9413300.0142

0038236

175

START

BHI-00054
Rev. 00

# Qualitative Risk Assessment for the 100-NR-1 Source Operable Unit

Environmental Excellence
HANFORD

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

**Bechtel Hanford, Inc.**
Richland, Washington

SEP 1994
RECEIVED
EDMC

Approved for Public Release

THIS PAGE INTENTIONALLY
LEFT BLANK

9413300.0143

BHI- 00054
Rev: 00
OU: 100-NR-1
TSD: N/A
ERA: N/A

# APPROVAL PAGE

Title of Document: Qualitative Risk Assessment for the 100-NR-1 Source Operable Unit

Authors: I. T. Corporation

Approval: M. J. Lauterbach BHI/PRJ
(Printed name and organization of responsible manager)

(Signed name of responsible manager) Date 8/26/94

The approval signature on this page indicates that this document has been authorized for information release to the public through appropriate channels. No other forms or signatures are required to document this status.

In some cases, for documents in process or previously issued with a WHC document number before July 1, 1994, this page will appear in documents identified with WHC document numbers. No other forms are required for these documents.

BHI-DIS 8/26/94

THIS PAGE INTENTIONALLY
LEFT BLANK

9413300.0144

BHI-00054
Rev. 00

# Qualitative Risk Assessment for the 100-NR-1 Source Operable Unit

Author
I. T. Corporation

Date Published
August 1994

Environmental Excellence
HANFORD

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

**Bechtel Hanford, Inc.**
Richland, Washington

Approved for Public Release

THIS PAGE INTENTIONALLY
LEFT BLANK

# EXECUTIVE SUMMARY

## BACKGROUND

The Washington Department of Ecology, the U.S. Environmental Protection Agency, and the U.S. Department of Energy, signatories to the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1992), have developed a strategy for early initiation and completion of waste site cleanups, as described in the *Hanford Past-Practice Strategy* document (DOE-RL 1991a). This strategy relies, in part, on the use of a qualitative risk assessment (QRA) to assist in decision making. The QRA is performed using the *Hanford Site Risk Assessment Methodology* (HSRAM) (DOE-RL 1994) as guidance. The results are used to help determine whether interim remedial measures (IRM) are warranted. The objective of IRM is to achieve cleanup and reduce risk in a timely and cost-effective manner.

The QRA is an evaluation of risk for a predefined set of human and environmental exposure scenarios and is not intended to replace or be a substitute for a baseline risk assessment. It is streamlined to consider two human health exposure scenarios (frequent-use and occasional-use) with four pathways (soil ingestion, fugitive dust inhalation, inhalation of volatile organics from soil, and external radiation exposure) and limited ecological and groundwater evaluations, as agreed to by the 100 Area Tri-Party unit managers. Because of the decommissioning activities underway at the 100 N Area, the commercial/industrial scenario is also considered to evaluate current land use.

Data for the 100-NR-1 Source Operable Unit QRA were obtained from historical information and limited field investigation (LFI) sampling in which 115 samples were collected. Historical information yielded the names of potential contaminants of concern (COPC) at some of the sites. Because the LFI data were not collected using random sampling techniques and, thus, are not necessarily representative of the sites, maximum concentrations were used for screening rather than 95th percentile or upper confidence limit concentrations. The maximum concentration of each analyte detected at a waste site was tabulated from the LFI data. To determine contaminants, inorganic analytes were screened by comparison with the 95% upper threshold limit of the mean for background soil data provided by *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes* (DOE-RL 1993a). Organic or radionuclide analytes were not screened by comparison with background because no background values have been agreed to by the Tri-Party signatories. Where contaminant levels were available from waste site sampling, risk calculations were performed. The human health and ecological risk screening evaluations for groundwater associated with the 100 N Area are presented in the 100-NR-2 QRA (WHC 1993e).

The ecological evaluation concentrates on the potential effects of contaminants on the Great Basin pocket mouse as an indicator species. The home range of this mouse closely matches the size of many waste sites, and the mice are a key part of the terrestrial food chain for threatened and/or endangered species at the Hanford Site. For humans, risk that might

occur under frequent- and occasional-use was included to provide a range of risk estimates using reasonable maximum exposure parameters, as provided in HSRAM (DOE-RL 1994).

## RESULTS

In general, human health the risk-driving pathway is external exposure to radionuclides. Specific radionuclides identified as key contributors to the overall risk estimates were potassium-40, cobalt-60, cesium-137, radium-226, thorium-228, and uranium-238. Under current land-use, excavation or disturbance of contaminated soil can be prevented. Although soil could provide complete shielding against gamma-emitting radionuclides deeper than 1.8 m (6 ft) below ground surface, significant concentrations occur in the upper 1.8 m (6 ft) of soils. Residual Radioactive (RESRAD) material guidelines were not used for the calculation of external risk because shielding was not a discriminating effect. Although RESRAD may provide more realistic estimates of risk than the Risk Assessment Guidance for Superfund (EPA 1989) methodology, the calculated external exposure risk was high and, thus, decision making was adequately supported without RESRAD.

Human health risk was quantified at four sites: 116-N-1 (1301-N) Crib and Trench, 116-N-3 (1325-N) Crib and Trench, 116-N-2 Treatment Storage Facility, and 1322-N/1322-NA Sample Buildings. Risk (incremental cancer risk [ICR]) is designated as high (ICR $> 10^{-2}$), medium ($10^{-2} <$ ICR $> 10^{-4}$), or low ($10^{-4} <$ ICR $> 10^{-6}$). Risk below $10^{-6}$ is considered very low. Except for the 1322-N/NA Sample Buildings site, which was rated medium, the risk at these sites was rated high under the frequent-use scenario. Under the occasional-use scenario, risk was rated high at 116-N-1 and 116-N-3, medium at 116-N-2, and low at 1322-N/1322-NA. Under the current commercial/industrial scenario, risk was rated high at the 116-N-1 and 116-N-3 sites and medium at the 1322-N/NA and 116-N-2 sites. After decay of radionuclides to the year 2018 was calculated, the risk at the 116-N-1 and 116-N-3 sites remained high for all three scenarios and the 1322-N/NA and 116-N-2 sites were rated medium for frequent-use and low for occasional-use. Under the commercial/industrial scenario for the year 2018, the risk was rated medium at 116-N-2 and low at 1322-N/1322-NA.

The 120-N-1 Percolation Pond and South Settling Pond, 120-N-2 Surface Impoundment, and the 119-N Cooling Water Drain Line sites also had quantitative LFI data available for the risk assessment. The data for these sites indicated the human health risk associated with them was less than the screening criteria, 1E-07 ICR and 0.1 hazard quotient (HQ), for nonradionuclides. There were no quantitative data available for radionuclides at these sites. The 116-N Supply Line Leak quantitative data was not available for the risk assessment depth range, 0-15 feet. The remaining sites had no quantitative data available for the LFI. Sites without quantitative data for some or all COPC were assessed using historical process knowledge, spill reports and site analogies. Incremental cancer risks were estimated using the same high, medium, low, and very low designations as the sites with quantified risk. Systemic hazards (HQ) were insignificant when quantified or there were no data or information available that indicated significant noncarcinogen hazards for 100-NR-1 sites.

Based on historical information and site analogy, the 118-N-1 Spacer Storage Silos, 1304-N Emergency Dump Tank, 116-N-4 Emergency Dump Basin, 105-N Spent Fuel Storage Basin, UN-100-N-6 Decontamination Drain Line and the 1314-N Liquid Waste Loadout Station were designated as high human health risks. The remaining sites were designated as very low human health risks.

The ecological evaluation estimates the likelihood of an adverse effect occurring to wildlife. In the case of 100-NR-1 terrestrial wildlife, the risk assessment assumed that the key receptor organism, the Great Basin pocket mouse, was a frequent site user and was exposed to the maximum level of soil contamination at an individual waste site. The use of the maximum level of soil contamination from the first 4.6 m (15 ft) is conservative; a second scenario was included to consider a mouse burrowing to depths of up to 1.8 m (6 ft). The qualitative ecological evaluation is a relative ranking between waste sites and is not a stand-alone assessment.

The ecological benchmark for radionuclides is a total internal dose of 1 rad/day. Organism dose that exceeded this dose rate was classified as a high risk. The following sites exceeded this dose rate, with strontium-90 as the primary contributor, in the 100-NR-1 Source Operable Unit:

- Soils <0 to 1.8 m (0 to 6 ft) in depth inside the 116-N-3 (1325-N) Trench and the 116-N-1 (1301-N) Trench exceed the 1 rad/day benchmark dose rate to the Great Basin pocket mouse. No information is available concerning soil depths >1.8 m (6 ft) directly under the trenches.

For nonradiological constituents, the following sites exceeded the environmental hazard quotient >1 and no observable effect level values for wildlife: the 120-N-1/120-N-2 Ponds, the 1322-N/1322-NA sites, and the 116-N-1 (1301-N) Trench.

The primary nonradiological constituents of concern for wildlife toxicity include cadmium, lead, and zinc.

## UNCERTAINTIES

Uncertainty exists in the human health and ecological evaluations for the following reasons:

- Identification of contaminants and their concentrations are based on historical information of unknown quality, and LFI data are limited and not likely to fully characterize the sites.

- A considerable amount of conservatism exists (e.g., the use of maximum concentrations, and the assumptions of frequent-users being at the site daily as receptors).

- Contaminants are assumed to be uniformly distributed across the waste sites.

- Concentrations used as a source term were assumed to be available for uptake by site vegetation, and all foodstuffs were assumed to be contaminated.

- The inclusion of contaminant concentrations from below the root zone (>1.8 m [>6 ft]) represents an unlikely exposure pathway for most human receptors and terrestrial organisms.

- The waste sites are primarily covered with cobble or gravel, which limits the amount of vegetation available for an ecological foodstuff. Two sites are covered with concrete barriers, which decrease potential entry by mice.

- Modeling from soil to the pocket mouse required a number of assumptions, including soil-to-plant transfer factors or coefficients. The highest transfer factor was used.

- The time the receptor spends feeding within the unit was estimated using the mouse home range size and the waste site size.

- The maximum detected concentration was used to assess qualitative risk; the actual risk is lower than this extreme.

# ACRONYMS

| | |
|---|---|
| BAP | benzo(a)pyrene |
| CERCLA | Comprehensive Environmental Response, Compensation and Liability Act of 1980 |
| CFR | Code of Federal Regulations |
| CLP | contract laboratory program |
| COC | contaminants of concern |
| COPC | contaminants of potential concern |
| DOE | U.S. Department of Energy |
| Ecology | Washington Department of Ecology |
| EDB | emergency dump basin |
| EDT | emergency dump tank |
| EHQ | environmental hazard quotient |
| EPA | U.S. Environmental Protection Agency |
| HEAST | health effects assessment summary tables |
| HFSUWG | Hanford Future Site Uses Working Group |
| HGP | Hanford Generating Plant |
| HI | hazard index |
| HQ | hazard quotient |
| HSRAM | Hanford Site Risk Assessment Methodology |
| HPPS | Hanford Past-Practice Strategy |
| IAEA | International Atomic Energy Agency |
| ICR | incremental cancer risk |
| IRIS | integrated risk information system |
| IRM | interim remedial measure |
| LFI | limited field investigation |
| LOEL | lowest observed effect level |
| LWLS | liquid waste loadout station |
| NCRP | National Council on Radiation Protection and Measurements |
| NOEL | no observable effect level |
| NPDES | National Pollutant Discharge Elimination System |
| NPL | National Priorities List |
| PAH | polycyclic aromatic hydrocarbon |
| PCB | polychlorinated biphenyl |
| PEF | particulate emission factor |
| QA | quality assurance |
| QC | quality control |
| QRA | qualitative risk assessment |
| RBC | risk-based concentration |
| RCRA | Resource Conservation and Recovery Act |
| RESRAD | Residual Radioactive material guidelines, and software model |
| RfD | reference dose |
| RL | Richland Operations Office |
| SF | slope factor |

## ACRONYMS (cont)

| | |
|---|---|
| TAL | target analyte list |
| TCL | target compound list |
| Tri-Party Agreement | Hanford Federal Facility Agreement and Consent Order |
| TSD | treatment, storage and disposal |
| TSS | total suspended solids |
| UCL | upper confidence limit |
| UST | underground storage tank |
| UTL | upper threshold limit |
| VF | volatilization factor |
| WAC | Washington Administrative Code |
| WHC | Westinghouse Hanford Company |

# CONTENTS

1.0 INTRODUCTION . . . . . 1-1
1.1 PURPOSE AND APPROACH OF REPORT . . . . . 1-1
1.1.1 Report Organization . . . . . 1-2
1.1.2 Guidelines Used in the Qualitative Risk Assessment . . . . . 1-2
1.2 OPERABLE UNIT BACKGROUND . . . . . 1-4
1.3 OVERVIEW OF THE QRA APPROACH . . . . . 1-5
1.3.1 Data Evaluation . . . . . 1-5
1.3.2 Human Health Evaluation . . . . . 1-8
1.3.3 Ecological Evaluation . . . . . 1-15

2.0 DATA OVERVIEW . . . . . 2-1
2.1 HIGH-PRIORITY RCRA WASTE SITES WITH HISTORICAL AND LFI DATA . . . . . 2-2
2.1.1 116-N-1 (1301-N) Crib and Trench . . . . . 2-2
2.1.2 116-N-3 (1325-N) Crib and Trench . . . . . 2-4
2.2 HIGH-PRIORITY WASTE SITES WITH LFI DATA . . . . . 2-4
2.2.1 Sites 120-N-1 Percolation Pond and South Settling Pond and the 120-N-2 Surface Impoundment . . . . . 2-5
2.2.2 Site 116-N-2 Treatment Storage Facility . . . . . 2-6
2.2.3 Site 1322-N/1322-NA Sample Buildings . . . . . 2-7
2.2.4 Site 119-N Cooling Water Drain Line . . . . . 2-7
2.3 HIGH-PRIORITY WASTE SITES WITHOUT HISTORICAL OR LFI DATA . . . . . 2-9
2.3.1 118-N-1 Spacer Storage Silos . . . . . 2-9
2.3.2 1304-N Emergency Dump Tank . . . . . 2-9
2.3.3 116-N-4 Emergency Dump Basin . . . . . 2-10
2.3.4 105-N Spent Fuel Storage Basin . . . . . 2-10
2.3.5 UN-100-N-6 Decontamination Waste Drain Line . . . . . 2-10
2.4 LOW-PRIORITY WASTE SITES WITHOUT HISTORICAL OR LFI DATA . . . . . 2-11
2.4.1 1314-N Liquid Waste Loadout Station . . . . . 2-11
2.4.2 1143-N Paint Shop . . . . . 2-12
2.4.3 N-17 Paint Shop . . . . . 2-12
2.4.4 184-N Day Tanks . . . . . 2-12
2.4.5 166-N - 184-N Piping . . . . . 2-13
2.4.6 166-N Drum Storage Area . . . . . 2-13
2.4.7 Acid/Caustic Storage and Transport System . . . . . 2-13
2.4.8 UN-100-N-11 Radioactive Spill from Valve Bonnet . . . . . 2-14
2.4.9 124-N-4 Septic Tank and Drainfield . . . . . 2-14
2.4.10 Other Septic Tanks and Sewer Systems . . . . . 2-14
2.4.11 Hanford Generating Plant Burn Pit . . . . . 2-15
2.4.12 1716-N Service Station Underground Storage Tanks . . . . . 2-15
2.4.13 182-N Underground Storage Tanks . . . . . 2-15

CONTENTS (cont)

2.4.14 184-N Plant Service Powerhouse . . . . . 2-15
2.4.15 116-N Air Stack . . . . . 2-16
2.4.16 116-N-8 Hazardous and Mixed Waste Storage Area and 120-N-4 Nonhazardous and Nonradioactive Storage Area . . . . 2-16
2.4.17 182-N Drain System . . . . . 2-16
2.4.18 181-N Inlet Screen Backwash Water Outfall and 182-N Tank Farm Overflow . . . . . 2-17
2.4.19 105-N Lift Station Underground Storage Tank . . . . . 2-17
2.4.20 181-N Waste Oil Tank . . . . . 2-17
2.4.21 260-cm (102-in) Outfall Line . . . . . 2-18
2.4.22 182-N Unplanned Release of Turbine Oil to the Columbia River . . . . . 2-18
2.4.23 128-N-1 Burn Pit, Grass Dump, and Construction Debris Dump . . . . . 2-18
2.5 IDENTIFICATION OF CONTAMINANTS OF POTENTIAL CONCERN . . . . . 2-19
2.5.1 Human Health Evaluation . . . . . 2-19
2.5.2 Ecological Data Evaluation . . . . . 2-20
2.6 UNCERTAINTY ASSOCIATED WITH DATA EVALUATION . . . . . 2-20

3.0 WASTE SITE QUALITATIVE RISK ASSESSMENT . . . . . 3-1
3.1 HIGH-PRIORITY RCRA WASTE SITES WITH DATA . . . . . 3-1
3.1.1 116-N-1 (1301-N) Crib and Trench . . . . . 3-2
3.1.2 116-N-3 (1325-N) Crib and Trench . . . . . 3-3
3.2 HIGH-PRIORITY WASTE SITES WITH DATA . . . . . 3-4
3.2.1 120-N-1 Percolation Pond and South Settling Pond and 120-N-2 Surface Impoundment . . . . . 3-4
3.2.2 116-N-2 Treatment Storage Facility . . . . . 3-5
3.2.3 1322-N/1322-NA Sample Buildings . . . . . 3-6
3.2.4 119-N Cooling Water Drain Line . . . . . 3-7
3.2.5 166-N Tank Farm (UN-100-N-17) . . . . . 3-8
3.3 HIGH-PRIORITY WASTE SITES WITHOUT DATA . . . . . 3-9
3.3.1 118-N-1 Spacer Storage Silos Risk Characterization . . . . . 3-9
3.3.2 1304-N Emergency Dump Tank Risk Characterization . . . . . 3-9
3.3.3 116-N-4 Emergency Dump Basin Risk Characterization . . . . . 3-10
3.3.4 105-N Spent Fuel Storage Basin Risk Characterization . . . . . 3-10
3.3.5 UN-100-N-6 Decontamination Waste Drain Line Risk Characterization . . . . . 3-10
3.3.6 Risk Characterization Uncertainty Analysis for High-Priority Sites Without Data . . . . . 3-10
3.4 LOW-PRIORITY WASTE SITES WITHOUT DATA . . . . . 3-11
3.4.1 1314-N Liquid Waste Loadout Station . . . . . 3-11
3.4.2 1143-N Paint Shop . . . . . 3-11

CONTENTS (cont)

3.4.3 N-17 Paint Shop . . . . . 3-12
3.4.4 184-N Day Tanks . . . . . 3-12
3.4.5 166-N - 184-N Piping . . . . . 3-13
3.4.6 166-N Drum Storage Area . . . . . 3-13
3.4.7 Acid/Caustic Storage and Transport System . . . . . 3-14
3.4.8 UN-100-N-11 Radioactive Spill from Valve Bonnet . . . . . 3-14
3.4.9 124-N-4 Septic Tank and Drainfield . . . . . 3-15
3.4.10 Other Septic Tanks and Sewer Systems . . . . . 3-15
3.4.11 Hanford Generating Plant Burn Pit . . . . . 3-16
3.4.12 1716-N Service Station Underground Storage Tanks . . . . . 3-16
3.4.13 182-N Underground Storage Tanks . . . . . 3-17
3.4.14 184-N Plant Service Powerhouse . . . . . 3-17
3.4.15 116-N Air Stack . . . . . 3-18
3.4.16 116-N-8 Hazardous and Mixed Waste Storage Area and 120-N-4 Nonhazardous and Nonradioactive Storage Area . . . . 3-18
3.4.17 182-N Drain System . . . . . 3-18
3.4.18 181-N Inlet Screen Backwash Water Outfall and 182-N Tank Farm Overflow . . . . . 3-19
3.4.19 105-N Lift Station Underground Storage Tank . . . . . 3-19
3.4.20 181-N Waste Oil Tank . . . . . 3-20
3.4.21 260-cm (102-in) Outfall Line . . . . . 3-20
3.4.22 182-N Unplanned Release of Turbine Lube Oil to the Columbia River . . . . . 3-20
3.4.23 128-N-1 Burn Pit, Grass Dump, and Construction Debris Dump . . . . . 3-21

4.0 SUMMARY AND CONCLUSIONS . . . . . 4-1
4.1 HUMAN HEALTH QUALITATIVE RISK ASSESSMENT . . . . . 4-1
4.1.1 Results of the Human Health QRA . . . . . 4-1
4.1.2 Summary of Key Uncertainties in the Human Health Risk Assessment . . . . . 4-5
4.2 ECOLOGICAL QUALITATIVE RISK ASSESSMENT . . . . . 4-6
4.2.1 Results of the Ecological Evaluation . . . . . 4-6
4.2.2 Summary of Key Uncertainties in the Ecological Evaluation . . . 4-6

5.0 REFERENCES . . . . . 5-1

**FIGURES:**

Figure 1-1 Hanford Site and Area Designations . . . . . 1F-1
Figure 1-2 RCRA TSD Facilities and High-Priority Sites in the 100 N Area . . . . . 1F-2
Figure 1-3 Low-Priority Sites in the 100 N Area . . . . . 1F-3
Figure 1-4 Conceptual Model for Human Exposure Assessment . . . . . 1F-4

CONTENTS (cont)

**FIGURES (cont):**

1-5 Contaminant Exposure Pathway for the 100-NR-1 Source Operable Unit . . . . . 1F-5
3-1 Site 116-N-1 (1301-N) Frequent-Use Scenario External Exposure Incremental Cancer Risk for Human Health QRA for 1992, 0-15 Feet . . . . . 3F-1
3-2 Site 116-N-3 (1325-N) Frequent-Use Scenario External Exposure Incremental Cancer Risk for Human Health QRA for 1992, 0-15 Feet . . . . . 3F-2
3-3 Site 116-N-2 Frequent-Use Scenario External Exposure Incremental Cancer Risk for Human Health QRA for 1992, 0-15 Feet . . . . . 3F-3
3-4 Site 1322-N/1322-NA Frequent-Use Scenario External Exposure Incremental Cancer Risk for Human Health QRA for 1992, 0-15 Feet . . . . . 3F-4

**TABLES:**

1-1 The Hanford Sitewide Background Summary Statistics and Upper Threshold Limits for Inorganic Analytes . . . . . 1T-1
1-2 100-NR-1 Source Operable Unit Facilities and Sites . . . . . 1T-2a
1-3 Human Toxicity Values for Radioactive Contaminants1T-3
1-4 Human Toxicity Values for Inorganic Contaminants . . . . . 1T-4
1-5 Human Toxicity Values for Organic Contaminants . . . . . 1T-5a
1-6 Estimated Wildlife NOEL . . . . . 1T-6
2-1 Site 116-N-1 (1301-N) Summary of Maximum Concentrations of Radionuclides (pCi/g) . . . . . 2T-1a
2-2 Site 116-N-1 (1301-N) Summary of Maximum Concentrations of Inorganics (mg/kg) . . . . . 2T-2a
2-3 Site 116-N-1 (1301-N) Summary of Maximum Concentrations of Volatile Organics (μg/kg) . . . . . 2T-3a
2-4 Site 116-N-1 (1301-N) Summary of Maximum Concentrations of Semi-Volatile Organics (μg/kg) . . . . . 2T-4a
2-5 Site 116-N-3 (1325-N) Summary of Maximum Concentrations of Radionuclides (pCi/g) . . . . . .2T-5
2-6 Summary of Radionuclide Maximum Concentrations for Sites with LFI Data Only (pCi/g) . . . . . 2T-6a
2-7 Summary of Maximum Concentrations of Inorganics for Sites with LFI Data Only (mg/kg) . . . . . 2T-7a
2-8 Summary of Maximum Concentrations of Volatile Organics for Sites with LFI Data Only (μg/kg) . . . . . 2T-8a
2-9 Summary of Maximum Concentrations of Semi-Volatile Organics for Sites with LFI Data Only (μg/kg) . . . . . 2T-9a
2-10 Source Operable Unit 100-NR-1 List of Nonquantitative Source Constituents . 2T-10a
2-11 100-NR-1 Preliminary Radionuclide Human Health Risk-Based Screening Concentrations . . . . . 2T-11
2-12 100-NR-1 Preliminary Inorganic Human Health Risk-Based Screening Concentrations . . . . . 2T-12

CONTENTS (cont)

TABLES (cont):

2-13 100-NR-1 Preliminary Organic Human Health Risk-Based Screening Concentrations . . . . . 2T-13a
2-14 LFI Work Plan High-Priority Waste Site Process Knowledge Source Constituents, Soil Human Health Risk Based Screening Concentrations for Frequent-Use . . . . . 2T-14
2-15 Contaminants of Potential Concern for the Human Health Evaluation at 100-NR-1 . . . . . 2T-15
2-16 Contaminants of Potential Concern Retained for Ecological Evaluation . . . . . 2T-16
2-17 General Parameters Used for Ecological Dose (Radionuclide) Equations . . . . . 2T-17
2-18 General Parameters Used for Ecological Dose (Nonradionuclide) Equations . . . 2T-18
2-19 Summary of Human Health Risk Above 1E-06 for Frequent-Use Scenario, Nondetected Radionuclides . . . . . 2T-19
2-20 Summary of Human Health Risk Above 1E-06 for the Frequent-Use Scenario, Nondetected Nonradionuclides . . . . . 2T-20
3-1 Site 116-N-1 (1301-N) Summary of the Human Health Risk Assessment for Radioactive Contaminants of Potential Concern for 1992 . . . . . 3T-1
3-2 Site 116-N-1 (1301-N) Summary of the Human Health Risk Assessment for Radioactive Contaminants of Potential Concern for 2018 . . . . . 3T-2
3-3 Site 116-N-1 (1301-N) Summary of the Human Health Risk Assessment for Nonradioactive Contaminants of Potential Concern for 1992 (0-15 feet) . . . . . 3T-3
3-4 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-N-1 (1301-N) Crib and Trench (0-6 feet) . . . . . 3T-4
3-5 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-N-1 (1301-N) Crib and Trench (6-15 feet) . . . . . 3T-5
3-6 Site 116-N-3 (1325-N) Summary of the Human Health Risk Assessment for Radioactive Contaminants of Potential Concern for 1992 (0-15 feet) . . . . . 3T-6
3-7 Site 116-N-3 (1325-N) Summary of the Human Health Risk Assessment for Radioactive Contaminants of Potential Concern for 2018 (0-15 feet) . . . . . 3T-7
3-8 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-N-3 (1325-N) Crib and Trench (0-6 feet) . . . . . 3T-8
3-9 Site 116-N-2 Summary of the Human Health Risk Assessment for Radioactive Contaminants of Potential Concern for 1992 (0-15 feet) . . . . . 3T-9
3-10 Site 116-N-2 Summary of the Human Health Risk Assessment for Radioactive Contaminants of Potential Concern for 2018 (0-15 feet) . . . . . 3T-10
3-11 Site 116-N-2 Summary of the Human Health Risk Assessment for Nonradioactive Contaminants of Potential Concern (0-15 feet) . . . . . 3T-11
3-12 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-N-2 Treatment Storage Facility (0-6 feet) . . . . . 3T-12
3-13 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-N-2 Treatment Storage Facility (6-15 feet) . . . . . 3T-13
3-14 Site 1322-N/1322-NA Summary of the Human Health Risk Assessment for Radioactive Contaminants of Potential Concern for 1992 (0-15 feet) . . . . . 3T-14

CONTENTS (cont)

**TABLES (cont):**

3-15 1322-N/1322-NA Summary of the Human Health Risk Assessment for Radioactive Contaminants of Potential Concern for 2018 (0-15 feet) . . . . . 3T-15
3-16 Estimated Dose Rate for the Great Basin Pocket Mouse for the 1322-N/1322-NA Sample Buildings (0-6 feet) . . . . . 3T-16
3-17 Estimated Dose Rate for the Great Basin Pocket Mouse for the 1322N/1322NA Sample Buildings (6-15 feet) . . . . . 3T-17
3-18 Estimated Dose Rate for the Great Basin Pocket Mouse for the 120-N-1/120-N-2 Ponds (0-6 feet) . . . . . 3T-18
3-19 Estimated Dose Rate for the Great Basin Pocket Mouse for the 120-N-1/120-N-2 Ponds (6-15 feet) . . . . . 3T-19
4-1 100-NR-1 Summary of LFI or Historical Data For 0-15 Feet . . . . . 4T-1
4-2 100-NR-1 Summary of Human Health QRA for Quantitative Data Sites . . . . . 4T-2
4-3 Summary of Human Health QRA for Waste Sites Without Quantitative Data for 0-15 Feet . . . . . 4T-3a
4-4 Environmental Hazard Quotients Summary for Radionuclides by Waste Site . . . . 4T-4
4-5 Summary of Contaminants at Sites Which Exceed the EHQ of 1 for Wildlife . . . . 4T-5

# 1.0 INTRODUCTION

The 100-NR-1 Source Operable Unit, the subject of this qualitative risk assessment (QRA), is located within the 100 Area of the Hanford Site (Figure 1-1). The Hanford Site was included on the U.S. Environmental Protection Agencies (EPA) national priorities list (NPL) under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA).

The Washington Department of Ecology (Ecology), EPA, and the U.S. Department of Energy (DOE) are signatories to the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1992). The signatories have developed a strategy to emphasize early initiation and completion of waste site cleanups, as described in the *Hanford Past-Practice Strategy* (HPPS) (DOE-RL 1991a). The application of the HPPS at the 100-NR-1 Source Operable Unit is discussed in detail in the *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-NR-1 Operable Unit* (DOE-RL 1991b), referred to hereinafter as the limited field investigation (LFI) work plan.

This report provides the QRA for the waste sites associated with the 100-NR-1 Source Operable Unit. The QRA focuses on the principal risk drivers in the operable unit. It may be used to help determine the need for interim remedial measures (IRM), to select the IRM, and to support the development of risk-based cleanup levels for the IRM. It also may be used to support other paths, when agreed upon by the Tri-Party Agreement signatories. An IRM, as defined in the HPPS, is "an onsite response conducted pursuant to CERCLA 40 Code of Federal Regulations (CFR) 300.430 involving interim remedial actions that are conducted at a CERCLA past-practice operable unit at any time prior to initiation of final remedial action. Interim response measures can include Resource Conservation and Recovery Act (RCRA) interim measures as deemed appropriate by the parties."

## 1.1 PURPOSE AND APPROACH OF REPORT

The QRA at the 100-NR-1 Source Operable Unit focuses on a limited set of human and environmental exposure scenarios in order to provide sufficient information to help the Tri-Party signatories make defensible decisions on the necessity of an IRM. Frequent-use and occasional-use exposure scenarios are evaluated in the human health QRA to provide bounding estimates of risk and are based on the residential and recreational exposure factors, respectively, presented in the *Hanford Site Risk Assessment Methodology* (HSRAM) (DOE-RL 1994), as agreed to by the 100 Area Tri-Party unit managers. There are no residential or recreational land-uses in the 100-NR-1 Source Operable Unit at present. The commercial/industrial scenario is also evaluated in the human health QRA because of the ongoing decommissioning activities. Ecological scenarios are evaluated using biological receptors with home ranges similar in size to the waste site. The Hanford Future Site Uses Working Group (HFSUWG) recommended that the 100 Area be classified for unrestricted land use and listed the following four options for consideration: (1) Native American uses; (2) limited recreation uses, recreation-related commercial uses, and wildlife uses;

(3) N Reactor use as a museum/visitor center; and (4) wildlife and recreation uses. None of the HFSUWG recommendations included residential use (HFSUWG 1992).

Available offsite monitoring information indicates that the overall risk from the Hanford Site to current offsite residents already meets the $10^{-4}$ to $10^{-6}$ target risk range established by the EPA. Therefore, 100-NR-1 waste sites, which contribute only a part of any offsite risk, also currently meet the target risk range for offsite exposure. In addition, current Hanford Site personnel are sufficiently protected because access to the 100-NR-1 waste sites is restricted by fencing, onsite and offsite monitoring is conducted, and soil or gravel cover reduces or eliminates the potential for exposure. Because these current protective measures may not exist in the future, the QRA evaluated contaminants detected in the soil at the waste sites. The contaminants detected from 0 to 4.6 m (0 to 15 ft) were considered to be exposed at the surface based on the potential depth of soil excavation, as required by the Washington Administrative Code (WAC) 173-340-740[6][c]. Risk calculations were not performed for contaminants detected below a depth of 4.6 m (15 ft).

The only other current risk scenario would be a trespasser at the site. The occasional-use scenario effectively addresses this pathway. It is also a conservative assessment of current risk because it includes the evaluation of soil ingestion of contaminants that may be as deep as 4.6 m (15 ft). This conservative approach is used because of the limited data set and because the QRA is a screening-level, bounding risk assessment.

Available LFI, historical, and analogous data are evaluated in exposure and toxicity assessments to determine the risks or hazards associated with each waste site in the 100-NR-1 Source Operable Unit. The QRA is conducted using the HSRAM (DOE-RL 1994) as guidance.

This QRA for the 100-NR-1 Source Operable Unit is based primarily on the nature and vertical extent of contamination in the vadose zone at individual waste sites. Based on historical information and process knowledge, the main contaminants are expected to be radionuclides.

### 1.1.1 Report Organization

This QRA is organized into five sections. Section 1.0 describes the purpose and scope of the report, operable unit background, and the QRA overview; Section 2.0 provides a data overview; Section 3.0 provides the human health and ecological evaluation of each waste site; Section 4.0 presents a summary of the major findings of the QRA and includes a summary table that identifies key results of the QRA; and Section 5.0 is the reference list.

### 1.1.2 Guidelines Used in the Qualitative Risk Assessment

The following guidelines were agreed to by the Tri-Party unit managers prior to performing the QRA:

- sitewide soil background concentration data are used to screen inorganic constituents
- historical radionuclide concentrations are decayed to 1992
- maximum contaminant concentrations within the upper 4.6 m (15 ft) of soil, either from historical or LFI data, are used to estimate risk
- two scenarios, frequent-use and occasional-use, are evaluated in the human health section of the QRA; the commercial/industrial scenario is also evaluated because of current and continuing work underway at 100-NR-1
- for the human health exposure assessment, the pathways evaluated in the QRA are soil ingestion, fugitive dust inhalation, inhalation of volatile organics, and external radiation exposure
- ecological scenarios are evaluated using the Great Basin pocket mouse because it is a key component of the Hanford Area food chain and a biological receptor with a home range similar in size to the dimensions of most individual waste sites.

Several other guidelines are used in the QRA. Data collection during the source operable unit LFI followed a known process and, therefore, the data are considered to be of high quality. In general, historical information did not include soil concentrations and is considered to be of medium quality for contaminant identification only. Chromium is assumed to be present as chromium (VI) because this provides the most conservative evaluation and chromium was not speciated during analysis. If toxicity factors are not available for a potential contaminant, surrogate values are generally not used unless specifically noted. If toxicity values for nonradionuclides are available for one route and not the other, the available route value is used for the other route.

The qualitative risk estimations are grouped into high (incremental cancer risk [ICR] > 1E-02), medium (ICR > 1E-04 to 1E-02), low (ICR > 1E-06 to 1E-04), and very low (ICR < 1E-06) risk categories. Qualitative risk estimations are calculated for the year 2018 to ascertain potential future risks associated with each waste site after additional radionuclide decay. Surface soil shielding was not evaluated because the significant maximum concentrations were detected in the upper 1.8 m (6 ft) of soil.

For the ecological risk assessment, metals are assumed to be bioavailable for uptake by vegetation. In addition, the identified concentrations are assumed to be uniformly distributed over the site, and the biological, chemical, and physical degradation of these chemicals is assumed to be minimal. Hazard quotients (HQ) for radionuclides are based on

an exposure limit of 1 rad/day (DOE Order 5400.5) (DOE 1990) and the no observed effect level (NOEL) dose.

The objective of this QRA is to develop a decision-making tool for the risk managers considering the need for IRM. Maximum concentrations from the LFI are used to provide a conservative screening of sites for no-further-action consideration. The QRA is not a full risk assessment, as described in the HSRAM (DOE-RL 1994), and does not replace or eliminate the need for one. It is only a tool to help determine whether an IRM is necessary.

## 1.2 OPERABLE UNIT BACKGROUND

The Hanford Site is a 1,434-$km^2$ (560-$mi^2$) tract of land located in Benton, Franklin, and Grant Counties in the south-central portion of the state of Washington. The 100 N Area is approximately 43 air and 61 river km (27 air and 38 river mi) north of the city of Richland, as shown in Figure 1-1. The 100 N Area is bounded by the Columbia River on the north and the 600 Area (the portion of the Hanford Site that surrounds the primary operation areas) on the remaining sides. The 100 D/DR Area is northeast and the 100 K Area is southwest of the 100 N Area (Ecker et al. 1983). The 100-NR-1 Source Operable Unit encompasses approximately 2.6 $km^2$ (1.0 $mi^2$), predominantly within Section 28, the southern portions of Sections 21 and 22, and the western portion of Section 27 of Township 14 North, Range 36 East. It is bounded by North American Datum 1983 metric Washington State plane north/south coordinates NN4400 and NN9000 and east/west coordinates WN5500 and WN7600 (DOE-RL 1991b).

The 100 N Area has been divided into two operable units: 100-NR-1 and 100-NR-2. This QRA addresses the 100-NR-1 Source Operable Unit. The 100-NR-1 Source Operable Unit is composed of the physical structures, potential source units, and the vadose zone within the boundaries of the 100 N Area. This area contains the facilities associated with the operation of the N Reactor. Figure 1-2 shows RCRA treatment, storage, and disposal (TSD) and high-priority sites. Figure 1-3 shows low-priority sites. Both figures show the approximate boundaries of the 100-NR-1 Source Operable Unit. The 100-NR-2 Operable Unit includes the groundwater below the 100 N Area Source Operable Unit, plus the adjacent groundwater, surface water, sediments, and aquatic biota impacted by 100 N Area operations. The 100-NR-2 Groundwater Operable Unit is addressed in a separate QRA.

The N Reactor was built between 1959 and 1964 and was designed to produce special nuclear materials and to generate steam for power production. The N Reactor first went on line in 1963 and operated continuously until it was placed in stand-down status in 1986. The reactor was placed in cold standby in 1988, and shutdown was ordered in 1991. Radioactive and hazardous effluent wastes were generated in processes that supported the N Reactor. These wastes include reactor primary cooling water, spent fuel storage basin cooling water, reactor periphery systems cooling water and rinse solution, and miscellaneous drainage from reactor support facilities. Hazardous and effluent wastes were generated primarily from the

reactor primary coolant loop decontamination and water treatment and demineralization plants.

## 1.3 OVERVIEW OF THE QRA APPROACH

This section provides an overview of the QRA process that is applied to each waste site in the 100-NR-1 Source Operable Unit. The QRA consists of three elements: data evaluation (Section 1.3.1), human health evaluation (Section 1.3.2), and ecological evaluation (Section 1.3.3).

### 1.3.1 Data Evaluation

Data evaluation involves an evaluation of site-specific data, including a comparison to background.

**1.3.1.1 Hanford Site Background Data Summary.** The natural composition of soils at the Hanford Site has recently been characterized (DOE-RL 1993a). The characterization effort involved the determination of the types and concentrations of nonradioactive inorganic analytes that exist naturally in soils at the Hanford Site. Physical properties and factors that might affect the natural soil chemical composition, as determined by regulatory protocols, were characterized.

The sitewide approach to characterization of soil background was used, as recommended in HSRAM (DOE-RL 1994). The sitewide approach is based on the premise that all waste sites are part of a common sequence of vadose zone sediments and the basic characteristics that control the chemical composition of the sediments are similar throughout the Hanford Site. Using this premise, a range of natural soil compositions was used to establish a single set of soil background data. This approach has the advantage of providing a single, consistent set of data for assessing baseline risk. However, use of project-specific background concentration may be more appropriate under certain circumstances. For example, soils in riparian ecosystems have concentrations of metals that are distinctly higher than the sitewide reference levels (DOE-RL 1993a). These higher concentrations were attributed to the higher concentrations of organic matter found in soils in riparian ecosystems. Thus, it may be more appropriate to develop project-specific background concentration to evaluate waste sites that are located in a riparian ecosystem (e.g., outfall structures). Although this approach should be evaluated further, it has not been used in this report.

Table 1-1 presents the 95% upper threshold limit (UTL) for inorganic analytes, as determined based on a lognormal distribution of the data in DOE-Richland Operations Office (RL) (1993a). The UTL is the 95% confidence limit for the 95th percentile of the distribution and serves as a statistically significant estimator on the upper population limits of background concentrations. To determine whether an inorganic analyte is a contaminant, the maximum measured LFI concentration, is compared with the 95% UTL, which is used as the

background value. If the maximum analyte concentration exceeds the 95% UTL, the analyte is considered a contaminant and is evaluated further in the risk assessment. Detected levels of organic and radionuclide analytes from historical or LFI data are not compared against background. All organic compounds and radionuclides are assumed to be contaminants and thus, are evaluated in the risk assessment, as recommended in HSRAM (DOE-RL 1994).

**1.3.1.2 100-NR-1 Source Operable Unit Waste Sites.** This section provides an overview of the general sources of information consulted to prepare the QRA. Table 1-2 lists the sites, along with alias names and an itemized list of spills.

Most of the historical data were obtained from the work plan (DOE-RL 1991b), unless otherwise referenced. Historical information was used to support identification of possible contaminants for consideration in the QRA and to support the characterization of the risk associated with each waste site. The available information includes data on media other than soil (air and water effluents) or process knowledge. Historical data were used for identification of contaminants of potential concern (COPC) in this QRA. The historical information used is considered to be of medium quality.

Former building or facility sites may be potential sources of contamination; therefore, some decommissioned facilities have been included in the list of waste sites. Decontamination and decommissioning activities have been instituted at some sites to minimize the spread of radioactive isotopes from reactors, buildings, and facilities after the reactors were retired. Decontamination and decommissioning data and information, if available, were reviewed and included in the historical information.

A common data set is being used for the QRA and the LFI. The maximum concentration summary tables show the data before blank evaluation, background evaluation, and risk screening. A summary of maximum concentrations for radionuclides, inorganics, volatile organics, and semi-volatile organics at 100-NR-1 is presented in Section 2.0.

The data available for waste sites sampled during the LFI include information from borehole, test pit, or surface soil samples that were collected because existing data were considered insufficient. Sampling and field activities for the 100-NR-1 Operable Unit are summarized and sampling locations within 100-NR-1 are shown in the LFI (DOE-RL 1993b). Samples were typically analyzed for the full suite of CERCLA target compound list (TCL) and target analyte list (TAL) constituents, anions, polychlorinated biphenyls (PCB) and pesticides, and radionuclides, as specified in Table 4-2 of the work plan (DOE-RL 1991b). Anion, PCB, and pesticide data are not included in this QRA. The analyses were performed by the TMA-Norcal and Skinner & Sherman laboratories.

A total of 115 samples were collected during the LFI at the 100-NR-1 Source Operable Unit. The LFI data collected for each waste site were analyzed using methods specified in Appendix A of the Quality Assurance Project Plan in the work plan (DOE-RL 1991b). Based on the validation reports, data results were assigned qualifiers in accordance with criteria specified in *Data Validation Procedures for Chemical Analyses* (Bechtold 1992). Data that are termed "usable" (detected compounds or estimated "J" values) can be used in

the risk assessment. Data that are not considered usable include data that were rejected (qualified with an "R") by the data validator. However, if review of the rejected data indicated that the reason for rejection was administrative concerns (e.g., missing data sheets) and not other quality assurance/quality control (QA/QC) issues (e.g., technical concerns), the rejected data were determined acceptable for the QRA. This is the only circumstance under which rejected data were considered in the QRA. The LFI data used in this report were 100% validated.

**1.3.1.2.1 Waste Sites with Historical and LFI Data.** Historical data and LFI data were available for the following waste sites:

- 116-N-1 Crib and Trench
- 116-N-3 Crib and Trench.

**1.3.1.2.2 Waste Sites with LFI Data.** Limited field investigation data were available for the following sites:

High-Priority Sites:

- 116-N-2 Treatment Storage Facility
- 1322-N/1322-NA Sample Buildings
- 119-N Cooling Water Drain Line
- 166-N Tank Farm (UN-100-N-17).

RCRA Sites:

- 120-N-1 Percolation Pond and South Settling Pond
- 120-N-2 Surface Impoundment.

**1.3.1.2.3 Waste Sites with No Historical or LFI Data.** Waste sites for which the QRA was limited to process knowledge or data from analogous sites include the following:

High-Priority Sites:

- 118-N-1 Spacer Storage Silos
- 1304-N Emergency Dump Tank (EDT)
- 116-N-4 Emergency Dump Basin (EDB)
- 105-N Spent Fuel Storage Basin
- UN-100-N-6 Decontamination Waste Drain Line.

Low-Priority Sites:

- 1314-N Liquid Waste Loadout Station (LWLS)
- 1143-N Paint Shop
- N-17 Paint Shop
- 184-N Day Tanks

- 166-N -- 184-N Piping
- 166-N Drum Storage Area
- Acid/Caustic Storage and Transport System
  - 120-N-3
  - 120-N-5
  - 120-N-6
  - 120-N-7
  - 120-N-8
  - Regeneration Waste Transport System
  - 116-N-2 Spring 1983 Unplanned Release
- UN-100-N-11 Radioactive Spill from Valve Bonnet
- 124-N-4 Septic Tank and Drainfield
- Other Septic Tanks and Sewer Systems
  - 124-N-1
  - 124-N-2
  - 124-N-3
  - 124-N-5
  - 124-N-6
  - 124-N-7
  - 124-N-8
  - 124-N-9
  - 124-N-10
- Hanford Generating Plant (HGP) Burn Pit
- 1716-N Service Station Underground Storage Tanks (UST)
- 182-N UST
- 184-N Plant Service Powerhouse
- 116-N Air Stack
- 116-N-8 Hazardous and Mixed Waste Storage Area
- 120-N-4 Nonhazardous and Nonradioactive Storage
- 182-N Drain System
- 181-N Inlet Screen
- 182-N Tank Farm Overflow
- 105-N Lift Station UST
- 181-N Waste Oil Tank
- 102-in Outfall Line
- 182-N Unplanned Release (Turbine Oil)
- 128-N-1 Burn Pit
- Grass Dump
- Construction Debris Dump.

### 1.3.2 Human Health Evaluation

This section discusses the general approach used to implement the four elements of the human health evaluation for the QRA: toxicity assessment, exposure assessment, risk

characterization, and evaluation of uncertainty. Qualitative risk assessment methodology is discussed in detail in Appendix C of the HSRAM (DOE-RL 1994).

**1.3.2.1 Exposure Assessment.** The exposure assessment methodology is presented in Section 2.2 and Appendices A and C of the HSRAM (DOE-RL 1994). The exposure assessment includes the determination of exposure scenarios, pathways, parameters, and point concentrations and the quantification of exposures. The scenarios and pathways for the QRA have been discussed and selected by the 100 Area Tri-Party unit managers. The individual components of the exposure assessment methodology are discussed in the following sections. The conceptual site model for human exposure assessment presented in Figure 1-4 is duplicated from HSRAM (DOE-RL 1994). The pathways covered in this QRA are shaded.

