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

Volume 12 of 15
Southwest Buffer Zone Area Exposure Unit

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ACRONYMS AND ABBREVIATIONS

µg/L	microgram per liter
AEU	Aquatic Exposure Unit
AI	adequate intake
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
CNHP	Colorado Natural Heritage Program
CMS	Corrective Measures Study
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
DOE	U.S. Department of Energy
DQA	data quality assessment
DQO	data quality objective
DRI	dietary reference intake
ECOC	ecological contaminant of concern
ECOI	ecological contaminant of interest
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

HRR	Historical Release Report
IA	Industrial Area
IAG	Interagency Agreement
IHSS	Individual Hazardous Substance Site
kg	kilogram
LOAEL	lowest observed adverse effect level
LOEC	lowest effects concentration
MDC	maximum detected concentration
mg	milligram
mg/day	milligram per day
mg/kg	milligram per kilogram
mg/l	milligram per liter
mL	milliliter
msl	mean sea level
N/A	not applicable or not available
NFA	No Further Action
NFAA	No Further Accelerated Action
NOAEL	no observed adverse effect level
OU	Operable Unit
PAC	Potential Area of Concern
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
pCi	picocurie
pCi/g	picocuries per gram
pCi/L	picocuries per liter
PCOC	potential contaminant of concern

PMJM	Preble's meadow jumping mouse
PRG	preliminary remediation goal
QAPjP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RDA	recommended daily allowance
RDI	recommended daily intake
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RFI	RCRA Facility Investigation
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
SCM	Site Conceptual Model
SEEU	Southeast Buffer Zone Area Exposure Unit
SWEU	Southwest Buffer Zone Area Exposure Unit
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
UWOEU	Upper Woman Drainage Exposure Unit
VOC	volatile organic compound
WRS	Wilcoxon Rank Sum
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 476-acre Southwest Buffer Zone Area Exposure Unit (EU) (SWEU) at the Rocky Flats Environmental Technology Site (RFETS). The purpose of this report is to assess risks to human health and ecological receptors posed by exposure to all identified contaminants of concern (COCs) and ecological contaminants of potential concern (ECOPCs), respectively, in the SWEU.

Results of the COC selection process for the HHRA indicate that no COCs were selected and there are no significant human health risks from RFETS-related operations at the SWEU. As a result, potential health risks for the wildlife refuge worker (WRW) and wildlife refuge visitor (WRV) are expected to be within the range of background risks. The estimated cancer risks for the WRW and WRV associated with potential exposure to background levels of naturally occurring metals in surface soil/surface sediment are both approximately 2E-06. The estimated noncancer hazard indices associated with potential exposure to background levels of metals in surface soil/surface sediment are approximately 0.3 for the WRW and 0.1 for the WRV.

The ECOPC identification process streamlines the ecological risk characterization by focusing the assessment on ecological contaminants of interest (ECOIs) that are present in the SWEU. The ECOPC identification process is described in the Final Comprehensive Risk Assessment (CRA) Work Plan and Methodology (CRA Methodology) (DOE 2005a) and additional details are provided in Appendix A, Volume 2 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation (RI)/Corrective Measures Study (CMS)-Feasibility Study (FS) Report (RI/FS Report). All ECOIs in surface soil for non-Preble's meadow jumping mouse (PMJM) receptors were eliminated from further consideration as ECOPCs based on comparisons of maximum detected concentrations (MDCs) to no observed adverse effect level (NOAEL) ecological screening levels (ESLs), background comparisons, threshold ESL (tESL) comparisons, or professional judgment. Based on the weight-of-evidence, professional judgment described in Attachment 3, aluminum, boron, chromium, lithium, nickel, and vanadium in surface soil at the SWEU were not considered ECOPCs for non-PMJM receptors and were not further evaluated quantitatively. Following a similar ECOPC identification process for burrowing receptors, no ECOIs in subsurface soil were evaluated in professional judgment (all ECOIs were eliminated in preceding steps) and therefore, no ECOPCs were identified for burrowing receptors. A similar ECOPC identification process was also used for PMJM receptors. All ECOIs except nickel and vanadium were eliminated prior to the professional judgment step of the ECOPC identification process. Based on the weight-of-evidence, professional judgment described in Attachment 3, nickel and vanadium in surface soil at the SWEU were not considered ECOPCs for PMJM receptors and are not further evaluated quantitatively.

Because this process did not identify any ECOPCs in the SWEU, no risk characterization was performed and site-related risks are likely to be minimal for the ecological receptors evaluated in the SWEU. In addition, data collected on wildlife abundance and diversity

indicate that wildlife species richness remains high at RFETS. Because there are no significant risks to ecological receptors or high levels of uncertainty with the data, there are no ecological contaminants of concern (ECOCs) for the SWEU.

1.0 SOUTHWEST BUFFER ZONE 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 Southwest Buffer Zone Area Exposure Unit (EU) (SWEU) 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 Southwest Buffer Zone Area Exposure Unit Description

This section provides a brief description of the SWEU, 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. The original HRR (DOE 1992) 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 1991) and the 1996 Rocky Flats Cleanup Agreement (RFCA 1996), 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, while the 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 a description of the potential contaminant releases for each IHSS 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 no further accelerated action.

The SWEU is located within the Buffer Zone (BZ) OU, south of the Industrial Area (IA) that was used for RFETS operations (Figure 1.1). A small portion of the historical IHSS, Roadway Spraying (PAC 000-501), is the only historical IHSS within the SWEU (Table 1.1 and Figure 1.2). Figure 1.2 in Appendix A, Volume 2 of the RI/FS Report shows the locations of the IHSSs in the buffer zone, including this IHSS in the SWEU. The roadway spray areas are roads that were sprayed with waste oil for dust control. Based on the historical summary presented for PAC 000-501 in the 2005 Annual Update to the HRR (DOE 2005b), the sources of oil for roadway spraying in the buffer zone would be one or both of the following: in October 1982, 120 liters of Number 2 diesel fuel from a tank spill on the northern side of Building 371 was used on roads; and in September 1983, 1,200 gallons of Mobil Number 634 gear lubrication oil from a Building 883 rolling mill lube system was used on Plant gravel roads. These oils are not expected to contain polychlorinated biphenyls (PCBs), but could contain polynuclear aromatic hydrocarbons (PAHs). However, in other EUs (Rock Creek Drainage EU and Lower Woman Drainage EU), samples were collected near the road for PAH (and PCB) analysis, and PAHs (and PCBs) were not detected at detection limits near (2-3 times) or below the ESLs. PAC 000-501 was one of 79 IHSSs/PACs proposed for No Further Action (NFA) by the NFA Working Group in 1991. The NFA was approved in 2002 (EPA et al. 2002) and is documented in the 2002 HRR Update (DOE 2002). In general, NFAs were based on human health considerations. The intent of the ecological component of the CRA is to evaluate any potential risk to ecological receptors associated with the residual contamination at the site.

1.1.1 Exposure Unit Characteristics and Location

The 476-acre SWEU is located in the southwestern portion of RFETS (Figure 1.1) and contains several distinguishing features:

- The SWEU is located within the BZ OU and is outside areas that were used historically for operation of the RFETS;
- Sources of contamination are limited within the SWEU boundaries. The EU contains only one PAC, Roadway Spraying (PAC 000-501), which is upwind[1] and is hydraulically isolated relative to the major contaminant release locations in the IA and elsewhere at RFETS; and

[1] Winds, though variable, are predominately from the northwest quadrant. Therefore, the SWEU is in a predominantly upwind direction.

- Most of the surface water flow in the SWEU is through Smart Ditch, an irrigation ditch that receives no runoff from the IA.

The SWEU is bounded by the Upper Woman Drainage EU (UWOEU) to the north and the Southeast Buffer Zone Area EU (SEEU) to the east (Figure 1.1). Land west of the SWEU, outside of the RFETS property boundary, is owned by the State of Colorado and includes Rocky Flats Lake. Land south of the SWEU (outside the RFETS boundary) is privately owned and used for horse operations, small hay fields, and cattle grazing.

1.1.2 Topography and Surface Water Hydrology

The SWEU is within the southwestern most portion of the Woman Creek drainage basin at RFETS. Elevations range from 5,850 feet mean sea level (msl) at the southeastern corner of the SWEU to 6,130 feet msl at the southwestern corner of the SWEU. The western half of the SWEU is characterized by a broad, gentle, easterly-sloping plain, while the eastern half is characterized by incised drainages (Figure 1.2). Several ephemeral streams (draws) are present in these drainages, but most of the flow through the EU is conveyed by Smart Ditch (Figure 1.2), which is privately owned and operated. Smart Ditch and the draws in the SWEU receive no runoff from the former IA. Although they do receive runoff from PAC 000-501, this IHSS is not expected to be a source of contamination (see Section 1.1).

Smart Ditch fills two ponds (D-1 and D-2) in the SEEU that are used for irrigation. Water from Rocky Flats Lake, located off-site west of the SWEU, flows through Smart Ditch for approximately 2.5 miles before reaching a splitter box in the SEEU that diverts water to the southeast away from the main channel of Woman Creek (Figure 1.1). Overland runoff is also intercepted and conveyed by Smart Ditch, and high flows can exceed the diversion capacity of the splitter box and flow into Woman Creek.

There are no prominent surface disturbance features in the SWEU (Figure 1.3).

1.1.3 Flora and Fauna

A vegetation map for the SWEU is shown on Figure 1.4. Vegetation in the SWEU is predominantly grassland, consisting primarily of xeric tallgrass prairie and mesic mixed grasslands. The xeric tallgrass prairie is distinguished at RFETS by such plant species as big bluestem (*Andropogon gerardii*), little bluestem (*Andropogon scoparius*), Indian-grass (*Sorghastrum nutans*), prairie dropseed (*Sporobolus heterolepis*), and switchgrass (*Panicum virgatum*), the same species that dominate the plant community on the eastern edge of the Great Plains. Xeric grasslands within the EU occur on the gently sloping pediment areas, and mesic mixed grasslands are found on hillsides where drainage ways become more defined. Wet meadows, short marshlands, short upland shrublands, and riparian woodlands are found along Smart Ditch, chiefly in the eastern portion of the EU.

Grasslands are important to wildlife and grassland conditions within the SWEU are generally good, although weeds and introduced grass species have degraded grasslands in some areas (PTI 1997).

No federally listed plant species are known to occur at RFETS. However, the xeric tallgrass prairie, tall upland shrubland, riparian shrubland, and plains cottonwood riparian woodland communities are considered rare and sensitive plant communities by the Colorado Natural Heritage Program (CNHP). RFETS also supports populations of four rare plant species that are listed as rare or imperiled by the CHNP. These include: forktip three-awn (*Aristida basiramea*), mountain-loving sedge (*Carex oreocharis*), carrionflower greenbriar (*Smilax herbacea var. lasioneuron*), and dwarf wild indigo (*Amorpha nana*). Forktip three-awn primarily occurs in disturbed habitat near the western edge of the IAEU. The other three species occur primarily along the piedmont slopes in the Rock Creek drainage (K-H 2002).

Numerous animal species have been observed at RFETS and the more common ones are expected to be present in the SWEU. Common large and medium-sized mammals likely to live at or frequent the SWEU include the mule deer (*Odocoileus hemionus*), coyote (*Canis latrans*), raccoon (*Procyon lotor*), and desert cottontail (*Sylvilagus audubonii*). The most common reptile observed at RFETS is the western prairie rattlesnake (*Crotalis viridus)*. Common bird species include the meadow lark (*Sturnella neglecta*), vesper sparrow (*Pooecetes gramineus*), and grasshopper sparrow (*Ammodramus savannarum*). The most common small mammal species include deer mice (*Peromyscus maniculatus*) (Ross 1930), prairie voles (*Microtus ochrogaster*), and two different species of harvest mice (*Reithrodontomys sp*.).

RFETS supports two wildlife species listed as threatened or endangered species under the Endangered Species Act (USFWS 2005) The Preble's meadow jumping mouse (PMJM; *Zapus hudsonius preblei*) and the bald eagle (*Haliaeetus leucocephalus*) are listed as threatened species. The PMJM may reside in every major drainage at RFETS. The bald eagle occasionally forages at RFETS although no nests have been identified on site.

There are also a number of wildlife species that have been observed at RFETS that are species of concern by the State of Colorado (USFWS 2005). The plains sharp-tailed grouse (*Tympanuchus phasianellus jamesii*) is listed as endangered by the State and has been observed infrequently at RFETS. The western burrowing owl (*Athene cunicularia hypugea*) is listed as threatened by the State and is a known resident or regular visitor at RFETS. The ferruginous hawk (*Buteo regalis*), American peregrine falcon (*Falco peregrinus*), and northern leopard frog (*Rana pipiens*) are listed as species of special concern by the State and are considered known residents or regular visitors at RFETS. The following species are listed as species of special concern and are observed infrequently at RFETS: greater sandhill crane (*Grus canadensis tibida*), long-billed curlew (*Numenius americanus*), mountain plover (*Charadrius montanus*), and the common garter snake (*Thamnophis sirtalis*).

More information on the plant communities and animal species that exist within RFETS is provided in Section 2.0 of the RI/FS Report.

1.1.4 Preble's Meadow Jumping Mouse Habitat within Southwest Buffer Zone Exposure Unit

The SWEU supports habitat for the federally protected PMJM (*Zapus hudsonius preblei*). 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 Smart Ditch in the northeastern portion of the SWEU (Figure 1.5). Only two captures of PMJM have occurred within Smart Ditch; once on May 5, 1993, and again on August 22, 2001 (K-H 2002). Trapping was conducted only on these two dates. The lack of continuously running water along Smart Ditch is undoubtedly a limiting factor to PMJM abundance.

Sitewide PMJM habitat patches were developed in an effort to characterize habitat discontinuity and provide indications of varying habitat quality. PMJM patches within the SWEU are presented in Figure 1.5. Patches that cross over into the SEEU are considered part of SWEU (Patch #29A). PMJM patches aid in the evaluation of surface soil within PMJM habitat, giving a spatial understanding of areas that may be used by individual or subpopulations of PMJM. More detail on the methodology of creating sitewide PMJM habitat patches can be found in Appendix A, Volume 2, Section 3.2 of the RI/FS Report.

PMJM habitat within the SWEU was divided into two habitat patches, each containing habitat capable of supporting at least one PMJM. The patches vary in size and shape dependent on their location within the Smart Ditch drainage and discontinuity or habitat quality of surrounding patches. The following is a brief discussion of the two patches within the SWEU (Figure 1.5) and the reasons each is considered distinct:

- **Patch #29A and #29B –** This patch is a combination of habitat along Smart Ditch (29A) and a small tributary to the south (29B). Supporting wetlands bridge the gap between the two habitat areas (USFWS 2004) and this hydrological connection provides the basis for considering these areas as a single unit. As previously discussed, PMJM have been captured within this patch. The upper boundary for this patch corresponds to the extent of habitat mapped previously (USFWS 2004), while the lower limit extends into the SEEU and corresponds to the point where contiguous riparian shrubland within this patch gives way to riparian woodlands.

- **Patch #30 –** This patch contains a series of short upland shrub areas and alternating areas of short marsh and tall upland shrubs. It is different from the vegetation found in Smart Ditch but is still considered PMJM habitat (USFWS 2004) due to the presence of shrubs and seeps. The upper and lower boundaries of the patch correspond to the extent of habitat mapped previously (USFWS 2004). No PMJM are known to be present in this patch although it has never been trapped.

1.1.5 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 SWEU. The data set for the CRA was prepared in accordance with data processing steps described in Appendix A, Volume 2, Attachment 2 of the RI/FS Report. 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 on Figures 1.6 and 1.7, and data summaries for detected analytes in each medium are provided in Tables 1.3 through 1.7. 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 (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 samples with a starting depth less than or equal to 8 feet below ground surface (bgs) are used in the CRA. Subsurface soil 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 SWEU is provided on a compact disc (CD) presented in Attachment 4. The CD in Attachment 4 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 SWEU HHRA and ERA are used 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.

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 SWEU consists of up to 22 samples that were analyzed for inorganics (16 samples) and radionuclides (22 samples) (Table 1.2). No samples were analyzed for organics in SWEU surface soil. A discussion of the uncertainties related to the number of organic analyses in surface soil/surface sediment is presented in Section 6.0. The surface soil/surface sediment data include sediment samples collected to depths down to 0.5 feet bgs. The sampling locations for surface soil and surface sediment are shown on Figure 1.6. All sample locations within the SWEU were not necessarily analyzed for all analyte groups (see Table 1.3). The surface soil/surface sediment samples were collected in the SWEU during November 1992, December 1993, September 1994, and March and December 2004. The samples collected in 2004 were located on a 30-acre grid, as described in SAP Addendum #04-01 (DOE 2004). For the grid sampling, five individual samples were collected and composited 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 on Figure 1.6 represent the 30-acre grid samples.

The data summary for detected analytes in surface soil/surface sediment for the SWEU is presented in Table 1.3. Detected analytes included representatives from the inorganic and radionuclide analyte groups. A summary of analytes that were either not detected in, or detected in less than 5 percent of, surface soil/surface sediment sample is presented and discussed in Attachment 1.

Subsurface Soil/Subsurface Sediment

The combined subsurface soil/subsurface sediment data set for SWEU consists of up to three samples analyzed for inorganics, one sample for organics, and one sample for radionuclides (Table 1.2). The data include sediment samples collected from a starting depth less than or equal to 8 feet bgs and an ending depth below 0.5 feet bgs. The sampling locations for subsurface soil and subsurface sediment are shown on Figure 1.7. All sample locations within the SWEU were not necessarily analyzed for all analyte groups (see Table 1.4). The samples were collected in the SWEU during January and December 2004.

The data summary for subsurface soil/subsurface sediment in the SWEU is presented in Table 1.4. Detected analytes included representatives from the inorganic and radionuclide analyte groups. No organic analytes were detected in subsurface soil/subsurface sediment samples within the SWEU. A summary of analytes that were not detected in subsurface soil/subsurface sediment is presented and discussed in Attachment 1.

Surface Soil

The surface soil data set for the SWEU consists of up to 20 samples that were analyzed for inorganics (14 samples) and radionuclides (20 samples) (Table 1.2). No samples were analyzed for organics in the SWEU surface soil. The surface soil sampling locations for the SWEU are shown on Figure 1.6. All sample locations within the SWEU were not necessarily analyzed for all analyte groups (see Table 1.5). The samples were collected in the SWEU during November 1992, December 1993, September 1994, and March 2004.

The samples collected in 2004 were located on a 30-acre grid, as described in 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 on Figure 1.6 represent the 30-acre grid samples.

There are four surface soil sample locations occurring in PMJM habitat within the SWEU (Figure 1.5). However, the data for one additional sample location from PMJM habitat patch 29a in the SEEU are used to complement the data for samples collected within the habitat patches in the SWEU. The SWEU surface soil samples within PMJM habitat were analyzed for inorganics (four samples) and radionuclides (up to seven samples) (Table 1.2).

The data summary for detected analytes in SWEU surface soil is presented in Table 1.5, while the data summary for the detected analytes for those samples within designated PMJM habitat is presented in Table 1.6. Inorganics and radionuclides were detected in SWEU surface soil samples. A summary of analytes that were not detected in surface soil in the SWEU is presented and discussed in Attachment 1.

Subsurface Soil

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. The subsurface soil data set for the SWEU consists of up to two samples analyzed for inorganics and one sample for organics (Table 1.2). No samples were analyzed for radionuclides in the SWEU subsurface soil. Subsurface soil sample locations are shown on Figure 1.7. All sample locations within the SWEU were not necessarily analyzed for all analyte groups (see Table 1.7). The samples were collected in the SWEU during January 2004.

The data summary for detected analytes in subsurface soil for the SWEU is presented in Table 1.7. Inorganics and organics were detected in SWEU subsurface soil samples. A summary of analytes that were not detected in subsurface soil is presented and discussed in Attachment 1.

1.2 Data Adequacy Assessment

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, Attachment 3 of the RI/FS Report. The adequacy of the data was assessed by comparing the number of samples for each analyte group in each medium as well as the spatial and temporal distributions of the data to data adequacy guidelines. If the data do not meet the guidelines, other lines of evidence (e.g., information on potential historical sources of contamination, migration pathways, and the concentration levels in the media) are examined to determine if it is possible to make risk management decisions given the data limitations.

The findings from the data adequacy assessment applicable to all EUs are as follows:

- The radionuclide and inorganic surface soil data are adequate for the purposes of the CRA.

- For herbicides and pesticides, although the existing surface soil and sediment data may not meet the minimal data adequacy guidelines for each EU, there is considerable site-wide data, and pesticides and herbicides are infrequently detected at low concentrations, generally below PRGs and ESLs. This line of evidence indicates that it is possible to make risk management decisions without additional sampling for these analyte groups

- For dioxins, although the existing surface soil and sediment data do not meet the minimal data adequacy guidelines for each EU, sample locations were specifically targeted for dioxin analysis at historical IHSSs in and near the former Industrial Area where dioxins may have been released based on process knowledge. Some of the dioxin concentrations at the historical IHSSs exceed the PRG and/or ESL. Additional samples were collected in targeted locations that represented low-lying or depositional areas where dioxin contamination may have migrated via runoff from these specific IHSSs. Results indicate that dioxin concentrations are not above the minimum ESL in sediment and dioxins are not detected in surface water. Therefore, although the existing data do not meet the minimal data adequacy guidelines for each EU/AEU, it is possible to make risk management decisions without additional sampling. However, unlike pesticides and herbicides where there is considerably more site-wide data, there is greater uncertainty in the overall risk estimates because fewer samples were collected at the site for dioxins.

- Subsurface soil contamination is largely confined to historical IHSSs (that is, areas of known or suspected historical releases). These areas have been characterized to understand the nature and extent of potential releases. For historical IHSSs where subsurface soil samples were not collected for an analyte group, the presence of this type of subsurface contamination was not expected based on process knowledge. Therefore, the existing subsurface soil data are adequate for the purposes of the CRA.

The findings from the data adequacy report applicable to the SWEU are as follows:

- No surface soil or surface sediment samples from the SWEU were analyzed for VOCs, SVOCs, or PCBs. A small portion of IHSS 000-501, roadway spray areas, is also located in the SWEU. However, in other EUs that contain this IHSS, SVOCs and PCBs were not detected. The SWEU is hydraulically isolated from potential historical source areas in and near the IA. Therefore, although the minimal data adequacy guideline for the number of samples is not met for organics, available information on potential historical sources of contamination, contaminant migration pathways from potential sources in other EUs, and concentration levels in surface soil show that organics are not likely to be present

in surface soil or sediment for this EU, and it is possible to make risk management decisions without additional sampling.

- No surface soil or sediment samples were collected for dioxins in the SWEU. Although this does not meet the minimal data adequacy guideline, as noted above, dioxins are not expected to have been released in SWEU and it is possible to make risk management decisions without additional sampling.

- For radionuclides and metals, the data adequacy guideline for 3 samples is not met for each of the PMJM habitat patches in the SWEU. There are no data for organics. However, available information on potential historical sources of contamination and contaminant migration pathways from potential sources in other EUs indicate concentration gradients for radionuclides and metals should not be present, and the radionuclide and metal data in aggregate are representative of all PMJM habitat patches. The available information also shows that organics are not likely to be of concern for the PMJM habitat patches in this EU. Therefore, although the existing SWEU PMJM habitat patch data do not meet the minimal data adequacy guidelines for the EU PMJM patches, it is possible to make risk management decisions without additional sampling

- For analytes not detected or detected in less than 5 percent of the samples, only thallium in surface soil has detection limits that exceed the ESL, and the frequency and magnitude of the exceedances are relatively low, i.e., less than 30 percent of the detection limits exceed the ESL, and these higher detection limits are of the same order of magnitude as the ESL. This represents minimal uncertainty in the overall risk conclusions. All detection limits are below the PRGs/ESLs in surface soil/surface sediment, subsurface soil/subsurface sediment, and subsurface soil (see Appendix A, Volume 12, Attachment 1 of the RI/FS report for a more detailed discussion).

1.3 Data Quality Assessment

A Data Quality Assessment (DQA) of the SWEU 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 DQOs through an overall review of precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. This review concluded that the data are of sufficient quality for use in the 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 at the SWEU. 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 criteria 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 values. The PRG screen in Section 2.1.2 includes essential nutrients for which toxicity criteria are 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 mg/day, are less than the DRIs. Therefore, these PCOCs were not evaluated further as COCs for surface soil/surface sediment.

2.1.2 Surface Soil/Surface Sediment Preliminary Remediation Goals Screen

Table 2.2 compares the 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 in surface soil/surface sediment had an MDC and UCL that exceeded the PRG and was retained as a PCOC.

PRGs were not available for all analytes 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).

2.1.4 Surface Soil/Surface Sediment Background Analysis

Results of the background statistical comparison for arsenic is presented in Table 2.3 and discussed in Attachment 3. Box plots for arsenic (both SWEU and background) are provided in Attachment 3. Arsenic is statistically greater than background at the 0.1 significance level, and it is 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, arsenic in surface soil/ surface sediment in the SWEU is not considered a COC. The weight of evidence supports the conclusion that arsenic concentrations in surface soil/surface sediment in the SWEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations.

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 the 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.

Essential nutrients without toxicity criteria that were detected in subsurface soil/ subsurface sediment in the SWEU are compared to DRIs in Table 2.4. The estimated daily maximum intakes for these PCOCs, based on the nutrient's MDCs and a subsurface soil/subsurface sediment ingestion rate of 100 milligrams (mg) per day (mg/day), are less than the DRIs. Therefore, the 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. The MDCs for all PCOCs were less than the PRGs and, therefore, the UCLs were not compared to the PRGs. No detected PCOCs in subsurface soil/subsurface sediment in the SWEU were retained for further evaluation in the COC selection process.

A PRG is not available for silica in subsurface soil/subsurface sediment (Table 2.5). The effect of this 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 was not performed for subsurface soil/subsurface sediment because there are no PCOCs with concentrations greater than the PRGs.

2.2.4 Subsurface Soil/Subsurface Sediment Background Analysis

The background analysis was not performed for subsurface soil/subsurface sediment because there are no PCOCs with concentrations greater than the PRGs.

2.2.5 Subsurface Soil/Subsurface Sediment Professional Judgment Evaluation

The professional judgment step was not performed for subsurface soil/subsurface sediment because there are no PCOCs with concentrations greater than the PRGs.

2.3 Contaminant of Concern Selection Summary

A summary of the results of the COC screening process is presented in Table 2.6. No COCs were selected for surface soil/surface sediment and subsurface soil/subsurface sediment at the SWEU.

3.0 HUMAN HEALTH EXPOSURE ASSESSMENT

The site conceptual model (SCM), presented in Figure 2.1 of the CRA Methodology and 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. However, all PCOCs were eliminated from further consideration as human health COCs for the SWEU based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2.0). A quantitative risk characterization is not necessary for the SWEU and, therefore, an exposure assessment was not conducted.

4.0 HUMAN HEALTH TOXICITY ASSESSMENT

Procedures and assumptions for the toxicity assessment are presented in the CRA Methodology. All PCOCs were eliminated from further consideration as human health COCs for the SWEU based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2.0). A quantitative risk characterization is not necessary for the SWEU and, therefore, a toxicity assessment was not conducted.

5.0 HUMAN HEALTH RISK CHARACTERIZATION

Information from the exposure assessment and the toxicity assessment is integrated in this section to characterize risk to the WRW and WRV receptors. However, all PCOCs were eliminated from further consideration as human health COCs for the SWEU based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional

judgment (see Section 2.0). Therefore, a quantitative risk characterization was not performed for the SWEU.

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 SWEU 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 (DOE 2005a). Although there are some uncertainties associated with the sampling and analyses conducted for surface soil/surface sediment and subsurface soil/subsurface sediment at the SWEU, data are considered adequate for the characterization of risk at the EU. The environmental samples for the SWEU were collected from 1992 through 2004. The CRA sampling and analysis requirements for the BZ (DOE 2004, 2005a) specify that the minimum sampling density requirement for surface soil/surface sediment is one five-sample composite for every 30-acre grid cell. In surface soil/surface sediment, there are up to 22 samples in the SWEU. Although there are no data for organics in surface soil/surface sediment, no known or suspected sources for organic contaminants exist in the SWEU. In subsurface soil/subsurface sediment, there are up to three samples in the SWEU.

Another source of uncertainty in the data is the relationship of detection limits to the PRGs for analytes eliminated as COCs because they were 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 utilized RFETS-specific PRGs based on a WRW scenario. The assumptions used in the development of these values were conservative. For example, it is assumed that a future WRW will consume 100 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 to and inhale surface soil and surface sediment particles in the air. These assumptions are likely to overestimate actual exposures to surface soil for WRWs in the SWEU 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 are also expected to conservatively estimate potential exposures because it is unlikely a WRW will excavate extensively in the SWEU.

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

PCOCs for the SWEU 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 inorganics are not usually included in HHRAs because they are not expected to result in significant human health impacts. 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

Arsenic 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 SWEU and the slightly elevated median value of arsenic in the SWEU is most likely due to natural variation. The weight of evidence presented in Attachment 3, Section 4.0 supports the conclusion that concentrations of arsenic are naturally occurring and not due to site activities. Uncertainty associated with the elimination of this chemical as a COC is low.

Because no PCOCs in subsurface soil/subsurface sediment were statistically greater than background, no PCOCs were eliminated in subsurface soil/subsurface sediment based on professional judgment in the SWEU.

6.4 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 SWEU risk characterization.

7.0 IDENTIFICATION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN

The ecological contaminant of potential concern (ECOPC) identification process streamlines the ecological risk characterization for each EU by focusing the assessment on ECOIs that are present in the SWEU. ECOIs are defined as any chemical detected in the SWEU 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 SWEU, are also 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. Generally, the most significant exposure pathways for wildlife at the SWEU 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 soil.

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 RFETS, 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).

7.1 Data Used in the Ecological Risk Assessment

The following SWEU data are used in the CRA:

- Twenty surface soil samples were collected and analyzed for inorganics (14 samples) and radionuclides (20 samples); and
- Two subsurface soil samples were collected and analyzed for inorganics (two samples) and organics (one sample).

A data summary is provided in Table 1.5 for surface soil and Table 1.7 for subsurface soil.

Sediment and surface water data for the SWEU also were collected (Section 1.2) and these data are evaluated for the ERA in Appendix A, Volume 15 of the RI/FS Report.

The SWEU has four sample locations occurring in PMJM habitat within SWEU (Figure 1.5). However, the PMJM habitat evaluated for the SWEU includes one additional sample location from PMJM habitat identified as part of the SEEU. As presented in Table 1.2, surface soil samples were collected and analyzed for inorganics (four samples) and radionuclides (seven samples). There were no organic samples collected in PMJM habitat. A data summary is provided in Table 1.6 for surface soil in PMJM habitat.

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 "MDC>ESL" 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

The NOAEL ESLs for PMJM receptors were compared to the MDCs of ECOIs in surface soil collected from PMJM habitat (Table 7.3). The MDCs in surface soil that exceed the NOAEL ESLs are identified in Table 7.3 with a "Yes" under the column heading "Retained for Further Analysis?"

Analytes for which a PMJM NOAEL ESL is not available are identified with a "N/A" in Table 7.3 under the column heading "MDC > ESL?" These analytes are discussed in the uncertainty section (Section 10.0) as ECOIs with UT.

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 unlikely and the ECOI is not further evaluated. None of the chemicals detected in surface soil at the SWEU that were retained after the NOAEL ESL screening step had a detection frequency less than 5 percent. Therefore, no ECOIs were excluded based on the detection frequency evaluation for surface soil in the SWEU.

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 comparisons are presented in Table 7.4 and Table 7.5 and discussed in Attachment 3. The statistical methods used for the background comparison are discussed 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 7.4. The analytes listed as being retained as ECOIs in Table 7.4 are evaluated further using upper-bound exposure point concentrations (EPCs) in the following section.

PMJM Receptors

The background comparison for PMJM receptors is performed using the same methods as for non-PMJM receptors, but the data set is restricted to soil samples from within PMJM areas. Table 7.5 presents the results of the PMJM comparison to background. Attachment 3 presents further discussion of the PMJM background analysis. The analytes listed as "Yes" on Table 7.5 are further evaluated in the professional judgment evaluation.

7.2.4 Exposure Point Concentration Comparisons to Threshold ESLs

The ECOIs retained after completion of all previous evaluations for non-PMJM receptors were then compared to threshold ESLs (tESLs) using upper-bound EPCs specific to small and large 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 7.6. 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 7.7. 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 7.8, and analytes exceeding limiting tESLs for large home-range receptors are compared to receptor-specific tESLs in Table 7.9. No analytes exceeded the limiting tESLs for large home-range receptors.

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, boron, chromium, lithium, nickel, and vanadium in surface soil at the SWEU were not considered ECOPCs for non-PMJM receptors and are not further evaluated quantitatively.

PMJM Receptors

Based on the weight-of-evidence, professional judgment described in Attachment 3, nickel and vanadium in surface soil at the SWEU were not considered ECOPCs for PMJM receptors and are not further evaluated quantitatively.

7.2.6 Summary of Surface Soil Ecological Contaminants of Potential Concern

The ECOPC screening process for surface soil is summarized below for non-PMJM receptors and PMJM receptors.

Non-PMJM Receptors

Inorganic and radionuclide surface soil ECOIs for non-PMJM receptors in the SWEU 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 SWEU 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. No chemicals were retained as surface soil ECOPCs for the SWEU.

A summary of the ECOPC screening process for non-PMJM receptors is presented in Table 7.10.

