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

Volume 11 of 15

Lower Woman Drainage Exposure Unit

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ACRONYMS AND ABBREVIATIONS

µg/kg	microgram per kilogram
AEU	Aquatic Exposure Unit
AI	adequate intakes
BAF	bioaccumulation factor
bgs	below ground surface
BZ	Buffer Zone
CAD/ROD	Corrective Action Decision/Record of Decision
CD	compact disc
CDF	polychlorinated dibenzofuran
CDPHE	Colorado Department of Public Health and Environment
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
Eco-SSL	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
FWS	U.S. Fish and Wildlife Service
HHRA	Human Health Risk Assessment
HRR	Historical Release Report
HQ	hazard quotient
IA	Industrial Area
IAG	Interagency Agreement
IHSS	Individual Hazardous Substance Site
LOAEL	lowest observed adverse effect level
LOEC	lowest observed effects concentration
LWOEU	Lower Woman Drainage Exposure Unit
MDC	maximum detected concentration
mg	milligram
mg/day	milligram per day
mg/kg	milligram per kilogram
mg/kg BW/day	milligram per kilogram per receptor body weight per day
N/A	not applicable or not available
NFA	No Further Action
NFAA	No Further Accelerated Action
NOAEL	no observed adverse effect level
NOEC	no observed effect concentration
OU	Operable Unit
PAC	Potential Area of Concern

PARCC	precision, accuracy, representativeness, completeness, and comparability
PCOC	potential contaminant of concern
PMJM	Preble's meadow jumping mouse
PRG	preliminary remediation goal
QA/QC	quality assurance/quality control
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
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
SCM	Site Conceptual Model
SEEU	Southeast Buffer Zone Area Exposure Unit
SID	South Interceptor Ditch
TCDD	tetrachlorodibenzo-p-dioxin
TEF	toxicity equivalency factor
TEQ	toxic equivalency
tESL	threshold ecological screening level
TRV	toxicity reference value
UBC	Under Building Contamination
UCL	upper confidence limit
UL	upper limit daily intake
UT	uncertain toxicity

UWOEU	Upper Woman Drainage Exposure Unit
UTL	upper tolerance limit
VOC	volatile organic compound
WBEU	Wind Blown Area Exposure Unit
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 448-acre Lower Woman Drainage Exposure Unit (EU) (LWOEU) at the Rocky Flats Environmental Technology Site (RFETS). The purpose of this report is to assess potential risks to human health and ecological receptors posed by exposure to contaminants of concern (COCs) and ecological contaminants of potential concern (ECOPCs) remaining at the LWOEU after completion of accelerated actions at RFETS.

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 LWOEU. 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 both the WRW and WRV associated with potential exposure to background levels of naturally occurring metals in surface soil/surface sediment are 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 LWOEU. The ECOPC identification process is described in the Comprehensive Risk Assessment (CRA) Methodology (U.S. Department of Energy [DOE] 2005a) and additional details are provided in Appendix A, Volume 2 of the Remedial Investigation/Feasibility Study (RI/FS) Report. Chromium, copper, manganese, nickel, thallium, tin, and vanadium were identified as ECOPCs for representative populations of non-Preble's meadow jumping mouse (PMJM) receptors in surface soil. ECOPCs for individual PMJM receptors included chromium, copper, manganese, nickel, selenium, tin, vanadium, and zinc. No ECOPCs were identified in subsurface soil for burrowing receptors.

ECOPC/receptor pairs were evaluated in the risk characterization using conservative default exposure and risk assumptions as defined in the CRA Methodology. Tier 1 and Tier 2 exposure point concentrations (EPCs) were used in the risk characterization: Tier 1 EPCs are based on the upper confidence limits of the arithmetic mean concentration for the EU data set and Tier 2 EPCs are calculated using a spatially-weighted averaging approach. In addition, a refinement of the exposure and risk models based on chemical-specific uncertainties associated with the initial default exposure models were completed for several ECOPC/receptor pairs to provide a refined estimate of potential risk.

Using Tier 1 EPCs and default exposure and risk assumptions, no observed adverse effect level (NOAEL), no observed effect concentration (NOEC) or in some cases lowest observed effect concentration (LOEC) hazard quotients (HQs) ranged from 65 (chromium/terrestrial invertebrates) to less than 1 (chromium III/deer mouse - insectivore). NOAEL or NOEC HQs also ranged from 81 (chromium/terrestrial invertebrates) to less than 1 (chromium III/deer mouse - insectivore) using Tier 2 EPCs and default exposure and risk assumptions.

For terrestrial plants, chromium, manganese, thallium, and vanadium all had HQs greater than or equal to 1 using the Tier 1 and Tier 2 EPCs. For terrestrial invertebrates, chromium had HQs greater than 1 using the Tier 1 and Tier 2 EPCs. However, there is low confidence placed in the ESLs for terrestrial plants and invertebrates (chromium only) for all four ECOPCs. As discussed in Attachment 5, additional NOEC or LOEC values for manganese and thallium were either not acceptable (low confidence in the values) or not available in the literature. For chromium, additional LOEC values were available for refined risk calculations for both plants and invertebrates. For vanadium, an additional LOEC value was available for refined risk calculations for plants.

For chromium, using the additional LOEC ESLs resulted in no HQs greater than 1 for plants or invertebrates. As discussed in the uncertainty analysis, the additional LOEC ESL for plants is representative of a concentration at which soybean roots had a 30 percent reduction in shoot weight while the additional LOEC for invertebrates is representative of a concentration at which there is a 30 percent reduction in earthworm growth (see Attachment 5). In addition, the default ESLs for plants and invertebrates are less than all site-specific background concentrations. HQs greater than 1 were calculated using the UTL background concentration for plants (HQ = 17) and for invertebrates (HQ = 42). The low confidence placed in the default ESL coupled with the similar HQs provided by the background risk evaluation and the lack of HQs greater than 1 using additional effects-based ESLs, indicate that the potential for adverse effects to terrestrial plant and invertebrate populations in the LWOEU from exposure to chromium in surface soils is likely to be low.

For manganese, the NOEC HQ was equal to 1 using both the Tier 1 and Tier 2 UTLs. For thallium, the NOEC HQ was equal to 2 using both the Tier 1 and Tier 2 UTLs. Based on the low HQs combined with the low confidence in the default ESLs (see Attachment 5) and the lack of known releases, the potential for adverse effects to populations of terrestrial plants from manganese and thallium in surface soils is likely to be low.

For vanadium, the NOEC HQ was greater than 1 using both the Tier 1 and Tier 2 UTLs. However, there is low confidence in the default ESL. In addition, the default NOEC ESL (2 mg/kg) is less than all site-specific background concentrations. HQs greater than 1 were calculated using UTL and UCL background concentrations (HQ = 23 and 15, respectively). An HQ equal to 5 would be calculated using the minimum background concentration and the default ESL. The uncertainty assessment for vanadium recommended the use of an additional LOEC value (50 mg/kg) even though there is low confidence in this additional LOEC as well. Based on this LOEC ESL, HQs were equal to 1 in the refined analysis, indicating that the potential for adverse effects to terrestrial plant populations are likely to be low.

Most of the ECOPC/receptor pairs for birds and mammals had lowest observed adverse effect level (LOAEL) HQs less than or equal to 1 using the default assumptions used in the risk calculations. However, the following ECOPC/receptor pairs had LOAEL HQs greater than 1 using the default exposure and toxicity assumptions:

- Chromium/mourning dove (insectivore) – The default LOAEL HQs were equal to 4 and 5 using the Tier 1 and Tier 2 EPCs, respectively. There is uncertainty associated with the use of the upper-bound BAF and the default TRV in the risk calculations (see Attachment 5). However, an additional median soil-to-invertebrate BAF was available for a refined analysis. Using the median BAF, LOAEL HQs were less than 1 using both the Tier 1 and Tier 2 EPCs. Therefore, the potential for adverse effects to populations of small home range receptors such as the mourning dove (insectivore) is likely to be low.

- Nickel/deer mouse (insectivore) – The default LOAEL HQs were equal to 5 and 6 using the Tier 1 and Tier 2 EPCs, respectively. Using a median BAF rather than the default upper-bound BAF for the estimation of invertebrate tissue concentrations, no LOAEL HQs greater than 1 were calculated. HQs were also calculated using additional TRVs from Sample et al. (1996). When these additional TRVs from Sample et al. (1996) were used in the refined analysis, no HQs greater than 1 were calculated using either the NOAEL or the LOAEL TRV. Based on the refined analysis and the similarity between site concentrations and background concentrations, the potential for adverse effects to populations of small home range receptors such as the deer mouse (insectivore) receptor are likely to be low.

- Nickel/PMJM - LOAEL HQs were greater than 1 in Patches #22, #23, #24, #25, and #27 using default exposure and toxicity assumptions. Using a median BAF rather than an upper-bound BAF for the estimation of invertebrate tissue concentrations, LOAEL HQs were less than 1 in all patches except Patch #27 (HQ= 2). However, using additional TRVs in the refined analysis resulted in NOAEL and LOAEL HQs less than 1, in all five patches. Therefore, based on the refined analysis and the similarity between site concentrations and background concentrations, the potential for adverse effects to PMJM receptors are likely to be low in all five patches.

Based on default and refined calculations, site-related risks are likely to be low for the ecological receptors evaluated in the LWOEU. In addition, data collected on wildlife abundance and diversity indicate that wildlife species richness remains high at RFETS. There are no significant risks to ecological receptors or high levels of uncertainty with the data, and therefore, there are no ecological contaminants of concern (ECOCs) for the LWOEU.

1.0 LOWER WOMAN DRAINAGE EXPOSURE UNIT

This volume of the Comprehensive Risk Assessment (CRA) presents the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) for the Lower Woman Drainage Exposure Unit (EU) (LWOEU) 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, is included in Appendix A, Volume 2, Section 2.0 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation/Corrective Measures Study (CMS)-Feasibility Study (RI/FS) Report (hereafter referred to as the RI/FS Report).

The anticipated future land use of RFETS is a wildlife refuge. 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. The HHRA and ERA methods and selection of receptors are described in detail in the CRA Methodology.

1.1 Lower Woman Drainage Exposure Unit Description

This section provides a brief description of the LWOEU, 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. This information is also summarized in Appendix A of Volume 2 of the RI/FS Report.

The 2005 Annual update to the Historical Release Report (HRR) (DOE 2005b) 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) areas (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 Table 1.4 of the RI/FS Report summarizes the disposition of all historic IHSSs at RFETS. In the 2005 Annual Update to the HRR (DOE 2005b), each IHSS is provided a description of the potential contaminant releases and any interim response to the releases; identifications of potential contaminants based on process, knowledge, and site data; data collection activities; accelerated action activities (if any); and the basis for recommending NFAA.

Five IHSSs exist within the LWOEU (Table 1.1 and Figure 1.2):

- Roadway Spraying (PAC 000-501);
- East Firing Range (SE-1602);
- Pond C-1 (SE-142.10);
- Pond C-2 (SE-142.11); and
- Surface Disturbance Southeast of Building 881 (SE-209).

Of these IHSSs, only the East Firing Range (SE-1602) required an accelerated action. The Closeout Report for IHSS Group 900-11, PAC SE-1602, East Firing Range, and Target Area was approved by the U.S. Environmental Protection Agency (EPA) in a letter from C. Mark Aguilar to Joseph Legare dated February 8, 2005. The NFAAs for SE-1602 and the other IHSSs are documented in the 2005 Annual Update to the HRR (DOE 2005b). In general, accelerated actions are based on human health exposures. 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 following the accelerated actions.

1.1.1 Exposure Unit Characteristics and Location

The LWOEU comprises 448 acres in the southeastern portion of RFETS (Figure 1.1) and contains several distinguishing features:

- The LWOEU is located within the Buffer Zone (BZ) OU and is southeast of the areas that were historically used for operation of RFETS. The LWOEU begins approximately 600 feet upstream of Pond C-1 and extends east to Indiana Street.
- The LWOEU is adjacent to the Wind Blown Area EU (WBEU), which was impacted by airborne migration of radionuclides from the 903 Pad site (IHSS 900-112). This introduced contamination into surface soil in the area. The LWOEU receives runoff from the WBEU.

- The LWOEU receives surface water drainage from the southern edge of the Industrial Area (IA) via the South Interceptor Ditch (SID), which discharges to Pond C-2 (IHSS SE-142.11).

The LWOEU is bounded by the WBEU on the north, the Upper Woman Drainage EU (UWOEU) on the west, the Southeast BZ Area EU (SEEU) to the south, and Indiana Street to the east.

1.1.2 Topography and Surface Water Hydrology

The LWOEU is located in the eastern portion of the Woman Creek Drainage, a major drainage at RFETS that traverses the southern side of the site. The Woman Creek Drainage captures runoff from the southern portion of the IA, as well as the majority of the southern BZ.

The principal surface water features in the LWOEU include the main stem of Woman Creek, South Woman Creek, and Ponds C-1 and C-2 (Figures 1.2 and 1.3). Upstream of the LWOEU, Woman Creek is largely isolated from IA runoff because the SID, which is located upslope to the north, intercepts surface flow and diverts it into Pond C-2, which is discharged into Woman Creek. Discharge from Pond C-2 has historically been necessary once a year. The annual discharge is monitored for compliance with surface water standards for Segment 4a of Big Dry Creek. In the future, Pond C-2 will be operated on a batch-release mode, and will sustain wetlands and provide for water quality benefit and storm flow storage. Woman Creek flows through Pond C-1, which was reconfigured as a low-profile, flow-through structure in 2005. Discharge from Pond C-1 is diverted around Pond C-2 and back into the Woman Creek Drainage, downgradient from Pond C-2. Downstream of Pond C-2, South Woman Creek joins the main stem of Woman Creek approximately 0.25 mile upstream from Indiana Street. Portions of the South Woman Creek Drainage that are upgradient of the Smart Ditch diversion, located where South Woman Creek crosses the southern boundary of the LWOEU, do not contribute flow to the LWOEU because Smart Ditch diverts these flows into the next drainage to the south, which contains Ponds D-1 and D-2.

Downstream from Pond C-2, water can be diverted from Woman Creek into Mower Ditch, which is a lateral ditch that traverses the hillside north of Woman Creek and empties into the next drainage basin to the north. Mower Ditch is an agricultural diversion.

1.1.3 Flora and Fauna

Many of the plant communities found at RFETS are present within the LWOEU, as shown on the vegetation map for the LWOEU in Figure 1.4. Mesic-mixed grassland and reclaimed grasslands are the two dominant vegetation communities. Other plant communities comprise annual forb/grass communities and wet meadows. There are three creek drainages that cross this EU: Woman Creek, South Woman Creek, and Mower Ditch. These drainages support drier riparian vegetation including lead plant (*Amorpha fruticosa*). Although found in every drainage at RFETS, the lead plant dominates the riparian (streamside) areas in this EU. The existence of the lead plant in the riparian areas results from the drier conditions caused by water diversion practices. Downstream of the Mower Ditch diversion structure, wet meadows and short marshes are present on the hillside between Mower Ditch and Woman Creek. This is likely the result of seepage from Mower Ditch into the hillside below, enabling vegetation to grow that require more moisture than this hillside normally receives from precipitation.

The mesic-mixed grassland is distinguished at RFETS by such plant species as western wheatgrass (*Agropyron smithii*), blue grama *(Bouteloua gracilis)*, side-oats grama *(Bouteloua curtipendula),* prairie junegrass *(Koeleria pyramidata)*, Canada bluegrass, Kentucky bluegrass, green needlegrass *(Stipa virigula)*, and little bluestem (*Andropogon scoparius*). Reclaimed grasslands are dominated by two introduced grass species, smooth brome (*Bromus inermis*) and intermediate wheatgrass (*Agropyron intermedium*). Land that is within the LWOEU was heavily grazed during past land use, which has contributed greatly to the expansive areas of annual grasses and forbs. With the purchase of this land by the DOE, grazing has not occurred in decades within the EU, and plant ecologists have partially restored native mesic grasslands in these disturbed areas. Reclaimed grasslands are also the result of past disturbances including DOE's construction of Pond C-2 and agricultural fields that pre-date DOE's ownership.

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 CNHP. These include: forktip three-awn (*Aristida basiramea*), mountain-loving sedge (*Carex oreocharis*), carrionflower greenbriar (*Smilax herbacea var. lasioneuron*), and dwarf wild indigo (*Amorpha nana*).

Numerous animal species have been observed at RFETS, and most of these species are expected to be present in the LWOEU. Common large- and medium-sized mammals likely to live or frequent the LWOEU include mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), 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*), and the most common amphibian is the boreal chorus frog (*Pseudacris tryseriatus*). Common birds include red-winged blackbird (*Agelaius phoeniceus*), song sparrow (*Melospiza melodia*), meadowlark (*Sturnella neglecta*), and vesper sparrow (*Pooecetes gramineus*). The most common small mammal species include deer mouse (*Peromyscus maniculatus*), prairie vole (*Microtus ochrogaster*), meadow vole (*Microtus pennsylvanicus*), and different species of harvest mice (*Reithrodontomys sp.*).

RFETS supports two wildlife species listed as threatened or endangered species under the Endangered Species Act (U.S. Fish and Wildlife Service [USFWS] 2005). The PMJM (*Zapus hudsonius preblei*) and the bald eagle (*Haliaeetus leucocephalus*) are listed as threatened species. The preferred habitat for the PMJM is the riparian corridors bordering RFETS' streams, ponds, and wetlands with an adjacent thin band of upland grasslands.

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 the 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 plant communities and 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 Lower Woman Drainage Exposure Unit

The LWOEU supports habitat for the federally protected PMJM. Figure 1.5 presents PMJM habitat in this EU. PMJM have been captured within the upper end of the LWOEU (i.e., above Pond C-2) for over a decade (Ebasco 1992; K-H 1997, 1999, 2002). No PMJM have been captured below the C-2 Pond in the EU, although trapping surveys have been conducted (K-H 1997, 2002). As shown in Figure 1.5, the PMJM habitat is subdivided into patches. Sitewide PMJM habitat patches were identified in an effort to characterize habitat discontinuity and provide indications of varying habitat quality. These patches aid in the evaluation of surface soil within PMJM habitat, giving a spatial understanding of areas that may be used by individual PMJM or subpopulations of PMJM. More detail on the methodology of creating sitewide PMJM habitat patches is presented in Appendix A, Volume 2, Section 3.2 of the RI/FS Report.

PMJM habitat within the LWOEU is subdivided into seven habitat patches (Figure 1.5). Each patch contains habitat capable of supporting at least several PMJM individuals, although habitat patches in LWOEU, below Pond C-2, are of lower quality due to the drier conditions in the Lower Woman Creek Drainage. The patches vary in size and shape dependent on their location within the Lower Woman Creek Drainage and the discontinuity or habitat quality of surrounding patches. The following is a brief discussion of the seven patches within LWOEU (Figure 1.5) and the reasons why each patch is distinct:

- Patch #22A and #22B – This patch is a combination of habitat along the creek corridor (#22A) and an adjacent seep area (#22B). These areas can be considered one unit based on the hydrological connection (supporting wetlands bridge the gap between the two habitat areas). PMJM are present within this patch. The upper boundary of the larger area (#22A) is a dirt road that crosses Woman Creek, and the lower boundary is the C-1 Pond dam face. The boundaries for the smaller area correspond to habitat boundaries mapped earlier by the USFWS (USFWS 2005). Patch #22 also includes a section of habitat (#22A) that extends into the UWOEU.

- Patch #23 – PMJM are present in this patch located between Ponds C-1 and C-2. The patch is thickly wooded immediately below the C-1 Pond and the lower section is comprised of alternating sections of riparian woodlands and shrublands.

- Patch #24A and #24B – This patch is a combination of two habitat areas along the Lower Woman Creek corridor and the confluence with Mower Ditch. These areas can be considered one unit based on available moisture and plant communities present in this section of the creek. The upper isolated habitat area (#24B) results from a gap created by rip-rapped sections of the creek and supporting wetlands. This area provides the same habitat quality as the lower area (#24A). The upper boundaries for the lower area correspond to habitat boundaries mapped earlier (USFWS 2005). The lower boundary corresponds to where riparian shrub (lead plant) changes to riparian woodland. Patch #24 also includes a section of habitat (#24B) that extends into the WBEU, but which is evaluated in this EU.

- Patch #25 – This patch contains habitat along Mower Ditch that is disconnected from the upper portion of the ditch by a long section of dry grasslands. Habitat quality within this patch is very low due to the lack of water most of the year; however, all the vegetative components are present to support PMJM. Patch #25 extends into the WBEU, although it is evaluated in the LWOEU. No PMJM have been found in this patch.

- Patch #26 – This patch begins on Lower Woman Creek where riparian woodlands mix with riparian shrublands. The patch includes the confluence with South Woman Creek upstream to a dirt access road and continues downstream to the RFETS eastern boundary. Patch #26 has more moisture available than upstream patches, possibly from recharged groundwater originating from Mower Ditch. No PMJM have been captured in this patch.

- Patch #27 – This patch includes a long section of South Woman Creek. The lower boundary corresponds to the dirt service road that crosses the creek, while the upper boundary corresponds to a vegetation change where lead plant is replaced by willow, indicating wetter conditions. No PMJM have been captured in this patch.

- Patch #28 – This patch extends into the SEEU, but is evaluated in this EU. Vegetation within this patch is dominated by riparian woodlands. Downstream, the patch boundary corresponds to a change to drier conditions supporting the lead plant. Upstream, the patch boundary is where riparian woodlands give way to continuous riparian willow shrublands. No PMJM have been captured in this patch.

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 EPA and Colorado Department of Public Health and Environment (CDPHE) guidance. Surface soil, subsurface soil, surface sediment, subsurface sediment, and groundwater samples were collected from the LWOEU. 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 in Figures 1.6 and 1.7, and data summaries for detected analytes in each medium are provided in Tables 1.3 through 1.7. Toxicity equivalence (TEQ) concentrations for 2, 3, 7, 8- tetrachlorodibenzo-p-dioxin (TCDD) in surface soil/surface sediment, subsurface soil/subsurface sediment, and subsurface soil are presented in Tables 1.8 and 1.9. The TEQ concentrations for 2,3,7,8-TCDD are derived using toxicity equivalency factors (TEFs) presented in Appendix A, Volume 2 of the RI/FS Report. Potential contaminants of concern (PCOCs) and ecological contaminants of interest (ECOIs) for which analyses were conducted but were not detected, or were detected in less than 5 percent of the samples, are presented in Attachment 1. Detection limits are compared to preliminary remediation goals (PRGs) and ecological screening levels (ESLs), and discussed in Attachment 1 (Tables A1.1 through A1.4). Only data from June 1991 to the present are used in the CRA because these data meet the approved analytical quality assurance/quality control (QA/QC) requirements.

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

The CRA analytical data set for the LWOEU is provided on a compact disc (CD) included in Attachment 6. The CD in Attachment 6 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 LWOEU HHRA and ERA are as follows:

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

These data for these media are briefly described below.

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

Surface Soil/Surface Sediment

The combined surface soil/surface sediment data set for the LWOEU consists of up to 144 samples for various analyte groups. The sediment samples were collected to depths less than 0.5 feet bgs. The surface soil/surface sediment sample locations are shown in Figure 1.6. All sample locations within the LWOEU were not necessarily analyzed for all analyte groups (see Table 1.3). The surface soil/surface sediment samples were collected in the LWOEU over several months from July 1991 through February 1995, and then again in February 1998, October 2000, March 2001, and over several months in 2004, ending in July 2005. The samples collected in 2004 were located on a 30-acre grid, as described in CRA SAP Addendum #04-01 (DOE 2004). For the grid sampling, five individual samples were collected from each 30-acre cell, one from each quadrant and one in the center, as described in the Addendum. Most of the evenly spaced surface soil sampling locations in Figure 1.6 represent the 30-acre grid samples. These samples were analyzed for radionuclides and metals only.

The LWOEU surface soil/surface sediment samples were analyzed for inorganics (106 samples), organics (34 samples), and radionuclides (144 samples) (Table 1.2). Detected analytes included many inorganics and organics (mostly polynuclear aromatic hydrocarbons, but also some solvents, pesticides, and dioxins), and several radionuclides (Table 1.3). The dioxins were present at concentrations less than 1 microgram per kilogram (µg/kg) in the one sample that was collected. A summary of analytes that were not detected, or were detected in less than 5 percent of the subsurface soil samples, is presented in Attachment 1.

Subsurface Soil/Subsurface Sediment

The combined subsurface soil/subsurface sediment data set for LWOEU consists of up to 55 samples for various analyte groups. The subsurface sediment samples have a starting depth of less than or equal to 8 feet bgs and an ending depth greater than 0.5 feet bgs. The subsurface soil/subsurface sediment sample locations are shown in Figure 1.7. All sample locations within the LWOEU were not necessarily analyzed for all analyte groups (see Table 1.4). The samples were collected in the LWOEU over several months from October 1991 through August 1994, and then again in July 1999, September 2002, and over several months in 2004, ending in July 2005.

The LWOEU subsurface soil/subsurface sediment samples were analyzed for inorganics (55 samples), organics (36 samples), and radionuclides (31 samples) (Table 1.2). Detected analytes included many inorganics and organics (mostly dioxins but also some solvents), as well as several radionuclides (Table 1.4). A summary of analytes that were not detected, or were detected in less than 5 percent of the subsurface soil samples, is presented in Attachment 1.

Surface Soil

The surface soil data set for LWOEU consists of up to 98 samples for various analyte groups. The samples were collected in the LWOEU over several months from July 1991 through February 1995, and then again in February 1998, March 2001, and over several months in 2004. Sample locations are shown in Figure 1.6. All sample locations within the LWOEU were not necessarily analyzed for all analyte groups (see Tables 1.5 and 1.6). The samples collected in 2004 were located on a 30-acre grid, as described in CRA SAP Addendum #04-01 (DOE 2004). For the grid sampling, five individual samples were collected from each 30-acre cell, one from each quadrant and one in the center, as described in the Addendum. Most of the evenly spaced surface soil sampling locations in Figure 1.6 represent the 30-acre grid samples. These samples were analyzed for radionuclides and metals only.

The LWOEU surface soil samples were analyzed for inorganics (74 samples), organics (nine samples), and radionuclides (98 samples) (Table 1.2). Detected analytes included many inorganics, organics, and several radionuclides (Table 1.5). A summary of analytes that were not detected, or were detected in less than 5 percent of the subsurface soil samples, is presented in Attachment 1.

The LWOEU surface soil samples within PMJM habitat were analyzed for inorganics (45 samples), organics (two samples), and radionuclides (41 samples). Detected analytes included many inorganics, one organic (benzoic acid), and several radionuclides (Tables 1.2 and 1.6).

Subsurface Soil

The subsurface soil data set for LWOEU consists of up to 47 samples for various analyte groups. The samples were collected in the LWOEU over several months from October 1991 through August 1994, and then again in July 1999, and over several months in 2004, ending in January 2005. Sample locations are shown in Figure 1.7. All sample locations within the LWOEU were not necessarily analyzed for all analyte groups (see Table 1.7). Subsurface soil samples to be 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 greater than 0.5 feet bgs.

The LWOEU subsurface soil samples were analyzed for inorganics (47 samples), organics (28 samples), and radionuclides (20 samples) (Table 1.2). Detected analytes included many inorganics and organics (mostly dioxins but also some solvents), as well as several radionuclides (Table 1.7). A summary of analytes that were not detected, or were detected in less than 5 percent of the subsurface soil samples, is presented 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 LWOEU are as follows:

- The number of surface soil and surface soil/surface sediment samples in the LWOEU for VOCs, SVOCs, and PCBs meet the data adequacy guideline.
- A sediment sample was collected from Pond C-1 for dioxin analysis. The dioxin concentration is not above the minimum ESL or the PRG. Although this does not meet the minimal data adequacy guideline, as noted above, it is possible to make risk management decisions without additional sampling.
- The spatial distribution of surface soil samples in the LWOEU for VOCs, SVOCs, and PCBs tends to be clustered near historical IHSSs. As a result, Tier 1 exposure point concentration calculations will tend to be conservative (i.e., overestimate exposures). With the addition of the sediment samples, the sample locations are more distributed throughout the EU. Therefore, the spatial distribution of the data are adequate for the purposes of the CRA.
- Except for radionuclide samples in PMJM habitat patches #22A, #23, #26, #27, and #28, and metal samples in patch #23, the data adequacy guideline for number of samples is not met for the PMJM habitat patches in the LWOEU. Organic data is absent for many of these patches. One sample was collected for organics in each of patches #23 and #25, and organics were not detected. Patch #23 has the greatest potential for organic contamination because historical IHSSs are located topographically upgradient to the north and south, and runoff from these historical IHSSs could have contaminated surface soil in the habitat patch. Although detection limits exceed the minimum ESLs for several of the organic analytes, professional judgment indicates these analytes would not likely be ECOPCs even if detection limits had been lower (see Attachment 1). Surface soil in the other patches would not be expected to have organic contamination because there are no historical IHSSs that are located topographically upgradient. Metal concentrations in surface soil are above the ESLs in patches #22, #23, #24, #25, and #27. Patch #23 includes a portion of IHSS SE-1602 (East Firing Range), a historical potential source of metal contamination. Metal concentrations in surface soil for habitat patches #22, #24, #25, and #27 should be similar because of the absence of potential historical sources for metal contamination near these patches. Although available data for each PMJM patch has been used to conduct patch-specific risk characterizations, there is greater reliability in the risk characterizations for metals in PMJM patch #23 where the number of samples meet the data adequacy guideline, and the risk estimates should be applicable to the other PMJM patches, if not biased high. Therefore, although the existing LWOEU 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.

- Because of the absence of historical potential sources within the EU for radionuclide contamination, and the remote location of the LWOEU PMJM habitat from historical potential sources in and near the IA, concentration gradients should not be present. There is only one historical potential source for metal contamination (SE-1602), but this IHHS was addressed through a soil removal accelerated action. Accordingly, surface soil data for the PMJM habitat patches can be aggregated for the purpose of conducting a statistical background comparison.

- The number of surface water samples in the LWOEU for radionuclides, metals, VOCs, SVOCs, and PCBs meet the data adequacy guideline. The sample locations are well distributed on the streams throughout the LWOEU, and therefore, meet the data adequacy guideline for spatial representativeness.

- With the exception of PCBs, the surface water data are considered temporally representative. Although there are no current PCB data, the historical data indicate PCBs are not detected, and therefore, a temporal trend in concentrations is not expected. However, as discussed in Appendix A, Volume 15B2, Attachment 1 of the RI/FS report, professional judgment suggests PCB-1254, PCB-1260 have the potential to be ECOPCs in the Woman Creek Aquatic Exposure Unit surface water had detection limits been lower, and therefore, there is some uncertainty in the risk assessment process with respect to PCBs in surface water.

- For analytes not detected or detected in less than 5 percent of the samples in surface soil/surface sediment, six analytes have detection limits that exceed PRGs, however, the frequencies of PRG exceedance are either very low, or the maximum detection limits are within an order of magnitude of the PRGs. All detection limits are below the PRGs/ESLs for subsurface soil/subsurface sediment and subsurface soil samples There are 15 analytes in surface soil where some percent of the detection limits exceed the lowest ESL. However, those analytes that have detection limits that exceed the lowest ESLs contribute only minimal uncertainty to the overall risk estimates because either only a small fraction of the detection limits are greater than the lowest ESL, or professional judgment indicates they are not likely to be ECOPCs in LWOEU surface soil even if detection limits had been lower. Although some of the analytes would present a potential for adverse ecological effects if they were detected at their maximum detection limits, because they are not expected to be ECOPCs in LWOEU surface soil, uncertainty in the overall risk estimates is low (see Attachment 1 for a more detailed discussion).

1.3 Data Quality Assessment

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

2.1.2 Surface Soil/Surface Sediment Preliminary Remediation 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, manganese, cesium-134, cesium-137, and radium-228 in surface soil/surface sediment had MDCs and UCLs that exceeded the PRGs and were retained as PCOCs.

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

2.1.3 Surface Soil/Surface Sediment Detection Frequency Screen

Arsenic and manganese were detected in more than 5 percent of surface soil/surface sediment samples and, therefore, were retained for further evaluation in the COC screen (Table 1.3).

The detection frequency screen was not performed for cesium-134, cesium-137, and radium-228 in subsurface soil/subsurface sediment because all reported values for radionuclides are considered detects.

2.1.4 Surface Soil/Surface Sediment Background Analysis

Results of the background statistical comparison for arsenic, manganese, cesium-124, cesium-137, and radium-228 are presented in Table 2.3 and discussed in Attachment 3. Box plots for arsenic, manganese, cesium-134, cesium-137, and radium-228 (both LWOEU and background) are provided in Attachment 3. Arsenic, manganese, and radium-228 are the PCOCs that were statistically greater than background at the 0.1 significance level and are evaluated further in the professional judgment section.

2.1.5 Surface Soil/Surface Sediment Professional Judgment Evaluation

Based on the weight of available evidence evaluated by professional judgment, PCOCs will either be included for further evaluation as COCs or excluded as COCs. The professional judgment evaluation takes into account process knowledge, spatial trends, pattern recognition comparison to RFETS background and other background data sets, and risk potential to human health and ecological receptors. 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, manganese, and radium-228 in surface soil/surface sediment in the LWOEU are not considered COCs because the weight of evidence supports the conclusion that arsenic, manganese, and radium-228 concentrations in surface soil/surface sediment in the LWOEU 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 toxicity criteria were 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 at the LWOEU were compared to DRIs in Table 2.4. The estimated daily maximum intakes for these PCOCs, based on the nutrients' MDCs and a subsurface soil/subsurface sediment ingestion rate of 100 mg/day, are less than the DRIs. Therefore, these PCOCs were not further evaluated as COCs for subsurface soil/subsurface sediment.

2.2.2 Subsurface Soil/Subsurface Sediment Preliminary Remediation Goal Screen

The PRG screen for detected analytes in subsurface soil/subsurface sediment is presented in Table 2.5. The MDC and UCL for radium-228 in subsurface soil/subsurface sediment were greater than the PRG and, therefore, radium-228 was retained for further evaluation in the COC selection process in the LWOEU.

PRGs were not available for several PCOCs in subsurface soil/subsurface sediment. Analytes without PRGs are listed in Table 2.5, and their effect on the conclusions of the risk assessment results 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 radium-228 in subsurface soil/subsurface sediment because all reported values for radionuclides are considered detects.

2.2.4 Subsurface Soil/Subsurface Sediment Background Analysis

Analyses were conducted to asses whether radium-228 activities in LWOEU subsurface soil/subsurface sediment are statistically higher than those in background subsurface soil/subsurface sediment at the 0.1 level of significance (1-p less than or equal to 0.1). The subsurface soil/subsurface sediment background data are described in detail in Appendix A, Volume 2 of the RI/FS Report.

The results of the statistical comparisons of the LWOEU data to the background data indicate site activities for radium-228 are not statistically greater than background at the 0.1 significance level. The results are summarized in Table 2.3 and in Attachment 3. Box plots for radium-228 (both LWOEU and background) are provided in Attachment 3. Radium-228 in subsurface soil/subsurface sediment is not further evaluated in the COC screening process.

2.2.5 Subsurface Soil/Subsurface Sediment Professional Judgment Evaluation

The professional judgment step was not performed for subsurface soil/subsurface sediment because there were no PCOCs with concentrations statistically greater than background concentrations.

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 any of the media at the LWOEU.

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 LWOEU 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 LWOEU 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 LWOEU 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 LWOEU 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. All PCOCs were eliminated from further consideration as human health COCs 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 LWOEU.

6.0 UNCERTAINTIES ASSOCIATED WITH THE HUMAN HEALTH RISK ASSESSMENT

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

6.1 Uncertainties Associated with the Data

Data adequacy for this CRA is evaluated and discussed in Appendix A, Volume 2 of the RI/FS Report. Although there are some uncertainties associated with the sampling and analyses conducted for surface soil/surface sediment and subsurface soil/subsurface sediment at the LWOEU, data are considered adequate for the characterization of risk at the EU. The environmental samples for the LWOEU were collected from 1991 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 144 samples in the LWOEU. Although there is limited data for organics in surface soil, there are no known or suspected sources for organic contaminants in the LWOEU. In subsurface soil/subsurface sediment, there are up to 55 samples in the LWOEU.

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

6.2 Uncertainties Associated with Screening Values

The COC screening analyses used RFETS-specific PRGs based on a WRW scenario. The assumptions used in the development of these values were conservative. For example, it is assumed that a future WRW will consume 100 milligrams (mg) of surface soil/surface sediment for 230 days per year for a period of 18.7 years. In addition, a WRW is assumed to be dermally exposed and to inhale surface soil and surface sediment particles in the air. These assumptions are likely to overestimate actual exposures to surface soil for WRWs in the LWOEU 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 LWOEU.

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

PCOCs for the LWOEU 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. The listed organics have low detection frequencies and, therefore, are not expected to affect the results of the HHRA. Radionuclide PRGs are available for all detected individual radionuclides. Therefore, the lack of PRGs for the gross alpha and gross beta activities is not expected to affect the results of the HHRA.

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

Arsenic, manganese, and radium-228 in surface soil/surface sediment were eliminated as COCs based on professional judgment. There is no identified source or pattern of release in the LWOEU, and the slightly elevated median values of arsenic, manganese, and radium-228 in the LWOEU 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, manganese, and radium-228 are naturally occurring and do not result from site activities. Uncertainty associated with the elimination of these chemicals as COCs is low.

No PCOCs were eliminated in subsurface soil/subsurface sediment based on professional judgment in the LWOEU.

6.4 Uncertainties Evaluation Summary

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

7.0 IDENTIFICATION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN

The ECOPC identification process streamlines the ecological risk characterization for each EU by focusing the assessment on ECOIs that are present in the LWOEU. ECOIs are defined as any chemical detected in the LWOEU and are assessed for surface soils and subsurface soils. ECOIs for sediments and surface water are assessed in Appendix A, Volume 15B 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 ecological SCM, including the receptors of concern, exposure pathways, and endpoints used in the ERA for the LWOEU, is also provided 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 LWOEU 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. The receptors of concern include representative birds and mammals in addition to the general plant and terrestrial invertebrate communities. The receptors were selected based on several criteria, including their potential to be found in the various habitats present within the

LWOEU, their potential to have contact with ECOIs, and the amount of life history and behavioral information available.

The ECOPC identification 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 LWOEU data are used in the CRA:

- Ninety-eight surface soil samples were collected in the LWOEU and analyzed for inorganics (74 samples), organics (nine samples), and radionuclides (98 samples) (Table 1.2).

- Forty-seven subsurface soil samples were analyzed for organics (47 samples), inorganics (28 samples), and radionuclides (20 samples) (Table 1.2).

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 LWOEU were also collected (Section 1.1.5), and these data are evaluated for the ERA in Appendix A, Volume 15B of the RI/FS Report. As discussed in Section 8.0, surface water EPCs are used in the risk model to estimate exposure via the surface water ingestion pathway. One thousand seven hundred and nineteen distinct surface water samples were collected in the LWOEU and analyzed for inorganics (372 samples), organics (111 samples), and radionuclides (1,719 samples).

As described in Section 1.1.4, there are 45 sample locations occurring in PMJM habitat within the LWOEU. Some of the sample locations are located in adjacent EUs but were considered a part of the PMJM habitat for the LWOEU (see Figure 1.5). Surface soil samples were collected and analyzed for inorganics (45 samples), organics (two samples), and radionuclides (41 samples). A data summary is provided in Table 1.6. Sampling locations and PMJM habitat patches within the LWOEU are shown in Figure 1.5.

7.2 Identification of Surface Soil Ecological Contaminants of Potential Concern

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

7.2.1 Comparison with No Observed Adverse Effect Level Ecological Screening Levels

In the first step of the ECOPC identification process, the MDCs of ECOIs in surface soil were compared to receptor-specific no observed adverse effect level (NOAEL) ESLs.

NOAEL ESLs for surface soil were developed in the CRA Methodology for three receptor groups: terrestrial vertebrates, terrestrial invertebrates, and terrestrial plants.

Non-PMJM Receptors

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

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" in the column titled "EPC > PMJM ESL?"

Analytes for which a PMJM NOAEL ESL is not available are identified with a "N/A" in Table 7.3 under the column heading "PMJM NOAEL 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 highly unlikely and the ECOI is not further evaluated. None of the chemicals detected in surface soil at the LWOEU that were retained after the NOAEL ESL screening step had a detection frequency of less than 5 percent. Therefore, no ECOIs were excluded based on the detection frequency evaluation for surface soil in the LWOEU.

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 Tables 7.4 and 7.5 and discussed in Attachment 3. The statistical methods used for the background comparison are summarized 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 an ECOI in Table 7.4 are further evaluated using upper-bound 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 EU 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 Upper-Bound 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 upper-bound EPCs is described in Attachment 3 and 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 of the mean, 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 the 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 upper-bound EPC comparison to 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 tESL for small home-range receptors are compared to receptor-specific tESLs in Table 7.8, and analytes exceeding the limiting tESLs for large home-range receptors are compared to receptor-specific tESLs in Table 7.9.

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 assessment.

7.2.5 Surface Soil Professional Judgment Evaluation

Non-PMJM Receptors

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

Chromium, copper, manganese, nickel, thallium, tin, and vanadium were identified as ECOPCs and retained for further evaluation in the risk characterization.

PMJM Receptors

Based on the weight of evidence and professional judgment described in Attachment 3, all analytes exceeding screening steps for PMJM receptors were identified as ECOPCs and retained for further evaluation in the risk characterization.

Chromium, copper, manganese, nickel, selenium, tin, vanadium, and zinc were identified as ECOPCs and retained for further evaluation in the risk characterization.

7.2.6 Summary of Surface Soil Ecological Contaminants of Potential Concern

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

Non-PMJM Receptors

Most inorganic, organic, and radionuclide surface soil ECOIs for non-PMJM receptors in the LWOEU were eliminated from further consideration in the ECOPC identification process based on one of the following: 1) the MDC of the ECOI is 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 LWOEU surface soils was not statistically greater than those from background surface soils; 4) the upper-bound EPC did not exceed the limiting tESL; or 5) the weight-of-evidence, professional judgment evaluation indicated that the ECOI was not a site-related contaminant of potential concern. Chemicals that were retained are identified as ECOPCs and presented in Table 7.10.

A summary of the ECOPC identification process for non-PMJM receptors is presented in Table 7.10. Receptors of potential concern for each ECOPC are also presented. The ECOPC/receptor pairs are evaluated further in Section 8.0 (Ecological Exposure Assessment), Section 9.0 (Ecological Toxicity Assessment), and Section 10.0 (Ecological Risk Characterization).

PMJM Receptors

ECOIs in surface soil in PMJM habitat located within the LWOEU were evaluated in the ECOPC identification process. Most 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 ESLs were available (these ECOIs are discussed in Section 10.0); 3) the ECOI concentrations within the PMJM habitat in LWOEU 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. Chemicals that were retained are identified as ECOPCs and are presented in Table 7.11.

A summary of the ECOPC identification process for PMJM receptors is presented in Table 7.11. The ECOPC/PMJM pairs are evaluated further in Section 8.0 (Ecological Exposure Assessment), Section 9.0 (Ecological Toxicity Assessment), and Section 10.0 (Ecological Risk Characterization).

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

7.3.1 Comparison to No Observed Adverse Effect Level Ecological Screening Levels

The CRA Methodology indicates subsurface soil must be evaluated for those ECOIs that have greater concentrations in the subsurface than in surface soil. As a conservative 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

The ECOPC identification process for burrowing receptors involves an evaluation of detection frequency for each ECOI retained after the NOAEL ESL screening step. If the detection frequency is less than 5 percent, population-level risks are considered highly unlikely and the ECOI is further evaluated. The detection frequencies for chemicals in subsurface soil are presented in Table 1.7. None of the chemicals in subsurface soil at the LWOEU that were retained after the NOAEL ESL screening step had a detection frequency of less than 5 percent. Therefore, no ECOIs were eliminated from further evaluation based on the detection frequency for subsurface soil in the LWOEU.

7.3.3 Subsurface Soil Background Comparison

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 7.13 and discussed in Attachment 3. The statistical methods used for the background comparison are summarized in Attachment 3.

Analyses were conducted to assess whether antimony, arsenic, nickel and vanadium in LWOEU subsurface soil are statistically greater than those in sitewide background surface soil at the 0.1 level of significance. The results of the statistical comparisons of the LWOEU data to background data indicate that site concentrations of nickel in LWOEU subsurface soil are not statistically greater than background concentrations. Nickel was eliminated as a potential ECOPC and was not evaluated further. Concentrations of arsenic and vanadium were statistically greater than background concentrations and therefore, are evaluated further using upper-bound EPCs in the following section.

Statistical comparisons could not be completed for antimony because detection frequencies for either the background data set or LWOEU data sets were too low. Antimony is evaluated further using upper-bound EPCs in the following section.

7.3.4 Upper-Bound Exposure Point Concentration Comparisons to Threshold ESLs

ECOIs retained after all previous evaluations for burrowing receptors are compared to tESLs using upper-bound EPCs specific to small home-range receptors. The calculation of upper-bound EPCs is discussed in the CRA Methodology (DOE 2005a).

Statistical concentrations for each remaining ECOI retained for the tESL screen are presented in Table 7.14. The upper-bound EPC comparison to tESLs for burrowing receptors is presented in Table 7.15. The subsurface soil UTL for arsenic and vanadium are lower than the tESLs for the prairie dog receptor; therefore, arsenic and vanadium are not evaluated further. The subsurface soil UTL for antimony is higher than the tESL for the prairie dog receptor; therefore, antimony is evaluated further in professional judgment.

7.3.5 Subsurface Soil Professional Judgment

ECOIs with subsurface soil concentrations that exceed NOAEL ESLs, which have been detected in more than 5 percent of the samples; are statistically higher at the 0.1 level of significance compared to the background data; and exceed tESLs are subject to a professional judgment evaluation. The weight-of-evidence, professional judgment evaluation takes into consideration several factors, as described in Attachment 3.

Based on the weight of evidence and professional judgment, antimony in subsurface soil in the LWOEU is not considered an ECOPC and is not further evaluated quantitatively.

7.3.6 Summary of Subsurface Soil Ecological Contaminants of Potential Concern

All subsurface soil ECOIs for burrowing receptors in the LWOEU were eliminated from further consideration in the ECOPC identification process based on one of the following: 1) the MDC of the ECOI was less than NOAEL ESL for the burrowing receptor; 2) no ESLs were available (these ECOIs are discussed in Section 10.0); 3) the concentration of the ECOI in LWOEU subsurface soils was not statistically greater than those in background subsurface soils; 4) the upper-bound EPC was less than the tESL; or 5) the weight-of-evidence, professional judgment evaluation indicated that the ECOI was not a site-related contaminant of potential concern. The results of the subsurface soil ECOPC identification process for burrowing receptors are summarized in Table 7.16.

7.4 Summary of Ecological Contaminants of Potential Concern

ECOIs in surface and subsurface soil in the LWOEU were evaluated in the ECOPC identification process for non-PMJM receptors, PMJM receptors, and burrowing receptors. Chromium, copper, manganese, nickel, thallium, tin, and vanadium were identified as ECOPCs for selected non-PMJM receptors (Table 7.10). Chromium, copper, manganese, nickel, selenium, tin, vanadium, and zinc were identified as ECOPCs for the PMJM (Table 7.11). No chemicals were identified as ECOPCs for burrowing receptors (Table 7.16). No other ECOIs were retained past the professional judgment step of the ECOPC identification process for any other receptor group (non-PMJM receptors, PMJM receptors, or burrowing receptors).

8.0 ECOLOGICAL EXPOSURE ASSESSMENT

The ECOPC identification process defined the steps necessary to identify those chemicals that could not reliably be removed from further consideration in the ERA process. The list of ECOPC/receptor pairs of potential concern (Table 8.1) represents those media, chemicals, and receptors in the LWOEU that require further assessment. The characterization of risk defines a range of potential exposures to site receptors from the ECOPCs and a parallel evaluation of the potential toxicity of each of the ECOPCs, as well as the uncertainties associated with the risk characterization. This section provides the estimation of potential exposure to surface soil ECOPCs for the receptors identified in Section 7.0 and Table 8.1. Exposure to ECOPCs via the ingestion of surface water is also considered a potentially significant exposure route as presented in the CRA Methodology (DOE 2005a). Details of the two exposure models, concentration-based exposure and dosage-based exposure, are presented in Appendix A, Volume 2 of the RI/FS Report.

8.1 Exposure Point Concentrations

Surface soil EPCs for all non-PMJM receptors were calculated using both Tier 1 and Tier 2 methods, as described in the CRA Methodology. Tier 1 EPCs are based on the upper-bound confidence limits of the arithmetic mean concentration for the EU data set, and Tier 2 EPCs are calculated using a spatially-weighted averaging approach. The 30-acre grid used for the Tier 2 calculations is shown in Figure 8.1. The Tier 1 and Tier 2

UTLs and UCLs are presented in Table 8.2. The methodology for the calculation of Tier 2 statistics is provided in Appendix A, Volume 2 of the RI/FS Report

Surface soil EPCs for PMJM receptors were calculated for each PMJM habitat patch, assuming that all samples were randomly located and weighted equally. The habitat patches showing sample locations exceeding the NOAEL ESL, or three times the NOAEL ESL, are shown for ECOPCs in Figure 8.2 (chromium), Figure 8.3 (copper), Figure 8.4 (manganese), Figure 8.5 (nickel), Figure 8.6 (selenium), Figure 8.7 (tin), Figure 8.8 (vanadium), and Figure 8.9 (zinc). The UCL concentrations for each ECOPC were used as EPCs to calculate hazard quotients (HQs). The UCL was not used if there were not sufficient numbers of samples to calculate this value or if it exceeded the MDC. In either case, the MDC was used as a surrogate EPC. The surface soil EPCs for each PMJM patch are presented in Table 8.3. The ECOPCs shown in Table 8.3 represent ECOPCs with patch-specific MDCs greater than their respective ESLs. All ECOPCs that are not detected in a specific patch at concentrations less than their ESLs are excluded from the table.

The surface water EPCs were calculated for ECOIs that were identified as soil ECOPCs using the same statistical basis as determined for the soil ECOPCs. For example, if the soil EPC statistic was the UCL, then the UCL concentration in surface water (total values only) was calculated as described for soils and selected as the EPC. Surface water EPCs for all ECOPCs are presented in Table 8.4. All surface water data are provided on CD in Attachment 6.

8.2 Receptor-Specific Exposure Parameters

Receptor-specific exposure factors are needed to estimate exposure to ECOPCs for each representative species. These include body weight; food, water, and media ingestion rates; and diet composition and respective proportion of each dietary component. Daily rates for intake of forage, prey, water, and incidental ingestion of soils were developed in the CRA Methodology (DOE 2005a) and are presented in Table 8.5 for the receptors of potential concern carried forward in the ERA for the LWOEU.

8.3 Bioaccumulation Factors

The measurement or estimation of concentrations of ECOPCs in wildlife food is necessary to evaluate how much of a receptor's exposure is via food versus direct uptake of contaminated media. Conservative bioaccumulation factors (BAFs) were identified in the CRA Methodology (DOE 2005a). These BAFs are either simple ratios between chemical concentrations in biota and soil or are based on quantitative relationships such as linear, logarithmic, or exponential equations. The values reported in the CRA Methodology are used as the BAFs for purposes of risk estimation.

8.4 Intake and Exposure Estimates

Intake and exposure estimates were completed for each ECOPC/receptor pair identified in Table 8.1. The "default" estimates use the default exposure parameters and BAFs presented in Appendix B of the CRA Methodology (DOE 2005a) and described in the previous subsection. These intake calculations represent conservative estimates of food tissue concentrations calculated using upper-bound EPCs, including the Tier 1 and Tier 2 UTLs and UCLs where appropriate.

Non-PMJM Receptors

The intake and exposure estimates for ECOPC/non-PMJM receptor pairs are presented in Attachment 4. Except for plants and invertebrates, a summary of the exposure estimates is presented in Table 8.6.

- Chromium – Default exposure estimates for the American kestrel, mourning dove (herbivore and insectivore), and deer mouse (insectivore);
- Chromium – Refined exposure estimates for the mourning dove (insectivore);
- Copper – Default exposure estimates for the mourning dove (herbivore and insectivore);
- Manganese – Default exposure estimates for the deer mouse (herbivore);
- Nickel – Default exposure estimates for the mourning dove (insectivore), deer mouse (herbivore and insectivore), and coyote (generalist and insectivore);
- Nickel – Refined exposure estimates for the deer mouse (insectivore);
- Tin – Default exposure estimates for the mourning dove (herbivore and insectivore), American kestrel, and deer mouse (insectivore); and
- Vanadium – Default exposure estimates for the deer mouse (insectivore).

PMJM Receptors

The intake and exposure estimates for ECOPC/PMJM receptor pairs are presented in Attachment 4 and are summarized in Table 8.7 for:

- Chromium – Default exposure estimates;
- Copper – Default exposure estimates;
- Manganese – Default exposure estimates;
- Nickel – Default and refined exposure estimates;
- Selenium – Default exposure estimates;
- Tin – Default exposure estimates;
- Vanadium – Default exposure estimates; and
- Zinc – Default exposure estimates.

9.0 ECOLOGICAL TOXICITY ASSESSMENT

Exposure to wildlife receptors was estimated for representative species of functional groups based on taxonomy and feeding behavior, in Section 8.0, in the form of a daily rate of intake for each ECOPC/receptor pair. To estimate risk, soil concentrations (plants and invertebrate exposure) and calculated intakes (birds and mammals) must then be compared to the toxicological properties of each ECOPC. The laboratory-based toxicity benchmarks are termed toxicity reference values (TRVs) and are of several basic types. The NOAEL and no observed effect concentration (NOEC) TRVs are intake rates or soil concentrations below which no ecologically significant effects are expected. The NOAEL and NOEC TRVs were used to calculate the NOAEL ESLs used in screening steps of the ECOPC identification process to eliminate chemicals that have no potential to cause risk to the representative receptors. The lowest observed adverse effects level (LOAEL) TRV is a concentration above which the potential for some ecologically significant adverse effect could be elevated. The threshold TRVs represent the hypothetical dose at which the response for a group of exposed organisms may first begin to be significantly greater than the response for unexposed receptors and are calculated as the geometric mean of the NOAEL and LOAEL. Threshold TRVs were calculated based on specific data quality rules for use in the ECOPC identification process for a small subset of ECOIs in the CRA Methodology (DOE 2005a).

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

10.0 ECOLOGICAL RISK CHARACTERIZATION

Risk characterization includes risk estimation and risk description. Details of these components are described in the CRA Methodology (DOE 2005a) 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 LWOEU.

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

$$HQ = Exposure / TRV$$

As described in Section 8.0, the units used for exposure and TRV depend upon the type of receptor evaluated. For plants and invertebrates, exposures and TRVs are expressed as concentrations (milligram per kilogram [mg/kg] soil). For birds and mammals, exposures and TRVs are expressed as ingested doses (mg/kg receptor body weight [BW]/day).

In general, if the NOAEL-based HQ is less than 1, then no adverse effects are predicted. If the LOAEL-based HQ is less than 1 but the NOAEL-based HQ is above 1, then some adverse effects are possible, although it is expected that the magnitude and frequency of the effects will usually be low (assuming the magnitude and severity of the response at the LOAEL are not large and the endpoint of the LOAEL accurately reflects the assessment endpoints for that receptor). If the LOAEL-based HQ is greater than or equal to 1, the risk of an adverse effect is of potential concern, with the probability and/or severity of effect tending to increase as the value of the HQ increases.

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

HQs were calculated for each ECOPC/receptor pair based on the exposures estimated and TRVs presented in the preceding sections. The NOAEL and NOEC TRVs along with default screening-level exposure assumptions are first used to calculate HQs. However, these no effects HQs are typically considered as screening level results and do not necessarily represent realistic risks for the site. EPA risk assessment guidance (EPA 1997) recommends a tiered approach to evaluation, and following the first tier of evaluation "the risk assessor should review the assumptions used (e.g., 100 percent bioavailability) against values reported in the literature (e.g., only up to 60 percent for a particular contaminant), and consider how the HQs would change if more realistic conservative assumptions were used instead." Accordingly, LOAEL and threshold TRVs are also used in this evaluation to calculate HQs. Where LOAEL HQs greater than 1 are calculated using default exposure assumptions, and the uncertainty analysis indicates that median BAFs and/or additional TRVs would be beneficial to reduce uncertainty and conservatism, refined HQs are calculated.

10.1 Chemical Risk Characterization

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

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

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

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

- **EPCs.** Because surface soil sampling programs in the EU sometimes tended to focus on areas of potential contamination (IHSS/PAC/UBCs), EPCs calculated using the Tier 1 approach (which assumes that all samples are randomly spread across the EU and are weighted equally) may tend to yield an EPC that is biased high. For this reason, a Tier 2 area-weighting approach was used to derive additional EPCs that help compensate for this potential bias. HQs were always calculated based on Tier 1 and Tier 2 EPCs for non-PMJM receptors. No Tier 2 EPCs were calculated for PMJM receptors due to the limited size of their habitat.

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

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

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

HQs calculated using the default BAFs and HQs with the Tier 1 and Tier 2 EPCs are provided in Tables 10.1 and 10.2 for each ECOPC/receptor pair. Shaded cells represent default HQ calculations based on exposure and toxicity models specifically identified in the CRA Methodology. Where no LOAEL HQs exceed 1 using the default exposure and toxicity values, no further HQs were calculated. Since the default HQs are generally the most conservative risk estimations, if low risk is estimated using these values then further reductions of conservatism would only serve to reduce risk estimates further.

Where LOAEL HQs greater than 1 are calculated using default assumptions, and the uncertainty analysis indicates that alternative BAFs and/or TRVs would be beneficial to reduce uncertainty and conservatism, alternative HQs are calculated and presented in Tables 10.1 and 10.2 as appropriate.

The selection of which EPC (e.g., UTL or UCL) is of primary importance will depend upon the type of receptor and the relative home-range size. Only the UTL EPC is provided in Table 10.1 for small home-range receptors, and only the UCL is provided for large home-range receptors. The patch-specific UCL is provided in Table 10.2 for the PMJM receptors.

All calculated exposure estimates and HQ values are also provided in Attachment 4. These include the default and refined HQs if needed. The results for each ECOPC are discussed in more detail below.

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

10.1.1 Chromium

Chromium HQs for terrestrial plants, terrestrial invertebrates, mourning dove (herbivore and insectivore), American kestrel, and deer mouse (insectivore) are presented in Table 10.1. Figure 10.1 shows the spatial distribution of chromium in relation to the lowest ESL, and also presents the data used in the calculation of the Tier 2 EPCs. Patch-specific HQs for the PMJM receptor (Patches #22 and #23) are presented in Table 10.2.

For terrestrial plants and invertebrates, the NOEC HQ was greater than 1 and no LOEC HQs were available using the default TRVs. For mammalian and avian receptors, only the mourning dove (insectivore) receptor had LOAEL HQs greater than 1, indicating a potential for adverse effects. The uncertainty analysis presented in Attachment 5 indicates that there is low confidence in the chromium risk calculations for plants and invertebrates as well as the default risk calculations using the upper-bound BAFs and default TRVs for the mourning dove (insectivore). Therefore, a refined analysis was provided for plants and invertebrates using additional NOEC and LOEC ESLs and for the mourning dove (insectivore) using a median soil-to-invertebrate BAF. The resulting HQs are presented in Table 10.1.

Care should, however, be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors, regardless of whether refined HQs were calculated to address uncertainties in the default risk model.

Chromium Risk Description

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

Terrestrial Plants and Invertebrates

For terrestrial plants, HQs were greater than 1 using the default ESL, indicating the potential for adverse effects. Because no default LOEC value was available for plants, it is uncertain whether risks have the potential to be significant based on the default HQ calculations.

The uncertainty assessment discussed the low confidence placed in the chromium ESL for terrestrial plants and provided additional NOEC and LOEC values. The additional NOEC ESL resulted in an HQ greater than 1, while no HQs greater than 1 were calculated using the LOEC ESL. As discussed in the uncertainty analysis, the LOEC ESL is representative of a concentration at which soybean roots had a 30 percent reduction in shoot weight (see Attachment 5). In addition, the default ESL is less than all site-specific background concentrations. HQs greater than 1 were calculated using the UTL background concentration (HQ = 17).

The low confidence placed in the default ESL and the lack of HQs greater than 1 using the LOEC ESL in the refined analysis suggest that the potential for adverse effects to terrestrial plant populations is likely to be low.

For terrestrial invertebrates, HQs greater than 1 were calculated using the default ESL, indicating the potential for adverse effects. Because no default LOEC value was available for invertebrates, it is uncertain whether risks have the potential to be significant based on the default HQ calculations.

However, the maximum HQ calculated using an additional LOEC ESL was less than 1. The LOEC ESL is representative of a concentration at which there is a 30 percent reduction in earthworm growth (see Attachment 5). In addition, the uncertainty assessment indicated that the default ESL is less than all site-specific background concentrations. HQs greater than 1 were calculated using UTL background concentration (HQ = 42).

Based on the low confidence placed in the default ESL and the lack of HQs greater than 1 using the LOEC ESL in the refined analysis, the potential for adverse effects to terrestrial invertebrate populations is likely to be low.

Non-PMJM Receptors – Small Home Range

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

Table 10.3 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Chromium samples were available from 26 grid cells (Figure 10.1). NOAEL and LOAEL HQs greater than 1 were calculated in 100 percent of the grid cells, while no LOAEL HQs greater than 5 were calculated in any grid cell for the most sensitive receptor (mourning dove [insectivore]). The results of the grid-cell analysis indicate that the average exposure to sub-populations of mourning dove (insectivore) results in low to moderate risk from exposure to chromium.

The uncertainty analysis indicated that exposure to the mourning dove (insectivore) may be overestimated based on the use of upper-bound BAFs. Table 10.1 presents HQs calculating using the default risk model but with a median BAF rather than the conservative 90th percentile BAF. Using the median BAF in the risk model, the mourning dove (insectivore) had NOAEL HQs greater than 1 (HQ = 2 or 3 using Tier 1 or Tier 2 EPCs, respectively). However, LOAEL HQs were less than 1 using both EPCs.

In addition, background risk evaluations also indicated similar HQs for the mourning dove (insectivore) using the default HQ calculations. Based on the additional risk calculations, the potential for adverse effects to populations of small home-range receptors such as the mourning dove (insectivore) are likely to be low.

PMJM Receptor

Chromium was identified as an ECOPC for the PMJM receptor in Patches #22 and #23. Sample locations within PMJM habitat and a comparison to the ESL are shown in Figure 8.2. HQs equal to 1 were calculated using the NOAEL TRV for chromium VI in Patches #22 and #23. All NOAEL HQs were less than 1 in all patches when the chromium III TRV was used in the HQ calculation. No LOAEL HQs greater than 1 were calculated in any patch using the conservative chromium VI TRV. These results indicate that the potential for adverse effects to PMJM receptors in Patches #22 and #23 are likely to be low.

10.1.2 Copper

Copper HQs for the mourning dove (herbivore and insectivore) are presented in Table 10.1. Copper was not identified as an ECOPC in the LWOEU for any other non-PMJM receptors. Figure 10.2 shows the spatial distribution of copper in relation to the lowest ESL, and also presents the data used in the calculation of the Tier 2 EPCs. Patch-specific HQs for the PMJM receptor (Patch #23) are presented in Table 10.2.

For non-PMJM receptors, no receptors had LOAEL HQs greater than 1 using the default exposure assumptions and no additional HQs were calculated. For PMJM receptors, no NOAEL or LOAEL HQs greater than 1 were calculated in Patch #23 using the default exposure assumptions and no additional HQs were calculated.

Care should, however, be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors, regardless of whether refined HQs were calculated to address uncertainties in the default risk model.

Copper Risk Description

Copper was identified as an ECOPC for the mourning dove (herbivore and insectivore) and PMJM receptors only. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

Non-PMJM Receptors – Small Home Range

NOAEL HQs calculated using Tier 1 and Tier 2 EPCs were equal to 1 for the mourning dove (herbivore). NOAEL HQs for the mourning dove (insectivore) were greater than 1 (HQs = 2) using both the Tier 1 and Tier 2 EPCs.

All LOAEL HQs using both Tier 1 and Tier 2 EPCs were less than 1 for both receptors. Therefore, risks to populations of small home-range receptors such as the mourning dove (herbivore and insectivore) are likely to be low.

Table 10.3 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL, threshold, and LOAEL TRVs were used in the HQ calculations. Copper samples were available from 26 grid cells (Figure 10.2). NOAEL HQs greater than 1 were calculated in 100 percent of the grid cells while no LOAEL HQs greater than 1 were calculated in any grid cell for the most sensitive receptor (mourning dove [insectivore]). The results of the grid-cell analysis indicate that the average exposure to sub-populations of mourning dove (insectivore) results in low risk from exposure to copper.

PMJM Receptor

Copper was identified as an ECOPC for the PMJM receptor in Patch #23 only. Sample locations within PMJM habitat and a comparison to the ESL are shown in Figure 8.3. No NOAEL or LOAEL HQs greater than 1 were calculated using the default risk model. Therefore, results indicate that the potential for adverse effects to PMJM receptors in Patch #23 are likely to be low.

10.1.3 Manganese

Manganese HQs for terrestrial plants and deer mouse (herbivore) receptors are presented in Table 10.1. Figure 10.3 shows the spatial distribution of manganese in relation to the lowest ESL, and also presents the data used in the calculation of the Tier 2 EPCs. Patch-specific HQs for the PMJM receptor (Patches #22, #23, and #27) are presented in Table 10.2.

For terrestrial plants, NOEC HQs were equal to 1 based on the default ESL and no additional HQs were calculated. For the deer mouse (herbivore), LOAEL HQs were less than 1 using the default exposure assumptions, and no additional HQs were calculated. For PMJM receptors, NOAEL HQs were greater than 1 in all three patches (HQs = 2) but no LOAEL HQs greater than 1 were calculated using the default exposure assumptions and no additional HQs were calculated.

Care should, however, be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors, regardless of whether refined HQs were calculated to address uncertainties in the default risk model.

Manganese Risk Description

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

Terrestrial Plants

For terrestrial plants, HQs were equal to 1 using the default NOEC, indicating that the potential for adverse effects to populations of terrestrial plants from exposure to manganese in LWOEU soils are likely to be low. No default LOEC value was available for plants.

Non-PMJM Receptors – Small Home Range

NOAEL HQs using the Tier 1 and Tier 2 EPCs were equal to 1 for the deer mouse (herbivore). LOAEL HQs using both EPCs were less than 1 for the deer mouse (herbivore). Therefore, the potential for adverse effects to populations of small home range receptors such as the deer mouse (herbivore) are likely to be low.

Table 10.3 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Manganese samples were available from 26 grid cells (Figure 10.3). NOAEL HQs greater than 1 were calculated in only 8 percent of grid cells for the most sensitive receptor (deer mouse (herbivore)). No LOAEL HQs greater than 1 were calculated in any grid cell. The results of the grid-cell analysis indicate that the average exposure to sub-populations of deer mouse (herbivore) results in low risk from exposure to manganese.

PMJM Receptor

Manganese was identified as an ECOPC for the PMJM receptor in Patches #22, #23, and #27. Sample locations within PMJM habitat and a comparison to the ESL are shown in Figure 8.4. HQs greater than 1 (HQs = 2) were calculated using the NOAEL TRV for manganese in all three patches. No LOAEL HQs greater than 1 were calculated in any of the three patches using the default HQ calculations. These results indicate that the potential for adverse effects to PMJM receptors are likely to be low.

10.1.4 Nickel

Nickel HQs for the mourning dove (insectivore), deer mouse (herbivore and insectivore), and coyote (generalist and insectivore) are presented in Table 10.1. Figure 10.4 shows the spatial distribution of nickel in relation to the lowest ESL, and also presents the data used in the calculation of the Tier 2 EPCs. Patch-specific HQs for the PMJM receptor (Patches #22, #23, #24, #25, and #27) are presented in Table 10.2.

For non-PMJM receptors, only the deer mouse (insectivore) had LOAEL HQs greater than 1, indicating a potential for adverse effects. The uncertainty analysis presented in Attachment 5 indicated that there were considerable uncertainties in the nickel risk calculations based on both upper-bound BAFs and TRVs used in the deer mouse (insectivore) risk calculations. For this reason, refined risk calculations was calculated for the deer mouse (insectivore) using a median soil-to-invertebrate BAF and additional TRVs. The results of the refined analysis are presented in Table 10.1

For PMJM receptors, NOAEL and LOAEL HQs greater than 1 were calculated using the UCL EPC in all of the patches in which nickel was an ECOPC, indicating a potential for adverse effects. However, as discussed above, the uncertainty analysis presented in Attachment 5 indicated that there were considerable uncertainties in the nickel risk calculations based on both the upper-bound BAFs and TRVs. For this reason, refined risk calculations were calculated for the PMJM using a median BAF and additional TRVs. The results of the refined analysis are presented in Table 10.2.

Care should, however, be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors, regardless of whether refined HQs were calculated to address uncertainties in the default risk model.

Nickel – Risk Description

Nickel was identified as an ECOPC for the mourning dove (insectivore), deer mouse (herbivore and insectivore), PMJM, and coyote (generalist and insectivore). Refined HQs were calculated for the deer mouse (insectivore) and PMJM using a median soil-to-invertebrate BAF and additional TRVs. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

Non-PMJM Receptors – Small Home Range

NOAEL HQs were greater than 1 for the mourning dove (insectivore) and deer mouse (insectivore) using the default risk model (Table 10.1). NOAEL HQs were equal to 1 for the deer mouse (herbivore). LOAEL HQs were less than 1 for all receptors except for the deer mouse (insectivore). Therefore, the potential for adverse effects to populations of the mourning dove (insectivore) and deer mouse (herbivore) from exposure to nickel are likely to be low. The potential for adverse effects to the deer mouse (insectivore) using the default HQ calculations may be low to moderate and require further evaluation.

Table 10.3 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Nickel samples were available from 26 grid cells (Figure 10.4). NOAEL HQs greater than 10 were calculated in 100 percent of the grid cells. LOAEL HQs greater than 1 but less than 5 were also calculated in 92 percent of grid cells and between 5 and 10 in 8 percent of grid cells (n=2) for the most sensitive receptor (deer mouse [insectivore]). The results of the grid-cell analysis indicate that risks from average exposure to sub-populations of insectivorous small mammals cannot be dismissed and require further evaluation.

The uncertainty analysis discussed the potential for risks at UCL and UTL background soil concentrations. For the deer mouse (insectivore), LOAEL HQs in background (UTL and UCL HQs = 3) are somewhat similar to those calculated for LWOEU surface soils. These results indicate that risks to insectivorous deer mouse populations within LWOEU are similar to those offsite.

The uncertainty analysis indicated that exposure to the deer mouse (insectivore) may be overestimated based on the use of upper-bound BAFs. Median intake rates were calculated for those receptors ingesting invertebrates in their diet. In addition, HQs were also calculated using additional TRVs from Sample et al. (1996). Table 10.1 presents HQs calculated using the default risk model but with a median BAF rather than the conservative 90th percentile BAF. The deer mouse (insectivore) had NOAEL HQs greater than 1 using the Tier 1 EPC (HQ = 12) and the Tier 2 EPC (HQ = 13). However, LOAEL HQs were equal to 1 using both EPCs. When the TRVs from Sample et al. (1996) were used instead of the default TRVs, no HQs greater than 1 were calculated using either the NOAEL or the LOAEL TRV.

The refined analysis supports the conclusion that the default HQs are likely overestimated and risks are low, not low to moderate as indicated by the default HQ results. In addition, background risk evaluations also indicated similar HQs for the deer mouse (insectivore) using the default HQ calculations. Therefore, the potential for adverse effects to populations of small home range receptors such as the deer mouse (insectivore) are likely to be low.

Non-PMJM Receptors – Large Home Range

NOAEL HQs were greater than 1 for the coyote (generalist and insectivore) using the default risk model (Table 10.1). LOAEL HQs for both receptors were less than 1 for all exposure scenarios. Because risks are classified as low using the more conservative default HQ calculations, no additional HQs were calculated and the potential for adverse effects are likely to be low for populations of large home-range receptors such as the coyote (generalist and insectivore).

PMJM Receptor

NOAEL HQs were greater than 1 in all five patches. LOAEL HQs were also greater than 1 in all five patches. Therefore, risks to the PMJM using the default HQ calculations may potentially be significant and require further evaluation.

The uncertainty analysis discussed the potential for risks at UCL background soil concentrations. For the PMJM, risks calculated using the background UCL as the EPC indicate potential adverse effects, with the NOAEL HQ equal to 20 for the UCL. LOAEL HQs in background using the UCL are the same as those calculated for LWOEU surface soils (HQs = 3) in three of the five patches. These results indicate that risks to insectivorous deer mouse populations within LWOEU are similar to those offsite.

No LOAEL HQs greater than 1 were calculated in four out of the five patches using the median soil-to-invertebrate BAF. The LOAEL HQ for Patch #27 was greater than 1 (HQ =2) when using the median BAF in the risk model. However, no HQs (NOAEL or LOAEL) were greater than 1 for any patch when using the additional NOAEL and LOAEL TRVs coupled with the median BAF in the refined risk analysis. Similarly, no HQs (NOAEL or LOAEL) were greater than 1 using the upper-bound soil-to-invertebrate BAF coupled with the additional NOAEL or LOAEL TRVs in the refined analysis.

The refined analysis indicates that the potential for adverse effects to the PMJM receptor are low in all five patches because HQs calculated in those patches are similar to those calculated using background data and LOAEL HQs were less than 1 for all patches (except Patch #27 where the HQ = 2) when the median soil-to-invertebrate BAF was used in the refined analysis. However, LOAEL HQ were less than 1 in all five patches when the additional TRVs were used in the analysis. Based on the refined analysis, the potential for adverse effects to PMJM receptors is likely to be low in all five patches.

10.1.5 Selenium

Selenium HQs for the PMJM receptor in Patch #23 are presented in Table 10.2. Selenium was not identified as an ECOPC in any other patch. Selenium was also not identified as an ECOPC for non-PMJM receptors.

No NOAEL or LOAEL HQ greater than 1 were calculated for the PMJM receptor in Patch #23 and no additional HQs were calculated.

Care should, however, be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors, regardless of whether refined HQs were calculated to address uncertainties in the default risk model.

Selenium – Risk Description

Selenium was identified as an ECOPC for the PMJM receptor in Patch #23 only. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

PMJM Receptor

Selenium was identified as an ECOPC for the PMJM receptor in Patch #23 only. Sample locations within PMJM habitat and a comparison to the ESL are shown in Figure 8.6. No NOAEL or LOAEL HQs greater than 1 were calculated in Patch #23 using the UCL EPC indicating that the potential for adverse effects for PMJM receptors is likely to be low in Patch #23.

10.1.6 Thallium

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

The terrestrial plant receptor had a NOEC HQ greater than 1 (HQ = 2). No LOEC TRV was available; therefore, it is unclear whether there is a potential for adverse effects using only the default NOEC ESL. The uncertainty analysis did not identify any additional toxicity information or ESLs. Therefore, no additional HQs were calculated.

Care should, however, be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results for all receptors regardless of whether refined HQs were calculated to address uncertainties.

Thallium – Risk Description

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

Terrestrial Plants

NOEC HQs were equal to 2 using both the Tier 1 and Tier 2 EPCs. As discussed in Attachment 5, there is low confidence in this ESL because it is reportedly based on unspecified effects. No additional ESLs were available for a refined analysis. The relatively low HQs coupled with the low confidence in the ESL and the lack of known releases of thallium, indicate that the potential for adverse effects to populations of terrestrial plants is likely to be low.

10.1.7 Tin

Tin HQs for the American kestrel, mourning dove (herbivore and insectivore), and deer mouse (insectivore) are presented in Table 10.1. Figure 10.6 shows the spatial distribution of tin in relation to the lowest ESL, and also presents the data used in the calculation of the Tier 2 EPCs. Patch-specific HQs for the PMJM receptor (Patches #23, and #25) are presented in Table 10.2.

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

Care should, however, be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors, regardless of whether refined HQs were calculated to address uncertainties in the default risk model.

Tin – Risk Description

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

Non-PMJM Receptors – Small Home Range

NOAEL HQs were equal to 1 for the mourning dove (herbivore). NOAEL HQs were greater than 1 for the mourning dove (insectivore), American kestrel, and deer mouse (insectivore). All LOAEL HQs for all receptors were less than 1. Therefore, the potential for adverse effects to populations of the mourning dove (herbivore and insectivore), American kestrel and deer mouse (insectivore) from exposure to tin are likely to be low.

Table 10.3 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Tin samples were available from 23 grid cells (Figure 10.6). NOAEL HQs greater than 1 were calculated in 56 percent of the grid cells while no LOAEL HQs greater than 1 were calculated in any grid cell for the most sensitive receptor (mourning dove [insectivore]). The results of the grid-cell analysis indicate that the average exposure to sub-populations of small home-range receptors results in low risk from exposure to tin.

PMJM Receptor

Tin was identified as an ECOPC for the PMJM receptor in Patches #23 and #25 only. Sample locations within PMJM habitat and a comparison to the ESL are shown in Figure 8.7. Results of the PMJM risk calculations indicate that NOAEL HQs were greater than 1 in Patch #25 and less than 1 in Patch #23 (Table 10.2). LOAEL HQs were less than 1 in both patches. Because no LOAEL HQs greater than 1 were calculated in Patches #23 and #25, the potential for adverse effects to PMJM receptors are likely to be low.

10.1.8 Vanadium

Vanadium HQs for terrestrial plants and the deer mouse (insectivore) are presented in Table 10.1. Figure 10.7 shows the spatial distribution of vanadium in relation to the lowest ESL, and also presents the data used in the calculation of the Tier 2 EPCs. Patch-specific HQs for the PMJM receptor (Patches #22, #23, #24, #25, and #27) are presented in Table 10.2.

For terrestrial plants, HQs calculated using the default ESL were greater than 1. An additional LOEC value was available for a refined analysis. Therefore, additional HQs were calculated.

For the deer mouse (insectivore), LOAEL HQs were less than 1 using the default exposure assumptions, and no additional HQs were calculated. For PMJM receptors, no LOAEL HQs greater than 1 were calculated in any of the patches using the default HQ calculations. Therefore, no additional HQs were calculated.

Care should, however, be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors, regardless of whether refined HQs were calculated to address uncertainties in the default risk model.

Vanadium – Risk Description

Vanadium was identified as an ECOPC for terrestrial plants as well as the deer mouse (insectivore) and PMJM receptors. Information on the historical use and a summary of site data and background data are provided in Attachment 3.

Terrestrial Plants

For terrestrial plants, the default HQ was greater than 1 using the default NOEC ESL. However, Efroymson et al. (1997) places low confidence in the TRV because there are no primary reference data showing toxicity to plants and the ESL value is based on unspecified toxic effects.

The uncertainty assessment recommended the use of an alternative LOEC value (50 mg/kg). The Tier 1 and Tier 2 UTL concentrations results in HQs equal to 1, indicating that the potential for adverse effects to terrestrial plant populations are likely to be low. However, there is also low confidence in this alternative LOEC as discussed in Attachment 5.

The default NOEC ESL (2 mg/kg) is less than all site-specific background concentrations. HQs greater than 1 were calculated using UTL and UCL background concentrations (HQ = 23 and 15, respectively). An HQ equal to 5 would be calculated using the minimum background concentration and the default ESL.

The potential for risk to terrestrial plant populations from exposure to vanadium in surface soils is likely to be low although there is high uncertainty or low confidence in both ESLs used in the risk calculations.

Non-PMJM Receptors – Small Home Range

Tier 1 EPCs resulted in NOAEL HQs greater than 1 (HQs = 2) using both the Tier 1 and Tier 2 EPCs for the deer mouse (insectivore). LOAEL HQs were less than 1 using both EPCs. Therefore, the potential for adverse effects to populations of small home range receptors such as the deer mouse (insectivore) are likely to be low.

Table 10.3 presents a summary of HQs calculated using the arithmetic mean concentration used as cell-specific EPCs for surface soil samples within each of the Tier 2 30-acre grid cells. Default NOAEL and LOAEL TRVs were used in the HQ calculations. Vanadium samples were available from 26 grid cells (Figure 10.7). NOAEL HQs greater than 1 were calculated in 62 percent of the grid cells while no grid cell had an LOAEL HQ greater than 1 for the most sensitive receptor (deer mouse [insectivore]). The results of the grid-cell analysis indicate that the average exposure to sub-populations of small home-range receptors results in low risk from exposure to vanadium.

PMJM Receptors

NOAEL HQs were greater than 1 (HQs = 2) in Patches #22, #23, #24, #25, and #27 for both the Tier 1 and Tier 2 EPCs (Table 10.2). Figure 8.8 presents vanadium sampling locations and a comparison to the PMJM ESL.

No LOAEL HQs in any of the five patches were greater than 1. These results indicate that potential for adverse effects to PMJM receptors from exposure to vanadium are likely to be low in all five patches.

10.1.9 Zinc

Patch-specific HQs for the PMJM receptor (Patches #22, #23, #24, #25, and #27) are presented in Table 10.2. Zinc was not identified as an ECOPC for non-PMJM receptors.

For PMJM receptors, no LOAEL HQs greater than 1 were calculated in any patch using the default HQ calculations and no additional HQs were calculated.

Care should, however, be taken to review the chemical-specific uncertainties discussed in Attachment 5 when reviewing the results of all receptors, regardless of whether refined HQs were calculated to address uncertainties in the default risk model.

PMJM Receptor

NOAEL HQs were greater than 1 (HQs = 2 or 3) in all five patches (#22, #23, #24, #25, and #27) using the UCL EPCs. Sample locations within PMJM habitat and a comparison to the ESL are shown in Figure 8.9. No LOAEL HQs in any of the patches were greater than 1 using the default risk model. Therefore, the potential for adverse effects to PMJM receptors are likely to be low in all five patches.

10.2 Ecosystem Characterization

An ecological monitoring program has been underway since 1991 when baseline data on wildlife species was gathered (Ebasco 1992). The purpose of this long-term program was to monitor specific habitats to provide a sitewide database from which to monitor trends in the wildlife populations at RFETS. Although a comprehensive compilation of monitoring results has not been presented, the annual reports of the monitoring program provide localized information and insights on the general health of the RFETS ecosystem. Permanent transects through three basic habitats were run monthly for over a decade (K-H 2002). Observations concerning the abundance, distribution, and diversity of wide-ranging wildlife species were recorded including observations of migratory birds, raptors, coyotes, and deer. Small mammal monitoring occurred through several tasks in the monitoring program. The Ecological Monitoring Program (DOE 1995) established permanent transects for small mammal monitoring in three habitat types; xeric grasslands, mesic grasslands, and riparian habitats. PMJM studies established small mammal trapping in nearly all riparian habitats across the site (K-H 1998, 1999, 2000, 2001, 2002).

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

Summarizing songbird surveys over the breeding season, diversity indices for RFETS for all habitats combined over 8 years of observations (1991 and 1993 to 1999) show a steady state in diversity of bird communities (K-H 2000). Among habitats, results were similar within grassland and wetland habitats, but riparian woodlands, which include shrublands, revealed a slight decrease (K-H 2000). However, this trend can be mostly attributed to transient species (i.e., those species not usually associated with woody cover) except for red-tailed hawk (*Buteo jamaicensis*) and American goldfinch (*Carduelis tristis*). The red-tailed hawk change in density can be attributed to a loss of a nesting site in Upper Woman Creek, not Lower Woman Creek. Goldfinch abundance can be heavily influenced by the availability of food sources.

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

Raptors, big game species, and carnivores were observed through relative abundance surveys and multi-species surveys (16 permanent transects) that provided species-specific sitewide counts. Raptors were noted on relative abundance surveys and nest sites were visited repeatedly during the nesting season to confirm nesting success. The three most common raptors on RFETS are the red-tailed hawk, great horned owl (*Bubo virginianus*), and American kestrel (*Falco sparverius*) (K-H 2002). Typically, in Lower Woman Creek, there is one great horned owl nest and several American kestrel nests. Owl nests on site generally fledge two young per nest, and kestrels usually fledge two to three young. Each species had a successful nesting season each year during the monitoring period from 1991 to 1999 (K-H 1997, 1998, 1999). The continued presence of nesting raptors at RFETS (K-H 2002) including the LWOEU, indicate that habitat quality and protection from human disturbance have contributed to making RFETS a desirable location for raptors to reproduce. Adequate habitat provides essential seasonal requirements. RFETS is estimated to be at optimum population density for raptors given available habitat and the territorial nature of these species (K-H 2000).

Two deer species inhabit RFETS: mule deer (*Odocoileus hemionus*) and white-tail deer (*Odocoileus virginianus*). No white-tail deer were present at RFETS in 1991 when monitoring began (K-H 2002). In 2000 (K-H 2001), numbers of white-tail deer were estimated between 10 and 15 individuals spending the majority of their time in the LWOEU. Mule deer frequent all parts of RFETS (14 mi^2) year-round. The RFETS population from winter counts is estimated at a mean 125 individuals ($n = 7$), with a density of 14 deer per square mile (K-H 2000, 2002). Winter mule deer counts have varied from 100 to 160 individuals over the monitoring period (1994 to 2000), with expected age/sex class distributions (K-H 2001). Obviously, the population at RFETS is "open," with individuals able to move freely on and off site. In comparison, mule deer populations at the Rocky Mountain Arsenal (27 mi^2) are estimated between 175 to 213 individuals based on ground observations (Whittaker 1995). This equates to a density of 93.6 km^2 (36.1mi^2), a much denser population. The number of mule deer at the Rocky Mountain Arsenal increased substantially toward the end of the study. The U.S. Army erected a chain-link fence around the site in the early 1990s (Skipper 2005) and effectively closed the population, thereby negating any immigration. Prior to the fence being installed, mule deer densities were estimated at 44.3 km^2 (17 mi^2), similar to those observed at RFETS. The mule deer populations from RFETS have been at a steady state, with good age/sex distributions (K-H 2001) over time and similar densities compared to other "open" populations that are not hunted. This provides a good indicator that habitat quality is high across the site, including the LWOEU, and that site activities have not affected deer populations. It is unlikely that deer populations are depressed or reproduction is affected by contaminants. A recent study on actinides in deer tissue found that plutonium levels were near or below detection limits (Todd and Sattelberg 2004). This provides further support that the deer population is healthy.

Coyotes (*Canis latrans*) are the top mammalian predator at RFETS. They prey upon mule deer fawns and other smaller prey species. The number of coyotes using the site has been estimated at 14 to 16 individuals (K-H 2002). Through surveys across the site, coyotes have been noted to have reproduction success, with as many as six dens active in 1 year. Typically, at RFETS, three to six coyote dens support an estimated 14 to 16 individuals at any given time (K-H, 2001). LWOEU generally does not support coyote dens but does support important hunting habitat for coyotes. Coyotes have been observed hunting deer in the LWOEU in winter on numerous occasions. Coyotes have exhibited a steady population over time, thereby indicating their prey species continue to be abundant and healthy.

Small mammal trapping has occurred over several years as a component of the ecological monitoring program, especially during studies of the PMJM. The LWOEU has been trapped over several years (K-H 1998, K-H 2001). Although no PMJM have ever been captured in the LWOEU, typical small mammal species are present, as listed in Section 1.1.3.). Additionally, less-common species include pocket mouse species such as hispid pocket mouse (*Chaetodipus hispidus*) found in riparian areas and plains pocket mouse (*Perognathus flavescens*) found in grasslands. The existence of both species is an indication of diverse and healthy small mammal communities, and monitoring has revealed abundance and species diversity that would be expected in typical native ecosystems on the plains of Colorado (Fitzgerald et al. 1994).

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

10.3 General Uncertainty Analysis

Quantitative evaluation of ecological risks is limited by uncertainties regarding the assumptions used to predict risk and the data available for quantifying risk. These limitations are usually circumvented by making estimates based on the data available or by making assumptions based on professional judgment when data are limited. Because of these assumptions and estimates, the results of the risk calculations themselves are uncertain, and it is important for risk managers and the public to view the results of the risk assessment with this in mind. Chemical-specific uncertainties are presented in Attachment 5 of this document and were discussed in terms of their potential effects on the risk characterization in the risk description section for each ECOPC. 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 LWOEU ERA.

10.3.1 Uncertainties Associated with Data Adequacy and Quality

Sections 1.2 and 1.3 summarize the general data adequacy and data quality for the LWOEU, 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 LWOEU 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 the number of LWOEU surface soil samples for each analyte group meet the data adequacy guideline; however, except for radionuclides and metals for PMJM patch #23, the number of surface soil samples for the analyte groups in the PMJM patches do not meet the data adequacy guideline. Organics were not detected in PMJM patch #23, and Patch #23 has the greatest potential for organic contamination because historical IHSSs are located topographically upgradient. Although detection limits exceed the minimum ESLs for several of the organic analytes, professional judgment indicates these analytes would not likely be ECOPCs even if detection limits had been lower (see Attachment 1). Surface soil in the other patches would not be expected to have organic contamination because there are no historical IHSSs that are located topographically upgradient. Metal concentrations in surface soil are above the ESLs in several PMJM patches, including patch #23. Although available data for each patch has been used to conduct patch-specific risk characterizations, there is greater reliability in the risk characterization for metals in PMJM patch #23 where the number of samples meets the data adequacy guideline, and the risk estimates should be applicable to the other PMJM patches, if not biased high. With respect to surface water data adequacy, the number of LWOEU surface water samples for each analyte group meet the data adequacy guideline; however, there are no current data for PCBs. Even though PCBs were not detected in surface water in the EU, there is some uncertainty in the risk assessment process because of the high detection limits associated with the PCBs. Overall, it is possible to make risk management decisions without additional surface soil or surface water sampling.

Data used in the CRA must also 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. There are 15 analytes in surface soil that have detection limits that exceed the lowest ESLs, but these higher detection limits contribute only minimal uncertainty to the overall risk assessment process because either only a small fraction of the detection limits are greater than the lowest ESL, or professional judgment indicates they are not likely to be ECOPCs in LWOEU surface soil even if detection limits had been lower.

10.3.2 Uncertainties Associated with the Lack of Toxicity Data for Ecological Contaminant of Interest Detected at the Lower Woman Drainage Exposure Unit

Several ECOIs detected in the LWOEU 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.

ESLs and/or TRVs were not available for several of the ECOPC/receptor pairs identified in Section 7.0. These include manganese (invertebrates), thallium (invertebrates), tin (invertebrates), and vanadium (invertebrates). The risks to these ECOPC/receptor pairs are uncertain. However, because risks to all of the ECOPCs mentioned above is considered to be low for those receptors where toxicity information is available, this source of uncertainty is not expected to be significant.

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

Several analytes in surface soil and subsurface soil were eliminated as ECOIs based on professional judgment. The professional judgment evaluation is intended to identify those ECOIs that have a limited potential for contamination in the LWOEU. The weight-of-evidence approach supports the conclusion that there is no identified source or pattern of release in the LWOEU, and the slightly elevated values of the LWOEU data for these ECOIs are most likely due to natural variation. The professional judgment evaluation is unlikely to have significant effect on the overall risk calculations because the ECOIs eliminated from further consideration are found at concentrations in LWOEU that are at levels that are unlikely to result in risk concerns for ecological receptors and are well within regional background levels. In addition, these ECOIs are not related to site-activities in the LWOEU and have very low potential to be transported from historical sources to the LWOEU.

