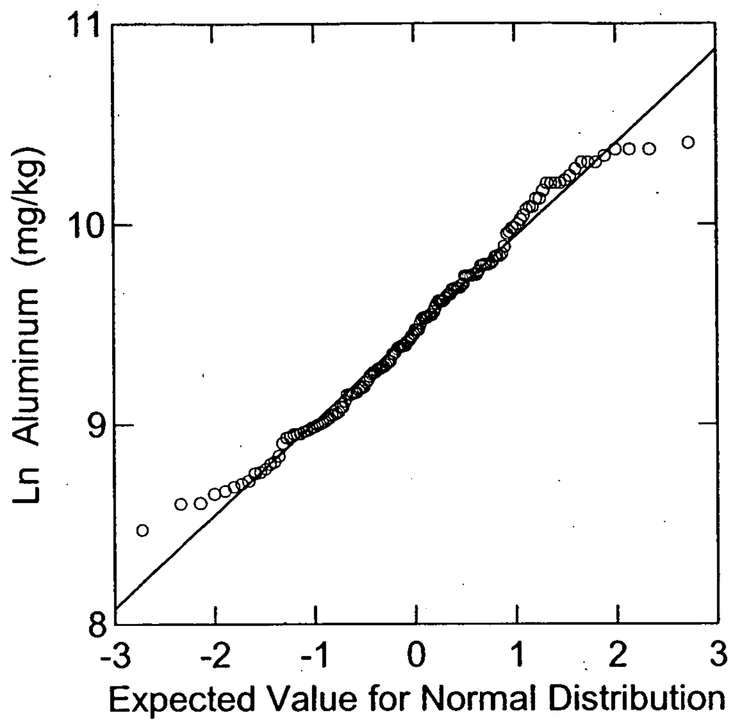


Figure A3.4.1 Probability Plot for Aluminum Concentrations (Natural Logarithm) in WBEU Surface Soil

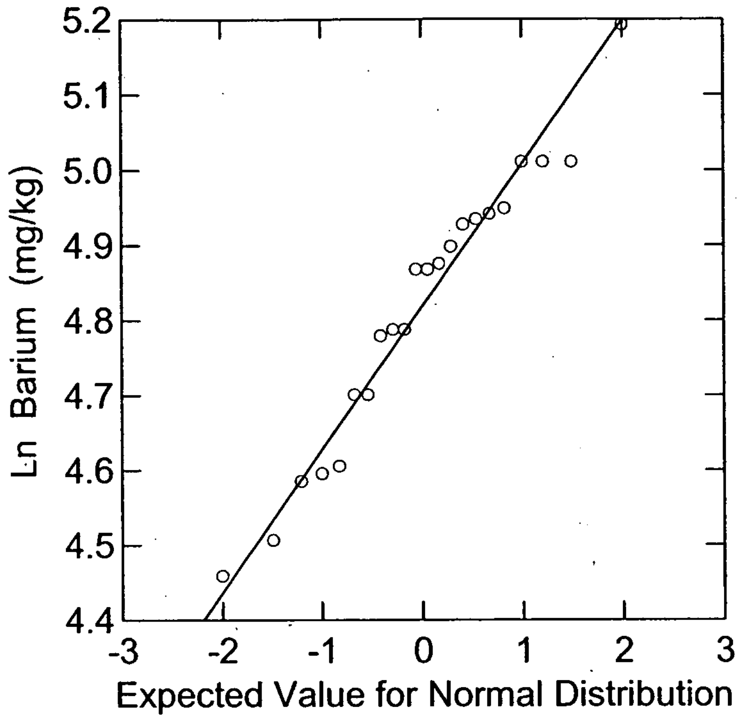


Figure A3.4.2. Probability Plot for Barium Concentrations (Natural Logarithm) in WBEU Surface Soil.

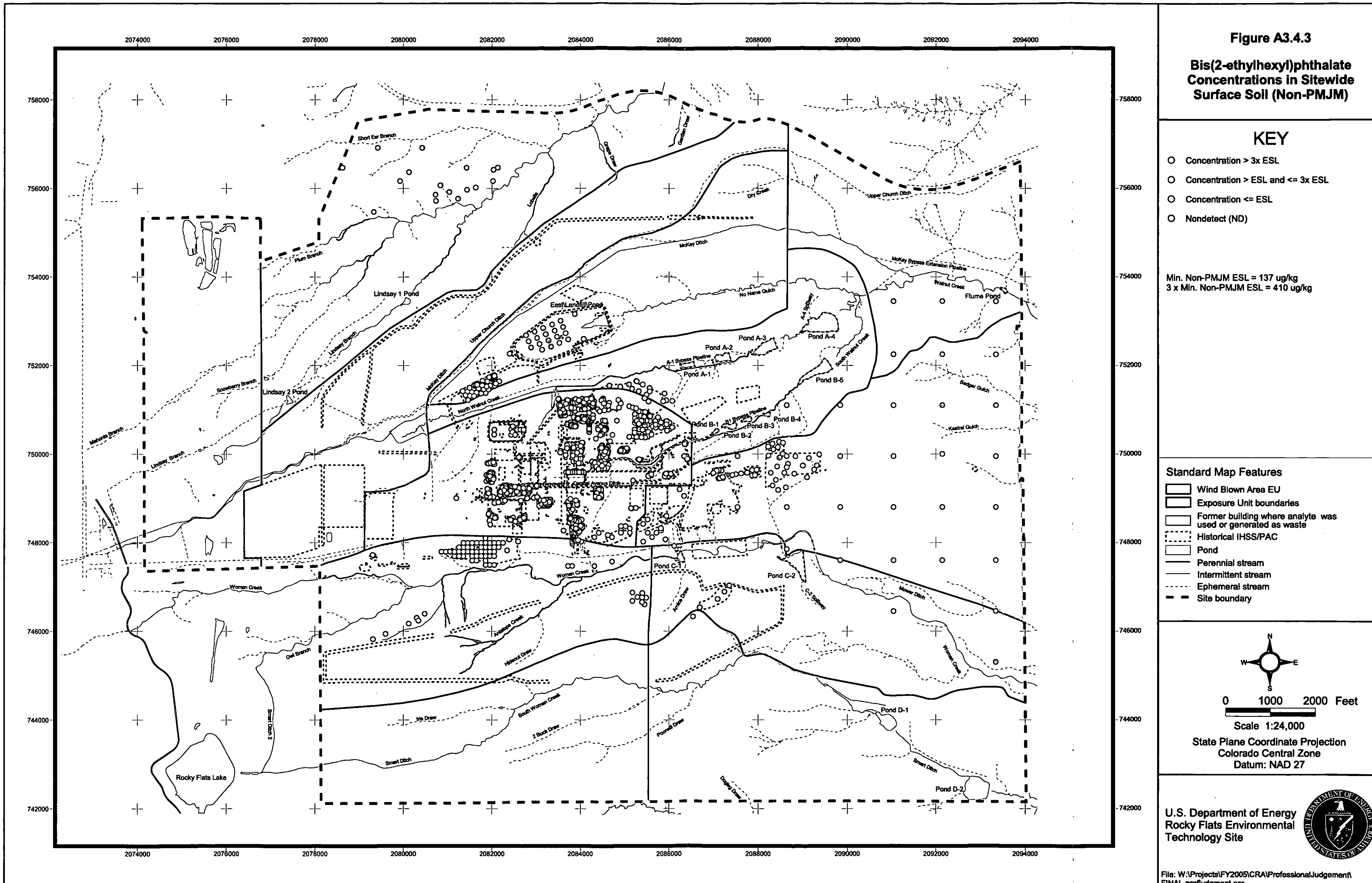


Figure A3.4.3
Bis(2-ethylhexyl)phthalate Concentrations in Sitewide Surface Soil (Non-PMJM)
KEY
Concentration > 3x ESL
Concentration > ESL and <= 3x ESL
Concentration <= ESL
Nondetect (ND)
Min. Non-PMJM ESL = 137 ug/kg
3 x Min. Non-PMJM ESL = 410 ug/kg
Standard Map Features
Wind Blown Area EU
Exposure Unit boundaries
Former building where analyte was used or generated as waste
Historical IHSS/PAC
Pond
Perennial stream
Intermittent stream
Ephemeral stream
Site boundary
0 1000 2000 Feet
Scale 1:24,000
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27
U.S. Department of Energy
Rocky Flats Environmental Technology Site
File: W:\Projects\FY2005\CRA\ProfessionalJudgement\FINAL-profjudgment.apr
Rocky Flats Lake
Woman Creek
Walnut Creek
Pond A-1
Pond A-2
Pond A-3
Pond A-4
Pond B-1
Pond B-2
Pond B-3
Pond B-4
Pond B-5
Pond C-1
Pond C-2
Pond D-1
Pond D-2
Flume Pond
Lindsay 1 Pond
Lindsay 2 Pond
East Landfill Pond

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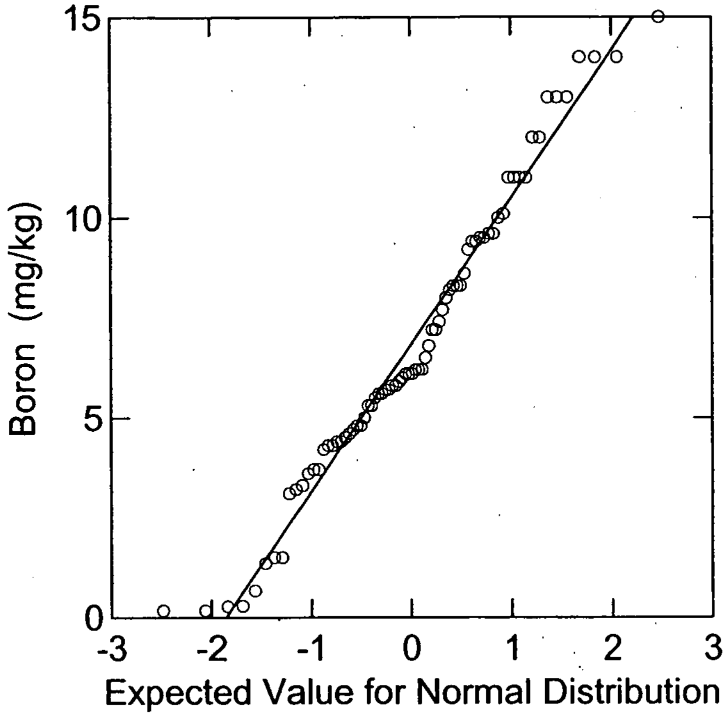
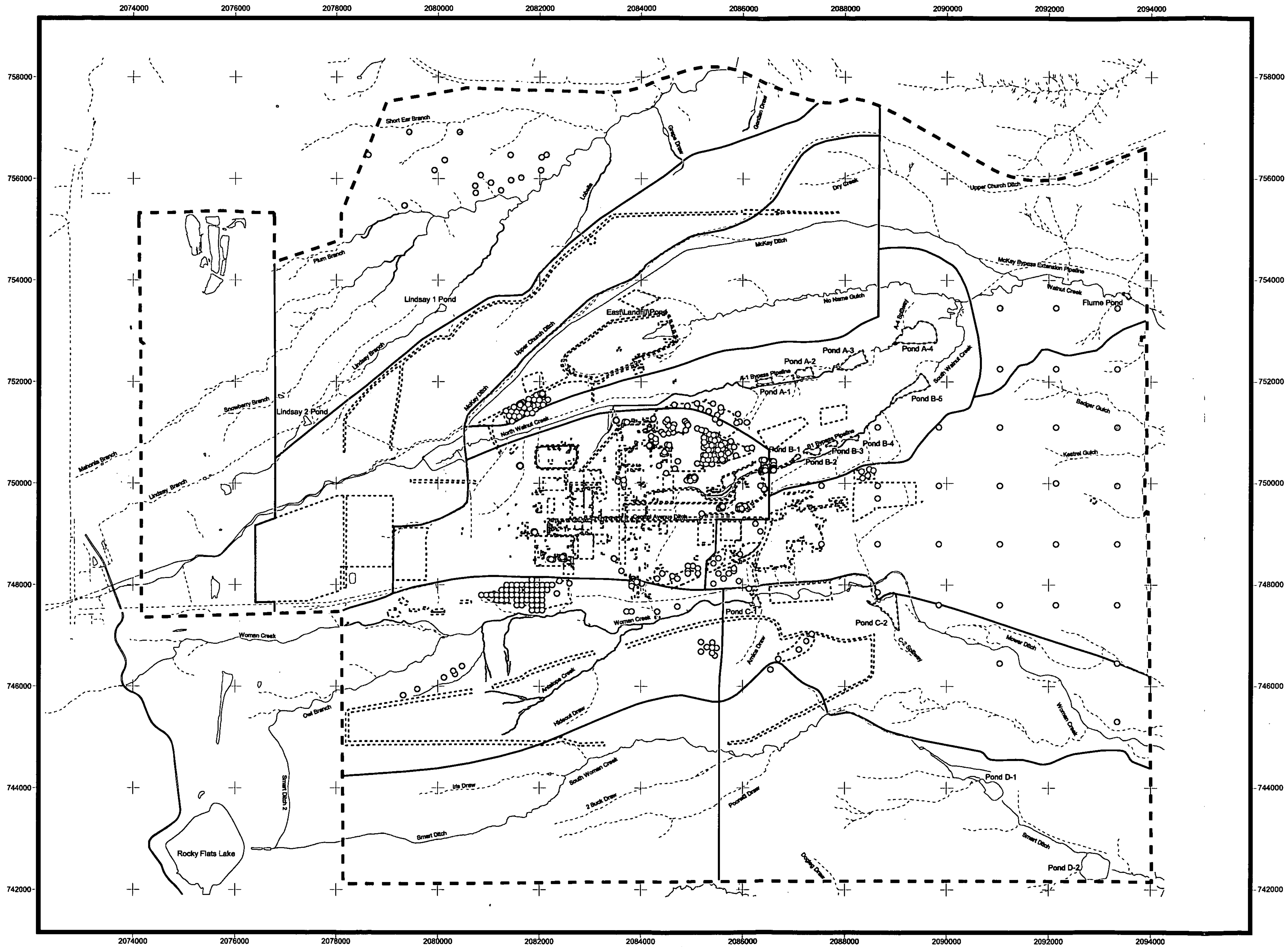


Figure A3.4.4 Probability Plot for Boron Concentrations (Natural Logarithm) in WBEU Surface Soil

Figure A3.4.5

Endrin Concentrations in Sitewide Surface Soil (Non-PMJM)



KEY

- O Concentration > 3x ESL
- O Concentration > ESL and <= 3x ESL
- O Concentration <= ESL
- O Nondetect (ND)

Min. Non-PMJM ESL = 1.40 ug/kg
3 x Min. Non-PMJM ESL = 4.19 ug/kg

Standard Map Features

- Wind Blown Area EU
- Exposure Unit boundaries
- Former building where analyte was used or generated as waste
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N
W E
S

0 1000 2000 Feet

Scale 1:24,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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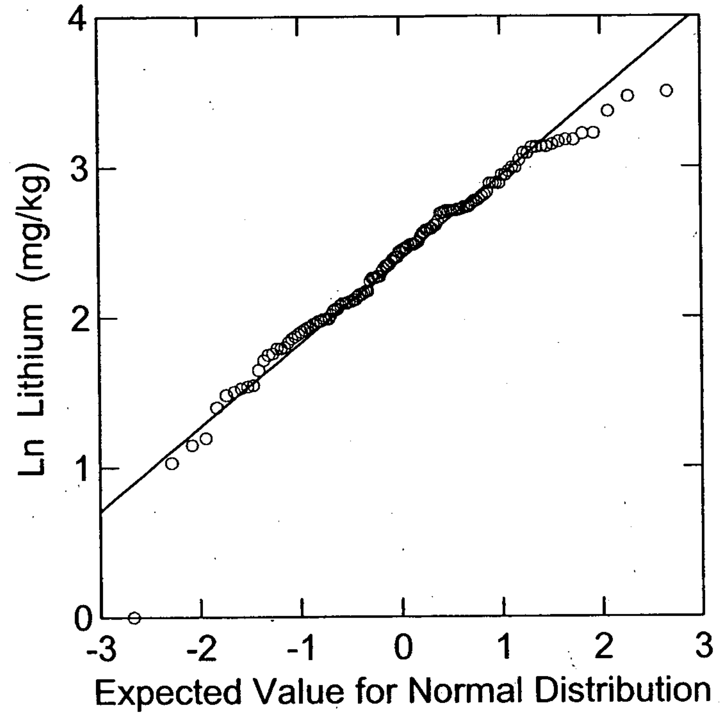

Figure A3.4.6. Probability Plot for Lithium Concentrations (Natural Logarithm) in WBEU Surface Soil

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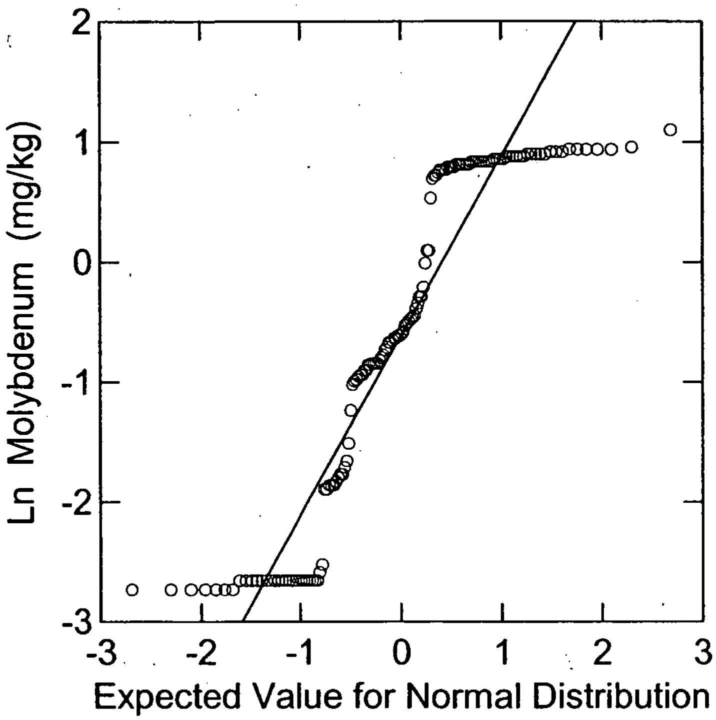

Figure A3.4.7a Probability Plot for Molybdenum Concentrations (Natural Logarithm) in WBEU Surface Soil (Non-Detected Samples Only)