**1.3.2.1.1 Conceptual Site Model.** The conceptual site model for contaminant exposure pathway for the 100-NR-1 Operable Unit is presented in Figure 1-5. The bold pathway lines indicate the pathways applicable to the 100-NR-1 Source Operable Unit. This model is taken from the work plan (DOE-RL 1991b). The pathways addressed in this QRA are a subset of those presented in the model. Other pathways may not be covered under the QRA methodology (DOE-RL 1994) or they may be covered in the 100-NR-2 Groundwater Operable Unit QRA (WHC 1993a).

**1.3.2.1.2 Exposure Scenarios.** The exposure scenarios selected to evaluate the waste sites are based on frequent-use and occasional-use of the waste site under contaminant conditions in 1992. The 100 N Area is currently undergoing decommissioning and demolition operations. The current activities are commercial/industrial; therefore, this additional scenario was evaluated for the 100 N Area. The exposures and associated risks presented in the QRA for frequent- and occasional-use are estimates of potential risks posed under high- or low-frequency use. In addition, the above scenarios are also evaluated for radionuclides using the maximum concentrations of radionuclides decayed to the year 2018. This additional evaluation is presented to assess the changing contribution of decaying radionuclides to exposures that would occur in the future.

Under current site conditions, institutional controls prevent inadvertent intrusion into a contaminated zone such that any clean soil cover present is maintained. Subsurface contaminants at depth are not accessible to receptors. However, radionuclides present in the soil could result in external exposures.

**1.3.2.1.3 Exposure Pathways.** The following pathways are evaluated for each scenario of the QRA for 100-NR-1:

- soil ingestion
- fugitive dust inhalation
- inhalation of volatile organics from soil
- external radiation exposure.

In accordance with HSRAM (DOE-RL 1994), additional pathways are not evaluated in this QRA. No modeling of contaminant transport has been conducted for the QRA of waste sites at the 100-NR-1 Source Operable Unit.

**1.3.2.1.4 Exposure Parameters.** Scenario-specific exposure parameters are defined in Appendix A of the HSRAM (DOE-RL 1994) and are used without modification herein. Recreational exposure parameters are used to evaluate the occasional-use scenario. Residential exposure parameters are used to evaluate the frequent-use scenario. Industrial exposure parameters are used for the commercial/industrial scenario for ongoing decommissioning activities at the site. The QRA uses maximum contaminant concentrations, as discussed in Section 1.3.2.1.5, to provide a conservative evaluation of receptors and exposure pathways.

**1.3.2.1.5 Exposure Point Concentrations.** For purposes of the QRA, if contaminant concentration data are available, the maximum concentration of a COPC detected in a specific medium is used as the exposure point concentration. "Exposure point" means that the receptor is assumed to be exposed at that point (location). The maximum concentration is used, rather than calculating a 95% upper confidence limit (UCL) of the mean, because of the limited number of samples that are available for each specific high-priority waste site and because this is only a qualitative evaluation of the potential risk.

Waste sites for which LFI data are available are evaluated quantitatively for the frequent-, occasional-, and industrial-use scenarios. Waste site historical data are limited to source constituents and are not evaluated quantitatively in the QRA. Sites for which process knowledge or historical data are available are evaluated qualitatively. Risk-based concentrations are calculated for known source historical process constituents for which toxicity values are available. The evaluation of constituents for which toxicity values are available is addressed in the uncertainty evaluation. The radionuclide concentrations used in the 1992 evaluation were decayed to 2018 to assess a frequent-use scenario in the future.

The WAC requires that a reasonable estimate of the depth of soil that could be excavated and distributed at the ground surface as a result of site development activities (e.g., constructing a basement) be considered to extend from ground surface to 4.6 m (15 ft) below ground surface (WAC 173-340-740 [6][c]). Therefore, for the soil ingestion or external exposure pathways, the maximum concentration of a contaminant detected in the upper 4.6 m (15 ft) of the soil is used to calculate contaminant intakes for the frequent-use and occasional-use scenarios in 1992 and the frequent-use scenario in 2018.

Concentrations at greater depth, although not likely to result in exposures through soil ingestion or external exposure pathways, may impact groundwater. Potential impacts to groundwater from soil contaminants present at 100-NR-1 waste sites are addressed in the LFI (DOE-RL 1993b).

**1.3.2.1.6 Quantification of Exposures.** The methodology for quantification of exposures is presented in Section 2.2.5 of the HSRAM (DOE-RL 1994). Equations used to estimate intakes (a measure of exposure expressed as the concentration contacted over a

period of time) are also provided in Section 2.2.5 of the same document. Standard EPA equations (EPA 1989, DOE-RL 1994) are used as the basis for all intake calculations. Example equations and calculations are provided in Appendix C of the 100-BC-1 QRA (WHC 1992).

For the air inhalation pathway, maximum contaminant concentrations in the upper 4.6 m (15 ft) of soil and a respirable particulate emission factor (PEF), as described by EPA (1991a), were used to generate preliminary risk-based soil concentrations for fugitive dust inhalation. The PEF relates contaminant concentrations in soil to the concentration of respirable particles in the air due to fugitive dust emissions. The PEF of 2E+07 $m^3/kg$ used in the QRA is based on the National Primary Ambient Air Quality Standard for particulate matter of 50 $\mu g/m^3$ and the assumption that 100% of the particulates are retained in the lungs and absorbed. The PEF calculation is provided in Appendix C of the 100-BC-1 QRA (WHC 1992). A site-specific PEF was not calculated for each high-priority site based on the qualitative nature of the assessment. For each volatile contaminant in the soil-air pathway, a contaminant-specific volatilization factor (VF) was calculated (EPA 1991a). The VF calculation is presented in Appendix C of the 100-BC-1 QRA (WHC 1992). Whereas fugitive dust and volatile emissions were evaluated separately in Appendix C of the 100-BC-1 QRA (WHC 1992), they are combined in this QRA so that the calculation will automatically include the preferential dispersion of the contaminant by volatilization or fugitive dust.

**1.3.2.1.7 Quantification of External Exposure with Shielding.** External exposure to radiation, evaluated using Residual Radioactive (RESRAD) guidelines and software, has been determined to be effectively shielded at soil depths >1.8 m (>6 ft) below ground surface (WHC 1993b). At depths of 0 to 1.8 m (0 to 6 ft), the interval containing the maximum COPC concentrations, shielding is assumed to be ineffective and was not included in the QRA.

**1.3.2.2 Toxicity Assessment.** The general procedures for toxicity assessment are presented in Section 2.3 of the HSRAM (DOE-RL 1994). The toxicity assessment for the QRA identifies contaminant-specific toxicity factors and briefly discusses the key toxicities associated with the COPC. The assessment is not intended to evaluate all potential toxicities or contaminant characteristics but, rather, to include sufficient information on the COPC to help project managers reach decisions on IRM. Toxicity profiles for the COPC in this QRA are compiled in the most recent revision of HSRAM (DOE-RL 1994). The human health toxicity values used in this QRA are presented in Tables 1-3 and 1-4.

The following assumptions were made with respect to the toxicity of parameters evaluated in the QRA:

- All chromium is assumed to be chromium (VI), the most toxic oxidation state of chromium. Chromium (VI) is generally accepted as not being a carcinogen via the dermal route (not evaluated in this QRA).

- The toxicity value for lead has been withdrawn by the EPA in favor of a biokinetic uptake model based on a level of concern in human blood of

10μg/dl. However, this model has not been finalized by the EPA. The maximum detected concentrations are within or less than the range of 500 to 1,000 mg/kg identified by the EPA as generally protective for residential (i.e., frequent) use (EPA 1989). Therefore, evaluation for human health was not conducted beyond the preliminary risk-based screening for the QRA.

- If toxicity factors are not available for a contaminant, surrogate factors are not used in the QRA. This may result in an underestimation of total waste site HQ or total waste site ICR values and is addressed in the uncertainty section.

- If toxicity factors are available for the ingestion route only or the inhalation route only, the available factor is used for the other route also, especially to evaluate volatilization from soil and fugitive dust exposure. This practice of cross-route extrapolation is advantageous for reducing uncertainty in the risk assessment.

**1.3.2.3 Risk Characterization.** The risk characterization for the QRA follows the methods described in Section 2.4 of the HSRAM (DOE-RL 1994). The qualitative approach evaluates sites with quantitative sampling data and sites with limited or no sampling data. Consequently, risk characterization is discussed separately for each situation in the following sections.

**1.3.2.3.1 Risk Characterization with Available Quantitative Data.** If quantitative data are available for calculating ICR and HQ values, the risk characterization includes the following elements:

- calculation of contaminant-specific ICR and HQ values

- calculation of site-specific risks from contaminant-specific risks

- qualitative discussion of the risks with respect to the following levels:

| | | |
|---|---|---|
| ICR $< 10^{-6}$ contaminant-specific or site-total risk | = | very low |
| $10^{-4} <$ ICR $> 10^{-6}$ contaminant-specific or site-total risk | = | low |
| $10^{-2} <$ ICR $> 10^{-4}$ contaminant-specific or site-total risk | = | medium |
| ICR $> 10^{-2}$ contaminant-specific or site-total risk | = | high |

- qualitative discussion of the uncertainty associated with the risk estimates

- qualitative discussion of the threat posed by the site.

Throughout the QRA, ICR values that exceed 1E-02 are reported as "> 1E-02" because the linear equation used to estimate cancer risk is only valid at risk levels below 1E-02 (EPA 1989). Risk estimates made using this equation become increasingly inaccurate as they approach a value of 1.0 because the stochastic nature of cancer induction implies that no exposure level is high enough to ensure a carcinogenic response of unity. In such cases, ICR values of "> 1E-02" are sufficient for assigning high risk for purposes of the QRA.

For noncarcinogenic contaminants, the HQ is calculated as follows:

$$HQ = \frac{Chronic\ Daily\ Intake}{Reference\ Dose\ (RfD)}$$

where the RfD is the contaminant-specific chronic reference dose.

For carcinogenic contaminants, the ICR is calculated as follows:

$$ICR = (Chronic\ Daily\ Intake)\ (Slope\ Factor\ [SF])$$

where the SF is the contaminant-specific slope factor.

**1.3.2.3.2 Risk Characterization with No Available Quantitative Data.** For those sites for which sampling data are not available to calculate ICR and HQ values, the risk characterization consists of a qualitative discussion of the threat posed by the site and the confidence in the information available to assess the threat. Available process knowledge, data from analogous sites, and other information are used to characterize the risk for a site qualitatively. Contaminants that have no history of onsite use and that were not detected in the analytical results were dropped from the quantitative evaluation.

Contaminant-specific risk-based concentrations in a medium can be calculated if information is available on possible contaminants at a waste site. The risk-based concentration (RBC) are then compared with estimated site concentrations in a medium. This comparison puts site information into perspective. For example, if historical data or process knowledge indicates that very high concentrations of contaminants may be present in the soil, the calculation of a risk-based soil concentration provides a means for identifying concentrations that would be of concern.

The basic intake equations are modified to identify concentrations in a medium associated with a given cancer risk or HQ using the HSRAM (DOE-RL 1994) exposure parameters. The appropriately modified basic equations are presented in the most recent revision of the HSRAM (DOE-RL 1994).

The risk characterization includes a qualitative discussion of the site information, the risk-based concentration comparison, and the potential threat posed by the site. The overall uncertainty in the risk characterization is an integral part of the QRA and is especially important when data are not available.

**1.3.2.4 Evaluation of Uncertainty**. The evaluation of uncertainty in the characterization of risks is an integral part of the QRA. The risks, both carcinogenic and noncarcinogenic, presented in the QRA are conditional estimates based on multiple assumptions about exposures, toxicity, and other variables. The uncertainty in the QRA risk characterization focuses on specific uncertainties related to the waste site (e.g., data evaluation) and to the risk assessment process (e.g., toxicity information, exposure assumptions, etc.).

Uncertainty can be related to the characterization of the waste site because of the quality of data used in the QRA. Uncertainty in the identification of contaminants and concentrations is rated high, medium, and low as follows:

- Low - historical and LFI data (either from the site or analogous data) generally are available for the waste site and for the same medium (i.e., historical and LFI soil data).

- Medium - historical and LFI data (analogous data) are available for the waste site but not for the same medium.

- High - historical data or information is available for the waste site but no LFI data are available.

Limited field investigation data used in this QRA are generally of high known quality but may be considered of medium quality if extrapolated across environmental media. Historical data are considered of medium quality. Limited field investigation data were analyzed following specific EPA methods, were validated following EPA functional guidelines, and are of known quality. The data used from historical process knowledge and data for the source constituent medium are of low quality. Specific uncertainty considerations are discussed in Section 3.0 as part of each waste site QRA. An overall uncertainty discussion is presented in Section 4.0.

The uncertainties in the risk assessment process are related to the appropriateness of the toxicity information, the interpretation of toxicity data, the exposure assumptions, and the risk characterization. The primary sources of uncertainty related to the toxicity of the contaminants include the following:

- Using information on dose-response effects from high-dose exposure scenarios to predict effect at low-dose exposure scenarios.

- Using animal dose-response data to predict effects in humans.

- Using short-term exposure data to extrapolate to long-term exposure or vice versa.

- Using dose-response information from a standard laboratory test species or healthy human population to predict the effects that may occur in the general population, where there are varying sensitivities to different contaminants.

- Toxicity factors were not available for some detected polycyclic aromatic hydrocarbon (PAH) contaminants. As a result, risks from these compounds are a source of uncertainty in the QRA, but the uncertainties are minor. For instance, PAH other than benzo(a)pyrene (BAP) normally incorporate the toxicity values for BAP as a surrogate for risk characterization. However, in this QRA it is determined that other PAH maximum detected concentrations

are within the same order of magnitude as the BAP maximum detected concentration. The relative carcinogenic potency of other detected PAH compared to BAP is at least an order of magnitude less (EPA 1993a). The risk for the maximum detected BAP concentration is determined to be less than the target risk/hazard criteria. Therefore, the risk/hazard for other PAH would also be less than the target risk/hazard criteria.

Uncertainty in the exposure assessment occurs because of the limited amount of data used in characterizing the exposure concentration. The use of maximum concentrations for soil exposures and assumed concentrations for air exposures may overestimate or underestimate exposures.

Uncertainty in the risk characterization is the result of adding multiple contaminant exposures over several pathways. The summation of cancer risks across pathways or for multiple pathways may make the total cancer risk estimate more conservative. In addition, some contaminants may not have been evaluated because SF or RfD values have not been established or analytical data were not available.

### 1.3.3 Ecological Evaluation

The purpose of the qualitative ecological evaluation is to estimate the potential ecological risks to selected ecological receptors from existing contaminant concentrations at 100-NR-1 Source Operable Unit waste sites.

The 100-NR-1 Source Operable Unit is a land-based (terrestrial) waste unit. The qualitative ecological evaluation approach relies primarily on professional judgment; experience with waste site stressors, appropriate ecological receptors, and primary pathways; and existing or limited field data. The QRA is not an absolute measure of risk based on detailed conceptual models and pathway analyses. The operating assumptions are that contaminants are present at the site and the QRA estimates the direct risk from these contaminants to an ecological receptor.

The approach consistent with the objective of the QRA is to assess the dose to the Great Basin pocket mouse from each of the waste sites within the 100-NR-1 Source Operable Unit (DOE-RL 1994). The mouse is used as the indicator receptor because its home range is comparable to the size of most waste sites and will receive most of its dose from within a waste site. This allows a risk comparison between waste sites.

**1.3.3.1 Problem Formulation.** Issues relevant to evaluating the qualitative ecological risk for waste sites within the 100-NR-1 Source Operable Unit are the stressor characteristics, the ecosystems likely to be affected by these stressors, and the possible results to the stressor from exposure of selected ecosystem receptors.

**1.3.3.1.1 Stressor Characteristics.** As identified in the human risk assessment, the stressors of concern are those constituents (chemicals and radionuclides) for which

concentrations exceed background. These stressors are used in the QRA and are discussed briefly in the human health section. A detailed discussion of stressor characteristics is not provided because all contaminants exceeding background concentrations are included in the risk assessment.

All contaminants evaluated were either detected in site soils or were identified through historical records. The waste sites do not contain surface-water bodies and apparently are not subject to sheet flows from surface-water runoff. No data were obtained to evaluate concentrations of contaminants in biological media within the sites; consequently, biological uptake was evaluated from a soil source term.

Components of the 100-NR-1 Source Operable Unit environment that may be affected by wastes at the sites include all parts of the food web shown in Figure 1-6. The indicator receptor for risk screening is the Great Basin pocket mouse, a herbivore known to be present at waste sites. Threatened, endangered, and candidate birds are listed in the most recent revision of HSRAM (DOE-RL 1994), along with the special-status plants and animals on the Hanford Site.

Contaminants found in the soil at waste sites within the 100-NR-1 Source Operable Unit include radioactive and nonradioactive elements. For nonradioactive elements, ecological effects from uptake from soil by plants and by accumulation of these elements through the food web were evaluated.

The ecological effects of radioactive elements result from their presence in the abiotic environment (external dose) and from ingestion (e.g., dose from contaminated food consumption), resulting in a total body burden. Total daily doses to an organism can be estimated as the sum of doses (weighted by energy of radiation) received from all radioactive elements ingested, residing in the body, and available in the organism's environment. The radiological dose an organism receives is usually expressed as rad/day. Exposure can result from both external environmental radiation and internal radiation from body burden. All exposure pathways are added in determining total organism dose.

Most of the available information concerning ionizing radiation relates to acute dose rather than low dose exposure and chronic effects (Rose 1992). The use of acute data extrapolated to chronic levels is not appropriate in all cases and must be viewed with caution. For example, during chronic exposure, a point occurs where injury and natural organism repair mechanisms balance, resulting in no effect (Ophel et al. 1976).

A major area of uncertainty in evaluating ecological effects from exposure to ionizing radiation exposure is extrapolation from individual level to the population level of ecological organization. Only minimal information is available on dose-response relationships at the population level for the pocket mouse.

**1.3.3.1.2 Endpoint Selection.** The major departure of the qualitative and quantitative risk assessments occurs at endpoint assessments. In a quantitative risk assessment, several trophic levels and several ecological receptors of the food chain typically

are selected for study in order to encompass receptors of varying sensitivity, different endpoints, and several contaminant transport pathways. For the qualitative ecological evaluation, only one receptor is generally used for limited exposure scenarios and simple endpoints.

The assessment and measurement endpoints are the health and mortality, respectively, of the Great Basin pocket mouse. This is consistent with the objective of the qualitative ecological evaluation. The dose to the pocket mouse was used to screen the level of risk of an individual waste site. For radionuclides, mouse dose is compared with 1 rad/day (IAEA 1992). For nonradiological contaminants, dose is compared with toxicity values.

**1.3.3.1.3 Conceptual Model.** The conceptual ecological model is be derived based on the descriptions of ecological resources present at or near the 100-NR-1 Source Operable Unit waste sites and assuming that a contaminant source is limited to the soil. In this model, uptake of contaminants from soil by vegetation serves as the basic source of contaminant entry into the food chain. Only major routes of exposure to contaminants are considered for the QRA. For contributions to dose rate, radionuclides are screened for those which may add significant external ionizing radiation. Contributions to dose by inhalation and ingestion via preening or grooming contaminated fur are not documented and are assumed to be minimal for the QRA. The herbivore component, represented in the model by insects, the dominant herbivorous mammals, and the dominant herbivorous (seed-eating) bird act as the primary conduits between contaminants in vegetation and contaminants in carnivores. Two levels of carnivores are common to the 100 Area: primary- and second-order carnivores. The primary carnivores prey almost entirely on herbivores; consequently, only three levels of bioaccumulation are possible (soil to plant, plant to herbivore, and herbivore to primary carnivore). Second-order carnivores prey on other carnivores as well as on herbivores (Figure 1-6).

The approach taken in this QRA is to evaluate risk to the small herbivore component (Great Basin pocket mouse) based on a two-step accumulation model operated on a waste-site-by-waste-site basis because each waste site approximates the size of the Great Basin pocket mouse home range. Equations for primary and secondary organisms are presented in the Appendix of HSRAM (DOE-RL 1994). The method of integration is based on averaging waste site constituent concentrations over the operable unit as a fraction of the total operable unit area.

Estimating ecological risks from contamination is problematic when considering animals whose habitat use extends beyond the operable unit boundaries. For example, the 116-N-2 site is a relatively small area within the much larger 100-NR-1 Operable Unit, and the other waste sites are separated from each other by areas in which contaminant concentrations have not been determined but are likely to be much lower than those found in the waste sites themselves. Consequently, the environment outside the 100-NR-1 Operable Unit waste sites, as used by most of the wide-ranging animals in the conceptual model, is likely to be a mix of contaminated and uncontaminated habitat.

Because the waste sites are small compared with the home ranges of animals such as hawks, owls, loggerhead shrikes, and coyotes, the increase in risk from an individual waste site is likely to be small. This increase in risk may be insignificant if an uncontaminated environment outside the operable unit is assumed. A worst-case assumption would be that the contaminated environment of the receptor outside the waste site is not much different from that within the site environment. Such an assumption would be highly conservative for the larger raptors and the coyote, which range over many square kilometers (miles). A reasonable estimation of risk for these receptors is somewhere between these extremes.

**1.3.3.2 Analysis Phase.** The analysis phase of the qualitative ecological evaluation is a technical evaluation of the available data used to assess the potential for exposure of the Great Basin pocket mouse to the stressors at each waste site.

**1.3.3.2.1 Characterization of Exposure.** The exposure relationship between receptor and site contaminants is described in this section. Contaminants are assumed to be distributed uniformly throughout the site and biologically available. In addition, the measured radionuclide concentrations are assumed to be appropriate at the time of the risk assessment.

**1.3.3.2.2 Ecosystem Characterization.** The spatial distribution or the home range of the pocket mouse was evaluated using available site data to establish the point of contact (length of exposure to contaminants of concern [COC]) between the stressor and the mouse. The overlap of receptor home range with the site was considered sufficient for evaluation of the organism as a potential receptor, and it was assumed that the entire life of the organism is spent within the site. The period of exposure is determined by evaluating the percentage of time an organism could potentially spend feeding within the site. This is determined by estimating the fraction of the site area within the receptor home range area. No attempt was made to discriminate between seasonal use of the site by receptors.

**1.3.3.2.3 Exposure Analysis.** The exposure analysis integrates the spatial and temporal distributions of the ecological components and stressors to evaluate exposure. All nonradioactive and radioactive constituents identified as potential concern in the human health risk assessment (before the screening of constituents with the greatest human health risk) are considered to be of concern in the ecological evaluation. Because of the lack of site-specific data other than soil data, it is assumed that the receptor spends some fraction of its life at the site and obtains all its food from the site when present and that all consumed food is contaminated. However, because no source of water is present within the site, drinking water is not considered a route of exposure.

For nonradiological constituents, concentrations estimated in mice are compared with the reported benchmark or potentially toxic concentrations. For radiological constituents, mice concentrations were converted to dose. Total dose for all radionuclides are compared with published effect levels and regulatory standards where available.

**1.3.3.2.4 Exposure Profile.** The ecological evaluation focuses on potential noncarcinogenic effects on the Great Basin pocket mouse potentially exposed to constituents

present in the 100-NR-1 Source Operable Unit waste sites. Terrestrial vegetation is represented by a generic plant species for the uptake of soil contaminants and as a food source for mice.

The major route of exposure to plants is assumed to be direct uptake from soil. Ingestion of vegetation is assumed to be a major route of exposure to the mouse for both nonradiological and radiological constituents. For radionuclides, the exposure pathway considered uptake from contaminated food, resulting in internal exposure. For both radiological and nonradiological contaminants, the dose is based on receptor whole-body concentrations. All chemicals and radionuclides are assumed to be bioavailable for uptake by vegetation, which is consistent with the objectives of the QRA.

For organisms whose home range is smaller than the operable unit, it is assumed that 100% of their diet consists of contaminated foodstuffs. However, for organisms spending a fraction of their time feeding within the operable unit, a usage factor is calculated based on the proportion of their home range that the operable unit could encompass. The usage factor for the Great Basin pocket mouse by waste site is presented in the most recent revision of HSRAM (DOE-RL 1994) and is incorporated into the dose equations. An example calculation for radiological and hazardous chemical dose is also presented in HSRAM (DOE-RL 1994).

**1.3.3.2.5 Characterization of Ecological Effects.** The characterization of ecological effects analyzes the relationship between the stressor and assessment and measurement endpoints. The only regulatory driver for radionuclides in the environment is DOE Order 5400.1, which requires exposure to aquatic organisms to be < 1 rad/day. Because of the lack of radionuclide data for terrestrial organisms, this limit is also applied to the pocket mouse at the waste sites in the 100-NR-1 Source Operable Unit. Toxicity data were reviewed for all nonradioactive constituents of potential ecological concern.

**1.3.3.2.6 Evaluation of Relevant Effects Data.** Ionizing radiation can impact wildlife depending upon the level of exposure. Exposure can be either acute or chronic. Depending on the concentration, acute exposures can result in organism mortality, generally characterized as the $LD_{50}$ (concentration to cause 50% mortality in some specified period of time - for mammals this is usually 30 days). Other possible effects from acute exposure are physiological and pathological changes, as well as developmental and reproductive effects. Effects from chronic exposure include physiological, reproductive, growth, and developmental impairment.

To evaluate the toxicity of chemicals to the pocket mouse, intake values for a given contaminant were compared with the NOEL value. Toxicity information for terrestrial organisms relied on animal studies that support the Integrated Risk Information System (IRIS) (EPA 1991b) and the Health Effects Assessment Summary Tables (HEAST) (EPA 1993b). As a screening tool, NOEL and lowest observed effect level (LOEL) values presented in the IRIS or (when not in IRIS) the HEAST database (EPA 1990) were used for mammals. Uncertainty factors were applied to the animal toxicity data to correct for differences between species, to modify LOEL values to NOEL values, and to adjust data

obtained through short-term studies to that which would be expected in long-term studies. Uncertainty factors were used to adjust $LD_{50}$ values to obtain an estimated NOEL. Short-term (<30 days) effect levels were multiplied by 0.1 to estimate chronic, long-term effects (DOE 1993). Lowest observed effect level values were converted to NOEL values by multiplying the effect concentration by 0.2 (DOE 1993). Oral $LD_{50}$ values were converted to acute NOEL values by multiplying the effect concentration by 0.2 (DOE 1993). Interspecies adjustments were made by multiplying the effect concentration by 0.1 (DOE 1993). For species of different phylogenetic classes (e.g., mammal to bird), 0.05 was used as the uncertainty factor. The NOEL values for the indicator species are provided in DOE (1993).

Intake of contaminants by each of the terrestrial wildlife indicator species was estimated using intake parameters obtained from either published literature or derived from EPA formulas (Suter et al. 1993). Intake of contaminants in vegetation were estimated using an equation adapted from EPA's *Human Health Evaluation Manual* (EPA 1989).

**1.3.3.2.7 Stressor-Response Profile.** A stressor-response profile is prepared for the Great Basin pocket mouse at each waste site. This profile includes the calculation of radiological doses and comparison with a threshold of 1 rad/day, as recommended by DOE Order 5400.5 and International Atomic Energy Agency (IAEA) (1992). In addition, wildlife NOEL values are compared with modeled exposure intakes for nonradiological contaminants.

**1.3.3.3 Environmental Risk Characterization.** The risk characterization phase evaluates the likelihood of an adverse effect to the receptor organism. The risk to the Great Basin pocket mouse was estimated by developing an environmental hazard quotient (EHQ). The EHQ is based on a comparison between identified dose benchmarks and calculated animal dose.

**1.3.3.3.1 Risk Estimation.** The likelihood of an adverse effect exists in the case of radiological contamination for the pocket mouse exceeding the benchmark of 1 rad/day. Risk associated with exposure to nonradiological contaminants is evaluated by comparison with NOEL values. The relationship between the benchmark for radionuclides or toxicity data for nonradiological chemicals is expressed as an EHQ. The EHQ is defined as the ratio of the contaminant dose to some benchmark dose/concentration (i.e., NOEL), as follows.

$$EHQ = \frac{Organism\ Dose}{Benchmark\ Dose}$$

The EHQ ratio is used to assess the potential adverse effect to an individual. For example, an EHQ that approaches or exceeds unity indicates a potential adverse effect to an individual. For chemicals such as arsenic, the NOEL value is used to assess risk. An EHQ value at or above 1.0 indicates a potential measurable risk.

**1.3.3.3.2 Integration of Stressor-Response and Exposure Profiles.** The receptor dose values for the constituents of concern are integrated with expected biological responses, and the significance of risk to the various ecological receptors is described in this section.

**1.3.3.3.3 Interpretation of Ecological Significance.** The approach presented for the QRA of the 100-NR-1 Source Operable Unit waste sites involves screening the dose to the pocket mouse. The screening or qualitative approach models COC uptake from soil/plant to the mouse. Ecological characterization implications are limited because its purpose is to compare risk among waste sites.

**1.3.3.4 Uncertainty.** The uncertainty associated with the approach used in the qualitative ecological evaluation for the 100-NR-1 Source Operable Unit waste sites is significant because concentrations used as the source terms were assumed to be available for uptake by site vegetation. Modeling from soil to the pocket mouse required a number of assumptions, including those associated with the use of nonsite-specific soil-to-plant transfer factors or coefficients. A review of the literature identified a range of values. As a conservative measure, the highest transfer factor was used in all cases. Other assumptions included estimating the time that a receptor spends feeding within the unit and assuming that all foodstuff consumed is contaminated. The highest soil concentration is used to assess qualitative risk, which is a conservative measure.

THIS PAGE INTENTIONALLY
LEFT BLANK

**Table 1-1 The Hanford Sitewide Background Summary Statistics and Upper Threshold Limits for Inorganic Analytes**

| Analyte | 95% Distribution[a] (mg/kg) | 95% UTL[b] (mg/kg) |
|---|---|---|
| Aluminum | 13,800 | 15,600 |
| Antimony | NR | 15.7[c] |
| Arsenic | 7.59 | 8.92 |
| Barium | 153 | 171 |
| Beryllium | 1.62 | 1.77 |
| Cadmium | NR | 0.24[c] |
| Calcium | 20,410 | 23,920 |
| Chromium | 23.4 | 27.9 |
| Cobalt | 17.9 | 19.6 |
| Copper | 25.3 | 28.2 |
| Iron | 36,000 | 39,160 |
| Lead | 12.46 | 14.75 |
| Magnesium | 7,970 | 8,760 |
| Manganese | 562 | 612 |
| Mercury | 0.614 | 1.25 |
| Nickel | 22.4 | 25.3 |
| Potassium | 2,660 | 3,120 |
| Selenium | NR | 5[c] |
| Silver | 1.4 | 2.7 |
| Sodium | 963 | 1,290 |
| Thallium | NR | 3.7[c] |
| Vanadium | 98.2 | 111 |
| Zinc | 73.3 | 79 |
| Molybdenum | NR | 1.4[c] |
| Titanium | 3,020 | 3,570 |
| Zirconium | 47.3 | 57.3 |
| Lithium | 35 | 37.1 |
| Ammonia | 15.3 | 28.2 |
| Alkalinity | 13,400 | 23,300 |
| Silicon | 108 | 192 |
| Fluoride | 6.4 | 12 |
| Chloride | 303 | 763 |
| Nitrite | NR | 21[c] |
| Nitrate | 96.4 | 199 |
| Ortho-phosphate | 3.7 | 16 |
| Sulfate | 580 | 1,320 |

Source: DOE-RL 1993a, Because of a table label mix up, Table 6-9b., mislabeled the Weibull distribution, was used for the lognormal distribution values listed here.

[a] 95th percentile of the data for a lognormal distribution.

[b] 95% confidence limit of the 95th percentile of the data distribution.

[c] Limit of detection.

NR - Not reported.

UTL - upper threshold limit.

THIS PAGE INTENTIONALLY
LEFT BLANK

## Table 1-2 100-NR-1 Source Operable Unit Facilities and Sites (page 1 of 2)

| Facility Identification | Alias/Former ID | Release/Spill ID |
|---|---|---|
| **RCRA TSD Facilities With Historical and LFI Data** | | |
| 116-N-1 Crib and Trench | (1301-N) | |
| 116-N-3 Crib and Trench | (1325-N) | |
| **High-Priority Sites With LFI Data** | | |
| 120-N-2 Surface Impoundment | (1324-N) | |
| 120-N-1 Percolation Pond | (1324-NA) | |
| 120-N-1 South Settling Pond | | |
| 1322-N/NA Sample Buildings | | UN-100-N-8 Sump Leak<br>UN-100-N-4 Sump Leak |
| 116-N-2 Treatment and Storage Facility | (1310-N; Golf Ball) | UN-100-N-5 Underground Pipe Leak |
| 119-N Cooling Water Drain Line | | UN-100-N-25 Vent Line Discharge<br>UPR-100-N-9 Punctured Drain Line |
| 166-N Tank Farm & Diesel Collection Trench | (UN-100-N-17) | UPR-100-N-14 Drain Backflow<br>Diesel Oil Supply Line Leak 8/66 |
| **High-Priority Sites Without Data** | | |
| 118-N-1 Spacer Storage Silos | (118-N) | UN-100-N-3 Transfer Line Leak<br>UN-100-N-12 Transfer Line Leak |
| 1304-N Emergency Dump Tank | | UN-100-N-1 Maint. Flow-stop Leak<br>UN-100-N-2 Crack In Relief Line<br>UN-100-N-7 Drain Line Leak<br>UN-100-N-29 Check Valve Leak<br>UN-100-N-30 Vac. Break Overflow |
| 116-N-4 Emergency Dump Basin | (1300-N) | UN-100-N-32 Check Valve Leak |
| 105-N Spent Fuel Storage Basin | N Reactor Spent Fuel Storage | |
| UN-100-N-6 Decontamination Waste Drain Line | | UN-100-N-10 Irradiated Water Leak<br>UN-100-N-35 Irradiated Water Leak |
| **Low-Priority Sites Without Data** | | |
| Unplanned Release NaOH Spill (Spring 1993) | | (Unloading to 116-N-2) |
| 108-N Chemical Unloading Facility | (1106-N) | UPR-100-N-15 Neutralizing Sump<br>UPR-100-N-33 Acid Transfer Spill |
| 120-N-7 Unloading Station French Drain (FD) | | |
| 120-N-6 Sulfuric Acid Tank French Drain | 108-N Acid Tank French Drain | |
| 120-N-8 Sulfuric Acid Day Tank Vent French Drain | 163-N Acid Day Tank Vent FD | |
| Drum Storage Area (reported) | | |
| 181-N Waste Oil Tank | | |
| 184-N Day Tanks | | UPR-100-N-19 Tank Overflow<br>UPR-100-N-21 Tank Overflow |
| UN-100-N-11 Unplanned Release Fuel Oil | | |
| 120-N-5 Acid/Caustic Transfer French Drain & Neutralization Unit | | |
| 120-N-3 Neutralization Pit & French Drain | 163-N Neutral. Pit & FD | |
| Regeneration Waste Transport System | | (2 leaks in acid regen. lines) |
| 166-N Piping | | UN-100-N-18 Line Leak<br>UN-100-N-20 Oil Line Leak<br>UN-100-N-24 Oil Line Leak |
| 184-N Piping | | UN-100-N-22 Line Leak<br>UN-100-N-23 Line Leak |

## Table 1-2 100-NR-1 Source Operable Unit Facilities and Sites (page 2 of 2)

| Facility Identification | Alias/Former ID | Release/Spill ID |
|---|---|---|
| 124-N-4 Septic Tank & Drain Field | Septic Sewer System No. 4 | |
| 124-N-5 Septic Tank | Septic Sewer System No. 5 | |
| 124-N-6 Septic Tank | Septic Sewer System No. 6 | |
| 124-N-7 Septic Tank | Septic Sewer System No. 7 | |
| 124-N-1 Septic Tank | Septic Sewer System No. 1 | |
| 124-N-2 Septic Tank | Septic Sewer System No. 2 | |
| 124-N-3 Septic System | Septic Sewer System No. 3 | |
| 124-N-8 Septic Tank | Septic Sewer System No. 8 | |
| 124-N-9 Septic Tank | Septic Sewer System No. 9 | |
| 124-N-10 Sewer System | Central Sewer System No. 10 | |
| 1314-N Liquid Waste Loadout Facility | | UN-100-N-13 Dry Well Overflow<br>UN-100-N-26 Rail Car Overflow |
| 1143-N Paint Shop | | |
| HGP Burn Pit | 100-N Burning Pit | (105-N UST Grouping) |
| 120-N-4 Storage Area | Nonhaz. LLW Storage Pad | |
| 128-N-1 Burning Pit | | |
| N-17 Paint Shop | | |
| 116-N Air Stack | | Atmospheric Gas Releases |
| 184-N Plant Service Power House | | Stack Releases |
| 105-N Lift Station Underground Tank | | |
| 102-in Outfall Line | | |
| 181-N Inlet Screen | | |
| 182-N UST (3) | | |
| 116-N-8 Mixed Waste Storage Pad | 163-N Storage Pad | |
| Grass Dump | | (105-N UST Grouping) |
| Tank Farm Overflow | | |
| Drain System | | |
| Construction Debris Dump | | (105-N UST Grouping) |
| Unplanned Release (Turbine Oil) | | |
| 1716-N UST (2) | | 100-N-SS-28 Gasoline Storage Tank<br>100-N-SS-27 Gasoline Storage Tank |

LFI - limited field investigation
UST - underground storage tanks
LLW - low level waste
RCRA - Resource Conservation and Recovery Act
TSD - treatment, storage, and disposal

**Table 1-3 Human Toxicity Values for Radioactive Contaminants**

| Radionuclides | SFo (pCi)-1 | SFi (pCi)-1 | SFe (pCi-yr/g)-1 |
|---|---|---|---|
| HEAST (annual 1992) is source for all radionuclide slope factors . | | | |
| Gross Alpha | Slope factors are not available for gross alpha | | |
| Gross Beta | Slope factors are not available for gross beta | | |
| Tritium (Hydrogen-3) | 5.4E-14 | 7.8E-14 | 0E+00 |
| Carbon-14 | 9.0E-13 | 6.4E-15 | 0E+00 |
| Potassium-40 | 1.1E-11 | 7.6E-12 | 5.4E-07 |
| Chromium-51 | 4.3E-14 | 3.0E-13 | 9.2E-08 |
| Iron-59 | 2.8E-12 | 9.7E-12 | 4.1E-06 |
| Cobalt-60 | 1.5E-11 | 1.5E-10 | 8.6E-06 |
| Zinc-65 | 8.5E-12 | 1.6E-11 | 2.0E-06 |
| Strontium-90 +D | 3.6E-11 | 6.2E-11 | 0E+00 |
| Technetium-99 | 1.3E-12 | 8.3E-12 | 6.0E-13 |
| Ruthenium-106 | 9.5E-12 | 4.4E-10 | 0E+00 |
| Cesium-134 | 4.1E-11 | 2.8E-11 | 5.2E-06 |
| Cesium-137 +D | 2.8E-11 | 1.9E-11 | 2.0E-06 |
| Europium-152 | 2.1E-12 | 1.1E-10 | 3.6E-06 |
| Europium-154 | 3.1E-12 | 1.4E-10 | 4.1E-06 |
| Radium-226 +D | 1.2E-10 | 3.0E-09 | 6.0E-06 |
| Thorium-228 +D | 5.5E-11 | 7.8E-08 | 5.6E-06 |
| Thorium-232 | 1.2E-11 | 2.8E-08 | 2.6E-11 |
| Uranium-233/234 (a) | 1.6E-11 | 2.7E-08 | 4.2E-11 |
| Uranium-235 +D | 1.6E-11 | 2.5E-08 | 2.4E-07 |
| Uranium-238 +D | 2.8E-11 | 5.2E-08 | 3.6E-08 |
| Plutonium-238 | 2.2E-10 | 3.9E-08 | 2.8E-11 |
| Plutonium-239/240 (b) | 2.3E-10 | 3.8E-08 | 2.7E-11 |
| Americium-241 | 2.4E-10 | 3.2E-08 | 4.9-09 |

Source: EPA 1992a.
(a) - Toxicity values for uranium-233.
(b) - Toxicity values for plutonium-240.
+D - Includes contribution of radioactive daughter products.
SFo - Oral slope factor.
SFi - Inhalation slope factor.
SFe - External slope factor.

## Table 1-4 Human Toxicity Values for Inorganic Contaminants

| INORGANICS | SFo (mg/kg-d)-1 | Source | SFi (mg/kg-d)-1 | Source | RfDo mg/kg-d | Source | RfDi mg/kg-d | Source |
|---|---|---|---|---|---|---|---|---|
| Aluminum | NA | | NA | | NA | | NA | |
| Antimony | NA | | NA | | NA | | NA | |
| Arsenic | NA | | NA | | NA | | NA | |
| Barium | NA | | NA | | NA | | NA | |
| Beryllium | NA | | NA | | NA | | NA | |
| Cadmium | | | 6.3E+00 | I | 1.0E-03 | I | | |
| Calcium | NA | | NA | | NA | | NA | |
| Chromium (III) | NA | | NA | | NA | | NA | |
| Chromium (VI) | NA | | NA | | NA | | NA | |
| Cobalt | NA | | NA | | NA | | NA | |
| Copper | | | | | 4.0E-02 | STSC (4/91) | | |
| Iron | NA | | NA | | NA | | NA | |
| Lead | toxicity values are not available | | | | | | | |
| Magnesium | NA | | NA | | NA | | NA | |
| Manganese (food) | | | | | 1.4E-01 | I | 1.1E-04 | I |
| Manganese (water) | | | | | 5.0E-03 | I | 1.1E-04 | I |
| Mercury | NA | | NA | | NA | | NA | |
| Nickel | | | (a) | I | 2.0E-02 | I | | |
| Potassium | NA | | NA | | NA | | NA | |
| Selenium | NA | | NA | | NA | | NA | |
| Silver | NA | | NA | | NA | | NA | |
| Sodium | NA | | NA | | NA | | NA | |
| Thallium (oxide) | NA | | NA | | NA | | NA | |
| Thallium (sulfide) | NA | | NA | | NA | | NA | |
| Thallium | NA | | NA | | NA | | NA | |
| Vanadium | NA | | NA | | NA | | NA | |
| Zinc | | | | | 3.0E-01 | I | | |
| Cyanide (free) | | | | | 2.0E-02 | I | | |

Sources: I - IRIS (EPA 1993b); STSC - Superfund Technology Support Center (EPA 1991c).
(a) Inhalation slope factor for nickel refinery dust is 8.4E-01 (mg/kg-d)-1 (EPA 1993b).
NA - Not applicable; compound eliminated prior to the risk screening.
RfDo - Oral reference dose. RfDi - Inhalation reference dose.
SFo - Oral slope factor. SFi - Inhalation slope factor.