10.4 Summary of Significant Sources of Uncertainty

The preceding discussion outlined the significant sources of uncertainty in the CRA process for assessing ecological risk. While some of the general sources of uncertainty discussed tend to 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 LWOEU is presented below.

11.1 Data Adequacy

The adequacy of the LWOEU 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 the total number of LWOEU surface soil and sediment samples for each analyte group meet the data adequacy guideline; however, for individual PMJM patches, the data adequacy guideline is not met, except for radionuclides and metals in PMJM patch #23. Although there are data limitations for the LWOEU, other lines of evidence (e.g., information on potential historical sources of contamination, migration pathways, and the concentration levels in the media) indicate that organics are not likely to be present in PMJM habitat surface soil,. For metals, although available data for each PMJM patch has been used to conduct patch-specific risk characterizations, there is greater reliability in the risk characterization for metals in PMJM patch #23 where the number of samples meet the data adequacy guideline, and the risk estimates should be applicable to the other PMJM patches, if not biased high. The number of LWOEU surface water samples for each analyte group meet the data adequacy guideline, although there is no current data for PCBs. Even though PCBs were not detected in surface water in the EU, there is some uncertainty in the risk assessment process because of the high detection limits associated with the PCBs. Overall, it is possible to make risk management decisions using the existing data. In addition, for analytes that are not detected or detected at a frequency less than 5 percent, there are several analytes in surface soil that have detection limits that exceed the lowest ESLs, but these higher detection limits contribute only minimal uncertainty to the overall risk assessment process because either only a small fraction of the detection limits are greater than the lowest ESL, or professional judgment indicates they are not likely to be ECOPCs in LWOEU surface soil even if detection limits had been lower.

11.2 Human Health

The COC screening analyses compared MDCs and UCLs of chemicals and radionuclides in LWOEU media to PRGs for the WRW receptor. Inorganic and radionuclide analytes with UCLs greater than the PRGs were statistically compared to the background concentration data set. Inorganic and radionuclide analytes that were statistically greater than background at the 0.1 significance level, and organics with UCL concentrations greater than the PRG were carried forward to professional judgment evaluation. Based on the COC selection process, no COCs were selected for surface soil/surface sediment or subsurface soil/subsurface sediment in the LWOEU and a risk characterization was not performed for the LWOEU.

11.3 Ecological Risk

The ECOPC identification process streamlines the ecological risk characterization by focusing the assessment on ECOIs that are present in the LWOEU. The ECOPC identification process is described in the CRA Methodology (DOE 2005a) and additional details are provided in Appendix A, Volume 2 of the RI/FS Report. Chromium, copper, manganese, nickel, thallium, tin, and vanadium were identified as ECOPCs for representative populations of non-PMJM receptors in surface soil. ECOPCs for individual PMJM receptors included chromium, copper, manganese, nickel, selenium, tin, vanadium, and zinc. Although there are no dioxin data for surface soil, the evaluation of site-wide data indicate dioxins are not expected to be present in LWOEU surface soil, however, there is some uncertainty in the overall risk estimates for the LWOEU as a result of this data limitation. No ECOPCs were identified in subsurface soil for burrowing receptors.

ECOPC/receptor pairs were evaluated in the risk characterization using conservative default exposure and risk assumptions as defined in the CRA Methodology. Tier 1 and Tier 2 EPCs were used in the risk characterization: Tier 1 EPCs are based on the upper confidence limits of the arithmetic mean concentration for the EU data set and Tier 2 EPCs are calculated using a spatially-weighted averaging approach. In addition, a refinement of the exposure and risk models based on chemical-specific uncertainties associated with the initial default exposure models were completed for several ECOPC/receptor pairs to provide a refined estimate of potential risk.

Using Tier 1 EPCs and default exposure and risk assumptions, NOAEL, NOEC or in some cases, LOEC HQs ranged from 65 (chromium/terrestrial invertebrates) to less than 1 (chromium III/deer mouse - insectivore). NOAEL or NOEC HQs also ranged from 81 (chromium/terrestrial invertebrates) to less than 1 (chromium III/deer mouse - insectivore) using Tier 2 EPCs and default exposure and risk assumptions (Table 10.1).

For terrestrial plants, chromium, manganese, thallium, and vanadium all had HQs greater than or equal to 1 using the Tier 1 and Tier 2 EPCs. For terrestrial invertebrates, chromium had HQs greater than 1 using the Tier 1 and Tier 2 EPCs. However, there is low confidence placed in the ESLs for terrestrial plants and invertebrates (chromium only) for all four ECOPCs. As discussed in Attachment 5, additional NOEC or LOEC values for manganese and thallium were either not acceptable (low confidence in the values) or not available in the literature. For chromium, additional LOEC values were available for refined risk calculations for both plants and invertebrates. For vanadium, an additional LOEC value was available for refined risk calculations for plants.

For chromium, using the additional LOEC ESLs resulted in no HQs greater than 1 for plants or invertebrates. As discussed in the uncertainty analysis, the additional LOEC ESL for plants is representative of a concentration at which soybean roots had a 30 percent reduction in shoot weight while the additional LOEC for invertebrates is representative of a concentration at which there is a 30 percent reduction in earthworm growth (see Attachment 5). In addition, the default ESLs for plants and invertebrates are less than all site-specific background concentrations. HQs greater than 1 were calculated using the UTL background concentration for plants (HQ = 17) and for invertebrates (HQ = 42). The low confidence placed in the default ESL coupled with the similar HQs provided by the background risk evaluation and the lack of HQs greater than 1 using additional effects-based ESLs, indicate that the potential for adverse effects to terrestrial plant and invertebrate populations in the LWOEU from exposure to chromium in surface soils is likely to be low.

For manganese, the NOEC HQ was equal to 1 using both the Tier 1 and Tier 2 UTLs. For thallium, the NOEC HQ was equal to 2 using both the Tier 1 and Tier 2 UTLs. Based on the low HQs combined with the low confidence in the default ESLs (see Attachment 5) and the lack of known releases, the potential for adverse effects to populations of terrestrial plants from manganese and thallium in surface soils is likely to be low.

For vanadium, the NOEC HQ was greater than 1 using both the Tier 1 and Tier 2 UTLs. However, there is low confidence in the default ESL. In addition, the default NOEC ESL (2 mg/kg) is less than all site-specific background concentrations. HQs greater than 1 were calculated using UTL and UCL background concentrations (HQ = 23 and 15, respectively). An HQ equal to 5 would be calculated using the minimum background concentration and the default ESL. The uncertainty assessment for vanadium recommended the use of an additional LOEC value (50 mg/kg) even though there is low confidence in this additional LOEC as well. Based on this LOEC ESL, HQs were equal to 1 in the refined analysis, indicating that the potential for adverse effects to terrestrial plant populations are likely to be low.

Most of the ECOPC/receptor pairs for birds and mammals had LOAEL HQs less than or equal to 1 using the default assumptions used in the risk calculations. However, the following ECOPC/receptor pairs had LOAEL HQs greater than 1 using the default exposure and toxicity assumptions:

- Chromium/mourning dove (insectivore) – The default LOAEL HQs were equal to 4 and 5 using the Tier 1 and Tier 2 EPCs, respectively. There is uncertainty associated with the use of the upper-bound BAF and the default TRV in the risk calculations (see Attachment 5). However, an additional median soil-to-invertebrate BAF was available for a refined analysis. Using the median BAF, LOAEL HQs were less than 1 using both the Tier 1 and Tier 2 EPCs. Therefore, the potential for adverse effects to populations of small home range receptors such as the mourning dove (insectivore) is likely to be low.

- Nickel/deer mouse (insectivore) – The default LOAEL HQs were equal to 5 and 6 using the Tier 1 and Tier 2 EPCs, respectively. Using a median BAF rather than the default upper-bound BAF for the estimation of invertebrate tissue concentrations, no LOAEL HQs greater than 1 were calculated. HQs were also calculated using additional TRVs from Sample et al. (1996). When these additional TRVs from Sample et al. (1996) were used in the refined analysis, no HQs greater than 1 were calculated using either the NOAEL or the LOAEL TRV. Therefore, based on the refined analysis and the similarity between site concentrations and background concentrations, the potential for adverse effects to populations of small home range receptors such as the deer mouse (insectivore) receptor are likely to be low.

- Nickel/PMJM - LOAEL HQs were greater than 1 in Patches #22, #23, #24, #25, and #27 using default exposure and toxicity assumptions. Using a median BAF rather than an upper-bound BAF for the estimation of invertebrate tissue concentrations, LOAEL HQs were less than 1 in all patches except Patch #27 (HQ= 2). However, using additional TRVs in the refined analysis resulted in NOAEL and LOAEL HQs less than 1, in all five patches. Therefore, based on the refined analysis and the similarity between site concentrations and background concentrations, the potential for adverse effects to PMJM receptors are likely to be low in all five patches.

Based on default and refined calculations, site-related risks are likely to be low for the ecological receptors evaluated in the LWOEU (Table 11.1). In addition, data collected on wildlife abundance and diversity indicate that wildlife species richness remains high at RFETS. There are no significant risks to ecological receptors or high levels of uncertainty with the data, and therefore, there are no ecological contaminants of concern (ECOCs) for the LWOEU.

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TABLES

Table 1.1
LWOEU 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 -2005 HRR
--	BZ	SE-1602	East Firing Range	The East Firing Range (PAC SE-1602) included two target areas where handgun, shotgun, and rifle bullets of various caliber, as well as depleted uranium armor-piercing bullets were fired into the hillside or into soil berms, potentially releasing lead into the soil.	NFA -2005 HRR[b]
142.10	BZ	SE-142.10	Pond C-1	Water from Woman Creek flows into and through Pond C-1. Outflow from C-1 is diverted around Pond C-2 and back into the Woman Creek channel or into Mower Ditch.	NFA -2005 HRR
142.11	BZ	SE-142.11	Pond C-2	Pond C-2 receives water from the South Interceptor Ditch, which intercepts water from the Industrial Area. Water in Pond C-2 is monitored prior to scheduled discharges.	NFA -2005 HRR
209	BZ	SE-209	Surface Disturbance Southeast of Bldg. 881	IHSS 209 is an area that has been disturbed by unknown activities. Three excavations were found in the 5.2-acre area.	NFA -2005 HRR

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

[b] Closeout Report for IHSS Group 900-11, PAC SE-1602, East Firing Range, and Target Area was approved by EPA in a letter from C. Mark Aguilar to Joseph Legare dated February 8, 2005.

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 (PMJM)[b]	Subsurface Soil[b]
Inorganics	106	55	74	45	47
Organics	34	36	9	2	28
Radionuclides	144	31	98	41	20

[a] Used in the HHRA.

[b] Used in the ERA.

The total number of results (samples) for the analytes listed in Tables 1.3 to 1.7 may differ from the 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		106	100	1,990	31,000	14,428	6,497
Ammonia[c]		1	100	2.05	2.05	2.05	N/A
Antimony	0.29 - 19.4	91	33.0	0.300	9.80	2.23	2.84
Arsenic		106	100	1.50	9.80	5.60	1.77
Barium		106	100	26.6	330	151	53.4
Beryllium	0.27 - 1.3	105	86.7	0.180	6.70	0.850	0.656
Boron	5.7 - 7	56	94.6	2.30	14	7.30	2.28
Cadmium	0.028 - 1.9	104	49.0	0.110	1.80	0.436	0.281
Calcium		106	100	1,300	47,700	7,105	7,317
Cesium[c]	7 - 178	33	21.2	1.70	7	32.5	32.3
Chromium		106	100	3.30	30	15.8	6.48
Cobalt		106	100	1.60	20.2	8.02	2.42
Copper	5.5 - 8	106	98.1	7.60	170	18.8	16.1
Iron		106	100	4,320	38,000	17,697	5,720
Lead		106	100	6.40	210	42.1	38.3
Lithium	3.4 - 28.4	90	91.1	1.80	28	11.8	5.31
Magnesium		106	100	523	5,800	3,023	1,088
Manganese		106	100	106	1,580	388	208
Mercury	0.012 - 0.2	90	53.3	0.0130	0.680	0.0711	0.130
Molybdenum	0.4 - 6.7	90	62.2	0.370	5.40	1.17	1.03
Nickel	3.3 - 13.1	106	95.3	5.30	45.2	15.4	5.90
Nitrate / Nitrite	1.5 - 6.47	23	78.3	0.611	26.6	3.91	6.20
Potassium	1,080 - 2,610	106	96.2	401	5,160	2,672	1,039
Selenium	0.2 - 1.8	105	35.2	0.260	2.80	0.549	0.438
Silica[c]		56	100	560	1,600	1,016	211
Silicon[c]		20	100	145	2,000	653	615
Silver	0.079 - 2.5	97	6.19	0.150	1.70	0.376	0.422
Sodium	49.1 - 250	106	44.3	47.8	643	110	89.6
Strontium		92	100	9.70	167	47.6	25.2
Thallium	0.2 - 2.4	105	38.1	0.250	10	0.956	1.39
Tin	0.86 - 61.8	91	22.0	1.70	85.9	6.56	11.4
Titanium		56	100	53	360	192	69.9
Vanadium		106	100	6.90	71	37.2	12.6
Zinc		106	100	17.9	201	65.8	29.9
Organics (µg/kg)							
1,2,3,4,6,7,8-HpCDF		1	100	8.07E-04	8.07E-04	8.07E-04	N/A
2,4-Dinitrophenol	1,700 - 10,000	29	3.45	890	890	1,822	1,033
2-Butanone	12 - 23	12	16.7	3.00	63.0	12.7	16.0
4,6-Dinitro-2-methylphenol	1,700 - 10,000	31	3.23	750	750	1,776	1,016
4-Methyl-2-pentanone	12 - 32	15	6.67	3.00	3.00	9.10	3.08
4-Methylphenol	360 - 2,100	31	6.45	93.0	200	364	225
Acenaphthene	360 - 2,100	31	6.45	74.0	320	325	180
Acetone[c]	12 - 230	15	13.3	18.0	66.0	29.8	32.2
Aldrin	8.6 - 99	28	3.57	0	0	9.78	9.25
alpha-Chlordane	86 - 990	28	3.57	0	0	97.8	92.5
Anthracene	360 - 2,100	31	12.9	90.0	450	330	181
Aroclor-1254	360 - 2,100	31	12.9	64.0	190	322	208
Benzo(a)anthracene	360 - 2,100	31	9.68	66.0	170	341	214
Benzo(a)pyrene	360 - 2,100	31	9.68	120	180	342	205
Benzo(b)fluoranthene	360 - 2,100	31	3.23	150	150	360	211
Benzo(g,h,i)perylene	360 - 2,100	31	6.45	110	150	358	214
Benzo(k)fluoranthene	1,700 - 10,000	30	16.7	180	700	1,681	1,147
Benzoic Acid	8.6 - 99	28	3.57	0	0	9.78	9.25
beta-BHC	360 - 2,100	31	41.9	64.0	2,200	422	425
bis(2-ethylhexyl)phthalate	360 - 2,100	31	3.23	57.0	57.0	372	222
Butylbenzylphthalate	360 - 2,100	31	16.1	42.0	190	317	212
Chrysene	8.6 - 99	28	3.57	0	0	9.78	9.25
delta-BHC	360 - 2,100	31	3.23	530	530	372	209
Dibenz(a,h)anthracene	360 - 2,100	31	9.68	45.0	70.0	360	234
Di-n-butylphthalate	8.6 - 99	28	3.57	0	0	9.78	9.25
Endosulfan I	360 - 2,100	31	19.4	79.0	330	308	197
Fluoranthene	8.6 - 99	28	3.57	4.40	4.40	10.6	10.4

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]
gamma-BHC (Lindane)	92 - 990	17	5.88	0	0	119	113
gamma-Chlordane	8.6 - 99	28	3.57	0	0	9.78	9.25
Heptachlor	8.6 - 99	28	3.57	0	0	9.78	9.25
Heptachlor epoxide		1	100	0.005	0.005	0.005	N/A
Heptachlorodibenzo-p-dioxin	360 - 2,100	31	6.45	340	500	363	204
Indeno(1,2,3-cd)pyrene	8 - 54	15	13.3	12.0	16.0	11.1	7.68
Methylene Chloride		1	100	0.031	0.031	0.031	N/A
OCDD		1	100	0.001	0.001	0.001	N/A
OCDF	58 - 2,000	32	9.38	94.0	220	199	202
Pentachlorophenol	1,700 - 10,000	31	3.23	950	950	1,782	1,009
Phenanthrene	360 - 2,100	31	19.4	46.0	360	322	184
Phenol	360 - 2,100	31	3.23	150	150	360	211
Pyrene	360 - 2,100	31	9.68	70.0	310	360	214
Toluene	6 - 12	16	31.3	2.00	410	75.4	149
Radionuclides (pCi/g)[d]							
Americium-241		131	N/A	-0.0153	1.66	0.265	0.306
Cesium-134		13	N/A	0.00200	0.200	0.0849	0.0520
Cesium-137		19	N/A	0.0391	1.18	0.349	0.315
Gross Alpha		29	N/A	-0.760	152	26.1	28.3
Gross Beta		29	N/A	8.02	45	28.6	10.5
Plutonium-238		6	N/A	0.00998	0.0601	0.0343	0.0198
Plutonium-239/240		140	N/A	-0.00192	12.2	1.58	1.98
Radium-226		10	N/A	0.985	2	1.30	0.310
Radium-228		9	N/A	1.19	2.80	1.94	0.519
Strontium-89/90		20	N/A	0.0300	3.24	0.636	0.932
Uranium-233/234		72	N/A	0.320	3.19	1.29	0.575
Uranium-235		72	N/A	-0.0562	0.405	0.0779	0.0789
Uranium-238		72	N/A	0.340	3.39	1.31	0.551

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

[b] For inorganics and organics, 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		55	100	3,130	37,000	18,484	9,711
Antimony	0.27 - 21.3	53	30.2	0.300	20.2	2.29	3.85
Arsenic		55	100	1.60	15	5.81	2.46
Barium		55	100	34.6	270	155	59.6
Beryllium		55	100	0.230	1.60	0.984	0.354
Boron	7.1 - 7.1	35	97.1	2.30	11	7.14	2.01
Cadmium	0.027 - 1.9	52	65.4	0.0790	1.80	0.424	0.304
Calcium		55	100	1,170	98,200	9,079	16,257
Cesium[c]	6.7 - 118	17	29.4	0.860	2.65	16.5	21.4
Chromium		55	100	5.40	73.9	23.4	12.6
Cobalt		55	100	2.20	17.1	8.21	2.93
Copper		55	100	6.40	30	18.3	5.48
Iron		55	100	5,120	35,800	19,433	6,606
Lead		55	100	3.20	1,400	51.8	189
Lithium		55	100	2.80	26	13.9	6.67
Magnesium		55	100	874	6,570	3,624	1,510
Manganese		55	100	41	793	292	131
Mercury	0.005 - 0.12	55	47.3	0.0120	1.80	0.122	0.355
Molybdenum	0.32 - 6.1	54	46.3	0.330	6.50	0.949	1.12
Nickel		55	100	5.20	49.9	18.6	7.31
Nitrate / Nitrite		6	100	0.700	1.30	1	0.253
Potassium		55	100	574	5,400	2,673	1,424
Selenium	0.21 - 1.9	54	14.8	0.270	1.50	0.445	0.273
Silica[c]		35	100	610	1,500	1,002	207
Silicon[c]		5	100	23.7	383	203	152
Silver	0.073 - 1.4	53	3.77	0.0940	0.120	0.188	0.195
Sodium	41.4 - 514	55	30.9	23.3	444	103	93.5
Strontium		55	100	10.9	401	58.6	62.7
Thallium	0.21 - 2.9	54	46.3	0.210	3.10	0.844	0.745
Tin	0.93 - 76.7	54	38.9	1	22.3	4.94	8.70
Titanium		35	100	41	370	197	80.4
Uranium	1.1 - 16	35	5.71	1.50	1.80	1.43	1.61
Vanadium		55	100	14	110	42.9	18.6
Zinc		55	100	18	110	57.7	20.5
Organics (µg/kg)							
1,2,3,4,6,7,8-HpCDF	0.00154 - 0.00154	3	66.7	8.32E-04	0.002	0.001	4.51E-04
1,2,3,4,7,8-HxCDF	0.00147 - 0.00154	3	33.3	0.001	0.001	9.25E-04	2.99E-04
1,2,3,6,7,8-HxCDF	0.00147 - 0.00154	3	33.3	5.62E-04	5.62E-04	6.89E-04	1.11E-04
1,2,3,7,8-PeCDF	0.00147 - 0.00226	3	33.3	4.27E-04	4.27E-04	7.64E-04	3.52E-04
2,3,4,6,7,8-HxCDF	0.00154 - 0.00154	3	66.7	3.39E-04	7.81E-04	6.30E-04	2.52E-04
2,3,4,7,8-PeCDF	0.00147 - 0.00147	3	66.7	7.70E-04	0.001	9.78E-04	3.92E-04
2,3,7,8-TCDD	5.87E-04 - 9.04E-04	3	33.3	5.33E-04	5.33E-04	4.26E-04	1.22E-04
2,3,7,8-TCDF[c]	5.87E-04 - 9.04E-04	3	33.3	0.002	0.002	9.45E-04	9.95E-04
Acenaphthene	340 - 1,800	11	9.09	360	360	366	208
Acetone	3.79 - 119	22	18.2	5.00	30.0	13.5	15.6
Anthracene	340 - 1,800	11	9.09	410	410	371	208
Aroclor-1254	340 - 1,800	11	18.2	59.0	83.0	328	237
Benzo(a)anthracene	340 - 1,800	11	9.09	79.0	79.0	359	221
Benzo(a)pyrene	2,000 - 6,800	12	41.7	190	490	1,268	1,007
Benzoic Acid	340 - 1,800	11	9.09	130	130	390	238
bis(2-ethylhexyl)phthalate	340 - 1,800	11	18.2	60.0	81.0	328	238
Chrysene	380 - 1,800	11	18.2	55.0	110	370	250
Di-n-butylphthalate	340 - 1,800	11	18.2	120	130	338	226
Fluoranthene	0.00153 - 0.00153	3	66.7	0.003	0.003	0.002	0.001
Heptachlorodibenzo-p-dioxin	340 - 1,800	10	10.0	400	400	383	211
Indeno(1,2,3-cd)pyrene	1.02 - 16	23	26.1	2.80	23.0	4.77	4.68
Methylene Chloride	5.5 - 1,800	13	7.69	2.00	2.00	337	270
Naphthalene		3	100	0.002	0.016	0.010	0.007
OCDD	0.00293 - 0.00293	3	66.7	0.002	0.004	0.002	0.001
OCDF	60 - 1,000	9	11.1	120	120	238	155
Pentachlorodibenzo-p-dioxin	0.00147 - 0.00154	3	33.3	3.72E-04	3.72E-04	6.26E-04	2.20E-04
Phenanthrene	340 - 1,800	11	18.2	84.0	350	354	220
Tetrachloroethene	5 - 16	23	8.70	1.00	2.00	3.08	1.48

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]
Toluene	0.878 - 6	24	75.0	3.00	520	76.6	148
Xylene[d]	3.5 - 16	23	4.35	1.60	1.60	3.10	1.45
Radionuclides (pCi/g)[e]							
Americium-241		31	N/A	-0.043	0.390	0.067	0.101
Cesium-134		5	N/A	-0.071	0.050	0.001	0.046
Cesium-137		5	N/A	0.004	0.080	0.047	0.034
Gross Alpha		23	N/A	-6.23	59.0	23.1	15.1
Gross Beta		23	N/A	9.07	46.0	24.1	7.46
Plutonium-238		3	N/A	0.00E+00	0.011	0.004	0.006
Plutonium-239/240		30	N/A	-0.030	1.64	0.346	0.445
Radium-226		5	N/A	0.433	2.08	1.17	0.737
Radium-228		5	N/A	1.07	1.57	1.27	0.198
Strontium-89/90		5	N/A	-0.344	0.030	-0.062	0.160
Uranium-233/234		21	N/A	0.612	3.50	1.52	0.808
Uranium-235		21	N/A	-0.057	0.341	0.081	0.079
Uranium-238		21	N/A	0.717	3.36	1.46	0.690

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

[b] For inorganics and organics, 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] The value for total xylene is used.

[e] 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		74	100	3,900	30,000	15,019	6,250
Ammonia[c]		1	100	2.05	2.05	2.05	N/A
Antimony	0.29 - 13.1	60	46.7	0.300	9.80	1.48	2.39
Arsenic		74	100	2	8.80	5.84	1.71
Barium		74	100	46.8	240	146	43.0
Beryllium	0.53 - 1.3	74	89.2	0.180	1.50	0.815	0.271
Boron	5.7 - 7	46	93.5	2.30	13	7.00	2.08
Cadmium	0.073 - 1.3	73	60.3	0.110	1.30	0.408	0.238
Calcium		74	100	1,300	33,000	5,534	4,790
Cesium[c]	7 - 130	14	14.3	2.70	7	20.5	26.8
Chromium		74	100	4.80	28	16.7	6.02
Cobalt		74	100	3.60	20.2	7.94	2.17
Copper		74	100	7.60	170	19.0	18.5
Iron		74	100	5,700	38,000	17,718	5,375
Lead		74	100	6.40	210	48.6	43.3
Lithium	9.3 - 20.6	58	94.8	1.80	22	12.5	4.60
Magnesium		74	100	770	5,300	2,977	977
Manganese		74	100	113	1,200	375	170
Mercury	0.012 - 0.14	58	60.3	0.0130	0.660	0.0446	0.0837
Molybdenum	0.48 - 5	59	74.6	0.370	1.30	0.887	0.644
Nickel	9.1 - 9.3	74	97.3	7.60	45.2	15.8	5.86
Nitrate / Nitrite[c]		1	100	0.800	0.800	0.800	N/A
Potassium		74	100	614	5,160	2,983	901
Selenium	0.2 - 1	74	27.0	0.260	2	0.444	0.274
Silica[c]		46	100	560	1,300	978	158
Silicon[c]		5	100	425	2,000	1,407	590
Silver	0.079 - 2.5	66	6.06	0.150	1.60	0.244	0.364
Sodium	49.1 - 250	74	24.3	47.8	643	80.2	69.0
Strontium		60	100	11.5	80	40.5	13.3
Thallium	0.2 - 1.1	74	47.3	0.250	5.70	0.930	0.936
Tin	0.86 - 23.8	60	18.3	1.70	85.9	5.16	12.7
Titanium		46	100	67	360	198	67.7
Vanadium		74	100	16.5	71	39.4	12.1
Zinc		74	100	17.9	86.1	56.7	13.4
Organics (µg/kg)							
Benzoic Acid	1,700 - 5,300	9	44.4	180	700	1,200	907
bis(2-ethylhexyl)phthalate	360 - 1,100	9	11.1	70	70	282	150
Chrysene	360 - 1,100	9	11.1	42	42	279	155
Fluoranthene	360 - 1,100	9	11.1	79	79	283	148
Phenanthrene	360 - 1,100	9	11.1	46	46	280	154
Pyrene	360 - 1,100	9	11.1	70	70	282	150
Radionuclides (pCi/g)[d]							
Americium-241		88	N/A	-0.015	1.66	0.302	0.341
Cesium-134		4	N/A	0.002	0.074	0.038	0.041
Cesium-137		4	N/A	0.649	1.18	0.845	0.233
Gross Alpha		7	N/A	-0.760	20.8	14.3	7.56
Gross Beta		7	N/A	19.0	43.0	32.6	8.06
Plutonium-238		6	N/A	0.010	0.060	0.034	0.020
Plutonium-239/240		94	N/A	-0.002	12.2	1.89	2.28
Radium-226		5	N/A	0.985	1.20	1.09	0.097
Radium-228		3	N/A	2.16	2.80	2.49	0.322
Strontium-89/90		4	N/A	0.110	0.770	0.410	0.274
Uranium-233/234		35	N/A	0.334	2.00	1.12	0.322
Uranium-235		35	N/A	-0.056	0.380	0.059	0.072
Uranium-238		35	N/A	0.477	2.20	1.18	0.332

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

[b] For inorganics and organics, 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 1.6
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		45	100	3,900	28,000	16,960	5,900
Antimony		43	55.8	0.300	0.900	0.770	1.52
Arsenic		45	100	3.20	8.80	6.53	1.38
Barium		45	100	84	240	155	40.5
Beryllium		45	93.3	0.180	1.40	0.864	0.251
Boron		40	95	2.30	9.90	6.84	1.85
Cadmium		45	73.3	0.150	0.800	0.391	0.207
Calcium		45	100	1,300	7,570	4,148	1,253
Cesium[c]		3	33.3	7	7	44	32.1
Chromium		45	100	7.20	28	18.8	5.41
Cobalt		45	100	4.60	20.2	8.22	2.32
Copper		45	100	7.60	170	20.9	23.3
Iron		45	100	5,700	38,000	18,920	5,033
Lead		45	100	12	210	60.8	51.0
Lithium		42	100	2.90	20	13.6	4.01
Magnesium		45	100	770	5,000	3,144	958
Manganese		45	100	270	1,200	418	191
Mercury		42	76.2	0.0130	0.0590	0.0328	0.0144
Molybdenum		43	88.4	0.370	1.30	0.731	0.481
Nickel		45	100	8.10	45.2	17.3	5.65
Potassium		45	100	930	4,600	3,190	837
Selenium		45	13.3	0.280	2	0.495	0.283
Silica[c]		40	100	560	1,300	960	152
Silicon[c]		2	100	1,670	1,770	1,720	70.7
Silver		44	2.27	0.160	0.160	0.121	0.262
Sodium		45	4.44	78.3	85.1	74.3	13.0
Strontium		43	100	21	62	39.5	9.48
Thallium		45	64.4	1.10	5.70	1.31	0.971
Tin		43	20.9	1.70	32.7	2.88	6.10
Titanium		40	100	68	360	203	66.3
Vanadium		45	100	20	59	42.4	9.29
Zinc		45	100	19	86.1	58.4	12.8
Organics (µg/kg)							
Benzoic Acid		2	100	300	410	355	77.8
bis(2-ethylhexyl)phthalate		2	0	N/A	N/A	203	10.6
Chrysene		2	50	50.0	50.0	130	113
Fluoranthene		2	50	78.0	78.0	144	93.3
Phenanthrene		2	50	40.0	40.0	125	120
Pyrene		2	50	94.0	94.0	152	82.0
Radionuclides (pCi/g)[d]							
Americium-241		36	N/A	7.00E-04	5.06	0.495	0.939
Cesium-134		2	N/A	0.002	0.073	0.038	0.050
Cesium-137		2	N/A	0.694	0.810	0.752	0.082
Gross Alpha		3	N/A	19.0	36.0	25.3	9.34
Gross Beta		3	N/A	37.6	43.0	40.6	2.76
Plutonium-239/240		38	N/A	3.00E-04	19.2	2.76	4.01
Radium-226		2	N/A	1.00	1.23	1.12	0.163
Radium-228		1	N/A	2.50	2.50	2.50	N/A
Strontium-89/90		2	N/A	0.340	0.418	0.379	0.055
Uranium-233/234		14	N/A	0.829	2.30	1.25	0.357
Uranium-235		14	N/A	-0.002	0.360	0.072	0.092
Uranium-238		14	N/A	0.834	1.70	1.18	0.210

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

[b] For inorganics and organics, 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 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		47	100	3,130	37,000	19,226	9,750
Antimony	0.27 - 21.3	46	34.8	0.300	20.2	2.44	4.07
Arsenic		47	100	1.60	15	5.96	2.59
Barium		47	100	34.6	220	154	56.0
Beryllium		47	100	0.230	1.60	1.01	0.352
Boron	7.1 - 7.1	30	96.7	3.10	11	7.49	1.78
Cadmium	0.059 - 0.92	45	71.1	0.0790	1.80	0.434	0.290
Calcium		47	100	1,170	98,200	9,421	17,487
Cesium[c]	6.7 - 118	17	29.4	0.860	2.65	16.5	21.4
Chromium		47	100	5.40	73.9	24.7	12.9
Cobalt		47	100	2.20	17.1	8.12	2.89
Copper		47	100	6.70	30	18.4	4.86
Iron		47	100	5,120	35,800	19,560	6,793
Lead		47	100	3.20	1,400	57.2	204
Lithium		47	100	2.80	26	14.3	6.65
Magnesium		47	100	874	6,570	3,746	1,496
Manganese		47	100	41	793	294	135
Mercury	0.019 - 0.12	47	40.4	0.0120	0.13	0.038	0.023
Molybdenum	0.32 - 6.1	47	42.6	0.330	6.50	0.934	1.17
Nickel		47	100	5.20	49.9	19.2	7.44
Nitrate/Nitrite		3	100	0.700	0.90	0.800	0.100
Potassium		47	100	574	5,400	2,757	1,465
Selenium	0.21 - 0.96	47	12.8	0.270	1.00	0.387	0.181
Silica[c]		30	100	680	1,400	1,027	165
Silicon[c]		5	100	23.7	383	203	152
Silver	0.073 - 1.4	46	4.35	0.0940	0.120	0.155	0.180
Sodium	41.4 - 514	47	27.7	52.7	444	109	98.4
Strontium		47	100	10.9	401	61.1	67.1
Thallium	0.21 - 1.1	47	53.2	0.210	3.10	0.882	0.779
Tin	0.93 - 76.7	46	45.7	1	22.3	5.29	9.35
Titanium		30	100	57	370	209	73.7
Uranium	1.1 - 1.7	30	6.67	1.50	1.80	0.827	0.238
Vanadium		47	100	14	110	44.9	19.1
Zinc		47	100	18	97	56.2	17.3
Organics (µg/kg)							
1234678-HpCDF	0.00154 - 0.00154	2	50.0	8.32E-04	8.32E-04	8.01E-04	4.38E-05
12378-PeCDF	0.00147 - 0.00147	2	50.0	4.27E-04	4.27E-04	5.81E-04	2.18E-04
234678-HxCDF	0.00154 - 0.00154	2	50.0	3.39E-04	3.39E-04	5.55E-04	3.05E-04
23478-PeCDF	0.00147 - 0.00147	2	50.0	7.70E-04	7.70E-04	7.53E-04	2.47E-05
2378-TCDD	5.87E-04 - 5.87E-04	2	50.0	5.33E-04	5.33E-04	4.13E-04	1.69E-04
2378-TCDF	5.87E-04 - 5.87E-04	2	50.0	0.002	0.002	0.001	0.001
Acetone	10 - 119	19	21.1	5.00	30.0	13.9	16.6
Benzoic Acid	3,300 - 4,300	6	33.3	210	260	1,278	828
Di-n-butylphthalate	380 - 890	6	16.7	55.0	55.0	291	142
Heptachlorodibenzo-p-dioxin	0.00153 - 0.00153	2	50.0	0.003	0.003	0.002	0.001
Methylene Chloride	5 - 11	20	30.0	2.80	23.0	4.72	4.86
OCDD		2	100	0.002	0.016	0.009	0.010
OCDF	0.00293 - 0.00293	2	50.0	0.004	0.004	0.003	0.002
Tetrachloroethene	5 - 6	20	5.00	2.00	2.00	2.74	0.298
Toluene	5 - 6	20	75.0	3.00	130	25.4	41.2
Xylene[d]	5 - 6	20	5.00	1.60	1.60	2.73	0.363
Radionuclides (pCi/g)[e]							
Americium-241		20	N/A	-0.043	0.390	0.038	0.092
Cesium-134		5	N/A	-0.071	0.050	0.001	0.046
Cesium-137		5	N/A	0.004	0.080	0.047	0.034
Gross Alpha		17	N/A	-6.23	38.9	16.5	10.3
Gross Beta		17	N/A	9.07	29.0	21.1	4.81
Plutonium-238		3	N/A	0.00E+00	0.011	0.004	0.006
Plutonium-239/240		19	N/A	-0.030	0.736	0.128	0.190

Table 1.7
Summary of Detected Analytes in Subsurface 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]
Radium-226		5	N/A	0.433	2.08	1.17	0.737
Radium-228		5	N/A	1.07	1.57	1.27	0.198
Strontium-89/90		5	N/A	-0.344	0.030	-0.062	0.160
Uranium-233/234		10	N/A	0.612	1.78	1.15	0.372
Uranium-235		10	N/A	-0.057	0.074	0.037	0.041
Uranium-238		10	N/A	0.717	1.68	1.21	0.332

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

[b] For inorganics and organics, 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] The value for total xylene is used.

[e] All radionuclide values are considered detects.

N/A = Not applicable.

Table 1.8
Toxicity Equivalence Calculations for Dioxins/Furans - Human Health Receptors

Sampling Location	Sample Number	Analyte	Result (mg/kg)	Detect?	Validation Qualifier	TEF [a]	TEQ Concentration [b] (mg/kg)
Surface Soil/Surface Sediment							
CR31-004	05F0140-005	1,2,3,4,6,7,8-HpCDF	0.000807	Yes	V	0.01	8.07E-06
CR31-004	05F0140-005	1,2,3,4,7,8-HxCDD	0.00271	No	V	0.1	0
CR31-004	05F0140-005	1,2,3,4,7,8-HxCDF	0.00271	No	V	0.1	0
CR31-004	05F0140-005	1,2,3,4,7,8,9-HpCDF	0.00271	No	V	0.01	0
CR31-004	05F0140-005	1,2,3,6,7,8-HxCDD	0.00271	No	V	0.1	0
CR31-004	05F0140-005	1,2,3,6,7,8-HxCDF	0.00271	No	V	0.1	0
CR31-004	05F0140-005	1,2,3,7,8-PeCDF	0.00271	No	V	0.05	0
CR31-004	05F0140-005	1,2,3,7,8,9-HxCDD	0.00271	No	V	0.1	0
CR31-004	05F0140-005	1,2,3,7,8,9-HxCDF	0.00271	No	V	0.1	0
CR31-004	05F0140-005	2,3,4,6,7,8-HxCDF	0.00271	No	V	0.1	0
CR31-004	05F0140-005	2,3,4,7,8-PeCDF	0.00271	No	V	0.5	0
CR31-004	05F0140-005	2,3,7,8-TCDD	0.00108	No	V	1	0
CR31-004	05F0140-005	2,3,7,8-TCDF	0.00108	No	V	0.1	0
CR31-004	05F0140-005	Heptachlorodibenzo-p-dioxin	0.00509	Yes	V	0.01	5.09E-05
CR31-004	05F0140-005	OCDD	0.0306	Yes	V	0.0001	3.06E-06
CR31-004	05F0140-005	OCDF	0.00128	Yes	V	0.0001	1.28E-07
CR31-004	05F0140-005	Pentachlorodibenzo-p-dioxin	0.00271	No	V	1	0
Total 2,3,7,8-TCDD TEQ Concentration for Sample 05F0140-005:							**6.22E-05**
2,3,7,8-TCDD TEQ Concentration used in Surface Soil/Surface Sediment PRG Screen [c]:							**6.22E-05**
Subsurface Soil/Subsurface Sediment							
CR31-004	05F0140-006	1,2,3,4,6,7,8-HpCDF	0.00158	Yes	V	0.01	1.58E-05
CR31-004	05F0140-006	1,2,3,4,7,8-HxCDD	0.00226	No	V	0.1	0
CR31-004	05F0140-006	1,2,3,4,7,8-HxCDF	0.00127	Yes	V	0.1	1.27E-04
CR31-004	05F0140-006	1,2,3,4,7,8,9-HpCDF	0.00226	No	V	0.01	0
CR31-004	05F0140-006	1,2,3,6,7,8-HxCDD	0.00226	No	V	0.1	0
CR31-004	05F0140-006	1,2,3,6,7,8-HxCDF	0.000562	Yes	V	0.1	5.62E-05
CR31-004	05F0140-006	1,2,3,7,8-PeCDF	0.00226	No	V	0.05	0
CR31-004	05F0140-006	1,2,3,7,8,9-HxCDD	0.00226	No	V	0.1	0
CR31-004	05F0140-006	1,2,3,7,8,9-HxCDF	0.00226	No	V	0.1	0
CR31-004	05F0140-006	2,3,4,6,7,8-HxCDF	0.000781	Yes	V	0.1	7.81E-05
CR31-004	05F0140-006	2,3,4,7,8-PeCDF	0.00143	Yes	V	0.5	7.15E-04
CR31-004	05F0140-006	2,3,7,8-TCDD	0.000904	No	V	1	0
CR31-004	05F0140-006	2,3,7,8-TCDF	0.000904	No	V	0.1	0
CR31-004	05F0140-006	Heptachlorodibenzo-p-dioxin	0.00285	Yes	V	0.01	2.85E-05
CR31-004	05F0140-006	OCDD	0.0133	Yes	V	0.0001	1.33E-06
CR31-004	05F0140-006	OCDF	0.00176	Yes	V	0.0001	1.76E-07
CR31-004	05F0140-006	Pentachlorodibenzo-p-dioxin	0.000372	Yes	V	1	3.72E-04
Total 2,3,7,8-TCDD TEQ Concentration for Sample 05F0140-006:							**0.00139**
CR31-004	05F0140-007	1,2,3,4,6,7,8-HpCDF	0.00154	No	V	0.01	0
CR31-004	05F0140-007	1,2,3,4,7,8-HxCDD	0.00154	No	V	0.1	0
CR31-004	05F0140-007	1,2,3,4,7,8-HxCDF	0.00154	No	V	0.1	0
CR31-004	05F0140-007	1,2,3,4,7,8,9-HpCDF	0.00154	No	V	0.01	0
CR31-004	05F0140-007	1,2,3,6,7,8-HxCDD	0.00154	No	V	0.1	0
CR31-004	05F0140-007	1,2,3,6,7,8-HxCDF	0.00154	No	V	0.1	0
CR31-004	05F0140-007	1,2,3,7,8-PeCDF	0.000427	Yes	V	0.05	2.14E-05
CR31-004	05F0140-007	1,2,3,7,8,9-HxCDD	0.00154	No	V	0.1	0
CR31-004	05F0140-007	1,2,3,7,8,9-HxCDF	0.00154	No	V	0.1	0
CR31-004	05F0140-007	2,3,4,6,7,8-HxCDF	0.00154	No	V	0.1	0
CR31-004	05F0140-007	2,3,4,7,8-PeCDF	0.00077	Yes	V	0.5	3.85E-04
CR31-004	05F0140-007	2,3,7,8-TCDD	0.000533	Yes	V	1	5.33E-04
CR31-004	05F0140-007	2,3,7,8-TCDF	0.00209	Yes	J	0.1	2.09E-04
CR31-004	05F0140-007	Heptachlorodibenzo-p-dioxin	0.00256	Yes	V	0.01	2.56E-05
CR31-004	05F0140-007	OCDD	0.0159	Yes	V	0.0001	1.59E-06
CR31-004	05F0140-007	OCDF	0.00394	Yes	V	0.0001	3.94E-07
CR31-004	05F0140-007	Pentachlorodibenzo-p-dioxin	0.00154	No	V	1	0
Total 2,3,7,8-TCDD TEQ Concentration for Sample 05F0140-007:							**0.00118**
CR31-004	05F0140-008	1,2,3,4,6,7,8-HpCDF	0.000832	Yes	V	0.01	8.32E-06
CR31-004	05F0140-008	1,2,3,4,7,8-HxCDD	0.00147	No	V	0.1	0
CR31-004	05F0140-008	1,2,3,4,7,8-HxCDF	0.00147	No	V	0.1	0
CR31-004	05F0140-008	1,2,3,4,7,8,9-HpCDF	0.00147	No	V	0.01	0
CR31-004	05F0140-008	1,2,3,6,7,8-HxCDD	0.00147	No	V	0.1	0
CR31-004	05F0140-008	1,2,3,6,7,8-HxCDF	0.00147	No	V	0.1	0
CR31-004	05F0140-008	1,2,3,7,8-PeCDF	0.00147	No	V	0.05	0
CR31-004	05F0140-008	1,2,3,7,8,9-HxCDD	0.00147	No	V	0.1	0

Table 1.8
Toxicity Equivalence Calculations for Dioxins/Furans - Human Health Receptors

Sampling Location	Sample Number	Analyte	Result (mg/kg)	Detect?	Validation Qualifier	TEF [a]	TEQ Concentration [b] (mg/kg)
CR31-004	05F0140-008	1,2,3,7,8,9-HxCDF	0.00147	No	V	0.1	0
CR31-004	05F0140-008	2,3,4,6,7,8-HxCDF	0.000339	Yes	V	0.1	3.39E-05
CR31-004	05F0140-008	2,3,4,7,8-PeCDF	0.00147	No	V	0.5	0
CR31-004	05F0140-008	2,3,7,8-TCDD	0.000587	No	V	1	0
CR31-004	05F0140-008	2,3,7,8-TCDF	0.000587	No	V	0.1	0
CR31-004	05F0140-008	Heptachlorodibenzo-p-dioxin	0.00153	No	V	0.01	0
CR31-004	05F0140-008	OCDD	0.002	Yes	V	0.0001	2.00E-07
CR31-004	05F0140-008	OCDF	0.00293	No	V	0.0001	0
CR31-004	05F0140-008	Pentachlorodibenzo-p-dioxin	0.00147	No	V	1	0
Total 2,3,7,8-TCDD TEQ Concentration for Sample 05F0140-008:							**4.24E-05**
2,3,7,8-TCDD TEQ Concentration used in Subsurface Soil/Subsurface Sediment PRG Screen [c]:							**0.00139**

[a]Toxicity equivalency factor (WHO, 1997).

[b]TEQ (toxicity equivalence) concentration = soil concentration x TEF. For nondetects, the TEQ concentration equals zero

[c]The 2,3,7,8-TCDD TEQ concentration used in the PRG screen is the maximum of all sampling locations for the medium.

Table 1.9
Toxicity Equivalence Calculations for Dioxins/Furans - Ecological Receptors

Sampling Location	Sample Number	Congener	Result (mg/kg)	Detect?	Validation Qualifier	Mammals TEF [a]	Mammals TEQ Concentration [b] (mg/kg)
Subsurface Soil							
CR31-004	05F0140-007	1,2,3,4,6,7,8-HpCDF	0.00154	No	V	0.01	0
CR31-004	05F0140-007	1,2,3,4,7,8-HxCDD	0.00154	No	V	0.1	0
CR31-004	05F0140-007	1,2,3,4,7,8-HxCDF	0.00154	No	V	0.1	0
CR31-004	05F0140-007	1,2,3,4,7,8,9-HpCDF	0.00154	No	V	0.01	0
CR31-004	05F0140-007	1,2,3,6,7,8-HxCDD	0.00154	No	V	0.1	0
CR31-004	05F0140-007	1,2,3,6,7,8-HxCDF	0.00154	No	V	0.1	0
CR31-004	05F0140-007	1,2,3,7,8-PeCDF	0.000427	Yes	V	0.05	2.14E-05
CR31-004	05F0140-007	1,2,3,7,8,9-HxCDD	0.00154	No	V	0.1	0
CR31-004	05F0140-007	1,2,3,7,8,9-HxCDF	0.00154	No	V	0.1	0
CR31-004	05F0140-007	2,3,4,6,7,8-HxCDF	0.00154	No	V	0.1	0
CR31-004	05F0140-007	2,3,4,7,8-PeCDF	0.00077	Yes	V	0.5	3.85E-04
CR31-004	05F0140-007	2,3,7,8-TCDD	0.000533	Yes	V	1	5.33E-04
CR31-004	05F0140-007	2,3,7,8-TCDF	0.00209	Yes	J	0.1	2.09E-04
CR31-004	05F0140-007	Heptachlorodibenzo-p-dioxin	0.00256	Yes	V	0.01	2.56E-05
CR31-004	05F0140-007	OCDD	0.0159	Yes	V	0.0001	1.59E-06
CR31-004	05F0140-007	OCDF	0.00394	Yes	V	0.0001	3.94E-07
CR31-004	05F0140-007	Pentachlorodibenzo-p-dioxin	0.00154	No	V	1	0
Total 2,3,7,8-TCDD TEQ Concentration for Sample 050140-007: [c]							**0.00118**
CR31-004	05F0140-008	1,2,3,4,6,7,8-HpCDF	0.000832	Yes	V	0.01	8.32E-06
CR31-004	05F0140-008	1,2,3,4,7,8-HxCDD	0.00147	No	V	0.1	0
CR31-004	05F0140-008	1,2,3,4,7,8-HxCDF	0.00147	No	V	0.1	0
CR31-004	05F0140-008	1,2,3,4,7,8,9-HpCDF	0.00147	No	V	0.01	0
CR31-004	05F0140-008	1,2,3,6,7,8-HxCDD	0.00147	No	V	0.1	0
CR31-004	05F0140-008	1,2,3,6,7,8-HxCDF	0.00147	No	V	0.1	0
CR31-004	05F0140-008	1,2,3,7,8-PeCDF	0.00147	No	V	0.05	0
CR31-004	05F0140-008	1,2,3,7,8,9-HxCDD	0.00147	No	V	0.1	0
CR31-004	05F0140-008	1,2,3,7,8,9-HxCDF	0.00147	No	V	0.1	0
CR31-004	05F0140-008	2,3,4,6,7,8-HxCDF	0.000339	Yes	V	0.1	3.39E-05
CR31-004	05F0140-008	2,3,4,7,8-PeCDF	0.00147	No	V	0.5	0
CR31-004	05F0140-008	2,3,7,8-TCDD	0.000587	No	V	1	0
CR31-004	05F0140-008	2,3,7,8-TCDF	0.000587	No	V	0.1	0
CR31-004	05F0140-008	Heptachlorodibenzo-p-dioxin	0.00153	No	V	0.01	0
CR31-004	05F0140-008	OCDD	0.002	Yes	V	0.0001	2.00E-07
CR31-004	05F0140-008	OCDF	0.00293	No	V	0.0001	0
CR31-004	05F0140-008	Pentachlorodibenzo-p-dioxin	0.00147	No	V	1	0
Total 2,3,7,8-TCDD TEQ Concentration for Sample 05F0140-008:							**0.0000424**
2,3,7,8-TCDD TEQ Concentration used in Subsurface Soil ESL Screen [c]:							**0.00118**

[a]Toxicity equivalency factor (WHO, 1997).

[b]TEQ (toxicity equivalence) concentration = soil concentration x TEF. For nondetects, the TEQ concentration equals zero.

[c]The 2,3,7,8-TCDD TEQ concentration used in the ESL screen is the maximum of all sampling locations for the medium.

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	47,700	4.77	500-1,200	2,500	No
Magnesium	5,800	0.580	80.0-420	65.0-110	No
Potassium	5,160	0.516	2,000-3,500	N/A	No
Sodium	643	0.064	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	24,774	31,000	Yes	15,602	No	No
Ammonia	910,997	2.05	No	--	--	No
Antimony	44.4	9.80	No	--	--	No
Arsenic	**2.41**	**9.80**	**Yes**	**5.88**	**Yes**	**Yes**
Barium	2,872	330	No	--	--	No
Beryllium	100	6.70	No	--	--	No
Boron	9,477	14	No	--	--	No
Cadmium	91.4	1.80	No	--	--	No
Cesium	N/A	7	UT	--	--	UT
Chromium[c]	28.4	30	Yes	16.8	No	No
Cobalt	122	20.2	No	--	--	No
Copper	4,443	170	No	--	--	No
Iron	33,326	38,000	Yes	18,619	No	No
Lead	1,000	210	No	--	--	No
Lithium	2,222	28	No	--	--	No
Manganese	**419**	**1,580**	**Yes**	**422**	**Yes**	**Yes**
Mercury	32.9	0.680	No	--	--	No
Molybdenum	555	5.40	No	--	--	No
Nickel	2,222	45.2	No	--	--	No
Nitrate / Nitrite[d]	177,739	26.6	No	--	--	No
Selenium	555	2.80	No	--	--	No
Silica	N/A	1,600	UT	--	--	UT
Silicon	N/A	2,000	UT	--	--	UT
Silver	555	1.70	No	--	--	No
Strontium	66,652	167	No	--	--	No
Thallium	7.78	10	Yes	1.80	No	No
Tin	66,652	85.9	No	--	--	No
Titanium	169,568	360	No	--	--	No
Vanadium	111	71	No	--	--	No
Zinc	33,326	201	No	--	--	No
Organics (mg/kg)						
2,3,7,8-TCDD TEQ[e]	0.0250	6.22E-05	No	--	--	No
2,4-Dinitrophenol	160,287	890	No	--	--	No
2-Butanone	4.64E+07	63	No	--	--	No
4,6-Dinitro-2-methylphenol	8,014	750	No	--	--	No
4-Methyl-2-pentanone	8.32E+07	3	No	--	--	No
4-Methylphenol	400,718	200	No	--	--	No
Acenaphthene	4.44E+06	320	No	--	--	No
Acetone	1.00E+08	66	No	--	--	No
Aldrin	176	0	No	--	--	No
alpha-Chlordane	10,261	0	No	--	--	No
Anthracene	2.22E+07	450	No	--	--	No
Aroclor-1254	1,349	220	No	--	--	No
Benzo(a)anthracene	3,793	190	No	--	--	No
Benzo(a)pyrene	379	170	No	--	--	No
Benzo(b)fluoranthene	3,793	180	No	--	--	No
Benzo(g,h,i)perylene	N/A	150	UT	--	--	UT
Benzo(k)fluoranthene	37,927	150	No	--	--	No
Benzoic Acid	3.21E+08	700	No	--	--	No
beta-BHC	1,995	0	No	--	--	No
bis(2-ethylhexyl)phthalate	213,750	2,200	No	--	--	No
Butylbenzylphthalate	1.60E+07	57	No	--	--	No
Chrysene	379,269	190	No	--	--	No
delta-BHC	570	0	No	--	--	No
Dibenz(a,h)anthracene	379	530	No	--	--	No
Di-n-butylphthalate	8.01E+06	70	No	--	--	No
Endosulfan I	480,861	0	No	--	--	No
Fluoranthene	2.96E+06	330	No	--	--	No
gamma-BHC (Lindane)	2,771	4.40	No	--	--	No
gamma-Chlordane	10,261	0	No	--	--	No
Heptachlor	665	0	No	--	--	No
Heptachlor epoxide	329	0	No	--	--	No
Indeno(1,2,3-cd)pyrene	3,793	500	No	--	--	No
Methylene Chloride	271,792	16	No	--	--	No

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?
Pentachlorophenol	17,633	950	No	--	--	No
Phenanthrene	N/A	360	UT	--	--	UT
Phenol	2.40E+07	150	No	--	--	No
Pyrene	2.22E+06	310	No	--	--	No
Toluene	3.09E+06	410	No	--	--	No
Radionuclides (pCi/g)						
Americium-241	7.69	1.66	No	--	--	No
Cesium-134	**0.0800**	**0.200**	**Yes**	**0.111**	**Yes**	**Yes**
Cesium-137	**0.221**	**1.18**	**Yes**	**0.508**	**Yes**	**Yes**
Gross Alpha	N/A	152	UT	--	--	UT
Gross Beta	N/A	45	UT	--	--	UT
Plutonium-238	5.97	0.0601	No	--	--	No
Plutonium-239/240	9.80	12.2	Yes	2.31	No	No
Radium-226	2.69	2	No	--	--	No
Radium-228	**0.111**	**2.80**	**Yes**	**2.26**	**Yes**	**Yes**
Strontium-89/90	13.2	3.24	No	--	--	No
Uranium-233/234	25.3	3.19	No	--	--	No
Uranium-235	1.05	0.405	No	--	--	No
Uranium-238	29.3	3.39	No	--	--	No

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

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

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

[d] The PRG for nitrate is used.

[e] The TEQ for 2,3,7,8-TCDD is calculated in Table 1.8 and the PRG for 2,3,7,8-TCDD is used in the PRG screen.

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 LWOEU[a]

Analyte	Statistical Distribution Testing Results						Background Comparison		
	Background			LWOEU			Test	1-p	Retain as PCOC?
	Total Samples	Distribution Recommended	Detects (%)	Total Samples	Distribution Recommended	Detects (%)			
Surface Soil/Surface Sediment									
Arsenic	**73**	**GAMMA**	**92**	**106**	**NON-PARAMETRIC**	**100**	**WRS**	**1.14E-09**	**Yes**
Manganese	**73**	**GAMMA**	**100**	**106**	**NON-PARAMETRIC**	**100**	**WRS**	**5.44E-12**	**Yes**
Cesium-134	77	NON-PARAMETRIC	N/A	13	NORMAL	N/A	WRS	0.994	No
Cesium-137	105	NON-PARAMETRIC	N/A	19	GAMMA	N/A	WRS	0.995	No
Radium-228	**40**	**GAMMA**	**N/A**	**9**	**NORMAL**	**N/A**	**WRS**	**0.0478**	**Yes**
Subsurface Soil/Subsurface Sediment									
Radium-228	31	GAMMA	N/A	5	NORMAL	N/A	WRS	0.912	No

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

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	98,200	9.82	500-1,200	2,500	No
Magnesium	6,570	0.657	80.0-420	65.0-110	No
Potassium	5,400	0.540	2,000-3,500	N/A	No
Sodium	444	0.044	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	284,902	37,000	No	--	--	No
Antimony	511	20.2	No	--	--	No
Arsenic	27.7	15	No	--	--	No
Barium	33,033	270	No	--	--	No
Beryllium	1,151	1.60	No	--	--	No
Boron	108,980	11	No	--	--	No
Cadmium	1,051	1.80	No	--	--	No
Cesium	N/A	2.65	UT	--	--	UT
Chromium[c]	327	73.9	No	--	--	No
Cobalt	1,401	17.1	No	--	--	No
Copper	51,100	30	No	--	--	No
Iron	383,250	35,800	No	--	--	No
Lead	1,000	1,400	Yes	230	No	No
Lithium	25,550	26	No	--	--	No
Manganese	4,815	793	No	--	--	No
Mercury	379	1.80	No	--	--	No
Molybdenum	6,388	6.50	No	--	--	No
Nickel	25,550	49.9	No	--	--	No
Nitrate / Nitrite[d]	2.04E+06	1.30	No	--	--	No
Selenium	6,388	1.50	No	--	--	No
Silica	N/A	1,500	UT	--	--	UT
Silicon	N/A	383	UT	--	--	UT
Silver	6,388	0.120	No	--	--	No
Strontium	766,500	401	No	--	--	No
Thallium	89.4	3.10	No	--	--	No
Tin	766,500	22.3	No	--	--	No
Titanium	1.95E+06	370	No	--	--	No
Uranium	3,833	1.80	No	--	--	No
Vanadium	1,278	110	No	--	--	No
Zinc	383,250	110	No	--	--	No
Organics (µg/kg)						
2,3,7,8-TCDD TEQ[e]	0.285	0.00139	No	--	--	No
Acenaphthene	5.10E+07	360	No	--	--	No
Acetone	1.15E+09	30	No	--	--	No
Anthracene	2.55E+08	410	No	--	--	No
Aroclor-1254	15,514	120	No	--	--	No
Benzo(a)anthracene	43,616	83	No	--	--	No
Benzo(a)pyrene	4,357	79	No	--	--	No
Benzoic Acid	3.69E+09	490	No	--	--	No
bis(2-ethylhexyl)phthalate	2.46E+06	130	No	--	--	No
Chrysene	4.36E+06	81	No	--	--	No
Di-n-butylphthalate	9.22E+07	110	No	--	--	No
Fluoranthene	3.40E+07	130	No	--	--	No
Indeno(1,2,3-cd)pyrene	43,616	400	No	--	--	No
Methylene Chloride	3.13E+06	23	No	--	--	No
Naphthalene	1.61E+07	2	No	--	--	No
Phenanthrene	N/A	350	UT	--	--	UT
Tetrachloroethene	77,111	2	No	--	--	No
Toluene	3.56E+07	520	No	--	--	No
Xylene	1.22E+07	1.60	No	--	--	No
Radionuclides (pCi/g)						
Americium-241	88.4	0.390	No	--	--	No
Cesium-134	0.910	0.050	No	--	--	No

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?
Cesium-137	2.54	0.080	No	--	--	No
Gross Alpha	N/A	59.0	UT	--	--	UT
Gross Beta	N/A	46.0	UT	--	--	UT
Plutonium-238	68.7	0.011	No	--	--	No
Plutonium-239/240	112	1.64	No	--	--	No
Radium-226	31.0	2.08	No	--	--	No
Radium-228	**1.28**	**1.57**	**Yes**	**1.46**	**Yes**	**Yes**
Strontium-89/90	152	0.030	No	--	--	No
Uranium-233/234	291	3.50	No	--	--	No
Uranium-235	12.1	0.341	No	--	--	No
Uranium-238	337	3.36	No	--	--	No

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

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

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

[d] The PRG for nitrate is used.

[e] The TEQ for 2,3,7,8-TCDD is calculated in Table 1.8 and the PRG for 2,3,7,8-TCDD is used in the PRG screen.

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 2.6
Summary of the COC Selection Process

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

[a] All radionuclide values are considered detects.
N/A = Not applicable.
-- = Screen not performed because analyte was eliminated from further consideration in a previous COC selection step.

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

PCOC	Surface Soil/Surface Sediment	Subsurface Soil/Subsurface Sediment
Inorganics		
Cesium	X[b]	X[b]
Silica	X[b]	X[b]
Silicon	X[b]	X[b]
Organics		
Benzo(g,h,i)perylene	X	N/A
Phenanthrene	X	X
Radionuclides		
Gross Alpha	X	X
Gross Beta	X	X

[a] Does not include essential nutrients or dioxin/furan congeners. Essential nutrients without PRGs were evaluated by comparing estimated intakes to recommended intakes. Dioxin and furan congeners were evaluated by calculating the 2,3,7,8-TCDD Equivalents (TEQ), which are presented in Table 1.8.

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

X = PRG is unavailable.

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

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

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	30,000	50	**Yes**	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Terrestrial Plants	**Yes**
Ammonia	2.05	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7,316	No	586	No	26,723	No	37,008	No	2,247	No	2,311	No	2,539	No	N/A	N/A	Deer Mouse Insectivore	No
Antimony	9.80	5	**Yes**	78	No	N/A	N/A	N/A	N/A	N/A	N/A	9.89	No	0.905	**Yes**	18.7	No	57.6	No	138	No	13.2	No	3.85	**Yes**	N/A	N/A	Deer Mouse Insectivore	**Yes**
Arsenic	8.80	10	No	60	No	20	No	164	No	1,028	No	2.57	**Yes**	51.4	No	9.35	No	13.0	No	709	No	341	No	293	No	N/A	N/A	Deer Mouse Herbivore	**Yes**
Barium	240	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	1.50	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	29.2	No	N/A	N/A	Deer Mouse Insectivore	No
Boron	13	0.5	**Yes**	N/A	N/A	30	No	115	No	167	No	62.1	No	422	No	237	No	314	No	929	No	6,070	No	1,816	No	N/A	N/A	Terrestrial Plants	**Yes**
Cadmium	1.30	32	No	140	No	28	No	0.705	**Yes**	15.0	No	59.9	No	1.56	No	198	No	723	No	1,360	No	51.2	No	9.75	No	N/A	N/A	Mourning Dove Insectivore	**Yes**
Calcium	33,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Cesium	7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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**	0.4	**Yes**	25	**Yes**	1.34	**Yes**	14.0	**Yes**	281	No	15.9	**Yes**	703	No	1,461	No	4,173	No	250	No	68.5	No	N/A	N/A	Terrestrial Invertebrates	**Yes**
Cobalt	20.2	13	**Yes**	N/A	N/A	278	No	87.0	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	Terrestrial Plants	**Yes**
Copper	170	100	**Yes**	50	**Yes**	29	**Yes**	8.25	**Yes**	164	**Yes**	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	38,000	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	210	110	**Yes**	1700	**Yes**	50	**Yes**	12.1	**Yes**	95.8	**Yes**	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	22	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	Terrestrial Plants	**Yes**
Magnesium	5,300	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Manganese	1,200	500	**Yes**	N/A	N/A	1,032	**Yes**	2,631	No	9,917	No	486	**Yes**	4,080	No	1,519	No	2,506	No	14,051	No	10,939	No	19,115	No	N/A	N/A	Deer Mouse Herbivore	**Yes**
Mercury	0.660	0.3	**Yes**	0.1	**Yes**	0.197	**Yes**	0.0001	**Yes**	1.57	No	0.439	**Yes**	0.179	**Yes**	3.15	No	7.56	No	8.18	No	8.49	No	37.3	No	N/A	N/A	Mourning Dove Insectivore	**Yes**
Molybdenum	1.30	2	No	N/A	N/A	44	No	6.97	No	76.7	No	8.68	No	1.90	No	27.1	No	44.3	No	275	No	28.9	No	8.18	No	N/A	N/A	Deer Mouse Insectivore	No
Nickel	45.2	30	**Yes**	200	No	44	**Yes**	1.24	**Yes**	13.1	**Yes**	16.4	**Yes**	0.431	**Yes**	38.3	**Yes**	124	No	90.9	No	6.02	**Yes**	1.86	**Yes**	N/A	N/A	Deer Mouse Insectivore	**Yes**
Nitrate / Nitrite[c]	0.800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4,478	No	7,647	No	16,233	No	22,660	No	32,879	No	32,190	No	32,879	No	N/A	N/A	Deer Mouse Herbivore	No
Potassium	5,160	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Selenium	2	1	**Yes**	70	No	1.61	**Yes**	1	**Yes**	8.5	No	0.872	**Yes**	0.754	**Yes**	2.80	No	3.82	No	32.5	No	12.2	No	5.39	No	N/A	N/A	Deer Mouse Insectivore	**Yes**
Silica	1,300	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Silicon	2,000	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
Silver	1.60	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	Terrestrial Plants	No
Sodium	643	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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	80	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
Thallium	5.70	1	**Yes**	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	180	No	7.24	No	204	No	1,039	No	212	No	81.6	No	30.8	No	N/A	N/A	Terrestrial Plants	**Yes**
Tin	85.9	50	**Yes**	N/A	N/A	26	**Yes**	2.90	**Yes**	19	**Yes**	45.0	**Yes**	3.77	**Yes**	80.6	**Yes**	242	No	70.0	**Yes**	36.1	**Yes**	16.2	**Yes**	N/A	N/A	Mourning Dove Insectivore	**Yes**
Titanium	360	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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	71	2	**Yes**	N/A	N/A	503	No	274	No	1,514	No	63.7	**Yes**	29.9	**Yes**	83.5	No	358	No	341	No	164	No	121	No	N/A	N/A	Terrestrial Plants	**Yes**
Zinc	86.1	50	**Yes**	200	No	109	No	0.646	**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**
Organics (µg/kg)																													
Benzoic Acid	700	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
bis(2-ethylhexyl)phthalate	70	N/A	N/A	N/A	N/A	19,547	No	137	No	398	No	960,345	No	8,071	No	2,759,555	No	4,931,556	No	42,305	No	40,167	No	34,967	No	N/A	N/A	Mourning Dove Insectivore	No
Chrysene	42	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Fluoranthene	79	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Phenanthrene	46	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Pyrene	70	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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
Radionuclides (pCi/g)																													
Americium-241	1.66	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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	N/A	N/A	No
Cesium-134	0.0740	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Cesium-137	1.18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20.8	No	N/A	No
Gross Alpha	20.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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	43	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Plutonium-238	0.0601	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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	12.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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	N/A	No
Radium-226	1.20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	50.6	No	N/A	No
Radium-228	2.80	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	43.9	No	N/A	No
Strontium-89/90	0.770	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22.5	No	N/A	No
Uranium-233/234	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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	N/A	No
Uranium-235	0.380	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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	N/A	No
Uranium-238	2.20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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	N/A	No

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

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

[c] The ESLs for nitrate are used.

N/A = Indicates no ESL was available for that 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 Non-PMJM NOAEL ESL Screening Results for Surface Soil in the LWOEU

Analyte	Terrestrial Plant Exceedance?	Terrestrial Invertebrate Exceedance?	Terrestrial Vertebrate Exceedance?
Inorganics			
Aluminum	**Yes**	UT	UT
Ammonia	UT	UT	No
Antimony	**Yes**	No	**Yes**
Arsenic	No	No	**Yes**
Barium	No	No	**Yes**
Beryllium	No	No	No
Boron	**Yes**	UT	No
Cadmium	No	No	**Yes**
Calcium	UT	UT	UT
Cesium	UT	UT	UT
Chromium	**Yes**	**Yes**	**Yes**
Cobalt	**Yes**	UT	No
Copper	**Yes**	**Yes**	**Yes**
Iron	UT	UT	UT
Lead	**Yes**	No	**Yes**
Lithium	**Yes**	UT	No
Magnesium	UT	UT	UT
Manganese	**Yes**	UT	**Yes**
Mercury	**Yes**	**Yes**	**Yes**
Molybdenum	No	UT	No
Nickel	**Yes**	No	**Yes**
Nitrate / Nitrite	UT	UT	No
Potassium	UT	UT	UT
Selenium	**Yes**	No	**Yes**
Silica	UT	UT	UT
Silicon	UT	UT	UT
Silver	No	UT	UT
Sodium	UT	UT	UT
Strontium	UT	UT	No
Thallium	**Yes**	UT	No
Tin	**Yes**	UT	**Yes**
Titanium	UT	UT	UT
Vanadium	**Yes**	UT	**Yes**
Zinc	**Yes**	No	**Yes**
Organics			
Benzoic Acid	UT	UT	UT
bis(2-ethylhexyl)phthalate	UT	UT	No
Chrysene	UT	UT	UT
Fluoranthene	UT	UT	UT
Phenanthrene	UT	UT	UT
Pyrene	UT	UT	UT
Radionuclides			
Americium-241	UT	UT	No
Cesium-134	UT	UT	UT
Cesium-137	UT	UT	No
Gross Alpha	UT	UT	UT

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

Analyte	Terrestrial Plant Exceedance?	Terrestrial Invertebrate Exceedance?	Terrestrial Vertebrate Exceedance?
Gross Beta	UT	UT	UT
Plutonium-238	UT	UT	UT
Plutonium-239/240	UT	UT	No
Radium-226	UT	UT	No
Radium-228	UT	UT	No
Strontium-89/90	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 Surface Soil with NOAEL ESLs for the PMJM in the LWOEU

Analyte	MDC	PMJM NOAEL ESL	EPC> PMJM ESL?
Inorganics (mg/kg)			
Aluminum	28,000	N/A	UT
Antimony	0.900	1	No
Arsenic	8.80	2.21	**Yes**
Barium	240	743	No
Beryllium	1.40	8.16	No
Boron	9.90	52.7	No
Cadmium	0.800	1.75	No
Calcium	7,570	N/A	UT
Cesium	7	N/A	UT
Chromium[a]	28	19.3	**Yes**
Cobalt	20.2	340	No
Copper	170	95.0	**Yes**
Iron	38,000	N/A	UT
Lead	210	220	No
Lithium	20	519	No
Magnesium	5,000	N/A	UT
Manganese	1,200	388	**Yes**
Mercury	0.0590	0.0521	**Yes**
Molybdenum	1.30	1.84	No
Nickel	45.2	0.510	**Yes**
Potassium	4,600	N/A	UT
Selenium	2	0.421	**Yes**
Silica	1,300	N/A	UT
Silicon	1,770	N/A	UT
Silver	0.160	N/A	UT
Sodium	85.1	N/A	UT
Strontium	62	833	No
Thallium	5.70	8.64	No
Tin	32.7	4.22	**Yes**
Titanium	360	N/A	UT
Vanadium	59	21.6	**Yes**
Zinc	86.1	6.41	**Yes**
Organics (µg/kg)			
Benzoic Acid	410	N/A	UT
Radionuclides (pCi/g)			
Americium-241	5.06	3,890	No
Cesium-134	0.0730	N/A	UT
Cesium-137	0.810	20.8	No
Gross Alpha	36	N/A	UT
Gross Beta	43	N/A	UT
Plutonium-239/240	191	6,110	No
Radium-226	1.23	50.6	No
Radium-228	2.50	43.9	No
Strontium-89/90	0.418	22.5	No
Uranium-233/234	2.30	4,980	No
Uranium-235	0.360	2,770	No
Uranium-238	1.70	1,580	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 Distribution and Comparison to Background for Surface Soil in the LWOEU

Analyte	Statistical Distribution Testing Results						Background Comparison		
	Background			LWOEU					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Retain as ECOI?
Inorganics (mg/kg)									
Aluminum	20	NORMAL	100	74	NORMAL	100	WRS	6.51E-04	**Yes**
Antimony	20	NONPARAMETRIC	0	60	NONPARAMETRIC	47	N/A	N/A	**Yes**[a]
Arsenic	20	NORMAL	100	74	NONPARAMETRIC	100	WRS	0.611	No
Barium	20	NORMAL	100	74	NORMAL	100	WRS	1.24E-05	**Yes**
Boron	N/A	N/A	N/A	46	NORMAL	93	N/A	N/A	**Yes**[a]
Cadmium	20	NONPARAMETRIC	65	73	GAMMA	60	WRS	1.000	No
Chromium	20	NORMAL	100	74	NORMAL	100	WRS	8.71E-05	**Yes**
Cobalt	20	NORMAL	100	74	NONPARAMETRIC	100	WRS	0.120	No
Copper	20	NONPARAMETRIC	100	74	NONPARAMETRIC	100	WRS	4.42E-05	**Yes**
Lead	20	NORMAL	100	74	NONPARAMETRIC	100	WRS	0.389	No
Lithium	20	NORMAL	100	58	NORMAL	95	WRS	1.13E-05	**Yes**
Manganese	20	NORMAL	100	74	NONPARAMETRIC	100	WRS	4.69E-07	**Yes**
Mercury	20	NONPARAMETRIC	40	58	NONPARAMETRIC	60	WRS	1.000	No
Nickel	20	NORMAL	100	74	GAMMA	97	WRS	6.22E-07	**Yes**
Selenium	20	NONPARAMETRIC	60	74	NONPARAMETRIC	27	WRS	0.982	No
Thallium	14	NORMAL	0	74	NONPARAMETRIC	47	N/A	N/A	**Yes**[a]
Tin	20	NORMAL	0	60	NONPARAMETRIC	18	N/A	N/A	**Yes**[a]
Vanadium	20	NORMAL	100	74	NORMAL	100	WRS	4.27E-05	**Yes**
Zinc	20	NORMAL	100	74	NORMAL	100	WRS	0.020	**Yes**

[a] Statistical comparisons to background cannot be performed. The analyte is retained as an ECOI for further evaluation.
WRS = Wilcoxon Rank Sum
N/A = Not applicable; site and/or background detection frequency less than 20%.
Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.5
Statistical Distribution and Comparison to Background for Surface Soil in PMJM Habitat in the LWOEU

Analyte	Statistical Distribution Testing Results						Background Comparison		
	Background			LWOEU					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Retain as ECOI?
Inorganics									
Arsenic	20	NORMAL	100	45	NON-PARAMETRIC	100	WRS	0.120	No
Chromium	20	NORMAL	100	45	NORMAL	100	t-Test_N	7.37E-08	**Yes**
Copper	20	NON-PARAMETRIC	100	45	NON-PARAMETRIC	100	WRS	6.34E-06	**Yes**
Manganese	20	NORMAL	100	45	NON-PARAMETRIC	100	WRS	8.04E-09	**Yes**
Mercury	20	NON-PARAMETRIC	40	42	GAMMA	76.2	WRS	1.00	No
Nickel	20	NORMAL	100	45	GAMMA	100	WRS	1.03E-08	**Yes**
Selenium	20	NON-PARAMETRIC	60	45	NON-PARAMETRIC	13.3	N/A	N/A	**Yes**[a]
Tin	20	NORMAL	0	43	NON-PARAMETRIC	20.9	N/A	N/A	**Yes**[a]
Vanadium	20	NORMAL	100	45	NORMAL	100	t-Test_N	2.59E-08	**Yes**
Zinc	20	NORMAL	100	45	NORMAL	100	t-Test_N	0.00696	**Yes**
Total PAHs	N/A	N/A	N/A	2	0	50	N/A	N/A	**Yes**[a]
Total PCBs	N/A	N/A	N/A	2	0	0	N/A	N/A	**Yes**[a]

[a] Statistical comparisons to background cannot be performed. The analyte is retained for further evaluation.
WRS = Wilcoxon Rank Sum
t-Test_N = Student's t-test using normal data
N/A = Not applicable; site and/or background detection frequency less than 20%.
Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.6

Statistical Concentrations in Surface Soil in the LWOEU[a]

Analyte	Total Samples	UCL Recommended by ProUCL	Distribution Recommended by ProUCL	Mean	Median	75th Percentile	95th Percentile	UCL	UTL	MDC
Inorganics (mg/kg)										
Aluminum	74	95% Student's-t UCL	NORMAL	15,019	15,000	19,750	25,350	16,230	24,844	30,000
Antimony	60	97.5% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	1.48	0.410	0.870	6.50	3.41	6.55	9.80
Barium	74	95% Student's-t UCL	NORMAL	146	141	170	225	155	214	240
Boron	46	95% Student's-t UCL	NORMAL	7.00	6.95	8.48	9.38	7.52	10.5	13.0
Chromium	74	95% Student's-t UCL	NORMAL	16.7	16.0	21.8	25.4	17.8	26.1	28.0
Copper	74	95% Student's-t UCL	NON-PARAMETRIC	19.0	16.0	18.5	28.1	22.6	30.0	170
Lithium	58	95% Student's-t UCL	NORMAL	12.5	13.0	15.8	20.0	13.5	19.9	22.0
Manganese	74	95% Student's-t UCL	NON-PARAMETRIC	375	344	390	610	408	636	1,200
Nickel	74	95% Approximate Gamma UCL	GAMMA	15.8	16.0	18.9	22.4	17.0	23.0	45.2
Thallium	74	97.5% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	0.930	0.500	1.50	2.10	1.61	2.10	5.70
Tin	60	97.5% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	5.16	1.35	2.03	25.7	15.4	29.1	85.9
Vanadium	74	95% Student's-t UCL	NORMAL	39.4	41.0	48.5	57.9	41.8	58.4	71.0
Zinc	74	95% Student's-t UCL	NORMAL	56.7	58.0	65.0	74.4	59.3	77.7	86.1

[a] For inorganics and organics, one-half the detection limit used as proxy value for nondetects in computation of the statistical concentrations.

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

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

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

Table 7.7
Upper-Bound Exposure Point Concentration Comparison to Limiting ESLs in the LWOEU

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	24,800	50	**Yes**	16,200	N/A	N/A
Antimony	6.55	0.905	**Yes**	3.41	3.85	No
Barium	214	222	No	155	4,770	No
Boron	10.5	0.5	**Yes**	7.52	314	No
Chromium[c]	26.1	0.4	**Yes**	17.8	68.5	No
Copper	30.0	8.25	**Yes**	22.6	3,000	No
Lithium	19.9	2	**Yes**	13.5	2,560	No
Manganese	636	486	**Yes**	408	2,510	No
Nickel	23.0	0.431	**Yes**	17.0	1.86	**Yes**
Thallium	2.10	1	**Yes**	1.61	53.3	No
Tin	29.1	2.9	**Yes**	15.4	16.2	No
Vanadium	58.4	2	**Yes**	41.8	121	No
Zinc	77.7	0.646	**Yes**	59.3	431	No

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

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

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

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 in the LWOEU

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	24,800	**50**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Antimony	6.55	**5**	78	N/A	N/A	N/A	9.89	**0.905**	18.7
Boron	10.5	**0.5**	N/A	167	30.3	115	62.1	422	237
Chromium	26.1	**1**	**0.4**	**14.2**	**24.6**	**1.34**	281	**15.9**	703
Copper	30.0	100	50.0	164	**28.8**	**8.25**	295	605	838
Lithium	19.9	**2**	N/A	N/A	N/A	N/A	1,880	610	3,180
Manganese	636	**500**	N/A	9,920	1,030	2,630	**486**	4,080	1,519
Nickel	23.0	30	200	89.9	320	**7.84**	**16.4**	**0.431**	38.3
Thallium	2.10	**1**	N/A	N/A	N/A	N/A	312	12.5	350
Tin	29.1	50	N/A	**19**	**26.1**	**2.9**	45	**3.77**	80.6
Vanadium	58.4	**2**	N/A	1,510	503	274	63.7	**29.9**	83.5
Zinc	77.7	**50**	200	113	109	**0.646**	171	**5.29**	1,170

[a]Lowest ESL (threshold if available) for that receptor.
N/A = Not applicable; ESL not available (assessed in Section 10).
Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.9
Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Large Home Range Receptors in the LWOEU

Analyte	Large Home Range Receptor UCL	Receptor-Specific ESLs[a]			
		Mule Deer	Coyote (carnivore)	Coyote (generalist)	Coyote (insectivore)
Inorganics (mg/kg)					
Nickel	17.0	124	90.9	**6.02**	**1.86**

[a]Lowest ESL (threshold if available) for that receptor.
Bold = Analyte retained for further consideration in the next ECOPC selection step.

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

Analyte	Exceed Any NOAEL ESL?	Detection Frequency >5%?	Exceeds Background?[a]	Upper Bound EPC > Limiting ESL	Professional Judgment - Retain?	ECOPC?	Receptor(s) of Potential Concern
Inorganics							
Aluminum	Yes	Yes	Yes	Yes	No	No	--
Ammonia	No	--	--	--	--	No	--
Antimony	Yes	Yes	N/A	Yes	No	No	--
Arsenic	Yes	Yes	No	--	--	No	--
Barium	Yes	Yes	Yes	No	--	No	--
Beryllium	No	--	--	--	--	No	--
Boron	Yes	Yes	N/A	Yes	No	No	--
Cadmium	Yes	Yes	No	--	--	No	--
Calcium	UT	--	--	--	--	No	--
Cesium	UT	--	--	--	--	No	--
Chromium	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Terrestrial plant** **Terrestrial invertebrate** **American kestrel** **Mourning dove (herbivore)** **Mourning dove (insectivore)** **Deer mouse (insectivore)**
Cobalt	Yes	Yes	No	--	--	No	--
Copper	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Mourning dove (herbivore)** **Mourning dove (insectivore)**
Iron	UT	--	--	--	--	No	--
Lead	Yes	Yes	No	--	--	No	--
Lithium	Yes	Yes	Yes	Yes	No	No	--
Magnesium	UT	--	--	--	--	No	--
Manganese	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Terrestrial plant** **Deer mouse (herbivore)**
Mercury	Yes	Yes	No	--	--	No	--
Molybdenum	No	--	--	--	--	No	--
Nickel	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Mourning dove (insectivore)** **Deer mouse (herbivore)** **Deer mouse (insectivore)** **Coyote (generalist)** **Coyote (insectivore)**
Nitrate/Nitrite	No	--	--	--	--	No	--
Potassium	UT	--	--	--	--	No	--
Selenium	Yes	Yes	No	--	--	No	--
Silica	UT	--	--	--	--	No	--
Silicon	UT	--	--	--	--	No	--
Silver	No	--	--	--	--	No	--
Sodium	UT	--	--	--	--	No	--
Strontium	No	--	--	--	--	No	--
Thallium	**Yes**	**Yes**	**N/A**	**Yes**	**Yes**	**Yes**	**Terrestrial plant**
Tin	**Yes**	**Yes**	**N/A**	**Yes**	**Yes**	**Yes**	**American kestrel** **Mourning dove (herbivore)** **Mourning dove (insectivore)** **Deer mouse (insectivore)**
Titanium	UT	--	--	--	--	No	--
Vanadium	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Terrestrial plant** **Deer mouse (insectivore)**
Zinc	Yes	Yes	Yes	Yes	No	No	--
Organics							
Benzoic Acid	UT	--	--	--	--	No	--
bis(2-ethylhexyl)phthalate	No	--	--	--	--	No	--
Chrysene	UT	--	--	--	--	No	--
Fluoranthene	UT	--	--	--	--	No	--
Phenanthrene	UT	--	--	--	--	No	--
Pyrene	UT	--	--	--	--	No	--
Radionuclides							
Americium-241	No	--	--	--	--	No	--
Cesium-134	UT	--	--	--	--	No	--
Cesium-137	No	--	--	--	--	No	--
Gross Alpha	UT	--	--	--	--	No	--

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

Analyte	Exceed Any NOAEL ESL?	Detection Frequency >5%?	Exceeds Background?[a]	Upper Bound EPC > Limiting ESL	Professional Judgment - Retain?	ECOPC?	Receptor(s) of Potential Concern
Gross Beta	UT	--	--	--	--	No	--
Plutonium-238	UT	--	--	--	--	No	--
Plutonium-239/240	No	--	--	--	--	No	--
Radium-226	No	--	--	--	--	No	--
Radium-228	No	--	--	--	--	No	--
Strontium-89/90	No	--	--	--	--	No	--
Uranium-233/234	No	--	--	--	--	No	--
Uranium-235	No	--	--	--	--	No	--
Uranium-238	No	--	--	--	--	No	--

[a] Based on results of statistical analysis at the 0.1 level of significance.
-- = Screen not performed because ECOI was eliminated from further consideration in a previous step.
N/A = Not applicable; background comparison could not be conducted.
UT = Uncertain toxicity; no ESL available (assessed in Section 10).
Bold = Chemicals retained as ECOPCs for further risk characterization.

Table 7.11
Summary of ECOPC Screening Steps for Surface Soil PMJM Receptors in the LWOEU

Analyte	Exceed PMJM NOAEL ESL?	Exceeds Background?	Professional Judgment - Retain?	ECOPC
Inorganics				
Aluminum	UT	--	--	No
Antimony	No	--	--	No
Arsenic	Yes	No	--	No
Barium	No	--	--	No
Beryllium	No	--	--	No
Boron	No	--	--	No
Cadmium	No	--	--	No
Calcium	UT	--	--	No
Cesium	UT	--	--	No
Chromium	**Yes**	**Yes**	**Yes**	**Yes**
Cobalt	No	--	--	No
Copper	**Yes**	**Yes**	**Yes**	**Yes**
Iron	UT	--	--	No
Lead	No	--	--	No
Lithium	No	--	--	No
Magnesium	UT	--	--	No
Manganese	**Yes**	**Yes**	**Yes**	**Yes**
Mercury	**Yes**	No	--	No
Molybdenum	No	--	--	No
Nickel	**Yes**	**Yes**	**Yes**	**Yes**
Potassium	UT	--	--	No
Selenium	**Yes**	**Yes**	**Yes**	**Yes**
Silica	UT	--	--	No
Silicon	UT	--	--	No
Silver	UT	--	--	No
Sodium	UT	--	--	No
Strontium	No	--	--	No
Thallium	No	--	--	No
Tin	**Yes**	**N/A**	**Yes**	**Yes**
Titanium	UT	--	--	No
Vanadium	**Yes**	**Yes**	**Yes**	**Yes**
Zinc	**Yes**	**Yes**	**Yes**	**Yes**
Organics				
Benzoic Acid	UT	--	--	No
Radionuclides				
Americium-241	No	--	--	No
Cesium-134	UT	--	--	No
Cesium-137	No	--	--	No
Gross Alpha	UT	--	--	No
Gross Beta	UT	--	--	No
Plutonium-239/240	No	--	--	No
Radium-226	No	--	--	No
Radium-228	No	--	--	No
Strontium-89/90	No	--	--	No
Uranium-233/234	No	--	--	No
Uranium-235	No	--	--	No
Uranium-238	No	--	--	No

-- = Screen not performed because ECOI was eliminated from further consideration in a previous step.
N/A = Not applicable; background comparison could not be conducted.
UT = Uncertain toxicity; no ESL available (assessed in Section 10).
Bold = Analyte retained for further consideration in the next ECOPC selection step.

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

Analyte	MDC	Prairie Dog NOAEL ESL	MDC>ESL?
Inorganics (mg/kg)			
Aluminum	37,000	N/A	UT
Antimony	20.2	18.7	**Yes**
Arsenic	15	9.35	**Yes**
Barium	220	3,220	No
Beryllium	1.60	211	No
Boron	11	237	No
Cadmium	1.80	198	No
Calcium	98,200	N/A	UT
Cesium	2.65	N/A	UT
Chromium[a]	73.9	703	No
Cobalt	17.1	2,460	No
Copper	30	838	No
Iron	35,800	N/A	UT
Lead	1,400	1,850	No
Lithium	26	3,180	No
Magnesium	6,570	N/A	UT
Manganese	793	1,520	No
Mercury	0.130	3.15	No
Molybdenum	6.50	27.1	No
Nickel	49.9	38.3	**Yes**
Nitrate / Nitrite[b]	0.900	16,200	No
Potassium	5,400	N/A	UT
Selenium	1	2.80	No
Silica	1,400	N/A	UT
Silicon	383	N/A	UT
Silver	0.120	N/A	UT
Sodium	444	N/A	UT
Strontium	401	3,520	No
Thallium	3.10	204	No
Tin	22.3	80.6	No
Titanium	370	N/A	UT
Uranium	1.80	1,230	No
Vanadium	110	83.5	**Yes**
Zinc	97	1,170	No
Organics (µg/kg)			
Acetone	30	248,000	No
Benzoic Acid	260	N/A	UT
Di-n-butylphthalate	55	4.06E+07	No
Methylene Chloride	23	210,000	No
Tetrachloroethene	2	72,500	No
Toluene	130	1.22E+06	No
2,3,7,8-TCDD TEQ[c]	0.00118	0.160	No
Xylene[d]	1.60	112,000	No

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

Analyte	MDC	Prairie Dog NOAEL ESL	MDC>ESL?
Radionuclides (pCi/g)			
Americium-241	0.390	3,890	No
Cesium-134	0.0500	N/A	UT
Cesium-137	0.0800	20.8	No
Gross Alpha	38.9	N/A	UT
Gross Beta	29	N/A	UT
Plutonium-238	0.0110	N/A	UT
Plutonium-239/240	0.736	6,110	No
Radium-226	2.08	50.6	No
Radium-228	1.57	43.9	No
Strontium-89/90	0.0304	22.5	No
Uranium-233/234	1.78	4,980	No
Uranium-235	0.0741	2,770	No
Uranium-238	1.68	1,580	No

[a] Chromium ESL is based on Chromium VI.

[b]The ESL for nitrate is used.

[c] The TEQ for 2,3,7,8-TCDD is calculated in Table 1.9 and the ESL for 2,3,7,8-TCDD is used in the ESL screen.

[d]The value for total xylene is used.

N/A = No ESL was available for that 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 7.13
Statistical Distribution and Comparison to Background for Subsurface Soil in the LWOEU

Analyte	Statistical Distribution Testing Results						Background Comparison		
	Background			LWOEU					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Retain as ECOI?
Inorganics (mg/kg)									
Antimony	28	NONPARAMETRIC	7	46	NONPARAMETRIC	35	N/A	N/A	**Yes**[a]
Arsenic	45	NONPARAMETRIC	93	47	NONPARAMETRIC	100	WRS	0.010	**Yes**
Nickel	44	GAMMA	100	47	NONPARAMETRIC	100	WRS	0.574	No
Vanadium	45	NORMAL	98	47	NONPARAMETRIC	100	WRS	0.002	**Yes**

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

Test: WRS = Wilcoxon Rank Sum

N/A = Not applicable; background data not available or not detected.