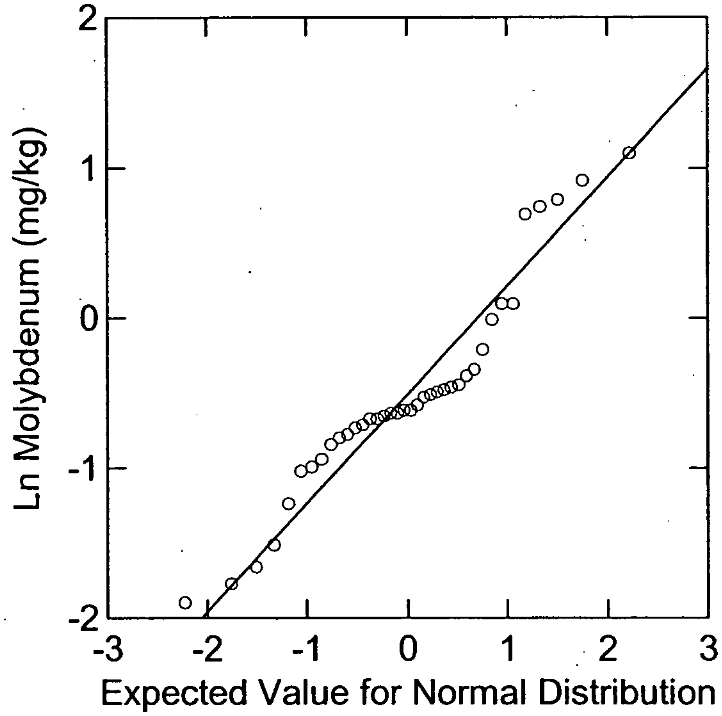

Figure A3.4.7b Probability Plot for Molybdenum Concentrations (Natural Logarithm) Above the Highest Detection Limit in WBEU Surface Soil (Detected Samples Only)

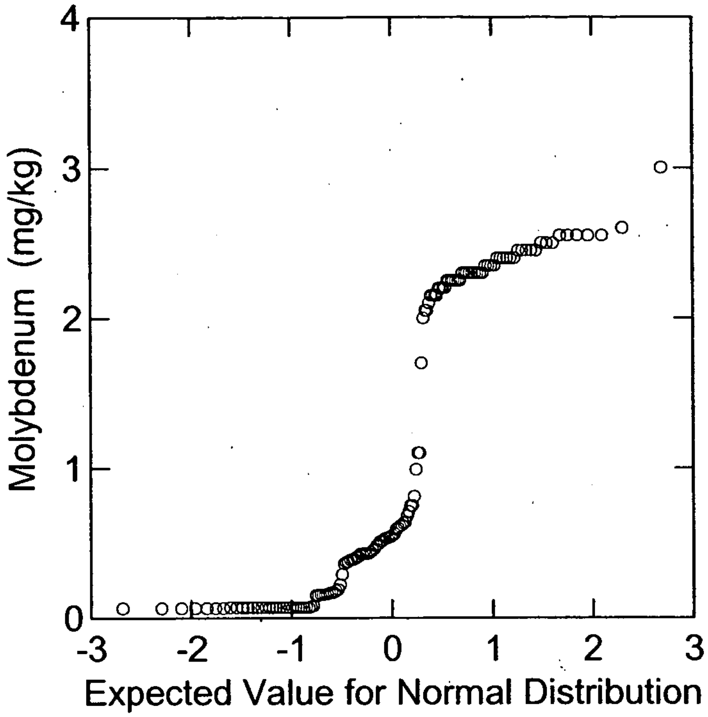

Figure A3.4.7c Probability Plot for Molybdenum Concentrations in WBEU Surface Soil (All Samples)

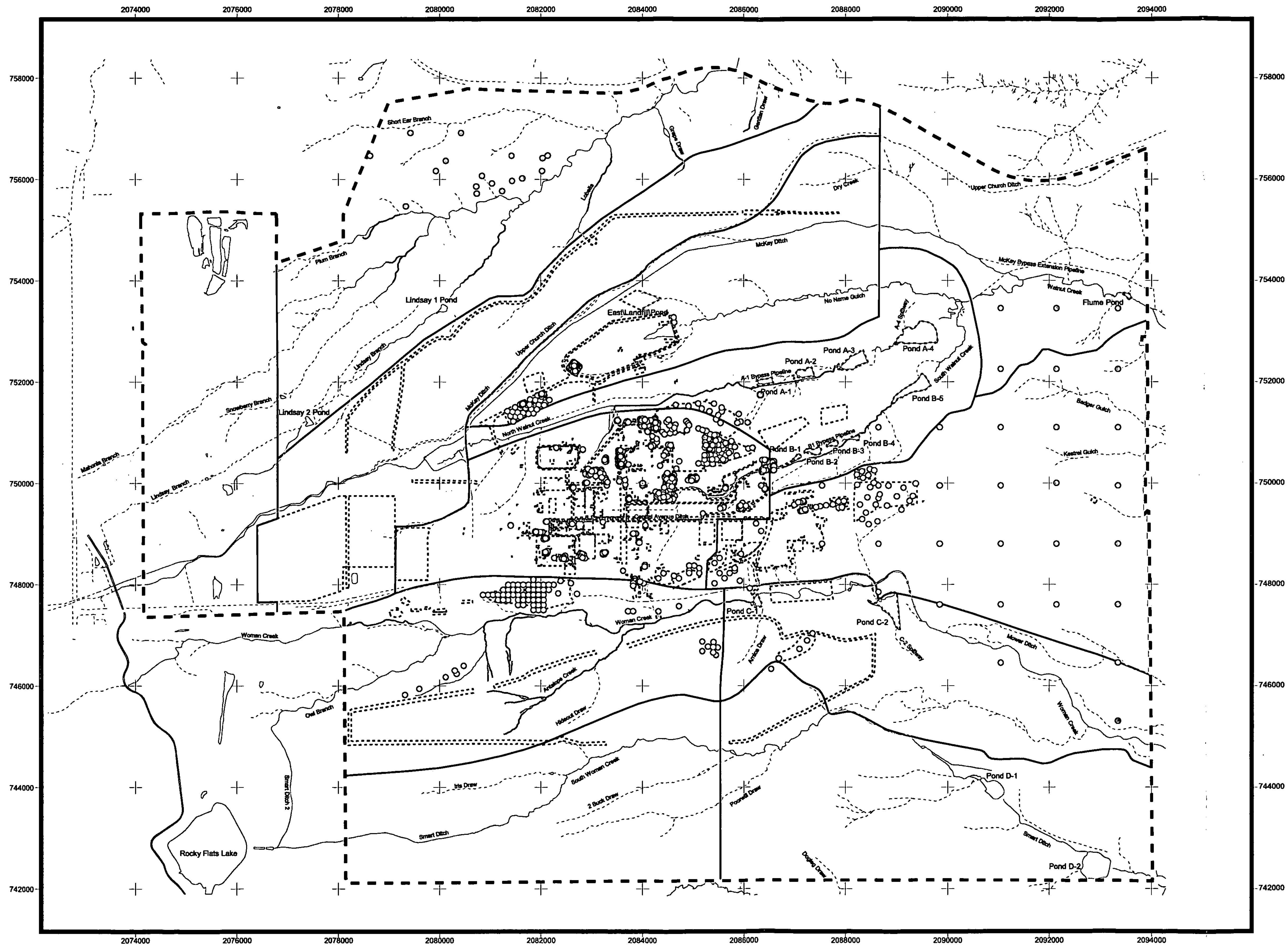

Figure A3.4.8

Total PCB Concentrations in Sitewide Surface Soil (Non-PMJM)

KEY

- Concentration > 3x ESL
- Concentration > ESL and <= 3x ESL
- Concentration <= ESL
- Nondetect (ND)

Min. Non-PMJM ESL = 42.3 ug/kg
3x Min. Non-PMJM ESL = 127 ug/kg

Standard Map Features

- Wind Blown Area EU
- Exposure Unit boundaries
- Former building where analyte was used or generated as waste
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:24,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
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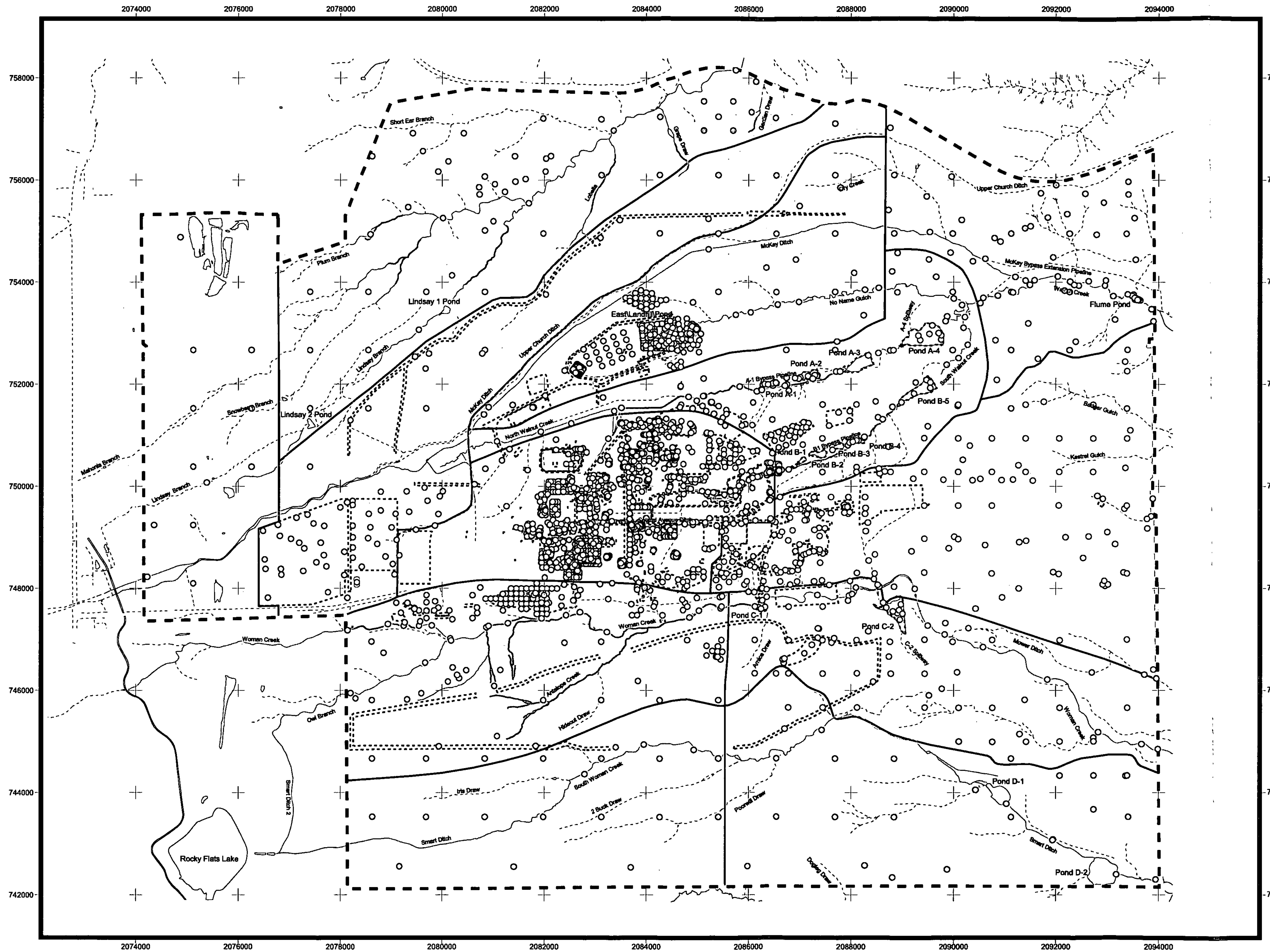

Figure A3.4.9

Plutonium-239/240 Activity in Sitewide Surface Soil/Surface Sediment

KEY

- Concentration > 3x WRW PRG
- Concentration > WRW PRG and <= 3x WRW PRG
- Concentration > Background MDC and <= WRW PRG
- Concentration <= Background MDC
- Nondetect (ND)

Background MDC = 0.350 pCi/g
WRW PRG = 9.80 pCi/g
3 x WRW PRG = 29.4 pCi/g

Standard Map Features

- Wind Blown Area EU
- Exposure Unit boundaries
- Former building where analyte was used or generated as waste
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N E S W

0 1000 2000 Feet

Scale 1:24,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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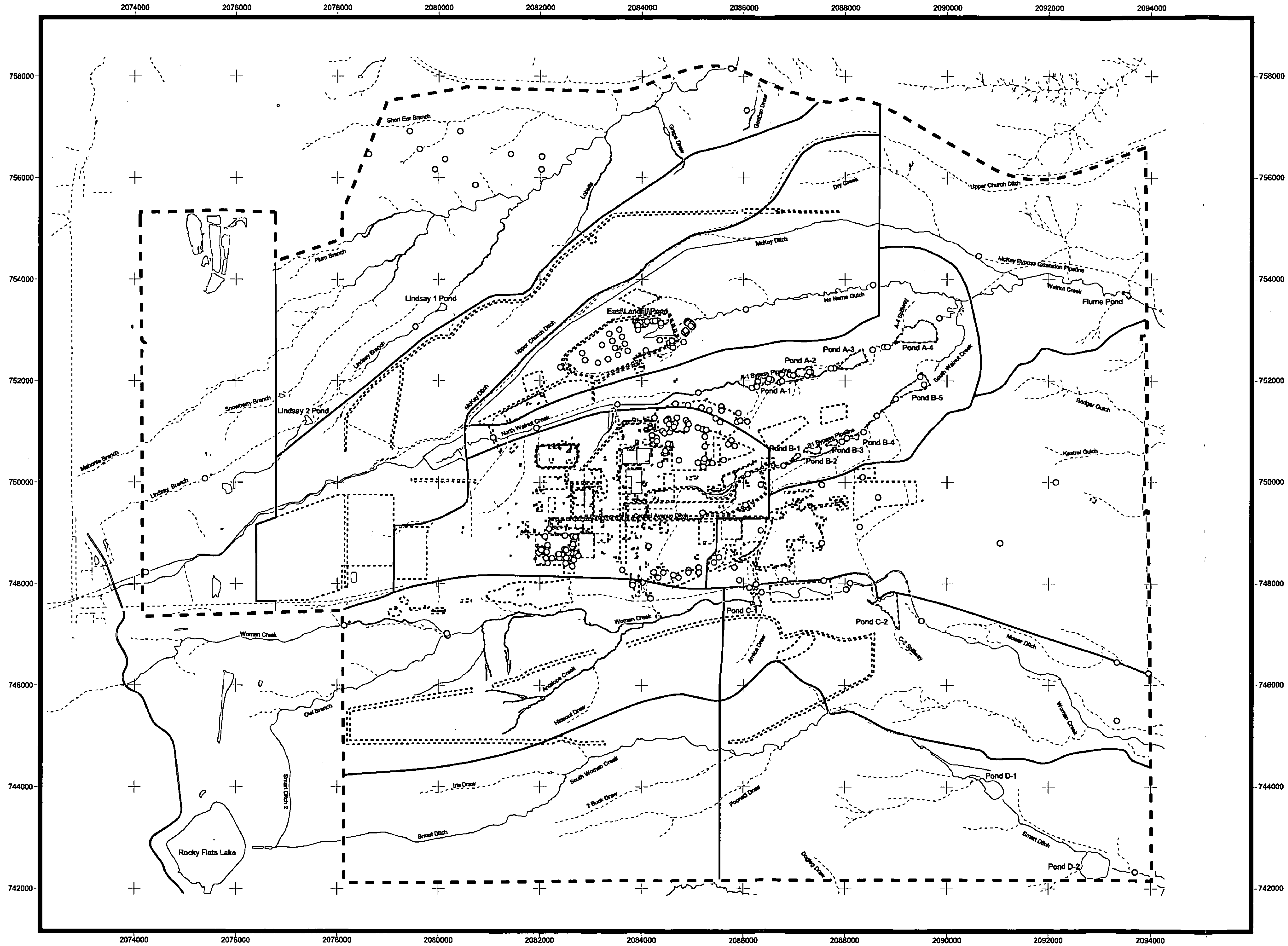

Figure A3.4.10

Radium-228 Activity in Sitewide Surface Soil/Surface Sediment

KEY

- Concentration > 3x Background MDC
- Concentration > Background MDC and <= 3x Background MDC
- Concentration > WRW PRG and <= Background MDC
- Concentration <= WRW PRG
- Nondetect (ND)

WRW PRG = 0.111 pCi/g
Background MDC = 4.10 pCi/g
3 x Background MDC = 12.3 pCi/g

Standard Map Features

- Wind Blown Area EU
- Exposure Unit boundaries
- Former building where analyte was used or generated as waste
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

0 1000 2000 Feet

Scale 1:24,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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File: W:\Projects\FY2005\CRA\ProfessionalJudgement\FINAL-profjudgment.apr

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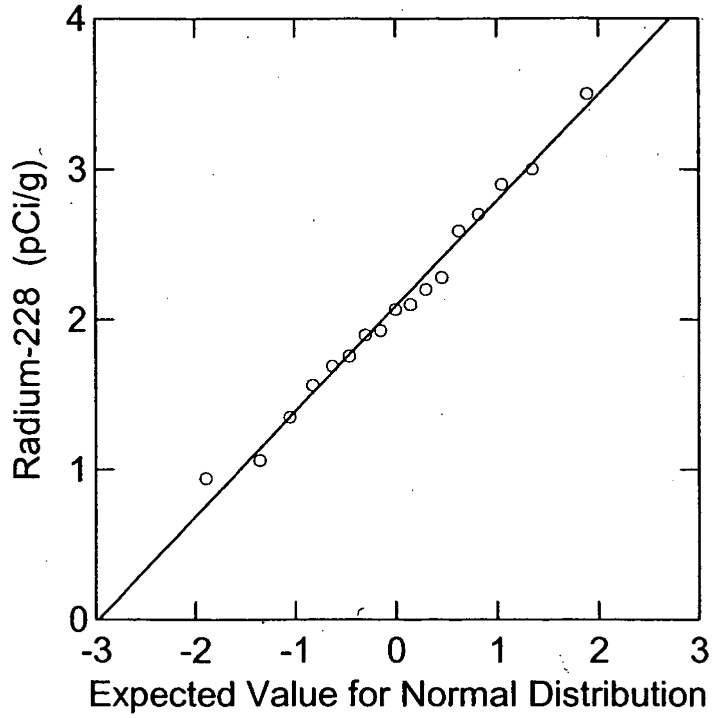

Figure A3.4.11 Probability Plot for Radium-228 Activities (Natural Logarithm) in WBEU Surface Soil/Surface Sediment

COMPREHENSIVE RISK ASSESSMENT

WIND BLOWN AREA EXPOSURE UNIT

VOLUME 9: ATTACHMENT 4

Risk Assessment Calculations

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3.0 ECOLOGICAL RISK ASSESSMENT TABLES

TABLES

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Table A4.1.1

Calculation of Chemical Cancer Risks and Non-Cancer Hazards for the Wildlife Refuge Worker using Tier 1 EPCs

Exposure Route	Contaminant of Concern	Tier 1 EPC (mg/kg)	Cancer Risk Calculations			Non-Cancer Hazard Calculations		
			Intake/Exposure Concentration (mg/kg/day)	CSF (mg/kg/day)-1	Cancer Risk	Intake/Exposure Concentration (mg/kg/day)	RfD (mg/kg/day)	Hazard Quotient
Surface Soil/Surface Sediment								
Ingestion	Arsenic	5.50	1.32E-06	1.5E+00	2.0E-06	4.95E-06	3.00E-04	0.016
				Ingestion Total:	**2E-06**		**Ingestion Total:**	**0.02**
Inhalation - (indoor + outdoor)	Arsenic	5.50	7.83E-09	1.5E+01	1.2E-07	2.93E-08	N/A	NC
				Inhalation Total:	**1E-07**		**Inhalation Total:**	**0**
Dermal	Arsenic	5.50	--	N/A	NC	--	N/A	NC
				Dermal Total:	**0**		**Dermal Total:**	**0**
				Surface Soil/Surface Sediment Total:	**2E-06**		**Surface Soil/Surface Sediment Total:**	**0.02**
				WRW Total:	**2E-06**		**WRW Total:**	**0.02**

N/A : Not Applicable or Not Available

NC : Not Calculated; Toxicity Factor (CSF or RfD) not available or exposure route was identified as insignificant in the CRA Methodology

-- : Exposure route is not complete because the exposure route was identified as insignificant in the CRA Methodology.