PMJM Receptors

ECOIs in surface soil in PMJM habitat located within the SWEU were evaluated in the ECOPC identification process. ECOIs were removed from further evaluation in the ECOPC identification process based on one of the following: 1) the MDC of the ECOI was less than the NOAEL ESL for PMJM; 2) no NOAEL ESLs were available (these ECOIs are discussed in Section 10.0); 3) the ECOI concentrations within the PMJM habitat in SWEU were not statistically greater than those from background surface soils; or 4) the weight-of-evidence, professional judgment evaluation indicated that the ECOI was not a site-related contaminant of potential concern. No chemicals were retained as surface soil ECOPCs for PMJM receptors in the SWEU.

The results of the ECOPC identification process for the PMJM are summarized in Table 7.11.

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 SWEU are identified on Figure 1.6. A data summary for subsurface soil less than 8 feet deep is presented in Table 1.7.

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 7.12). 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 7.12. These constituents are considered ECOIs with UT and are discussed in the uncertainty analysis (Section 10.0).

7.3.2 Subsurface Soil Detection Frequency Evaluation

No detection frequency evaluation was performed for subsurface soils because there are no ECOIs with concentrations greater than the NOAEL ESLs.

7.3.3 Subsurface Soil Background Comparison

The subsurface background comparison was not performed for subsurface soils because there are no ECOIs with concentrations greater than the NOAEL ESLs.

7.3.4 Exposure Point Concentration Comparisons to Threshold ESLs

The exposure point concentration comparison to tESLs was not performed for subsurface soils because there are no ECOIs with concentrations greater than the NOAEL ESLs.

7.3.5 Subsurface Soil Professional Judgment

The professional judgment step was not performed for subsurface soils because there are no ECOIs with concentrations greater than the NOAEL ESLs.

7.3.6 Summary of Subsurface Soil Ecological Contaminants of Potential Concern

All subsurface soil ECOIs for burrowing receptors in the SWEU were eliminated from further consideration as ECOPCs based on one of the following: 1) the MDC of the ECOI was less than the 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 SWEU subsurface soils was not 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 SWEU were evaluated in the ECOPC identification process for non-PMJM receptors, PMJM receptors, and burrowing receptors. No chemicals were identified as ECOPCs for non-PMJM receptors (Table 7.10). No chemicals were identified as ECOPCs for the PMJM (Table 7.11). No chemicals were identified as ECOPCs for burrowing receptors (Table 7.13).

8.0 ECOLOGICAL EXPOSURE ASSESSMENT

The ECOPC identification steps did not identify any ECOPCs for either surface or subsurface soil in the SWEU. Therefore, no exposure assessment was performed for the SWEU.

9.0 ECOLOGICAL TOXICITY ASSESSMENT

The ECOPC identification steps did not identify any ECOPCs for either surface or subsurface soil in the SWEU. Therefore, no toxicity assessment for the SWEU was performed.

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 SWEU.

Because this process did not identify any ECOPCs in either surface or subsurface soil, no risk characterization was performed for the SWEU.

10.1 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. The following general uncertainties associated with the ERAs for all the EUs may under- or overestimate risk to an unknown degree A full discussion of these general uncertainties is provided in Volume 2 of Appendix A of the RI/FS Report:

- Uncertainties associated with data quality and adequacy;
- Uncertainties associated with the ECOPC identification process;
- Uncertainties associated with the selection of representative receptors;
- Uncertainties associated with exposure calculations;
- Uncertainties associated with the development of NOAEL ESLs;
- Uncertainties associated with the lack of toxicity data for ECOIs; and,
- Uncertainties associated with eliminating ECOIs based on professional judgment.

The following sections are potential sources of general uncertainty that are specific to the SWEU ERA.

10.1.1 Uncertainties Associated With Data Adequacy and Quality

Sections 1.2 and 1.3 summarize the general data adequacy and data quality for the SWEU, respectively. A more detailed discussion is presented in Appendix A, Volume 2, Attachments 2 and 3 of the RI/FS Report, and Attachment 2 of this volume. The data quality assessment indicates the data are of sufficient quality for use in the CRA. The adequacy of the SWEU data was assessed by comparing the number of samples for each analyte group in each medium as well as the spatial and temporal distributions of the data to data adequacy guidelines. The assessment indicates an absence of surface soil organic data, including dioxins. A small portion of IHSS 000-501, roadway spray areas, is also located in the SWEU. However, in other EUs that contain this IHSS, organics were not detected at detections limits near or below the ESLs. The SWEU is also hydraulically isolated from potential historical source areas in and near the IA. Therefore, organics are not likely to be present in surface soil, and it is possible to make risk management decisions without additional sampling. Data used in the CRA must have detection limits to allow meaningful comparison to ESLs. When these detection limits exceed the respective ESLs, this is a source of uncertainty in the risk assessment. Attachment 1 to this volume provides a detection limit adequacy screen where detection limits for non-

detected analytes as well as analytes detected in less than 5 percent of the samples are compared to ESLs. Only thallium in surface soil has detection limits that exceed the ESL, and the frequency and magnitude of the exceedances are relatively low, i.e., less than 30 percent of the detection limits exceed the ESL, and these higher detection limits are of the same order of magnitude as the ESL. This represents minimal uncertainty in the overall risk conclusions.

10.1.2 Uncertainties Associated with the Lack of Toxicity Data for Ecological Contaminant of Interest Detected at the Southwest Buffer Zone Area Exposure Unit

Several ECOIs detected in the SWEU do not have adequate toxicity data for the derivation of ESLs (CRA Methodology [DOE 2005a]). These ECOIs are listed in Tables 7.1, 7.3, and 7.12 with a "UT" designation. Included as a subset of the ECOIs with a "UT" designation are the essential nutrients (calcium, iron, magnesium, potassium, and sodium). Although these nutrients may be potentially toxic to certain ecological receptors at high concentrations, the uncertainty associated with the toxicity of these nutrients is expected to be low. 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.

10.1.3 Uncertainties Associated With Eliminating Ecological Contaminants of Interest Based on Professional Judgment

Several analytes in surface 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 SWEU. The weight-of-evidence approach indicates that the ECOI concentrations likely represent variations in the naturally occurring elements because there is no identified contaminant source or pattern of release in the SWEU, and the SWEU is hydraulically isolated from historical IHSSs in the former Industrial Area. Furthermore, the ECOI concentrations in the SWEU are unlikely to result in risk concerns for ecological receptors. Therefore, the professional judgment evaluation is unlikely to have a significant effect on the overall risk calculations.

10.2 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 sources of uncertainty discussed tend to either underestimate risk or overestimate risk, many result in an unknown effect on the potential risks. However, the CRA Methodology outlines a tiered process of risk

evaluation that includes conservative assumptions for the ECOPC identification process and more realistic assumptions, as appropriate, for risk characterization.

11.0 SUMMARY AND CONCLUSIONS

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

11.1 Data Adequacy

The adequacy of the SWEU data was assessed by comparing the number of samples for each analyte group in each medium as well as the spatial and temporal distributions of the data to data adequacy guidelines. The assessment indicates an absence of surface soil and sediment organic data. However, other lines of evidence (e.g., information on potential historical sources of contamination, migration pathways, and the concentration levels in the media) indicate that organic analytes are not likely to be present in SWEU surface soil and sediment. Therefore, it is possible to render risk management decisions using the existing data. In addition, for analytes that are not detected or detected at a frequency less than 5 percent, only thallium in surface soil has detection limits that exceed the ESL, and the frequency and magnitude of the exceedances are relatively low. Therefore, it is concluded that the occurrence of these higher detection limits represents only minimal uncertainty in the overall risk estimates.

11.2 Human Health

The COC screening analyses compared MDCs and UCLs of chemicals and radionuclides in SWEU media to PRGs for the WRW receptor. PCOCs with UCLs greater than the PRGs were statistically compared to the background concentration data set. Inorganic 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, no COCs were selected for surface soil/surface sediment and subsurface soil/subsurface sediment in the SWEU and a risk characterization was not performed for this EU.

11.3 Ecological Risk

The ECOPC identification process streamlines the ecological risk characterization by focusing the assessment on ECOIs that are present in the SWEU. The ECOPC identification process is described in the CRA Methodology and additional details are provided in Appendix A, Volume 2 of the RI/FS Report. All ECOIs in surface soil for non-PMJM receptors were eliminated from further consideration as ECOPCs based on comparisons of MDCs to NOAEL ESLs, background comparisons, tESL comparisons, or professional judgment. Based on the weight-of-evidence, professional judgment described in Attachment 3, aluminum, boron, chromium, lithium, nickel, and vanadium in surface soil at the SWEU were not considered ECOPCs for non-PMJM receptors and were not further evaluated quantitatively. Although there are no organic data for surface soil, other lines of evidence indicate organics are not expected to be present in SWEU

surface soil, and accordingly, are not a concern to ecological receptors. Following a similar ECOPC identification process for burrowing receptors, no ECOIs in subsurface soil were evaluated in professional judgment (all ECOIs were eliminated in preceding steps) and therefore, no ECOPCs were identified for burrowing receptors. A similar ECOPC identification process was also used for PMJM receptors. All ECOIs except nickel and vanadium were eliminated prior to the professional judgment step of the ECOPC identification process. Based on the weight-of-evidence, professional judgment described in Attachment 3, nickel and vanadium in surface soil at the SWEU were not considered ECOPCs for PMJM receptors and are not further evaluated quantitatively.

Because this process did not identify any ECOPCs in the SWEU, no risk characterization was performed and site-related risks are likely to be minimal for the ecological receptors evaluated in the SWEU. In addition, data collected on wildlife abundance and diversity indicate that wildlife species richness remains high at RFETS. Because there are no significant risks to ecological receptors or high levels of uncertainty with the data, there are no ecological contaminants of concern (ECOCs) for the SWEU.

12.0 REFERENCES

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TABLES

Table 1.1
SWEU IHSSs

IHSS	OU	PAC	Title	Description	Disposition
--	BZ	000-501	Roadway Spraying	Roadways in the BZ OU were sprayed with waste oils for dust suppression; reverse osmosis brine solutions and footing drain water were also applied.[a]	NFA - 2002 HRR

[a] PAC 000-501 was one of 79 IHSS/PACs proposed for NFA by the NFA Working Group in 1991. The NFA was approved in 2002 (EPA et al, 2002).

Note: The FY2005 Final Historical Release Report (Appendix B to the RI/FS Report) provides the chemicals of potential concern for these IHSSs based on previous investigations.

Table 1.2
Number of Samples in Each Medium by Analyte Suite

Analyte Suite	Surface Soil/Surface Sediment[a]	Subsurface Soil/Subsurface Sediment[a]	Surface Soil[b]	Surface Soil within PMJM Habitat	Subsurface Soil[b]
Inorganics	16	3	14	3[c](4)[d]	2
Organics	0	1	0	0[c](0)[d]	1
Radionuclides	22	1	20	6[c](7)[d]	0

[a] Used in the HHRA.

[b] Used in the ERA.

[c] Number of samples in SWEU PMJM patches.

[d] Total number of samples used in ERA. The data for one additional sample location from PMJM habitat patch 29a in the SEEU are used to complement the data for samples collected within the habitat patches in the SWEU(see Figure 1.5).

Note: The total number of results (samples) in Tables 1.3 through 1.7 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[a]	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[b]	Standard Deviation[b]
Inorganics (mg/kg)							
Aluminum		16	100	11,000	29,000	15,800	4,040
Antimony	0.31 - 1.7	16	12.5	0.390	0.480	0.260	0.190
Arsenic		16	100	3.30	9.00	7.16	1.43
Barium		16	100	78.0	210	132	30.7
Beryllium	0.65 - 0.95	16	62.5	0.590	1.30	0.704	0.275
Boron		16	100	3.00	9.70	6.10	1.84
Cadmium[c]	0.066 - 0.2	16	50.0	0.190	0.710	0.210	0.203
Calcium		16	100	1,500	8,200	4,050	1,800
Chromium		16	100	12.0	28.0	15.9	3.62
Cobalt		16	100	3.70	9.70	6.12	1.52
Copper		16	100	6.50	19.0	12.9	3.48
Iron		16	100	10,000	23,000	14,300	3,090
Lead		16	100	17.0	38.0	26.6	5.88
Lithium		16	100	7.70	19.0	11.2	2.78
Magnesium		16	100	1,200	4,800	2,340	809
Manganese		16	100	83.0	330	228	65.2
Mercury		16	100	0.027	0.130	0.045	0.026
Molybdenum	0.28 - 0.28	16	93.8	0.500	0.990	0.653	0.196
Nickel		16	100	7.60	21.0	12.3	3.34
Potassium		16	100	1,700	3,900	2,560	605
Selenium	0.82 - 2	16	18.8	1.00	1.20	0.602	0.272
Silica		16	100	650	2,200	982	393
Silver	0.08 - 0.42	16	31.3	0.087	0.160	0.117	0.051
Sodium	130 - 170	16	12.5	320	340	105	88.2
Strontium		16	100	14.0	79.0	32.4	16.7
Thallium[c]	0.87 - 1.2	16	6.25	0.550	0.550	0.511	0.040
Tin	0.92 - 4	16	18.8	1.50	1.70	0.910	0.518
Titanium		16	100	74.0	260	188	58.1
Vanadium		16	100	27.0	65.0	36.1	8.56
Zinc		16	100	23.0	79.0	46.9	15.8
Radionuclides (pCi/g)[d]							
Americium-241		16	N/A	-0.050	0.100	0.017	0.037
Gross Alpha		2	N/A	18.0	19.0	18.5	0.707
Gross Beta		2	N/A	21.0	21.0	21.0	0
Plutonium-239/240		22	N/A	0.006	0.250	0.057	0.054
Uranium-233/234		16	N/A	0.413	2.04	0.992	0.432
Uranium-235		16	N/A	-0.0241	0.188	0.0602	0.0635
Uranium-238		16	N/A	0.579	1.53	0.930	0.267

[a] Values in this column are reported results for nondetects (i.e., U-qualified results).

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

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

[d] All radionuclide values are considered detects.

N/A = Not applicable.

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

Analyte	Range of Reported Detection Limits[a]	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[b]	Standard Deviation[b]
Inorganics (mg/kg)							
Aluminum		3	100	12,000	20,000	17,000	4,360
Arsenic		3	100	2.10	4.60	3.47	1.27
Barium		3	100	80	180	127	50.3
Beryllium	0.59 - 0.96	3	33.3	1.10	1.10	0.625	0.422
Boron		3	100	2.40	7.50	5.10	2.56
Cadmium[c]	0.068 - 0.07	3	33.3	0.560	0.560	0.210	0.303
Calcium		3	100	5,400	7,600	6,730	1,170
Chromium		3	100	14	20	16.3	3.21
Cobalt		3	100	5.80	8	6.57	1.24
Copper		3	100	13	22	17.7	4.51
Iron		3	100	12,000	14,000	13,300	1,150
Lead		3	100	9.10	20	13.4	5.82
Lithium		3	100	12	14	13	1
Magnesium		3	100	3,100	3,100	3,100	0
Manganese		3	100	82	230	181	85.4
Mercury		3	100	0.0160	0.0490	0.0280	0.0182
Molybdenum	0.31 - 0.32	3	33.3	0.690	0.690	0.335	0.307
Nickel	10 - 10	3	66.7	13	17	11.7	6.11
Potassium		3	100	2,400	3,000	2,730	306
Silica[c]		3	100	710	1,800	1,080	624
Sodium	430 - 630	3	33.3	150	150	227	83.1
Strontium		3	100	21	46	31.3	13.1
Titanium[c]		3	100	140	420	277	140
Uranium	1.5 - 1.6	3	33.3	1.50	1.50	1.02	0.419
Vanadium		3	100	23	45	34.3	11
Zinc		3	100	54	190	104	75
Radionuclides (pCi/g)[d]							
Americium-241		1	N/A	-0.00555	-0.00555	-0.00555	N/A
Plutonium-239/240		1	N/A	0.0875	0.0875	0.0875	N/A
Uranium-233/234		1	N/A	1.47	1.47	1.47	N/A
Uranium-235		1	N/A	0.111	0.111	0.111	N/A
Uranium-238		1	N/A	1.10	1.10	1.10	N/A

[a] Values in this column are reported results for nondetects (i.e., U-qualified results).

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

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

[d] All radionuclide values are considered detects.

N/A = Not applicable.

Table 1.5
Summary of Detected Analytes in Surface Soil

Analyte	Range of Reported Detection Limits[a]	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[b]	Standard Deviation[b]
Inorganics (mg/kg)							
Aluminum		14	100	11,000	29,000	15,900	4,330
Antimony	0.31 - 0.43	14	14.3	0.390	0.480	0.207	0.0999
Arsenic		14	100	5.70	9	7.47	1.05
Barium		14	100	78	210	130	32.4
Beryllium	0.65 - 0.95	14	57.1	0.590	1.30	0.668	0.276
Boron		14	100	3	9.70	5.93	1.76
Cadmium[c]	0.066 - 0.2	14	42.9	0.190	0.350	0.152	0.130
Calcium		14	100	1,500	7,800	3,690	1,490
Chromium		14	100	12	28	16	3.88
Cobalt		14	100	3.70	9.70	5.96	1.47
Copper		14	100	6.50	19	12.3	3.36
Iron		14	100	10,000	23,000	14,400	3,160
Lead		14	100	17	38	27.8	5.18
Lithium		14	100	7.70	19	11.2	2.96
Magnesium		14	100	1,200	4,800	2,310	865
Manganese		14	100	150	330	246	45.4
Mercury		14	100	0.0270	0.130	0.0426	0.0261
Molybdenum		14	100	0.500	0.990	0.668	0.131
Nickel		14	100	7.60	21	12	3.46
Potassium		14	100	1,700	3,900	2,660	588
Selenium	0.82 - 1	14	21.4	1	1.20	0.581	0.268
Silica		14	100	650	1,200	865	190
Silver	0.08 - 0.33	14	35.7	0.0870	0.160	0.114	0.0449
Sodium[c]	130 - 170	14	7.14	340	340	92.1	71.5
Strontium		14	100	14	79	31	17.5
Tin	0.92 - 2.6	14	21.4	1.50	1.70	0.858	0.454
Titanium		14	100	74	260	197	55
Vanadium		14	100	27	65	36.1	9.19
Zinc		14	100	23	74	43.5	13.4
Radionuclides (pCi/g)[d]							
Americium-241		14	N/A	-0.0497	0.0444	0.00992	0.0308
Gross Alpha		2	N/A	18	19	18.5	0.707
Gross Beta		2	N/A	21	21	21	N/A
Plutonium-239/240		20	N/A	0.00555	0.250	0.0565	0.0560
Uranium-233/234		14	N/A	0.413	1.28	0.870	0.286
Uranium-235		14	N/A	-0.0241	0.138	0.0484	0.0560
Uranium-238		14	N/A	0.579	1.22	0.859	0.193

[a] Values in this column are reported results for nondetects (i.e., U-qualified results).

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

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

[d] All radionuclide values are considered detects.

Table 1.5
Summary of Detected Analytes in Surface Soil

Analyte	Range of Reported Detection Limits[a]	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[b]	Standard Deviation[b]

N/A = Not applicable.

Table 1.6
Summary of Detected Analytes in Surface Soil (PMJM Habitat)

Analyte	Range of Reported Detection Limits[a]	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[b]	Standard Deviation[b]
Inorganics (mg/kg)							
Aluminum		4	100	13,000	17,000	15,500	1,915
Arsenic		4	100	6.30	8.20	7.08	0.818
Barium		4	100	100	170	138	29.9
Beryllium		4	75	0.820	0.940	0.771	0.257
Boron		4	100	4.90	6.40	5.53	0.629
Cadmium		4	50	0.280	0.340	0.173	0.160
Calcium		4	100	3,200	5,000	4,275	763
Chromium		4	100	14.0	21.0	16.8	3.10
Cobalt		4	100	5.10	8.00	6.90	1.25
Copper		4	100	12.0	18.0	14.8	2.50
Iron		4	100	13,000	18,000	16,000	2,449
Lead		4	100	25.0	28.0	26.5	1.29
Lithium[c]		4	100	7.90	15.0	11.2	3.05
Magnesium		4	100	2,100	3,300	2,750	493
Manganese		4	100	210	330	288	56.8
Mercury		4	75	0.0310	0.0400	0.0280	0.0133
Molybdenum		4	100	0.580	0.960	0.683	0.185
Nickel		4	100	11.0	17.0	14.5	2.65
Potassium		4	100	2,100	3,900	2,900	783
Silica		4	100	740	1,200	990	245
Sodium[c]		4	25	340	340	136	136
Strontium		4	100	32.0	79.0	47.5	21.9
Tin		4	50	1.50	1.70	1.12	0.570
Titanium		4	100	74.0	190	141	48.5
Vanadium		4	100	31.0	48.0	39.5	6.95
Zinc		4	100	46.0	68.0	56.8	11.4
Radionuclides (pCi/g)[d]							
Americium-241		3	N/A	-0.0425	0.381	0.0815	0.200
Gross Alpha		1	N/A	19	19	19	N/A
Gross Beta		1	N/A	21	21	21	N/A
Plutonium-239/240		6	N/A	0.00937	0.250	0.0762	0.0864
Uranium-233/234		3	N/A	0.737	1.28	0.964	0.262
Uranium-235		3	N/A	-0.0218	0.125	0.0339	0.0675
Uranium-238		3	N/A	0.791	1.07	0.936	0.121

[a] Values in this column are reported results for nondetects (i.e., U-qualified results).

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

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

[d] All radionuclide values are considered detects.

N/A = Not applicable.

Table 1.7
Summary of Detected Analytes in Subsurface Soil

Analyte	Range of Reported Detection Limit[a]	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[b]	Standard Deviation[b]
Inorganics (mg/kg)							
Aluminum		2	100	12,000	19,000	15,500	4,950
Arsenic		2	100	2.10	4.60	3.35	1.77
Barium		2	100	80	120	100	28.3
Boron		2	100	2.40	5.40	3.90	2.12
Calcium		2	100	7,200	7,600	7,400	283
Chromium		2	100	14	15	14.5	0.707
Cobalt		2	100	5.90	8	6.95	1.48
Copper		2	100	13	22	17.5	6.36
Iron		2	100	14,000	14,000	14,000	N/A
Lead		2	100	9.10	11	10.1	1.34
Lithium[c]		2	100	12	13	12.5	0.707
Magnesium		2	100	3,100	3,100	3,100	N/A
Manganese		2	100	230	230	230	N/A
Mercury		2	100	0.0160	0.0190	0.0175	0.00212
Nickel	10 - 10	2	50	13	13	9	5.66
Potassium		2	100	2,800	3,000	2,900	141
Silica[c]		2	100	710	730	720	14.1
Strontium		2	100	21	27	24	4.24
Titanium[c]		2	100	270	420	345	106
Uranium	1.5 - 1.5	2	50	1.50	1.50	1.13	0.530
Vanadium		2	100	23	35	29	8.49
Zinc		2	100	54	190	122	96.2

[a] Values in this column are reported results for nondetects (i.e., U-qualified results).

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

[c] 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.

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	8,200	0.820	500-1,200	2,500	No
Magnesium	4,800	0.480	80.0-420	65.0-110	No
Potassium	3,900	0.390	2,000-3,500	N/A	No
Sodium	340	0.0340	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 and 2002.

N/A = Not available.

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	24,800	29,000	Yes	17,600	No	No
Antimony	44.4	0.480	No	--	--	No
Arsenic	**2.41**	**9**	**Yes**	**7.78**	**Yes**	**Yes**
Barium	2,870	210	No	--	--	No
Beryllium	100	1.30	No	--	--	No
Boron	9,480	9.70	No	--	--	No
Cadmium	91.4	0.710	No	--	--	No
Chromium[c]	28.4	28	No	--	--	No
Cobalt	122	9.70	No	--	--	No
Copper	4,440	19	No	--	--	No
Iron	33,300	23,000	No	--	--	No
Lead	1,000	38	No	--	--	No
Lithium	2,220	19	No	--	--	No
Manganese	419	330	No	--	--	No
Mercury	32.9	0.130	No	--	--	No
Molybdenum	555	0.990	No	--	--	No
Nickel	2,220	21	No	--	--	No
Selenium	555	1.20	No	--	--	No
Silica	N/A	2,200	No	--	--	UT
Silver	555	0.160	No	--	--	No
Strontium	66,700	79	No	--	--	No
Thallium	7.78	0.550	No	--	--	No
Tin	66,700	1.70	No	--	--	No
Titanium	170,000	260	No	--	--	No
Vanadium	111	65	No	--	--	No
Zinc	33,300	79	No	--	--	No
Radionuclides (pCi/g)						
Americium-241	7.69	0.0997	No	--	--	No
Gross Alpha	N/A	19	No	--	--	UT
Gross Beta	N/A	21	No	--	--	UT
Plutonium-239/240	9.80	0.250	No	--	--	No
Uranium-233/234	25.3	2.04	No	--	--	No
Uranium-235	1.05	0.188	No	--	--	No
Uranium-238	29.3	1.53	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 in the PRG screen because it is more conservative than the PRG for chromium (III).

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.

Table 2.3

Statistical Distributions and Comparison to Background for the SWEU[a]

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			SWEU Data Set					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1-p	Retain as PCOC?
Surface Soil/Surface Sediment									
Arsenic	**73**	**GAMMA**	**92**	**16**	**NORMAL**	**100**	**WRS**	**1.36E-06**	**Yes**

[a] EU data used for background comparisons do not include data from background locations.

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	7,600	0.760	500-1,200	2,500	No
Magnesium	3,100	0.310	80.0-420	65.0-110	No
Potassium	3,000	0.300	2,000-3,500	N/A	No
Sodium	150	0.0150	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 and 2002.

N/A = Not available.

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	285,000	20,000	--	--	--	No
Arsenic	27.7	4.60	--	--	--	No
Barium	33,000	180	--	--	--	No
Beryllium	1,150	1.10	--	--	--	No
Boron	109,000	7.50	--	--	--	No
Cadmium	1,050	0.560	--	--	--	No
Chromium[c]	327	20	--	--	--	No
Cobalt	1,400	8	--	--	--	No
Copper	51,100	22	--	--	--	No
Iron	383,000	14,000	--	--	--	No
Lead	1,000	20	--	--	--	No
Lithium	25,600	14	--	--	--	No
Manganese	4,820	230	--	--	--	No
Mercury	379	0.0490	--	--	--	No
Molybdenum	6,390	0.690	--	--	--	No
Nickel	25,600	17	--	--	--	No
Silica	N/A	1,800	--	--	--	UT
Strontium	767,000	46	--	--	--	No
Titanium	1.95E+06	420	--	--	--	No
Uranium	3,830	1.50	--	--	--	No
Vanadium	1,280	45	--	--	--	No
Zinc	383,000	190	--	--	--	No
Radionuclides (pCi/g)						
Americium-241	88.4	-0.00555	--	--	--	No
Plutonium-239/240	112	0.0875	--	--	--	No
Uranium-233/234	291	1.47	--	--	--	No
Uranium-235	12.1	0.111	--	--	--	No
Uranium-238	337	1.10	--	--	--	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 in the PRG screen because it is more conservative than the PRG for chromium (III).

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.

Table 2.6
Summary of the COC Selection Process

Analyte	MDC Exceeds PRG?	UCL Exceeds PRG?	Detection Frequency > 5%	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	No	No
Subsurface Soil/ Subsurface Sediment							
None >PRG	No	--	--	--	--	--	No

N/A = Not applicable.

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

Table 6.1
Summary of Detected PCOCs Without PRGs[a]

Analyte	Surface Soil/Surface Sediment	Subsurface Soil/Subsurface Sediment
Inorganics		
Silica[b]	X	X
Radionuclides		
Gross alpha	X	N/A
Gross beta	X	N/A

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

[b] All detections for subsurface soil 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 = PRG is unavailable.

Table 7.1
Comparison of MDCs in Surface Soil to NOAEL ESLs for Terrestrial Plants, Invertebrates, and Vertebrates in the SWEU

Analyte	MDC	Terrestrial Plants		Terrestrial Invertebrates		Mourning Dove Herbivore		Mourning Dove Insectivore		American Kestrel		Deer Mouse Herbivore		Deer Mouse Insectivore		Prairie Dog		Mule Deer		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	29,000	**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	Plant	**Yes**
Antimony	0.48	5	No	78	No	N/A	N/A	N/A	N/A	N/A	N/A	10	No	0.90	No	19	No	58	No	138	No	13	No	3.85	No	N/A	N/A	Deer Mouse Insectivore	No
Arsenic	9	10	No	60	No	20	No	164	No	1,028	No	**2.57**	**Yes**	51	No	9.35	No	13	No	709	No	341	No	293	No	N/A	N/A	Deer Mouse Herbivore	**Yes**
Barium	210	500	No	330	No	**159**	**Yes**	357	No	1,317	No	930	No	4,427	No	3,224	No	4,766	No	24,896	No	19,838	No	18,369	No	N/A	N/A	Mourning Dove Herbivore	**Yes**
Beryllium	1.3	10	No	40	No	N/A	N/A	N/A	N/A	N/A	N/A	160	No	6.82	No	211	No	896	No	1,072	No	103	No	29	No	N/A	N/A	Deer Mouse Insectivore	No
Boron	9.7	**0.5**	**Yes**	N/A	N/A	30	No	115	No	167	No	62	No	422	No	237	No	314	No	929	No	6,070	No	1,816	No	N/A	N/A	Plant	**Yes**
Cadmium	0.35	32	No	140	No	28	No	0.71	No	15	No	60	No	1.56	No	198	No	723	No	1,360	No	51	No	10	No	N/A	N/A	Mourning Dove Insectivore	No
Calcium	7,800	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
Chromium[b]	28	**1**	**Yes**	**0.40**	**Yes**	**25**	**Yes**	**1.34**	**Yes**	**14**	**Yes**	281	No	**16**	**Yes**	703	No	1,461	No	4,173	No	250	No	69	No	N/A	N/A	Invertebrate	**Yes**
Cobalt	9.7	13	No	N/A	N/A	278	No	87	No	440	No	1,476	No	363	No	2,461	No	7,902	No	3,785	No	2,492	No	1,519	No	N/A	N/A	Plant	No
Copper	19	100	No	50	No	29	No	**8.25**	**Yes**	164	No	295	No	605	No	838	No	4,119	No	5,459	No	3,000	No	4,641	No	N/A	N/A	Mourning Dove Insectivore	**Yes**
Iron	23,000	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	38	110	No	1700	No	50	No	**12**	**Yes**	96	No	1,344	No	242	No	1,850	No	9,798	No	8,927	No	3,066	No	1,393	No	N/A	N/A	Mourning Dove Insectivore	**Yes**
Lithium	19	**2**	**Yes**	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,882	No	610	No	3,178	No	10,173	No	18,431	No	5,608	No	2,560	No	N/A	N/A	Plant	**Yes**
Magnesium	4,800	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
Manganese	330	500	No	N/A	N/A	1,032	No	2,631	No	9,917	No	486	No	4,080	No	1,519	No	2,506	No	14,051	No	10,939	No	19,115	No	N/A	N/A	Deer Mouse Herbivore	No
Mercury	0.13	0.3	No	**0.1**	**Yes**	0.2	No	**0.0001**	**Yes**	1.57	No	0.44	No	0.18	No	3.15	No	7.56	No	8.18	No	8.49	No	37	No	N/A	N/A	Mourning Dove Insectivore	**Yes**
Molybdenum	0.99	2	No	N/A	N/A	44	No	6.97	No	77	No	8.68	No	1.9	No	27	No	44	No	275	No	29	No	8.18	No	N/A	N/A	Deer Mouse Insectivore	No
Nickel	21	30	No	200	No	44	No	**1.24**	**Yes**	**13**	**Yes**	**16**	**Yes**	**0.43**	**Yes**	38	No	124	No	91	No	**6.02**	**Yes**	**1.86**	**Yes**	N/A	N/A	Deer Mouse Insectivore	**Yes**
Potassium	3,900	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
Selenium	1.2	**1**	**Yes**	70	No	1.61	No	**1**	**Yes**	8.48	No	**0.87**	**Yes**	**0.75**	**Yes**	2.8	No	3.82	No	32	No	12	No	5.39	No	N/A	N/A	Deer Mouse Insectivore	**Yes**
Silica	1,200	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
Silver	0.16	2	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	Plant	No
Sodium	340	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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	79	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	3,519	No	4,702	No	584,444	No	144,904	No	57,298	No	N/A	N/A	Deer Mouse Herbivore	No
Tin	1.7	50	No	N/A	N/A	26.1	No	2.9	No	18.98	No	45	No	3.77	No	81	No	241.78	No	70	No	36.1	No	16.2	No	N/A	N/A	Mourning Dove Insectivore	No
Titanium	260	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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
Vanadium	65	**2**	**Yes**	N/A	N/A	503	No	274	No	1,514	No	**64**	**Yes**	**30**	**Yes**	84	No	358	No	341	No	164	No	121	No	N/A	N/A	Plant	**Yes**
Zinc	74	**50**	**Yes**	200	No	109	No	**0.65**	**Yes**	113	No	171	No	**5.29**	**Yes**	1,174	No	2,772	No	16,489	No	3,887	No	431	No	N/A	N/A	Mourning Dove Insectivore	**Yes**
Radionuclides (pCi/g)																													
Americium-241	0.0444	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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 Receptors	No
Gross Alpha	19	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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	21	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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	0.25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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 Receptors	No
Uranium-233/234	1.28	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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 Receptors	No
Uranium-235	0.138	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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 Receptors	No
Uranium-238	1.22	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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 Receptors	No

[a] Radionuclide ESLs are not receptor-specific. They are considered protective of all terrestrial ecological species.
[b] ESLs for chromium were developed based on available toxicity data and are based on chromium III (birds) and chromium VI (plants, invertebrates, and mammals).
N/A = No ESL available for the ECOI/receptor pair.
UT = Uncertain toxicity; no ESL available (assessed in Section 10).
Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.2
Summary of NOAEL ESL Screening Results for SWEU Surface Soil - Non-PMJM Receptors

Analyte	Terrestrial Plant Exceedance?	Terrestrial Invertebrate Exceedance?	Terrestrial Vertebrate Exceedance?
Inorganics			
Aluminum	**Yes**	UT	UT
Antimony	No	No	No
Arsenic	No	No	**Yes**
Barium	No	No	**Yes**
Beryllium	No	No	No
Boron	**Yes**	UT	No
Cadmium	No	No	No
Calcium	UT	UT	UT
Chromium	**Yes**	**Yes**	**Yes**
Cobalt	No	UT	No
Copper	No	No	**Yes**
Iron	UT	UT	UT
Lead	No	No	**Yes**
Lithium	**Yes**	UT	No
Magnesium	UT	UT	UT
Manganese	No	UT	No
Mercury	No	**Yes**	**Yes**
Molybdenum	No	UT	No
Nickel	No	No	**Yes**
Potassium	UT	UT	UT
Selenium	**Yes**	No	**Yes**
Silica	UT	UT	UT
Silver	No	UT	UT
Sodium	UT	UT	UT
Strontium	UT	UT	No
Tin	No	UT	No
Titanium	UT	UT	UT
Vanadium	**Yes**	UT	**Yes**
Zinc	**Yes**	No	**Yes**
Radionuclides			
Americium-241	UT	UT	No
Gross Alpha	UT	UT	UT
Gross Beta	UT	UT	UT
Plutonium-239/240	UT	UT	No
Uranium-233/234	UT	UT	No
Uranium-235	UT	UT	No
Uranium-238	UT	UT	No

UT = Uncertain toxicity; no ESL available (assessed in Section 10).