9413300.0165

**Table 1-5 Human Toxicity Values for Organic Contaminants (page 1 of 4)**

| ORGANICS | SFo (mg/kg-d)-1 | Source | SFi (mg/kg-d)-1 | Source | RfDo mg/kg-d | Source | Rfdi mg/kg-d | Source |
|---|---|---|---|---|---|---|---|---|
| 1,1,1-Trichloroethane | | | | | 9.0E-02 | H | 3.0E-01 | H |
| 1,1,2,2-Tetrachloroethane | 2.0E-01 | I | 2.0E-01 | I | | | | |
| 1,1,2-Trichloroethane | 5.7E-02 | I | 5.6E-02 | I | 4.0E-03 | I | | |
| 1,1-Dichloroethane | | | | | | | 1.0E-01 | H |
| 1,1-Dichloroethene | 6.0E-01 | I | 1.8E-01 | I | 9.0E-03 | I | | |
| 1,2-Dichloroethane | 9.1E-02 | I | 9.1E-02 | I | | | | |
| 1,2-Dichloroethene (cis) | | | | | 1.0E-02 | H | | |
| 1,2-Dichloroethene (trans) | | | | | 2.0E-02 | I | | |
| 1,2-Dichloropropane | 6.8E-02 | H | | | | | 1.1E-03 | I |
| 2-Butanone (MEK) | | | | | 6.0E-01 | I | 2.9E-01 | I |
| 2-Hexanone (MBK) (a) | | | | | 6.0E-01 | I (a) | 2.9E-01 | I (a) |
| 4-Methyl-2-Pentanone (MIBK) | | | | | 5.0E-02 | H | 2E-02 | H |
| Acetone | | | | | 1.0E-01 | I | | |
| Bromodichloromethane | 6.2E-02 | I | | | 2.0E-02 | I | | |
| Bromoform | 7.9E-03 | I | 3.9E-03 | I | 2.0E-02 | I | | |
| Bromomethane | | | | | 1.4E-03 | I | 1E-03 | I |
| Carbon Disulfide | | | | | 1.0E-01 | I | 2.9E-03 | H |
| Carbon Tetrachloride | 1.3E-01 | I | 5.3E-02 | I | 7.0E-04 | I | | |
| Chlorobenzene | | | | | 2.0E-02 | I | 5.7E-03 | H |
| Chloroethane (ethyl chloride) | | | | | | | 3E+00 | I |
| Chloroform | 6.1E-03 | I | 8.0E-02 | I | 1.0E-02 | I | | |
| Chloromethane | 1.3E-02 | H | 6.3E-03 | H | | | | |
| Dibromochloromethane | 8.4E-02 | I | | | 2.0E-02 | I | | |
| Ethylbenzene | | | | | 1.0E-01 | I | 2.9E-01 | I |
| Methylene Chloride | 7.5E-03 | I | 1.6E-03 | I | 6.0E-02 | I | | |
| Styrene | | | | | 2.0E-01 | I | 2.9E-01 | I |
| Tetrachloroethene | 5.2E-02 | STSC (4/92) | 2.0E-03 | STSC (4/92) | 1.0E-02 | I | | |
| Toluene | | | | | 2.0E-01 | I | 1.0E-01 | I |
| Trichloroethene | 1.1E-02 | STSC (4/92) | 6.0E-03 | STSC (4/92) | 6.0E-03 | STSC (4/92) | | |
| Vinyl Chloride | 1.9E+00 | H | 3.0E-01 | H | | | | |
| Xylenes (total) | | | | | 2.0E+00 | I | | |

**Table 1-5 Human Toxicity Values for Organic Contaminants (page 2 of 4)**

| ORGANICS (continued) | SFo (mg/kg-d)-1 | Source | SFi (mg/kg-d)-1 | Source | RfDo mg/kg-d | Source | Rfdi mg/kg-d | Source |
|---|---|---|---|---|---|---|---|---|
| cis-1,3-Dichloropropene (b) | 1.8E-01 | H (b) | 1.3E-01 | H (b) | 3.0E-04 | I (b) | 6E-03 | I (b) |
| trans-1,3-Dichloropropene (b) | 1.8E-01 | H (b) | 1.3E-01 | H (b) | 3.0E-04 | I (b) | 6E-03 | I (b) |
| 1,2,4-Trichlorobenzene | | | | | 1.0E-02 | I | 2.6E-03 | H |
| 1,2-Dichlorobenzene | | | | | 9.0E-02 | I | 5.7E-02 | H |
| 1,3-Dichlorobenzene | | | | | under review | I | | |
| 1,4-Dichlorobenzene | 2.4E-02 | H | | | | | 2E-01 | H |
| 2,4,5-Trichlorophenol | | | | | 1.0E-01 | I | | |
| 2,4,6-Trichlorophenol | 1.1E-02 | I | 1.1E-02 | I | | | | |
| 2,4-Dichlorophenol | | | | | 3.0E-03 | I | | |
| 2,4-Dimethylphenol | | | | | 2.0E-02 | I | | |
| 2,4-Dinitrophenol | | | | | 2.0E-03 | I | | |
| 2-Chloronaphthalene | | | | | 8.0E-02 | I | | |
| 2-Chlorophenol | | | | | 5.0E-03 | I | | |
| 2-Methylnaphthalene (c) | | | | | 4.0E-03 | STSC (c) | | |
| 2-Methylphenol | | | | | 5.0E-02 | I | | |
| 2-Nirtoaniline | | | | | | | 6.0E-05 | H |
| 2-Nitrophenol | | | | | inadequate data - H | | | |
| 3-Nitroaniline | | | | | inadequate data - H | | | |
| 4-Chloro-3-methylphenol | under review by EPA (source - I) | | | | | | | |
| 4-Chloroaniline | | | | | 4.0E-03 | I | | |
| 4-Methylphenol | | | | | 5.0E-02 | H | | |
| Acenaphthene | | | | | 6.0E-02 | I | | |
| Acenaphthylene | | | | | 6.0E-02 | STSC (1/92) | | |
| bis(2-Chloroethoxy)methane | no data available (source - I) | | | | | | | |
| bis(2-Chloroethyl)ether (BCEE) | 1.1E+00 | I | 1.1E+00 | I | inadequate data - H | | | |
| bis(2-Chloroisopropyl)ether | 7.0E-02 | H | 3.5E-02 | H | 4.0E-02 | I | | |
| Dimethylphthalate | | | | | under review | I | inadequate data - H | |
| Hexachlorobutadiene | 7.8E-02 | I | 7.7E-02 | I | 2.0E-03 | H | | |
| Hexachlorocyclopentadiene | | | | | 7.0E-03 | I | 2.0E-05 | H |
| Hexachloroethane | 1.4E-02 | I | 1.4E-02 | I | 1.0E-03 | I | under review | I |
| Isophorone | 9.5E-04 | I | | | 2.0E-01 | I | | |

**Table 1-5 Human Toxicity Values for Organic Contaminants (page 3 of 4)**

| ORGANICS (continued) | SFo (mg/kg-d)-1 | Source | SFi (mg/kg-d)-1 | Source | RfDo mg/kg-d | Source | Rfdi mg/kg-d | Source |
|---|---|---|---|---|---|---|---|---|
| N-nitroso-di-n-dipropylamine | 7.0E+00 | I | | | | | | |
| Naphthalene | | | | | 4.0E-03 | STSC (1/92) | | |
| Nitrobenzene | | | | | 5.0E-04 | I | 6.0E-04 | H |
| Phenol | | | | | 6.0E-01 | I | | |
| 2,4-Dinitrotoluene (e) | 6.8E-01 | I (e) | | | 2.0E-03 | I | data inadequate -I | |
| 2,6-Dinitrotoluene (e) | 6.8E-01 | I (e) | | | under review | I | | |
| 3,3'-Dichlorobenzidine | 4.5E-01 | | | | | | data inadequate -I | |
| 4,6-Dinitro-2-methylphenol | under review by EPA (source - I) | | | | | | | |
| 4-Bromodiphenyl ether | | | | | | | | |
| 4-Chlorodiphenyl ether | no toxicity information | | | | | | | |
| 4-Nitroaniline | | | | | data inadequate for quantitative risk assessment - H | | | |
| 4-Nitrophenol | under review by EPA (source - I) | | | | | | | |
| Carbazole | 2.0E-02 | H | | | | | | |
| Anthracene | | | | | 3.0E-01 | I | | |
| Benzene | 2.9E-02 | I | 2.9E-02 | I | | | | |
| Benz(a)anthracene | under review by EPA (source - I) | | | | | | | |
| Benzo(a)pyrene | 7.3E+00 | I | 6.1E+00 | H | | | | |
| Benzo(b)fluoranthene | under review by EPA (source - I) | | | | | | | |
| Benzo(ghi)perylene | under review by EPA (source - I) | | | | | | | |
| Benzo(k)fluoranthene | under review by EPA (source - I) | | | | | | | |
| bis(2-ethylhexyl)phthalate | 1.4E-02 | I | | | 2.0E-02 | I | | |
| Butylbenzylphthalate | | | | | 2.0E-01 | I | | |
| Chrysene | under review by EPA (source - I) | | | | | | | |
| Di-n-butylphthalate | | | | | 1.0E-01 | I | | |
| Di-n-octylphthalate | | | | | 2.0E-02 | H | | |
| Dibenz[a,h]anthracene | under review by EPA (source - I) | | | | | | | |
| Dibenzofuran | under review by EPA (source - I) | | | | | | | |
| Diethyl phthalate | | | | | 8.0E-01 | I | | |
| Fluoranthene | | | | | 4.0E-02 | I | | |
| Fluorene | | | | | 4.0E-02 | I | | |

Table 1-5 Human Toxicity Values for Organic Contaminants (page 4 of 4)

| ORGANICS (continued) | SFo (mg/kg-d)-1 | Source | SFi (mg/kg-d)-1 | Source | RfDo mg/kg-d | Source | Rfdi mg/kg-d | Source |
|---|---|---|---|---|---|---|---|---|
| Hexachlorobenzene | 1.6E+00 | I | 1.6E+00 | I | 8.0E-04 | I | | |
| Indeno(1,2,3-cd)pyrene | under review by EPA (source - I) | | | | | | | |
| N-Nitrosodiphenylamine | 4.9E-03 | I | | | | | | |
| Pentachlorophenol | 1.2E-01 | I | | | 3.0E-02 | I | | |
| Phenanthrene (d) | | | | | 3.0E-02 | I (d) | | |
| Pyrene | | | | | 3.0E-02 | I | | |

Sources: I - IRIS (EPA 1993b); H - HEAST (EPA 1992a); STSC - Superfund Technology Support Center (EPA 1992b and 1992c).
(a) - 2-Butanone used as surrogate for 2-hexanone.
(b) - 1,3-Dichloropropene toxicity values used for both cis and trans.
(c)- Naphthalene used as surrogate for 2-methylnaphthalene.
(d)- Pyrene used as surrogate for phenanthrene.
(e) - Oral slope factor for 2,4-/2,6- dinitrotoluene mixture.
SFo - Oral slope factor
SFi - Inhalation slope factor
RfDo - Oral reference dose
RfDi - Inhalation reference dose

**Table 1-6 Estimated Wildlife NOEL**

| Chemical | Adjusted Wildlife NOEL (mg/kg/day) |
|---|---|
| **Organics** | |
| Carbon disulfide | 1.0 |
| Di-n-butylphthalate | NA |
| Toluene | 22 |
| N-nitrosodiphenylamine | NA |
| **Inorganics** | |
| Cadmium | 0.003 |
| Copper | NA |
| Lead | 0.000069 |
| zinc | 0.2 |

NA - Not available.
Primary source for NOEL (DOE 1993).

THIS PAGE INTENTIONALLY
LEFT BLANK

## 2.0 DATA OVERVIEW

This section provides brief descriptions of high-priority and low-priority 100-NR-1 Source Operable Unit waste sites and of the data used in the QRA. Detailed descriptions of the waste sites and sampling locations and activities are presented in the LFI (DOE-RL 1993b) and the work plan (DOE-RL 1991b). The COPC identification process is described and tables listing COPC at individual waste sites are included in this section.

Sources of data for this QRA include results of the LFI sampling of soils and historical data from earlier investigations. Limited field investigation data were extracted directly from laboratory result forms and from the data validation reports for the 100-NR-1 Operable Unit vadose soil (WHC 1993c, 1993d, 1993e). Analyses included the full suite of CERCLA Contract Laboratory Program (CLP) TCL and TAL constituents, as well as specified anions and radionuclides. The TCL and TAL constituent groups include volatile organics, semi-volatile organics, pesticides/PCB, and inorganics.

Historical site use information was obtained from the work plan (DOE-RL 1991b). The historical sampling data include concentrations of radionuclides reported in the 100 N Area surveillance reports (UNC 1980 through 1984, 1986, WHC 1988). All maximum concentrations of radionuclides measured in years before 1992 were corrected for radioactive decay to 1992. Only limited historical data are available for the characterization of nonradioactive inorganic and organic constituents that might be present at the waste sites.

Maximum concentrations of COPC in the soil within 4.6 m (15 ft) below the surface are used in the human health QRA. Maximum concentrations within 1.8 m (6 ft) and 4.6 m (15 ft) are used in the ecological QRA. Analytical results for samples below 4.6 m (15 ft) are not evaluated in this QRA, but potential contamination of groundwater is evaluated in the LFI report (DOE-RL 1993b).

Several radionuclides were analyzed for but not detected. Radionuclides that were not detected within a waste site depth interval were not evaluated in the QRA for that particular interval at that site. The radionuclides not carried through the QRA for all waste sites are listed in Section 2.0 risk-based screening tables. The radionuclides include chromium-51, iron-59, zinc-65, cesium-134, europium-152, europium-154, and uranium-235. At the respective detection limits, these radionuclides pose a calculated risk > 1E-06. Iron-59 and zinc-65 pose risks > 1E-04 at the respective detection limits.

Several organic and inorganic compounds were included in the analyses but not detected in samples from the 100-NR-1 Area. Organics and inorganics never detected within a waste site depth interval were not carried through the QRA for that depth interval at that site. These compounds include 2,4-dinitrotoluene, 2,6-dinitrotoluene, 3,3'-dichlorobenzidine, BAP, bis(2-chloroethyl)ether, cadmium, hexachlorobenzene, hexachlorocyclopentadiene, n-nitroso-di-n-dipropylamine, pentachlorophenol, and vinyl chloride. At the respective detection limits, these compounds pose a calculated risk > 1E-06. The only one of these compounds identified as a suspected COPC according to the historical information available in the work plan (DOE-RL 1991b) is BAP, which is a constituent of diesel. The waste sites

at which BAP was not detected and, thus, was not carried through the QRA did not include diesel as a suspected COPC.

Although gross alpha and gross beta radioactivity measurements data are tabulated, these data are not used in the QRA because they are addressed elsewhere according to individual radionuclide contaminants.

Limited field investigation analytical data are available for total nitrite and nitrate. The estimated human health risk is based on the assumption that the total nitrite and nitrate concentration represents nitrite, the more toxic form.

Information from analogous sites is used to evaluate waste sites for which no historical or LFI data are available. Selection of analogous sites for the QRA is based on available information at the time of QRA preparation.

Brief descriptions of individual waste sites are provided in Sections 2.1 through 2.4. More detailed descriptions are presented in Section 3.1 of the work plan (DOE-RL 1991b). Waste site priorities and locations are illustrated in Figures 1-2 and 1-3.

Table 4-2 of the Source work plan (DOE-RL 1991b) identified the waste sites to be included as a part of the HPPS (DOE-RL 1991a). A list of the waste sites, with aliases, addressed in this QRA are presented in Table 1-2.

## 2.1 HIGH-PRIORITY RCRA WASTE SITES WITH HISTORICAL AND LFI DATA

High-priority RCRA waste sites for which historical and LFI data are available are described in this section.

### 2.1.1 116-N-1 (1301-N) Crib and Trench

The following sections present historical data, LFI data, and a data summary for the 116-N-1 (1301-N) Crib and Trench.

**2.1.1.1 Historical Data for the 116-N-1 (1301-N) Crib and Trench.** The 116-N-1 Crib and Trench constitute a major inactive waste management unit located approximately 300 m (984 ft) east of the N Reactor Building. The unit is commonly referred to as a liquid waste disposal facility and is designated 1301-N on another labeling system. The crib is approximately 88 m (289 ft) long, 38 m (125 ft) wide, and 3.7 m (12 ft) deep. The walls are sloped soil and gravel and the floor is not lined. The trench is approximately 15 m (49 ft) wide and 3.7 m (12 ft) deep and extends 490 m (1,608 ft) from the crib. The crib and trench were used from 1964 to 1985. The crib was filled with a 0.9-m (3-ft) layer of boulders and the trench was covered with concrete panels in 1982 to minimize access and airborne contamination (DOE-RL 1992).

The unit received water from the primary reactor cooling system, the periphery reactor cooling systems, and the decontamination of these systems from 1963 through 1985. The inventory of radionuclides disposed of in the trench includes cobalt-60, strontium-90, cesium-134, cesium-137, ruthenium-160, and plutonium-239. In addition, one documented unplanned release of 3,800 L (1,003 gal) of effluent water contaminated 190 $m^2$ (2,044 $ft^2$) of soil. The extent of remediation is unknown (DOE-RL 1992).

Data were obtained from surveillance reports from 1980 through 1985 and 1987 (UNC 1980 through 1984, 1986, WHC 1988). The data included analytical results for surface soil samples collected near the facility and sediment samples from the crib and trench. Maximum concentrations are reported for both sets of samples.

**2.1.1.2 LFI Data for the 116-N-1 (1301-N) Crib and Trench.** Limited field investigation data were collected from three wells located between the unit and the Columbia River: wells 199-N-75, 199-N-76, and 199-N-80. Soil samples were collected from the borings and were analyzed for the full suite of CERCLA TCL and TAL constituents and for specified anions and radionuclides. The TCL and TAL constituent groups include volatile organics, semi-volatile organics, pesticides/PCB, and inorganics.

**2.1.1.3 Data Summary for the 116-N-1 (1301-N) Crib and Trench.** The maximum concentrations from the LFI data and the historical data are summarized in Tables 2-1, 2-2, 2-3, and 2-4. The historical radionuclide data concentrations reported from 1980 through 1987 are decayed to 1992 and are compared with LFI data in the tables. The maximum concentrations are then presented in the final column, labeled "Concentration Used in the QRA."

The following items are noted:

- Gross alpha and beta contamination identified in the LFI data is not used in the QRA because it is a screening value that is not specific to any one radionuclide contaminant.

- For convenience, data are reported for three horizons; 0 to 1.8 m, 1.8 to 4.6 m, and >4.6 m (0 to 6 ft, 6 to 15 ft, and >15 ft). The ecological evaluation uses the 0 to 1.8 m and 1.8 to 4.6 m (0 to 6 ft and 6 to 15 ft) horizons separately, and the human health evaluation uses the combination of the 0 to 1.8 m and 1.8 to 4.6 m (0 to 6 ft and 6 to 15 ft) horizons that make up the 0 to 4.6 m (0 to 15 ft) horizon. The >4.6-m (>15-ft) horizon is not evaluated in the QRA. However, the potential for contaminants in all three horizons to impact groundwater is evaluated in the LFI (DOE-RL 1993b).

- The only inorganic contaminant detected at a concentration exceeding Hanford Site background was cadmium.

### 2.1.2 116-N-3 (1325-N) Crib and Trench

The following sections present historical data, LFI data, and a data summary for the 116-N-3 (1325-N) Crib and Trench.

**2.1.2.1 Historical Data for the 116-N-3 (1325-N) Crib and Trench.** The 116-N-3 Crib and Trench unit is located 300 m (984 ft) east of the 116-N-1 facility. The unit is also known as the 1325-N Liquid Waste Disposal Facility (DOE-RL 1991b). The crib is 76 m (249 ft) long, 73 m (240 ft) wide, and approximately 3.7 m (12.1 ft) deep (DOE-RL 1993c). The trench is approximately 17 m (56 ft) wide, 2 m (6.6 ft) deep, and 910 m (2,986 ft) long and is covered with concrete panels. The crib is covered by concrete panels approximately 3 m (10 ft) below ground surface and <1.5 m (<5 ft) above the percolation surface.

The unit received radioactive liquid effluents from the reactor coolant systems, spent fuel storage basin, and various radioactive drain systems located in the reactor facility from 1983 through 1991 (DOE-RL 1993b). The inventory of radionuclides disposed of at the facility include cobalt-60, strontium-90, ruthenium-106, cesium-134, cesium-137, and plutonium-239. The same type of N Reactor wastes were managed at the 116-N-3 Crib and Trench as at the 116-N-1 Crib and Trench (DOE-RL 1991b).

Data were obtained from the surveillance reports from 1984, 1985, and 1987 (UNC 1984, 1986, WHC 1988). The data included analytical results for surface soil samples collected near the facility and sediment samples collected from the crib and trench. Maximum concentrations are reported for both sets of samples.

Nonradioactive parameter data was not available for this site.

**2.1.2.2 LFI Data for the 116-N-3 (1325-N) Crib and Trench.** No LFI data were available for the 116-N-3 (1325-N) Crib and Trench.

**2.1.2.3 Data Summary for the 116-N-3 (1325-N) Crib and Trench.** The maximum concentrations from the historical data are summarized in Table 2-5. The historical radionuclide data concentrations reported from 1984 through 1987 are decayed to 1992. Maximum concentrations are then presented in the final column, labeled "Concentration Used in the QRA."

## 2.2 HIGH-PRIORITY WASTE SITES WITH LFI DATA

High-priority waste sites for which LFI data are available are described in this section.

### 2.2.1 Sites 120-N-1 Percolation Pond and South Settling Pond and the 120-N-2 Surface Impoundment

The 120-N-2 Surface Impoundment was constructed at the site of the unlined North Settling Pond. It was placed in service in 1986 and operated until 1988. The unit is located approximately 910 m (3,000 ft) southeast of the N Reactor Building. The 120-N-2 Surface Impoundment was used to neutralize the wastes from the 163-N Demineralization Plant and filter backwash from the 183-N Filtered Water Plant prior to discharge to the 120-N-1 Percolation Pond (DOE-RL 1991b).

The 120-N-2 unit is a double-lined surface impoundment equipped with leak detection equipment. The unit is approximately 43 by 23 m (140 by 75 ft) at grade, sloping to 24 by 4.6 m (80 by 15 ft) at approximately 4.6 m (15 ft) below grade. The impoundment was designed to contain a volume of 1,600,000 L (424,000 gal). No leaks have been detected from this unit (DOE-RL 1991b).

The 120-N-1 Percolation Pond is a large, unlined pond located approximately 910 m (3,000 ft) southeast of the N Reactor Building. The pond was placed in service in August 1977 and was used to treat corrosive regeneration effluent from the 163-N Demineralization Plant and filter backwash water from the 183-N Filtered Water Plant. The effluent was treated in the 120-N-1 Percolation Pond by the alternate addition of acidic cation column regeneration effluent and alkaline anion column regeneration effluent. This alternating of low- and high-pH effluent served to neutralize the effluents. The 120-N-1 Percolation Pond managed corrosive regeneration effluent at an average rate of 600,000 L/day (160,000 gal/day) and filter backwash water at a rate of 1,100,000 L/day (300,000 gal/day) (DOE-RL 1991b).

In the spring of 1983, the 120-N-1 Percolation Pond was enlarged from a bottom area of 850 $m^2$ (9,200 $ft^2$) with a volume of approximately 4,500,000 L (1,200,000 gal) to a bottom area of 2,700 $m^2$ (29,000 $ft^2$). This enlarged pond was designed to contain up to 11,000,000 L (3,000,000 gal) of corrosive wastes from the regeneration of ion-exchange columns in the 163-N Demineralization Plant. During pond enlargement, the filter backwash water was routed to the 130-N-1 Filter Backwash Disposal Pond and the South Settling Pond was backfilled to grade (DOE-RL 1991b).

The South Settling Pond and the North Settling Pond received corrosive regeneration effluent and process and cooling water from the 163-N Demineralization Plant and filter backwash water from the 183-N Filtered Water Plant from 1977 until 1983. Volumes of effluent discharged to these ponds are the same as for the 120-N-1 Percolation Pond. Low levels of naturally occurring thorium may be present in the pond as a result of using alum in the water treatment process (DOE-RL 1991b).

The South Settling Pond was a rectangular, unlined basin constructed below grade. The dimensions of the pond were approximately 34 by 15 m (110 by 50 ft) at grade; the sides sloped to a bottom measuring approximately 21 by 3 m (70 by 10 ft). Depth is estimated to have been approximately 4.6 m (15 ft). The South Settling Pond was backfilled.

Limited field investigation data for the 120-N-1 Percolation Pond, 120-N-2 Surface Impoundment, and the South Settling Pond were collected from one boring for each site and from a well (199-N-177) just north of the site group. The borings were generally completed to a depth of 21.3 m (70 ft) below ground surface, and samples were collected from the surface and at 1.5-m (5-ft) intervals to total depth.

Samples were analyzed for the full suite of CERCLA TCL and TAL compounds but not for radionuclides, which were excluded based on field screening data.

A summary of the maximum concentrations for the 120-N-1 Percolation Pond, 120-N-2 Surface Impoundment, and the South Settling Pond is presented in Tables 2-6, 2-7, 2-8, and 2-9. The data for these three sites were combined based on the proximity of the sites and the similarity of the process knowledge, history, and data.

In addition to the parameters analyzed during the LFI, ammonium ion, chloride, coliform, nitrate, strontium, sulfate, and thorium were detected in the effluent discharged at the sites according to historical data (Table 2-10).

### 2.2.2 Site 116-N-2 Treatment Storage Facility

The 116-N-2 Facility is a waste management unit complex consisting of piping, pumps, a transfer tank commonly referred to as the silo, and a large treatment and storage tank referred to as the golf ball. The treatment tank is a spherical metal structure with a capacity of 3,400,000 L (900,000 gal). It is partially buried in the ground and is surrounded by a 7.6-m (25-ft) high, compacted-soil radiation barrier on three sides. The unit was operated from 1968 until 1987.

The silo routed the acidic decontamination solutions into the 116-N-2 Storage Tank for neutralization. The dangerous wastes in the decontamination solution included approximately 80,000 L (21,000 gal) of 70% phosphoric acid and 140 to 180 kg (300 to 400 lb) of diethylthiourea. Decontamination of the primary loop of the reactor occurred every 3 to 5 years, resulting in approximately 2,300,000 L (600,000 gal) of solution per decontamination event (DOE-RL 1991b).

From 1968 until 1972, the neutralized decontamination solution was routed from 116-N-2 directly to tanker trucks parked east of the containment area. The area was not paved. Although no releases have been documented in this area, small, incidental releases probably have occurred (DOE-RL 1991b).

Limited field investigation data for the 116-N-2 Treatment Storage Facility were collected from three surface soil sample locations and from one boring drilled to a depth of 7.2 m (23.5 ft) below ground surface. Boring samples were collected from the surface and from depths of 2.7, 4.1, and 5.6 m (9, 13.5, and 18.5 ft). Sample depths indicated are the top of the sampling interval. Samples were analyzed for the full suite of CERCLA TCL and TAL compounds and radionuclides regardless of the field screening data. A summary of the

maximum concentrations for the 116-N-2 Treatment Storage Facility is presented in Tables 2-6, 2-7, 2-8, and 2-9.

A spectral gamma ray survey of the 116-N-2 borehole surface sample estimated the same maximum concentration of cobalt-60 that was detected in a surface soil sample used in the QRA. The field screening data and spectral gamma ray data were not used in the quantitative analysis of the QRA but were used as confirmation data.

Historical information for 116-N-2 Treatment Storage Facility indicates that phosphoric acid, diethylthiourea, and cobalt-60 are known process constituents (Table 2-10).

### 2.2.3 Site 1322-N/1322-NA Sample Buildings

The 1322-N/1322-NA Buildings contain the Liquid Effluent Waste Treatment Facility Pilot Plant. These buildings are located immediately north of the 116-N-2 Tank. Building 1322-N contains a drainage tank. Two documented unplanned releases of 378.5 and 5,867 L (100 and 1,550 gal) occurred in 1975 and 1977, respectively (UN-100-N-8 and UN-100-N-4). Unspecified volumes of soil were contaminated and removed (DOE-RL 1991b).

Limited field investigation data for the 1322-N/1322-NA Sample Buildings were collected from four surface soil sample locations and from one boring drilled to a depth of 7.5 m (24.5 ft) below ground surface. Boring samples were collected from depths of 2.7, 4.6, and 6.1 m (9, 15, and 20 ft). Sample depths indicated are the top of the sampling interval. Samples were analyzed for radionuclides and the full suite of CERCLA TCL and TAL compounds, except for volatile organics, which were excluded based on field screening. A summary of the maximum concentrations for 1322-N/1322-NA Sample Buildings is presented in Tables 2-6, 2-7, 2-8, and 2-9.

### 2.2.4 Site 119-N Cooling Water Drain Line

The 119-N Cooling Water Drain Line is located in the vicinity of the 119-N Air Sampling and Monitoring Building, which is 150 m (500 ft) north of the N Reactor Building and directly south of the 1314-N LWLS. Releases occurred adjacent to the building. The coolant drain pipe was improperly connected (when originally installed) to the nearby 91-cm (36-in) low-pressure flush line, which carried irradiated reactor cooling water from the 105-N Lift Station to the 116-N-1 Crib and Trench. The improper connection caused the 119-N drain to become pressurized whenever the 105-N Lift Station pumps were operating. Two unplanned releases occurred in 1974, totaling 8,592 L (2,270 gal) of coolant released (UN-100-N-9 and UN-100-N-14). Unspecified volumes of soil were contaminated and removed. The drain line was eventually disconnected permanently and routed to an earthen absorption pit (DOE-RL 1991b).

Limited field investigation data for the 119-N Cooling Water Drain Line were collected from one boring drilled to a total depth of 7.6 m (25 ft) below ground surface.

Boring samples were collected from depths of 2.9, 5.3, and 6.9 m (9.5, 17.5, and 22.5 ft). Sample depths indicated are the top of the sampling interval. Samples were analyzed for the full suite of CERCLA TCL and TAL compounds, regardless of the field screening data, but not for radionuclides, which were excluded based on field screening data. A summary of the maximum concentrations for 119-N Cooling Water Drain Line is presented in Tables 2-6, 2-7, 2-8, and 2-9.

### 2.2.5 166-N Tank Farm (UN-100-N-17)

The 166-N Supply Line Leak is included in the 166-N Fuel Unloading and Storage Area source grouping. This grouping is located near the 116-N Air Stack and the 116-N-2 Radioactive Chemical Waste Treatment and Storage Facility.

The fuel oil unloading station is a concrete-lined containment structure containing 30-cm (12-in) fuel oil supply piping that connects to the No. 6 Fuel Oil Storage Tank at the 166-N Tank Farm. Tanker railcars unloaded No. 6 fuel oil at the station, and oil was transferred by underground piping to the tank farm. Numerous small, unreported spills have occurred during tanker unloading activities (DOE-RL 1991b).

The 166-N Tank Farm is an earthen-bermed tank farm containing one aboveground, 5,200,000 L (1,375,000 gal) No. 6 fuel oil tank and four aboveground, 400,000 L (105,000 gal) diesel oil storage tanks. The earthen berm has a total containment capacity of 11,500,000 L (3,030,000 gal). The tank farm is located between the 116-N Air Stack and the 116-N-2 Radioactive Chemical Waste Treatment and Storage Facility. It was in operation between 1963 and 1990 (DOE-RL 1991b).

Three documented unplanned releases have occurred at the 166-N Tank Farm. In August 1966, an unplanned release of 300,000 L (80,000 gal) of diesel oil was discovered (UN-100-N-17). The diesel oil migrated through the soil, then to the Columbia River. A trench was excavated along the riverbank in an attempt to intercept the oil before it could reach the river. Oil exposed in the trench was ignited and burned periodically through 1967. No contaminated soil was removed from the site (DOE-RL 1991b).

In 1985, 760 L (200 gal) of diesel was released to soil within the bermed area (UN-100-N-20). In 1987, an unknown amount of No. 6 fuel oil was released to soil within the bermed area (UN-100-N-24) (DOE-RL 1991b). No information is available on the cleanup of these spills.

Limited field investigation data for the 166-N Tank Farm were collected from one boring drilled to a total depth of 22.9 m (75 ft) below ground surface. Boring samples were collected from depths of 4.6, 5.8, 7.3, 8.8, 14.9, 16.5, 18, 19.5, 21, and 22.1 m (15, 19, 24, 29, 49, 54, 59, 64, 69, and 72.5 ft). Sample depths indicated are the top of the sampling interval. Samples were not collected until the clean fill layer was passed through. Samples were analyzed for the full suite of CERCLA TCL and TAL compounds and for radionuclides. A summary of the maximum concentrations for 166-N Supply Line Leak is presented in Tables 2-3, 2-7, 2-8, and 2-9.

Historical information for 166-N Tank Farm indicates that diesel fuel and No. 6 Bunker C fuel oil are contaminants historically detected at the site (Table 2-10).

## 2.3 HIGH-PRIORITY WASTE SITES WITHOUT HISTORICAL OR LFI DATA

High-priority waste sites with no historical or LFI data are described in this section.

### 2.3.1 118-N-1 Spacer Storage Silos

The three 118-N-1 Spacer Storage Silos were used for the temporary storage of irradiated fuel spacers. The steel spacers came in immediate contact with the fuel rods in the N Reactor. The silos, approximately 4.9 m (16 ft) in diameter by 6 m (20 ft) deep, are located north of the N Reactor Building. Two of the three silos have earthen floors, and the third silo has a concrete floor. The silos have approximately 0.5 to 1 m (1.5 to 3 ft) thick concrete caps covered with soil (DOE-RL 1991b).

Releases occurred from 1963 until 1987, during spacer placement in or removal from the silos. Spacers were placed in the silos through the buried spacer transfer line. The reinforced plastic spacer transfer line connected the N Reactor fuel storage basin (where the spent spacers were placed in water after use) and the silos. The depth of the line varies. No secondary containment surrounded the line. Small amounts of irradiated water passed through the line with the spacers and were deposited in the silos. In addition, water was sprayed over the spacers during removal from the top of the silos to eliminate the potential airborne release of radionuclides. In recent years, paint was used as a fixative when spacers were transferred from the silos. The silos currently contain dry, irradiated spacers. The volume of water that reached the soil through either the bottom of the silos or the exposed soil around the silos is not known (DOE-RL 1991b).

### 2.3.2 1304-N Emergency Dump Tank

The 1304-N EDT is a 4.9 million L (1.3 million gal), steel aboveground storage tank located south of the 107-N Basin Recirculation Building and west of the 1300-N EDB. The EDT replaced the EDB as the storage facility used for emergency blowdown of thermally hot, pressurized reactor primary coolant water. The tank maintained a constant volume of 2,000,000 L (680,000 gal) of unheated water for quenching hot water to prevent it from flashing to steam. Because a small flow of primary coolant was maintained to the EDT to keep interconnecting piping thermally warm, the quench water normally contained a small inventory of radioactive materials. The unit was used from 1973 until reactor shutdown in 1987 (DOE-RL 1991b).

### 2.3.3 116-N-4 Emergency Dump Basin

The 116-N-4 EDB is a liquid effluent storage basin that was originally designed to receive emergency cooling water from the N Reactor. It is located northwest of the 109-N Building. The unit, a concrete basin with a welded steel liner, is approximately 40 m (130 ft) long, 24 m (80 ft) wide, and 4.6 m (15 ft) deep and has a storage capacity of 3,800,000 L (1,000,000 gal) (DOE-RL 1991b).

The EDB was constructed in 1963 to receive "single pass" radioactive emergency cooling water. In the late 1960s, the unit was determined to be insufficient for its original use. The basin did not have the capacity needed to contain the volume of coolant used during emergency cooling operations. It was replaced by the 1304-N EDT in 1973. From 1973 until 1987, the EDB received contaminated liquid effluent generated during the periodic blowdown of 12 N Reactor steam generators located in the 109-N Building. This condensate contained low levels of radioactive contamination. Contents of the unit were sampled on a monthly basis from 1978 to 1985. At various times, the EDB also received radioactive wastes from the N Reactor lift station. Since the N Reactor shutdown in 1987, water has been maintained in the EDB (approximately 2,000,000 L [750,000 gal]) so that the bottom sludge layer will not become exposed. Subsequent drying of the sludge could expose receptors to airborne contaminated particulate matter. Filtered river water has been added as needed to maintain the water level. Documentation of the amount of water added to the EDB has not been maintained. No documented releases have occurred at this unit (DOE-RL 1991b).

### 2.3.4 105-N Spent Fuel Storage Basin

The 105-N Spent Fuel Storage Basin is a concrete containment basin used to store spent fuel elements, irradiated spacers, and other fuel handling equipment. Underwater transfer carts moved the irradiated fuel elements to the storage basin, where they were stored in the temporary storage baskets. Baskets were emptied and fuel elements were placed in storage canisters, sorted by enrichment and discharge dates. The filled canisters were moved by bridge cranes to storage cubicles that were formed by a lattice of boron concrete walls. The storage basin began operation in 1963 and ceased storing irradiated nuclear fuel in 1989, when all fuel was transferred to the 100 K Fuel Storage Basins. However, the basin remains filled with water for purposes of shielding and radiological contamination control.

### 2.3.5 UN-100-N-6 Decontamination Waste Drain Line

Decontamination of the N Reactor was performed every 2 to 3 years. Although the decontamination solution generally contained phosphoric acid and diethylthiourea, small-scale decontaminations were also performed using a variety of cleaning solutions. The 3.8-cm (1.5-in) chemical decontamination waste drain line generally transported these smaller scale decontamination solutions to the 116-N-2 Facility.

On September 10, 1985, a leak of water contaminated with radiation occurred at four locations along the decontamination waste drain line between the N Reactor Building and the 116-N-2 Facility (UN-100-N-6), near the N-29 Craft Shop. Approximately 6,800 L (1,800 gal) of irradiated water was released. The water contained a total estimated 0.2 Ci of cobalt-60, 0.04 Ci of manganese-54, 0.003 Ci of ruthenium-103, and 0.003 Ci of cesium-137. Approximately 17 $m^2$ (590 $ft^2$) of contaminated soil reading between 7,000 and 25,000 cpm was removed and drummed for disposal. No documented sampling was conducted at the base of the excavation. The area was backfilled with clean fill (DOE-RL 1991b).

## 2.4 LOW-PRIORITY WASTE SITES WITHOUT HISTORICAL OR LFI DATA

Low-priority waste sites with no historical or LFI data are described in this section.

### 2.4.1 1314-N Liquid Waste Loadout Station

This grouping is located at the 1314-N LWLS north of the N Reactor Building. The grouping consists of one waste management unit and two unplanned releases that occurred at this site in 1973 and 1978. The two unplanned releases were documented as UN-100-N-13 and UN-100-N-26, respectively. The spills involved 380 and 3,800 L (100 and 1,000 gal) of decontamination waste, respectively. The smaller spill also resulted in contamination of an unspecified volume of soil, which was subsequently removed (DOE-RL 1991b).

The 1314-N LWLS is a transfer station consisting of numerous valves, pumps, underground and overhead pipings and couplings, and UST at the northern end of the 100 N Area, approximately 90 m (300 ft) from the Columbia River. The unit receives liquid radioactive waste from 116-N-2 Radioactive Chemical Waste Treatment and Storage Facility and the 107-N Spent Fuel Basin Recirculation Facility. The effluent is transferred into railway cars and transported to the 200 Area for processing and disposal (DOE-RL 1991b).

The 1314-N LWLS has been used since 1972; the shelter building was built in 1978. One valve pit is located in the building and one is located outside, along the north side of the building. Valve pit floors are soil. Two drains in the catch basin connect to a separate catch tank and a 3,800 L (1,000 gal) transfer tank located inside the 1314-N Building.

The radioactive effluent piped from the 116-N-2 Storage Tank consisted of internal decontamination solution from cleaning of the primary loop in the N Reactor and various waste decontamination solutions from small decontamination jobs. Decontamination of the primary loop was performed every 3 to 5 years. The radioactive wastewater resulting from this procedure contained phosphoric acid and diethylthiourea and may have contained other agents such as oxalic acid. The wastewater was neutralized in the 116-N-2 Facility by adding sodium hydroxide solution.

### 2.4.2 1143-N Paint Shop

The 1143-N Paint Shop has three waste management units: a water scrubber for paint overspray; a 210 L (55 gal) solvent accumulation drum; and an associated outdoor sandblasting area, the 1143-N Blast Yard.

Paint wastes and overspray collected by the water curtain filtration system were collected, drummed, and transferred offsite for disposal. The blast yard manages paint chips and spent garnet sand. No documentation or evidence was found of releases from this unit. The waste management units are still active, and no remedial activities have taken place.

### 2.4.3 N-17 Paint Shop

This grouping includes the entire craft shop area. Paints, solvents, and oils are used at the N-17 Paint Shop. The N-17 Paint Shop has two waste accumulation drums, one for waste paint and the other for waste oil, as well as an associated sandblasting area. The paint shop is located about 300 m (1,000 ft) east of the N Reactor Facility and is presently active.

An air compressor located east of the paint shop has leaked lubrication oil over the years, as evidenced by oil staining of the surrounding soil. The extent of contamination is not known. Six drums of contaminated soil were removed from the shop area (DOE-RL 1991b).

### 2.4.4 184-N Day Tanks

Three aboveground day tanks are located outside the 184-N Plant Service Power House, on the north side of the building. Two 130,000 L (35,000 gal) tanks are used to store No. 6 (Bunker C) fuel oil, and one 30,000 L (8,000 gal) tank is used to store diesel oil. The day tanks are surrounded by a concrete retaining wall (DOE-RL 1991b).

Several unplanned releases in the 184-N day tank area have been documented. In April 1984, approximately 7,600 L (2,000 gal) of No. 6 fuel oil spilled to the ground when the day tank overflowed during filling (UN-100-N-19). All of the fuel oil was contained within the surrounding retaining walls and did not penetrate the hard sand floor of the containment structure. The waste oil was removed and disposed of (DOE-RL 1991b).

In April 1986, approximately 3,000 L (800 gal) of diesel oil was released to the ground (UN-100-N-21). The oil was removed from the tank impoundment area. Groundwater monitoring wells were sampled and no oil was detected in them (DOE-RL 1991b).

In October 1987, the diesel oil day tank overflowed. An undocumented volume of oil was cleaned up (DOE-RL 1991b).

### 2.4.5 166-N - 184-N Piping

The 184-N Fuel Oil Day Tanks are connected to the oil storage tank at 166-N by a 20-cm (8-in) underground supply line. The 184-N Diesel Oil Day Tank is connected to the storage tanks at 166-N by a 10-cm (4-in) underground supply line (DOE-RL 1991b). Several unplanned releases from the pipelines have been documented.

In August 1973, approximately 760 L (200 gal) of diesel oil was released to the ground (UN-100-N-18) (DOE-RL 1991b). The extent of soil contamination and remediation activities was not documented.

In June 1986, 3,800 L (1,000 gal) of diesel oil was released (UN-100-N-22). An unknown volume of contaminated soil was removed. In July 1986, groundwater monitoring well 199-N-16 was sampled and oil was detected in it. Well 199-N-16 is located approximately 9 m (30 ft) west of the 184-N Building. An unknown volume of residual oil was recovered from the groundwater through this well (DOE-RL 1991b).

In January 1987, approximately 760 L (200 gal) of diesel oil was released to the soil (UN-100-N-23). Groundwater monitoring well 199-N-16 was sampled, and oil was found. Residual oil was recovered from the well (DOE-RL 1991b). No soil remediation was documented.

In October 1987, an unknown volume of fuel oil was released. Oil was contained in the 184-N Annex Drain Trench and cleaned up. In April 1989, at least 1,100 L (300 gal) of diesel oil was released to the soil along the pipeline. Monitoring wells 199-N-16 and 199-N-17 were sampled, and oil was detected. Soil removal involved a total of 46 drums and 8 dump trucks (DOE-RL 1991b).

### 2.4.6 166-N Drum Storage Area

No information was identified for this waste site except that it is a drum storage area between the 166-N Fuel Oil Unloading Station and the 166-N Tank Farm. The only reference to this site is in Table 4-2 of the work plan (DOE-RL 1991b).

### 2.4.7 Acid/Caustic Storage and Transport System

This grouping includes the 108-N Chemical Unloading Facility, 120-N-6 Sulfuric Acid French Drains, 120-N-7 Unloading Station French Drain, 120-N-3 (163-N) Neutralization Pit and French Drain, 120-N-5 Acid/Caustic Transfer Trench and Neutralization Unit, 120-N-8 Sulfuric Acid Day Tank Vent French Drain, Regeneration Waste Transport System, and 116-N-2 Spring 1983 unplanned release. The grouping includes all of the process units, waste management units, unplanned releases, and pipelines associated with the storage and transport of acids and caustics used in the 163-N Demineralization Plant. Solutions of 93% sulfuric acid and 50% sodium hydroxide were delivered in train tank cars and transferred to aboveground storage tanks. The solutions were

transferred to the 163-N Facility as needed. Spent solutions were transferred to the 120-N-1 and 120-N-2 ponds or impoundments. The pits, french drains, and trenches were used to contain and neutralize spills from the transfer, storage, and transport activities.

A number of spills of sulfuric acid and sodium hydroxide solutions were documented for this system. Some of the spills contaminated soil. Remedial activities included neutralization and removal of unknown volumes of soil.

### 2.4.8 UN-100-N-11 Radioactive Spill from Valve Bonnet

On October 2, 1975, a radioactive 230-kg (500-lb) valve bonnet fell from a truck onto the road and into the adjacent field. This occurred at the corner of Route 4 North and the 100 N Area access road. Cleanup consisted of removal and disposal of 6.1 $m^3$ (8 $yd^3$) of contaminated soil and asphalt (DOE-RL 1991b).

### 2.4.9 124-N-4 Septic Tank and Drainfield

The 124-N-4 Septic Tank and Drainfield constituted the primary septic system servicing the majority of the 100 N buildings from 1963 until 1987. It is located east of the 116-N-2 Facility and consists of two septic tanks (the second tank was installed in 1975) with a total fluid capacity of 53,000 L (14,000 gal). The septic tank effluent drained into a large drainfield. The drainfield is divided into four sections, with a distribution box in each section feeding eight drain lines. The drainfield provided approximately 830 $m^2$ (8,900 $ft^2$) of infiltrative surface area. The unit received sanitary sewage at a rate of approximately 110,000 L/day (30,000 gal/day) (DOE-RL 1991b).

The only documented releases that have occurred to or from this unit involved sanitary sewage. However, surveys have detected radioactive surface contamination at this unit, suggesting possible subsurface contamination. In addition, the proximity of this unit to the area where tanker trucks were loaded with irradiated, neutralized decontamination solutions from 1968 until 1972 suggests that residual contamination may be present due to small, intermittent releases.

### 2.4.10 Other Septic Tanks and Sewer Systems

The sewer system and septic tanks used at the 100 N Area included the 124-N-10 Sewer System and the 124-N-1, 124-N-2, 124-N-3, 124-N-5, 124-N-6, 124-N-7, 124-N-8, and 124-N-9 Septic Tanks. The only documented releases that have occurred at these units have involved sanitary sewage. Some of the units were upgraded or replaced because of technical failure before any inconvenience or potential health hazards were incurred. No remedial activities have been conducted.

### 2.4.11 Hanford Generating Plant Burn Pit

The HGP Burn Pit is an area of open ground that was previously used to burn paper, wood, and probably trash. It is not known whether solvents were burned at this site, although barrels containing hazardous oil were found at the site. The burn pit was last used on June 1, 1989.

### 2.4.12 1716-N Service Station Underground Storage Tanks

Two UST were located at the 1716-N Service Station, south of the 120-N-4 Nonhazardous and Nonradioactive Storage Area. The tanks are identified as 100-N-SS-27 and 100-N-SS-28. Both tanks contained unleaded gasoline. Tank 100-N-SS-27 had a capacity of 11,000 L (3,000 gal), and Tank 100-N-SS-28 had a capacity of 7,600 L (2,000 gal). The tanks were constructed of single-wall carbon steel and had no cathodic or interior protection. Tank 100-N-SS-27 was installed in 1967, and Tank 100-N-SS-28 was installed in 1976. Tank 100-N-SS-27 was removed in December 1990, and 100-N-SS-28 was removed in July 1991. Soil sampling indicates that the tanks have leaked, and remediation is planned as part of the UST program (DOE-RL 1991b).

### 2.4.13 182-N Underground Storage Tanks

Three UST were located south of the N Reactor Building, on the north side of the 182-N High Lift Pumphouse. The tanks were identified as 182-N-1-DT, 182-N-2-DT, and 182-N-3-DT and were constructed of single-wall carbon steel, with capacities of 38,000 to 72,000 L (10,000 to 19,000 gal). The tanks were approximately 16 to 20 years old and had no cathodic or interior protection. No releases have been reported from the tanks. The three tanks were pumped dry and removed in December 1990. Soil sampling indicated that the valve area is contaminated, and the area is scheduled for remediation under the UST program (DOE-RL 1991b).

### 2.4.14 184-N Plant Service Powerhouse

The 184-N Plant Service Power House consists of three boilers located in the 184-N Building and the 184-N Annex. The boiler system provides oil-fired, boiler-generated steam to the main steam supply system during reactor startup and shutdown periods. The 184-N Stack released a variety of constituents to the air from 1963 until 1987. The steam piping system in the 184-N Facility is contaminated with low-level radioactivity as a result of leaks that developed in the primary reactor cooling system. Contaminated steam piping is identified and labeled (DOE-RL 1991b).

### 2.4.15 116-N Air Stack

The 116-N Air Stack functions as the primary air emission point from reactor operations. No discharge records were available for the years 1963 to 1970. Recordkeeping to document radioactive material discharges began in 1971. The discharge of radionuclides to the atmosphere was greatly decreased in December 1987, when the N Reactor standdown was initiated. Only air emissions data are available (DOE-RL 1991b).

### 2.4.16 116-N-8 Hazardous and Mixed Waste Storage Area and 120-N-4 Nonhazardous and Nonradioactive Storage Area

The 116-N-8 and 120-N-4 storage areas are described individually in the following sections.

**2.4.16.1 116-N-8 Hazardous and Mixed Waste Storage Area.** The 116-N-8 Hazardous and Mixed Waste Storage Area is a concrete-paved waste container storage pad. The 18 by 46 m (60 by 152 ft) pad is curbed, covered by a roof, bounded by walls on two sides, and surrounded by a wire mesh fence. It is located inside the double-fenced reactor area at the southern corner of the fence. The unit has been in operation since December 1986 (DOE-RL 1991b).

Drums and containers stored in this area contain mixed or hazardous wastes from satellite collection areas within the 100 N Area and from other points of generation at the 100 K Area. Prior to 1986, the area was used as a maintenance storage area. No documentation was found of any dangerous or radioactive releases from the unit (DOE-RL 1991b).

**2.4.16.2 120-N-4 Nonhazardous and Nonradioactive Storage Area.** This unit is currently used as a nonhazardous and or low-level radioactive waste storage pad. It is a 30 by 23 m (100 by 75 ft), curbed concrete pad located immediately southwest of the berm surrounding the 116-N-2 Radioactive Chemical Waste Treatment and Storage Facility.

The unit has been in its current configuration since November 1985. Prior to 1985, the unit was unpaved and was used as a laydown yard for equipment contaminated with radiation and for storage of oils contaminated with radiation. No information is available on the types and amounts of wastes stored in this area. Aerial photographs prior to 1985 indicate storage of unknown materials in the area immediately southeast of the current pad. No documentation was found of any releases to soil from this unit.