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

Table 7.14

Statistical Concentrations in Subsurface Soil in the LWOEU[a]

Analyte	Total Samples	UCL Recommended by ProUCL	Distribution Recommended by ProUCL	Mean	Median	75th Percentile	95th Percentile	UCL	UTL	MDC
Inorganics (mg/kg)										
Antimony	46	99% Chebyshev (Mean, Sd) UCL	NON-PARAMETRIC	2.44	0.435	3.21	10.2	8.40	10.7	20.2
Arsenic	47	95% Student's-t UCL	NON-PARAMETRIC	5.96	6.30	7.10	10.1	6.60	10.4	15.0
Vanadium	47	95% Student's-t UCL	NON-PARAMETRIC	44.9	49.0	56.0	65.7	49.6	66.0	110

[a] For inorganics and organics, one-half the detection limit used as proxy value for nondetects in computation of the statistical concentrations.

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

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

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

Table 7.15
Upper-Bound Exposure Point Concentration Comparison to tESLs in the LWOEU Subsurface Soil

Analyte	Burrowing Receptors		
	EPC (UTL)	tESL[a]	EPC>ESL?
Inorganics (mg/kg)			
Antimony	10.7	1.87	**Yes**
Arsenic	10.4	35.9	No
Vanadium	66.0	83.5	No

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

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

Table 7.16
Summary of ECOPC Screening Steps for Subsurface Soil in the LWOEU

Analyte	Exceed Prairie Dog NOAEL ESL ?	Frequency of Detection >5%	Exceeds Background?[a]	Upper Bound EPC > Limiting ESL?	Professional Judgment - Retain?	Retain as ECOPC?
Inorganics						
Aluminum	UT	--	--	--	--	No
Antimony	Yes	Yes	N/A	Yes	No	No
Arsenic	Yes	Yes	Yes	No	--	No
Barium	No	--	--	--	--	No
Beryllium	No	--	--	--	--	No
Boron	No	--	--	--	--	No
Cadmium	No	--	--	--	--	No
Calcium	UT	--	--	--	--	No
Cesium	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
Nitrate / Nitrite	No	--	--	--	--	No
Potassium	UT	--	--	--	--	No
Selenium	No	--	--	--	--	No
Silica	UT	--	--	--	--	No
Silicon	UT	--	--	--	--	No
Silver	UT	--	--	--	--	No
Sodium	UT	--	--	--	--	No
Strontium	No	--	--	--	--	No
Thallium	No	--	--	--	--	No
Tin	No	--	--	--	--	No
Titanium	UT	--	--	--	--	No
Uranium	No	--	--	--	--	No
Vanadium	Yes	Yes	Yes	No	--	No
Zinc	No	--	--	--	--	No
Organics						
Acetone	No	--	--	--	--	No
Benzoic Acid	UT	--	--	--	--	No
Di-n-butylphthalate	No	--	--	--	--	No
Methylene Chloride	No	--	--	--	--	No
Tetrachloroethene	No	--	--	--	--	No
Toluene	No	--	--	--	--	No
Total Dioxins	No	--	--	--	--	No
Xylene	No	--	--	--	--	No
Radionuclides						
Americium-241	No	--	--	--	--	No

Table 7.16
Summary of ECOPC Screening Steps for Subsurface Soil in the LWOEU

Analyte	Exceed Prairie Dog NOAEL ESL ?	Frequency of Detection >5%	Exceeds Background?[a]	Upper Bound EPC > Limiting ESL?	Professional Judgment - Retain?	Retain as ECOPC?
Cesium-134	UT	--	--	--	--	No
Cesium-137	No	--	--	--	--	No
Gross Alpha	UT	--	--	--	--	No
Gross Beta	UT	--	--	--	--	No
Plutonium-238	UT	--	--	--	--	No
Plutonium-239/240	No	--	--	--	--	No
Radium-226	No	--	--	--	--	No
Radium-228	No	--	--	--	--	No
Strontium-89/90	No	--	--	--	--	No
Uranium-233/234	No	--	--	--	--	No
Uranium-235	No	--	--	--	--	No
Uranium-238	No	--	--	--	--	No

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

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

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

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

Table 8.1
Summary of ECOPC/Receptor Pairs

ECOPC	Receptors of Potential Concern
Surface Soil	
Chromium	Terrestrial plant Terrestrial invertebrate American kestrel Mourning dove (herbivore) Mourning dove (insectivore) Deer mouse (insectivore)
Copper	Mourning Dove (herbivore) Mourning Dove (insectivore)
Manganese	Terrestrial plant Deer mouse (herbivore)
Nickel	Mourning dove (insectivore) Deer mouse (herbivore) Deer mouse (insectivore) Coyote (generalist) Coyote (insectivore)
Thallium	Terrestrial plant
Tin	American kestrel Mourning dove (herbivore) Mourning dove (insectivore) Deer mouse (insectivore)
Vanadium	Terrestrial plant Deer mouse (insectivore)
Surface Soil-PMJM	
Chromium	PMJM
Copper	PMJM
Manganese	PMJM
Nickel	PMJM
Selenium	PMJM
Tin	PMJM
Vanadium	PMJM
Zinc	PMJM
Subsurface Soil	
None	None

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

ECOPC	Tier I Exposure Point Concentrations		Tier II Exposure Point Concentrations	
	UTL	UCL	UTL	UCL
Inorganics (mg/kg)				
Chromium	26.1	17.8	32.2[a]	17.2
Copper	30.0	22.6	36.2[a]	18.3
Manganese	636	408	636[a]	379
Nickel	23.0	17.0	23.9	16.2
Thallium	2.10	1.61	1.7[a]	0.779
Tin	29.10	15.40	38.5[a]	19.9
Vanadium	58.4	41.8	71[a]	41.4

[a]Tier 2 soil UTL was greater than the maximum grid mean, so the maximum grid mean was used as the proxy exposure point concentration,

Table 8.3
Surface Soil Exposure Point Concentrations in PMJM Patches

Analyte[a]	Number of Samples	Number of Detects	Frequency of Detection (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Arithmetic Mean Concentration (mg/kg)	UCL (mg/kg)
Patch 22							
Chromium	2	2	100	18	22	20	22[b]
Manganese	2	2	100	330	460	395	460[b]
Nickel	2	2	100	18	19	18.5	19[b]
Vanadium	2	2	100	44	49	46.5	49[b]
Zinc	2	2	100	59	66	62.5	66[b]
Patch 23							
Chromium	39	39	100	8.4	28	19.6	21.0
Copper	39	39	100	7.6	170	22.1	29.0
Manganese	39	39	100	270	1,200	420	475
Nickel	39	39	100	8.1	25	16.9	17.9
Selenium	39	5	12.8	0.28	2	0.522	0.6
Tin	38	8	21.1	1.7	32.7	2.24	3.6
Vanadium	39	39	100	20	59	43.0	45.5
Zinc	39	39	100	19	84	58.0	61.4
Patch 24							
Nickel	1	1	100	15	15	N/A	15[b]
Vanadium	1	1	100	45	45	N/A	45[b]
Zinc	1	1	100	55	55	N/A	55[b]
Patch 25							
Nickel	1	1	100	13.4	13.4	N/A	13.4[b]
Tin	1	1	100	25.5	25.5	N/A	25.5[b]
Vanadium	1	1	100	35.1	35.1	N/A	35.1[b]
Zinc	1	1	100	52	52	N/A	52[b]
Patch 27							
Manganese	2	2	100	330	596	463	596[b]
Nickel	2	2	100	10.1	45.2	27.7	45.2[b]
Vanadium	2	2	100	25.7	33.8	29.8	33.8[b]
Zinc	2	2	100	46.3	86.1	66.2	86.1[b]

[a] ECOPCs shown on this table were detected at least once in a given patch and are only those that have patch-specific MDCs > ESL.
[b]Insufficient number of samples to calculate UCL; the MDC was used as a proxy exposure point concentration.
N/A = could not be calculated due to low number of samples.
calculated due to low number of samples.

Table 8.4
ater Exposure Point Concentrations for Non-PMJM and PMJM

ECOPC	UTL	UCL
Inorganics (mg/L)		
Chromium	0.004	0.004
Copper	0.007	0.005
Manganese	0.57	0.162
Nickel	0.01	0.006
Selenium	0.003	0.004
Thallium	0.003	0.007
Tin	0.019	0.009
Vanadium	0.008	0.006
Zinc	0.033	0.015

Table 8.5
Receptor-Specific Exposure Parameters

Receptor	Body Weight (kg)	Body Weight Reference	Percentage of Diet				Food Ingestion Rate (kg/kg BW day^{-1})	Ingestion Rate Reference	Water Ingestion Rate (L/kg BW day^{-1})	Ingestion Rate Reference	Percentage of Diet as Soil	Soil Ingestion Reference
			Plant Tissue	Invertebrate Tissue	Bird or Mammal Tissue	Dietary Reference						
Non-Wildlife Terrestrial Receptors												
Terrestrial Plants							N/A					
Terrestrial Invertebrates							N/A					
Vertebrate Receptors - Birds												
American kestrel	0.116	Brown and Amadon (1968) - Average value	0	20	80	Generalized Diet from several studies presented in the Watershed ERA DOE (1996)	0.092	Kolpin et al. (1980)	0.12	EPA (1993) - Estimated using model for all birds - Calder and Braun (1983)	5	Assumed value based on conservative estimates for carnivores
Mourning Dove (herbivore)	0.113	Average of adult values from CalEPA (2004) Online Database	100	0	0	Cowan (1952)	0.23	EPA (2003)	0.12	EPA (1993) - Estimated using model for all birds - Calder and Braun (1983)	9.3	Beyer et al. (1994) - Wild turkey used as a surrogate.
Mourning Dove (insectivore)	0.113	Average of adult values from CalEPA (2004) Online Database	0	100	0	Generalized Diet	0.23	EPA (2003)	0.12	EPA (1993) - Estimated using model for all birds - Calder and Braun (1983)	9.3	Beyer et al. (1994) - Wild turkey used as a surrogate.
Vertebrate Receptors - Mammals												
Preble's Meadow Jumping Mouse	0.019	Morrison and Ryser (1962)	70	30	0	Estimated from Whitacker (1972)	0.17	EPA (1993) - Estimated-Nagy (1987) - Rodent Model	0.15	EPA (1993) - Estimated using model for all mammals - Calder and Braun (1983)	2.4	Beyer et al. (1994) - Meadow Vole used as a conservative surrogate
Deer Mouse (herbivore)	0.0187	Flake (1973)	100	0	0	Generalized Diet	0.111	Cronin and Bradley (1988)	0.19	Ross (1930); Dice (1922) as cited in EPA (1993).	2	Beyer et al. (1994)

Table 8.5
Receptor-Specific Exposure Parameters

Receptor	Body Weight (kg)	Body Weight Reference	Percentage of Diet				Food Ingestion Rate (kg/kg BW day^{-1})	Ingestion Rate Reference	Water Ingestion Rate (L/kg BW day^{-1})	Ingestion Rate Reference	Percentage of Diet as Soil	Soil Ingestion Reference
			Plant Tissue	Invertebrate Tissue	Bird or Mammal Tissue	Dietary Reference						
Deer Mouse (insectivore)	0.0187	Flake (1973)	0	100	0	Generalized Diet	0.065	Cronin and Bradley (1988)	0.19	Ross (1930); Dice (1922) as cited in USEPA 1993.	2	Beyer et al. (1994)
Coyote (generalist)	12.75	Bekoff (1977) - Average of male and female weights	0	25	75	Generalized Diet	0.015	Gier (1975)	0.08	EPA (1993) - Estimated using model for all mammals - Calder and Braun (1983)	5	Beyer et al. (1994) - High end estimate for Red Fox
Coyote (insectivore)	12.75	Bekoff (1977) - Average of male and female weights	0	100	0	Generalized Diet	0.015	Gier (1975)	0.08	EPA (1993) - Estimated using model for all mammals - Calder and Braun (1983)	2.8	Beyer et al. (1994) - Red Fox

Receptor parameters for all receptors with the exception of the prairie dog and mourning dove were taken from the Watershed Risk Assessment (DOE 1996) and referenced to the original source.
All receptor parameters are estimates of central tendency except where noted.
All values are presented in a dry weight basis.
N/A = Not applicable.

Table 8.6
Receptor-Specific Intake Estimates

Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Default Exposure Estimates						
Chromium						
Mourning Dove - Herbivore						
Tier 1 UTL	0.504	N/A	N/A	0.558	4.80E-04	1.06
Tier 2 UTL[a]	0.622	N/A	N/A	0.689	4.80E-04	1.31
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	19.0	N/A	0.558	4.80E-04	19.5
Tier 2 UTL[a]	N/A	23.4	N/A	0.689	4.80E-04	24.1
American Kestrel						
Tier 1 UTL	N/A	1.52	0.180	0.120	4.80E-04	1.82
Tier 2 UTL[a]	N/A	1.87	0.210	0.148	4.80E-04	2.23
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	5.36	N/A	0.0339	7.60E-04	5.40
Tier 2 UTL[a]	N/A	6.62	N/A	0.0419	7.60E-04	6.66
Copper						
Mourning Dove - Herbivore						
Tier 1 UTL	1.71	N/A	N/A	0.642	8.40E-04	2.36
Tier 2 UTL[a]	1.85	N/A	N/A	0.774	8.40E-04	2.62
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	3.01	N/A	0.642	8.40E-04	3.66
Tier 2 UTL[a]	N/A	3.17	N/A	0.774	8.40E-04	3.94
Manganese						
Deer Mouse - Herbivore						
Tier 1 UTL	16.5	N/A	N/A	1.41	0.108	18.0
Tier 2 UTL[a]	16.5	N/A	N/A	1.41	0.108	18.0
Nickel						
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	25.0	N/A	0.492	0.00120	25.5
Tier 2 UTL	N/A	26.0	N/A	0.511	0.00120	26.5
Deer Mouse - Herbivore						
Tier 1 UTL	0.125	N/A	N/A	0.0511	0.00190	0.178
Tier 2 UTL	0.129	N/A	N/A	0.0531	0.00190	0.184
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	7.07	N/A	0.0299	0.00190	7.10
Tier 2 UTL	N/A	7.35	N/A	0.0311	0.00190	7.38
Coyote - Generalist						
Tier 1 UCL	N/A	0.302	0.0329	0.0128	4.80E-04	0.348
Tier 2 UCL	N/A	0.287	0.0322	0.0122	4.80E-04	0.332
Coyote - Insectivore						
Tier 1 UCL	N/A	1.21	N/A	0.00714	4.80E-04	1.21
Tier 2 UCL	N/A	1.15	N/A	0.00680	4.80E-04	1.16
Tin						
Mourning Dove - Herbivore						
Tier 1 UTL	0.201	N/A	N/A	0.622	0.00233	0.826
Tier 2 UTL[a]	0.266	N/A	N/A	0.824	0.00233	1.09

Table 8.6
Receptor-Specific Intake Estimates

Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Default Exposure Estimates						
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	6.69	N/A	0.622	0.00233	7.32
Tier 2 UTL[a]	N/A	8.86	N/A	0.824	0.00233	9.68
American Kestrel						
Tier 1 UTL	N/A	0.535	0.450	0.134	0.00233	1.12
Tier 2 UTL[a]	N/A	0.708	0.595	0.177	0.00233	1.48
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	1.89	N/A	0.0378	0.00370	1.93
Tier 2 UTL[a]	N/A	2.50	N/A	0.0501	0.00370	2.56
Vanadium						
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	0.334	N/A	0.0759	0.00152	0.411
Tier 2 UTL[a]	N/A	0.406	N/A	0.0923	0.00152	0.500
Alternative Exposure Estimates						
Chromium						
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	1.84	N/A	0.558	4.80E-04	2.40
Tier 2 UTL[a]	N/A	2.27	N/A	0.689	4.80E-04	2.96
Nickel						
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	1.58	N/A	0.0299	0.00190	1.62
Tier 2 UTL	N/A	1.65	N/A	0.0311	0.00190	1.68

N/A = Not applicable.
[a]Tier 2 soil UTL was greater than the maximum grid mean, so the maximum grid mean was used to calculate intake.

Table 8.7
PMJM Intake Estimates

	Intake Estimates (mg/kg BW day)					
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Default Exposure Estimates						
Chromium						
Patch 22						
UCL[a]	0.220	3.55	N/A	0.0898	6.00E-04	3.86
Patch 23						
UCL	0.210	3.39	N/A	0.0857	6.00E-04	3.68
Copper						
Patch 23						
UCL	0.876	0.662	N/A	0.118	0.0243	1.68
Manganese						
Patch 22						
UCL[a]	12.8	7.50	N/A	1.88	0.0243	22.2
Patch 23						
UCL	13.2	7.66	N/A	1.94	0.0243	22.9
Patch 27						
UCL[a]	16.6	8.95	N/A	2.43	0.0243	28.0
Nickel						
Patch 22						
UCL[a]	0.116	4.58	N/A	0.0775	9.00E-04	4.78
Patch 23						
UCL	0.111	4.32	N/A	0.0730	9.00E-04	4.50
Patch 24						
UCL[a]	0.0976	3.62	N/A	0.0612	9.00E-04	3.78
Patch 25						
UCL[a]	0.0897	3.23	N/A	0.0547	9.00E-04	3.38
Patch 27						
UCL[a]	0.223	10.9	N/A	0.184	9.00E-04	11.3
Selenium						
Patch 23						
UCL	0.0344	0.0325	N/A	0.00245	6.00E-04	0.0700
Tin						
Patch 23						
UCL	UCL	0.0129	0.184	N/A	0.0147	0.00135
Patch 25						
UCL[a]	0.0910	1.30	N/A	0.104	0.00135	1.50
Vanadium						
Patch 22						
UCL[a]	0.0566	0.220	N/A	0.200	9.00E-04	0.477
Patch 23						
UCL	0.0525	0.204	N/A	0.186	9.00E-04	0.443
Patch 24						
UCL[a]	0.0519	0.202	N/A	0.184	9.00E-04	0.438
Patch 25						
UCL[a]	0.0405	0.158	N/A	0.143	9.00E-04	0.342
Patch 27						
UCL[a]	0.0390	0.152	N/A	0.138	9.00E-04	0.330

Table 8.7
PMJM Intake Estimates

Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Default Exposure Estimates						
Zinc						
Patch 22						
UCL[a]	5.86	17.2	N/A	0.269	0.00225	23.4
Patch 23						
UCL	5.63	16.8	N/A	0.251	0.00225	22.7
Patch 24						
UCL[a]	5.29	16.2	N/A	0.224	0.00225	21.8
Patch 25						
UCL[a]	5.13	15.9	N/A	0.212	0.00225	21.3
Patch 27						
UCL[a]	6.79	18.8	N/A	0.351	0.00225	26.0
Alternative Exposure Estimates						
Nickel						
Patch 22						
UCL[a]	0.116	1.03	N/A	0.0775	9.00E-04	1.22
Patch 23						
UCL	0.111	0.967	N/A	0.0730	9.00E-04	1.15
Patch 24						
UCL[a]	0.0976	0.810	N/A	0.0612	9.00E-04	0.970
Patch 25						
UCL[a]	0.0897	0.724	N/A	0.0547	9.00E-04	0.869
Patch 27						
UCL[a]	0.223	2.44	N/A	0.184	9.00E-04	2.85

[a] Soil UCL could not be calculated due to low number of samples; the MDC was used as a proxy value for estimating intake.
N/A = Not applicable.

Table 9.1
TRVs for Terrestrial Plant and Invertebrate Receptors

ECOPC	Soil Concentration (mg/kg)	Endpoint	Effect Measured/Observed	Reference	Notes
Terrestrial Plants					
Chromium	1	Screening ESL	Value was not based on any specific study.	Efroymson et al. 1997a	Low confidence in value.
Manganese	500	Screening ESL	Reduction in leaf and stem weights of bush beans	Efroymson et al. 1997a	Low confidence in value.
Thallium	1	Screening ESL	Value based on unspecified effects.	Efroymson et al. 1997a	Low confidence in value.
Vanadium	2	Screening ESL	Value was not based on any specific study.	Efroymson et al. 1997a	Low confidence in value.
Terrestrial Invertebrates					
Chromium	0.4	Screening ESL	Value based on lowest concentration tested and then adjusted by an uncertainty factor of 5.	Efroymson et al. 1997b	Low confidence in value.

Table 9.2
TRVs for Terrestrial Vertebrate Receptors

ECOPC	NOAEL (mg/kg day)	NOAEL Endpoint	LOAEL (mg/kg day)	LOAEL Endpoint	TRV Source	Uncertainty Factor	Final NOAEL (mg/kg day)	Threshold (mg/kg day)	Rationale For Calculation	TRV Confidence
Birds										
Chromium III	1	No effect on black duckling survival	5	Reduction in black duckling survival	Sample et al. (1996)	1	1	N/A	Threshold not provided in CRA Methodology	High
Chromium VI	***No Values Available***									NA
Copper	2.3	No effects noted	52.3	Increase in chicken gizzard erosion	PRC (1994)	1	2.3	11.0	The nature of the effect is not likely to cause a significant effect on growth, reproduction or survival. Thus, the data satisfy the requirements described in the text for calculating a threshold.	High
Nickel	1.38	No increase in tremors or toe and leg joint edema	55.26	Increase in tremors and toe and knee joint edema in mallard	PRC (1994)	1	1.38	8.7	The nature of the effect is not likely to cause a significant effect on growth, reproduction or survival. Thus, the data satisfy the requirements described in the text for calculating a threshold.	High
Tin (Butyltins)	0.73	No change in Japanese quail growth and reproduction.	18.34	Decrease in Japanese quail reproduction	PRC (1994)	1	0.73	N/A	The original paper was not reviewed. Not enough information was available to calculate the threshold TRV	High
Mammals										
Chromium III	2,737	No effects on rat reproduction and life span	NA	No effects at the highest study dose	Sample et al. (1996)	1	2,737	NA	Theshold not provided in CRA Methodology.	High
Chromium VI	3.28	No effects on rat body weight or food consumption	13.14	Increased mortality in rats	Sample et al. (1996)	1	3.28	N/A	Theshold not provided in CRA Methodology.	High
Copper	2.67	No immune response effects	631.58	Increased mortality and decreased body weight in mice.	PRC (1994)	1	2.67	NA	Not enough data available for calculation of threshold	High

Table 9.2
TRVs for Terrestrial Vertebrate Receptors

ECOPC	NOAEL (mg/kg day)	NOAEL Endpoint	LOAEL (mg/kg day)	LOAEL Endpoint	TRV Source	Uncertainty Factor	Final NOAEL (mg/kg day)	Threshold (mg/kg day)	Rationale For Calculation	TRV Confidence
Manganese	13.7	No change in mouse testicle weight	159.1	Decrease in mouse testicle weight	PRC (1994)	1	13.7	N/A	Theshold not provided in CRA Methodology.	High
Nickel	0.133	NOAEL was estimated from LOAEL	1.33	Increase in pup mortality in rats	PRC (1994)	1	0.133	N/A	NOAEL was estimated from LOAEL	High
Selenium	0.05	No increase in liver lesions in mice	1.21	Decrease in mouse reproductive success	PRC (1994)	1	0.05	N/A	The effects were noted to be in the mid-range, therefore, no threshold was calculated	High
Tin (Butyltins)	0.25	No systemic effects	15	Midrange of effects less than mortality	PRC (1994)	1	0.25	N/A	Theshold not provided in CRA Methodology.	High
Vanadium	0.21	NOAEL estimated from LOAEL	2.1	Significant reproductive effects in rats	Sample et al. (1996)	1	0.21	N/A	NOAEL was estimated from the LOAEL.	High
Zinc	9.61	NOAEL was estimated from LOAEL	411.4	Increase in fetal developmental effects in rats	PRC (1994)	1	9.61	N/A	NOAEL was estimated from LOAEL	High

Threshold TRVs were independently calculated using the procedures outline in the CRA Methodology, Section 3.1.4.
TRV Confidence:
NA = No TRV has been identified or the TRV has been deemed unacceptable for use in ECOPC selection.
Low = TRVs that have data for only one species looking at one endpoint (non-mortality) and from one primary literature source.
Moderate = TRVs that have multiple primary literature sources looking at one endpoint (non-mortality or mortality) but with only one species evaluated.
Good = For TRVs that have either multiple species with one endpoint from multiple studies or those TRVs with multiple species and multiple endpoints from only one study.
High = For TRVs that have multiple study sources looking at multiple endpoints and more than one species.
Very High = All EcoSSLs (EPA 2003a) will be assigned this level of confidence by default.

Table 10.1
Hazard Quotient Summary For Non-PMJM Receptors

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs)	
				Based on Default TRVs	Based on Refined Analysis
Chromium	Terrestrial Plants	N/A	Tier 1	NOEC UTL = 26	***NOEC*** UTL = 3 ***LOEC*** UTL = 0.9
			Tier 2	NOEC UTL[a] = 32	***NOEC*** UTL[a] = 3 ***LOEC*** UTL[a] = 1
	Terrestrial Invertebrates	N/A	Tier 1	***NOEC*** UTL = 65 ***LOEC*** Not Available	***NOEC*** Not Available ***LOEC*** UTL = 0.8
			Tier 2	***NOEC*** UTL[a] = 81 ***LOEC*** Not Available	***NOEC*** Not Available ***LOEC*** UTL[a] = 0.99
	Mourning Dove (Herbivore)	Default	Tier 1	***NOAEL*** UTL = 1 ***LOAEL*** UTL = 0.2	Not Calculated
			Tier 2	***NOAEL*** UTL[a] = 1 ***LOAEL*** UTL[a] = 0.3	Not Calculated
		Median	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
	Mourning Dove (Insectivore)	Default	Tier 1	***NOAEL*** UTL = 20 ***LOAEL*** UTL = 4	Not Calculated
			Tier 2	***NOAEL*** UTL[a] = 24 ***LOAEL*** UTL[a] = 5	Not Calculated
		Median	Tier 1	***NOAEL*** UTL = 2 ***LOAEL*** UTL = 0.5	Not Calculated
			Tier 2	***NOAEL*** UTL[a] = 3 ***LOAEL*** UTL[a] = 0.6	Not Calculated

Table 10.1
Hazard Quotient Summary For Non-PMJM Receptors

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs) Based on Default TRVs	Hazard Quotients (HQs) Based on Refined Analysis
Chromium	American kestrel	Default	Tier 1	***NOAEL*** UTL = 2 ***LOAEL*** UTL = 0.4	Not Calculated
			Tier 2	***NOAEL*** UTL[a] = 2 ***LOAEL*** UTL[a] = 0.4	Not Calculated
		Median	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
	Deer Mouse (Insectivore)	Default	Tier 1	**Chromium VI** ***NOAEL*** UTL = 2 ***LOAEL*** UTL = 0.4 **Chromium III** ***NOAEL*** UTL = 0.002	Not Calculated
			Tier 2	**Chromium VI** ***NOAEL*** UTL[a] = 2 ***LOAEL*** UTL[a] = 0.5 **Chromium III** ***NOAEL*** UTL[a] = 0.002	Not Calculated
		Median	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
Copper	Mourning Dove (Herbivore)	Default	Tier 1	***NOAEL*** UTL = 1 ***LOAEL*** UTL = 0.05	Not Calculated
			Tier 2	***NOAEL*** UTL[a] = 1 ***LOAEL*** UTL[a] = 0.05	Not Calculated
		Median	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated

Table 10.1
Hazard Quotient Summary For Non-PMJM Receptors

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs)	
				Based on Default TRVs	**Based on Refined Analysis**
Copper	Mourning Dove (Insectivore)	Default	Tier 1	***NOAEL*** UTL = 2 ***LOAEL*** UTL = 0.1	Not Calculated
			Tier 2	***NOAEL*** UTL[a] = 2 ***LOAEL*** UTL[a] = 0.1	Not Calculated
		Median	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
Manganese	Terrestrial Plants	N/A	Tier 1	***NOEC*** UTL = 1 ***LOEC*** Not Available	Not Calculated
			Tier 2	***NOEC*** UTL[a] = 1 ***LOEC*** Not Available	Not Calculated
	Deer Mouse (Herbivore)	Default	Tier 1	***NOAEL*** UTL = 1 ***LOAEL*** UTL = 0.1	Not Calculated
			Tier 2	***NOAEL*** UTL[a] = 1 ***LOAEL*** UTL[a] = 0.1	Not Calculated
		Median	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
Nickel	Mourning Dove (Insectivore)	Default	Tier 1	***NOAEL*** UTL = 18 ***LOAEL*** UTL = 0.5	Not Calculated
			Tier 2	***NOAEL*** UTL = 19 ***LOAEL*** UTL = 0.5	Not Calculated
		Median	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated

Table 10.1
Hazard Quotient Summary For Non-PMJM Receptors

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs) Based on Default TRVs	Hazard Quotients (HQs) Based on Refined Analysis
Nickel	Deer Mouse (Herbivore)	Default	Tier 1	***NOAEL*** UTL = 1 ***LOAEL*** UTL = 0.1	Not Calculated
			Tier 2	***NOAEL*** UTL = 1 ***LOAEL*** UTL = 0.1	Not Calculated
		Median	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
	Deer Mouse (Insectivore)	Default	Tier 1	***NOAEL*** UTL = 53 ***LOAEL*** UTL = 5	***NOAEL*** UTL = 0.2 ***LOAEL*** UTL = 0.09
			Tier 2	***NOAEL*** UTL = 55 ***LOAEL*** UTL = 6	***NOAEL*** UTL = 0.2 ***LOAEL*** UTL = 0.09
		Median	Tier 1	***NOAEL*** UTL = 12 ***LOAEL*** UTL = 1	***NOAEL*** UTL = 0.04 ***LOAEL*** UTL = 0.02
			Tier 2	***NOAEL*** UTL = 13 ***LOAEL*** UTL = 1	***NOAEL*** UTL = 0.04 ***LOAEL*** UTL = 0.02
	Coyote (Generalist)	Default	Tier 1	***NOAEL*** UCL = 3 ***LOAEL*** UCL = 0.3	Not Calculated
			Tier 2	***NOAEL*** UCL = 2 ***LOAEL*** UCL = 0.2	Not Calculated
		Median	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
	Coyote (Insectivore)	Default	Tier 1	***NOAEL*** UCL = 9 ***LOAEL*** UCL = 0.9	Not Calculated
			Tier 2	***NOAEL*** UCL = 9 ***LOAEL*** UCL = 0.9	Not Calculated
		Median	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated

Table 10.1
Hazard Quotient Summary For Non-PMJM Receptors

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs) Based on Default TRVs	Hazard Quotients (HQs) Based on Refined Analysis
Thallium	Terrestrial Plants	N/A	Tier 1	***NOEC*** UTL = 2 ***LOEC*** Not Available	Not Calculated
			Tier 2	***NOEC*** UTL[a] = 2 ***LOEC*** Not Available	Not Calculated
Tin	Mourning Dove (Herbivore)	Default	Tier 1	***NOAEL*** UTL = 1 ***LOAEL*** UTL = 0.05	Not Calculated
			Tier 2	***NOAEL*** UTL[a] = 1 ***LOAEL*** UTL[a] = 0.06	Not Calculated
		Median	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
	Mourning Dove (Insectivore)	Default	Tier 1	***NOAEL*** UTL = 10 ***LOAEL*** UTL = 0.4	Not Calculated
			Tier 2	***NOAEL*** UTL[a] = 13 ***LOAEL*** UTL[a] = 0.5	Not Calculated
		Median	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
	American kestrel	Default	Tier 1	***NOAEL*** UTL = 2 ***LOAEL*** UTL = 0.06	Not Calculated
		Default	Tier 2	***NOAEL*** UTL[a] = 2 ***LOAEL*** UTL[a] = 0.08	Not Calculated
		Median	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated

Table 10.1
Hazard Quotient Summary For Non-PMJM Receptors

ECOPC	Receptor	BAF	EPC	Hazard Quotients (HQs)	
				Based on Default TRVs	Based on Refined Analysis
Tin	Deer Mouse (Insectivore)	Default	Tier 1	***NOAEL*** UTL = 8 ***LOAEL*** UTL = 0.1	Not Calculated
			Tier 2	***NOAEL*** UTL[a] = 10 ***LOAEL*** UTL[a] = 0.2	Not Calculated
		Median	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated
Vanadium	Terrestrial Plants	N/A	Tier 1	***NOEC*** UTL = 29 ***LOEC*** Not Available	**LOEC** UTL = 1
			Tier 2	***NOEC*** UTL[a] = 36 ***LOEC*** Not Available	**LOEC** UTL[a] = 1
	Deer Mouse (Insectivore)	Default	Tier 1	***NOAEL*** UTL = 2 ***LOAEL*** UTL = 0.2	Not Calculated
			Tier 2	***NOAEL*** UTL[a] = 2 ***LOAEL*** UTL[a] = 0.2	Not Calculated
		Median	Tier 1	Not Calculated	Not Calculated
			Tier 2	Not Calculated	Not Calculated

[a]Tier 2 soil UTL was greater than the maximum grid mean, so the maximum grid mean was used to calculate intake.
Shaded cells represent default HQ calculations based on exposure and toxicity models specifically identified in the CRA Meth
All HQ Calculations are provided in Attachment 4.
Discussion of the chemical-specific uncertainties is provided in Attachment 5.

Table 10.2
Hazard Quotient Summary For PMJM Receptors

ECOPC	Patch	BAF	EPC	Hazard Quotients (HQs)	
				Based on Default TRVs	Based on Refined Analysis
Chromium	Patch 22	Default	UCL[a]	***Chromium VI*** NOAEL = 1 LOAEL = 0.3 ***Chromium III*** NOAEL = 0.001	Not Calculated
		Median	UCL	Not Calculated	Not Calculated
	Patch 23	Default	UCL	***Chromium VI*** NOAEL = 1 LOAEL = 0.3 ***Chromium III*** NOAEL = 0.001	Not Calculated
		Median	UCL	Not Calculated	Not Calculated
Copper	Patch 23	Default	UCL	NOAEL = 0.6 LOAEL = 0.003	Not Calculated
		Median	UCL	Not Calculated	Not Calculated
Manganese	Patch 22	Default	UCL[a]	NOAEL = 2 LOAEL = 0.1	Not Calculated
		Median	UCL	Not Calculated	Not Calculated
	Patch 23	Default	UCL	NOAEL = 2 LOAEL = 0.1	Not Calculated
		Median	UCL	Not Calculated	Not Calculated
	Patch 27	Default	UCL[a]	NOAEL = 2 LOAEL = 0.2	Not Calculated
		Median	UCL	Not Calculated	Not Calculated
Nickel	Patch 22	Default	UCL[a]	NOAEL = 36 LOAEL = 4	NOAEL = 0.1 LOAEL = 0.06
		Median	UCL[a]	NOAEL = 9 LOAEL = 0.9	NOAEL = 0.03 LOAEL = 0.02
	Patch 23	Default	UCL	NOAEL = 34 LOAEL = 3	NOAEL = 0.1 LOAEL = 0.06
		Median	UCL	NOAEL = 9 LOAEL = 0.9	NOAEL = 0.03 LOAEL = 0.01
	Patch 24	Default	UCL[a]	NOAEL = 28 LOAEL = 3	NOAEL = 0.09 LOAEL = 0.05
		Median	UCL[a]	NOAEL = 7 LOAEL = 0.7	NOAEL = 0.02 LOAEL = 0.01
	Patch 25	Default	UCL[a]	NOAEL = 25 LOAEL = 3	NOAEL = 0.08 LOAEL = 0.04
		Median	UCL[a]	NOAEL = 7 LOAEL = 0.7	NOAEL = 0.02 LOAEL = 0.01
	Patch 27	Default	UCL[a]	NOAEL = 85 LOAEL = 9	NOAEL = 0.3 LOAEL = 0.1
		Median	UCL[a]	NOAEL = 21 LOAEL = 2	NOAEL = 0.07 LOAEL = 0.04
Selenium	Patch 23	Default	UCL	NOAEL = 1 LOAEL = 0.06	Not Calculated
		Median	UCL	Not Calculated	Not Calculated
Tin	Patch 23	Default	UCL	NOAEL = 0.8 LOAEL = 0.01	Not Calculated
		Median	UCL	Not Calculated	Not Calculated
	Patch 25	Default	UCL[a]	NOAEL = 6 LOAEL = 0.1	Not Calculated
		Median	UCL	Not Calculated	Not Calculated

Table 10.2
Hazard Quotient Summary For PMJM Receptors

ECOPC	Patch	BAF	EPC	Hazard Quotients (HQs)	
				Based on Default TRVs	Based on Refined Analysis
Vanadium	Patch 22	Default	UCL[a]	NOAEL = 2 LOAEL = 0.02	Not Calculated
		Median	UCL[a]	Not Calculated	Not Calculated
	Patch 23	Default	UCL	NOAEL = 2 LOAEL = 0.02	Not Calculated
		Median	UCL	Not Calculated	Not Calculated
	Patch 24	Default	UCL[a]	NOAEL = 2 LOAEL = 0.02	Not Calculated
		Median	UCL[a]	Not Calculated	Not Calculated
	Patch 25	Default	UCL[a]	NOAEL = 2 LOAEL = 0.02	Not Calculated
		Median	UCL[a]	Not Calculated	Not Calculated
	Patch 27	Default	UCL[a]	NOAEL = 2 LOAEL = 0.2	Not Calculated
		Median	UCL[a]	Not Calculated	Not Calculated
Zinc	Patch 22	Default	UCL[a]	NOAEL = 2 LOAEL = 0.06	Not Calculated
		Median	UCL[a]	Not Calculated	Not Calculated
	Patch 23	Default	UCL	NOAEL = 2 LOAEL = 0.06	Not Calculated
		Median	UCL	Not Calculated	Not Calculated
	Patch 24	Default	UCL[a]	NOAEL = 2 LOAEL = 0.05	Not Calculated
		Median	UCL[a]	Not Calculated	Not Calculated
	Patch 25	Default	UCL[a]	NOAEL = 2 LOAEL = 0.05	Not Calculated
		Median	UCL[a]	Not Calculated	Not Calculated
	Patch 27	Default	UCL[a]	NOAEL = 3 LOAEL = 0.06	Not Calculated
		Median	UCL	Not Calculated	Not Calculated

[a] Soil UCL was greater than the MDC or could not be calculated due to low numbers of samples, so the MDC was used as a proxy value to calculate intake.
Shaded cells represent default HQ calculations based on exposure and toxicity models specifically identified in the CRA Methodology.
All HQ Calculations are provided in Attachment 4.
Discussion of the chemical-specific uncertainties are provided in Attachment 5.

Table 10.3
Tier 2 Grid Cell Hazard Quotients for Surface Soil in LWOEU

ECOPC	Most Sensitive Receptor	Number of Grid Cells	Percent of Tier 2 Grid Means											
			NOAEL TRV				Threshold TRV				LOAEL TRV			
			HQ < 1	HQ > 1 <5	HQ > 5 <10	HQ > 10	HQ < 1	HQ > 1 <5	HQ > 5 <10	HQ > 10	HQ < 1	HQ > 1 <5	HQ > 5 <10	HQ > 10
Inorganics														
Chromium	Mourning Dove - Insectivore	26	0	0	46	54	N/A	N/A	N/A	N/A	0	100	0	0
Copper	Mourning Dove - Insectivore	26	0	100	0	0	100	0	0	0	100	0	0	0
Manganese	Mourning Dove - Herbivore	26	92	8	0	0	N/A	N/A	N/A	N/A	100	0	0	0
Nickel	Deer Mouse - Insectivore	26	0	0	0	100	N/A	N/A	N/A	N/A	0	92	8	0
Tin	Mourning Dove - Insectivore	23	35	43	9	13	N/A	N/A	N/A	N/A	100	0	0	0
Vanadium	Deer Mouse - Insectivore	26	38	62	0	0	N/A	N/A	N/A	N/A	100	0	0	0

N/A = No value available
The limiting receptor is chosen as the receptor with the lowest ESL.
Default exposure model and TRVs used.

Table 11.1
Summary of Risk Characterization Results for the LWOEU

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

Table 11.1
Summary of Risk Characterization Results for the LWOEU

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

Table 11.1
Summary of Risk Characterization Results for the LWOEU

Analyte	Ecological Receptors	Result of Risk Characterization	Risk Description Conclusion
Thallium	Terrestrial plants	Screening ESL HQs >1 Risk estimates based on use of MDC as proxy value for UTL.	Low Risk
	Terrestrial invertebrate	Not an ECOPC[a].	ECOPC of Uncertain Risk
	American kestrel	Not an ECOPC[a].	ECOPC of Uncertain Risk
	Mourning dove (herbivore)	Not an ECOPC[a].	ECOPC of Uncertain Risk
	Mourning dove (insectivore)	Not an ECOPC[a].	ECOPC of Uncertain Risk
	Deer mouse (herbivore)	Not an ECOPC.	Not an ECOPC
	Deer mouse (Insectivore)	Not an ECOPC.	Not an ECOPC
	Prairie dog	Not an ECOPC.	Not an ECOPC
	Coyote (carnivore)	Not an ECOPC.	Not an ECOPC
	Coyote (generalist)	Not an ECOPC.	Not an ECOPC
	Coyote (insectivore)	Not an ECOPC.	Not an ECOPC
	Mule Deer	Not an ECOPC.	Not an ECOPC
Tin	Terrestrial plants	Not an ECOPC.	Not an ECOPC
	Terrestrial invertebrate	Not an ECOPC[a].	ECOPC of Uncertain Risk
	American kestrel	NOAEL HQs > 1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	Mourning dove (herbivore)	NOAEL HQs = 1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	Mourning dove (insectivore)	NOAEL HQs > 1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	Deer mouse (herbivore)	Not an ECOPC.	Not an ECOPC
	Deer mouse (Insectivore)	NOAEL HQs > 1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	Prairie dog	Not an ECOPC.	Not an ECOPC
	Coyote (carnivore)	Not an ECOPC.	Not an ECOPC
	Coyote (generalist)	Not an ECOPC.	Not an ECOPC
	Coyote (insectivore)	Not an ECOPC.	Not an ECOPC
	Mule Deer	Not an ECOPC.	Not an ECOPC
Vanadium	Terrestrial plants	Screening ESL HQs >1 for default TRVs. Screening ESL HQs =1 for alternative TRVs.	Low Risk
	Terrestrial invertebrate	Not an ECOPC[a].	ECOPC of Uncertain Risk
	American kestrel	Not an ECOPC.	Not an ECOPC
	Mourning dove (herbivore)	Not an ECOPC.	Not an ECOPC
	Mourning dove (insectivore)	Not an ECOPC.	Not an ECOPC
	Deer mouse (herbivore)	Not an ECOPC.	Not an ECOPC
	Deer mouse (Insectivore)	NOAEL HQs > 1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	Prairie dog	Not an ECOPC.	Not an ECOPC
	Coyote (carnivore)	Not an ECOPC.	Not an ECOPC
	Coyote (generalist)	Not an ECOPC.	Not an ECOPC
	Coyote (insectivore)	Not an ECOPC.	Not an ECOPC
	Mule Deer	Not an ECOPC.	Not an ECOPC

Table 11.1
Summary of Risk Characterization Results for the LWOEU

Analyte	Ecological Receptors	Result of Risk Characterization	Risk Description Conclusion
Surface Soil - PMJM Receptors			
Chromium	PMJM - Patch 22	NOAEL HQs = 1 for default exposures and Cr VI TRVs LOAEL HQs <1 for default exposures and Cr VI TRVs. NOAEL HQs <1 for default exposures and Cr III TRVs.	Low Risk
	PMJM - Patch 23	NOAEL HQs = 1 for default exposures and Cr VI TRVs LOAEL HQs <1 for default exposures and Cr VI TRVs. NOAEL HQs <1 for default exposures and Cr III TRVs.	Low Risk
	PMJM - Patch 24	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 25	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 26	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 27	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 28	Not an ECOPC.	Not an ECOPC
Copper	PMJM - Patch 22	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 23	NOAEL and LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	PMJM - Patch 24	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 25	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 26	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 27	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 28	Not an ECOPC.	Not an ECOPC
Manganese	PMJM - Patch 22	NOAEL HQs > 1 for default exposures and TRVs. LOAEL HQs <1 for all default exposures and TRVs.	Low Risk
	PMJM - Patch 23	NOAEL HQs > 1 for default exposures and TRVs. LOAEL HQs <1 for all default exposures and TRVs.	Low Risk
	PMJM - Patch 24	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 25	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 26	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 27	NOAEL HQs > 1 for default exposures and TRVs. LOAEL HQs <1 for all default exposures and TRVs.	Low Risk
	PMJM - Patch 28	Not an ECOPC.	Not an ECOPC

Table 11.1
Summary of Risk Characterization Results for the LWOEU

Analyte	Ecological Receptors	Result of Risk Characterization	Risk Description Conclusion
Nickel	PMJM - Patch 22	NOAEL and LOAEL HQs >1 for default exposures and TRVs. NOAEL HQs >1 for all alternative exposures and default TRVs. LOAEL HQs <1 for all alternative exposures and default TRVs. NOAEL and LOAEL HQs <1 for all default and alternative exposures using alternative TRVs.	Low to Moderate Risk
	PMJM - Patch 23	NOAEL and LOAEL HQs >1 for default exposures and TRVs. NOAEL HQs >1 for all alternative exposures and default TRVs. LOAEL HQs <=1 for all alternative exposures and default TRVs. NOAEL and LOAEL HQs <1 for all default and alternative exposures using alternative TRVs.	Low to Moderate Risk
	PMJM - Patch 24	NOAEL and LOAEL HQs >1 for default exposures and TRVs. NOAEL HQs >1 for all alternative exposures and default TRVs. LOAEL HQs <1 for all alternative exposures and default TRVs. NOAEL and LOAEL HQs <1 for all default and alternative exposures using alternative TRVs.	Low to Moderate Risk
	PMJM - Patch 25	NOAEL and LOAEL HQs >1 for default exposures and TRVs. NOAEL HQs >1 for all alternative exposures and default TRVs. LOAEL HQs <1 for all alternative exposures and default TRVs. NOAEL and LOAEL HQs <1 for all default and alternative exposures using alternative TRVs.	Low to Moderate Risk
	PMJM - Patch 26	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 27	NOAEL and LOAEL HQs >1 for default exposures and TRVs. NOAEL HQs >1 for all alternative exposures and default TRVs. LOAEL HQs >1 for all alternative exposures and default TRVs. NOAEL and LOAEL HQs <1 for all default and alternative exposures using alternative TRVs.	Low to Moderate Risk
	PMJM - Patch 28	Not an ECOPC.	Not an ECOPC
Selenium	PMJM - Patch 22	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 23	NOAEL HQ =1 using default exposures. LOAEL HQ <1 using default exposures.	Low Risk
	PMJM - Patch 24	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 25	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 26	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 27	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 28	Not an ECOPC.	Not an ECOPC

Table 11.1
Summary of Risk Characterization Results for the LWOEU

Analyte	Ecological Receptors	Result of Risk Characterization	Risk Description Conclusion
Tin	PMJM - Patch 22	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 23	NOAEL HQs < 1 using default exposures and TRVs. LOAEL HQs <1 using default exposures and TRVs.	Low Risk
	PMJM - Patch 24	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 25	NOAEL HQs > 1 using default exposures and TRVs. LOAEL HQs <1 using default exposures and TRVs.	Low Risk
	PMJM - Patch 26	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 27	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 28	Not an ECOPC.	Not an ECOPC
Vanadium	PMJM - Patch 22	NOAEL HQs >1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	PMJM - Patch 23	NOAEL HQs >1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	PMJM - Patch 24	NOAEL HQs >1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	PMJM - Patch 25	NOAEL HQs >1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	PMJM - Patch 26	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 27	NOAEL HQs >1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	PMJM - Patch 28	Not an ECOPC.	Not an ECOPC
Zinc	PMJM - Patch 22	NOAEL HQs >1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	PMJM - Patch 23	NOAEL HQs >1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	PMJM - Patch 24	NOAEL HQs >1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	PMJM - Patch 25	NOAEL HQs >1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	PMJM - Patch 26	Not an ECOPC.	Not an ECOPC
	PMJM - Patch 27	NOAEL HQs >1 for default exposures and TRVs. LOAEL HQs <1 for default exposures and TRVs.	Low Risk
	PMJM - Patch 28	Not an ECOPC.	Not an ECOPC
Subsurface Soil			
None	Prairie dog	No ECOPCs.	No Risk

[a]ESL was not available. Analyte evaluated in Section 10.

FIGURES

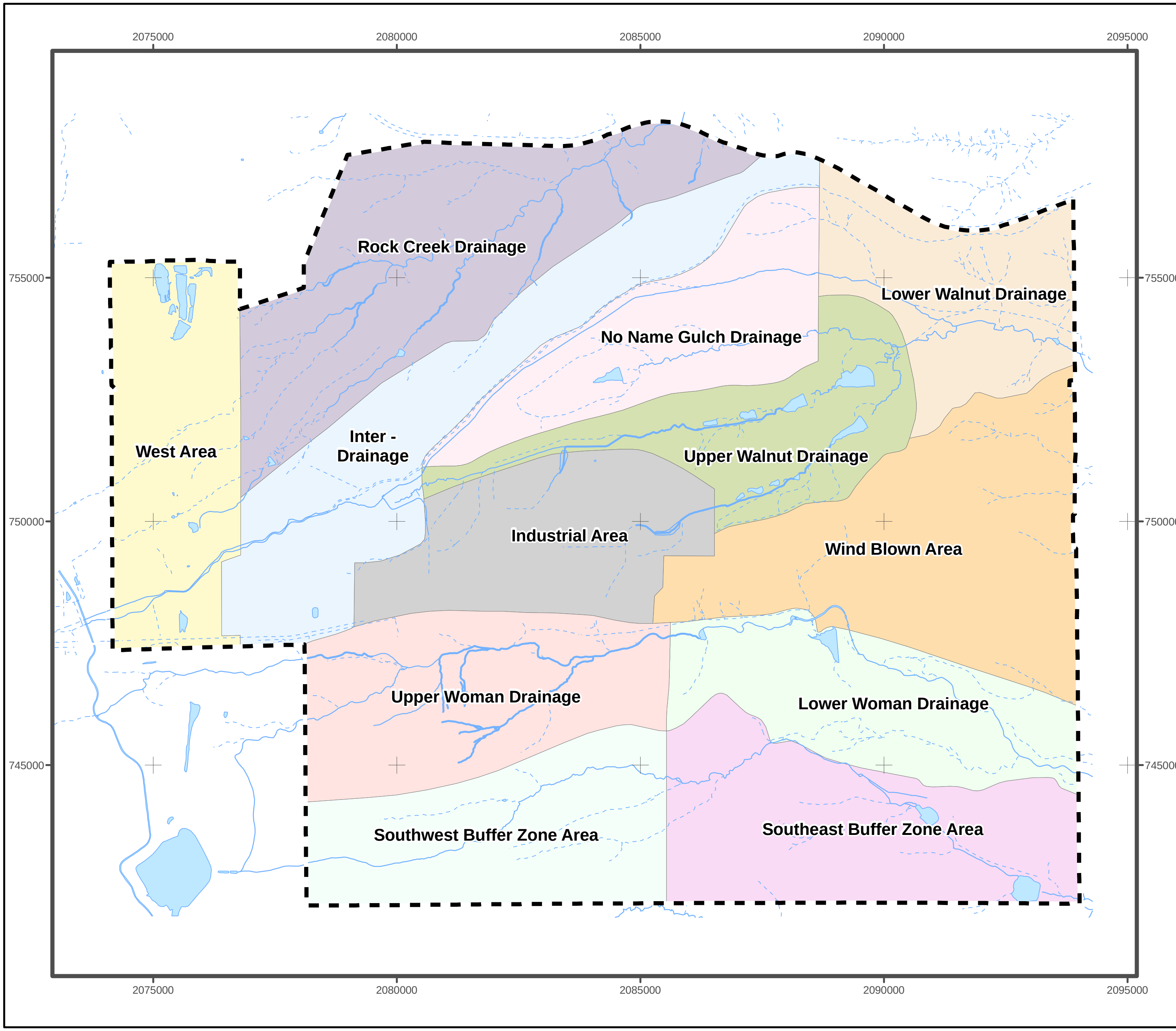

Figure 1.1
Rocky Flats Environmental
Technology Site
Exposure Units

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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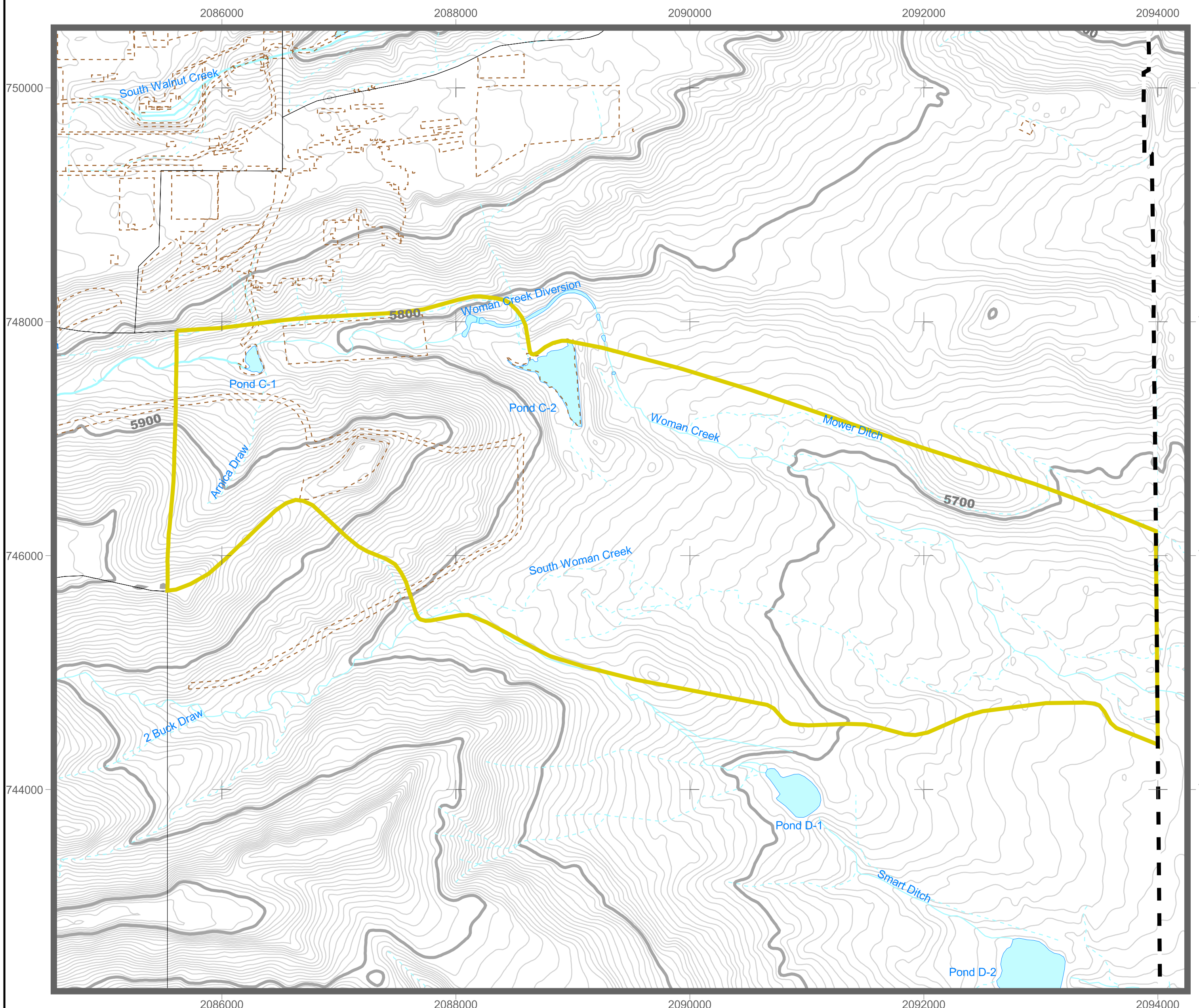


Figure 1.2
Topography and Historical IHSS Locations in the Lower Woman Drainage Exposure Unit

KEY

Lower Woman Drainage 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

0 650 1300 Feet

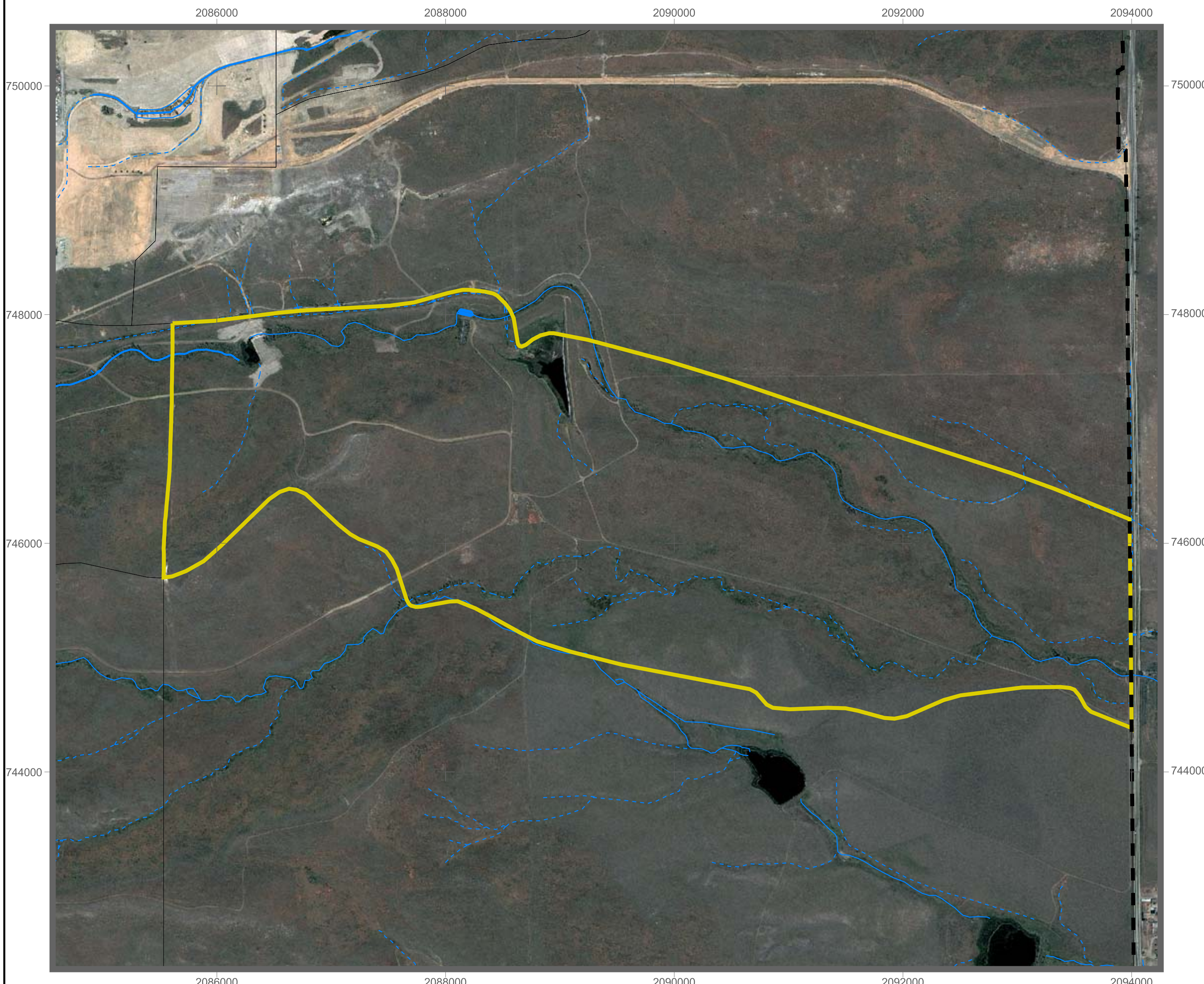
Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

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

Figure 1.3
Aerial Photograph of the
Lower Woman Drainage
Exposure Unit
July 2005



KEY

Lower Woman Drainage EU

Standard Map Features

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

N
W
E
S

0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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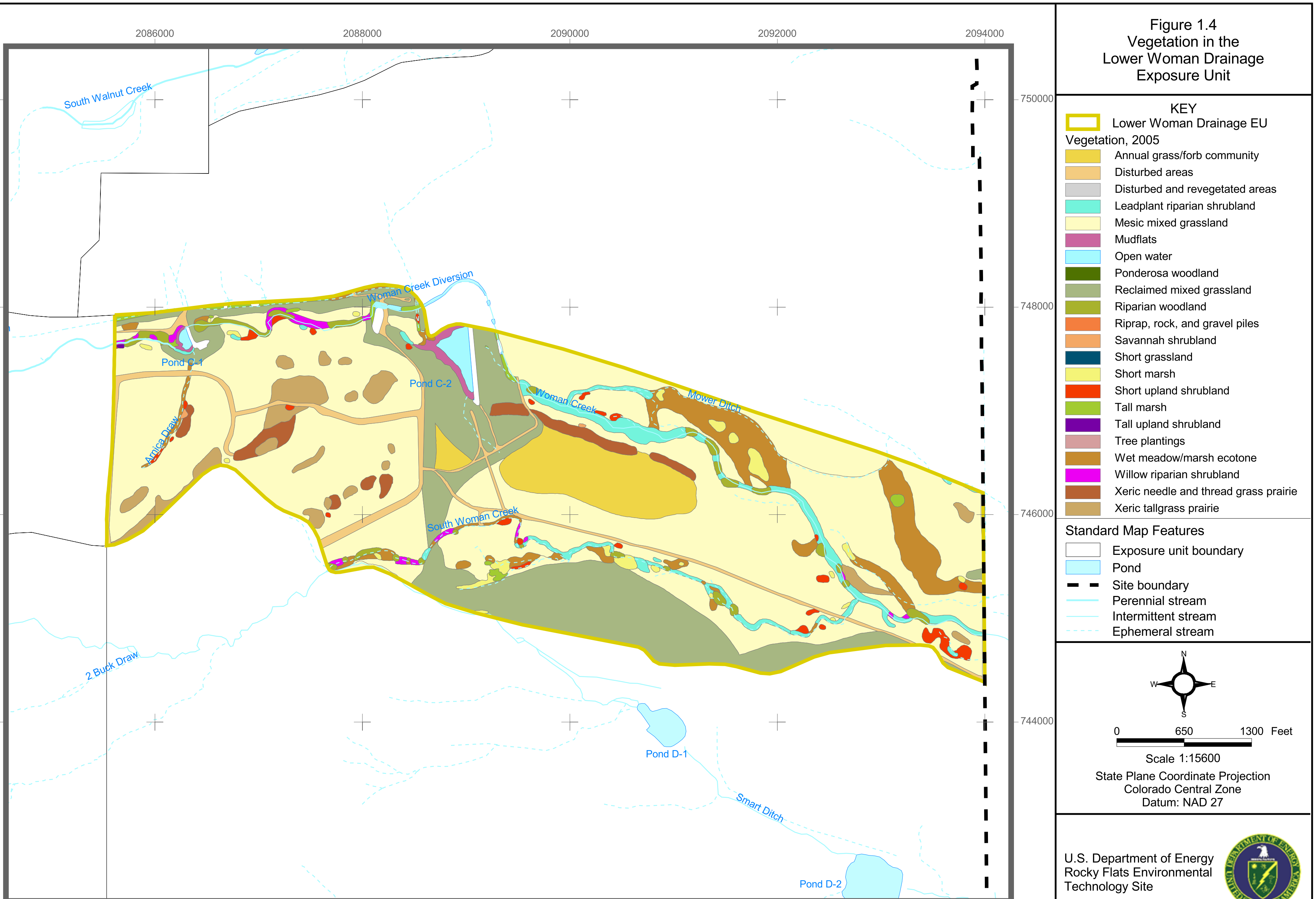

Figure 1.4
Vegetation in the
Lower Woman Drainage
Exposure Unit

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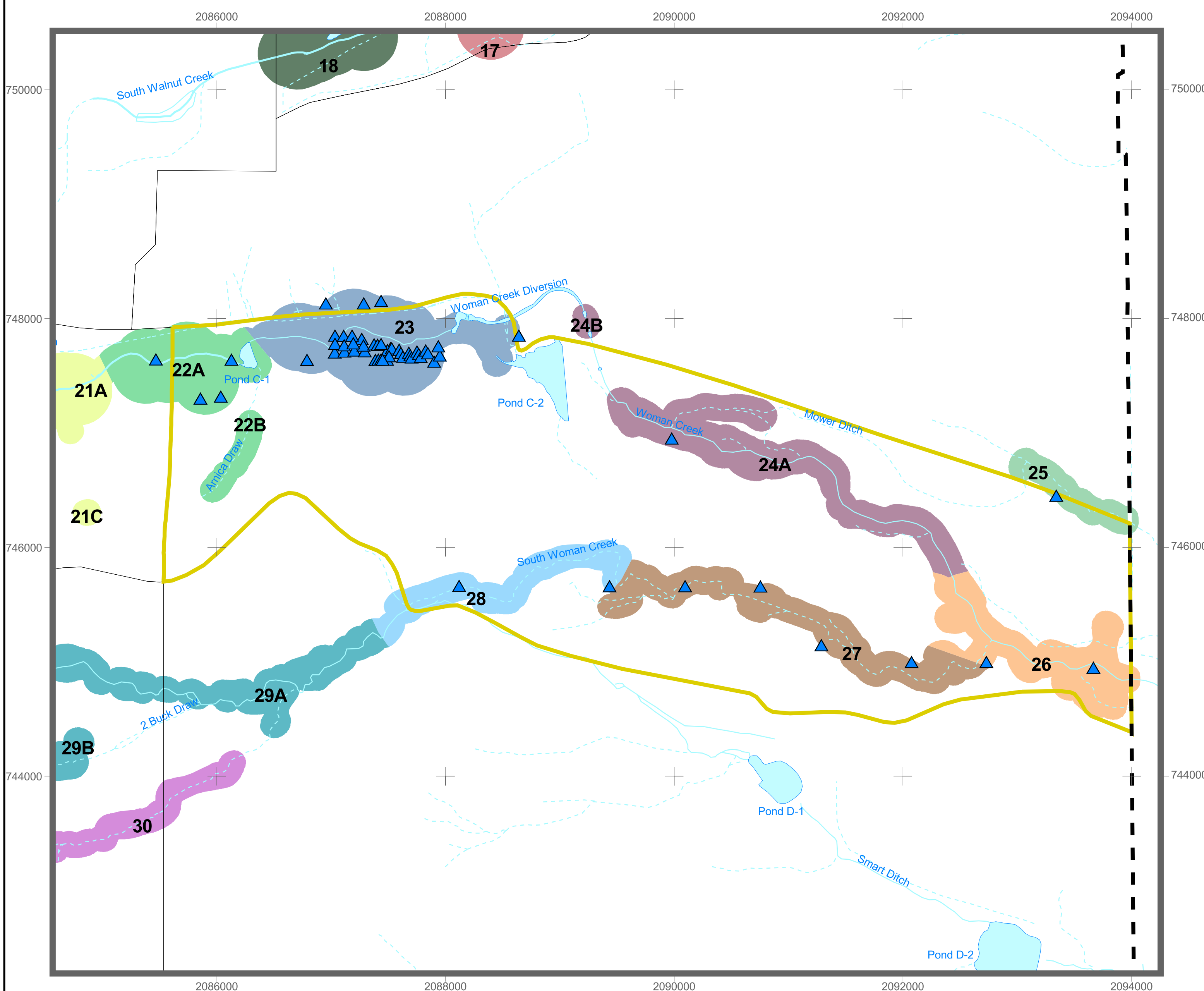
Rocky Flats Environmental
Technology Site

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

Figure 1.5
Preble's Meadow Jumping Mouse Habitat and Surface Soil Sample Locations in the Lower Woman Drainage Exposure Unit



KEY

Surface soil sample location
Lower Woman Drainage EU
PMJM habitat patch
1 PMJM habitat patch ID

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

Standard Map Features

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

N
E
S
W

0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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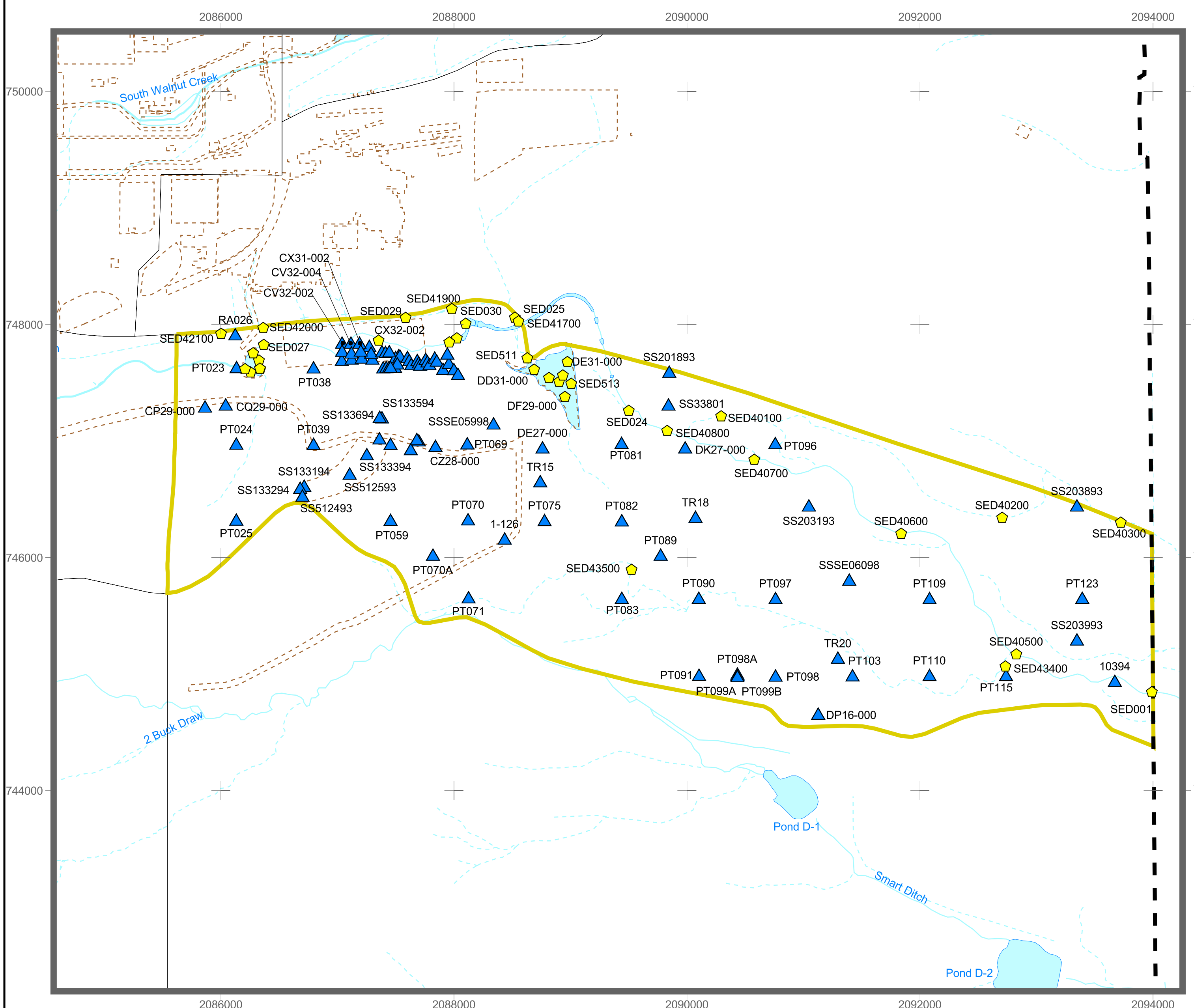

Figure 1.6
Lower Woman Drainage Exposure Unit Surface Soil and Surface Sediment Sample Locations

KEY

Sample location

- Surface sediment sample location
- Surface soil sample location
- Lower Woman Drainage EU
- Historical IHSS/PAC

Standard Map Features

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

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

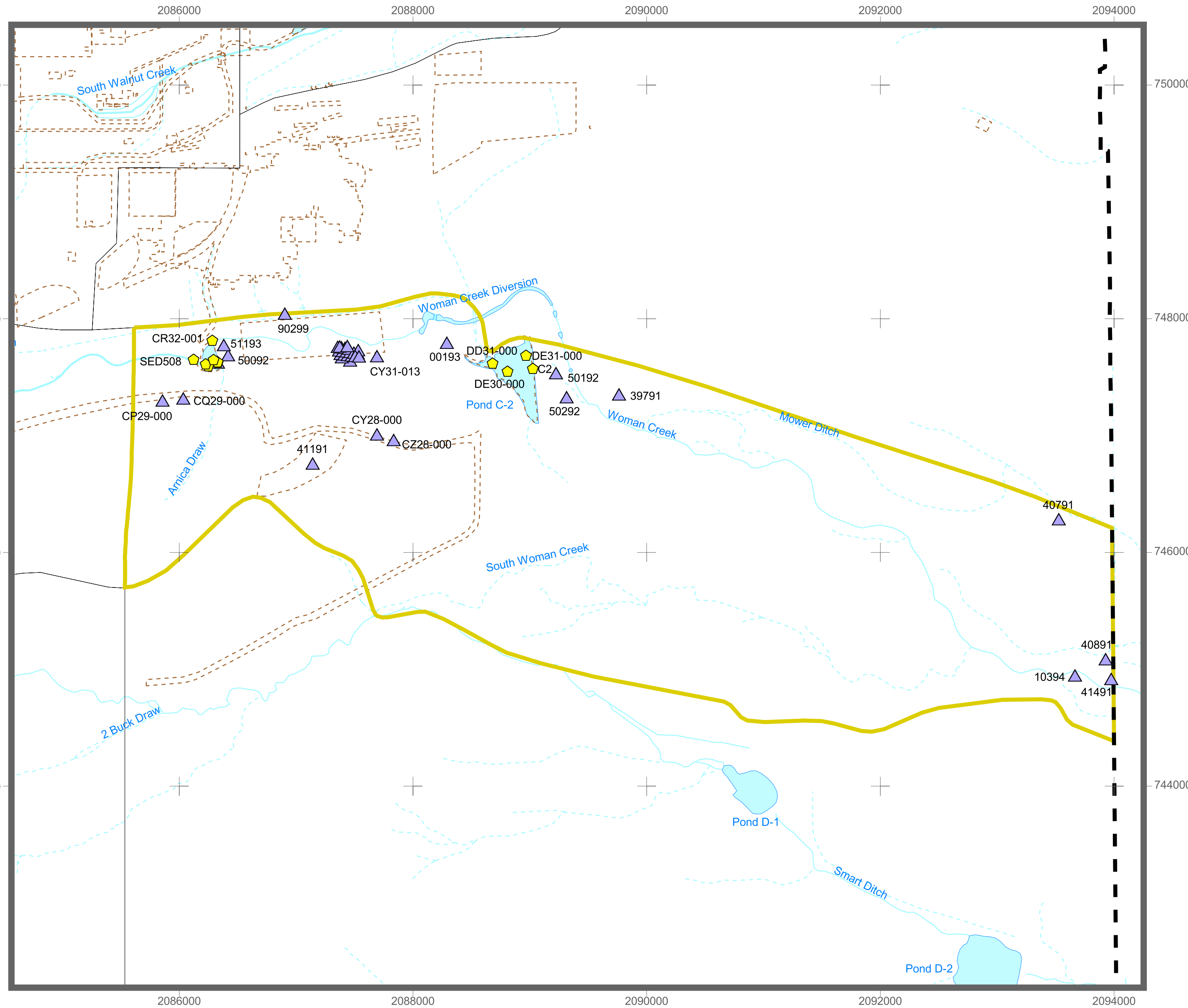


Figure 1.7
Lower Woman Drainage Exposure Unit Subsurface Soil and Subsurface Sediment Sample Locations

KEY

Sample location
Subsurface sediment sample location
Subsurface soil sample location
Lower Woman Drainage EU
Historical IHSS/PAC

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

N
W
E
S

0 650 1300 Feet

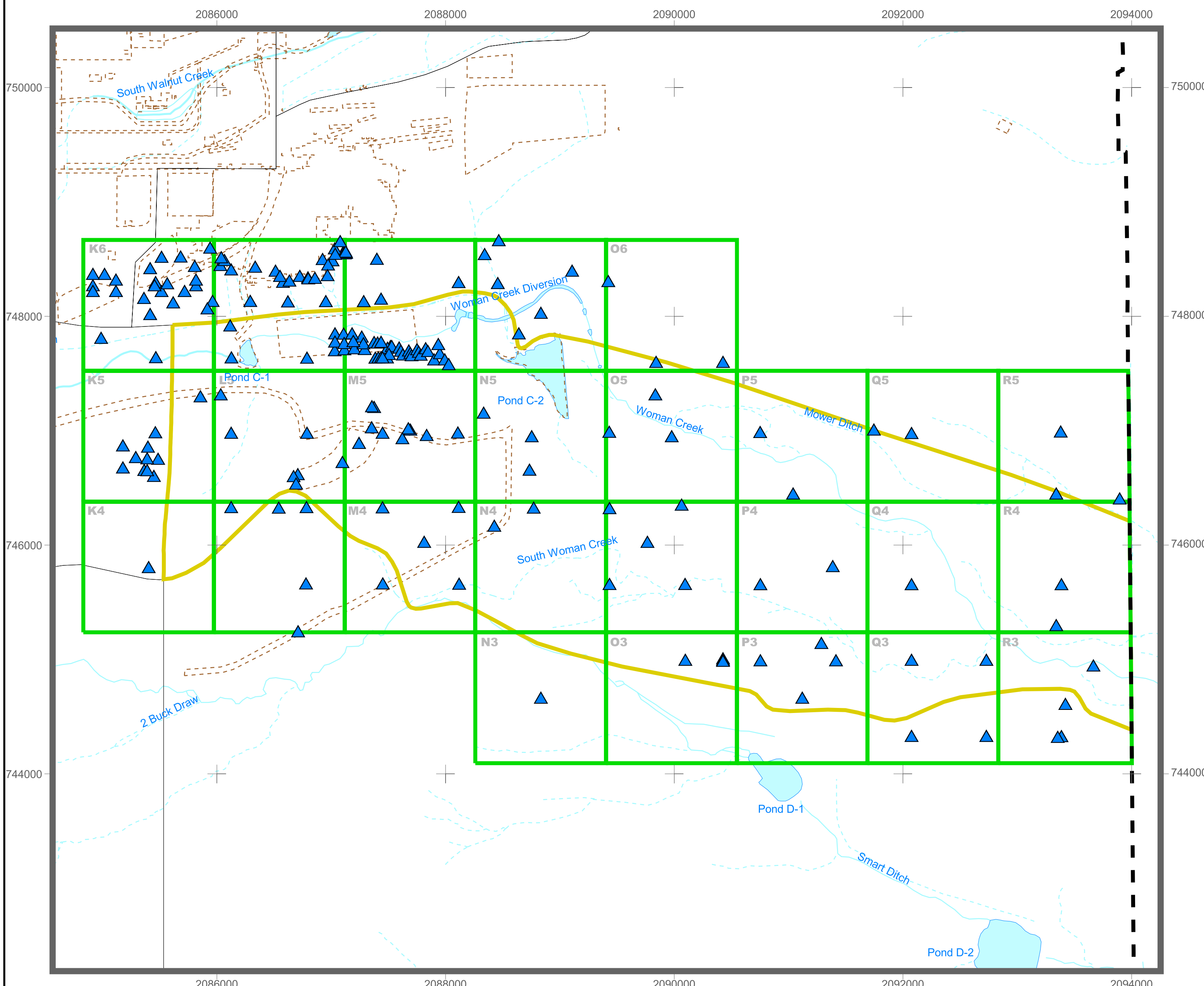
Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

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

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



KEY

Surface soil sample location
Lower Woman Drainage EU
30-acre grid
Historical IHSS/PAC
A1 Grid cell ID

Standard Map Features

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

N
W E
S

0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

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

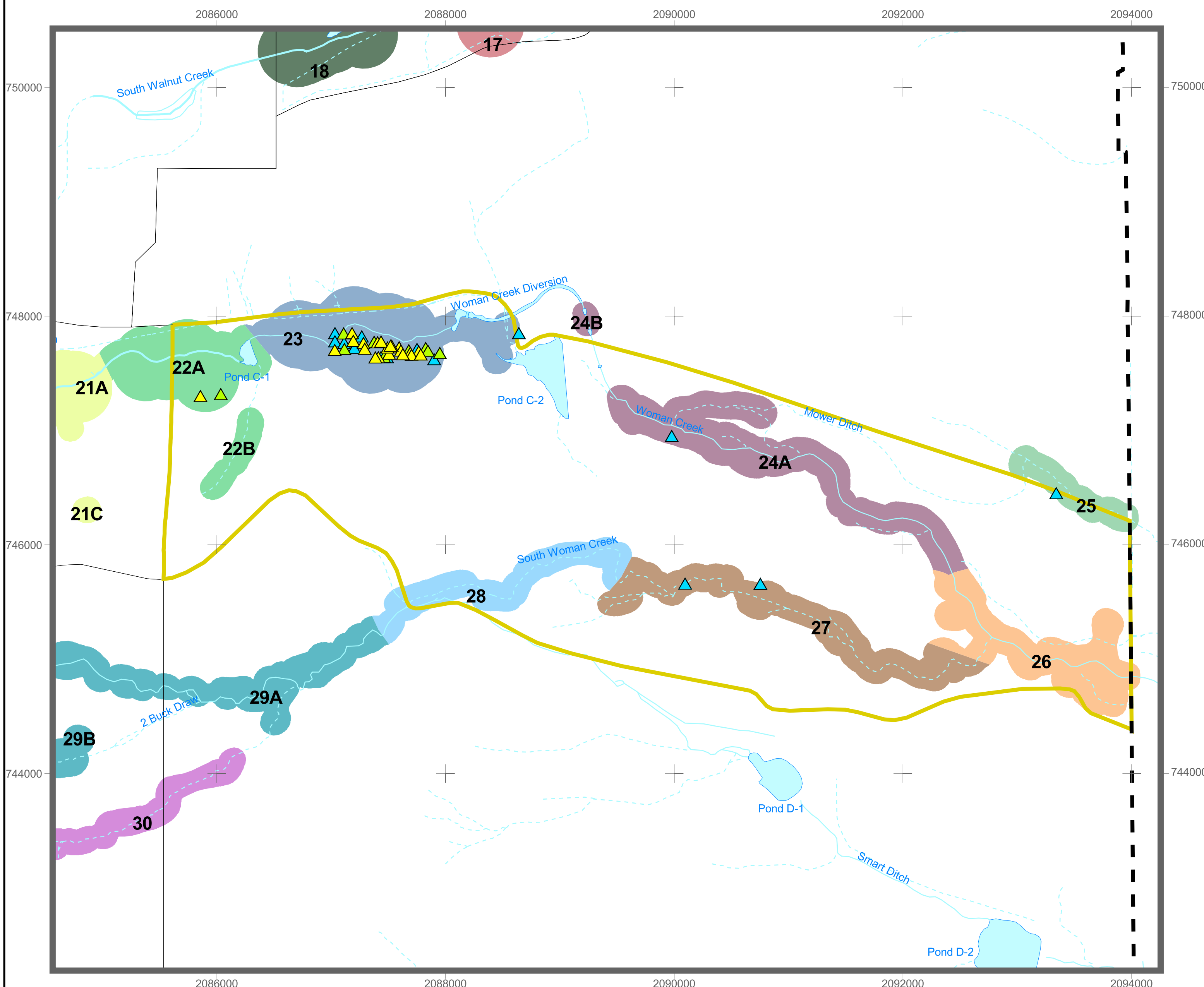


Figure 8.2
Lower Woman Drainage
Exposure Unit Surface Soil
Sampling Locations in PMJM
Habitat for Chromium

KEY

Surface soil sample location

- Detect >= Maximum background >= 3 x ESL
- Detect >= Maximum background >= ESL
- Detect >= Maximum background < ESL
- Detect < Maximum background
- Nondetect
- Lower Woman Drainage EU
- PMJM habitat patch
- 1 PMJM habitat patch ID

ESL: 19.3 mg/kg
Maximum background concentration: 16.9 mg/kg

Standard Map Features

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

N
W
E
S

0 650 1300 Feet

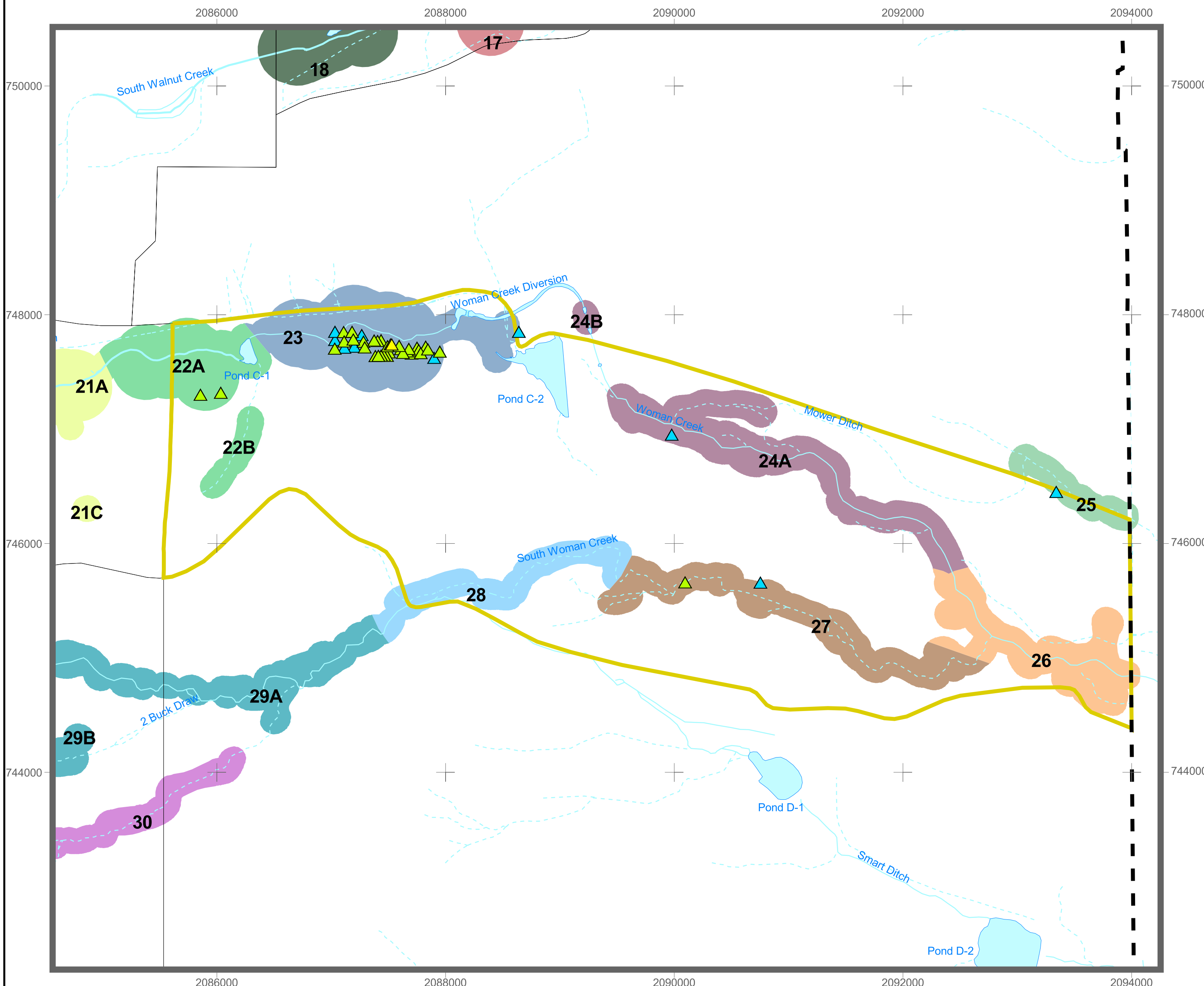
Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

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

Figure 8.3
Lower Woman Drainage
Exposure Unit Surface Soil
Sampling Locations in PMJM
Habitat for Copper



KEY

Surface soil sample location

- Detect >= Maximum background >= 3 x ESL
- Detect >= Maximum background >= ESL
- Detect >= Maximum background < ESL
- Detect < Maximum background
- Nondetect
- Lower Woman Drainage EU
- PMJM habitat patch
- 1 PMJM habitat patch ID

ESL: 94.97 mg/kg
Maximum background concentration: 16 mg/kg

Standard Map Features

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

N S E W

0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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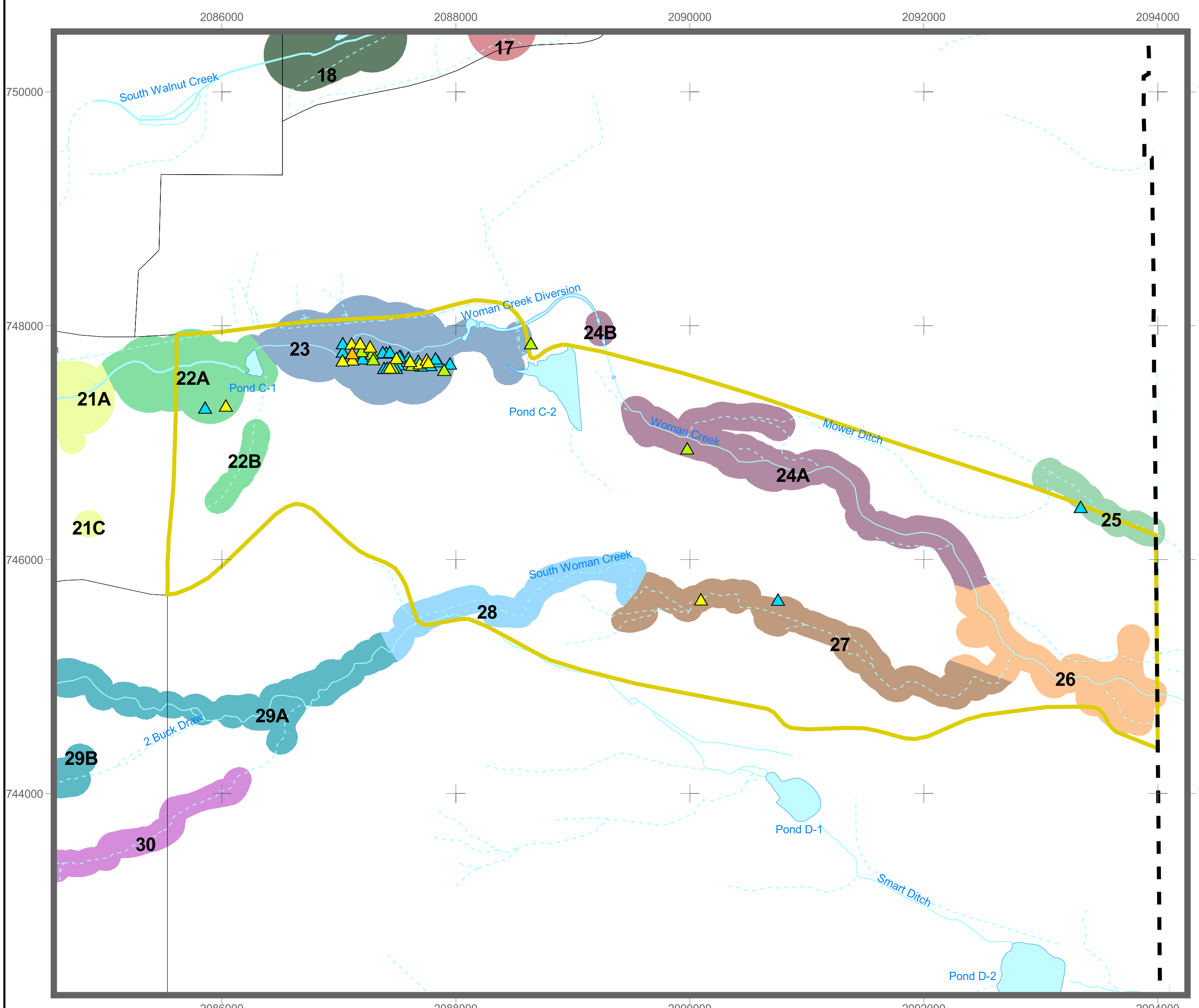
Rocky Flats Environmental
Technology Site