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

Table 7.3
Comparison of MDCs in SWEU Surface Soil with NOAEL ESLs for the PMJM

Analyte	MDC	PMJM NOAEL ESL	MDC > ESL	Retained for Further Analysis?
Inorganics (mg/kg)				
Aluminum	17,000	N/A	N/A	UT
Arsenic	8.2	2.21	**Yes**	**Yes**
Barium	170	743	No	No
Beryllium	0.94	8.16	No	No
Boron	6.4	52.7	No	No
Cadmium	0.28	1.75	No	No
Calcium	5,000	N/A	N/A	UT
Chromium[a]	17	19.3	No	No
Cobalt	7.3	340	No	No
Copper	18	95.0	No	No
Iron	18,000	N/A	N/A	UT
Lead	28	220	No	No
Lithium	12	519	No	No
Magnesium	2,800	N/A	N/A	UT
Manganese	330	388	No	No
Mercury	0.04	0.052	No	No
Molybdenum	0.6	1.84	No	No
Nickel	17	0.510	**Yes**	**Yes**
Potassium	3,100	N/A	N/A	UT
Silica	1,200	N/A	N/A	UT
Sodium	340	N/A	N/A	UT
Strontium	79	833	No	No
Tin	1.7	4.22	No	No
Titanium	190	N/A	N/A	UT
Vanadium	40	21.6	**Yes**	**Yes**
Zinc	68	6.41	**Yes**	**Yes**
Radionuclides (pCi/L)				
Americium-241	-0.00184	3,890	No	No
Gross Alpha	19	N/A	N/A	UT
Gross Beta	21	N/A	N/A	UT
Plutonium-239/240	0.25	6,110	No	No
Uranium-233/234	1.28	4,980	No	No
Uranium-235	0.125	2,770	No	No
Uranium-238	1.07	1,580	No	No

[a] Chromium ESL is based on Chromium VI.

UT = Uncertain toxicity; no ESLs available (assessed in Section 10).

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

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

Table 7.4
Statistical Distributions and Background Comparisons for ECOIs in SWEU Surface Soil - Non-PMJM Receptors

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		Retain as ECOI?
	Background Data Set			SWEU Data Set					
	Total No. of Samples	Distribution Recommended by ProUCL	Detections (%)	Total No. of Samples	Distribution Recommended by ProUCL	Detections (%)	Test	1-p	
Aluminum	20	NORMAL	100	14	GAMMA	100	WRS	8.27E-05	**Yes**
Arsenic	20	NORMAL	100	14	NORMAL	100	t-Test_N	0.012	**Yes**
Barium	20	NORMAL	100	14	NORMAL	100	t-Test_N	0.002	**Yes**
Boron	N/A	N/A	N/A	14	NORMAL	100	N/A	N/A	**Yes**[a]
Chromium	20	NORMAL	100	14	NON-PARAMETRIC	100	WRS	5.79E-05	**Yes**
Copper	20	NON-PARAMETRIC	100	14	NORMAL	100	WRS	0.862	No
Lead	20	NORMAL	100	14	NORMAL	100	t-Test_N	0.966	No
Lithium	20	NORMAL	100	14	NORMAL	100	t-Test_N	8.76E-05	**Yes**
Mercury	20	NON-PARAMETRIC	40	14	NON-PARAMETRIC	100	WRS	1.000	No
Nickel	20	NORMAL	100	14	NON-PARAMETRIC	100	WRS	0.020	**Yes**
Selenium	20	NON-PARAMETRIC	60	14	NON-PARAMETRIC	21	WRS	0.431	No
Vanadium	20	NORMAL	100	14	GAMMA	100	WRS	0.002	**Yes**
Zinc	20	NORMAL	100	14	NORMAL	100	t-Test_N	0.917	No

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

N/A = Not applicable. Background comparison was not performed because background data were not available or detection frequency of an analyte in EU or background data set is less than 20 percent.

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

Table 7.5
Statistical Distributions and Background Comparisons for ECOIs in SWEU Surface Soil - PMJM Receptors

Analyte	Statistical Distribution Testing Results						Background Comparison		Retain as ECOI?
	Background			SWEU					
	Total No. of Samples	Distribution Recommended by ProUCL	Detections (%)	Total No. of Samples	Distribution Recommended by ProUCL	Detections (%)	Test	1-p	
Arsenic	20	NORMAL	100	4	NORMAL	100	t-Test_N	0.173	No
Nickel	20	NORMAL	100	4	NORMAL	100	t-Test_N	0.001	**Yes**
Vanadium	20	NORMAL	100	4	NORMAL	100	t-Test_N	0.005	**Yes**
Zinc	20	NORMAL	100	4	NORMAL	100	t-Test_N	0.152	No

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

Table 7.6

Statistical Concentrations in SWEU Surface Soil - Non-PMJM[a]

Analyte	Number of Samples	Mean Concentration	Median	75th Percentile	95th Percentile	95UCL	95UTL	MDC
Inorganics (mg/kg)								
Aluminum	14	15,857	15,500	16,750	21,850	17,892	29,000	29,000
Arsenic	14	7.47	7.40	8.43	8.74	7.97	9.00	9.00
Barium	14	130	130	138	184	145	198	210
Boron	14	5.93	5.55	6.55	8.60	6.76	9.63	9.70
Chromium	14	16.0	15.5	17.0	20.9	17.8	28.0	28.0
Lithium	14	11.2	11.0	12.0	15.8	12.6	17.4	19.0
Nickel	14	12.0	11.0	12.5	18.4	13.7	21.0	21.0
Vanadium	14	36.1	34.5	36.8	48.8	40.3	65.0	65.0

[a] Statistics computed using one-half the reported values for non-detects.

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<UCL, then the MDC is used as the UTL.

Table 7.7
Upper-Bound Exposure Point Concentration Comparison to Limiting ESLs - SWEU Surface Soil

Analyte	Small Home Range Receptors			Large Home Range Receptors		
	EPC (UTL)	Limiting ESL[a]	EPC>ESL?	EPC (UCL)	Limiting ESL[b]	EPC>ESL?
Inorganics (mg/kg)						
Aluminum	29,000	50	**Yes**	17,892	N/A	N/A
Arsenic	9.68	9.87	No	7.97	49.9	No
Barium	198	222	No	145	4,770	No
Boron	9.63	0.5	**Yes**	6.76	314	No
Chromium	28.0	0.4	**Yes**	17.8	68.5	No
Lithium	17.4	2	**Yes**	12.6	2,560	No
Nickel	21.0	0.431	**Yes**	13.7	1.86	**Yes**
Vanadium	65.0	2	**Yes**	40.3	121	No

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

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

If tESL was not available, then the NOAEL ESL was used.

N/A = Not applicable; ESL not available.

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

Table 7.8
Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Small Home Range Receptors

Analyte	Small Home Range Receptor UTL	Receptor-Specific ESLs[a]							
		Terrestrial Plant	Terrestrial Invertebrate	American Kestrel	Mourning Dove (herbivore)	Mourning Dove (insectivore)	Deer Mouse (herbivore)	Deer Mouse (insectivore)	Prairie Dog
Inorganics (mg/kg)									
Aluminum	29,000	**50**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boron	9.63	**0.5**	N/A	167	30.3	115	62.1	422	237
Chromium	28.0	**1**	**0.4**	**14.2**	**24.6**	**1.34**	281	**15.9**	703
Lithium	17.4	**2**	N/A	N/A	N/A	N/A	1,880	610	3,180
Nickel	21.0	30	200	89.9	320	**7.84**	**16.4**	**0.431**	38.3
Vanadium	65.0	**2**	N/A	1,510	503	274	**63.7**	**29.9**	83.5

[a]Threshold ESL, if available, for that receptor.
N/A = Not applicable; ESL not available.
Bold = Receptors of potential concern.

Table 7.9

Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Large Home Range Receptors

Analyte	Large Home Range Receptor 95th UCL	Receptor-Specific ESLs[a]			
		Mule Deer	Coyote (carnivore)	Coyote (generalist)	Coyote (insectivore)
Inorganics (mg/kg)					
Nickel	13.7	124	90.9	**6.02**	**1.86**

[a]Lowest ESL (threshold if available) for that receptor.

Bold = Receptors of potential concern.

Table 7.10
Summary of ECOPC Screening Steps for Surface Soil - Non-PMJM Receptors

Analyte	Exceed Any NOAEL ESL?	Detection Frequency >5%?	Exceed Background?[a]	Upper-Bound EPC > Threshold ESL[b]?	Professional Judgment - Retain?	Retain as ECOPC?	Receptor of Potential Concern?
Inorganics							
Aluminum	Yes	Yes	Yes	Yes	No	No	--
Antimony	No	--	--	--	--	No	--
Arsenic	Yes	Yes	Yes	No	--	No	--
Barium	Yes	Yes	Yes	No	--	No	--
Beryllium	No	--	--	--	--	No	--
Boron	Yes	Yes	N/A	Yes	No	No	--
Cadmium	No	--	--	--	--	No	--
Calcium	UT	--	--	--	--	No	--
Chromium	Yes	Yes	Yes	Yes	No	No	--
Cobalt	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	No	--	--	--	--	No	--
Mercury	Yes	Yes	No	--	--	No	--
Molybdenum	No	--	--	--	--	No	--
Nickel	Yes	Yes	Yes	Yes	No	No	--
Potassium	UT	--	--	--	--	No	--
Selenium	Yes	Yes	No	--	--	No	--
Silica	UT	--	--	--	--	No	--
Silver	No	--	--	--	--	No	--
Sodium	UT	--	--	--	--	No	--
Strontium	No	--	--	--	--	No	--
Tin	No	--	--	--	--	No	--
Titanium	UT	--	--	--	--	No	--
Vanadium	Yes	Yes	Yes	Yes	No	No	--
Zinc	Yes	Yes	No	--	--	No	--
Radionuclides							
Americium-241	No	--	--	--	--	No	--
Gross Alpha	UT	--	--	--	--	No	--
Gross Beta	UT	--	--	--	--	No	--
Plutonium-239/240	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.

[b] If tESL was not available, then the NOAEL ESL was used.

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

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

Table 7.11
Summary of ECOPC Screening Steps for Surface Soil - PMJM

Analyte	Exceed PMJM NOAEL ESL	Exceed Background	Professional Judgment - Retain?	ECOPC
Inorganics				
Aluminum	UT	--	--	No
Arsenic	Yes	No	--	No
Barium	No	--	--	No
Beryllium	No	--	--	No
Boron	No	--	--	No
Cadmium	No	--	--	No
Calcium	UT	--	--	No
Chromium	No	--	--	No
Cobalt	No	--	--	No
Copper	No	--	--	No
Iron	UT	--	--	No
Lead	No	--	--	No
Lithium	No	--	--	No
Magnesium	UT	--	--	No
Manganese	No	--	--	No
Mercury	No	--	--	No
Molybdenum	No	--	--	No
Nickel	Yes	Yes	No	No
Potassium	UT	--	--	No
Silica	UT	--	--	No
Sodium	UT	--	--	No
Strontium	No	--	--	No
Tin	No	--	--	No
Titanium	UT	--	--	No
Vanadium	Yes	Yes	No	No
Zinc	Yes	No	--	No
Radionuclides				
Americium-241	No	--	--	No
Gross Beta	UT	--	--	No
Plutonium-239/240	No	--	--	No
Uranium-233/234	No	--	--	No
Uranium-238	No	--	--	No

-- = Screen not performed because analyte was eliminated from further consideration in a previous ECOPC step.
UT = Uncertain toxicity; no ESL available (assessed in Section 10.0).

Table 7.12
Comparison of MDCs in Subsurface Soil to NOAEL ESLs for the Burrowing Receptor

Analyte	MDC	Prairie Dog NOAEL ESL[a]	MDC > ESL?
Inorganics (mg/kg)			
Aluminum	19,000	N/A	UT
Arsenic	4.6	9.35	No
Barium	120	3,220	No
Boron	5.4	237	No
Calcium	7,600	N/A	UT
Chromium[a]	15	703	No
Cobalt	8	2,460	No
Copper	22	838	No
Iron	14,000	N/A	UT
Lead	11	1,850	No
Lithium	13	3,180	No
Magnesium	3,100	N/A	UT
Manganese	230	1,519	No
Mercury	0.019	3.15	No
Nickel	13	38.3	No
Potassium	3,000	N/A	UT
Silica	730	N/A	UT
Strontium	27	3,520	No
Titanium	420	N/A	UT
Uranium	1.5	1,230	No
Vanadium	35	83.5	No
Zinc	190	1,170	No

[a] Chromium ESL is based on Chromium (VI).
UT = Uncertain toxicity; no ESLs available (assessed in Section 10).
N/A = ESL not available.

Table 7.13
Summary of ECOPC Screening Steps for Subsurface Soil

Analyte	Exceed NOAEL ESL?	Detection Frequency >5%?	Exceed Background?[a]	Upper Bound EPC > Limiting ESL?	Professional Judgment - Retain?	Retain as ECOPC?
Inorganics						
Aluminum	N/A	--	--	--	--	No
Arsenic	No	--	--	--	--	No
Barium	No	--	--	--	--	No
Boron	No	--	--	--	--	No
Calcium	N/A	--	--	--	--	No
Chromium	No	--	--	--	--	No
Cobalt	No	--	--	--	--	No
Copper	No	--	--	--	--	No
Iron	N/A	--	--	--	--	No
Lead	No	--	--	--	--	No
Lithium	No	--	--	--	--	No
Magnesium	N/A	--	--	--	--	No
Manganese	No	--	--	--	--	No
Mercury	No	--	--	--	--	No
Nickel	No	--	--	--	--	No
Potassium	N/A	--	--	--	--	No
Silica	N/A	--	--	--	--	No
Strontium	No	--	--	--	--	No
Titanium	N/A	--	--	--	--	No
Uranium	No	--	--	--	--	No
Vanadium	No	--	--	--	--	No
Zinc	No	--	--	--	--	No

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

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

N/A = Not applicable; ESL not available (assessed in Section 10.0).

FIGURES

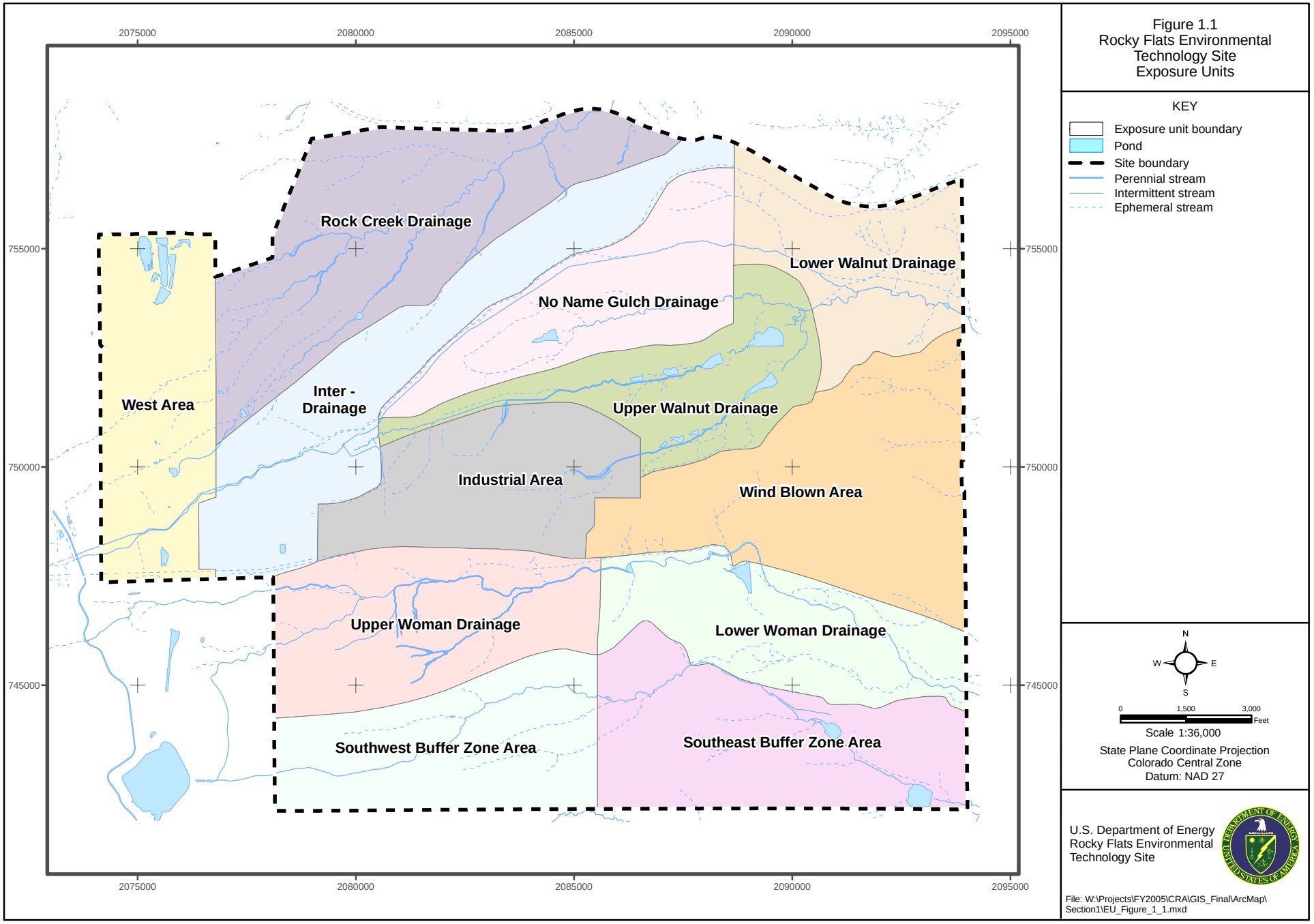

Figure 1.1
Rocky Flats Environmental
Technology Site
Exposure Units

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

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

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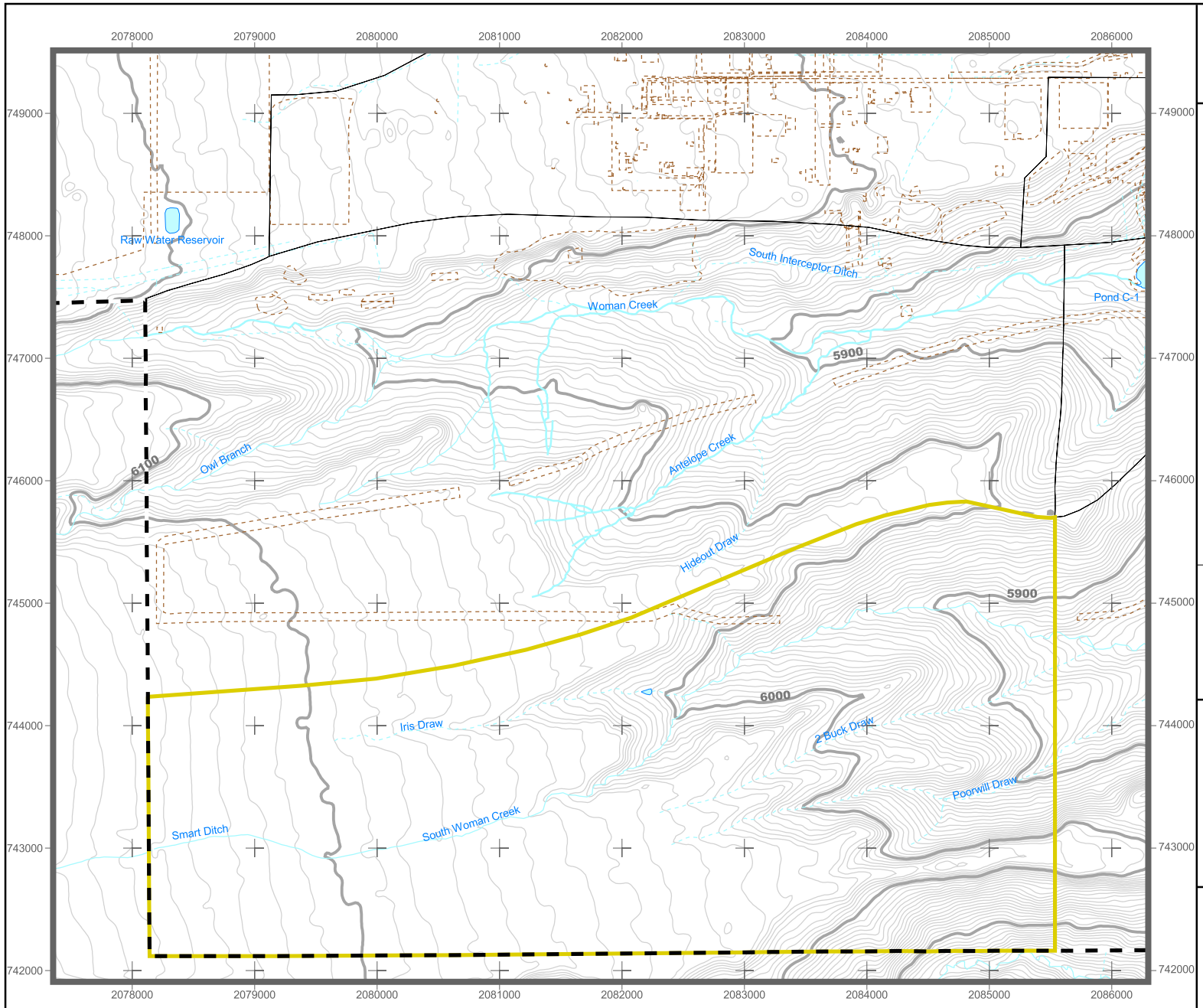

Figure 1.2
Topography and Historical IHSS Locations in the Southwest Buffer Zone Area Exposure Unit

KEY

- Southwest Buffer Zone 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

0 600 1200 Feet

Scale 1:14400

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

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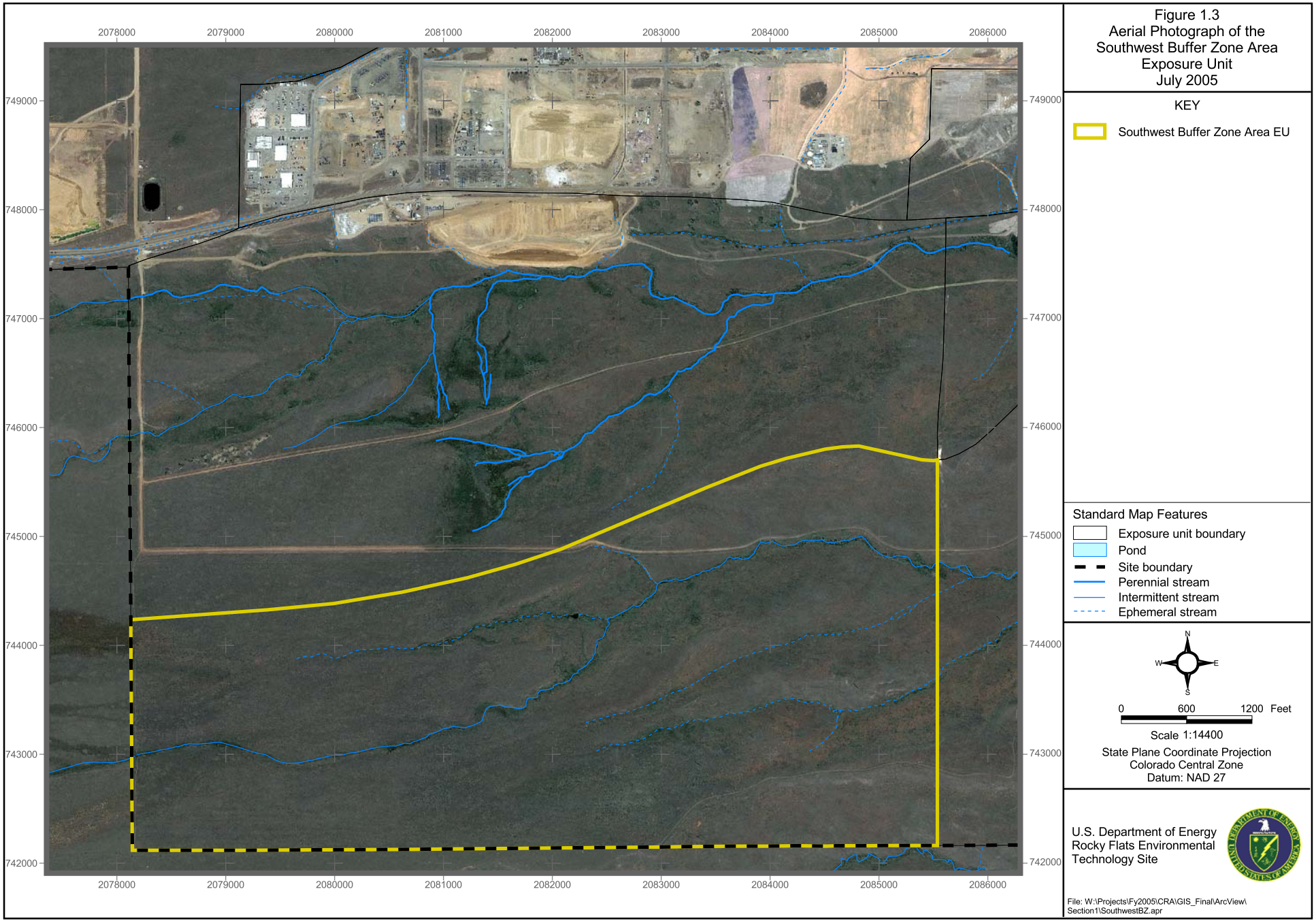

Figure 1.3
Aerial Photograph of the
Southwest Buffer Zone Area
Exposure Unit
July 2005

KEY

Southwest Buffer Zone Area EU

Standard Map Features

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

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0 600 1200 Feet

Scale 1:14400

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

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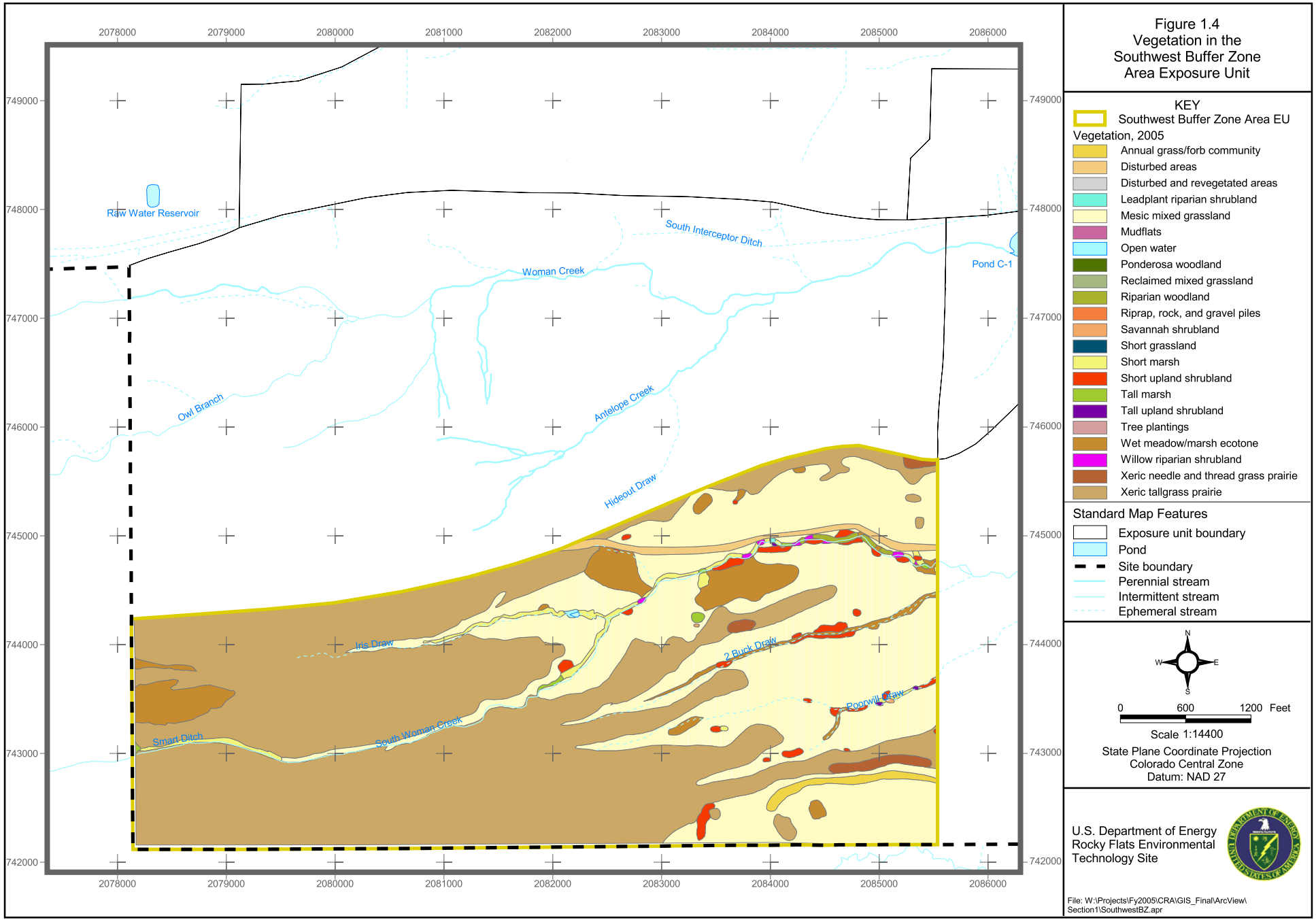

Figure 1.4
Vegetation in the Southwest Buffer Zone Area Exposure Unit

KEY

Southwest Buffer Zone Area EU

Vegetation, 2005

- Annual grass/forb community
- Disturbed areas
- Disturbed and revegetated areas
- Leadplant riparian shrubland
- Mesic mixed grassland
- Mudflats
- Open water
- Ponderosa woodland
- Reclaimed mixed grassland
- Riparian woodland
- Riprap, rock, and gravel piles
- Savannah shrubland
- Short grassland
- Short marsh
- Short upland shrubland
- Tall marsh
- Tall upland shrubland
- Tree plantings
- Wet meadow/marsh ecotone
- Willow riparian shrubland
- Xeric needle and thread grass prairie
- Xeric tallgrass prairie

Standard Map Features

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

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0 600 1200 Feet

Scale 1:14400

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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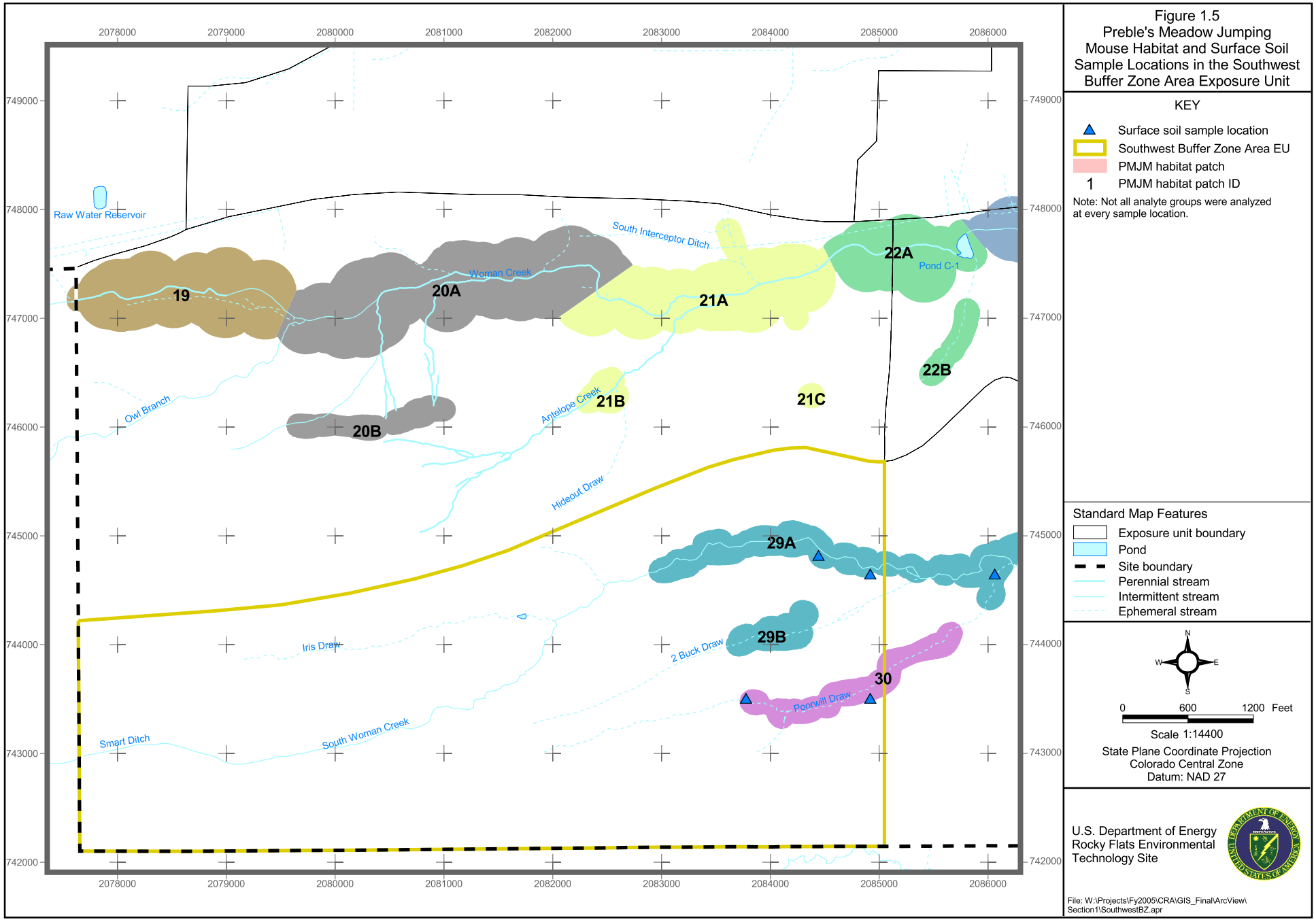