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Table A4.1.2

Calculation of Radionuclide Cancer Risks for the Wildlife Refuge Worker using Tier 1 EPCs

Medium/ Exposure Route	Contaminant of Concern	Tier 1 EPC (pCi/g)	Cancer Risk Calculations				
			Intake/Activity		CSF		Cancer Risk
			Value	Units	Value	Units	
Surface Soil/Surface Sediment							
Ingestion	Plutonium-239/240	12.12	5,214	pCi	1.21E-10	risk/pCi	6.31E-07
						Ingestion Total:	**6E-07**
Inhalation	Plutonium-239/240	12.12	30.88	pCi	3.33E-08	risk/pCi	1.03E-06
						Inhalation Total:	**1E-06**
External	Plutonium-239/240	12.12	30.00	pCi-yr/g	2.00E-10	(risk/yr)/(pCi/g)	6.00E-09
						External Total:	**6E-09**
Combined	Plutonium-239/240						1.67E-06
						Surface Soil/Surface Sediment Total:	**2E-06**
						Tier 1 WRW Total:	**2E-06**

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Table A4.1.3
Calculation of Radiation Dose for the Wildlife Refuge Worker using Tier 1 EPCs

Exposure Route	Contaminant of Concern	Tier 1 EPC (pCi/g)	RESRAD Radiation Dose Time = 0 (mrem)
Surface Soil/Surface Sediment			
Ingestion	Plutonium-239/240	12.1	0.281
		Ingestion Total:	**3E-01**
Inhalation	Plutonium-239/240	12.1	0.058
		Inhalation Total:	**6E-02**
External	Plutonium-239/240	12.1	5.55E-04
		External Total:	**6E-04**
		Surface Soil/Surface Sediment Total:	**3E-01**
		Tier 1 WRW Total:	**3E-01**

Table A4.1.4

Calculation of Chemical Cancer Risks and Non-Cancer Hazards for the Wildlife Refuge Worker using Tier 2 EPCs

Exposure Route	Contaminant of Concern	Tier 2 EPC (mg/kg)	Cancer Risk Calculations			Non-Cancer Hazard Calculations		
			Intake/Exposure Concentration (mg/kg/day)	CSF (mg/kg/day)-1	Cancer Risk	Intake/Exposure Concentration (mg/kg/day)	RfD (mg/kg/day)	Hazard Quotient
Surface Soil/Surface Sediment								
Ingestion	Arsenic	4.22	1.02E-06	1.5E+00	1.5E-06	3.80E-06	3.00E-04	0.013
				Ingestion Total:	**2E-06**		**Ingestion Total:**	**0.01**
Inhalation - (indoor + outdoor)	Arsenic	4.22	6.01E-09	1.5E+01	9.1E-08	2.25E-08	N/A	NC
				Inhalation Total:	**9E-08**		**Inhalation Total:**	**0**
Dermal	Arsenic	4.22	--	N/A	NC	--	N/A	NC
				Dermal Total:	**0**		**Dermal Total:**	**0**
				Surface Soil/Surface Sediment Total:	**2E-06**		**Surface Soil/Surface Sediment Total:**	**0.01**
				WRW Total:	**2E-06**		**WRW Total:**	**0.01**

N/A : Not Applicable or Not Available

NC : Not Calculated; Toxicity Factor (CSF or RfD) not available or exposure route was identified as insignificant in the CRA Methodology

-- : Exposure route is not complete because the exposure route was identified as insignificant in the CRA Methodology.

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Table A4.1.5
Calculation of Radionuclide Cancer Risks for the Wildlife Refuge Worker using Tier 2 EPCs

Exposure Route	Contaminant of Concern	Tier 2 EPC (pCi/g)	Cancer Risk Calculations				
			Intake/Activity		CSF		Cancer Risk
			Value	Units	Value	Units	
Surface Soil/Surface Sediment							
Ingestion	Plutonium-239/240	5.82	2,504	pCi	1.21E-10	risk/pCi	3.03E-07
						Ingestion Total:	**3E-07**
Inhalation - (indoor + outdoor)	Plutonium-239/240	5.82	14.83	pCi	3.33E-08	risk/pCi	4.94E-07
						Inhalation Total:	**5E-07**
External	Plutonium-239/240	5.82	14.40	(pCi-yr)/g	2.00E-10	(risk/yr)/(pCi/g)	2.88E-09
						External Total:	**3E-09**
Combined	Plutonium-239/240						8.00E-07
						Surface Soil/Surface Sediment Total:	**8E-07**
						Tier 2 WRW Total:	**8E-07**

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Table A4.1.6
Calculation of Radiation Dose for the Wildlife Refuge Worker using Tier 2 EPCs

Medium/ Exposure Route	Contamaninant of Concern	Tier 2 EPC (pCi/g)	RESRAD Radiation Dose Time = 0 (mrem)
Surface Soil/Surface Sediment			
Ingestion	Plutonium-239/240	5.82	0.135
		Ingestion Total:	1.4E-01
Inhalation	Plutonium-239/240	5.82	0.028
		Inhalation Total:	2.8E-02
External	Plutonium-239/240	5.82	2.7E-04
		External Total:	2.7E-04
		Surface Soil/Surface Sediment Total:	1.6E-01
		Tier 2 WRW Total:	1.6E-01

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Table A4.1.7

Calculation of Chemical Cancer Risks and Non-Cancer Hazards for the Wildlife Refuge Visitor using Tier 1 EPCs

Exposure Route	Contaminant of Concern	Tier 1 EPC (mg/kg)	Cancer Risk Calculations			Non-Cancer Hazard Calculations		
			Intake/Exposure Concentration (mg/kg/day)	CSF (mg/kg/day)-1	Cancer Risk	Intake/Exposure Concentration (mg/kg/day)	RfD (mg/kg/day)	Hazard Quotient
Surface Soil/Surface Sediment								
Ingestion	Arsenic	5.50	1.23E-06	1.5E+00	1.8E-06	2.87E-06	3.00E-04	0.010
				Ingestion Total:	**2E-06**		**Ingestion Total:**	**0.01**
Inhalation - (outdoor)	Arsenic	5.50	5.27E-09	1.5E+01	8.0E-08	1.23E-08	N/A	NC
				Inhalation Total:	**8E-08**		**Inhalation Total:**	**0**
Dermal	Arsenic	5.50	--	N/A	NC	--	N/A	NC
				Dermal Total:	**0**		**Dermal Total:**	**0**
				Surface Soil/Surface Sediment Total:	**2E-06**		**Surface Soil/Surface Sediment Total:**	**0.01**
				WRV Total:	**2E-06**		**WRV Total:**	**0.01**

N/A : Not Applicable or Not Available

NC : Not Calculated; Toxicity Factor (CSF or RfD) not available or exposure route was identified as insignificant in the CRA Methodology

-- : Exposure route is not complete because the exposure route was identified as insignificant in the CRA Methodology.

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Table A4.1.8

Calculation of Radionuclide Cancer Risks for the Wildlife Refuge Visitor using Tier 1 EPCs

Exposure Route	Contaminant of Concern	Tier 1 EPC (pCi/g)	Cancer Risk Calculations				
			Intake/Activity		CSF		Cancer Risk
			Value	Units	Value	Units	
Surface Soil/Surface Sediment							
Ingestion	Plutonium-239/240	12.1	2,182	pCi	2.76E-10	risk/pCi	6.02E-07
						Ingestion Total:	**6E-07**
Inhalation - (outdoor)	Plutonium-239/240	12.1	13.40	pCi	3.33E-08	risk/pCi	4.46E-07
						Inhalation Total:	**4E-07**
External	Plutonium-239/240	12.1	9.34	(pCi-yr)/g	2.00E-10	(risk/yr)/(pCi/g)	1.87E-09
						External Total:	**2E-09**
Combined	Plutonium-239/240						1.05E-06
						Surface Soil/Surface Sediment Total:	**1E-06**
						Tier 1 WRV Total:	**1E-06**

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Table A4.1.9
Calculation of Radiation Dose for the Wildlife Refuge Visitor using Tier 1 EPCs

Medium/ Exposure Route	Contaminant of Concern	Tier 1 EPC (pCi/g)	RESRAD Radation Dose Adult Receptor Time = 0 (mrem)	RESRAD Radation Dose Child Receptor Time = 0 (mrem)
Surface Soil/Surface Sediment				
Ingestion	Plutonium-239/240	12.1	0.059	0.203
		Ingestion Total:	**5.9E-02**	**2.0E-01**
Inhalation	Plutonium-239/240	12.1	0.013	0.014
		Inhalation Total:	**1.3E-02**	**1.4E-02**
External	Plutonium-239/240	12.1	1.04E-04	1.04E-04
		External Total:	**1.0E-04**	**1.0E-04**
		Surface Soil/Surface Sediment Total:	**7.2E-02**	**2.2E-01**
		Tier 1 WRV Total:	**7.2E-02**	**2.2E-01**

Table A4.1.10

Calculation of Chemical Cancer Risks and Non-Cancer Hazards for the Wildlife Refuge Visitor using Tier 2 EPCs

Exposure Route	Contaminant of Concern	Tier 2 EPC (mg/kg)	Cancer Risk Calculations			Non-Cancer Hazard Calculations		
			Intake/Exposure Concentration (mg/kg/day)	CSF (mg/kg/day)-1	Cancer Risk	Intake/Exposure Concentration (mg/kg/day)	RfD (mg/kg/day)	Hazard Quotient
Surface Soil/Surface Sediment								
Ingestion	Arsenic	4.22	9.44E-07	1.5E+00	1.4E-06	2.20E-06	0.000	0.007
				Ingestion Total:	**1E-06**		**Ingestion Total:**	**0.01**
Inhalation - (outdoor)	Arsenic	4.22	4.05E-09	1.5E+01	6.1E-08	9.45E-09	N/A	NC
				Inhalation Total:	**6E-08**		**Inhalation Total:**	**0**
Dermal	Arsenic	4.22	--	N/A	NC	--	N/A	NC
				Dermal Total:	**0**		**Dermal Total:**	**0**
				Surface Soil/Surface Sediment Total:	**1E-06**		**Surface Soil/Surface Sediment Total:**	**0.01**
				WRV Total:	**1E-06**		**WRV Total:**	**0.01**

N/A : Not Applicable or Not Available

NC : Not Calculated; Toxicity Factor (CSF or RfD) not available or exposure route was identified as insignificant in the CRA Methodology

-- : Exposure route is not complete because the exposure route was identified as insignificant in the CRA Methodology.

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Table A4.1.11
Calculation of Radionuclide Cancer Risks for the Wildlife Refuge Visitor using Tier 2 EPCs

Exposure Route	Contaminant of Concern	Tier 2 EPC (pCi/g)	Cancer Risk Calculations				
			Intake/Activity		CSF		Cancer Risk
			Value	Units	Value	Units	
Surface Soil/Surface Sediment							
Ingestion	Plutonium-239/240	5.82	1048	pCi	2.76E-10	risk/pCi	2.89E-07
						Ingestion Total:	**3E-07**
Inhalation - (outdoor)	Plutonium-239/240	5.82	6.44	pCi	3.33E-08	risk/pCi	2.14E-07
						Inhalation Total:	**2E-07**
External	Plutonium-239/240	5.82	4.49	(pCi-yr)/g	2.00E-10	(risk/yr)/(pCi/g)	8.97E-10
						External Total:	**9E-10**
Combined	Plutonium-239/240						5.04E-07
						Surface Soil/Surface Sediment Total:	**5E-07**
						Tier 2 WRV Total:	**5E-07**

Table A4.1.12

Calculation of Radiation Dose for the Wildlife Refuge Visitor using Tier 2 EPCs

Exposure Route	Contaminant of Concern	Tier 2 EPC (pCi/g)	RESRAD Radiation Dose Adult Receptor Time = 0 (mrem)	RESRAD Radiation Dose Child Receptor Time = 0 (mrem)
Surface Soil/Surface Sediment				
Ingestion	Plutonium-239/240	5.82	0.028	0.098
		Ingestion Total:	**2.8E-02**	**9.8E-02**
Inhalation	Plutonium-239/240	5.82	0.006	0.007
		Inhalation Total:	**6.1E-03**	**6.6E-03**
External	Plutonium-239/240	5.82	5.02E-05	5.02E-05
		External Total:	**5.0E-05**	**5.0E-05**
		Surface Soil/Surface Sediment Total:	**3.5E-02**	**1.0E-01**
		Tier 2 WRV Total:	**3.5E-02**	**1.0E-01**

RESRAD OUTPUT

WILDLIFE REFUGE WORKER – TIER 1

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Part I: Mixture Sums and Single Radionuclide Guidelines

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Dose Conversion Factor (and Related) Parameter Summary
File: 91918581.LIB

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(2)
B-1	Pu-239	1.900E-01	4.290E-01	DCF2(3)
B-1	U-235+D	1.100E-02	1.230E-01	DCF2(4)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(2)
D-1	Pu-239	9.300E-04	3.540E-03	DCF3(3)
D-1	U-235+D	1.720E-03	2.670E-04	DCF3(4)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Pu-239 , plant/soil concentration ratio, dimensionless	5.800E-05	1.000E-03	RTF(3,1)
D-34	Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(3,2)
D-34	Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(3,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	6.000E-03	2.500E-03	RTF(4,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(4,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(4,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
D-5				
D-5	Pu-239 , fish	3.000E+01	3.000E+01	BIOFAC(3,1)
D-5	Pu-239 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(4,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(4,2)

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.400E+06	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	1.500E-01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Pu-239	1.210E+01	0.000E+00	---	S1(3)
R012	Concentration in groundwater (pCi/L): Pu-239	not used	0.000E+00	---	W1(3)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.700E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	7.490E-05	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	3.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	1.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	4.450E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	1.040E+01	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	4.200E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	2.530E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	3.810E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	4.000E-03	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	not used	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	not used	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	not used	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	not used	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	not used	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	not used	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	not used	2.000E-02	---	HGWT
R014	Saturated zone b parameter	not used	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	not used	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	not used	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	not used	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	not used	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Pu-239				
R016	Contaminated zone (cm**3/g)	2.300E+03	2.000E+03	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+03	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+03	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.833E-04	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.519E-02	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.217E-02	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for daughter U-235				
R016	Contaminated zone (cm**3/g)	2.300E+00	5.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.551E-01	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R017	Inhalation rate (m**3/yr)	1.400E+04	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	6.700E-05	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	7.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	4.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	1.140E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	1.140E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	1.095E+02	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	not used	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	not used	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	not used	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	not used	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	not used	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	not used	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	1.234E+02	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	suppressed
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

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Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	1400000.00 square meters	Pu-239	1.210E+01
Thickness:	0.15 meters		
Cover Depth:	0.00 meters		

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 25 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	3.391E-01	3.388E-01	3.381E-01	3.357E-01	3.290E-01	3.061E-01	2.473E-01	1.018E-01
M(t):	1.357E-02	1.355E-02	1.352E-02	1.343E-02	1.316E-02	1.225E-02	9.893E-03	4.074E-03

Maximum TDOSE(t): 3.391E-01 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	5.550E-04	0.0016	5.778E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.808E-01	0.8280
Total	5.550E-04	0.0016	5.778E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.808E-01	0.8280

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.391E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.391E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	5.547E-04	0.0016	5.772E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.805E-01	0.8280
Total	5.547E-04	0.0016	5.772E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.805E-01	0.8280

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.388E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.388E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	5.540E-04	0.0016	5.760E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.799E-01	0.8280
Total	5.540E-04	0.0016	5.760E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.799E-01	0.8280

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.381E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.381E-01	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Pu-239	5.519E-04	0.0016	5.720E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.780E-01	0.8280
Total	5.519E-04	0.0016	5.720E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.780E-01	0.8280

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.357E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.357E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	5.457E-04	0.0017	5.605E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.724E-01	0.8280
Total	5.457E-04	0.0017	5.605E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.724E-01	0.8280

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.290E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.290E-01	1.0000

*S[illegible]f all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	5.247E-04	0.0017	5.215E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.535E-01	0.8279
Total	5.247E-04	0.0017	5.215E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.535E-01	0.8279

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.061E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.061E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	4.675E-04	0.0019	4.213E-02	0.1703	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.047E-01	0.8278
Total	4.675E-04	0.0019	4.213E-02	0.1703	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.047E-01	0.8278

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.473E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.473E-01	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Pu-239	2.925E-04	0.0029	1.733E-02	0.1702	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.422E-02	0.8270
Total	2.925E-04	0.0029	1.733E-02	0.1702	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.422E-02	0.8270

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.018E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.018E-01	1.0000

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Branch Fraction*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	Pu-239	1.000E+00	2.803E-02	2.800E-02	2.794E-02	2.775E-02	2.719E-02	2.530E-02	2.044E-02	8.417E-03
Pu-239	U-235	1.000E+00	6.836E-11	1.704E-10	2.760E-10	3.427E-10	3.410E-10	3.249E-10	2.822E-10	1.598E-10
Pu-239	Pa-231	1.000E+00	1.008E-15	6.220E-15	2.535E-14	1.119E-13	3.062E-13	5.499E-13	5.077E-13	2.186E-13
Pu-239	Ac-227	1.000E+00	2.088E-17	2.797E-16	2.566E-15	3.287E-14	1.959E-13	5.068E-13	5.027E-13	2.441E-13
Pu-239	∑DSR(j)		2.803E-02	2.800E-02	2.794E-02	2.775E-02	2.719E-02	2.530E-02	2.044E-02	8.417E-03

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 25 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	8.920E+02	8.929E+02	8.947E+02	9.010E+02	9.195E+02	9.881E+02	1.223E+03	2.970E+03

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Pu-239	1.210E+01	0.000E+00	2.803E-02	8.920E+02	2.803E-02	8.920E+02

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Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	Pu-239	1.000E+00	3.391E-01	3.388E-01	3.381E-01	3.357E-01	3.290E-01	3.061E-01	2.473E-01	1.018E-01
U-235	Pu-239	1.000E+00	8.272E-10	2.062E-09	3.339E-09	4.147E-09	4.126E-09	3.932E-09	3.414E-09	1.934E-09
Pa-231	Pu-239	1.000E+00	1.219E-14	7.526E-14	3.067E-13	1.354E-12	3.705E-12	6.653E-12	6.143E-12	2.645E-12
Ac-227	Pu-239	1.000E+00	2.527E-16	3.384E-15	3.105E-14	3.977E-13	2.371E-12	6.132E-12	6.082E-12	2.954E-12

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	Pu-239	1.000E+00	1.210E+01	1.209E+01	1.208E+01	1.204E+01	1.192E+01	1.150E+01	1.038E+01	7.251E+00
U-235	Pu-239	1.000E+00	0.000E+00	9.571E-09	1.948E-08	2.580E-08	2.582E-08	2.491E-08	2.248E-08	1.571E-08
Pa-231	Pu-239	1.000E+00	0.000E+00	1.081E-13	7.369E-13	3.948E-12	1.139E-11	2.139E-11	2.191E-11	1.533E-11
Ac-227	Pu-239	1.000E+00	0.000E+00	1.166E-15	2.433E-14	4.274E-13	2.778E-12	7.512E-12	8.058E-12	5.642E-12

BRF(i) is the branch fraction of the parent nuclide.