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

Figure 8.4
Lower Woman Drainage
Exposure Unit Surface Soil
Sampling Locations in PMJM
Habitat for Manganese



KEY

Surface soil sample location
- Detect >= Maximum background >= 3 x ESL
- Detect >= Maximum background >= ESL
- Detect >= Maximum background < ESL
- Detect < Maximum background
- Nondetect
- Lower Woman Drainage EU
- PMJM habitat patch
- 1 PMJM habitat patch ID

ESL: 388 mg/kg
Maximum background concentration: 357 mg/kg

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

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0 650 1300 Feet

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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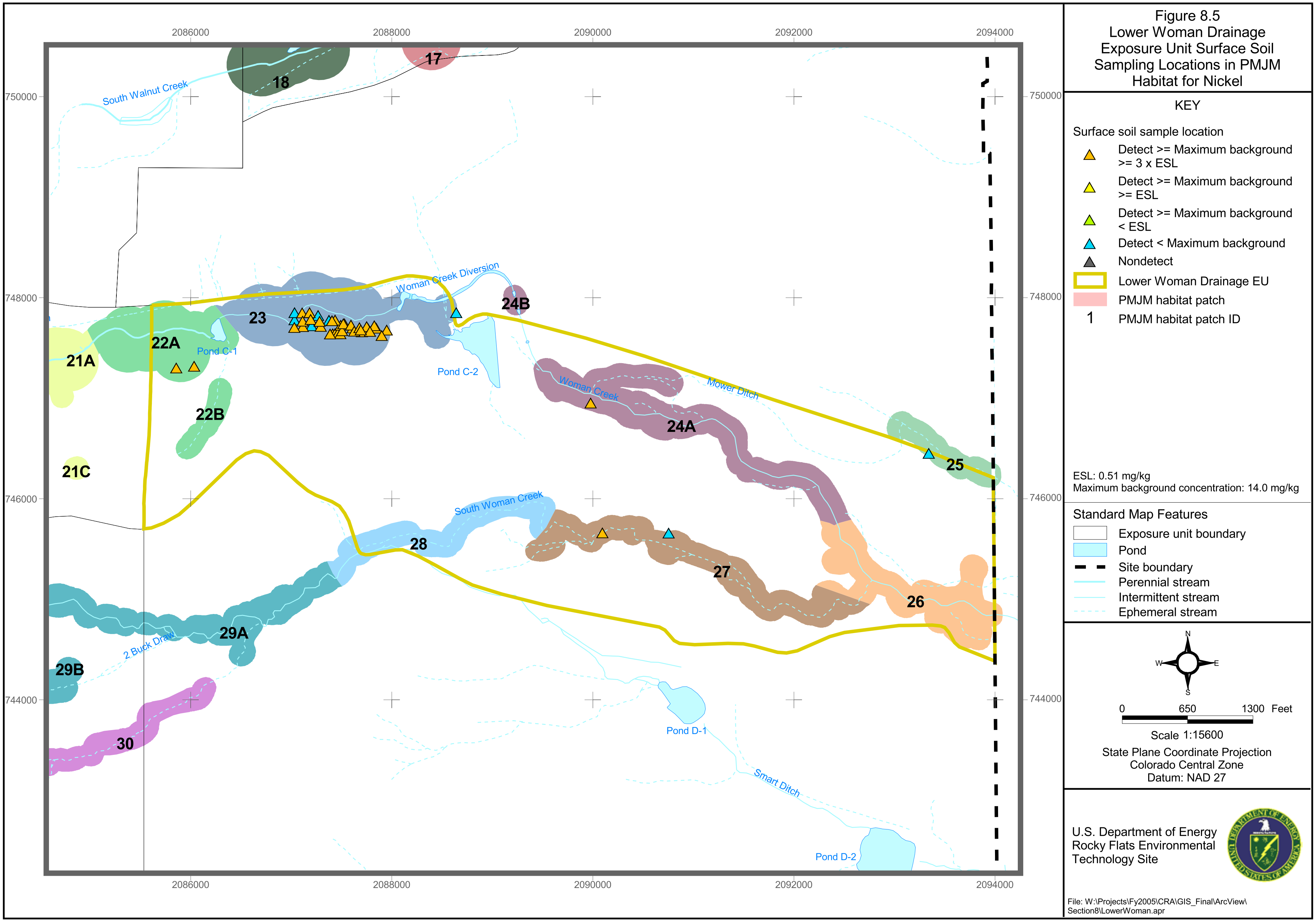

Figure 8.5
Lower Woman Drainage
Exposure Unit Surface Soil
Sampling Locations in PMJM
Habitat for Nickel
KEY
Surface soil sample location
Detect >= Maximum background >= 3 x ESL
Detect >= Maximum background >= ESL
Detect >= Maximum background < ESL
Detect < Maximum background
Nondetect
Lower Woman Drainage EU
PMJM habitat patch
1 PMJM habitat patch ID
ESL: 0.51 mg/kg
Maximum background concentration: 14.0 mg/kg
Standard Map Features
Exposure unit boundary
Pond
Site boundary
Perennial stream
Intermittent stream
Ephemeral stream
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0 650 1300 Feet
Scale 1:15600
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27
U.S. Department of Energy
Rocky Flats Environmental
Technology Site
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2086000
2088000
2090000
2092000
2094000
750000
748000
746000
744000
17
18
21A
21C
22A
22B
23
24A
24B
25
26
27
28
29A
29B
30
South Walnut Creek
Woman Creek Diversion
Pond C-1
Pond C-2
Woman Creek
Mower Ditch
South Woman Creek
2 Buck Draw
Pond D-1
Smart Ditch
Pond D-2

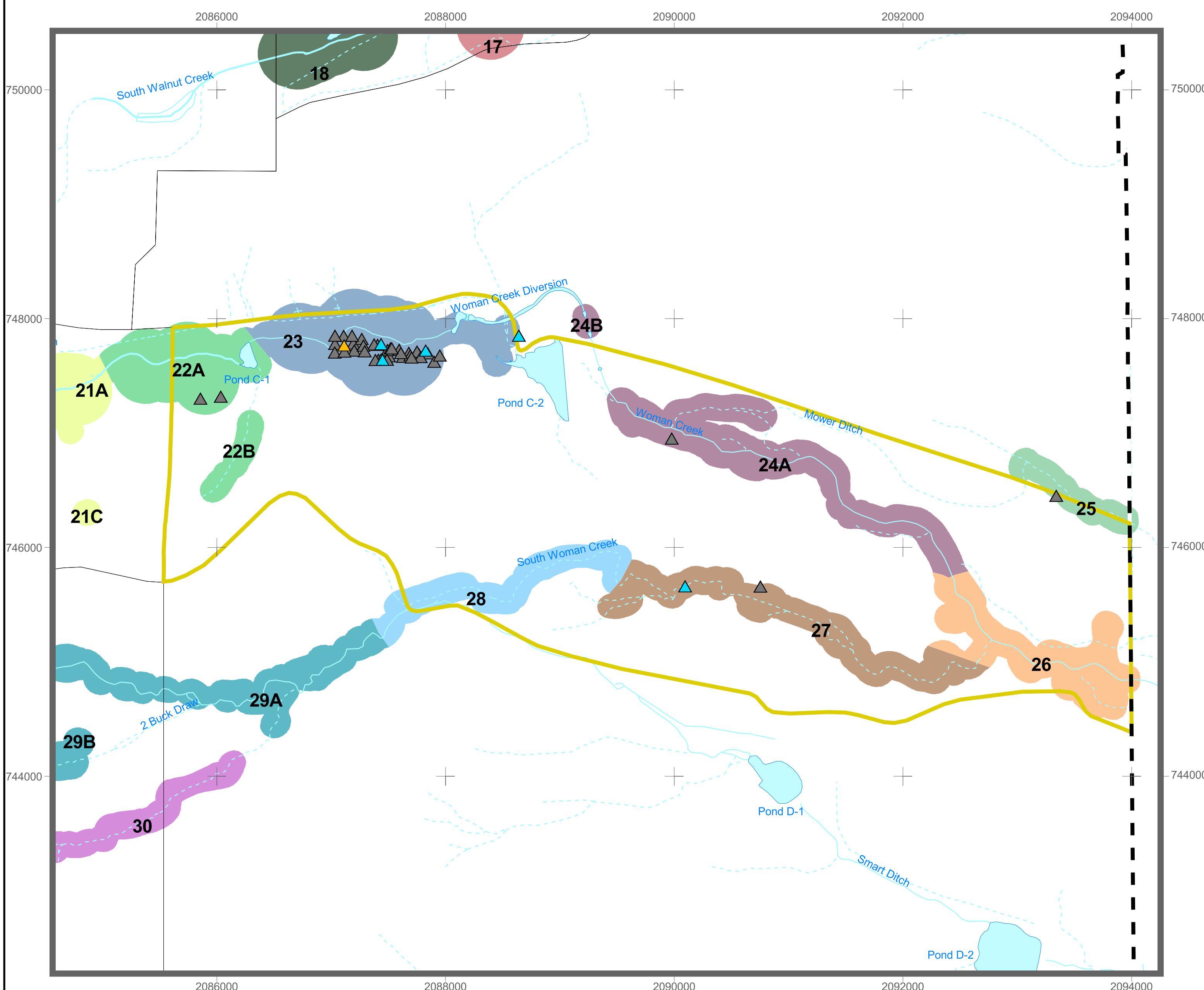

Figure 8.6
Lower Woman Drainage
Exposure Unit Surface Soil
Sampling Locations in PMJM
Habitat for Selenium

KEY

Surface soil sample location

- Detect >= Maximum background >= 3 x ESL
- Detect >= Maximum background >= ESL
- Detect >= Maximum background < ESL
- Detect < Maximum background
- Nondetect
- Lower Woman Drainage EU
- PMJM habitat patch
- 1 PMJM habitat patch ID

ESL: 0.42 mg/kg
Maximum background concentration: 1.4 mg/kg

Standard Map Features

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

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Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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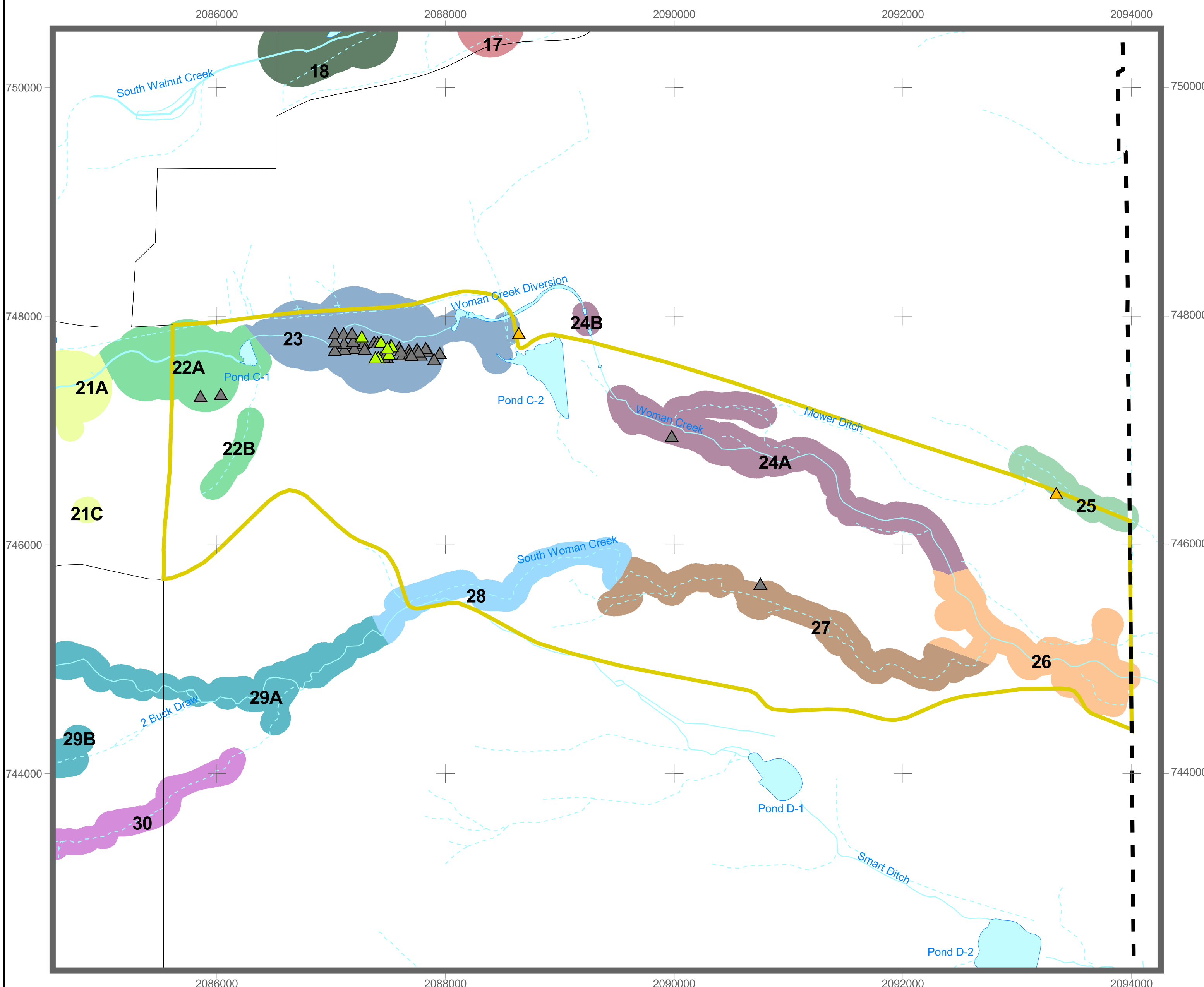
Figure 8.7
Lower Woman Drainage
Exposure Unit Surface Soil
Sampling Locations in PMJM
Habitat for Tin



KEY

Surface soil sample location

- Detect >= Maximum background >= 3 x ESL
- Detect >= Maximum background >= ESL
- Detect >= Maximum background < ESL
- Detect < Maximum background
- Nondetect
- Lower Woman Drainage EU
- PMJM habitat patch
- 1 PMJM habitat patch ID

ESL: 4.21 mg/kg
Maximum background concentration: N/A

Standard Map Features

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

N E S W

0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Technology Site

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

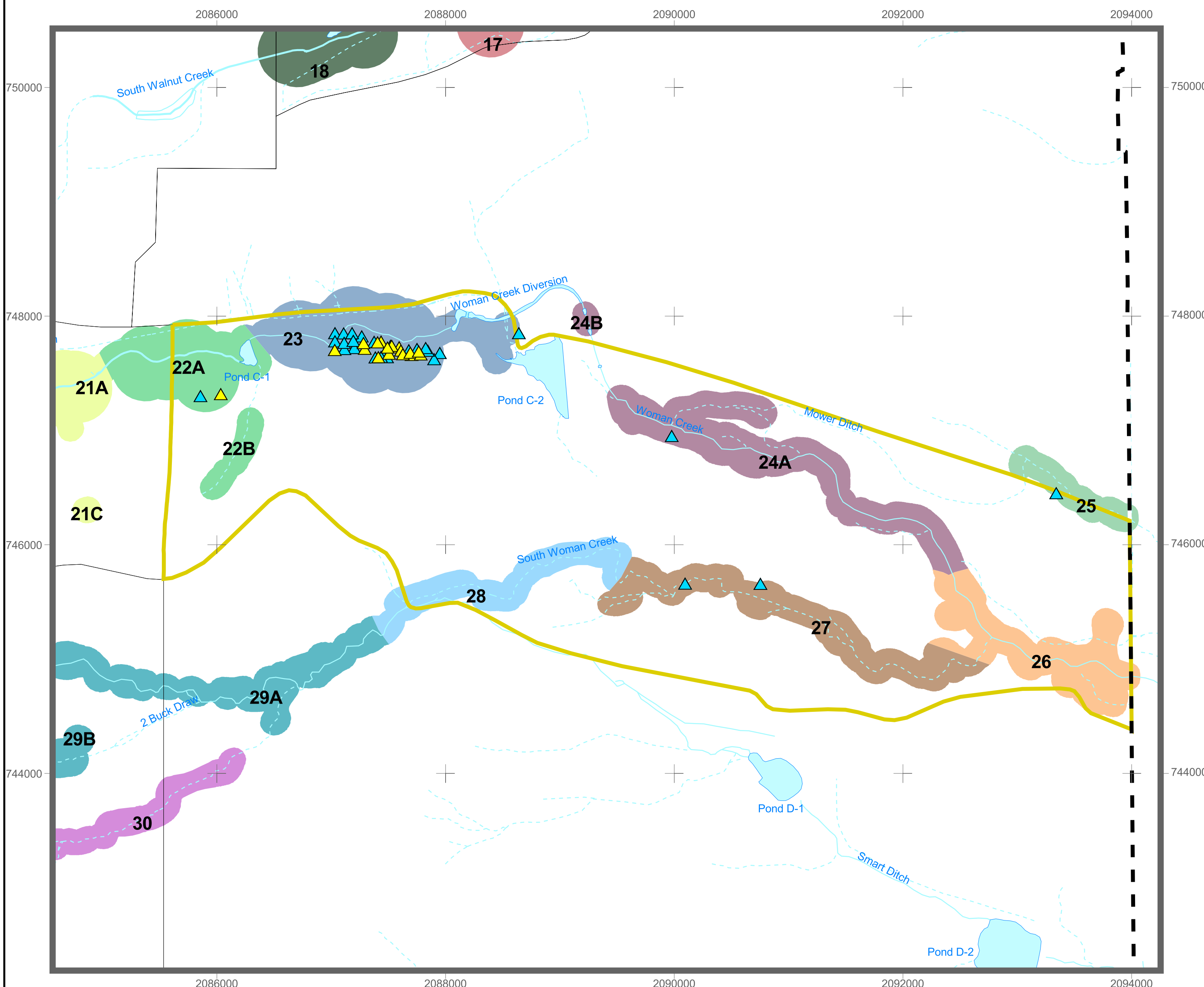

Figure 8.8
Lower Woman Drainage
Exposure Unit Surface Soil
Sampling Locations in PMJM
Habitat for Vanadium

KEY

Surface soil sample location

- Detect >= Maximum background >= 3 x ESL
- Detect >= Maximum background >= ESL
- Detect >= Maximum background < ESL
- Detect < Maximum background
- Nondetect
- Lower Woman Drainage EU
- PMJM habitat patch
- 1 PMJM habitat patch ID

ESL: 21.6 mg/kg
Maximum background concentration: 45.8 mg/kg

Standard Map Features

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

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0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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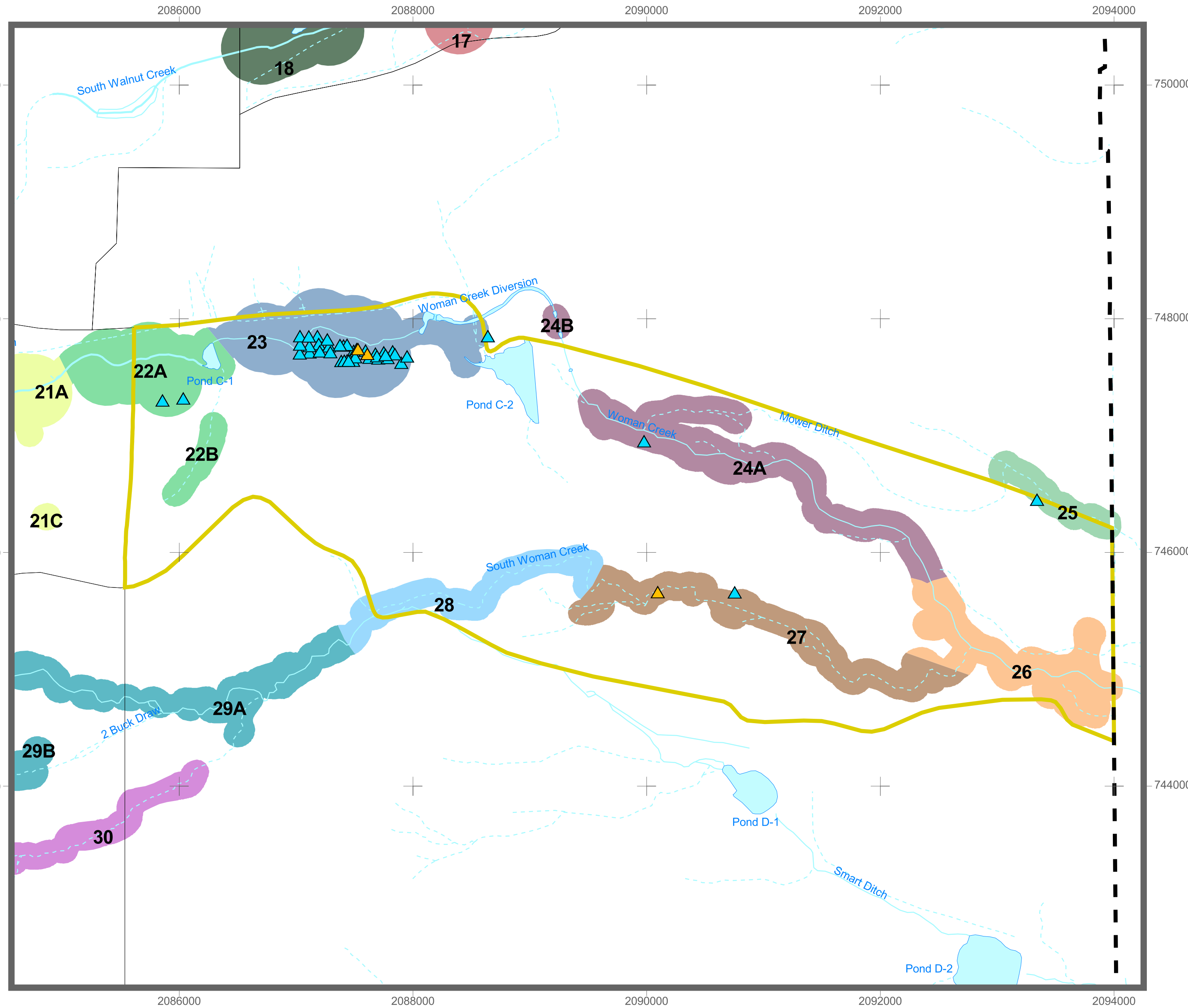

Figure 8.9
Lower Woman Drainage
Exposure Unit Surface Soil
Sampling Locations in PMJM
Habitat for Zinc

KEY

Surface soil sample location

Detect >= Maximum background >= 3 x ESL

Detect >= Maximum background >= ESL

Detect >= Maximum background < ESL

Detect < Maximum background

Nondetect

Lower Woman Drainage EU

PMJM habitat patch

1 PMJM habitat patch ID

ESL: 6.4 mg/kg
Maximum background concentration: 75.9 mg/kg

Standard Map Features

Exposure unit boundary

Pond

Site boundary

Perennial stream

Intermittent stream

Ephemeral stream

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0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Technology Site

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

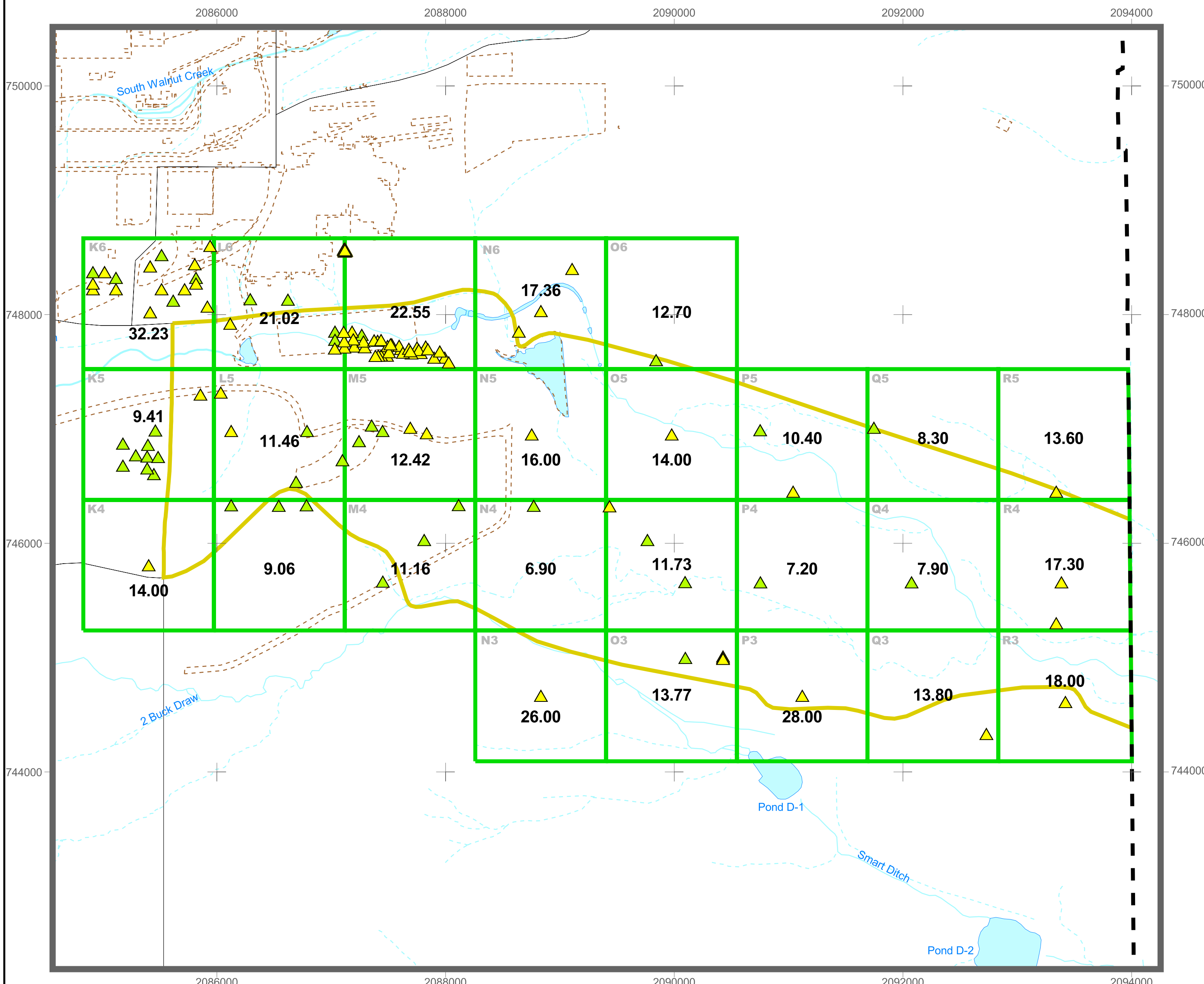

Figure 10.1
Lower Woman Drainage Exposure Unit Sample-by-Sample Comparison to the Limiting ESL - Chromium

KEY

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

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

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

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0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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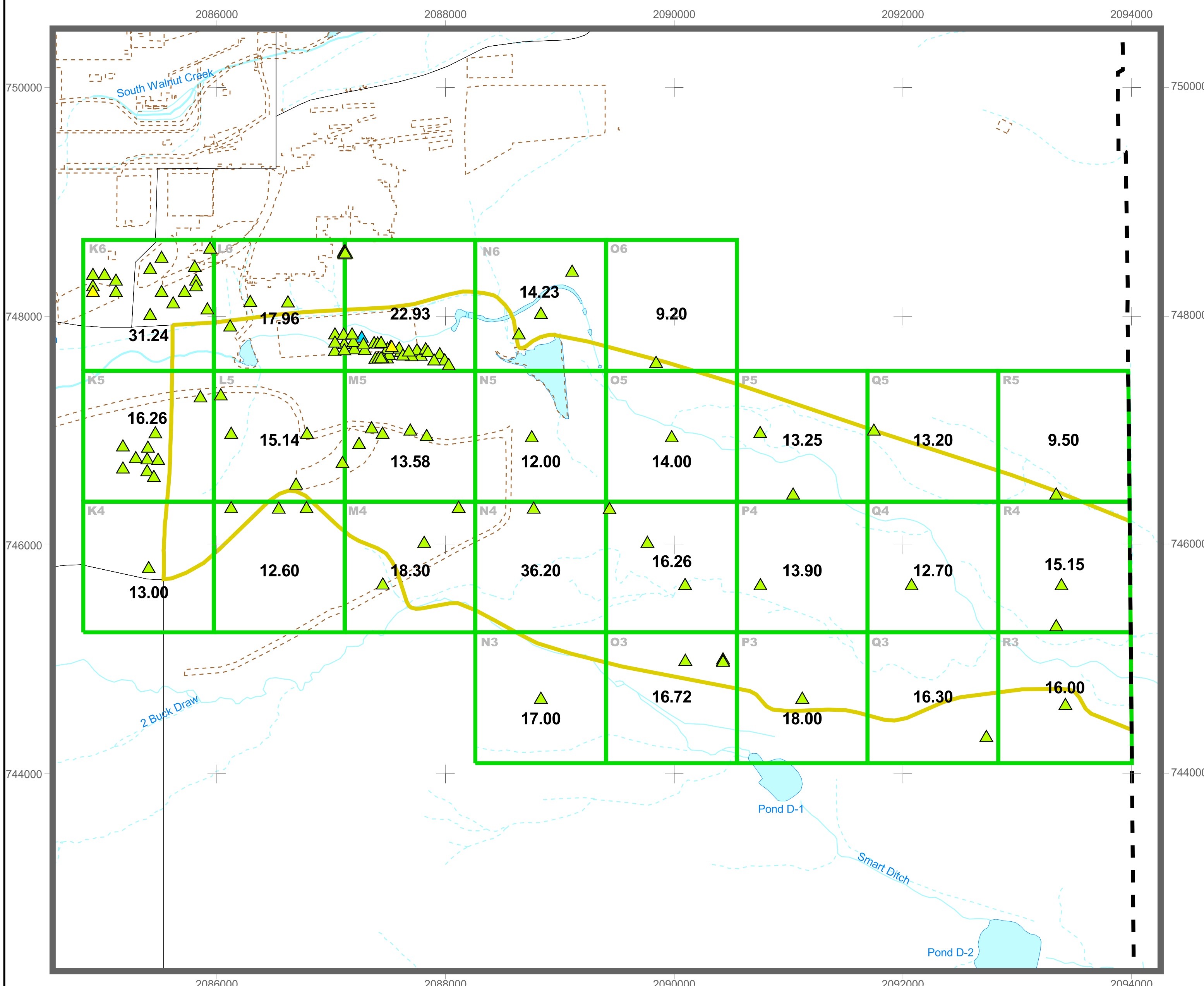
Figure 10.2
Lower Woman Drainage Exposure Unit Sample-by-Sample Comparison to the Limiting ESL - Copper



KEY

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

ESL: 8.25 mg/kg
Receptor: Mourning Dove (Insectivore)
95th UCL background: 14 mg/kg
Maximum background concentration: 16 mg/kg

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

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0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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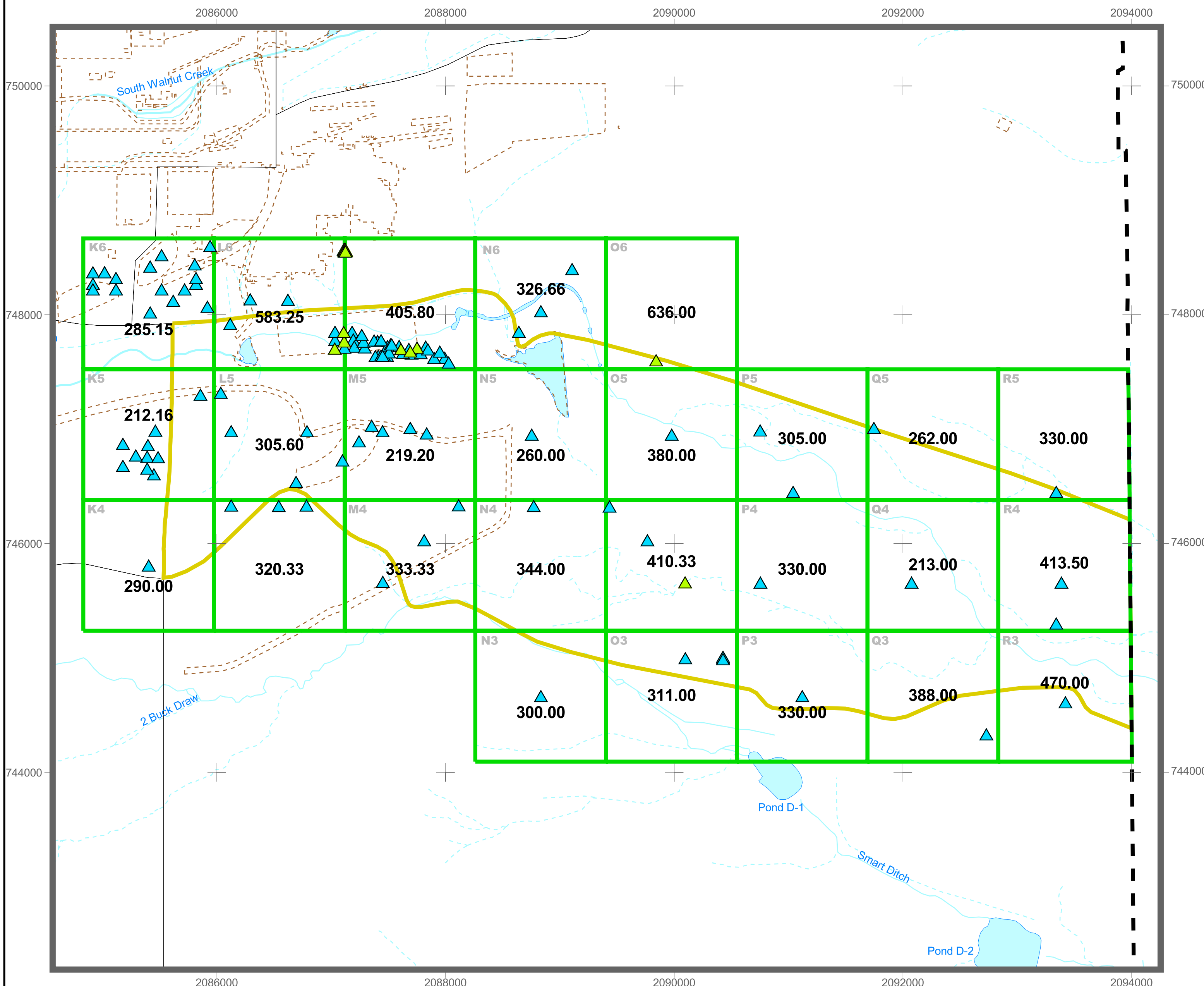
Figure 10.3
Lower Woman Drainage Exposure Unit Sample-by-Sample Comparison to the Limiting ESL - Manganese



KEY

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

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

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

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Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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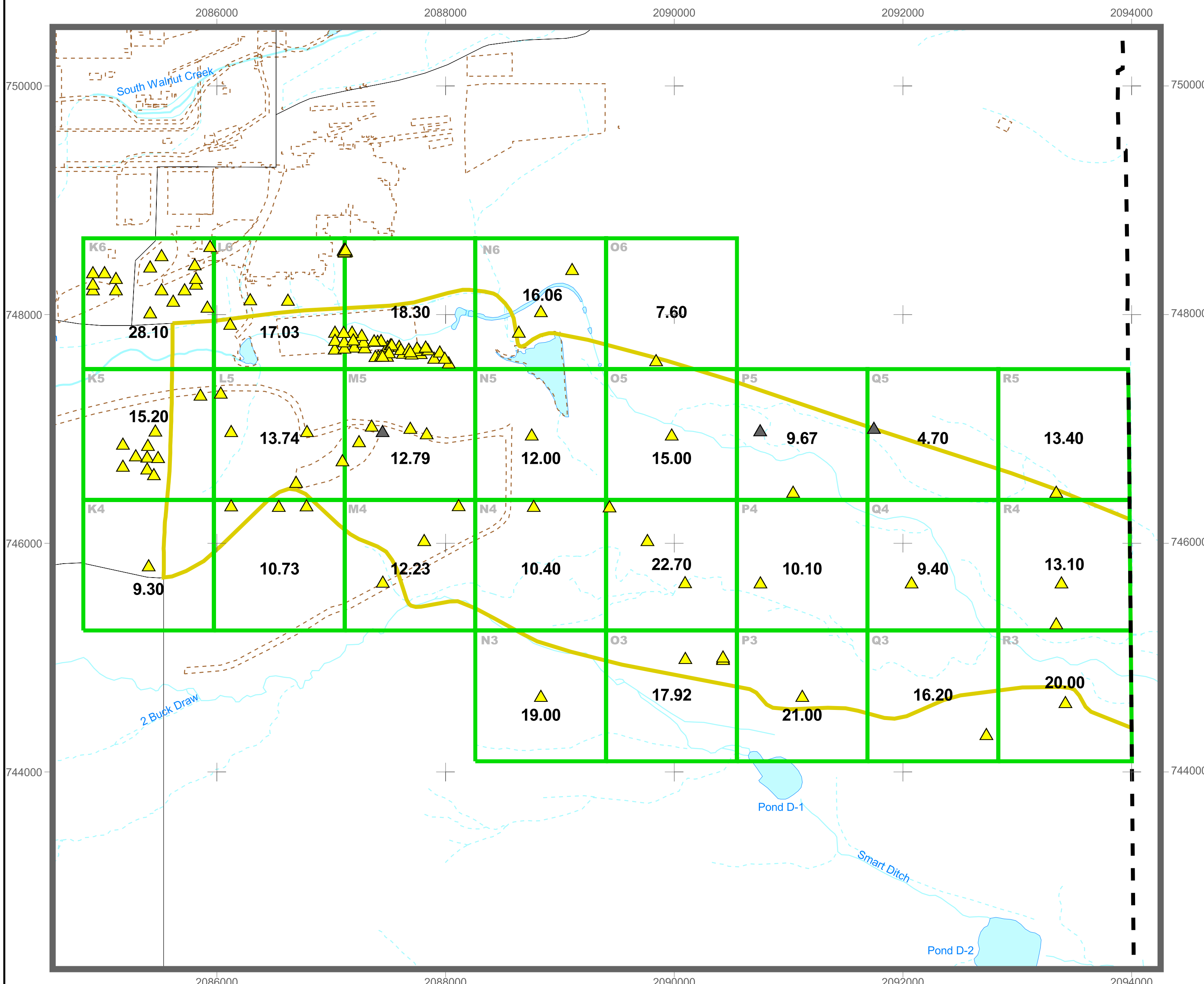
Figure 10.4
Lower Woman Drainage Exposure Unit Sample-by-Sample Comparison to the Limiting ESL - Nickel



KEY

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

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

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

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0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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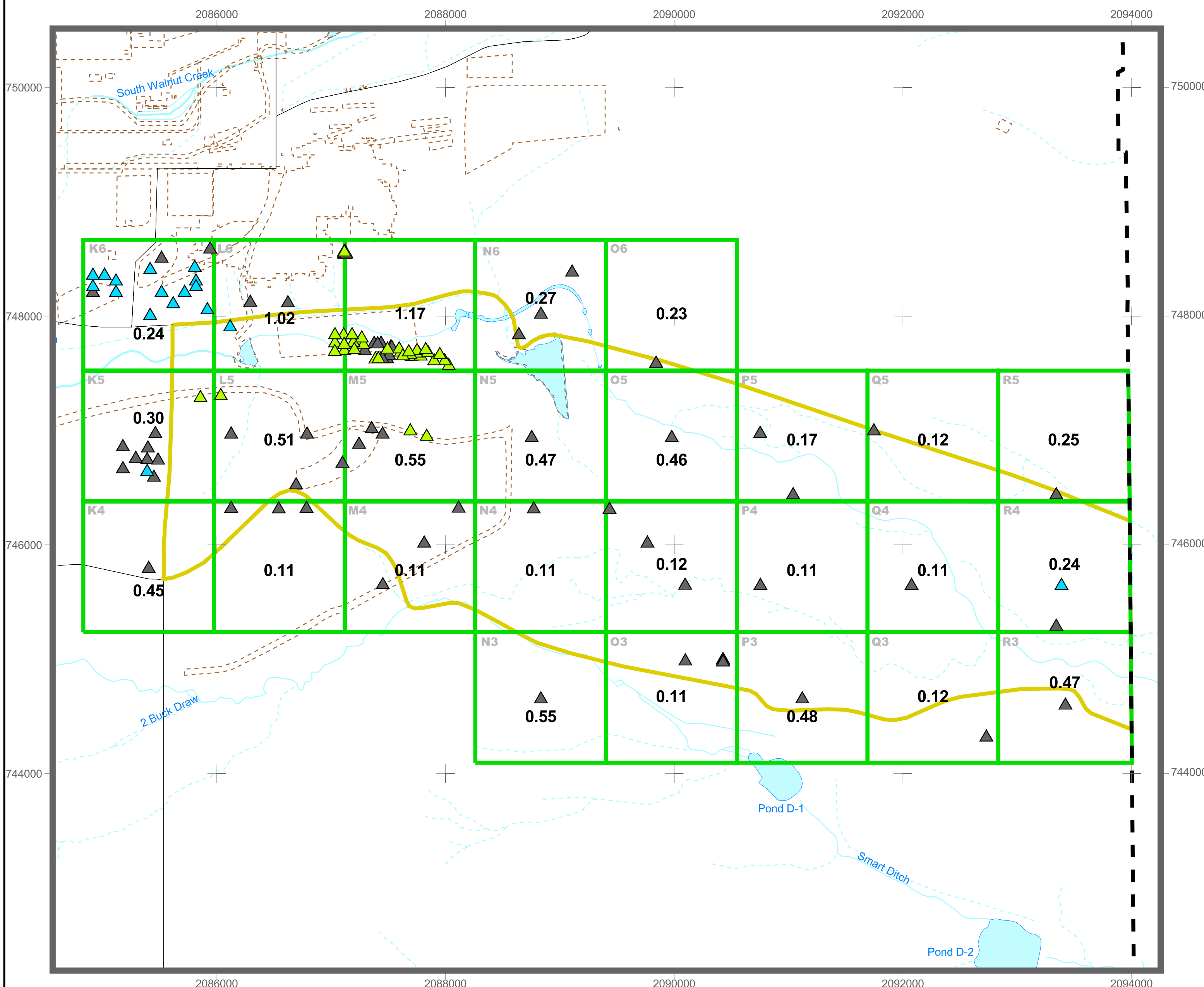

Figure 10.5
Lower Woman Drainage Exposure Unit Sample-by-Sample Comparison to the Limiting ESL - Thallium

KEY

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

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

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

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0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
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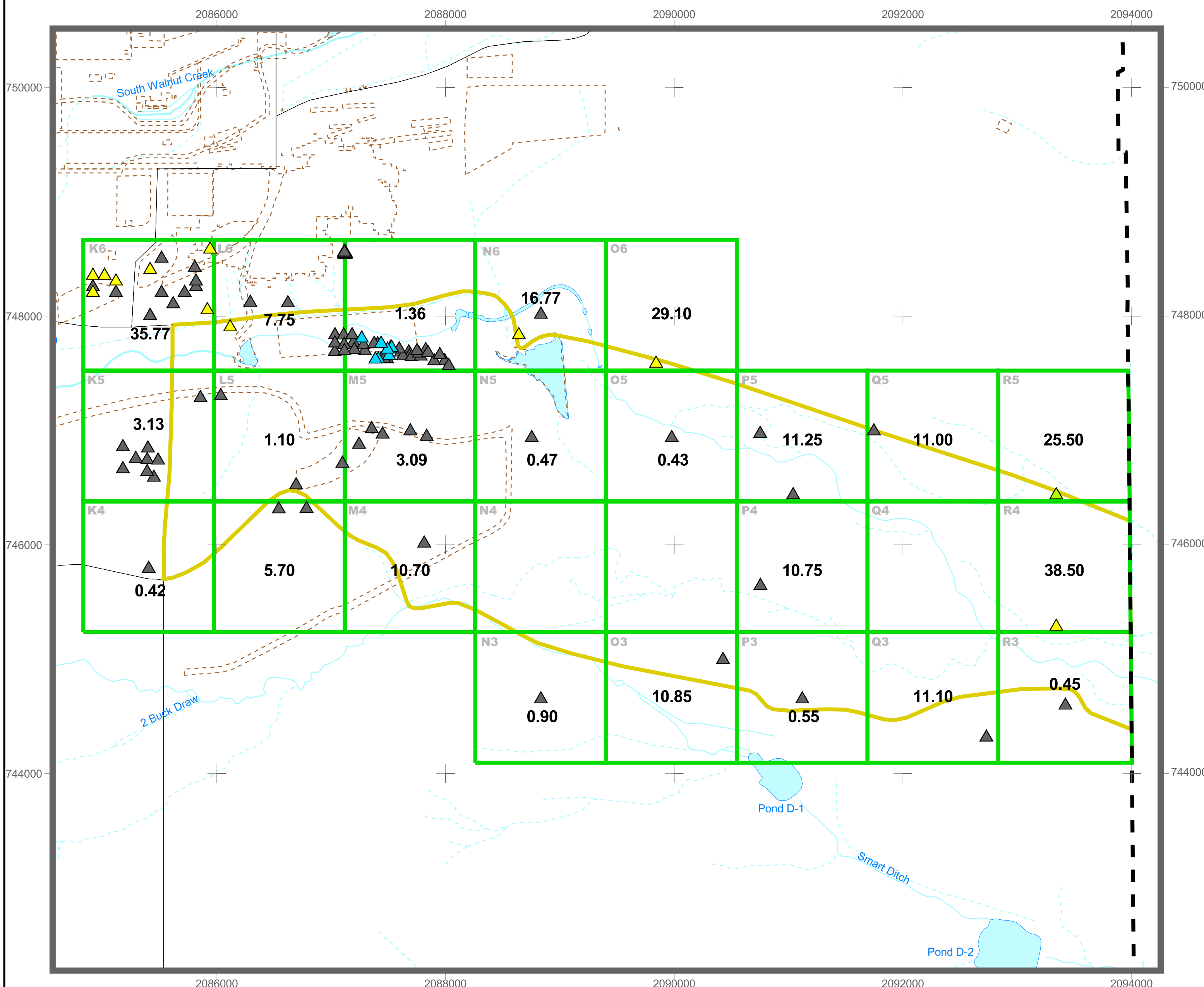

Figure 10.6
Lower Woman Drainage Exposure Unit Sample-by-Sample Comparison to the Limiting ESL - Tin

KEY

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

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

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

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0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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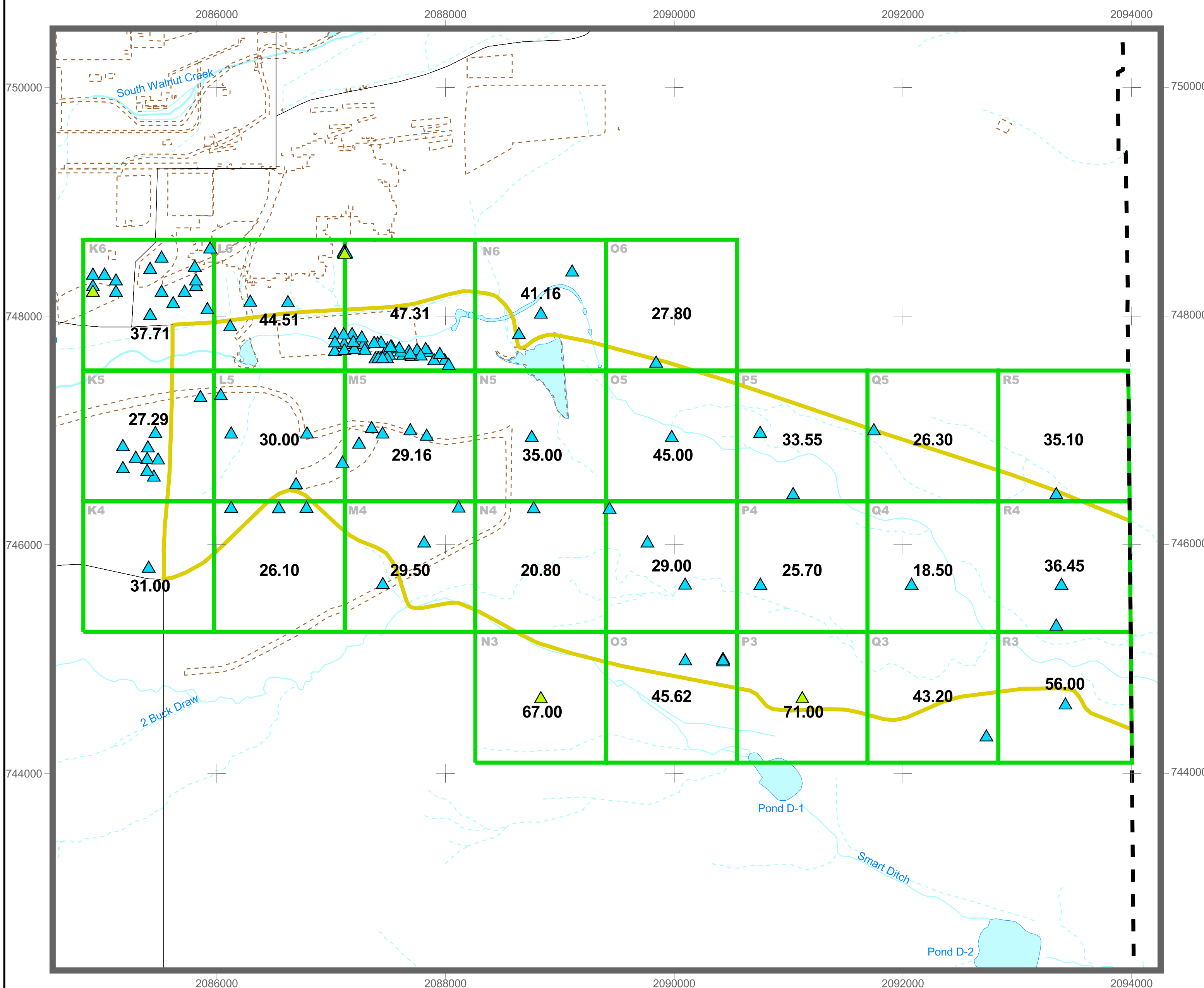

Figure 10.7
Lower Woman Drainage Exposure Unit Sample-by-Sample Comparison to the Limiting ESL - Vanadium

KEY

Surface soil sample location

- Detect >= 10 x ESL
- Detect >= ESL < 10 x ESL
- Detect < ESL
- Nondetect
- Lower Woman Drainage EU
- 30-acre grid
- Historical IHSS/PAC
- A1 Grid cell ID

ESL: 63.7 mg/kg
Receptor: Deer Mouse (Insectivore)
95th UCL background: 30.7 mg/kg
Maximum background concentration: 45.8 mg/kg

Standard Map Features

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

N S E W

0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
Colorado Central Zone
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COMPREHENSIVE RISK ASSESSMENT

LOWER WOMAN DRAINAGE EXPOSURE UNIT

VOLUME 11: ATTACHMENT 1

Detection Limit Screen

TABLE OF CONTENTS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

µg/kg	micrograms per kilogram
µg/L	micrograms per liter
CD	compact disc
CRA	Comprehensive Risk Assessment
ESL	ecological screening level
IHSS	Individual Hazardous Substance Site
LWOEU	Lower Woman Exposure Unit
mg/kg	milligrams per kilogram
N/A	not available or not applicable
NOAEL	no observed adverse effect level
PAC	Potential Area of Concern
pCi/g	picocuries per gram
PRG	preliminary remediation goal
TIC	tentatively identified compound
VOC	volatile organic compound
WRW	wildlife refuge worker

1.0 EVALUATION OF ANALYTE DETECTION LIMITS FOR THE LOWER WOMAN DRAINAGE EXPOSURE ZONE AREA EXPOSURE UNIT

For the Lower Woman Drainage Exposure Unit (EU) (LWOEU), 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 minimum 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 certain, i.e., Instrument Detection Limit (IDL), Method Detection Limit (MDL), Reporting Limit (RL), Sample Quantitation Limit (SQL), etc. 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 10.3.2 of the main text of this volume.

1.1 Comparison of Reported Results to Preliminary Remediation Goals

1.1.1 Surface Soil/Surface Sediment

As shown in Table A1.1, there are only six analytes in surface soil/surface sediment where the reported results exceed the PRG: 4,6-dinitro-2-methylphenol (3%), dibenz(a,h)anthracene (97%), dieldrin (4%), hexachlorobenzene (3%), N-nitroso-di-n-propylamine (77%), and PCB-1260 (6%). For 4,6-dinitro-2-methylphenol, dieldrin, hexachlorobenzene, and PCB-1260 greater than 90% of the reported results are less than the PRGs, which represents only minimal uncertainty in the overall risk estimates. For dibenz(a,h)anthracene and N-nitroso-di-n-propylamine, the maximum reported results are within an order of magnitude of the lowest ESLs. Therefore, the higher reported results for these two analytes also represent minimal uncertainty in the overall risk estimates.

1.1.2 Subsurface Soil/Subsurface Sediment

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

1.2 Comparison of Reported Results to Ecological Screening Levels

1.2.1 Surface Soil

As shown in Table A1.3, there are 27 analytes in surface soil where some percent of the reported results exceed the lowest ESL. For 12 of these analytes, over 50% of the reported results are less than the lowest ESL. Consequently, for these analytes, there is minimal uncertainty in the overall risk estimates because of these higher reported results. Of the remaining 15 analytes, 80 to 100% of the reported results exceed the lowest ESL, and in some cases, the maximum reported results are more than an order of magnitude higher than the lowest ESL. This condition requires further analysis to determine the extent of uncertainty in the overall risk estimates, i.e., ecological risks may be underestimated because these analytes may have been included as ECOPCs had they been detected more frequently using lower detection limits (lower reported results).

First, for these remaining 15 analytes, it is noted that the reported results are generally consistent with industry standards for laboratory detection limits. In all cases, the minimum reported results (see Table A1.3) are similar in magnitude to the Contract Required Quantitation Limits (CRQLs) for the Environmental Protection Agency's (EPA) Contract Laboratory Program (CLP) (330-830 ug/kg for semi-volatile organic compounds (SVOCs); 1.7-3.3 ug/kg for pesticides; and 33-67 ug/kg for PCBs depending on the compound). The CRQLs are minimum limits established by the CLP for identifying contaminants at Superfund sites.

Even though the lower limit of the range of reported results are generally consistent with industry standards for laboratory detection limits, the extent of uncertainty in the overall risk estimates was further assessed based on professional judgment and ecological risk potential.

Professional judgment indicates whether the analytes are likely to be ECOPCs in the LWOEU surface soil based on 1) a listing of the analytes (or classes of analytes) as constituents in wastes potentially released at historical Individual Hazardous Substance Sites (IHSSs) in the LWOEU (DOE 2005a), 2) the historical inventory for the chemical at RFETS (CDH 1991), and 3) a comparison of the maximum detected concentration and detection frequency in the EU and sitewide surface soil (see Table A1.4 for sitewide surface soil summary statistics). The comparison of the EU and sitewide maximum detected concentrations and detection frequencies in surface soil is performed to assess if the EU observations are much higher, which may potentially also indicate a source for the analyte within the EU. Using professional judgment, the analytes can be grouped into four categories that represent an ascending order of uncertainty. Category 1 is for analytes that were not listed as waste constituents for the EU historical IHSSs, and are not detected in the EU or sitewide surface soil. Category 2 is for analytes that may or may not be listed as waste constituents for the EU historical IHSSs, but nevertheless are not detected in the EU surface soil even though they were detected in other EU surface soil at RFETS at low maximum detected concentrations and low detection frequencies. Category 3 is for analytes that may or may not be listed as waste constituents for the EU historical IHSSs, and are detected in the EU (and therefore sitewide) surface soil, and the maximum detected concentrations in the EU surface soil are approximately the same order of magnitude as the ESL, and the detection frequencies are low. For these first three categories, the uncertainty with regard to the risk estimates because of the higher detection limits is considered small. Category 4 is for analytes that are detected in the EU (and therefore sitewide) surface soil at maximum concentrations that substantially exceed the ESLs and at detection frequencies generally higher than for Category 3, i.e., these analytes have the highest likelihood of being ECOPCs had they been detected more frequently using lower detection limits (lower reported results), and therefore, there is some uncertainty with regard to the risk estimates because of the higher detection limits.

The assessment of the ecological risk potential compares the maximum reported result to a Lowest Observed Adverse Effect Level (LOAEL)-based soil concentration. ESLs are based on No Observed Adverse Effect Levels (NOAELs) (DOE 2005b). The LOAEL-based soil concentration is estimated by multiplying the lowest ESL by the LOAEL/NOAEL ratio for the mammal or the bird depending on whether a mammal or bird is the most sensitive terrestrial vertebrate receptor for the chemical (see Appendix B, Table B-2 of the Final CRA Work Plan and Methodology, Revision 1 (DOE 2005b) for the Lowest Bounded LOAELs and Final NOAELs for mammals and birds). A maximum reported result/LOAEL-based soil concentration ratio greater than one indicates a potential for an adverse ecological effect if the analyte was detected at the highest reported result.

As shown in Table A1.5, all of the 15 analytes assessed using professional judgment are in categories 1 through 3, and thus are not likely to be ECOPCs in the LWOEU surface soil based on professional judgment, which minimizes the uncertainty in the overall risk estimates because of their higher reported results. Although di-n-butylphthalate and pentachlorophenol were not detected in the EU surface soil, they have been classified as category 3 analytes because of the relatively high concentrations of these chemicals observed in sitewide surface soil. Nevertheless, the uncertainty associated with category 3 analytes is low. Comparing the maximum reported results to the LOAEL-based soil concentrations indicates more than half of the above noted analytes would also not present a potential for adverse ecological effects if they were detected at the maximum reported results.

In conclusion, analytes in surface soil that have reported results that exceed the lowest ESLs contribute only minimal uncertainty to the overall risk estimates because either only a small fraction of the reported results are greater than the lowest ESL, or professional judgment indicates they are not likely to be ECOPCs in LWOEU surface soil even if detection limits had been lower. Although some of the analytes would present a potential for adverse ecological effects if they were detected at their maximum reported results, because they are not expected to be present in LWOEU surface soil, uncertainty in the overall risk estimates is low.

1.2.2 Subsurface Soil

All reported results are below the ESLs in subsurface soil (Table A1.6).

2.0 REFERENCES

CDH, 1991. Colorado Department of Health Project Task 1 Report (Revised 1), Identification of Chemicals and Radionuclides Used at Rocky Flats. Prepared by ChemRisk. March.

DOE, 2005a, 2005 Annual Update to the Historical Release Report, Rocky Flats Environmental Technology Site, October.

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

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 LWOEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	PRG	Number of Nondetected Results > PRG	Percent Nondetected Results > PRG	Analyte Detected?
Inorganic (mg/kg)								
Uranium	1.40	-	18	56	333	0	0	No
Organic (ug/kg)								
1,1,1-Trichloroethane	6	-	16	15	9.18E+06	0	0	No
1,1,2,2-Tetrachloroethane	6	-	16	15	10,483	0	0	No
1,1,2-Trichloroethane	6	-	16	15	28,022	0	0	No
1,1-Dichloroethane	6	-	16	15	2.72E+06	0	0	No
1,1-Dichloroethene	6	-	16	15	17,366	0	0	No
1,2,4-Trichlorobenzene	360	-	2,100	31	151,360	0	0	No
1,2-Dichlorobenzene	360	-	2,100	27	2.89E+06	0	0	No
1,2-Dichloroethane	6	-	16	15	13,270	0	0	No
1,2-Dichloroethene	6	-	16	15	999,783	0	0	No
1,2-Dichloropropane	6	-	16	15	38,427	0	0	No
1,3-Dichlorobenzene	360	-	2,100	31	3.33E+06	0	0	No
1,4-Dichlorobenzene	360	-	2,100	27	91,315	0	0	No
1234789-HpCDF	0.00271	-	0.00271	1		0	0	No
123478-HxCDD	0.00271	-	0.00271	1	0.483	0	0	No
123478-HxCDF	0.00271	-	0.00271	1		0	0	No
123678-HxCDD	0.00271	-	0.00271	1	0.483	0	0	No
123678-HxCDF	0.00271	-	0.00271	1		0	0	No
123789-HxCDD	0.00271	-	0.00271	1	0.483	0	0	No
123789-HxCDF	0.00271	-	0.00271	1		0	0	No
12378-PeCDF	0.00271	-	0.00271	1		0	0	No
2,4,5-Trichlorophenol	1,200	-	10,000	31	8.01E+06	0	0	No
2,4,6-Trichlorophenol	360	-	2,100	31	272,055	0	0	No
2,4-Dichlorophenol	360	-	2,100	31	240,431	0	0	No
2,4-Dimethylphenol	360	-	2,100	31	1.60E+06	0	0	No
2,4-Dinitrophenol	1,700	-	10,000	28	160,287	0	0	Yes
2,4-Dinitrotoluene	360	-	2,100	31	160,287	0	0	No
2,6-Dinitrotoluene	360	-	2,100	31	80,144	0	0	No
234678-HxCDF	0.00271	-	0.00271	1		0	0	No
23478-PeCDF	0.00271	-	0.00271	1		0	0	No
2378-TCDD	0.00108	-	0.00108	1	0.0248	0	0	No
2378-TCDF	0.00108	-	0.00108	1		0	0	No
2-Chloronaphthalene	360	-	2,100	31	6.41E+06	0	0	No
2-Chlorophenol	360	-	2,100	31	555,435	0	0	No
2-Hexanone	12	-	32	14		0	0	No
2-Methylnaphthalene	360	-	2,100	31	320,574	0	0	No
2-Methylphenol	360	-	2,100	31	4.01E+06	0	0	No
2-Nitroaniline	1,700	-	10,000	31	192,137	0	0	No
2-Nitrophenol	360	-	2,100	31		0	0	No
3,3'-Dichlorobenzidine	720	-	4,100	31	6,667	0	0	No
3-Nitroaniline	1,700	-	10,000	31		0	0	No
4,4'-DDD	17	-	200	28	15,528	0	0	No
4,4'-DDE	17	-	200	28	10,961	0	0	No
4,4'-DDT	17	-	200	28	10,927	0	0	No
4,6-Dinitro-2-methylphenol	1,700	-	10,000	30	8,014	1	3.33	Yes
4-Bromophenyl-phenylether	360	-	2,100	31		0	0	No
4-Chloro-3-methylphenol	360	-	3,100	31		0	0	No
4-Chloroaniline	360	-	3,100	31	320,574	0	0	No
4-Chlorophenyl-phenyl ether	360	-	2,100	31		0	0	No
4-Nitroaniline	1,700	-	10,000	30	207,917	0	0	No
4-Nitrophenol	1,700	-	10,000	31	641,148	0	0	No
Acenaphthylene	360	-	2,100	31		0	0	No

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 LWOEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	PRG	Number of Nondetected Results > PRG	Percent Nondetected Results > PRG	Analyte Detected?
Inorganic (mg/kg)								
Aldrin	8.60	-	99	27	176	0	0	Yes
alpha-BHC	8.60	-	99	28	570	0	0	No
alpha-Chlordane	86	-	990	27	10,261	0	0	Yes
Ametryne	50	-	50	1		0	0	No
Atraton	50	-	50	1		0	0	No
Atrazine	50	-	50	1	13,636	0	0	No
Benzene	6	-	16	15	23,563	0	0	No
Benzo(g,h,i)perylene	360	-	2,100	30		0	0	Yes
Benzyl Alcohol	360	-	3,100	31	2.40E+07	0	0	No
beta-BHC	8.60	-	99	27	1,995	0	0	Yes
beta-Chlordane	86	-	270	11	10,261	0	0	No
bis(2-Chloroethoxy) methane	360	-	2,100	31		0	0	No
bis(2-Chloroethyl) ether	360	-	2,100	31	3,767	0	0	No
bis(2-Chloroisopropyl) ether	360	-	2,100	31	59,301	0	0	No
Bromodichloromethane	6	-	16	15	67,070	0	0	No
Bromoform	6	-	16	15	419,858	0	0	No
Bromomethane	12	-	32	15	20,959	0	0	No
Butylbenzylphthalate	360	-	2,100	30	1.60E+07	0	0	Yes
Carbon Disulfide	6	-	16	15	1.64E+06	0	0	No
Carbon Tetrachloride	6	-	16	15	8,446	0	0	No
Chlorobenzene	6	-	16	15	666,523	0	0	No
Chloroethane	12	-	32	15	1.43E+06	0	0	No
Chloroform	6	-	16	15	7,850	0	0	No
Chloromethane	15	-	32	13	115,077	0	0	No
cis-1,3-Dichloropropene	6	-	16	15	19,432	0	0	No
delta-BHC	8.60	-	99	27	570	0	0	Yes
Dibenz(a,h)anthracene	360	-	2,100	30	379	29	96.7	Yes
Dibenzofuran	360	-	2,100	31	222,174	0	0	No
Dibromochloromethane	6	-	16	15	49,504	0	0	No
Dieldrin	17	-	200	28	187	1	3.57	No
Diethylphthalate	360	-	2,100	31	6.41E+07	0	0	No
Dimethylphthalate	360	-	2,100	31	8.01E+08	0	0	No
Di-n-octylphthalate	360	-	2,100	31	3.21E+06	0	0	No
Endosulfan I	8.60	-	99	27	480,861	0	0	Yes
Endosulfan II	17	-	200	28	480,861	0	0	No
Endosulfan sulfate	17	-	200	28	480,861	0	0	No
Endrin	17	-	200	28	24,043	0	0	No
Endrin ketone	17	-	200	28	33,326	0	0	No
Ethylbenzene	6	-	16	15	5.39E+06	0	0	No
Fluorene	360	-	2,100	31	3.21E+06	0	0	No
gamma-BHC (Lindane)	8.60	-	99	27	2,771	0	0	Yes
Heptachlor	8.60	-	99	27	665	0	0	Yes
Heptachlor epoxide	8.60	-	99	27	329	0	0	Yes
Hexachlorobenzene	360	-	2,100	31	1,870	1	3.23	No
Hexachlorobutadiene	360	-	2,100	31	22,217	0	0	No
Hexachlorocyclopentadiene	360	-	2,100	30	380,452	0	0	No
Hexachloroethane	360	-	2,100	31	111,087	0	0	No
Isophorone	360	-	2,100	31	3.16E+06	0	0	No
Methoxychlor	86	-	990	28	400,718	0	0	No
Naphthalene	360	-	2,100	31	1.40E+06	0	0	No
Nitrobenzene	360	-	2,100	31	43,246	0	0	No
N-Nitroso-di-n-propylamine	360	-	2,100	31	429	24	77.4	No
N-nitrosodiphenylamine	360	-	2,100	31	612,250	0	0	No

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 LWOEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	PRG	Number of Nondetected Results > PRG	Percent Nondetected Results > PRG	Analyte Detected?
Inorganic (mg/kg)								
PCB-1016	58	-	990	32	1,349	0	0	No
PCB-1221	58	-	990	32	1,349	0	0	No
PCB-1232	58	-	990	32	1,349	0	0	No
PCB-1242	58	-	990	32	1,349	0	0	No
PCB-1248	58	-	990	32	1,349	0	0	No
PCB-1260	58	-	2,000	32	1,349	2	6.25	No
Pentachlorodibenzo-p-dioxin	0.00271	-	0.00271	1		0	0	No
Pentachlorophenol	1,700	-	10,000	30	17,633	0	0	Yes
Phenol	360	-	2,100	30	2.40E+07	0	0	Yes
Prometon	50	-	50	1		0	0	No
Prometryn	50	-	50	1		0	0	No
Propazine	50	-	50	1		0	0	No
Pyridine	1,200	-	1,600	4		0	0	No
Simazine	50	-	50	1	25,000	0	0	No
Simetryn	50	-	50	1		0	0	No
Styrene	6	-	16	15	1.38E+07	0	0	No
Terbutryn	50	-	50	1		0	0	No
Terbutylazine	50	-	50	1		0	0	No
Tetrachloroethene	6	-	16	15	6,705	0	0	No
Toxaphene	170	-	2,000	28	2,720	0	0	No
trans-1,3-Dichloropropene	6	-	16	15	20,820	0	0	No
Trichloroethene	6	-	16	15	1,770	0	0	No
Vinyl acetate	12	-	32	15	2.65E+06	0	0	No
Vinyl Chloride	12	-	32	15	2,169	0	0	No
Xylene	6	-	16	15	1.06E+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 LWOEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	PRG	Number of Nondetected Results > PRG	Percent Nondetected Results > PRG	Analyte Detected?
Inorganic (mg/kg)								
Silver	0.0730	-	1.40	51	6,388	0	0	Yes
Organic (ug/kg)								
1,1,1,2-Tetrachloroethane	0.952	-	6	3	1.05E+06	0	0	No
1,1,1-Trichloroethane	0.841	-	16	23	1.06E+08	0	0	No
1,1,2,2-Tetrachloroethane	0.928	-	16	23	120,551	0	0	No
1,1,2-Trichloro-1,2,2-trifluoroethane	0.840	-	6	3	2.74E+10	0	0	No
1,1,2-Trichloroethane	1.57	-	16	23	322,253	0	0	No
1,1-Dichloroethane	0.782	-	16	23	3.12E+07	0	0	No
1,1-Dichloroethene	0.873	-	16	23	199,706	0	0	No
1,1-Dichloropropene	0.606	-	6	3		0	0	No
1,2,3-Trichlorobenzene	2.05	-	6	3		0	0	No
1,2,3-Trichloropropane	1.08	-	6	3	23,910	0	0	No
1,2,4-Trichlorobenzene	1.76	-	1,800	13	1.74E+06	0	0	No
1,2,4-Trimethylbenzene	1.20	-	6	3	1.53E+06	0	0	No
1,2-Dibromo-3-chloropropane	2.21	-	6	3	34,137	0	0	No
1,2-Dibromoethane	1.34	-	6	3	403	0	0	No
1,2-Dichlorobenzene	1.08	-	1,800	11	3.32E+07	0	0	No
1,2-Dichloroethane	1.17	-	16	23	152,603	0	0	No
1,2-Dichloroethene	5	-	16	20	1.15E+07	0	0	No
1,2-Dichloropropane	0.747	-	16	23	441,907	0	0	No
1,3,5-Trimethylbenzene	0.942	-	6	3	1.31E+06	0	0	No
1,3-Dichlorobenzene	0.911	-	1,800	13	3.83E+07	0	0	No
1,3-Dichloropropane	0.850	-	6	3		0	0	No
1,4-Dichlorobenzene	1.32	-	1,800	11	1.05E+06	0	0	No
1234789-HpCDF	0.00147	-	0.00226	3		0	0	No
123478-HxCDD	0.00147	-	0.00226	3	5.55	0	0	No
123678-HxCDD	0.00147	-	0.00226	3	5.55	0	0	No
123789-HxCDD	0.00147	-	0.00226	3	5.55	0	0	No
123789-HxCDF	0.00147	-	0.00226	3		0	0	No
2,2-Dichloropropane	0.667	-	6	3		0	0	No
2,4,5-Trichlorophenol	410	-	8,900	11	9.22E+07	0	0	No
2,4,6-Trichlorophenol	340	-	1,800	11	3.13E+06	0	0	No
2,4-Dichlorophenol	340	-	1,800	11	2.76E+06	0	0	No
2,4-Dimethylphenol	340	-	1,800	11	1.84E+07	0	0	No
2,4-Dinitrophenol	1,600	-	8,900	11	1.84E+06	0	0	No
2,4-Dinitrotoluene	340	-	1,800	11	1.84E+06	0	0	No
2,6-Dinitrotoluene	340	-	1,800	11	921,651	0	0	No
2-Butanone	3.89	-	119	15	5.33E+08	0	0	No
2-Chloronaphthalene	340	-	1,800	11	7.37E+07	0	0	No
2-Chlorophenol	340	-	1,800	11	6.39E+06	0	0	No
2-Chlorotoluene	0.680	-	6	3	2.56E+07	0	0	No
2-Hexanone	2.20	-	59.5	23		0	0	No
2-Methylnaphthalene	340	-	1,800	11	3.69E+06	0	0	No
2-Methylphenol	340	-	1,800	11	4.61E+07	0	0	No
2-Nitroaniline	1,600	-	8,900	11	2.21E+06	0	0	No
2-Nitrophenol	340	-	1,800	11		0	0	No
3,3'-Dichlorobenzidine	670	-	3,700	11	76,667	0	0	No
3-Nitroaniline	1,600	-	8,900	10		0	0	No
4,4'-DDD	33	-	100	7	178,570	0	0	No
4,4'-DDE	33	-	100	7	126,049	0	0	No
4,4'-DDT	33	-	100	7	125,658	0	0	No
4,6-Dinitro-2-methylphenol	1,600	-	8,900	11	92,165	0	0	No
4-Bromophenyl-phenylether	340	-	1,800	11		0	0	No
4-Chloro-3-methylphenol	340	-	2,700	11		0	0	No
4-Chloroaniline	340	-	2,700	11	3.69E+06	0	0	No
4-Chlorophenyl-phenyl ether	340	-	1,800	11		0	0	No
4-Chlorotoluene	0.891	-	6	3		0	0	No
4-Isopropyltoluene	0.990	-	6	3		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 LWOEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	PRG	Number of Nondetected Results > PRG	Percent Nondetected Results > PRG	Analyte Detected?
Inorganic (mg/kg)								
4-Methyl-2-pentanone	2.78	-	59.5	21	9.57E+08	0	0	No
4-Methylphenol	340	-	1,800	11	4.61E+06	0	0	No
4-Nitroaniline	1,600	-	8,900	11	2.39E+06	0	0	No
4-Nitrophenol	1,600	-	8,900	11	7.37E+06	0	0	No
Acenaphthylene	340	-	1,800	11		0	0	No
Aldrin	17	-	50	7	2,024	0	0	No
alpha-BHC	17	-	50	7	6,555	0	0	No
alpha-Chlordane	170	-	500	7	117,997	0	0	No
Ametryne	50	-	50	1		0	0	No
Atraton	50	-	50	1		0	0	No
Atrazine	50	-	410	2	156,820	0	0	No
Benzene	0.900	-	16	23	270,977	0	0	No
Benzo(b)fluoranthene	340	-	1,800	11	43,616	0	0	No
Benzo(g,h,i)perylene	340	-	1,800	11		0	0	No
Benzo(k)fluoranthene	340	-	1,800	11	436,159	0	0	No
Benzyl Alcohol	340	-	2,700	10	2.76E+08	0	0	No
beta-BHC	17	-	50	7	22,942	0	0	No
beta-Chlordane	330	-	330	1	117,997	0	0	No
bis(2-Chloroethoxy) methane	340	-	1,800	11		0	0	No
bis(2-Chloroethyl) ether	340	-	1,800	11	43,315	0	0	No
bis(2-Chloroisopropyl) ether	340	-	1,800	10	681,967	0	0	No
Bromobenzene	0.954	-	6	3		0	0	No
Bromochloromethane	1.03	-	6	3		0	0	No
Bromodichloromethane	1.08	-	16	23	771,304	0	0	No
Bromoform	1.18	-	16	23	4.83E+06	0	0	No
Bromomethane	4.43	-	32	21	241,033	0	0	No
Butylbenzylphthalate	340	-	1,800	11	1.84E+08	0	0	No
Carbon Disulfide	0.898	-	16	23	1.88E+07	0	0	No
Carbon Tetrachloride	0.823	-	16	23	97,124	0	0	No
Chlorobenzene	0.717	-	16	23	7.67E+06	0	0	No
Chloroethane	2.23	-	32	23	1.65E+07	0	0	No
Chloroform	0.777	-	16	23	90,270	0	0	No
Chloromethane	2.51	-	32	23	1.32E+06	0	0	No
cis-1,2-Dichloroethene	1.13	-	6	3	1.28E+07	0	0	No
cis-1,3-Dichloropropene	1.13	-	16	23	223,462	0	0	No
delta-BHC	17	-	50	7	6,555	0	0	No
Dibenz(a,h)anthracene	340	-	1,800	10	4,362	0	0	No
Dibenzofuran	340	-	1,800	11	2.56E+06	0	0	No
Dibromochloromethane	1.17	-	16	23	569,296	0	0	No
Dibromomethane	1.12	-	6	3		0	0	No
Dichlorodifluoromethane	2.76	-	6	3	2.64E+06	0	0	No
Dieldrin	33	-	100	7	2,151	0	0	No
Diethylphthalate	340	-	1,800	11	7.37E+08	0	0	No
Dimethylphthalate	340	-	1,800	11	9.22E+09	0	0	No
Di-n-octylphthalate	340	-	1,800	11	3.69E+07	0	0	No
Endosulfan I	17	-	50	7	5.53E+06	0	0	No
Endosulfan II	33	-	100	7	5.53E+06	0	0	No
Endosulfan sulfate	33	-	100	7	5.53E+06	0	0	No
Endrin	33	-	100	7	276,495	0	0	No
Endrin ketone	33	-	100	7	383,250	0	0	No
Ethylbenzene	0.657	-	16	23	6.19E+07	0	0	No
Fluorene	340	-	1,800	11	3.69E+07	0	0	No
gamma-BHC (Lindane)	17	-	50	7	31,864	0	0	No
gamma-Chlordane	170	-	500	6	117,997	0	0	No
Heptachlor	17	-	50	7	7,647	0	0	No
Heptachlor epoxide	17	-	50	7	3,782	0	0	No
Hexachlorobenzene	340	-	1,800	11	21,508	0	0	No
Hexachlorobutadiene	1.13	-	1,800	13	255,500	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 LWOEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	PRG	Number of Nondetected Results > PRG	Percent Nondetected Results > PRG	Analyte Detected?
Inorganic (mg/kg)								
Hexachlorocyclopentadiene	340	-	1,800	11	4.38E+06	0	0	No
Hexachloroethane	340	-	1,800	11	1.28E+06	0	0	No
Isophorone	340	-	1,800	11	3.63E+07	0	0	No
Isopropylbenzene	0.516	-	6	3	375,823	0	0	No
Methoxychlor	170	-	500	7	4.61E+06	0	0	No
n-Butylbenzene	1.34	-	6	3		0	0	No
Nitrobenzene	340	-	1,800	11	497,333	0	0	No
N-Nitroso-di-n-propylamine	340	-	1,800	11	4,929	0	0	No
N-nitrosodiphenylamine	340	-	1,800	11	7.04E+06	0	0	No
n-Propylbenzene	0.828	-	6	3		0	0	No
PCB-1016	41	-	500	9	15,514	0	0	No
PCB-1221	41	-	500	9	15,514	0	0	No
PCB-1232	41	-	500	9	15,514	0	0	No
PCB-1242	41	-	500	9	15,514	0	0	No
PCB-1248	41	-	500	9	15,514	0	0	No
PCB-1260	41	-	1,000	9	15,514	0	0	No
Pentachlorophenol	1,600	-	8,900	11	202,777	0	0	No
Phenol	340	-	1,800	11	2.76E+08	0	0	No
Prometon	50	-	50	1		0	0	No
Prometryn	50	-	50	1		0	0	No
Propazine	50	-	50	1		0	0	No
Pyrene	340	-	1,800	11	2.55E+07	0	0	No
Pyridine	820	-	1,400	2		0	0	No
sec-Butylbenzene	0.786	-	6	3		0	0	No
Simazine	50	-	50	1	287,502	0	0	No
Simetryn	50	-	50	1		0	0	No
Styrene	0.900	-	16	23	1.59E+08	0	0	No
Terbutryn	50	-	50	1		0	0	No
Terbutylazine	50	-	50	1		0	0	No
tert-Butylbenzene	1.06	-	6	3		0	0	No
Toxaphene	330	-	1,000	7	31,284	0	0	No
trans-1,2-Dichloroethene	1.09	-	6	3	3.30E+06	0	0	No
trans-1,3-Dichloropropene	1.09	-	16	21	239,434	0	0	No
Trichloroethene	0.715	-	16	23	20,354	0	0	No
Trichlorofluoromethane	0.935	-	6	3	1.74E+07	0	0	No
Vinyl acetate	10	-	32	18	3.04E+07	0	0	No
Vinyl Chloride	2.45	-	32	23	24,948	0	0	No
Xylene	3.50	-	16	22	1.22E+07	0	0	Yes

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 LWOEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	Lowest ESL	Number of Nondetected Results > ESL	Percent Nondetected Results > ESL	Analyte Detected?
Inorganic (mg/kg)								
Uranium	1.40	-	1.80	46	5	0	0	No
Organic (ug/kg)								
1,2,4-Trichlorobenzene	360	-	1,100	9	777	2	22.2	No
1,2-Dichlorobenzene	360	-	1,100	9		0	0	No
1,3-Dichlorobenzene	360	-	1,100	9		0	0	No
1,4-Dichlorobenzene	360	-	1,100	9	20,000	0	0	No
2,4,5-Trichlorophenol	1,700	-	5,300	9	4,000	2	22.2	No
2,4,6-Trichlorophenol	360	-	1,100	9	161	9	100	No
2,4-Dichlorophenol	360	-	1,100	9	2,744	0	0	No
2,4-Dimethylphenol	360	-	1,100	9		0	0	No
2,4-Dinitrophenol	1,700	-	5,300	9	20,000	0	0	No
2,4-Dinitrotoluene	360	-	1,100	9	32.1	9	100	No
2,6-Dinitrotoluene	360	-	1,100	9	6,186	0	0	No
2-Chloronaphthalene	360	-	1,100	9		0	0	No
2-Chlorophenol	360	-	1,100	9	281	9	100	No
2-Methylnaphthalene	360	-	1,100	9	2,769	0	0	No
2-Methylphenol	360	-	1,100	9	123,842	0	0	No
2-Nitroaniline	1,700	-	5,300	9	5,659	0	0	No
2-Nitrophenol	360	-	1,100	9		0	0	No
3,3'-Dichlorobenzidine	720	-	2,100	9		0	0	No
3-Nitroaniline	1,700	-	5,300	9		0	0	No
4,4'-DDD	17	-	52	9	13,726	0	0	No
4,4'-DDE	17	-	52	9	7.95	9	100	No
4,4'-DDT	17	-	52	9	1.20	9	100	No
4,6-Dinitro-2-methylphenol	1,700	-	5,300	9	560	9	100	No
4-Bromophenyl-phenylether	360	-	1,100	9		0	0	No
4-Chloro-3-methylphenol	360	-	1,100	9		0	0	No
4-Chloroaniline	360	-	1,100	9	716	2	22.2	No
4-Chlorophenyl-phenyl ether	360	-	1,100	9		0	0	No
4-Methylphenol	360	-	1,100	9		0	0	No
4-Nitroaniline	1,700	-	5,300	9	41,050	0	0	No
4-Nitrophenol	1,700	-	5,300	9	7,000	0	0	No
Acenaphthene	360	-	1,100	9	20,000	0	0	No
Acenaphthylene	360	-	1,100	9		0	0	No
Aldrin	8.60	-	26	9	47.0	0	0	No
alpha-BHC	8.60	-	26	9	18,662	0	0	No
alpha-Chlordane	86	-	260	9	289	0	0	No
Anthracene	360	-	1,100	9		0	0	No
Benzo(a)anthracene	360	-	1,100	9		0	0	No
Benzo(a)pyrene	360	-	1,100	9	631	4	44.4	No
Benzo(b)fluoranthene	360	-	1,100	9		0	0	No
Benzo(g,h,i)perylene	360	-	1,100	9		0	0	No
Benzo(k)fluoranthene	360	-	1,100	9		0	0	No
Benzyl Alcohol	360	-	1,100	9	4,403	0	0	No
beta-BHC	8.60	-	26	9	207	0	0	No
beta-Chlordane	86	-	100	5	289	0	0	No
bis(2-Chloroethoxy) methane	360	-	1,100	9		0	0	No
bis(2-Chloroethyl) ether	360	-	1,100	9		0	0	No
bis(2-Chloroisopropyl) ether	360	-	1,100	9		0	0	No
Butylbenzylphthalate	360	-	1,100	9	24,155	0	0	No
delta-BHC	8.60	-	26	9	25.9	1	11.1	No
Dibenz(a,h)anthracene	360	-	1,100	9		0	0	No
Dibenzofuran	360	-	1,100	9	21,200	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 LWOEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	Lowest ESL	Number of Nondetected Results > ESL	Percent Nondetected Results > ESL	Analyte Detected?
Inorganic (mg/kg)								
Dieldrin	17	-	52	9	7.40	9	100	No
Diethylphthalate	360	-	1,100	9	100,000	0	0	No
Dimethylphthalate	360	-	1,100	9	200,000	0	0	No
Di-n-butylphthalate	360	-	1,100	9	15.9	9	100	No
Di-n-octylphthalate	360	-	1,100	9	731,367	0	0	No
Endosulfan I	8.60	-	26	9	80.1	0	0	No
Endosulfan II	17	-	52	9	80.1	0	0	No
Endosulfan sulfate	17	-	52	9	80.1	0	0	No
Endrin	17	-	52	9	1.40	9	100	No
Endrin ketone	17	-	52	9	1.40	9	100	No
Fluorene	360	-	1,100	9	30,000	0	0	No
gamma-BHC (Lindane)	8.60	-	26	9	25.9	1	11.1	No
gamma-Chlordane	160	-	260	4	289	0	0	No
Heptachlor	8.60	-	26	9	63.3	0	0	No
Heptachlor epoxide	8.60	-	26	9	64.0	0	0	No
Hexachlorobenzene	360	-	1,100	9	7.73	9	100	No
Hexachlorobutadiene	360	-	1,100	9	431	4	44.4	No
Hexachlorocyclopentadiene	360	-	1,100	9	5,518	0	0	No
Hexachloroethane	360	-	1,100	9	366	8	88.9	No
Indeno(1,2,3-cd)pyrene	360	-	1,100	9		0	0	No
Isophorone	360	-	1,100	9		0	0	No
Methoxychlor	86	-	260	9	1,226	0	0	No
Naphthalene	360	-	1,100	9	27,048	0	0	No
Nitrobenzene	360	-	1,100	9	40,000	0	0	No
N-Nitroso-di-n-propylamine	360	-	1,100	9		0	0	No
N-nitrosodiphenylamine	360	-	1,100	9	20,000	0	0	No
PCB-1016	86	-	260	9	172	2	22.2	No
PCB-1221	86	-	260	9	172	2	22.2	No
PCB-1232	86	-	260	9	172	2	22.2	No
PCB-1242	86	-	260	9	172	2	22.2	No
PCB-1248	86	-	260	9	172	2	22.2	No
PCB-1254	170	-	520	9	172	8	88.9	No
PCB-1260	170	-	520	9	172	8	88.9	No
Pentachlorophenol	1,700	-	5,300	9	122	9	100	No
Phenol	360	-	1,100	9	23,090	0	0	No
Toxaphene	170	-	520	9	3,756	0	0	No

Table A1.4
Sitewide Summary Statistics for Analytes in Surface Soil with an Ecological Screening Level

Analyte	Total Number of Results	Detection Frequency (%)	Number of Detects	Minimum Detected Conc.	Maximum Detected Conc.	Minimum Nondetected Result	Maximum Nondetected Result	Minimum ESL
Inorganics (mg/kg)								
Aluminum	2,622	99.9	2,620	1,450	61,000	10.9	70	50
Ammonia	32	78.1	25	0.335	4.81	0.338	6.12	586
Antimony	2,482	20.0	497	0.270	348	0.0360	19.3	0.905
Arsenic	2,613	99.0	2,586	0.290	56.2	0.400	6.20	2.57
Barium	2,624	99.9	2,622	0.640	1,500	2.20	95	159
Beryllium	2,623	81.7	2,142	0.0710	26.8	0.0620	1.90	6.82
Boron	1,303	85.7	1,117	0.350	28	0.340	7	0.500
Cadmium	2,603	36.1	940	0.0600	270	0.0300	2.80	0.705
Chromium	2,624	99.2	2,604	1.20	210	2.20	19.8	0.400
Chromium VI	17	5.88	1.000	0.850	0.850	0.530	1.20	1.34
Cobalt	2,622	98.1	2,573	1.10	137	2.10	10.4	13
Copper	2,621	98.2	2,575	1.70	1,860	2.20	22.8	8.25
Cyanide	245	2.45	6.00	0.170	0.290	0.180	4.70	607
Fluoride	9	100	9	1.87	3.61	NA	NA	1.33
Lead	2,618	100	2,618	0.870	814	NA	NA	12.1
Lithium	2,433	94.5	2,300	0.990	50	1.60	20.6	2
Manganese	2,617	99.9	2,615	15	2,220	2.20	130	486
Mercury	2,541	48.8	1,239	0.00140	48	0.00120	0.190	1.00E-04
Molybdenum	2,421	47.0	1,138	0.140	19.1	0.0990	7.50	1.84
Nickel	2,620	97.5	2,554	1.90	280	1.60	19.1	0.431
Nitrate / Nitrite	450	83.3	375	0.216	765	0.200	5.60	4,478
Selenium	2,590	13.3	345	0.220	2.20	0.0540	4.50	0.754
Silver	2,589	28.4	735	0.0580	364	0.0490	7	2
Strontium	2,423	100.0	2,422	2.40	413	1.10	1.10	940
Thallium	2,597	14.1	366	0.100	5.80	0.0160	2.50	1
Tin	2,423	10.0	243	0.289	161	0.0780	58.5	2.90
Uranium	1,296	8.80	114	0.430	370	0.130	16.8	5
Vanadium	2,622	100.0	2,621	4.40	5,300	2.20	2.20	2
Zinc	2,622	99.8	2,617	4.20	11,900	2.20	99.8	0.646
Organics (ug/kg)								
1,1,1-Trichloroethane	633	1.58	10.00	1.10	47.7	0.587	680	551,453
1,1,2,2-Tetrachloroethane	632	0.158	1.000	1.39	1.39	0.527	680	60,701
1,1-Dichloroethane	633	0	0	NA	NA	0.512	680	3,121
1,1-Dichloroethene	633	0.158	1.000	7.90	7.90	0.610	680	16,909
1,2,3-Trichloropropane	517	0.193	1.000	1.47	1.47	0.525	129	13,883
1,2,4-Trichlorobenzene	1,549	0.323	5.00	0.870	150	0.621	7,000	777
1,2-Dichloroethane	629	0	0	NA	NA	0.522	680	2,764

Table A1.4
Sitewide Summary Statistics for Analytes in Surface Soil with an Ecological Screening Level

Analyte	Total Number of Results	Detection Frequency (%)	Number of Detects	Minimum Detected Conc.	Maximum Detected Conc.	Minimum Nondetected Result	Maximum Nondetected Result	Minimum ESL
1,2-Dichloroethene	101	0.990	1.000	16	16	5	680	25,617
1,2-Dichloropropane	633	0.316	2.00	18	140	0.413	680	49,910
1,3,5-Trimethylbenzene	515	6.60	34.0	0.610	490	0.535	65.2	7,598
1,4-Dichlorobenzene	1,329	0.677	9.00	0.450	110	0.649	6,900	20,000
2,4,5-T	9	11.1	1.000	1.80	1.80	21	100	162
2,4,5-Trichlorophenol	1,180	0.0847	1.000	1,100	1,100	330	34,000	4,000
2,4,6-Trichlorophenol	1,180	0.0847	1.000	950	950	330	7,000	161
2,4,6-Trinitrotoluene	8	12.5	1	56	56	0.220	250	283
2,4-DB	9	0	0	NA	NA	83	100	426
2,4-Dichlorophenol	1,180	0	0	NA	NA	330	7,000	2,744
2,4-Dinitrophenol	1,173	0	0	NA	NA	850	35,000	20,000
2,4-Dinitrotoluene	1,232	0	0	NA	NA	250	7,000	32.1
2,6-Dinitrotoluene	1,232	0	0	NA	NA	250	7,000	6,186
2378-TCDD	22	68.2	15.0	2.59E-05	0.00680	2.20E-04	0.00106	0.00425
2-Butanone	631	2.54	16.0	3	155	2.72	1,400	1.07E+06
2-Chlorophenol	1,180	0	0	NA	NA	330	7,000	281
2-Methylnaphthalene	1,223	6.95	85.0	34	12,000	330	7,000	2,769
2-Methylphenol	1,180	0	0	NA	NA	330	7,000	123,842
2-Nitroaniline	1,224	0	0	NA	NA	370	35,000	5,659
4,4'-DDD	468	0.427	2.00	3.50	10	1.80	190	13,726
4,4'-DDE	468	1.50	7.00	0.600	7.20	1.80	190	7.95
4,4'-DDT	468	0.855	4.00	9.10	26	1.80	190	1.20
4,6-Dinitro-2-methylphenol	1,176	0.0850	1.000	390	390	850	35,000	560
4-Chloroaniline	1,217	0	0	NA	NA	330	14,000	716
4-Methyl-2-pentanone	630	2.38	15.0	4	73	1.94	2,960	14,630
4-Nitroaniline	1,218	0.328	4.00	62	820	850	55,000	41,050
4-Nitrophenol	1,169	0.171	2.00	53	320	850	35,000	7,000
4-Nitrotoluene	5	0	0	NA	NA	250	250	61,422
Acenaphthene	1,239	22.3	276	21	44,000	330	6,900	20,000
Acetone	632	19.3	122	1.70	1,280	2.65	2,960	6,182
Aldrin	468	0.855	4.00	0.590	17	1.80	95	47.0
alpha-BHC	468	0.214	1.000	7.90	7.90	1.80	95	18,662
alpha-Chlordane	433	0	0	NA	NA	1.80	950	289
Benzene	633	0.948	6.00	1	11	0.502	680	500
Benzo(a)pyrene	1,235	41.2	509	36	43,000	19	7,000	631
Benzyl Alcohol	1,114	0.718	8.00	140	2,800	330	14,000	4,403
beta-BHC	467	0.428	2.00	11	11	1.80	95	207
beta-Chlordane	411	0.243	1.000	2.60	2.60	1.80	950	289

Table A1.4
Sitewide Summary Statistics for Analytes in Surface Soil with an Ecological Screening Level

Analyte	Total Number of Results	Detection Frequency (%)	Number of Detects	Minimum Detected Conc.	Maximum Detected Conc.	Minimum Nondetected Result	Maximum Nondetected Result	Minimum ESL
bis(2-ethylhexyl)phthalate	1,227	29.7	365	29	75,000	330	7,000	137
Bromodichloromethane	633	0	0	NA	NA	0.502	680	5,750
Bromoform	633	0	0	NA	NA	0.525	680	2,855
Butylbenzylphthalate	1,226	9.79	120	35	7,100	330	7,000	24,155
Carbon Disulfide	633	0.158	1.000	4	4	0.535	680	5,676
Carbon Tetrachloride	633	3.32	21.0	0.340	103	0.575	680	8,906
Chlordane	34	0	0	NA	NA	18	220	289
Chlorobenzene	633	0.316	2.00	2	2.03	0.484	680	4,750
Chloroform	633	1.11	7.00	1.30	7	0.543	680	8,655
cis-1,2-Dichloroethene	517	1.74	9.00	1.10	15	0.502	590	1,814
cis-1,3-Dichloropropene	633	0	0	NA	NA	0.502	680	2,800
delta-BHC	468	0.214	1.000	23	23	1.80	95	25.9
Dibenzofuran	1,227	10.9	134	36	20,000	330	7,000	21,200
Dibromochloromethane	633	0	0	NA	NA	0.502	680	5,730
Dicamba	9	55.6	5.00	2.30	150	42	100	1,690
Dichlorodifluoromethane	499	0	0	NA	NA	1.73	398	855
Dieldrin	468	2.35	11.0	1.80	92	1.80	190	7.40
Diethylphthalate	1,224	0.654	8.00	33	420	330	7,000	100,000
Dimethoate	7	0	0	NA	NA	18	180	13.7
Dimethylphthalate	1,227	1.47	18.0	69	460	330	7,000	200,000
Di-n-butylphthalate	1,227	7.99	98.0	35	10,000	330	7,000	15.9
Di-n-octylphthalate	1,225	3.92	48.0	38	11,000	330	7,000	731,367
Endosulfan I	468	0.427	2.00	3.90	7.40	1.80	95	80.1
Endosulfan II	461	0.651	3.00	0.700	9.90	1.80	170	80.1
Endosulfan sulfate	468	0.641	3.00	5.50	24	1.80	190	80.1
Endrin	468	1.28	6.00	2.40	17	1.80	200	1.40
Endrin aldehyde	66	3.03	2.00	8.70	9.20	1.80	38	1.40
Endrin ketone	437	0.229	1.000	36	36	1.80	190	1.40
Fluorene	1,244	18.8	234	27	39,000	140	7,000	30,000
gamma-BHC (Lindane)	468	0.214	1.000	8.30	8.30	1.80	95	25.9
gamma-Chlordane	23	0	0	NA	NA	2	260	289
Heptachlor	468	0	0	NA	NA	1.80	95	63.3
Heptachlor epoxide	467	0.642	3.00	7.20	23	1.80	95	64.0
Hexachlorobenzene	1,224	0.327	4.00	110	380	330	7,000	7.73
Hexachlorobutadiene	1,550	0.0645	1.000	2.20	2.20	0.508	7,000	431
Hexachlorocyclopentadiene	1,208	0	0	NA	NA	330	7,000	5,518
Hexachloroethane	1,227	0	0	NA	NA	330	7,000	366
HMX	5	20	1	230	230	250	250	16,012

Table A1.4
Sitewide Summary Statistics for Analytes in Surface Soil with an Ecological Screening Level

Analyte	Total Number of Results	Detection Frequency (%)	Number of Detects	Minimum Detected Conc.	Maximum Detected Conc.	Minimum Nondetected Result	Maximum Nondetected Result	Minimum ESL
Methoxychlor	468	1.71	8.00	0.280	450	3.50	950	1,226
Methylene Chloride	631	12.0	76.0	0.790	45	0.502	2,200	3,399
Naphthalene	1,567	14.1	221	0.850	41,000	0.751	7,000	27,048
Nitrobenzene	1,218	0	0	NA	NA	250	7,000	40,000
N-nitrosodiphenylamine	1,227	0	0	NA	NA	330	7,000	20,000
PCB-1016	795	0.755	6.00	13	95	33	4,500	172
PCB-1221	845	0	0	NA	NA	33	4,500	172
PCB-1232	845	0	0	NA	NA	33	4,500	172
PCB-1242	845	0.237	2.00	23	350	33	4,500	172
PCB-1248	845	0.710	6.00	17	840	33	4,500	172
PCB-1254	842	17.9	151	6.80	8,900	33	9,000	172
PCB-1260	838	17.2	144	6.20	7,800	33	4,300	172
Pentachlorophenol	1,180	1.02	12.0	39	39,000	850	35,000	122
Phenol	1,180	0.424	5.00	33	130	330	7,000	23,090
Styrene	633	0.158	1.000	7.80	7.80	0.550	680	16,408
Tetrachloroethene	633	8.53	54.0	0.380	29,000	0.641	680	763
Toluene	633	9.00	57.0	0.0990	990	0.528	60.8	14,416
Toxaphene	468	0	0	NA	NA	86	2,200	3,756
trans-1,2-Dichloroethene	532	0	0	NA	NA	0.738	93.3	25,617
trans-1,3-Dichloropropene	633	0	0	NA	NA	0.502	680	2,800
Trichloroethene	633	4.11	26.0	0.170	200	0.500	680	389
Vinyl acetate	78	0	0	NA	NA	10	1,400	13,986
Vinyl Chloride	633	0	0	NA	NA	0.748	1,400	97.7
Xylene	633	10.4	66.0	0.600	933	0.502	680	1,140

NA = Not applicable.