Figure 1.5
Preble's Meadow Jumping Mouse Habitat and Surface Soil Sample Locations in the Southwest Buffer Zone Area Exposure Unit

KEY

- Surface soil sample location
- Southwest Buffer Zone 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

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W E
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0 600 1200 Feet

Scale 1:14400

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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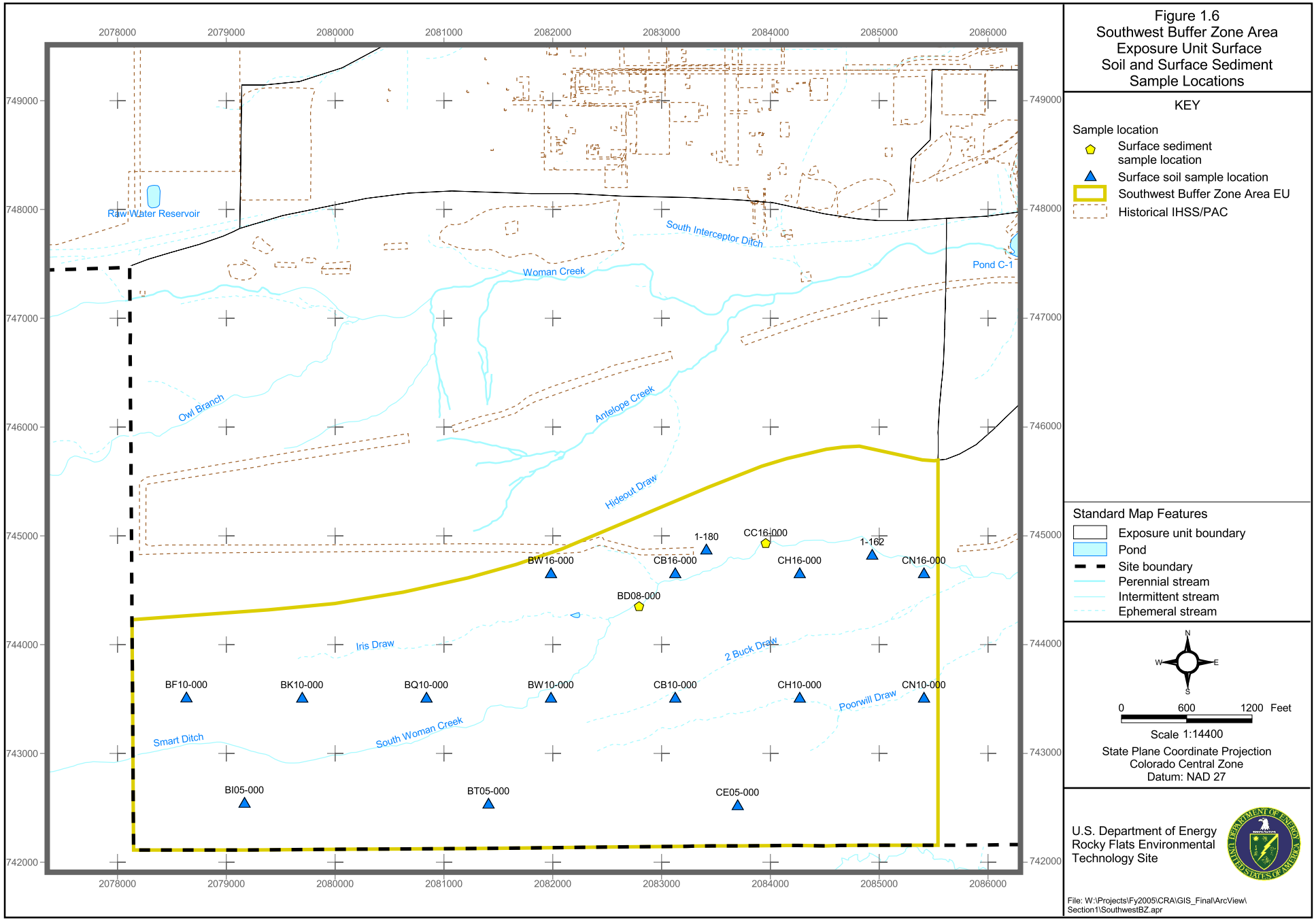

Figure 1.6
Southwest Buffer Zone Area
Exposure Unit Surface
Soil and Surface Sediment
Sample Locations

KEY

Sample location
- Surface sediment sample location
- Surface soil sample location
- Southwest Buffer Zone Area EU
- Historical IHSS/PAC

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

N
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0 600 1200 Feet

Scale 1:14400

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Rocky Flats Environmental
Technology Site

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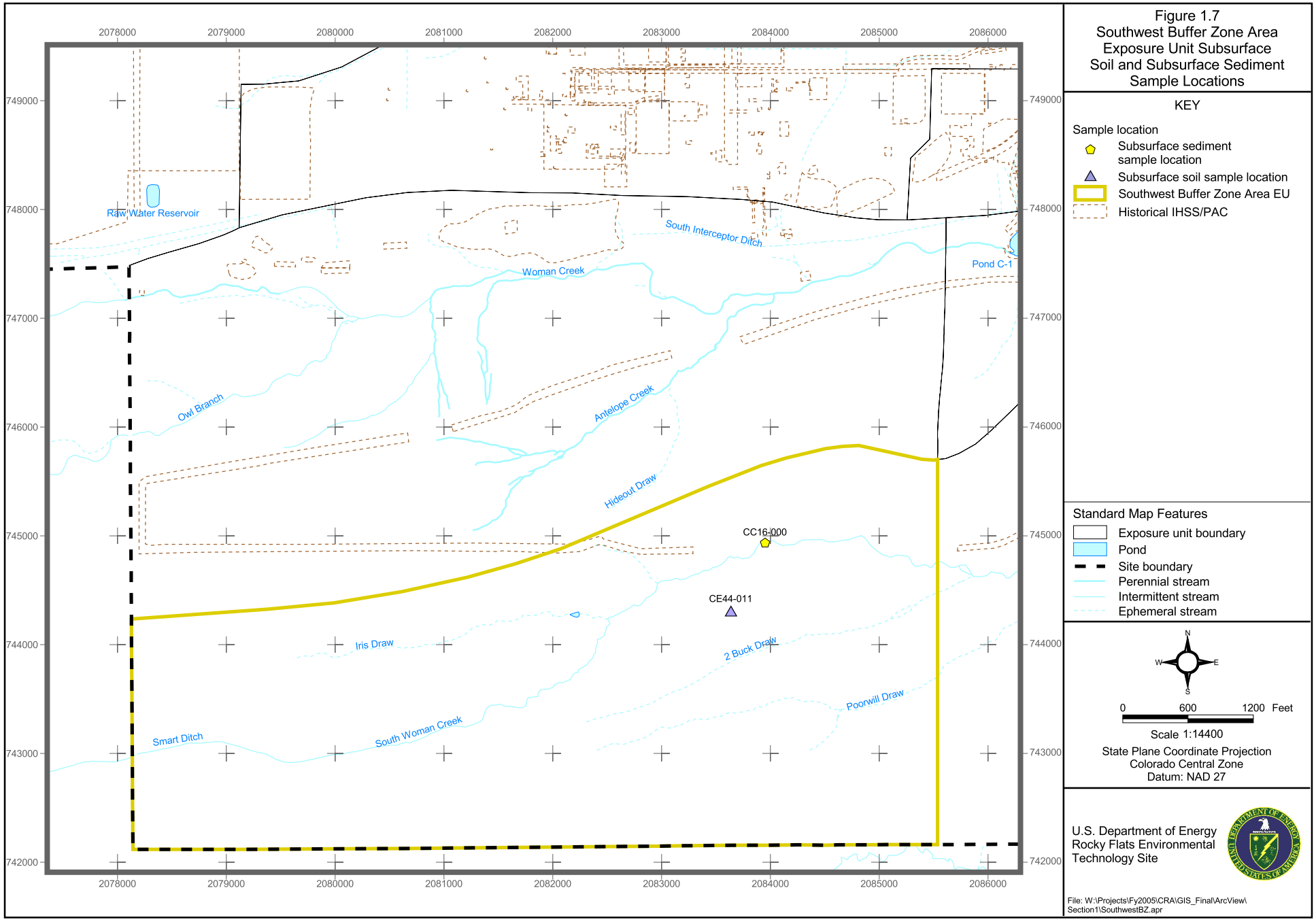

Figure 1.7
Southwest Buffer Zone Area Exposure Unit Subsurface Soil and Subsurface Sediment Sample Locations

KEY

Sample location

- Subsurface sediment sample location
- Subsurface soil sample location
- Southwest Buffer Zone Area EU
- Historical IHSS/PAC

Standard Map Features

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

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0 600 1200 Feet

Scale 1:14400

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

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COMPREHENSIVE RISK ASSESSMENT

SOUTHWEST BUFFER ZONE AREA EXPOSURE UNIT

VOLUME 12: ATTACHMENT 1

Detection Limit Screen

TABLE OF CONTENTS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

CRA	Comprehensive Risk Assessment
ECOI	Ecological Contaminant of Interest
ESL	ecological screening level
EU	Exposure Unit
IDL	instrument detection limit
MDL	method detection limit
PCOC	Potential Contaminant of Concern
PRG	preliminary remediation goal
RL	reporting limit
SQL	sample quantitation limit
SWD	soil water database
SWEU	Southwest Buffer Zone Area Exposure Unit
WRW	wildlife refuge worker

For the Southwest Buffer Zone Area Exposure Unit (EU) (SWEU), the detection limits for non-detected analytes as well as analytes detected in less than 5 percent of the samples are compared to human health preliminary remediation goals (PRGs) for the wildlife refuge worker (WRW) and the lowest ecological screening levels (ESLs). The comparisons are made in the tables to this attachment for potential contaminants of concern (PCOCs) in surface soil/surface sediment and subsurface soil/subsurface sediment, and ecological contaminants of interest (ECOIs) in surface soil and subsurface soil. The percent of the samples with detection limits that exceed the PRGs and ESLs are listed in these tables. When these detection limits exceed the respective PRGs and ESLs, this is a source of uncertainty in the risk assessment process, which is discussed herein.

Laboratory reported results for "U" qualified data (nondetects) are used to perform the detection limit screen rather than the detection limit identified in the detection limit field within the Soil Water Database (SWD). The basis for the detection limit is not always provided in SWD, e.g., Instrument Detection Limit (IDL), Method Detection Limit (MDL), Reporting Limit (RL), and Sample Quantitation Limit (SQL). Therefore, to be consistent in reporting, the "reported results" are presented in the tables to this attachment. Also, for statistical computations and risk estimations presented in the main text and tables to this volume, one-half the reported results are used as proxy values for nondetected data.

The term analyte as used in the following sections refers to analytes that are non-detected or detected in less than 5 percent of the samples. PRGs and ESLs do not exist for some of these analytes, which is also a source of uncertainty for the risk assessment. This uncertainty is discussed in Sections 6.2.1 and 10.1.2 of the main text of this volume.

1.0 COMPARISON OF REPORTED RESULTS TO PRELIMINARY REMEDIATION GOALS

1.1 Surface Soil/Surface Sediment

All reported results are below the PRGs in surface soil/surface sediment (Table A1.1).

1.2 Subsurface Soil/Subsurface Sediment

All reported results are below the PRGs in subsurface soil/subsurface sediment (Table A1.2).

2.0 COMPARISON OF REPORTED RESULTS TO ECOLOGICAL SCREENING LEVELS

2.1 Surface Soil

As shown in Table A1.3, only thallium in surface soil has reported results that exceed the minimum ESL. In this case, approximately 29 percent of the reported results exceed the minimum ESL. However, the reported results are within a factor of 2 of the minimum ESL. Therefore, because only one analyte has reported results that exceed the minimum ESL, and for this analyte, the reported results are the same order of magnitude as the minimum ESL, this represents minimal uncertainty in the overall risk conclusions.

2.2 Subsurface Soil

All reported results are below the ESLs in subsurface soil (Table A1.4).

TABLES

Table A1.1
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil/Surface Sediment in the SWEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	Lowest PRG	Number of Nondetected Results > PRG	Percent of Nondetected Results > PRG	Analyte Detected?
Inorganic (mg/kg)								
Uranium	1.40	-	2.90	16	333	0	0	No

Table A1.2
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil/Subsurface Sediment in the SWEU

Analyte	Range of Reported Values			Total Number of Nondetected Results	PRG	Number of Nondetected Results > PRG	Percent Nondetected Results > PRG	Analyte Detected?
Inorganic (mg/kg)								
Antimony	0.300	-	0.870	3	511	0	0	No
Selenium	0.840	-	1.10	3	6,388	0	0	No
Silver	0.0980	-	0.210	3	6,388	0	0	No
Thallium	0.460	-	0.990	3	89.4	0	0	No
Tin	0.920	-	2	3	766,500	0	0	No
Organic (ug/kg)								
1,1,1,2-Tetrachloroethane	1.36	-	1.36	1	1.05E+06	0	0	No
1,1,1-Trichloroethane	1.21	-	1.21	1	1.06E+08	0	0	No
1,1,2,2-Tetrachloroethane	1.25	-	1.25	1	120,551	0	0	No
1,1,2-Trichloro-1,2,2-trifluoroethane	2.05	-	2.05	1	2.74E+10	0	0	No
1,1,2-Trichloroethane	1.02	-	1.02	1	322,253	0	0	No
1,1-Dichloroethane	1.09	-	1.09	1	3.12E+07	0	0	No
1,1-Dichloroethene	1.63	-	1.63	1	199,706	0	0	No
1,1-Dichloropropene	1.38	-	1.38	1	N/A	0	0	No
1,2,3-Trichlorobenzene	1.57	-	1.57	1	N/A	0	0	No
1,2,3-Trichloropropane	1.14	-	1.14	1	23,910	0	0	No
1,2,4-Trichlorobenzene	1.58	-	1.58	1	1.74E+06	0	0	No
1,2,4-Trimethylbenzene	1.12	-	1.12	1	1.53E+06	0	0	No
1,2-Dibromo-3-chloropropane	2.93	-	2.93	1	34,137	0	0	No
1,2-Dibromoethane	1.23	-	1.23	1	403	0	0	No
1,2-Dichlorobenzene	1.41	-	1.41	1	3.32E+07	0	0	No
1,2-Dichloroethane	1.24	-	1.24	1	152,603	0	0	No
1,2-Dichloropropane	1	-	1	1	441,907	0	0	No
1,3,5-Trimethylbenzene	0.776	-	0.776	1	1.31E+06	0	0	No
1,3-Dichlorobenzene	1.55	-	1.55	1	3.83E+07	0	0	No
1,3-Dichloropropane	0.868	-	0.868	1	N/A	0	0	No
1,4-Dichlorobenzene	1.22	-	1.22	1	1.05E+06	0	0	No
2,2-Dichloropropane	1.15	-	1.15	1	N/A	0	0	No
2-Butanone	11.0	-	11.0	1	5.33E+08	0	0	No
2-Chlorotoluene	1.74	-	1.74	1	2.56E+07	0	0	No
2-Hexanone	8.79	-	8.79	1	N/A	0	0	No
4-Chlorotoluene	1.02	-	1.02	1	N/A	0	0	No
4-Isopropyltoluene	1.28	-	1.28	1	N/A	0	0	No
4-Methyl-2-pentanone	7.43	-	7.43	1	9.57E+08	0	0	No
Acetone	25.5	-	25.5	1	1.15E+09	0	0	No
Benzene	0.943	-	0.943	1	270,977	0	0	No
Bromobenzene	1.43	-	1.43	1	N/A	0	0	No
Bromochloromethane	1.37	-	1.37	1	N/A	0	0	No
Bromodichloromethane	0.752	-	0.752	1	771,304	0	0	No
Bromoform	1.22	-	1.22	1	4.83E+06	0	0	No
Bromomethane	1.75	-	1.75	1	241,033	0	0	No
Carbon Disulfide	3.04	-	3.04	1	1.88E+07	0	0	No
Carbon Tetrachloride	1.29	-	1.29	1	97,124	0	0	No
Chlorobenzene	1.09	-	1.09	1	7.67E+06	0	0	No
Chloroethane	4.27	-	4.27	1	1.65E+07	0	0	No
Chloroform	0.983	-	0.983	1	90,270	0	0	No
Chloromethane	1.53	-	1.53	1	1.32E+06	0	0	No
cis-1,2-Dichloroethene	1.37	-	1.37	1	1.28E+07	0	0	No
cis-1,3-Dichloropropene	0.958	-	0.958	1	223,462	0	0	No
Dibromochloromethane	1.10	-	1.10	1	569,296	0	0	No
Dibromomethane	1.21	-	1.21	1	N/A	0	0	No
Dichlorodifluoromethane	2.96	-	2.96	1	2.64E+06	0	0	No

Table A1.2
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil/Subsurface Sediment in the SWEU

Analyte	Range of Reported Values			Total Number of Nondetected Results	PRG	Number of Nondetected Results > PRG	Percent Nondetected Results > PRG	Analyte Detected?
Ethylbenzene	0.948	-	0.948	1	6.19E+07	0	0	No
Hexachlorobutadiene	1.66	-	1.66	1	255,500	0	0	No
Isopropylbenzene	1.42	-	1.42	1	375,823	0	0	No
Methylene Chloride	1.42	-	1.42	1	3.13E+06	0	0	No
Naphthalene	1.48	-	1.48	1	1.61E+07	0	0	No
n-Butylbenzene	1.13	-	1.13	1	N/A	0	0	No
n-Propylbenzene	1.26	-	1.26	1	N/A	0	0	No
sec-Butylbenzene	1.19	-	1.19	1	N/A	0	0	No
Styrene	1.15	-	1.15	1	1.59E+08	0	0	No
tert-Butylbenzene	1.25	-	1.25	1	N/A	0	0	No
Tetrachloroethene	1.49	-	1.49	1	77,111	0	0	No
Toluene	1.44	-	1.44	1	3.56E+07	0	0	No
trans-1,2-Dichloroethene	1.53	-	1.53	1	3.30E+06	0	0	No
trans-1,3-Dichloropropene	1.07	-	1.07	1	239,434	0	0	No
Trichloroethene	0.813	-	0.813	1	20,354	0	0	No
Trichlorofluoromethane	1.43	-	1.43	1	1.74E+07	0	0	No
Vinyl Chloride	3.22	-	3.22	1	24,948	0	0	No
Xylene	2.86	-	2.86	1	1.22E+07	0	0	No

Table A1.3
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil in the SWEU

Analyte	Range of Nondetected Reported Results	Total Number of Nondetected Results	Lowest ESL	Number of Nondetected Results > PRG	Percent of Nondetected Results > PRG	Analyte Detected?
Inorganic (mg/kg)						
Thallium	0.930 - 1.20	14	1	4	28.6	No
Uranium	1.40 - 1.80	14	5	0	0	No

Table A1.4
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Suburface Soil in the SWEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	Lowest ESL	Number of Nondetected Results > PRG	Percent of Nondetected Results > PRG	Analyte Detected?
Inorganic (mg/kg)								
Antimony	0.300	-	0.310	2	18.7	0	0	No
Beryllium	0.590	-	0.960	2	211	0	0	No
Cadmium	0.0680	-	0.0700	2	198	0	0	No
Molybdenum	0.310	-	0.320	2	27.1	0	0	No
Selenium	0.840	-	0.870	2	2.80	0	0	No
Silver	0.0980	-	0.210	2	N/A	0	0	No
Sodium	430	-	630	2	N/A	0	0	No
Thallium	0.960	-	0.990	2	204	0	0	No
Tin	0.920	-	1.30	2	80.6	0	0	No
Organic (ug/kg)								
1,1,1,2-Tetrachloroethane	1.36	-	1.36	1	N/A	0	0	No
1,1,1-Trichloroethane	1.21	-	1.21	1	4.85E+07	0	0	No
1,1,2,2-Tetrachloroethane	1.25	-	1.25	1	4.70E+06	0	0	No
1,1,2-Trichloro-1,2,2-trifluoroethane	2.05	-	2.05	1	N/A	0	0	No
1,1,2-Trichloroethane	1.02	-	1.02	1	N/A	0	0	No
1,1-Dichloroethane	1.09	-	1.09	1	215,360	0	0	No
1,1-Dichloroethene	1.63	-	1.63	1	1.28E+06	0	0	No
1,1-Dichloropropene	1.38	-	1.38	1	N/A	0	0	No
1,2,3-Trichlorobenzene	1.57	-	1.57	1	N/A	0	0	No
1,2,3-Trichloropropane	1.14	-	1.14	1	1.17E+06	0	0	No
1,2,4-Trichlorobenzene	1.58	-	1.58	1	94,484	0	0	No
1,2,4-Trimethylbenzene	1.12	-	1.12	1	N/A	0	0	No
1,2-Dibromo-3-chloropropane	2.93	-	2.93	1	N/A	0	0	No
1,2-Dibromoethane	1.23	-	1.23	1	N/A	0	0	No
1,2-Dichlorobenzene	1.41	-	1.41	1	N/A	0	0	No
1,2-Dichloroethane	1.24	-	1.24	1	2.00E+06	0	0	No
1,2-Dichloropropane	1	-	1	1	3.92E+06	0	0	No
1,3,5-Trimethylbenzene	0.776	-	0.776	1	855,709	0	0	No
1,3-Dichlorobenzene	1.55	-	1.55	1	N/A	0	0	No
1,3-Dichloropropane	0.868	-	0.868	1	N/A	0	0	No
1,4-Dichlorobenzene	1.22	-	1.22	1	5.93E+06	0	0	No
2,2-Dichloropropane	1.15	-	1.15	1	N/A	0	0	No
2-Butanone	11.0	-	11.0	1	4.94E+07	0	0	No
2-Chlorotoluene	1.74	-	1.74	1	N/A	0	0	No
2-Hexanone	8.79	-	8.79	1	N/A	0	0	No
4-Chlorotoluene	1.02	-	1.02	1	N/A	0	0	No
4-Isopropyltoluene	1.28	-	1.28	1	N/A	0	0	No
4-Methyl-2-pentanone	7.43	-	7.43	1	859,131	0	0	No
Acetone	25.5	-	25.5	1	247,687	0	0	No
Benzene	0.943	-	0.943	1	1.10E+06	0	0	No
Bromobenzene	1.43	-	1.43	1	N/A	0	0	No
Bromochloromethane	1.37	-	1.37	1	N/A	0	0	No
Bromodichloromethane	0.752	-	0.752	1	381,135	0	0	No
Bromoform	1.22	-	1.22	1	198,571	0	0	No
Bromomethane	1.75	-	1.75	1	N/A	0	0	No
Carbon Disulfide	3.04	-	3.04	1	410,941	0	0	No
Carbon Tetrachloride	1.29	-	1.29	1	736,154	0	0	No
Chlorobenzene	1.09	-	1.09	1	413,812	0	0	No
Chloroethane	4.27	-	4.27	1	N/A	0	0	No
Chloroform	0.983	-	0.983	1	560,030	0	0	No
Chloromethane	1.53	-	1.53	1	N/A	0	0	No
cis-1,2-Dichloroethene	1.37	-	1.37	1	132,702	0	0	No
cis-1,3-Dichloropropene	0.958	-	0.958	1	222,413	0	0	No
Dibromochloromethane	1.10	-	1.10	1	389,064	0	0	No
Dibromomethane	1.21	-	1.21	1	N/A	0	0	No
Dichlorodifluoromethane	2.96	-	2.96	1	59,980	0	0	No
Ethylbenzene	0.948	-	0.948	1	N/A	0	0	No
Hexachlorobutadiene	1.66	-	1.66	1	150,894	0	0	No
Isopropylbenzene	1.42	-	1.42	1	N/A	0	0	No
Methylene Chloride	1.42	-	1.42	1	209,560	0	0	No
Naphthalene	1.48	-	1.48	1	1.60E+07	0	0	No

Table A1.4
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Suburface Soil in the SWEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	Lowest ESL	Number of Nondetected Results > PRG	Percent of Nondetected Results > PRG	Analyte Detected?
n-Butylbenzene	1.13	-	1.13	1	N/A	0	0	No
n-Propylbenzene	1.26	-	1.26	1	N/A	0	0	No
sec-Butylbenzene	1.19	-	1.19	1	N/A	0	0	No
Styrene	1.15	-	1.15	1	1.53E+06	0	0	No
tert-Butylbenzene	1.25	-	1.25	1	N/A	0	0	No
Tetrachloroethene	1.49	-	1.49	1	72,494	0	0	No
Toluene	1.44	-	1.44	1	1.22E+06	0	0	No
trans-1,2-Dichloroethene	1.53	-	1.53	1	1.87E+06	0	0	No
trans-1,3-Dichloropropene	1.07	-	1.07	1	222,413	0	0	No
Trichloroethene	0.813	-	0.813	1	32,424	0	0	No
Trichlorofluoromethane	1.43	-	1.43	1	4	0	0	No
Vinyl Chloride	3.22	-	3.22	1	6,494	0	0	No
Xylene	2.86	-	2.86	1	111,663	0	0	No

N/A = Not available.

COMPREHENSIVE RISK ASSESSMENT

SOUTHWEST BUFFER ZONE AREA EXPOSURE UNIT

VOLUME 12: ATTACHMENT 2

Data Quality Assessment

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ACRONYMS AND ABBREVIATIONS

AA	atomic absorption
ASD	Analytical Services Division
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
CRDL	contract required detection limit
DAR	data adequacy report
DER	duplicate error ratio
DOE	U.S. Department of Energy
DQA	Data Quality Assessment
DQO	data quality objective
DRC	data review checklist
ECOPC	ecological contaminant of potential concern
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ESL	ecological screening level
EU	exposure unit
FD	field duplicate
IAG	Interagency Agreement
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
N/A	not applicable
PARCC	precision, accuracy, representativeness, completeness, and comparability
PPT	Pipette
PRG	preliminary remediation goal
PCB	polychlorinated biphenyl
QC	quality control
RDL	required detection limit
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
RL	reporting limit
RPD	relative percent difference
SDP	standard data package
SOW	Statement of Work
SVOC	semi-volatile organic compound
SWD	Soil Water Database
SWEU	Southwest Buffer Zone Area Exposure Unit
TCLP	Toxicity Characteristic Leaching Procedure
TIC	tentatively identified compound
V&V	verification and validation
VOC	volatile organic compound

1.0 INTRODUCTION

This document provides an assessment of the quality of the data used in the human health and ecological risk assessments for the Southwest Buffer Zone Area Exposure Unit (SWEU). The data quality was evaluated against standard precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters by the data validator under the multiple work plans that guided the data collection over the past 15 years, as well as the requirements for the PARCC parameters provided in the Comprehensive Risk Assessment (CRA) Methodology (DOE 2005). The details of this data quality assessment (DQA) process are presented in the Sitewide DQA contained in Appendix A, Volume 2, Attachment 2 of the Remedial Investigation/Feasibility Study (RI/FS).

Of the 8,479 environmental sampling records in the RFETS database associated with the SWEU, 4,514 were used in the SWEU risk assessment based on the data processing rules described in Section 2.0 of the Sitewide DQA. Of the 4,514 analytical records existing in the SWEU CRA data set, 95 percent (4,279 records) have undergone verification or validation (V&V) (Table A2.1). The V&V review involved applying observation notes and qualifiers flags or observation notes without qualifier flags to the data.

PARCC parameter analysis was used to determine if the data quality could affect the risk assessment decisions (i.e., have significant impact on risk calculations or selection of contaminants of concern [COCs] for human health or ecological contaminants of potential concern [ECOPCs]). In consultation with the data users and project team, the primary ways in which the PARCC parameters could impact the risk assessment decisions were identified and these include the following:

- Detect results are falsely identified as nondetects;
- Nondetect results are falsely identified as detects;
- Issues that cause detection limit uncertainty;
- Issues that cause significant overestimation of detect results; and
- Issues that cause significant underestimation of detect results.

2.0 SUMMARY OF FINDINGS

2.1 PARCC Findings

A summary of V&V observations and the associated, affected PARCC parameter is presented in Table A2.2 by analyte group and matrix (i.e., “soil” includes soil and sediment, and “water” includes surface water and groundwater). Table A2.3 presents the percentage of the SWEU V&V data that were qualified as estimated and/or undetected by

analyte group and matrix. Overall, approximately 14 percent of the SWEU CRA data were qualified as estimated or undetected. Three percent of the data reported as detected by the laboratory were qualified as undetected by the validator due to blank contamination (Table A2.4). In general, data qualified as estimated or undetected are marked as such because of various laboratory noncompliance issues that are not serious enough to render the data unusable. The precision between field duplicate (FD)/target sample analyte pairs is summarized in Table A2.5.

Of the 95 percent of the SWEU data set that underwent V&V, 81 percent were qualified as having no QC issues, and approximately 14 percent were qualified as estimated or undetected (Table A2.3). The remaining 5 percent of the V&V data are made up of records qualified with additional flags indicating acceptable and non-estimated data such as “A”, “C”, or “E”.

Less than 4 percent of the entire data set was rejected during the V&V process (Table A2.6). Rejected data were removed from the SWEU CRA data set during the data processing as defined in Section 2.0 of the Sitewide DQA.

The general discussion below summarizes the data quality as presented by the data validator’s observations. The relationship between these observations and the PARCC parameters can be found in the Sitewide DQA. Several observations have no impact on data quality because they represent issues that were noted but corrected, or represent other general observations, such as missing documentation that was not required for data assessment. Approximately 19 percent of the SWEU V&V data were marked with these V&V observations that have no affect on any of the PARCC parameters.

Of the V&V data, approximately 3 percent were noted for observations related to precision. Of that 3 percent, 96 percent contained issues related to sample matrices. Result confirmation and instrument setup observations make up the other 4 percent.

Of the V&V data, 41 percent were noted for accuracy-related observations. Of that 41 percent, 79 percent was noted for laboratory practice-related observations, while sample-specific accuracy observations make up the other 21 percent. It is important to note that not all accuracy-related observations resulted in data qualification. Only 14 percent of the SWEU CRA data set was qualified as estimated and/or undetected (Table A2.3).

The data were determined to meet the representativeness parameter because sampling locations are spatially distributed such that contaminant randomness and bias considerations are addressed based on the site-specific history (see the Data Adequacy Report [DAR] in Appendix A, Volume 2, Attachment 3). Samples were also analyzed by the SW-846 or alpha-spectroscopy methods and results were documented as quality records according to approved procedures and guidelines (V&V).

Of the V&V data, approximately 51 percent were noted for observations related to representativeness. Of that 51 percent, 87 percent was marked for blank observations, 4 percent for failure to observe allowed holding times, 4 percent for documentation issues, and 2 percent for instrument sensitivity issues. Instrument set-up, LCS, and other

observations make up the other 3 percent of the data noted for observations related to sample representativeness. Reportable levels of target analytes were not routinely detected in the laboratory blanks greater than the laboratory RLs and samples were generally stored and preserved properly.

The CRA Methodology specifies completeness criteria based on data adequacy and these criteria and the findings are discussed in the DAR in Appendix A, Volume 2, Attachment 3 of the RI/FS. Additionally, it should be noted that less than 4 percent of all V&V data associated with the SWEU were rejected.

Comparability of the SWEU CRA data set is ensured as all analytical results have been converted into common units. Comparability is addressed more specifically in Appendix A, Volume 2, Attachment 2 of the RI/FS.

2.2 PARCC Findings Potential Impact on Data Usability

PARCC parameter influence on data usability is discussed below with an emphasis on the risk assessment decisions as described in the Introduction to this document.

Table A2.3 summarizes the overall percentage of qualified data, independent of validation observation. The table is used for overall guidance in selecting analyte group and matrix combinations of interest in the analysis of the risk assessment decisions, the impact on data usability is better analyzed using Tables A2.5 through A2.7, as these can be more directly related to the 5 key risk assessment decision factors described in the introduction.

A summary of FD/target sample precision information can be found in Table A2.5. Where there are analyte group and matrix combinations failures that have the potential to impact risk assessment decisions, the data quality is discussed in further detail in the bulleted list below.