RESMAIN5.EXE execution time = 1.82 seconds

RESRAD OUTPUT

WILDLIFE REFUGE VISITOR – ADULT – TIER 1

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Dose Conversion Factor (and Related) Parameter Summary
File: 91918581.LIB

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(2)
B-1	Pu-239	1.900E-01	4.290E-01	DCF2(3)
B-1	U-235+D	1.100E-02	1.230E-01	DCF2(4)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(2)
D-1	Pu-239	9.300E-04	3.540E-03	DCF3(3)
D-1	U-235+D	1.720E-03	2.670E-04	DCF3(4)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Pu-239 , plant/soil concentration ratio, dimensionless	5.800E-05	1.000E-03	RTF(3,1)
D-34	Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(3,2)
D-34	Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(3,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	6.000E-03	2.500E-03	RTF(4,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(4,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(4,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
D-5				
D-5	Pu-239 , fish	3.000E+01	3.000E+01	BIOFAC(3,1)
D-5	Pu-239 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(4,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(4,2)

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.400E+06	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	1.500E-01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Pu-239	1.210E+01	0.000E+00	---	S1(3)
R012	Concentration in groundwater (pCi/L): Pu-239	not used	0.000E+00	---	W1(3)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.700E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	7.490E-05	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	3.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	1.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	4.450E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	1.040E+01	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	4.200E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	2.530E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	3.810E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	4.000E-03	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	not used	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	not used	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	not used	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	not used	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	not used	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	not used	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	not used	2.000E-02	---	HGWT
R014	Saturated zone b parameter	not used	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	not used	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	not used	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	not used	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	not used	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Pu-239				
R016	Contaminated zone (cm**3/g)	2.300E+03	2.000E+03	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+03	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+03	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.833E-04	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.519E-02	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.217E-02	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for daughter U-235				
R016	Contaminated zone (cm**3/g)	2.300E+00	5.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.551E-01	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R017	Inhalation rate (m**3/yr)	2.000E+04	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	6.700E-05	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	7.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	4.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	0.000E+00	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	3.000E-02	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	1.752E+02	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	not used	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	not used	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	not used	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	not used	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	not used	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	not used	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	1.234E+02	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	suppressed
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	1400000.00 square meters	Pu-239	1.210E+01
Thickness:	0.15 meters		
Cover Depth:	0.00 meters		

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 25 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	7.200E-02	7.192E-02	7.178E-02	7.127E-02	6.984E-02	6.499E-02	5.250E-02	2.162E-02
M(t):	2.880E-03	2.877E-03	2.871E-03	2.851E-03	2.794E-03	2.600E-03	2.100E-03	8.648E-04

Maximum TDOSE(t): 7.200E-02 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	1.043E-04	0.0014	1.278E-02	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.912E-02	0.8211
Total	1.043E-04	0.0014	1.278E-02	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.912E-02	0.8211

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.200E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.200E-02	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	1.043E-04	0.0014	1.276E-02	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.906E-02	0.8211
Total	1.043E-04	0.0014	1.276E-02	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.906E-02	0.8211

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.192E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.192E-02	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	1.041E-04	0.0015	1.274E-02	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.894E-02	0.8211
Total	1.041E-04	0.0015	1.274E-02	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.894E-02	0.8211

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.178E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.178E-02	1.0000

*S[illegible]f all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	1.037E-04	0.0015	1.265E-02	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.852E-02	0.8211
Total	1.037E-04	0.0015	1.265E-02	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.852E-02	0.8211

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.127E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.127E-02	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	1.026E-04	0.0015	1.239E-02	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.734E-02	0.8211
Total	1.026E-04	0.0015	1.239E-02	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.734E-02	0.8211

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.984E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.984E-02	1.0000

*S[illegible] all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	9.862E-05	0.0015	1.153E-02	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.336E-02	0.8210
Total	9.862E-05	0.0015	1.153E-02	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.336E-02	0.8210

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.499E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.499E-02	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	8.787E-05	0.0017	9.316E-03	0.1774	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.310E-02	0.8209
Total	8.787E-05	0.0017	9.316E-03	0.1774	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.310E-02	0.8209

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.250E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.250E-02	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	5.499E-05	0.0025	3.832E-03	0.1773	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.773E-02	0.8202
Total	5.499E-05	0.0025	3.832E-03	0.1773	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.773E-02	0.8202

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.162E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.162E-02	1.0000

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Branch Fraction*	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
			DSR(j,t) (mrem/yr)/(pCi/g)							
Pu-239	Pu-239	1.000E+00	5.950E-03	5.944E-03	5.932E-03	5.890E-03	5.772E-03	5.371E-03	4.339E-03	1.787E-03
Pu-239	U-235	1.000E+00	1.327E-11	3.307E-11	5.355E-11	6.650E-11	6.615E-11	6.299E-11	5.459E-11	3.068E-11
Pu-239	Pa-231	1.000E+00	2.112E-16	1.303E-15	5.313E-15	2.345E-14	6.417E-14	1.152E-13	1.063E-13	4.555E-14
Pu-239	Ac-227	1.000E+00	4.270E-18	5.719E-17	5.247E-16	6.720E-15	4.005E-14	1.035E-13	1.024E-13	4.914E-14
Pu-239	∑DSR(j)		5.950E-03	5.944E-03	5.932E-03	5.890E-03	5.772E-03	5.371E-03	4.339E-03	1.787E-03

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 25 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	4.202E+03	4.206E+03	4.214E+03	4.244E+03	4.331E+03	4.654E+03	5.761E+03	1.399E+04

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Pu-239	1.210E+01	0.000E+00	5.950E-03	4.202E+03	5.950E-03	4.202E+03

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Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	Pu-239	1.000E+00	7.200E-02	7.192E-02	7.178E-02	7.127E-02	6.984E-02	6.499E-02	5.250E-02	2.162E-02
U-235	Pu-239	1.000E+00	1.605E-10	4.001E-10	6.480E-10	8.047E-10	8.004E-10	7.622E-10	6.605E-10	3.712E-10
Pa-231	Pu-239	1.000E+00	2.555E-15	1.577E-14	6.428E-14	2.838E-13	7.764E-13	1.394E-12	1.286E-12	5.512E-13
Ac-227	Pu-239	1.000E+00	5.167E-17	6.920E-16	6.349E-15	8.131E-14	4.846E-13	1.252E-12	1.239E-12	5.946E-13

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	Pu-239	1.000E+00	1.210E+01	1.209E+01	1.208E+01	1.204E+01	1.192E+01	1.150E+01	1.038E+01	7.251E+00
U-235	Pu-239	1.000E+00	0.000E+00	9.571E-09	1.948E-08	2.580E-08	2.582E-08	2.491E-08	2.248E-08	1.571E-08
Pa-231	Pu-239	1.000E+00	0.000E+00	1.081E-13	7.369E-13	3.948E-12	1.139E-11	2.139E-11	2.191E-11	1.533E-11
Ac-227	Pu-239	1.000E+00	0.000E+00	1.166E-15	2.433E-14	4.274E-13	2.778E-12	7.512E-12	8.058E-12	5.642E-12

BRF(i) is the branch fraction of the parent nuclide.

RESMAIN5.EXE execution time = 1.81 seconds

RESRAD OUTPUT

WILDLIFE REFUGE VISITOR – CHILD – TIER 1

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Dose Conversion Factor (and Related) Parameter Summary
File: 06957644.LIB

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(2)
B-1	Pu-239	2.900E-01	4.290E-01	DCF2(3)
B-1	U-235+D	3.550E-02	1.230E-01	DCF2(4)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(2)
D-1	Pu-239	1.600E-03	3.540E-03	DCF3(3)
D-1	U-235+D	4.750E-04	2.670E-04	DCF3(4)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Pu-239 , plant/soil concentration ratio, dimensionless	5.800E-05	1.000E-03	RTF(3,1)
D-34	Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(3,2)
D-34	Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(3,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	6.000E-03	2.500E-03	RTF(4,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(4,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(4,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
D-5				
D-5	Pu-239 , fish	3.000E+01	3.000E+01	BIOFAC(3,1)
D-5	Pu-239 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(4,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(4,2)

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.400E+06	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	1.500E-01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Pu-239	1.210E+01	0.000E+00	---	S1(3)
R012	Concentration in groundwater (pCi/L): Pu-239	not used	0.000E+00	---	W1(3)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.700E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	7.490E-05	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	3.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	1.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	4.450E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	1.040E+01	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	4.200E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	2.530E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	3.810E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	4.000E-03	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	not used	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	not used	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	not used	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	not used	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	not used	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	not used	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	not used	2.000E-02	---	HGWT
R014	Saturated zone b parameter	not used	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	not used	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	not used	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	not used	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	not used	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Pu-239				
R016	Contaminated zone (cm**3/g)	2.300E+03	2.000E+03	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+03	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+03	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.833E-04	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.519E-02	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.217E-02	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for daughter U-235				
R016	Contaminated zone (cm**3/g)	2.300E+00	5.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.551E-01	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R017	Inhalation rate (m**3/yr)	1.400E+04	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	6.700E-05	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	7.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	4.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	0.000E+00	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	3.000E-02	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.504E+02	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	not used	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	not used	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	not used	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	not used	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	not used	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	not used	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	1.234E+02	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	suppressed
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

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Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	1400000.00 square meters	Pu-239	1.210E+01
Thickness:	0.15 meters		
Cover Depth:	0.00 meters		

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 25 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	2.172E-01	2.169E-01	2.165E-01	2.150E-01	2.107E-01	1.960E-01	1.583E-01	6.516E-02
M(t):	8.687E-03	8.678E-03	8.660E-03	8.599E-03	8.426E-03	7.841E-03	6.334E-03	2.606E-03

Maximum TDOSE(t): 2.172E-01 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	1.043E-04	0.0005	1.365E-02	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.034E-01	0.9367
Total	1.043E-04	0.0005	1.365E-02	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.034E-01	0.9367

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.172E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.172E-01	1.0000

*S[illegible]f all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	1.043E-04	0.0005	1.364E-02	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.032E-01	0.9367
Total	1.043E-04	0.0005	1.364E-02	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.032E-01	0.9367

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.169E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.169E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	1.041E-04	0.0005	1.361E-02	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.028E-01	0.9367
Total	1.041E-04	0.0005	1.361E-02	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.028E-01	0.9367

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.165E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.165E-01	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Pu-239	1.037E-04	0.0005	1.351E-02	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.014E-01	0.9367
Total	1.037E-04	0.0005	1.351E-02	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.014E-01	0.9367

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.150E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.150E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	1.026E-04	0.0005	1.324E-02	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.973E-01	0.9367
Total	1.026E-04	0.0005	1.324E-02	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.973E-01	0.9367

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.107E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.107E-01	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	9.862E-05	0.0005	1.232E-02	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.836E-01	0.9366
Total	9.862E-05	0.0005	1.232E-02	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.836E-01	0.9366

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.960E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.960E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	8.787E-05	0.0006	9.953E-03	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.483E-01	0.9366
Total	8.787E-05	0.0006	9.953E-03	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.483E-01	0.9366

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.583E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.583E-01	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	5.499E-05	0.0008	4.095E-03	0.0628	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.101E-02	0.9363
Total	5.499E-05	0.0008	4.095E-03	0.0628	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.101E-02	0.9363

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.516E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.516E-02	1.0000

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Branch Fraction*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	Pu-239	1.000E+00	1.795E-02	1.793E-02	1.789E-02	1.777E-02	1.741E-02	1.620E-02	1.309E-02	5.385E-03
Pu-239	U-235	1.000E+00	1.158E-11	2.886E-11	4.674E-11	5.807E-11	5.781E-11	5.523E-11	4.832E-11	2.810E-11
Pu-239	Pa-231	1.000E+00	3.768E-16	2.326E-15	9.480E-15	4.185E-14	1.145E-13	2.053E-13	1.887E-13	7.952E-14
Pu-239	Ac-227	1.000E+00	5.917E-18	7.925E-17	7.269E-16	9.308E-15	5.543E-14	1.428E-13	1.400E-13	6.467E-14
Pu-239	∑DSR(j)		1.795E-02	1.793E-02	1.789E-02	1.777E-02	1.741E-02	1.620E-02	1.309E-02	5.385E-03

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 25 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	1.393E+03	1.394E+03	1.397E+03	1.407E+03	1.436E+03	1.543E+03	1.910E+03	4.642E+03

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Pu-239	1.210E+01	0.000E+00	1.795E-02	1.393E+03	1.795E-02	1.393E+03

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Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	Pu-239	1.000E+00	2.172E-01	2.169E-01	2.165E-01	2.150E-01	2.107E-01	1.960E-01	1.583E-01	6.516E-02
U-235	Pu-239	1.000E+00	1.401E-10	3.492E-10	5.656E-10	7.026E-10	6.995E-10	6.683E-10	5.846E-10	3.400E-10
Pa-231	Pu-239	1.000E+00	4.560E-15	2.815E-14	1.147E-13	5.064E-13	1.385E-12	2.484E-12	2.283E-12	9.622E-13
Ac-227	Pu-239	1.000E+00	7.160E-17	9.589E-16	8.796E-15	1.126E-13	6.707E-13	1.728E-12	1.695E-12	7.826E-13

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	Pu-239	1.000E+00	1.210E+01	1.209E+01	1.208E+01	1.204E+01	1.192E+01	1.150E+01	1.038E+01	7.251E+00
U-235	Pu-239	1.000E+00	0.000E+00	9.571E-09	1.948E-08	2.580E-08	2.582E-08	2.491E-08	2.248E-08	1.571E-08
Pa-231	Pu-239	1.000E+00	0.000E+00	1.081E-13	7.369E-13	3.948E-12	1.139E-11	2.139E-11	2.191E-11	1.533E-11
Ac-227	Pu-239	1.000E+00	0.000E+00	1.166E-15	2.433E-14	4.274E-13	2.778E-12	7.512E-12	8.058E-12	5.642E-12

BRF(i) is the branch fraction of the parent nuclide.

RESMAIN5.EXE execution time = 1.82 seconds

RESRAD OUTPUT

WILDLIFE REFUGE WORKER – TIER 2

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Dose Conversion Factor (and Related) Parameter Summary
File: 91918581.LIB

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(2)
B-1	Pu-239	1.900E-01	4.290E-01	DCF2(3)
B-1	U-235+D	1.100E-02	1.230E-01	DCF2(4)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(2)
D-1	Pu-239	9.300E-04	3.540E-03	DCF3(3)
D-1	U-235+D	1.720E-03	2.670E-04	DCF3(4)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Pu-239 , plant/soil concentration ratio, dimensionless	5.800E-05	1.000E-03	RTF(3,1)
D-34	Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(3,2)
D-34	Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(3,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	6.000E-03	2.500E-03	RTF(4,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(4,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(4,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
D-5				
D-5	Pu-239 , fish	3.000E+01	3.000E+01	BIOFAC(3,1)
D-5	Pu-239 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(4,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(4,2)

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.400E+06	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	1.500E-01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Pu-239	5.820E+00	0.000E+00	---	S1(3)
R012	Concentration in groundwater (pCi/L): Pu-239	not used	0.000E+00	---	W1(3)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.700E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	7.490E-05	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	3.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	1.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	4.450E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	1.040E+01	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	4.200E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	2.530E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	3.810E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	4.000E-03	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	not used	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	not used	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	not used	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	not used	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	not used	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	not used	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	not used	2.000E-02	---	HGWT
R014	Saturated zone b parameter	not used	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	not used	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	not used	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	not used	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	not used	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Pu-239				
R016	Contaminated zone (cm**3/g)	2.300E+03	2.000E+03	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+03	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+03	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.833E-04	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.519E-02	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.217E-02	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for daughter U-235				
R016	Contaminated zone (cm**3/g)	2.300E+00	5.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.551E-01	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R017	Inhalation rate (m**3/yr)	1.400E+04	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	6.700E-05	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	7.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	4.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	1.140E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	1.140E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	1.095E+02	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	not used	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	not used	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	not used	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	not used	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	not used	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	not used	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	1.234E+02	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	suppressed
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

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Contaminated Zone Dimensions	
Area:	1400000.00 square meters
Thickness:	0.15 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g	
Pu-239	5.820E+00

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 25 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	1.631E-01	1.630E-01	1.626E-01	1.615E-01	1.582E-01	1.472E-01	1.190E-01	4.899E-02
M(t):	6.525E-03	6.518E-03	6.505E-03	6.459E-03	6.329E-03	5.890E-03	4.758E-03	1.960E-03

Maximum TDOSE(t): 1.631E-01 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	2.669E-04	0.0016	2.779E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.351E-01	0.8280
Total	2.669E-04	0.0016	2.779E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.351E-01	0.8280

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.631E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.631E-01	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	2.668E-04	0.0016	2.776E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.349E-01	0.8280
Total	2.668E-04	0.0016	2.776E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.349E-01	0.8280

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.630E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.630E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Pu-239	2.665E-04	0.0016	2.771E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.347E-01	0.8280
Total	2.665E-04	0.0016	2.771E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.347E-01	0.8280

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.626E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.626E-01	1.0000

*S[illegible]f all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	2.654E-04	0.0016	2.751E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.337E-01	0.8280
Total	2.654E-04	0.0016	2.751E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.337E-01	0.8280