Table A1.5
Summary of Professional Judgment and Ecological Risk Potential

ANALYTE	SUMMARY OF PROFESSIONAL JUDGMENT								ECOLOGICAL RISK POTENTIAL						
	Listed as Waste Constituent for LOWEU Historical IHSSs ?[1]	Historical RFETS Inventory [2] (1974/1988) (kg)	Maximum Conc. in Soil Sitewide (ug/kg)	Detection Frequency in Sitewide Soil (%)	Maximum Conc. in LOWEU Soil (ug/kg)	Detection Frequency in LOWEU Soil (%)	Potential to be an ECOPC?	Uncertainty Category[3]	Lowest ESL (ug/kg)	Most Sensitive Receptor [4]	LOAEL/ NOAEL [5]	LOAEL-Based Soil Conc. (ug/kg)	Maximum Reported Result for Non-detects in LOWEU (ug/kg)	Maximum Reported Result/ LOAEL-Based Soil Conc. [6]	Potential for Adverse Effects if Detected at Maximum Reported Result Level?
2,4,6-Trichlorophenol	No	0/.01	950	0.1	NA	0	No	2	161	Deer Mouse Insectivore	100	16100	1100	0.07	No
2,4-Dinitrotoluene	No	0/0	N/A	0	NA	0	No	1	32.1	Deer Mouse Insectivore	10	321	1100	3	Yes
2-Chlorophenol	No	0.12/0.02	N/A	0	NA	0	No	1	281	Deer Mouse Insectivore	100	28100	1100	0.04	No
4,4'-DDE	No	0/0.001	7.2	1.5	NA	0	No	2	7.95	Mourning Dove Insectivore	10	79.5	52	0.7	No
4,4'-DDT	No	0/0.001	26	0.9	NA	0	No	2	1.20	Mourning Dove Insectivore	167	200.4	52	0.3	No
4,6-Dinitro-2-methylphenol	No	0/0	390	0.1	NA	0	No	2	560	Deer Mouse Insectivore	20	11200	5300	0.5	No
Dieldrin	No	0/0/003	92	2.4	NA	0	No	2	7.4	Deer Mouse Insectivore	2	14.8	52	4	Yes
Di-n-butylphthalate	Yes(1)	0/0.005	10000	8.0	NA	0	Yes	3	15.9	Mourning Dove Insectivore	10	159	1000	6	Yes
Endrin	No	0/0.004	17	1.3	NA	0	No	2	1.40	Mourning Dove Insectivore	10	14	52	4	Yes
Endrin ketone	No	0/0	36	0.2	NA	0	No	2	1.40	Mourning Dove Insectivore	10	14	52	4	Yes
Hexachlorobenzene	No	1.000/1.005	380	0.3	NA	0	No	2	7.73	Mourning Dove Insectivore	40	309	1100	4	Yes
Hexachloroethane	No	0.02/0.02	NA	0	NA	0	No	2	366	Deer Mouse Insectivore	20	7320	1100	0.2	No
PCB-1254	No	0/0.17	8900	17.9	NA	0	No	2	172	Mourning Dove Insectivore	14.1	2425	520	0.2	No
PCB-1260	No	0/0.17	7800	17.2	NA	0	No	2	172	Mourning Dove Insectivore	14.1	2425	520	0.2	No
Pentachlorophenol	No	0.02/0.02	39000	1.0	NA	0	No	3	122	Deer Mouse Insectivore	10	1220	5300	4	Yes

[1] Includes listing of the class of compound, e.g., herbicides, pesticides, chlorinated solvents, polynuclear aromatic hydrocarbons, etc. Ref. DOE, 2005a.
[2] CDH, 1991.
[3] See text for explanation.
[4] Basis for the lowest ESL.
[5] LOAELs and NOAELs from Appendix B, Table B-2, "TRVs for Terrestrial Vertebrate Receptors", Ref. DOE 2005b.
[6] Ratios are rounded to one significant figure.
(1) There are historical IHSSs upgradient of the LWOEU where wastes were burned or there was a release of oil. Phthalates may be a component of the oil.
CDH – Colorado Department of Health
DDE – dichlorodiphenyldichloroethylene
DDT – dichlorodiphenyltrichloroethane
DOE – Department of Energy
ECOPC – Ecological Contaminant of Potential Concern
ESL – Ecological Screening Level
IHSS – Individual Hazardous Substance Site
LOAEL – Lowest Bounded Lowest Observed Adverse Effect Level
NOAEL - Final No Observed Adverse Effect Level
RFETS – Rocky Flats Environmental Technology Site
WBEU – Wind Blown Exposure Unit
NA – Not applicable
NVA – No Value Available
I- Inconclusive

Table A1.6
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Subsurface Soil in the LWOEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	Lowest ESL	Number of Nondetected Results > ESL	Percent Nondetected Results > ESL	Analyte Detected?
Inorganic (mg/kg)								
Silver	0.0730	-	1.40	44		0	0	Yes
Organic (ug/kg)								
1,1,1,2-Tetrachloroethane	5.50	-	6	2		0	0	No
1,1,1-Trichloroethane	5	-	6	20	4.85E+07	0	0	No
1,1,2,2-Tetrachloroethane	5	-	6	20	4.70E+06	0	0	No
1,1,2-Trichloro-1,2,2-trifluoroethane	5.50	-	6	2		0	0	No
1,1,2-Trichloroethane	5	-	6	20		0	0	No
1,1-Dichloroethane	5	-	6	20	215,360	0	0	No
1,1-Dichloroethene	5	-	6	20	1.28E+06	0	0	No
1,1-Dichloropropene	5.50	-	6	2		0	0	No
1,2,3-Trichlorobenzene	5.50	-	6	2		0	0	No
1,2,3-Trichloropropane	5.50	-	6	2	1.17E+06	0	0	No
1,2,4-Trichlorobenzene	5.50	-	890	8	94,484	0	0	No
1,2,4-Trimethylbenzene	5.50	-	6	2		0	0	No
1,2-Dibromo-3-chloropropane	5.50	-	6	2		0	0	No
1,2-Dibromoethane	5.50	-	6	2		0	0	No
1,2-Dichlorobenzene	5.50	-	890	8		0	0	No
1,2-Dichloroethane	5	-	6	20	2.00E+06	0	0	No
1,2-Dichloroethene	5	-	6	18	1.87E+06	0	0	No
1,2-Dichloropropane	5	-	6	20	3.92E+06	0	0	No
1,3,5-Trimethylbenzene	5.50	-	6	2	855,709	0	0	No
1,3-Dichlorobenzene	5.50	-	890	8		0	0	No
1,3-Dichloropropane	5.50	-	6	2		0	0	No
1,4-Dichlorobenzene	5.50	-	890	8	5.93E+06	0	0	No
1234789-HpCDF	0.00147	-	0.00154	2		0	0	No
123478-HxCDD	0.00147	-	0.00154	2		0	0	No
123478-HxCDF	0.00147	-	0.00154	2		0	0	No
123678-HxCDD	0.00147	-	0.00154	2		0	0	No
123678-HxCDF	0.00147	-	0.00154	2		0	0	No
123789-HxCDD	0.00147	-	0.00154	2		0	0	No
123789-HxCDF	0.00147	-	0.00154	2		0	0	No
2,2-Dichloropropane	5.50	-	6	2		0	0	No
2,4,5-Trichlorophenol	1,600	-	4,300	6		0	0	No
2,4,6-Trichlorophenol	340	-	890	6	17,263	0	0	No
2,4-Dichlorophenol	340	-	890	6	249,324	0	0	No
2,4-Dimethylphenol	340	-	890	6		0	0	No
2,4-Dinitrophenol	1,600	-	4,300	6	4.90E+06	0	0	No
2,4-Dinitrotoluene	340	-	890	6	2,473	0	0	No
2,6-Dinitrotoluene	340	-	890	6	477,309	0	0	No
2-Butanone	10	-	119	14	4.94E+07	0	0	No
2-Chloronaphthalene	340	-	890	6		0	0	No
2-Chlorophenol	340	-	890	6	21,598	0	0	No
2-Chlorotoluene	5.50	-	6	2		0	0	No
2-Hexanone	10	-	59.5	20		0	0	No
2-Methylnaphthalene	340	-	890	6	319,121	0	0	No
2-Methylphenol	340	-	890	6	9.26E+06	0	0	No
2-Nitroaniline	1,600	-	4,300	6	418,475	0	0	No
2-Nitrophenol	340	-	890	6		0	0	No
3,3'-Dichlorobenzidine	670	-	1,800	6		0	0	No
3-Nitroaniline	1,600	-	3,400	5		0	0	No
4,4'-DDD	33	-	43	4	6.19E+06	0	0	No
4,4'-DDE	33	-	43	4	54,420	0	0	No
4,4'-DDT	33	-	43	4	175,708	0	0	No
4,6-Dinitro-2-methylphenol	1,600	-	4,300	6	44,283	0	0	No
4-Bromophenyl-phenylether	340	-	890	6		0	0	No
4-Chloro-3-methylphenol	340	-	890	6		0	0	No

Table A1.6
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Subsurface Soil in the LWOEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	Lowest ESL	Number of Nondetected Results > ESL	Percent Nondetected Results > ESL	Analyte Detected?
Inorganic (mg/kg)								
4-Chloroaniline	340	-	890	6	48,856	0	0	No
4-Chlorophenyl-phenyl ether	340	-	890	6		0	0	No
4-Chlorotoluene	5.50	-	6	2		0	0	No
4-Isopropyltoluene	5.50	-	6	2		0	0	No
4-Methyl-2-pentanone	10	-	59.5	18	859,131	0	0	No
4-Methylphenol	340	-	890	6		0	0	No
4-Nitroaniline	1,600	-	4,300	6	2.62E+06	0	0	No
4-Nitrophenol	1,600	-	4,300	6	1.02E+06	0	0	No
Acenaphthene	340	-	890	6		0	0	No
Acenaphthylene	340	-	890	6		0	0	No
Aldrin	17	-	22	4	11,282	0	0	No
alpha-BHC	17	-	22	4	2.47E+06	0	0	No
alpha-Chlordane	170	-	220	4	472,808	0	0	No
Anthracene	340	-	890	6		0	0	No
Benzene	5	-	6	20	1.10E+06	0	0	No
Benzo(a)anthracene	340	-	890	6		0	0	No
Benzo(a)pyrene	340	-	890	6	502,521	0	0	No
Benzo(b)fluoranthene	340	-	890	6		0	0	No
Benzo(g,h,i)perylene	340	-	890	6		0	0	No
Benzo(k)fluoranthene	340	-	890	6		0	0	No
Benzyl Alcohol	340	-	710	5	253,015	0	0	No
beta-BHC	17	-	22	4	27,399	0	0	No
bis(2-Chloroethoxy) methane	340	-	890	6		0	0	No
bis(2-Chloroethyl) ether	340	-	890	6		0	0	No
bis(2-Chloroisopropyl) ether	340	-	710	5		0	0	No
bis(2-ethylhexyl)phthalate	340	-	890	6	2.76E+06	0	0	No
Bromobenzene	5.50	-	6	2		0	0	No
Bromochloromethane	5.50	-	6	2		0	0	No
Bromodichloromethane	5	-	6	20	381,135	0	0	No
Bromoform	5	-	6	20	198,571	0	0	No
Bromomethane	5.50	-	13	18		0	0	No
Butylbenzylphthalate	340	-	890	6	3.37E+06	0	0	No
Carbon Disulfide	5	-	6	20	410,941	0	0	No
Carbon Tetrachloride	5	-	6	20	736,154	0	0	No
Chlorobenzene	5	-	6	20	413,812	0	0	No
Chloroethane	5.50	-	13	20		0	0	No
Chloroform	5	-	6	20	560,030	0	0	No
Chloromethane	5.50	-	13	20		0	0	No
Chrysene	340	-	890	6		0	0	No
cis-1,2-Dichloroethene	5.50	-	6	2	132,702	0	0	No
cis-1,3-Dichloropropene	5	-	6	20	222,413	0	0	No
delta-BHC	17	-	22	4	3,425	0	0	No
Dibenz(a,h)anthracene	340	-	890	6		0	0	No
Dibenzofuran	340	-	890	6	2.44E+06	0	0	No
Dibromochloromethane	5	-	6	20	389,064	0	0	No
Dibromomethane	5.50	-	6	2		0	0	No
Dichlorodifluoromethane	5.50	-	6	2	59,980	0	0	No
Dieldrin	33	-	43	4	301	0	0	No
Diethylphthalate	340	-	890	6	2.21E+08	0	0	No
Dimethylphthalate	340	-	890	6	1.35E+07	0	0	No
Di-n-octylphthalate	340	-	890	6	2.58E+08	0	0	No
Endosulfan I	17	-	22	4	8,726	0	0	No
Endosulfan II	33	-	43	4	8,726	0	0	No
Endosulfan sulfate	33	-	43	4	8,726	0	0	No
Endrin	33	-	43	4	8,060	0	0	No
Endrin ketone	33	-	43	4	8,060	0	0	No

Table A1.6
Evaluation of Reported Results for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Subsurface Soil in the LWOEU

Analyte	Range of Nondetected Reported Results			Total Number of Nondetected Results	Lowest ESL	Number of Nondetected Results > ESL	Percent Nondetected Results > ESL	Analyte Detected?
Inorganic (mg/kg)								
Ethylbenzene	5	-	6	20		0	0	No
Fluoranthene	340	-	890	6		0	0	No
Fluorene	340	-	890	6		0	0	No
gamma-BHC (Lindane)	17	-	22	4	3,425	0	0	No
gamma-Chlordane	170	-	220	4	472,808	0	0	No
Heptachlor	17	-	22	4	12,359	0	0	No
Heptachlor epoxide	17	-	22	4	9,121	0	0	No
Hexachlorobenzene	340	-	890	6	190,142	0	0	No
Hexachlorobutadiene	5.50	-	890	8	150,894	0	0	No
Hexachlorocyclopentadiene	340	-	890	6	799,679	0	0	No
Hexachloroethane	340	-	890	6	45,656	0	0	No
Indeno(1,2,3-cd)pyrene	340	-	710	5		0	0	No
Isophorone	340	-	890	6		0	0	No
Isopropylbenzene	5.50	-	6	2		0	0	No
Methoxychlor	170	-	220	4	228,896	0	0	No
Naphthalene	5.50	-	890	8	1.60E+07	0	0	No
n-Butylbenzene	5.50	-	6	2		0	0	No
Nitrobenzene	340	-	890	6		0	0	No
N-Nitroso-di-n-propylamine	340	-	890	6		0	0	No
N-nitrosodiphenylamine	340	-	890	6	2.15E+06	0	0	No
n-Propylbenzene	5.50	-	6	2		0	0	No
PCB-1016	170	-	220	4	37,963	0	0	No
PCB-1221	170	-	220	4	37,963	0	0	No
PCB-1232	170	-	220	4	37,963	0	0	No
PCB-1242	170	-	220	4	37,963	0	0	No
PCB-1248	170	-	220	4	37,963	0	0	No
PCB-1254	330	-	430	4	37,963	0	0	No
PCB-1260	330	-	430	4	37,963	0	0	No
Pentachlorodibenzo-p-dioxin	0.00147	-	0.00154	2		0	0	No
Pentachlorophenol	1,600	-	4,300	6	18,373	0	0	No
Phenanthrene	340	-	890	6		0	0	No
Phenol	340	-	890	6	1.49E+06	0	0	No
Pyrene	340	-	890	6		0	0	No
sec-Butylbenzene	5.50	-	6	2		0	0	No
Styrene	5	-	6	20	1.53E+06	0	0	No
tert-Butylbenzene	5.50	-	6	2		0	0	No
Toxaphene	330	-	430	4	909,313	0	0	No
trans-1,2-Dichloroethene	5.50	-	6	2	1.87E+06	0	0	No
trans-1,3-Dichloropropene	5	-	6	18	222,413	0	0	No
Trichloroethene	5	-	6	20	32,424	0	0	No
Trichlorofluoromethane	5.50	-	6	2		0	0	No
Vinyl acetate	10	-	13	16	730,903	0	0	No
Vinyl Chloride	5.50	-	13	20	6,494	0	0	No

COMPREHENSIVE RISK ASSESSMENT
LOWER WOMAN DRAINAGE EXPOSURE UNIT

VOLUME 11: ATTACHMENT 2
Data Quality Assessment

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ACRONYMS AND ABBREVIATIONS

μg/kg	micrograms per kilogram
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
HQ	hazard quotient
IAG	Interagency Agreement
ICP	inductively couple plasma
IDL	instrument detection limit
LCS	laboratory control sample
LOAEL	lowest observable adverse effect level

LWOEU	Lower Woman Drainage Exposure Unit
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
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 Lower Woman Drainage Exposure Unit (LWOEU). 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 117,420 environmental sampling records in the RFETS database associated with the LWOEU, 52,001 were used in the LWOEU risk assessment based on the data processing rules described in Section 2.0 of the Sitewide DQA. Of the 52,001 analytical records existing in the LWOEU CRA data set, 75 percent (39,027 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 LWOEU V&V data that were qualified as estimated and/or undetected by analyte group and matrix. Overall, approximately 16 percent of the LWOEU CRA data were qualified as estimated or undetected. Four 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 75 percent of the LWOEU data set that underwent V&V, 81 percent were qualified as having no QC issues, and approximately 16 percent were qualified as estimated or undetected (Table A2.3). The remaining 3 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 5 percent of the entire data set was rejected during the V&V process (Table A2.6). Rejected data were removed from the LWOEU 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 17 percent of the LWOEU 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 2 percent were noted for observations related to precision. Of that 2 percent, 99 percent contained issues related to sample matrices. Result confirmation and instrument setup observations make up the other 1 percent.

Of the V&V data, 36 percent were noted for accuracy-related observations. Of that 36 percent, 75 percent was noted for laboratory practice-related observations, while sample-specific accuracy observations make up the other 25 percent. Although the percentage of data with noted accuracy issues is slightly elevated, it is important to note that not all accuracy-related observations resulted in data qualification. Only 16 percent of the LWOEU 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 36 percent were noted for observations related to representativeness. Of that 36 percent, 67 percent was marked for blank observations, 25 percent for failure to observe allowed holding times, 3 percent for documentation issues, 1 percent for sample preparation observations, and 1 percent for instrument sensitivity issues. Matrix, LCS, instrument set-up, 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 5 percent of all V&V data associated with the LWOEU were rejected.

Comparability of the LWOEU 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.

Issues that have the potential to impact the risk assessment decisions include the following:

- Approximately 10 percent of all metal/soil FD/target sample analyte pairs failed relative percent difference (RPD) criteria (Table A2.5). Of the 47 records that did not meet RPD criteria, 13 are associated with an analyte that was selected as an ECOPC in the LWOEU. The affected analytes include copper, manganese, nickel, vanadium, and zinc. Copper, nickel and vanadium are each associated with only one FD/target sample pair that exceeded RPD criteria, and manganese and zinc are each associated with five pairs.

  The copper, nickel, and vanadium exceedances, as well as one of the manganese and one of the zinc exceedances, all resulted from the analysis of the same FD/target sample pair. Imprecision noted in one sample does not indicate an overall precision issue. The analytical results associated with the other manganese and zinc FD/target sample pairs are all within an order of magnitude of one another. The risk characterization determined that the hazard quotients (HQs) calculated using the lowest observable adverse effect level (LOAEL) for manganese and zinc are all well below 1 (0.1 – 0.2). As a result, it has been determined that any data imprecision related to the failed RPD criterion is not likely to impact the magnitude of the associated analytical results by a large enough margin to raise the HQs to a value above one. The ecological HQs for the LWOEU are discussed in further detail in Section 10.1 of the main text of this volume**.**

- Approximately 11 percent of the polychlorinated biphenyl (PCB)/soil data set were qualified as estimated and noted with V&V observations related to surrogate analyses that did not meet recovery criteria. This V&V observation has the potential to affect the accuracy of associated data. Data accuracy is important at or near the contract required detection limit (CRDL) as false nondetect results have the potential to impact the ECOPC and COC selection processes. As all records qualified and noted with this V&V observation are nondetect results, the potential impact to risk assessment results was reviewed. The impact to the human health portion of the risk assessment is determined to be minimal as none of the nondetect PCB results associated with the LWOEU exceeded human health preliminary remediation goals (PRGs). Although several results that were qualified as nondetect either by the laboratory or the validator exceed the lowest associated ecological screening level (ESL) for surface soils, it is important to note that PCBs were never detected in surface or subsurface soils in the LWOEU. The single detected PCB/soil result was reported in LWOEU sediments. For all PCBs except PCB-1254 and PCB-1260, the percentage of nondetect results that exceeded the lowest ESL is also very low (22 percent). Eighty-eight percent of the PCB-1254 and PCB-1260 nondetect results exceeded the lowest ESL, but again the potential impact on risk assessment decisions is determined to be minimal. The maximum nondetected result for these analytes (520 µg/kg) is within an order of magnitude of, and only 3 times greater than, the lowest ESL (170 µg/kg). Refer to Attachment 1 of this volume for a further detailed discussion of nondetected results.

- Similarly, approximately 12 percent of the pesticide/soil data and 10 percent of the pesticide water data were qualified as estimated and noted with V&V observations related to poor surrogate recoveries. The potential impact on the human health risks assessment decisions is very low as only one nondetect pesticide result exceeded the associated PRG. Except for dieldrin, all nondetect pesticide results for both soil, and water, were well below the PRG. Dieldrin is not considered to be as issue as only one nondetect result (5 percent of 19 total results) was reported above the PRG, and it was not detected anywhere in the LWOEU.

  The impact on the ecological risk assessment decisions is also determined to be minimal. Although several nondetect pesticide results exceed the lowest associated surface soil ESL, and in some cases 100 percent of the nondetect results exceed, it is important to note that pesticides were never detected in LWOEU surface or subsurface soils. The only pesticide/soil detected result was reported in LWOEU sediments. Additionally, the highest sitewide concentrations of these analytes do not indicate a possible source of pesticide contamination anywhere on site.

- Approximately 14 percent of all radionuclide/soil FD/target sample analyte pairs failed duplicate error ratio (DER) criteria (Table A2.5). While this does indicate a possible precision issue in the data set, it is important to note that no radionuclides were selected as ECOPCs or COCs in the LWOEU. The maximum detected values for all radionuclides are well below the associated PRGs and ESLs. The impact on risk assessment decisions is determined to be minimal.

- 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 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 LWOEU 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 LWOEU 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 LWOEU.

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	Soil	68	68	100.00
Dioxins and Furans	Water	14	14	100.00
Herbicide	Soil	42	44	95.45
Herbicide	Water	93	241	38.59
Metal	Soil	4,573	4,578	99.89
Metal	Water	10,408	12,549	82.94
PCB	Soil	238	287	82.93
PCB	Water	245	371	66.04
Pesticide	Soil	680	760	89.47
Pesticide	Water	799	1,497	53.37
Radionuclide	Soil	771	820	94.02
Radionuclide	Water	3,013	7,618	39.55
SVOC	Soil	2,472	2,476	99.84
SVOC	Water	2,696	4,227	63.78
VOC	Soil	1,443	1,511	95.50
VOC	Water	10,280	13,204	77.86
Wet Chem	Soil	121	121	100.00
Wet Chem	Water	1,071	1,615	66.32
	Total	**39,027**	**52,001**	**75.05%**

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
Dioxins and Furans	Soil	Calibration	Continuing calibration verification criteria were not met	Yes	1	68	1.47	Accuracy
Dioxins and Furans	Water	Documentation Issues	Record added by the validator	No	2	14	14.29	N/A
Dioxins and Furans	Water	Documentation Issues	Transcription error	No	3	14	21.43	N/A
Herbicide	Soil	Holding Times	Holding times were exceeded	No	3	42	7.14	Representativeness
Herbicide	Soil	Other	See hard copy for further explanation	No	3	42	7.14	N/A
Herbicide	Water	Calibration	Continuing calibration verification criteria were not met	No	1	93	1.08	Accuracy
Herbicide	Water	Documentation Issues	Record added by the validator	No	1	93	1.08	N/A
Herbicide	Water	Documentation Issues	Transcription error	No	21	93	22.58	N/A
Herbicide	Water	Internal Standards	Internal standards did not meet criteria	No	1	93	1.08	Accuracy
Herbicide	Water	Other	See hard copy for further explanation	No	32	93	34.41	N/A
Metal	Soil	Blanks	Calibration verification blank contamination	No	117	4,573	2.56	Representativeness
Metal	Soil	Blanks	Calibration verification blank contamination	Yes	19	4,573	0.42	Representativeness
Metal	Soil	Blanks	Method, preparation, or reagent blank contamination	No	65	4,573	1.42	Representativeness
Metal	Soil	Blanks	Method, preparation, or reagent blank contamination	Yes	12	4,573	0.26	Representativeness
Metal	Soil	Blanks	Negative bias indicated in the blanks	No	13	4,573	0.28	Representativeness
Metal	Soil	Blanks	Negative bias indicated in the blanks	Yes	26	4,573	0.57	Representativeness
Metal	Soil	Calibration	Calibration correlation coefficient did not meet requirements	Yes	6	4,573	0.13	Accuracy
Metal	Soil	Calibration	Continuing calibration verification criteria were not met	No	6	4,573	0.13	Accuracy
Metal	Soil	Calibration	Continuing calibration verification criteria were not met	Yes	6	4,573	0.13	Accuracy
Metal	Soil	Documentation Issues	Key data fields incorrect	Yes	2	4,573	0.04	N/A
Metal	Soil	Documentation Issues	Transcription error	No	33	4,573	0.72	N/A
Metal	Soil	Documentation Issues	Transcription error	Yes	87	4,573	1.90	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	Soil	Holding Times	Holding times were exceeded	No	5	4,573	0.11	Representativeness
Metal	Soil	Instrument Set-up	Interference was indicated in the interference check sample	No	6	4,573	0.13	Accuracy
Metal	Soil	Instrument Set-up	Interference was indicated in the interference check sample	Yes	24	4,573	0.52	Accuracy
Metal	Soil	LCS	CRDL check sample recovery criteria were not met	No	16	4,573	0.35	Accuracy
Metal	Soil	LCS	CRDL check sample recovery criteria were not met	Yes	22	4,573	0.48	Accuracy
Metal	Soil	LCS	LCS recovery criteria were not met	No	84	4,573	1.84	Accuracy
Metal	Soil	LCS	LCS recovery criteria were not met	Yes	274	4,573	5.99	Accuracy
Metal	Soil	LCS	Low level check sample recovery criteria were not met	No	61	4,573	1.33	Accuracy
Metal	Soil	LCS	Low level check sample recovery criteria were not met	Yes	37	4,573	0.81	Accuracy
Metal	Soil	Matrices	Duplicate sample precision criteria were not met	Yes	42	4,573	0.92	Precision
Metal	Soil	Matrices	LCS/LCSD precision criteria were not met	Yes	18	4,573	0.39	Precision
Metal	Soil	Matrices	Percent solids < 30 percent	Yes	39	4,573	0.85	Representativeness
Metal	Soil	Matrices	Post-digestion MS did not meet control criteria	No	20	4,573	0.44	Accuracy
Metal	Soil	Matrices	Post-digestion MS did not meet control criteria	Yes	25	4,573	0.55	Accuracy
Metal	Soil	Matrices	Predigestion MS recovery criteria were not met	No	99	4,573	2.16	Accuracy
Metal	Soil	Matrices	Predigestion MS recovery criteria were not met	Yes	386	4,573	8.44	Accuracy
Metal	Soil	Matrices	Predigestion MS recovery was < 30 percent	Yes	13	4,573	0.28	Accuracy
Metal	Soil	Matrices	Serial dilution criteria were not met	Yes	114	4,573	2.49	Accuracy
Metal	Soil	Other	IDL is older than 3 months from date of analysis	No	304	4,573	6.65	Accuracy
Metal	Soil	Other	IDL is older than 3 months from date of analysis	Yes	1,209	4,573	26.44	Accuracy
Metal	Soil	Other	Result obtained through dilution	Yes	4	4,573	0.09	N/A
Metal	Soil	Other	See hard copy for further explanation	No	9	4,573	0.20	N/A
Metal	Soil	Other	See hard copy for further explanation	Yes	43	4,573	0.94	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	Soil	Sensitivity	IDL changed due to a significant figure discrepancy	No	2	4,573	0.04	Representativeness
Metal	Water	Blanks	Calibration verification blank contamination	No	384	10,408	3.69	Representativeness
Metal	Water	Blanks	Calibration verification blank contamination	Yes	38	10,408	0.37	Representativeness
Metal	Water	Blanks	Method, preparation, or reagent blank contamination	No	482	10,408	4.63	Representativeness
Metal	Water	Blanks	Method, preparation, or reagent blank contamination	Yes	286	10,408	2.75	Representativeness
Metal	Water	Blanks	Negative bias indicated in the blanks	No	138	10,408	1.33	Representativeness
Metal	Water	Blanks	Negative bias indicated in the blanks	Yes	82	10,408	0.79	Representativeness
Metal	Water	Calculation Errors	Control limits not assigned correctly	No	23	10,408	0.22	N/A
Metal	Water	Calculation Errors	Control limits not assigned correctly	Yes	18	10,408	0.17	N/A
Metal	Water	Calibration	Calibration correlation coefficient did not meet requirements	No	51	10,408	0.49	Accuracy
Metal	Water	Calibration	Calibration correlation coefficient did not meet requirements	Yes	7	10,408	0.07	Accuracy
Metal	Water	Calibration	Continuing calibration verification criteria were not met	No	7	10,408	0.07	Accuracy
Metal	Water	Calibration	Continuing calibration verification criteria were not met	Yes	10	10,408	0.10	Accuracy
Metal	Water	Calibration	Frequency or sequencing verification criteria not met	No	1	10,408	0.01	Accuracy
Metal	Water	Documentation Issues	Key data fields incorrect	No	56	10,408	0.54	N/A
Metal	Water	Documentation Issues	Key data fields incorrect	Yes	316	10,408	3.04	N/A
Metal	Water	Documentation Issues	Missing deliverables (not required for validation)	No	81	10,408	0.78	N/A
Metal	Water	Documentation Issues	Missing deliverables (not required for validation)	Yes	42	10,408	0.40	N/A
Metal	Water	Documentation Issues	Missing deliverables (required for validation)	No	34	10,408	0.33	Representativeness
Metal	Water	Documentation Issues	Missing deliverables (required for validation)	Yes	32	10,408	0.31	Representativeness
Metal	Water	Documentation Issues	Omissions or errors in data package (not required for validation)	No	239	10,408	2.30	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	Omissions or errors in data package (not required for validation)	Yes	232	10,408	2.23	N/A
Metal	Water	Documentation Issues	Omissions or errors in data package (required for validation)	No	2	10,408	0.02	Representativeness
Metal	Water	Documentation Issues	Omissions or errors in data package (required for validation)	Yes	1	10,408	0.01	Representativeness
Metal	Water	Documentation Issues	Record added by the validator	No	99	10,408	0.95	N/A
Metal	Water	Documentation Issues	Record added by the validator	Yes	125	10,408	1.20	N/A
Metal	Water	Documentation Issues	Transcription error	No	363	10,408	3.49	N/A
Metal	Water	Documentation Issues	Transcription error	Yes	120	10,408	1.15	N/A
Metal	Water	Holding Times	Holding times were exceeded	No	22	10,408	0.21	Representativeness
Metal	Water	Holding Times	Holding times were exceeded	Yes	1	10,408	0.01	Representativeness
Metal	Water	Instrument Set-up	AA duplicate injection precision criteria were not met	Yes	3	10,408	0.03	Precision
Metal	Water	Instrument Set-up	Interference was indicated in the interference check sample	No	5	10,408	0.05	Accuracy
Metal	Water	Instrument Set-up	Interference was indicated in the interference check sample	Yes	12	10,408	0.12	Accuracy
Metal	Water	LCS	CRDL check sample recovery criteria were not met	No	68	10,408	0.65	Accuracy
Metal	Water	LCS	CRDL check sample recovery criteria were not met	Yes	74	10,408	0.71	Accuracy
Metal	Water	LCS	LCS recovery criteria were not met	No	37	10,408	0.36	Accuracy
Metal	Water	LCS	LCS recovery criteria were not met	Yes	73	10,408	0.70	Accuracy
Metal	Water	LCS	Low level check sample recovery criteria were not met	No	62	10,408	0.60	Accuracy
Metal	Water	LCS	Low level check sample recovery criteria were not met	Yes	57	10,408	0.55	Accuracy
Metal	Water	Matrices	Duplicate sample precision criteria were not met	No	17	10,408	0.16	Precision
Metal	Water	Matrices	Duplicate sample precision criteria were not met	Yes	60	10,408	0.58	Precision
Metal	Water	Matrices	LCS/LCSD precision criteria were not met	No	8	10,408	0.08	Precision
Metal	Water	Matrices	LCS/LCSD precision criteria were not met	Yes	20	10,408	0.19	Precision

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	Matrices	MS/MSD precision criteria were not met	No	8	10,408	0.08	Precision
Metal	Water	Matrices	MSA calibration correlation coefficient < 0.995	Yes	1	10,408	0.01	Accuracy
Metal	Water	Matrices	Post-digestion MS did not meet control criteria	No	111	10,408	1.07	Accuracy
Metal	Water	Matrices	Post-digestion MS did not meet control criteria	Yes	19	10,408	0.18	Accuracy
Metal	Water	Matrices	Predigestion MS recovery criteria were not met	No	175	10,408	1.68	Accuracy
Metal	Water	Matrices	Predigestion MS recovery criteria were not met	Yes	130	10,408	1.25	Accuracy
Metal	Water	Matrices	Predigestion MS recovery was < 30 percent	No	1	10,408	0.01	Accuracy
Metal	Water	Matrices	Predigestion MS recovery was < 30 percent	Yes	4	10,408	0.04	Accuracy
Metal	Water	Matrices	Recovery criteria were not met	Yes	2	10,408	0.02	Accuracy
Metal	Water	Matrices	Serial dilution criteria were not met	No	10	10,408	0.10	Accuracy
Metal	Water	Matrices	Serial dilution criteria were not met	Yes	191	10,408	1.84	Accuracy
Metal	Water	Other	Analysis was not requested according to the statement of work	No	1	10,408	0.01	N/A
Metal	Water	Other	IDL is older than 3 months from date of analysis	No	152	10,408	1.46	Accuracy
Metal	Water	Other	IDL is older than 3 months from date of analysis	Yes	227	10,408	2.18	Accuracy
Metal	Water	Other	See hard copy for further explanation	No	17	10,408	0.16	N/A
Metal	Water	Other	See hard copy for further explanation	Yes	41	10,408	0.39	N/A
Metal	Water	Sample Preparation	Samples were not properly preserved in the field	No	76	10,408	0.73	Representativeness
Metal	Water	Sample Preparation	Samples were not properly preserved in the field	Yes	80	10,408	0.77	Representativeness
Metal	Water	Sensitivity	IDL changed due to a significant figure discrepancy	No	22	10,408	0.21	Representativeness
PCB	Soil	Documentation Issues	Transcription error	No	6	238	2.52	N/A
PCB	Soil	Documentation Issues	Transcription error	Yes	1	238	0.42	N/A
PCB	Soil	Holding Times	Holding times were exceeded	No	7	238	2.94	Representativeness
PCB	Soil	Other	See hard copy for further explanation	Yes	1	238	0.42	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
PCB	Soil	Surrogates	Surrogate recovery criteria were not met	No	27	238	11.34	Accuracy
PCB	Soil	Surrogates	Surrogate recovery criteria were not met	Yes	1	238	0.42	Accuracy
PCB	Water	Documentation Issues	Record added by the validator	No	7	245	2.86	N/A
PCB	Water	Documentation Issues	Transcription error	No	48	245	19.59	N/A
PCB	Water	Documentation Issues	Transcription error	Yes	1	245	0.41	N/A
PCB	Water	Holding Times	Holding times were exceeded	No	6	245	2.45	Representativeness
PCB	Water	Holding Times	Holding times were exceeded	Yes	1	245	0.41	Representativeness
PCB	Water	Surrogates	Surrogate recovery criteria were not met	No	21	245	8.57	Accuracy
Pesticide	Soil	Blanks	Method, preparation, or reagent blank contamination	No	1	680	0.15	Representativeness
Pesticide	Soil	Documentation Issues	Transcription error	No	19	680	2.79	N/A
Pesticide	Soil	Documentation Issues	Transcription error	Yes	1	680	0.15	N/A
Pesticide	Soil	Holding Times	Holding times were exceeded	No	23	680	3.38	Representativeness
Pesticide	Soil	Other	See hard copy for further explanation	No	5	680	0.74	N/A
Pesticide	Soil	Surrogates	Surrogate recovery criteria were not met	No	80	680	11.76	Accuracy
Pesticide	Water	Blanks	Method, preparation, or reagent blank contamination	No	1	799	0.13	Representativeness
Pesticide	Water	Calibration	Continuing calibration verification criteria were not met	No	18	799	2.25	Accuracy
Pesticide	Water	Calibration	Continuing calibration verification criteria were not met	Yes	1	799	0.13	Accuracy
Pesticide	Water	Confirmation	Results were not confirmed	No	1	799	0.13	Precision
Pesticide	Water	Documentation Issues	Record added by the validator	No	21	799	2.63	N/A
Pesticide	Water	Documentation Issues	Transcription error	No	54	799	6.76	N/A
Pesticide	Water	Documentation Issues	Transcription error	Yes	1	799	0.13	N/A
Pesticide	Water	Holding Times	Holding times were exceeded	No	21	799	2.63	Representativeness
Pesticide	Water	Internal Standards	Internal standards did not meet criteria	No	1	799	0.13	Accuracy
Pesticide	Water	Other	See hard copy for further explanation	No	1	799	0.13	N/A
Pesticide	Water	Other	See hard copy for further explanation	Yes	1	799	0.13	N/A
Pesticide	Water	Surrogates	Surrogate recovery criteria were not met	No	82	799	10.26	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	Soil	Blanks	Blank recovery criteria were not met	Yes	13	771	1.69	Representativeness
Radionuclide	Soil	Blanks	Method, preparation, or reagent blank contamination	Yes	68	771	8.82	Representativeness
Radionuclide	Soil	Calculation Errors	Calculation error	Yes	10	771	1.30	N/A
Radionuclide	Soil	Calibration	Continuing calibration verification criteria were not met	Yes	20	771	2.59	Accuracy
Radionuclide	Soil	Documentation Issues	Record added by the validator	Yes	25	771	3.24	N/A
Radionuclide	Soil	Documentation Issues	Results were not included on Data Summary Table	No	1	771	0.13	N/A
Radionuclide	Soil	Documentation Issues	Results were not included on Data Summary Table	Yes	1	771	0.13	N/A
Radionuclide	Soil	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	139	771	18.03	Representativeness
Radionuclide	Soil	Documentation Issues	Transcription error	No	1	771	0.13	N/A
Radionuclide	Soil	Documentation Issues	Transcription error	Yes	138	771	17.90	N/A
Radionuclide	Soil	Holding Times	Holding times were grossly exceeded	Yes	6	771	0.78	Representativeness
Radionuclide	Soil	Instrument Set-up	Detector efficiency did not meet requirements	Yes	28	771	3.63	Accuracy
Radionuclide	Soil	Instrument Set-up	Resolution criteria were not met	Yes	2	771	0.26	Representativeness
Radionuclide	Soil	LCS	LCS recovery > +/- 3 sigma	Yes	56	771	7.26	Accuracy
Radionuclide	Soil	LCS	LCS recovery criteria were not met	Yes	32	771	4.15	Accuracy
Radionuclide	Soil	LCS	LCS relative percent error criteria not met	Yes	74	771	9.60	Accuracy
Radionuclide	Soil	Matrices	Recovery criteria were not met	Yes	4	771	0.52	Accuracy
Radionuclide	Soil	Matrices	Replicate precision criteria were not met	No	1	771	0.13	Precision
Radionuclide	Soil	Matrices	Replicate precision criteria were not met	Yes	96	771	12.45	Precision
Radionuclide	Soil	Matrices	Replicate recovery criteria were not met	Yes	8	771	1.04	Accuracy
Radionuclide	Soil	Other	Sample exceeded efficiency curve weight limit	Yes	5	771	0.65	Accuracy
Radionuclide	Soil	Other	See hard copy for further explanation	Yes	11	771	1.43	N/A
Radionuclide	Soil	Other	Tracer requirements were not met	No	1	771	0.13	Accuracy
Radionuclide	Soil	Other	Tracer requirements were not met	Yes	2	771	0.26	Accuracy
Radionuclide	Soil	Sensitivity	Incorrect reported activity or MDA	No	1	771	0.13	N/A
Radionuclide	Soil	Sensitivity	Incorrect reported activity or MDA	Yes	1	771	0.13	N/A
Radionuclide	Soil	Sensitivity	MDA exceeded the RDL	Yes	5	771	0.65	Representativeness
Radionuclide	Soil	Sensitivity	MDA was calculated by reviewer	Yes	187	771	24.25	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
Radionuclide	Soil	Sensitivity	Results considered qualitative not quantitative	Yes	1	771	0.13	Accuracy
Radionuclide	Water	Blanks	Blank data not submitted	Yes	3	3,013	0.10	Representativeness
Radionuclide	Water	Blanks	Blank recovery criteria were not met	No	8	3,013	0.27	Representativeness
Radionuclide	Water	Blanks	Blank recovery criteria were not met	Yes	26	3,013	0.86	Representativeness
Radionuclide	Water	Blanks	Method, preparation, or reagent blank contamination	No	16	3,013	0.53	Representativeness
Radionuclide	Water	Blanks	Method, preparation, or reagent blank contamination	Yes	106	3,013	3.52	Representativeness
Radionuclide	Water	Calculation Errors	Calculation error	No	12	3,013	0.40	N/A
Radionuclide	Water	Calculation Errors	Calculation error	Yes	7	3,013	0.23	N/A
Radionuclide	Water	Calibration	Calibration counting statistics did not meet criteria	No	4	3,013	0.13	Accuracy
Radionuclide	Water	Calibration	Calibration counting statistics did not meet criteria	Yes	1	3,013	0.03	Accuracy
Radionuclide	Water	Calibration	Continuing calibration verification criteria were not met	No	19	3,013	0.63	Accuracy
Radionuclide	Water	Calibration	Continuing calibration verification criteria were not met	Yes	150	3,013	4.98	Accuracy
Radionuclide	Water	Documentation Issues	Information missing from case narrative	No	2	3,013	0.07	N/A
Radionuclide	Water	Documentation Issues	Information missing from case narrative	Yes	5	3,013	0.17	N/A
Radionuclide	Water	Documentation Issues	Missing deliverables (not required for validation)	No	2	3,013	0.07	N/A
Radionuclide	Water	Documentation Issues	Missing deliverables (required for validation)	No	5	3,013	0.17	Representativeness
Radionuclide	Water	Documentation Issues	Missing deliverables (required for validation)	Yes	6	3,013	0.20	Representativeness
Radionuclide	Water	Documentation Issues	Omissions or errors in data package (not required for validation)	No	65	3,013	2.16	N/A
Radionuclide	Water	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	54	3,013	1.79	N/A
Radionuclide	Water	Documentation Issues	Omissions or errors in data package (required for validation)	No	9	3,013	0.30	Representativeness
Radionuclide	Water	Documentation Issues	Omissions or errors in data package (required for validation)	Yes	11	3,013	0.37	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	Water	Documentation Issues	Record added by the validator	Yes	35	3,013	1.16	N/A
Radionuclide	Water	Documentation Issues	Sufficient documentation not provided by the laboratory	No	2	3,013	0.07	Representativeness
Radionuclide	Water	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	129	3,013	4.28	Representativeness
Radionuclide	Water	Documentation Issues	Transcription error	No	100	3,013	3.32	N/A
Radionuclide	Water	Documentation Issues	Transcription error	Yes	124	3,013	4.12	N/A
Radionuclide	Water	Holding Times	Holding times were exceeded	No	24	3,013	0.80	Representativeness
Radionuclide	Water	Holding Times	Holding times were exceeded	Yes	68	3,013	2.26	Representativeness
Radionuclide	Water	Holding Times	Holding times were grossly exceeded	No	9	3,013	0.30	Representativeness
Radionuclide	Water	Holding Times	Holding times were grossly exceeded	Yes	5	3,013	0.17	Representativeness
Radionuclide	Water	Instrument Set-up	Resolution criteria were not met	No	5	3,013	0.17	Representativeness
Radionuclide	Water	Instrument Set-up	Resolution criteria were not met	Yes	16	3,013	0.53	Representativeness
Radionuclide	Water	Instrument Set-up	Transformed spectral index external site criteria were not met	No	5	3,013	0.17	Representativeness
Radionuclide	Water	LCS	Expected LCS value not submitted/verifiable	No	3	3,013	0.10	Representativeness
Radionuclide	Water	LCS	Expected LCS value not submitted/verifiable	Yes	38	3,013	1.26	Representativeness
Radionuclide	Water	LCS	LCS recovery > +/- 3 sigma	No	40	3,013	1.33	Accuracy
Radionuclide	Water	LCS	LCS recovery > +/- 3 sigma	Yes	109	3,013	3.62	Accuracy
Radionuclide	Water	LCS	LCS recovery criteria were not met	No	6	3,013	0.20	Accuracy
Radionuclide	Water	LCS	LCS recovery criteria were not met	Yes	26	3,013	0.86	Accuracy
Radionuclide	Water	LCS	LCS relative percent error criteria not met	No	28	3,013	0.93	Accuracy
Radionuclide	Water	LCS	LCS relative percent error criteria not met	Yes	76	3,013	2.52	Accuracy
Radionuclide	Water	Matrices	Duplicate analysis was not performed	No	12	3,013	0.40	Precision
Radionuclide	Water	Matrices	Duplicate analysis was not performed	Yes	3	3,013	0.10	Precision
Radionuclide	Water	Matrices	Duplicate sample precision criteria were not met	Yes	4	3,013	0.13	Precision
Radionuclide	Water	Matrices	Recovery criteria were not met	No	5	3,013	0.17	Accuracy
Radionuclide	Water	Matrices	Recovery criteria were not met	Yes	18	3,013	0.60	Accuracy
Radionuclide	Water	Matrices	Replicate analysis was not performed	No	2	3,013	0.07	Precision
Radionuclide	Water	Matrices	Replicate analysis was not performed	Yes	20	3,013	0.66	Precision
Radionuclide	Water	Matrices	Replicate precision criteria were not met	No	32	3,013	1.06	Precision
Radionuclide	Water	Matrices	Replicate precision criteria were not met	Yes	144	3,013	4.78	Precision

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	Matrices	Replicate recovery criteria were not met	No	1	3,013	0.03	Accuracy
Radionuclide	Water	Matrices	Replicate recovery criteria were not met	Yes	9	3,013	0.30	Accuracy
Radionuclide	Water	Other	Lab results not verified due to unsubmitted data	No	2	3,013	0.07	Representativeness
Radionuclide	Water	Other	Lab results not verified due to unsubmitted data	Yes	6	3,013	0.20	Representativeness
Radionuclide	Water	Other	QC sample does not meet method requirements	No	18	3,013	0.60	Representativeness
Radionuclide	Water	Other	QC sample does not meet method requirements	Yes	15	3,013	0.50	Representativeness
Radionuclide	Water	Other	See hard copy for further explanation	No	57	3,013	1.89	N/A
Radionuclide	Water	Other	See hard copy for further explanation	Yes	120	3,013	3.98	N/A
Radionuclide	Water	Other	Tracer requirements were not met	No	17	3,013	0.56	Accuracy
Radionuclide	Water	Other	Tracer requirements were not met	Yes	10	3,013	0.33	Accuracy
Radionuclide	Water	Sample Preparation	Samples were not properly preserved in the field	No	17	3,013	0.56	Representativeness
Radionuclide	Water	Sample Preparation	Samples were not properly preserved in the field	Yes	11	3,013	0.37	Representativeness
Radionuclide	Water	Sensitivity	Incorrect reported activity or MDA	No	3	3,013	0.10	N/A
Radionuclide	Water	Sensitivity	Incorrect reported activity or MDA	Yes	13	3,013	0.43	N/A
Radionuclide	Water	Sensitivity	MDA exceeded the RDL	No	15	3,013	0.50	Representativeness
Radionuclide	Water	Sensitivity	MDA exceeded the RDL	Yes	43	3,013	1.43	Representativeness
Radionuclide	Water	Sensitivity	MDA was calculated by reviewer	No	18	3,013	0.60	N/A
Radionuclide	Water	Sensitivity	MDA was calculated by reviewer	Yes	292	3,013	9.69	N/A
SVOC	Soil	Blanks	Method, preparation, or reagent blank contamination	No	1	2,472	0.04	Representativeness
SVOC	Soil	Calibration	Continuing calibration verification criteria were not met	Yes	2	2,472	0.08	Accuracy
SVOC	Soil	Documentation Issues	Omissions or errors in data package (not required for validation)	No	6	2,472	0.24	N/A
SVOC	Soil	Documentation Issues	Transcription error	No	7	2,472	0.28	N/A
SVOC	Soil	Holding Times	Holding times were exceeded	No	166	2,472	6.72	Representativeness
SVOC	Soil	Holding Times	Holding times were exceeded	Yes	11	2,472	0.44	Representativeness
SVOC	Soil	Internal Standards	Internal standards did not meet criteria	No	21	2,472	0.85	Accuracy
SVOC	Soil	Matrices	Percent solids < 30 percent	Yes	1	2,472	0.04	Representativeness
SVOC	Soil	Other	See hard copy for further explanation	No	173	2,472	7.00	N/A
SVOC	Soil	Other	See hard copy for further explanation	Yes	2	2,472	0.08	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
SVOC	Water	Blanks	Method, preparation, or reagent blank contamination	No	4	2,696	0.15	Representativeness
SVOC	Water	Calibration	Continuing calibration verification criteria were not met	No	43	2,696	1.59	Accuracy
SVOC	Water	Calibration	Continuing calibration verification criteria were not met	Yes	1	2,696	0.04	Accuracy
SVOC	Water	Calibration	Independent calibration verification criteria not met	No	9	2,696	0.33	Accuracy
SVOC	Water	Documentation Issues	Information missing from case narrative	No	3	2,696	0.11	N/A
SVOC	Water	Documentation Issues	Missing deliverables (not required for validation)	No	6	2,696	0.22	N/A
SVOC	Water	Documentation Issues	Omissions or errors in data package (not required for validation)	No	45	2,696	1.67	N/A
SVOC	Water	Documentation Issues	Omissions or errors in data package (required for validation)	No	6	2,696	0.22	Representativeness
SVOC	Water	Documentation Issues	Record added by the validator	No	41	2,696	1.52	N/A
SVOC	Water	Documentation Issues	Transcription error	No	11	2,696	0.41	N/A
SVOC	Water	Holding Times	Holding times were exceeded	No	48	2,696	1.78	Representativeness
SVOC	Water	Holding Times	Holding times were exceeded	Yes	1	2,696	0.04	Representativeness
SVOC	Water	Instrument Set-up	Instrument tune criteria were not met	No	36	2,696	1.34	Accuracy
SVOC	Water	Internal Standards	Internal standards did not meet criteria	No	46	2,696	1.71	Accuracy
SVOC	Water	LCS	LCS recovery criteria were not met	No	10	2,696	0.37	Accuracy
SVOC	Water	Matrices	MS/MSD precision criteria were not met	No	1	2,696	0.04	Precision
SVOC	Water	Other	See hard copy for further explanation	No	57	2,696	2.11	N/A
VOC	Soil	Blanks	Method, preparation, or reagent blank contamination	No	27	1,443	1.87	Representativeness
VOC	Soil	Blanks	Method, preparation, or reagent blank contamination	Yes	2	1,443	0.14	Representativeness
VOC	Soil	Calculation Errors	Calculation error	No	32	1,443	2.22	N/A
VOC	Soil	Calculation Errors	Calculation error	Yes	2	1,443	0.14	N/A
VOC	Soil	Calibration	Continuing calibration verification criteria were not met	No	8	1,443	0.55	Accuracy
VOC	Soil	Calibration	Continuing calibration verification criteria were not met	Yes	6	1,443	0.42	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
VOC	Soil	Documentation Issues	Omissions or errors in data package (not required for validation)	No	118	1,443	8.18	N/A
VOC	Soil	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	3	1,443	0.21	N/A
VOC	Soil	Documentation Issues	Transcription error	No	36	1,443	2.49	N/A
VOC	Soil	Documentation Issues	Transcription error	Yes	1	1,443	0.07	N/A
VOC	Soil	Holding Times	Holding times were exceeded	No	79	1,443	5.47	Representativeness
VOC	Soil	Holding Times	Holding times were exceeded	Yes	1	1,443	0.07	Representativeness
VOC	Soil	Internal Standards	Internal standards did not meet criteria	No	42	1,443	2.91	Accuracy
VOC	Soil	Matrices	MS/MSD precision criteria were not met	No	8	1,443	0.55	Precision
VOC	Soil	Matrices	Percent solids < 30 percent	Yes	2	1,443	0.14	Representativeness
VOC	Soil	Other	See hard copy for further explanation	No	12	1,443	0.83	N/A
VOC	Water	Blanks	Method, preparation, or reagent blank contamination	No	51	10,280	0.50	Representativeness
VOC	Water	Blanks	Method, preparation, or reagent blank contamination	Yes	25	10,280	0.24	Representativeness
VOC	Water	Calibration	Continuing calibration verification criteria were not met	No	207	10,280	2.01	Accuracy
VOC	Water	Calibration	Continuing calibration verification criteria were not met	Yes	8	10,280	0.08	Accuracy
VOC	Water	Calibration	Independent calibration verification criteria not met	No	27	10,280	0.26	Accuracy
VOC	Water	Calibration	Independent calibration verification criteria not met	Yes	7	10,280	0.07	Accuracy
VOC	Water	Documentation Issues	Information missing from case narrative	No	58	10,280	0.56	N/A
VOC	Water	Documentation Issues	Key data fields incorrect	No	1	10,280	0.01	N/A
VOC	Water	Documentation Issues	Missing deliverables (not required for validation)	No	110	10,280	1.07	N/A
VOC	Water	Documentation Issues	Omissions or errors in data package (not required for validation)	No	795	10,280	7.73	N/A
VOC	Water	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	23	10,280	0.22	N/A
VOC	Water	Documentation Issues	Omissions or errors in data package (required for validation)	No	109	10,280	1.06	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
VOC	Water	Documentation Issues	Omissions or errors in data package (required for validation)	Yes	1	10,280	0.01	Representativeness
VOC	Water	Documentation Issues	Record added by the validator	No	134	10,280	1.30	N/A
VOC	Water	Documentation Issues	Record added by the validator	Yes	1	10,280	0.01	N/A
VOC	Water	Documentation Issues	Transcription error	No	417	10,280	4.06	N/A
VOC	Water	Documentation Issues	Transcription error	Yes	8	10,280	0.08	N/A
VOC	Water	Holding Times	Holding times were exceeded	No	625	10,280	6.08	Representativeness
VOC	Water	Holding Times	Holding times were exceeded	Yes	8	10,280	0.08	Representativeness
VOC	Water	Instrument Set-up	Instrument tune criteria were not met	No	629	10,280	6.12	Accuracy
VOC	Water	Instrument Set-up	Instrument tune criteria were not met	Yes	32	10,280	0.31	Accuracy
VOC	Water	Internal Standards	Internal standards did not meet criteria	No	147	10,280	1.43	Accuracy
VOC	Water	LCS	LCS recovery criteria were not met	No	85	10,280	0.83	Accuracy
VOC	Water	LCS	LCS recovery criteria were not met	Yes	9	10,280	0.09	Accuracy
VOC	Water	Matrices	MS/MSD precision criteria were not met	No	10	10,280	0.10	Precision
VOC	Water	Matrices	MS/MSD precision criteria were not met	Yes	3	10,280	0.03	Precision
VOC	Water	Other	Sample results were not validated due to re-analysis	No	6	10,280	0.06	N/A
VOC	Water	Other	See hard copy for further explanation	No	55	10,280	0.54	N/A
VOC	Water	Other	See hard copy for further explanation	Yes	1	10,280	0.01	N/A
VOC	Water	Surrogates	Surrogate recovery criteria were not met	No	30	10,280	0.29	Accuracy
VOC	Water	Surrogates	Surrogate recovery criteria were not met	Yes	6	10,280	0.06	Accuracy
Wet Chem	Soil	Blanks	Calibration verification blank contamination	Yes	1	121	0.83	Representativeness
Wet Chem	Soil	Documentation Issues	Record added by the validator	Yes	2	121	1.65	N/A
Wet Chem	Soil	Holding Times	Holding times were exceeded	No	1	121	0.83	Representativeness
Wet Chem	Soil	Holding Times	Holding times were exceeded	Yes	4	121	3.31	Representativeness
Wet Chem	Soil	Matrices	Percent solids < 30 percent	Yes	2	121	1.65	Representativeness
Wet Chem	Soil	Matrices	Predigestion MS recovery criteria were not met	No	1	121	0.83	Accuracy
Wet Chem	Soil	Matrices	Predigestion MS recovery criteria were not met	Yes	49	121	40.50	Accuracy
Wet Chem	Soil	Matrices	Predigestion MS recovery was < 30 percent	Yes	43	121	35.54	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	Serial dilution criteria were not met	Yes	4	121	3.31	Accuracy
Wet Chem	Soil	Other	IDL is older than 3 months from date of analysis	Yes	50	121	41.32	Accuracy
Wet Chem	Water	Blanks	Calibration verification blank contamination	No	1	1,071	0.09	Representativeness
Wet Chem	Water	Blanks	Method, preparation, or reagent blank contamination	No	3	1,071	0.28	Representativeness
Wet Chem	Water	Blanks	Method, preparation, or reagent blank contamination	Yes	2	1,071	0.19	Representativeness
Wet Chem	Water	Blanks	Negative bias indicated in the blanks	No	3	1,071	0.28	Representativeness
Wet Chem	Water	Blanks	Negative bias indicated in the blanks	Yes	1	1,071	0.09	Representativeness
Wet Chem	Water	Calculation Errors	Control limits not assigned correctly	Yes	1	1,071	0.09	N/A
Wet Chem	Water	Calibration	Calibration correlation coefficient did not meet requirements	Yes	7	1,071	0.65	Accuracy
Wet Chem	Water	Calibration	Continuing calibration verification criteria were not met	Yes	2	1,071	0.19	Accuracy
Wet Chem	Water	Documentation Issues	Omissions or errors in data package (not required for validation)	No	2	1,071	0.19	N/A
Wet Chem	Water	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	13	1,071	1.21	N/A
Wet Chem	Water	Documentation Issues	Omissions or errors in data package (required for validation)	Yes	1	1,071	0.09	Representativeness
Wet Chem	Water	Documentation Issues	Record added by the validator	No	26	1,071	2.43	N/A
Wet Chem	Water	Documentation Issues	Record added by the validator	Yes	21	1,071	1.96	N/A
Wet Chem	Water	Documentation Issues	Transcription error	No	17	1,071	1.59	N/A
Wet Chem	Water	Documentation Issues	Transcription error	Yes	15	1,071	1.40	N/A
Wet Chem	Water	Holding Times	Holding times were exceeded	No	13	1,071	1.21	Representativeness
Wet Chem	Water	Holding Times	Holding times were exceeded	Yes	7	1,071	0.65	Representativeness
Wet Chem	Water	Holding Times	Holding times were grossly exceeded	No	13	1,071	1.21	Representativeness
Wet Chem	Water	Holding Times	Holding times were grossly exceeded	Yes	3	1,071	0.28	Representativeness
Wet Chem	Water	Matrices	Duplicate sample precision criteria were not met	Yes	2	1,071	0.19	Precision
Wet Chem	Water	Matrices	Predigestion MS recovery criteria were not met	No	4	1,071	0.37	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	Water	Matrices	Predigestion MS recovery criteria were not met	Yes	22	1,071	2.05	Accuracy
Wet Chem	Water	Matrices	Predigestion MS recovery was < 30 percent	Yes	2	1,071	0.19	Accuracy
Wet Chem	Water	Other	Lab results not verified due to unsubmitted data	Yes	14	1,071	1.31	Representativeness
Wet Chem	Water	Other	See hard copy for further explanation	No	2	1,071	0.19	N/A
Wet Chem	Water	Other	See hard copy for further explanation	Yes	4	1,071	0.37	N/A
Wet Chem	Water	Sample Preparation	Preservation requirements were not met by the laboratory	Yes	8	1,071	0.75	Representativeness
Wet Chem	Water	Sample Preparation	Samples were not properly preserved in the field	Yes	14	1,071	1.31	Representativeness

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 (%)
Dioxins and Furans	Soil	1	68	Yes	1.47
Herbicide	Soil	6	42	No	14.29
Herbicide	Water	34	93	No	36.56
Metal	Soil	426	4,573	No	9.32
Metal	Soil	891	4,573	Yes	19.48
Metal	Water	1,433	10,408	No	13.77
Metal	Water	965	10,408	Yes	9.27
PCB	Soil	34	238	No	14.29
PCB	Water	27	245	No	11.02
Pesticide	Soil	106	680	No	15.59
Pesticide	Water	116	799	No	14.52
Radionuclide	Soil	2	771	Yes	0.26
Radionuclide	Water	14	3,013	No	0.46
Radionuclide	Water	35	3,013	Yes	1.16
SVOC	Soil	347	2,472	No	14.04
SVOC	Water	205	2,696	No	7.60
SVOC	Water	1	2,696	Yes	0.04
VOC	Soil	163	1,443	No	11.30
VOC	Soil	9	1,443	Yes	0.62
VOC	Water	1,107	10,280	No	10.77
VOC	Water	38	10,280	Yes	0.37
Wet Chem	Soil	2	121	No	1.65
Wet Chem	Soil	99	121	Yes	81.82
Wet Chem	Water	35	1,071	No	3.27
Wet Chem	Water	64	1,071	Yes	5.98
	Total	**6,160**	**39,027**		**15.78%**

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	105	3,558	2.95
Metal	Water	233	4,762	4.89
	Total	**338**	**8,320**	**4.06%**

[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 (%)
Herbicide	Soil	0	2	0.00	4.55
Herbicide	Water	0	6	0.00	2.49
Metal	Soil	47	449	10.47	9.81
Metal	Water	28	784	3.57	6.25
PCB	Soil	0	7	0.00	2.44
PCB	Water	0	49	0.00	13.21
Pesticide	Soil	0	23	0.00	3.03
Pesticide	Water	0	148	0.00	9.89
Radionuclide	Soil	10	74	13.51	9.02
Radionuclide	Water	2	286	0.70	3.75
SVOC	Soil	0	115	0.00	4.64
SVOC	Water	0	419	0.00	9.91
VOC	Soil	1	71	1.41	4.70
VOC	Water	0	697	0.00	5.28
Wet Chem	Soil	0	10	0.00	8.26
Wet Chem	Water	0	52	0.00	3.22

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	Soil	0	68	0.00
Dioxins and Furans	Water	2	27	7.41
Herbicide	Soil	3	60	5.00
Herbicide	Water	3	132	2.27
Metal	Soil	106	7,163	1.48
Metal	Water	548	17,346	3.16
PCB	Soil	28	434	6.45
PCB	Water	0	427	0.00
Pesticide	Soil	87	1,262	6.89
Pesticide	Water	1	1,364	0.07
Radionuclide	Soil	298	1,828	16.30
Radionuclide	Water	738	5,424	13.61
SVOC	Soil	189	3,569	5.30
SVOC	Water	67	4,950	1.35
VOC	Soil	153	3,384	4.52
VOC	Water	592	15,900	3.72
Wet Chem	Soil	1	190	0.53
Wet Chem	Water	29	1,764	1.64
	Total	**2,845**	**65,292**	**4.36%**

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
Herbicide	Soil	Holding Times	Holding times were exceeded	No	7.14	0.00	7.14	Representativeness	No
Metal	Soil	LCS	LCS recovery criteria were not met	Yes	5.99	0.00	5.99	Accuracy	No
Metal	Soil	Matrices	Predigestion MS recovery criteria were not met	Yes	8.44	0.00	8.44	Accuracy	No
Metal	Soil	Other	IDL is older than 3 months from date of analysis	No	6.65	1.60	0.72	Accuracy	No
Metal	Soil	Other	IDL is older than 3 months from date of analysis	Yes	26.44	0.00	4.33	Accuracy	No
PCB	Soil	Surrogates	Surrogate recovery criteria were not met	No	11.34	0.00	11.34	Accuracy	No
PCB	Water	Surrogates	Surrogate recovery criteria were not met	No	8.57	0.00	8.57	Accuracy	No
Pesticide	Soil	Surrogates	Surrogate recovery criteria were not met	No	11.76	0.00	11.76	Accuracy	No
Pesticide	Water	Surrogates	Surrogate recovery criteria were not met	No	10.26	0.00	10.26	Accuracy	No
Radionuclide	Soil	Blanks	Method, preparation, or reagent blank contamination	Yes	8.82	0.00	0.00	Representativeness	No
Radionuclide	Soil	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	18.03	0.00	0.00	Representativeness	No
Radionuclide	Soil	LCS	LCS recovery > +/- 3 sigma	Yes	7.26	0.00	0.00	Accuracy	No
Radionuclide	Soil	LCS	LCS relative percent error criteria not met	Yes	9.60	0.00	0.00	Accuracy	No
Radionuclide	Soil	Matrices	Replicate precision criteria were not met	Yes	12.45	0.00	0.00	Precision	No
SVOC	Soil	Holding Times	Holding times were exceeded	No	6.72	0.00	6.72	Representativeness	No
VOC	Water	Holding Times	Holding times were exceeded	No	6.08	3.71	2.37	Representativeness	No
VOC	Water	Instrument Set-up	Instrument tune criteria were not met	No	6.12	1.58	0.21	Accuracy	No
Wet Chem	Soil	Matrices	Predigestion MS recovery criteria were not met	Yes	40.50	0.00	40.50	Accuracy	No
Wet Chem	Soil	Matrices	Predigestion MS recovery was < 30 percent	Yes	35.54	0.00	35.54	Accuracy	No
Wet Chem	Soil	Other	IDL is older than 3 months from date of analysis	Yes	41.32	0.00	41.32	Accuracy	No

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

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

COMPREHENSIVE RISK ASSESSMENT

LOWER WOMAN DRAINAGE EXPOSURE UNIT

VOLUME 11: ATTACHMENT 3

Statistical Analyses and Professional Judgment

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ACRONYMS AND ABBREVIATIONS

CDH	Colorado Department of Health
COC	contaminant of concern
ECOI	ecological contaminant of interest
ECOPC	ecological contaminant of potential concern
EcoSSL	Ecological Soil Screening Level
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
LWOEU	Lower Woman Drainage Exposure Unit
MDC	maximum detected concentration
mg/kg	milligrams per kilogram
NCP	National Contingency Plan
NFA	No Further Action
NOAEL	no observed adverse effect level
PCOC	potential contaminant of concern
pCi/g	picocuries per gram
PMJM	Preble’s meadow jumping mouse
PRG	preliminary remediation goal
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Report

tESL	threshold ecological screening level
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 Lower Woman Drainage Exposure Unit (EU) (LWOEU) at the Rocky Flats Environmental Technology Site (RFETS). The methods used to perform the statistical analysis and to develop the professional judgment sections are described in Appendix A, Volume 2, Section 2.0 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation/Corrective Measures Study (CMS)-Feasibility Study (RI/FS) Report (hereafter referred to as the RI/FS Report), and follow the Final Comprehensive Risk Assessment (CRA) Work Plan and Methodology (DOE 2005).

2.0 RESULTS OF STATISTICAL COMPARISONS TO BACKGROUND FOR THE LOWER WOMAN 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 LWOEU 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 A3.2.31.[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.

ECOIs for surface soil (Preble's meadow jumping mouse [PMJM] receptor) and PCOCs with concentrations in the LWOEU that are statistically greater than background (or those where background comparisons were not performed) are carried through to the professional judgment step of the COC/ECOPC selection processes. ECOIs (for non-PMJM receptors) with concentrations in the LWOEU that are statistically greater than background (or those where background comparisons were not performed) are carried through to the exposure point concentration (EPC) – threshold ecological screening level (tESL) comparison step of the ECOPC selection processes.

[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 LWOEU 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.

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 Human Health Risk Assessment

For the LWOEU surface soil/surface sediment data set, the maximum detected concentrations (MDCs) and upper confidence limits (UCLs) on the mean for arsenic, manganese, cesium-134, cesium-137, and radium-228 exceed the wildlife refuge worker (WRW) preliminary remediation goals (PRGs) for the LWOEU data set, and these PCOCs were carried forward into the statistical background comparison step. The results of the statistical comparison of the LWOEU surface soil/surface sediment data to background data for these PCOCs are presented in Table A3.2.1 and the summary statistics for background and LWOEU surface soil/surface sediment data are shown in Table A3.2.2. The LWOEU MDCs and UCLs for all other PCOCs do not exceed the PRGs and were not evaluated further.

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

Statistically Greater than Background at the 0.1 Significance Level

- Arsenic
- Manganese
- Radium-228

Not Statistically Greater than Background at the 0.1 Significance Level

- Cesium-134
- Cesium-137

Background Comparison Not Performed[1]

- None

2.2 Subsurface Soil/Subsurface Sediment Used in the HHRA

For the LWOEU subsurface soil/subsurface sediment data set, the MDC and UCL for radium-228 exceeded the WRW PRG for the LWOEU data set, and this PCOC was carried forward into the statistical background comparison step. The results of the statistical comparison of the LWOEU subsurface soil/subsurface sediment data to background data for this PCOC is presented in Table A3.2.3, and the summary statistics for background and LWOEU subsurface soil/subsurface sediment data are shown in Table A3.2.4.

The results of the statistical comparisons of the LWOEU subsurface soil/subsurface sediment data to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- None

Not Statistically Greater than Background at the 0.1 Significance Level

- Radium-228

Background Comparison Not Performed[1]

- None

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

For the ECOIs in surface soil, the MDCs for aluminum, antimony, arsenic, barium, boron, cadmium, chromium, cobalt, copper, lead, lithium, manganese, mercury, nickel, selenium, thallium, tin, vanadium, and zinc exceeded a non-PMJM ESL, and these ECOIs were carried forward into the statistical background comparison step. The results of the statistical comparison of the LWOEU surface soil data to background data are presented in Table A3.2.5 and the summary statistics for background and LWOEU surface soil data are shown in Table A3.2.6.

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

Statistically Greater than Background at the 0.1 Significance Level

- Aluminum
- Barium
- Chromium
- Copper
- Lithium
- Manganese
- Nickel
- Vanadium
- Zinc

Not Statistically Greater than Background at the 0.1 Significance Level

- Arsenic
- Cadmium
- Cobalt
- Lead
- Mercury
- Selenium

Background Comparison Not Performed[1]

- Antimony
- Boron

- Thallium
- Tin

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

For the ECOIs in surface soil in PMJM habitat, the MDCs for arsenic, chromium, copper, manganese, nickel, selenium, tin, vanadium and zinc exceed the PMJM ESL, and were carried forward into the background comparison step. The results of the statistical comparison of the LWOEU surface soil data in PMJM habitat to background data are presented in Table A3.2.7. The summary statistic for background and LWOEU surface soil in PMJM habitats are shown in Table A3.2.8.

The results of the statistical comparisons of the LWOEU surface soil in PMJM habitat to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- Chromium
- Copper
- Manganese
- Nickel
- Vanadium
- Zinc

Not Statistically Greater than Background at the 0.1 Significance Level

- Arsenic
- Mercury

Background Comparison Not Performed[1]

- Selenium
- Tin

2.5 Subsurface Soil Data Used in the ERA

For the ECOIs in subsurface soil, the MDC for antimony, arsenic, nickel, and vanadium exceeded the prairie dog ESL and was carried forward into the statistical background comparison step. The MDCs for all other ECOIs do not exceed the prairie dog ESL. The results of the statistical comparison of the LWOEU subsurface soil data to background data are presented in Table A3.2.9 and the summary statistics for background and LWOEU subsurface soil data are shown in Table A3.2.10.

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

Statistically Greater than Background at the 0.1 Significance Level

- Arsenic

- Vanadium

Not Statistically Greater than Background at the 0.1 Significance Level

- Nickel

Background Comparison Not Performed[1]

- Antimony

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

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

3.1 ECOIs in Surface Soil

Barium in surface soil (non-PMJM) was eliminated from further consideration because the EPC is not greater than the limiting tESLs. Aluminum, antimony, boron, chromium, copper, lithium, manganese, nickel, thallium, tin, vanadium, and zinc have EPCs greater than the limiting tESLs and are evaluated in the professional judgment evaluation screening step (Section 4.0).

3.2 ECOIs in Subsurface Soil

Vanadium and arsenic in subsurface soil were eliminated from further consideration because the EPCs are not greater than the tESLs. Antimony has an EPC greater than the limiting tESL and is evaluated in the professional judgment evaluation screening step (Section 4.0).

4.0 PROFESSIONAL JUDGMENT

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

The professional judgment evaluation takes into account the following lines of evidence: process knowledge, spatial trends, pattern recognition[2], comparison to RFETS

[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,

background and regional background data sets (see Table A3.4.1 for a summary of regional background data)[3], and risk potential. For PCOCs or ECOIs where the process knowledge and/or spatial trends indicate that the presence of the analyte in the EU may be a result of historical site-related activities, the professional judgment discussion 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 from these evaluations are noted in this attachment.

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

- Surface soil/surface sediment (HHRA)
  - Arsenic
  - Manganese
  - Radium-228
- Subsurface soil/subsurface sediment (HHRA)
  - No PCOCs were found to be statistically greater than background and above a PRG in accordance with the COC selection process; therefore, no PCOCs in subsurface soil/subsurface sediment are evaluated using professional judgment.
- Surface soil for non-PMJM receptors (ERA)
  - Aluminum
  - Antimony
  - Boron
  - Chromium
  - Copper

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but not definitive proof of, the hypothesis that no releases have occurred. However, if a release has occurred within the sampled area and has been included in the samples, then the elemental concentrations associated with that release are either within the background concentration range or the entire sampled population represents a release, a highly unlikely probability.

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

  - Lithium
  - Manganese
  - Nickel
  - Thallium
  - Tin
  - Vanadium
  - Zinc
- Surface soil for PMJM receptors (ERA)
  - Chromium
  - Copper
  - Manganese
  - Nickel
  - Selenium
  - Tin
  - Vanadium
  - Zinc
- Subsurface soil (ERA)
  - Antimony

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 limiting 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, process knowledge indicates a potential for aluminum to have been released into RFETS soil because of the large aluminum metal inventory and presence of aluminum in waste generated during former operations. However, these operations occurred in the former Industrial Area. Therefore, aluminum is unlikely to be present in LWOEU 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, the spatial trend analysis indicates that aluminum concentrations in LWOEU surface soil reflect variations in naturally occurring aluminum.

4.1.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for aluminum in surface soil (Figure A3.4.1) suggests the presence of a single population, which is indicative of background conditions.

4.1.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Aluminum concentrations in LWOEU surface soil range from 3,900 to 30,000 milligram per kilogram (mg/kg), with a mean concentration of 15,019 mg/kg and a standard deviation of 6,250 mg/kg. Aluminum concentrations in the background data set range from 4,050 to 17,100 mg/kg, with a mean concentration of 10,203 mg/kg and a standard deviation of 3,256 mg/kg (Table A3.2.6).

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

4.1.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The MDC for aluminum in the LWOEU (30,000 mg/kg) exceeds the no observed adverse effect level (NOAEL) ESL for only one receptor group, terrestrial plants (50 mg/kg). However, EPA Ecological Soil Screening Level (Eco-SSL) guidance (EPA 2003) for aluminum recommends that aluminum should not be considered an ECOPC for soils at sites where the pH of the soil exceeds 5.5 due to its limited bioavailability in non-acidic soils. Average pH values at RFETS are 8.2 for surface soil. Therefore, aluminum concentrations in LWOEU surface soil are unlikely to result in risk concerns for wildlife populations.

4.1.6 Conclusion

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

4.2 Antimony

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

4.2.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates antimony may be present in LWOEU soil as a result of historical site-related activities.

4.2.2 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 antimony concentrations in LWOEU surface soil reflect variations in naturally occurring antimony.

Subsurface Soil

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

4.2.3 Pattern Recognition

Surface Soil

The log-probability plot (Figure A3.4.2) appears to show three distinct populations, which stems from the low detection frequency (47%) and multiple detection limits in the data set. Because of this limitation, the log-probability plot is inconclusive with regard to the presence of a single background population.

The antimony data set for LWOEU consists of samples from two time periods: 1992-1993 and 2004. For the earlier samples, there is only one detected concentration (9.8 mg/kg) and the nondetect samples have reported results ranging from 2.7 to 13.1 mg/kg. For the 2004 samples, the detected results range from 0.3 to 0.9 mg/kg and the reported results for nondetects range from 0.29 to 0.36 mg/kg.

Subsurface Soil

The probability plot for antimony in subsurface soil (Figure A3.4.3) suggests the presence of a single population, which is indicative of background conditions.

4.2.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil

Antimony concentrations in LWOEU surface soil range from 0.300 to 9.80 mg/kg, with a mean concentration of 1.48 mg/kg and a standard deviation of 2.39 mg/kg (Table A3.2.6). None of the background antimony sample results were detects. Detection limits varied from 0.38 to 0.94 mg/kg.

Most of the antimony concentrations in LWOEU surface soils are within the range for antimony in soils of Colorado and the bordering states (less than 1.038 to 2.531 mg/kg, with a mean concentration of 0.647 mg/kg and a standard deviation of 0.378 mg/kg) (Table A3.4.1). There is only one detected antimony concentration (9.8 mg/kg) in the LWOEU that is above this range.

Subsurface Soil

Antimony concentrations in LWOEU subsurface soil range from 0.30 to 20.2 mg/kg, with a mean concentration of 2.44 mg/kg and a standard deviation of 4.07 mg/kg. Antimony concentrations in the background data set range from 2.90 to 8.20 mg/kg, with a mean concentration of 4.21 mg/kg and a standard deviation of 2.78 mg/kg (Table A3.2.10).

4.2.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for antimony in the LWOEU (6.55 mg/kg) exceeds the NOAEL ESLs for three non-PMJM receptors: terrestrial plants (5 mg/kg), deer mouse insectivore (0.90 mg/kg), and coyote insectivore (3.85 mg/kg). The ESLs for all other non-PMJM receptors were greater than the antimony MDC and UTL and range from 13.0 to 138 mg/kg. The UTL also exceeds the mammalian Eco-SSL of 0.27 mg/kg for antimony (EPA 2005). No Eco-SSL is currently available for plants.

It is important to note that there is only one detected result for antimony in the LWOEU that exceeds an ESL (9.8 mg/kg) and this sample was collected in 1992. All other detected results were from samples collected in 2004 and the concentrations in these samples are all less than or equal to the lowest ESL (deer mouse insectivore ESL of 0.90 mg/kg). As described in Section 4.2.3 above, the antimony data set has a group of nondetect samples from 1992-1993 that have high detection limits. Therefore, the UTL value is biased high because of these high detection limits.

Subsurface Soil

The MDC for antimony in LWOEU (20.2 mg/kg) subsurface soil exceeds the NOAEL ESL for the prairie dog (18.7 mg/kg).

4.2.6 Conclusion

The weight of evidence presented above shows that antimony concentrations in LWOEU surface soil (non-PMJM receptors) and subsurface soil could be related to historical site-related activities based on process knowledge; a spatial distribution that suggests antimony is naturally occurring; a single LWOEU concentration that was above the background concentration range; and the MDC for antimony in subsurface soil only slightly exceeded the prairie dog ESL. In addition, there is only one detected result in surface soil that exceeds the minimum ESL. Antimony is not considered an ECOPC in surface soil or subsurface soil for the LWOEU and, therefore, is not further evaluated quantitatively.

4.3 Arsenic

Arsenic has concentrations statistically greater than background in surface soil/surface sediment and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if arsenic 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 arsenic may be present in LWOEU soil as a result of historical site-related activities.

4.3.2 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 LWOEU surface soil/surface sediment reflect variations in naturally occurring arsenic.

4.3.3 Pattern Recognition

Surface Soil/Surface Sediment

The probability plot for arsenic in surface soil (Figure A3.4.4) suggests 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/Surface Sediment

Arsenic concentrations in LWOEU surface soil/surface sediment range from 1.50 to 9.80 mg/kg, with a mean concentration of 5.53 mg/kg and a standard deviation of 1.79 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).

Arsenic concentrations in LWOEU surface soil/surface sediment 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).

4.3.5 Risk Potential for HHRA

Surface Soil/Surface Sediment

The arsenic MDC for surface soil/surface sediment is 9.8 mg/kg and the UCL is 6.10 mg/kg. The UCL is less than three times greater than the PRG (2.41 mg/kg), with 94 of the 96 detections greater than the PRG. Because the PRG is based on an excess carcinogenic risk of 1E-06, the cancer risk based on the UCL concentration is less than 3E-06, and is well within the National Contingency Plan (NCP) risk range of 1E-06 to 1E-04. Arsenic was detected in 67 of 73 background samples, and detected concentrations in 39 of the 67 samples exceeded the PRG. The background UCL for arsenic in surface soil/surface sediment is 4.03 mg/kg (Appendix A, Volume 2, Attachment 9 of the RI/FS Report), which equates to a cancer risk of 2E-06. Therefore, the excess cancer risks to the WRW from exposure to arsenic in surface soil/surface sediment in the LWOEU are similar to background risk.

4.3.6 Conclusion

The weight of evidence presented above shows that arsenic concentrations in LWOEU surface soil/surface sediment are not likely to be a result of historical site-related activities based on a spatial distribution that suggest arsenic is naturally occurring; a probability plot that suggests the presence of a single arsenic data population, which is also indicative of background conditions; LWOEU concentrations that are well within regional background levels; and LWOEU concentrations that are unlikely to result in risks to humans that are significantly above background. Although process knowledge indicates arsenic may be present in LWOEU soil as a result of historical site-related activities, arsenic is not considered a COC in surface soil/surface sediment for the LWOEU based on the other lines of evidence, and therefore, is not further evaluated quantitatively.

4.4 Boron

For boron in surface soil, a statistical comparison between LWOEU and RFETS background data could not be performed because RFETS background surface soil samples were not analyzed for boron. Boron has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if boron should be retained for risk characterization are summarized below.

4.4.1 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.

4.4.2 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 that boron concentrations in LWOEU surface soil reflect variations in naturally occurring boron.

4.4.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot of boron concentrations in surface soil in the LWOEU shows the presence of a single population, which is indicative of background conditions (Figure A3.4.5).