Table A2.7 lists V&V observations where the number of observations by analyte group and matrix exceeds 5 percent of the associated records (see column “Percent Observed”) with the exception of those observations that were determined to have no impact on any of the PARCC parameters. Such observations are identified in Table A2.2 by an “Affected PARCC Parameter” of not applicable (N/A). Additionally the analyte group and matrix is broken down further in the columns “Percent Qualified U” and “Percent Qualified J”. Data qualifications that are considered to have potential impact on risk assessment decisions were reviewed and are discussed in detail in the bulleted list below. Other issues are not considered to have the potential for significant impacts on the results of the risk assessments because the uncertainty associated with these data quality issues is assumed to be less than the overall uncertainty in the risk assessment process (e.g., uncertainties such as exposure assumptions, toxicity values, and statistical methods for calculating exposure point concentrations).

Data qualifications associated with the water matrix are not discussed below. Surface water data are used in the ecological risk assessment for an EU only for those analytes identified as ECOPCs, and the surface water component of exposure contributes only minimally to the overall risk estimates. As described in the Sitewide DQA (Attachment 2 of Volume 2 of Appendix A of the RI/FS Report), groundwater data are not used in the ecological risk assessment and the groundwater evaluations for the human health portion of the risk assessment are performed on a sitewide basis. In addition, surface water is evaluated for the human health risk assessment on a sitewide basis. Therefore, data quality evaluations for groundwater and surface water are presented in the Sitewide DQA.

An issue that has the potential to impact the risk assessment decisions is described below.

- Several V&V observations related to the wet chemistry/soil analyte group and matrix combination resulted in data qualifications in notable percentages of the data set (Table A2.7). It is important to note, however, that this analyte group contains general chemistry parameters such as ions/anions and alkalinity that are not directly related to site characterization. Therefore, the impact of these qualifications on risk assessment results is determined to be minimal.

3.0 CONCLUSIONS

This review concludes that the quality of the SWEU data is acceptable and the CRA objectives for PARCC performance have generally been met. Where either CRA Methodology or V&V guidance have not been met, the data are either flagged by the V&V process, or for those instances where the frequency of issues may influence the risk assessment decisions, the data quality issues were reviewed for potential impact on risk assessment results.

Those elements of data quality that could affect risk assessment decisions in the SWEU have been analyzed and it was concluded that the noted deviations from the PARCC parameter criteria have minimal impact on risk assessment results related to the SWEU.

4.0 REFERENCES

DOE, 2002, Final Work Plan for the Development of the Remedial Investigation and Feasibility Study Report, Rocky Flats Environmental Technology Site, Golden, Colorado, March.

DOE, 2005. Final Comprehensive Risk Assessment Work Plan and Methodology, Environmental Restoration, Rocky Flats Environmental Technology Site, Golden, Colorado. Revision 1, September 2005.

TABLES

Table A2.1
CRA Data V&V Summary

Analyte Group	Matrix	Total No. of CRA V&V Records	Total No. of CRA Records	Percent V&V (%)
Dioxins and Furans	Water	7	7	100.00
Herbicide	Water	5	5	100.00
Metal	Soil	570	570	100.00
Metal	Water	1,618	1,833	88.27
PCB	Water	7	7	100.00
Pesticide	Water	22	22	100.00
Radionuclide	Soil	91	95	95.79
Radionuclide	Water	336	344	97.67
SVOC	Soil	3	3	100.00
SVOC	Water	103	103	100.00
VOC	Soil	61	61	100.00
VOC	Water	1,206	1,206	100.00
Wet Chem	Soil	19	19	100.00
Wet Chem	Water	231	239	96.65
	Total	**4,279**	**4,514**	**94.79%**

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Metal	Soil	Blanks	Calibration verification blank contamination	No	38	570	6.67	Representativeness
Metal	Soil	Blanks	Calibration verification blank contamination	Yes	8	570	1.40	Representativeness
Metal	Soil	LCS	Low level check sample recovery criteria were not met	No	31	570	5.44	Accuracy
Metal	Soil	LCS	Low level check sample recovery criteria were not met	Yes	16	570	2.81	Accuracy
Metal	Soil	Matrices	LCS/LCSD precision criteria were not met	Yes	13	570	2.28	Precision
Metal	Soil	Matrices	Predigestion MS recovery criteria were not met	No	13	570	2.28	Accuracy
Metal	Soil	Matrices	Predigestion MS recovery criteria were not met	Yes	18	570	3.16	Accuracy
Metal	Soil	Matrices	Predigestion MS recovery was < 30 percent	Yes	5	570	0.88	Accuracy
Metal	Soil	Matrices	Serial dilution criteria were not met	Yes	9	570	1.58	Accuracy
Metal	Soil	Other	IDL is older than 3 months from date of analysis	No	118	570	20.70	Accuracy
Metal	Soil	Other	IDL is older than 3 months from date of analysis	Yes	362	570	63.51	Accuracy
Metal	Water	Blanks	Calibration verification blank contamination	No	4	1,618	0.25	Representativeness
Metal	Water	Blanks	Method, preparation, or reagent blank contamination	No	175	1,618	10.82	Representativeness
Metal	Water	Blanks	Method, preparation, or reagent blank contamination	Yes	36	1,618	2.22	Representativeness
Metal	Water	Blanks	Negative bias indicated in the blanks	No	23	1,618	1.42	Representativeness
Metal	Water	Blanks	Negative bias indicated in the blanks	Yes	5	1,618	0.31	Representativeness
Metal	Water	Calibration	Calibration correlation coefficient did not meet requirements	No	13	1,618	0.80	Accuracy
Metal	Water	Calibration	Calibration correlation coefficient did not meet requirements	Yes	2	1,618	0.12	Accuracy
Metal	Water	Documentation Issues	Key data fields incorrect	No	5	1,618	0.31	N/A
Metal	Water	Documentation Issues	Key data fields incorrect	Yes	15	1,618	0.93	N/A

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Metal	Water	Documentation Issues	Transcription error	No	331	1,618	20.46	N/A
Metal	Water	Instrument Set-up	AA duplicate injection precision criteria were not met	No	2	1,618	0.12	Precision
Metal	Water	LCS	CRDL check sample recovery criteria were not met	No	3	1,618	0.19	Accuracy
Metal	Water	LCS	CRDL check sample recovery criteria were not met	Yes	9	1,618	0.56	Accuracy
Metal	Water	LCS	LCS recovery criteria were not met	Yes	2	1,618	0.12	Accuracy
Metal	Water	LCS	Low level check sample recovery criteria were not met	No	3	1,618	0.19	Accuracy
Metal	Water	LCS	Low level check sample recovery criteria were not met	Yes	2	1,618	0.12	Accuracy
Metal	Water	Matrices	Duplicate sample precision criteria were not met	Yes	5	1,618	0.31	Precision
Metal	Water	Matrices	Post-digestion MS did not meet control criteria	No	19	1,618	1.17	Accuracy
Metal	Water	Matrices	Post-digestion MS did not meet control criteria	Yes	1	1,618	0.06	Accuracy
Metal	Water	Matrices	Predigestion MS recovery criteria were not met	No	30	1,618	1.85	Accuracy
Metal	Water	Matrices	Predigestion MS recovery criteria were not met	Yes	19	1,618	1.17	Accuracy
Metal	Water	Matrices	Serial dilution criteria were not met	No	1	1,618	0.06	Accuracy
Metal	Water	Matrices	Serial dilution criteria were not met	Yes	38	1,618	2.35	Accuracy
Metal	Water	Other	IDL is older than 3 months from date of analysis	No	19	1,618	1.17	Accuracy
Metal	Water	Other	IDL is older than 3 months from date of analysis	Yes	10	1,618	0.62	Accuracy
Metal	Water	Sensitivity	IDL changed due to a significant figure discrepancy	No	14	1,618	0.87	Representativeness
Pesticide	Water	Calibration	Continuing calibration verification criteria were not met	No	1	22	4.55	Accuracy
Radionuclide	Soil	LCS	LCS recovery criteria were not met	Yes	2	91	2.20	Accuracy
Radionuclide	Soil	Other	QC sample does not meet method requirements	No	33	91	36.26	Representativeness

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Radionuclide	Soil	Other	QC sample does not meet method requirements	Yes	22	91	24.18	Representativeness
Radionuclide	Water	Blanks	Method, preparation, or reagent blank contamination	No	8	336	2.38	Representativeness
Radionuclide	Water	Blanks	Method, preparation, or reagent blank contamination	Yes	25	336	7.44	Representativeness
Radionuclide	Water	Calibration	Calibration counting statistics did not meet criteria	No	3	336	0.89	Accuracy
Radionuclide	Water	Calibration	Continuing calibration verification criteria were not met	No	18	336	5.36	Accuracy
Radionuclide	Water	Calibration	Continuing calibration verification criteria were not met	Yes	56	336	16.67	Accuracy
Radionuclide	Water	Documentation Issues	Record added by the validator	Yes	9	336	2.68	N/A
Radionuclide	Water	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	81	336	24.11	Representativeness
Radionuclide	Water	Documentation Issues	Transcription error	No	62	336	18.45	N/A
Radionuclide	Water	Documentation Issues	Transcription error	Yes	16	336	4.76	N/A
Radionuclide	Water	Holding Times	Holding times were exceeded	No	1	336	0.30	Representativeness
Radionuclide	Water	Holding Times	Holding times were exceeded	Yes	5	336	1.49	Representativeness
Radionuclide	Water	Holding Times	Holding times were grossly exceeded	No	1	336	0.30	Representativeness
Radionuclide	Water	Instrument Set-up	Resolution criteria were not met	No	1	336	0.30	Representativeness
Radionuclide	Water	Instrument Set-up	Transformed spectral index external site criteria were not met	No	3	336	0.89	Representativeness
Radionuclide	Water	LCS	Expected LCS value not submitted/verifiable	No	2	336	0.60	Representativeness
Radionuclide	Water	LCS	Expected LCS value not submitted/verifiable	Yes	5	336	1.49	Representativeness
Radionuclide	Water	LCS	LCS recovery > +/- 3 sigma	No	12	336	3.57	Accuracy
Radionuclide	Water	LCS	LCS recovery > +/- 3 sigma	Yes	6	336	1.79	Accuracy
Radionuclide	Water	LCS	LCS recovery criteria were not met	No	1	336	0.30	Accuracy
Radionuclide	Water	LCS	LCS recovery criteria were not met	Yes	5	336	1.49	Accuracy
Radionuclide	Water	LCS	LCS relative percent error criteria not met	No	5	336	1.49	Accuracy

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Radionuclide	Water	LCS	LCS relative percent error criteria not met	Yes	20	336	5.95	Accuracy
Radionuclide	Water	Matrices	Recovery criteria were not met	Yes	3	336	0.89	Accuracy
Radionuclide	Water	Matrices	Replicate analysis was not performed	No	8	336	2.38	Precision
Radionuclide	Water	Matrices	Replicate analysis was not performed	Yes	9	336	2.68	Precision
Radionuclide	Water	Matrices	Replicate precision criteria were not met	No	7	336	2.08	Precision
Radionuclide	Water	Matrices	Replicate precision criteria were not met	Yes	27	336	8.04	Precision
Radionuclide	Water	Matrices	Replicate recovery criteria were not met	No	1	336	0.30	Accuracy
Radionuclide	Water	Matrices	Replicate recovery criteria were not met	Yes	1	336	0.30	Accuracy
Radionuclide	Water	Other	Sample results were not validated due to re-analysis	No	1	336	0.30	N/A
Radionuclide	Water	Other	See hard copy for further explanation	No	6	336	1.79	N/A
Radionuclide	Water	Other	See hard copy for further explanation	Yes	31	336	9.23	N/A
Radionuclide	Water	Sensitivity	Incorrect reported activity or MDA	Yes	3	336	0.89	N/A
Radionuclide	Water	Sensitivity	MDA exceeded the RDL	No	3	336	0.89	Representativeness
Radionuclide	Water	Sensitivity	MDA exceeded the RDL	Yes	9	336	2.68	Representativeness
Radionuclide	Water	Sensitivity	MDA was calculated by reviewer	No	6	336	1.79	N/A
Radionuclide	Water	Sensitivity	MDA was calculated by reviewer	Yes	160	336	47.62	N/A
SVOC	Water	Documentation Issues	Transcription error	No	1	103	0.97	N/A
SVOC	Water	LCS	LCS recovery criteria were not met	No	2	103	1.94	Accuracy
VOC	Soil	Calibration	Continuing calibration verification criteria were not met	No	2	61	3.28	Accuracy
VOC	Soil	Calibration	Independent calibration verification criteria not met	No	1	61	1.64	Accuracy
VOC	Water	Blanks	Method, preparation, or reagent blank contamination	No	11	1,206	0.91	Representativeness
VOC	Water	Confirmation	Results were not confirmed	Yes	1	1,206	0.08	Precision
VOC	Water	Documentation Issues	Record added by the validator	No	99	1,206	8.21	N/A
VOC	Water	Documentation Issues	Transcription error	No	33	1,206	2.74	N/A
VOC	Water	Holding Times	Holding times were exceeded	No	6	1,206	0.50	Representativeness
VOC	Water	LCS	LCS recovery criteria were not met	No	38	1,206	3.15	Accuracy
Wet Chem	Soil	Matrices	Predigestion MS recovery criteria were not met	Yes	3	19	15.79	Accuracy

Table A2.2
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect	No. of Records w/ Noted Observation	Total No. of V&V Records	Percent Observed (%)	PARCC Parameter Affected
Wet Chem	Soil	Matrices	Predigestion MS recovery was < 30 percent	Yes	10	19	52.63	Accuracy
Wet Chem	Soil	Other	IDL is older than 3 months from date of analysis	Yes	16	19	84.21	Accuracy
Wet Chem	Water	Blanks	Method, preparation, or reagent blank contamination	No	1	231	0.43	Representativeness
Wet Chem	Water	Blanks	Negative bias indicated in the blanks	No	1	231	0.43	Representativeness
Wet Chem	Water	Calibration	Calibration correlation coefficient did not meet requirements	Yes	2	231	0.87	Accuracy
Wet Chem	Water	Documentation Issues	Record added by the validator	No	6	231	2.60	N/A
Wet Chem	Water	Documentation Issues	Record added by the validator	Yes	3	231	1.30	N/A
Wet Chem	Water	Documentation Issues	Transcription error	Yes	4	231	1.73	N/A
Wet Chem	Water	Holding Times	Holding times were exceeded	No	7	231	3.03	Representativeness
Wet Chem	Water	Holding Times	Holding times were exceeded	Yes	3	231	1.30	Representativeness
Wet Chem	Water	Holding Times	Holding times were grossly exceeded	No	5	231	2.16	Representativeness
Wet Chem	Water	Holding Times	Holding times were grossly exceeded	Yes	3	231	1.30	Representativeness
Wet Chem	Water	Matrices	Predigestion MS recovery criteria were not met	No	1	231	0.43	Accuracy
Wet Chem	Water	Matrices	Predigestion MS recovery criteria were not met	Yes	6	231	2.60	Accuracy
Wet Chem	Water	Matrices	Predigestion MS recovery was < 30 percent	Yes	1	231	0.43	Accuracy
Wet Chem	Water	Other	IDL is older than 3 months from date of analysis	Yes	1	231	0.43	Accuracy
Wet Chem	Water	Other	Lab results not verified due to unsubmitted data	Yes	1	231	0.43	Representativeness
Wet Chem	Water	Other	Result obtained through dilution	Yes	1	231	0.43	N/A

Table A2.3
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 (%)
Metal	Soil	70	570	No	12.28
Metal	Soil	64	570	Yes	11.23
Metal	Water	262	1,618	No	16.19
Metal	Water	113	1,618	Yes	6.98
Pesticide	Water	1	22	No	4.55
Radionuclide	Water	2	336	No	0.60
Radionuclide	Water	5	336	Yes	1.49
SVOC	Water	2	103	No	1.94
VOC	Soil	3	61	No	4.92
VOC	Water	55	1,206	No	4.56
Wet Chem	Soil	13	19	Yes	68.42
Wet Chem	Water	15	231	No	6.49
Wet Chem	Water	15	231	Yes	6.49
	Total	**620**	**4,279**		**14.49%**

Table A2.4
Summary of Data Qualified as Undetected Due to Blank Contamination

Analyte Group	Matrix	No. of CRA Records Qualified as Undetected Due to Blank Contaimination	Total No. of CRA Records with Detected Results[a]	Percent Qualified as Undetected
Metal	Soil	29	433	6.70
Metal	Water	2	516	0.39
	Total	**31**	**949**	**3.27%**

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

Table A2.5
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 (%)
Metal	Soil	0	30	0.00	5.26
Metal	Water	1	174	0.57	9.49
Radionuclide	Soil	0	6	0.00	6.32
VOC	Water	0	100	0.00	8.29
Wet Chem	Soil	0	1	0.00	5.26
Wet Chem	Water	0	21	0.00	8.79

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

Analyte Group	Matrix	Total No. of Rejected Records	Total No. of V&V Records	Percent Rejected (%)
Dioxins and Furans	Water	0	7	0.00
Herbicide	Water	0	6	0.00
Metal	Soil	31	1,102	2.81
Metal	Water	69	2,600	2.65
PCB	Water	0	7	0.00
Pesticide	Water	0	23	0.00
Radionuclide	Soil	0	97	0.00
Radionuclide	Water	98	616	15.91
SVOC	Soil	0	3	0.00
SVOC	Water	10	113	8.85
VOC	Soil	0	61	0.00
VOC	Water	58	1,819	3.19
Wet Chem	Soil	0	77	0.00
Wet Chem	Water	8	422	1.90
	Total	**274**	**6,953**	**3.94%**

Table A2.7
Summary of Data Quality Issues Identified by V&V

Analyte Group	Matrix	Categories Description	V&V Observation	Detect	Percent Observed	Percent Qualified U[a]	Percent Qualified J[b]	PARCC Parameter Affected	Impacts Risk Assessment Decisions
Metal	Soil	Blanks	Calibration verification blank contamination	No	6.67	6.67	0.00	Representativeness	No
Metal	Soil	Other	IDL is older than 3 months from date of analysis	No	20.70	5.79	4.04	Accuracy	No
Metal	Soil	Other	IDL is older than 3 months from date of analysis	Yes	63.51	0.00	8.77	Accuracy	No
Metal	Water	Blanks	Method, preparation, or reagent blank contamination	No	10.82	0.00	10.82	Representativeness	No
Radionuclide	Soil	Other	QC sample does not meet method requirements	No	36.26	0.00	0.00	Representativeness	No
Radionuclide	Soil	Other	QC sample does not meet method requirements	Yes	24.18	0.00	0.00	Representativeness	No
Radionuclide	Water	Blanks	Method, preparation, or reagent blank contamination	Yes	7.44	0.00	0.89	Representativeness	No
Radionuclide	Water	Calibration	Continuing calibration verification criteria were not met	Yes	16.67	0.00	0.89	Accuracy	No
Radionuclide	Water	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	24.11	0.00	0.00	Representativeness	No
Radionuclide	Water	LCS	LCS relative percent error criteria not met	Yes	5.95	0.00	0.00	Accuracy	No
Radionuclide	Water	Matrices	Replicate precision criteria were not met	Yes	8.04	0.00	0.00	Precision	No
Wet Chem	Soil	Matrices	Predigestion MS recovery criteria were not met	Yes	15.79	0.00	15.79	Accuracy	No
Wet Chem	Soil	Matrices	Predigestion MS recovery was < 30 percent	Yes	52.63	0.00	52.63	Accuracy	No
Wet Chem	Soil	Other	IDL is older than 3 months from date of analysis	Yes	84.21	0.00	52.63	Accuracy	No

[a]Defined as validation qualifier codes containing "U"

[b]Defined as validation qualifier codes containing "J", except "UJ"

COMPREHENSIVE RISK ASSESSMENT

SOUTHWEST BUFFER ZONE AREA EXPOSURE UNIT

VOLUME 12: ATTACHMENT 3

Statistical Analyses and Professional Judgment

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ACRONYMS AND ABBREVIATIONS

CDPHE	Colorado Department of Public Health and Environment
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
IHSS	Individual Hazardous Substance Site
MDC	maximum detected concentration
mg/kg	milligrams per kilogram
NCP	National Contingency Plan
NOAEL	no observed adverse effect level
PAC	Potential Area of Concern
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

SWEU	Southwest Buffer Zone Area Exposure Unit
tESL	threshold ESL
UCL	upper confidence limit
UTL	upper tolerance limit
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 Southwest Buffer Zone (BZ) Area Exposure Unit (EU) (SWEU) 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 Section 2.2.5 (HHRA) and Section 2.3.4 (ERA) of Appendix A, Volume 2 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) and follow the Final Comprehensive Risk Assessment (CRA) Work Plan and Methodology (DOE 2005).

2.0 RESULTS OF STATISTICAL COMPARISONS TO BACKGROUND FOR THE SOUTHWEST BUFFER ZONE 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 SWEU 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 A3.2.17.[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 inter-quartile 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.

PCOCs and ECOIs for surface soil with concentrations in the SWEU that are statistically greater than background (or background comparisons are not performed) are carried through to the professional judgment step of the COC/ECOPC selection processes. ECOIs (for non-PMJM receptors) with concentrations in the SWEU that are statistically greater than background (or background comparisons are not performed) are carried

[1] Statistical background comparisons are not performed for analytes if: 1) the background concentrations are nondetections; 2) background data are unavailable; 3) the analyte has low detection frequency in the SWEU 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.

through to the upper-bound exposure point concentration 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 SWEU surface soil/surface sediment data set, the maximum detected concentrations (MDC) for aluminum exceeded the wildlife refuge worker (WRW) preliminary remediation goals (PRGs), but the upper confidence limit (UCL) on the mean concentration for the site data set for aluminum did not exceed the PRG. Consequently, aluminum was not evaluated further.

The MDCs and UCLs for arsenic exceeded the PRGs for the SWEU data set; thus, arsenic was carried forward into the statistical background comparison step. The results of the statistical comparison of the SWEU surface soil/surface sediment data to background data for arsenic are presented in Table A3.2.1 and the summary statistics for background and SWEU surface soil/surface sediment data are shown in Table A3.2.2.

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

Analytes Statistically Greater than Background at the 0.1 Significance Level

- Arsenic

Background Comparison Not Performed[1]

- Not Applicable

2.2 Subsurface Soil/Subsurface Sediment Data Used in the HHRA

No analytes exceeded the applicable PRG for the combined SWEU subsurface soil and subsurface sediment data set.

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

For the SWEU surface soil data set, the MDCs for aluminum, arsenic, barium, boron, chromium, copper, lead, lithium, mercury, nickel, selenium, vanadium, and zinc exceeded a non-Preble's meadow jumping mouse (PMJM) no observed adverse effect level (NOAEL) ecological screening level (ESL) and, consequently, these analytes were carried forward into the statistical background comparison step. The results of the statistical comparison of the SWEU surface soil data to background data are presented in Table A3.2.3 and the summary statistics for background and SWEU surface soil data are shown in Table A3.2.4.

The results of the statistical comparisons of the SWEU surface soil for non-PMJM receptors to background data indicate the following:

Analytes Statistically Greater than Background at the 0.1 Significance Level

- Aluminum
- Arsenic
- Barium
- Chromium
- Lithium
- Nickel
- Vanadium

Analytes Not Statistically Greater than Background at the 0.1 Significance Level

- Copper
- Lead
- Mercury
- Selenium
- Zinc

Background Comparison not Performed[1]

- Boron

2.4 Surface Soil Data used in the ERA (PMJM Receptors)

The MDCs for arsenic, nickel, vanadium, and zinc exceed the ESLs for the PMJM receptor for the SWEU surface soil data set (i.e., samples within the PMJM habitat areas) and were carried forward into the background comparison step. The results of the statistical comparison of the SWEU surface soil (PMJM) data to background data are presented in Table A3.2.5 and the summary statistics for background and SWEU surface soil data are shown in Table A3.2.6.

The results of the statistical comparisons of the SWEU surface soil for PMJM receptors to background data indicate the following:

Analytes Statistically Greater than Background at the 0.1 Significance Level

- Nickel
- Vanadium

Analytes Not Statistically Greater than Background at the 0.1 Significance Level

- Arsenic
- Zinc

Background Comparison not Performed[1]

- Not Applicable.

2.5 Subsurface Soil Data used in the ERA

No analytes exceeded the applicable ESL for the subsurface soil data set at SWEU.

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

ECOIs in surface soil and subsurface soil (non-PMJM receptors only) with concentrations that are statistically greater than background or for which background comparisons could not be performed are evaluated further by comparing the exposure point concentration (EPC) to the threshold ESL (tESL). The upper-bound EPCs are the 95 percent UCL 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.

ECOIs in surface soil for PMJM receptors are not screened against tESLs. They are carried forward to the professional judgment evaluation.

3.1 ECOIs in Surface Soil

Arsenic and barium in surface soil (non-PMJM receptors) were eliminated from further consideration because their EPCs are not greater than the tESLs.

Aluminum, boron, chromium, lithium, nickel, and vanadium for surface soil (non-PMJM receptors) have EPCs greater than the tESLs and are evaluated in the professional judgment evaluation screening step (Section 4.0).

3.2 ECOIs in Subsurface Soil

No ECOIs were found to be statistically greater than background and above an ESL in accordance with the ECOPC selection process. Therefore, the upper-bound EPC comparison to tESLs was not performed.

4.0 PROFESSIONAL JUDGMENT

This section describes the professional judgment applied in the COC and ECOPC selection processes for the HHRA and ERA, respectively, for the SWEU. 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 other background data sets[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 related to site activities, the professional judgment discussion 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 is 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 for these evaluations for the SWEU are noted in this attachment.

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

- Surface soil/surface sediment (HHRA)
  - Arsenic
- Surface soil for non-PMJM receptors (ERA)

[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, 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 background data set for Colorado and bordering states 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 provides regional benchmarks for naturally-occurring metals in soil. The comparison of RFETS's soil data to these regional benchmarks is only performed for non-PMJM professional judgment because the PMJM habitat is restricted to the front range of Colorado.

  - Aluminum
  - Boron
  - Chromium
  - Lithium
  - Nickel
  - Vanadium
- Surface soil for PMJM receptors (ERA)
  - Nickel
  - Vanadium

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

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 wastes generated during former RFETS operations, aluminum may be present in RFETS soil as a result of historical site-related activities.

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, a spatial concentration trend for aluminum in surface soil at RFETS is not suggested. Aluminum concentrations in surface soil for all EUs 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 (Figure A3.4.1) does not suggests the presence of a single population because of the occurrence of an anomalously high concentration in one sample (04F0740-004, Location Number = CH16-000). However, sample 04F0740-004 is located in the northeastern

portion of SWEU, south of South Woman Creek. This sample is not located near any historical Individual Hazardous Substance Sites (IHSSs) or Potential Areas of Concern (PACs), and was collected approximately 1,000 feet southeast of the eastern edge of PAC 000-501, on the other side of the South Woman Creek Drainage. There is no known contaminant source or release mechanism that would impact the area where this site is located. This anomalous sample contains the highest aluminum concentration (29,000 milligrams per kilogram [mg/kg]) and is also the same anomalous sample identified for the other analytes (except boron) evaluated in this attachment.

4.1.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Aluminum was detected in each of the 14 surface soil samples collected within SWEU. Aluminum concentrations in surface soil samples at the SWEU range from 11,000 to 29,000 mg/kg, with a mean concentration of 15,857 mg/kg and a standard deviation of 4,330 mg/kg. Background aluminum concentrations range from 4,050 to 17,100 mg/kg, with a mean concentration of 10,202 mg/kg and a standard deviation of 3,256 mg/kg (Table A3.2.4).

The reported range for aluminum in surface soils of Colorado and bordering states (Table A3.4.1) is 10 to 100,000 mg/kg, with an arithmetic mean of 45,900 mg/kg and a standard deviation of 26,900 mg/kg (Shacklette and Boerngen 1984). Aluminum concentrations reported in surface soil samples at the SWEU (11,000 to 29,000 mg/kg) are well within this range.

4.1.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The MDC for aluminum in the SWEU (29,000 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (50 mg/kg). However, the U.S. Environmental Protection Agency (EPA) Ecological Soil Screening Level (EcoSSL) guidance (EPA 2003) for aluminum recommends that aluminum 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. Aluminum concentrations in the SWEU show a distribution similar to sitewide background concentrations and there are no historical records of a source area in the SWEU. Therefore, it is unlikely that the aluminum concentrations in surface soil within the SWEU could present potential risk concerns for wildlife populations.

4.1.6 Conclusion

The weight of evidence presented above shows that aluminum concentrations in SWEU surface soil (non-PMJM receptors) represent variations in naturally occurring aluminum based on the spatial distribution of concentrations and because only one sampling location has a relatively high aluminum concentration, and that location is not near any

historical IHSSs. In addition, the aluminum concentrations in SWEU surface soil for non-PMJM receptors are well within regional background levels and are unlikely to result in risk concerns for wildlife populations. Aluminum is not considered an ECOPC in surface soil for the SWEU and, therefore, is not further evaluated quantitatively.

4.2 Arsenic

Arsenic had concentrations that were considered to be statistically greater than background in surface soil/surface sediment for the HHRA evaluation of the SWEU data set. Therefore, arsenic was carried forward to the professional judgment step. The lines of evidence used to determine if arsenic should be retained as a COC 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 arsenic is unlikely to be present in SWEU soil as a result of historical site-related activities.

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, the spatial trend analysis indicates that arsenic concentrations in SWEU surface soil/surface sediment reflect variations in naturally occurring arsenic.

4.2.3 Pattern Recognition

Surface Soil/ Surface Sediment

The probability plot for the natural log-transformed data set for arsenic in the combined surface soil and surface sediment within the SWEU (Figure A3.4.2) is a classical "S"-shaped single population calculated on a limited number of samples (n=16) that do not adequately define the lower asymptotic suite of samples. The sample with the lowest arsenic concentration (05F0011-22) has an arsenic concentration of only 3.3 mg/kg, while the sample with the next lowest concentration (04F0731-002) contains 5.7 mg/kg. On the uppermost part of the probability plot, the four samples with the highest arsenic concentrations (04F0731-005, 04F0740-006, 04F0740-001, and 04F0731-003) are defining an upper asymptotic limb with arsenic concentrations of 8.5, 8.6, 8.6, and 9.0 mg/kg, respectively. The limited differences in arsenic concentrations for these four samples support this single background population with an upper arsenic concentration less than 10 mg/kg.

4.2.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil/Surface Sediment

Arsenic was detected in each of the 16 surface soil/surface sediment samples collected in the SWEU. Arsenic concentrations at SWEU range from 3.30 to 9.0 mg/kg, with a mean concentration of 7.16 mg/kg and a standard deviation of 1.43 mg/kg. Arsenic concentrations in the background data set range from 0.27 to 9.6 mg/kg, with a mean concentration of 3.42 mg/kg and a standard deviation of 2.55 mg/kg (Table A3.2.2).

The ranges of the SWEU and background data sets overlap. In addition, the MDC for the SWEU does not exceed the background MDC.

Arsenic concentrations reported in surface soil/surface sediment samples at the SWEU are well within the range for arsenic in soils of Colorado and the bordering states (1.22 to 97 mg/kg), with a mean concentration of 6.9 mg/kg and a standard deviation of 7.64 mg/kg (Table A3.4.1).

4.2.5 Risk Potential for HHRA

Surface Soil/Surface Sediment

The arsenic MDC for surface soil/surface sediment is 9.0 mg/kg and the UCL is 7.78 mg/kg. Even though the UCL of 7.78 mg/kg is slightly more than three times greater than the PRG (2.41 mg/kg), the surface soil/surface sediment concentrations for arsenic within the SWEU are within naturally occurring concentrations in soils in Colorado and bordering states. The PRG is based on an excess carcinogenic risk of 1E-06; therefore, the risk to human health, approximately 2E-06, is well within the National Contingency Plan (NCP) risk range of 1E-06 to 1E-04. Risks estimated for arsenic background surface soil/surface sediment concentrations (2E-06) are similar. Furthermore, because the arsenic MDC of 9.0 mg/kg in SWEU surface soil/surface sediment within the SWEU does not exceed the background MDC of 9.60 mg/kg and the arsenic concentrations in surface soil/surface sediment within the SWEU appear to represent naturally occurring arsenic levels, this risk is unassociated with arsenic releases from RFETS.

4.2.6 Conclusion

The weight of evidence presented above shows that arsenic concentrations in SWEU surface soil/surface sediment are unlikely to be a result of historical site-related activities based on process knowledge, the spatial distribution analysis; and the presence of a single data population indicative of naturally occurring arsenic. In addition, the concentrations of arsenic in SWEU surface soil/surface sediment are well within regional background levels and are unlikely to result in risks to humans significantly above background risks. Arsenic is not considered a COC in surface soil/surface sediment for the SWEU and, therefore, is not further evaluated quantitatively.

4.3 Boron

Boron 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 boron 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 boron 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 boron concentrations in SWEU surface soil (non-PMJM) reflect variations in naturally occurring boron.

4.3.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log-transformed data set for boron (Figure A3.4.3) indicates the presence of a single population, which is indicative of background conditions.

4.3.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

RFETS background data were not collected for boron. However, 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 (Shacklette and Boerngen 1984). Boron concentrations reported in surface soil samples at the SWEU (3.0 to 9.7 mg/kg, with a mean concentration of 5.93 mg/kg and a standard deviation of 1.76 mg/kg) (Table A3.2.4) are well within the range for boron in surface soil in Colorado and the bordering states (Table A3.4.1).

4.3.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The MDC for boron in SWEU (9.7 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (0.5 mg/kg). All other NOAEL ESLs were considerably greater than the MDC 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 MDCs above the NOAEL ESL are not likely to be indicative of site-related risk to the terrestrial plant community in the SWEU. Kabata-Pendias and Pendias (1992) indicate 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. (1997a and 1997b) 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. (1997a and 1997b) was low. Because no NOAEL ESLs other than the terrestrial plant NOAEL ESL are exceeded by the MDC, boron is highly unlikely to present a risk to terrestrial receptor populations in the SWEU.