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.615E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.615E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	2.625E-04	0.0017	2.696E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.310E-01	0.8280
Total	2.625E-04	0.0017	2.696E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.310E-01	0.8280

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.582E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.582E-01	1.0000

*S[illegible]f all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	2.524E-04	0.0017	2.509E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.219E-01	0.8279
Total	2.524E-04	0.0017	2.509E-02	0.1704	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.219E-01	0.8279

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.472E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.472E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	2.249E-04	0.0019	2.026E-02	0.1703	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.847E-02	0.8278
Total	2.249E-04	0.0019	2.026E-02	0.1703	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.847E-02	0.8278

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.190E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.190E-01	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	1.407E-04	0.0029	8.336E-03	0.1702	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.051E-02	0.8270
Total	1.407E-04	0.0029	8.336E-03	0.1702	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.051E-02	0.8270

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.899E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.899E-02	1.0000

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Branch Fraction*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	Pu-239	1.000E+00	2.803E-02	2.800E-02	2.794E-02	2.775E-02	2.719E-02	2.530E-02	2.044E-02	8.417E-03
Pu-239	U-235	1.000E+00	6.836E-11	1.704E-10	2.760E-10	3.427E-10	3.410E-10	3.249E-10	2.822E-10	1.598E-10
Pu-239	Pa-231	1.000E+00	1.008E-15	6.220E-15	2.535E-14	1.119E-13	3.062E-13	5.499E-13	5.077E-13	2.186E-13
Pu-239	Ac-227	1.000E+00	2.088E-17	2.797E-16	2.566E-15	3.287E-14	1.959E-13	5.068E-13	5.027E-13	2.441E-13
Pu-239	∑DSR(j)		2.803E-02	2.800E-02	2.794E-02	2.775E-02	2.719E-02	2.530E-02	2.044E-02	8.417E-03

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 25 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	8.920E+02	8.929E+02	8.947E+02	9.010E+02	9.195E+02	9.881E+02	1.223E+03	2.970E+03

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Pu-239	5.820E+00	0.000E+00	2.803E-02	8.920E+02	2.803E-02	8.920E+02

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Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	Pu-239	1.000E+00	1.631E-01	1.630E-01	1.626E-01	1.615E-01	1.582E-01	1.472E-01	1.190E-01	4.899E-02
U-235	Pu-239	1.000E+00	3.979E-10	9.918E-10	1.606E-09	1.995E-09	1.985E-09	1.891E-09	1.642E-09	9.303E-10
Pa-231	Pu-239	1.000E+00	5.864E-15	3.620E-14	1.475E-13	6.514E-13	1.782E-12	3.200E-12	2.955E-12	1.272E-12
Ac-227	Pu-239	1.000E+00	1.215E-16	1.628E-15	1.493E-14	1.913E-13	1.140E-12	2.949E-12	2.926E-12	1.421E-12

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	Pu-239	1.000E+00	5.820E+00	5.817E+00	5.811E+00	5.790E+00	5.731E+00	5.529E+00	4.991E+00	3.488E+00
U-235	Pu-239	1.000E+00	0.000E+00	4.604E-09	9.371E-09	1.241E-08	1.242E-08	1.198E-08	1.081E-08	7.556E-09
Pa-231	Pu-239	1.000E+00	0.000E+00	5.199E-14	3.545E-13	1.899E-12	5.478E-12	1.029E-11	1.054E-11	7.375E-12
Ac-227	Pu-239	1.000E+00	0.000E+00	5.606E-16	1.170E-14	2.056E-13	1.336E-12	3.613E-12	3.876E-12	2.714E-12

BRF(i) is the branch fraction of the parent nuclide.

RESMAIN5.EXE execution time =   1.93 seconds

RESRAD OUTPUT

WILDLIFE REFUGE VISITOR – ADULT – TIER 2

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I: Mixture Sums and Single Radionuclide Guidelines

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Dose Conversion Factor (and Related) Parameter Summary
File: 91918581.LIB

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(2)
B-1	Pu-239	1.900E-01	4.290E-01	DCF2(3)
B-1	U-235+D	1.100E-02	1.230E-01	DCF2(4)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(2)
D-1	Pu-239	9.300E-04	3.540E-03	DCF3(3)
D-1	U-235+D	1.720E-03	2.670E-04	DCF3(4)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Pu-239 , plant/soil concentration ratio, dimensionless	5.800E-05	1.000E-03	RTF(3,1)
D-34	Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(3,2)
D-34	Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(3,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	6.000E-03	2.500E-03	RTF(4,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(4,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(4,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
D-5				
D-5	Pu-239 , fish	3.000E+01	3.000E+01	BIOFAC(3,1)
D-5	Pu-239 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(4,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(4,2)

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.400E+06	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	1.500E-01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Pu-239	5.820E+00	0.000E+00	---	S1(3)
R012	Concentration in groundwater (pCi/L): Pu-239	not used	0.000E+00	---	W1(3)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.700E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	7.490E-05	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	3.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	1.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	4.450E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	1.040E+01	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	4.200E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	2.530E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	3.810E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	4.000E-03	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	not used	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	not used	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	not used	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	not used	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	not used	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	not used	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	not used	2.000E-02	---	HGWT
R014	Saturated zone b parameter	not used	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	not used	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	not used	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	not used	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	not used	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Pu-239				
R016	Contaminated zone (cm**3/g)	2.300E+03	2.000E+03	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+03	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+03	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.833E-04	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.519E-02	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.217E-02	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for daughter U-235				
R016	Contaminated zone (cm**3/g)	2.300E+00	5.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.551E-01	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R017	Inhalation rate (m**3/yr)	2.000E+04	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	6.700E-05	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	7.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	4.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	0.000E+00	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	3.000E-02	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	1.752E+02	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	not used	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	not used	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	not used	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	not used	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	not used	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	not used	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	1.234E+02	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	suppressed
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

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Contaminated Zone Dimensions	
Area:	1400000.00 square meters
Thickness:	0.15 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g	
Pu-239	5.820E+00

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 25 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	3.463E-02	3.460E-02	3.453E-02	3.428E-02	3.359E-02	3.126E-02	2.525E-02	1.040E-02
M(t):	1.385E-03	1.384E-03	1.381E-03	1.371E-03	1.344E-03	1.250E-03	1.010E-03	4.159E-04

Maximum TDOSE(t): 3.463E-02 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	5.018E-05	0.0014	6.146E-03	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.843E-02	0.8211
Total	5.018E-05	0.0014	6.146E-03	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.843E-02	0.8211

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.463E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.463E-02	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	5.015E-05	0.0014	6.140E-03	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.841E-02	0.8211
Total	5.015E-05	0.0014	6.140E-03	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.841E-02	0.8211

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.460E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.460E-02	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	5.009E-05	0.0015	6.127E-03	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.835E-02	0.8211
Total	5.009E-05	0.0015	6.127E-03	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.835E-02	0.8211

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.453E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.453E-02	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	4.990E-05	0.0015	6.084E-03	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.815E-02	0.8211
Total	4.990E-05	0.0015	6.084E-03	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.815E-02	0.8211

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.428E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.428E-02	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	4.934E-05	0.0015	5.961E-03	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.758E-02	0.8211
Total	4.934E-05	0.0015	5.961E-03	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.758E-02	0.8211

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.359E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.359E-02	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	4.744E-05	0.0015	5.547E-03	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.567E-02	0.8210
Total	4.744E-05	0.0015	5.547E-03	0.1775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.567E-02	0.8210

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.126E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.126E-02	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	4.227E-05	0.0017	4.481E-03	0.1774	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.073E-02	0.8209
Total	4.227E-05	0.0017	4.481E-03	0.1774	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.073E-02	0.8209

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.525E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.525E-02	1.0000

*S[illegible]f all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	2.645E-05	0.0025	1.843E-03	0.1773	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.529E-03	0.8202
Total	2.645E-05	0.0025	1.843E-03	0.1773	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.529E-03	0.8202

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.040E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.040E-02	1.0000

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Branch Fraction*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	Pu-239	1.000E+00	5.950E-03	5.944E-03	5.932E-03	5.890E-03	5.772E-03	5.371E-03	4.339E-03	1.787E-03
Pu-239	U-235	1.000E+00	1.327E-11	3.307E-11	5.355E-11	6.650E-11	6.615E-11	6.299E-11	5.459E-11	3.068E-11
Pu-239	Pa-231	1.000E+00	2.112E-16	1.303E-15	5.313E-15	2.345E-14	6.417E-14	1.152E-13	1.063E-13	4.555E-14
Pu-239	Ac-227	1.000E+00	4.270E-18	5.719E-17	5.247E-16	6.720E-15	4.005E-14	1.035E-13	1.024E-13	4.914E-14
Pu-239	∑DSR(j)		5.950E-03	5.944E-03	5.932E-03	5.890E-03	5.772E-03	5.371E-03	4.339E-03	1.787E-03

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 25 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	4.202E+03	4.206E+03	4.214E+03	4.244E+03	4.331E+03	4.654E+03	5.761E+03	1.399E+04

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Pu-239	5.820E+00	0.000E+00	5.950E-03	4.202E+03	5.950E-03	4.202E+03

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Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	Pu-239	1.000E+00	3.463E-02	3.460E-02	3.453E-02	3.428E-02	3.359E-02	3.126E-02	2.525E-02	1.040E-02
U-235	Pu-239	1.000E+00	7.721E-11	1.925E-10	3.117E-10	3.871E-10	3.850E-10	3.666E-10	3.177E-10	1.786E-10
Pa-231	Pu-239	1.000E+00	1.229E-15	7.586E-15	3.092E-14	1.365E-13	3.735E-13	6.704E-13	6.184E-13	2.651E-13
Ac-227	Pu-239	1.000E+00	2.485E-17	3.329E-16	3.054E-15	3.911E-14	2.331E-13	6.023E-13	5.958E-13	2.860E-13

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	Pu-239	1.000E+00	5.820E+00	5.817E+00	5.811E+00	5.790E+00	5.731E+00	5.529E+00	4.991E+00	3.488E+00
U-235	Pu-239	1.000E+00	0.000E+00	4.604E-09	9.371E-09	1.241E-08	1.242E-08	1.198E-08	1.081E-08	7.556E-09
Pa-231	Pu-239	1.000E+00	0.000E+00	5.199E-14	3.545E-13	1.899E-12	5.478E-12	1.029E-11	1.054E-11	7.375E-12
Ac-227	Pu-239	1.000E+00	0.000E+00	5.606E-16	1.170E-14	2.056E-13	1.336E-12	3.613E-12	3.876E-12	2.714E-12

BRF(i) is the branch fraction of the parent nuclide.

RESMAIN5.EXE execution time = 1.82 seconds

RESRAD OUTPUT

WILDLIFE REFUGE VISITOR – CHILD – TIER 2

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Part I: Mixture Sums and Single Radionuclide Guidelines

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Dose Conversion Factor (and Related) Parameter Summary
File: 06957644.LIB

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(2)
B-1	Pu-239	2.900E-01	4.290E-01	DCF2(3)
B-1	U-235+D	3.550E-02	1.230E-01	DCF2(4)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(2)
D-1	Pu-239	1.600E-03	3.540E-03	DCF3(3)
D-1	U-235+D	4.750E-04	2.670E-04	DCF3(4)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Pu-239 , plant/soil concentration ratio, dimensionless	5.800E-05	1.000E-03	RTF(3,1)
D-34	Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(3,2)
D-34	Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(3,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	6.000E-03	2.500E-03	RTF(4,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(4,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(4,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
D-5				
D-5	Pu-239 , fish	3.000E+01	3.000E+01	BIOFAC(3,1)
D-5	Pu-239 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(4,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(4,2)

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.400E+06	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	1.500E-01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Pu-239	5.820E+00	0.000E+00	---	S1(3)
R012	*Concentration in groundwater (pCi/L): Pu-239*	not used	0.000E+00	---	W1(3)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.700E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	7.490E-05	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	3.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	1.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	4.450E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	1.040E+01	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	4.200E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	2.530E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	3.810E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	4.000E-03	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	not used	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	not used	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	not used	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	not used	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	not used	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	not used	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	not used	2.000E-02	---	HGWT
R014	Saturated zone b parameter	not used	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	not used	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	not used	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	not used	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	not used	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Pu-239				
R016	Contaminated zone (cm**3/g)	2.300E+03	2.000E+03	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+03	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+03	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.833E-04	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.519E-02	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.217E-02	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for daughter U-235				
R016	Contaminated zone (cm**3/g)	2.300E+00	5.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.551E-01	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R017	Inhalation rate (m**3/yr)	1.400E+04	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	6.700E-05	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	7.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	4.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	0.000E+00	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	3.000E-02	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.504E+02	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	not used	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	not used	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	not used	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	not used	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	not used	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	not used	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	1.234E+02	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	suppressed
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

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Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	1400000.00 square meters	Pu-239	5.820E+00
Thickness:	0.15 meters		
Cover Depth:	0.00 meters		

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 25 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	1.045E-01	1.043E-01	1.041E-01	1.034E-01	1.013E-01	9.429E-02	7.616E-02	3.134E-02
M(t):	4.178E-03	4.174E-03	4.166E-03	4.136E-03	4.053E-03	3.771E-03	3.047E-03	1.254E-03

Maximum TDOSE(t): 1.045E-01 mrem/yr   at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	5.018E-05	0.0005	6.566E-03	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.784E-02	0.9367
Total	5.018E-05	0.0005	6.566E-03	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.784E-02	0.9367

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.045E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.045E-01	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	5.015E-05	0.0005	6.560E-03	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.774E-02	0.9367
Total	5.015E-05	0.0005	6.560E-03	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.774E-02	0.9367

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.043E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.043E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Pu-239	5.009E-05	0.0005	6.546E-03	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.754E-02	0.9367
Total	5.009E-05	0.0005	6.546E-03	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.754E-02	0.9367

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.041E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.041E-01	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	4.990E-05	0.0005	6.500E-03	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.685E-02	0.9367
Total	4.990E-05	0.0005	6.500E-03	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.685E-02	0.9367

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.034E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.034E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	4.934E-05	0.0005	6.369E-03	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.490E-02	0.9367
Total	4.934E-05	0.0005	6.369E-03	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.490E-02	0.9367

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.013E-01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.013E-01	1.0000

*S[illegible]f all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	4.744E-05	0.0005	5.927E-03	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.831E-02	0.9366
Total	4.744E-05	0.0005	5.927E-03	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.831E-02	0.9366

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.429E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.429E-02	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	4.227E-05	0.0006	4.787E-03	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.133E-02	0.9366
Total	4.227E-05	0.0006	4.787E-03	0.0629	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.133E-02	0.9366

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.616E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.616E-02	1.0000

*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	2.645E-05	0.0008	1.970E-03	0.0628	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.935E-02	0.9363
Total	2.645E-05	0.0008	1.970E-03	0.0628	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.935E-02	0.9363

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.134E-02	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.134E-02	1.0000

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Branch Fraction*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	Pu-239	1.000E+00	1.795E-02	1.793E-02	1.789E-02	1.777E-02	1.741E-02	1.620E-02	1.309E-02	5.385E-03
Pu-239	U-235	1.000E+00	1.158E-11	2.886E-11	4.674E-11	5.807E-11	5.781E-11	5.523E-11	4.832E-11	2.810E-11
Pu-239	Pa-231	1.000E+00	3.768E-16	2.326E-15	9.480E-15	4.185E-14	1.145E-13	2.053E-13	1.887E-13	7.952E-14
Pu-239	Ac-227	1.000E+00	5.917E-18	7.925E-17	7.269E-16	9.308E-15	5.543E-14	1.428E-13	1.400E-13	6.467E-14
Pu-239	∑DSR(j)		1.795E-02	1.793E-02	1.789E-02	1.777E-02	1.741E-02	1.620E-02	1.309E-02	5.385E-03

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 25 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	1.393E+03	1.394E+03	1.397E+03	1.407E+03	1.436E+03	1.543E+03	1.910E+03	4.642E+03

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Pu-239	5.820E+00	0.000E+00	1.795E-02	1.393E+03	1.795E-02	1.393E+03

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	Pu-239	1.000E+00	1.045E-01	1.043E-01	1.041E-01	1.034E-01	1.013E-01	9.429E-02	7.616E-02	3.134E-02
U-235	Pu-239	1.000E+00	6.738E-11	1.680E-10	2.720E-10	3.379E-10	3.365E-10	3.214E-10	2.812E-10	1.636E-10
Pa-231	Pu-239	1.000E+00	2.193E-15	1.354E-14	5.518E-14	2.436E-13	6.662E-13	1.195E-12	1.098E-12	4.628E-13
Ac-227	Pu-239	1.000E+00	3.444E-17	4.612E-16	4.231E-15	5.417E-14	3.226E-13	8.312E-13	8.151E-13	3.764E-13

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Pu-239	Pu-239	1.000E+00	5.820E+00	5.817E+00	5.811E+00	5.790E+00	5.731E+00	5.529E+00	4.991E+00	3.488E+00
U-235	Pu-239	1.000E+00	0.000E+00	4.604E-09	9.371E-09	1.241E-08	1.242E-08	1.198E-08	1.081E-08	7.556E-09
Pa-231	Pu-239	1.000E+00	0.000E+00	5.199E-14	3.545E-13	1.899E-12	5.478E-12	1.029E-11	1.054E-11	7.375E-12
Ac-227	Pu-239	1.000E+00	0.000E+00	5.606E-16	1.170E-14	2.056E-13	1.336E-12	3.613E-12	3.876E-12	2.714E-12

BRF(i) is the branch fraction of the parent nuclide.

RESMAIN5.EXE execution time = 1.78 seconds

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Table A4.3.1
Non-PMJM Intake Estimates for Chromium in WBEU Surface Soils; Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.084	3.162	lnCm = -1.495 + 0.7326(lnCs)				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
31	Tier 1 UTL	2.60	98.0	2.78	0.019	
20.2	Tier 1 UCL	1.70	63.9	2.03	0.003	
14.6	Tier 2 UTL	1.23	46.2	1.60	0.019	
13.7	Tier 2 UCL	1.15	43.3	1.53	0.003	
Intake Parameters						
Receptor	$IR_{(food)}$ (kg/kg BW day)	$IR_{(water)}$ (kg/kg BW day)	$IR_{(soil)}$ (kg/kg BW day)	P_{plant}	P_{invert}	P_{mammal}
Mourning Dove - Herbivore	0.23	0.12	0.021	1	0	0
Mourning Dove - Insectivore	0.23	0.12	0.021	0	1	0
American Kestrel	0.092	0.12	0.005	0	0.2	0.8
Deer Mouse - Insectivore	0.065	0.19	0.001	0	1	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Mourning Dove - Herbivore						
Tier 1 UTL	0.599	N/A	N/A	0.663	0.00228	1.26
Tier 1 UCL	0.390	N/A	N/A	0.379	3.60E-04	0.823
Tier 2 UTL	0.282	N/A	N/A	0.312	0.00228	0.597
Tier 2 UCL	0.265	N/A	N/A	0.293	3.60E-04	0.558
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	22.5	N/A	0.663	0.00228	23.2
Tier 1 UCL	N/A	14.7	N/A	0.432	3.60E-04	15.1
Tier 2 UTL	N/A	10.6	N/A	0.312	0.00228	10.9
Tier 2 UCL	N/A	9.96	N/A	0.293	3.60E-04	10.3
American Kestrel						
Tier 1 UTL	N/A	1.80	0.204	0.143	0.00228	2.15
Tier 1 UCL	N/A	1.18	0.149	0.0929	3.60E-04	1.42
Tier 2 UTL	N/A	0.849	0.118	0.0672	0.00228	1.04
Tier 2 UCL	N/A	0.797	0.112	0.0630	7.20E-04	0.973
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	6.37	N/A	0.0403	0.00361	6.42
Tier 1 UCL	N/A	4.15	N/A	0.0263	5.70E-04	4.18
Tier 2 UTL	N/A	3.00	N/A	0.0190	0.00361	3.02
Tier 2 UCL	N/A	2.82	N/A	0.0178	0.00114	2.83

N/A = Not applicable.