4.4.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

The reported range for boron in surface soils within Colorado and the bordering states is 20 to 150 mg/kg, with a mean of 27.9 mg/kg and a standard deviation of 19.7 mg/kg

(Table A3.4.1). Boron concentrations reported in surface soil samples at the LWOEU range from 2.3 to 13.0 mg/kg, with a mean concentration of 7.00 mg/kg and a standard deviation of 2.08 mg/kg (Table A3.2.6). The range of concentrations of boron in surface soil is well within the range for boron in soils of Colorado and bordering states (20 to 150 mg/kg).

4.4.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for boron in the LWOEU (10.5 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (0.5 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 30 to 6,070 mg/kg. Site-specific background data for boron were not available but the MDC did not exceed the low end (20 mg/kg) of the background range presented in Shacklette and Boerngen (1984). This indicates the terrestrial plant NOAEL ESL (0.5 mg/kg) is well below expected background concentrations, and because risks are not typically expected at background concentrations, boron concentrations are not likely to be indicative of site-related risk to the terrestrial plant community in the LWOEU. 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. (1997) notes that the source of the 0.5 mg/kg NOAEL ESL indicates boron was toxic when added at 0.5 mg/kg to soil, but gives no indication of the boron concentration in the baseline soil before addition. The confidence placed by Efroymson et al. (1997) was low. No boron Eco-SSLs are currently available. Because no NOAEL ESLs other than the terrestrial plant NOAEL ESL are exceeded by the MDC, boron is unlikely to present a risk to terrestrial receptor populations in the LWOEU.

4.4.6 Conclusion

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

4.5 Chromium

Chromium had 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, chromium in surface soil (for PMJM receptors) had concentrations statistically greater than background and, therefore, was carried forward to the professional judgment step. The lines of evidence that were used to determine if chromium should be retained as a COC are summarized below.

4.5.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for chromium to have been released into RFETS soil because of the moderate chromium metal inventory and presence of chromium in waste generated during former operations. Spills of chromium have occurred at RFETS. However, these operations occurred in the former Industrial Area. Therefore, chromium is unlikely to be present in LWOEU 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 indicates that elevated chromium concentrations in LWOEU surface soil (non-PMJM) are located within or near historical IHSSs and, therefore, could not be eliminated as an ECOPC.

Surface Soil (PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that chromium concentrations in LWOEU surface soil (PMJM) appear to have a spatial concentration trend.

4.5.3 Conclusion

Chromium in surface soil is being carried forward into the ecological non-PMJM risk characterization because elevated concentrations (greater than background MDC, less than three times background MDC) are within or near historical Individual Hazardous Substance Sites (IHSSs). Chromium was used in limited quantities during historical RFETS operations, which would indicate it is unlikely to be a site-related contaminant. Nevertheless, as a conservative measure, chromium is carried forward into the risk characterization, recognizing that its classification as a COC/ECOPC is uncertain.

Chromium in surface soil concentrations is being carried forward into the ecological PMJM risk characterization because elevated concentrations (greater than the ESL) are within one or more PMJM habitat patches. Due to the exceedances in the PMJM habitat patches, chromium is retained as an ECOPC for further evaluation in the risk characterization.

4.6 Copper

Copper 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 copper should be retained as a COC 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, copper may be present in LWOEU soil as a result of historical site-related activities.

4.6.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, elevated copper concentrations in the LWOEU were located near historical IHSS, therefore copper could not be eliminated as an EPCOC.

Surface Soil (PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, elevated copper concentrations in the PMJM habitat in LWOEU were located near historical IHSS, therefore copper could not be eliminated as an EPCOC.

4.6.3 Conclusion

Copper in surface soil is being carried forward into the ecological non-PMJM risk characterization because elevated concentrations (greater than 10 times the MDC) are within or near historical IHSSs. Copper may be a site-related contaminant as a result of historical site-related activities. As a conservative measure, copper is carried forward into the risk characterization, recognizing that its classification as a COC/ECOPC is uncertain.

Copper in surface soil is being carried forward into the ecological PMJM risk characterization because one elevated concentration (greater than the PMJM ESL) is within one PMJM habitat patch. Due to the exceedances in the PMJM habitat patch, copper is retained as an ECOPC for further evaluation in the risk characterization.

4.7 Lithium

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

4.7.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for lithium to have been released into RFETS soil because of the moderate lithium metal inventory and presence of lithium in waste generated during former operations. However, these operations occurred in the former Industrial Area. Therefore lithium is unlikely to be present in LWOEU soil as a result of historical site-related activities.

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 lithium concentrations in LWOEU surface soil reflect variations in naturally occurring lithium.

4.7.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot of lithium concentrations in surface soil in the LWOEU shows the presence of a single population (Figure A3.4.6), which is indicative of background conditions.

4.7.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Lithium concentrations in surface soil samples at the LWOEU range from 1.80 to 22.0 mg/kg, with a mean concentration of 12.5 and a standard deviation of 4.60 mg/kg. Lithium concentrations in the background data set range from 4.80 to 11.6 mg/kg, with a mean of 7.66 mg/kg and a standard deviation of 1.89 mg/kg (Table A3.2.6).

Lithium concentrations reported in surface soils samples at the LWOEU are well within the range for lithium in soils of Colorado and the bordering states (5 to 130 mg/kg, with a mean concentration of 25.3 mg/kg and a standard deviation of 14.4 mg/kg) (Table A3.4.1).

4.7.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for lithium in the LWOEU (19.9 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (2 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 610 to 18,431 mg/kg. The authors of the document from which the terrestrial plant NOAEL ESL was selected (Efroymson et al. 1997) placed a low confidence rating on the value. Other studies reported in Efroymson et al 1997 report no observed adverse effects at 25 mg/kg, which is greater than the UTL and MDC (22 mg/kg). The ESL for terrestrial plants is also lower than all detected background concentrations. No lithium Eco-SSLs are currently available.

4.7.6 Conclusion

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

4.8 Manganese

Manganese has concentrations statistically greater than background in surface soil/surface sediment, has an EPC in surface soil (for non-PMJM receptors) greater than the tESL, and has concentrations statistically greater than background in surface soil (for PMJM receptor). Therefore, manganese in surface soil/surface sediment and surface soil (non-PMJM and PMJM receptors) was carried forward to the professional judgment step.

The lines of evidence used to determine if manganese should be retained for risk characterization are summarized below.

4.8.1 Summary of Process Knowledge

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

4.8.2 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 manganese concentrations in LWOEU surface soil/surface sediment reflect variations in naturally occurring manganese.

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that elevated manganese concentrations in LWOEU surface soil (non-PMJM) were located near historical IHSSs and therefore cannot be eliminated as an ECOPC.

Surface Soil (PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that elevated manganese concentrations in LWOEU surface soil (PMJM) were located near historical IHSSs and therefore cannot be eliminated as an ECOPC.

4.8.3 Pattern Recognition

Surface Soil/Surface Sediment

The probability plot for manganese concentrations suggests a single population, which indicates background conditions (Figure A3.4.7).

4.8.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil/Surface Sediment

Manganese concentrations in surface soil/surface sediment samples at the LWOEU range from 106 to 1,580 mg/kg, with a mean concentration of 383 mg/kg and a standard deviation of 207 mg/kg. Manganese concentrations in the background data set range from 9.00 to 1,280 mg/kg, with a mean concentration of 241 mg/kg and a standard deviation of 189 mg/kg (Table A3.2.2).

4.8.5 Risk Potential for HHRA

Surface Soil/Surface Sediment

The manganese UCL for surface soil/surface sediment is 422 mg/kg. The UCL is slightly greater than the PRG (419 mg/kg), with one of the 97 detections greater than the PRG. Because the PRG is based on a hazard quotient of 0.1, the hazard quotient for manganese in the LWOEU is well below EPA's guideline of an HQ of 1.

4.8.6 Conclusion

The weight of evidence presented above shows that manganese concentrations in the LWOEU surface soil/surface sediment are not likely to be a result of historical site-related activities based on process knowledge; spatial distributions that suggest manganese is naturally occurring; probability plots that suggest the presence of single populations, which are also indicative of background conditions; and LWOEU concentrations that are unlikely to result in risks to humans. Manganese is not considered a COC in surface soil/surface sediment for the LWOEU.

Manganese in surface soil is being carried forward into the ecological non-PMJM risk characterization because elevated concentrations (greater than three times the ESL) are within or near historical IHSSs.

Manganese in surface soil is being carried forward into the ecological PMJM risk characterization because elevated concentrations (more than three times greater than the ESL) are within one or more PMJM habitat patches.

4.9 Nickel

Nickel has an EPC in surface soil (for non-PMJM receptors) greater than the tESL, and concentrations statistically greater than background in surface soil (for the PMJM receptor) 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.

4.9.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for nickel to have been released into RFETS soil because of the moderate nickel metal inventory and presence of nickel in waste generated during former operations. However, these operations occurred in the former Industrial Area. Therefore nickel is unlikely to be present in LWOEU soil as a result of historical site-related activities.

4.9.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that elevated nickel concentrations in LWOEU surface soil are located near historical IHSSs and therefore cannot be eliminated as an ECOPC.

Surface Soil (PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that elevated nickel concentrations in LWOEU surface soil in PMJM habitat are located near historical IHSSs and therefore cannot be eliminated as an ECOPC.

4.9.3 Conclusion

Nickel in surface soil is being carried forward into the ecological non-PMJM risk characterization because elevated concentrations (greater than 10 times the ESL) are within or near historical IHSSs.

Nickel in surface soil is being carried forward into the ecological PMJM risk characterization because elevated concentrations (more than three times greater than the ESL) are within one or more PMJM habitat patches. Nickel is also used at RFETS and/or identified in wastes, although uses and releases in the LWOEU have not been identified.

4.10 Radium-228

Radium-228 has activities that are statistically greater than background in surface soil/surface sediment and was carried forward to the professional judgment step. The lines of evidence used to determine if radium-228 should be retained for risk characterization are summarized below.

4.10.1 Summary of Process Knowledge

The ChemRisk Task 1 Report did not identify radium-228 as a radionuclide used at RFETS (CDH 1991), and no radium-228 waste was reported to have been generated. It is unlikely that radium-228 is present in soil at RFETS as a result of historical site-related activities.

4.10.2 Evaluation of Spatial Trends

Surface Soil/Surface Sediment

As shown in Figure A3.4.8, radium-228 activities exceed the PRG of 0.111 picocuries per gram (pCi/g) at locations throughout the LWOEU. There are no locations where the radium-228 activity exceeds the background MDC. None of these locations are near historical IHSSs. Thus it appears that radium-228 activities in LWOEU surface soil reflect variations in naturally occurring radium-228.

4.10.3 Pattern Recognition

Surface Soil/Surface Sediment

The probability plot for radium-228 activities suggests a single population which is indicative of background conditions (Figure A3.4.9).

4.10.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil/Surface Sediment

Radium-228 activities in surface soil/surface sediment samples at the LWOEU range from 1.19 to 2.80 pCi/g, with a mean activity of 1.94 pCi/g and a standard deviation of 0.519 pCi/g. The radium-228 activities in the background data set range from 0.200 to 4.10 pCi/g, with a mean activity of 1.60 pCi/g and a standard deviation of 0.799 pCi/g (Table A3.2.2). The range of activities of radium-228 in the LWOEU and background samples considerably overlap and the means are similar. Furthermore, radium-228 detections in LWOEU surface soil/surface sediment are all below the background MDC.

4.10.5 Risk Potential for HHRA

The radium-228 UCL for surface soil/surface sediment is 2.26 pCi/g. The PRG is 0.111 pCi/g, with all of the detections greater than the PRG. Because the PRG is based on an excess carcinogenic risk of 1E-06, the cancer risk based on the UCL activity is less than 2E-05 and is well within the NCP risk range of 1E-06 to 1E-04. Because the radium-228 activities appear to be naturally occurring, the excess cancer risks to the WRW from exposure to radium-228 in surface soil/surface sediment in the LWOEU are similar to background risk.

4.10.6 Conclusion

The weight of evidence presented above shows that radium-228 activities in LWOEU surface soil/surface sediment are not likely to be a result of historical site-related activities based on process knowledge; a spatial distribution indicative of naturally occurring radium-228; a probability plot that suggests the presence of a single population, which is also indicative of background conditions; and LWOEU radium-228 activities that are unlikely to result in risks to humans significantly above background risks. Radium-228 is not considered a COC in surface soil/surface sediment for the LWOEU and, therefore, is not further evaluated quantitatively.

4.11 Selenium

Selenium had concentrations statistically greater than background in surface soil (for PMJM receptors) and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if selenium should be retained as a COC are summarized below.

4.11.1 Summary of Process Knowledge

Based on process knowledge as detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, selenium was used in relatively small quantities at RFETS. Selenium was initially identified in the ChemRisk Reports, but was not carried forward as a material of concern (CDH 1991). Based on process knowledge, selenium is unlikely to be present in RFETS soil as a result of historical site-related activities.

4.11.2 Evaluation of Spatial Trends

Surface Soil (PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, elevated selenium concentrations in the LWOEU surface soil are located near historical IHSSs and therefore cannot be eliminated as an ECOPC.

4.11.3 Conclusion

Although process knowledge indicates selenium should not be present in the LWOEU surface soil, selenium is being carried forward into the ecological PMJM risk characterization as a conservative measure because the concentrations above background were located near historical IHSSs.

4.12 Thallium

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

4.12.1 Summary of Process Knowledge

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

4.12.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, elevated thallium concentrations in the LWOEU surface soil are located near historical IHSSs and therefore cannot be eliminated as an ECOPC.

4.12.3 Conclusion

Thallium in surface soil is being carried forward into the ecological PMJM risk characterization because elevated concentrations (more than three times greater than the ESL) are located within or near historical IHSSs. Thallium was used at RFETS and identified in wastes, although uses and releases in the LWOEU have not been identified.

4.13 Tin

For tin in surface soil, a statistical comparison between LWOEU and RFETS background data could not be performed because tin was not detected in RFETS background surface soil samples. Tin has an EPC in surface soil (for non-PMJM receptors) greater than the limiting tESL and, therefore, was carried forward to the professional judgment step. In addition, tin in surface soil (for PMJM receptors) has concentrations statistically greater than background and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if tin should be retained for risk characterization are summarized below.

4.13.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for tin to have been released into RFETS soil because of the moderate tin metal inventory during former operations. However, these operations occurred in the former Industrial Area. Therefore tin is unlikely to be present in LWOEU soil as a result of historical site-related activities.

4.13.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, elevated tin concentrations in the LWOEU are located near historical IHSSs and therefore cannot be eliminated as an ECOPC.

Surface Soil (PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, elevated tin concentrations in the LWOEU are located near historical IHSSs and therefore cannot be eliminated as an ECOPC.

4.13.3 Conclusion

Tin in surface soil is being carried forward into the ecological non-PMJM risk characterization because elevated concentrations (greater than 10 times the ESL) within or near historical IHSSs. Tin was also used at RFETS and identified in wastes, although uses and releases in the LWOEU have not been identified.

Tin in surface soil is being carried forward into the ecological PMJM risk characterization because elevated concentrations (more than three times greater than the ESL) are within one or more PMJM habitat patches. Tin was also used at RFETS and identified in wastes, although uses and releases in the LWOEU have not been identified.

4.14 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 in surface soil (for PMJM receptors) and subsurface soils had concentrations statistically greater than background and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if vanadium should be retained as a COC are summarized below.

4.14.1 Summary of Process Knowledge

Based on process knowledge as detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, vanadium is unlikely to be present in LWOEU soil as a result of historical site-related activities.

4.14.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, elevated vanadium concentrations in the LWOEU are located near historical IHSSs and therefore cannot be eliminated as an ECOPC.

Surface Soil (PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, elevated vanadium concentrations in the LWOEU are located near historical IHSSs and therefore cannot be eliminated as an ECOPC.

4.14.3 Conclusion

Vanadium in surface soil concentrations is being carried forward into the ecological non-PMJM risk characterization because elevated concentrations (greater than 10 times the ESL) are within an historical PAC. Based on process knowledge, vanadium is unlikely to be present in LWOEU soil as a result of historical site-related activities. Nevertheless, as a conservative measure, it is carried forward into the risk characterization recognizing that its classification as an ECOPC is uncertain.

Vanadium in surface soil concentrations is being carried forward into the ecological PMJM risk characterization because elevated concentrations (more than three times greater than the ESL) are within one or more PMJM habitat patches. Based on process knowledge, vanadium is unlikely to be present in LWOEU soil as a result of historical site-related activities. However, due to the exceedances in the PMJM habitat patches, vanadium is retained as an ECOPC for further evaluation in the risk characterization.

4.15 Zinc

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

4.15.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for zinc to have been released into RFETS soil because of the moderate zinc metal inventory and the presence of zinc in waste generated during former operations. However, these operations occurred in the former Industrial Area. Therefore zinc is unlikely to be present in LWOEU soil as a result of historical site-related activities.

4.15.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

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

Surface Soil (PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that zinc concentrations in LWOEU surface soil reflect variations in naturally occurring zinc. However, because all four locations where zinc concentrations in surface soil exceed the background MDC are in PMJM habitat, to be conservative, zinc is being carried forward into the ecological PMJM risk characterization

4.15.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot of zinc concentrations in surface soil in the LWOEU shows the presence of a single population (Figure A3.4.10), which is indicative of background conditions.

4.15.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Zinc concentrations in surface soil samples at the LWOEU range from 17.9 to 86.1 mg/kg, with a mean concentration of 56.7 mg/kg and a standard deviation of 13.4 mg/kg. Zinc concentrations in the background data set range from 21.1 to 75.9 mg/kg, with a mean concentration of 49.8 mg/kg and a standard deviation of 12.2 mg/kg (Table A3.2.6). The range of concentrations of zinc in the LWOEU and background samples overlap and the means are similar.

The reported range for zinc in surface soils within Colorado and the bordering states is 10 mg/kg to 2,080 mg/kg, with an arithmetic mean of 72.4 mg/kg and a standard deviation of 159 mg/kg (Table A3.4.1). The range of concentrations of zinc in surface soil is within the range for zinc in soils of Colorado and the bordering states.

4.15.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for zinc in the LWOEU (77.7 mg/kg) exceeds the NOAEL ESLs for three receptor groups: terrestrial plants (50 mg/kg), mourning dove insectivore (0.65 mg/kg), and deer mouse insectivore (5.29 mg/kg). All other NOAEL ESLs were greater than the UTL and ranged from 109 to more than 16,489 mg/kg. No zinc Eco-SSLs are currently available for any receptor (the zinc Eco-SSL document is “pending”).The mourning dove and deer mouse (insectivore) ESLs are both considerably lower than the range of zinc concentrations in background soils (21.1 to 75.9 mg/kg). The terrestrial plant ESL is approximately equal to the mean background concentration of 49.8 mg/kg.

4.15.6 Conclusion

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

Zinc is being carried forward into the ecological PMJM risk characterization because elevated concentrations (more than three times greater than the ESL) are within one or more PMJM habitat patches. Zinc was also used at RFETS and/or identified in wastes, although uses and releases in the LWOEU have not been identified.

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TABLES

Table A3.2.1
Statistical Distributions and Comparison to Background for LWOEU Surface Soil/Surface Sediment

Analyte	Units	Statistical Distribution Testing Results						Background Comparison Test Results		
		Background Data Set			LWOEU Data Set [a]					
		Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Arsenic	**mg/kg**	**73**	**GAMMA**	**92**	**97**	**NORMAL**	**100**	**WRS**	**5.35E-09**	**Yes**
Manganese	**mg/kg**	**73**	**GAMMA**	**100**	**97**	**NON-PARAMETRIC**	**100**	**WRS**	**1.65E-11**	**Yes**
Cesium-134	pCi/g	77	NONPARAMETRIC	N/A	13	NORMAL	N/A	WRS	0.994	No
Cesium-137	pCi/g	105	NONPARAMETRIC	N/A	19	GAMMA	N/A	WRS	0.995	No
Radium-228	**pCi/g**	**40**	**GAMMA**	**N/A**	**9**	**NORMAL**	**N/A**	**WRS**	**0.048**	**Yes**

[a] LWOEU data exclude background data.
WRS = Wilcoxon Rank Sum
N/A = Not applicable; all radionuclide values are considered detect.
Bold = Analyte retained for further consideration in the next COC selection step.

Table A3.2.2

Summary Statistics for Background and LWOEU Surface Soil/Surface Sediment[a]

Analyte	Units	Background					LWOEU [b]				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Detected Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Detected Concentration	Standard Deviation
Arsenic	mg/kg	73	0.270	9.60	3.42	2.55	97	1.50	9.80	5.53	1.79
Manganese	mg/kg	73	9.00	1,280	241	189	97	106	1,580	383	207
Cesium-134	pCi/g	77	1.00E-03	0.300	0.141	0.066	13	0.002	0.200	0.085	0.052
Cesium-137	pCi/g	105	-0.027	1.80	0.692	0.492	19	0.039	1.18	0.349	0.315
Radium-228	pCi/g	40	0.200	4.10	1.60	0.799	9	1.19	2.80	1.94	0.519

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

[b] LWOEU data exclude background data.

Table A3.2.3
Statistical Distributions and Comparison to Background for LWOEU Subsurface Soil/Subsurface Sediment

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			LWOEU Data Set [a]					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Radium-228	31	GAMMA	N/A	5	NORMAL	N/A	WRS	0.912	No

[a] LWOEU data exclude background data.
WRS = Wilcoxon Rank Sum
N/A = Not applicable; all radionuclide values are considered detect.

Table A3.2.4
Summary Statistics for Background and LWOEU Subsurface Soil/Subsurface Sediment[a]

		Background					LWOEU [b]				
Analyte	**Units**	**Total Samples**	**Minimum Detected Concentration**	**Maximum Detected Concentration**	**Mean Detected Concentration**	**Standard Deviation**	**Total Samples**	**Minimum Detected Concentration**	**Maximum Detected Concentration**	**Mean Detected Concentration**	**Standard Deviation**
Radium-228	pCi/g	31	1.00	2.10	1.45	0.320	5	1.07	1.57	1.27	0.198

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

[b] LWOEU data exclude background data.

Table A3.2.5
Statistical Distributions and Comparison to Background for LWOEU Surface Soil

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			LWOEU Data Set [a]					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statiscally Greater than Background?
Aluminum	**20**	**NORMAL**	**100**	**74**	**NORMAL**	**100**	**t-Test_N**	**6.51E-04**	**Yes**
Antimony	**20**	**NONPARAMETRIC**	**0**	**60**	**NONPARAMETRIC**	**47**	**N/A**	**N/A**	**N/A**
Arsenic	20	NORMAL	100	74	NONPARAMETRIC	100	WRS	0.611	No
Barium	**20**	**NORMAL**	**100**	**74**	**NORMAL**	**100**	**t-Test_N**	**1.24E-05**	**Yes**
Boron	**N/A**	**N/A**	**N/A**	**46**	**NORMAL**	**93**	**N/A**	**N/A**	**N/A**
Cadmium	20	NONPARAMETRIC	65	73	GAMMA	60	WRS	1.000	No
Chromium	**20**	**NORMAL**	**100**	**74**	**NORMAL**	**100**	**t-Test_N**	**8.71E-05**	**Yes**
Cobalt	20	NORMAL	100	74	NONPARAMETRIC	100	WRS	0.120	No
Copper	**20**	**NONPARAMETRIC**	**100**	**74**	**NONPARAMETRIC**	**100**	**WRS**	**4.42E-05**	**Yes**
Lead	20	NORMAL	100	74	NONPARAMETRIC	100	WRS	0.389	No
Lithium	**20**	**NORMAL**	**100**	**58**	**NORMAL**	**95**	**t-Test_N**	**1.13E-05**	**Yes**
Manganese	**20**	**NORMAL**	**100**	**74**	**NONPARAMETRIC**	**100**	**WRS**	**4.69E-07**	**Yes**
Mercury	20	NONPARAMETRIC	40	58	NONPARAMETRIC	60	WRS	1.000	No
Nickel	**20**	**NORMAL**	**100**	**74**	**GAMMA**	**97**	**WRS**	**6.22E-07**	**Yes**
Selenium	20	NONPARAMETRIC	60	74	NONPARAMETRIC	27	WRS	0.982	No
Thallium	**14**	**NORMAL**	**0**	**74**	**NONPARAMETRIC**	**47**	**N/A**	**N/A**	**N/A**
Tin	**20**	**NORMAL**	**0**	**60**	**NONPARAMETRIC**	**18**	**N/A**	**N/A**	**N/A**
Vanadium	**20**	**NORMAL**	**100**	**74**	**NORMAL**	**100**	**t-Test_N**	**4.27E-05**	**Yes**
Zinc	**20**	**NORMAL**	**100**	**74**	**NORMAL**	**100**	**t-Test_N**	**0.020**	**Yes**

[a] LWOEU data exclude background data.
WRS = Wilcoxon Rank Sum
t-Test_N = Student's t-test using normal data
N/A = Not applicable; site and/or background detection frequency less than 20%.
Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table A3.2.6

Summary Statistics for Background and LWOEU Surface Soil[a]

Analyte	Units	Background					LWOEU [b]				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Detected Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Detected Concentration	Standard Deviation
Aluminum	mg/kg	20	4,050	17,100	10,203	3,256	74	3,900	30,000	15,019	6,250
Antimony	mg/kg	20	N/A	N/A	0.279	0.078	60	0.300	9.80	1.48	2.39
Arsenic	mg/kg	20	2.30	9.60	6.09	2.00	74	2.00	8.80	5.84	1.71
Barium	mg/kg	20	45.7	134	102	19.4	74	46.8	240	146	43.0
Boron	mg/kg	N/A	N/A	N/A	N/A	N/A	46	2.30	13.0	7.00	2.08
Cadmium	mg/kg	20	0.670	2.30	0.708	0.455	73	0.110	1.30	0.408	0.238
Chromium	mg/kg	20	5.50	16.9	11.2	2.78	74	4.80	28.0	16.7	6.02
Cobalt	mg/kg	20	3.40	11.2	7.27	1.79	74	3.60	20.2	7.94	2.17
Copper	mg/kg	20	5.20	16.0	13.0	2.58	74	7.60	170	19.0	18.5
Lead	mg/kg	20	8.60	53.3	33.5	10.5	74	6.40	210	48.6	43.3
Lithium	mg/kg	20	4.80	11.6	7.66	1.89	58	1.80	22.0	12.5	4.60
Manganese	mg/kg	20	129	357	237	63.9	74	113	1,200	375	170
Mercury	mg/kg	20	0.090	0.120	0.072	0.031	58	0.013	0.660	0.045	0.084
Nickel	mg/kg	20	3.80	14.0	9.60	2.59	74	7.60	45.2	15.8	5.86
Selenium	mg/kg	20	0.680	1.40	0.628	0.305	74	0.260	2.00	0.444	0.274
Thallium	mg/kg	14	N/A	N/A	0.414	0.015	74	0.250	5.70	0.930	0.936
Tin	mg/kg	20	N/A	N/A	2.06	0.410	60	1.70	85.9	5.16	12.7
Vanadium	mg/kg	20	10.8	45.8	27.7	7.68	74	16.5	71.0	39.4	12.1
Zinc	mg/kg	20	21.1	75.9	49.8	12.2	74	17.9	86.1	56.7	13.4

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

[b] LWOEU data exclude background data.

N/A = Not applicable; Data are nondetects.

Table A3.2.7
Statistical Distributions and Comparison to Background for Surface Soil in PMJM Habitat in the LWOEU

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			LWOEU Data Set [a]					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Inorganics									
Arsenic	20	NORMAL	100	45	NON-PARAMETRIC	100.00	WRS	0.120	No
Chromium	**20**	**NORMAL**	**100**	**45**	**NORMAL**	**100.00**	**t-Test_N**	**7.37E-08**	**Yes**
Copper	**20**	**NON-PARAMETRIC**	**100**	**45**	**NON-PARAMETRIC**	**100.00**	**WRS**	**6.34E-06**	**Yes**
Manganese	**20**	**NORMAL**	**100**	**45**	**NON-PARAMETRIC**	**100.00**	**WRS**	**8.04E-09**	**Yes**
Mercury	20	NON-PARAMETRIC	40	42	GAMMA	76.19	WRS	1.000	No
Nickel	**20**	**NORMAL**	**100**	**45**	**GAMMA**	**100.00**	**WRS**	**1.03E-08**	**Yes**
Selenium	**20**	**NON-PARAMETRIC**	**60**	**45**	**NON-PARAMETRIC**	**13.33**	**N/A**	**N/A**	**N/A**
Tin	**20**	**NORMAL**	**0**	**43**	**NON-PARAMETRIC**	**20.93**	**N/A**	**N/A**	**N/A**
Vanadium	**20**	**NORMAL**	**100**	**45**	**NORMAL**	**100.00**	**t-Test_N**	**2.59E-08**	**Yes**
Zinc	**20**	**NORMAL**	**100**	**45**	**NORMAL**	**100.00**	**t-Test_N**	**0.007**	**Yes**

[a] LWOEU data exclude background data.
WRS = Wilcoxon Rank Sum
t-Test_N = Student's t-test using normal data
N/A = Not applicable; site and/or background detection frequency less than 20%.
Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table A3.2.8

Summary Statistics for Background and LWOEU Surface Soil in PMJM Habitat[a]

Analyte	Units	Background					LWOEU[b]				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Detected Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Detected Concentration	Standard Deviation
Arsenic	mg/kg	20	2.30	9.60	6.09	2.00	45	3.20	8.80	6.53	1.38
Chromium	mg/kg	20	5.50	16.9	11.2	2.78	45	7.20	28.0	18.8	5.41
Copper	mg/kg	20	5.20	16.0	13.0	2.58	45	7.60	170	20.9	23.3
Manganese	mg/kg	20	129	357	237	63.9	45	270	1,200	418	191
Mercury	mg/kg	20	0.090	0.120	0.072	0.031	42	0.013	0.059	0.033	0.014
Nickel	mg/kg	20	3.80	14.0	9.60	2.59	45	8.10	45.2	17.3	5.65
Selenium	mg/kg	20	0.680	1.40	0.628	0.305	45	0.280	2.00	0.495	0.283
Tin	mg/kg	20	N/A	N/A	2.06	0.410	43	1.70	32.7	2.88	6.10
Vanadium	mg/kg	20	10.8	45.8	27.7	7.68	45	20.0	59.0	42.4	9.29
Zinc	mg/kg	20	21.1	75.9	49.8	12.2	45	19.0	86.1	58.4	12.8

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

[b] LWOEU data exclude background data.

N/A = Not applicable; Data are nondetects.

Table A3.2.9
Statistical Distributions and Comparison to Background for LWOEU Subsurface Soil

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			LWOEU Data Set [a]					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Antimony	**28**	**NONPARAMETRIC**	**7**	**46**	**NONPARAMETRIC**	**35**	**N/A**	**N/A**	**N/A**
Arsenic	**45**	**NONPARAMETRIC**	**93**	**47**	**NONPARAMETRIC**	**100**	**WRS**	**0.010**	**Yes**
Nickel	44	GAMMA	100	47	NONPARAMETRIC	100	WRS	0.574	No
Vanadium	**45**	**NORMAL**	**98**	**47**	**NONPARAMETRIC**	**100**	**WRS**	**0.002**	**Yes**

[a] LWOEU data exclude background data.

WRS = Wilcoxon Rank Sum
N/A = Not applicable; site and/or background detection frequency less than 20%.

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

Table A3.2.10

Summary Statistics for Background and LWOEU Subsurface Soil[a]

Analyte	Units	Background					LWOEU[b]				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Detected Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Detected Concentration	Standard Deviation
Antimony	mg/kg	28	2.90	8.20	4.21	2.78	46	0.300	20.2	2.44	4.07
Arsenic	mg/kg	45	1.70	41.8	5.48	6.02	47	1.60	15.0	5.96	2.59
Nickel	mg/kg	44	4.30	54.2	20.9	11.1	47	5.20	49.9	19.2	7.44
Vanadium	mg/kg	45	11.4	70.0	33.8	14.8	47	14.0	110	44.9	19.1

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

[b] LWOEU data exclude background data.

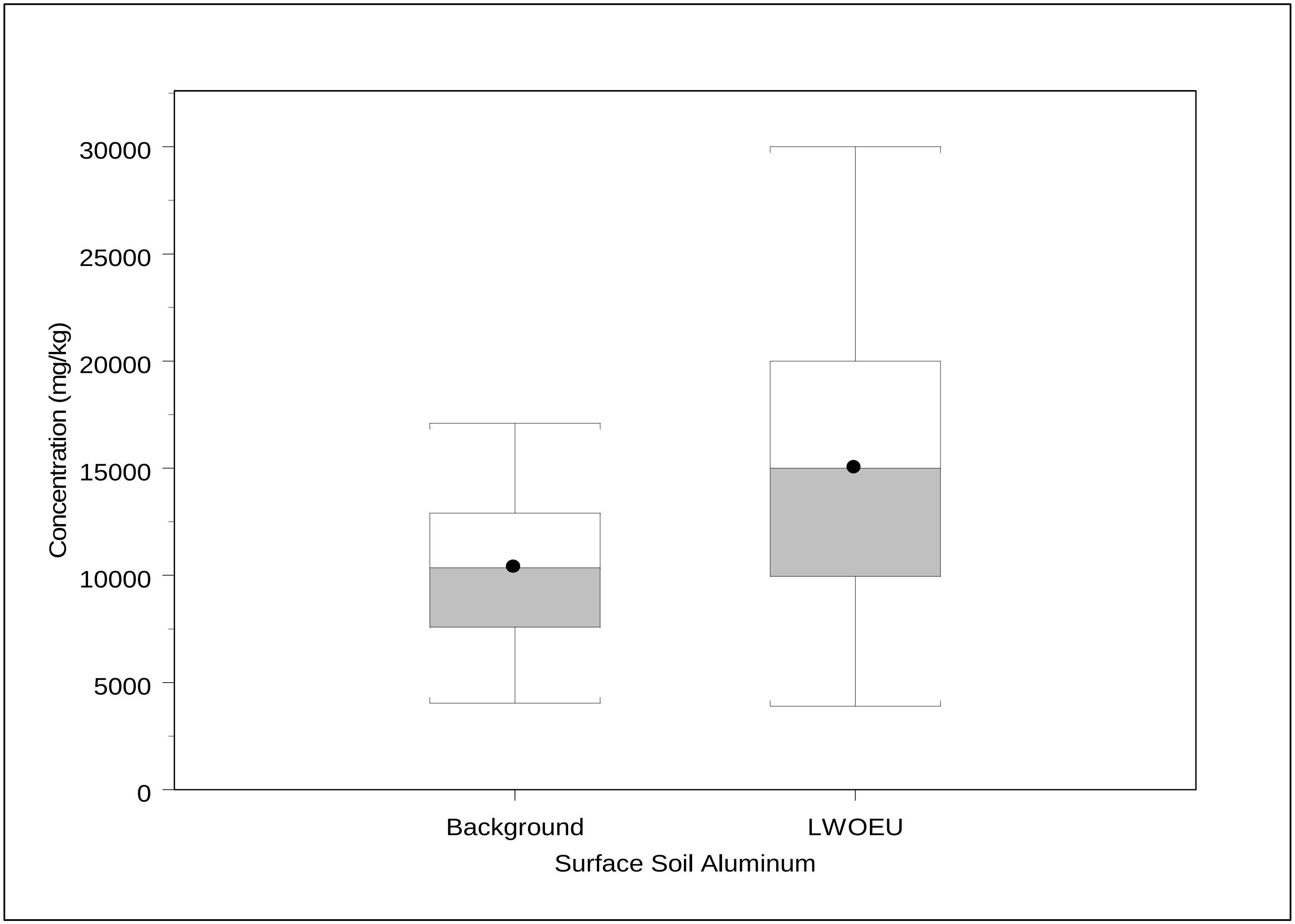
Table A3.4.1
Summary of Element Soil Concentrations in Colorado and Bordering States[a]

Analyte	Total Number of Results	Detection Frequency (%)	Range of Detected Values (mg/kg)	Average (mg/kg)[b]	Standard Deviation (mg/kg)[b]
Aluminum	303	100	5,000 - 100,000	50,800	23,500
Antimony	84	15.5	1.038 - 2.531	0.647	0.378
Arsenic	307	99.3	1.224 - 97	6.9	7.64
Barium	342	100	100 - 3,000	642	330
Beryllium	342	36.0	1 - 7	0.991	0.876
Boron	342	66.7	20 - 150	27.9	19.7
Bromine	85	50.6	0.5038 - 3.522	0.681	0.599
Calcium	342	100	0.055 - 32	3.09	4.13
Carbon	85	100	0.3 - 10	2.18	1.92
Cerium	291	16.2	150 - 300	90	38.4
Chromium	342	100	3 - 500	48.2	41
Cobalt	342	88.6	3 - 30	8.09	5.03
Copper	342	100	2 - 200	23.1	17.7
Fluorine	264	97.3	10 - 1,900	394	261
Gallium	340	99.1	5 - 50	18.3	8.9
Germanium	85	100	0.578 - 2.146	1.18	0.316
Iodine	85	78.8	0.516 - 3.487	1.07	0.708
Iron	342	100	3,000 - 100,000	21,100	13,500
Lanthanum	341	66.3	30 - 200	39.8	28.8
Lead	342	92.7	10 - 700	24.8	41.5
Lithium	307	100	5 - 130	25.3	14.4
Magnesium	341	100	300 - 50,000	8,630	6,400
Manganese	342	100	70 - 2,000	414	272
Mercury	309	99.0	0.01 - 4.6	0.0768	0.276
Molybdenum	340	3.53	3 - 7	1.59	0.522
Neodymium	256	22.7	70 - 300	47.1	31.7
Nickel	342	96.5	5 - 700	18.8	39.8
Niobium	335	63.3	10 - 100	11.4	8.68
Phosphorus	249	100	40 - 4,497	399	397
Potassium	341	100	1,900 - 63,000	18,900	6,980
Rubidium	85	100	35 - 140	75.8	25
Scandium	342	85.1	5 - 30	8.64	4.69
Selenium	309	80.6	0.1023 - 4.3183	0.349	0.415
Silicon	85	100	149,340 - 413,260	302,000	61,500
Sodium	335	100	500 - 70,000	10,400	6,260
Strontium	342	100	10 - 2,000	243	212
Sulfur	85	16.5	816 - 47,760	1,250	5,300
Thallium	76	100	2.45 - 20.79	9.71	3.54
Tin	85	96.5	0.117 - 5.001	1.15	0.772
Titanium	342	100	500 - 7,000	2,290	1,350
Uranium	85	100	1.11 - 5.98	2.87	0.883
Vanadium	342	100	7 - 300	73	41.7
Ytterbium	330	99.1	1 - 20	3.33	2.06
Yttrium	342	98.0	10 - 150	26.9	18.1
Zinc	330	100	10 - 2,080	72.4	159
Zirconium	342	100	30 - 1,500	220	157

[a] Based on data from Shacklette and Boerngen 1984 for the states of Colorado, Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming.
[b] One-half the detection limit used as proxy value for nondetects in computation of the mean and standard deviation.

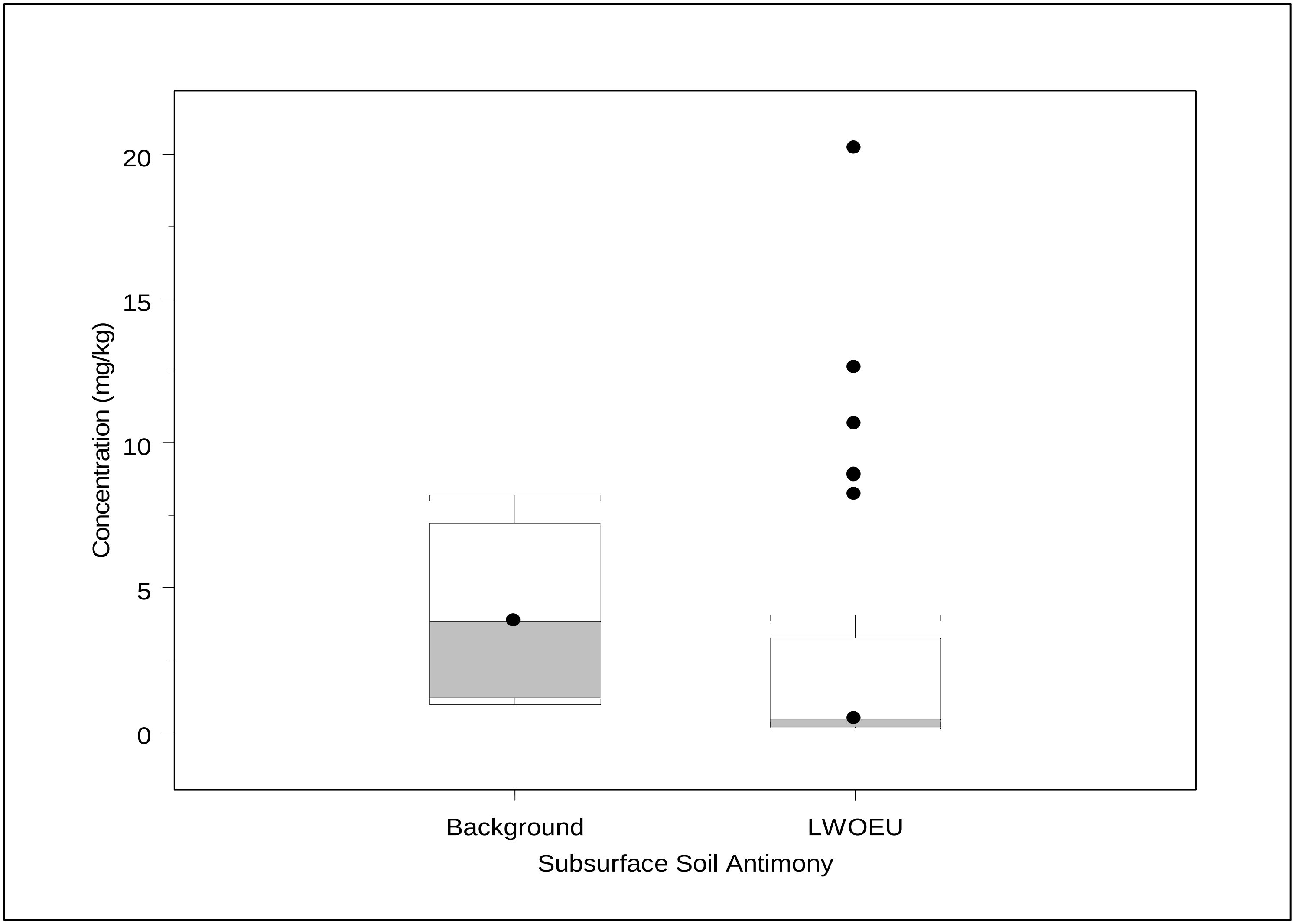
FIGURES

Figure A3.2.1
LWOEU Surface Soil Box Plots for Aluminum



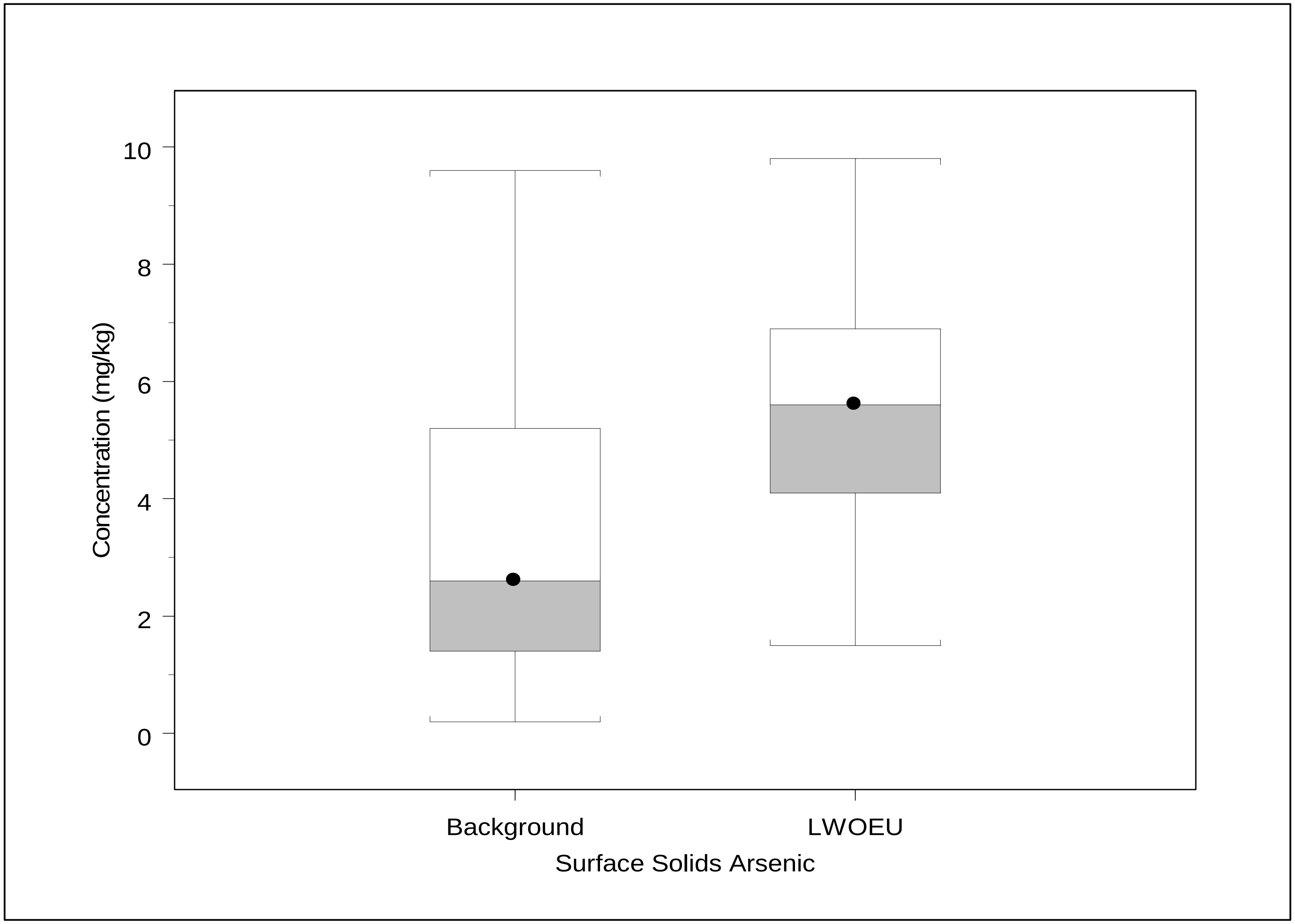
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.2
LWOEU Subsurface Soil Box Plots for Antimony



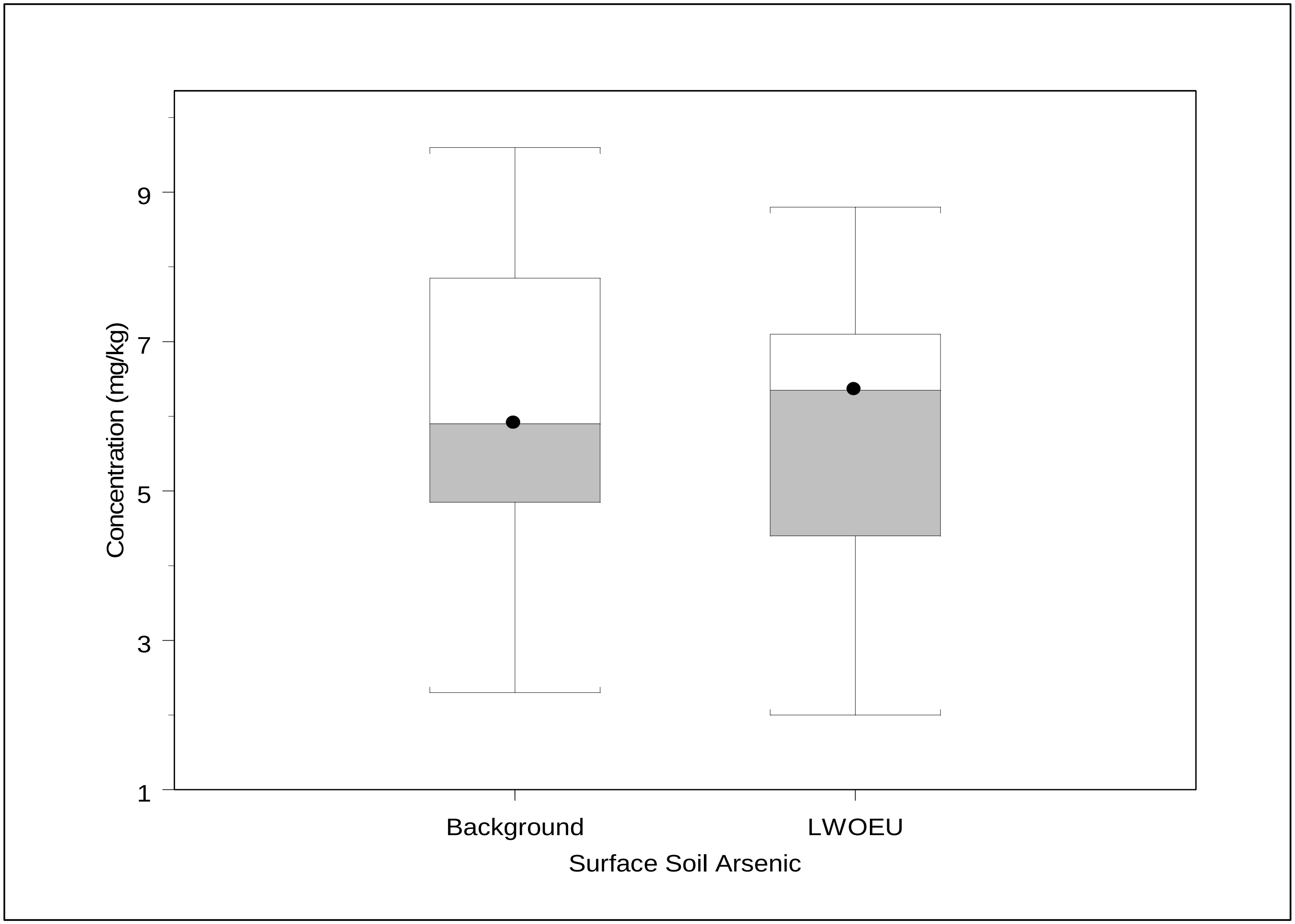
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.3
LWOEU Surface Soil/Surface Sediment Box Plots for Arsenic



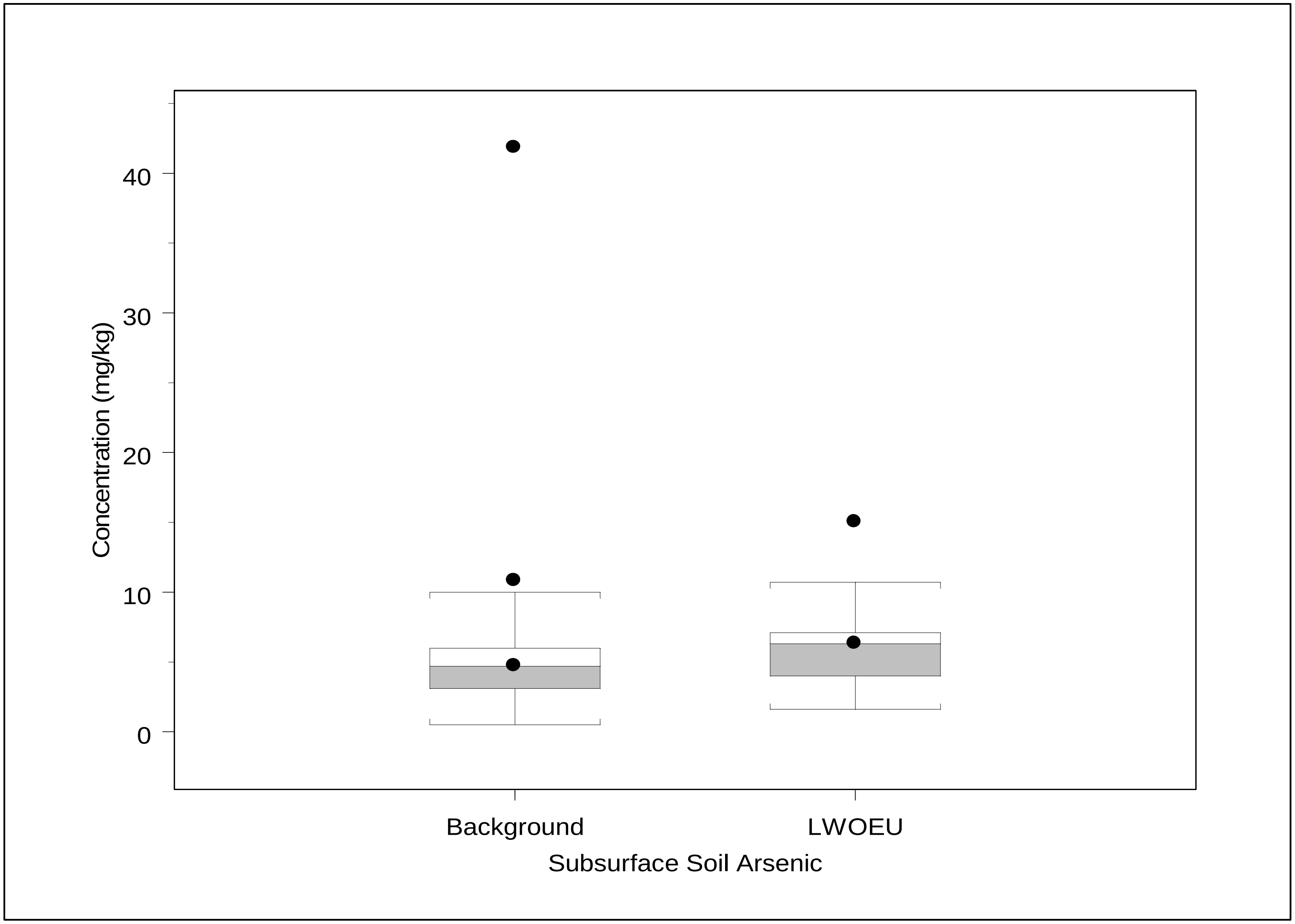
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.4
LWOEU Surface Soil Box Plots for Arsenic



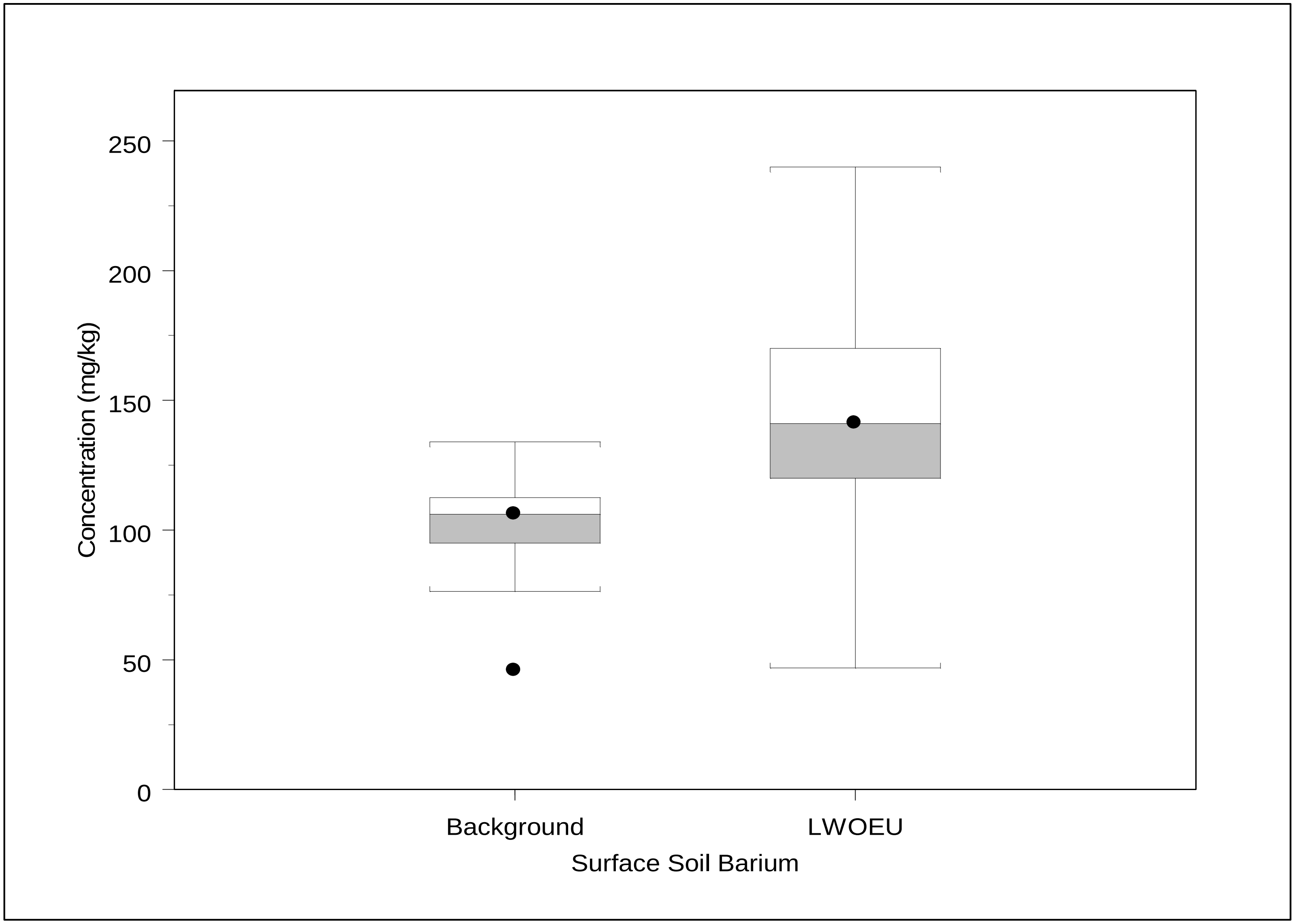
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.5
LWOEU Subsurface Soil Box Plots for Arsenic



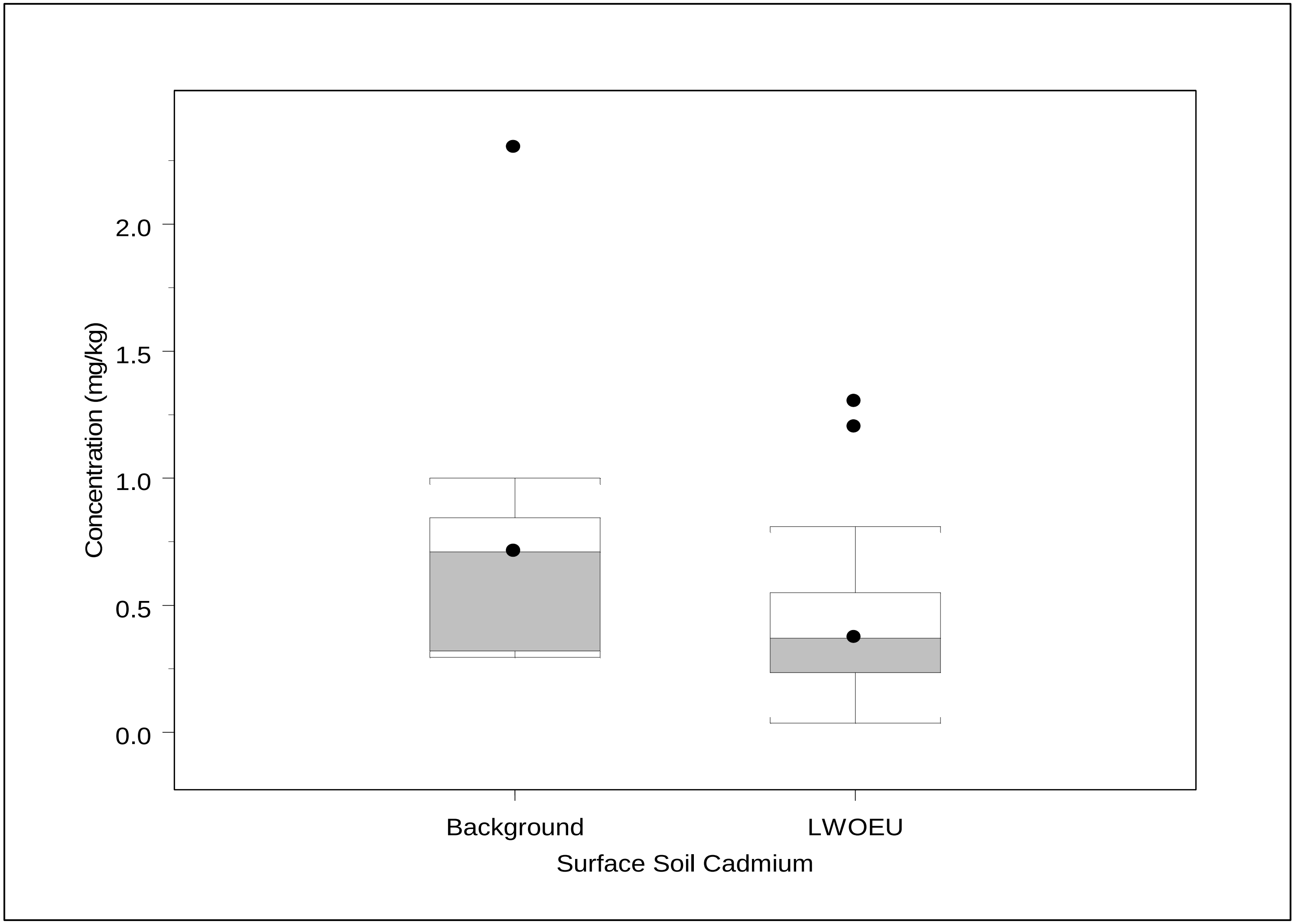
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.6
LWOEU Surface Soil Box Plots for Barium



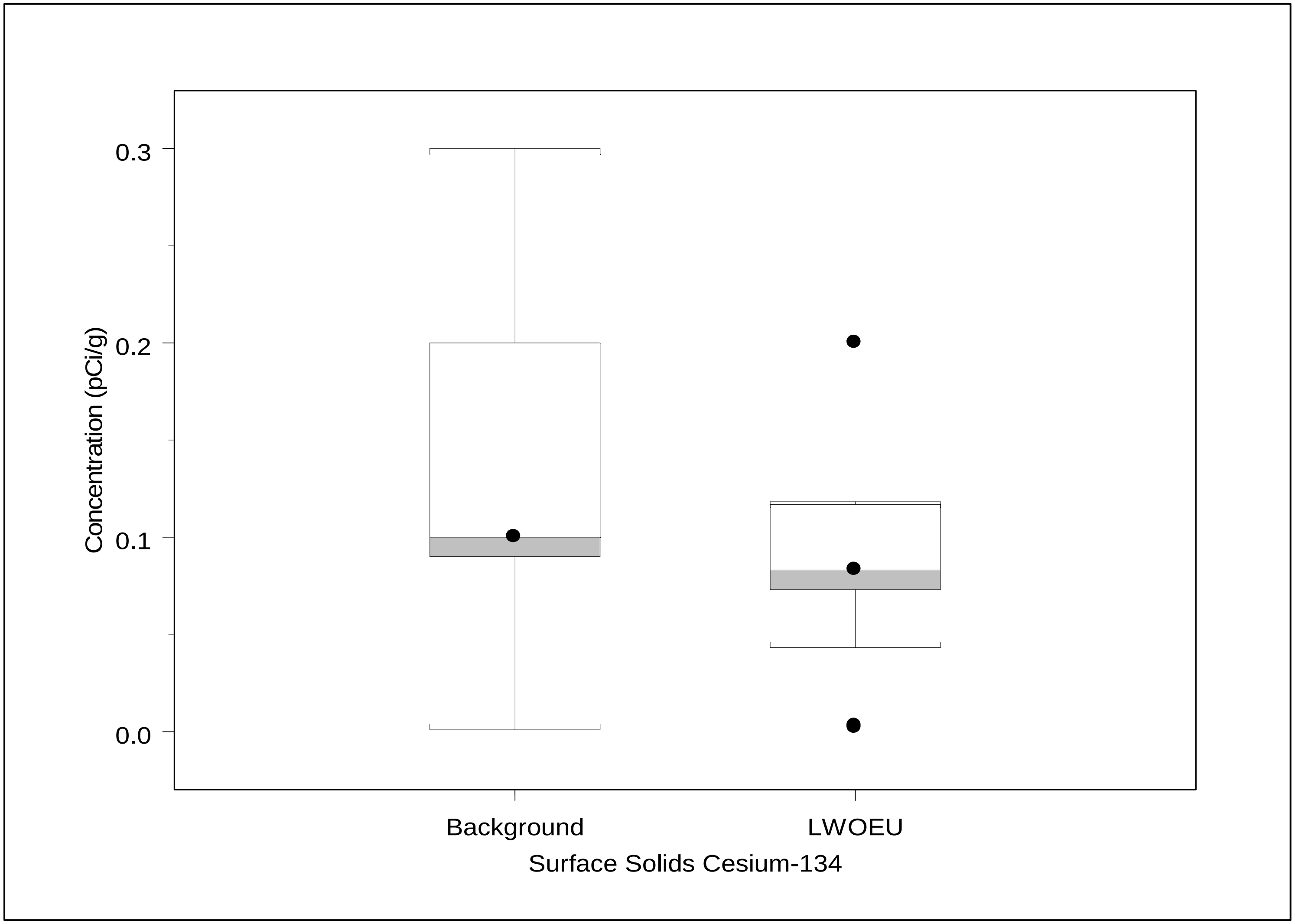
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.7
LWOEU Surface Soil Box Plots for Cadmium



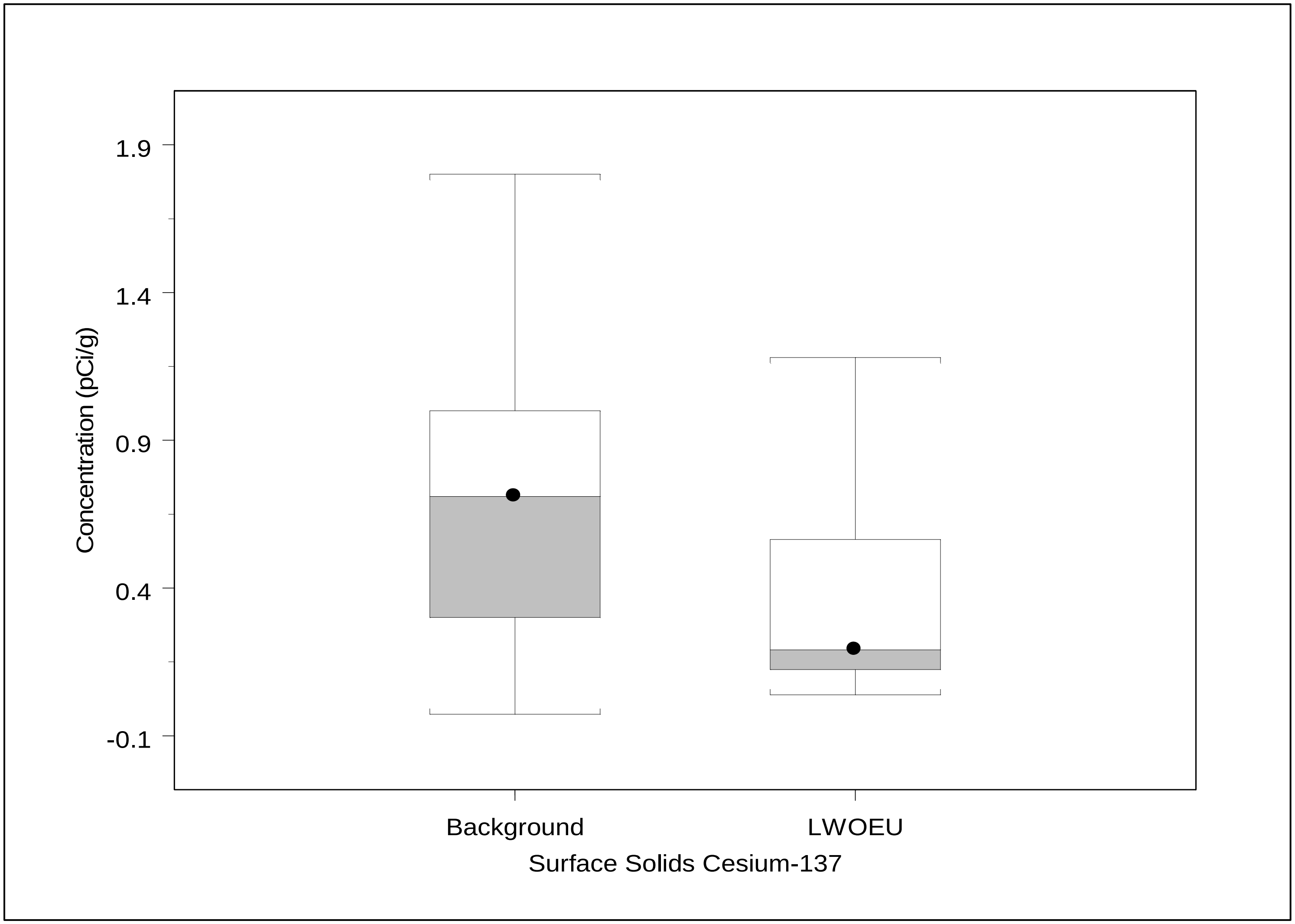
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.8
LWOEU Surface Soil/Surface Sediment Box Plots for Cesium-134



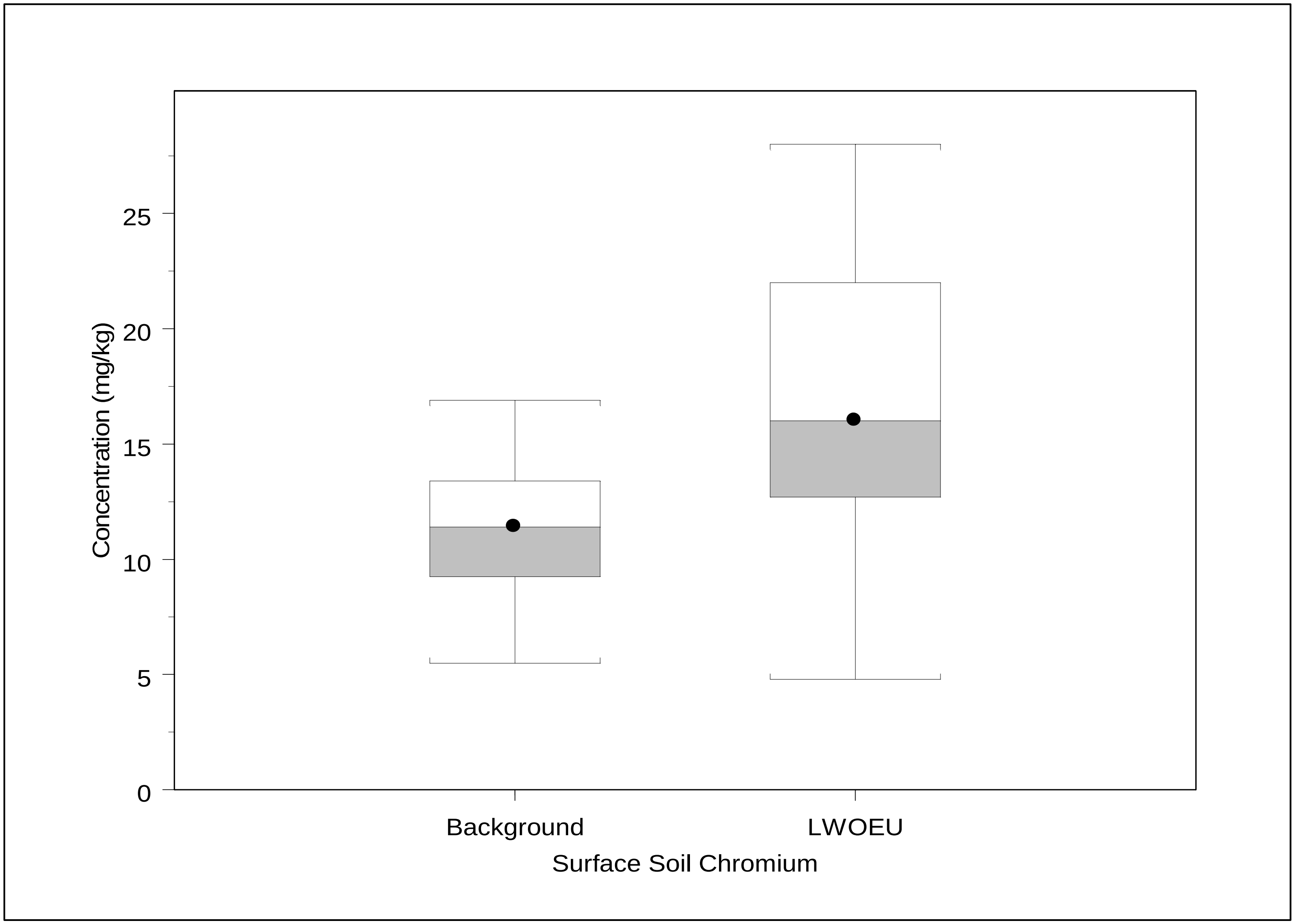
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.9
LWOEU Surface Soil/Surface Sediment Box Plots for Cesium-137



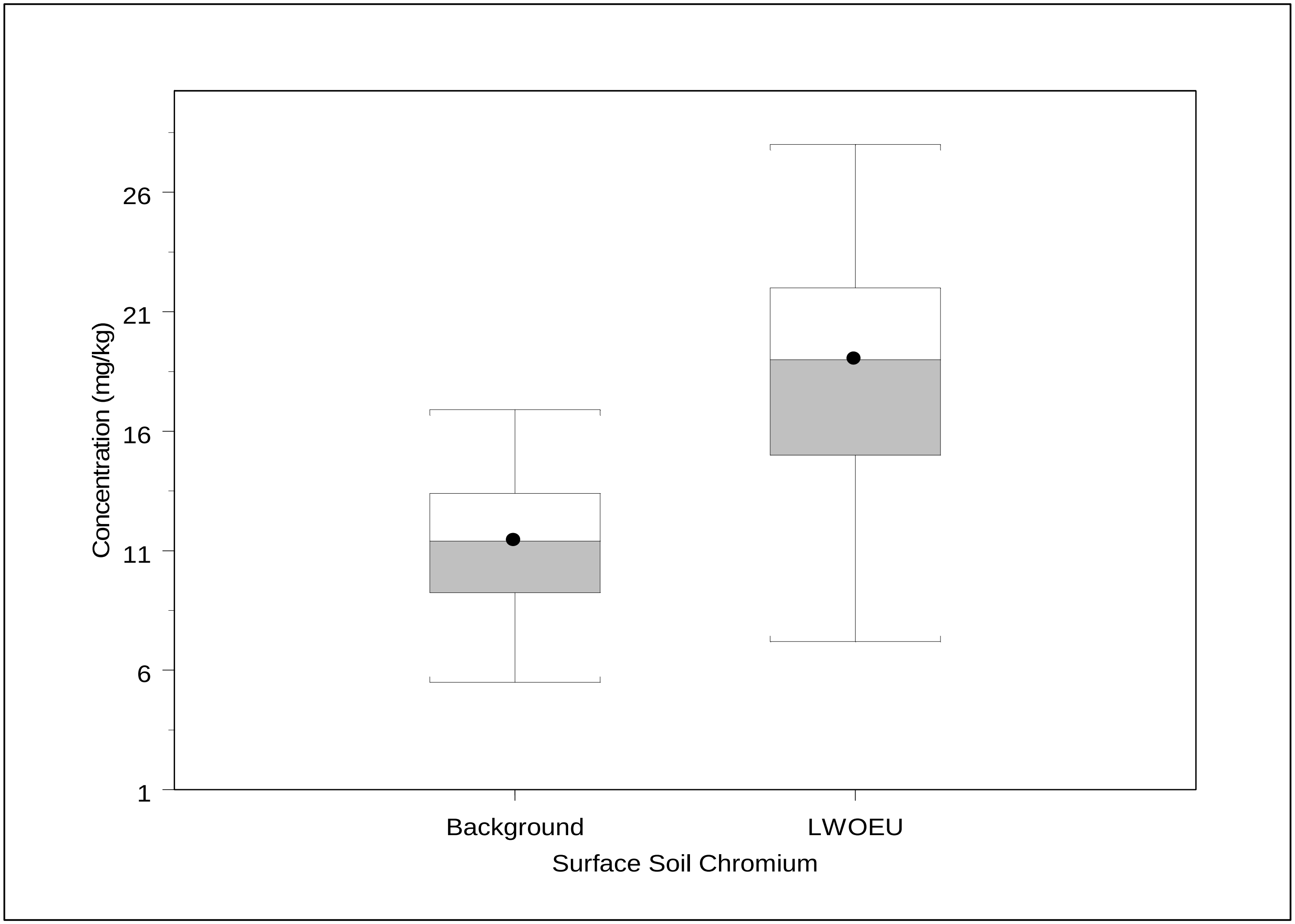
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.10
LWOEU Surface Soil Box Plots for Chromium



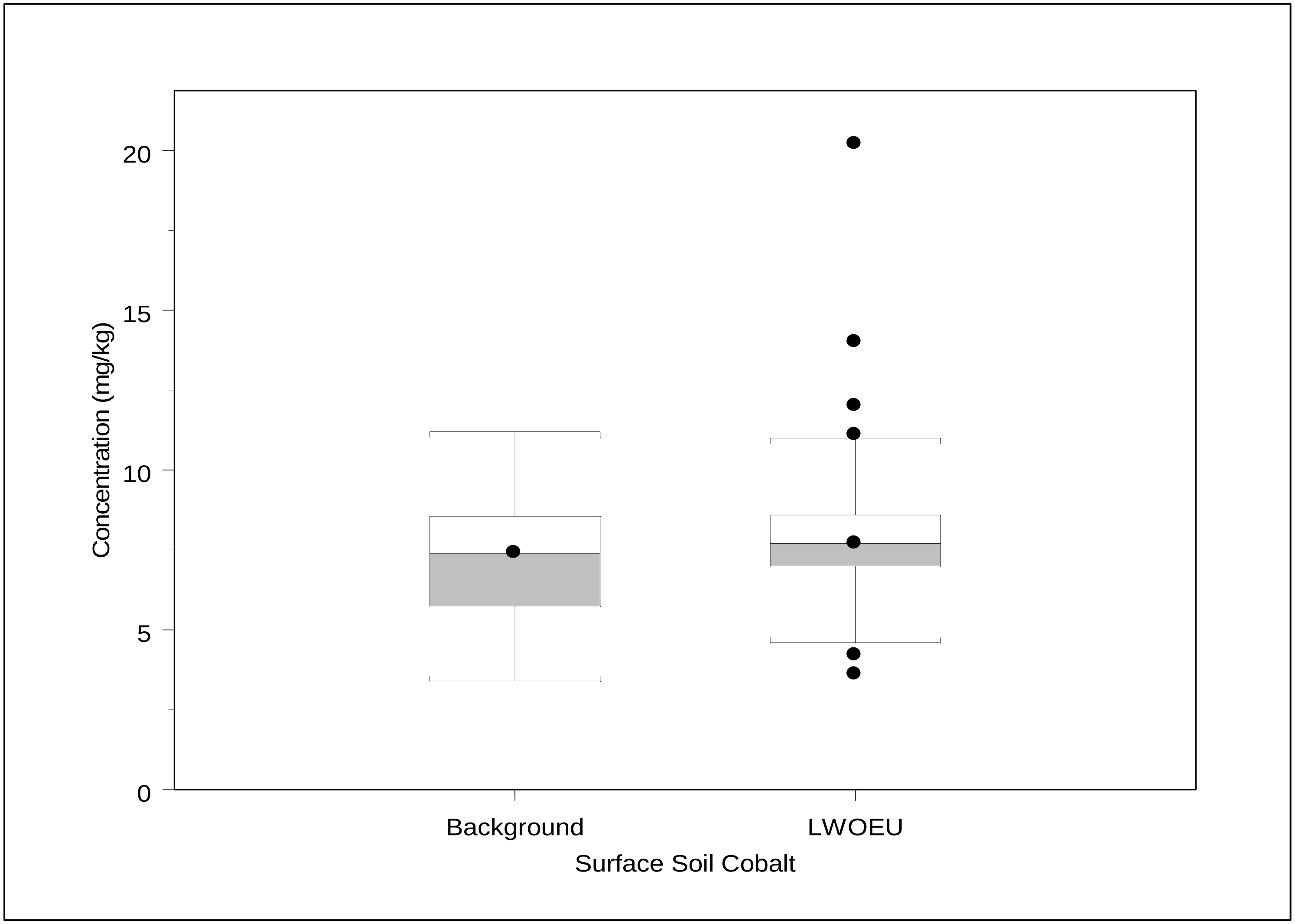
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.11
LWOEU Surface Soil (PMJM) Box Plots for Chromium



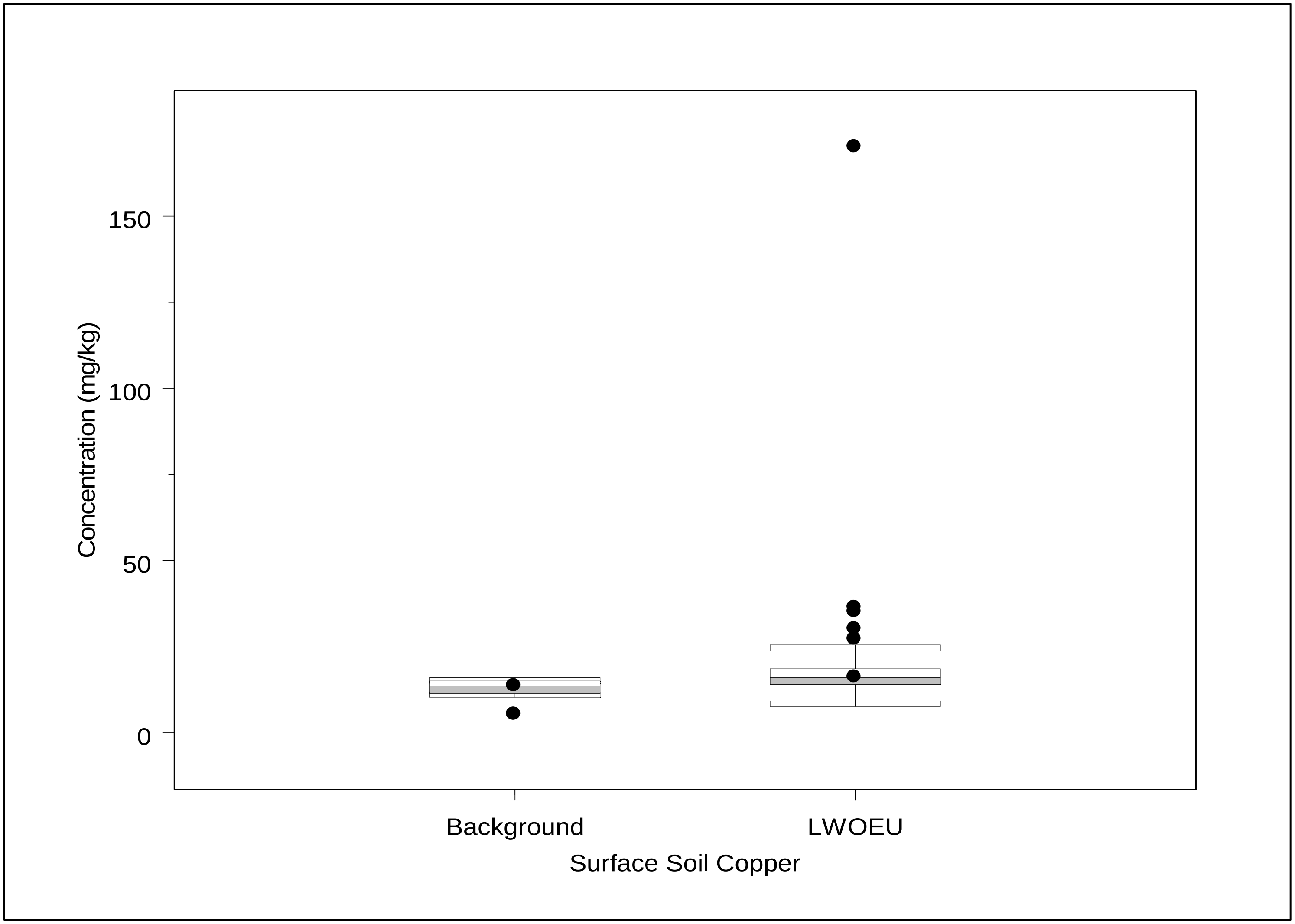
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.12
LWOEU Surface Soil Box Plots for Cobalt



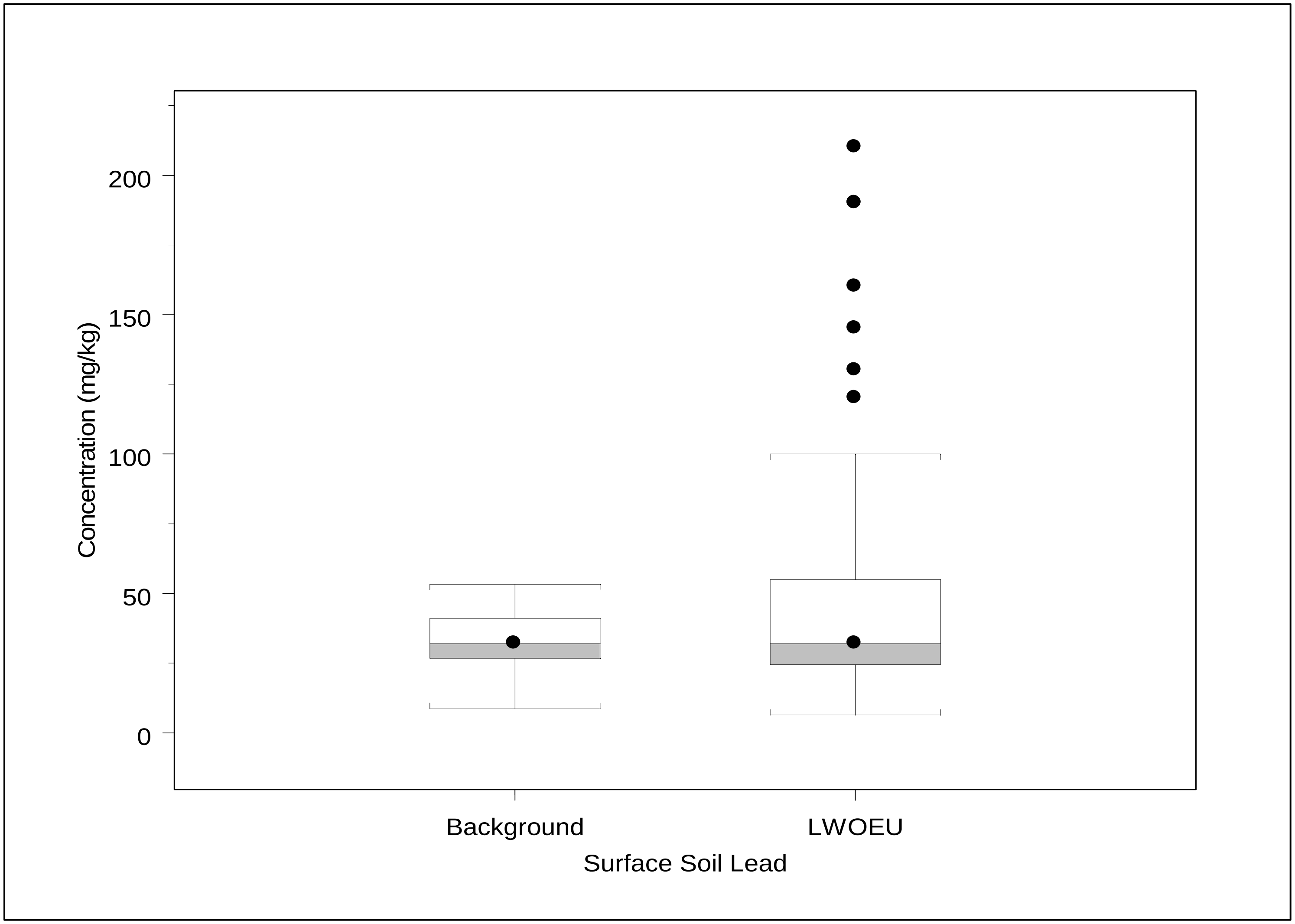
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.13
LWOEU Surface Soil Box Plots for Copper



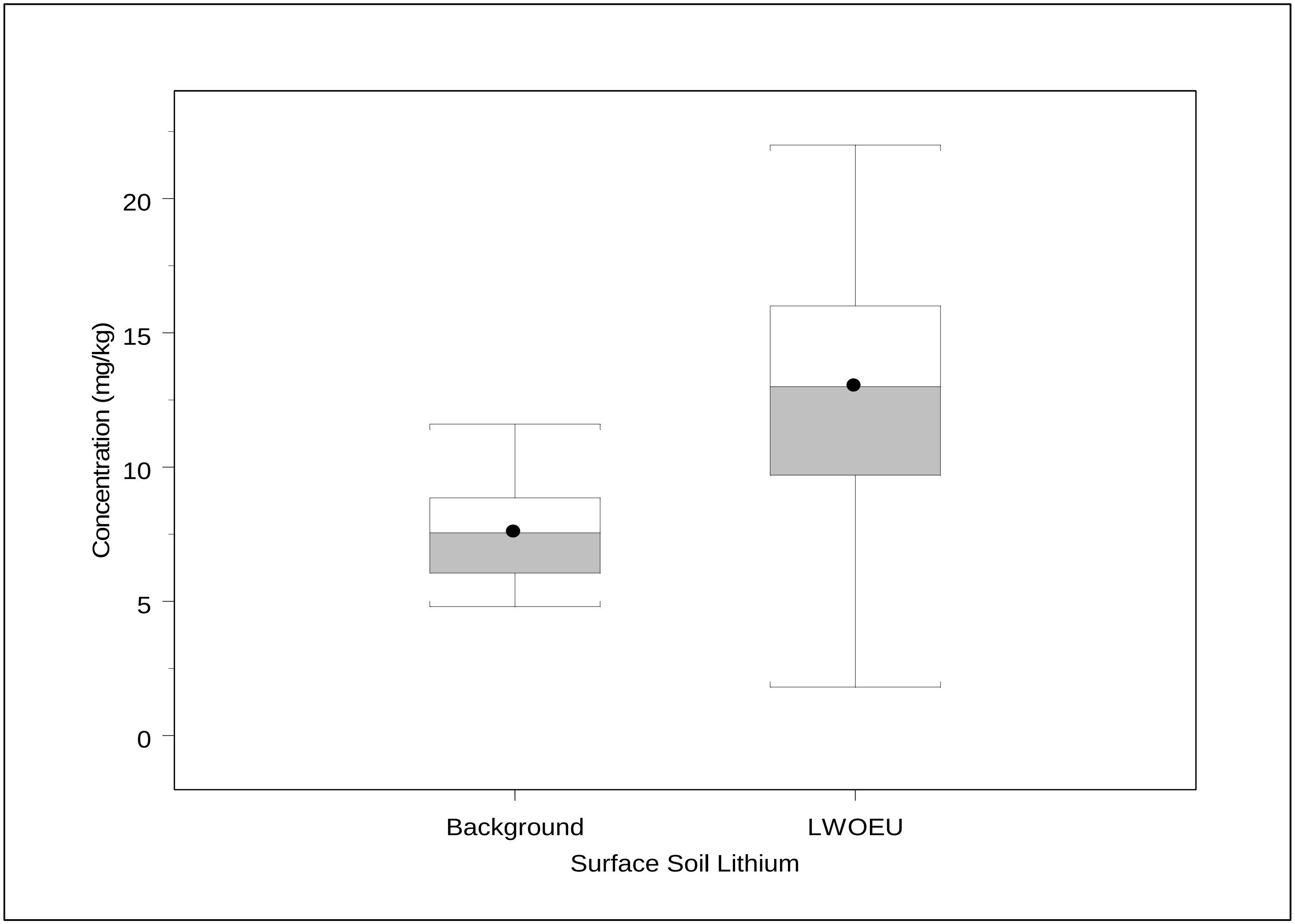
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.14
LWOEU Surface Soil Box Plots for Lead