### 2.4.17 182-N Drain System

The 182-N Drain System is a National Pollutant Discharge Elimination System (NPDES) permitted discharge point (Source No. 006) to the Columbia River. Drainage from the 182-N High Lift Pumphouse is discharged to the river by a 107-cm (42-in) raw water return line. The discharge point is 30 m (100 ft) upstream of the 181-N Pumphouse. In

1987, the average daily discharge to the river at this point was 1,000,000 L (270,000 gal). The startup date for the discharge was 1964, and the drain system remains in use. Raw and filter water from pump seal leakage is discharged from this point. Small quantities of low-level radionuclides released from reactor emergency core cooling system pump seals have been discharged to the river (DOE-RL 1991b).

### 2.4.18 181-N Inlet Screen Backwash Water Outfall and 182-N Tank Farm Overflow

These units are described individually in the following sections.

**2.4.18.1 181-N Inlet Screen Backwash Water Outfall.** This unit is an NPDES discharge point (Outfall No. 007) located at the 181-N River Pumphouse, which pumps water from the Columbia River for various 100 N Area processes. The screen removes larger solids from the inlet water prior to use at the 100 N Area. The only NPDES required parameters are total flow and total suspended solids (TSS). In 1987, the average TSS concentration was approximately 3.7 mg/L and the discharge rate was approximately 1,300,000 L/day (340,000 gal/day). No documentation was found of any dangerous or radioactive releases from this unit (DOE-RL 1991b).

**2.4.18.2 182-N Tank Farm Overflow.** This unit is an NPDES permitted discharge point (Source No. 005) to the Columbia River. It contains drainage (water) from the 182-N Tank Farm area. The area discharges to the river through a 91-cm (36-in) raw water return line. The discharge point is 90 m (30.0 ft) upstream of the 181-N Pumphouse. In 1987, the average daily discharge to the river at this point was 10 million L (2.7 million gal). Discharges from this point are minimal at present. The startup date for the discharge was 1964. No documentation was found of any dangerous or radioactive releases to the river from this discharge point (DOE-RL 1991b).

### 2.4.19 105-N Lift Station Underground Storage Tank

The 105-N Lift Station UST was a 19,000 L (5,000 gal), single-wall carbon steel tank used for storage of diesel oil. The tank had no cathodic or interior protection and was approximately 11 to 15 years old when it was removed in December 1990. Soil sampling indicated that the site is not contaminated with petroleum derivatives (DOE-RL 1991b).

### 2.4.20 181-N Waste Oil Tank

An aboveground steel waste oil tank is located at the base of the bluff near the 181-N River Pumphouse. The tank has a capacity of 980 L (260 gal). The tank was designed to store waste oil from drip pans used to catch oil from the river pumps but has never been used (DOE-RL 1991b).

### 2.4.21 260-cm (102-in) Outfall Line

The 260-cm (102-in) outfall line is an NPDES discharge point (Outfall No. 009) for raw river water used to cool the secondary cooling water for the N Reactor. The line extends approximately 120 m (400 ft) into the Columbia River, where it discharges water through a 4-m (13-ft) port. From 1982 until 1986, the annual discharge to the river was approximately 570 billion L (150 billion gal). The unit has been releasing to the Columbia River since 1963. In addition to recirculated river water, the outfall has discharged wastewater from other sources (DOE-RL 1991b).

On April 18, 1986, a release to the river of regeneration wastewater from the 163-N Demineralization Plant resulted in a violation of the NPDES permit limits for pH. The NPDES permit requires that the pH of the discharge be no $<6.0$ and no $>9.0$. A test was conducted to determine whether the concurrent release of acidic cation regeneration wastewater and caustic anion regeneration wastewater would result in a neutral discharge from the outfall. However, sampling of the discharge indicated that neutralization was not occurring as rapidly as necessary. For about 60 minutes, wastewater below the 6.0 pH limit was released. The pH then elevated rapidly above the 9.0 limit for about 10 minutes. The amount of wastewater discharged during this 30 minute period is not known (DOE-RL 1991b).

### 2.4.22 182-N Unplanned Release of Turbine Oil to the Columbia River

On February 6, 1987, approximately 19 L (5 gal) of turbine oil was discharged to the Columbia River through the 182-N Tank Farm raw water return line. A small (pinhole size) leak in a lube oil line in the No. 2 Drive Turbine allowed oil to enter the secondary steam system. Steam condensate from this system returns to the 100 N Steam Condensate System that drains to the river. The leak in the lube line was repaired (DOE-RL 1991b).

### 2.4.23 128-N-1 Burn Pit, Grass Dump, and Construction Debris Dump

These sites are described individually in the following sections.

**2.4.23.1 128-N-1 Burn Pit.** The 128-N Burn Pit is located directly east of the 116-N-3 Crib and Trench. The unit was used primarily for burning nonhazardous waste (e.g., paper, wood, and trash) generated at the 100 N Area. The amount of waste managed by the unit is not known. No documentation or evidence was found of any release of dangerous or radioactive wastes from the unit. The dimensions of this unit were altered and the location shifted during its operation from 1962 to 1986 (DOE-RL 1991b).

**2.4.23.2 Grass Dump.** The Grass Dump is an open area of ground used as a grass dump over an unknown period of time. It is not known whether other wastes have been placed in the unit.

**2.4.23.3 Construction Debris Dump.** The Construction Debris Dump was used by the J.A. Jones Construction Company during past construction work at the 100 N Area. Debris dumped at the site consisted of dirt, rocks, asphalt, concrete, metal, and wood. No hazardous or radioactive waste disposal has been documented. Standard practice at the 100 N Area is to survey materials for radioactivity before disposal. Materials disposed of at the Construction Debris Dump were surveyed for radioactivity and released (no radiation was detected prior to disposal) (DOE-RL 1991b).

## 2.5 IDENTIFICATION OF CONTAMINANTS OF POTENTIAL CONCERN

This section describes the identification of COPC for the QRA. The processes used for the human health and ecological evaluations are described separately in the following sections.

### 2.5.1 Human Health Evaluation

Information available for each waste site was reviewed to identify chemicals or radionuclides that may impact the soil. This information includes process knowledge, disposal knowledge, records of inventory, historical information, information obtained during site reconnaissance, and data generated from LFI sampling activities. Information or data collected from analogous sites or similar categories of sites (e.g., cribs associated with the reactor sites) were also used as appropriate to identify potential chemicals or radionuclides at the sites.

In general, both the historical and LFI data were considered for identification of COPC. Constituents were considered only if present in the upper 4.6 m (15 ft) of soil. The highest concentration for each analyte from the LFI data set was selected for evaluation in the QRA.

The process discussed in Section C.2.1 of the HSRAM (DOE-RL 1994) was used to identify COPC for each waste site. This process includes the definition of contaminants based on sitewide background (DOE-RL 1993a) and preliminary risk-based screening (DOE-RL 1994) using residential scenario exposure parameters with an ICR of 1E-07 and an HQ of 0.1. Risk-based concentrations calculated for the contaminants detected during the LFI are presented in Tables 2-11, 2-12, and 2-13. Risk-based concentration values for radionuclides suspected at high-priority waste sites are presented in Table 2-14.

If no LFI sampling data were available, available historical information was used to qualitatively develop a list of COPC for the sites. A list of COPC identified for waste sites using historical information is presented in Table 2-10.

Contaminants of potential concern were selected by the process stated above. Risks were calculated on a site-specific basis for selected COPC and are discussed in Section 3.0. The COPC carried through this QRA for the human health evaluation are presented in Table 2-15.

### 2.5.2 Ecological Data Evaluation

The process for the selection of ecological COPC is different than the process described in Section 3.3 of HSRAM (DOE-RL 1994). The process used includes the selection of COPC that exceed the Hanford Site background values (DOE-RL 1993a) but not the risk-based screening process used for the human health evaluation. As a result, contaminants not included in the human health evaluation may be retained in the ecological risk evaluation because sensitivity to these contaminants may be greater for ecological populations (organisms).

Table 2-16 lists the COPC used in the ecological evaluation. These contaminants were detected at concentrations exceeding the Hanford Site background levels. Contaminants for which Hanford Site background levels have not been established were also retained for the ecological evaluation. Table 2-17 (radiological) and 2-18 (nonradiological) list the general parameters for calculation of the radiological dose rate to the pocket mouse from radiological contaminants identified at the 100-NR-1 Unit. The most recent revision of the HSRAM (DOE-RL 1994) presents ecological dose equations for modeling the dose rate to the pocket mouse.

## 2.6 UNCERTAINTY ASSOCIATED WITH DATA EVALUATION

The uncertainty in the QRA risk characterization includes specific uncertainties related to the data evaluation process for detected contaminants. Uncertainty can also relate to the quality of data used in the QRA.

Data used in this QRA are generally of high, known quality (LFI data) or medium quality (historical data). Limited field investigation data were validated in accordance with Westinghouse Hanford Company (WHC) Sample Management Administration Manual (WHC 1990). The data from the historical surveillance reports were generated following routine laboratory protocols but were not validated; therefore, these data are considered to be of medium quality.

Because historical data and LFI data vary, the highest concentrations from either data set were used in the QRA as a conservative measure.

Some of the validated data have been reconsidered to include some rejected or estimated data values in the QRA. For instance, "J" (estimated value) qualified data were used and "R" (rejected value) data were included if the reason for rejection was administrative rather than technical reasons.

The contaminants and concentrations identified in the LFI data are not necessarily representative of all the soil within 4.6 m (15 ft) of the surface. The maximum COPC used might be an underestimate or overestimate of the maximum concentration. Because only one borehole was drilled and sampled at many sites, contaminants other than those identified could also be present.

Uncertainty associated with the historical or LFI data contributes to the overall uncertainties of human health risk estimates in this QRA. The uncertainty in the identification and quantification of soil contaminant concentrations used in the exposure assessment was defined as follows:

- Low - analytical data were obtained from media similar to the exposure pathway medium.
- Moderate - analytical data were not obtained from media similar to the exposure pathway medium.
- High - site-specific analytical data were not available. Waste sites characterized by comparison with analogous waste sites are considered to have "high" uncertainty with regard to both contaminant identification and concentration.

According to these definitions, the LFI and historical data used in the ingestion pathway evaluations were considered to have "low" uncertainty for the contaminants reported.

Uncertainties associated with data used to evaluate external radiation exposures to humans are considered "moderate" because the evaluation used toxicity SF values that extrapolate external radiation risks from radionuclide concentrations in soil. Direct measurements of external radiation intensity were not available for this QRA. Because exposure via the external radiation pathway is shown to be a major contributor to risk at many waste sites (Section 3.0), this "moderate" data uncertainty is expected to significantly impact the QRA.

Uncertainties associated with data used to evaluate inhalation exposure pathways for humans are also considered "moderate" because the evaluation required extrapolation of airborne dust concentrations from soil concentrations. However, this "moderate" data uncertainty is not expected to significantly impact the QRA because exposure via the inhalation pathway is not shown to be a major contributor to risk at most waste sites (Section 3.0).

Uncertainties associated with the identification of contaminants are considered "low" for waste sites evaluated using LFI data or both historical and LFI data. The COPC identified have established release histories at the 100-NR-1 Source Operable Unit. Several of the chemical COPC have established background soil concentrations at the Hanford Site. Because the systematic and/or random errors attributed to the analytical methods used are expected to be minimal relative to exposure assumptions of HSRAM (DOE-RL 1994), the uncertainty associated with the contaminant concentrations reported is also considered "low."

Uncertainties associated with the identification of contaminants are considered "low" to "moderate" for waste sites evaluated using only historical data. The primary objective of historical studies was to investigate radionuclides in exposure media contributed by Hanford

operations. As a result, the historical data do not include analyses for chemical COPC and do not report soil concentrations of naturally occurring radionuclides (e.g., potassium-40).

The impact of data uncertainty on the 100-NR-1 Source Operable Unit human health QRA is described in Section 1.3.2.4. Briefly, uncertainty might result in either an overestimation or underestimation of risk and the magnitude of the error might be "low," "moderate," or "high." Uncertainties in risks estimated for 100-NR-1 Source Operable Unit QRA waste sites are dominated by the uncertainty of the exposure assessment, which is considered to be "moderate" to "high." This "moderate" to "high" exposure uncertainty reflects overestimations or underestimations of risk resulting from the use of maximum COPC concentrations in the exposure assessment. Further sampling or refinements in existing data cannot reduce uncertainties associated with the exposure assessment unless the maximum concentrations change.

Table 2-19 lists radionuclides that are known to have been released at the 100-NR-1 Source Operable Unit but were not detected by any of the analytical sampling efforts and would result in a risk above the RBC at the associated detection limits. Such undetected concentrations of these radionuclides represent "low" to "medium" human health risks (i.e., ICR from $1x10^{-6}$ to $1x10^{-4}$). Table 2-20 lists nonradionuclides that were not detected at many sites but would result in risk above the RBC at the associated detection limits. Such undetected concentrations of these nonradionuclides represent "low" human health risks (i.e., ICR from 1E-06 to 1E-05). The potential risks from these undetected radionuclides and nonradionuclides are much lower than the primary contributors to risk at most 100-NR-1 Operable Unit sites (Section 3.0). Therefore, the uncertainties attributed to the detection limits are not expected to have a significant impact on this QRA.

Table 2-2 Site 116-N-1 (1301-N) Summary of Maximum Concentrations of Inorganics (mg/kg) (page 1 of 2)

| Inorganics | Depth (ft) | LFI Data from Wells | | |
|---|---|---|---|---|
| | | 199-N-75 | 199-N-76 | 199-N-80 |
| Aluminum | 0-6 | 6720 (a) | 6440 (a) | 5090 (a)(b) |
| | 6-15 | 5720 (a)(b) | -- | -- |
| | >15 | 6300 (a) | 7670 (a) | 11500(a) |
| Antimony | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Arsenic | 0-6 | 2.6 (a) | 2.6 (a) | ND |
| | 6-15 | 2.3 (a)(b) | -- | -- |
| | >15 | 1.6 B (a) | 3.6 (a) | 3.9(a) |
| Barium | 0-6 | 62.3 (a) | 51.7 (a) | 72.1 (a)(b) |
| | 6-15 | 60.6 (a)(b) | -- | -- |
| | >15 | 63.9 (a) | 74.6 (a) | 98.5(a) |
| Beryllium | 0-6 | 0.24 B (a) | 0.21 B (a) | ND |
| | 6-15 | 0.24 B (a)(b) | -- | -- |
| | >15 | ND | 0.27 B (a) | 0.37(a) |
| Cadmium | 0-6 | 0.61 B | 0.52 B | ND |
| | 6-15 | 0.49 B (b) | -- | -- |
| | >15 | ND | 0.9 B | ND |
| Calcium | 0-6 | 6780 (a) | 7040 (a) | 6560 (a)(b) |
| | 6-15 | 7370 (a)(b) | -- | -- |
| | >15 | 2590 (a) | 5790 (a) | 19900 (a) |
| Chromium | 0-6 | 8.7 (a) | 8.3 (a) | ND |
| | 6-15 | 7.6 (a)(b) | -- | -- |
| | >15 | 14.7 (a) | 11.4 (a) | 16.5 (a) |
| Cobalt | 0-6 | 9.8 B (a) | 9.8 B (a) | ND |
| | 6-15 | 9.4 B (a)(b) | -- | -- |
| | >15 | 5.7 B (a) | 11.4 (a) | 10.7 (a) |
| Copper | 0-6 | 15.4 (a) | 18.7 (a) | ND |
| | 6-15 | 15.8 (a)(b) | -- | -- |
| | >15 | 13.5 (a) | 25.9 (a) | 21.7 (a) |
| Iron | 0-6 | 17400 (a) | 18500 (a) | 18400 (a)(b) |
| | 6-15 | 18100 (a)(b) | -- | -- |
| | >15 | 11000 (a) | 21400 (a) | 21400 (a) |
| Lead | 0-6 | 5.1 (a) | 4.5 (a) | 3.1 (a)(b) |
| | 6-15 | 4.2 (a)(b) | -- | -- |
| | >15 | 2.7 (a) | 7.6 (a) | 8.4 (a) |
| Magnesium | 0-6 | 4460 (a) | 4460 (a) | 3920 (a)(b) |
| | 6-15 | 4400 (a)(b) | -- | -- |
| | >15 | 4350 (a) | 5460 (a) | 6590 (a) |
| Manganese | 0-6 | 320 N (a) | 269 N (a) | 296 (a)(b) |
| | 6-15 | 317 N (a)(b) | -- | -- |
| | >15 | 227 (a) | 345 (a) | 612 (a) |
| Mercury | 0-6 | ND | 0.11 (a)(c) | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | 0.10 (a)(c) | 0.05 (a) |
| Nickel | 0-6 | 11 (a) | 10.4 (a) | ND |
| | 6-15 | 9.2 (a)(b) | -- | -- |
| | >15 | 14.4 (a) | 14.8 (a) | 16.9 (a) |

## Table 2-2 Site 116-N-1 (1301-N) Summary of Maximum Concentrations of Inorganics (mg/kg) (page 2 of 2)

| Inorganics | Depth (ft) | LFI Data from Wells | | |
|---|---|---|---|---|
| | | 199-N-75 | 199-N-76 | 199-N-80 |
| Potassium | 0-6 | 1350 (a) | 1040 (a) | ND |
| | 6-15 | 1210 (a)(b) | -- | -- |
| | >15 | 919 (a) | 1350 (a) | 2160 (a) |
| Selenium | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Silver | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | 1.2 (a) |
| Sodium | 0-6 | 204 B (a) | 190 B (a) | ND |
| | 6-15 | 164 B (a)(b) | -- | -- |
| | >15 | 246 (a) | 314 B (a) | 233 (a) |
| Thallium | 0-6 | ND | 0.43 B (a)(c) | ND |
| | 6-15 | 0.43 B (a)(b) | -- | -- |
| | >15 | ND | ND | ND |
| Vanadium | 0-6 | 36.8 (a) | 36 (a) | 42.4 (a)(b) |
| | 6-15 | 33.9 (a)(b) | -- | -- |
| | >15 | 23.6 (a) | 45.4 (a) | 42.1 (a) |
| Zinc | 0-6 | 42.8 (a) | 41.8 (a) | 39.7 (a)(b) |
| | 6-15 | 40.2 (a)(b) | -- | -- |
| | >15 | 29 (a) | 46.9 (a) | 53.5 (a) |
| Cyanide | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Fluoride | 0-6 | -- | -- | 3.1(a)(b) |
| | 6-15 | -- | -- | -- |
| | >15 | -- | -- | 4.6 (a) |
| Sulfate | 0-6 | -- | -- | 42 (a)(b) |
| | 6-15 | -- | -- | -- |
| | >15 | -- | -- | 88 (a) |
| Nitrate | 0-6 | -- | -- | ND |
| | 6-15 | -- | -- | -- |
| | >15 | -- | -- | 56.4 (a) |

Shaded cells indicate concentrations that exceed Hanford Site background and the risk-based concentration (RBC) at 1E-07 incremental cancer risk (ICR).

-- No samples collected in this interval.

(a) Less than Hanford background.

(b) Consistency assumed; only one sample from interval.

(c) Value is inconsistent with other results within this interval. Result is suspect.

(d) Value is less than or equal to five times the concentration detected in associated blank. Sample contamination is suspected.

B - Estimated value; reading was less than contract-required detection limit but greater than or equal to instrument detection limit.

N - Spiked sample recovery not within control limits.

**Table 2-3 Site 116-N-1 (1301-N) Summary of Maximum Concentrations of Volatile Organics (μg/kg) (page 1 of 3)**

| Volatile Organics | Depth (ft) | LFI Data from Wells | | |
|---|---|---|---|---|
| | | 199-N-75 | 199-N-76 | 199-N-80 |
| 1,1,1-Trichloroethane | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 1,1,2,2-Tetrachloroethane | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 1,1,2-Trichloroethane | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 1,1-Dichloroethane | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 1,1-Dichloroethene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 1,2-Dichloroethane | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 1,2-Dichloroethene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 1,2-Dichloropropane | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 2-Butanone | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | 8J |
| 2-Hexanone | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 4-Methyl-2-Pentanone | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | 7 J(a) | ND |
| Acetone | 0-6 | 17 B(b) | 12 B(b) | ND |
| | 6-15 | 22 B(b)(c) | -- | -- |
| | >15 | 51 B(b) | 140 B(b) | 23 |
| Benzene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Bromodichloromethane | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Bromoform | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |

Table 2-3 Site 116-N-1 (1301-N) Summary of Maximum Concentrations of Volatile Organics ($\mu$g/kg) (page 2 of 3)

| Volatile Organics | Depth (ft) | LFI Data from Wells | | |
|---|---|---|---|---|
| | | 199-N-75 | 199-N-76 | 199-N-80 |
| Bromomethane | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Carbon Disulfide | 0-6 | 1 J(a) | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | 2 J(a) | ND | ND |
| Carbon Tetrachloride | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | 8 J(a) | ND |
| Chlorobenzene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Chloroethane | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Chloroform | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | 3 BJ(a)(d) | 3 BJ(a)(d) | ND |
| Chloromethane | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Dibromochloromethane | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Ethylbenzene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Methylene Chloride | 0-6 | 4 J(b) | 3 J(a)(b) | ND |
| | 6-15 | 4 J(b)(c) | -- | -- |
| | >15 | 28 (b) | 63 (b) | 6J |
| Styrene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Tetrachloroethene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Toluene | 0-6 | 2 J(a) | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | 3 J(a) | 7J |
| Trichloroethene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Vinyl Chloride | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |

Table 2-3 Site 116-N-1 (1301-N) Summary of Maximum Concentrations of Volatile Organics (μg/kg) (page 3 of 3)

| Volatile Organics | Depth (ft) | LFI Data from Wells | | |
|---|---|---|---|---|
| | | 199-N-75 | 199-N-76 | 199-N-80 |
| Xylenes (total) | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| cis-1,3-Dichloropropene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| trans-1,3-Dichloropropene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |

No reported concentrations exceed the risk-based concentration (RBC) at 1E-07 incremental cancer risk (ICR) or 1.0 hazard quotient (HQ).

-- No sample collected in this interval.

(a) Value is inconsistent with other sample results. Result is suspect.

(b) Value is less than or equal to ten times the concentration detected in associated blank. Sample contamination is suspected.

(c) Consistency assumed; only one sample in interval.

(d) Value is less than or equal to five times the concentration detected in associated blank. Sample contamination is suspected.

B - Analyte detected in associated laboratory blank.

J - Estimated value.

ND - Not detected.

THIS PAGE INTENTIONALLY
LEFT BLANK

Table 2-4 Site 116-N-1 (1301-N) Summary of Maximum Concentrations of Semi-Volatile Organics ($\mu$g/kg) (page 1 of 5)

| Semivolatile Organics | Depth (ft) | LFI Data from Wells | | |
|---|---|---|---|---|
| | | 199-N-75 | 199-N-76 | 199-N-80 |
| 1,2,4-Trichlorobenzene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 1,2-Dichlorobenzene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 1,3-Dichlorobenzene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 1,4-Dichlorobenzene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 2,4,5-Trichlorophenol | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 2,4,6-Trichlorophenol | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 2,4-Dichlorophenol | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 2,4-Dimethylphenol | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 2,4-Dinitrophenol | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 2-Chloronaphthalene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 2-Chlorophenol | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 2-Methylnaphthalene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 2-Methylphenol | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 2-Nitroaniline | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |

**Table 2-4 Site 116-N-1 (1301-N) Summary of Maximum Concentrations of Semi-Volatile Organics (μg/kg) (page 2 of 5)**

| Semivolatile Organics | Depth (ft) | LFI Data from Wells | | |
|---|---|---|---|---|
| | | 199-N-75 | 199-N-76 | 199-N-80 |
| 2-Nitrophenol | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 3-Nitroaniline | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 4-Chloro-3-methylphenol | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 4-Chloroaniline | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 4-Methylphenol | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Acenaphthene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Acenaphthylene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| bis(2-Chloroethoxy)methane | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| bis(2-Chloroethyl)ether | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| bis(2-Chloroisopropyl)ether | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Dimethylphthalate | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Hexachlorobutadiene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Hexachlorocyclopentadiene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Hexachloroethane | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |

Table 2-4 Site 116-N-1 (1301-N) Summary of Maximum Concentrations of Semi-Volatile Organics (μg/kg) (page 3 of 5)

| Semivolatile Organics | Depth (ft) | LFI Data from Wells | | |
|---|---|---|---|---|
| | | 199-N-75 | 199-N-76 | 199-N-80 |
| Isophorone | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| N-nitroso-di-n-dipropylamine | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Naphthalene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Nitrobenzene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Phenol | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 2,4-Dinitrotoluene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 2,6-Dinitrotoluene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 3,3'-Dichlorobenzidine | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 4,6-Dinitro-2-methylphenol | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 4-Bromophenylphenyl ether | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 4-Chlorophenylphenyl ether | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 4-Nitroaniline | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| 4-Nitrophenol | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Carbazole | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |

Table 2-4 Site 116-N-1 (1301-N) Summary of Maximum Concentrations of Semi-Volatile Organics ($\mu$g/kg) (page 4 of 5)

| Semivolatile Organics | Depth (ft) | LFI Data from Wells | | |
|---|---|---|---|---|
| | | 199-N-75 | 199-N-76 | 199-N-80 |
| Anthracene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Benzo(a)anthracene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Benzo(a)pyrene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Benzo(b)fluoranthene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Benzo(ghi)perylene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Benzo(k)fluoranthene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| bis(2-ethylhexyl)phthalate | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | 61 J(a) | 530 B(b) | 260J(a) |
| Butylbenzylphthalate | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Chrysene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Di-n-butylphthalate | 0-6 | 51 J | 63 J | ND |
| | 6-15 | ND | -- | -- |
| | >15 | 110 BJ(b) | 100 BJ(b) | 44J |
| Di-n-octylphthalate | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Dibenz[a,h]anthracene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Dibenzofuran | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Diethyl phthalate | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |

Table 2-4 Site 116-N-1 (1301-N) Summary of Maximum Concentrations of Semi-Volatile Organics (μg/kg) (page 5 of 5)

| Semivolatile Organics | Depth (ft) | LFI Data from Wells | | |
|---|---|---|---|---|
| | | 199-N-75 | 199-N-76 | 199-N-80 |
| Fluoranthene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Fluorene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Hexachlorobenzene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Indeno(1,2,3-cd)pyrene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| N-Nitrosodiphenylamine | 0-6 | ND | ND | ND |
| | 6-15 | 110 J(c) | -- | -- |
| | >15 | ND | ND | ND |
| Pentachlorophenol | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Phenanthrene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |
| Pyrene | 0-6 | ND | ND | ND |
| | 6-15 | ND | -- | -- |
| | >15 | ND | ND | ND |

No reported concentration exceeds the risk-based concentration (RBC) at 1E-07 incremental cancer risk (ICR) or 1.0 hazard quotient (HQ).

-- No sample collected from this interval.

(a) Value is inconsistent with other sample results. Result is suspect.

(b) Value is less than or equal to five times the concentration detected in associated blank. Sample contamination is suspected.

(c) Consistency assumed; only one sample from interval.

B - Detected in associated laboratory blank.

D - Analysis performed on diluted sample.

J - Estimated value.

ND - Not detected.

THIS PAGE INTENTIONALLY
LEFT BLANK

## Table 2-5 Site 116-N-3 (1325-N) Summary of Maximum Concentrations of Radionuclides (pCi/g)

| Radionuclides | Half-Life (years) | Depth (ft) | Historical Data: Date of Data(a): 1987 Source(b): WHC 1988 | Historical Data: Date of Data(a): 1985 Source(b): UNC 1986 | Historical Data Decayed to1992: Source(b): WHC 1988 | Historical Data Decayed to1992: Source(b): UNC 1986 | Concentration Used in the QRA: For 1992 | Concentration Used in the QRA: For 2018 |
|---|---|---|---|---|---|---|---|---|
| Cesium-137 | 3.00E+01 | 0-6 | 4.80E+04 | 7.10E+04 | 4.08E+04 | 6.04E+04 | 6.04E+04 | 3.31E+04 |
| | | 6-15 | | | | | | |
| | | >15 | | | | | | |
| Cerium-144 | 7.81E-01 | 0-6 | | 1.20E+05 | | 2.40E+02 | 2.40E+02 | 2.27E-08 |
| | | 6-15 | | | | | | |
| | | >15 | | | | | | |
| Cobalt-60 | 5.30E+00 | 0-6 | 1.40E+06 | 1.70E+06 | 5.60E+05 | 6.81E+05 | 6.81E+05 | 2.27E+04 |
| | | 6-15 | | | | | | |
| | | >15 | | | | | | |
| Manganese-54 | 8.58E-01 | 0-6 | 2.70E+05 | 3.60E+05 | 9.42E+02 | 1.26E+03 | 1.26E+03 | 9.37E-07 |
| | | 6-15 | | | | | | |
| | | >15 | | | | | | |
| Plutonium-238 | 8.78E+01 | 0-6 | 2.10E+04 | 8.60E+03 | 1.99E+04 | 8.14E+03 | 1.99E+04 | 1.62E+04 |
| | | 6-15 | | | | | | |
| | | >15 | | | | | | |
| Plutonium-239/240 | 2.40E+04 | 0-6 | 1.20E+05 | 5.60E+04 | 1.20E+05 | 5.60E+04 | 1.20E+05 | 1.20E+05 |
| | | 6-15 | | | | | | |
| | | >15 | | | | | | |
| Strontium-90 | 2.90E+01 | 0-6 | 6.30E+05 | 2.00E+05 | 5.33E+05 | 1.69E+05 | 5.33E+05 | 2.86E+05 |
| | | 6-15 | | | | | | |
| | | >15 | | | | | | |

(a) The date the data was collected; necessary to calculate decay of radionuclides to 1992.
(b) Sources are presented in Section 5.0 References.

Shaded cells indicate concentrations greater than the risk-based concentration (RBC) at 1E-07 incremental cancer risk (ICR).
Decay calculation: Concentration after Time Interval = (Initial Concentration)(0.5)^(Elapsed Time/Half-Life of Radionuclide)
Three sample horizons are presented for convenience. The ecological risk assessment uses the 0- to 6-ft horizon.
The human health risk assessment uses the maximum concentration from the combination of the 0- to 6-ft horizon and the 6- to 15-ft horizon for a 0- to 15-ft horizon.
The >15-ft horizon is used to correlate the soil assessment to the groundwater assessment in the 100-NR-2 QRA (WHC 1993a).

THIS PAGE INTENTIONALLY
LEFT BLANK

9413300.0186

**Table 2-6 Summary of Radionuclide Maximum Concentrations for Sites with LFI Data Only (pCi/g) (page 1 of 3)**

| Radionuclides | Depth (ft) | Site: 116-N-2 | 119-N | 1322-N | 166-N | 120-N2 | 120-N-1 | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Sample Location: 116-N-2 | 119-N | 1322-N | UN-100-N-17 | 120-N-2 | 120-N-1 | 199-N-77 | South Pond |
| Americium-241 | 0-6 | 0.062 | -- | 0.039 J(a) | -- | -- | -- | -- | -- |
| | 6-15 | ND | -- | ND | -- | -- | -- | -- | -- |
| | >15 | ND | -- | ND | ND | -- | -- | -- | -- |
| Carbon-14 | 0-6 | ND | -- | ND | -- | -- | -- | -- | -- |
| | 6-15 | ND | -- | ND | -- | -- | -- | -- | -- |
| | >15 | ND | -- | ND | ND | -- | -- | -- | -- |
| Cesium-134 | 0-6 | ND | -- | ND | -- | -- | -- | -- | -- |
| | 6-15 | ND | -- | ND | -- | -- | -- | -- | -- |
| | >15 | ND | -- | ND | ND | -- | -- | -- | -- |
| Cesium-137 | 0-6 | 3.8 | -- | 1.5 | -- | -- | -- | -- | -- |
| | 6-15 | ND | -- | ND | -- | -- | -- | -- | -- |
| | >15 | ND | -- | ND | ND | -- | -- | -- | -- |
| Chromium-51 | 0-6 | ND | -- | ND | -- | -- | -- | -- | -- |
| | 6-15 | ND | -- | ND | -- | -- | -- | -- | -- |
| | >15 | ND | -- | ND | ND | -- | -- | -- | -- |
| Cobalt-60 | 0-6 | 100 | -- | 7 | -- | -- | -- | -- | -- |
| | 6-15 | 4.3 | -- | 0.098 (b) | -- | -- | -- | -- | -- |
| | >15 | ND | -- | ND | 1.3 | -- | -- | -- | -- |
| Europium-152 | 0-6 | ND | -- | ND | -- | -- | -- | -- | -- |
| | 6-15 | ND | -- | ND | -- | -- | -- | -- | -- |
| | >15 | ND | -- | ND | ND | -- | -- | -- | -- |
| Europium-154 | 0-6 | ND | -- | ND | -- | -- | -- | -- | -- |
| | 6-15 | ND | -- | ND | -- | -- | -- | -- | -- |
| | >15 | ND | -- | ND | ND | -- | -- | -- | -- |
| Gross Alpha | 0-6 | 9.5 J | -- | 9.7 (a) | -- | -- | -- | -- | -- |
| | 6-15 | 8.5 J | -- | ND | -- | -- | -- | -- | -- |
| | >15 | ND | -- | 11 (a) | 7.9 J | -- | -- | -- | -- |
| Gross Beta | 0-6 | 58 | -- | 31 | -- | -- | -- | -- | -- |
| | 6-15 | 14 | -- | 21 (b) | -- | -- | -- | -- | -- |
| | >15 | 8.9 J(b) | -- | 38 | 18 | -- | -- | -- | -- |

**Table 2-6 Summary of Radionuclide Maximum Concentrations for Sites with LFI Data Only (pCi/g) (page 2 of 3)**

| Radionuclides | Depth (ft) | Site | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 116-N-2 | 119-N | 1322-N | 166-N | 120-N2 | 120-N-1 | | |
| | | Sample Location | | | | | | | |
| | | 116-N-2 | 119-N | 1322-N | UN-100-N-17 | 120-N-2 | 120-N-1 | 199-N-77 | South Pond |
| Iron-59 | 0-6 | ND | – | ND | – | – | – | – | – |
| | 6-15 | ND | – | ND | – | – | – | – | – |
| | >15 | ND | – | ND | ND | – | – | – | – |
| Plutonium-238 | 0-6 | ND | – | ND | – | – | – | – | – |
| | 6-15 | ND | – | ND | – | – | – | – | – |
| | >15 | ND | – | ND | ND | – | – | – | – |
| Plutonium-239/240 | 0-6 | 0.15 | – | 0.064 B(a) | – | – | – | – | – |
| | 6-15 | ND | – | ND | – | – | – | – | – |
| | >15 | ND | – | ND | ND | – | – | – | – |
| Potassium-40 | 0-6 | 14 | – | 13 | – | – | – | – | – |
| | 6-15 | 16 | – | 17 (b) | – | – | – | – | – |
| | >15 | 8.3 (b) | – | 9.4 | 16 | – | – | – | – |
| Radium-226 | 0-6 | 0.67 | – | 0.652 | – | – | – | – | – |
| | 6-15 | 0.55 | – | 0.54 (b) | – | – | – | – | – |
| | >15 | 0.31 (b) | – | 0.39 | 0.49 | – | – | – | – |
| Ruthenium-106 | 0-6 | ND | – | ND | – | – | – | – | – |
| | 6-15 | ND | – | ND | – | – | – | – | – |
| | >15 | ND | – | ND | ND | – | – | – | – |
| Strontium-90 | 0-6 | ND | – | 2.4 | – | – | – | – | – |
| | 6-15 | ND | – | ND | – | – | – | – | – |
| | >15 | ND | – | 8.0 (a) | 1.1 J | – | – | – | – |
| Technetium-99 | 0-6 | NR | – | NR | – | – | – | – | – |
| | 6-15 | NR | – | NR | – | – | – | – | – |
| | >15 | NR | – | NR | NR | – | – | – | – |
| Thorium-228 | 0-6 | 1.2 | – | 1.0 | – | – | – | – | – |
| | 6-15 | 1.0 | – | 1.2 (b) | – | – | – | – | – |
| | >15 | 0.51 (b) | – | 0.54 | 1.1 | – | – | – | – |
| Thorium-232 | 0-6 | 0.84 | – | 0.95 | – | – | – | – | – |
| | 6-15 | 1.1 | – | 0.9 (b) | – | – | – | – | – |
| | >15 | 0.47 (b) | – | 0.49 | 1.2 | – | – | – | – |

9413300.0187

**Table 2-6 Summary of Radionuclide Maximum Concentrations for Sites with LFI Data Only (pCi/g) (page 3 of 3)**

| Radionuclides | Depth (ft) | Site: 116-N-2 | 119-N | 1322-N | 166-N | 120-N2 | 120-N-1 | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Sample Location: 116-N-2 | 119-N | 1322-N | UN-100-N-17 | 120-N-2 | 120-N-1 | 199-N-77 | South Pond |
| Tritium | 0-6 | NR | -- | NR | -- | -- | -- | -- | -- |
| | 6-15 | NR | -- | NR | -- | -- | -- | -- | -- |
| | >15 | NR | -- | NR | NR | -- | -- | -- | -- |
| Uranium-233/234 | 0-6 | 0.65 (c) | -- | 0.64 | -- | -- | -- | -- | -- |
| | 6-15 | 0.46 | -- | 0.37 (b) | -- | -- | -- | -- | -- |
| | >15 | 0.48 (b) | -- | 0.29 J(a) | 0.55 | -- | -- | -- | -- |
| Uranium-235 | 0-6 | ND | -- | ND | -- | -- | -- | -- | -- |
| | 6-15 | ND | -- | ND | -- | -- | -- | -- | -- |
| | >15 | ND | -- | ND | ND | -- | -- | -- | -- |
| Uranium-238 | 0-6 | 0.56 | -- | 0.73 | -- | -- | -- | -- | -- |
| | 6-15 | 0.59 | -- | 0.35 | -- | -- | -- | -- | -- |
| | >15 | 0.33 (b) | -- | 0.29 J | 0.5 | -- | -- | -- | -- |
| Zinc-65 | 0-6 | ND | -- | ND | -- | -- | -- | -- | -- |
| | 6-15 | ND | -- | ND | -- | -- | -- | -- | -- |
| | >15 | ND | -- | ND | ND | -- | -- | -- | -- |

Shaded cells indicate concentrations that exceed the risk-based concentration (RBC) at 1E-07 incremental cancer risk (ICR).

-- No sample collected from this interval.

(a) Value is inconsistent with other sample results. Result is suspect.

(b) Consistency assumed; only one sample from interval.

(c) Value is less than or equal to five times the concentration detected in associated blank. Sample contamination is suspected.

B - Analyte detected in associated laboratory blank.

J - Estimated value.

ND - Not detected.

NR - Not reported.

THIS PAGE INTENTIONALLY
LEFT BLANK

9413300.0188

**Table 2-7 Summary of Maximum Concentrations of Inorganics for Sites with LFI Data Only (mg/kg) (page 1 of 3)**

| | | Site | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 116-N-2 | 119-N | 120-N-2 | 1322-N | 166-N | 120-N-1 | | |
| | Depth | Boring | | | | | | | |
| Inorganics | (ft) | 116-N-2 | 119-N | 120-N-2 | 1322-N | UN-100-N-17 | 120-N-1 | South Pond | 199-N-77 |
| Aluminum | 0-6 | 7740 (a) | -- | 9010 (a) | 8050 (a) | -- | 5520 (a) | 6540 (a) | -- |
| | 6-15 | 4220 (a) | 5160 (a)(b) | 4800 (a) | 5890 (a)(b) | -- | 4610 (a) | 8120 (a) | -- |
| | >15 | 3050 (a)(b) | 4990(a) | 5380 (a) | 3970 (a) | 5980 (a) | 5210 (a) | 5370 (a) | 5070 * (a) |
| Antimony | 0-6 | ND | -- | ND | 10.8 B (a)(c) | -- | 3.9 BN (a)(c)(d) | ND | -- |
| | 6-15 | ND | ND | ND | ND | -- | ND | ND | -- |
| | >15 | ND | ND | ND | ND | 4.4 B (a)(c) | ND | 5.0 BN (a) | ND |
| Arsenic | 0-6 | 2.2 (a)(d) | -- | 2.9 (a) | 2.5 S (a) | -- | 1.7 BW (a) | 2.4 S (a) | -- |
| | 6-15 | 1.5 BW (a) | 2.0 B (a)(b) | 1.0 BWN (a)(d) | 2.0 (a)(b) | -- | 1.2 B (a) | 3.5 N (a) | -- |
| | >15 | 0.76 BW (a)(b) | 1.7 B (a) | 1.4 BN (a)(d) | 0.95 B (a) | 1.6 BW (a)(d) | 2.1 B (a)(d) | 2.7 SN (a) | 1.5 B (a)(d) |
| Barium | 0-6 | 67.4 (a) | -- | 72.7 (a) | 63.6 (a) | -- | 93.7 (a) | 59.3 (a) | -- |
| | 6-15 | 84.9 (a) | 49.4 (a)(b) | 54.3 E (a) | 51.6 (a)(b) | -- | 75.5 (a) | 63.6 (a) | -- |
| | >15 | 49.4 (a)(b) | 59.4 (a) | 74 (a) | 47.1 (a) | 69.7 E (a) | 55.1 (a) | 65.6 (a) | 55 (a) |
| Beryllium | 0-6 | 0.63 B (a) | -- | 0.35 B (a) | 0.53 B (a) | -- | ND | 0.1 B (a) | -- |
| | 6-15 | 0.23 B (a) | 0.28 B (a)(b) | 0.23 B (a) | 0.21 B (a)(b) | -- | ND | 0.11 B (a) | -- |
| | >15 | 0.21 B (a)(b) | 0.25 B (a) | 0.39 B (a) | 0.22 B (a) | 0.35 B (a) | ND | 0.3 B (a) | 0.29 B (a) |
| Cadmium | 0-6 | ND | -- | ND | ND | -- | ND | ND | -- |
| | 6-15 | ND | ND | ND | ND | -- | ND | ND | -- |
| | >15 | ND | ND | ND | ND | ND | ND | ND | 3.1 (c) |
| Calcium | 0-6 | 10700 (a) | -- | 6130 (a) | 6280 (a) | -- | 9170 * (a) | 6750 (a) | -- |
| | 6-15 | 5610 (a) | 7160 (a)(b) | 6670 E (a) | 2540 (a)(b) | -- | 5490 * (a) | 7860 (a) | -- |
| | >15 | 5510 (a)(b) | 7130 (a) | 6240 E (a) | 5970 (a) | 10600 (a) | 4460 * (a) | 5680 (a) | 5950 (a) |
| Chromium | 0-6 | 15 (a) | -- | 13.7 * (a) | 13.1 (a) | -- | 8.4 (a) | 12.1 (a) | -- |
| | 6-15 | 6.8 * (a) | 7.4 (a)(b) | 5.9 (a) | 10.9 (a)(b) | -- | 5.6 (a) | 10.4 (a) | -- |
| | >15 | 3.9 * (a)(b) | 7.1 (a) | 14.6 (a) | 4.3 (a) | 18.2 (a) | 12.2 (a) | 11.2 (a) | 15.5 * (a) |
| Cobalt | 0-6 | 9.3 B (a) | -- | 10.8 (a) | 14.8 (a) | -- | 10.7 B (a) | 8.2 B (a) | -- |
| | 6-15 | 11.8 (a) | 10.4 E (a)(b) | 13.7 (a) | 6.0 B (a)(b) | -- | 13.4 (a) | 11.2 (a) | -- |
| | >15 | 11.9 (a)(b) | 13.1 E (a) | 13.6 (a) | 13.3 (a) | 14.1 (a) | 10.2 B (a) | 15.8 (a) | 14.9 (a) |
| Copper | 0-6 | 26 (a) | -- | 19.9 (a) | 29.8 | -- | 28.7 | 14.8 (a) | -- |
| | 6-15 | 20.6 (a) | 25.3 E (a)(b) | 31.5 | 7.0 (a)(b) | -- | 20 (a) | 17.9 (a) | -- |
| | >15 | 16.5 (a)(b) | 22.3 E (a) | 24.8 (a) | 16.1 (a) | 25.4 (a) | 19.1 (a)(d) | 30.6 | 34.9 (d) |

**Table 2-7 Summary of Maximum Concentrations of Inorganics for Sites with LFI Data Only (mg/kg) (page 2 of 3)**

| Inorganics | Depth (ft) | Site | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 116-N-2 | 119-N | 120-N-2 | 1322-N | 166-N | 120-N-1 | | |
| | | Boring | | | | | | | |
| | | 116-N-2 | 119-N | 120-N-2 | 1322-N | UN-100-N-17 | 120-N-1 | South Pond | 199-N-77 |
| Iron | 0-6 | 18300 (a) | -- | 20000 (a) | 19700 (a) | -- | 23800 (a) | 17100 (a) | -- |
| | 6-15 | 22300 (a) | 19300 (a)(b) | 26100 (a) | 11900 (a)(b) | -- | 29500 (a) | 21800 (a) | -- |
| | >15 | 21700 (a)(b) | 24500 (a) | 24300 (a) | 23500 (a) | 23400 (a) | 23600 (a) | 26600 (a) | 27900 (a) |
| Lead | 0-6 | 171 * (c) | -- | 5.9 (a) | 15.8 * | -- | 5.9 S* (a) | 5.1 (a) | -- |
| | 6-15 | 2.7 (a) | 10.5 + (a)(b) | 2.4 (a) | 3.3 (a)(b) | -- | 4.1 (a) | 6 (a) | -- |
| | >15 | 1.8 (a)(b) | 2.8 (a) | 3.8 (a) | 2.0 (a) | 3.5 (a) | 2.6 (a) | 6.4 (a) | 6.3 (a) |
| Magnesium | 0-6 | 4520 (a) | -- | 4390 (a) | 7150 (a) | -- | 5320 (a) | 4640 (a) | -- |
| | 6-15 | 4030 (a) | 4420 (a)(b) | 4790 * (a) | 3680 (a)(b) | -- | 4260 (a) | 5140 (a) | -- |
| | >15 | 3890 (a)(b) | 4680 (a) | 4570 (a) | 4100 (a) | 4250 * (a) | 4160 (a) | 4270 (a) | 4330 (a) |
| Manganese | 0-6 | 312 N (a) | -- | 326 (a) | 297 N (a) | -- | 227 N* (a) | 271 (a) | -- |
| | 6-15 | 284 (a) | 267 N(a)(b) | 316 (a) | 198 (a)(b) | -- | 275 N* (a) | 285 (a) | -- |
| | >15 | 254 (a)(b) | 295 N (a) | 292 (a) | 268 (a) | 462 * (a) | 217 (a) | 702 | 328 |
| Mercury | 0-6 | ND | -- | ND | 0.05 BN (a)(c) | -- | 0.37 (a) | 0.07 B (a) | -- |
| | 6-15 | ND | ND | ND | ND | -- | 0.15 (a) | 0.09 B (a) | -- |
| | >15 | ND | ND | ND | ND | ND | 0.19 (a) | 0.10 B (a) | 0.05 B (a)(c) |
| Nickel | 0-6 | 12.8 (a) | -- | 11.9 (a) | 19 (a) | -- | 8.2 B (a) | 10.1 (a) | -- |
| | 6-15 | 8.1 (a) | 11.4 (a)(b) | 8.7 (a) | 11.7 (a)(b) | -- | 5.8 B (a) | 9.9 (a) | -- |
| | >15 | 6.8 B (a)(b) | 10.2 (a) | 15.5 (a) | 7.2 B (a) | 12.4 (a) | 11.8 (a) | 17.6 (a) | 135 N* (a)(c) |
| Potassium | 0-6 | 1720 (a) | -- | 1320 (a) | 1290 (a) | -- | 427 B (a) | 1110 (a) | -- |
| | 6-15 | 749 B (a) | 857 B (a)(b) | 718 B (a) | 1140 (a)(b) | -- | 409 B (a) | 1080 (a) | -- |
| | >15 | 420 B (a)(b) | 823 B (a) | 1370 (a) | 560 B (a) | 891 B (a) | 909 B (a) | 886 B (a) | 743 B (a) |
| Selenium | 0-6 | ND | -- | ND | ND | -- | ND | ND | -- |
| | 6-15 | ND | 1.1 S (a)(b) | ND | 1.5 + (a)(c) | -- | ND | 1.9 SN* (a) | -- |
| | >15 | ND | ND | 2.5 +N (a)(c) | ND | ND | ND | 2.3 +(a) | 1.8 SN (a)(d) |
| Silver | 0-6 | 1.1 B (a)(d) | -- | 1.3 B (a)(d) | 0.81 B (a) | -- | ND | ND | -- |
| | 6-15 | 1.3 B (a)(d) | ND | 1.1 B (a) | ND | -- | ND | ND | -- |
| | >15 | 1.9 B (a)(b)(d) | 1.9 B (a) | 1.4 B (a) | 1.4 B (a) | 1.4 B (a) | 1.0 B (a)(c)(d) | 2.5 * (a) | 1.6 B (a) |
| Sodium | 0-6 | 201 B (a) | -- | 254 B (a) | 828 B (a) | -- | 508 B (a) | 319 B (a) | -- |
| | 6-15 | 355 B (a) | 275 B (a)(b) | 452 B (a) | 83 B (a)(b) | -- | 516 B (a) | 368 (a) | -- |
| | >15 | 319 B (a)(b) | 399 (a) | 513 B (a) | 301 B (a) | 455 B (a) | 523 B (a) | 407 B (a) | 589 B (a) |

9413300.0189

## Table 2-7 Summary of Maximum Concentrations of Inorganics for Sites with LFI Data Only (mg/kg) (page 3 of 3)

| Inorganics | Depth (ft) | Site: 116-N-2 | 119-N | 120-N-2 | 1322-N | 166-N | 120-N-1 | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Boring: 116-N-2 | 119-N | 120-N-2 | 1322-N | UN-100-N-17 | 120-N-1 | South Pond | 199-N-77 |
| Thallium | 0-6 | ND | -- | ND | ND | -- | ND | ND | -- |
| | 6-15 | ND | ND | ND | 0.33 B (a)(c) | -- | ND | ND | -- |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Vanadium | 0-6 | 38 (a) | -- | 48.2 (a) | 38.1 (a) | -- | 61.2 (a) | 38.8 (a) | -- |
| | 6-15 | 46 (a) | 45.3 (a)(b) | 60 E (a) | 22.4 (a)(b) | -- | 70.7 (a) | 46.6 (a) | -- |
| | >15 | 46.7 (a)(b) | 57.8 (a) | 56.9 E (a) | 51.6 (a) | 61.7 E (a) | 66.1 (a) | 81.1 (a) | 73.1 (a) |
| Zinc | 0-6 | 68.8 (a) | -- | 61.5 E (a) | 91.6 | -- | 94.4 *E | 42.4 NE (a) | -- |
| | 6-15 | 37.1 E(a) | 37 (a)(b) | 45.4 (a) | 32.9 (a)(b) | -- | 77.4 *E (a) | 51.5 E (a) | -- |
| | >15 | 36.7 E(a)(b) | 42.4 (a) | 43.1 (a) | 41.1 (a) | 41.7 (a) | 41.6 *E(a) | 53.6 (a) | 43.2 (a) |
| Cyanide | 0-6 | ND | -- | ND | ND | -- | ND | ND | -- |
| | 6-15 | ND | ND | ND | ND | -- | ND | ND | -- |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |

Shaded cells indicate concentrations above Hanford Site background that exceed the risk-based concentration (RBC) at 1E-07 incremental cancer risk (ICR).