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Table A4.3.2
Non-PMJM Intake Estimates for Chromium in WBEU Surface Soils; Alternative Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.041	0.306	lnCm = -1.495 + 0.7326(lnCs)				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
31	Tier 1 UTL	1.27	9.5	2.78	0.019	
20.2	Tier 1 UCL	0.73	5.4	1.84	0.003	
14.6	Tier 2 UTL	0.60	4.5	1.60	0.019	
13.7	Tier 2 UCL	0.56	4.2	1.53	0.003	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	$IR_{(water)}$ (kg/kg BW day)	$IR_{(soil)}$ (kg/kg BW day)	P_{plant}	P_{invert}	P_{mammal}
Mourning Dove - Herbivore	0.23	0.12	0.021	1	0	0
Mourning Dove - Insectivore	0.23	0.12	0.021	0	1	0
American Kestrel	0.092	0.12	0.005	0	0.2	0.8
Deer Mouse - Insectivore	0.065	0.19	0.001	0	1	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	2.18	N/A	0.663	0.00228	2.85
Tier 1 UCL	N/A	1.25	N/A	0.379	3.60E-04	1.85
Tier 2 UTL	N/A	1.03	N/A	0.312	0.00228	1.34
Tier 2 UCL	N/A	0.964	N/A	0.293	3.60E-04	1.26

N/A = Not applicable.

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Table A4.3.3
Non-PMJM Intake Estimates for Manganese in WBEU Surface Soils; Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.234	lnCi = 0.809 + 0.682(lnCs)	0.037				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
490	Tier 1 UTL	114.66	153.5	18.13	0.19	
336	Tier 1 UCL	78.39	118.4	12.40	0.093	
344	Tier 2 UTL	80.50	120.6	12.73	0.19	
319	Tier 2 UCL	74.65	114.5	11.80	0.093	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	**$IR_{(water)}$ (kg/kg BW day)**	**$IR_{(soil)}$ (kg/kg BW day)**	**P_{plant}**	**P_{invert}**	**P_{mammal}**
Deer Mouse - Herbivore	0.111	0.19	0.002	1	0	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Deer Mouse - Herbivore						
Tier 1 UTL	12.7	N/A	N/A	1.09	0.0361	13.9
Tier 1 UCL	8.73	N/A	N/A	0.746	0.0177	9.49
Tier 2 UTL	8.94	N/A	N/A	0.764	0.0361	9.73
Tier 2 UCL	8.29	N/A	N/A	0.708	0.0177	9.01

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Table A4.3.4
Non-PMJM Intake Estimates for Nickel in WBEU Surface Soils; Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
lnCp = -2.224+0.748(lnCs)	4.73	lnCm = -0.2462 + 0.4658(lnCs)				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
25.6	Tier 1 UTL	1.22	121.1	3.54	0.012	
16	Tier 1 UCL	0.86	75.2	2.84	0.008	
12.9	Tier 2 UTL	0.73	61.0	2.57	0.012	
12	Tier 2 UCL	0.69	56.8	2.49	0.008	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	$IR_{(water)}$ (kg/kg BW day)	$IR_{(soil)}$ (kg/kg BW day)	P_{plant}	P_{invert}	P_{mammal}
Mourning Dove - Insectivore	0.23	0.12	0.021	0	1	0
Deer Mouse - Herbivore	0.111	0.19	0.002	1	0	0
Deer Mouse - Insectivore	0.065	0.19	0.001	0	1	0
Coyote - Generalist	0.015	0.08	0.001	0	0.25	0.75
Coyote - Insectivore	0.015	0.08	0.0004	0	1	0
Intake Estimates (mg/kg B.W.day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	27.9	N/A	0.548	0.00144	28.4
Tier 1 UCL	N/A	17.3	N/A	0.340	9.60E-04	17.6
Tier 2 UTL	N/A	14.0	N/A	0.276	0.00144	14.3
Tier 2 UCL	N/A	13.1	N/A	0.257	9.60E-04	13.3
Deer Mouse - Herbivore						
Tier 1 UTL	0.136	N/A	N/A	0.0568	0.00228	0.195
Tier 1 UCL	0.0951	N/A	N/A	0.0353	0.00152	0.132
Tier 2 UTL	0.0813	N/A	N/A	0.0286	0.00228	0.112
Tier 2 UCL	0.0770	N/A	N/A	0.0266	0.00152	0.105
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	7.87	N/A	0.0333	0.00228	7.91
Tier 1 UCL	N/A	4.89	N/A	0.0207	0.00152	4.91
Tier 2 UTL	N/A	3.97	N/A	0.0168	0.00228	3.99
Tier 2 UCL	N/A	3.69	N/A	0.0156	0.00152	3.71
Coyote - Generalist						
Tier 1 UTL	N/A	0.454	0.0398	0.0192	9.60E-04	0.514
Tier 1 UCL	N/A	0.282	0.0319	0.0119	6.40E-04	0.326
Tier 2 UTL	N/A	0.229	0.0289	0.00968	9.60E-04	0.268
Tier 2 UCL	N/A	0.213	0.0280	0.00900	6.40E-04	0.250
Coyote - Insectivore						
Tier 1 UTL	N/A	1.82	N/A	0.0108	9.60E-04	1.83
Tier 1 UCL	N/A	1.13	N/A	0.00668	6.40E-04	1.14
Tier 2 UTL	N/A	0.915	N/A	0.00542	9.60E-04	0.922
Tier 2 UCL	N/A	0.851	N/A	0.00504	6.40E-04	0.857

N/A = Not applicable.

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Table A4.3.5
Non-PMJM Intake Estimates for Nickel in WBEU Surface Soils; Alternative Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
lnCp = -2.224+0.748(lnCs)	1.059	lnCm = -0.2462 + 0.4658(lnCs)				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
25.6	Tier 1 UTL	1.22	27.1	3.54	0.012	
16	Tier 1 UCL	0.86	16.8	2.84	0.008	
12.9	Tier 2 UTL	0.73	13.7	2.57	0.012	
12	Tier 2 UCL	0.69	12.7	2.49	0.008	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	$IR_{(water)}$ (kg/kg BW day)	$IR_{(soil)}$ (kg/kg BW day)	P_{plant}	P_{invert}	P_{mammal}
Mourning Dove - Insectivore	0.23	0.12	0.021	0	1	0
Deer Mouse - Herbivore	0.111	0.19	0.002	1	0	0
Deer Mouse - Insectivore	0.065	0.19	0.001	0	1	0
Coyote - Generalist	0.015	0.08	0.001	0	0.25	0.75
Coyote - Insectivore	0.015	0.08	0.0004	0	1	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	1.76	N/A	0.0333	0.00228	1.80
Tier 1 UCL	N/A	1.09	N/A	0.0207	0.00152	1.12
Tier 2 UTL	N/A	0.888	N/A	0.0168	0.00228	0.907
Tier 2 UCL	N/A	0.826	N/A	0.0156	0.00152	0.843

N/A = Not applicable.

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Table A4.3.6
Non-PMJM Intake Estimates for Tin in WBEU Surface Soils; Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.03	1	0.21				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
31	Tier 1 UTL	0.93	31.00	6.51	0.068	
14	Tier 1 UCL	0.42	13.90	2.92	0.047	
15.7	Tier 2 UTL	0.47	15.70	3.30	0.068	
13.8	Tier 2 UCL	0.41	13.80	2.90	0.047	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	$IR_{(water)}$ (kg/kg BW day)	$IR_{(soil)}$ (kg/kg BW day)	P_{plant}	P_{invert}	P_{mammal}
Mourning Dove - Herbivore	0.23	0.12	0.021	1	0	0
Mourning Dove - Insectivore	0.23	0.12	0.021	0	1	0
American Kestrel	0.092	0.12	0.005	0	0.2	0.8
Deer Mouse - Insectivore	0.065	0.19	0.001	0	1	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Mourning Dove - Herbivore						
Tier 1 UTL	0.214	N/A	N/A	0.663	0.00816	0.885
Tier 1 UCL	0.0959	N/A	N/A	0.297	0.00564	0.399
Tier 2 UTL	0.108	N/A	N/A	0.336	0.00816	0.452
Tier 2 UCL	0.0952	N/A	N/A	0.295	0.00564	0.396
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	7.13	N/A	0.663	0.00816	7.80
Tier 1 UCL	N/A	3.20	N/A	0.297	0.00564	3.50
Tier 2 UTL	N/A	3.61	N/A	0.336	0.00816	3.95
Tier 2 UCL	N/A	3.17	N/A	0.295	0.00564	3.47
American Kestrel						
Tier 1 UTL	N/A	0.570	0.479	0.143	0.00816	1.20
Tier 1 UCL	N/A	0.256	0.215	0.0639	0.00564	0.540
Tier 2 UTL	N/A	0.289	0.243	0.0722	0.00816	0.612
Tier 2 UCL	N/A	0.254	0.213	0.0635	0.00564	0.536
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	2.02	N/A	0.0403	0.0129	2.07
Tier 1 UCL	N/A	0.904	N/A	0.0181	0.00893	0.931
Tier 2 UTL	N/A	1.02	N/A	0.0204	0.0129	1.05
Tier 2 UCL	N/A	0.897	N/A	0.0179	0.00893	0.924

N/A = Not applicable.

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Table A4.3.7
Non-PMJM Intake Estimates for Bis(2-ethylhexyl)phthalate in WBEU Surface Soils; Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.15	34.9	28.81				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
0.395	Tier 1 UTL	0.06	13.8	11.38	0	
0.224	Tier 1 UCL	0.03	7.8	6.45	0	
0.2	Tier 2 UTL	0.03	7.0	5.76	0	
0.188	Tier 2 UCL	0.03	6.6	5.42	0	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	$IR_{(water)}$ (kg/kg BW day)	$IR_{(soil)}$ (kg/kg BW day)	P_{plant}	P_{invert}	P_{mammal}
Mourning Dove - Insectivore	0.23	0.12	0.021	0	1	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	3.17	N/A	0.00845	0	3.18
Tier 1 UCL	N/A	1.80	N/A	0.00479	0	1.80
Tier 2 UTL	N/A	1.61	N/A	0.00428	0	1.61
Tier 2 UCL	N/A	1.51	N/A	0.00402	0	1.51

N/A = Not applicable.

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Table A4.3.8
Non-PMJM Intake Estimates for Endrin in WBEU Surface Soils; Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.32	31.1	28.49				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
0.0105	Tier 1 UTL	0.00	0.3	0.30	0	
0.0093	Tier 1 UCL	0.00	0.3	0.26	0	
0.01	Tier 2 UTL	0.00	0.3	0.28	0	
0.0097	Tier 2 UCL	0.00	0.3	0.28	0	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	$IR_{(water)}$ (kg/kg BW day)	$IR_{(soil)}$ (kg/kg BW day)	P_{plant}	P_{invert}	P_{mammal}
Mourning Dove - Insectivore	0.23	0.12	0.021	0	1	0
American Kestrel	0.092	0.12	0.005	0	0.2	0.8
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	0.0751	N/A	2.25E-04	0	0.0753
Tier 1 UCL	N/A	0.0665	N/A	1.99E-04	0	0.0667
Tier 2 UTL	N/A	0.0715	N/A	2.14E-04	0	0.0717
Tier 2 UCL	N/A	0.0694	N/A	2.07E-04	0	0.0696
American Kestrel						
Tier 1 UTL	N/A	0.00601	0.0220	4.83E-05	0	0.0281
Tier 1 UCL	N/A	0.00532	0.0195	4.28E-05	0	0.0249
Tier 2 UTL	N/A	0.00572	0.0210	4.60E-05	0	0.0267
Tier 2 UCL	N/A	0.00555	0.0203	4.46E-05	0	0.0259

N/A = Not applicable.

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Table A4.3.9
Non-PMJM Intake Estimates for Total PCBs in WBEU Surface Soils; Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.25	lnCe = 1.41 + 1.361(lnCs)	28.79				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
0.38	Tier 1 UTL	0.10	1.1	10.94	0	
0.449	Tier 1 UCL	0.11	1.4	12.93	0	
0.223	Tier 2 UTL	0.06	0.5	6.42	0	
0.204	Tier 2 UCL	0.05	0.5	5.87	0	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	$IR_{(water)}$ (kg/kg BW day)	$IR_{(soil)}$ (kg/kg BW day)	P_{plant}	P_{invert}	P_{mammal}
Mourning Dove - Insectivore	0.23	0.12	0.021	0	1	0
American Kestrel	0.092	0.12	0.005	0	0.2	0.8
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	0.252	N/A	0.00813	0	0.261
Tier 1 UCL	N/A	0.317	N/A	0.00960	0	0.326
Tier 2 UTL	N/A	0.122	N/A	0.00477	0	0.127
Tier 2 UCL	N/A	0.108	N/A	0.00436	0	0.113
American Kestrel						
Tier 1 UTL	N/A	0.0202	0.108	0.00175	0	0.130
Tier 1 UCL	N/A	0.0253	0.111	0.00207	0	0.138
Tier 2 UTL	N/A	0.00978	0.102	0.00103	0	0.113
Tier 2 UCL	N/A	0.00866	0.101	9.38E-04	0	0.110

N/A = Not applicable.

Table A4.3.10
Terrestrial Plant and Invertebrate Hazard Quotients for Surface Soils in the WBEU - Chromium

Receptor/ EPC Statistic	Concentration (mg/kg)	TRV (mg/kg)			Hazard Quotients		
		Screening ESL	Alternate NOEC	Alternate LOEC	Screening ESL	Alternate NOEC	Alternate LOEC
Terrestrial Plant							
Tier 1 UTL	31	1.00	10.0	30.0	**31**	**3**	1
Tier 1 UCL	20.2	1.00	10.0	30.0	**20**	**2**	0.7
Tier 2 UTL	14.6	1.00	10.0	30.0	**15**	1	0.5
Tier 2 UCL	13.7	1.00	10.0	30.0	**14**	1	0.5
Terrestrial Invertebrate							
Tier 1 UTL	31	0.400	N/A	32.6	**78**	N/A	0.9
Tier 1 UCL	20.2	0.400	N/A	32.6	**51**	N/A	0.6
Tier 2 UTL	14.6	0.400	N/A	32.6	**37**	N/A	0.4
Tier 2 UCL	13.7	0.400	N/A	32.6	**34**	N/A	0.4

Bold = Hazard quotients>1.
N/A = Not applicable.

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Table A4.3.11
Non-PMJM Hazard Quotients for Surface Soils in the WBEU - Chromium

Receptor/ EPC Statistic		TRV (mg/kg BW day)				Hazard Quotients			
	Total Intake (mg/kg BW day)	Chromium (VI) NOAEL	Chromium VI LOAEL	Chromium (III) NOAEL	Chromium III LOAEL	Chromium (VI) NOAEL	Chromium (VI) LOAEL	Chromium (III) NOAEL	Chromium (III) LOAEL
Chromium (Default Exposure)									
Mourning Dove - Herbivore									
Tier 1 UTL	1.26	N/A	N/A	1	5	N/A	N/A	**1.3**	0.3
Tier 1 UCL	0.823	N/A	N/A	1	5	N/A	N/A	0.8	0.2
Tier 2 UTL	0.597	N/A	N/A	1	5	N/A	N/A	0.6	0.1
Tier 2 UCL	0.558	N/A	N/A	1	5	N/A	N/A	0.6	0.1
Mourning Dove - Insectivore									
Tier 1 UTL	23.2	N/A	N/A	1	5	N/A	N/A	**23**	**5**
Tier 1 UCL	15.1	N/A	N/A	1	5	N/A	N/A	**15**	**3**
Tier 2 UTL	10.9	N/A	N/A	1	5	N/A	N/A	**11**	**2**
Tier 2 UCL	10.3	N/A	N/A	1	5	N/A	N/A	**10**	**2**
American Kestrel									
Tier 1 UTL	2.15	N/A	N/A	1	5	N/A	N/A	**2**	0.4
Tier 1 UCL	1.42	N/A	N/A	1	5	N/A	N/A	1	0.3
Tier 2 UTL	1.04	N/A	N/A	1	5	N/A	N/A	1	0.2
Tier 2 UCL	0.973	N/A	N/A	1	5	N/A	N/A	1	0.2
Deer Mouse - Insectivore									
Tier 1 UTL	6.42	3.28	13.1	2,737	N/A	2	0.5	0.002	N/A
Tier 1 UCL	4.18	3.28	13.1	2,737	N/A	1	0.3	0.002	N/A
Tier 2 UTL	3.02	3.28	13.1	2,737	N/A	0.9	0.2	0.001	N/A
Tier 2 UCL	2.83	3.28	13.1	2,737	N/A	0.9	0.2	0.001	N/A
Chromium (Alternative Exposure Scenario; Median BAFs)									
Mourning Dove - Insectivore									
Tier 1 UTL	2.85	N/A	N/A	1	5	N/A	N/A	**3**	0.6
Tier 1 UCL	1.85	N/A	N/A	1	5	N/A	N/A	**2**	0.4
Tier 2 UTL	1.34	N/A	N/A	1	5	N/A	N/A	1	0.3
Tier 2 UCL	1.26	N/A	N/A	1	5	N/A	N/A	1	0.3

N/A = Not applicable.

Bold = Hazard Quotients greater than 1.

Table A4.3.12
Non-PMJM Hazard Quotients for Surface Soils in the WBEU - Manganese

Receptor/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)		Hazard Quotients	
		NOAEL	LOAEL	NOAEL	LOAEL
Manganese (Default Exposure)					
Deer Mouse - Herbivore					
Tier 1UTL	13.9	13.3	159	1	0.09
Tier 1 UCL	9.46	13.3	159	0.7	0.06
Tier 2 UTL	9.73	13.3	159	0.7	0.06
Tier 2 UCL	9.01	13.3	159	0.7	0.06

N/A = Not applicable.