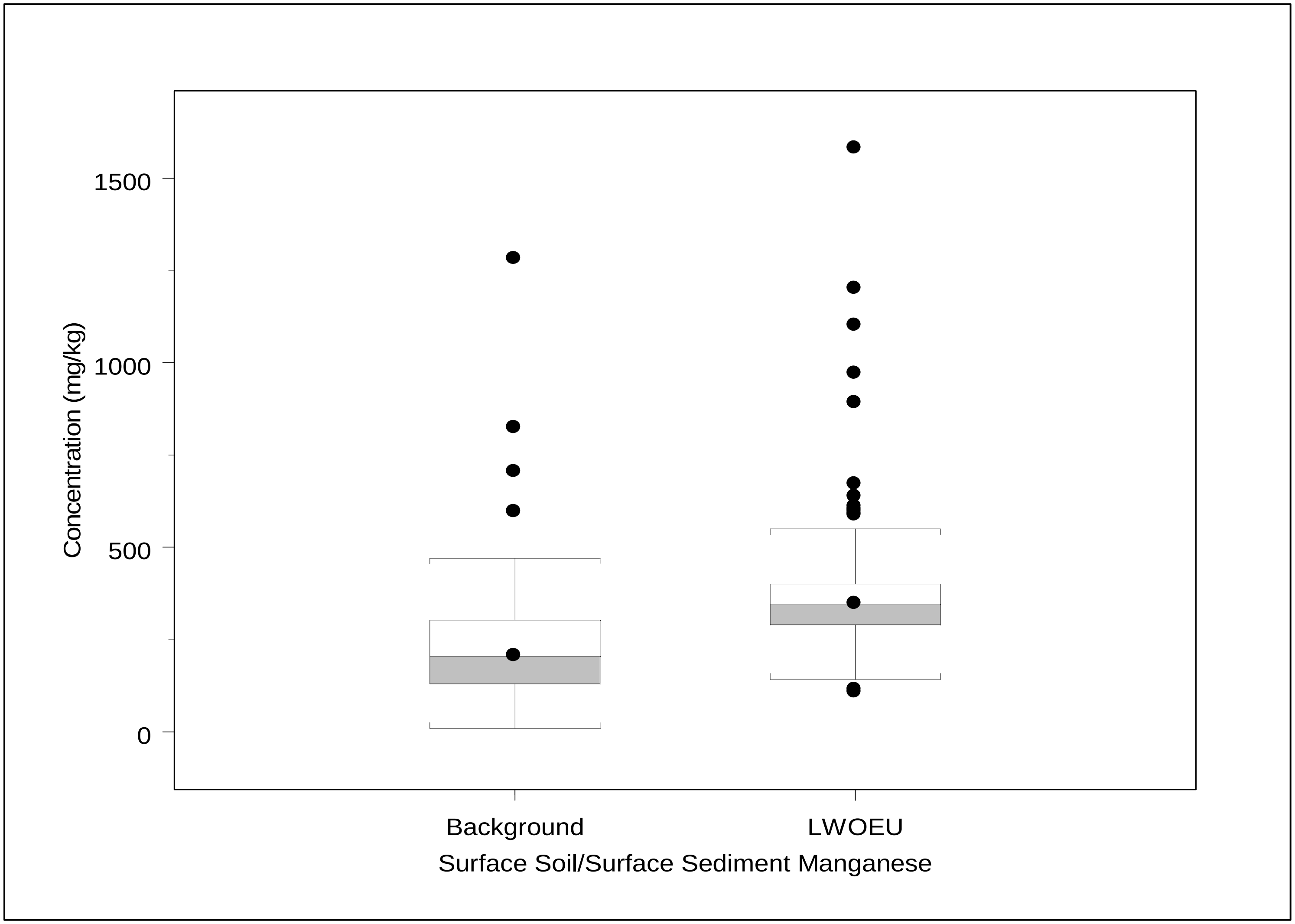
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.15
LWOEU Surface Soil Box Plots for Lithium



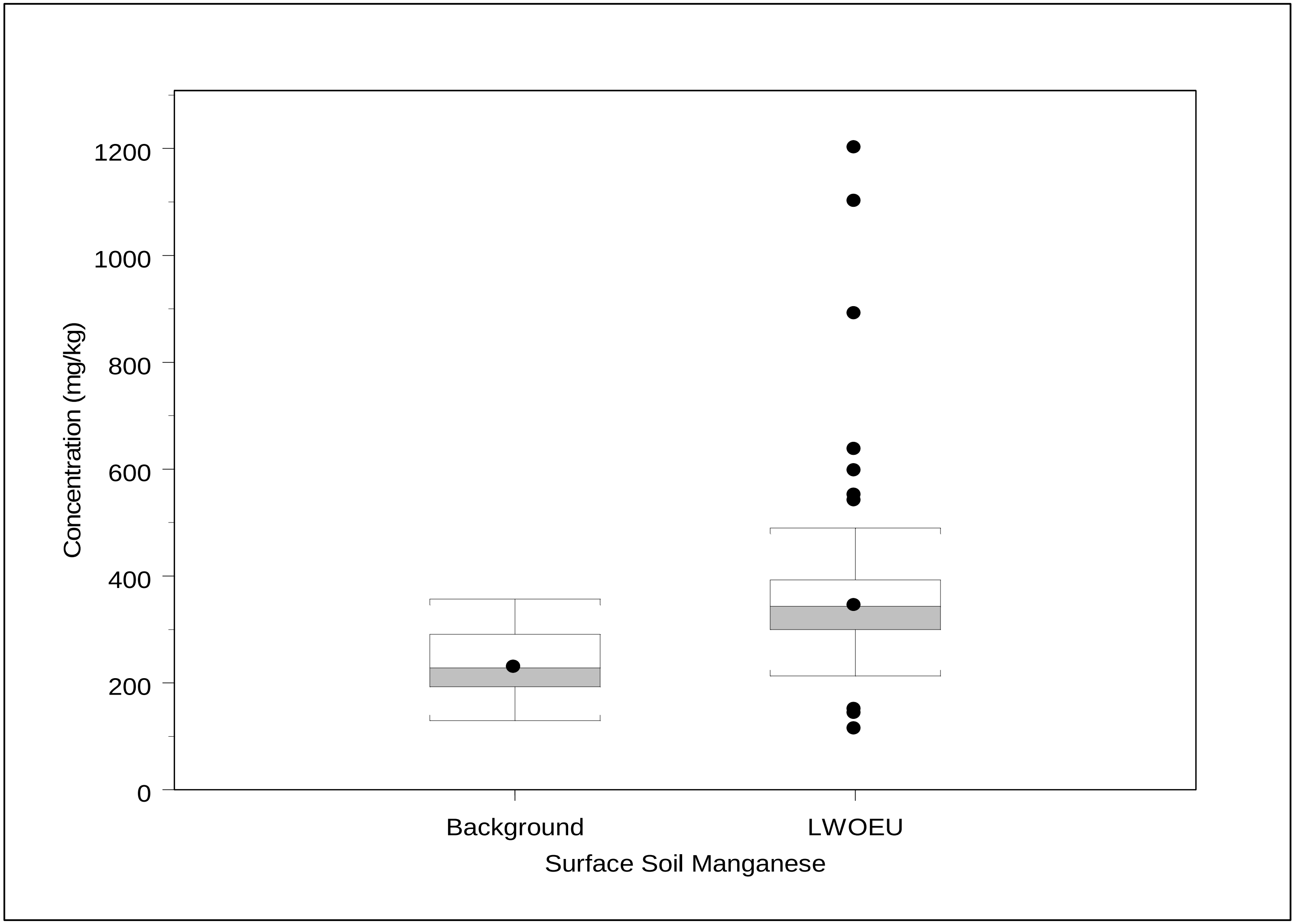
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.16
LWOEU Surface Soil/Surface Sediment Box Plots for Manganese



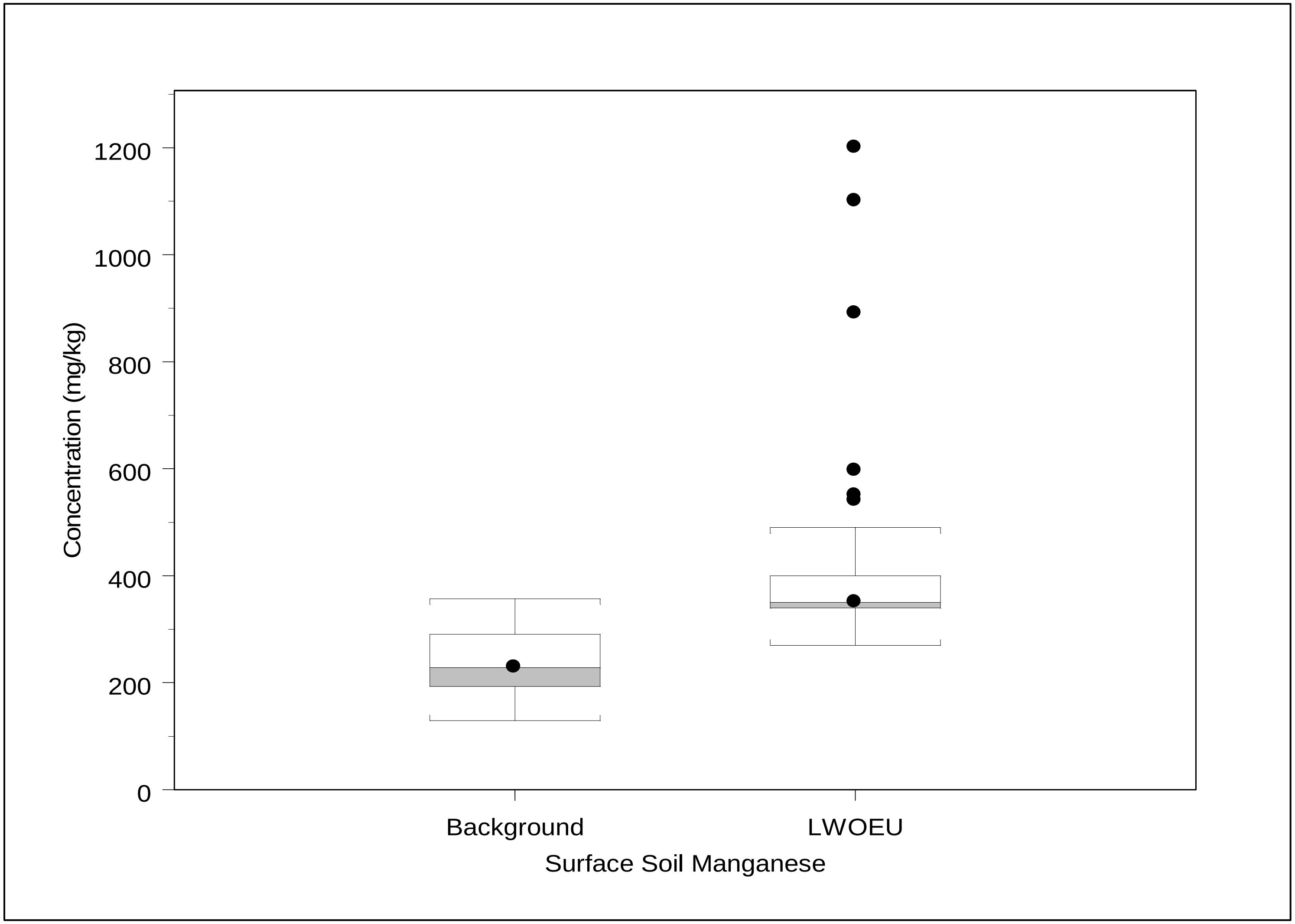
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.17
LWOEU Surface Soil Box Plots for Manganese



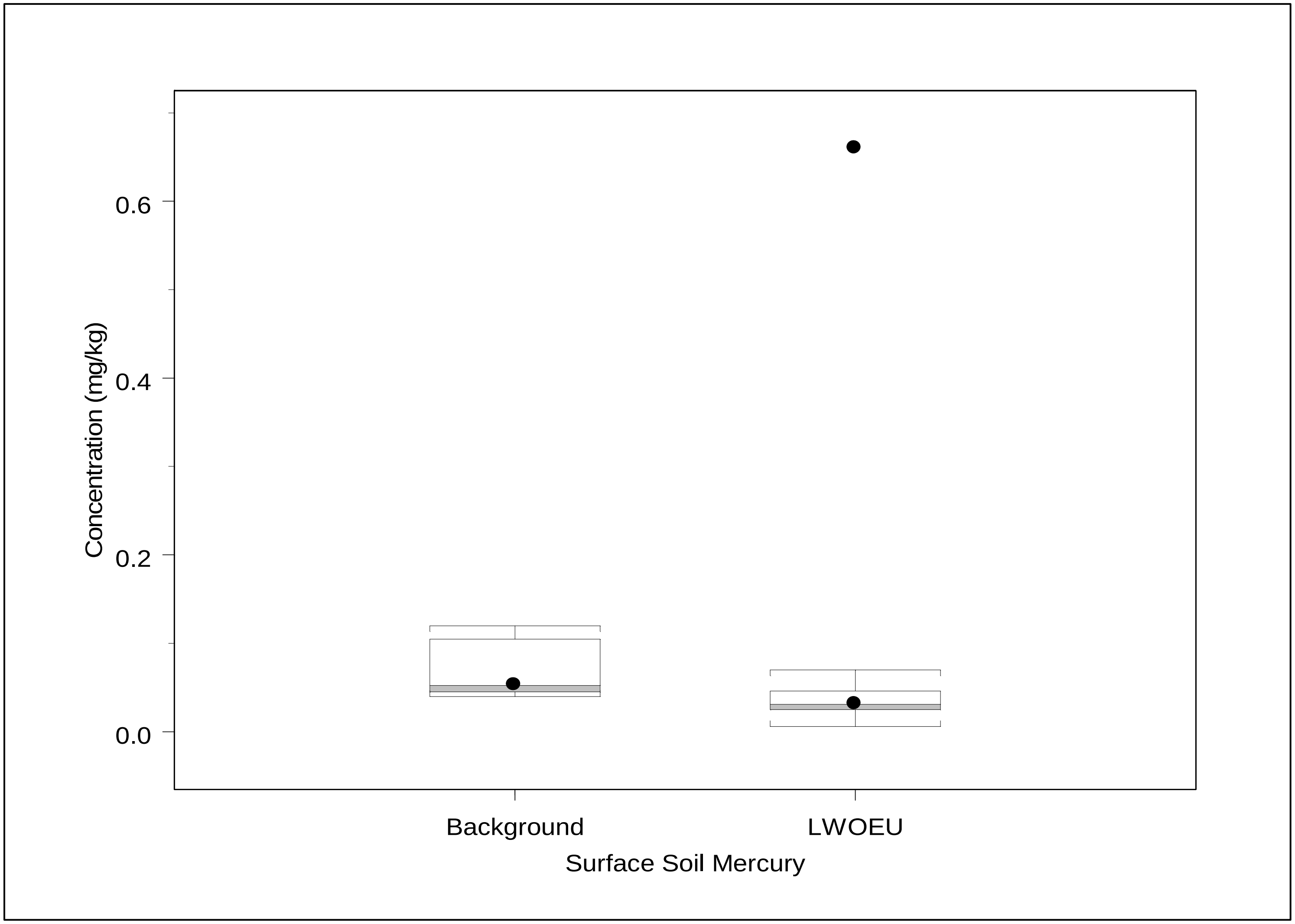
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.18
LWOEU Surface Soil (PMJM) Box Plots for Manganese



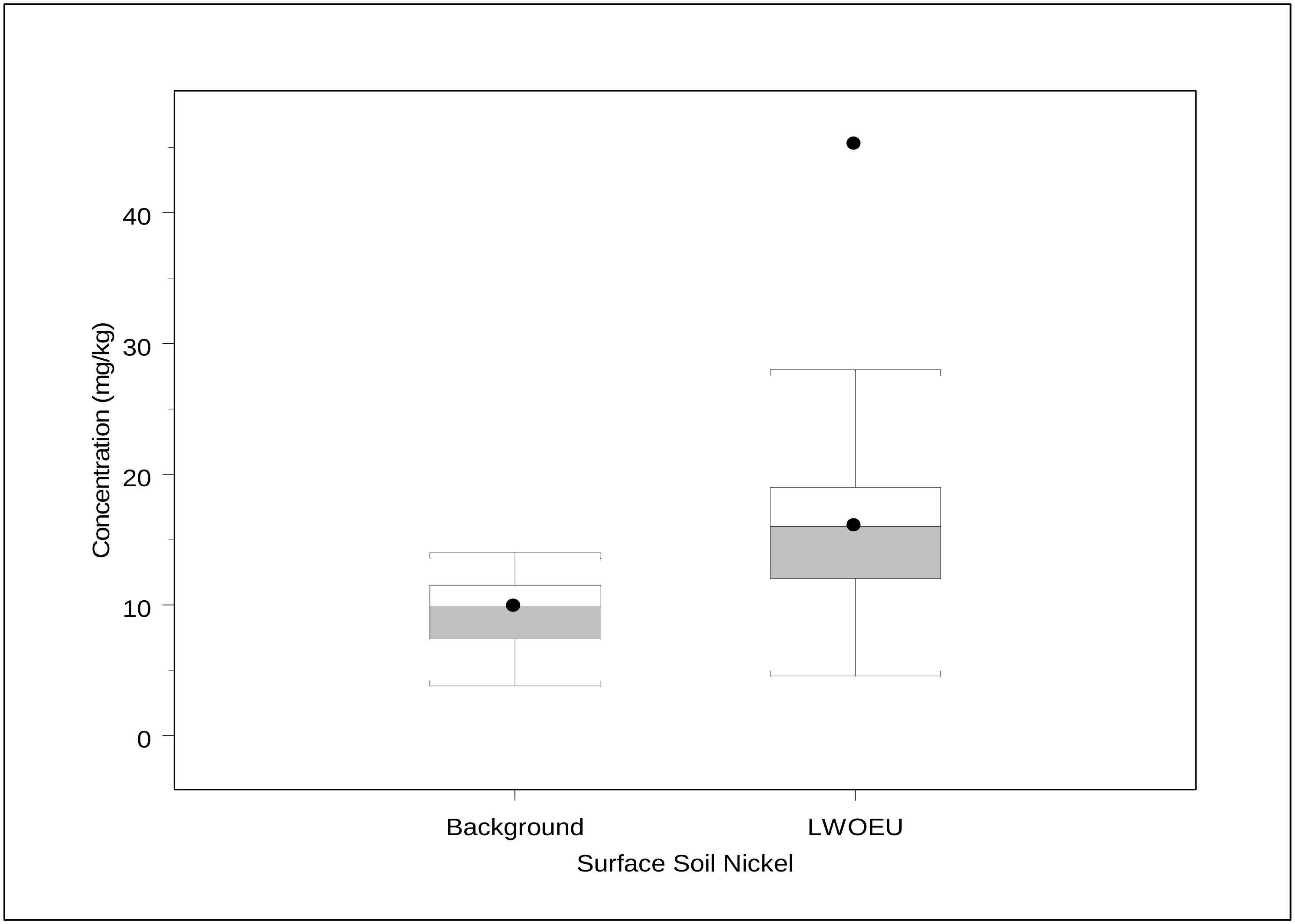
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.19
LWOEU Surface Soil Box Plots for Mercury



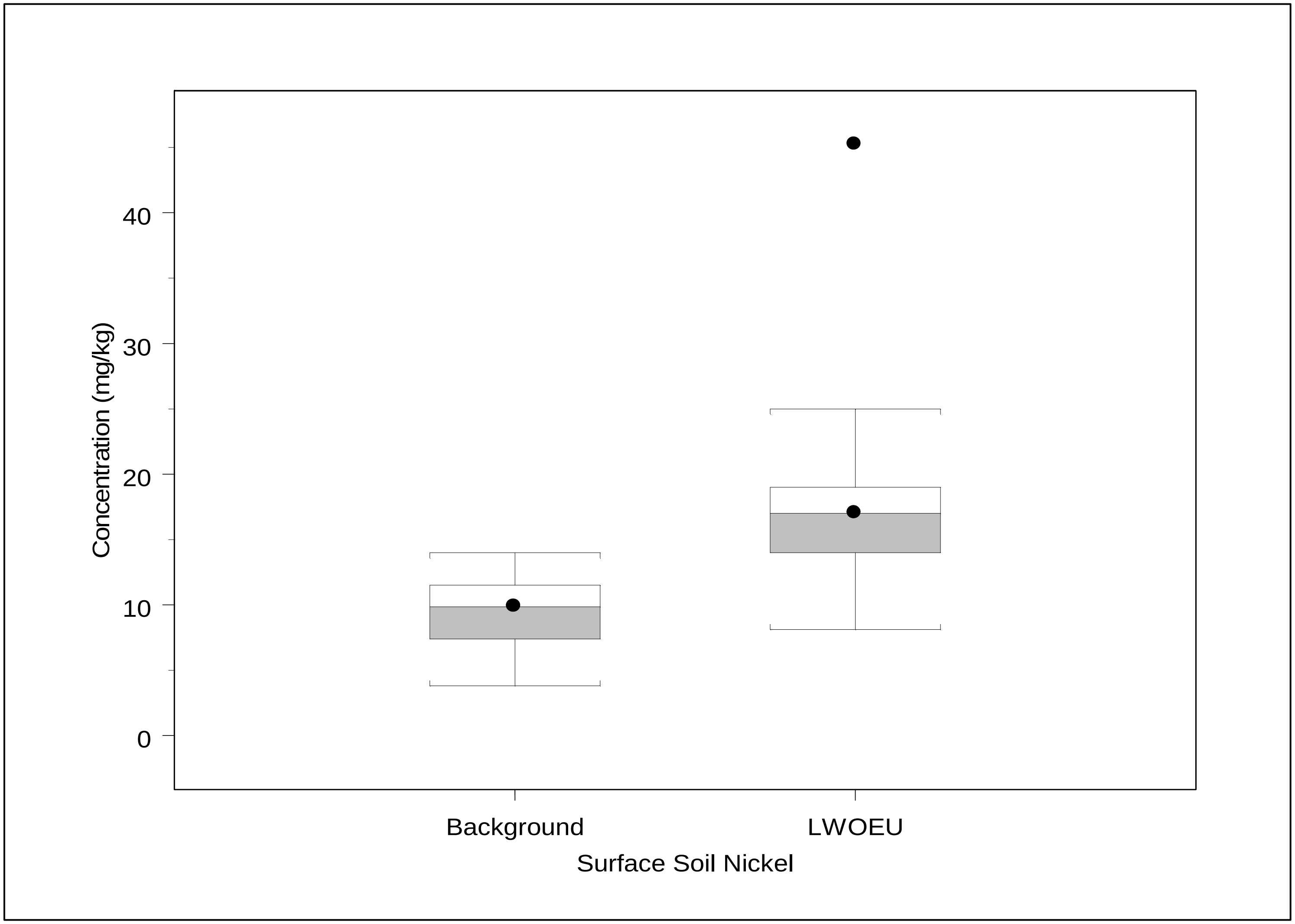
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.20
LWOEU Surface Soil Box Plots for Nickel



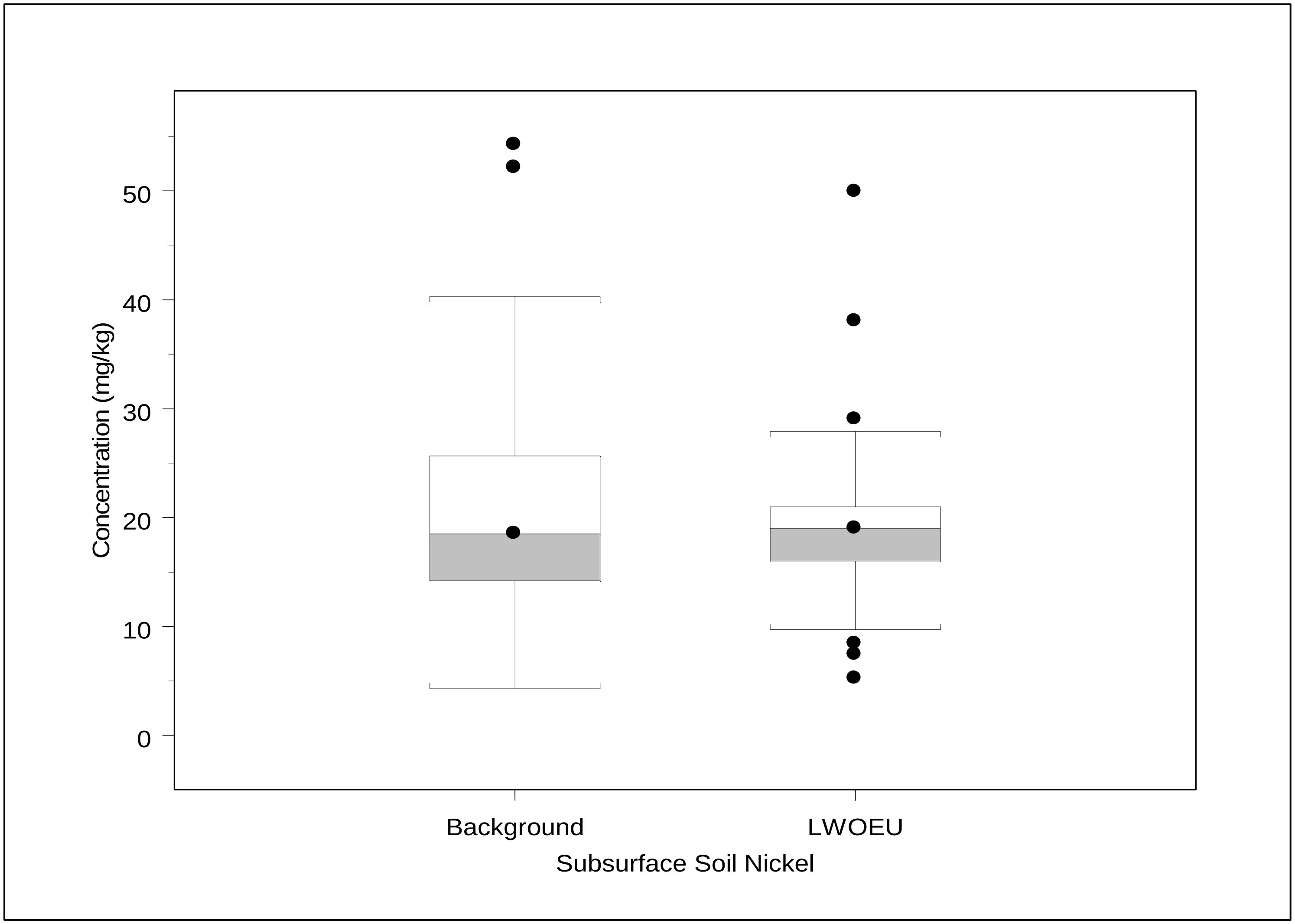
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.21
LWOEU Surface Soil (PMJM) Box Plots for Nickel



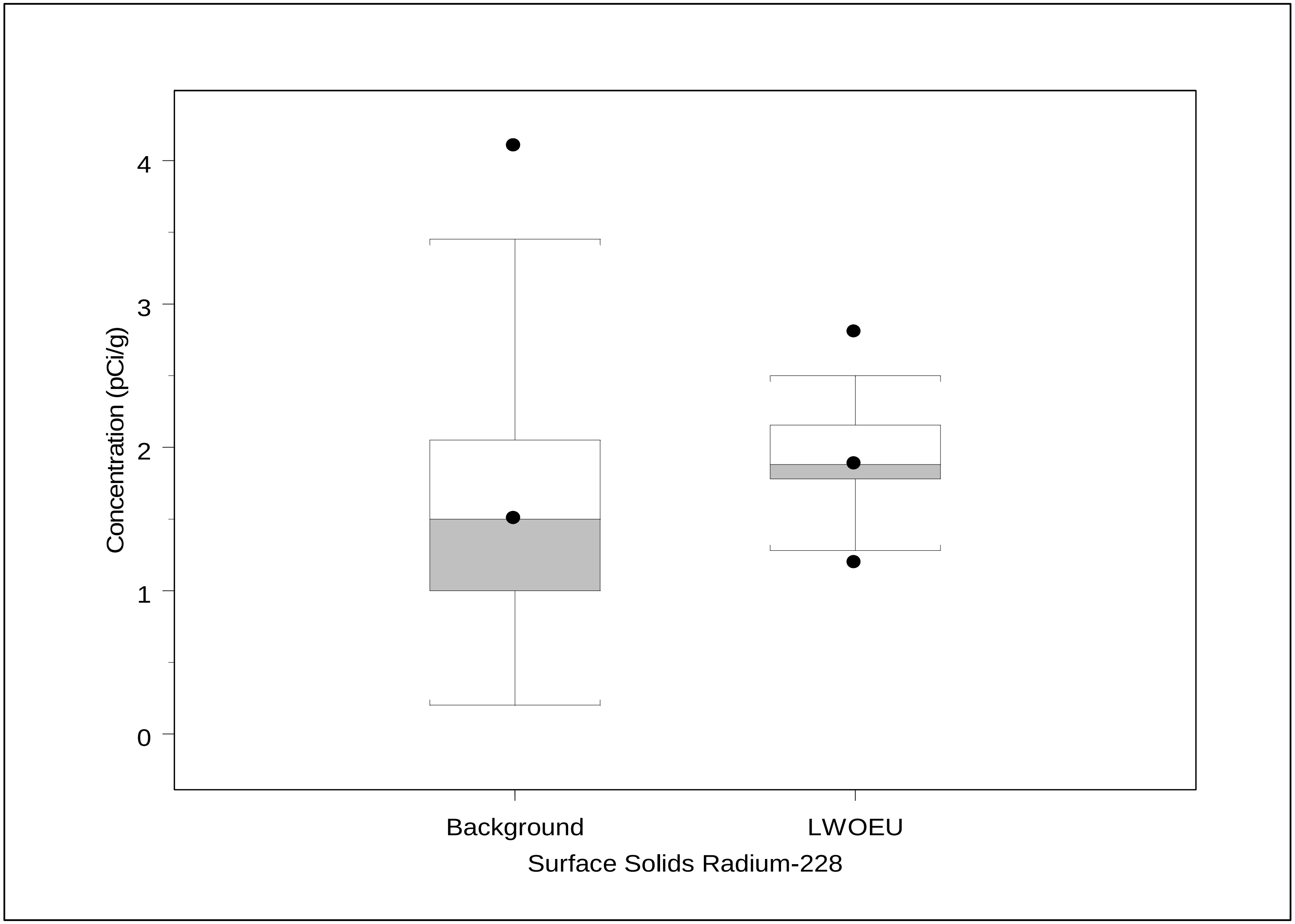
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.22
LWOEU Subsurface Soil Box Plots for Nickel



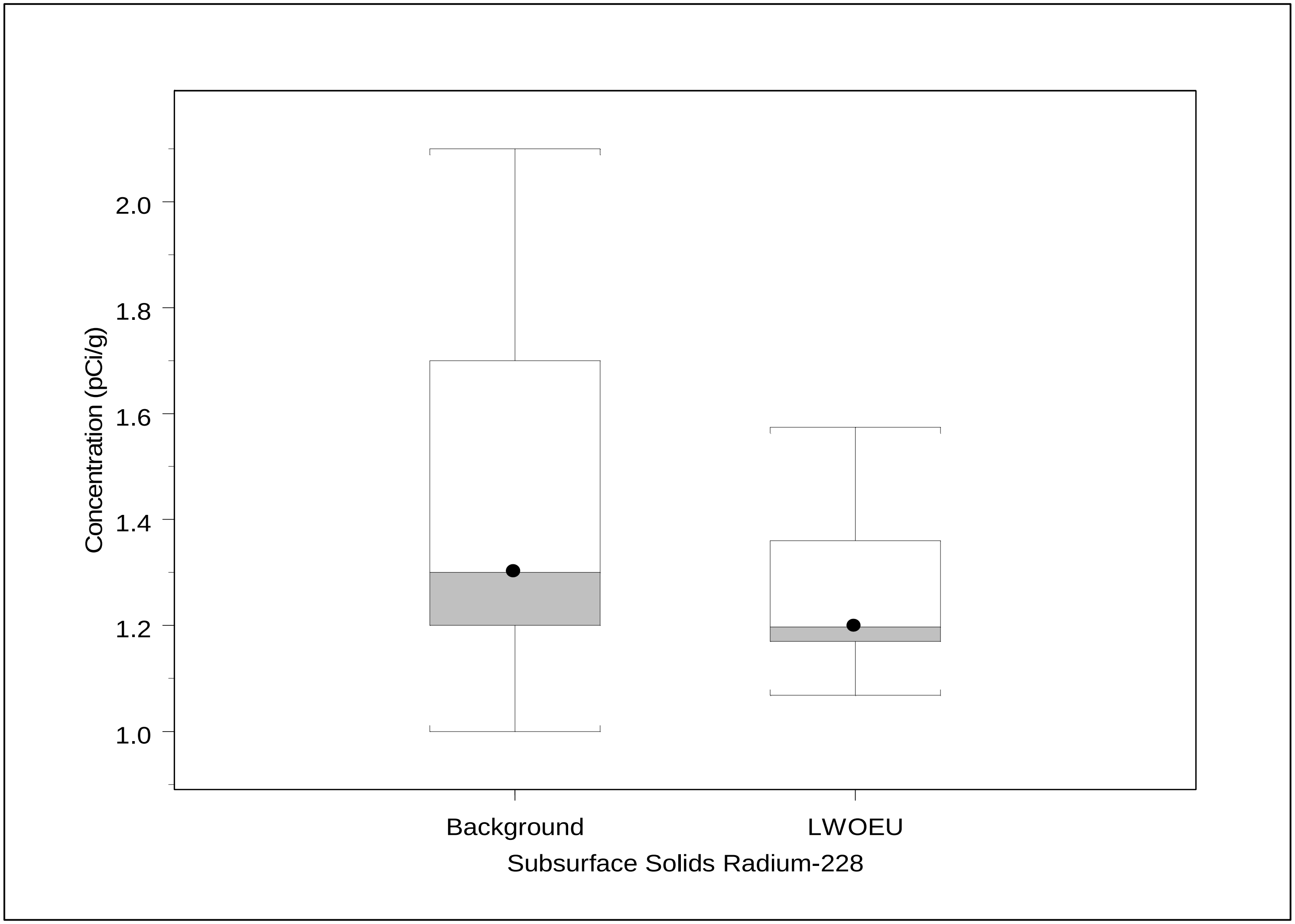
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.23
LWOEU Surface Soil/Surface Sediment Box Plots for Radium-228



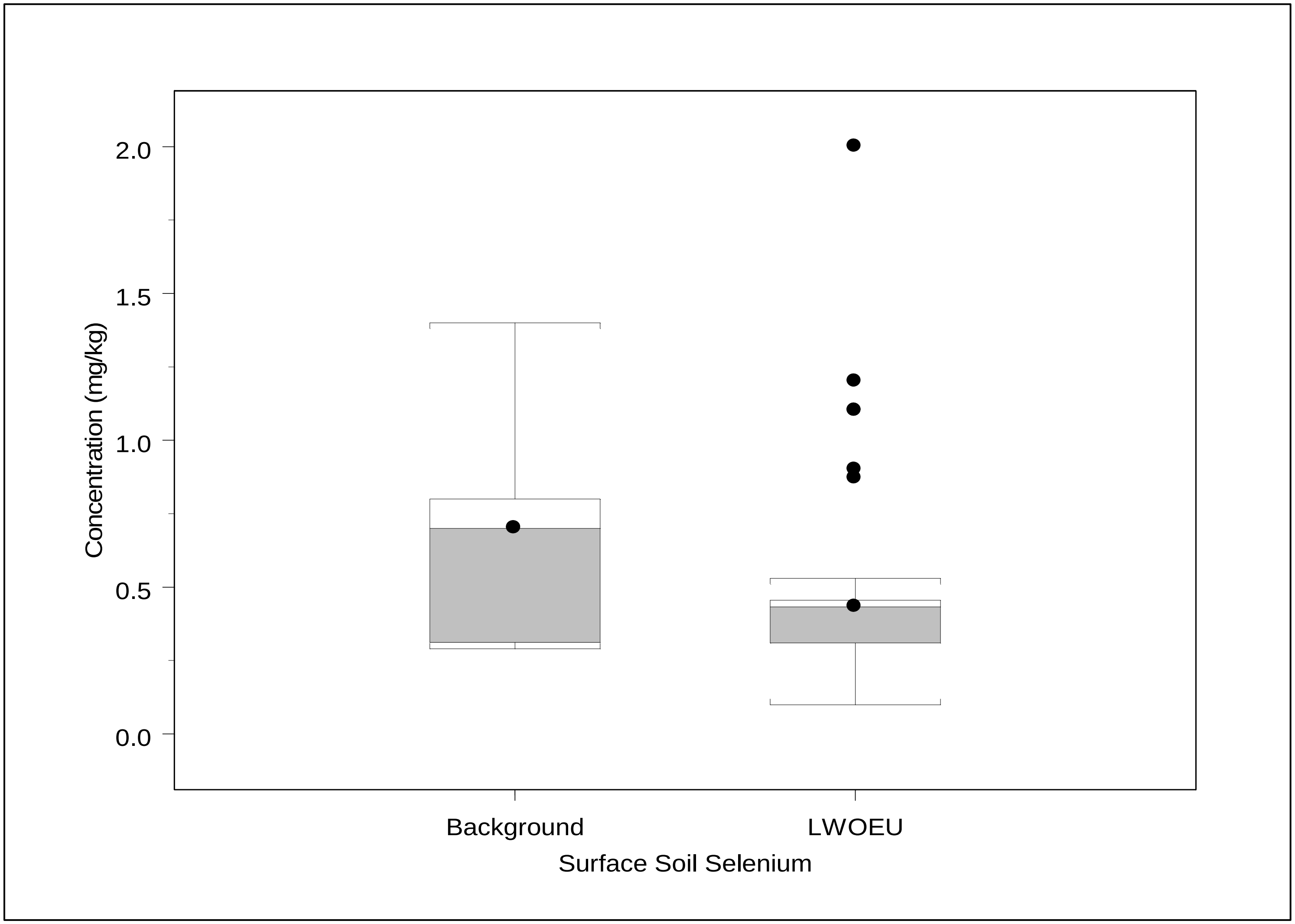
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.24
LWOEU Subsurface Soil/Subsurface Sediment Box Plots for Radium-228



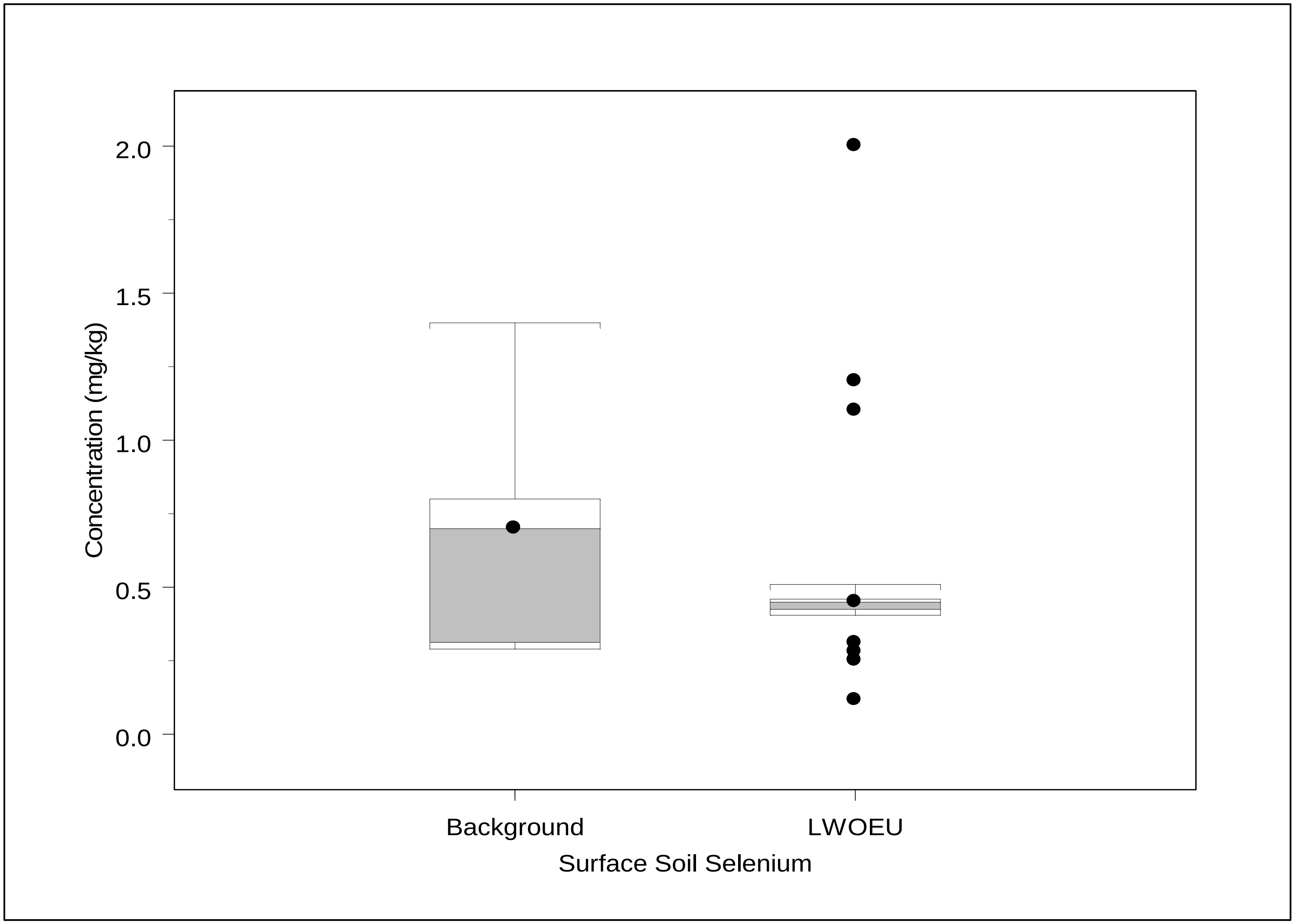
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.25
LWOEU Surface Soil Box Plots for Selenium



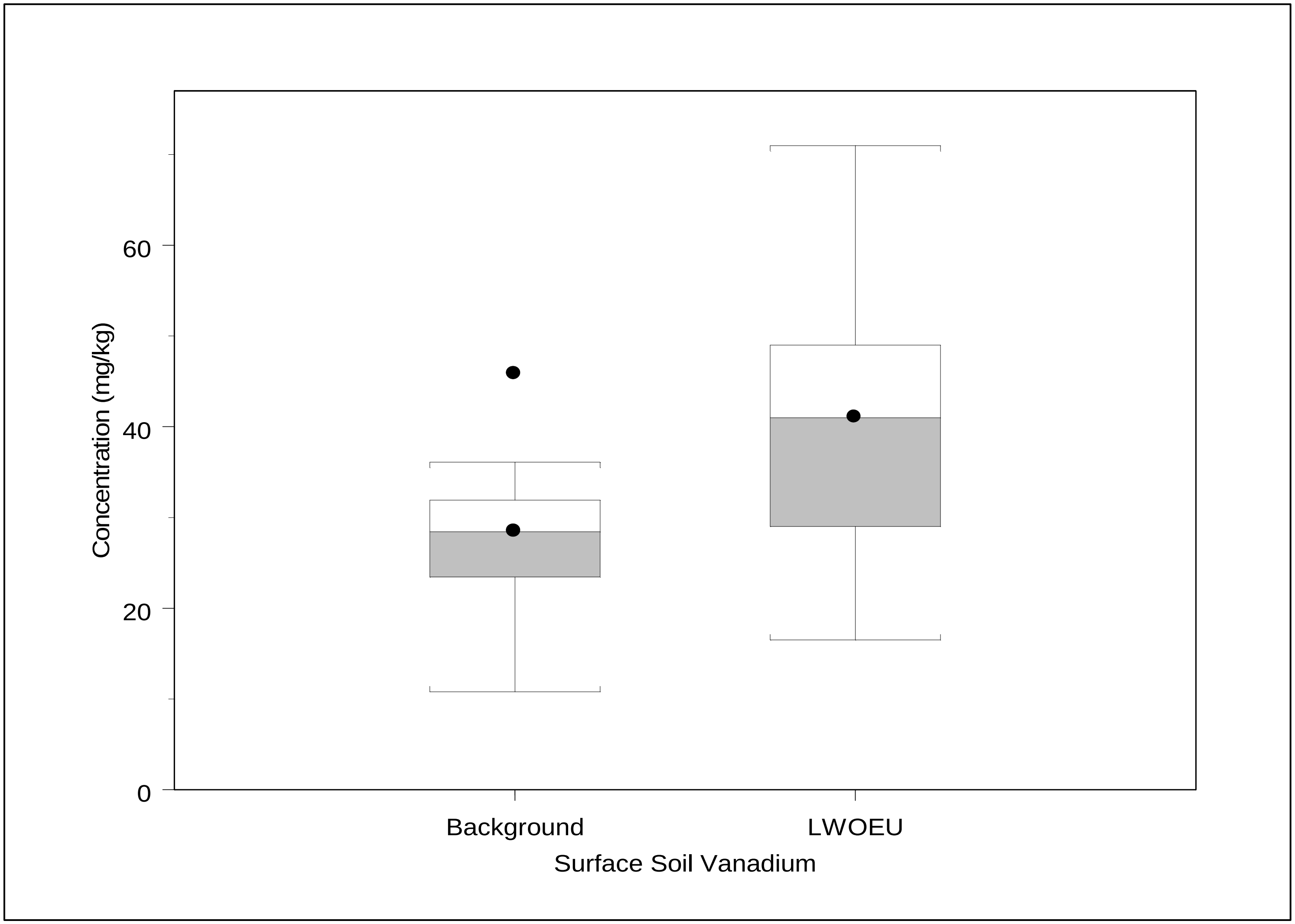
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.26
LWOEU Surface Soil (PMJM) Box Plots for Selenium



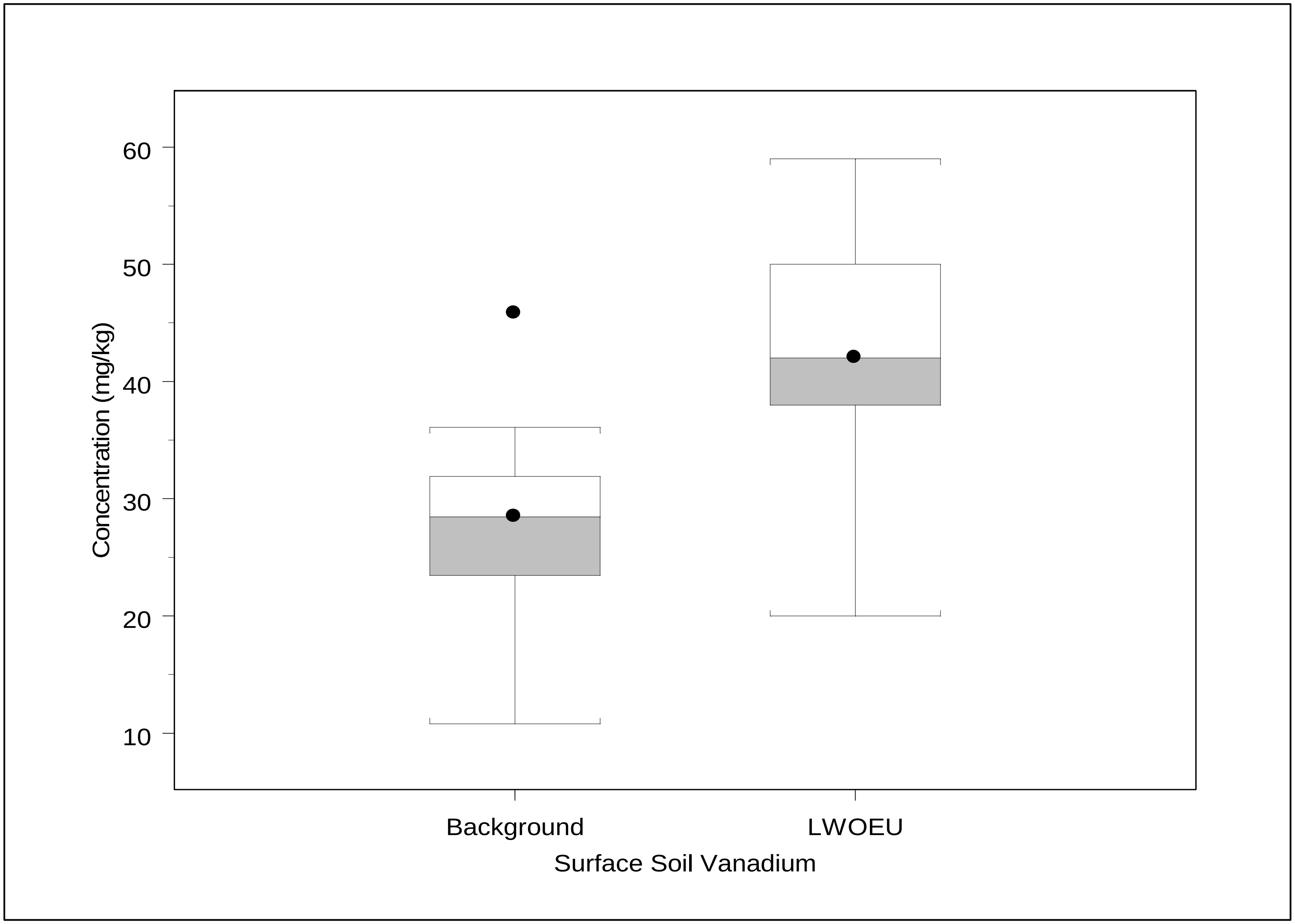
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.27
LWOEU Surface Soil Box Plots for Vanadium



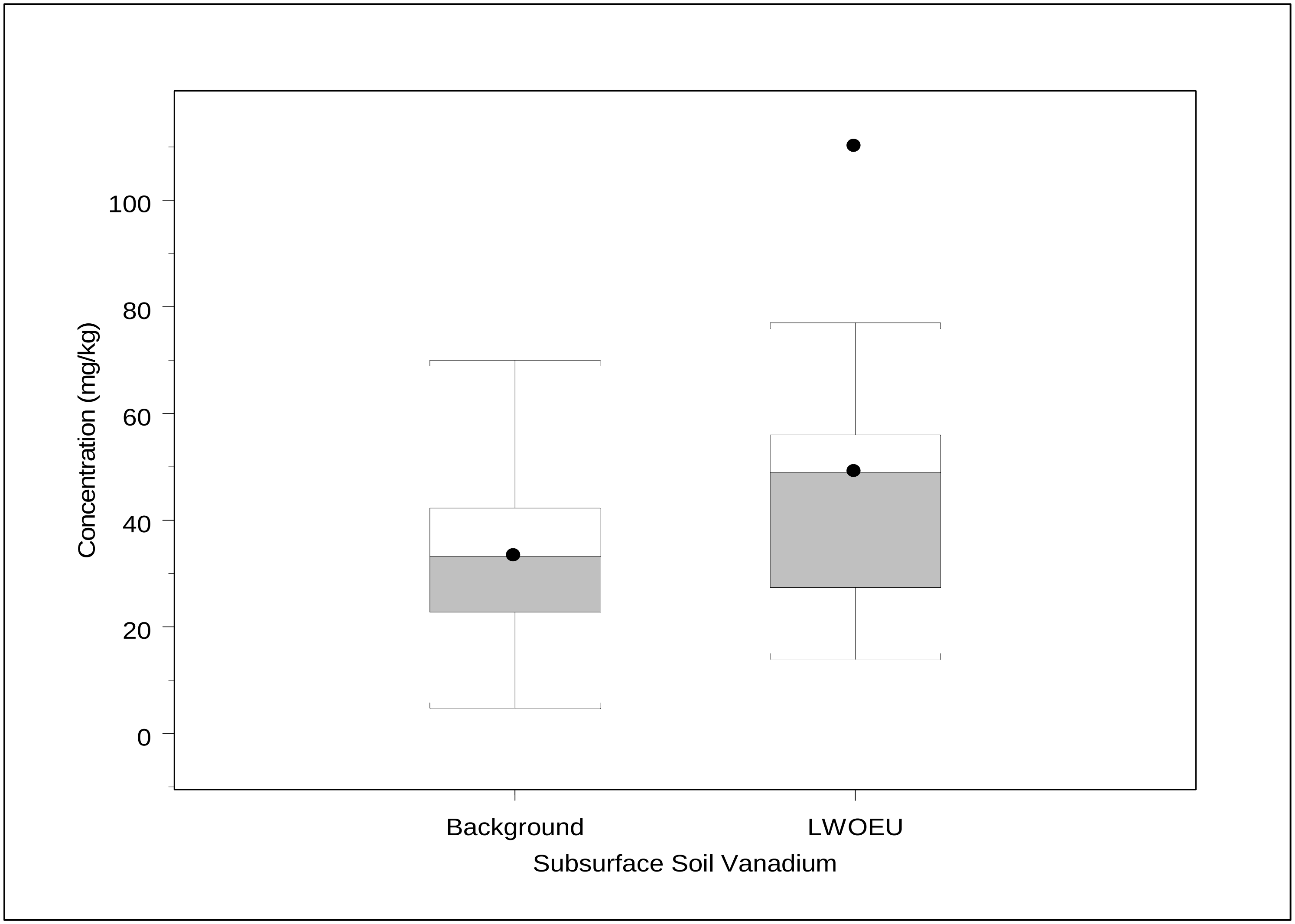
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.28
LWOEU Surface Soil (PMJM) Box Plots for Vanadium



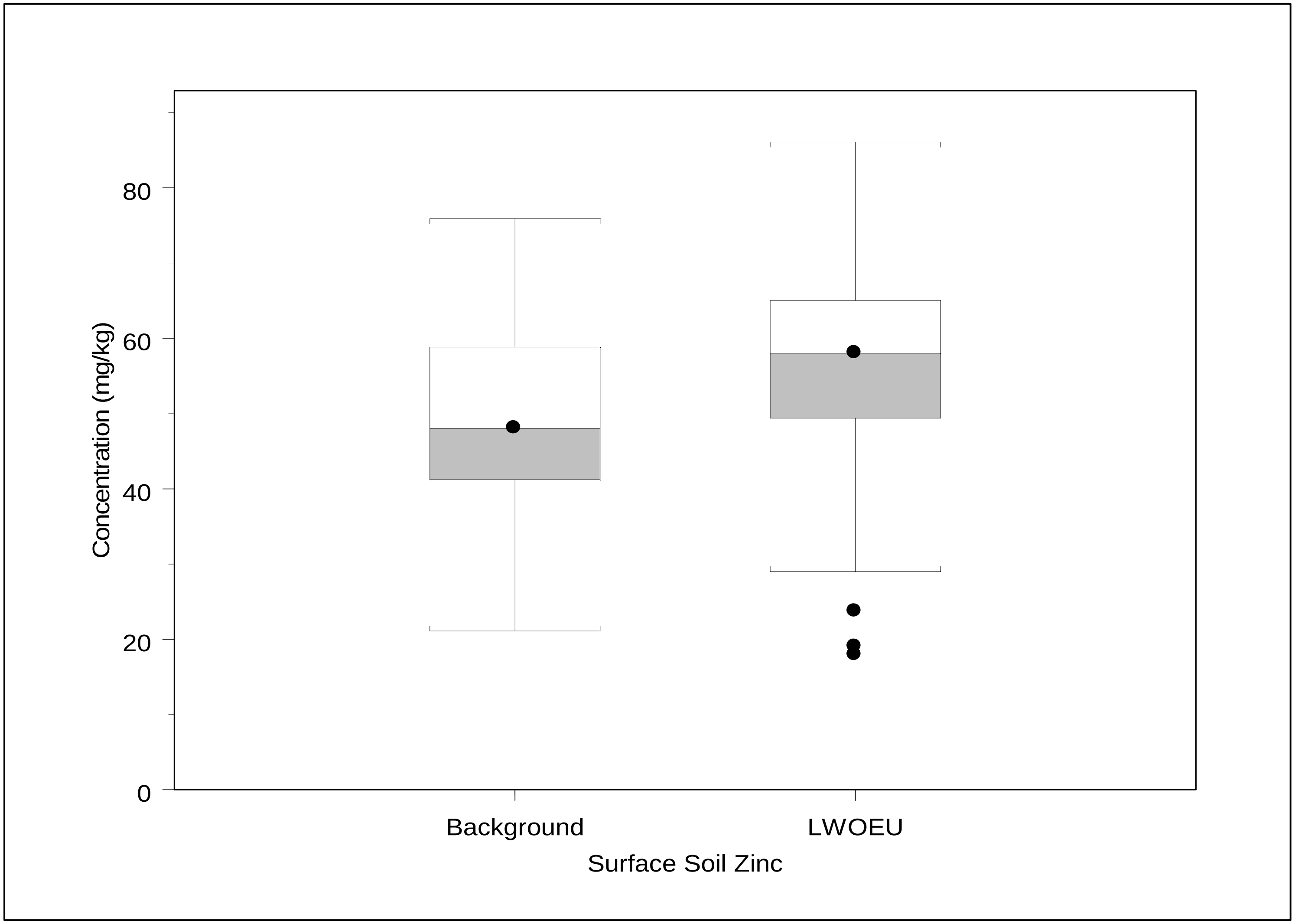
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.29
LWOEU Subsurface Soil Box Plots for Vanadium



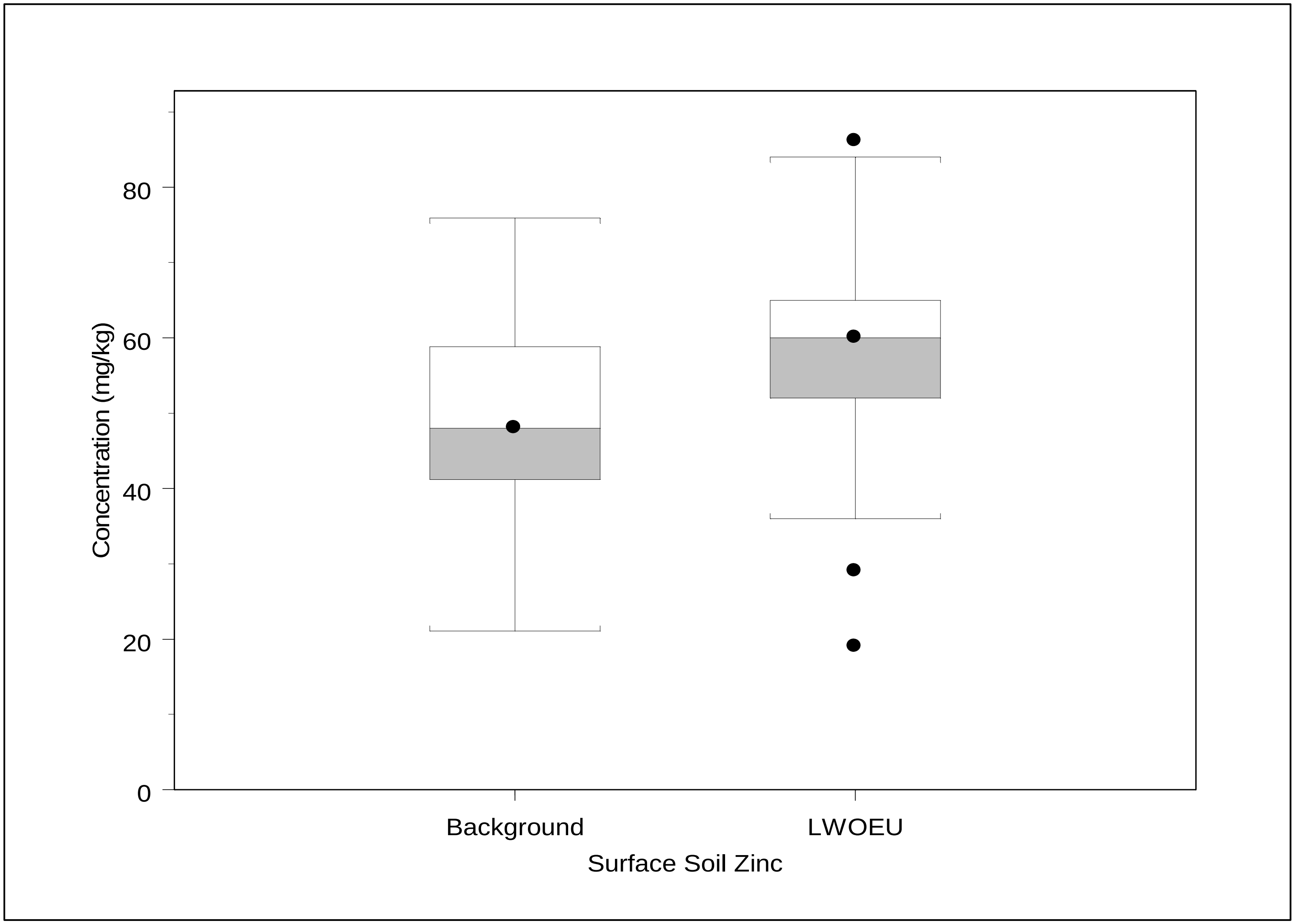
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.30
LWOEU 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 A3.2.31
LWOEU Surface Soil (PMJM) 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

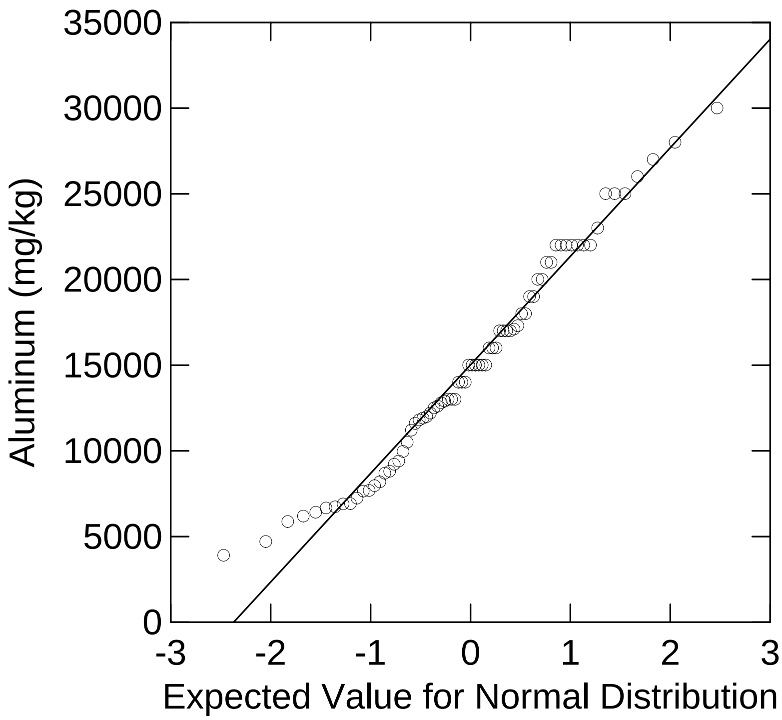


Figure A3.4.1 Probability Plot of Aluminum Concentrations in LWOEU Surface Soil

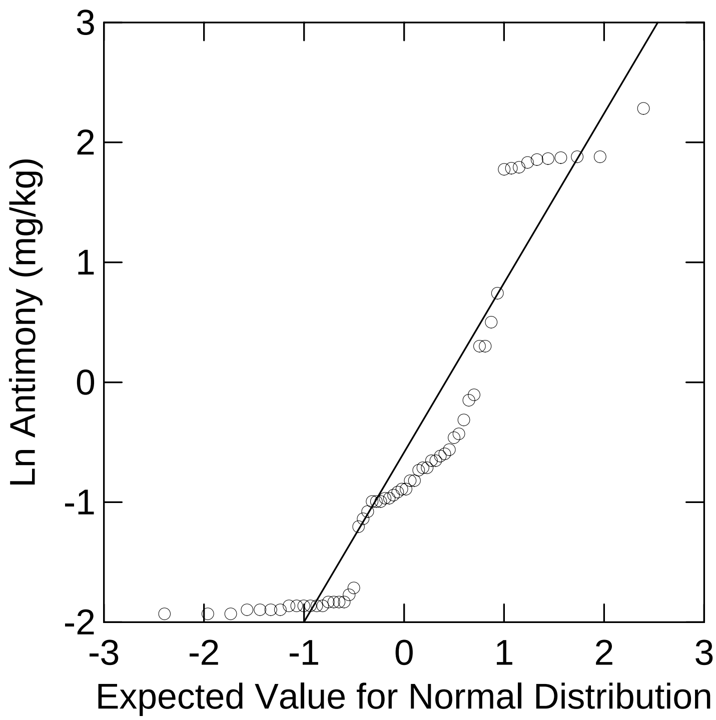


Figure A3.4.2 Probability Plot of Antimony Concentrations (Natural Logarithm) in LWOEU Surface Soil

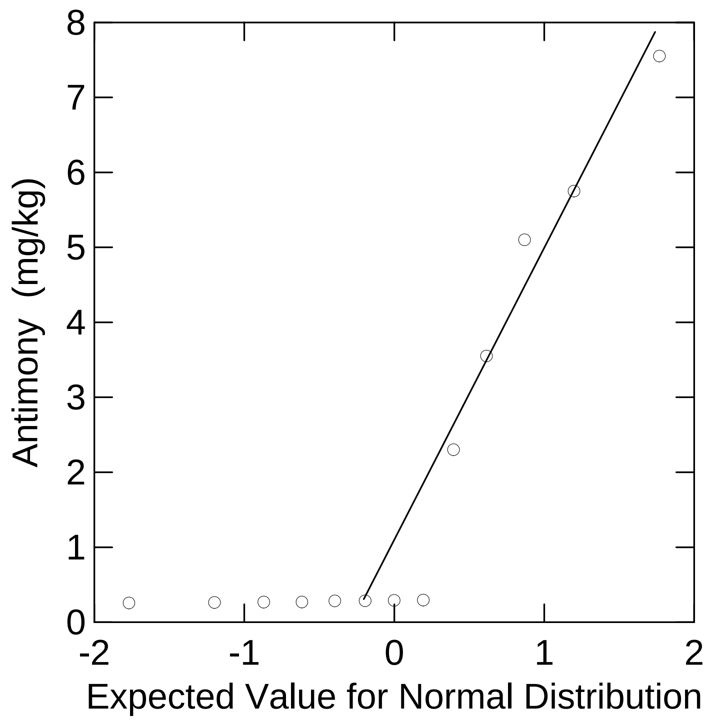


Figure A3.4.3 Probability Plot of Antimony Concentrations in LWOEU Subsurface Soil

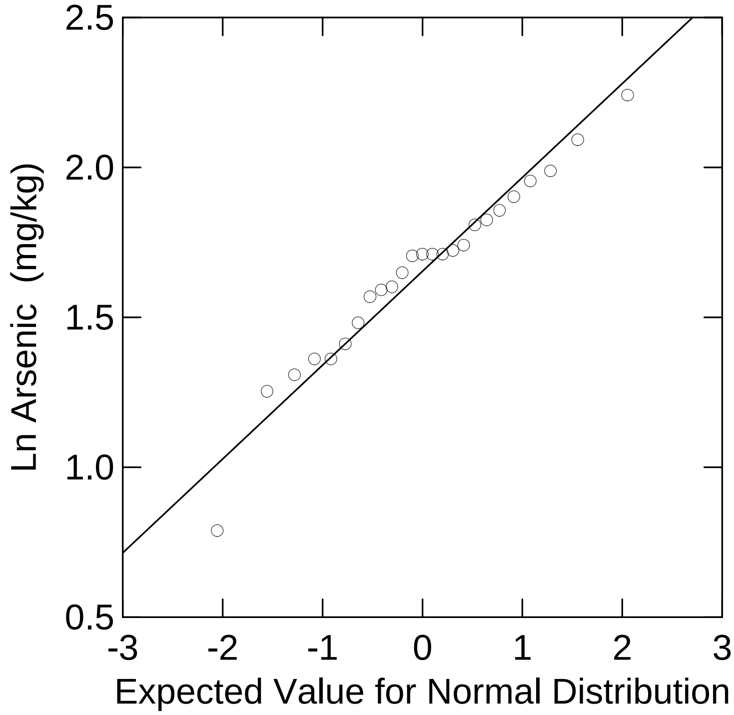


Figure A3.4.4 Probability Plot of Arsenic Concentrations (Natural Logarithm) in LWOEU Surface Soil/Surface Sediment

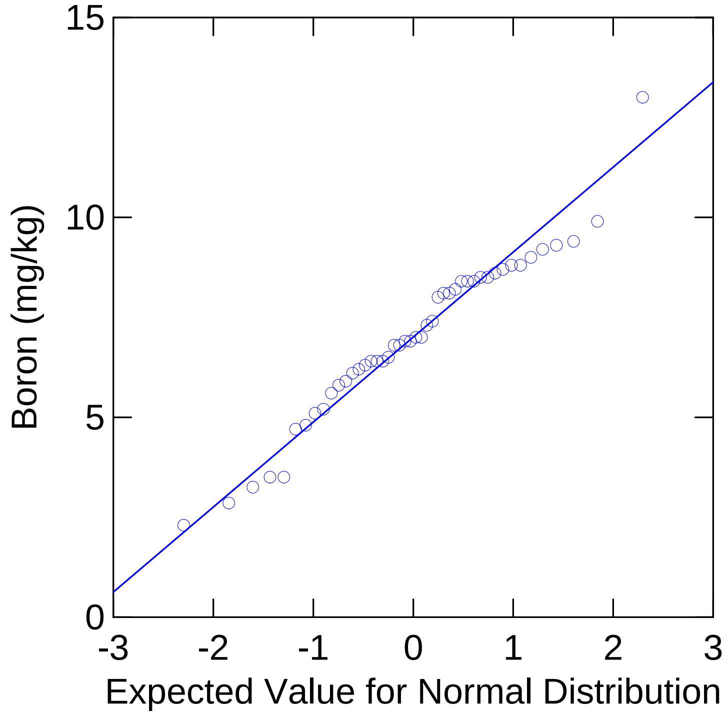


Figure A3.4.5 Probability Plot of Boron Concentrations in LWOEU Surface Soil

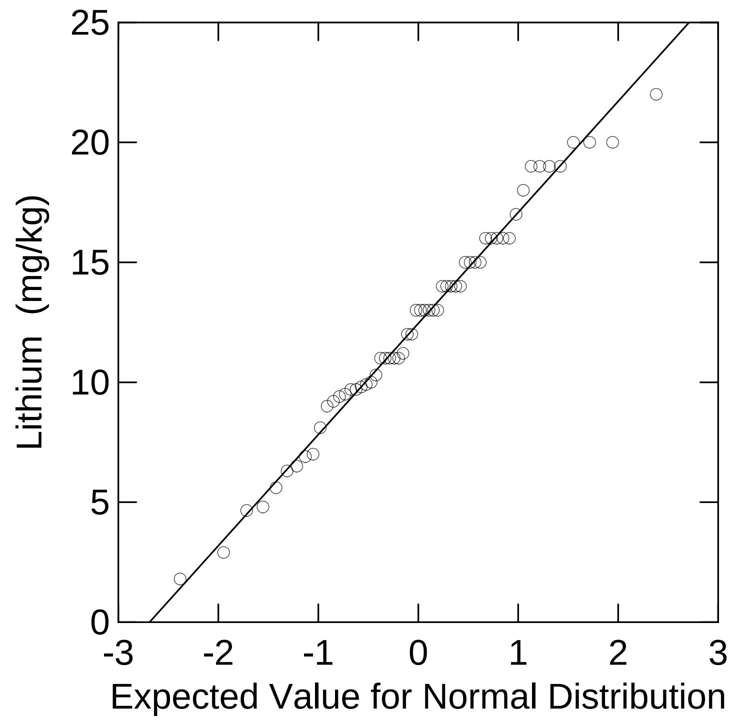


Figure A3.4.6 Probability Plot of Lithium Concentrations in LWOEU Surface Soil

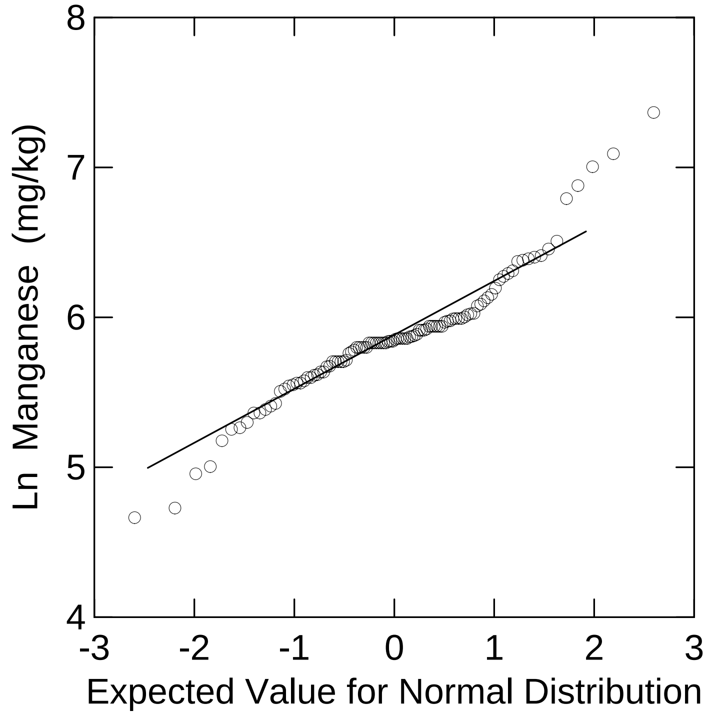


Figure A3.4.7 Probability Plot of Manganese Concentrations (Natural logarithm) in LWOEU Surface Soil/Surface Sediment

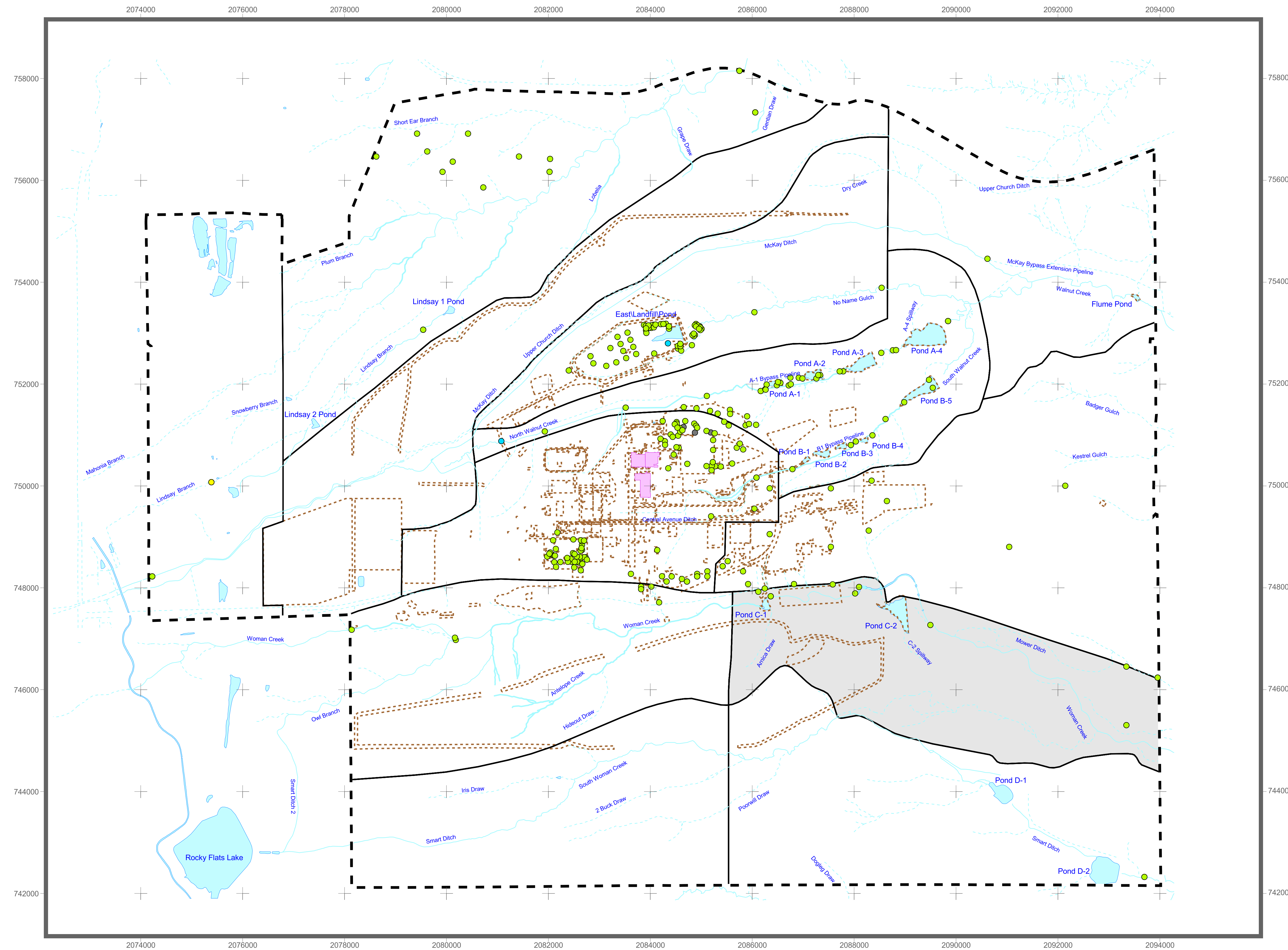


Figure A3.4.8

Radium-228 Concentrations in Sitewide Surface Soil/Surface Sediment

KEY

- Concentration > 3x Background MDC
- Concentration > Background MDC and <= 3x Background MDC
- Concentration > WRW PRG and <= Background MDC
- Concentration <= WRW PRG
- Nondetect (ND)

WRW PRG = 0.111 pCi/g
Background MDC = 4.10 pCi/g
3 x Background MDC = 12.3 pCi/g

Standard Map Features

- Lower Woman Drainage EU
- Exposure Unit boundaries
- Former building where analyte was used or generated as waste
- Historical IHSS/PAC
- Pond
- Ephemeral stream
- Intermittent stream
- Perennial stream
- Site boundary

N
W E
S

0 1000 2000 Feet

Scale 1:24,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

File: W:\Projects\FY2005\CRA\ProfessionalJudgement\FINAL-profjudgment.apr

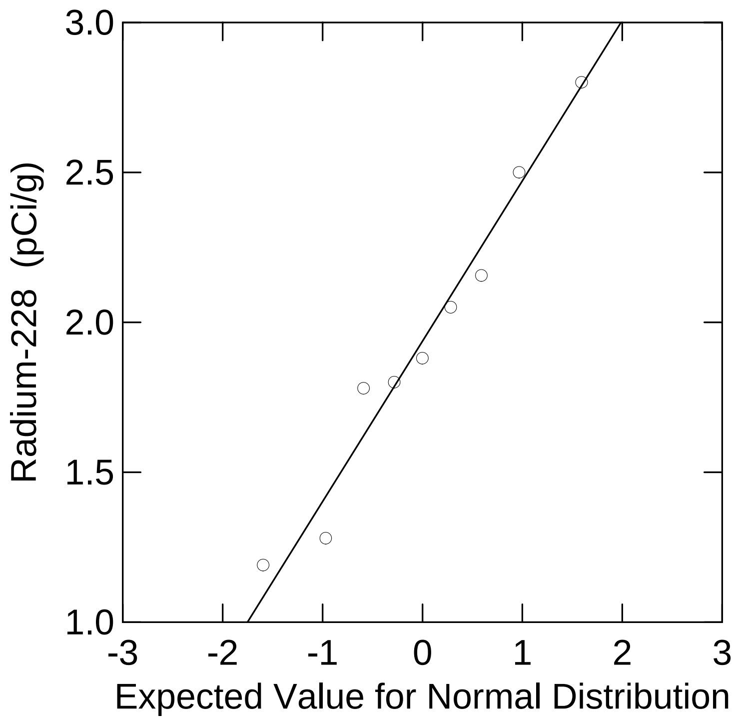


Figure A3.4.9 Probability Plot of Radium-228 Activities in LWOEU Surface Soil/Surface Sediment

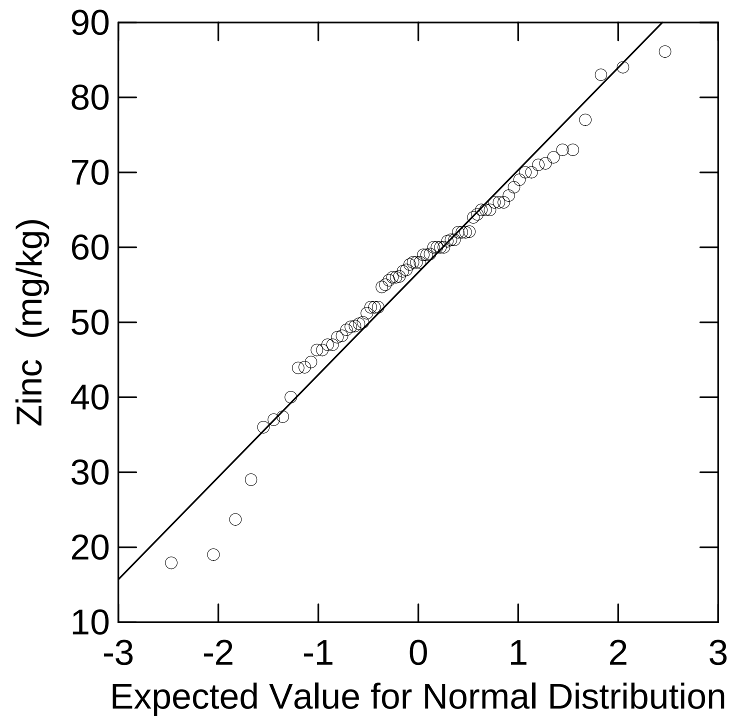


Figure A3.4.10 Probability Plot of Zinc Concentrations in LWOEU Surface Soil

COMPREHENSIVE RISK ASSESSMENT

LOWER WOMAN DRAINAGE EXPOSURE UNIT

VOLUME 11: ATTACHMENT 4

Risk Assessment Calculations

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Table A4.2.1
Intake and Exposure Estimates for Chromium - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.084	3.162	lnCm = -1.495 + 0.7326(lnCs)				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
26.1	Tier 1 UTL	2.19	82.5	2.45	0.004	
17.8	Tier 1 UCL	1.50	56.3	1.85	0.004	
32.2	Tier 2 UTL[a]	2.70	101.8	2.85	0.004	
17.2	Tier 2 UCL	1.44	54.4	1.80	0.004	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	**$IR_{(water)}$** (kg/kg BW day)	**$IR_{(soil)}$** (kg/kg BW day)	**P_{plant}**	**P_{invert}**	**P_{mammal}**
Mourning Dove - Hervibore	0.23	0.12	0.021	1	0	0
Mourning Dove - Insectivore	0.23	0.12	0.021	0	1	0
American Kestrel	0.092	0.12	0.005	0	0.2	0.8
Deer Mouse - Insectivore	0.065	0.19	0.001	0	1	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Mourning Dove - Herbivore						
Tier 1 UTL	0.504	N/A	N/A	0.558	4.80E-04	1.06
Tier 1 UCL	0.344	N/A	N/A	0.381	4.80E-04	0.725
Tier 2 UTL[a]	0.622	N/A	N/A	0.689	4.80E-04	1.31
Tier 2 UCL	0.332	N/A	N/A	0.368	4.80E-04	0.701
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	19.0	N/A	0.558	4.80E-04	19.5
Tier 1 UCL	N/A	12.9	N/A	0.381	4.80E-04	13.3
Tier 2 UTL[a]	N/A	23.4	N/A	0.689	4.80E-04	24.1
Tier 2 UCL	N/A	12.5	N/A	0.368	4.80E-04	12.9
American Kestrel						
Tier 1 UTL	N/A	1.52	0.180	0.120	4.80E-04	1.82
Tier 1 UCL	N/A	1.04	0.136	0.0819	4.80E-04	1.25
Tier 2 UTL[a]	N/A	1.87	0.210	0.148	4.80E-04	2.23
Tier 2 UCL	N/A	1.00	0.133	0.0791	4.80E-04	1.21
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	5.36	N/A	0.0339	7.60E-04	5.40
Tier 1 UCL	N/A	3.66	N/A	0.0231	7.60E-04	3.68
Tier 2 UTL[a]	N/A	6.62	N/A	0.0419	7.60E-04	6.66
Tier 2 UCL	N/A	3.54	N/A	0.0224	7.60E-04	3.56

[a]Tier 2 soil UTL was greater than the maximum grid mean, so the maximum grid mean was used to calculate intake.
N/A = Not applicable or not available.

Table A4.2.2
PMJM Intake and Exposure Estimates for Chromium - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.084	3.162	lnCm = -1.495 + 0.7326(lnCs)				
Media Concentrations (mg/kg)						
Patch	**Soil Concentration**	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**
22	22	MDC	1.85	69.6	2.16	0.07
22	22	UTL[a]	1.85	69.6	2.16	0.004
22	22	UCL[a]	1.85	69.6	2.16	0.004
22	20	Mean	1.68	63.2	2.01	0.03
23	28	MDC	2.35	88.5	2.58	0.07
23	28	UTL[a]	2.35	88.5	2.58	0.004
23	21	UCL	1.76	66.4	2.09	0.004
23	19.6	Mean	1.65	62.0	1.98	0.03
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	**$IR_{(water)}$** (kg/kg BW day)	**$IR_{(soil)}$** (kg/kg BW day)	**P_{plant}**	**P_{invert}**	**P_{mammal}**
PMJM	0.17	0.15	0.004	0.7	0.3	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Patch 22						
MDC	0.220	3.55	N/A	0.0898	0.0105	3.87
UTL[a]	0.220	3.55	N/A	0.0898	6.00E-04	3.86
UCL[a]	0.220	3.55	N/A	0.0898	6.00E-04	3.86
Mean	0.200	3.23	N/A	0.0816	0.00450	3.51
Patch 23						
MDC	0.280	4.52	N/A	0.114	0.0105	4.92
UTL[a]	0.280	4.52	N/A	0.114	6.00E-04	4.91
UCL	0.210	3.39	N/A	0.0857	6.00E-04	3.68
Mean	0.196	3.16	N/A	0.0800	0.00450	3.44

[a] Soil UTL and/or UCL was greater than the MDC or could not be calculated due to low numbers of samples, so the MDC was used as a proxy value to calculate intake.
N/A = Not applicable or not available

Table A4.2.3
Intake and Exposure Estimates for Chromium - Alternative Exposure Scenario

Bioaccumulation Factors (Median Values)						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.041	0.306	$\ln Cm = -1.495 + 0.7326(\ln Cs)$				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
26.1	Tier 1 UTL	1.07	8.0	2.45	0.004	
17.8	Tier 1 UCL	0.73	5.4	1.85	0.004	
32.2	Tier 2 UTL[a]	1.32	9.9	2.85	0.004	
17.2	Tier 2 UCL	0.71	5.3	1.80	0.004	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	$IR_{(water)}$ (kg/kg BW day)	$IR_{(soil)}$ (kg/kg BW day)	P_{plant}	P_{invert}	P_{mammal}
Mourning Dove - Insectivore	0.23	0.12	0.021	0	1	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	1.84	N/A	0.558	4.80E-04	2.40
Tier 1 UCL	N/A	1.25	N/A	0.381	4.80E-04	1.63
Tier 2 UTL[a]	N/A	2.27	N/A	0.689	4.80E-04	2.96
Tier 2 UCL	N/A	1.21	N/A	0.368	4.80E-04	1.58

[a]Tier 2 soil UTL was greater than the maximum grid mean, so the maximum grid mean was used to calculate intake.
N/A = Not applicable or not available.

Table A4.2.4
Terrestrial Plant Hazard Quotients for Surface Soils in the LWOEU - Chromium

EPC Statistic	Concentration (mg/kg)	TRV (mg/kg BW day)			Hazard Quotients		
		Screening ESL	Alternate NOEC	Alternate LOEC	Screening ESL	Alternate NOEC	Alternate LOEC
Terrestrial Plant							
Tier 1 UTL	26.1	1.00	10.0	30.0	**26**	**3**	0.9
Tier 1 UCL	17.8	1.00	10.0	30.0	**18**	**2**	0.6
Tier 2 UTL[a]	32.2	1.00	10.0	30.0	**32**	**3**	1
Tier 2 UCL	17.2	1.00	10.0	30.0	**17**	**2**	0.6

[a]Tier 2 soil UTL was greater than the maximum grid mean, so the maximum grid mean was used to calculate risk.
NA = Not applicable or not available.
Bold = Hazard quotients>1.

Table A4.2.5
Terrestrial Invertebrate Hazard Quotients for Surface Soils in the LWOEU - Chromium

EPC Statistic	Concentration (mg/kg)	TRV (mg/kg)		Hazard Quotients	
		Screening ESL	LOEC	Screening ESL	LOEC
Terrestrial Invertebrate					
Tier 1 UTL	26.1	0.400	32.6	**65**	0.8
Tier 1 UCL	17.8	0.400	32.6	**45**	0.5
Tier 2 UTL[a]	32.2	0.400	32.6	**81**	0.99
Tier 2 UCL	17.2	0.400	32.6	**43**	0.5

[a]Tier 2 soil UTL was greater than the maximum grid mean, so the maximum grid mean was used to calculate risk.
NA = Not applicable or not available.
Bold = Hazard quotients>1.