4.3.6 Conclusion

The weight of evidence presented above shows that boron concentrations in SWEU 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; and the presence of a single data population indicative of naturally occurring boron. In addition, boron concentrations in SWEU surface soil for non-PMJM receptors are well within regional background levels and are unlikely to result in risk concerns for wildlife populations. Review of the source data for the ESL indicates that the ESL is questionable in its ability to predict risk. Boron is not considered an ECOPC in surface soil for the SWEU and, therefore, is not further evaluated quantitatively.

4.4 Chromium

Chromium 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 chromium should be retained for risk characterization are summarized below.

4.4.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates the potential for chromium to be an ECOPC in the SWEU is low due to a moderate inventory, and limited identification as a constituent in wastes generated at RFETS and localized documented historical source areas remote from the SWEU.

4.4.2 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 the potential for chromium to be an ECOPC in the SWEU is low

due to a moderate inventory, and limited identification as a constituent in wastes generated at RFETS and localized documented historical source areas remote from the SWEU.

4.4.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log-transformed data set for chromium (Figure A3.4.4) does not suggests the presence of a single population because of the occurrence of an anomalously high concentration in one sample (04F0740-004, Location Number = CH16-000). However, the anomalous sample (04F0740-004, CH16-000) which contains the highest chromium concentration (28 mg/kg) is not near an historic IHSS, and is the same anomalous sample identified in the other analytes (except boron) evaluated in this section.

4.4.4 Comparison to RFETS Background and Other Background Data Sets

Chromium was detected in each of the 14 surface soil samples collected in the SWEU. Chromium concentrations at the SWEU range from 12.0 to 28.0 mg/kg, with a mean concentration of 16.0 mg/kg and a standard deviation of 3.88 mg/kg. Background chromium concentrations range from 5.5 to 16.9 mg/kg, with a mean concentration of 11.2 mg/kg and a standard deviation of 2.78 mg/kg (Table A3.2.4).

The reported range for chromium in surface soils of Colorado and bordering states is 3 to 500 mg/kg (Table A3.4.1), with an arithmetic mean of 48.2 mg/kg and standard deviation of 41 mg/kg. Chromium concentrations reported in surface soil samples at the SWEU (12 to 28.0 mg/kg and mean concentration of 16.0 mg/kg) are well within this range.

4.4.5 Risk Potential for Plants and Wildlife

The UTL for chromium in the SWEU (28 mg/kg) exceeded the NOAEL ESL for six receptor groups, terrestrial invertebrates (0.4 mg/kg), terrestrial plants (1 mg/kg), herbivorous mourning dove (25.0 mg/kg), insectivorous mourning dove (1.34 mg/kg), American kestrel (14.0 mg/kg), and the insectivorous deer mouse (15.9 mg/kg). With the exception of the herbivorous mourning dove ESL of 25.0 mg/kg, all of the ESLs exceeded by the UTL of 28 mg/kg are less than the MDC in background soils (16.9 mg/kg). The ESLs for all other non-PMJM receptors were greater than the site background MDC and range from 281.3 to 4,173 mg/kg.

The UTL of 28 mg/kg slightly exceeded the avian Eco-SSL for chromium (III) of 26 mg/kg but was less than the mammalian Eco-SSL for chromium (III) (34 mg/kg) and chromium (VI) (81 mg/kg) (EPA 2005a). No chromium Eco-SSLs are currently available for plants, invertebrates or birds (chromium [VI] only).

4.4.6 Conclusion

The weight of evidence presented above shows that chromium concentrations in SWEU surface soil (non-PMJM receptors) represent variations in naturally occurring chromium based on process knowledge and the spatial distribution of concentrations, and because only one sampling location has a relatively high chromium concentration, and that location is not near any historical IHSSs. In addition, the chromium concentrations in SWEU surface soil (non-PMJM receptors) are well within regional background levels, and are unlikely to result in risk concerns for wildlife populations. Chromium is not considered an ECOPC in surface soil for the SWEU and, therefore, is not further evaluated quantitatively.

4.5 Lithium

Lithium had 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 lithium should be retained as an ECOPC are summarized below.

4.5.1 Summary of Process Knowledge

Based on process knowledge as detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, lithium was present in moderate quantities in the historical RFETS' metals inventory and lithium may 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 lithium concentrations in SWEU surface soil reflect variations in naturally occurring lithium.

4.5.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log-transformed data set for lithium (Figure A3.4.5) does not suggests the presence of a single population because of the occurrence of an anomalously high concentration in one sample (04F0740-004, Location Number = CH16-000). However, the anomalous sample (04F0740-004, CH16-000) which contains the highest lithium concentration (19 mg/kg) is not near an historic IHSS, and is the same anomalous sample identified in the other analytes (except boron) evaluated in this section.

4.5.4 Comparison to RFETS Background and Other Background Data Sets

Lithium was detected in each of the 14 surface soil for non-PMJM receptor samples collected at the SWEU and concentrations ranged from 7.7 to 19.0 mg/kg, with a mean concentration of 11.2 and a standard deviation of 2.96 mg/kg. Background concentrations of lithium range from 4.8 to 11.6 mg/kg, with a mean of 7.66 mg/kg and a standard deviation of 1.89 mg/kg (Table A3.2.4).

The reported range for lithium in surface soils within Colorado and the bordering states, presented in Table A3.4.1 shows that background concentrations range from 5 to 130 mg/kg, with an arithmetic mean of 25.3 mg/kg and a standard deviation of 14.4 mg/kg (Shacklette and Boerngen 1984). Lithium concentrations reported in surface soil samples at the SWEU (7.7 to 19.0 mg/kg) are well within this range.

4.5.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for lithium in the SWEU (17.4 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (2 mg/kg). The UTL did not exceed the available NOAEL ESLs for any other receptor group (ESLs were not available for avian receptors due to lack of toxicity information). The NOAEL ESL for terrestrial plants is lower than the minimum detection of lithium in background surface soil. The authors of the document from which the terrestrial plant NOAEL ESL was selected (Efroymson et al 1997a and 1997b) placed a low confidence rating on the value. Other studies reported in Efroymson et al. (1997a and 1997b) report no observed adverse effects at 25 mg/kg, which is greater than the MDC. Lithium concentrations greater than the background in the SWEU are most likely due to local variations in natural sources. It is unlikely that lithium poses a risk potential to non-PMJM receptors in the SWEU.

4.5.6 Conclusion

The weight of evidence presented above shows that lithium concentrations in SWEU surface soil (non-PMJM receptors) represent variations in naturally occurring lithium based on the spatial distribution of concentrations and because only one sampling location has a relatively high lithium concentration, and that location is not near any historical IHSSs. In addition, the lithium concentrations in SWEU surface soil (non-PMJM receptors) are well within regional background levels and are unlikely to result in risk concerns for wildlife populations. Lithium is not considered an ECOPC in surface soil for the SWEU and, therefore, is not further evaluated quantitatively.

4.6 Nickel

Nickel has an EPC in surface soil (for non-PMJM receptors) greater than the tESL and therefore, was carried forward to the professional judgment step. In addition, nickel has concentrations statistically greater than background in surface soil in PMJM habitat 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.

4.6.1 Summary of Process Knowledge

Based on process knowledge as detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, nickel was present in moderate quantities in the historical RFETS' metals inventory and nickel 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 indicates that nickel concentrations in SWEU surface soil (non-PMJM) reflect variations in naturally occurring nickel.

Surface Soil (PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that nickel concentrations in SWEU surface soil (PMJM habitat) reflect variations in naturally occurring nickel.

4.6.3 Pattern Recognition

Surface Soil (Non-PMJM and PMJM)

It is difficult to ascertain if nickel concentrations in surface soil in the SWEU reflect the presence of a single population based on the probability plot for the natural log-transformed data set for nickel (Figure A3.4.6). As shown in this figure, there is an anomalously high concentration associated with one sample (04F0740-004, CH16-000). Furthermore, over half (eight) of the analytical values for nickel represent a detection limit as illustrated by the horizontal line at approximately natural logarithm 2.4 on the probability plot, which further weakens the ability of the probability plot to detect two populations. However, the potentially anomalous sample (04F0740-004, CH16-000) contains the highest nickel concentration (21 mg/kg) and is also the same anomalous sample identified for the other analytes (except boron) evaluated in this section. The sample location is not near a historical IHSS. Unlike the other analytes, the nickel concentration for this sample is only slightly above the normal distribution line. Other distribution defining methods would probably find the nickel distribution to be lognormal.

4.6.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Nickel was detected in each of the 14 surface soil (non-PMJM) samples collected in the SWEU. Nickel concentrations in surface soil at the SWEU range from 7.6 to 21.0 mg/kg,

with a mean concentration of 12.0 mg/kg and a standard deviation of 3.46 mg/kg. Background concentrations of nickel range from 3.8 to 14 mg/kg, with a mean of 9.6 mg/kg and a standard deviation of 2.59 mg/kg (Table A3.2.4).

Table A3.4.1 presents the reported range for nickel in surface soil within Colorado and the bordering states and shows that nickel concentrations range from less than 5 to 700 mg/kg, with an arithmetic mean of 18.8 mg/kg and a standard deviation of 39.8 mg/kg (Shacklette and Boerngen 1984). Nickel concentrations reported in surface soil samples at the SWEU for non-PMJM receptors (7.6 to 21 mg/kg) are well within this range.

Surface Soil (PMJM)

Nickel was detected in each of the four surface soil (PMJM receptors) samples collected in the SWEU. Nickel concentrations in surface soil (PMJM receptor) at the SWEU range from 11.0 to 17.0 mg/kg, with a mean concentration of 14.5 mg/kg and a standard deviation of 2.65 mg/kg. Background concentrations of nickel range from 3.8 to 14 mg/kg, with a mean of 9.6 mg/kg and a standard deviation of 2.59 mg/kg (Table A3.2.6).

4.6.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL of nickel in the SWEU (21 mg/kg) exceeds the NOAEL ESL for six receptor groups, insectivorous mourning dove (1.24 mg/kg), insectivorous deer mouse (0.43 mg/kg), insectivorous coyote (1.86 mg/kg), generalist coyote (6.0 mg/kg), American kestrel (13.1 mg/kg), and herbivorous deer mouse (16.4 mg/kg). All of these ESLs (except the herbivorous deer mouse) are less than the MDC in background soils (14 mg/kg). No nickel Eco-SSLs are currently available for any receptor (the nickel Eco-SSL document is “pending”).

Surface Soil (PMJM)

The MDC of nickel in PMJM habitat (17 mg/kg) also exceeded the PMJM NOAEL ESL (0.5 mg/kg). The MDC exceeded the maximum detected background concentration at all four samples in PMJM habitat (three samples within SWEU and one sample within the Southeast Buffer Zone Area EU [SEEU]). The PMJM ESL is lower than all background concentrations.

4.6.6 Conclusion

The weight of evidence presented above shows that nickel concentrations in SWEU surface soil (non-PMJM) represent variations in naturally occurring nickel primarily based on the spatial distribution of concentrations. In addition, nickel concentrations in SWEU surface soil (non PMJM) are well within regional background levels. The other

lines of evidence are inconclusive. Nickel is not considered an ECOPC in surface soil for the SWEU and, therefore, is not further evaluated quantitatively.

4.7 Vanadium

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

4.7.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, vanadium was used in small quantities at RFETS, and was identified as a constituent of waste generated in only 2 buildings. A small volume of vanadium contaminated surface soil in the PU&D Yard (IHSS 170) was removed as a best management practice. Based on process knowledge, vanadium may be present in NNEU soil as a result of historical site-related activities, but is unlikely to be present in SWEU surface soil.

4.7.2 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 vanadium concentrations in SWEU surface soil (non-PMJM) reflect variations in naturally occurring vanadium.

Surface Soil (PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that vanadium concentrations in SWEU surface soil (in PMJM habitat) reflect variations in naturally occurring vanadium.

4.7.3 Pattern Recognition

Surface Soil (Non-PMJM and PMJM)

The probability plot for the natural log-transformed data set for vanadium (Figure A3.4.7) does not suggest the presence of a single population because of the occurrence of an anomalously high concentration in one sample (04F0740-004, Location Number = CH16-000). However, the anomalous sample (04F0740-004, CH16-000) which contains the highest vanadium concentration (65 mg/kg) is not near an historic IHSS, and is the same anomalous sample identified in the other analytes (except boron) evaluated in this section.

4.7.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Vanadium was detected in each of the 14 surface soil (non-PMJM) samples collected in the SWEU. Vanadium concentrations in surface soil at the SWEU range from 27.0 to 65.0 mg/kg, with a mean concentration of 36.1 mg/kg and a standard deviation of 9.19 mg/kg. Background concentrations of vanadium range from 10.8 to 45.8 mg/kg, with a mean of 27.7 mg/kg and a standard deviation of 7.68 mg/kg (Table A3.2.4).

Vanadium concentrations at the SWEU are well within the range of reported literature values. Table A3.4.1 presents the reported range for vanadium in surface soil of Colorado and bordering states and shows that concentrations range from 7 to 300 mg/kg, with a mean concentration of 73 mg/kg and a standard deviation of 41.7 mg/kg (Table A3.4.1). Vanadium concentrations reported in surface soil samples at the SWEU (27.0 to 65.0 mg/kg) are well within this range.

Surface Soil (PMJM)

Vanadium was detected in each of the four surface soil (PMJM) samples collected in the SWEU. Vanadium concentrations in surface soil for PMJM receptors at the SWEU range from 31.0 to 48.0 mg/kg, with a mean concentration of 39.5 mg/kg and a standard deviation of 6.95 mg/kg. Background concentrations of vanadium range from 10.8 to 45.8 mg/kg, with a mean of 27.7 mg/kg and a standard deviation of 7.68 mg/kg (Table A3.2.6).

4.7.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL (65 mg/kg) exceeds the NOAEL ESL for three receptor groups, terrestrial plants (2 mg/kg), the insectivorous deer mouse (29.9 mg/kg) and the herbivorous deer mouse (64.0 mg/kg). The NOAEL ESLs for all other non-PMJM receptors were greater than or almost equal to the UTL and range from 84.0 to 1,514 mg/kg. The ESL for the insectivorous deer mouse is less than the MDC in background soils (45.8 mg/kg) and approximately equal to the mean background concentration (27.7 mg/kg). The UTL of 65 mg/kg is just slightly above the herbivorous deer mouse ESL of 64.0 mg/kg. In addition, the UTL is less than the mammalian Eco-SSL of 280 mg/kg (EPA 2005b).

The plant NOAEL ESL is lower than all background concentrations of vanadium. In addition, the confidence placed on the value by the source (Efroymson et al. 1997a and 1997b) is low. Other studies reported in the same reference (Efroymson et al. 1997a and 1997b) indicate no effects at concentrations up to 40 mg/kg and low effects at concentrations up to 60 mg/kg. No vanadium Eco-SSL is currently available for plants (EPA 2005b).

Surface Soil (PMJM)

All four samples in PMJM habitat (three samples within SWEU and one sample within SEEU) had concentrations greater than the NOAEL ESL of 21.6 mg/kg for the PMJM. Only one of four samples had a concentration that exceeded the maximum background of 45.8 mg/kg (Table A3.2.6).

4.7.6 Conclusion

The weight of evidence presented above shows that vanadium concentrations in SWEU surface soil (non-PMJM receptors) represent variations in naturally occurring vanadium based on process knowledge and the spatial distribution of concentrations, and because only one sampling location has a relatively high vanadium concentration, and that location is not near any historical IHSSs. In addition, the vanadium concentrations in SWEU surface soil (non-PMJM receptors) are well within regional background levels and are unlikely to result in risk concerns for wildlife populations. Vanadium is not considered an ECOPC in surface soil for the SWEU and, therefore, is not further evaluated quantitatively.

5.0 REFERENCES

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TABLES

Table A3.2.1

Statistical Distributions and Comparison to Background for SWEU Surface Soil/Surface Sediment[a]

Analyte	Statistical Distribution Testing Results						Background Comparison Results		
	Background Data Set			SWEU 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**	**92**	**16**	**NORMAL**	**100**	**WRS**	**1.36E-06**	**Yes**

[a] EU data used for background comparisons do not include data from background locations.

WRS = Wilcoxon Rank Sum.

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

Table A3.2.2

Summary Statistics for SWEU Surface Soil/Surface Sediment [a, b]

		Background					SWEU				
Analyte	**Units**	**Total Samples**	**Minimum Detected Concentration**	**Maximum Detected Concentration**	**Mean Concentration**	**Standard Deviation**	**Total Samples**	**Minimum Detected Concentration**	**Maximum Detected Concentration**	**Mean Concentration**	**Standard Deviation**
Inorganics											
Arsenic	mg/kg	73	0.27	9.6	3.42	2.55	16	3.3	9	7.16	1.43

[a] No background samples were collected from the SWEU.

[b] Statistics are computed using one-half the reported value for nondetects.

Table A3.2.3
Statistical Distributions and Comparison to Background for SWEU Surface Soil (Non-PMJM)

Analyte	Statistical Distribution Testing Results						Background Comparison Results		
	Background Data Set			SWEU Data Set					
	Total No. of Samples	Distribution Recommended by ProUCL	Detections (%)	Total No. of Samples	Distribution Recommended by ProUCL	Detections (%)	Test	1-p	Statistically Greater than Background?
Aluminum	20	NORMAL	100	14	GAMMA	100	WRS	8.27E-05	**Yes**
Arsenic	20	NORMAL	100	14	NORMAL	100	t-Test_N	0.012	**Yes**
Barium	20	NORMAL	100	14	NORMAL	100	t-Test_N	0.002	**Yes**
Boron	N/A	N/A	N/A	14	NORMAL	100	N/A	N/A	N/A
Chromium	20	NORMAL	100	14	NON-PARAMETRIC	100	WRS	5.79E-05	**Yes**
Copper	20	NON-PARAMETRIC	100	14	NORMAL	100	WRS	0.862	No
Lead	20	NORMAL	100	14	NORMAL	100	t-Test_N	0.966	No
Lithium	20	NORMAL	100	14	NORMAL	100	t-Test_N	8.76E-05	**Yes**
Mercury	20	NON-PARAMETRIC	40	14	NON-PARAMETRIC	100	WRS	1.000	No
Nickel	20	NORMAL	100	14	NON-PARAMETRIC	100	WRS	0.020	**Yes**
Selenium	20	NON-PARAMETRIC	60	14	NON-PARAMETRIC	21	WRS	0.431	No
Vanadium	20	NORMAL	100	14	GAMMA	100	WRS	0.002	**Yes**
Zinc	20	NORMAL	100	14	NORMAL	100	t-Test_N	0.917	No

N/A = Not applicable.
Bolded entries indicate ECOIs retained for further consideration in the upper-bound EPC comparison step.
WRS = Wilcoxon Rank Sum.

Table A3.2.4

Summary Statistics for SWEU Surface Soil (Non-PMJM) [a, b]

		Background					SWEU				
Analyte	**Units**	**Total Samples**	**Minimum Detected Concentration**	**Maximum Detected Concentration**	**Mean Concentration**	**Standard Deviation**	**Total Samples**	**Minimum Detected Concentration**	**Maximum Detected Concentration**	**Mean Concentration**	**Standard Deviation**
Inorganics											
Aluminum	mg/kg	20	4,050	17,100	10,202	3,256	14	11,000	29,000	15,857	4,330
Arsenic	mg/kg	20	2.3	9.6	6.09	2.00	14	5.7	9	7.47	1.05
Barium	mg/kg	20	45.7	134	102	19.4	14	78	210	130	32.4
Boron	mg/kg	N/A	N/A	N/A	N/A	N/A	14	3	9.7	5.93	1.76
Chromium	mg/kg	20	5.5	16.9	11.2	2.78	14	12	28	16.0	3.88
Copper	mg/kg	20	5.20	16.0	13.0	2.58	14	6.50	19.0	12.3	3.36
Lead	mg/kg	20	8.60	53.3	33.5	10.5	14	17.0	38.0	27.8	5.18
Lithium	mg/kg	20	4.8	11.6	7.66	1.89	14	7.7	19	11.2	2.96
Mercury	mg/kg	20	0.090	0.120	0.072	0.031	14	0.027	0.130	0.043	0.026
Nickel	mg/kg	20	3.8	14	9.60	2.59	14	7.6	21	12.0	3.46
Selenium	mg/kg	20	0.680	1.40	0.628	0.305	14	1.00	1.20	0.581	0.268
Vanadium	mg/kg	20	10.8	45.8	27.7	7.68	14	27	65	36.1	9.19
Zinc	mg/kg	20	21.1	75.9	49.8	12.2	14	23.0	74.0	43.5	13.4

[a] No background samples were collected from the SWEU.

[b] Statistics are computed using one-half the reported value for nondetects.

N/A = Not applicable. Background comparison was not performed because background data were not available or detection frequency of an analyte in EU or background data set is less than 20 percen

Bolded entries indicate ECOIs retained for further consideration in the upper-bound EPC comparison step.

Table A3.2.5
Statistical Distributions and Comparison to Background SWEU Surface Soil (PMJM)

Analyte	Statistical Distribution Testing Results						Background Comparison		
	Background			SWEU					
	Total No. of Samples	Distribution Recommended by ProUCL	Detections (%)	Total No. of Samples	Distribution Recommended by ProUCL	Detections (%)	Test	1-p	Statistically Greater than Background?
Arsenic	20	NORMAL	100	4	NORMAL	100	t-Test_N	0.173	No
Nickel	20	NORMAL	100	4	NORMAL	100	t-Test_N	0.001	**Yes**
Vanadium	20	NORMAL	100	4	NORMAL	100	t-Test_N	0.005	**Yes**
Zinc	20	NORMAL	100	4	NORMAL	100	t-Test_N	0.152	No

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

Table A3.2.6
Summary Statistics for SWEU Surface Soil (PMJM)

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)							
Arsenic	0.87 - 0.95	4	100	6.30	8.20	7.08	0.818
Nickel	0.21 - 0.23	4	100	11.0	17.0	14.5	2.65
Vanadium	0.5 - 0.54	4	100	31.0	48.0	39.5	6.95
Zinc	0.49 - 0.53	4	100	46.0	68.0	56.8	11.4

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

Table A3.4.1

Summary of Element Concentrations in Colorado and Bordering States Soils [a]

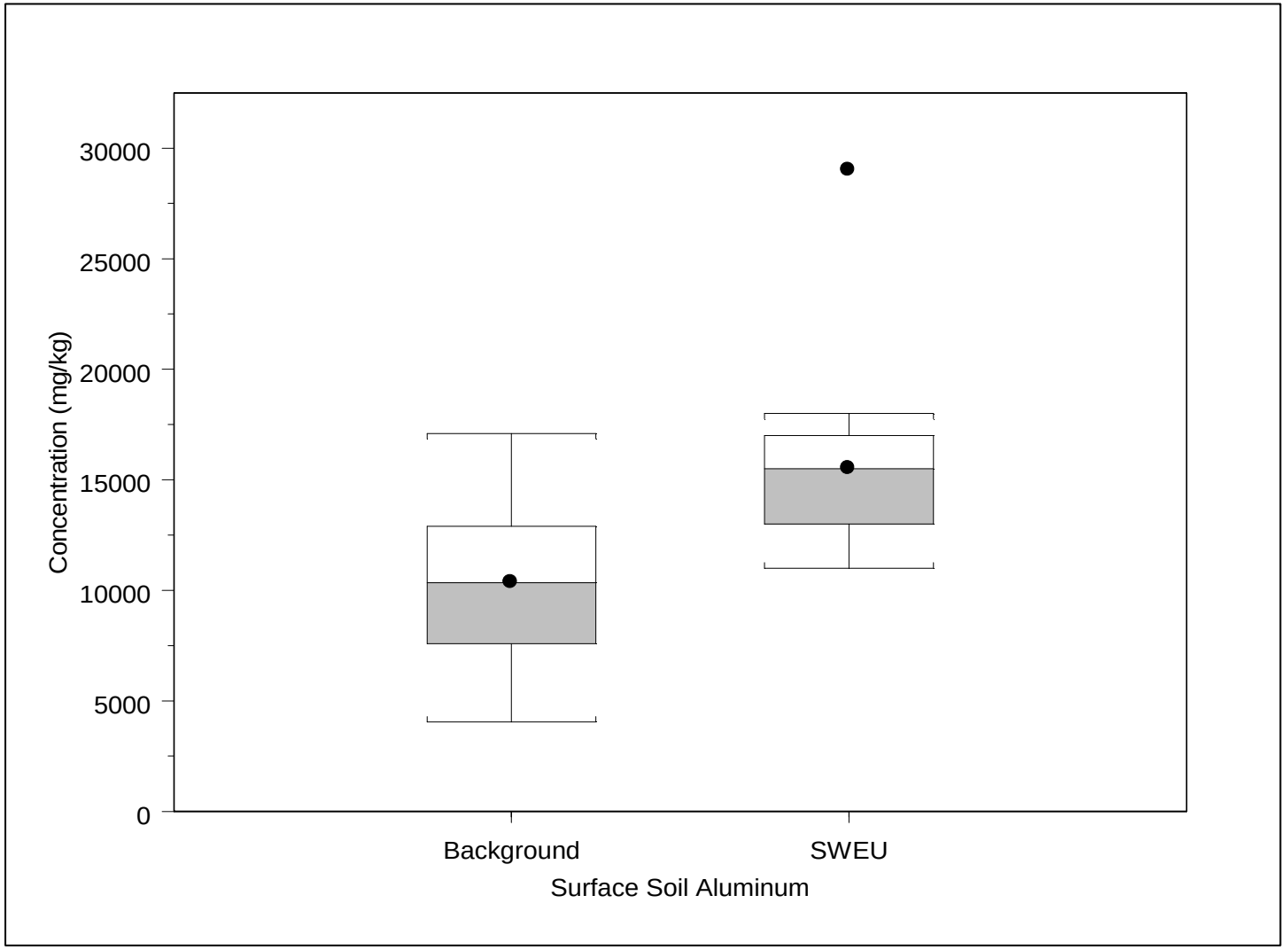
Analyte	Total Number of Results	Number of Nondetects	Detection Frequency (%)	Minimum Detected Value (mg/kg)	Maximum Detected Value (mg/kg)	Range of Detected Values (mg/kg)	Average Detected Value (mg/kg)[b]	Standard Deviation (mg/kg)[b]
Aluminum	335	0	100%	10.0	100,000	10 - 100,000	45,900	26,900
Antimony	84	71	15%	1.04	2.53	1.038 - 2.531	0.647	0.378
Arsenic	307	2	99%	1.22	97.0	1.224 - 97	6.90	7.64
Barium	342	0	100%	100	3,000	100 - 3,000	642	330
Beryllium	342	219	36%	1.00	7.00	1 - 7	0.991	0.876
Boron	342	114	67%	20.0	150	20 - 150	27.9	19.7
Bromine	85	42	51%	0.504	3.52	0.5038 - 3.522	0.681	0.599
Calcium	342	0	100%	0.055	32.0	0.055 - 32	3.09	4.13
Carbon	85	0	100%	0.300	10.0	0.3 - 10	2.18	1.92
Cerium	291	244	16%	150	300	150 - 300	90.0	38.4
Chromium	342	0	100%	3.00	500	3 - 500	48.2	41.0
Cobalt	342	39	89%	3.00	30.0	3 - 30	8.09	5.03
Copper	342	0	100%	2.00	200	2 - 200	23.1	17.7
Fluorine	264	7	97%	10.0	1,900	10 - 1,900	394	261
Gallium	340	3	99%	5.00	50.0	5 - 50	18.3	8.90
Germanium	85	0	100%	0.578	2.15	0.5777 - 2.146	1.18	0.316
Iodine	85	18	79%	0.516	3.49	0.516 - 3.487	1.07	0.708
Iron	342	0	100%	3,000	100,000	3,000 - 100,000	21,100	13,500
Lanthanum	341	115	66%	30.0	200	30 - 200	39.8	28.8
Lead	342	25	93%	10.0	700	10 - 700	24.8	41.5
Lithium	307	0	100%	5.00	130	5 - 130	25.3	14.4
Magnesium	342	0	100%	300	100,000	300 - 100,000	8,890	8,080
Manganese	342	0	100%	70.0	2,000	70 - 2,000	414	272
Mercury	309	3	99%	0.010	4.60	0.01 - 4.6	0.077	0.276
Molybdenum	340	328	4%	3.00	7.00	3 - 7	1.59	0.522
Neodymium	256	198	23%	70.0	300	70 - 300	47.1	31.7
Nickel	342	12	96%	5.00	700	5 - 700	18.8	39.8
Niobium	335	123	63%	10.0	100	10 - 100	11.4	8.68
Phosphorus	249	0	100%	40.0	4,497	40 - 4,497	399	397
Potassium	341	0	100%	1,900	63,000	1,900 - 63,000	18,900	6,980
Rubidium	85	0	100%	35.0	140	35 - 140	75.8	25.0
Scandium	342	51	85%	5.00	30.0	5 - 30	8.64	4.69
Selenium	309	60	81%	0.102	4.32	0.1023 - 4.3183	0.349	0.415
Silicon	85	0	100%	149,340	413,260	149,340 - 413,260	302,000	61,500
Sodium	335	0	100%	500	70,000	500 - 70,000	10,400	6,260
Strontium	342		100%	10.0	2,000	10 - 2,000	243	212
Sulfur	85	71	16%	816	47,760	816 - 47,760	1,250	5,300
Thallium	76	0	100%	2.45	20.8	2.45 - 20.79	9.71	3.54
Tin	85	3	96%	0.117	5.00	0.117 - 5.001	1.15	0.772
Titanium	342	0	100%	500	7,000	500 - 7,000	2,290	1,350
Uranium	85	0	100%	1.11	5.98	1.11 - 5.98	2.87	0.883
Vanadium	342	0	100%	7.00	300	7 - 300	73.0	41.7
Ytterbium	330	3	99%	1.00	20.0	1 - 20	3.33	2.06
Yttrium	342	7	98%	10.0	150	10 - 150	26.9	18.1
Zinc	330	0	100%	10.0	2,080	10 - 2,080	72.4	159
Zirconium	342	0	100%	30.0	1,500	30 - 1,500	220	157

[a] The western U.S. background data set (Shacklette and Boerngen 1984) is composed of background values from Colorado, as well as all states bordering Colorado (Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming). See Section 4.0.

[b] Average and standard deviation values were calculated using one-half the reported value for nondetects.