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Table A4.3.13

Non-PMJM Hazard Quotients for Surface Soils in the WBEU - Nickel

Receptor/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)					Hazard Quotients				
		NOAEL	Threshold	LOAEL	Sample et al. (1996) NOAEL	Sample et al. (1996) LOAEL	NOAEL	Threshold	LOAEL	Sample et al. (1996) NOAEL	Sample et al. (1996) LOAEL
Nickel (Default Exposure)											
Mourning Dove - Insectivore											
Tier 1 UTL	28.4	1.38	8.70	55.3	77.4	107	**21**	**3**	0.5	0.4	0.3
Tier 1 UCL	17.6	1.38	8.70	55.3	77.4	107	**13**	**2**	0.3	0.2	0.2
Tier 2 UTL	14.3	1.38	8.70	55.3	77.4	107	**10**	**2**	0.3	0.2	0.1
Tier 2 UCL	13.3	1.38	8.70	55.3	77.4	107	**10**	**2**	0.2	0.2	0.1
Deer Mouse - Herbivore											
Tier 1 UTL	0.195	0.133	N/A	1.33	40	80	1	N/A	0.1	0.005	0.002
Tier 1 UCL	0.132	0.133	N/A	1.33	40	80	1	N/A	0.1	0.003	0.002
Tier 2 UTL	0.112	0.133	N/A	1.33	40	80	0.8	N/A	0.1	0.003	0.001
Tier 2 UCL	0.105	0.133	N/A	1.33	40	80	0.8	N/A	0.1	0.003	0.001
Deer Mouse - Insectivore											
Tier 1 UTL	7.91	0.133	N/A	1.33	40	80	**59**	N/A	**6**	0.2	0.1
Tier 1 UCL	4.91	0.133	N/A	1.33	40	80	**37**	N/A	**4**	0.1	0.1
Tier 2 UTL	3.99	0.133	N/A	1.33	40	80	**30**	N/A	**3**	0.1	0.05
Tier 2 UCL	3.71	0.133	N/A	1.33	40	80	**28**	N/A	**3**	0.1	0.05
Coyote - Generalist											
Tier 1 UTL	0.514	0.133	N/A	1.33	40	80	**4**	N/A	0.4	0.01	0.01
Tier 1 UCL	0.326	0.133	N/A	1.33	40	80	**2**	N/A	0.2	0.01	0.004
Tier 2 UTL	0.268	0.133	N/A	1.33	40	80	**2**	N/A	0.2	0.01	0.003
Tier 2 UCL	0.250	0.133	N/A	1.33	40	80	**2**	N/A	0.2	0.01	0.003
Coyote - Insectivore											
Tier 1 UTL	1.83	0.133	N/A	1.33	40	80	**14**	N/A	1	0.05	0.02
Tier 1 UCL	1.14	0.133	N/A	1.33	40	80	**9**	N/A	0.9	0.03	0.01
Tier 2 UTL	0.922	0.133	N/A	1.33	40	80	**7**	N/A	0.7	0.02	0.01
Tier 2 UCL	0.857	0.133	N/A	1.33	40	80	**6**	N/A	0.6	0.02	0.01
Nickel (Alternative Exposure Scenario, Median BAFs)											
Deer Mouse - Insectivore											
Tier 1 UTL	1.80	0.133	N/A	1.33	40	80	**14**	N/A	1	0.04	0.02
Tier 1 UCL	1.12	0.133	N/A	1.33	40	80	**8**	N/A	0.8	0.03	0.01
Tier 2 UTL	0.907	0.133	N/A	1.33	40	80	**7**	N/A	0.7	0.02	0.01
Tier 2 UCL	0.843	0.133	N/A	1.33	40	80	**6**	N/A	0.6	0.02	0.01

N/A = Not applicable.

Bold = Hazard Quotients greater than 1.

Table A4.3.14

Terrestrial Plant Hazard Quotients for Surface Soils in the WBEU - Silver

Receptor/ EPC Statistic	Concentration (mg/kg)	TRV (mg/kg)	Hazard Quotients
		Screening ESL	Screening ESL
Terrestrial Plant			
Tier 1 UTL	2.6	2	1
Tier 1 UCL	3.51	2	**2**
Tier 2 UTL	1.42	2	0.7
Tier 2 UCL	1.17	2	0.6

Bold = Hazard Quotient greater than 1.

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Table A4.3.15
Terrestrial Plant Hazard Quotients for Surface Soils in the WBEU - Thallium

Receptor/ EPC Statistic	Concentration (mg/kg)	TRV (mg/kg)	Hazard Quotients
		Screening ESL	Screening ESL
Terrestrial Plant			
Tier 1 UTL	1.1	1	1
Tier 1 UCL	0.556	1	0.6
Tier 2 UTL	0.328	1	0.3
Tier 2UCL	0.387	1	0.4

Table A4.3.16
Non-PMJM Hazard Quotients for Surface Soils in the WBEU - Tin

Receptor/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)		Hazard Quotients	
		NOAEL	LOAEL	NOAEL	LOAEL
Tin (Default Exposure)					
Mourning Dove - Herbivore					
Tier 1 UTL	0.885	0.730	18.3	1	0.05
Tier 1 UCL	0.399	0.730	18.3	0.5	0.02
Tier 2 UTL	0.452	0.730	18.3	0.6	0.02
Tier 2 UCL	0.396	0.730	18.3	0.5	0.02
Mourning Dove - Insectivore					
Tier 1 UTL	7.80	0.730	18.3	**11**	0.4
Tier 1 UCL	3.50	0.730	18.3	**5**	0.2
Tier 2 UTL	3.95	0.730	18.3	**5**	0.2
Tier 2 UCL	3.47	0.730	18.3	**5**	0.2
American Kestrel					
Tier 1 UTL	1.20	0.730	18.3	**2**	0.1
Tier 1 UCL	0.540	0.730	18.3	0.7	0.03
Tier 2 UTL	0.612	0.730	18.3	0.8	0.03
Tier 2 UCL	0.536	0.730	18.3	0.7	0.03
Deer Mouse - Insectivore					
Tier 1 UTL	2.07	0.250	15	**8**	0.1
Tier 1UCL	0.931	0.250	15	**4**	0.06
Tier 2 UTL	1.05	0.250	15	**4**	0.07
Tier 2 UCL	0.924	0.250	15	**4**	0.06

Bold = Hazard Quotients greater than 1.

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Table A4.3.17

Non-PMJM Hazard Quotients for Surface Soils in the WBEU - Bis(2-ethylhexyl)phthalate

Receptor/ EPC Statistic	Total Intake	TRV (mg/kg BW day) NOAEL	TRV (mg/kg BW day) LOAEL	Hazard Quotients NOAEL	Hazard Quotients LOAEL
Bis(2-ethylhexyl)phthalate (Default Exposure)					
Mourning Dove - Insectivore					
Tier 1 UTL	3.18	1.10	214	**3**	0.01
Tier 1 UCL	1.80	1.10	214	**2**	0.008
Tier 2 UTL	1.61	1.10	214	1	0.008
Tier 2 UCL	1.51	1.10	214	1	0.007

Bold = Hazard quotients greater than 1.

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Table A4.3.18
Non-PMJM Hazard Quotients for Surface Soils in the WBEU - Endrin

Receptor/ EPC Statistic	Total Intake	TRV (mg/kg BW day) NOAEL	Threshold	LOAEL	Hazard Quotients NOAEL	Threshold	LOAEL
Endrin (Default Exposure)							
Mourning Dove - Insectivore							
Tier 1 UTL	0.0753	0.0100	N/A	0.100	**8**	N/A	0.8
Tier 1 UCL	0.0667	0.0100	N/A	0.100	**7**	N/A	0.7
Tier 2 UTL	0.0717	0.0100	N/A	0.100	**7**	N/A	0.7
Tier 2 UCL	0.0696	0.0100	N/A	0.100	**7**	N/A	0.7
American Kestrel							
Tier 1 UTL	0.0281	0.0100	N/A	0.100	**3**	N/A	0.3
Tier 1 UCL	0.0249	0.0100	N/A	0.100	**2**	N/A	0.2
Tier 2 UTL	0.0267	0.0100	N/A	0.100	**3**	N/A	0.3
Tier 2 UCL	0.0259	0.0100	N/A	0.100	**3**	N/A	0.3

N/A = Not applicable.

Bold = Hazard quotients greater than 1.

Table A4.3.19

Non-PMJM Hazard Quotients for Surface Soils in the WBEU - Total PCBs

Receptor/EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)			Hazard Quotients		
		NOAEL	Threshold	LOAEL	NOAEL	Threshold	LOAEL
PCB (Total) (Default Exposure)							
Mourning Dove - Insectivore							
Tier 1 UTL	0.261	0.0900	N/A	1.27	**3**	N/A	0.2
Tier 1 UCL	0.326	0.0900	N/A	1.27	**4**	N/A	0.3
Tier 2 UTL	0.127	0.0900	N/A	1.27	1	N/A	0.10
Tier 2 UCL	0.113	0.0900	N/A	1.27	1	N/A	0.09
American Kestrel							
Tier 1 UTL	0.827	0.0900	N/A	1.27	**1**	N/A	0.1
Tier 1 UCL	0.979	0.0900	N/A	1.27	**2**	N/A	0.1
Tier 2 UTL	0.483	0.0900	N/A	1.27	**1**	N/A	0.09
Tier 2 UCL	0.442	0.0900	N/A	1.27	**1**	N/A	0.09

N/A = Not applicable.

Bold = Hazard quotients greater than 1.

COMPREHENSIVE RISK ASSESSMENT

WIND BLOWN AREA EXPOSURE UNIT

VOLUME 9: ATTACHMENT 5

Chemical-Specific Uncertainty Analysis

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ACRONYMS AND ABBREVIATIONS

BAF	bioaccumulation factor
CMS	Corrective Measures Study
CRA	Comprehensive Risk Assessment
DOE	U.S. Department of Energy
ECOI	ecological contaminant of interest
ECOPC	ecological contaminant of potential concern
EcoSSL	Ecological Soil Screening Level
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ESL	ecological screening level
HQ	hazard quotient
LOAEL	lowest observed adverse effect level
LOEC	lowest observed effect concentration
mg/kg	milligrams per kilogram
NOAEL	no observed adverse effect level
NOEC	no observed effect concentration
PCB	polychlorinated biphenyl
PMJM	Preble's meadow jumping mouse
RCRA	Resource Conservation and Recovery Act
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
TRV	toxicity reference value
UCL	upper confidence limit
UTL	upper tolerance limit

1.0 INTRODUCTION

One potential limitation of the hazard quotient (HQ) approach is that calculated HQ values may sometimes be uncertain due to simplifications and assumptions in the underlying exposure and toxicity data used to derive the HQs. Where possible, this risk assessment provides information on two potential sources of uncertainty, described below.

- **Bioaccumulation Factors (BAFs).** For wildlife receptors, concentrations of contaminants in dietary items were estimated from surface soil using uptake equations. When the uptake equation was based on a simple linear model (e.g., $C_{tissue} = BAF * C_{soil}$), the default exposure scenario used a high-end estimate of the BAF (the 90th percentile BAF). However, the use of high-end BAFs may tend to overestimate tissue concentrations in some dietary items. If necessary, to estimate more typical tissue concentrations, an alternative exposure scenario calculated total chemical intake using a 50th percentile (median) BAF. The use of the median BAF is consistent with the approach used in the U.S. Environmental Protection Agency (EPA) ecological soil screening level (EcoSSL) guidance (EPA 2005).
- **Toxicity Reference Values (TRVs).** The Final Comprehensive Risk Assessment (CRA) Work Plan and Methodology (DOE 2004), hereafter referred to as the CRA Methodology, used an established hierarchy to identify the most appropriate default TRVs for use in the ecological contaminant of potential concern (ECOPC) selection. However, in some instances, the default TRV selected may be overly conservative with regard to characterizing population-level risks. The determination of whether the default TRVs are thought to yield overly conservative estimates of risk is addressed in the uncertainty sections below on a chemical-by-chemical basis. If lowest observed adverse effect level (LOAEL) HQs greater than 1 were calculated using the default HQ calculations and an alternative TRV is identified, the chemical-specific uncertainty sections provide a discussion of why the alternative TRV is thought to be appropriate to provide an alternative estimate of toxicity (e.g., endpoint relevance, species relevance, data quality, chemical form, etc.), and HQs were calculated using both default and alternative TRVs.

The influences of each of these uncertainties on the calculated HQs are discussed for each ECOPC in the following subsections.

1.1 Chromium

Bioaccumulation Factors

There are several important uncertainties associated with the intake and HQ calculations for vertebrate receptors. Chromium has two types of bioaccumulation factors used in the intake calculations. For the soil-to-small mammal BAF, a regression equation was used to estimate tissue concentrations. Confidence placed in this value is high; however, uncertainty is unavoidable when using even high-quality models to predict tissue

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concentrations. In cases without available measurements of tissue concentrations, regression-based models are generally the best available predictor of tissue concentrations. However, the regression-based BAFs may still overestimate or underestimate tissue concentrations of chromium to an unknown degree.

The soil-to-invertebrate and soil-to-plant BAFs used to estimate invertebrate tissue concentrations are both based on screening-level upper-bound (90th percentile) BAFs presented in Sample et al. (1998a) and ORNL (1998). These values provide conservative estimates of uptake from soils to invertebrate and plant tissues. This conservative estimate may serve to overestimate chromium concentrations in tissues. For this reason, the median BAFs presented in the same documents were used as alternative BAFs to estimate invertebrate and plant tissue concentrations as recommended in USEPA EcoSSL guidance (EPA 2005). It is unclear whether the use of median BAFs reduces the uncertainty involved in the estimation of invertebrate tissue concentrations, but the likelihood of overestimation of risks is reduced.

Toxicity Reference Values

For terrestrial plants, the summary of chromium toxicity in Efroymson et al. (1997a) places low confidence in the value because there are no primary reference data showing toxicity to plants and the basis for the no observed effect concentration (NOEC) ecological screening level (ESL) is not discussed in the document. The document simply notes that confidence in the values is low due to the small number of studies on which it was based. Efroymson et al. (1997a) also provides plant toxicity values from Turner and Rust (1971) that are based on growth effects on plants grown in loamy soils. No effects to plant growth were noted at 10 milligrams per kilogram (mg/kg) while shoot weight was reduced by 30 percent at chromium concentrations equal to 30 mg/kg. Uncertainty is high using the alternative values but reduced from the unspecified and unsupported 1 mg/kg value used as the ESL.

For terrestrial invertebrates, the ESL is based on survival effects to earthworms exposed to hexavalent chromium (chromium VI). Severe effects on survival were noted at 2 mg/kg chromium VI. The 0.4 mg/kg ESL was calculated by Efroymson et al. (1997b) by dividing be a safety factor of 5. There is some uncertainty in the chromium VI TRV because trivalent chromium (chromium III) is the most prevalent form of inorganic chromium found in soils (Kabata-Pendias 2002) and chromium VI was rarely detected when sampled for anywhere at Rocky Flats Environmental Technology Site (RFETS). This introduces uncertainty into the TRV selection process as chromium VI is regarded as the more toxic form of chromium. Efroymson et al. (1997b) also provide data for a lowest observed effect concentration (LOEC) where growth to earthworms was reduced by 30 percent at 32.6 mg/kg of chromium III. The alternative chromium III LOEC provides a useful alternative estimate of toxicity based on a more applicable estimate of chromium III toxicity.

The NOAEL and LOAEL TRVs for birds were obtained from Sample et al. (1996). The mammalian TRV was based on effects from chromium VI, while the bird TRV was based on effects from chromium III.

The NOAEL TRV for chromium VI represents a dose at which no effects to the survival of ducks were noted. The LOAEL TRV represents a dose rate at which an a decrease in survivability was noted in the same study. No threshold TRV was calculated in the CRA Methodology, and one is not identified here. Therefore, the threshold for chromium VI toxicity lies somewhere between the NOAEL and LOAEL, but the actual intake rate is uncertain.

There is some uncertainty in the chromium VI TRV because chromium III is the most prevalent form of inorganic chromium found in soils (Kabata-Pendias 2002) and chromium VI was rarely detected when sampled for anywhere at RFETs. This introduces uncertainty into the TRV selection process as chromium VI is regarded as the more toxic form of chromium (IRIS 2005). The bird TRVs are based on mortality effects in black ducks and are based on chromium II toxicity. These values are based on appropriate endpoints and uncertainty in them is considered low. No alternative TRVs were identified for chromium III and none were available for chromium VI.

NOAEL and LOAEL TRVs for chromium VI were available for estimating risk to mammals. Only an NOAEL TRV was available for assessing risks to mammals from exposure to chromium III. All of the mammalian TRVs were obtained from Sample et al. (1996) and relate to reproduction and mortality endpoints. Both the chromium VI and chromium III TRVs were used in the default analysis. As discussed above for birds, the use of the chromium VI TRV is likely to overestimate risks. The chromium VI NOAEL is less than the chromium III NOAEL by three orders of magnitude for similar endpoints. Care should be taken when reviewing the HQs calculated using the chromium VI TRVs. Uncertainty is also introduced into the risk estimates due to the lack of a LOAEL TRV for chromium. Because both TRVs were based on acceptable endpoints, no alternative TRVs were identified.

Background Risks

Chromium was detected in RFETS background surface soils. Because risks are generally not expected at naturally occurring background levels, it is important to calculate the risks that would be predicted at naturally occurring concentrations using the same assumptions and models as used in the CRA. This provides information necessary to gauge the predictive ability of the risk assessment models used in the CRA. In addition, risks calculated using background data can provide additional information on the magnitude of potentially site-related risks.

Risks to the terrestrial plants, terrestrial invertebrates, mourning dove (herbivore and insectivore), American kestrel, deer mouse (insectivore), and Preble's meadow jumping mouse (PMJM) were calculated using both the upper confidence limit (UCL) and upper tolerance limit (UTL) of background soils. No observed adverse effect level (NOAEL) HQs greater than 1 were calculated for terrestrial plants, terrestrial invertebrates, and mourning dove (insectivore) with both the UCL and UTL exposure point concentrations (EPCs). NOAEL HQs for terrestrial plants equaled 17 using the UTL while those calculated for terrestrial invertebrates equaled 42. Both NOAEL and LOAEL HQs greater than 1 were calculated for the mourning dove (insectivore). The LOAEL HQ equaled 3 using the UTL EPC. No LOAEL TRVs were available for terrestrial plants or

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invertebrates. These results suggest that since potentially significant risks are not typically expected at normal background levels, risks using the default HQ calculations may be overpredicted. Site-specific background concentrations of chromium do not appear to be elevated as the maximum detected concentration in background surface soil samples equaled 16.9 mg/kg which is lower than the mean concentration of chromium in Colorado and bordering states as discussed in Attachment 3. These uncertainties should be considered in risk management decisions.