-- No sample collected from this interval.

(a) Less than Hanford background.

(b) Consistency assumed, only one sample from interval.

(c) Value is inconsistent with other results within the interval. Result is suspect.

(d) Value is less than or equal to five times the concentration detected in associated blank. Sample contamination is suspected.

* Duplicate analysis not within control limits.

+ Correlation coefficient for Method of Standard Additions is <0.995.

B - Estimated value; reading was less than contract-required detection limit but greater than or equal to instrument detection limit.

E - Estimated value due to the presence of interference.

N - Spiked sample recovery not within control limits.

S - Concentration determined by the Method of Standard Additions.

W - Postdigestion spike is out of control limits, while sample absorbance is <50% of spike absorbance.

THIS PAGE INTENTIONALLY
LEFT BLANK

9413300.0190

**Table 2-8 Summary of Maximum Concentrations of Volatile Organics for Sites with LFI Data Only (μg/kg) (page 1 of 4)**

| Volatile Organics | Depth (ft) | Site: 116-N-2 | 1322-N | 119-N | 166-N | 120-N-2 | 120-N-1 | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Boring: 116-N-2 | 1322-N | 119-N | UN-100-N-17 | 120-N-2 | 120-N-1 | 199-N-77 | South Pond |
| 1,1,1-Trichloroethane | 0-6 | 2 J(a) | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,1,2,2-Tetrachloroethane | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,1,2-Trichloroethane | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,1-Dichloroethane | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,1-Dichloroethene | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,2-Dichloroethane | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,2-Dichloroethene | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,2-Dichloropropane | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 2-Butanone | 0-6 | 7 J(a) | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | 4 J(a) | 4 BJ(a)(b) | ND | ND | ND |
| 2-Hexanone | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | 1 BJ(a)(c) | ND | ND | ND |

Table 2-8 Summary of Maximum Concentrations of Volatile Organics for Sites with LFI Data Only (μg/kg) (page 2 of 4)

| Volatile Organics | Depth (ft) | Site | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 116-N-2 | 1322-N | 119-N | 166-N | 120-N-2 | 120-N-1 | | |
| | | Boring | | | | | | | |
| | | 116-N-2 | 1322-N | 119-N | UN-100-N-17 | 120-N-2 | 120-N-1 | 199-N-77 | South Pond |
| 4-Methyl-2-Pentanone | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Acetone | 0-6 | 12 B(b) | -- | -- | -- | 12 B(b) | 16 B(b) | -- | 19 B(b) |
| | 6-15 | 14 B(b) | 28 B(b)(d) | 23 B(b)(d) | -- | 15 B(b) | 13 B(b) | -- | 54 B(b)(d) |
| | >15 | 13 B(b)(d) | 28 B(b) | 22 B(b) | 2800(a) | 23 B(b) | 23 B(b) | 26 B(b) | 44 B(b) |
| Benzene | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | 1 J(a) | -- | ND |
| | >15 | ND | ND | ND | 190 J(a) | ND | ND | ND | ND |
| Bromodichloromethane | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Bromoform | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Bromomethane | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Carbon Disulfide | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Carbon Tetrachloride | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Chlorobenzene | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Chloroethane | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |

9413300.0191

**Table 2-8 Summary of Maximum Concentrations of Volatile Organics for Sites with LFI Data Only (μg/kg) (page 3 of 4)**

| Volatile Organics | Depth (ft) | Site: 116-N-2 | 1322-N | 119-N | 166-N | 120-N-2 | 120-N-1 | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Boring: 116-N-2 | 1322-N | 119-N | UN-100-N-17 | 120-N-2 | 120-N-1 | 199-N-77 | South Pond |
| Chloroform | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | 3 J(a) | 2 J(b) | ND | ND |
| Chloromethane | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Dibromochloromethane | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Ethylbenzene | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | 330 J(a) | ND | ND | ND | ND |
| Methylene Chloride | 0-6 | 2 J(a) | -- | -- | -- | 2 J | 4 J(a) | -- | 23 |
| | 6-15 | 2 J(a) | 6 J(d) | 2 J(d) | -- | ND | ND | -- | ND |
| | >15 | ND | 6 J | 2 J(a) | ND | 5 J | 9 BJ(b) | ND | 10 J |
| Styrene | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Tetrachloroethene | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Toluene | 0-6 | 1 J(a) | -- | -- | -- | 11 | 8 J | -- | 3 J |
| | 6-15 | 1 J(a) | ND | ND | -- | 1 J(a) | ND | -- | 52 (d) |
| | >15 | ND | 2 J(a) | ND | 1 J(a) | 2 J | 2 J | ND | 8 J(a) |
| Trichloroethene | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Vinyl Chloride | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |

## Table 2-8 Summary of Maximum Concentrations of Volatile Organics for Sites with LFI Data Only (µg/kg) (page 4 of 4)

| Volatile Organics | Depth (ft) | Site: 116-N-2 | 1322-N | 119-N | 166-N | 120-N-2 | 120-N-1 | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Boring: 116-N-2 | 1322-N | 119-N | UN-100-N-17 | 120-N-2 | 120-N-1 | 199-N-77 | South Pond |
| Xylenes (total) | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | 1300 J | 2 J(a) | ND | ND | ND |
| cis-1,3-Dichloropropene | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| trans-1,3-Dichloropropene | 0-6 | ND | -- | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | ND | -- | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |

Shading indicates a concentration greater than the risk-based concentration (RBC) at 1E-07 incremental cancer risk (ICR).

-- No sample collected from this interval.

(a) Value is inconsistent with other sample results. Result is suspect.

(b) Value is less than or equal to ten times the concentration detected in associated blank. Sample contamination is suspected.

(c) Value is less than or equal to five times the concentration detected in associated blank. Sample contamination is suspected.

(d) Consistency assumed, only one sample from interval.

B - Analyte detected in associated laboratory blank.

J - Estimated value.

ND - Not detected.

9413306.0192

**Table 2-9 Summary of Maximum Concentrations of Semi-Volatile Organics for Sites with LFI Data Only (μg/kg) (page 1 of 7)**

| Semivolatile Organics | Depth (ft) | Site: 116-N-2 | 1322-N | 166-N | 119-N | 120-N-2 | 120-N-1 | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Boring: 116-N-2 | 1322-N | UN-100-N-17 | 119-N | 120-N-2 | 120-N-1 | 199-N-77 | South Pond |
| 1,2,4-Trichlorobenzene | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,2-Dichlorobenzene | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,3-Dichlorobenzene | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,4-Dichlorobenzene | 0-6 | 51 J(a) | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4,5-Trichlorophenol | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4,6-Trichlorophenol | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4-Dichlorophenol | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4-Dimethylphenol | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4-Dinitrophenol | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 2-Chloronaphthalene | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |

**Table 2-9 Summary of Maximum Concentrations of Semi-Volatile Organics for Sites with LFI Data Only (μg/kg) (page 2 of 7)**

| Semivolatile Organics | Depth (ft) | Site | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 116-N-2 | 1322-N | 166-N | 119-N | 120-N-2 | 120-N-1 | | |
| | | Boring | | | | | | | |
| | | 116-N-2 | 1322-N | UN-100-N-17 | 119-N | 120-N-2 | 120-N-1 | 199-N-77 | South Pond |
| 2-Chlorophenol | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 2-Methylnaphthalene | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | 13000 D | ND | ND | ND | ND | ND |
| 2-Methylphenol | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 2-Nitroaniline | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 2-Nitrophenol | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 3-Nitroaniline | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 4-Chloro-3-methylphenol | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 4-Chloroaniline | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 4-Methylphenol | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Acenaphthene | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |

9413306.0193

**Table 2-9 Summary of Maximum Concentrations of Semi-Volatile Organics for Sites with LFI Data Only (μg/kg) (page 3 of 7)**

| Semivolatile Organics | Depth (ft) | Site: 116-N-2 | 1322-N | 166-N | 119-N | 120-N-2 | 120-N-1 | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Boring: 116-N-2 | 1322-N | UN-100-N-17 | 119-N | 120-N-2 | 120-N-1 | 199-N-77 | South Pond |
| Acenaphthylene | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| bis(2-Chloroethoxy)methane | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| bis(2-Chloroethyl)ether | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| bis(2-Chloroisopropyl)ether | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Dimethylphthalate | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Hexachlorobutadiene | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Hexachlorocyclopentadiene | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Hexachloroethane | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Isophorone | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| N-nitroso-di-n-dipropylamine | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |

**Table 2-9 Summary of Maximum Concentrations of Semi-Volatile Organics for Sites with LFI Data Only (μg/kg) (page 4 of 7)**

| Semivolatile Organics | Depth (ft) | Site | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 116-N-2 | 1322-N | 166-N | 119-N | 120-N-2 | 120-N-1 | | |
| | | Boring | | | | | | | |
| | | 116-N-2 | 1322-N | UN-100-N-17 | 119-N | 120-N-2 | 120-N-1 | 199-N-77 | South Pond |
| Naphthalene | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | 4100 D | ND | ND | ND | ND | ND |
| Nitrobenzene | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Phenol | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,4-Dinitrotoluene | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 2,6-Dinitrotoluene | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 3,3'-Dichlorobenzidine | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 4,6-Dinitro-2-methylphenol | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 4-Bromophenylphenyl ether | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 4-Chlorophenylphenyl ether | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| 4-Nitroaniline | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |

9413300.0194

**Table 2-9 Summary of Maximum Concentrations of Semi-Volatile Organics for Sites with LFI Data Only (µg/kg) (page 5 of 7)**

| Semivolatile Organics | Depth (ft) | Site | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 116-N-2 | 1322-N | 166-N | 119-N | 120-N-2 | 120-N-1 | | |
| | | Boring | | | | | | | |
| | | 116-N-2 | 1322-N | UN-100-N-17 | 119-N | 120-N-2 | 120-N-1 | 199-N-77 | South Pond |
| 4-Nitrophenol | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Carbazole | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Anthracene | 0-6 | 38 J(a) | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | 6300 D | ND | ND | ND | ND | ND |
| Benzo(a)anthracene | 0-6 | 140 J | 63 J(a) | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Benzo(a)pyrene | 0-6 | 53 J | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Benzo(c)fluoranthene | 0-6 | 120 J | 69 J(a) | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Benzo(ghi)perylene | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Benzo(k)fluoranthene | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| bis(2-ethylhexyl)phthalate | 0-6 | ND | 48 J | -- | -- | 55 J(a) | 58 J(a) | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | 33 J(a) | 180 J | 150 J(a) |
| Butylbenzylphthalate | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |

**Table 2-9 Summary of Maximum Concentrations of Semi-Volatile Organics for Sites with LFI Data Only (µg/kg) (page 6 of 7)**

| Semivolatile Organics | Depth (ft) | Site: 116-N-2 | 1322-N | 166-N | 119-N | 120-N-2 | 120-N-1 | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Boring: 116-N-2 | 1322-N | UN-100-N-17 | 119-N | 120-N-2 | 120-N-1 | 199-N-77 | South Pond |
| Chrysene | 0-6 | 120 J | 62 J(a) | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Di-n-butylphthalate | 0-6 | 130 BJ(b) | 250 BJ(b) | -- | -- | 150 BJ(b) | 140 BJ(b) | -- | 170 J(a) |
| | 6-15 | ND | ND | -- | ND | 86 BJ(b) | ND | -- | ND |
| | >15 | ND | ND | 420 B(b) | ND | 230 BJ(b) | 110 BJ(b) | ND | 84 J |
| Di-n-octylphthalate | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Dibenz[a,h]anthracene | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Dibenzofuran | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Diethyl phthalate | 0-6 | 78 J(a) | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | 130 BJ(b) | ND | -- | ND | ND | ND | -- | ND |
| | >15 | 50 J(c) | ND | ND | ND | 48 J(a) | ND | ND | 120 J(a) |
| Fluoranthene | 0-6 | 260 J | 99 J(a) | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Fluorene | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | 1700 DJ(a) | ND | ND | ND | ND | ND |
| Hexachlorobenzene | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Indeno(1,2,3-cd)pyrene | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |

9413300.0195

Table 2-9 Summary of Maximum Concentrations of Semi-Volatile Organics for Sites with LFI Data Only (µg/kg) (page 7 of 7)

| Semivolatile Organics | Depth (ft) | Site: 116-N-2 | 1322-N | 166-N | 119-N | 120-N-2 | 120-N-1 | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Boring: 116-N-2 | 1322-N | UN-100-N-17 | 119-N | 120-N-2 | 120-N-1 | 199-N-77 | South Pond |
| N-Nitrosodiphenylamine | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Pentachlorophenol | 0-6 | ND | ND | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | ND | ND | ND | ND | ND | ND |
| Phenanthrene | 0-6 | 150 J(a) | 95 J(a) | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | 2500 DJ(a) | ND | ND | ND | ND | ND |
| Pyrene | 0-6 | 320 J | 110 J(a) | -- | -- | ND | ND | -- | ND |
| | 6-15 | ND | ND | -- | ND | ND | ND | -- | ND |
| | >15 | ND | ND | 240 J | ND | ND | ND | ND | ND |

Shading indicates a concentration greater than the risk-based concentration (RBC) at 1E-07 incremental lifetime cancer risk (ICR).

-- No sample collected from this interval.

(a) Value is inconsistent with other sample results. Result is suspect.

(b) Value is less than or equal to five times the concentration detected in associated blank. Sample contamination is suspected.

(c) Consistency assumed; only one sample from interval.

B - Detected in associated laboratory blank.

D - Analysis performed on diluted sample.

J - Estimated value.

ND - Not detected.

THIS PAGE INTENTIONALLY
LEFT BLANK

## Table 2-10 Source Operable Unit 100-NR-1 List of Nonquantitative Source Constituents (page 1 of 2)

| Waste Site | Suspected Contaminants | Emission Mode |
|---|---|---|
| 118-N-1 Spacer Storage Silos | Cobalt-60<br>Strontium-90<br>Cerium/Praseodymium-144<br>Plutonium-239 | $\beta,\gamma$<br>$\beta$<br>$\beta,\gamma$<br>$\alpha$ |
| 1304-N Emergency Dump Tank | Sodium-24<br>Manganese-56 | $\beta,\gamma$<br>$\beta,\gamma$ |
| 116-N-4 Emergency Dump Basin | Potassium-40<br>Manganese-56<br>Iron-59<br>Cobalt-58<br>Cobalt-60<br>Zircon/Niobium-95<br>Ruthenium-103<br>Antimony-124<br>Iodine-131<br>Cesium-137<br>Barium/Lanthanum-140 | $\beta,\gamma$<br>$\beta,\gamma$<br>$\beta,\gamma$<br>$\beta$<br>$\beta,\gamma$<br>$\beta,\gamma$<br>$\beta,\gamma$<br>$\beta,\gamma$<br>$\beta,\gamma$<br>$\beta,\gamma$<br>$\beta,\gamma$ |
| 105-N Reactor Spent Fuel Storage Basin | Iodine-131 | $\beta,\gamma$ |
| UN-100-N-6 Decontamination Waste Drain Line | Manganese-54<br>Cobalt-60<br>Ruthenium-103<br>Cesium-137 | $\beta,\gamma$<br>$\beta,\gamma$<br>$\beta,\gamma$<br>$\beta,\gamma$ |
| 116-N-2 Treatment and Storage Facility | Phosphoric Acid<br>Diethylthiourea<br>Cobalt-60 | <br><br>$\beta,\gamma$ |
| 120-N-1 Percolation Pond and South Settling Pond<br>120-N-2 Surface Impoundment | Strontium<br>Nitrate<br>Sulphate<br>Chloride<br>Ammonium Ion<br>Coliform<br>Thorium | |
| 108-N Chemical Unloading Facility | Sulfuric Acid<br>Sodium Hydroxide | |
| 120-N-3 Neutralization Pit and French Drain | Sulfuric Acid<br>Sodium Hydroxide | |
| 120-N-5 Acid/Caustic Transfer Trench and Neutralization Unit | Sulfuric Acid<br>Sodium Hydroxide | |
| Regeneration Waste Transport System | Caustic Soda (Soda Ash) | |
| 184-N Day Tank Area | Diesel Oil | |
| 116-N / 184-N Piping | Diesel Oil<br>No. 6 (Bunker C) Fuel Oil | |

## Table 2-10 Source Operable Unit 100-NR-1 List of Nonquantitative Source Constituents (page 2 of 2)

| Waste Site | Suspected Contaminants | Emission Mode |
|---|---|---|
| 116-N Fuel Unloading Station | No. 6 Fuel Oil<br>Diesel Oil | |
| N-17 Paint Shop | Lubrication Oil | |
| 1716-N Service Station Underground Storage Tank | Unleaded Gasoline | |

All information taken from LFI work plan (DOE-RL 1992) and HSRAM (DOE-RL 1994)

$\alpha$ Alpha emitters; ingestion hazard but no external exposure hazard.

$\beta$ Beta emitters; ingestion hazard but no external exposure hazard.

$\gamma$ Gamma emitters; external exposure hazard.

# Table 2-11 100-NR-1 Preliminary Radionuclide Human Health Risk-Based Screening Concentrations for LFI Analytes

| Radionuclides | SFo (pCi)^-1 | RBC at ICR=E-07 (pCi/g) | SFi (pCi)^-1 | RBC at ICR=E-07 (pCi/g) | SFe (pCi-yr/g)^-1 | RBC at ICR=E-07 (pCi/g) |
|---|---|---|---|---|---|---|
| Americium-241 | 2.4E-10 | 3.2E-01 | 3.2E-08 | 2.8E-01 | 4.9E-09 | 6.9E-01 |
| Carbon-14 | 9.0E-13 | 8.4E+01 | 6.4E-15 | 1.4E+06 | 0E+00 | |
| Cerium-144 | 6.1E-12 | 1.2E+01 | 3.4E-10 | 2.7E+01 | 1.4E-07 | 2.4E-02 |
| Cesium-134 | 4.1E-11 | 1.9E+00 | 2.8E-11 | 3.3E+02 | 5.2E-06 | 6.5E-04 |
| Cesium-137(a) | 2.8E-11 (a) | 2.7E+00 | 1.9E-11 (a) | 4.8E+02 | 2.0E-06 (a) | 1.7E-03 |
| Chromium-51 | 4.3E-14 | 1.8E+03 | 3.0E-13 | 3.0E+04 | 9.2E-08 | 3.7E-02 |
| Cobalt-58 | 1.6E-12 | 4.8E+01 | 9.8E-12 | 9.3E+02 | 3.3E-06 | 1.0E-03 |
| Cobalt-60 | 1.5E-11 | 5.1E+00 | 1.5E-10 | 6.1E+01 | 8.6E-06 | 4.0E-04 |
| Europium-152 | 2.1E-12 | 3.6E+01 | 1.1E-10 | 8.3E+01 | 3.6E-06 | 9.4E-04 |
| Europium-154 | 3.1E-12 | 2.5E+01 | 1.4E-10 | 6.5E+01 | 4.1E-06 | 8.3E-04 |
| Europium-155 | 4.5E-13 | 1.7E+02 | 1.8E-11 | 5.1E+02 | 5.9E-08 | 5.8E-02 |
| Iron-59 | 2.8E-12 | 2.7E+01 | 9.7E-12 | 9.4E+02 | 4.1E-06 | 8.3E-04 |
| Niobium-95 | 1.6E-12 | 4.8E+01 | 1.5E-11 | 6.1E+02 | 5.1E-06 | 6.7E-04 |
| Plutonium-238 | 2.2E-10 | 3.5E-01 | 3.9E-08 | 2.3E-01 | 2.8E-11 | 1.2E+02 |
| Plutonium-239/240(b) | 2.3E-10 (b) | 3.3E-01 | 3.8E-08 (b) | 2.4E-01 | 2.7E-11 (b) | 1.3E+02 |
| Potassium-40 | 1.1E-11 | 6.9E+00 | 7.6E-12 | 1.2E+03 | 5.4E-07 | 6.3E-03 |
| Radium-226(a) | 1.2E-10 (a) | 6.3E-01 | 3.0E-09 (a) | 3.0E+00 | 6.0E-06 (a) | 5.7E-04 |
| Ruthenium-103 | 9.0E-13 | 8.4E+01 | 8.4E-12 | 1.1E+03 | 1.5E-06 | 2.3E-03 |
| Ruthenium-106 | 9.5E-12 | 8.0E+00 | 4.4E-10 | 2.1E+01 | 0E+00 | |
| Strontium-90(a) | 3.6E-11 (a) | 2.1E+00 | 6.2E-11 (a) | 1.5E+02 | 0E+00 (a) | |
| Technetium-99 | 1.3E-12 | 5.8E+01 | 8.3E-12 | 1.1E+03 | 6.0E-13 | 5.7E+03 |
| Thorium-228(a) | 5.5E-11 (a) | 1.4E+00 | 7.8E-08 (a) | 1.2E-01 | 5.6E-06 (a) | 6.1E-04 |
| Thorium-232 | 1.2E-11 | 6.3E+00 | 2.8E-08 | 3.3E-01 | 2.6E-11 | 1.3E+02 |
| Tritium | 5.4E-14 | 1.4E+03 | 7.8E-14 | 1.2E+05 | 0E+00 | |
| Uranium-233/234(c) | 1.6E-11 (c) | 4.8E+00 | 2.7E-08 (c) | 3.4E-01 | 4.2E-11 (c) | 8.1E+01 |
| Uranium-235(a) | 1.6E-11 (a) | 4.7E+00 | 2.5E-08 (a) | 3.6E-01 | 2.4E-07 (a) | 1.4E-02 |
| Uranium-238(a) | 2.8E-11 (a) | 2.7E+00 | 5.2E-08 (a) | 1.8E-01 | 3.6E-08 (a) | 9.4E-02 |
| Zinc-65 | 8.5E-12 | 8.9E+00 | 1.6E-11 | 5.6E+02 | 2.0E-06 | 1.7E-03 |
| Zirconium-95 | 1.6E-12 (a) | 4.8E+01 | 1.5E-11 (a) | 6.1E+02 | 5.1E-06 (a) | 6.7E-04 |

Source: HEAST (EPA 1992a).
(a) Toxicity calculation includes contribution of radioactive daughter products.
(b) Toxicity values for plutonium-240.
(c) Toxicity values for uranium-233.
pCi/g - Picocuries per gram.
B - Analyte detected in associated laboratory blank.
J - Estimated value.
ND - Not detected. The highest reported minimum detectable amount (MDA) is listed after ND.
NR - Not reported. Analyte was not included on analytical result Form 1.
SFo - Oral slope factor.
SFi - Inhalation slope factor.
SFe - External slope factor.
RBC - Risk-based concentration. RBC are calculated using equations and residential exposure factors from HSRAM (DOE-RL 1994), except as noted.

Equations:

RBC at ICR of 1E-07 oral route = 7.6E-11/SFo
RBC at ICR of 1E-07 inhalation route by fugitive dust pathway = 9.1E-09/SFi
RBC at ICR of 1E-07 external route = 3.4E-09/SFe

ICR - Incremental cancer risk.
QRA - Qualitative risk assessment.

# Table 2-12 100-NR-1 Preliminary Inorganic Human Health Risk-Based Screening Concentrations for LFI Analytes

| Inorganics | SFo (mg/kg-d)^-1 | RBC at ICR=E-07 (mg/kg) | SFi (mg/kg-d)^-1 | RBC at ICR=E-07 (mg/kg) | RfDo (mg/kg-d) | RBC at HQ=0.1 (mg/kg) | RfDi (mg/kg-d) | RBC at HQ=0.1 (mg/kg) |
|---|---|---|---|---|---|---|---|---|
| Aluminum | NA | | NA | | NA | | NA | |
| Antimony | NA | | NA | | NA | | NA | |
| Arsenic | NA | | NA | | NA | | NA | |
| Barium | NA | | NA | | NA | | NA | |
| Beryllium | NA | | NA | | NA | | NA | |
| Cadmium | 6.3E+00 N | 1.0E-02 | 6.3E+00 I | 2.5E+00 | 1.0E-03 I | 8.0E+00 | 1.0E-03 O | 3.2E+03 |
| Calcium | NA | | NA | | NA | | NA | |
| Chromium | NA | | NA | | NA | | NA | |
| Cobalt | NA | | NA | | NA | | NA | |
| Copper | | | | | 4.0E-02 S | 3.2E+02 | 4.0E-02 O | 1.3E+05 |
| Iron | NA | | NA | | NA | | NA | |
| Lead | | | | | | | | |
| Magnesium | NA | | NA | | NA | | NA | |
| Manganese | | | | | 5.0E-03 I | 4.0E+01 | 1.1E-04 I | 3.5E+02 |
| Mercury | NA | | NA | | NA | | NA | |
| Nickel (a) | 8.4E-01 N | 7.6E-02 | 8.4E-01 I (a) | 1.9E+01 | 2.0E-02 I | 1.6E+02 | 2.0E-02 O | 6.4E+04 |
| Potassium | NA | | NA | | NA | | NA | |
| Selenium | NA | | NA | | NA | | NA | |
| Silver | NA | | NA | | NA | | NA | |
| Sodium | NA | | NA | | NA | | NA | |
| Thallium | NA | | NA | | NA | | NA | |
| Vanadium | NA | | NA | | NA | | NA | |
| Zinc | | | | | 3.0E-01 I | 2.4E+03 | 3.0E-01 O | 9.6E+05 |
| Cyanide | | | | | 2.0E-02 | 1.6E+02 | 2.0E-02 O | 6.4E+04 |

Sources: I - IRIS (EPA 1993b), S - STSC (1991c).
Toxicity values were cross-route extrapolated if only an oral or only an inhalation toxicity value was available.
O - Cross-route extrapolated from oral toxicity value.
N - Cross-route extrapolated from inhalation toxicity value.
(a) Inhalation slope factor for nickel refinery dust is used.
mg/kg - milligrams per kilogram.
* Duplicate analysis not within control limits.
B - Estimated value, reading was less than contract detection limit but greater than or equal to instrument detection limit.
E - Estimated value due to the presence of interference.
N - Spiked sample recovery not within control limits.
W - Postdigestion spike is out of control limits, while sample absorbance is less than 50% of spike absorbance.
NA - Not applicable; maximum concentration was lower than Hanford Site background and was screened out before risk-based screening.
ND - Not detected; the highest reported detection limit is listed after ND.
SFo - Oral slope factor.
SFi - Inhalation slope factor.
RfDo - Oral reference dose.
RfDi - Inhalation reference dose.
RBC - Risk-based concentration. RBC are calculated using equations and residential exposure factors from HSRAM (DOE-RL 1994), except as noted.

Equations:

RBC at ICR of 1E-07 oral route = 6.4E-02/SFo
RBC at ICR of 1E-07 inhalation route by fugitive dust pathway = 1.6E+01/SFi
RBC at HQ of 0.1 inhalation route by fugitive dust pathway = (RfDi) * (3.2E+06)
RBC at HQ of 0.1 oral route = (RfDo) * (8.0E+03)

QRA - Qualitative risk assessment.
ICR - Incremental cancer risk.
HQ - Hazard quotient.

9413300.0198

# Table 2-13 100-NR-1 Preliminary Organic Human Health Risk-Based Screening Concentrations (page 1 of 3)

| Volatile Organics | SFo (mg/kg-d)^-1 | | RBC at ICR=1E-07 (ug/kg) | SFi (mg/kg-d)^-1 | | RBC at ICR=1E-07 (ug/kg) | RfDo (mg/kg-d) | | RBC at HQ=0.1 (ug/kg) | RfDi (mg/kg-d) | | RBC at HQ=0.1 (ug/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,1,1-Trichloroethane | | | | | | | 9.0E-02 | H | 7.2E+05 | 3.0E-01 | H | 1.8E+05 |
| 1,1,2,2-Tetrachloroethane | 2.0E-01 | I | 3.2E+02 | 2.0E-01 | I | 2.1E+02 | | | | | | |
| 1,1,2-Trichloroethane | 5.7E-02 | I | 1.1E+03 | 5.6E-02 | I | 1.6E+02 | 4.0E-03 | I | 3.2E+04 | 4.0E-03 | O | 7.1E+03 |
| 1,1-Dichloroethane | | | | | | | 1.0E-01 | N | 8.0E+05 | 1.0E-01 | H | 4.1E+04 |
| 1,1-Dichloroethene | 6.0E-01 | I | 1.1E+02 | 1.8E-01 | I | 1.9E+01 | 9.0E-03 | I | 7.2E+04 | 9.0E-03 | O | 6.2E+03 |
| 1,2-Dichloroethane | 9.1E-02 | I | 7.0E+02 | 9.1E-02 | I | 5.7E+01 | | | | | | |
| 1,2-Dichloroethene | | | | | | | 1.0E-02 | H | 8.0E+04 | 1.0E-02 | O | 5.5E+03 |
| 1,2-Dichloropropane | 6.8E-02 | H | 9.4E+02 | 6.8E-02 | O | 4.4E+01 | 1.1E-03 | N | 8.8E+03 | 1.1E-03 | I | 6.4E+02 |
| 2-Butanone | | | | | | | 6.0E-01 | I | 4.8E+06 | 2.9E-01 | I | 5.1E+05 |
| 2-Hexanone (a) | | | | | | | 6.0E-01 | I (a) | 4.8E+06 | 2.9E-01 | I (a) | 5.1E+05 |
| 4-Methyl-2-Pentanone | | | | | | | 5.0E-02 | H | 4.0E+05 | 2.0E-02 | H | 4.7E+04 |
| Benzene | 2.9E-02 | I | 2.2E+03 | 2.9E-02 | I | 7.4E+01 | | | | | | |
| Acetone | | | | | | | 1.0E-01 | I | 8.0E+05 | 1.0E-01 | O | 3.6E+05 |
| Bromodichloromethane | 6.2E-02 | I | 1.0E+03 | 6.2E-02 | O | 8.8E+01 | 2.0E-02 | I | 1.6E+05 | 2.0E-02 | O | 2.1E+04 |
| Bromoform | 7.9E-03 | I | 8.1E+03 | 3.9E-03 | I | 2.2E+03 | 2.0E-02 | I | 1.6E+05 | 2.0E-02 | O | 3.4E+04 |
| Bromomethane | | | | | | | 1.4E-03 | I | 1.1E+04 | 1.0E-03 | I | 6.9E+02 |
| Carbon Disulfide | | | | | | | 1.0E-01 | I | 8.0E+05 | 2.9E-03 | H | 6.2E+02 |
| Carbon Tetrachloride | 1.3E-01 | I | 4.9E+02 | 5.3E-02 | I | 4.7E+01 | 7.0E-04 | I | 5.6E+03 | 7.0E-04 | O | 3.4E+02 |
| Chlorobenzene | | | | | | | 2.0E-02 | I | 1.6E+05 | 5.7E-03 | H | 9.8E+03 |
| Chloroethane | | | | | | | 3.0E+00 | N | 2.4E+07 | 3.0E+00 | I | 9.8E+05 |
| Chloroform | 6.1E-03 | I | 1.0E+04 | 8.0E-02 | I | 4.0E+01 | 1.0E-02 | I | 8.0E+04 | 1.0E-02 | O | 6.3E+03 |
| Chloromethane | 1.3E-02 | H | 4.9E+03 | 6.3E-03 | H | 3.7E+02 | | | | | | |
| Dibromochloromethane | 8.4E-02 | I | 7.6E+02 | 8.4E-02 | O | 1.1E+02 | 2.0E-02 | I | 1.6E+05 | 2.0E-02 | O | 3.6E+04 |
| Ethylbenzene | | | | | | | 1.0E-01 | I | 8.0E+05 | 2.9E-01 | I | 2.5E+03 |
| Methylene Chloride | 7.5E-03 | I | 8.5E+03 | 1.6E-03 | I | 1.9E+03 | 6.0E-02 | I | 4.8E+05 | 6.0E-02 | O | 3.6E+04 |
| Styrene | | | | | | | 2.0E-01 | I | 1.6E+06 | 2.9E-01 | I | 1.1E+06 |
| Tetrachloroethene | 5.2E-02 | S | 1.2E+03 | 2.0E-03 | S | 1.8E+03 | 1.0E-02 | I | 8.0E+04 | 1.0E-02 | O | 7.0E+03 |
| Toluene | | | | | | | 2.0E-01 | I | 1.6E+06 | 1.0E-01 | I | 7.2E+04 |
| Trichloroethene | 1.1E-02 | S | 5.8E+03 | 6.0E-03 | S | 5.0E+02 | 6.0E-03 | S | 4.8E+04 | 6.0E-03 | O | 3.5E+03 |
| Vinyl Chloride | 1.9E+00 | H | 3.4E+01 | 3.0E-01 | H | 6.0E+00 | | | | | | |
| Xylenes (total) | | | | | | | 2.0E+00 | I | 1.6E+07 | 2.0E+00 | O | 1.9E+01 |
| cis-1,3-Dichloropropene (b) | 1.8E-01 | H (b) | 3.6E+02 | 1.3E-01 | H (b | 4.5E+01 | 3.0E-04 | I (b) | 2.4E+03 | 6.0E-03 | I (b) | 6.9E+03 |
| trans-1,3-Dichloropropene (b) | 1.8E-01 | H (b) | 3.6E+02 | 1.3E-01 | H (b | 4.5E+01 | 3.0E-04 | I (b) | 2.4E+03 | 6.0E-03 | I (b) | 6.9E+03 |
| **Semi-Volatile Organics** | | | | | | | | | | | | |
| 1,2,4-Trichlorobenzene | | | | | | | 1.0E-02 | I | 8.0E+04 | 2.6E-03 | H | 1.7E+04 |
| 1,2-Dichlorobenzene | | | | | | | 9.0E-02 | I | 7.2E+05 | 5.7E-02 | H | 1.4E+05 |
| 1,3-Dichlorobenzene | | | | | | | | | | | | |
| 1,4-Dichlorobenzene | 2.4E-02 | H | 2.7E+03 | 2.4E-02 | O | 6.8E+02 | 2.0E-01 | N | 1.6E+06 | 2.0E-01 | H | 6.4E+05 |
| 2,4,5-Trichlorophenol | | | | | | | 1.0E-01 | I | 8.0E+05 | 1.0E-01 | O | 1.2E+07 |
| 2,4,6-Trichlorophenol | 1.1E-02 | I | 5.8E+03 | 1.1E-02 | I | 2.7E+04 | | | | | | |
| 2,4-Dichlorophenol | | | | | | | 3.0E-03 | I | 2.4E+04 | 3.0E-03 | O | 1.2E+05 |
| 2,4-Dimethylphenol | | | | | | | 2.0E-02 | I | 1.6E+05 | 2.0E-02 | O | 3.9E+05 |
| 2,4-Dinitrophenol | | | | | | | 2.0E-03 | I | 1.6E+04 | 2.0E-03 | O | 1.3E+05 |
| 2-Chloronaphthalene | | | | | | | 8.0E-02 | I | 6.4E+05 | 8.0E-02 | O | 2.1E+06 |
| 2-Chlorophenol | | | | | | | 5.0E-03 | I | 4.0E+04 | 5.0E-03 | O | 2.0E+05 |
| 2-Methylnaphthalene (c) | | | | | | | 4.0E-03 | S(c) | 3.2E+04 | 4.0E-03 | O | 1.1E+05 |

# Table 2-13 100-NR-1 Preliminary Organic Human Health Risk-Based Screening Concentrations (page 2 of 3)

| Semi-Volatile Organics | SFo (mg/kg-d)^-1 | | RBC at ICR=1E-07 (ug/kg) | SFi (mg/kg-d)^-1 | | RBC at ICR=1E-07 (ug/kg) | RfDo (mg/kg-d) | | RBC at HQ=0.1 (ug/kg) | RfDi (mg/kg-d) | | RBC at HQ=0.1 (ug/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2-Methylphenol | | | | | | | 5.0E-02 | I | 4.0E+05 | 5.0E-02 | O | 2.8E+06 |
| 2-Nitroaniline | | | | | | | 6.0E-05 | N | 4.8E+02 | 6.0E-05 | H | 1.6E+02 |
| 2-Nitrophenol | | | | | | | | | | | | |
| 3-Nitroaniline | | | | | | | | | | | | |
| 4-Chloro-3-methylphenol | | | | | | | | | | | | |
| 4-Chloroaniline | | | | | | | 4.0E-03 | I | 3.2E+04 | 4.0E-03 | O | 1.2E+05 |
| 4-Methylphenol | | | | | | | 5.0E-02 | H | 4.0E+05 | 5.0E-02 | O | 2.4E+06 |
| Acenaphthene | | | | | | | 6.0E-02 | I | 4.8E+05 | 6.0E-02 | O | 1.3E+05 |
| Acenaphthylene | | | | | | | 6.0E-02 | S | 4.8E+05 | 6.0E-02 | O | 1.7E+06 |
| bis(2-Chloroethoxy)methane | | | | | | | | | | | | |
| bis(2-Chloroethyl)ether | 1.1E+00 | I | 5.8E+01 | 1.1E+00 | I | 6.4E+01 | | | | | | |
| bis(2-Chloroisopropyl)ether | 7.0E-02 | H | 9.1E+02 | 3.5E-02 | H | 8.1E+02 | 4.0E-02 | I | 3.2E+05 | 4.0E-02 | O | 2.2E+05 |
| Dimethylphthalate | | | | | | | | | | | | |
| Hexachlorobutadiene | 7.8E-02 | I | 8.2E+02 | 7.7E-02 | I | 5.1E+02 | 2.0E-03 | H | 1.6E+04 | 2.0E-03 | O | 1.5E+04 |
| Hexachlorocyclopentadiene | | | | | | | 7.0E-03 | I | 5.6E+04 | 2.0E-05 | H | 3.9E+01 |
| Hexachloroethane | 1.4E-02 | I | 4.6E+03 | 1.4E-02 | I | 1.9E+03 | 1.0E-03 | I | 8.0E+03 | 1.0E-03 | O | 5.1E+03 |
| Isophorone | 9.5E-04 | I | 6.7E+04 | 9.5E-04 | O | 8.6E+04 | 2.0E-01 | I | 1.6E+06 | 2.0E-01 | O | 3.2E+06 |
| N-nitroso-di-n-dipropylamine | 7.0E+00 | I | 9.1E+00 | 7.0E+00 | O | 1.7E+01 | | | | | | |
| Naphthalene | | | | | | | 4.0E-03 | S | 3.2E+04 | 4.0E-03 | O | 3.6E+04 |
| Nitrobenzene | | | | | | | 5.0E-04 | I | 4.0E+03 | 6.0E-04 | H | 1.3E+04 |
| Phenol | | | | | | | 6.0E-01 | I | 4.8E+06 | 6.0E-01 | O | 2.4E+07 |
| 2,4-Dinitrotoluene (d) | 6.8E-01 | I (d) | 9.4E+01 | 6.8E-01 | O | 1.2E+03 | 2.0E-03 | I | 1.6E+04 | 2.0E-03 | O | 3.3E+05 |
| 2,6-Dinitrotoluene (d) | 6.8E-01 | I (d) | 9.4E+01 | 6.8E-01 | O | 5.6E+02 | | | | | | |
| 3,3'-Dichlorobenzidine | 4.5E-01 | | 1.4E+02 | 4.5E-01 | O | 3.4E+04 | | | | | | |
| 4,6-Dinitro-2-methylphenol | | | | | | | | | | | | |
| 4-Bromophenylphenyl ether | | | | | | | | | | | | |
| 4-Chlorophenylphenyl ether | | | | | | | | | | | | |
| 4-Nitroaniline | | | | | | | | | | | | |
| 4-Nitrophenol | | | | | | | | | | | | |
| Carbazole (e) | 2.0E-02 | H | 3.2E+03 | 2.0E-02 | O | | | | | | | |
| Anthracene | | | | | | | 3.0E-01 | I | 2.4E+06 | 3.0E-01 | O | 3.4E+07 |
| Benzo(a)anthracene | | | | | | | | | | | | |
| Benzo(a)pyrene | 7.3E+00 | I | 8.8E+00 | 6.1E+00 | H | 1.4E+03 | | | | | | |
| Benzo(b)fluoranthene | | | | | | | | | | | | |
| Benzo(ghi)perylene | | | | | | | | | | | | |
| Benzo(k)fluoranthene | | | | | | | | | | | | |
| bis(2-ethylhexyl)phthalate | 1.4E-02 | I | 4.6E+03 | 1.4E-02 | O | 2.1E+05 | 2.0E-02 | I | 1.6E+05 | 2.0E-02 | O | 1.1E+07 |
| Butylbenzylphthalate | | | | | | | 2.0E-01 | I | 1.6E+06 | 2.0E-01 | O | 1.5E+08 |
| Chrysene | | | | | | | | | | | | |
| Di-n-butylphthalate | | | | | | | 1.0E-01 | I | 8.0E+05 | 1.0E-01 | O | 1.2E+06 |
| Di-n-octylphthalate | | | | | | | 2.0E-02 | H | 1.6E+05 | 2.0E-02 | O | 1.1E+07 |
| Dibenz[a,h]anthracene | | | | | | | | | | | | |
| Dibenzofuran | | | | | | | | | | | | |
| Diethyl phthalate | | | | | | | 8.0E-01 | I | 6.4E+06 | 8.0E-01 | O | 8.5E+07 |
| Fluoranthene | | | | | | | 4.0E-02 | I | 3.2E+05 | 4.0E-02 | O | 4.8E+05 |
| Fluorene | | | | | | | 4.0E-02 | I | 3.2E+05 | 4.0E-02 | O | 1.4E+06 |
| Hexachlorobenzene | 1.6E+00 | I | 4.0E+01 | 1.6E+00 | I | 7.5E+01 | 8.0E-04 | I | 6.4E+03 | 8.0E-04 | O | 1.9E+04 |

9413500.0199

# Table 2-13 100-NR-1 Preliminary Organic Human Health Risk-Based Screening Concentrations (page 3 of 3)

| Semi-Volatile Organics | SFo (mg/kg-d)^-1 | | RBC at ICR=1E-07 (ug/kg) | SFi (mg/kg-d)^-1 | | RBC at ICR=1E-07 (ug/kg) | RfDo (mg/kg-d) | | RBC at HQ=0.1 (ug/kg) | RfDi (mg/kg-d) | | RBC at HQ=0.1 (ug/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Indeno(1,2,3-cd)pyrene | | | | | | | | | | | | |
| N-Nitrosodiphenylamine | 4.9E-03 | I | 1.3E+04 | 4.9E-03 | O | 1.2E+05 | | | | | | |
| Pentachlorophenol | 1.2E-01 | I | 5.3E+02 | 1.2E-01 | O | 4.1E+04 | 3.0E-02 | I | 2.4E+05 | 3.0E-02 | O | 2.9E+07 |
| Phenanthrene (f) | | | | | | | 3.0E-02 | I (f) | 2.4E+05 | 3.0E-02 | O | 5.1E+06 |
| Pyrene | | | | | | | 3.0E-02 | I | 2.4E+05 | 3.0E-02 | O | 1.6E+07 |

Sources: I - IRIS (EPA 1993c), H - HEAST (EPA 1992a), S - STSC (EPA 1992b) and SPTC 1993.
Toxicity values were cross-route extrapolated if only an oral or only an inhalation toxicity value was available.
O - Cross-route extrapolated from oral toxicity value; N - Cross-route extrapolated from inhalation toxicity value.
(a) 2-Butanone used as surrogate for 2-hexanone.
(b) 1,3-Dichloropropene toxicity values used for both cis and trans.
(c) Naphthalene used as surrogate for 2 methylnaphthalene.
(d) Oral slope factor for 2,4-/2,6- dinitrotoluene mixture.
(e) Parameters necessary to calculate inhalation route RBC were not available.
(f) Pyrene used as surrogate for phenanthrene.
ND - Not detected with highest reported detection limit.
-- - No samples collected in this interval.
B - Detected in associated laboratory blank.
J - Estimated value.
mg/kg-d - Milligrams per kilogram-day.
ug/kg - Micrograms per kilogram.
SFo - Oral slope factor.
SFi - Inhalation slope factor.
RfDo - Oral reference dose.
RfDi - Inhalation reference dose.
HQ - Hazard quotient.
ICR - Incremental cancer risk.
QRA - Qualitative risk assessment.
RBC - Risk-based concentration. RBC are calculated using equations and residential exposure factors from HSRAM (DOE-RL 1994), except as noted.