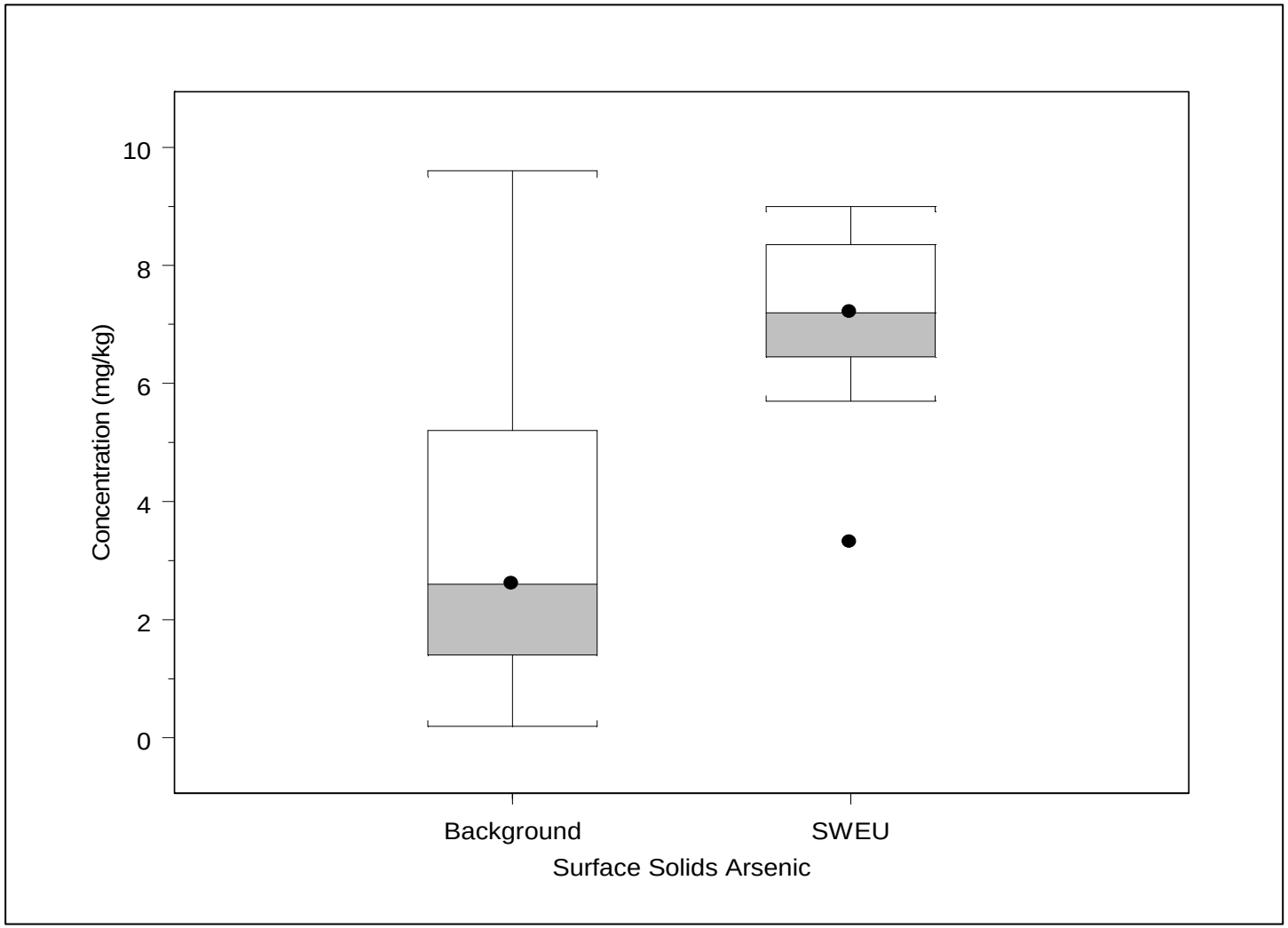
FIGURES

Figure A3.2.1
SWEU Surface Soil Box Plots for Aluminum



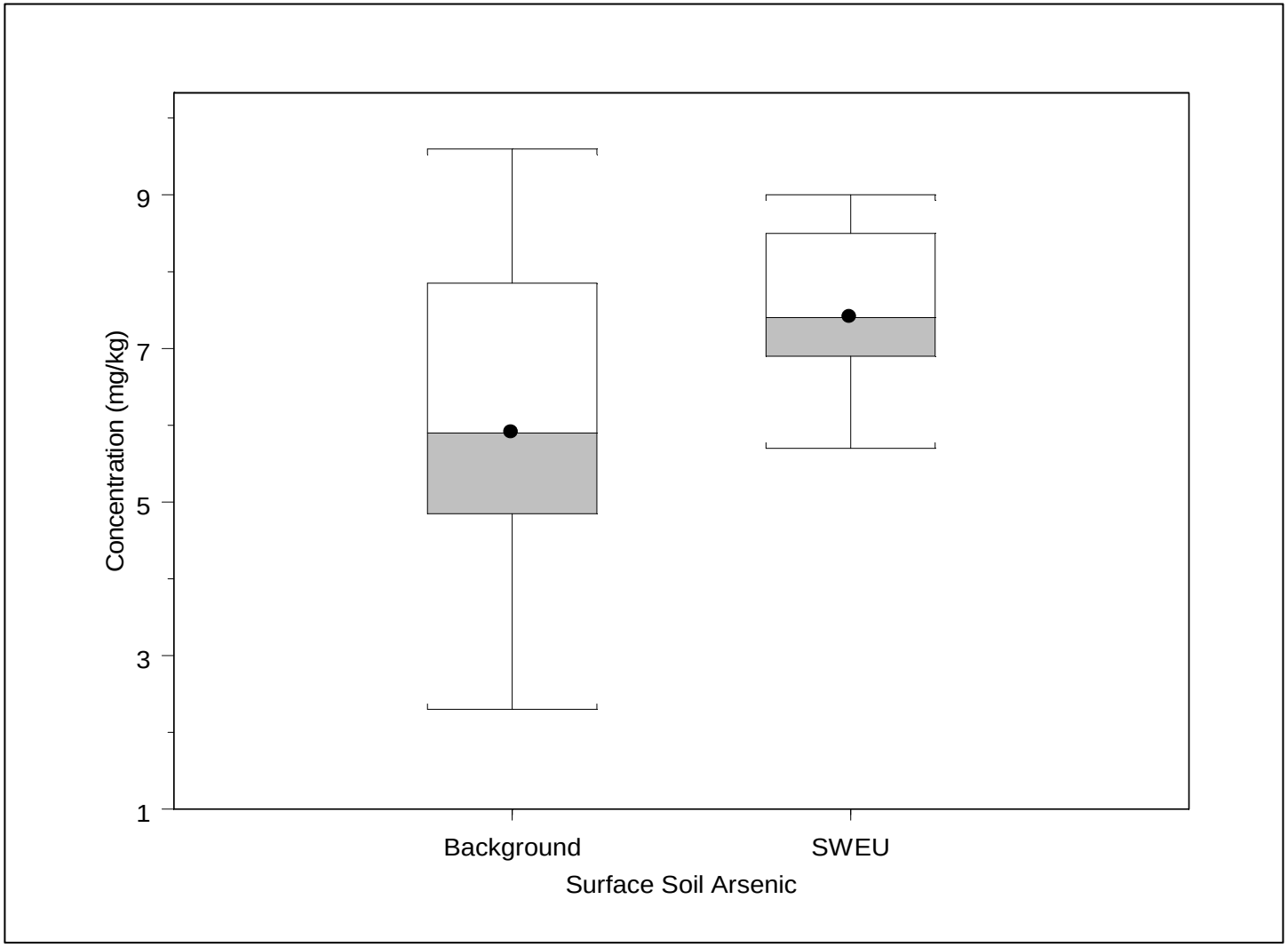
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.2
SWEU Surface Soil/ Surface Sediment Box Plots for Arsenic



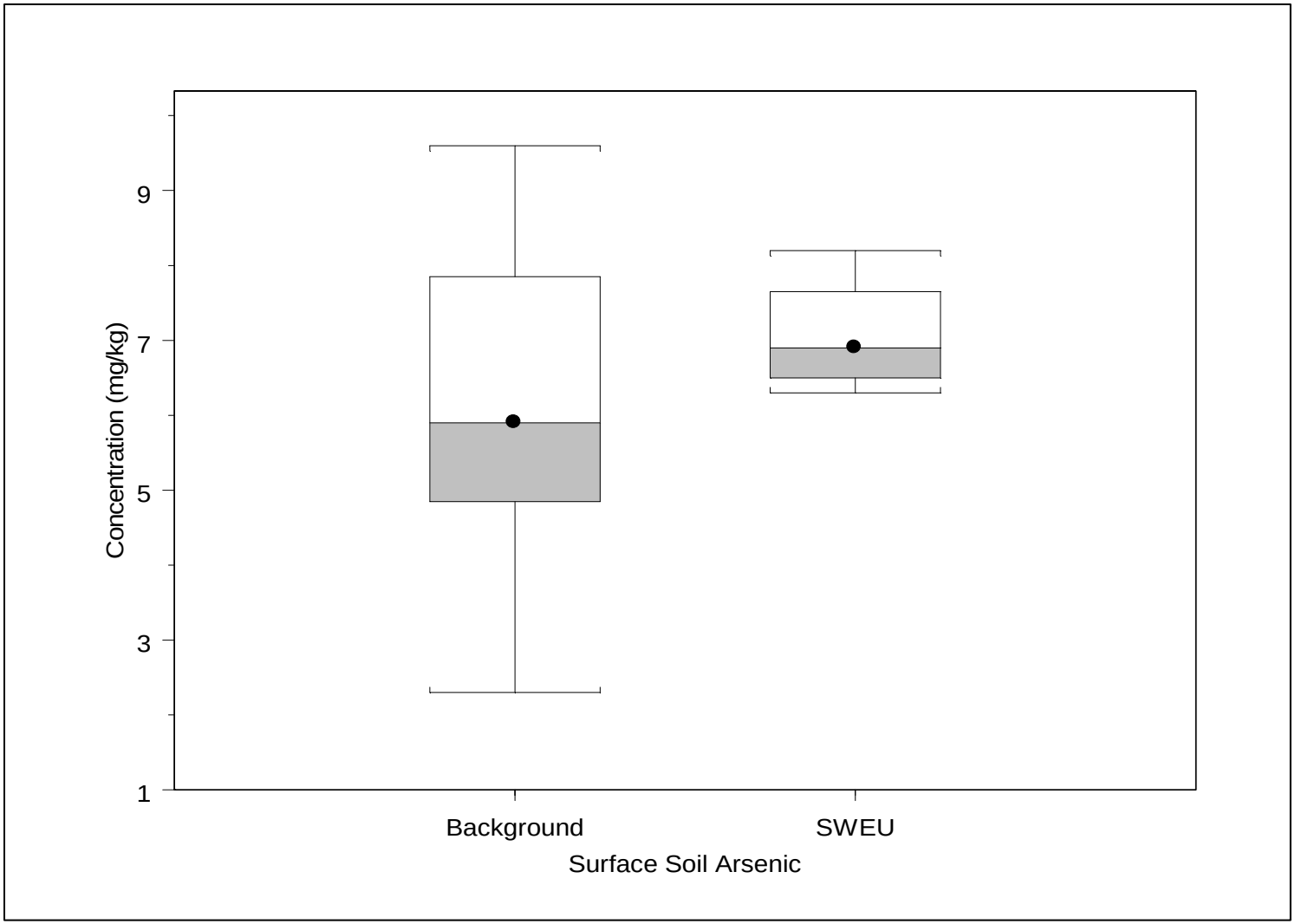
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.3
SWEU Surface Soil Box Plots for Arsenic



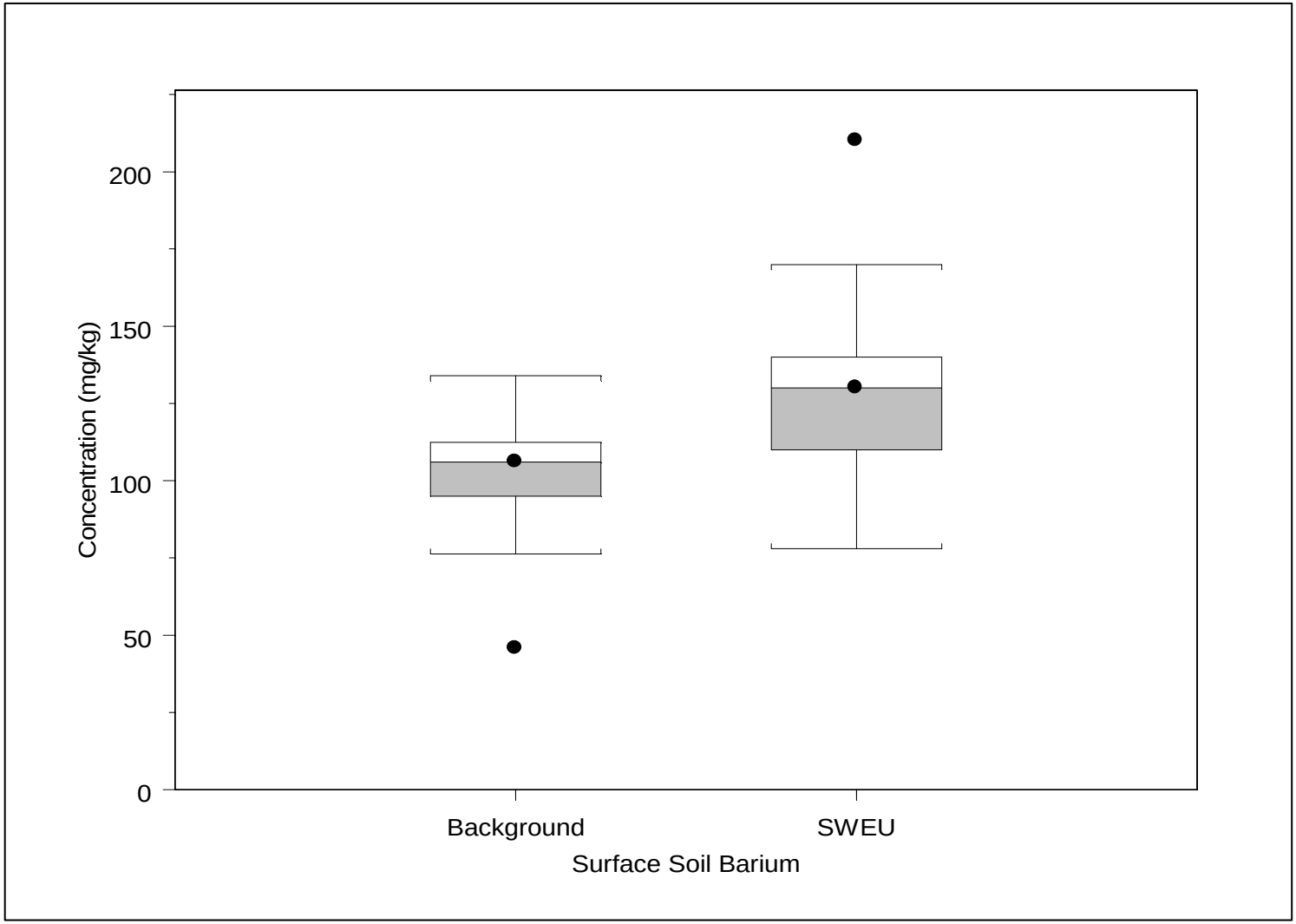
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.4
SWEU Surface Soil in PMJM Habitat Box Plots for Arsenic



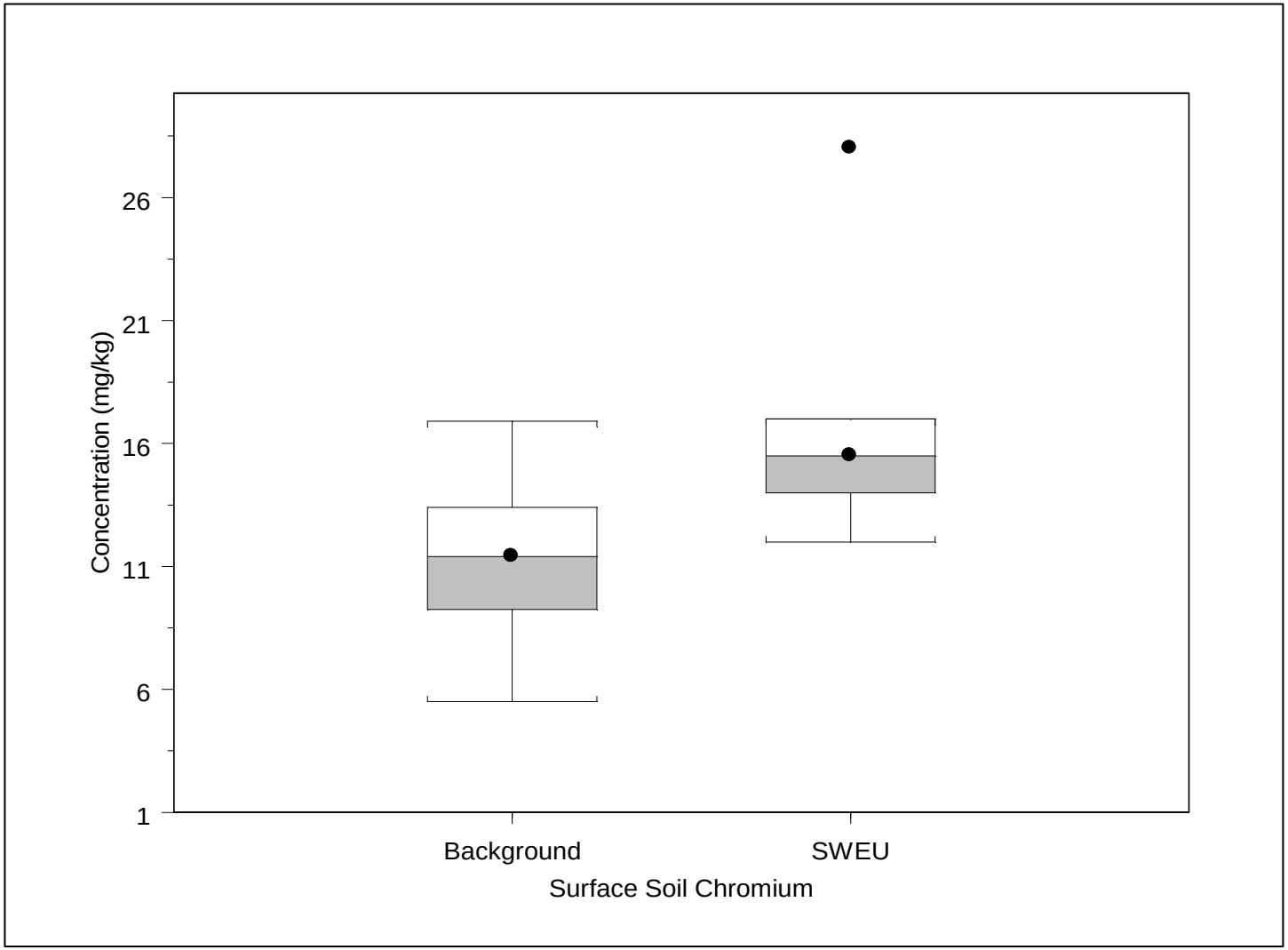
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.5
SWEU Surface Soil Box Plots for Barium



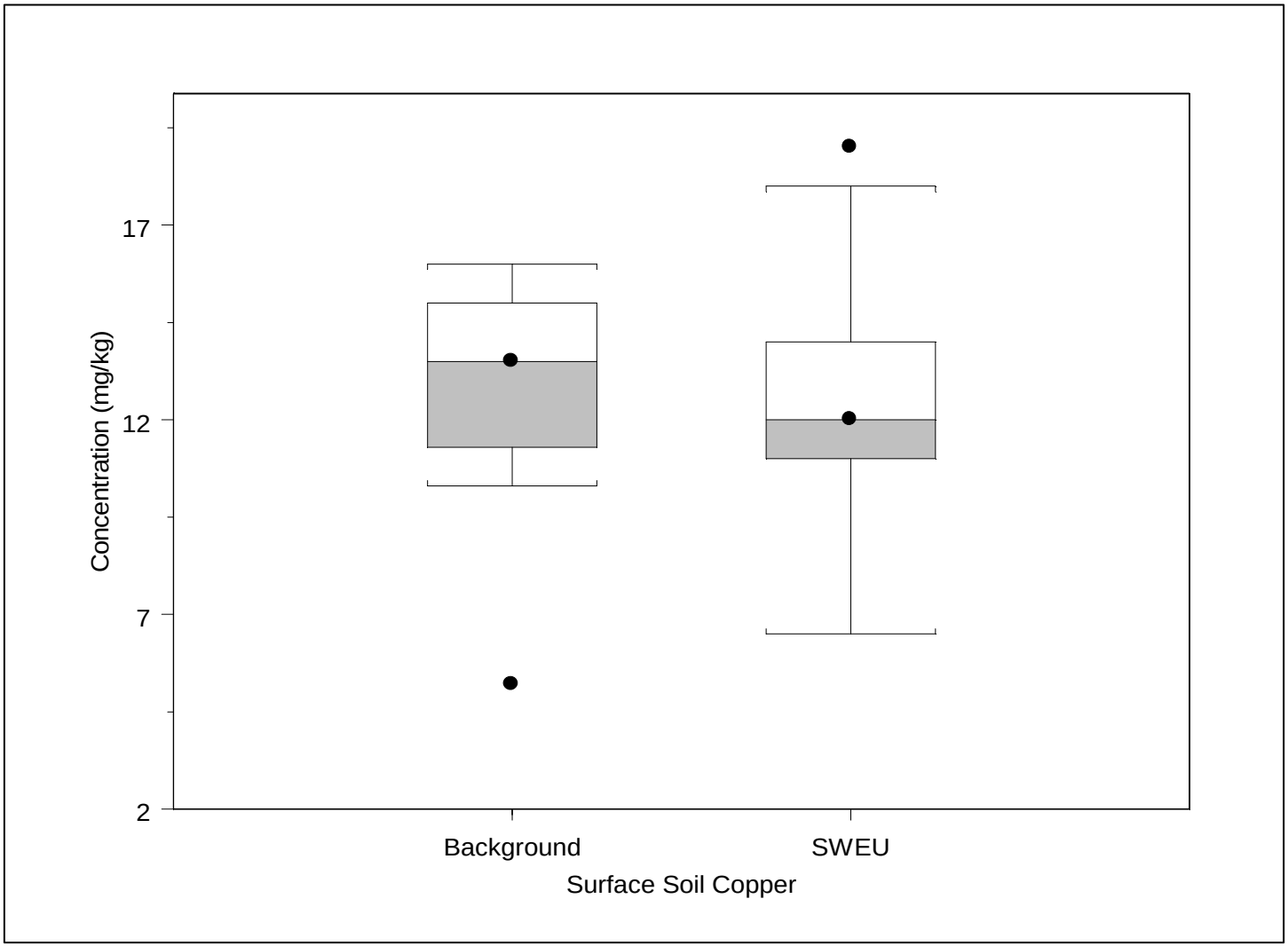
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.6
SWEU Surface Soil Box Plots for Chromium



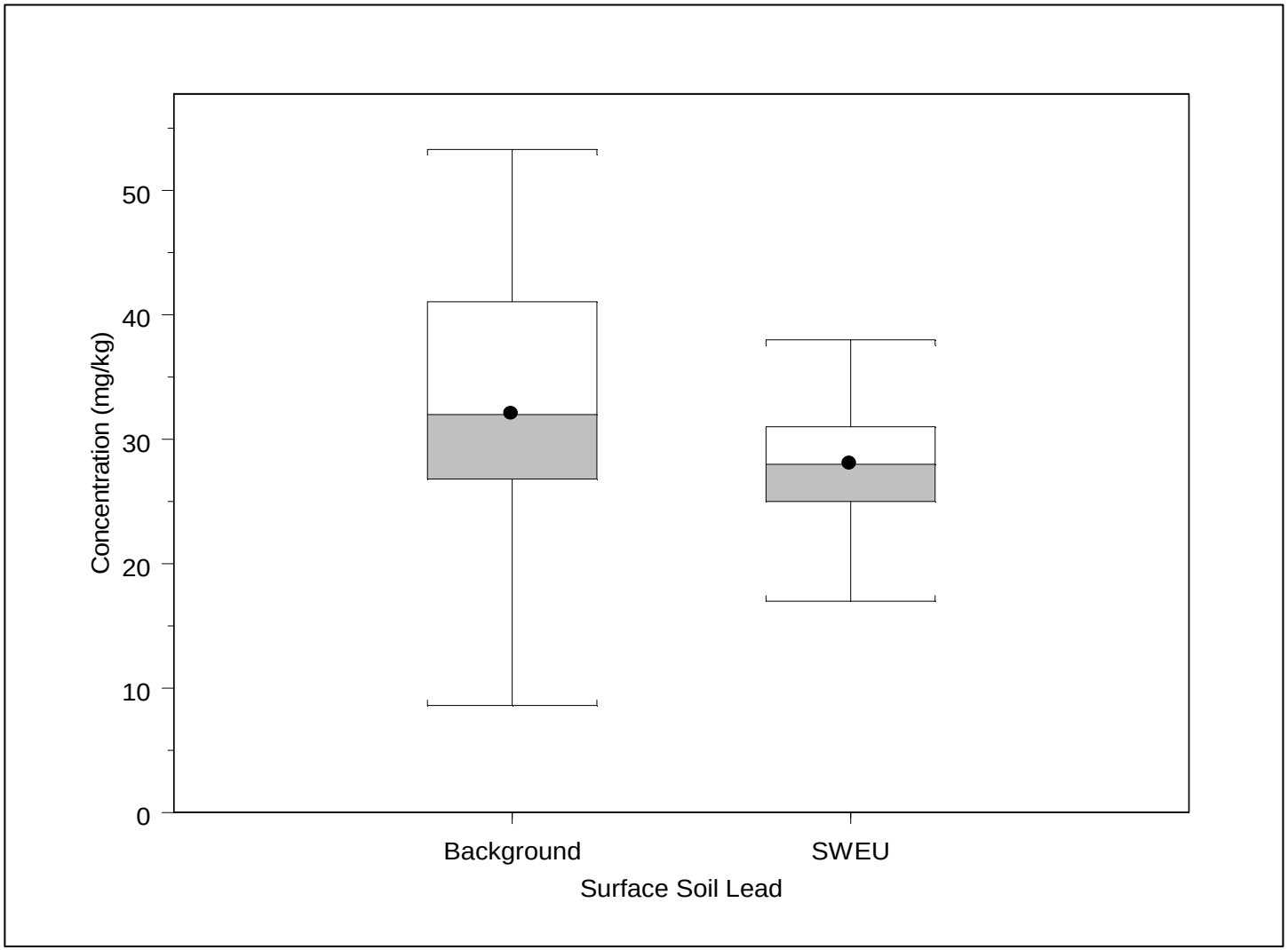
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.7
SWEU Surface Soil Box Plots for Copper



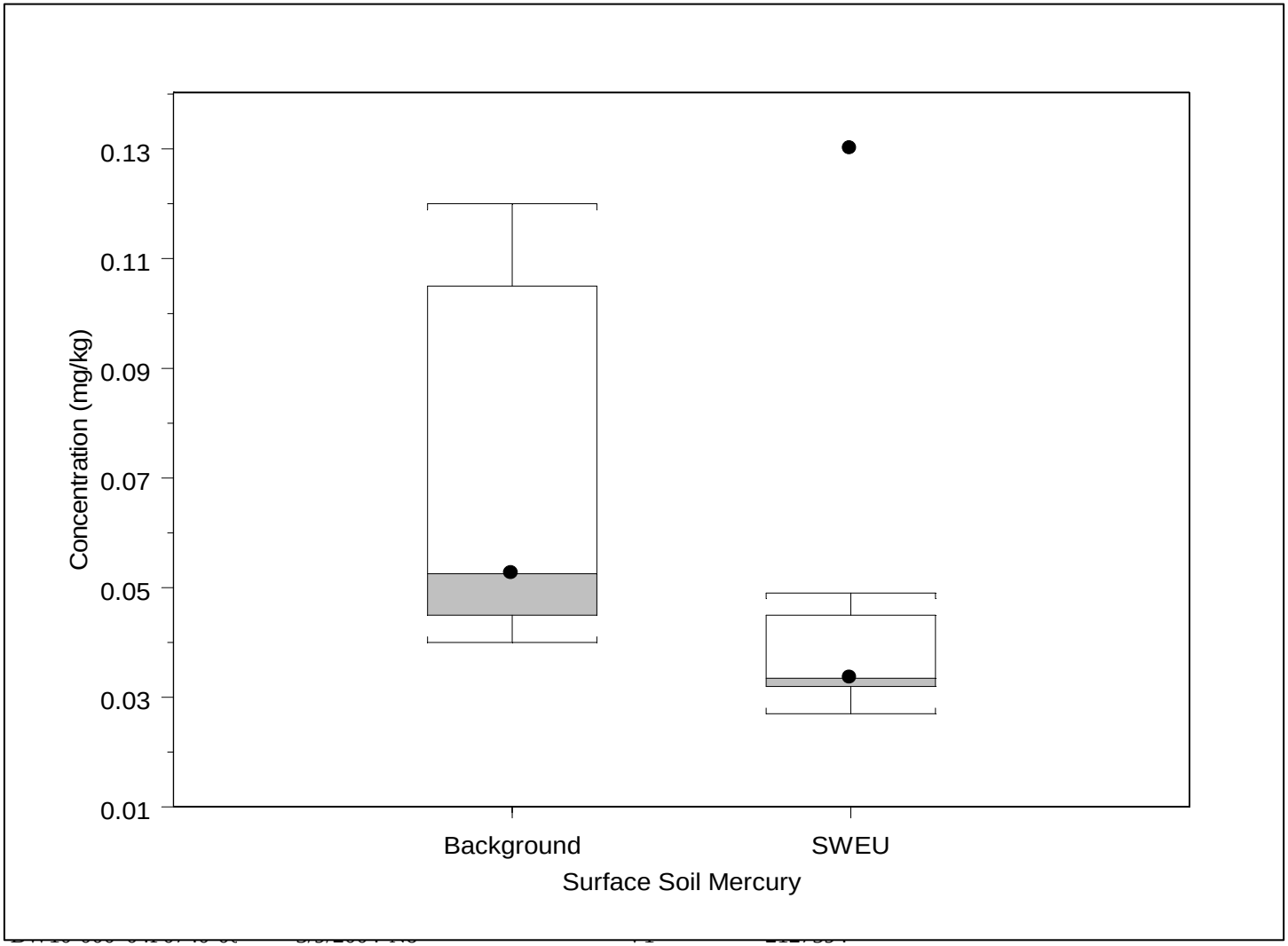
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.8
SWEU Surface Soil Box Plots for Lead



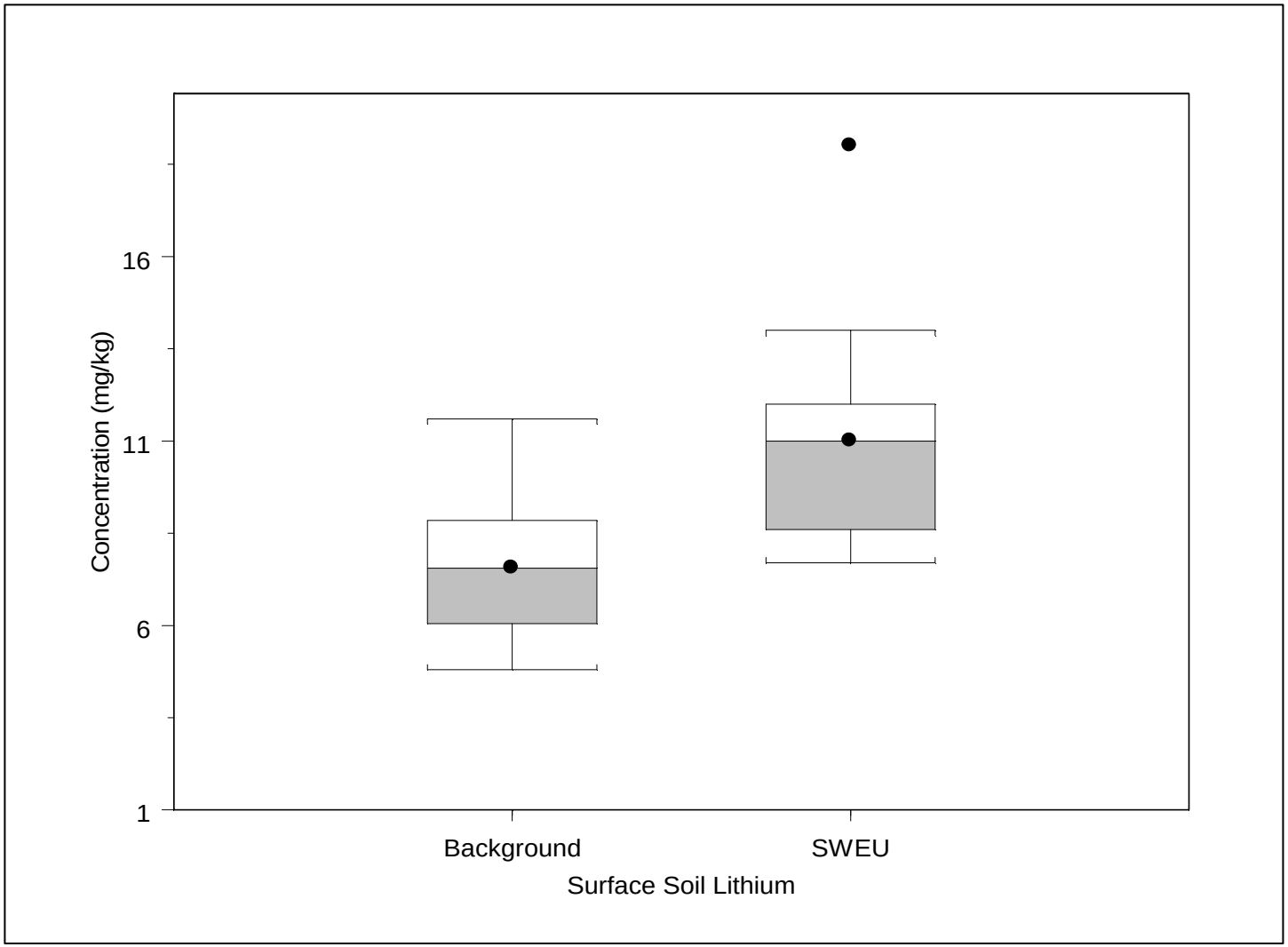
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.10
SWEU 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

Figure A3.2.9
SWEU Surface Soil Box Plots for Lithium

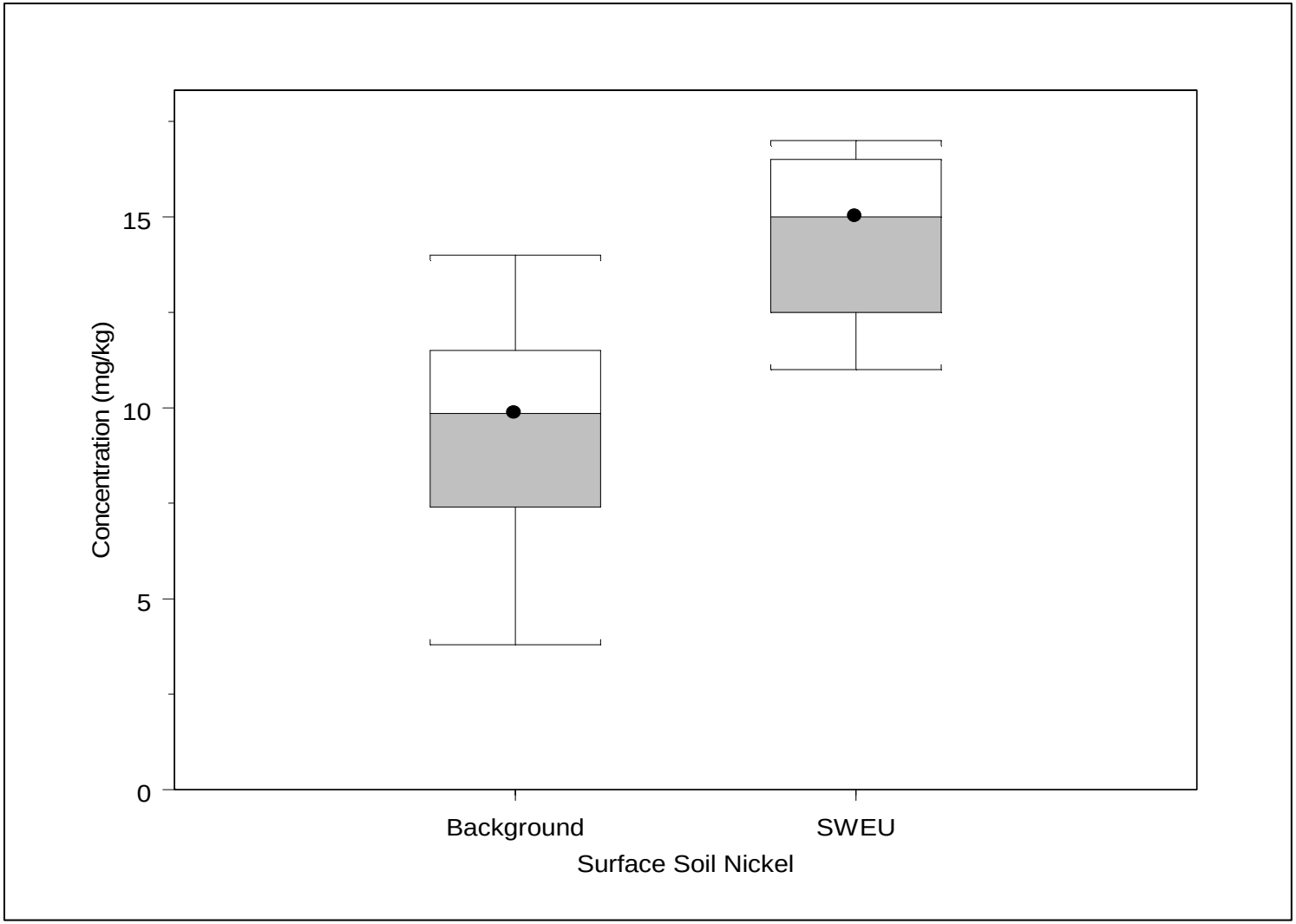


Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.11
SWEU Surface Soil Box Plots for Nickel