Table A4.2.6
Non-PMJM Receptor Hazard Quotients for Surface Soils in the LWOEU - Chromium

Receptor/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day) Chromium VI NOAEL	Chromium VI LOAEL	Chromium III NOAEL	Chromium III LOAEL	Hazard Quotients Chromium VI NOAEL	Chromium VI LOAEL	Chromium III NOAEL	Chromium III LOAEL
Chromium (Default Exposure)									
Mourning Dove - Herbivore									
Tier 1 UTL	1.06	N/A	N/A	1	5	N/A	N/A	1	0.2
Tier 1 UCL	0.725	N/A	N/A	1	5	N/A	N/A	0.7	0.1
Tier 2 UTL[a]	1.31	N/A	N/A	1	5	N/A	N/A	1	0.3
Tier 2 UCL	0.701	N/A	N/A	1	5	N/A	N/A	0.7	0.1
Mourning Dove - Insectivore									
Tier 1 UTL	19.5	N/A	N/A	1	5	N/A	N/A	**20**	**4**
Tier 1 UCL	13.3	N/A	N/A	1	5	N/A	N/A	**13**	**3**
Tier 2 UTL[a]	24.1	N/A	N/A	1	5	N/A	N/A	**24**	**5**
Tier 2 UCL	12.9	N/A	N/A	1	5	N/A	N/A	**13**	**3**
American Kestrel									
Tier 1 UTL	1.82	N/A	N/A	1	5	N/A	N/A	**2**	0.4
Tier 1 UCL	1.25	N/A	N/A	1	5	N/A	N/A	1	0.3
Tier 2 UTL[a]	2.23	N/A	N/A	1	5	N/A	N/A	**2**	0.4
Tier 2 UCL	1.21	N/A	N/A	1	5	N/A	N/A	1	0.2
Deer Mouse - Insectivore									
Tier 1 UTL	5.40	3.28	13.14	2737	N/A	**2**	0.4	0.002	N/A
Tier 1 UCL	3.68	3.28	13.14	2737	N/A	1	0.3	0.001	N/A
Tier 2 UTL[a]	6.66	3.28	13.14	2737	N/A	**2**	0.5	0.002	N/A
Tier 2 UCL	3.56	3.28	13.14	2737	N/A	1	0.3	0.001	N/A
Chromium (Alternative Exposure Scenario; Median BAFs)									
Mourning Dove - Insectivore									
Tier 1 UTL	2.40	N/A	N/A	1	5	N/A	N/A	**2**	0.5
Tier 1 UCL	1.63	N/A	N/A	1	5	N/A	N/A	**2**	0.3
Tier 2 UTL[a]	2.96	N/A	N/A	1	5	N/A	N/A	**3**	0.6
Tier 2 UCL	1.58	N/A	N/A	1	5	N/A	N/A	**2**	0.3

[a]Tier 2 soil UTL was greater than the maximum grid mean, so the maximum grid mean was used to calculate intake.

Bold = Hazard quotients>1.

Table A4.2.7
PMJM Receptor Hazard Quotients for Surface Soils in LWOEU - Chromium

Patch/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day) Chromium VI NOAEL	Chromium VI LOAEL	Chromium III NOAEL	Chromium III LOAEL	Hazard Quotients Chromium VI NOAEL	Chromium VI LOAEL	Chromium III NOAEL	Chromium III LOAEL
Chromium (Default Exposure)									
Patch 22									
MDC	3.87	3.28	13.14	2737	N/A	1	0.3	0.001	N/A
UTL[a]	3.86	3.28	13.14	2737	N/A	1	0.3	0.001	N/A
UCL[a]	3.86	3.28	13.14	2737	N/A	1	0.3	0.001	N/A
Mean	3.51	3.28	13.14	2737	N/A	1	0.3	0.001	N/A
Patch 23									
MDC	4.92	3.28	13.14	2737	N/A	1	0.4	0.002	N/A
UTL[a]	4.91	3.28	13.14	2737	N/A	1	0.4	0.002	N/A
UCL	3.68	3.28	13.14	2737	N/A	1	0.3	0.001	N/A
Mean	3.44	3.28	13.14	2737	N/A	1	0.3	0.001	N/A

[a] Soil UTL and/or UCL was greater than the MDC or could not be calculated due to low numbers of samples, so the MDC was used as a proxy value to calculate intake.

NA = Not applicable

Bold = Hazard quotients>1.

Table A4.2.8
Intake and Exposure Estimates for Copper - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
$\ln Cp = 0.669 + 0.394(\ln Cs)$	$\ln Ci = 1.675 + 0.264(\ln Cs)$	$\ln Csm = 2.042 + .1444(\ln Cs)$				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
30	Tier 1 UTL	7.46	13.10	12.59	0.007	
22.6	Tier 1 UCL	6.67	12.16	12.09	0.005	
36.2	Tier 2 UTL[a]	8.03	13.77	12.94	0.007	
18.3	Tier 2 UCL	6.14	11.50	11.73	0.005	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	**$IR_{(water)}$ (kg/kg BW day)**	**$IR_{(soil)}$ (kg/kg BW day)**	**P_{plant}**	**P_{invert}**	**P_{mammal}**
Mourning Dove - Hervibore	0.23	0.12	0.021	1	0	0
Mourning Dove - Insectivore	0.23	0.12	0.021	0	1	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Mourning Dove - Herbivore						
Tier 1 UTL	1.71	N/A	N/A	0.642	8.40E-04	2.36
Tier 1 UCL	1.53	N/A	N/A	0.483	6.00E-04	2.02
Tier 2 UTL[a]	1.85	N/A	N/A	0.774	8.40E-04	2.62
Tier 2 UCL	1.41	N/A	N/A	0.391	6.00E-04	1.80
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	3.01	N/A	0.642	8.40E-04	3.66
Tier 1 UCL	N/A	2.80	N/A	0.483	6.00E-04	3.28
Tier 2 UTL[a]	N/A	3.17	N/A	0.774	8.40E-04	3.94
Tier 2 UCL	N/A	2.65	N/A	0.391	6.00E-04	3.04

[a]Tier 2 soil UTL was greater than the maximum grid mean, so the maximum grid mean was used to calculate intake.
NA = Not applicable

Table A4.2.9
PMJM Intake Estimates for Copper - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
$\ln Cp = 0.669 + 0.394(\ln Cs)$	$\ln Ci = 1.675 + 0.264(\ln Cs)$	$Csm = 2.042 + .1444(\ln Cs)$				
Media Concentrations (mg/kg)						
Patch	**Soil Concentration**	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**
23	170	MDC	14.8	20.7	N/A	0.903
23	64.3	UTL	10.1	16.0	N/A	0.57
23	29	UCL	7.4	13.0	N/A	0.162
23	21.8	Mean	6.6	12.0	N/A	0.131
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	**$IR_{(water)}$ (kg/kg BW day)**	**$IR_{(soil)}$ (kg/kg BW day)**	**P_{plant}**	**P_{invert}**	**P_{mammal}**
PMJM	0.17	0.15	0.004	0.7	0.3	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Patch 23						
MDC	1.76	1.06	N/A	0.694	0.135	3.64
UTL	1.20	0.817	N/A	0.262	0.0855	2.36
UCL	0.876	0.662	N/A	0.118	0.0243	1.68
Mean	0.782	0.614	N/A	0.0889	0.0197	1.51

NA = Not applicable or not available.

Table A4.2.10
Non-PMJM Receptor Hazard Quotients for Surface Soils in the LWOEU - Copper

Receptor/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)		Hazard Quotients	
		NOAEL	LOAEL	NOAEL	LOAEL
Copper (Default Exposure)					
Mourning Dove - Herbivore					
Tier 1 UTL	2.36	2.3	52.3	1	0.05
Tier 1 UCL	2.02	2.3	52.3	1	0.04
Tier 2 UTL[a]	2.62	2.3	52.3	1	0.05
Tier 2 UCL	1.80	2.3	52.3	1	0.03
Mourning Dove - Insectivore					
Tier 1 UTL	3.66	2.3	52.3	**2**	0.1
Tier 1 UCL	3.28	2.3	52.3	1	0.1
Tier 2 UTL[a]	3.94	2.3	52.3	**2**	0.1
Tier 2 UCL	3.04	2.3	52.3	1	0.1

[a]Tier 2 soil UTL was greater than the maximum grid mean, so the maximum grid mean was used to calculate intake.
NA = Not applicable
Bold = Hazard quotients>1.

Table A4.2.11
PMJM Hazard Quotients for Surface Soils in LWOEU: Copper

Patch/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)		Hazard Quotients	
		NOAEL	LOAEL	NOAEL	LOAEL
Copper (Default Exposure)					
Patch 23					
MDC	3.64	2.67	631.6	1	0.01
UTL	2.36	2.67	631.6	0.9	0.004
UCL	1.68	2.67	631.6	0.6	0.003
Mean	1.51	2.67	631.6	0.6	0.002

Table A4.2.12
Intake and Exposure Estimates for Manganese - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.234	$\ln Ci = 0.809 + 0.682(\ln Cs)$	0.037				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
636	Tier 1 UTL	149	183	23.5	0.570	
408	Tier 1 UCL	95.5	135	15.1	0.162	
636	Tier 2 UTL[a]	149	183	23.5	0.570	
379	Tier 2 UCL	88.7	129	14.0	0.162	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	**$IR_{(water)}$** (kg/kg BW day)	**$IR_{(soil)}$** (kg/kg BW day)	**P_{plant}**	**P_{invert}**	**P_{mammal}**
Deer Mouse - Herbivore	0.111	0.190	0.00222	1	0	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Iammal Tissu**	**Soil**	**Surface Water**	**Total**
Deer Mouse - Herbivore						
Tier 1 UTL	16.5	N/A	N/A	1.41	0.108	18.0
Tier 1 UCL	10.6	N/A	N/A	0.906	0.0308	11.5
Tier 2 UTL[a]	16.5	N/A	N/A	1.41	0.108	18.0
Tier 2 UCL	9.84	N/A	N/A	0.841	0.0308	10.7

[a]Tier 2 soil UTL was greater than the maximum grid mean, so the maximum grid mean was used to calculate intake.
N/A = Not applicable

Table A4.2.13
PMJM Receptor Intake and Exposure Estimates for Manganese - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.234	lnCi = 0.809 + 0.682(lnCs)	0.037				
Media Concentrations (mg/kg)						
Patch	**Soil Concentration**	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**
22	460	MDC	108	147	17.0	0.903
22	460	UTL[a]	108	147	17.0	0.570
22	460	UCL[a]	108	147	17.0	0.162
22	395	Mean	92.4	133	14.6	0.131
23	1200	MDC	281	283	44.4	0.903
23	764	UTL	179	208	28.3	0.570
23	475	UCL	111	150	17.6	0.162
23	420	Mean	98.3	138	15.5	0.131
27	596	MDC	139	175	22.1	0.903
27	596	UTL[a]	139	175	22.1	0.570
27	596	UCL[a]	139	175	22.1	0.162
27	463	Mean	108	148	17.1	0.131
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	**$IR_{(water)}$ (kg/kg BW day)**	**$IR_{(soil)}$ (kg/kg BW day)**	**P_{plant}**	**P_{invert}**	**P_{mammal}**
PMJM	0.17	0.15	0.004	0.7	0.3	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Patch 22						
MDC	12.8	7.50	N/A	1.88	0.135	22.3
UTL[a]	12.8	7.50	N/A	1.88	0.0855	22.3
UCL[a]	12.8	7.50	N/A	1.88	0.0243	22.2
Mean	11.0	6.76	N/A	1.61	0.0197	19.4
Patch 23						
MDC	33.4	14.4	N/A	4.90	0.135	52.9
UTL	21.3	10.6	N/A	3.12	0.0855	35.1
UCL	13.2	7.66	N/A	1.94	0.0243	22.9
Mean	11.7	7.05	N/A	1.71	0.0197	20.5
Patch 27						
MDC	16.6	8.95	N/A	2.43	0.135	28.1
UTL[a]	16.6	8.95	N/A	2.43	0.0855	28.1
UCL[a]	16.6	8.95	N/A	2.43	0.0243	28.0
Mean	12.9	7.53	N/A	1.89	0.0197	22.3

[a] Soil UTL and/or UCL was greater than the MDC or could not be calculated due to low numbers of samples, so the MDC was used as a proxy value to calculate intake.
NA = Not applicable or not available

Table A4.2.14
Terrestrial Plant Hazard Quotients for Surface Soils in the LWOEU - Manganese

EPC Statistic	Concentration (mg/kg)	TRV (mg/kg)	Hazard Quotients
		Screening ESL	Screening ESL
Terrestrial Plant			
Tier 1 UTL[a]	636	500	1
Tier 1 UCL	408	500	0.8
Tier 2 UTL[a]	636	500	1
Tier 2 UCL	379	500	0.8

[a]Tier 2 soil UTL was greater than the maximum grid mean, so the maximum grid mean was used to calculate risk.

Table A4.2.15
Non-PMJM Receptor Hazard Quotients for Surface Soils in the LWOEU - Manganese

Receptor/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)		Hazard Quotients	
		NOAEL	LOAEL	NOAEL	LOAEL
Manganese (Default Exposure)					
Deer Mouse - Herbivore					
Tier 1 UTL[a]	18.0	13.7	159.1	1	0.1
Tier 1 UCL	11.5	13.7	159.1	0.8	0.07
Tier 2 UTL[a]	18.0	13.7	159.1	1	0.1
Tier 2 UCL	10.7	13.7	159.1	0.8	0.07

[a]Tier 2 soil UTL was greater than the maximum grid mean, so the maximum grid mean was used to calculate intake.
NA = Not applicable

Table A4.2.16
PMJM Receptor Hazard Quotients for Surface Soils in LWOEU - Manganese

		TRV (mg/kg BW day)		Hazard Quotients	
Patch/ EPC Statistic	**Total Intake (mg/kg BW day)**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Manganese (Default Exposure)					
Patch 22					
MDC	22.3	13.7	159.1	**2**	0.1
UTL[a]	22.3	13.7	159.1	**2**	0.1
UCL[a]	22.2	13.7	159.1	**2**	0.1
Mean	19.4	13.7	159.1	1	0.1
Patch 23					
MDC	52.9	13.7	159.1	**4**	0.3
UTL	35.1	13.7	159.1	**3**	0.2
UCL	22.9	13.7	159.1	**2**	0.1
Mean	20.5	13.7	159.1	**2**	0.1
Patch 27					
MDC	28.1	13.7	159.1	**2**	0.2
UTL[a]	28.1	13.7	159.1	**2**	0.2
UCL[a]	28.0	13.7	159.1	**2**	0.2
Mean	22.3	13.7	159.1	**2**	0.1

[a] Soil UTL and/or UCL was greater than the MDC or could not be calculated due to low numbers of samples, so the MDC was used as a proxy value to calculate intake.
NA = Not applicable or not available
Bold = Hazard quotients>1.

Table A4.2.17
Intake and Exposure Estimates for Nickel - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
lnCp = -2.224+0.748(lnCs)	4.73	lnCm = -0.2462 + 0.4658(lnCs)				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
23	Tier 1 UTL	1.13	108.8	3.37	0.01	
17	Tier 1 UCL	0.90	80.4	2.93	0.006	
23.9	Tier 2 UTL	1.16	113.0	3.43	0.01	
16.2	Tier 2 UCL	0.87	76.6	2.86	0.006	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	**$IR_{(water)}$** (kg/kg BW day)	**$IR_{(soil)}$** (kg/kg BW day)	**P_{plant}**	**P_{invert}**	**P_{mammal}**
Mourning Dove - Insectivore	0.23	0.12	0.021	0	1	0
Deer Mouse - Herbivore	0.111	0.19	0.002	1	0	0
Deer Mouse - Insectivore	0.065	0.19	0.001	0	1	0
Coyote - Generalist	0.015	0.08	0.001	0	0.25	0.75
Coyote - Insectivore	0.015	0.08	0.0004	0	1	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	25.0	N/A	0.492	0.00120	25.5
Tier 1 UCL	N/A	18.5	N/A	0.364	7.20E-04	18.9
Tier 2 UTL	N/A	26.0	N/A	0.511	0.00120	26.5
Tier 2 UCL	N/A	17.6	N/A	0.347	7.20E-04	18.0
Deer Mouse - Herbivore						
Tier 1 UTL	0.125	N/A	N/A	0.0511	0.00190	0.178
Tier 1 UCL	0.1000	N/A	N/A	0.0377	0.00114	0.139
Tier 2 UTL	0.129	N/A	N/A	0.0531	0.00190	0.184
Tier 2 UCL	0.0964	N/A	N/A	0.0360	0.00114	0.134
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	7.07	N/A	0.0299	0.00190	7.10
Tier 1 UCL	N/A	5.23	N/A	0.0221	0.00114	5.25
Tier 2 UTL	N/A	7.35	N/A	0.0311	0.00190	7.38
Tier 2 UCL	N/A	4.98	N/A	0.0211	0.00114	5.00

Table A4.2.17
Intake and Exposure Estimates for Nickel - Default Exposure Scenario

Coyote - Generalist						
Tier 1 UTL	N/A	0.408	0.0379	0.0173	8.00E-04	0.464
Tier 1 UCL	N/A	0.302	0.0329	0.0128	4.80E-04	0.348
Tier 2 UTL	N/A	0.424	0.0386	0.0179	8.00E-04	0.481
Tier 2 UCL	N/A	0.287	0.0322	0.0122	4.80E-04	0.332
Coyote - Insectivore						
Tier 1 UTL	N/A	1.63	N/A	0.00966	8.00E-04	1.64
Tier 1 UCL	N/A	1.21	N/A	0.00714	4.80E-04	1.21
Tier 2 UTL	N/A	1.70	N/A	0.0100	8.00E-04	1.71
Tier 2 UCL	N/A	1.15	N/A	0.00680	4.80E-04	1.16

NA = Not applicable

Table A4.2.18
Intake and Exposure Estimates for Nickel - Alternative Exposure Scenario

Bioaccumulation Factors (Median Values)						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
$\ln Cp = -2.224+0.748(\ln Cs)$	1.059	$\ln Cm = -0.2462 + 0.4658(\ln Cs)$				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
23	Tier 1 UTL	1.13	24.4	3.37	0.01	
17	Tier 1 UCL	0.90	18.0	2.93	0.006	
23.9	Tier 2 UTL	1.16	25.3	3.43	0.01	
16.2	Tier 2 UCL	0.87	17.2	2.86	0.006	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	**$IR_{(water)}$ (kg/kg BW day)**	**$IR_{(soil)}$ (kg/kg BW day)**	**P_{plant}**	**P_{invert}**	**P_{mammal}**
Deer Mouse - Insectivore	0.065	0.19	0.001	0	1	0
Intake Estimates						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	1.58	N/A	0.0299	0.00190	1.62
Tier 1 UCL	N/A	1.17	N/A	0.0221	0.00114	1.19
Tier 2 UTL	N/A	1.65	N/A	0.0311	0.00190	1.68
Tier 2 UCL	N/A	1.12	N/A	0.0211	0.00114	1.14

NA = Not applicable

Table A4.2.19
PMJM Receptor Intake and Exposure Estimates for Nickel - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
lnCp = -2.224+0.748(lnCs)	4.73	lnCm = -0.2462 + 0.4658(lnCs)				
Media Concentrations (mg/kg)						
Patch	**Soil Concentration**	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**
22	19	MDC	0.98	89.9	3.08	0.02
22	19	UTL[a]	0.98	89.9	3.08	0.01
22	19	UCL[a]	0.98	89.9	3.08	0.006
22	18.5	Mean	0.96	87.5	3.04	0.004
23	25	MDC	1.20	118.3	3.50	0.02
23	23.3	UTL	1.14	110.2	3.39	0.01
23	17.9	UCL	0.94	84.7	3.00	0.006
23	16.9	Mean	0.90	79.9	2.92	0.004
24	15	MDC	0.82	71.0	2.76	0.02
24	15	UTL[a]	0.82	71.0	2.76	0.01
24	15	UCL[a]	0.82	71.0	2.76	0.006
24	15	Mean[a]	0.82	71.0	2.76	0.004
25	13.4	MDC	0.75	63.4	2.62	0.02
25	13.4	UTL[a]	0.75	63.4	2.62	0.01
25	13.4	UCL[a]	0.75	63.4	2.62	0.006
25	13.4	Meana	0.75	63.4	2.62	0.004
27	45.2	MDC	1.87	213.8	4.61	0.02
27	45.2	UTL[a]	1.87	213.8	4.61	0.01
27	45.2	UCL[a]	1.87	213.8	4.61	0.006
27	27.65	Mean	1.30	130.8	3.67	0.004
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	**$IR_{(water)}$** (kg/kg BW day)	**$IR_{(soil)}$** (kg/kg BW day)	**P_{plant}**	**P_{invert}**	**P_{mammal}**
PMJM	0.17	0.15	0.004	0.7	0.3	0

Table A4.2.19
PMJM Receptor Intake and Exposure Estimates for Nickel - Default Exposure Scenario

Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Patch 22						
MDC	0.116	4.58	N/A	0.0775	0.00300	4.78
UTL[a]	0.116	4.58	N/A	0.0775	0.00150	4.78
UCL[a]	0.116	4.58	N/A	0.0775	9.00E-04	4.78
Mean	0.114	4.46	N/A	0.0755	6.00E-04	4.65
Patch 23						
MDC	0.143	6.03	N/A	0.102	0.00300	6.28
UTL	0.136	5.62	N/A	0.0951	0.00150	5.85
UCL	0.111	4.32	N/A	0.0730	9.00E-04	4.50
Mean	0.107	4.08	N/A	0.0690	6.00E-04	4.25
Patch 24						
MDC	0.0976	3.62	N/A	0.0612	0.00300	3.78
UTL[a]	0.0976	3.62	N/A	0.0612	0.00150	3.78
UCL[a]	0.0976	3.62	N/A	0.0612	9.00E-04	3.78
Mean[a]	0.0976	3.62	N/A	0.0612	6.00E-04	3.78
Patch 25						
MDC	0.0897	3.23	N/A	0.0547	0.00300	3.38
UTL[a]	0.0897	3.23	N/A	0.0547	0.00150	3.38
UCL[a]	0.0897	3.23	N/A	0.0547	9.00E-04	3.38
Mean	0.0897	3.23	N/A	0.0547	6.00E-04	3.38
Patch 27						
MDC	0.223	10.9	N/A	0.184	0.00300	11.3
UTL[a]	0.223	10.9	N/A	0.184	0.00150	11.3
UCL[a]	0.223	10.9	N/A	0.184	9.00E-04	11.3
Mean	0.154	6.67	N/A	0.113	6.00E-04	6.94

[a] Soil UTL and/or UCL was greater than the MDC or could not be calculated due to low numbers of samples, so the MDC was used as a proxy value to calculate intake.
NA = Not applicable or not available

Table A4.2.20
PMJM Intake Estimates for Nickel - Alternative Exposure Scenario

Bioaccumulation Factors (Median Values)						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
lnCp = -2.224+0.748(lnCs)	1.059	lnCm = -0.2462 + 0.4658(lnCs)				
Media Concentrations (mg/kg)						
Patch	**Soil Concentration**	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**
22	19	MDC	0.98	20.1	3.08	0.02
22	19	UTL[a]	0.98	20.1	3.08	0.01
22	19	UCL[a]	0.98	20.1	3.08	0.006
22	18.5	Mean	0.96	19.6	3.04	0.004
23	25	MDC	1.20	26.5	3.50	0.02
23	23.3	UTL	1.14	24.7	3.39	0.01
23	17.9	UCL	0.94	19.0	3.00	0.006
23	16.9	Mean	0.90	17.9	2.92	0.004
24	15	MDC	0.82	15.9	2.76	0.02
24	15	UTL[a]	0.82	15.9	2.76	0.01
24	15	UCL[a]	0.82	15.9	2.76	0.006
24	15	Mean[a]	0.82	15.9	2.76	0.004
25	13.4	MDC	0.75	14.2	2.62	0.02
25	13.4	UTL[a]	0.75	14.2	2.62	0.01
25	13.4	UCL[a]	0.75	14.2	2.62	0.006
25	13.4	Mean[a]	0.75	14.2	2.62	0.004
27	45.2	MDC	1.87	47.9	4.61	0.02
27	45.2	UTL[a]	1.87	47.9	4.61	0.01
27	45.2	UCL[a]	1.87	47.9	4.61	0.006
27	27.65	Mean	1.30	29.3	3.67	0.004
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	**$IR_{(water)}$** (kg/kg BW day)	**$IR_{(soil)}$** (kg/kg BW day)	**P_{plant}**	**P_{invert}**	**P_{mammal}**
PMJM	0.17	0.15	0.004	0.7	0.3	0

Table A4.2.20
PMJM Intake Estimates for Nickel - Alternative Exposure Scenario

	Intake Estimates (mg/kg BW day)					
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Patch 22						
MDC	0.116	1.03	N/A	0.0775	0.00300	1.22
UTL[a]	0.116	1.03	N/A	0.0775	0.00150	1.22
UCL[a]	0.116	1.03	N/A	0.0775	9.00E-04	1.22
Mean	0.114	0.999	N/A	0.0755	6.00E-04	1.19
Patch 23						
MDC	0.143	1.35	N/A	0.102	0.00300	1.60
UTL	0.136	1.26	N/A	0.0951	0.00150	1.49
UCL	0.111	0.967	N/A	0.0730	9.00E-04	1.15
Mean	0.107	0.913	N/A	0.0690	6.00E-04	1.09
Patch 24						
MDC	0.0976	0.810	N/A	0.0612	0.00300	0.972
UTL[a]	0.0976	0.810	N/A	0.0612	0.00150	0.970
UCL[a]	0.0976	0.810	N/A	0.0612	9.00E-04	0.970
Mean[a]	0.0976	0.810	N/A	0.0612	6.00E-04	0.970
Patch 25						
MDC	0.0897	0.724	N/A	0.0547	0.00300	0.871
UTL[a]	0.0897	0.724	N/A	0.0547	0.00150	0.870
UCL[a]	0.0897	0.724	N/A	0.0547	9.00E-04	0.869
Mean	0.0897	0.724	N/A	0.0547	6.00E-04	0.869
Patch 27						
MDC	0.223	2.44	N/A	0.184	0.00300	2.85
UTL[a]	0.223	2.44	N/A	0.184	0.00150	2.85
UCL[a]	0.223	2.44	N/A	0.184	9.00E-04	2.85
Mean	0.154	1.49	N/A	0.113	6.00E-04	1.76

[a] Soil UTL and/or UCL was greater than the MDC or could not be calculated due to low numbers of samples, so the MDC was used as a proxy value to calculate intake.
NA = Not applicable or not available.

Table A4.2.21
Non-PMJM Receptor Hazard Quotients for Surface Soils in the LWOEU - Nickel

Receptor/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)				Hazard Quotients			
		NOAEL	LOAEL	Sample et al. (1996) NOAEL	Sample et al. (1996) LOAEL	NOAEL	LOAEL	Sample et al. (1996) NOAEL	Sample et al. (1996) LOAEL
Nickel (Default Exposure)									
Mourning Dove - Insectivore									
Tier 1 UTL	25.5	1.38	55.26	77.4	107	**18**	0.5	0.3	0.01
Tier 1 UCL	18.9	1.38	55.26	77.4	107	**14**	0.3	0.2	0.01
Tier 2 UTL	26.5	1.38	55.26	77.4	107	**19**	0.5	0.3	0.01
Tier 2 UCL	18.0	1.38	55.26	77.4	107	**13**	0.3	0.2	0.01
Deer Mouse - Herbivore									
Tier 1 UTL	0.178	0.133	1.33	40	80	1	0.1	0.004	0.002
Tier 1 UCL	0.139	0.133	1.33	40	80	1	0.1	0.003	0.002
Tier 2 UTL	0.184	0.133	1.33	40	80	1	0.1	0.005	0.002
Tier 2 UCL	0.134	0.133	1.33	40	80	1	0.1	0.003	0.002
Deer Mouse - Insectivore									
Tier 1 UTL	7.10	0.133	1.33	40	80	**53**	**5**	0.2	0.09
Tier 1 UCL	5.25	0.133	1.33	40	80	**39**	**4**	0.1	0.07
Tier 2 UTL	7.38	0.133	1.33	40	80	**55**	**6**	0.2	0.09
Tier 2 UCL	5.00	0.133	1.33	40	80	**38**	**4**	0.1	0.06
Coyote - Generalist									
Tier 1 UTL	0.464	0.133	1.33	40	80	**3**	0.3	0.01	0.01
Tier 1 UCL	0.348	0.133	1.33	40	80	**3**	0.3	0.01	0.004
Tier 2 UTL	0.481	0.133	1.33	40	80	**4**	0.4	0.01	0.006
Tier 2 UCL	0.332	0.133	1.33	40	80	**2**	0.2	0.01	0.004
Coyote - Insectivore									
Tier 1 UTL	1.64	0.133	1.33	40	80	**12**	1	0.04	0.02
Tier 1 UCL	1.21	0.133	1.33	40	80	**9**	0.9	0.03	0.02
Tier 2 UTL	1.71	0.133	1.33	40	80	**13**	1	0.04	0.02
Tier 2 UCL	1.16	0.133	1.33	40	80	**9**	0.9	0.03	0.01
Nickel (Alternative Exposure Scenario; Median BAFs)									
Deer Mouse - Insectivore									
Tier 1 UTL	1.62	0.133	1.33	40	80	**12**	1	0.04	0.02
Tier 1 UCL	1.19	0.133	1.33	40	80	**9**	1	0.03	0.01
Tier 2 UTL	1.68	0.133	1.33	40	80	**13**	1	0.04	0.02
Tier 2 UCL	1.14	0.133	1.33	40	80	**9**	1	0.03	0.01

N/A = Not applicable or not available.
Bold = Hazard quotients>1.

Table A4.2.22
PMJM Receptor Hazard Quotients for Surface Soils in LWOEU - Nickel

Patch/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)				Hazard Quotients			
		NOAEL	LOAEL	Sample et al. (1996) NOAEL	Sample et al. (1996) LOAEL	NOAEL	LOAEL	Sample et al. (1996) NOAEL	Sample et al. (1996) LOAEL
Nickel (Default Exposure)									
Patch 22									
MDC	4.78	0.133	1.33	40	80	**36**	**4**	0.1	0.06
UTL[a]	4.78	0.133	1.33	40	80	**36**	**4**	0.1	0.06
UCL[a]	4.78	0.133	1.33	40	80	**36**	**4**	0.1	0.06
Mean	4.65	0.133	1.33	40	80	**35**	**3**	0.1	0.06
Patch 23									
MDC	6.28	0.133	1.33	40	80	**47**	**5**	0.2	0.08
UTL	5.85	0.133	1.33	40	80	**44**	**4**	0.1	0.07
UCL	4.50	0.133	1.33	40	80	**34**	**3**	0.1	0.06
Mean	4.25	0.133	1.33	40	80	**32**	**3**	0.1	0.05
Patch 24									
MDC	3.78	0.133	1.33	40	80	**28**	**3**	0.09	0.05
UTL[a]	3.78	0.133	1.33	40	80	**28**	**3**	0.09	0.05
UCL[a]	3.78	0.133	1.33	40	80	**28**	**3**	0.09	0.05
Mean[a]	3.78	0.133	1.33	40	80	**28**	**3**	0.09	0.05
Patch 25									
MDC	3.38	0.133	1.33	40	80	**25**	**3**	0.08	0.04
UTL[a]	3.38	0.133	1.33	40	80	**25**	**3**	0.08	0.04
UCL[a]	3.38	0.133	1.33	40	80	**25**	**3**	0.08	0.04
Mean	3.38	0.133	1.33	40	80	**25**	**3**	0.08	0.04
Patch 27									
MDC	11.3	0.133	1.33	40	80	**85**	**9**	0.3	0.1
UTL[a]	11.3	0.133	1.33	40	80	**85**	**9**	0.3	0.1
UCL[a]	11.3	0.133	1.33	40	80	**85**	**9**	0.3	0.1
Mean	6.94	0.133	1.33	40	80	**52**	**5**	0.2	0.09

Table A4.2.22
PMJM Receptor Hazard Quotients for Surface Soils in LWOEU - Nickel

Patch/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)				Hazard Quotients			
		NOAEL	LOAEL	Sample et al. (1996) NOAEL	Sample et al. (1996) LOAEL	NOAEL	LOAEL	Sample et al. (1996) NOAEL	Sample et al. (1996) LOAEL
Nickel (Alternative Exposure Scenario; Median BAFs)									
Patch 22									
MDC	1.22	0.133	1.33	40	80	**9**	0.9	0.03	0.02
UTL[a]	1.22	0.133	1.33	40	80	**9**	0.9	0.03	0.02
UCL[a]	1.22	0.133	1.33	40	80	**9**	0.9	0.03	0.02
Mean	1.19	0.133	1.33	40	80	**9**	0.9	0.03	0.01
Patch 23									
MDC	1.60	0.133	1.33	40	80	**12**	1	0.04	0.02
UTL	1.49	0.133	1.33	40	80	**11**	1	0.04	0.02
UCL	1.15	0.133	1.33	40	80	**9**	0.9	0.03	0.01
Mean	1.09	0.133	1.33	40	80	**8**	0.8	0.03	0.01
Patch 24									
MDC	0.972	0.133	1.33	40	80	**7**	0.7	0.02	0.01
UTL[a]	0.970	0.133	1.33	40	80	**7**	0.7	0.02	0.01
UCL[a]	0.970	0.133	1.33	40	80	**7**	0.7	0.02	0.01
Mean[a]	0.970	0.133	1.33	40	80	**7**	0.7	0.02	0.01
Patch 25									
MDC	0.871	0.133	1.33	40	80	**7**	0.7	0.02	0.01
UTL[a]	0.870	0.133	1.33	40	80	**7**	0.7	0.02	0.01
UCL[a]	0.869	0.133	1.33	40	80	**7**	0.7	0.02	0.01
Mean	0.869	0.133	1.33	40	80	**7**	0.7	0.02	0.01
Patch 27									
MDC	2.85	0.133	1.33	40	80	**21**	**2**	0.07	0.04
UTL[a]	2.85	0.133	1.33	40	80	**21**	**2**	0.07	0.04
UCL[a]	2.85	0.133	1.33	40	80	**21**	**2**	0.07	0.04
Mean	1.76	0.133	1.33	40	80	**13**	1	0.04	0.02

[a] Soil UTL and/or UCL was greater than the MDC or could not be calculated due to low numbers of samples, so the MDC was used as a proxy
NA = Not applicable
Bold = Hazard quotients>1.

Table A4.2.23
PMJM Receptor Intake and Exposure Estimates for Selenium - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
lnCp = -0.678 + 1.104 (ln Cs)	lnCi = -0.075 + 0.733 (ln Cs)	lnCsm = -0.4158 + 0.3764 (ln Cs)				
Media Concentrations (mg/kg)						
Patch	**Soil Concentration**	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**
23	2	MDC	1.09	1.54	0.86	0.038
23	1	UTL	0.51	0.93	0.66	0.003
23	0.6	UCL	0.29	0.64	0.54	0.004
23	0.522	Mean	0.25	0.58	0.52	0.002
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	**$IR_{(water)}$** (kg/kg BW day)	**$IR_{(soil)}$** (kg/kg BW day)	**P_{plant}**	**P_{invert}**	**P_{mammal}**
PMJM	0.17	0.15	0.004	0.7	0.3	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Patch 23						
MDC	0.130	0.0786	N/A	0.00816	0.00570	0.222
UTL	0.0604	0.0473	N/A	0.00408	4.50E-04	0.112
UCL	0.0344	0.0325	N/A	0.00245	6.00E-04	0.0700
Mean	0.0295	0.0294	N/A	0.00213	3.00E-04	0.0613

N/A = Not applicable or not available.

Table A4.2.24
PMJM Receptor Hazard Quotients for Surface Soils in LWOEU - Selenium

Patch/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)		Hazard Quotients	
		NOAEL	LOAEL	NOAEL	LOAEL
Selenium (Default Exposure)					
Patch 23					
MDC	0.222	0.05	1.21	**4**	0.2
UTL	0.112	0.05	1.21	**2**	0.09
UCL	0.0700	0.05	1.21	1	0.06
Mean	0.0613	0.05	1.21	1	0.05

Bold = Hazard quotients>1.

Table A4.2.25
Terrestrial Plant Hazard Quotients for Surface Soils in the LWOEU - Thallium

EPC Statistic	Concentration (mg/kg)	TRV (mg/kg)	Hazard Quotients
		Screening ESL	Screening ESL
Terrestrial Plant			
Tier 1 UTL	2.1	1.00	**2**
Tier 1 UCL	1.61	1.00	**2**
Tier 2 UTL[a]	1.7	1.00	**2**
Tier 2 UCL	0.779	1.00	0.8

[a]Tier 2 soil UTL was greater than the maximum grid mean, so the maximum grid mean was used to calculate risk.

Bold = Hazard quotients>1.

Table 4.2.26
Intake and Exposure Estimates for Tin - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.03	1	0.21				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
29.1	Tier 1 UTL	0.87	29.10	6.11	0.019	
15.4	Tier 1 UCL	0.46	15.40	3.23	0.009	
38.5	Tier 2 UTL[a]	1.16	38.50	8.09	0.019	
19.9	Tier 2 UCL	0.60	19.90	4.18	0.009	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	**$IR_{(water)}$** (kg/kg BW day)	**$IR_{(soil)}$** (kg/kg BW day)	**P_{plant}**	**P_{invert}**	**P_{mammal}**
Mourning Dove - Hervibore	0.23	0.12	0.021	1	0	0
Mourning Dove - Insectivore	0.23	0.12	0.021	0	1	0
American Kestrel	0.092	0.12	0.005	0	0.2	0.8
Deer Mouse - Insectivore	0.065	0.19	0.001	0	1	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Mourning Dove - Herbivore						
Tier 1 UTL	0.201	N/A	N/A	0.622	0.00233	0.826
Tier 1 UCL	0.106	N/A	N/A	0.329	0.00113	0.437
Tier 2 UTL[a]	0.266	N/A	N/A	0.824	0.00233	1.09
Tier 2 UCL	0.137	N/A	N/A	0.426	0.00113	0.564
Mourning Dove - Insectivore						
Tier 1 UTL	N/A	6.69	N/A	0.622	0.00233	7.32
Tier 1 UCL	N/A	3.54	N/A	0.329	0.00113	3.87
Tier 2 UTL[a]	N/A	8.86	N/A	0.824	0.00233	9.68
Tier 2 UCL	N/A	4.58	N/A	0.426	0.00113	5.00
American Kestrel						
Tier 1 UTL	N/A	0.535	0.450	0.134	0.00233	1.12
Tier 1 UCL	N/A	0.283	0.238	0.0708	0.00113	0.593
Tier 2 UTL[a]	N/A	0.708	0.595	0.177	0.00233	1.48
Tier 2 UCL	N/A	0.366	0.308	0.0915	0.00113	0.766
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	1.89	N/A	0.0378	0.00370	1.93
Tier 1 UCL	N/A	1.00	N/A	0.0200	0.00179	1.02
Tier 2 UTL[a]	N/A	2.50	N/A	0.0501	0.00370	2.56
Tier 2 UCL	N/A	1.29	N/A	0.0259	0.00179	1.32

[a]Tier 2 soil UTL was greater than the maximum grid mean, so the maximum grid mean was used to calculate intake.
N/A = Not applicable

Table A4.2.27
PMJM Receptor Intake and Exposure Estimates for Tin - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.03	1	0.21				
Media Concentrations (mg/kg)						
Patch	**Soil Concentration**	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**
23	32.7	MDC	1.0	32.7	6.9	0.025
23	11	UTL	0.3	11.0	2.3	0.019
23	3.6	UCL	0.1	3.6	0.8	0.009
23	2.24	Mean	0.1	2.2	0.5	0.006
25	25.5	MDC	0.8	25.5	5.4	0.025
25	25.5	UTL[a]	0.8	25.5	5.4	0.019
25	25.5	UCL[a]	0.8	25.5	5.4	0.009
25	25.5	Mean[a]	0.8	25.5	5.4	0.006
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	**$IR_{(water)}$** (kg/kg BW day)	**$IR_{(soil)}$** (kg/kg BW day)	**P_{plant}**	**P_{invert}**	**P_{mammal}**
PMJM	0.17	0.15	0.004	0.7	0.3	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Patch 23						
MDC	0.117	1.67	N/A	0.133	0.00375	1.92
UTL	0.0393	0.561	N/A	0.0449	0.00285	0.648
UCL	0.0129	0.184	N/A	0.0147	0.00135	0.212
Mean	0.00800	0.114	N/A	0.00914	9.00E-04	0.132
Patch 25						
MDC	0.0910	1.30	N/A	0.104	0.00375	1.50
UTL[a]	0.0910	1.30	N/A	0.104	0.00285	1.50
UCL[a]	0.0910	1.30	N/A	0.104	0.00135	1.50
Mean[a]	0.0910	1.30	N/A	0.104	9.00E-04	1.50

[a] Soil UTL and/or UCL was greater than the MDC or could not be calculated due to low numbers of samples, so the MDC was used as a proxy value to calculate intake.
N/A = Not applicable or not available

Table A4.2.28
Non-PMJM Receptor Hazard Quotients for Surface Soils in the LWOEU - Tin

Receptor/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)		Hazard Quotients	
		NOAEL	LOAEL	NOAEL	LOAEL
Tin (Default Exposure)					
Mourning Dove - Herbivore					
Tier 1 UTL	0.826	0.73	18.34	1	0.05
Tier 1 UCL	0.437	0.73	18.34	0.6	0.02
Tier 2 UTL[a]	1.09	0.73	18.34	1	0.06
Tier 2 UCL	0.564	0.73	18.34	0.8	0.03
Mourning Dove - Insectivore					
Tier 1 UTL	7.32	0.73	18.34	**10**	0.4
Tier 1 UCL	3.87	0.73	18.34	**5**	0.2
Tier 2 UTL[a]	9.68	0.73	18.34	**13**	0.5
Tier 2 UCL	5.00	0.73	18.34	**7**	0.3
American Kestrel					
Tier 1 UTL	1.12	0.73	18.34	**2**	0.06
Tier 1 UCL	0.593	0.73	18.34	0.8	0.03
Tier 2 UTL[a]	1.48	0.73	18.34	**2**	0.08
Tier 2 UCL	0.766	0.73	18.34	1	0.04
Deer Mouse - Insectivore					
Tier 1 UTL	1.93	0.25	15	**8**	0.1
Tier 1 UCL	1.02	0.25	15	**4**	0.07
Tier 2 UTL[a]	2.56	0.25	15	**10**	0.2
Tier 2 UCL	1.32	0.25	15	**5**	0.09

[a]Tier 2 soil UTL was greater than the maximum grid mean, so the maximum grid mean was used to calculate intake.

Bold = Hazard quotients>1.

Table A4.2.29
PMJM Receptor Hazard Quotients for Surface Soils in LWOEU - Tin

Patch/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)		Hazard Quotients	
		NOAEL	LOAEL	NOAEL	LOAEL
Tin (Default Exposure)					
Patch 23					
MDC	1.92	0.25	15	**8**	0.13
UTL	0.648	0.25	15	**3**	0.04
UCL	0.212	0.25	15	0.8	0.01
Mean	0.132	0.25	15	0.5	0.01
Patch 25					
MDC	1.50	0.25	15	**6**	0.1
UTL[a]	1.50	0.25	15	**6**	0.1
UCL[a]	1.50	0.25	15	**6**	0.1
Mean[a]	1.50	0.25	15	**6**	0.1

[a] Soil UTL and/or UCL was greater than the MDC or could not be calculated due to low numbers of samples, so the MDC was used as a proxy value to calculate intake.
Bold = Hazard quotients>1.

Table A4.2.30
Intake and Exposure Estimates for Vanadium - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.0097	0.088	0.0131				
Media Concentrations (mg/kg)						
Soil Concentration	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**	
58.4	Tier 1 UTL	0.57	5.1	0.77	0.008	
41.8	Tier 1 UCL	0.41	3.7	0.55	0.006	
71	Tier 2 UTL[a]	0.69	6.2	0.93	0.008	
41.4	Tier 2 UCL	0.40	3.6	0.54	0.006	
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	**$IR_{(water)}$ (kg/kg BW day)**	**$IR_{(soil)}$ (kg/kg BW day)**	**P_{plant}**	**P_{invert}**	**P_{mammal}**
Deer Mouse - Insectivore	0.065	0.19	0.001	0	1	0
Intake Estimates (mg/kg BW day)						
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Deer Mouse - Insectivore						
Tier 1 UTL	N/A	0.334	N/A	0.0759	0.00152	0.411
Tier 1 UCL	N/A	0.239	N/A	0.0543	0.00114	0.295
Tier 2 UTL[a]	N/A	0.406	N/A	0.0923	0.00152	0.500
Tier 2 UCL	N/A	0.237	N/A	0.0538	0.00114	0.292

[a]Tier 2 soil UTL was greater than the maximum grid mean, so the maximum grid mean was used to calculate intake.
N/A = Not applicable or not available.

Table A4.2.31
PMJM Receptor Intake and Exposure Estimates for Vanadium - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
0.0097	0.088	0.0131				
Media Concentrations (mg/kg)						
Patch	**Soil Concentration**	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**
22	49	MDC	0.5	4.3	0.6	0.073
22	49	UTL[a]	0.5	4.3	0.6	0.008
22	49	UCL[a]	0.5	4.3	0.6	0.006
22	46.5	Mean	0.5	4.1	0.6	0.003
23	59	MDC	0.6	5.2	0.8	0.073
23	58.9	UTL	0.6	5.2	0.8	0.008
23	45.5	UCL	0.4	4.0	0.6	0.006
23	43	Mean	0.4	3.8	0.6	0.003
24	45	MDC	0.4	4.0	0.6	0.073
24	45	UTL[a]	0.4	4.0	0.6	0.008
24	45	UCL[a]	0.4	4.0	0.6	0.006
24	45	Mean[a]	0.4	4.0	0.6	0.003
25	35.1	MDC	0.3	3.1	0.5	0.073
25	35.1	UTL[a]	0.3	3.1	0.5	0.008
25	35.1	UCL[a]	0.3	3.1	0.5	0.006
25	35.1	Mean[a]	0.3	3.1	0.5	0.003
27	33.8	MDC	0.3	3.0	0.4	0.073
27	33.8	UTL[a]	0.3	3.0	0.4	0.008
27	33.8	UCL[a]	0.3	3.0	0.4	0.006
27	29.8	Mean	0.3	2.6	0.4	0.003
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	**$IR_{(water)}$** (kg/kg BW day)	**$IR_{(soil)}$** (kg/kg BW day)	**P_{plant}**	**P_{invert}**	**P_{mammal}**
PMJM	0.17	0.15	0.004	0.7	0.3	0

Table A4.2.31
PMJM Receptor Intake and Exposure Estimates for Vanadium - Default Exposure Scenario

	Intake Estimates (mg/kg BW day)					
	Plant Tissue	Invertebrate Tissue	Mammal Tissue	Soil	Surface Water	Total
Patch 22						
MDC	0.0566	0.220	N/A	0.200	0.0110	0.487
UTL[a]	0.0566	0.220	N/A	0.200	0.00120	0.478
UCL[a]	0.0566	0.220	N/A	0.200	9.00E-04	0.477
Mean	0.0537	0.209	N/A	0.190	4.50E-04	0.453
Patch 23						
MDC	0.0681	0.265	N/A	0.241	0.0110	0.585
UTL	0.0680	0.264	N/A	0.240	0.00120	0.574
UCL	0.0525	0.204	N/A	0.186	9.00E-04	0.443
Mean	0.0496	0.193	N/A	0.175	4.50E-04	0.419
Patch 24						
MDC	0.0519	0.202	N/A	0.184	0.0110	0.448
UTL[a]	0.0519	0.202	N/A	0.184	0.00120	0.439
UCL[a]	0.0519	0.202	N/A	0.184	9.00E-04	0.438
Mean[a]	0.0519	0.202	N/A	0.184	4.50E-04	0.438
Patch 25						
MDC	0.0405	0.158	N/A	0.143	0.0110	0.352
UTL[a]	0.0405	0.158	N/A	0.143	0.00120	0.342
UCL[a]	0.0405	0.158	N/A	0.143	9.00E-04	0.342
Mean[a]	0.0405	0.158	N/A	0.143	4.50E-04	0.342
Patch 27						
MDC	0.0390	0.152	N/A	0.138	0.0110	0.340
UTL[a]	0.0390	0.152	N/A	0.138	0.00120	0.330
UCL[a]	0.0390	0.152	N/A	0.138	9.00E-04	0.330
Mean	0.0344	0.134	N/A	0.122	4.50E-04	0.290

[a] Soil UTL and/or UCL was greater than the MDC or could not be calculated due to low numbers of samples, so the MDC was used as a proxy value to calculate
N/A = Not applicable or not available

Table A4.2.32
Terrestrial Plant Hazard Quotients for Surface Soils in the LWOEU - Vanadium

EPC Statistic	Concentration (mg/kg)	TRV (mg/kg)		Hazard Quotients	
		Screening ESL	Alternate LOEC	Screening ESL	Alternate LOEC
Terrestrial Plant					
Tier 1 UTL	58.4	2	50	**29**	1
Tier 1 UCL	41.8	2	50	**21**	0.8
Tier 2 UTL[a]	71	2	50	**36**	1
Tier 2 UCL	41.4	2	50	**21**	0.8

[a]Tier 2 soil UTL was greater than the maximum grid mean, so the maximum grid mean was used to calculate risk.
Bold = Hazard quotients>1.

Table A4.2.33
Non-PMJM Receptor Hazard Quotients for Surface Soils in the LWOEU - Vanadium

Receptor/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)		Hazard Quotients	
		NOAEL	LOAEL	NOAEL	LOAEL
Vanadium (Default Exposure)					
Deer Mouse - Insectivore					
Tier 1 UTL	0.411	0.21	2.1	**2**	0.2
Tier 1 UCL	0.295	0.21	2.1	1	0.1
Tier 2 UTL[a]	0.500	0.21	2.1	**2**	0.2
Tier 2 UCL	0.292	0.21	2.1	1	0.1

[a]Tier 2 soil UTL was greater than the maximum grid mean, so the maximum grid mean was used to calculate intake.
Bold = Hazard quotients>1.

Table A4.2.34
PMJM Receptor Hazard Quotients for Surface Soils in LWOEU - Vanadium

Patch/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg)		Hazard Quotients	
		NOAEL	LOAEL	NOAEL	LOAEL
Vanadium (Default Exposure)					
Patch 22					
MDC	0.487	0.21	2.1	**2**	0.2
UTL[a]	0.478	0.21	2.1	**2**	0.2
UCL[a]	0.477	0.21	2.1	**2**	0.2
Mean	0.453	0.21	2.1	**2**	0.2
Patch 23					
MDC	0.585	0.21	2.1	**3**	0.3
UTL	0.574	0.21	2.1	**3**	0.3
UCL	0.443	0.21	2.1	**2**	0.2
Mean	0.419	0.21	2.1	**2**	0.2
Patch 24					
MDC	0.448	0.21	2.1	**2**	0.2
UTL[a]	0.439	0.21	2.1	**2**	0.2
UCL[a]	0.438	0.21	2.1	**2**	0.2
Mean[a]	0.438	0.21	2.1	**2**	0.2
Patch 25					
MDC	0.352	0.21	2.1	**2**	0.2
UTL[a]	0.342	0.21	2.1	**2**	0.2
UCL[a]	0.342	0.21	2.1	**2**	0.2
Mean[a]	0.342	0.21	2.1	**2**	0.2
Patch 27					
MDC	0.340	0.21	2.1	**2**	0.2
UTL[a]	0.330	0.21	2.1	**2**	0.2
UCL[a]	0.330	0.21	2.1	**2**	0.2
Mean	0.290	0.21	2.1	1	0.1

[a] Soil UTL and/or UCL was greater than the MDC or could not be calculated due to low numbers of samples, so the MDC was used as a proxy value to calculate intake.
Bold = Hazard quotients>1.

Table A4.2.35
PMJM Receptor Intake and Exposure Estimates for Zinc - Default Exposure Scenario

Bioaccumulation Factors						
Soil to Plant	Soil to Invertebrate	Soil to Small Mammal				
lnCp = 1.575 + 0.554 (ln Cs)	lnCi = 4.449 + 0.328 (ln Cs)	lnCsm = 4.4987 + 0.0745 (ln Cs)				
Media Concentrations (mg/kg)						
Patch	**Soil Concentration**	**Statistic**	**Plant**	**Earthworm**	**Small Mammal**	**Surface Water (mg/L)**
22	66	MDC	49.21	338.05	122.83	0.27
22	66	UTL[a]	49.21	338.05	122.83	0.33
22	66	UCL[a]	49.21	338.05	122.83	0.015
22	62.5	Mean	47.75	332.07	122.34	0.013
23	84	MDC	56.24	365.88	125.06	0.27
23	79.8	UTL	54.67	359.78	124.58	0.33
23	61.4	UCL	47.28	330.14	122.17	0.015
23	58	Mean	45.81	324.03	121.66	0.013
24	55	MDC	44.48	318.43	121.18	0.27
24	55	UTL[a]	44.48	318.43	121.18	0.33
24	55	UCL[a]	44.48	318.43	121.18	0.015
24	55	Mean[a]	44.48	318.43	121.18	0.013
25	52	MDC	43.12	312.63	120.67	0.27
25	52	UTL[a]	43.12	312.63	120.67	0.33
25	52	UCL[a]	43.12	312.63	120.67	0.015
25	52	Mean[a]	43.12	312.63	120.67	0.013
27	86.1	MDC	57.02	368.86	125.29	0.27
27	86.1	UTL[a]	57.02	368.86	125.29	0.33
27	86.1	UCL[a]	57.02	368.86	125.29	0.015
27	66.2	Mean	49.29	338.39	122.86	0.013
Intake Parameters						
	$IR_{(food)}$ (kg/kg BW day)	**$IR_{(water)}$** (kg/kg BW day)	**$IR_{(soil)}$** (kg/kg BW day)	**P_{plant}**	**P_{invert}**	**P_{mammal}**
PMJM	0.17	0.15	0.004	0.7	0.3	0

Table A4.2.35
PMJM Receptor Intake and Exposure Estimates for Zinc - Default Exposure Scenario

	Intake Estimates (mg/kg BW day)					
	Plant Tissue	**Invertebrate Tissue**	**Mammal Tissue**	**Soil**	**Surface Water**	**Total**
Patch 22						
MDC	5.86	17.2	N/A	0.269	0.0405	23.4
UTL[a]	5.86	17.2	N/A	0.269	0.0495	23.4
UCL[a]	5.86	17.2	N/A	0.269	0.00225	23.4
Mean	5.68	16.9	N/A	0.255	0.00195	22.9
Patch 23						
MDC	6.69	18.7	N/A	0.343	0.0405	25.7
UTL	6.51	18.3	N/A	0.326	0.0495	25.2
UCL	5.63	16.8	N/A	0.251	0.00225	22.7
Mean	5.45	16.5	N/A	0.237	0.00195	22.2
Patch 24						
MDC	5.29	16.2	N/A	0.224	0.0405	21.8
UTL[a]	5.29	16.2	N/A	0.224	0.0495	21.8
UCL[a]	5.29	16.2	N/A	0.224	0.00225	21.8
Mean[a]	5.29	16.2	N/A	0.224	0.00195	21.8
Patch 25						
MDC	5.13	15.9	N/A	0.212	0.0405	21.3
UTL[a]	5.13	15.9	N/A	0.212	0.0495	21.3
UCL[a]	5.13	15.9	N/A	0.212	0.00225	21.3
Mean[a]	5.13	15.9	N/A	0.212	0.00195	21.3
Patch 27						
MDC	6.79	18.8	N/A	0.351	0.0405	26.0
UTL[a]	6.79	18.8	N/A	0.351	0.0495	26.0
UCL[a]	6.79	18.8	N/A	0.351	0.00225	26.0
Mean	5.87	17.3	N/A	0.270	0.00195	23.4

[a] Soil UTL and/or UCL was greater than the MDC or could not be calculated due to low numbers of samples, so the MDC was used as a proxy value to calculate intake.
NA = Not applicable or not available

Table A4.2.36
PMJM Receptor Hazard Quotients for Surface Soils in LWOEU - Zinc

Patch/ EPC Statistic	Total Intake (mg/kg BW day)	TRV (mg/kg BW day)		Hazard Quotients	
		NOAEL	LOAEL	NOAEL	LOAEL
Zinc (Default Exposure)					
Patch 22					
MDC	23.4	9.61	411.4	**2**	0.06
UTL[a]	23.4	9.61	411.4	**2**	0.06
UCL[a]	23.4	9.61	411.4	**2**	0.06
Mean	22.9	9.61	411.4	**2**	0.06
Patch 23					
MDC	25.7	9.61	411.4	**3**	0.06
UTL	25.2	9.61	411.4	**3**	0.06
UCL	22.7	9.61	411.4	**2**	0.06
Mean	22.2	9.61	411.4	**2**	0.05
Patch 24					
MDC	21.8	9.61	411.4	**2**	0.05
UTL[a]	21.8	9.61	411.4	**2**	0.05
UCL[a]	21.8	9.61	411.4	**2**	0.05
Mean[a]	21.8	9.61	411.4	**2**	0.05
Patch 25					
MDC	21.3	9.61	411.4	**2**	0.05
UTL[a]	21.3	9.61	411.4	**2**	0.05
UCL[a]	21.3	9.61	411.4	**2**	0.05
Mean[a]	21.3	9.61	411.4	**2**	0.05
Patch 27					
MDC	26.0	9.61	411.4	**3**	0.06
UTL[a]	26.0	9.61	411.4	**3**	0.06
UCL[a]	26.0	9.61	411.4	**3**	0.06
Mean	23.4	9.61	411.4	**2**	0.06

[a] Soil UTL and/or UCL was greater than the MDC or could not be calculated due to low numbers of samples, so the MDC was used as a proxy value to calculate intake.
Bold = Hazard quotients>1.

COMPREHENSIVE RISK ASSESSMENT

LOWER WOMAN DRAINAGE EXPOSURE UNIT

VOLUME 11: ATTACHMENT 5

Chemical-Specific Uncertainty Analysis

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

BAF	Bioaccumulation Factors
BW	body weight
CMS	Corrective Measures Study
CRA	Comprehensive Risk Assessment
DOE	U.S. Department of Energy
ECOPC	ecological contaminant of potential concern
EcoSSL	Ecological Soil Screening Level
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ESL	ecological screening level
HQ	hazard quotient
LOAEL	lowest observed adverse effect level
LOEC	lowest observed effect concentration
mg/kg	milligrams per kilogram
mg/kg BW/day	milligram per kilogram per receptor body weight per day
NOAEL	no observed adverse effect level
NOEC	no observed effect concentration
PMJM	Preble’s meadow jumping mouse
PRC	PRC Environmental Management, Inc
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
RFETS	Rocky Flats Environmental Technology Site
TRV	toxicity reference value

UCL	upper confidence limit
UTL	upper tolerance limit

1.0 INTRODUCTION

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

- **Bioaccumulation Factors (BAFs).** For wildlife receptors, concentrations of contaminants in dietary items were estimated from surface soil using uptake equations. When the uptake equation was based on a simple linear model (e.g., C_{tissue} = BAF * C_{soil}), the default exposure scenario used a high-end estimate of the BAF (the 90th percentile BAF). However, the use of high-end BAFs may tend to overestimate tissue concentrations in some dietary items. In order to estimate more typical tissue concentrations, where necessary, an alternative exposure scenario calculated total chemical intake using a 50th percentile (median) BAF and HQs were calculated. The use of the median BAF is consistent with the approach used in the ecological soil screening level (EcoSSL) guidance (EPA 2005).
- **Toxicity Reference Values (TRVs).** The Comprehensive Risk Assessment (CRA) Methodology (U.S. Department of Energy [DOE] 2005), hereafter referred to as the CRA Methodology, used an established hierarchy to identify the most appropriate default TRVs for use in the ecological contaminant of potential concern (ECOPC) selection. However, in some instances, the default TRV selected may be overly conservative with regard to characterizing population-level risks. The determination of whether the default TRVs are thought to yield overly conservative estimates of risk is addressed in the uncertainty sections below on a chemical-by-chemical basis in the following subsections. When an alternative TRV is identified, the chemical-specific subsections provide a discussion of why the alternative TRV is thought to be appropriate to provide an alternative estimate of toxicity (e.g., endpoint relevance, species relevance, data quality, chemical form, etc.), and HQs were calculated using both default and alternative TRVs where necessary.

The influences of each of these uncertainties on the calculated HQs are discussed for each ECOPC in the following subsections.

1.1 Chromium

Plant Toxicity

The summary of chromium toxicity in Efroymson et al. (1997a) places low confidence in the value because there are no primary reference data showing toxicity to plants and the basis for the ecological screening level (ESL) is not discussed in the document. The document simply notes that confidence in the values is low due to the small number of studies on which it was based. Efroymson et al. (1997a) also provides plant toxicity values from Turner and Rust (1971) that are based on growth effects on plants grown in loamy soils. No effects to plant growth were noted at 10 milligram per kilogram (mg/kg), while shoot weight was reduced by 30 percent at chromium concentrations equal to 30 mg/kg. Uncertainty is high using the additional toxicity information but reduced from the unspecified and unsupported 1 mg/kg value used as the default ESL.

Invertebrate Toxicity

The ESL is based on survival effects to earthworms exposed to hexavalent chromium (chromium VI). Severe effects on survival were noted at 2 mg/kg chromium VI. The 0.4 mg/kg ESL was calculated by Efroymson et al. (1997b) by dividing by a safety factor of 5. There is some uncertainty in the chromium VI TRV because trivalent chromium (chromium III) is the most prevalent form of inorganic chromium found in soils (Kabata-Pendias 2002). This introduces uncertainty into the TRV selection process as chromium VI is regarded as the more toxic form of chromium. Efroymson et al. (1997b) also provide data for a lowest observed effect concentration (LOEC) where growth to earthworms was reduced by 30 percent at 32.6 mg/kg of chromium III. The alternative chromium III LOEC provides a useful alternative estimate of toxicity based on a more applicable estimate of chromium III toxicity.

Bioaccumulation Factors

There are several important uncertainties associated with the intake and HQ calculations for vertebrate receptors. Chromium has two types of bioaccumulation factors used in the intake calculations. For the soil-to-small mammal BAF, a regression equation was used to estimate tissue concentrations. Confidence placed in this value is high; however, uncertainty is unavoidable when using even high-quality models to predict tissue concentrations. In cases without available measurements of tissue concentrations, regression-based models are generally the best available predictor of tissue concentrations. However, the regression-based BAFs may still overestimate or underestimate tissue concentrations of chromium to an unknown degree.

The soil-to-invertebrate and soil-to-plant BAFs used to estimate invertebrate tissue concentrations are both based on screening-level upper-bound (90th percentile) BAFs presented in Sample et al. (1998a) and ORNL (1998). These values provide conservative estimates of uptake from soils to invertebrate and plant tissues. This conservative estimate may serve to overestimate chromium concentrations in tissues. For this reason, the median BAFs presented in the same documents were used as alternative BAFs to estimate invertebrate and plant tissue concentrations as recommended in U.S. Environmental Protection Agency (EPA) EcoSSL guidance (EPA 2005). It is unclear whether the use of median BAFs reduces the uncertainty involved in the estimation of invertebrate tissue concentrations, but the likelihood of overestimation of risks is reduced.

Toxicity Reference Values

For birds, the no observed adverse effect level (NOAEL) and lowest observed adverse effect level (LOAEL) TRVs are based on mortality effects in black ducks from chromium III and were obtained from Sample et al. (1996). The NOAEL TRV (1.0 mg/kg BW/day) represents a dose at which no effects on the survival of ducks were noted. The LOAEL

TRV (5.0 mg/kg BW/day) represents a dose at which a decrease in survivability was noted in the same study. Because the effects endpoint is based on mortality, no threshold TRV was calculated in the CRA Methodology. However, the threshold for chromium III toxicity lies somewhere between the NOAEL and LOAEL, but the true threshold dose is not known. No toxicity data were available for chromium VI, so avian TRVs for chromium VI could not be derived. However, chromium III is the most prevalent form of inorganic chromium found in soils (Kabata-Pendias 2002). Because the avian NOAEL and LOAEL TRVs are based on appropriate endpoints and the chemical form most likely to be present in soil, uncertainty in the avian TRVs is considered low. No alternative avian TRVs were identified for chromium III.

For mammals, both a NOAEL and LOAEL TRVs were available for chromium VI, but only a NOAEL TRV was available for chromium III. All of the mammalian TRVs were obtained from Sample et al. (1996) and relate to reproduction and mortality endpoints. For chromium III, The NOAEL TRV (2,737 mg/kg BW/day) represents a dose at which no effects on reproduction or longevity were noted. For chromium VI, the NOAEL TRV (3.28 mg/kg BW/day) represents a dose at which no body weight or food consumption effects were noted in rats. The LOAEL TRV (13.14 mg/kg BW/day) for chromium VI, which was derived from a different study than the NOAEL TRV, represents the dose at which mortality effects were noted in rats. Both the chromium III and chromium VI TRVs were used in the default analysis. However, as noted above, chromium III is likely to be the chemical form present in soils at RFETS. Since both chromium III and chromium VI TRVs were based on acceptable effects endpoints, no alternative TRVs were identified.

Since the completion of the TRV derivation process in the CRA Methodology, EPA has derived Eco-SSLs for both birds (chromium III only) and mammals (chromium III and chromium VI) (EPA 2005). While the Eco-SSL TRVs were not utilized in the default analysis, a comparison of Eco-SSL TRVs to those selected by Sample et al. (1996) which were used in the default analysis provides information on the applicability of and underlying uncertainties in the selected TRVs. For birds, the dose-based TRV derived for chromium III (2.66 mg/kg BW/day) was based on the geomean of all growth and reproduction NOAELs. As seen, this TRV is similar to the chromium III TRVs identified by Sample et al. (1996) utilized in the default analysis. This supports the conclusion that uncertainty in the avian TRVs for chromium III is low.

For mammals, the Eco-SSL dose-based TRV derived for chromium III (2.4 mg/kg BW/day) was based on the geomean of all growth and reproduction NOAELs. As seen, the Eco-SSL TRV is more than 1000 times lower than the NOAEL TRV selected by Sample et al. (1996). Inspection of the toxicity dataset for chromium III provided in EPA (2005) shows that there are several unbounded LOAELs below the NOAEL TRV selected by Sample et al. (1996). Therefore, the uncertainty associated with the mammalian chromium III NOAEL TRV utilized in the default analysis is high. The mammalian dose-based TRV derived for chromium VI (5.66 mg/kg BW/day) was based on the highest bounded NOAEL below the lowest bounded LOAEL for growth, reproduction, or survival, and is similar to the chromium VI TRVs identified by Sample et al. (1996) utilized in the default analysis. However, as noted above, chromium III is likely to be the chemical form present in soils at RFETS, so HQs based on a TRV for chromium VI are also uncertain.

Background Risks

Chromium was detected in RFETS background surface soils. Because risks are generally not expected at naturally occurring background levels, it is important to calculate the risks that would be predicted at naturally occurring concentrations using the same assumptions and models as used in the CRA. This provides information necessary to gauge the predictive ability of the risk assessment models used in the CRA. In addition, risks calculated using background data can provide additional information on the magnitude of potentially site-related risks.

Risks to terrestrial plants, terrestrial invertebrates, mourning dove (herbivore and insectivore), American kestrel, deer mouse (insectivore), and Preble's meadow jumping mouse (PMJM) were calculated using both the upper confidence limit (UCL) and upper tolerance limit (UTL) of background soils. NOAEL HQs greater than 1 were calculated for terrestrial plants, terrestrial invertebrates, and mourning dove (insectivore), with both the UCL, and UTL exposure point concentrations (EPCs). NOAEL HQs for terrestrial plants equaled 17 using the UTL, while those calculated for terrestrial invertebrates equaled 42. Both NOAEL and LOAEL HQs greater than 1 were calculated for the mourning dove (insectivore). The LOAEL HQ equaled 3 using the UTL EPC, indicating potentially significant risks at background concentrations. No LOAEL TRVs were available for terrestrial plants or invertebrates.

1.2 Copper

Bioaccumulation Factors

For the soil-to-plant, soil-to-invertebrate, and soil-to-small mammal BAFs, regression equations were used to estimate plant tissue concentrations. Confidence placed in these values is high; however, uncertainty is unavoidable when using even high-quality models to predict tissue concentrations. In cases without available measurements of tissue concentrations, regression-based models are generally the best available predictor of tissue concentrations. However, the regression-based BAFs may still overestimate or underestimate tissue concentrations of copper to an unknown degree.

Toxicity Reference Values

The NOAEL and LOAEL TRVs for birds were obtained from PRC Environmental Management, Inc. (PRC) (PRC 1994). The PRC document reviewed the available effects database for avian effects from copper. The NOAEL TRV represents a dose of copper at which no growth, developmental, reproductive, or mortality effects were noted. The LOAEL TRV represents a dose rate at which an increase in the erosion of chicken gizzards was noted. The CRA Methodology noted that the nature of the effect predicted by the LOAEL TRV is not likely to cause significant effects on growth, reproduction, or survival in birds and, subsequently, calculated a threshold TRV. The threshold TRV represents an estimate of the point between the NOAEL and LOAEL TRVs where effects related to the LOAEL TRV may begin to occur. This point is uncertain and it is impossible to accurately estimate where the threshold for effects lies given the available data. Therefore, the calculation of the threshold TRV may overestimate or underestimate the calculated risks by a degree less than half of the difference between the NOAEL and LOAEL TRVs. In addition, the ability of the LOAEL TRV endpoint to predict effects to populations of avian receptors at RFETS under the assessment endpoints used in this CRA is uncertain. The effect that gizzard erosion in birds has on population-level endpoints is unclear, but risk estimations are likely to be conservative and over-predict risk. However, Sample et al. (1996), a CRA Methodology-approved TRV source, provides avian TRVs for growth and mortality endpoints to neonate chickens that are very similar to the LOAEL TRV from PRC (PRC - LOAEL = 52.3 mg/kg receptor body weight [BW]/day; Sample - LOAEL = 61.7 mg/kg BW/day). Because the two LOAEL values are similar, the uncertainty in the PRC LOAEL is reduced and no alternative TRVs are provided to calculate risk to the mourning dove receptors. The PRC value is considered to be protective of growth and mortality effects in birds. Although it may over-predict risks, the degree is likely to be small.

The NOAEL and LOAEL TRVs for mammals were obtained from PRC Environmental Management, Inc. (PRC) (1994). The PRC document reviewed the available effects database for mammalian effects from copper. The NOAEL TRV represents a dose of copper at which no growth, developmental, reproductive, or mortality effects were noted. The LOAEL TRV represents a dose at which increased mortality and decreased body weight were noted in mice. No threshold TRV was calculated due to both the mortality endpoint of the LOAEL TRV and the lack of specific data necessary to calculate the TRV. Since the endpoint for the LOAEL TRV is based on an acceptable endpoint as defined by the CRA methodology, the overall uncertainty related to the mammalian TRVs for copper should be considered to be low. The TRVs may overestimate or underestimate risk to an unknown degree.

Background Risks

Copper was detected in RFETS background surface soils. Because risks are generally not expected at naturally occurring background levels, it is important to calculate the risks that would be predicted at naturally occurring concentrations using the same assumptions and models as used in the CRA. This provides information necessary to gauge the predictive ability of the risk assessment models used in the CRA. In addition, risks calculated using background data can provide additional information on the magnitude of potentially site-related risks.

Risks to the mourning dove (herbivore and insectivore) were calculated using both the UCL and UTL of background soils. No HQs greater than 1 were calculated for either receptor using the NOAEL or LOAEL TRVs. NOAEL HQs equal to 1 were calculated for the mourning dove (insectivore) with both the UCL and UTL EPCs. NOAEL HQs for the mourning dove (herbivore) are less than 1 for the UCL and UTL EPCs. NOAEL HQs were less than 1 for the PMJM using either the UCL or the UTL EPCs.

1.3 Manganese

Plant Toxicity

The summary of manganese toxicity in Efroymson et al. (1997a) places low confidence in the value of 500 mg/kg because the benchmark is based on only one study. This study identified a reduction in leaf and stem weight in bush beans (Wallace et al. 1997 as cited in Efroymson et al. 1997a). There were no additional TRVs presented in Efroymson et al. (1997a). The uncertainty associated with the lack of toxicity data for terrestrial plants is high. It is unclear whether risks are overestimated or underestimated by using the default toxicity value, but overestimation is the more likely scenario because the ESL is termed a screening level and represents only one study.

Bioaccumulation Factors

There are several important uncertainties associated with the intake and HQ calculations for vertebrate receptors. Manganese has two types of bioaccumulation factors used in the intake calculations. For the soil-to-invertebrate BAF, a regression equation was used to estimate tissue concentrations. Confidence placed in this value is high; however, uncertainty is unavoidable when using even high-quality models to predict tissue concentrations. In cases without available measurements of tissue concentrations, regression-based models are generally the best available predictor of tissue concentrations. However, the regression-based BAFs may still overestimate or underestimate invertebrate tissue concentrations of manganese to an unknown degree.

The soil-to-plant and soil-to-small mammal BAFs used to estimate tissue concentrations are based on screening-level upper bound (90th percentile) BAFs presented in ORNL (1998) and Sample et al. (1998b). These values provide conservative estimates of uptake from soils to tissues. This conservative estimate may serve to overestimate manganese concentrations in plant and small mammal tissues. For this reason, the median BAFs presented in the same document were used as alternative BAFs to estimate tissue concentrations. It is unclear whether the use of median BAFs reduces the uncertainty involved in the estimation of plant and small mammal tissue concentrations, but the likelihood of overestimation of risks is reduced. In addition, the conservative nature of the upper-bound soil-to-plant BAF directly affects the conservatisms in the soil-to-small mammal BAF that uses both the soil-to-plant and soil-to-invertebrate BAFs in its calculation. It is unclear to what degree and direction that uncertainty can be estimated for the soil-to-small mammal BAF, but the uncertainty associated with the estimated small mammal tissue concentrations is high.

Toxicity Reference Values

The NOAEL and LOAEL TRVs for mammalian receptors were obtained from PRC (1994), a CRA Methodology-approved source of TRVs. The LOAEL TRV represents an intake rate at which a decrease in testical weight in mice was noted. The NOAEL TRV was taken from the same study and represents an intake rate at which no effects on testicular weight was noted. No threshold TRV was identified in the CRA Methodology, thus it is unknown where the threshold for effects lies at intake rates lower than the LOAEL TRV. In addition, no relationship appears to have been identified between decreased testicular weight to reductions in reproductive success. This introduces some uncertainty into the risk assessment. However, because the endpoint for the LOAEL TRV is based on potential reproductive effects, the uncertainty is likely to be limited. Risks predicted by the LOAEL TRV may be overestimated, but the degree of uncertainty is low.

Background Risks

Manganese was detected in RFETS background surface soils. Because risks are generally not expected at naturally occurring background levels, it is important to calculate the risks that would be predicted at naturally occurring concentrations using the same assumptions and models as used in the CRA. This provides information necessary to gauge the predictive ability of the risk assessment models used in the CRA. In addition, risks calculated using background data can provide additional information on the magnitude of potentially site-related risks.

Risks to all receptors were calculated using both the UCL and UTL of background soils. NOAEL HQs less than or equal to 1 were calculated for all receptors using either the UCL or UTL EPCs. The HQs for terrestrial plants were also less than 1. No LOAEL HQs greater than 1 were calculated for any receptor using LOAEL TRVs.

1.4 Nickel

Bioaccumulation Factors

There are several important uncertainties associated with the intake and HQ calculations for vertebrate receptors. Nickel has two types of bioaccumulation factors used in the intake calculations. For the soil-to-plant and soil-to-small mammal BAFs, regression equations were used to estimate tissue concentrations. Confidence placed in these values is high; however, uncertainty is unavoidable when using even high-quality models to predict tissue concentrations. In cases without available measurements of tissue concentrations, regression-based models are generally the best available predictor of tissue concentrations. However, the regression-based BAFs may still overestimate or underestimate tissue concentrations of nickel to an unknown degree.

The soil-to-invertebrate BAF used to estimate invertebrate tissue concentrations is based on a screening-level upper bound (90th percentile) BAF presented in Sample et al. (1998a). This value provides a conservative estimate of uptake from soils to invertebrate tissues. This conservative estimate may serve to overestimate nickel concentrations in invertebrate tissues. For this reason, the median BAF presented in the same document (Sample et al. 1998b) can be used as an alternative BAF to estimate invertebrate tissue concentrations.

It is unclear whether the use of median BAFs reduces the uncertainty involved in the estimation of invertebrate tissue concentrations, but the likelihood of overestimation of risks is reduced.

Toxicity Reference Values

Uncertainty is also present in the TRVs used in the default HQ calculations for nickel. The NOAEL-based ESL calculated for the deer mouse (insectivore) was equal to 0.431 mg/kg, a concentration less than all site-specific background samples (minimum background concentration = 3.8 mg/kg). The NOAEL TRV used to calculate the ESL was estimated from the LOAEL TRV in the CRA Methodology by dividing by a factor of 10. The LOAEL TRV for mammals (1.33 mg/kg BW/day) is based on pup mortality in rats. Given that the LOAEL TRV is 10 times the NOAEL TRV, a back-calculated soil concentration using the LOAEL TRV equals 3.8 mg/kg. This concentration is equal to the minimum detected concentration of nickel in background soils and would be exceeded by 19 of the 20 site-specific background soil concentrations.

For avian receptors, there is also uncertainty in the quality of the TRVs selected in the CRA Methodology to predict population-level effects to birds at RFETS. The TRVs selected by PRC (1994) relate to the prediction of edema and swelling in leg and foot joints in mallard ducks. The CRA Methodology noted that the nature of the effect predicted by the LOAEL TRV is not likely to cause significant effects on growth, reproduction, or survival in birds and, subsequently, calculated a threshold TRV. The threshold TRV represents an estimate of the point between the NOAEL and LOAEL TRVs where effects related to the LOAEL TRV may begin to occur. This point is uncertain, and it is impossible to accurately estimate where the threshold for effects lies. Therefore, the calculation of the threshold TRV may overestimate or underestimate the calculated risks by a degree less than half of the difference between the NOAEL and LOAEL TRVs. In addition, the ability of the LOAEL TRV endpoint to predict effects to populations of avian receptors at RFETS under the assessment endpoints used in this CRA is also uncertain. The effect that swelling of leg and toe joints in birds has on population-level endpoints is unclear and risk estimations are likely to be conservative and over-predict risks related to the assessment endpoints.

Given the uncertainties related to the TRVs for both mammals and birds, a further review of TRVs was conducted to provide additional toxicologically-based information for use in the risk characterization. The CRA Methodology prescribed a hierarchy of TRV sources from which TRVs could be identified and used without modification. TRVs were selected first from EPA Eco-SSL guidance (EPA 2003) from which no nickel TRVs were available. The second Tier TRV source was PRC (1994), from which the TRVs were obtained. Due to the uncertain nature of predicting potential risk at even the lowest end of the range of background concentrations in an uncontaminated background area, additional TRVs were identified from the third tier TRV source (Sample et al. 1996). Sample et al. (1996) presents TRVs for birds and mammals that provide useful comparison points to the default TRVs identified in the CRA Methodology.

For mammals, the alternative TRVs were derived from a multi-generational study of rat reproduction and changes due to nickel contamination in food items. At a dose level equal to 80 mg/kg BW/day (LOAEL), significant decreases were noted in offspring weight in rats. No effects were noted at 40 mg/kg BW/day (NOAEL). The effect-endpoint is questionable in terms of predicting population level effects based on the assessment endpoint, but was identified as an acceptable endpoint in the CRA

Methodology. These values can be used in conjunction with the alternative BAFs discussed above to provide risk managers with another valuable line of evidence to be used in making risk management decisions.

For birds, the alternative TRVs were derived from a chronic exposure study on mallard ducklings exposed to nickel in food items. No growth, reproductive or mortality-based effects were noted at the 77.4 mg/kg BW/day dose level (NOAEL) but significant decreased in growth rate and increased in mortality were noted at the 107 mg/kg BW/day dose level (lowest observed effect level [LOEC]). As with the mammalian alternative TRVs, these values can be used in conjunction with the alternative BAFs discussed above to provide risk managers with another valuable line of evidence to be used in making risk management decisions.

The use of these alternative risk calculations serves to provide an estimate of risk using a reasonable, yet reduced, level of conservatism for all receptors and a reduction of uncertainty (to an unknown extent) for the deer mouse (insectivore) and PMJM receptors.

Background Risks

Nickel was detected in RFETS background surface soils. Because risks are generally not expected at naturally occurring background levels, it is important to calculate the risks that would be predicted at naturally occurring concentrations using the same assumptions and models as used in the CRA. This provides information necessary to gauge the predictive ability of the risk assessment models used in the CRA. In addition, risks calculated using background data can provide additional information on the magnitude of potentially site-related risks.

Risks to the PMJM, deer mouse (insectivore and herbivore), coyote (generalist and insectivore), and mourning dove (insectivore) were calculated using both the UCL and UTL of background soils and default NOAEL, threshold (mourning dove only), and LOAEL TRVs.

NOAEL HQs greater or equal to 1 for all receptors were calculated using both the UCL and UTL background surface soil concentrations. NOAEL HQs ranged from 1 for the deer mouse (herbivore) to 27 for the PMJM. LOAEL HQs were less than 1 for the deer mouse (herbivore), mourning dove (insectivore), and both coyote receptors but greater than 1 for the PMJM (HQ = 3) and deer mouse (insectivore) (HQ = 3). Site-specific background concentrations of nickel do not appear to be elevated as the maximum detected concentration in background surface samples equaled 14.0 mg/kg which is lower than the mean concentration of nickel in Colorado and bordering states (18.8 mg/kg) as discussed in Attachment 3.

1.5 Selenium

Bioaccumulation Factors

For the soil-to-invertebrate BAF, a regression equation was used to estimate tissue concentrations. Confidence placed in this value is high; however, uncertainty is unavoidable when using even high-quality models to predict tissue concentrations. In cases without available measurements of tissue concentrations, regression-based models are generally the best available predictor of tissue concentrations. However, the regression-based BAFs may still overestimate or underestimate tissue concentrations of selenium to an unknown degree.

Toxicity Reference Values

The NOAEL and LOAEL TRVs for mammals were obtained from PRC (PRC 1994). The PRC document reviewed the available effects database mammalian effects of selenium. The NOAEL TRV represents a dose of selenium at which no liver lesions were noted in mice. The LOAEL TRV represents a dose rate at which an increase in the reductions in reproductive success in mice were noted. There is no threshold TRV provided and it is uncertain and impossible to accurately estimate where the threshold for effects lies given the available data. The NOAEL TRV is based on an endpoint with questionable ability to predict risks to populations of mammals. However, the LOAEL TRV is based on an appropriate endpoint for use in the ERA. For this reason, no alternative TRVs are recommended for selenium but HQ results based on the NOAEL TRV should consider the endpoint used for the TRV.

Background Risks

Selenium was detected in RFETS background surface soils. Because risks are generally not expected at naturally occurring background levels, it is important to calculate the risks that would be predicted at naturally occurring concentrations using the same assumptions and models as used in the CRA. This provides information necessary to gauge the predictive ability of the risk assessment models used in the CRA. In addition, risks calculated using background data can provide additional information on the magnitude of potentially site-related risks.

Risks to the PMJM were calculated using the UCL of background soils. NOAEL and LOAEL HQs were less than 1 for the PMJM using the UCL EPC.

1.6 Thallium

Plant Toxicity

The summary of thallium toxicity in Efroymson et al. (1997a) places low confidence in the value because the LOEC ESL value is based on unspecified toxic effects. The only additional TRV that could be located was the same as the default value. The uncertainty associated with the lack of toxicity data for terrestrial plants is high. It is unclear whether risks are overestimated or underestimated by using the default toxicity values, but overestimation is the more likely scenario because the ESL is termed a screening level and represents unclear effects.

Background Risks

Thallium was not detected in background surface soils. Therefore, background risks were not calculated for thallium in Appendix A, Volume 2, Attachment 9 of the RI/FS Report.

1.7 Tin

Bioaccumulation Factors

The primary source of uncertainty in the risk estimation for tin is in the estimation of tissue concentrations. No high-quality regression models or BAF data were available for any of the three soil-to-tissue pathways. As a result, plant tissue concentrations are estimated using a biotransfer factor from soil-to-plant tissue from Baes et al. (1984). The values presented in Baes et al. (1984) were the lowest tier for data quality in the CRA Methodology and represent the most uncertain BAF available. It is unclear whether the Baes et al. (1984) BAFs overestimate or underestimate uptake into plant tissues, and the magnitude of uncertainty is also unknown but could be high.

No data were available to estimate invertebrate concentrations from soil. As a result, a default value of 1 was used. This value assumes that the concentration in invertebrate tissues is equal to the surface soil concentration. There is a large degree of uncertainty in this assumption. Because tin is not expected to bioaccumulate in the food chain, invertebrate tissue concentrations are likely to be overestimated to an unknown degree using this BAF. The lack of quality soil-to-plant and soil-to-invertebrate BAFs directly affects the quality of the soil-to-small mammal BAF that uses the previous two values in its calculation. Compounding the uncertainty for this BAF is a food-to-tissue BAF, again from Baes et al. (1984). It is unclear to what degree and direction that uncertainty can be estimated for the soil-to-small mammal BAF, but the uncertainty associated with the estimated small mammal tissue concentrations is high.

Toxicity Reference Values

The NOAEL and LOAEL TRVs for mammalian receptors were obtained from PRC (1994). The selected NOAEL TRV is protective of systemic effects in mice. These effects are not associated with the assessment endpoints for mammalian receptors at RFETS and, therefore, are overly conservative for use in the CRA. However, the LOAEL TRV selected by PRC (1994) is from a proper endpoint for use in the CRA and is described by PRC (1994) as predictive of a mid-range of effects less than mortality. Therefore, while the uncertainty related to the NOAEL TRV for mammals is high, the uncertainty for the LOAEL TRV is considerably lower. For this reason, no alternative TRVs are recommended in the uncertainty analysis.

For avian receptors, the TRVs selected for use in the CRA were also obtained from PRC (1994) and represent a paired NOAEL and LOAEL from a study on Japanese quail reproduction. No effects on reproduction were noted at the NOAEL, while reduced reproduction was noted at the LOAEL intake rate. Because the endpoints represented by the TRVs are appropriate for use in the CRA, the uncertainty in the avian TRVs for tin is considered to be low.

All of the TRVs used for tin were based on toxicity to tributyl tin. Tributyl tin compounds are commonly regarded as the most toxic forms of tin while inorganic tins are likely to be among the least toxic forms. In terrestrial environments, organic forms of tin, such as tributyl tin, on which the TRVs are based are not generally found in elevated concentrations unless a source of them is nearby. No known source of organic tin is present at RFETs. It is likely that much of the tin detected in soil samples is either inorganic tin or in compounds less toxic than tributytin. The use of tributyltin TRVs likely overestimates risks from tin to an unknown degree.

Background Risks

Tin was not detected in background surface soils, therefore, background risks were not calculated for tin in Appendix A, Volume 2, Attachment 9 of the RI/FS Report.

1.8 Vanadium

Plant Toxicity

The summary of vanadium toxicity in Efroymson et al. (1997a) places low confidence in the value because there are no primary reference data showing toxicity to plants, and the ESL value is based on unspecified toxic effects. An additional LOEC TRV was also available as cited in Efroymson et al. (1997a) and was based again on unspecified effects of vanadium added to soil at a concentration of 50 mg/kg. No information regarding the baseline concentration of vanadium in the soil was available. Low confidence is also placed on this additional LOEC ESL. The uncertainty associated with the lack of toxicity data for terrestrial plants is high. It is unclear whether risks are overestimated or underestimated by using the default or additional LOEC toxicity value, but overestimation is the more likely scenario. The additional LOEC ESL may reduce that uncertainty to an unknown degree.

Bioaccumulation Factors

The soil-to-invertebrate and soil-to-plant BAFs used to estimate invertebrate tissue concentrations are both based on screening-level upper-bound (90th percentile) BAFs presented in Sample et al. (1998a) and ORNL (1998). These values provide conservative estimates of uptake from soils to invertebrate and plant tissues. This estimate may serve to overestimate vanadium concentrations in tissues.

Toxicity Reference Values

The NOAEL and LOAEL TRVs for mammalian receptors were obtained from Sample et al. (1996), a CRA Methodology-approved source of TRVs. The LOAEL TRV represents an intake rate at which a decrease in reproductive success in mice was noted. No NOAEL TRV was available, thus the NOAEL TRV was estimated from the LOAEL TRV by dividing by a factor of 10. The estimation of the NOAEL TRV from the LOAEL TRV introduces uncertainty into the risk characterization process. It is unknown where the threshold for effects lies at intake rates lower than the LOAEL TRV; therefore, it is also unclear at which intake-rate the true NOAEL lies. However, this source of uncertainty is limited because the LOAEL TRV is of sufficient quality to assess risks and the LOAEL TRV endpoint may be predictive of population risks. Risks predicted by the LOAEL TRV may be overestimated or underestimated, but the degree of uncertainty is low.

Background Risks

Vanadium was detected in RFETS background surface soils. Because risks are generally not expected at naturally occurring background levels, it is important to calculate the risks that would be predicted at naturally occurring concentrations using the same assumptions and models as used in the CRA. This provides information necessary to gauge the predictive ability of the risk assessment models used in the CRA. In addition, risks calculated using background data can provide additional information on the magnitude of potentially site-related risks.

Risks to the terrestrial plant, PMJM, and deer mouse (insectivore) were calculated using both the UCL and UTL of background soils and default NOAEL and LOAEL TRVs. HQs equal to 23 and 15 were calculated for the terrestrial plant receptor using UTL and UCL EPCs, respectively. NOAEL HQs greater or equal to 1 were calculated using both the UCL and UTL background surface soil concentrations for the PMJM and deer mouse (insectivore) receptors. NOAEL HQs ranged from 1 for both receptors using the UCL to 2 for both receptors using the UTL EPCs. LOAEL HQs were less than 1 for both receptors.

1.9 Zinc

Bioaccumulation Factors

For the soil-to-plant, soil-to-invertebrate, and soil-to-small mammal BAFs, regression equations were used to estimate plant tissue concentrations. Confidence placed in these values is high. Uncertainty is unavoidable when using even high-quality models to predict tissue concentrations. However, in cases without available measurements of tissue concentrations, regression-based models are the best available predictor of tissue concentrations. The regression-based BAFs may overestimate or underestimate tissue concentrations of zinc to an unknown degree.

Toxicity Reference Values

The NOAEL and LOAEL TRVs for mammalian receptors were obtained from PRC (1994), a CRA Methodology-approved source of TRVs. The LOAEL TRV represents an intake rate at which there is an increased incidence of fetal developmental effects in rats. No NOAEL TRV was available, therefore, the NOAEL TRV was estimated from the LOAEL TRV by dividing by a factor of 10. The estimation of the NOAEL TRV from the LOAEL TRV introduces uncertainty into the risk characterization process. It is unknown where the threshold for effects lies at intake rates lower than the LOAEL TRV; therefore, it is unclear at which intake rate the true NOAEL lies. However, this source of uncertainty is limited because the LOAEL TRV is of sufficient quality to assess risks, and the LOAEL TRV endpoint may be predictive of population risks. Risks predicted by the LOAEL TRV may be overestimated or underestimated but the degree of uncertainty is low.

Background Risks

Zinc was detected in RFETS background surface soils. Because risks are generally not expected at naturally occurring background levels, it is important to calculate the risks that would be predicted at naturally occurring concentrations using the same assumptions and models as used in the CRA. This provides information necessary to gauge the predictive ability of the risk assessment models used in the CRA. In addition, risks calculated using background data can provide additional information on the magnitude of potentially site-related risks.

Risks to the PMJM were calculated using both the UCL and UTL of background soils and default NOAEL and LOAEL TRVs. For the PMJM receptor, NOAEL HQs greater than 1 were calculated using both the UCL and UTL background surface soil concentrations whereas LOAEL HQs were less than 1 using the UCL and UTL background surface soil concentrations.

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COMPREHENSIVE RISK ASSESSMENT

LOWER WOMAN DRAINAGE EXPOSURE UNIT

VOLUME 8: ATTACHMENT 6

CRA Analytical Data Set