1.2 Manganese

Bioaccumulation Factors

There are several important uncertainties associated with the intake and HQ calculations for vertebrate receptors. Manganese has two types of bioaccumulation factors used in the intake calculations. For the soil-to-invertebrate BAF, a regression equation was used to estimate tissue concentrations. Confidence placed in this value is high; however, uncertainty is unavoidable when using even high-quality models to predict tissue concentrations. In cases without available measurements of tissue concentrations, regression-based models are generally the best available predictor of tissue concentrations. However, the regression-based BAFs may still overestimate or underestimate invertebrate tissue concentrations of manganese to an unknown degree.

The soil-to-plant and soil-to-small mammal BAFs used to estimate tissue concentrations are based on screening-level, upper-bound (90th percentile) BAFs presented in ORNL (1998) and Sample et al. (1998b). These values provide conservative estimates of uptake from soils to tissues. This conservative estimate may serve to overestimate manganese concentrations in plant and small mammal tissues. For this reason, the median BAFs presented in the same document were used as alternative BAFs to estimate tissue concentrations. It is unclear whether the use of median BAFs reduces the uncertainty involved in the estimation of plant and small mammal tissue concentrations, but the likelihood of overestimation of risks is reduced. In addition, the conservative nature of the upper-bound soil-to-plant BAF directly affects the conservatisms in the soil-to-small mammal BAF that uses both the soil-to-plant and soil-to-invertebrate BAFs in its calculation. It is unclear to what degree and direction that uncertainty can be estimated for the soil-to-small mammal BAF, but the uncertainty associated with the estimated small mammal tissue concentrations is high.

Toxicity Reference Values

The NOAEL and LOAEL TRVs for mammalian receptors were obtained from PRC (1994), a CRA Methodology-approved source of TRVs. The LOAEL TRV represents an intake rate at which a decrease in testical weight in mice was noted. The NOAEL TRV was taken from the same study and represents an intake rate at which no effects on testicular weight were noted. No threshold TRV was identified in the CRA Methodology, so it is unknown where the threshold for effects lies at intake rates lower than the LOAEL TRV. In addition, no relationship appears to have been identified between decreased testicular weight to reductions in reproductive success. This introduces some uncertainty into the risk assessment. However, because the endpoint for the LOAEL TRV is based on potential reproductive effects, the uncertainty is likely to be limited. Risks predicted by the LOAEL TRV may be overestimated, but the degree of uncertainty is low.

Background Risks

Manganese was detected in RFETS background surface soils. Because risks are generally not expected at naturally occurring background levels, it is important to calculate the risks that would be predicted at naturally occurring concentrations using the same assumptions and models as used in the CRA. This provides information necessary to gauge the predictive ability of the risk assessment models used in the CRA. In addition, risks calculated using background data can provide additional information on the magnitude of potentially site-related risks.

Risks to all receptors were calculated using both the UCL and UTL of background soils. NOAEL HQs greater than 1 were calculated for the mourning dove (herbivore and insectivore). NOAEL HQs equaled 5 and 4 respectively when calculated using the background UTL as the ECP. No HQs greater than 1 were calculated for any receptor using LOAEL TRVs.

1.3 Nickel

Bioaccumulation Factors

There are several important uncertainties associated with the intake and HQ calculations for vertebrate receptors. Nickel has two types of bioaccumulation factors used in the intake calculations. For the soil-to-plant and soil-to-small mammal BAFs, regression equations were used to estimate tissue concentrations. Confidence placed in these values is high; however, uncertainty is unavoidable when using even high-quality models to predict tissue concentrations. In cases without available measurements of tissue concentrations, regression-based models are generally the best available predictor of tissue concentrations. However, the regression-based BAFs may still overestimate or underestimate tissue concentrations of nickel to an unknown degree.

The soil-to-invertebrate BAF used to estimate invertebrate tissue concentrations is based on a screening-level upper bound (90th percentile) BAF presented in Sample et al. (1998a). This value provides a conservative estimate of uptake from soils to invertebrate tissues. This conservative estimate may serve to overestimate nickel concentrations in invertebrate tissues. For this reason, the median BAF presented in the same document (Sample et al. 1998b) can be used as an alternative BAF to estimate invertebrate tissue concentrations.

It is unclear whether the use of median BAFs reduces the uncertainty involved in the estimation of invertebrate tissue concentrations, but the likelihood of overestimation of risks is reduced.

Toxicity Reference Values

Uncertainty is also present in the TRVs used in the default HQ calculations for nickel. The NOAEL-based ESL calculated for the deer mouse (insectivore) was equal to 0.431 mg/kg, a concentration less than all site-specific background samples (minimum

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background concentration = 3.8 mg/kg). The NOAEL TRV used to calculate the ESL was estimated from the LOAEL TRV in the CRA Methodology by dividing by a factor of 10. The LOAEL TRV for mammals (1.33 mg/kg/receptor body weight [BW]/day) is based on pup mortality in rats. Given that the LOAEL TRV is 10 times the NOAEL TRV, a back-calculated soil concentration using the LOAEL TRV equals 3.8 mg/kg. This concentration is equal to the minimum detected concentration of nickel in background soils and would be exceeded by 19 of the 20 site-specific background soil concentrations. Because risks to ecological receptors are not generally expected in background areas, this indicates that the default TRVs used to calculate risks for mammals in general, and the deer mouse (insectivore) specifically, are too conservative, and risks are over-predicted when using these TRVs.

For avian receptors, there is also uncertainty in the quality of the TRVs selected in the CRA Methodology to predict population-level effects to birds at RFETS. The TRVs selected by PRC (1994) relate to the prediction of edema and swelling in leg and foot joints in mallard ducks. The CRA Methodology noted that the nature of the effect predicted by the LOAEL TRV is not likely to cause significant effects on growth, reproduction, or survival in birds and, subsequently, calculated a threshold TRV. The threshold TRV represents an estimate of the point between the NOAEL and LOAEL TRVs where effects related to the LOAEL TRV may begin to occur. This point is uncertain, and it is impossible to accurately estimate where the threshold for effects lies. Therefore, the calculation of the threshold TRV may overestimate or underestimate the calculated risks by a degree less than half of the difference between the NOAEL and LOAEL TRVs. In addition, the ability of the LOAEL TRV endpoint to predict effects to populations of avian receptors at RFETS under the assessment endpoints used in this CRA is also uncertain. The effect that swelling of leg and toe joints in birds has on population-level endpoints is unclear, and risk estimations are likely to be conservative and over-predict risks related to the assessment endpoints.

The CRA Methodology prescribed a hierarchy of TRV sources from which TRVs could be identified and used without modification. TRVs were selected first from EPA EcoSSL guidance (EPA 2003) from which no nickel TRVs were available. The second Tier TRV source was PRC (1994), from which the LOAEL TRV was obtained and the NOAEL TRV was estimated. Because this value appears to be overly-conservative, the third Tier TRV source (Sample et al. 1996) was reviewed for a usable TRV. Sample et al. (1996) presents TRVs for birds and mammals.

The use of these alternative risk calculations serves to provide an estimate of risk using a reasonable, yet reduced, level of conservatism for all receptors and a reduction of uncertainty (to an unknown extent) for the mourning dove (insectivore) receptor.

Background Risks

Nickel was detected in RFETS background surface soils. Because risks are generally not expected at naturally occurring background levels, it is important to calculate the risks that would be predicted at naturally occurring concentrations using the same assumptions and models as used in the CRA. This provides information necessary to gauge the predictive ability of the risk assessment models used in the CRA. In addition, risks calculated using background data can provide additional information on the magnitude of potentially site-related risks.

Risks to the PMJM, deer mouse (insectivore and herbivore), coyote (generalist and insectivore), and mourning dove (insectivore) were calculated using both the UCL and UTL of background soils and default NOAEL, threshold (mourning dove only), and LOAEL TRVs.

NOAEL HQs greater or equal to 1 for all receptors were calculated using both the UCL and UTL background surface soil concentrations. NOAEL HQs ranged from 1 for the deer mouse (herbivore) to 27 for the PMJM. LOAEL HQs were less than 1 for the deer mouse (herbivore), mourning dove (insectivore), and both coyote receptors but greater than 1 for the PMJM (HQ = 3), deer mouse (insectivore) (HQ = 3). These results suggest that since potentially significant risks are not typically expected at normal background concentrations that risks using the default HQ calculations may be over-predicted. Site-specific background concentrations of nickel do not appear to be elevated as the maximum detected concentration in background surface samples equaled 14.0 mg/kg which is lower than the mean concentration of nickel in Colorado and bordering states (18.8 mg/kg) as discussed in Attachment 3. These uncertainties should be considered in risk management decisions.

1.4 Silver

Plant Toxicity

The summary of silver toxicity in Efroymson et al. (1997a) places low confidence in the value because there are no primary reference data showing toxicity to plants, and the NOAEL ESL value is based on unspecified toxic effects. The only alternative TRV available in the literature was an ESL soil screening benchmark from EPA Region 5. Low confidence is also placed in the alternative values because no effects are specified. The uncertainty associated with the lack of toxicity data for terrestrial plants is high. It is unclear whether risks are overestimated or underestimated by using the default or alternative toxicity values but overestimation is the more likely scenario because both are termed screening levels and represent unclear effects.

Background Risk Calculations

Silver was not detected in background surface soils. Therefore, background risks were not calculated for thallium in Appendix A, Volume 2, Attachment 9 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation/Corrective Measures Study (CMS)-Feasibility Study (RI/FS) Report (hereafter referred to as the RI/FS Report).

1.5 Thallium

Plant Toxicity

The summary of thallium toxicity in Efroymson et al. (1997a) places low confidence in the value because the NOAEL ESL value is based on unspecified toxic effects. The only alternative TRV that could be located was the same as the default value. The uncertainty

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associated with the lack of toxicity data for terrestrial plants is high. It is unclear whether risks are overestimated or underestimated by using the default toxicity values but overestimation is the more likely scenario because the ESL is termed a screening level and represent unclear effects.

Background Risk Calculations

Thallium was not detected in background surface soils. Therefore, background risks were not calculated for thallium in Appendix A, Volume 2, Attachment 9 of the RI/FS Report.

1.6 Tin

Bioaccumulation Factors

The primary source of uncertainty in the risk estimation for tin is in the estimation of tissue concentrations. No high-quality regression models or BAF data were available for any of the three soil-to-tissue pathways. As a result, plant tissue concentrations are estimated using a biotransfer factor from soil-to-plant tissue from Baes et al. (1984). The values presented in Baes et al. (1994) were the lowest tier for data quality in the CRA Methodology and represent the most uncertain BAF available. It is unclear whether the Baes et al. (1984) BAFs overestimate or underestimate uptake into plant tissues, and the magnitude of uncertainty is also unknown but could be high.

No data were available to estimate invertebrate concentrations from soil. As a result, a default value of 1 was used. This value assumes that the concentration in invertebrate tissues is equal to the surface soil concentration. There is a large degree of uncertainty in this assumption. Because tin is not expected to bioaccumulate in the food chain, invertebrate tissue concentrations are likely to be overestimated to an unknown degree using this BAF. The lack of quality soil-to-plant and soil-to-invertebrate BAFs directly affects the quality of the soil-to-small mammal BAF that uses the previous two values in its calculation. Compounding the uncertainty for this BAF is a food-to-tissue BAF, again from Baes et al. (1984). It is unclear to what degree and direction that uncertainty can be estimated for the soil-to-small mammal BAF, but the uncertainty associated with the estimated small mammal tissue concentrations is high.

Toxicity Reference Values

The NOAEL and LOAEL TRVs for mammalian receptors were obtained from PRC (1994). The selected NOAEL TRV is protective of systemic effects in mice. These effects are not associated with the assessment endpoints for mammalian receptors at RFETS and, therefore, are overly conservative for use in the CRA. However, the LOAEL TRV selected by PRC (1994) is from a proper endpoint for use in the CRA and is described by PRC (1994) as predictive of a mid-range of effects less than mortality. Therefore, while the uncertainty related to the NOAEL TRV for mammals is high, the uncertainty for the LOAEL TRV is considerably lower. For this reason, no alternative TRVs are recommended in the uncertainty analysis.

For avian receptors, the TRVs selected for use in the CRA were also obtained from PRC (1994) and represent a paired NOAEL and LOAEL from a study on Japanese quail reproduction. No effects on reproduction were noted at the NOAEL, while reduced reproduction was noted at the LOAEL intake rate. Because the endpoints represented by the TRVs are appropriate for use in the CRA, the uncertainty in the avian TRVs for tin is considered to be low.

Background Risk Calculations

Tin was not detected in background surface soils, therefore, background risks were not calculated for tin in Appendix A, Volume 2, Attachment 9 of the RI/FS Report.

1.7 Bis(2-Ethylhexyl)Phthalate

Bioaccumulation Factors

Both invertebrate and small mammal tissue concentrations for bis(2-ethylhexyl)phthalate were estimated using uptake models based on the log K_{ow} of bis(2-ehtylhexyl)phthalate. As cited in the CRA Methodology, if organic ecological contaminants of interest (ECOIs) with no empirically calculated BAFs available in the first two sources, log K_{ow} equations are used (as presented and modified in the EPA EcoSSL [EPA 2003]). These values are more uncertain than empirically based BAFs and are likely to overestimate tissue concentrations to an unknown degree. This uncertainty is compounded in the soil-to-small mammal BAF that uses both the soil-to-invertebrate and soil-to-plant (also log K_{ow}-based) BAFs to estimate the diet of the small mammal. A second model is then used to estimate the amount of ECOI transferred from prey food to prey tissues. This compounded uncertainty may overestimate the concentrations of bis(2-ethylhexyl) phthalate by an even larger degree than was noted for the soil-to-invertebrate pathway.

Toxicity Reference Values

Appendix B of the CRA Methodology presents only a NOAEL TRV for avian effects from bis(2-ethylhexyl)phthalate. No reproductive effects were noted in ring doves at a dose of 1.1 mg/kg/BW/day. Because no effects were noted at the highest dose level in the study presented in the CRA Methodology, EPA's Ecotox database was searched for an alternative study. The following study was identified as applicable for use in the risk characterization.

European starlings were fed a concentration of 0, 25, and 250-mg/kg bis(2-ethylhexyl)phthalate via capsules daily (O'Shea and Stafford 1980). Significant increases in body weight were noted at the 25 mg/kg level, which was identified as the LOAEL. While the effects of increased body weight on the health of bird populations is questionable, the resulting TRV is used as the LOAEL for the risk characterization. No food ingestion rates or body weight for the animals used in the study were provided in the Ecotox database, so they were estimated. The body weight and ingestion rate for the American robin (EPA 1993) were used as surrogates (body weight = 0.077 kg; food ingestion rate = 1.52 mg/kg/BW/day). Converting the 25-mg/kg concentration to a dose resulted in a LOAEL TRV equal to 214 mg/kg. Given the questionable endpoint used in the LOAEL study, the risks calculated using the LOAEL are likely to be overestimated to an unknown degree. The uncertainty associated with the TRVs used to assess risk to avian receptors from bis(2-ethylhexyl)phthalate is high.

Background Risk Calculations

Bis(2-ethylhexyl)phthalate was not analyzed for in background surface soils. Therefore, background risks were not calculated for bis(2-ethylhexyl)phthalate in Appendix A, Volume 2, Attachment 9 of the RI/FS Report.

1.8 Endrin

Bioaccumulation Factors

All bioaccumulation factors used for endrin were log K_{ow}-based BAFs. As cited in the CRA Methodology, if organic ECOIs with no empirically calculated BAFs available in the first two sources, log K_{ow} equations are used (as presented and modified in the EPA EcoSSL [EPA 2003a]). These values are more uncertain than empirically based BAFs and are likely to overestimate tissue concentrations to an unknown degree.

Toxicity Reference Values

The TRV used was obtained from Sample et al. (1996) from a study of reproductive effects in screech owls. Egg production and hatching success were reduced at the LOAEL intake rate. No NOAEL TRV was available, so the NOAEL TRV was estimated from the LOAEL TRV by dividing by a factor of 10. The estimation of the NOAEL TRV from the LOAEL TRV introduces uncertainty into the risk characterization process. It is unknown where the threshold for effects lies at intake rates lower than the LOAEL TRV; therefore, it is unclear at which intake-rate the true NOAEL lies. However, this source of uncertainty is limited because LOAEL TRV is of sufficient quality to assess risks and the LOAEL TRV endpoint may be predictive of population risks. Risks predicted by the LOAEL TRV may be overestimated or underestimated, but the degree of uncertainty is low.

Background Risk Calculations

Endrin was not analyzed for in background surface soils. Therefore, background risks were not calculated for di-n-butylphthalate in Appendix A, Volume 2, Attachment 9 of the RI/FS Report.

1.9 Polychlorinated Biphenyls (Total)

Bioaccumulation Factors

For the soil-to-plant, soil-to-invertebrate, and soil-to-small mammal BAFs, regression equations were used to estimate plant tissue concentrations. Confidence placed in these values is high. Uncertainty is unavoidable when using even high-quality models to predict tissue concentrations. However, in cases without available measurements of tissue concentrations, regression-based models are the best available predictor of tissue concentrations. The regression-based BAFs may overestimate or underestimate tissue concentrations of total polychlorinated biphenyls (PCBs) to an unknown degree.

A higher level of uncertainty is associated with the log K_{ow}-based soil-to-small mammal BAF, which uses both the soil-to-invertebrate and soil-to-plant (also log K_{ow}-based) BAFs to estimate the diet of the small mammal. The food-to-tissue model used in the second step of the estimation of total PCB concentrations in small mammals is used to estimate the amount of PCBs transferred from prey food to prey tissues. This compounded uncertainty may overestimate the concentrations of total PCBs by a larger degree than noted for the soil-to-invertebrate pathway.

Toxicity Reference Values

For avian receptors, total PCB TRVs were obtained from the database of TRVs from PRC (1994). The LOAEL TRV was derived from a study of reproductive effects in chickens. At the LOAEL intake rate, a significant decrease in egg hatchability was noted. The NOAEL TRV is set at an intake rate that showed potential effects on egg hatchability in chickens and then reduced by one-tenth to convert the concentration to a NOAEL. Because the NOAEL and LOAEL TRVs came from two different studies with different methods and the NOAEL TRV was estimated from an effect-based TRV, no threshold TRV has been calculated for birds. The estimation of the NOAEL TRV from a LOAEL TRV introduces uncertainty in the NOAEL TRV. However, because the LOAEL TRV is based on endpoints appropriate for use by receptors in the WBEU, the uncertainty associated with the TRVs is considered low. The TRVs may overestimate or underestimate risk to an unknown degree.

Background Risk Calculations

PCB was not analyzed for in background surface soils. Therefore, background risks were not calculated for PCB in Appendix A, Volume 2, Attachment 9 of the RI/FS Report.

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COMPREHENSIVE RISK ASSESSMENT

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CRA Analytical Data Set