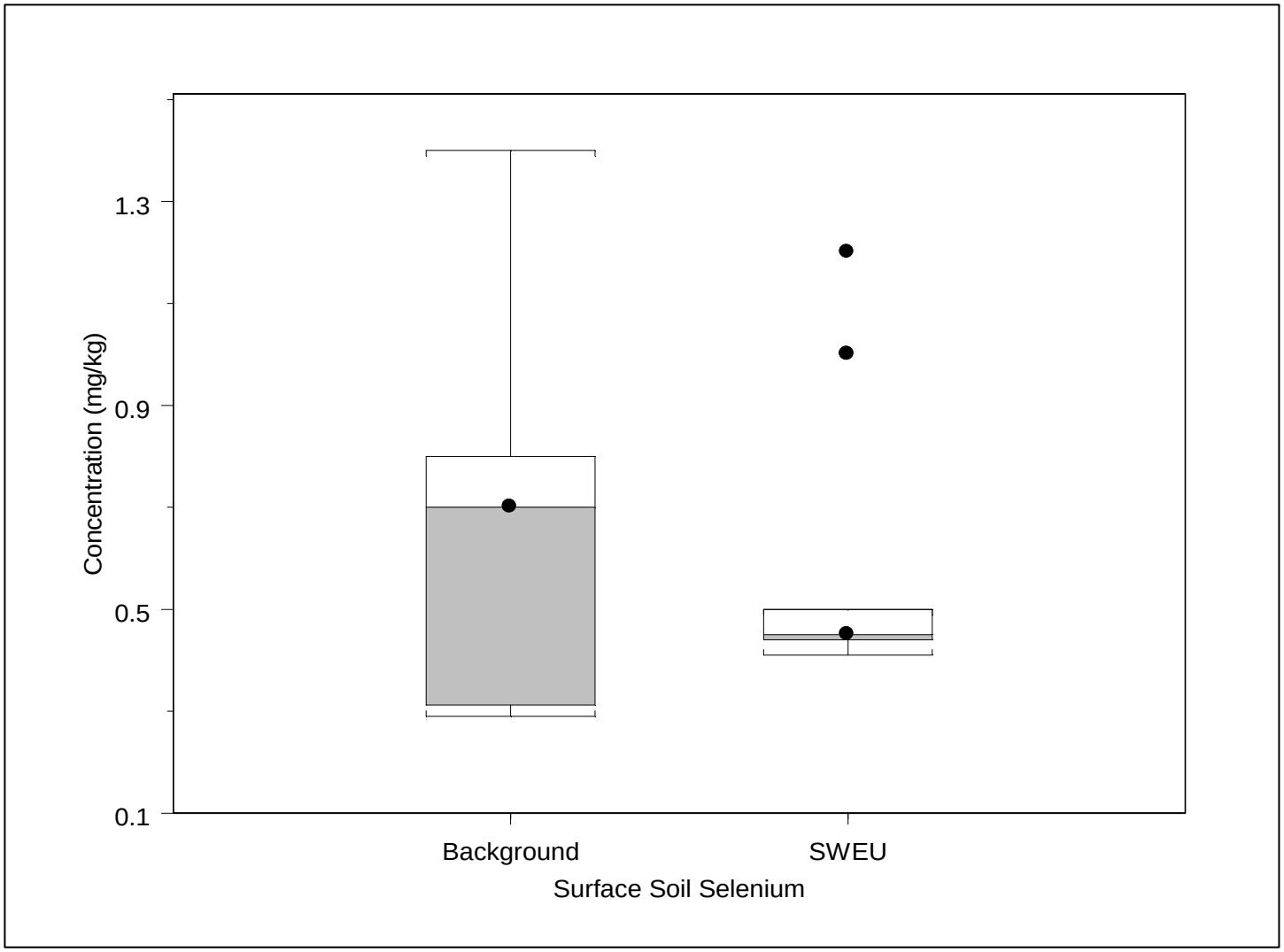
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.12
SWEU Surface Soil in PMJM Habitat Box Plots for Nickel



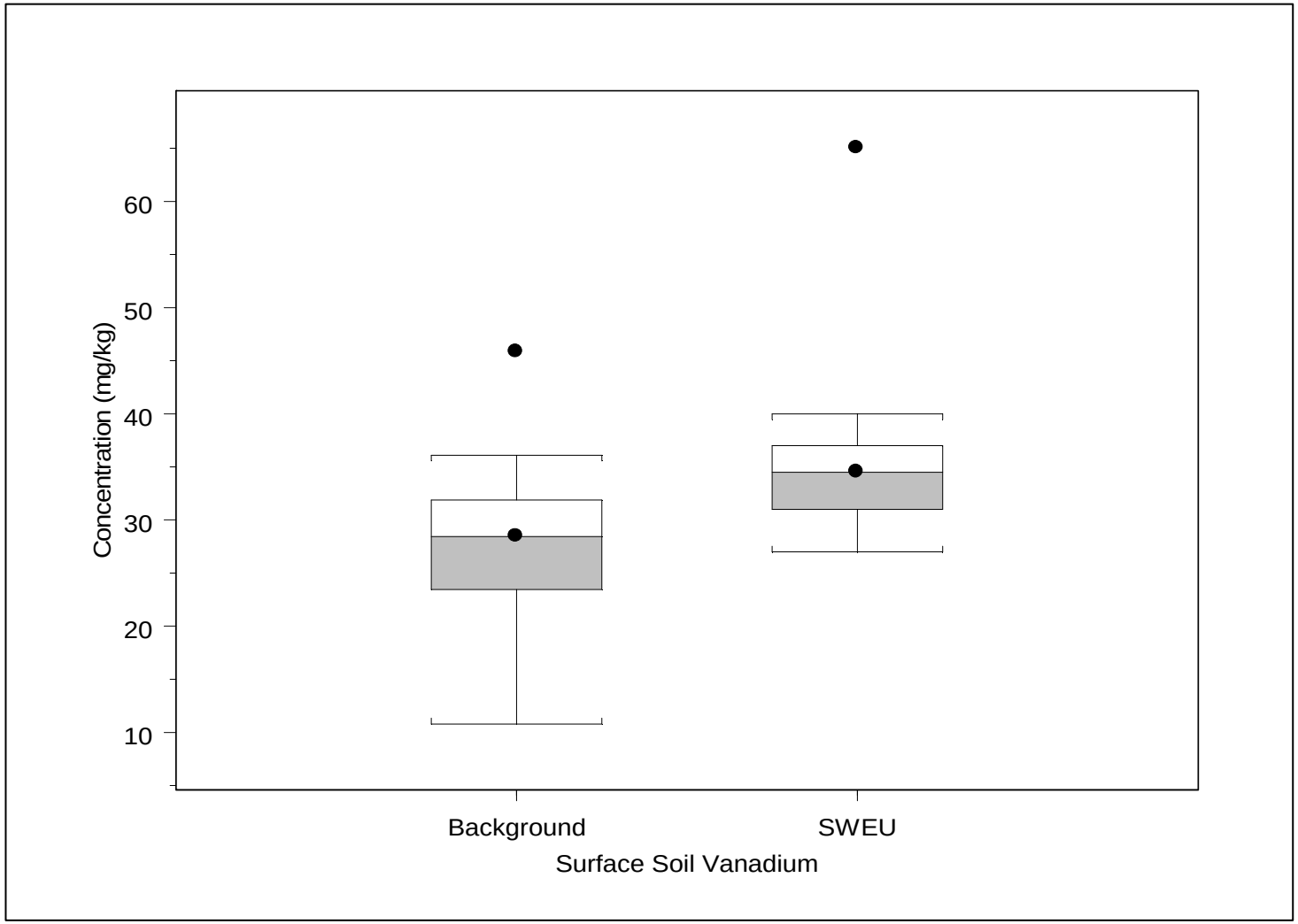
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.13
SWEU Surface Soil Box Plots for Selenium



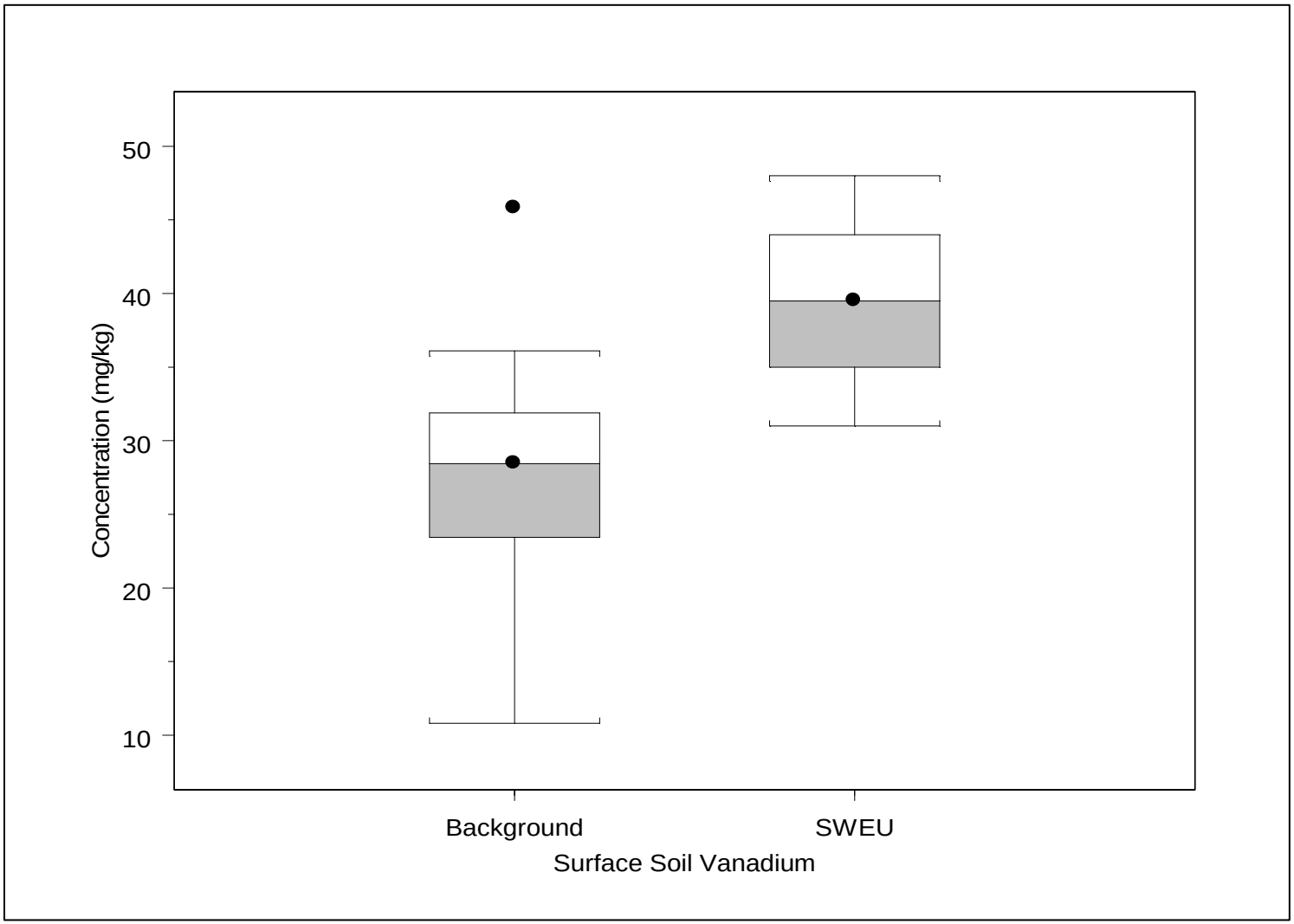
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.14
SWEU Surface Soil Box Plots for Vanadium



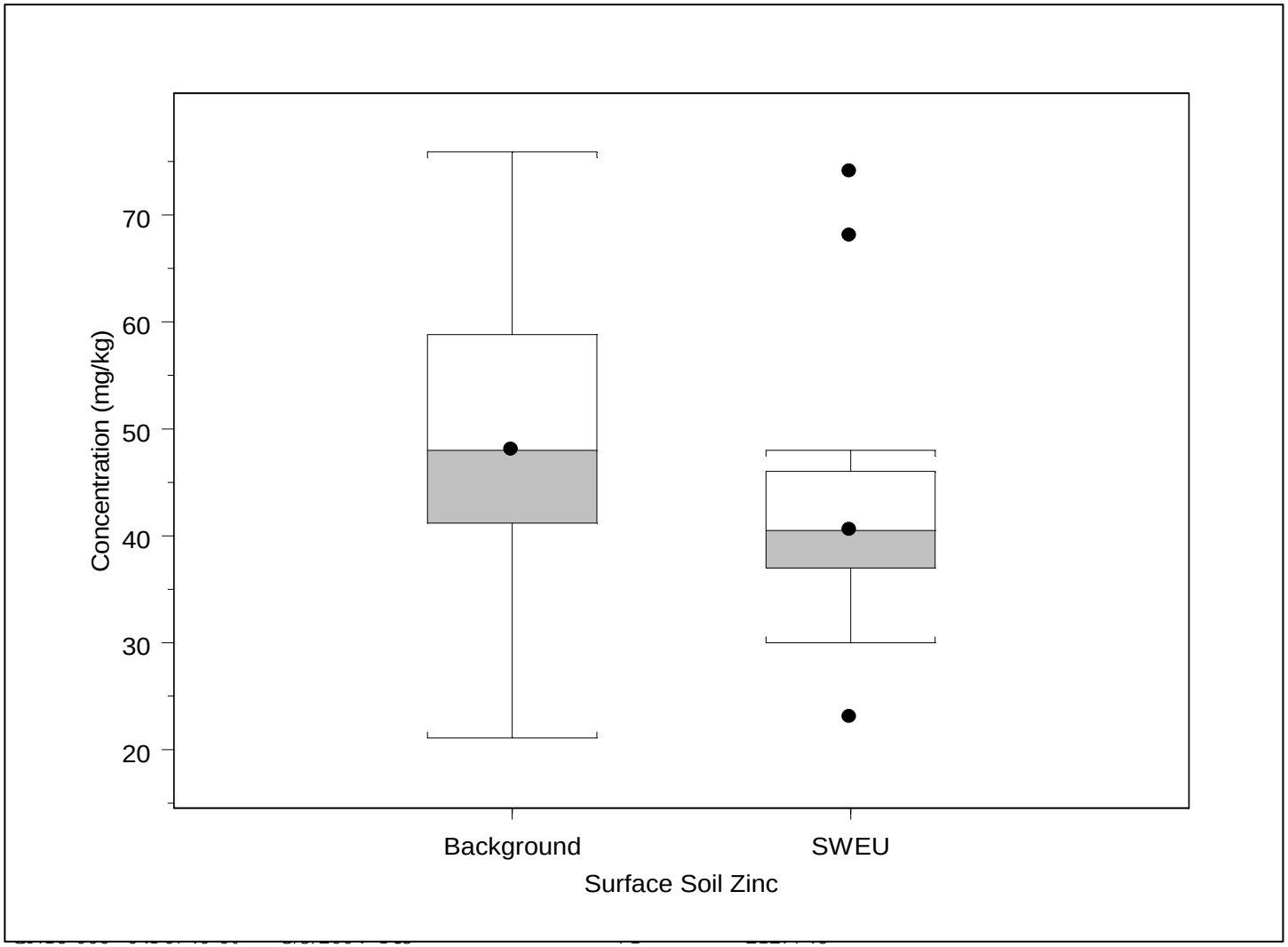
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.15
SWEU Surface Soil in PMJM Habitat Box Plots for Vanadium



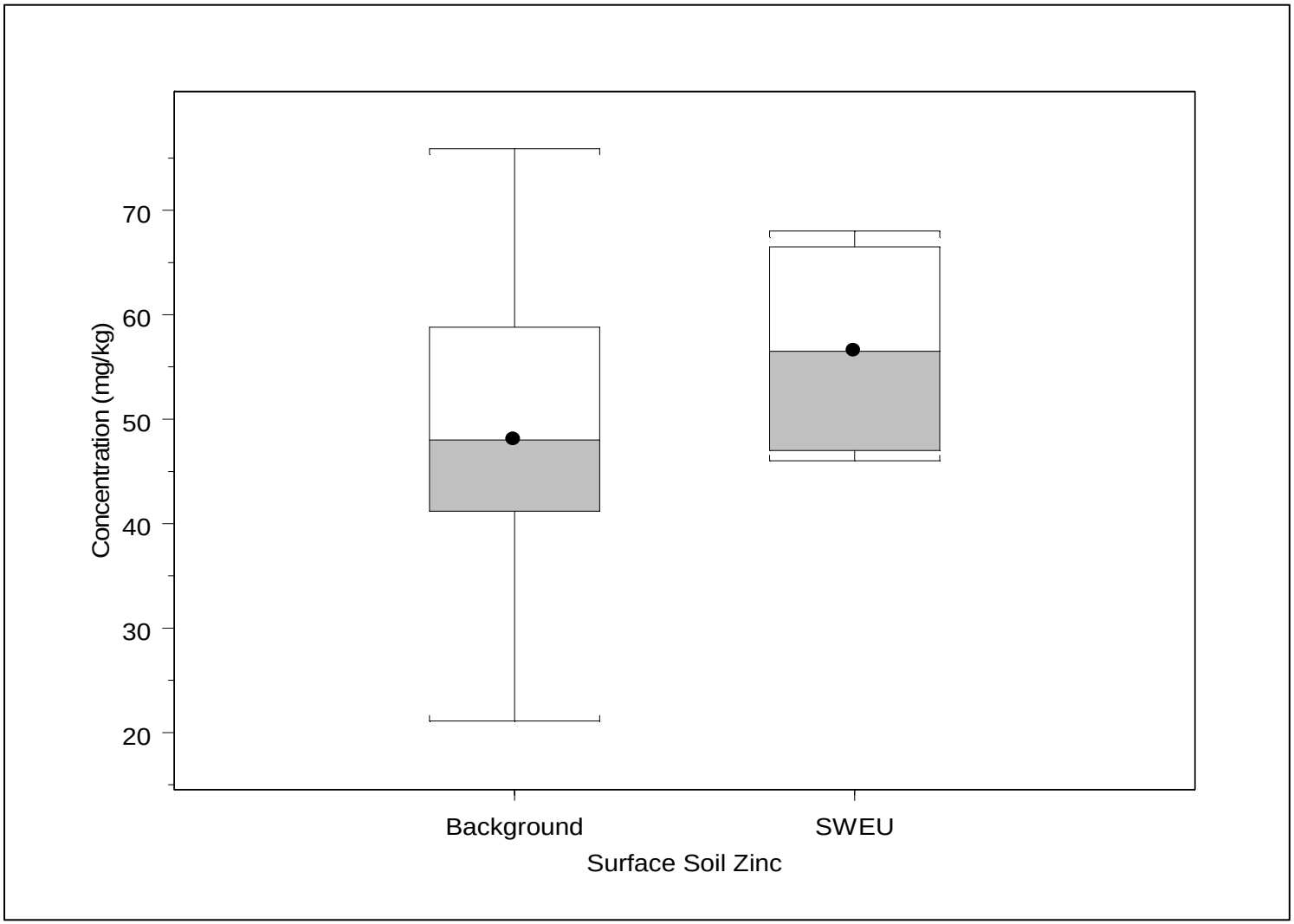
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.16
SWEU 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 A3.2.17
SWEU Surface Soil in PMJM Habitat 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.

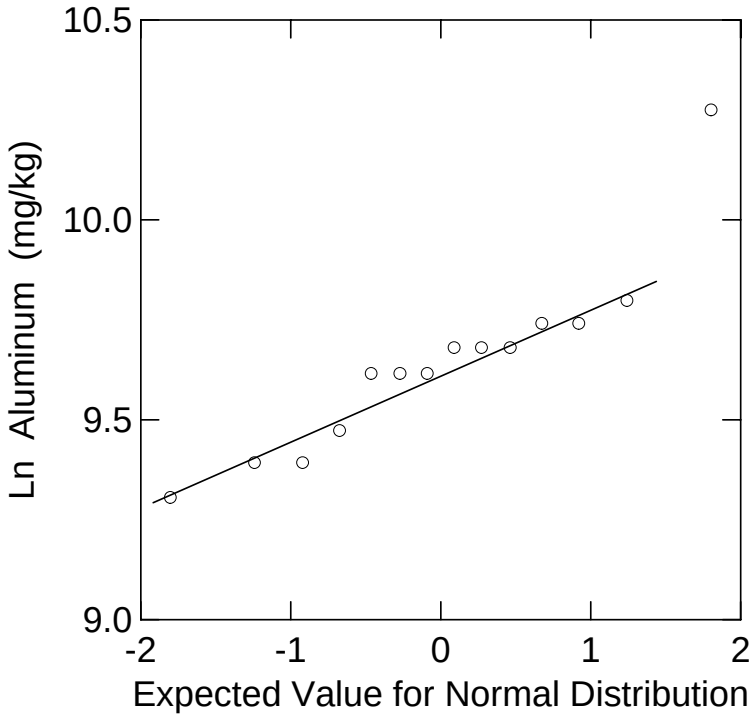


Figure A3.4.1. Probability Plot for Aluminum Concentrations (Natural Logarithm) in SWEU Surface Soil

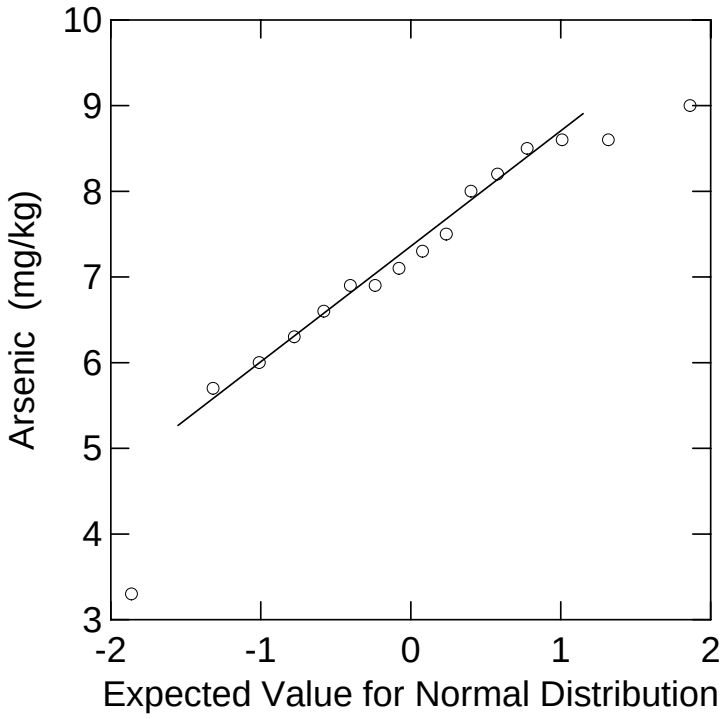


Figure A3.4.2. Probability Plot for Arsenic Concentrations (Natural Logarithm) in SWEU Surface Soil/Surface Sediment

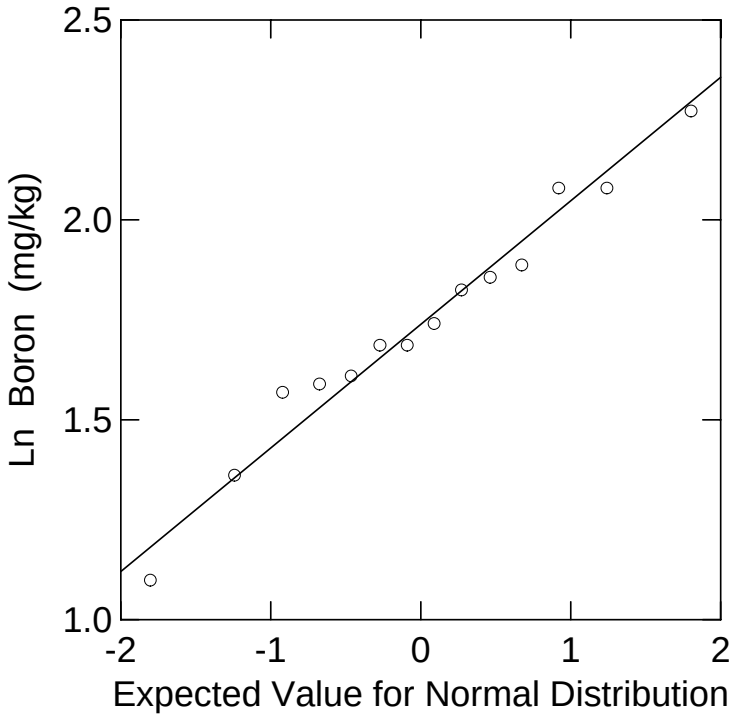


Figure A3.4.3. Probability Plot for Boron Concentrations (Natural Logarithm) in SWEU Surface Soil

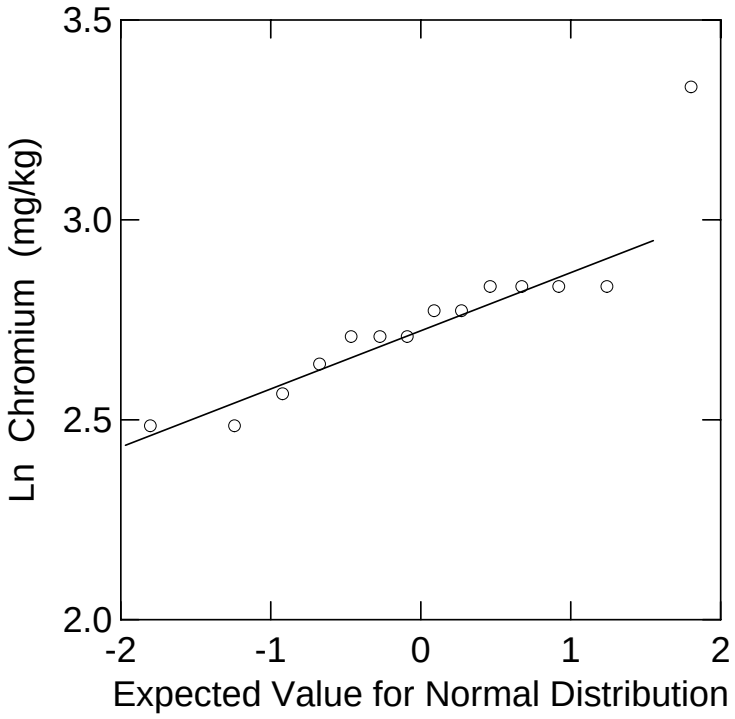


Figure A3.4.4. Probability Plot for Chromium Concentrations (Natural Logarithm) in SWEU Surface Soil

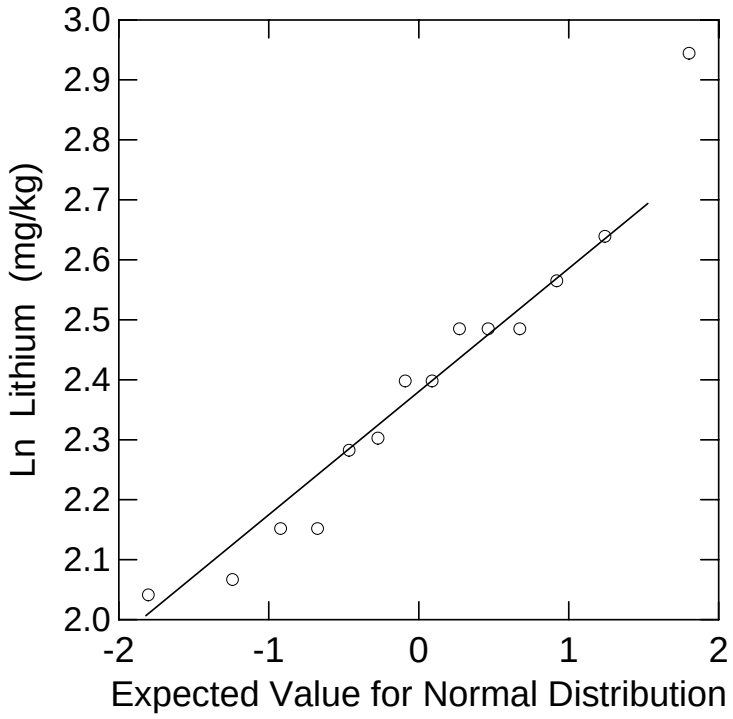


Figure A3.4.5. Probability Plot for Lithium Concentrations (Natural Logarithm) in SWEU Surface Soil

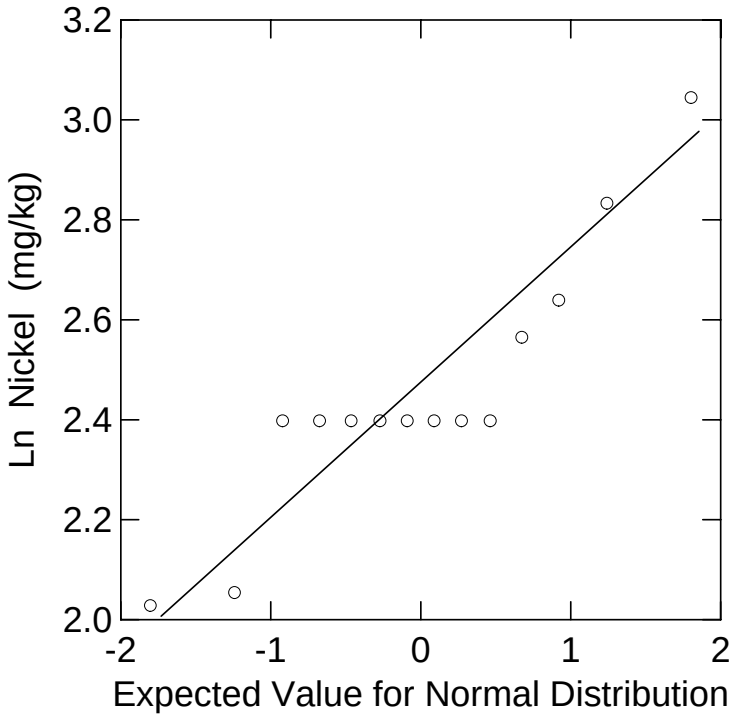


Figure A3.4.6. Probability Plot for Nickel Concentrations (Natural Logarithm) in SWEU Surface Soil

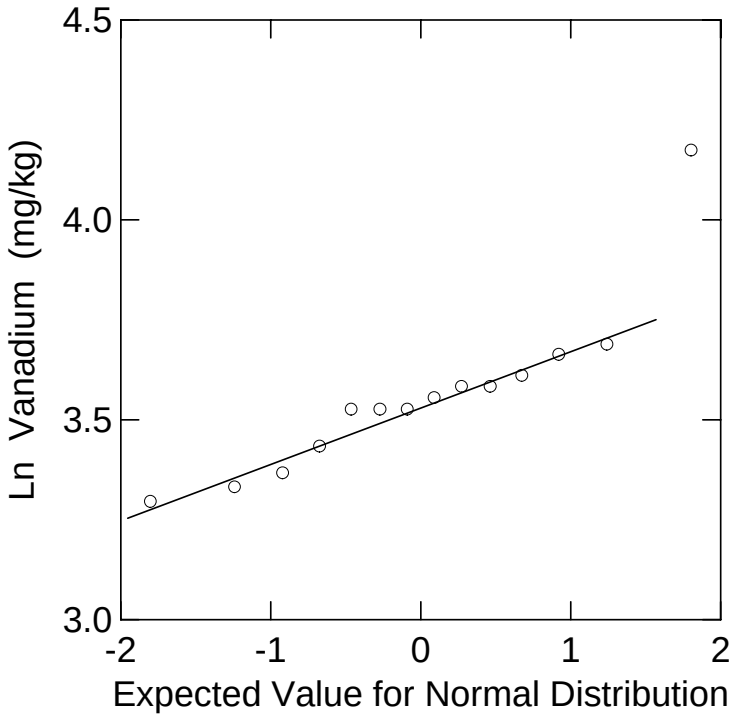


Figure A3.4.7. Probability Plot for Vanadium Concentrations (Natural Logarithm) in SWEU Surface Soil

COMPREHENSIVE RISK ASSESSMENT

SOUTHWEST BUFFER ZONE AREA EXPOSURE UNIT

VOLUME 12: ATTACHMENT 4

CRA Analytical Data Set