Equations:

RBC at ICR of 1E-07 oral route = (6.4E-02)/SFo

RBC at ICR of 1E-07 inhalation route = ((8.16E-07*((VF*PEF)/(VF+PEF)))/SFi) - Modified from Risk Assessment Guidance for Superfund (EPA 1991a, p.27).

RBC at HQ of 0.1 oral route = RfDo*8E+03

RBC at HQ of 0.1 inhalation route = 1.6E-01*RfDi*((VF*PEF)/(VF+PEF)) - Modified from EPA (1991a, p.27).

(RBC are converted to ug/kg to compare to the maximum concentrations by multiplying by 1000)

PEF - Respirable particulate factor, 2E+07, based on the National Ambient Air Quality Standard for particulate matter.

VF - Volatilization factor. VF was calculated using the formula in DOE-RL 1994 with the following parameters:

LS - Width of contaminated area = 45m
MH - Mixing height = 2m
A - Area of contamination = 2.03E+6cm2
Dei - Effective diffusivity = Di*E^.33
E - Soil porosity = 0.25
Kas - Soil/air partition coefficient = (H/Kd)*41
Ps - True soil density = 2.7 g/cm3
Di - Molecular diffusivity = contaminant specific (calculated using the method from EPA 1988, p.17).
V - Site-specific wind speed in mixing zone = 3.3 m/s
H - Henry's law constant = contaminant specific
Kd - Soil-water partition coefficient = Koc*OC (cm3/g)
Koc - Organic carbon partition coefficient = contaminant specific
CF - Conversion factor = 0.001 kg/g
T - Exposure interval = 9.5E+08s
OC - Organic carbon content of soil = 0.01

THIS PAGE INTENTIONALLY
LEFT BLANK

9413300.0200

**Table 2-14 LFI Work Plan High-Priority Waste Site Process Knowledge Source Constituents, Soil Human Health Risk Based Screening Concentrations for Frequent-Use**

| Radionuclides | Ingestion Pathway | | | | Inhalation Pathway | | | | External Pathway | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SFo (pCi)-1 | RBC at ICR=1E-06 (pCi/g) | RBC at ICR=1E-04 (pCi/g) | RBC at ICR=1E-02 (pCi/g) | SFi (pCi)-1 | RBC at ICR=1E-06 (pCi/g) | RBC at ICR=1E-04 (pCi/g) | RBC at ICR=1E-02 (pCi/g) | SFe (pCi-yr/g)-1 | RBC at ICR=1E-06 (pCi/g) | RBC at ICR=1E-04 (pCi/g) | RBC at ICR=1E-02 (pCi/g) |
| Sodium-24 | 1.00E-12 | 8E+02 | 8E+04 | 8E+06 | 1E-12 | 1E+05 | 1E+07 | 1E+09 | 2E-05 | 2E-03 | 2E-01 | 2E+01 |
| Manganese-54 | 1.10E-12 | 7E+02 | 7E+04 | 7E+06 | 5E-12 | 2E+04 | 2E+06 | 2E+08 | 3E-06 | 1E-02 | 1E+00 | 1E+02 |
| Manganese-56 | 4.00E-13 | 2E+03 | 2E+05 | 2E+07 | 3E-13 | 3E+05 | 3E+07 | 3E+09 | 6E-06 | 6E-03 | 6E-01 | 6E+01 |
| Cobalt-58 | 1.60E-12 | 5E+02 | 5E+04 | 5E+06 | 1E-11 | 9E+03 | 9E+05 | 9E+07 | 3E-06 | 1E-02 | 1E+00 | 1E+02 |
| Zirconium/Niobium-95 | 1.60E-12 | 5E+02 | 5E+04 | 5E+06 | 2E-11 | 6E+03 | 6E+05 | 6E+07 | 5E-06 | 7E-03 | 7E-01 | 7E+01 |
| Ruthenium-103 | 9.00E-13 | 8E+02 | 8E+04 | 8E+06 | 8E-12 | 1E+04 | 1E+06 | 1E+08 | 2E-06 | 2E-02 | 2E+00 | 2E+02 |
| Antimony-124 | 2.90E-12 | 3E+02 | 3E+04 | 3E+06 | 2E-11 | 4E+03 | 4E+05 | 4E+07 | 7E-06 | 5E-03 | 5E-01 | 5E+01 |
| Iodine-131 | 3.60E-11 | 2E+01 | 2E+03 | 2E+05 | 2E-11 | 4E+03 | 4E+05 | 4E+07 | 2E-06 | 2E-02 | 2E+00 | 2E+02 |
| Barium/Lanthanum-140 | 5.00E-12 | 2E+02 | 2E+04 | 2E+06 | 5E-12 | 2E+04 | 2E+06 | 2E+08 | 9E-06 | 4E-03 | 4E-01 | 4E+01 |
| Cerium/Praseodymium-144 | 6.10E-12 | 1E+02 | 1E+04 | 1E+06 | 3E-10 | 3E+02 | 3E+04 | 3E+06 | 1E-07 | 2E-01 | 2E+01 | 2E+03 |

Source of toxicity values: HEAST (EPA 1993b).

SFo - Oral slope factor.
SFi - Inhalation slope factor.
SFe - External exposure slope factor.
ICR - Incremental cancer risk.
RBC - Risk-based concentration.
pCi/g - Picocuries per gram.

THIS PAGE INTENTIONALLY
LEFT BLANK

**Table 2-15 Contaminants of Potential Concern for the Human Health Evaluation at 100-NR-1**

| 116-N-1 (1301-N) Crib and Trench | 116-N-2 Treatment Storage Facility | 116-N-3 (1325-N) Crib and Trench | 1322-N/NA Sample Buildings |
|---|---|---|---|
| Cesium-134 | Cesium-137 | Cesium-137 | Cesium-137 |
| Cesium-137 | Cobalt-60 | Cerium-144 | Cobalt-60 |
| Cerium-144 | Potassium-40 | Cobalt-60 | Potassium-40 |
| Cobalt-60 | Radium-226 | Manganese-54 | Radium-226 |
| Europium-154 | Thorium-228 | Plutonium-238 | Strontium-90 |
| Europium-155 | Thorium-232 | Plutonium-239/240 | Thorium-228 |
| Manganese-54 | Uranium-233/234 | Strontium-90 | Thorium-232 |
| Plutonium-238 | Uranium-238 | | Uranium-233/234 |
| Plutonium-239/240 | | | Uranium-238 |
| Potassium-40 | Benzo(a)pyrene | | |
| Radium-226 | | | |
| Ruthenium-106 | | | |
| Strontium-90 | | | |
| Thorium-228 | | | |
| Thorium-232 | | | |
| Uranium-233/234 | | | |
| Uranium-238 | | | |
| Cadmium | | | |

**Table 2-16 Contaminants of Potential Concern Retained for Ecological Evaluation**

| 116-N-1(1301-N) Crib and Trench | | 116-N-2 Treatment Storage Facility | | 116-N-3(1325-N) Crib and Trench | 1322- N/NA Sample Building | | 120N-1 and 120N-2 Ponds | |
|---|---|---|---|---|---|---|---|---|
| 0-6ft | 6-15ft | 0-6ft | 6-15ft | 0-6ft | 0-6ft | 6-15ft | 6-15ft | |
| Am-241<br>Cs-134<br>Cs-137<br>Ce-144<br>Co-60<br>Eu-154<br>Eu-155<br>Mn-54<br>Pu-238<br>Pu-239/240<br>Ra-226<br>Ru-106<br>Sr-90<br>Tc-99<br>Th-228<br>Th-232<br>U-233/234<br>U-238<br>Cadmium<br>Carbon<br>Disulphide<br>Copper<br>Di-n-butylphthalate<br>N-nitrodoiphenylamine<br>Toluene | Ra-226<br>Th-228<br>Th-232<br>U-238<br>Cadmium | Am-241<br>C0-60<br>Cs-137<br>Ra-226<br>Th-228<br>Th-232<br>U-233/240<br>Cadmium<br>Anthracene<br>Benzo(a)anthracene<br>Benzo(b)fluoranthene<br>Phenanthrene<br>Pyrene | Co-60<br>Ra-226<br>Th-228<br>Th-232<br>U-233/234<br>U-238<br>Cadmium | Cs-137<br>Ce-144<br>Co-60<br>Mn-54<br>Pu-238<br>Pu-239/240<br>Sr-90 | Co-60<br>Sr-90<br>Cs-137<br>Ra-226<br>Th-228<br>Th-232<br>U-233/234<br>U-238<br>Copper<br>Lead<br>Zinc<br>Benzo(a)anthracene<br>Benzo(b)fluoranthene<br>Bis(2-ethylhexyl)phthalate<br>Chrysene<br>Fluoranthene<br>Phenanthrene<br>Pyrene | Co-60<br>Ra-226<br>Th-228<br>U-233/234<br>U-238 | Copper | Copper<br>Zinc<br>Bis(2-ethylhexyl)phthalate |

## Table 2-17 General Parameters Used for Ecological Dose (Radionuclide) Equations

| Contaminant | Biological Half-Life (days) | Physical Half-Life (days) | Mev (absorbed energy for 2-cm diameter sphere) | Soil-to-Plant Transfer Factor | Fraction Uptake (unitless) |
|---|---|---|---|---|---|
| **Radionuclides** | | | | | |
| Americium-241 | 20000(a) | 1.58E+05(b) | 5.28(a)(c) | 0.01(g) | 0.001(l) |
| Cerium-144 | 563(a) | 2.84E+02(b) | 1.32(a)(c) | 0.0025(c) | 0.0003(l) |
| Cesium-134 | 7.5(f) | 7.53E+02(b) | 0.259(a) | 0.62(h) | 1(l) |
| Cesium-137 | 7.5(f) | 1.10E+04(b) | 0.267(a)(c) | 0.62(h) | 1(l) |
| Cobalt-60 | 9.5(a) | 1.92E+03(b) | 0.237(a) | 0.5(g) | 0.3(l) |
| Europium-154 | 635(a) | 3.21E+03(b) | 0.311(a) | 0.001(g) | 0.001(l) |
| Europium-155 | 635(a) | 1.81E+03(b) | 0.061(a) | 0.001(g) | 0.001(l) |
| Manganese-54 | 17(a) | 3.13E+02(b) | 0.0514(a) | 10.6(k) | 0.1(l) |
| Plutonium-238 | 65000(a) | 3.20E+04(b) | 5.51(a) | 0.07(g) | 0.001(l) |
| Plutonium-239 | 65000(a) | 8.78E+06(b) | 5.15(a) | 0.07(g) | 0.001(l) |
| Plutonium-240 | 65000(a) | 8.78E+06(b) | 5.15(a) | 0.07(g) | 0.001(l) |
| Radium-226 | 8100(a) | 5.84E+05(b) | 11(a) | 0.1(g) | 0.2(l) |
| Ruthenium-106 | 7.3(a) | 1.88E-03(b) | 1.44(a)(c) | 0.00005(i) | 0.05(l) |
| Strontium-90 | 244(j) | 1.06E+04(b) | 1.14(a)(c) | 19(j) | 0.3(l) |
| Technetium-99 | 1(a) | 1.06E+04(b) | 0.84(a)(c) | 19(j) | 0.3(l) |
| Thorium-228 | 57000(a) | 6.97E+02(b) | 5.6(a)(e) | 0.0001(i) | 0.0002(l) |
| Thorium-232 | 57000(a) | 5.13E+12(b) | 4(a)(e) | 0.0001(i) | 0.0002(l) |
| Uranium-233 | 100(a) | 5.79E+07(b) | 4.9(a)(e) | 1(i) | 0.05(l) |
| Uranium-234 | 100(a) | 5.79E+07(b) | 4.9(a) | 1(i) | 0.05(l) |
| Uranium-235 | 100(a) | 2.57E+11(b) | 4.6(a)(c) | 1(i) | 0.05(l) |
| Uranium-238 | 100(a) | 1.63E+12(b) | 4.39(a)(c) | 1(i) | 0.05(l) |

Sources are as follows:
(a) Baker and Soldat (1992).
(b) Shleien (1992).
(c) Includes the decay products in the energy absorbed.
(d) Parameter are continually revised with new information and are subject to change.
(e) Personal phone discussions with J. K. Soldat (1/94).
(f) Value for cesium calculated as $Y = 3.5\ (\text{mass})^{0.24}$ (Digregorio et al. 1978).
(g) Coughtrey et al. (1985).
(h) Miller et al. (1977).
(i) Whicker and Schultz (1982).
(j) Rouston and Cataldo (1978).
(k) Cataldo and Wildung (1978).
(l) International Commission on Radiological Protection (1959) for standard man.

**Table 2-18 General Parameters Used for Ecological Dose (Nonradionuclide) Equations**

| Contaminant | Plant-to-Soil Transfer Coefficient[a] | Wildlife NOEL[b] (mg/kg-day) |
|---|---|---|
| **Organics** | | |
| Anthracene | 0.104 | 33 |
| Benzo(a)anthracene | 0.022 | NA |
| Benzo(b)fluoranthene | 0.0062 | NA |
| Bis(2-ethyhexyl)phthalate | 0.043 | 0.003 |
| Carbon disulfide | 3.35 | 1 |
| Chrysene | 0.022 | NA |
| Diethylphthalate | NA[c] | NA |
| Di-n-butylphthalate | 0.072 | NA |
| Fluoranthene | 0.032 | 3 |
| N-nitrosodiphenylamine | 1.27 | NA |
| Phenanthrene | 0.102 | NA |
| Pyrene | 0.03 | 2 |
| Toluene | 1.02 | 22 |
| **Inorganics** | | |
| Cadmium | 0.55 | 0.001 |
| Copper | 0.40 | NA |
| Lead | 0.045 | 0.000069 |
| Zinc | 1.50 | 0.2 |

(a) soil-to-plant transfer coefficient from Baes et al. (1984)
(b) Adjusted wildlife no observable effect level values from U.S. Department of Energy (1993)
(c) note diethylphthalate has a biological half-life of 2-14 days under aerobic conditions and bioaccumulation should not be significant in the upper soil levels where pocket mice would live.
NA = Not available

9413300.0203

## Table 2-19 Summary of Human Health Risk Above 1E-06 for Frequent-Use Scenario, Nondetected Radionuclides

| Radioactive COPC | Maximum Reported MDA (pCi/g) | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | | Commercial/Industrial-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pathway | | | Total COPC ICR | Pathway | | | Total COPC ICR | Pathway | | | Total COPC ICR |
| | | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | |
| Iron-59 | 3 | 1E-08 | 3E-10 | 3E-04 | 3E-04 | 2E-10 | 6E-12 | 2E-06 | 2E-06 | 1E-09 | 1E-10 | 3E-05 | 3E-05 |
| Zinc-65 | 2 | 2E-08 | 4E-10 | 1E-04 | 1E-04 | | | | | 2E-09 | 2E-10 | 9E-06 | 9E-06 |
| Cesium-134 | 0.6 | 3E-08 | 2E-10 | 7E-05 | 7E-05 | | | | | 4E-09 | 8E-11 | 7E-06 | 7E-06 |
| Europium-152 | 0.6 | 2E-09 | 7E-10 | 5E-05 | 5E-05 | | | | | 2E-10 | 3E-10 | 5E-06 | 5E-06 |
| Europium-154 | 0.4 | 2E-09 | 6E-10 | 4E-05 | 4E-05 | | | | | 2E-10 | 3E-10 | 3E-06 | 3E-06 |
| Chromium-51 | 9 | 5E-10 | 3E-11 | 2E-05 | 2E-05 | | | | | 6E-11 | 1E-11 | 2E-06 | 2E-06 |
| Uranium-235 | 0.2 | 4E-09 | 5E-08 | 1E-06 | 1E-06 | | | | | | | | |
| TOTAL | | 7E-08 | 6E-08 | 6E-04 | 6E-04 | 2E-10 | 6E-12 | 2E-06 | 2E-06 | 8E-09 | 1E-09 | 5E-05 | 5E-05 |

COPC - Chemical of potential concern.
ICR - Incremental cancer risk.
MDA - Minimum detectable activity from analytical data sheets.

**Table 2-20 Summary of Human Health Risk Above 1E-06 for the Frequent-Use Scenario, Nondetected Nonradionuclides**

| Organic COPC | Maximum Reported Detection Limit (a) (ug/kg) | Frequent-Use Scenario | | | Commercial/Industrial-Use Scenario | | |
|---|---|---|---|---|---|---|---|
| | | Pathway | | Total COPC ICR | Pathway | | Total COPC ICR |
| | | Soil Ingestion ICR | Fugitive Dust and Volatile Fraction Inhalation ICR | | Soil Ingestion ICR | Fugitive Dust and Volatile Fraction Inhalation ICR | |
| Benzo(a)pyrene | 360 | 4E-06 | 3E-08 (b) | 4E-06 | | | |
| bis(2-Chloroethyl)ether | 360 | 6E-07 | 6E-07 | 1E-06 | | | |
| Hexachlorobenzene | 360 | 9E-07 | 5E-07 | 1E-06 | | | |
| N-nitroso-di-n-dipropylamine | 360 | 4E-06 | 2E-06 | 6E-06 | 2E-07 | 1E-06 | 1E-06 |
| TOTAL | | 1E-05 | 3E-06 | 1.3E-05 | 2E-07 | 1E-06 | 1E-06 |

| Inorganic COPC | Maximum Reported Detection Limit (a) (mg/kg) | Frequent-Use Scenario | | |
|---|---|---|---|---|
| | | Pathway | Pathway | Total COPC ICR |
| | | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | |
| Cadmium | 0.37 | 4E-06 (b) | 1E-08 | 4E-06 |
| TOTAL | | 4E-06 (b) | 1E-08 | 4E-06 |

COPC - Chemical of potential concern.
ICR - Incremental cancer risk.
(a) Maximum reported detection limit from analytical sheets.
(b) Used toxicity value from other route.

# 3.0 WASTE SITE QUALITATIVE RISK ASSESSMENT

This section presents the human health and ecological qualitative risk evaluations for the high-priority and low-priority waste sites at the 100-NR-1 Source Operable Unit. The individual site risk characterizations were performed using the maximum concentrations of the COPC identified in Section 2.0 and the methodology described in Section 1.3.

The risk characterizations in this QRA were based on a number of conservative assumptions. Although these conservative assumptions served to simplify the risk characterization process, the resulting numerical values do not represent the most realistic estimates of risks and hazards to human health and ecological receptors. A review of the uncertainty discussions in Sections 1.3 and 2.6 is recommended to assist the reader in the interpretation of the risk characterization results in this QRA.

The risk characterization for human health is described in Section 1.3.2.3. Calculated ICR, HQ, and hazard index (HI) values were compared with an ICR of 1E-06 and an HQ or HI of 1.0. All ICR values $\leq$1E-06 and all HQ and HI values greater than or equal to unity are highlighted in Tables 3-1 through 3-17, respectively. Risk characterization for ecological evaluation has been described in section 1.3.3.3.1.

The 100-NR-1 waste sites were assessed in three groupings: those RCRA sites for which quantitative data collected during the LFI or from historical sources are available, those sites for which LFI data are available, and those sites for which only process knowledge is available. Section 3.1 addresses RCRA waste sites for which quantitative data are available from historical sources and the LFI. Section 3.2 addresses waste sites for which LFI data are available. Section 3.3 address sites for which only process knowledge is available.

Risks presented here use one of two dates for the unitization of exposure, 1992 and 2018. The year 2018 refers to the time when the site's scheduled for completion of cleanup activities.

## 3.1 HIGH-PRIORITY RCRA WASTE SITES WITH DATA

The 100-NR-1 Source Operable Unit contains four RCRA TSD facilities: the 116-N-1 Crib and Trench, the 116-N-3 Crib and Trench, the 120-N-1 Percolation Pond and South Settling Pond, and the 120-N-2 Surface Impoundment. The 116-N-1 and 116-N-3 Facilities are addressed in this section, and the 120-N-1 and 120-N-2 Facilities are addressed in Section 3.2.1, under the high-priority waste sites with LFI data.

The following sections present qualitative discussions of the risk at each high-priority RCRA waste site characterized using historical and LFI analytical data. Site-specific uncertainties associated with the risk characterization are also identified.

### 3.1.1 116-N-1 (1301-N) Crib and Trench

**3.1.1.1 Human Health Risk Characterization.** The total estimated ICR values in 1992 and 2018 for the frequent-use, the occasional-use, and the commercial/industrial-use scenarios are >1E-02 and are mainly attributable to cobalt-60 and cesium-137 via the external exposure pathway. Plutonium 239/240 was a main contributor for the three scenarios for 1992 and 2018 via the ingestion and inhalation pathways. Tables 3-1 and 3-2 provide summaries of the risks calculated for radioactive COPC for 1992 and 2018, respectively. Table 3-3 provides a summary of the risk calculated for nonradioactive COPC. Cadmium was the sole nonradioactive COPC identified with an estimated ICR <1E-06 and HQ <1.0. Figure 3-1 illustrates the effect that the risk-driving contaminants have on the cumulative ICR for the site under the frequent-use scenario in 1992.

Based on the QRA, the threat posed by radionuclides in 1992 at the 116-N-1 (1301-N) Crib and Trench would be high under all three scenarios. The threat in 2018 would be the same because the risk drivers have very long half-lives.

**3.1.1.2 Human Health Risk Characterization Uncertainty Analysis.** The risks presented are considered qualitative and estimated, and multiple assumptions have been made about sampling, data quality, exposures, toxicity, and other variables.

The underlying assumptions for exposure are that COPC are readily accessible for receptor contact via external exposure, soil ingestion, and inhalation. The risk-driving concentrations were from historical sediment sample data from the trench at the site. The trench has been covered with concrete panels; however, surface radiological surveys indicate that radiation levels exceed background. The risks estimated in this QRA are for exposures without shielding.

**3.1.1.3 Ecological Risk Characterization.** The total calculated dose rates to the Great Basin pocket mouse from radionuclides in the soil in the 116-N-1 (1301-N) Trench are listed in Tables 3-4 and 3-5 and the associated EHQ values are summarized in Section 4.0 (Tables 4-4 and 4-5). The total dose (4,460 rad/day) from radionuclides in soils exceeds the EHQ (1 rad/day) for the 0 to 1.8 m (0 to 6 ft) soil profile. Cobalt-60, strontium-90, cesium-137, and plutonium (plutonium-239 and plutonium-240 combined) exceed the EHQ by themselves, although strontium-90 accounts for nearly 87% of the total dose rate. Several radionuclides that were measured in historical data were eliminated from consideration because of their short half-lives (e.g., <0.5 year). These include cobalt-58, iron-59, niobium-95, zirconium-95, and ruthenium-103.

For the nonradiological constituents measured at the 116-N-1 Trench, cadmium exceeds the associated wildlife NOEL value. Copper, di-n-butylphthalate, and n-nitrosodiphenylamine were also measured at the trench (with estimated intake values of 1.1, 0.00041, and 0.013 mg/kg/day, respectively) but were not evaluated because wildlife NOEL values were not available.

**3.1.1.4 Ecological Risk Characterization Uncertainty Analysis.** The uncertainty associated with the approach used in the qualitative ecological evaluation for this waste site is

significant because the concentrations used as source terms (soil concentrations) were assumed to be available for uptake by site vegetation. Because the estimated dose rate to the pocket mouse is so much greater (4,460 times) than the EHQ threshold (1 rad/day), the uncertainty is less important for conclusions about this site. However, much of the site is covered with concrete and soil contaminants may not be available to the pocket mouse. Vegetation-free areas (e.g., where herbicide has been applied) are maintained along the trench. It was also assumed that the contaminants are uniformly distributed in the soil profile. Some radionuclides may quickly bind to the surface soil (e.g., plutonium), whereas other more soluble radionuclides (strontium and uranium) may move with the water profile. Site maintenance factors could reduce expected pocket mouse populations. Plant species growing near the disturbed area of the concrete-covered trench may be different from those of surrounding areas and may have different rooting depths and contaminant uptake values. Because of the uncertainty of actual and predicted successional vegetation, a conservative approach was used. In all cases, the highest transfer factor was used.

### 3.1.2 116-N-3 (1325-N) Crib and Trench

**3.1.2.1 Human Health Risk Characterization.** The total estimated ICR values in 1992 and 2018 for the frequent-use, the occasional-use, and the commercial/industrial-use scenarios are > 1E-02 and are mainly attributable to cobalt-60 and cesium-137 via the external exposure pathway. Tables 3-6 and 3-7 provide summaries of the risks calculated for the radioactive COPC in 1992 and 2018, respectively. Figure 3-2 illustrates the effect that the risk-driving COPC have on the cumulative ICR for the site under the frequent-use scenario in 1992.

Based on the QRA, the threat posed by radionuclides in 1992 at the 116-N-3 (1325-N) Crib and Trench would be high under all three scenarios. The threat in 2018 would be the same because the risk drivers have very long half-lives.

**3.1.2.2 Human Health Risk Characterization Uncertainty Analysis.** The risks presented are considered qualitative and estimated, and multiple assumptions have been made about sampling, data quality, exposures, toxicity, and other variables.

The underlying assumptions for exposure are that COPC are readily accessible for receptor contact via external exposure, soil ingestion, and inhalation. The risk-driving concentrations were from historical sediment sample data from the crib and trench at the site. The crib and trench have been covered with concrete panels; however, surface radiological surveys indicate that radiation levels exceed background. The risks estimated in this QRA are for exposures without shielding.

**3.1.2.3 Ecological Risk Characterization.** The total calculated dose rates to the Great Basin pocket mouse from radionuclides in the soil in the 116-N-3 (1325-N) Trench are listed in Table 3-8 and the associated EHQ values are summarized in Section 4.0 (Tables 4-4 and 4-5). The total dose (3,642 rad/day) from radionuclides in soils greatly exceeds the EHQ (1 rad/day) for the 0 to 1.8 m (0 to 6 ft) soil profile. No information is available for radionuclides at greater depths (1.8 to 4.6 m [6 to 15 ft]). Both cobalt-60 and strontium-90

exceed the EHQ by themselves, although strontium-90 accounts for nearly 99% of the total dose rate. No data are available for the nonradiological constituents at the 116-N-1 Trench.

**3.1.2.4 Ecological Risk Characterization Uncertainty Analysis.** The uncertainty associated with the approach used in the qualitative ecological evaluation for this waste site is significant because the concentrations used as source terms (soil concentrations) were assumed to be available for uptake by site vegetation. However, because the estimated dose rate to the pocket mouse is so much greater than the EHQ threshold (1 rad/day), the uncertainty is less important for conclusions about this site. Much of the site is covered with concrete and soil contaminants may not be available to the pocket mouse. Vegetation-free areas (e.g., where herbicide has been applied) are maintained along the trench. It was also assumed that the contaminants are uniformly distributed in the soil profile. Some radionuclides may quickly bind to the surface soil (e.g., plutonium), whereas other more soluble radionuclides (strontium) may move with the water profile. Site maintenance factors could reduce expected pocket mouse populations. Plant species growing near the disturbed area of the concrete-covered trench may be different from those of surrounding areas and may have different rooting depths and contaminant uptake values. Because of the uncertainty of actual and predicted successional vegetation, a conservative approach was used. In all cases, the highest transfer factor was used.

## 3.2 HIGH-PRIORITY WASTE SITES WITH DATA

The following sections present qualitative discussions of the risk at each high-priority waste site characterized using LFI analytical data.

The two RCRA sites for which LFI data are available were grouped together because of their proximity and because similar process knowledge and similar LFI data are available for them. These are the 120-N-1 Percolation Pond and South Settling Pond and the 120-N-2 Surface Impoundment. The other four sites are the 116-N-2 Treatment Storage Facility, the 1322-N/1322-NA Sample Buildings, the 119-N Cooling Water Drain Line, and the 166-N Tank Farm.

### 3.2.1 120-N-1 Percolation Pond and South Settling Pond and 120-N-2 Surface Impoundment

**3.2.1.1 Human Health Risk Characterization.** Limited field investigation data were collected for these waste sites for nonradionuclides and maximum concentrations were compared with RBC values. The detected chemical concentrations were less than the RBC based on 1E-06 ICR and 1.0 HQ. The total estimated ICR and HQ values are estimated to be $<$1E-07 and $<$0.1, respectively, for nonradioactive chemicals detected at the sites. The risk associated with nonradionuclide exposure is very low. Because disposal of radionuclides or handling of effluent cooling water is not documented at these sites, the risks associated with radionuclide exposure are expected to be very low.

**3.2.1.2 Human Health Risk Characterization Uncertainty Analysis.** None of the soil samples collected during the LFI were analyzed for radionuclides, which were excluded based on field screening and historical process knowledge. Radionuclide data for this site are from field screening and are considered to be of high uncertainty. Organic and inorganic compound identification and concentrations are considered to be of low uncertainty based on the LFI data. Field screening for radionuclides consisted of gross beta and/or gamma measurements; specific radionuclides were not identified and concentrations were not determined. No detected chemicals were carried past the risk-based screening.

**3.2.1.3 Ecological Risk Characterization.** Data for radiological constituents were not available for this site. For nonradiological contaminants exceeding Hanford background levels, zinc exceeds the wildlife NOEL value for the surface (0 to 1.8 m [0 to 6 ft]) profile and, therefore, may be potentially hazardous to the pocket mouse (Tables 3-18 and Table 4-5). Copper was measured at concentrations exceeding the Hanford background in both the surface profile (0 to 1.8 m [0 to 6 ft]) and the deeper soil depths (1.8 to 2 m [6 to 15 ft]) at 1.3 and 1.4 mg/kg/day (Tables 3-18 and 3-19), respectively, but a wildlife NOEL value for copper was not available in the literature for comparison. Diethylphthalate was measured but no wildlife NOEL was available for this contaminant.

**3.2.1.4 Ecological Risk Characterization Uncertainty Analysis.** The uncertainty associated with the approach used in the qualitative ecological evaluation for this waste site is significant because vegetation-free areas (e.g., where herbicide has been applied) are maintained along the former water holding ponds. Calculation of the source term also assumed that the contaminant is uniformly distributed in the soil profile and did not consider variation of contaminant mobility in soil. Site maintenance factors could reduce expected pocket mouse populations. Plant species growing near the disturbed area of the ponds may be different from those of surrounding areas and may have different rooting depths and contaminant uptake values. Because of the uncertainty of actual and predicted successional vegetation, a conservative approach was used. In all cases, the highest transfer factor was used.

### 3.2.2 116-N-2 Treatment Storage Facility

**3.2.2.1 Human Health Risk Characterization.** The total estimated ICR values for radioactive COPC in 1992 and 2018, as shown in Tables 3-9 and 3-10, are as follows:

- for the frequent-use scenario, the ICR is > 1E-02 for 1992 and 1E-03 for 2018
- for the occasional-use scenario, the ICR is 1E-04 for 1992 and 8E-06 for 2018
- for the commercial/industrial-use scenario, the ICR is 2E-03 for 1992 and 1E-04 for 2018.

In 1992, the main contributor to the ICR is cobalt-60 by the external exposure pathway. In addition, potassium-40, cesium-137, radium-226, and thorium-228 contributed > 1E-06 to the ICR for the frequent-use scenario for 1992. The main contributors for 2018

are potassium-40, cobalt-60, cesium-137, and radium-226. Figure 3-3 shows the contaminant-specific contributions to the total ICR.

The estimated ICR and HQ values for nonradionuclides at this site did not exceed the RBC values. Table 3-11 presents the calculated risks for the nonradionuclides.

The threat posed by 116-N-2 for frequent-use in 1992 is high. The current threat for the occasional-use and commercial/industrial scenarios is medium. In 2018, the threat would be medium for frequent-use and commercial/industrial scenarios and low for occasional-use.

**3.2.2.2 Human Health Risk Characterization Uncertainty Analysis.** The LFI data for this site are considered to be of medium uncertainty. The radionuclide risk driver, cobalt-60, was detected both in the laboratory soil analysis and the spectral gamma ray borehole survey at the same activity level. The COPC identification and concentrations are considered to be of low uncertainty. Uncertainty is associated primarily with the limited data set. Only one boring and three surface locations were sampled.

**3.2.2.3 Ecological Risk Characterization.** The total dose rate from radionuclides present in the soil does not exceed 1 rad/day benchmark dose (Tables 3-12, 3-13, and 4-4) for either the 0 to 1.8 m (0 to 6 ft) or the 1.8 to 4.6 m (6 to 15 ft) soil profiles. For the nonradiological contaminants exceeding Hanford background levels, cadmium exceeds the wildlife NOEL value for surface profile (0.1 to 1.8 m [0 to 6 ft]) and the deeper soil depths (1.8 to 2 m [6 to 15 ft]) (Table 4-5). The dose rate was calculated for several contaminants, but their wildlife NOEL were not available. They include benzo(a)anthracene, benzo(b)fluoranthene, chrysene, diethylphthalate, phenanthrene, and pyrene.

**3.2.2.4 Ecological Risk Characterization Uncertainty Analysis.** The uncertainty associated with the approach used in the qualitative ecological evaluation for this waste site is significant because concentrations used as source terms were assumed to be available for uptake by site vegetation. Modeling from soil to the pocket mouse required a number of assumptions, including soil-to-plant transfer factors or coefficients. A review of the literature provided a range of values. The highest transfer factor was used in all cases. Other assumptions included estimating the time that a receptor spends feeding within the unit and the amount of foodstuff consumed, making foraging assumptions, and assuming that all foodstuff consumed is contaminated. The calculated dose to the pocket mouse is then used to assess a qualitative potential ecological risk. In reality, the actual dose to the pocket mouse may be less than the calculated dose because the assumptions are very conservative.

### 3.2.3 1322-N/1322-NA Sample Buildings

**3.2.3.1 Human Health Risk Characterization.** The total estimated ICR values for radioactive COPC in 1992 and 2018, as shown in Tables 3-14 and 3-15, are as follows:

- for the frequent-use scenario, the ICR is 2E-03 for 1992 and 4E-04 for 2018
- for the occasional-use scenario, the ICR is 1E-05 for 1992 and 3E-06 for 2018

- for the commercial/industrial-use scenario, the ICR is 2E-04 for 1992 and 4E-05 for 2018.

In 1992, the main contributor is cobalt-60 by the external exposure pathway. In addition, potassium-40, cesium-137, radium-226, thorium-228, and uranium-238 contributed >1E-06 to the ICR for the frequent-use scenario for 1992. The main contributors for 2018 are potassium-40, cobalt-60, cesium-137, and radium-226. Figure 3-4 illustrates the effect that the risk-driving contaminants have on the cumulative ICR for the site under the frequent-use scenario in 1992.

The nonradionuclides for this site did not exceed RBC values, and risks were not calculated for them. The risk due to nonradionuclides is expected to be very low.

The threat posed by 1322-N/1322-NA for frequent-use and commercial/industrial-use scenarios in 1992 is medium. The threat posed for the occasional-use scenario in 1992 is low. In 2018, the threat would be low for occasional-use and commercial/industrial-use and medium for frequent-use.

**3.2.3.2 Human Health Risk Characterization Uncertainty Analysis.** The LFI data for this site are considered to be of low uncertainty. Contaminant identification and concentrations are also considered to be of low uncertainty. Considerable uncertainty exists because of the limited data set. Only one boring and four surface locations were sampled.

**3.2.3.3 Ecological Risk Characterization.** The total dose from radionuclides present in the soil does not exceed 1 rad/day (Tables 3-16, 3-17, and 4-4) for either the 0 to 1.8 m (0 to 6 ft) or the 1.8 to 4.6 m (6 to 15 ft) soil profile. Of the inorganic and organic contaminants measured, lead and zinc exceed the wildlife NOEL values in the surface soil profile (Table 4-5). As such, lead may be potentially hazardous to the pocket mouse. The dose rate for several contaminants were determined, but their EHQ could not be determined. This is because the wildlife NOEL for benzo(a)anthracene, benzo(b)fluoranthene, chrysene, copper, and phenanthrene are not available.

**3.2.3.4 Ecological Risk Characterization Uncertainty Analysis.** The uncertainty associated with the approach used in the qualitative ecological evaluation for this waste site is significant because vegetation-free areas (e.g., where herbicide has been applied) are maintained. It is also assumed that the contaminants are uniformly distributed in the soil profile. Site maintenance factors could reduce expected pocket mouse populations. Plant species growing near the disturbed area of the site may be different from those of surrounding areas may have different rooting depths and contaminant uptake values. Because of the uncertainty of actual and predicted successional vegetation, a conservative approach was used. In all cases, the highest transfer factor was used.

### 3.2.4 119-N Cooling Water Drain Line

**3.2.4.1 Human Health Risk Characterization.** Limited field investigation data were collected for this waste site for nonradionuclides and maximum concentrations were

compared to RBC values. The detected chemical concentrations were less than the RBC of 1E-07 ICR and 0.1 HQ. The total estimated ICR and HQ values are estimated to be <1E-07 and <0.1, respectively, for nonradioactive chemicals detected at this site. The risk associated with nonradionuclide exposure is very low. Analytical data for radionuclides were not available for this site because soil samples were not analyzed for these constituents based on field screening. The risks associated with radionuclide exposure are expected to be low based on field screening.

**3.2.4.2 Human Health Risk Characterization Uncertainty Analysis.** None of the soil samples collected during the LFI were analyzed for radionuclides, which were excluded based on field screening. Uncertainty in the field screening data is high. The data for radionuclides for this site are from field screening and are considered to be of high uncertainty. Field detection devices are not radionuclide specific and have relatively high detection limits compared with laboratory methods. Organic and inorganic compound identification and concentrations are considered to be of low uncertainty based on the LFI data. Field screening for radionuclides consisted of gross beta and/or gamma measurements; specific radionuclides were not identified and concentrations were not determined. No detected chemicals were carried past the risk-based screening.

**3.2.4.3 Ecological Risk Characterization.** No radionuclide data are available for determining whether the EHQ for radionuclides is exceeded in the 0 to 1.8 m or 1.8 to 4.6 m (0 to 6 ft or 6 to 15 ft) soil profiles. No nonradionuclides measured in the soil profile exceed the wildlife NOEL (EHQ > 1) for either soil profile.

**3.2.4.4 Ecological Risk Characterization Uncertainty Analysis.** The uncertainty associated with the approach used in the qualitative ecological evaluation for this waste site is significant because data used as source terms were assumed to be available for uptake by site vegetation. Modeling from soil to the pocket mouse required a number of assumptions, including soil-to-plant transfer factors or coefficients. Other assumptions included estimating the time that a receptor spends feeding within the unit and the amount of foodstuff consumed, making foraging assumptions, and assuming that all foodstuff consumed is contaminated. The calculated dose to the pocket mouse is then used to assess a qualitative potential ecological risk. In reality, the actual dose to the pocket mouse may be less than the calculated dose because the calculated dose is based on very conservative assumptions.

### 3.2.5 166-N Tank Farm (UN-100-N-17)

**3.2.5.1 Risk Characterization.** This site apparently was covered with a surface layer (4.6 m [15 ft]) of clean fill. Given the lack of data, no ecological evaluation could be performed. A release from this site was documented to have migrated to groundwater and the Columbia River in 1966. Limited field investigation data indicate a benzene concentration of 190 $\mu$g/kg below a depth of 4.6 m (15 ft) and a total xylenes concentration of 1,300 $\mu$g/kg at approximately 18 to 20 m (60 to 65 ft) below surface. Because neither disposal of radionuclides nor handling of effluent cooling water is documented at this site, the risks associated with radionuclide exposure are expected to be very low. Based on field

screening data and historical knowledge, the risk associated with nonradioactive contaminants suspected at the site (diesel No. 6 fuel oil) is expected to be low.

**3.2.5.2 Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of data for the upper 4.6 m (15 ft) of soil. Uncertainty in field screening data is high. It is not known whether the surface fill covers the entire site, and chemical COPC may be present in the upper 4.6 m (15 ft). Although these sources of uncertainty have an unknown impact on the risk characterization, they could result in an underestimation of risks.

## 3.3 HIGH-PRIORITY WASTE SITES WITHOUT DATA

The decision process to determine whether an IRM is needed for high-priority waste sites requires only a records review (DOE-RL 1991b). Therefore, no soil samples were collected during the LFI.

The characterization of risk associated with uncharacterized sites is based on process knowledge. Suspected site contaminants were identified and RBC values were calculated using available toxicity values. The major uncertainties associated with this type of QRA evaluation were also identified.

Because no sampling information is available for these sites, an ecological evaluation could not be completed. The identification of potential contaminants is limited to process information, and these sites may not be ecologically comparable to any analogous sites. Further discussion is presented in Section 2.0.

### 3.3.1 118-N-1 Spacer Storage Silos Risk Characterization

Soil remedial action will be integrated with draining of the 105-N Basin. Given the lack of soil data, no ecological evaluation could be made. The human health evaluation consisted of identification of suspected contaminants and risk-based calculations. Suspected contaminants identified (radionuclides only) during the LFI records review are cobalt-60, strontium-90, cerium/praseodymium-144, and plutonium-239 (Table 2-10). Risk-based concentration values for these constituents are presented in Table 2-14. Based on historical knowledge, the risk at this site is expected to be high.

### 3.3.2 1304-N Emergency Dump Tank Risk Characterization

This waste site has been designated a high-priority based on the LFI records review. Soil remedial action for this area is planned following reactor decommissioning. Given the lack of soil data, no ecological evaluation could be made. The human health evaluation consisted of identification of suspected contaminants and risk-based calculations. Suspected contaminants identified (radionuclides only) during the LFI records review are sodium-24 and manganese-56 (Table 2-10). Risk-based contaminants values for these constituents are

presented in Table 2-14. Based on historical knowledge, the risk at this site is expected to be high.

### 3.3.3 116-N-4 Emergency Dump Basin Risk Characterization

This waste site has been designated a high-priority based on the LFI records review. Soil remedial action for this area is planned after the 105-N Basin has been drained and residual materials have been removed. Given the lack of soil data, no ecological evaluation could be made. The human health evaluation consisted of identification of suspected contaminants and risk-based calculations. Suspected contaminants identified (radionuclides only) during the LFI records review are potassium-40, manganese-56, cobalt-58, iron-59, cobalt-60, zirconium/niobium-95, ruthenium-103, antimony-124, iodine-131, cesium-137, and barium/lanthanum-140 (Table 2-10). Risk-based concentration values for these constituents are presented in Table 2-14. Based on historical knowledge, the risk at this site is expected to be high.

### 3.3.4 105-N Spent Fuel Storage Basin Risk Characterization

This waste site has been designated a high-priority based on the LFI records review. Soil remedial action will be integrated with the draining of the 105-N Basin. Given the lack of soil data, no ecological evaluation could be made. The human health evaluation consisted of identification of suspected contaminants and risk-based calculations. The only suspected contaminant identified (radionuclides only) during the LFI records review is iodine-131 (Table 2-10). The RBC value for iodine-131 is presented in Table 2-14. Based on historical knowledge, the risk at this site is expected to be high.

### 3.3.5 UN-100-N-6 Decontamination Waste Drain Line Risk Characterization

This waste site has been designated a high-priority based on the LFI records review. Characterization of the soil at this site will be integrated with remediation. Given the lack of soil data, no ecological evaluation could be made. The human health evaluation consisted of identification of suspected contaminants and risk-based calculations. Contaminants of potential concern identified (radionuclides only) during the LFI records review are manganese-54, cobalt-60, ruthenium-103, and cesium-137 (Table 2-10). Risk-based concentration values for these constituents are presented in Table 2-14. Based on historical knowledge, the risk at this site is expected to be high.

### 3.3.6 Risk Characterization Uncertainty Analysis for High-Priority Sites Without Data

The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for these high-priority waste sites. Although the impact of this uncertainty on the qualitative risk characterization of the 118-N-1, 1304-N, 116-N-4, 105-N, and

UN-100-N-6 sites could not be determined, the estimated risks could be overestimated or underestimated.

## 3.4 LOW-PRIORITY WASTE SITES WITHOUT DATA

The characterization of risk associated with uncharacterized sites is based on process knowledge and characterization information from analogous sites, as available. Suspected site contaminants were identified and RBC values were calculated using available toxicity values. The major uncertainties associated with this type of QRA evaluation were also identified.

Because no sampling information is available for these sites, an ecological evaluation could not be completed. The identification of potential contaminants is limited to process information, and these sites may not be ecologically comparable to any analogous sites. Further discussion is provided in Section 2.0.

### 3.4.1 1314-N Liquid Waste Loadout Station

**3.4.1.1 Human Health Risk Characterization.** The 116-N-2 Treatment Storage Facility was selected as the waste site analogous to the 1314-N LWLS. The threat posed by 116-N-2 for frequent-use in 1992 is high. The current threat for the occasional-use and commercial/industrial-use scenarios is medium. For 2018, the threat would be medium for frequent-use and commercial/industrial-use scenarios and low for occasional-use. 1314-N LWLS received wastes from its analogous site. The risk-driving COPC are cobalt-60 and cesium-137 via the external exposure pathway.

**3.4.1.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for this waste site. The extent of contamination and remediation is not known. Although the impact of this uncertainty on the qualitative risk characterization could not be determined, the risk could be overestimated or underestimated.

### 3.4.2 1143-N Paint Shop

**3.4.2.1 Human Health Risk Characterization.** None of the characterized 100-NR-1 Source Operable Unit waste sites could be identified as analogous to the 1143-N Paint Shop. No documented releases to soil have occurred at this site. Suspected contaminants identified at the paint shop include paints, solvents, and oils. Constituents of paints, solvents, and oils were included in the analysis for other 100-NR-1 Source Operable Unit waste sites and RBC values for these constituents are presented in Table 2-13. Because disposal of radionuclides or handling of effluent cooling water is not documented at this site, the risks associated with radionuclide exposure are expected to be very low. The ICR values for chemical COPC evaluated at other 100-NR-1 Source Operable Unit waste sites generally are below the ICR values for radionuclide exposure. In addition, the HI estimated for systemic toxicity from

exposure to chemicals is < 1.0 for all other 100-NR-1 Source Operable Unit waste sites. As such, the risk estimated for this site is very low.

**3.4.2.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for this waste site. This site might contain chemical COPC that have not been reported at other waste sites or the COPC concentrations might be higher than reported at other waste sites. Although the impact of this uncertainty on the qualitative risk characterization could not be determined, the risk could be underestimated.

### 3.4.3 N-17 Paint Shop

**3.4.3.1 Human Health Risk Characterization.** An oil release and subsequent soil removal have been documented at this site. Suspected contaminants identified at the paint shop include paints, solvents, and oils. Constituents of paints, solvents, and oils were included in the analysis for other 100-NR-1 Source Operable Unit waste sites, and RBC values for these constituents are presented in Table 2-13. Because disposal of radionuclides or handling of effluent cooling water is not documented at this site, the risks associated with radionuclide exposure are expected to be very low. The ICR values for chemical COPC evaluated at other 100-NR-1 Source Operable Unit waste sites generally are below the ICR values for radionuclide exposure. In addition, the HI estimated for systemic toxicity from exposure to chemicals is < 1.0 for all other 100-NR-1 Source Operable Unit waste sites. As such, the risk estimated for this site is very low.

**3.4.3.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for this waste site. This site might contain chemical COPC that have not been reported at other waste sites or the COPC concentrations might be higher than reported at other waste sites. Although the impact of this uncertainty on the qualitative risk characterization could not be determined, the risk may be underestimated.

### 3.4.4 184-N Day Tanks

**3.4.4.1 Human Health Risk Characterization.** Diesel oil was identified as a suspected contaminant at this waste site. No RBC could be calculated because no toxicity value is available for diesel. However, constituents of diesel were included in the analysis for other 100-NR-1 Source Operable Unit waste sites, and RBC values for these constituents are presented in Table 2-13. Because disposal of radionuclides or handling of effluent cooling water is not documented at this site, the risks associated with radionuclide exposure are expected to be very low. The ICR values for chemical COPC evaluated at other 100-NR-1 Source Operable Unit waste sites generally are below the ICR values for radionuclide exposure. In addition, the HI estimated for systemic toxicity from exposure to chemicals is < 1.0 for all other 100-NR-1 Source Operable Unit waste sites. As such, the risk estimated for this site is very low.

**3.4.4.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for this waste site. This site might contain chemical COPC that have not been reported at other waste sites or the COPC concentrations might be higher than reported at other waste sites. Although the impact of this uncertainty on the qualitative risk characterization could not be determined, the risk could be underestimated.

### 3.4.5 166-N - 184-N Piping

**3.4.5.1 Human Health Risk Characterization.** Documented releases have occurred from the piping and are suspected to have impacted groundwater. Wells 199-N-16 and 199-N-17 were sampled after releases, and oil was found in them. The impact to groundwater is evaluated in the 100-NR-2 QRA (WHC 1993a). The extent of soil contamination and remediation is not known. Diesel oil was identified as a suspected contaminant at this waste site. No RBC value could be calculated because no toxicity value is available for diesel. However, constituents of diesel were included in the analysis for other 100-NR-1 Source Operable Unit waste sites, and RBC values for these constituents are presented in Table 2-13. Because disposal of radionuclides or handling of effluent cooling water is not documented at this site, the risks associated with radionuclide exposure are expected to be very low. The ICR values for the chemical COPC evaluated at other 100-NR-1 Source Operable Unit waste sites generally are below the ICR values for radionuclide exposure. In addition, the HI estimated for systemic toxicity from exposure to chemicals is $<1.0$ for all other 100-NR-1 Source Operable Unit waste sites. As such, the risk estimated for this site is very low.

**3.4.5.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for this waste site. This site might contain chemical COPC that have not been reported at other waste sites or the COPC concentrations might be higher than reported at other waste sites. Although the impact of this uncertainty on the qualitative risk characterization could not be determined, the risk could be underestimated.

### 3.4.6 166-N Drum Storage Area

**3.4.6.1 Human Health Risk Characterization.** No releases have been documented at this site. Diesel oil was identified as a suspected contaminant by analogy to the 166-N Tank Farm. No RBC could be calculated because no toxicity value is available for diesel. However, constituents of diesel were included in the analysis for other 100-NR-1 Source Operable Unit waste sites, and RBC values for these constituents are presented in Table 2-13. Because disposal of radionuclides or handling of effluent cooling water is not documented at this site, the risks associated with radionuclide exposure are expected to be very low. The ICR values for chemical COPC evaluated at other 100-NR-1 Source Operable Unit waste sites generally are below the ICR values for radionuclide exposure. In addition, the HI estimated for systemic toxicity from exposure to chemicals is $<1.0$ for all other 100-NR-1 Source Operable Unit waste sites. As such, the risk estimated for this site is very low.

**3.4.6.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for this waste site. This site might contain chemical COPC that have not been reported at other waste sites or the COPC concentrations might be higher than reported at other waste sites. Although the impact of this uncertainty on the qualitative risk characterization could not be determined, the risk could be underestimated.

### 3.4.7 Acid/Caustic Storage and Transport System

This grouping includes the 108-N Chemical Unloading Facility, 120-N-6 Sulfuric Acid French Drains, 120-N-7 Unloading Station French Drain, 120-N-3 (163-N) Neutralization Pit and French Drain, 120-N-5 Acid/Caustic Transfer Trench and Neutralization Unit, 120-N-8 Sulfuric Acid Day Tank Vent French Drain, Regeneration Waste Transport System, and 116-N-2 Spring 1983 unplanned release.

**3.4.7.1 Human Health Risk Characterization.** Various spills and releases have been documented at these waste sites. Sodium hydroxide and sulfuric acid have been identified as suspected contaminants. No RBC values were calculated because no toxicity values are available for these suspected contaminants. Because disposal of radionuclides or handling of effluent cooling water is not documented at these sites, the risks associated with radionuclide exposure are expected to be very low. The ICR values for chemical COPC evaluated at other 100-NR-1 Source Operable Unit waste sites generally are below the ICR values for radionuclide exposure. In addition, the HI estimated for systemic toxicity from exposure to chemicals is $< 1.0$ for all other 100-NR-1 Source Operable Unit waste sites. As such, the risk estimated for these sites is very low.

**3.4.7.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for these waste sites. These sites might contain chemical COPC that have not been reported at other waste sites or the COPC concentrations might be higher than reported at other waste sites. Although the impact of this uncertainty on the qualitative risk characterization could not be determined, the risk could be underestimated.

### 3.4.8 UN-100-N-11 Radioactive Spill from Valve Bonnet

**3.4.8.1 Human Health Risk Characterization.** A radioactive spill and subsequent cleanup were documented for this site. Human health RBC values for 100 N Area radionuclide COPC are presented in Table 2-11. Although the extent of soil contamination and remediation is not known, the cleanup is assumed to have been adequate such that clean fill was placed over the contaminated area after obviously contaminated soil was removed. Therefore, the risk is expected to be low.

**3.4.8.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for this waste site. The risk estimation is based on an assumption that the obviously contaminated soil was

removed and the contaminated area was backfilled with clean soil. However, this site might contain chemical COPC that have not been reported at other waste sites or the COPC concentrations might be higher than reported at other waste sites. Although the impact of this uncertainty on the qualitative risk characterization could not been determined, the risk could be underestimated.

### 3.4.9 124-N-4 Septic Tank and Drainfield

**3.4.9.1 Human Health Risk Characterization.** No releases have been documented to or from this site. Radioactivity was detected, but specific radionuclides were not identified. The source of contamination may be the nearby irradiated solution loading area at Sites 116-N-2 and 1314-N. Human health RBC for 100 N Area radionuclide COPC are presented in Table 2-11. Because disposal of radionuclides or handling of effluent cooling water is not documented at this site, the risks associated with radionuclide exposure are expected to be very low. The ICR values for chemical COPC evaluated at other 100-NR-1 Source Operable Unit waste sites generally are below the ICR values for radionuclide exposure. In addition, the HI estimated for systemic toxicity from exposure to chemicals is $< 1.0$ for all other 100-NR-1 Source Operable Unit waste sites. As such, the risk estimated for this site is very low.

**3.4.9.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for this waste site. This site might contain chemical COPC that have not been reported at other waste sites or the COPC concentrations might be higher than reported at other waste sites. Although the impact of this uncertainty on the qualitative risk characterization could not be determined, the risk could be underestimated.

### 3.4.10 Other Septic Tanks and Sewer Systems

This grouping includes the 124-N-10 Sewer System and the 124-N-1, 124-N-2, 124-N-3, 124-N-5, 124-N-6, 124-N-7, 124-N-8, and 124-N-9 Septic Tanks.

**3.4.10.1 Human Health Risk Characterization.** Documented releases for the tanks and sewer system have been limited to sanitary sewage. Because disposal of radionuclides or handling of effluent cooling water is not documented at these sites, the risks associated with radionuclide exposure are expected to be very low. The ICR values for chemical COPC evaluated at other 100-NR-1 Source Operable Unit waste sites generally are below the ICR values for radionuclide exposure. In addition, the HI estimated for systemic toxicity from exposure to chemicals is $< 1.0$ for all other 100-NR-1 Source Operable Unit waste sites. As such, the risk estimated for these sites is very low.

**3.4.10.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for these waste sites. The sites might contain chemical COPC that have not been reported at other waste sites or the COPC concentrations might be higher than reported at other waste sites.

Although the impact of this uncertainty on the qualitative risk characterization could not be determined, the risk could be underestimated.

### 3.4.11 Hanford Generating Plant Burn Pit

**3.4.11.1 Human Health Risk Characterization.** It is not known whether solvents were burned at this site. Hazardous oil drums were found at this site. No releases were documented, and no suspected soil contaminants were identified. Risk-based concentration values for solvents and oil constituents (e.g., trichloroethene, tetrachloroethene, and naphthalene) included in the analysis for other 100-NR-1 Source Operable Unit waste sites are presented in Table 2-13. Because disposal of radionuclides or handling of effluent cooling water is not documented at this site, the risks associated with radionuclide exposure are expected to be very low. The ICR values for chemical COPC evaluated at other 100-NR-1 Source Operable Unit waste sites generally are below the ICR values for radionuclide exposure. In addition, the HI estimated for systemic toxicity from exposure to chemicals is $<1.0$ for all other 100-NR-1 Source Operable Unit waste sites. As such, the risk estimated for this site is very low.

**3.4.11.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for this waste site. This site might contain chemical COPC that have not been reported at other waste sites or the COPC concentrations might be higher than reported at other waste sites. Although the impact of this uncertainty on the qualitative risk characterization could not be determined, the risk could be underestimated.

### 3.4.12 1716-N Service Station Underground Storage Tanks

**3.4.12.1 Human Health Risk Characterization.** Unleaded gasoline has been identified as a suspected contaminant at this site. Remediation is planned as part of the UST program. No RBC values were calculated because no toxicity values are available for unleaded gasoline. However, constituents of unleaded gasoline (benzene, ethylbenzene, and toluene) were included in the analysis for other 100-NR-1 Source Operable Unit waste sites, and RBC values for these constituents are presented in Table 2-13. Because disposal of radionuclides or handling of effluent cooling water is not documented at this site, the risks associated with radionuclide exposure are expected to be very low. The ICR values for chemical COPC evaluated at other 100-NR-1 Source Operable Unit waste sites generally are below the ICR values for radionuclide exposure. In addition, the HI estimated for systemic toxicity from exposure to chemicals is $<1.0$ for all other 100-NR-1 Source Operable Unit waste sites. As such, the risk estimated for this site is very low.

**3.4.12.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for this waste site. This site might contain chemical COPC that have not been reported at other waste sites or the COPC concentrations might be higher than reported at other waste sites. Although the

impact of this uncertainty on the qualitative risk characterization could not be determined, the risk could be underestimated.

### 3.4.13 182-N Underground Storage Tanks

**3.4.13.1 Human Health Risk Characterization.** Soil sampling indicated contamination from these tanks. Diesel oil was identified as a suspected soil contaminant. No RBC value was calculated because no toxicity value is available for diesel oil. However, constituents of diesel were included in the analysis for other 100-NR-1 Source Operable Unit waste sites, and RBC values for these constituents are presented in Table 2-13. Remediation is scheduled under the UST program. Because disposal of radionuclides or handling of effluent cooling water is not documented at this site, the risks associated with radionuclide exposure are expected to be very low. The ICR values for chemical COPC evaluated at other 100-NR-1 Source Operable Unit waste sites generally are below the ICR values for radionuclide exposure. In addition, the HI estimated for systemic toxicity from exposure to chemicals is $<1.0$ for all other 100-NR-1 Source Operable Unit waste sites. As such, the risk estimated for this site is very low.

**3.4.13.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for this waste site. This site might contain chemical COPC that have not been reported at other waste sites or the COPC concentrations might be higher than reported at other waste sites. Although the impact of this uncertainty on the qualitative risk characterization could not be determined, the risk could be underestimated.

### 3.4.14 184-N Plant Service Powerhouse

**3.4.14.1 Human Health Risk Characterization.** Data for this site were limited to air emissions data. The direct pathway for receptor exposure to air is not addressed under the QRA methodology (DOE-RL 1994). No suspected soil contaminants were identified at this site. Because disposal of radionuclides or handling of effluent cooling water is not documented at this site, the risks associated with radionuclide exposure are expected to be very low. The ICR values for chemical COPC evaluated at other 100-NR-1 Source Operable Unit waste sites generally are below the ICR values for radionuclide exposure. In addition, the HI estimated for systemic toxicity from exposure to chemicals is $<1.0$ for all other 100-NR-1 Source Operable Unit waste sites. As such, the risk estimated for this site is very low.

**3.4.14.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for this waste site. This site might contain chemical COPC that have not been reported at other waste sites or the COPC concentrations might be higher than reported at other waste sites. Although the impact of this uncertainty on the qualitative risk characterization could not be determined, the risk could be underestimated.

### 3.4.15 116-N Air Stack

**3.4.15.1 Human Health Risk Characterization.** Data for this site were limited to available air emissions data. The direct pathway for receptor exposure to air is not addressed under the QRA methodology (DOE-RL 1994). No suspected soil contaminants were identified at this site. Because disposal of radionuclides or handling of effluent cooling water is not documented at this site, the risks associated with radionuclide exposure are expected to be very low. The ICR values for chemical COPC evaluated at other 100-NR-1 Source Operable Unit waste sites generally are below the ICR values for radionuclide exposure. In addition, the HI estimated for systemic toxicity from exposure to chemicals is $<1.0$ for all other 100-NR-1 Source Operable Unit waste sites. As such, the risk estimated for this site is very low.

**3.4.15.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for this waste site. This site might contain chemical COPC that have not been reported at other waste sites or the COPC concentrations might be higher than reported at other waste sites. Although the impact of this uncertainty on the qualitative risk characterization could not be determined, the risk could be underestimated.

### 3.4.16 116-N-8 Hazardous and Mixed Waste Storage Area and 120-N-4 Nonhazardous and Nonradioactive Storage Area

**3.4.16.1 Human Health Risk Characterization.** No releases have been documented at these waste sites. No suspected contaminants were identified during the LFI. Because disposal of radionuclides or handling of effluent cooling water is not documented at these sites, the risks associated with radionuclide exposure are expected to be very low. The ICR values for chemical COPC evaluated at other 100-NR-1 Source Operable Unit waste sites generally are below the ICR values for radionuclide exposure. In addition, the HI estimated for systemic toxicity from exposure to chemicals is $<1.0$ for all other 100-NR-1 Source Operable Unit waste sites. As such, the risk estimated for these sites is very low.

**3.4.16.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for these waste sites. These sites might contain chemical COPC that have not been reported at other waste sites or the COPC concentrations might be higher than reported at other waste sites. Although the impact of this uncertainty on the qualitative risk characterization could not be determined, the risk could be underestimated.

### 3.4.17 182-N Drain System

**3.4.17.1 Human Health Risk Characterization.** This site had a documented release to the river. No suspected soil contaminants were identified. Because disposal of radionuclides or handling of effluent cooling water is not documented at this site, the risks associated with radionuclide exposure are expected to be very low. The ICR values for chemical COPC

evaluated at other 100-NR-1 Source Operable Unit waste sites generally are below the ICR values for radionuclide exposure. In addition, the HI estimated for systemic toxicity from exposure to chemicals is < 1.0 for all other 100-NR-1 Source Operable Unit waste sites. As such, the risk estimated for this site is very low.

**3.4.17.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for this waste site. This site might contain chemical COPC that have not been reported at other waste sites or the COPC concentrations might be higher than reported at other waste sites. Although the impact of this uncertainty on the qualitative risk characterization could not be determined, the risk could be underestimated.

### 3.4.18 181-N Inlet Screen Backwash Water Outfall and 182-N Tank Farm Overflow

**3.4.18.1 Human Health Risk Characterization.** No dangerous or radioactive releases have been documented from these waste sites. Because disposal of radionuclides or handling of effluent cooling water is not documented at these sites, the risks associated with radionuclide exposure are expected to be very low. The ICR values for chemical COPC evaluated at other 100-NR-1 Source Operable Unit waste sites generally are below the ICR values for radionuclide exposure. In addition, the HI estimated for systemic toxicity from exposure to chemicals is < 1.0 for all other 100-NR-1 Source Operable Unit waste sites. As such, the risk estimated for these sites is very low.

**3.4.18.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for these waste sites. These sites might contain chemical COPC that have not been reported at other waste sites or the COPC concentrations might be higher than reported at other waste sites. Although the impact of this uncertainty on the qualitative risk characterization could not be determined, the risk could be underestimated.

### 3.4.19 105-N Lift Station Underground Storage Tank

**3.4.19.1 Human Health Risk Characterization.** Soil sampling indicated that this site has not been contaminated with petroleum derivatives. Because disposal of radionuclides or handling of effluent cooling water is not documented at this site, the risks associated with radionuclide exposure are expected to be very low. The ICR values for chemical COPC evaluated at other 100-NR-1 Source Operable Unit waste sites generally are below the ICR values for radionuclide exposure. In addition, the HI estimated for systemic toxicity from exposure to chemicals is < 1.0 for all other 100-NR-1 Source Operable Unit waste sites. As such, the risk estimated for this site is very low.

**3.4.19.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for this waste site. This site might contain chemical COPC that have not been reported at other waste sites or the COPC concentrations might be higher than reported at other waste sites. Although the

impact of this uncertainty on the qualitative risk characterization could not be determined, the risk could be underestimated.

### 3.4.20 181-N Waste Oil Tank

**3.4.20.1 Human Health Risk Characterization.** This tank was never used. No suspected contaminants were identified. Because disposal of radionuclides or handling of effluent cooling water is not documented at this site, the risks associated with radionuclide exposure are expected to be very low. The ICR values for chemical COPC evaluated at other 100-NR-1 Source Operable Unit waste sites generally are below the ICR values for radionuclide exposure. In addition, the HI estimated for systemic toxicity from exposure to chemicals is $<1.0$ for all other 100-NR-1 Source Operable Unit waste sites. As such, the risk estimated for this site is very low.

**3.4.20.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for this waste site. This site might contain chemical COPC that have not been reported at other waste sites or the COPC concentrations might be higher than reported at other waste sites. Although the impact of this uncertainty on the qualitative risk characterization could not be determined, the risk could be underestimated.

### 3.4.21 260-cm (102-in) Outfall Line

**3.4.21.1 Human Health Risk Characterization.** A release to the river in violation of pH limits was reported. No suspected soil contaminants were identified. Because disposal of radionuclides or handling of effluent cooling water is not documented at this site, the risks associated with radionuclide exposure are expected to be very low. The ICR values for chemical COPC evaluated at other 100-NR-1 Source Operable Unit waste sites generally are below the ICR values for radionuclide exposure. In addition, the HI estimated for systemic toxicity from exposure to chemicals is $<1.0$ for all other 100-NR-1 Source Operable Unit waste sites. As such, the risk estimated for this site is very low.

**3.4.21.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for this waste site. This site might contain chemical COPC that have not been reported at other waste sites or the COPC concentrations might be higher than reported at other waste sites. Although the impact of this uncertainty on the qualitative risk characterization could not be determined, the risk could be underestimated.

### 3.4.22 182-N Unplanned Release of Turbine Lube Oil to the Columbia River

**3.4.22.1 Human Health Risk Characterization.** Turbine lube oil was identified as a suspected contaminant in a release to the river. No suspected soil contaminants were identified. Because disposal of radionuclides or handling of effluent cooling water is not

documented at this site, the risks associated with radionuclide exposure are expected to be very low. The ICR values for chemical COPC evaluated at other 100-NR-1 Source Operable Unit waste sites generally are below the ICR values for radionuclide exposure. In addition, the HI estimated for systemic toxicity from exposure to chemicals is < 1.0 for all other 100-NR-1 Source Operable Unit waste sites. As such, the risk estimated for this site is very low.

**3.4.22.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for this waste site. This site might contain chemical COPC that have not been reported at other waste sites or the COPC concentrations might be higher than reported at other waste sites. Although the impact of this uncertainty on the qualitative risk characterization could not be determined, the risk could be underestimated.

### 3.4.23 128-N-1 Burn Pit, Grass Dump, and Construction Debris Dump

**3.4.23.1 Human Health Risk Characterization.** No releases have been documented at these sites, and no suspected contaminants have been identified. Because disposal of radionuclides or handling of effluent cooling water is not documented at these sites, the risks associated with radionuclide exposure are expected to be very low. The ICR values for chemical COPC evaluated at other 100-NR-1 Source Operable Unit waste sites generally are below the ICR values for radionuclide exposure. In addition, the HI estimated for systemic toxicity from exposure to chemicals is < 1.0 for all other 100-NR-1 Source Operable Unit waste sites. As such, the risk estimated for these sites is very low.

**3.4.23.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain because of the lack of soil analytical data for these waste sites. These sites might contain chemical COPC that have not been reported at other waste sites or the COPC concentrations may be higher than reported at other waste sites. Although the impact of this uncertainty on the qualitative risk characterization could not be determined, the risk could be underestimated.

THIS PAGE INTENTIONALLY
LEFT BLANK

Figure 3-1 Site 116-N-1 (1301-N) Frequent-Use Scenario External Exposure Incremental Cancer Risk for Human Health QRA for 1992, 0-15 Feet

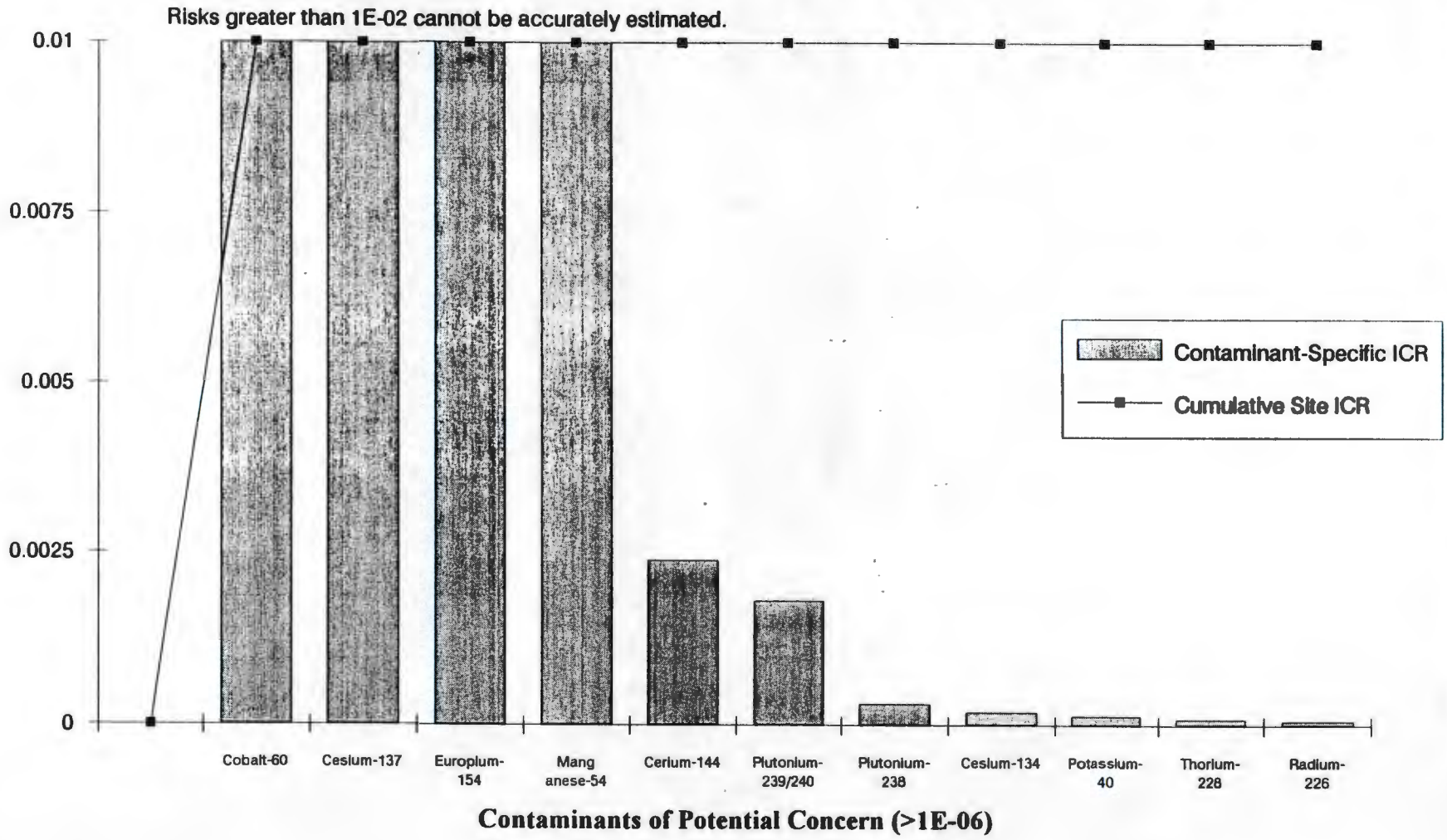
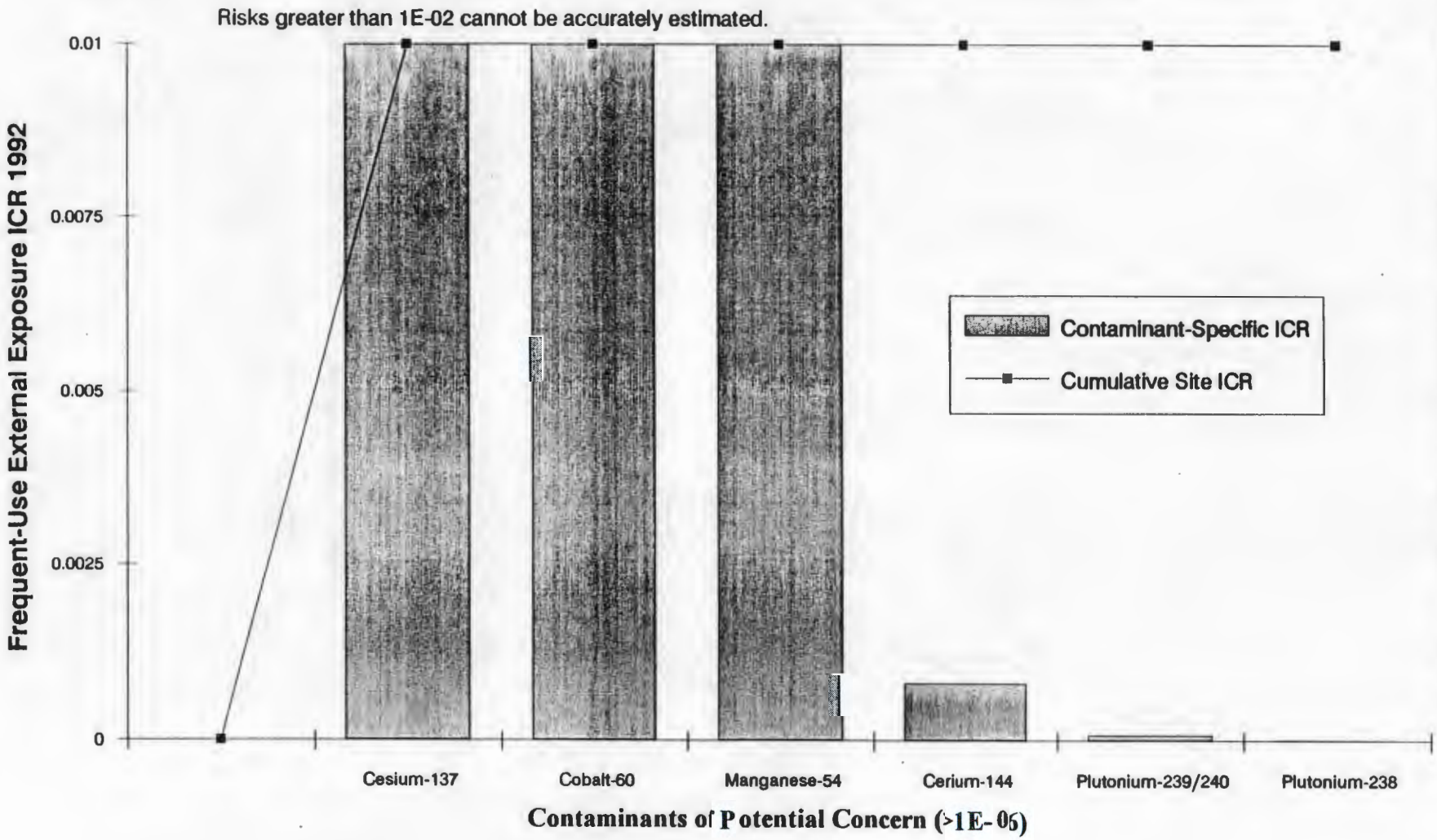


**Figure 3-2 Site 116-N-3 (1325-N) Frequent-Use Scenario External Exposure Incremental Cancer Risk for Human Health QRA for 1992, 0-15 Feet**



9413300.0216

**Figure 3-3 Site 116-N-2 Frequent-Use Scenario External Exposure Incremental Cancer Risk for Human Health QRA for 1992, 0-15 Feet**

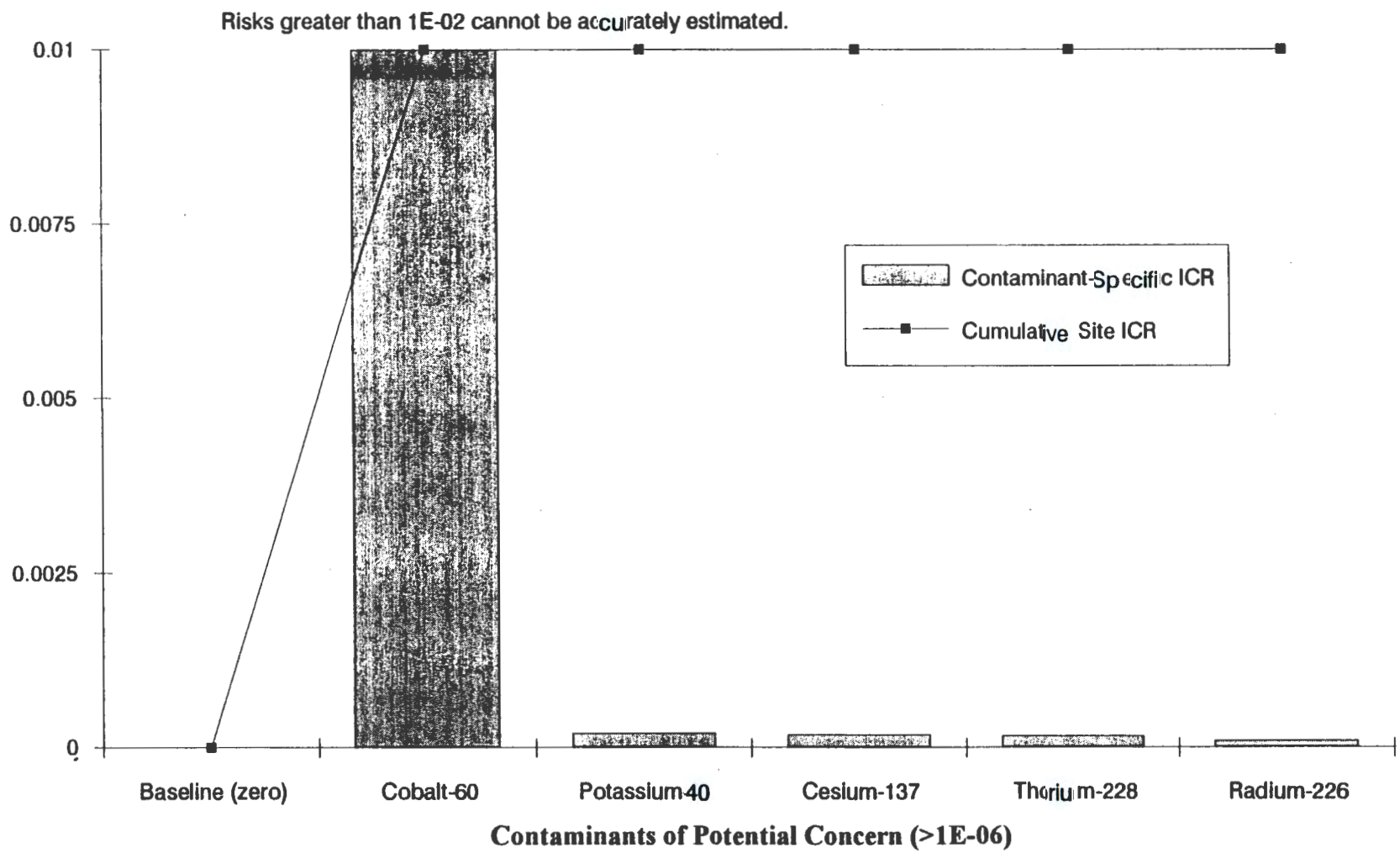
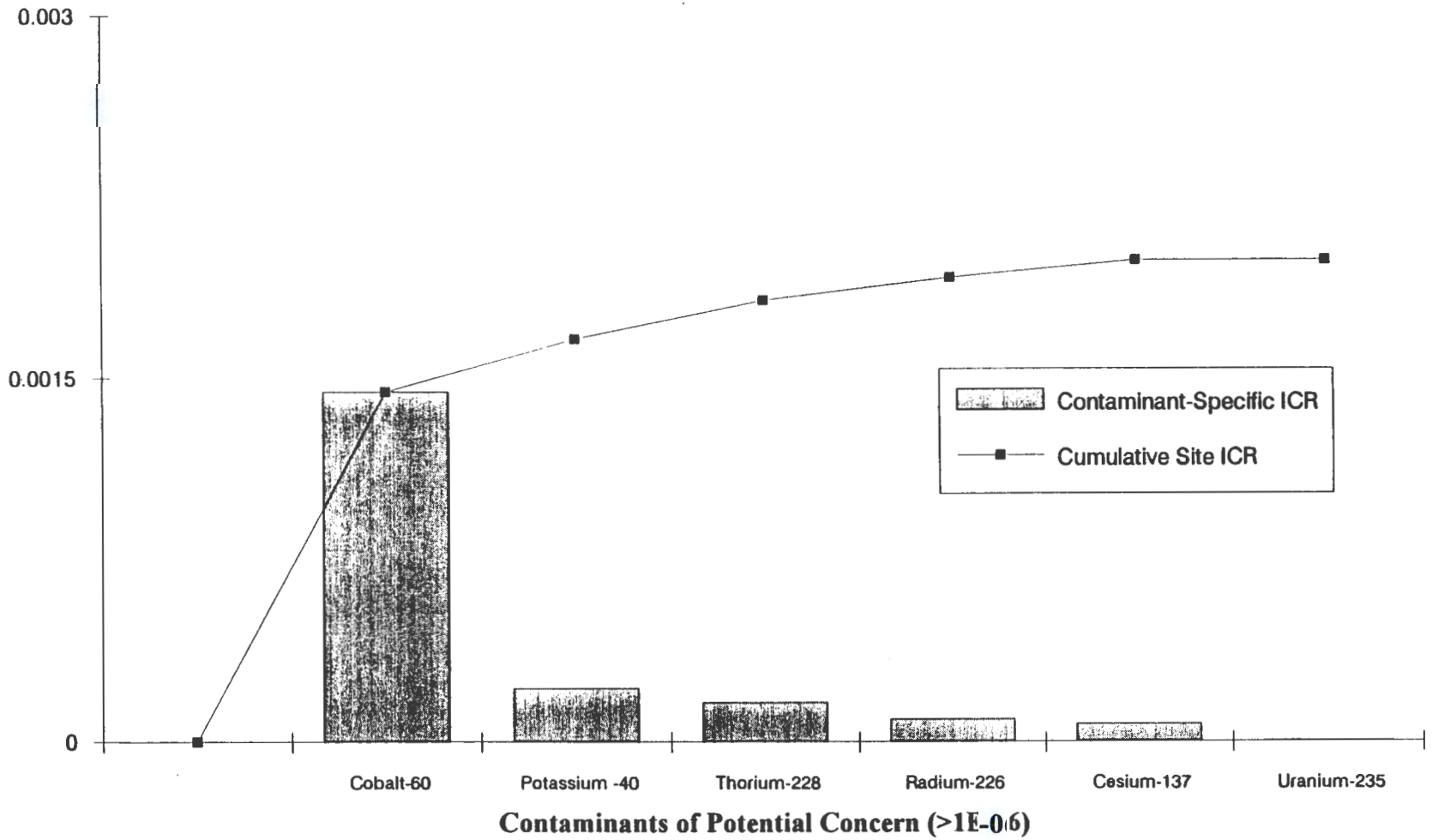


**Figure 3-4 Site 1322-N/1322-NA Frequent-Use Scenario External Exposure Incremental Cancer Risk for Human Health QRA for 1992, 0-15 Feet**



9413300.0217

**Table 3-1 Site 116-N-1 (1301-N) Summary of the Human Health Risk Assessment for Radioactive Contaminants of Potential Concern for 1992**

| Radioactive COPC | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | | Commercial/Industrial-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pathway | | | Total COPC ICR | Pathway | | | Total COPC ICR | Pathway | | | Total COPC ICR |
| | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | |
| Cesium-134 | 9E-05 | 5E-07 | 2E-04 | 3E-04 | 2E-06 | 1E-08 | 1E-06 | 3E-06 | 1E-05 | 2E-07 | 2E-05 | 3E-05 |
| Cesium-137 | >1E-02 | 1E-02 | >1E-02 | >1E-02 | >1E-02 | 3E-04 | >1E-02 | >1E-02 | >1E-02 | 6E-03 | >1E-02 | >1E-02 |
| Cerium-144 | 6E-06 | 3E-06 | 2E-03 | 2E-03 | 1E-07 | 5E-08 | 2E-05 | 2E-05 | 6E-07 | 1E-06 | 2E-04 | 2E-04 |
| Cobalt-60 | >1E-02 | >1E-02 | >1E-02 | >1E-02 | 7E-03 | 6E-04 | >1E-02 | >1E-02 | >1E-02 | >1E-02 | >1E-02 | >1E-02 |
| Europium-154 | 3E-04 | 1E-04 | >1E-02 | >1E-02 | 7E-06 | 2E-06 | >1E-02 | >1E-02 | 4E-05 | 6E-05 | >1E-02 | >1E-02 |
| Europium-155 | 2E-11 | 6E-12 | 4E-08 | 4E-08 | 3E-13 | 1E-13 | 3E-10 | 3E-10 | 2E-12 | 3E-12 | 4E-09 | 4E-09 |
| Manganese-54 | 7E-06 | 3E-07 | 3E-01 | 3E-01 | 1E-07 | 6E-09 | 2E-03 | 2E-03 | 8E-07 | 1E-07 | >1E-02 | >1E-02 |
| Plutonium-238 | >1E-02 | >1E-02 | 3E-04 | >1E-02 | 3E-03 | 4E-03 | 2E-06 | 6E-03 | >1E-02 | >1E-02 | 3E-05 | >1E-02 |
| Plutonium-239/240 | >1E-02 | >1E-02 | 2E-03 | >1E-02 | >1E-02 | >1E-02 | 1E-05 | >1E-02 | >1E-02 | >1E-02 | 2E-04 | >1E-02 |
| Potassium-40 | 2E-07 | 9E-10 | 1E-04 | 1E-04 | 3E-09 | 2E-11 | 9E-07 | 9E-07 | 2E-08 | 4E-10 | 1E-05 | 1E-05 |
| Radium-226 | 8E-08 | 2E-08 | 7E-05 | 7E-05 | 1E-09 | 3E-10 | 5E-07 | 5E-07 | 9E-09 | 7E-09 | 6E-06 | 6E-06 |
| Ruthenium-106 | 9E-06 | 3E-06 | | 1E-05 | 2E-07 | 7E-08 | | 2E-07 | 1E-06 | 2E-06 | | 3E-06 |
| Strontium-90 | 3E-02 | 4E-04 | | >1E-02 | 5E-04 | 8E-06 | | 5E-04 | 3E-03 | 2E-04 | | 3E-03 |
| Thorium-228 | 5E-08 | 6E-07 | 9E-05 | 9E-05 | 1E-09 | 1E-08 | 6E-07 | 6E-07 | 6E-09 | 3E-07 | 8E-06 | 9E-06 |
| Thorium-232 | 1E-08 | 2E-07 | 4E-10 | 2E-07 | 2E-10 | 4E-09 | 3E-12 | 4E-09 | 1E-09 | 1E-07 | 4E-11 | 1E-07 |
| Uranium-233/234 | 1E-08 | 1E-07 | 5E-10 | 1E-07 | 2E-10 | 3E-09 | 3E-12 | 3E-09 | 1E-09 | 6E-08 | 4E-11 | 6E-08 |
| Uranium-238 | 3E-08 | 5E-07 | 7E-07 | 1E-06 | 6E-10 | 9E-09 | 5E-09 | 1E-08 | 3E-09 | 2E-07 | 6E-08 | 3E-07 |
| TOTALS | >1E-02 | >1E-02 | >1E-02 | >1E-02 | >1E-02 | >1E-02 | >1E-02 | >1E-02 | >1E-02 | >1E-02 | >1E-02 | >1E-02 |

Shaded cells indicate risks greater than 1E-06 ICR.

Equations and exposure factors used for each scenario are from HSRAM (DOE-RL 1994).

COPC - Contaminant of potential concern.

ICR - Incremental cancer risk.

**Table 3-2 Site 116-N-1 (1301-N) Summary of the Human Health Risk Assessment for Radioactive Contaminants of Potential Concern for 2018**

| Radioactive COPC | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | | Commercial/Industrial-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pathway | | | Total COPC ICR | Pathway | | | Total COPC ICR | Pathway | | | Total COPC ICR |
| | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | |
| Cesium-134 | 1E-08 | 6E-11 | 2E-08 | 3E-08 | 2E-10 | 1E-12 | 1E-10 | 4E-10 | 1E-09 | 3E-11 | 2E-09 | 3E-09 |
| Cesium-137 | >1E-02 | 8E-03 | >1E-02 | >1E-02 | >1E-02 | 1E-04 | >1E-02 | >1E-02 | >1E-02 | 4E-03 | >1E-02 | >1E-02 |
| Cerium-144 | 5E-16 | 3E-16 | 2E-13 | 2E-13 | 1E-17 | 5E-18 | 1E-15 | 1E-15 | 6E-17 | 1E-16 | 2E-14 | 2E-14 |
| Cobalt-60 | 1E-02 | 1E-03 | >1E-02 | >1E-02 | 2E-04 | 2E-05 | >1E-02 | >1E-02 | 1E-03 | 5E-04 | >1E-02 | >1E-02 |
| Europium-154 | 4E-05 | 2E-05 | >1E-02 | >1E-02 | 8E-07 | 3E-07 | 7E-03 | 7E-03 | 5E-06 | 8E-06 | >1E-02 | >1E-02 |
| Europium-155 | 5E-13 | 2E-13 | 1E-09 | 1E-09 | 9E-15 | 3E-15 | 7E-12 | 7E-12 | 5E-14 | 7E-14 | 1E-10 | 1E-10 |
| Manganese-54 | 5E-15 | 2E-16 | 3E-10 | 3E-10 | 1E-16 | 4E-18 | 2E-12 | 2E-12 | 6E-16 | 1E-16 | 2E-11 | 2E-11 |
| Plutonium-238 | >1E-02 | >1E-02 | 3E-04 | >1E-02 | 2E-03 | 3E-03 | 2E-06 | 5E-03 | 1E-02 | >1E-02 | 2E-05 | >1E-02 |
| Plutonium-239/240 | 8E-01 | >1E-02 | 2E-03 | >1E-02 | >1E-02 | >1E-02 | 1E-05 | >1E-02 | >1E-02 | >1E-02 | 2E-04 | >1E-02 |
| Potassium-40 | 2E-07 | 9E-10 | 1E-04 | 1E-04 | 3E-09 | 2E-11 | 9E-07 | 9E-07 | 2E-08 | 4E-10 | 1E-05 | 1E-05 |
| Radium-226 | 8E-08 | 2E-08 | 7E-05 | 7E-05 | 1E-09 | 3E-10 | 4E-07 | 4E-07 | 8E-09 | 7E-09 | 6E-06 | 6E-06 |
| Ruthenium-106 | 2E-13 | 6E-14 | | 2E-13 | 3E-15 | 1E-15 | | 4E-15 | 2E-14 | 3E-14 | | 4E-14 |
| Strontium-90 | >1E-02 | 2E-04 | | >1E-02 | 3E-04 | 4E-06 | | 3E-04 | 2E-03 | 1E-04 | | 2E-03 |
| Thorium-228 | 4E-12 | 5E-11 | 8E-09 | 8E-09 | 8E-14 | 9E-13 | 5E-11 | 5E-11 | 4E-13 | 2E-11 | 7E-10 | 7E-10 |
| Thorium-232 | 1E-08 | 2E-07 | 4E-10 | 2E-07 | 2E-10 | 4E-09 | 3E-12 | 4E-09 | 1E-09 | 1E-07 | 4E-11 | 1E-07 |
| Uranium-233/234 | 1E-08 | 1E-07 | 5E-10 | 1E-07 | 2E-10 | 3E-09 | 3E-12 | 3E-09 | 1E-09 | 6E-08 | 4E-11 | 6E-08 |
| Uranium-238 | 3E-08 | 5E-07 | 7E-07 | 1E-06 | 6E-10 | 9E-09 | 5E-09 | 1E-08 | 3E-09 | 2E-07 | 6E-08 | 3E-07 |
| **TOTALS** | >1E-02 | >1E-02 | >1E-02 | >1E-02 | >1E-02 | >1E-02 | >1E-02 | >1E-02 | >1E-02 | >1E-02 | >1E-02 | >1E-02 |

Shaded cells indicate risks greater than 1E-06 ICR.

Equations and exposure factors used for each scenario are from HSRAM (DOE-RL 1994).

COPC - Contaminant of potential concern.

ICR - Incremental cancer risk.

**Table 3-3 Site 116-N-1 (1301-N) Summary of the Human Health Risk Assessment for Nonradioactive Contaminants of Potential Concern for 1992 (0-15 feet)**

| Inorganic COPC | Frequent-Use Scenario | | | Occassional-Use Scenario | | | Commercial/Industrial-Use Scenario | | |
|---|---|---|---|---|---|---|---|---|---|
| | Pathway | | Total COPC ICR | Pathway | | Total COPC ICR | Pathway | | Total COPC ICR |
| | Soil Ingestion ICR | Fugitive Dust and Volatile Soil Contaminant Inhalation ICR | | Soil Ingestion ICR | Fugitive Dust and Volatile Soil Contaminant Inhalation ICR | | Soil Ingestion ICR | Fugitive Dust and Volatile Soil Contaminant Inhalation ICR | |
| Cadmium | | 2E-08 | 2E-08 | | 5E-10 | 5E-10 | | 1E-08 | 1E-08 |
| | HQ | HQ | HQ | HQ | HQ | HQ | HQ | HQ | HQ |
| | 8E-09 | | 8E-09 | 1E-10 | | 1E-10 | 2E-10 | | 2E-10 |

No reported risks are greater then 1E-06 ICR.

COPC - Contaminant of potential concern.

ICR - Incremental cancer risk.

**Table 3-4 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-N-1 (1301-N) Crib and Trench (0-6 feet)**

| Isotope | Soil Activity (pCi/g) | Vegetation Activity Wet (Ci/kg) | Dose Rate (rad/day) | Fractional Use | Dose Rate (rad/day) | Exceed EHQ |
|---|---|---|---|---|---|---|
| Am-241 | 0.0239 | 7.65E-09 | 2.2E-09 | 1 | 2.2E-09 | No |
| Cs-134 | 1,640 | 3.25E-07 | 1.3E-02 | 1 | 1.3E-02 | No |
| Cs-137 | 67,400,000 | 7.6E+03 | 5.6E+02 | 1 | 5.6E+02 | Yes |
| Ce-144 | 717 | 5.74E-10 | 6.7E-07 | 1 | 6.7E-07 | No |
| Co-60 | 18,600,000 | 2.98E-03 | 4.2E+01 | 1 | 4.2E+01 | Yes |
| Eu-154 | 83,400 | 2.67E-08 | 3.5E-05 | 1 | 3.5E-05 | No |
| Eu-155 | 0.089 | 2.85E-14 | 7.2E-12 | 1 | 7.2E-12 | No |
| Mn-54 | 4,980 | 1.69E-05 | 2.9E-02 | 1 | 2.9E-02 | No |
| Pu-238 | 471,000 | 1.06E-05 | 3.1E-01 | 1 | 3.1E-01 | No |
| Pu-239/240 | 2,800,000 | 6.27E-05 | 1.7E+00 | 1 | 1.7E+00 | Yes |
| Ra-226 | 0.35 | 1.12E-11 | 1.3E-04 | 1 | 1.3E-04 | No |
| Ru-106 | 705 | 1.13E-08 | 1.2E-04 | 1 | 1.2E-04 | No |
| Sr-90 | 564,000 | 3.43E-03 | 3.9E+03 | 1 | 3.9E+03 | Yes |
| Tc-99 | 1 | 1.35E-07 | 9.7E-04 | 1 | 9.7E-04 | No |
| Th-228 | 0.7 | 2.24E-14 | 1.1E-10 | 1 | 1.1E-10 | No |
| Th-232 | 0.69 | 2.21E-14 | 9.4E-11 | 1 | 9.4E-11 | No |
| U-233/234 | 0.46 | 1.47E-10 | 7.0E-05 | 1 | 7.0E-05 | No |
| U-238 | 0.82 | 2.62E-10 | 1.1E-04 | 1 | 1.1E-04 | No |
| | | | | TOTAL | 4460 | Yes |
| **Organic/Inorganic** | **Maximum Soil Conc. (mg/kg)** | **Veg. Conc. Wet (mg/kg)** | **Dose Rate (mg/kg/day)** | **Fractional Use** | **Dose Rate (mg/kg/day)** | **Exceed EHQ** |
| Cadmium | 0.61 | 1.07E-01 | 3.1E-02 | 1 | 3.1E-02 | Yes |
| Carbon disulfide | 0.001 | 1.07E-03 | 3.1E-04 | 1 | 3.1E-04 | No |
| Copper | 31.5 | 4.03E+00 | 1.1E+00 | 1 | 1.1E+00 | N/A |
| Di-n-butylphthalate | 0.063 | 1.45E-03 | 4.1E-04 | 1 | 4.1E-04 | N/A |
| N-nitrosodiphenylamine | 0.110 | 4.47E-02 | 1.3E-02 | 1 | 1.3E-02 | N/A |
| Toluene | 0.002 | 6.53E-04 | 1.9E-04 | 1 | 1.9E-04 | No |

Note - Co-58, Fe-59, Nb-95, Ru-103, and Zr-95 are from historical data and were eliminated owing to their short half-life (<0.5 years).
N/A - No published wildlife no observable effect level values available.
EHQ - environmental hazard quotient

**Table 3-5 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-N-1 (1301-N) Crib and Trench (6-15 feet)**

| Isotope | Soil Activity (pCi/g) | Vegetation Activity Wet (Ci/kg) | Dose Rate (rad/day) | Fractional Use | Dose Rate (rad/day) | Exceed EHQ |
|---|---|---|---|---|---|---|
| Ra-226 | 0.49 | 1.57E-11 | 1.8E-04 | 1 | 1.8E-04 | No |
| Th-228 | 0.67 | 2.14E-14 | 1.1E-10 | 1 | 1.1E-10 | No |
| Th-232 | 0.72 | 2.30E-14 | 9.8E-11 | 1 | 9.8E-11 | No |
| U-238 | 0.73 | 2.34E-10 | 9.7E-05 | 1 | 9.7E-05 | No |
| | | | | TOTAL | 2.8E-04 | No |
| **Organic/ Inorganic** | **Maximum Soil Conc. (mg/kg)** | **Veg. Conc. Wet (mg/kg)** | **Dose Rate (mg/kg/day)** | **Fractional Use** | **Dose Rate (mg/kg/day)** | **Exceed EHQ** |
| Cadmium | 0.49 | 8.62E-02 | 2.5E-02 | 1 | 2.5E-02 | Yes |

Note - Most of the soil samples are from the well-bore samples which are near the trench. The data may not be representative of soil directly below the trench.
EHQ - environmental hazard quotient

**Table 3-6 Site 116-N-3 (1325-N) Summary of the Human Health Risk Assessment for Radioactive Contaminants of Potential Concern for 1992 (0-15 feet)**

| Radioactive COPC | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | | Commercial/Industrial-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pathway | | | Total COPC ICR | Pathway | | | Total COPC ICR | Pathway | | | Total COPC ICR |
| | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | |
| Cesium-137 | 2E-03 | 1E-05 | >1E-02 | >1E-02 | 4E-05 | 2E-07 | >1E-02 | >1E-02 | 2E-04 | 6E-06 | >1E-02 | >1E-02 |
| Cerium-144 | 2E-06 | 9E-07 | 8E-04 | 8E-04 | 4E-08 | 2E-08 | 5E-06 | 5E-06 | 2E-07 | 4E-07 | 7E-05 | 7E-05 |
| Cobalt-60 | >1E-02 | 1E-03 | >1E-02 | >1E-02 | 3E-04 | 2E-05 | >1E-02 | >1E-02 | 1E-03 | 5E-04 | >1E-02 | >1E-02 |
| Manganese-54 | 2E-06 | 7E-08 | >1E-02 | >1E-02 | 3E-08 | 1E-09 | 6E-04 | 6E-04 | 2E-07 | 3E-08 | 8E-03 | 8E-03 |
| Plutonium-238 | 6E-03 | 8E-03 | 1E-05 | >1E-02 | 1E-04 | 2E-04 | 9E-08 | 3E-04 | 6E-04 | 4E-03 | 1E-06 | 5E-03 |
| Plutonium-239/240 | >1E-02 | >1E-02 | 8E-05 | >1E-02 | 7E-04 | 1E-03 | 5E-07 | 2E-03 | 4E-03 | >1E-02 | 7E-06 | >1E-02 |
| Strontium-90 | >1E-02 | 4E-04 | | >1E-02 | 5E-04 | 7E-06 | | 5E-04 | 3E-03 | 2E-04 | | 3E-03 |
| TOTALS | >1E-02 | >1E-02 | >1E-02 | >1E-02 | 2E-03 | 1E-03 | >1E-02 | >1E-02 | 9E-03 | >1E-02 | >1E-02 | >1E-02 |

Shaded cells indicate risks greater than 1E-06 ICR.

Equations and exposure factors used for each scenario are from HSRAM (DOE-RL 1994).

COPC - Contaminant of potential concern.

ICR - Incremental lcancer risk.

**Table 3-7 Site 116-N-3 (1325-N) Summary of the Human Health Risk Assessment for Radioactive Contaminants of Potential Concern for 2018 (0-15 feet)**

| Radioactive COPC | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | | Commercial/Industrial-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pathway | | | Total COPC ICR | Pathway | | | Total COPC ICR | Pathway | | | Total COPC ICR |
| | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | |
| Cerium-144 | 2E-16 | 8E-17 | 8E-14 | 8E-14 | 3E-18 | 2E-18 | 5E-16 | 5E-16 | 2E-17 | 4E-17 | 7E-15 | 7E-15 |
| Cesium-137 | 1E-03 | 7E-06 | >1E-02 | >1E-02 | 2E-05 | 1E-07 | >1E-02 | >1E-02 | 1E-04 | 3E-06 | >1E-02 | >1E-02 |
| Cobalt-60 | 4E-04 | 4E-05 | >1E-02 | >1E-02 | 9E-06 | 7E-07 | >1E-02 | >1E-02 | 5E-05 | 2E-05 | >1E-02 | >1E-02 |
| Manganese-54 | 1E-15 | 5E-17 | 7E-11 | 7E-11 | 3E-17 | 1E-18 | 4E-13 | 4E-13 | 2E-16 | 2E-17 | 6E-12 | 6E-12 |
| Plutonium-238 | 5E-03 | 7E-03 | 1E-05 | 1E-02 | 9E-05 | 1E-04 | 7E-08 | 2E-04 | 5E-04 | 3E-03 | 1E-06 | 4E-03 |
| Plutonium-239/240 | >1E-02 | >1E-02 | 8E-05 | >1E-02 | 7E-04 | 1E-03 | 5E-07 | 2E-03 | 4E-03 | >1E-02 | 7E-06 | >1E-02 |
| Strontium-90 | 1E-02 | 2E-04 | | 1E-02 | 3E-04 | 4E-06 | | 3E-04 | 2E-03 | 9E-05 | | 2E-03 |
| TOTALS | >1E-02 | >1E-02 | >1E-02 | >1E-02 | 1E-03 | 1E-03 | >1E-02 | >1E-02 | 6E-03 | >1E-02 | >1E-02 | >1E-02 |

Shaded cells indicate risks greater than 1E-06 ICR.

Equations and exposure factors used for each scenario are from HSRAM (DOE-RL 1994).

COPC - Contaminant of potential concern.

ICR - Incremental cancer risk.

**Table 3-8 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-N-3 (1325-N) Crib and Trench (0-6 feet)**

| Isotope | Soil Activity (pCi/g) | Vegetation Activity Wet (Ci/kg) | Dose Rate (rad/day) | Fractional Use | Dose Rate (rad/day) | Exceed EHQ |
|---|---|---|---|---|---|---|
| Cs-137 | 60,400 | 1.20E-05 | 5.1E-01 | 1 | 5.1E-01 | No |
| Ce-144 | 240 | 1.92E-10 | 2.2E-07 | 1 | 2.2E-07 | No |
| Co-60 | 681,000 | 1.09E-04 | 1.5E+00 | 1 | 1.5E+00 | Yes |
| Mn-54 | 1,260 | 4.27E-06 | 7.5E-03 | 1 | 7.5E-03 | No |
| Pu-238 | 19,900 | 4.46E-07 | 1.3E-02 | 1 | 1.3E-02 | No |
| Pu-239/240 | 120,000 | 2.69E-06 | 7.4E-02 | 1 | 7.4E-02 | No |
| Sr-90 | 533,000 | 3.24E-03 | 3.6E+03 | 1 | 3.6E+03 | Yes |
| | | | | TOTAL | 3642 | Yes |

Note - Information for organics and inorganics not available. Information for contaminants below 1.8 m is not available.
EHQ - environmental hazard quotient

9413300.0221

**Table 3-9 Site 116-N-2 Summary of the Human Health Risk Assessment for Radioactive Contaminants of Potential Concern for 1992 (0-15 feet)**

| Radioactive COPC | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | | Commercial/Industrial-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pathway | | | Total COPC ICR | Pathway | | | Total COPC ICR | Pathway | | | Total COPC ICR |
| | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | |
| Cesium-137 | 1E-07 | 8E-10 | 2E-04 | 2E-04 | 3E-09 | 2E-11 | 1E-06 | 1E-06 | 2E-08 | 4E-10 | 2E-05 | 2E-05 |
| Cobalt-60 | 2E-06 | 2E-07 | >1E-02 | >1E-02 | 4E-08 | 3E-09 | 1E-04 | 1E-04 | 2E-07 | 8E-08 | 2E-03 | 2E-03 |
| Potassium-40 | 2E-07 | 1E-09 | 2E-04 | 2E-04 | 4E-09 | 3E-11 | 1E-06 | 1E-06 | 3E-08 | 6E-10 | 2E-05 | 2E-05 |
| Radium-226 | 1E-07 | 2E-08 | 1E-04 | 1E-04 | 2E-09 | 4E-10 | 6E-07 | 6E-07 | 1E-08 | 1E-08 | 9E-06 | 9E-06 |
| Thorium-228 | 9E-08 | 1E-06 | 2E-04 | 2E-04 | 2E-09 | 2E-08 | 1E-06 | 1E-06 | 1E-08 | 5E-07 | 1E-05 | 1E-05 |
| Thorium-232 | 2E-08 | 3E-07 | 7E-10 | 4E-07 | 3E-10 | 6E-09 | 4E-12 | 7E-09 | 2E-09 | 2E-07 | 6E-11 | 2E-07 |
| Uranium-233/234 | 1E-08 | 2E-07 | 7E-10 | 2E-07 | 3E-10 | 4E-09 | 4E-12 | 4E-09 | 2E-09 | 9E-08 | 6E-11 | 9E-08 |
| Uranium-238 | 2E-08 | 3E-07 | 5E-07 | 9E-07 | 4E-10 | 6E-09 | 3E-09 | 1E-08 | 2E-09 | 2E-07 | 5E-08 | 2E-07 |
| TOTALS | 3E-06 | 2E-06 | >1E-02 | >1E-02 | 5E-08 | 4E-08 | 1E-04 | 1E-04 | 3E-07 | 9E-07 | 2E-03 | 2E-03 |

Shaded cells indicate risks greater than 1E-06 ICR.

Equations and exposure factors used for each scenario are from HSRAM (DOE-RL 1994).

COPC - Contaminant of potential concern.

ICR - Incremental cancer risk.

**Table 3-10 Site 116-N-2 Summary of the Human Health Risk Assessment for Radioactive Contaminants of Potential Concern for 2018 (0-15 feet)**

| Radioactive COPC | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | | Commercial/Industrial-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pathway | | | Total COPC ICR | Pathway | | | Total COPC ICR | Pathway | | | Total COPC ICR |
| | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | |
| Cesium-137 | 8E-08 | 4E-10 | 1E-04 | 1E-04 | 2E-09 | 9E-12 | 7E-07 | 7E-07 | 9E-09 | 2E-10 | 9E-06 | 9E-06 |
| Cobalt-60 | 7E-08 | 6E-09 | 8E-04 | 8E-04 | 1E-09 | 1E-10 | 5E-06 | 5E-06 | 8E-09 | 3E-09 | 7E-05 | 7E-05 |
| Potassium-40 | 2E-07 | 1E-09 | 2E-04 | 2E-04 | 4E-09 | 3E-11 | 1E-06 | 1E-06 | 3E-08 | 6E-10 | 2E-05 | 2E-05 |
| Radium-226 | 1E-07 | 2E-08 | 1E-04 | 1E-04 | 2E-09 | 4E-10 | 6E-07 | 6E-07 | 1E-08 | 1E-08 | 8E-06 | 8E-06 |
| Thorium-228 | 1E-11 | 1E-10 | 2E-08 | 2E-08 | 2E-13 | 2E-12 | 1E-10 | 1E-10 | 1E-12 | 5E-11 | 2E-09 | 2E-09 |
| Thorium-232 | 2E-08 | 3E-07 | 7E-10 | 4E-07 | 3E-10 | 6E-09 | 4E-12 | 7E-09 | 2E-09 | 2E-07 | 6E-11 | 2E-07 |
| Uranium-233/234 | 1E-08 | 2E-07 | 7E-10 | 2E-07 | 3E-10 | 4E-09 | 4E-12 | 4E-09 | 2E-09 | 9E-08 | 6E-11 | 9E-08 |
| Uranium-238 | 2E-08 | 3E-07 | 5E-07 | 9E-07 | 4E-10 | 6E-09 | 3E-09 | 1E-08 | 2E-09 | 2E-07 | 5E-08 | 2E-07 |
| **TOTALS** | 5E-07 | 9E-07 | 1E-03 | 1E-03 | 1E-08 | 2E-08 | 8E-06 | 8E-06 | 6E-08 | 4E-07 | 1E-04 | 1E-04 |

Shaded cells indicate risks greater than 1E-06 ICR.

Equations and exposure factors used for each scenario are from HSRAM (DOE-RL 1994).

COPC - Contaminant of potential concern.

ICR - Incremental cancer risk.

**Table 3-11 Site 116-N-2 Summary of the Human Health Risk Assessment for Nonradioactive Contaminants of Potential Concern (0-15 feet)**

| Organic COPC | Frequent-Use Scenario | | | Occassional-Use Scenario | | | Commercial/Industrial-Use Scenario | | |
|---|---|---|---|---|---|---|---|---|---|
| | Pathway | | Total COPC ICR | Pathway | | Total COPC ICR | Pathway | | Total COPC ICR |
| | Soil Ingestion ICR | Fugitive Dust and Volatile Soil Contaminant Inhalation ICR | | Soil Ingestion ICR | Fugitive Dust and Volatile Soil Contaminant Inhalation ICR | | Soil Ingestion ICR | Fugitive Dust and Volatile Soil Contaminant Inhalation ICR | |
| Benzo(a)pyrene | 6E-07 | 4E-09 | 6E-07 | 1E-08 | 7E-11 | 1E-08 | 3E-08 | 2E-09 | 3E-08 |
| TOTALS | 6E-07 | 4E-09 | 6E-07 | 1E-08 | 7E-11 | 1E-08 | 3E-08 | 2E-09 | 3E-08 |

No reported risks are greater then 1E-06 ICR.

COPC - Contaminant of potential concern.

ICR - Incremental cancer risk.

**Table 3-12 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-N-2 Treatment Storage Facility (0-6 feet)**

| Isotope | Soil Activity (pCi/g) | Vegetation Activity Wet (Ci/kg) | Dose Rate (rad/day) | Fractional Use | Dose Rate (rad/day) | Exceed EHQ |
|---|---|---|---|---|---|---|
| Am-241 | 0.062 | 1.98E-13 | 5.8E-09 | 1 | 5.8E-01 | No |
| Co-60 | 100 | 1.60E-08 | 2.3E-04 | 1 | 2.3E-04 | No |
| Cs-137 | 3.8 | 7.54E-10 | 4.3E-04 | 1 | 4.3E-04 | No |
| Ra-226 | 0.67 | 2.14E-11 | 2.5E-04 | 1 | 2.5E-04 | No |
| Th-228 | 1.2 | 3.84E-14 | 1.9E-10 | 1 | 1.9E-10 | No |
| Th-232 | 0.84 | 2.69E-14 | 1.1E-10 | 1 | 1.1E-10 | No |
| U-233/234 | 0.65 | 2.08E-10 | 9.9E-05 | 1 | 9.9E-05 | No |
| U-238 | 0.56 | 1.79E-10 | 7.5E-05 | 1 | 7.5E-05 | No |
| Pu-239/240 | 0.15 | 3.36E-12 | 9.2E-08 | 1 | 9.2E-08 | No |
| | | | | TOTAL | 0.001 | No |
| **Organic/Inorganic** | **Maximum Soil Conc. (mg/kg)** | **Veg. Conc. Wet (mg/kg)** | **Dose Rate (mg/day/kg)** | **Fractional Use** | **Dose Rate (mg/day/kg)** | **Exceed EHQ** |
| Cadmium | 0.37 | 6.51E-02 | 1.9E-02 | 1 | 1.9E-02 | Yes |
| Anthracene | 0.038 | 1.26E-03 | 3.6E-04 | 1 | 3.6E-04 | No |
| Benzo(a)anthracene | 0.14 | 9.86E-04 | 2.8E-04 | 1 | 2.8E-04 | N/A |
| Benzo(b)fluoranthene | 0.12 | 2.38E-04 | 6.8E-05 | 1 | 6.8E-05 | N/A |
| Chrysene | 0.12 | 8.45E-04 | 2.4E-04 | 1 | 2.4E-04 | N/A |
| Diethylphthalate[a] | 0.78 | | | | | N/A |
| Fluoranthene | 0.26 | 2.66E-03 | 7.6E-04 | 1 | 7.6E-04 | No |
| Phenanthrene | 0.15 | 4.90E-03 | 1.4E-03 | 1 | 1.4E-03 | N/A |
| Pyrene | 0.32 | 3.07E-03 | 8.8E-04 | 1 | 8.8E-04 | No |

[a] - No soil to plant transfer value available
N/A - No published wildlife no observable effect levels value available
EHQ - environmental hazard quotient

**Table 3-13 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-N-2 Treatment Storage Facility (6-15 feet)**

| Isotope | Soil Activity (pCi/g) | Vegetation Activity Wet (Ci/kg) | Dose Rate (rad/day) | Fractional Use | Dose Rate (rad/day) | Exceed EHQ |
|---|---|---|---|---|---|---|
| Co-60 | 4.3 | 6.88E-10 | 9.7E-06 | 1 | 9.7E-06 | No |
| Ra-226 | 0.55 | 1.76E-11 | 2.0E-04 | 1 | 2.0E-04 | No |
| Th-228 | 1 | 3.20E-14 | 1.6E-10 | 1 | 1.6E-10 | No |
| Th-232 | 1.1 | 3.52E-14 | 1.5E-10 | 1 | 1.5E-10 | No |
| U-233/234 | 0.46 | 1.47E-10 | 7.0E-05 | 1 | 7.0E-05 | No |
| U-238 | 0.59 | 1.89E-10 | 7.9E-05 | 1 | 7.9E-05 | No |
| | | | | TOTAL | 0.00036 | No |
| **Organic/Inorganic** | **Maximum Soil Conc. (mg/kg)** | **Veg. Conc. Wet (mg/kg)** | **Dose Rate (mg/day/kg)** | **Fractional Use** | **Dose Rate (mg/day/kg)** | **Exceed EHQ** |
| Cadmium | 0.32 | 5.63E-02 | 1.6E-02 | 1 | 1.6E-02 | Yes |

EHQ - environmental hazard quotient

**Table 3-14 Site 1322-N/1322-NA Summary of the Human Health Risk Assessment for Radioactive Contaminants of Potential Concern for 1992 (0-15 feet)**

| Radioactive COPC | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | | Commercial/Industrial-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pathway | | | Total COPC | Pathway | | | Total COPC | Pathway | | | Total COPC |
| | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | ICR | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | ICR | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | ICR |
| Cesium-137 | 2E-03 | 1E-05 | 3E+00 | 3E+00 | 4E-05 | 2E-07 | 2E-02 | 2E-02 | 2E-04 | 5E-06 | 2E-01 | 2E-01 |
| Cerium-144 | 3E-07 | 2E-07 | 1E-04 | 1E-04 | 6E-09 | 3E-09 | 9E-07 | 9E-07 | 4E-08 | 7E-08 | 1E-05 | 1E-05 |
| Cobalt-60 | 1E-02 | 9E-04 | 1E+02 | 1E+02 | 2E-04 | 2E-05 | 7E-01 | 7E-01 | 1E-03 | 4E-04 | 1E+01 | 1E+01 |
| Manganese-54 | 1E-06 | 5E-08 | 7E-02 | 7E-02 | 3E-08 | 1E-09 | 4E-04 | 4E-04 | 2E-07 | 2E-08 | 6E-03 | 6E-03 |
| Plutonium-238 | 6E-03 | 8E-03 | 1E-05 | 1E-02 | 1E-04 | 2E-04 | 9E-08 | 3E-04 | 6E-04 | 4E-03 | 1E-06 | 5E-03 |
| Plutonium-239/240 | 4E-02 | 5E-02 | 8E-05 | 9E-02 | 7E-04 | 1E-03 | 5E-07 | 2E-03 | 4E-03 | 2E-02 | 7E-06 | 3E-02 |
| Strontium-90 | 3E-02 | 4E-04 | | 3E-02 | 5E-04 | 7E-06 | | 5E-04 | 3E-03 | 2E-04 | | 3E-03 |
| **TOTALS** | 8E-02 | 6E-02 | 1E+02 | 1E+02 | 2E-03 | 1E-03 | 8E-01 | 8E-01 | 9E-03 | 3E-02 | 1E+01 | 1E+01 |

Notes:

COPC - Contaminants of potential concern.

ICR - Incremental cancer risk.

**Table 3-15 1322-N/1322-NA Summary of the Human Health Risk Assessment for Radioactive Contaminants of Potential Concern for 2018 (0-15 feet)**

| Radioactive COPC | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | | Commercial/Industrial-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pathway | | | Total COPC ICR | Pathway | | | Total COPC ICR | Pathway | | | Total COPC ICR |
| | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | | Soil Ingestion ICR | Fugitive Dust Inhalation ICR | External Exposure ICR | |
| Cesium-137 | 3E-08 | 2E-10 | 4E-05 | 4E-05 | 6E-10 | 3E-12 | 3E-07 | 3E-07 | 3E-09 | 8E-11 | 4E-06 | 4E-06 |
| Cobalt-60 | 5E-09 | 4E-10 | 5E-05 | 5E-05 | 1E-10 | 8E-12 | 3E-07 | 3E-07 | 6E-10 | 2E-10 | 5E-06 | 5E-06 |
| Potassium-40 | 2E-07 | 1E-09 | 2E-04 | 2E-04 | 5E-09 | 3E-11 | 1E-06 | 1E-06 | 3E-08 | 6E-10 | 2E-05 | 2E-05 |
| Radium-226 | 1E-07 | 2E-08 | 9E-05 | 9E-05 | 2E-09 | 4E-10 | 6E-07 | 6E-07 | 1E-08 | 1E-08 | 8E-06 | 8E-06 |
| Strontium | 6E-34 | 8E-36 | | 6E-34 | 1E-35 | 2E-37 | | 1E-35 | 6E-35 | 4E-36 | | 6E-35 |
| Thorium-228 | 1E-11 | 1E-10 | 2E-08 | 2E-08 | 2E-13 | 2E-12 | 1E-10 | 1E-10 | 1E-12 | 5E-11 | 2E-09 | 2E-09 |
| Thorium-232 | 1E-08 | 3E-07 | 6E-10 | 3E-07 | 3E-10 | 6E-09 | 4E-12 | 6E-09 | 2E-09 | 1E-07 | 5E-11 | 1E-07 |
| Uranium-233/234 | 1E-08 | 2E-07 | 6E-10 | 2E-07 | 3E-10 | 4E-09 | 4E-12 | 4E-09 | 1E-09 | 9E-08 | 6E-11 | 9E-08 |
| Uranium-238 | 3E-08 | 4E-07 | 6E-07 | 1E-06 | 5E-10 | 8E-09 | 4E-09 | 1E-08 | 3E-09 | 2E-07 | 6E-08 | 2E-07 |
| **TOTALS** | 4E-07 | 9E-07 | 4E-04 | 4E-04 | 8E-09 | 2E-08 | 3E-06 | 3E-06 | 5E-08 | 4E-07 | 4E-05 | 4E-05 |

Shaded cells indicate risks greater than 1E-06 ICR.

Equations and exposure factors used for each scenario are from HSRAM (DOE-RL 1994).

COPC - Contaminant of potential concern.

ICR - Incremental cancer risk.

**Table 3-16 Estimated Dose Rate for the Great Basin Pocket Mouse for the 1322-N/1322-NA Sample Buildings (0-6 feet)**

| Isotope | Soil Activity (pCi/g) | Vegetation Activity Wet (Ci/kg) | Dose Rate (rad/day) | Fractional Use | Dose Rate (rad/day) | Exceed EHQ |
|---|---|---|---|---|---|---|
| Co-60 | 7 | 1.12E-09 | 1.6E-05 | 1 | 1.6E-05 | No |
| Sr-90 | 2.4 | 1.46E-08 | 1.6E-02 | 1 | 1.6E-02 | No |
| Cs-137 | 1.5 | 2.98E-10 | 1.3E-04 | 1 | 1.3E-04 | No |
| Ra-226 | 0.652 | 2.09E-11 | 2.4E-04 | 1 | 2.4E-04 | No |
| Th-228 | 1 | 3.20E-14 | 1.6E-10 | 1 | 1.6E-10 | No |
| Th-232 | 0.95 | 3.04E-14 | 1.3E-10 | 1 | 1.3E-10 | No |
| U-233/234 | 0.64 | 2.05E-10 | 9.7E-05 | 1 | 9.7E-05 | No |
| U-238 | 0.73 | 2.34E-10 | 9.7E-05 | 1 | 9.7E-05 | No |
| | | | | TOTAL | 0.017 | No |
| **Inorganic/ Organic** | **Maximum Soil Conc. (mg/kg)** | **Veg. Conc. Wet (mg/kg)** | **Dose Rate (mg/kg/day)** | **Fractional Use** | **Dose Rate (mg/kg/day)** | **Exceed EHQ** |
| Copper | 29.8 | 3.67E-00 | 1.3E+00 | 1 | 1.3E+00 | N/A |
| Lead | 15.8 | 2.28E-01 | 6.5E-02 | 1 | 6.5E-02 | Yes |
| Zinc | 91.6 | 4.40E+01 | 1.2E+01 | 1 | 1.2E+01 | Yes |
| Benzo(a)anthracene | 0.063 | 4.44E-04 | 1.3E-04 | 1 | 1.3E-04 | N/A |
| Benzo(b)fluoranthene | 0.069 | 1.37E-04 | 3.9E-05 | 1 | 3.9E-05 | N/A |
| Bis(2-ethyhexyl)phthalate | 0.048 | 6.60E-04 | 1.9E-01 | 1 | 1.9E-01 | No |
| Chrysene | 0.062 | 4.36E-04 | 1.2E-04 | 1 | 1.2E-04 | N/A |
| Fluoranthene | 0.099 | 1.01E-03 | 2.9E-04 | 1 | 2.9E-04 | No |
| Phenanthrene | 0.095 | 3.10E-03 | 8.8E-04 | 1 | 8.8E-04 | N/A |
| Pyrene | 0.11 | 1.06E-03 | 3.0E-04 | 1 | 3.0E-04 | No |

N/A - No published wildlife no observable effect levels values available.
EHQ - environmental hazard quotient

**Table 3-17 Estimated Dose Rate for the Great Basin Pocket Mouse for the 1322N/1322NA Sample Buildings (6-15 feet)**

| Isotope | Soil Activity (pCi/g) | Vegetation Activity Wet (Ci/kg) | Dose Rate (rad/day) | Fractional Use | Dose Rate (rad/day) | Exceed EHQ |
|---|---|---|---|---|---|---|
| Co-60 | 0.1 | 1.60E-11 | 2.3E-07 | 1 | 2.3E-07 | No |
| Ra-226 | 0.54 | 1.73E-11 | 2.0E-04 | 1 | 2.0E-04 | No |
| Th-228 | 1.28 | 3.84E-14 | 1.9E-10 | 1 | 1.9E-10 | No |
| U-233/234 | 0.37 | 1.18E-10 | 5.6E-05 | 1 | 5.6E-05 | No |
| U-238 | 0.35 | 1.12E-10 | 4.7E-05 | 1 | 4.7E-05 | No |
| | | | | TOTAL | 0.00030 | No |

Note - no inorganics were measured above the Hanford Site background value.
EHQ - environmental hazard quotient

**Table 3-18 Estimated Dose Rate for the Great Basin Pocket Mouse for the 120-N-1/120-N-2 Ponds (0-6 feet)**

| Organic/ Inorganic | Maximum Soil Conc. (mg/kg) | Veg. Conc. Wet (mg/kg) | Dose Rate (mg/kg/day) | Fractional Use | Dose Rate (mg/kg/day) | Exceed EHQ |
|---|---|---|---|---|---|---|
| Copper | 28.7 | 4.59E+00 | 1.3E+00 | 1 | 1.3E+00 | N/A |
| Zinc | 94.4 | 5.66E+01 | 1.6E+01 | 1 | 1.6E+01 | Yes |
| Bis(2-ethylhexl)phthalate | 0.058 | 7.98E-04 | 2.3E-04 | 1 | 2.3E-04 | No |
| Diethylphthalate | 0.048 | | | | | N/A |

N/A - no published wildlife no observable effect level values available.
No radionuclide samples were collected at this site.
EHQ - environmental hazard quotient

Table 3-19 Estimated Dose Rate for the Great Basin Pocket Mouse for the 120-N-1/120-N-2 Ponds (6-15 feet)

| Organic/ Inorganic | Maximum Soil Conc. (mg/kg) | Veg. Conc. Wet (mg/kg) | Dose Rate (mg/kg/day) | Fractional Use | Dose Rate (mg/kg/day) | Exceed EHQ |
|---|---|---|---|---|---|---|
| Copper | 31.5 | 5.04E+00 | 1.4E+00 | 1 | 1.4E+00 | N/A |

N/A - No published wildlife no observable effect level values available.
No radionuclide samples were collected at this site.
EHQ - environmental hazard quotient

THIS PAGE INTENTIONALLY
LEFT BLANK

# 4.0 SUMMARY AND CONCLUSIONS

The 100-NR-1 Source Operable Unit QRA presents a qualitative evaluation of human health and ecological risks associated with the high-priority and low-priority waste sites included in the 100-NR-1 Source Operable Unit. The human health QRA evaluates two exposure scenarios (i.e., frequent- and occasional-use) over four exposure pathways (i.e., soil ingestion, fugitive dust inhalation, inhalation of volatile organics, and external radiation exposure), as specified in HSRAM (DOE-RL 1994). The commercial/industrial-use exposure scenario is also evaluated for the decommissioning work underway at the sites. The ecological QRA estimates risks to a specific ecologic receptor - the Great Basin pocket mouse. The use of these scenarios and pathways was agreed to by the 100 Area Tri-Party unit managers. The reductions in human health risks from decaying the onset of human exposures to the year 2018 (i.e., decreasing radionuclide COPC soil concentrations through radioactive decay) is also estimated. This QRA is not intended to replace or be a substitute for a baseline risk assessment.

The QRA includes conservative assumptions that serve a useful purpose by providing strict criteria for identifying the contaminants and exposure pathways of concern at the 100-NR-1 Source Operable Unit. Although these conservative assumptions served to simplify the risk characterization process, the resulting numerical values do not represent the most realistic estimates of risks and hazards to human health and the environment. The use of the numerical risk and hazard estimates for the 100-NR-1 Source Operable Unit QRA should be limited to comparisons with QRA for other operable units evaluated using the same methodology (DOE-RL 1994).

## 4.1 HUMAN HEALTH QUALITATIVE RISK ASSESSMENT

The 100-NR-1 Source Operable Unit human health QRA provides estimates of risks that occur under frequent-, occasional-, or commercial/industrial-use scenarios based on the best available knowledge of current waste site conditions. Because neither the frequent- nor the occasional-use exposure scenarios currently occur, the results of this QRA provide upper and lower limits of potential health risks, respectively, once human exposure begins. The results of this QRA for the current commercial/industrial-use exposure scenario provide conservative estimations of potential human risks for the decommissioning work underway.

### 4.1.1 Results of the Human Health QRA

Results of the QRA and associated uncertainties for the 100-NR-1 Source Operable Unit are summarized in the following sections.

Tables 4-1 and 4-2 summarize the following information from the human health evaluation of the waste sites:

- data availability and uncertainty

- qualitative risk estimation
- risk-driving contaminants for the frequent-use, occasional-use, and commercial/industrial-use scenarios
- risk-driving pathways for the frequent-use, occasional-use, and commercial/industrial-use scenarios.

The uncertainty levels assigned in Table 4-1 are considered estimates based on available knowledge of the waste sites. Characterization of uncertainty in the contaminant identification is based primarily on the LFI and historical data that are available to evaluate the waste sites. Characterization of uncertainty in the concentrations is based on the data available and the representativeness of these data.

With respect to uncertainty in contaminant identification and contaminant concentrations, a "low" rating is assigned if LFI data are available from the specific waste site and the same medium. A "medium" rating is assigned if historical or analogous LFI data are available for the site but site-specific soil data are not available to identify COPC. Uncertainty exists as to whether all contaminants have been identified and what concentrations of the identified COPC occur in the soil. A "high" rating is assigned if no historical or LFI sampling data are available, very little information is available for the site, or the potentially identified contaminants and concentrations are not well known. Uncertainty in the concentrations is generally higher than uncertainty in the identification of contaminants for all ratings because of the limited number of samples and/or boreholes drilled at one site.

Waste site information presented in Table 4-3 includes the following:

- identified suspected contaminants, if any
- site information/description
- QRA analysis, including estimation of risk rating and reference to RBC for suspected contaminants, if any.

The waste sites listed in the work plan (DOE-RL 1991b) are evaluated in this QRA. Quantitative LFI or historical data are available only for the sites listed in Tables 4-1 and 4-2. For sites with no quantitative sampling data, historical information and analogous site data were used to identify COPC or suspected contaminants and are summarized in Table 4-3.

Waste sites that have no LFI data but that remain high-priority sites based on records review are 118-N-1 Spacer Storage Silos, 1304-N EDT, 116-N-4 EDB, 105-N Spent Fuel Storage Basin, and the UN-100-N-6 Decontamination Waste Drain Line. Quantitative soil data are not available for these high-priority waste sites.

Based on the QRA, waste sites with LFI data within the 100-NR-1 Source Operable Unit are grouped into high, medium, low, and very low risk categories, as shown in Table 4-2. The high and medium risk categories are summarized below:

High Risk Category

- The 116-N-1 and 116-N-3 Crib and Trench Facilities are considered high risk for frequent-, occasional-, and commercial/industrial-use in 1992 and 2018.

- The 116-N-2 Treatment Storage Facility and the 1314-N LWLS are considered high risk for frequent-use in 1992.

Medium Risk Category

- The 1322-N/1322-NA Sample Buildings waste site is considered medium risk for the frequent-use scenario in 1992.

- The 116-N-2 Treatment Storage Facility, 1314-N LWLS, and 1322-N/1322-NA Sample Buildings are considered medium risk for the frequent-use scenario in 2018.

- The 116-N-2 Treatment Storage Facility and 1314-N LWLS are considered medium risk for the occasional-use scenario in 1992.

- The 116-N-2 Treatment Storage Facility, 1314-N LWLS, and 1322-N/1322-NA Sample Buildings are considered medium risk for the commercial/industrial-use scenario in 1992.

Low Risk Category

- The 1322-N/1322-NA Sample Buildings are considered low risk for occasional-use in 1992.

- The 1322-N/1322-NA Sample Buildings are considered low risk for the occasional-use and commercial/industrial-use scenario in 2018.

- The 116-N-2 Treatment Storage Facility is considered low risk for the occasional-use scenario in 2018.

Very Low Risk Category

The remaining sites are considered very low risks for all three exposure scenarios in 1992 and 2018.

The following QRA results are also summarized in Table 4-2:

- Radionuclides are identified as the main contributors to the overall risk via the external exposure pathway. The specific radionuclides identified as key contributors to the risk at the 116-N-1 and 116-N-3 Crib and Trench Facilities, the 116-N-2 Treatment Storage Facility, and the 1322-N/1322-NA Sample Buildings are cobalt-60 and cesium-137.

- The nonradionuclides identified as COPC were BAP and cadmium. Risks estimated for these COPC were below an HQ of 1.0.

The primary risk-driving exposure pathway at most of the waste sites is external exposure due to radionuclides. Based on the risk estimations presented in Section 3.0, the risk for the 0 to 1.8 m (0 to 6 ft) depth interval does not change significantly from the 0 to 4.6 m (0 to 15 ft) depth interval for the 116-N-1 and 116-N-3 Crib and Trench Facilities, the 116-N-2 Treatment Storage Facility, and the 1322-N/1322-NA Sample Buildings. No shielding effect was evaluated for reducing risk for the occasional-use scenario at these sites. However, the 116-N-1 and 116-N-3 facilities have been covered with concrete slabs or filled with boulders. Surface radiation surveys of the facilities have indicated that external exposure hazards exceed background. Risk estimates are based on the conservative assumption that the maximum detected contaminant concentration (in the upper 1.8 m [6 ft]) defines a contaminated zone with an area of at least 1,200 $m^2$ (12,900 $ft^2$) and a thickness of at least 1 m (3 ft) (i.e., essentially an infinite slab source).

The QRA results for waste sites with historical process knowledge are presented in Table 4-3 and summarized as follows:

- The high-priority sites required no further data for an IRM decision and were not sampled during the LFI. Suspected contaminants were identified by historical records review, and RBC values were calculated (Table 2-14).

- Limited field investigation data collected for the 166-N Tank Farm were limited to a depth below 4.6 m (15 ft). This site was evaluated using historical information and process knowledge. Groundwater was impacted by a documented release from this site in 1966. Diesel oil and No. 6 fuel oil were identified as COPC at that time.

- For several other sites, potential contaminants were identified only on the basis of historical information and soil contaminant concentrations are not known. Risk estimates were made for these sites based on historical knowledge and comparison with the other waste sites within the 100-NR-1 Source Operable Unit.

### 4.1.2 Summary of Key Uncertainties in the Human Health Risk Assessment

The human health risks presented in this QRA are conditional estimates that reflect multiple assumptions and related uncertainties. This section discusses the sources of uncertainty that were considered to have the greatest influence on the conclusions of the 100-NR-1 Source Operable Unit QRA.

Exposure estimates for hypothetical human receptors include an extrapolation of external radiation exposures and air COPC particulate concentrations from soil COPC concentrations. The uncertainty associated with the external radiation exposure extrapolation is expected to greatly impact the QRA because this exposure pathway was found to be the primary risk contributor at all of the 100-NR-1 Source Operable Unit waste sites in the "high risk" category. Media-specific data (i.e., external radiation dosimeters) are expected to significantly reduce this source of uncertainty in the 100-NR-1 Source Operable Unit QRA.

The use of maximum soil concentrations of all COPC from the surface to a depth of 4.6 m (15 ft) as the exposure point concentration ignores the spatial distribution of surface and subsurface COPC concentrations at the waste sites. Because the maximum concentrations are assumed to be ubiquitous and readily accessible to potential human receptors, this source of uncertainty results in overestimation of the exposure intakes and corresponding health risks from all COPC detected at each waste site.

An "infinite source" geometry was assumed, such that homogenous distributions of the maximum soil concentration of each radionuclide COPC are used to evaluate individual external radiation exposure risks. Uncertainty is introduced into the QRA because this assumption ignores the differences in radiation intensity for any other distribution of radionuclide COPC in soil and results in an overestimation of the external radiation exposure risks. Because the external radiation exposure pathway was found to be the primary risk-contributing pathway at all waste sites evaluated, this source of uncertainty is expected to significantly impact the 100-NR-1 Source Operable Unit QRA.

Some of the ICR values for the waste sites listed in the "high risk" category are contributed by radionuclides that are naturally occurring or are reported at concentrations that appear to be consistent with background concentrations. Background concentrations of naturally occurring radionuclides at the Hanford Site were not available during preparation of this report. However, average soil concentrations of naturally occurring radionuclides are presented in the National Council on Radiation Protection and Measurements (NCRP) Report No. 94 (NCRP 1987). Soil concentrations of radionuclides originating from nuclear weapons testing fallout have been reported for 23 locations not influenced by Hanford Site operations (DOE-RL 1992). Risks associated with these values were evaluated using the same methodology used in the QRA (Table 4-2).

According to this evaluation, potassium-40, a naturally occurring radionuclide, is estimated to contribute to the ICR via the external radiation exposure pathway for the 116-N-1, 116-N-2, and 1322-N/NA facilities. The radionuclide of major concern at the "high risk" sites is cobalt-60. Risk presented by potassium-40, a naturally occurring radionuclide, is approximately an order of magnitude less at the 1322-N/NA Facility and at

least two orders of magnitude less at the 116-N-2, 116-N-1, and 116-N-3 Facilities. This presents a medium risk according to the HSRAM (DOE-RL 1994).

## 4.2 ECOLOGICAL QUALITATIVE RISK ASSESSMENT

### 4.2.1 Results of the Ecological Evaluation

A qualitative ecological evaluation was completed for radiological constituents for the 100-NR-1 Source Operable Unit. The findings are summarized as follows:

- Soils in the 0 to 1.8 m (0 to 6 ft) profile in the 116-N-3 (1325-N) Trench and the 116-N-1 (1301-N) Trench exceed the 1 rad/day benchmark with an EHQ > 1 (Tables 4-4 and 4-5). No data are available for soil depths > 1.8 to 4.6 m (6 to 15 ft) directly beneath the trenches.

- At least one nonradiological contaminant in the soil at the 116-N-1 (1301-N) Trench, 116-N-2, the 1322-N/1322-NA sites, and the 120-N site group exceeds the respective wildlife NOEL (EHQ > 1) (Table 4-5).

- Cadmium concentrations at the 116-N-1 (1301-N) Trench and 116-N-2, lead concentrations at the 1322-N/1322-NA site, and zinc concentrations at the 120-N site group and 1322N/1322NA sites exceed the respective wildlife NOEL.

The presence of radionuclides above the EHQ in the surface soil profile (0 to 1.8 m [0 to 6 ft]) indicates that radionuclides at the 116-N-3 (1325-N) and 116-N-1 (1301-N) Trenches are available for uptake by plants and can potentially biotransport to the pocket mouse. For sites where the total dose is > 1.0, strontium-90 exceeds the EHQ by itself and is the primary dose contributor. Metals, organic compounds, and radionuclides that exceed the EHQ of 1.0 at individual waste sites are listed in Table 4-5.

### 4.2.2 Summary of Key Uncertainties in the Ecological Evaluation

Uncertainties associated with contaminant concentrations used in the ecological evaluation are related to the accuracy of the data. For the QRA, uncertainty exists in both contaminants identified and exposure concentrations. As with the human health assessment, the maximum contaminant concentration is used. Uncertainty associated with site-specific information is discussed in Section 3.0 for individual sites.

The QRA models the potential exposure of wildlife suspected to be present at or near the waste sites. Issues of concern with regard to ecological risk assessment (particularly qualitative) are the uncertainties in using an assortment of environmental variables in risk modeling. For example, if the source term is not realistic, no amount of modeling will

overcome this deficiency. In the case of the QRA, the maximum reported waste concentration is used as the source term no matter how deep this concentration is found.

Although site-specific organisms (e.g., pocket mouse) generally can be identified as being associated with a site, little if any data may be available on transfer of contaminants to site-specific organisms. Biological trophic transfer information for related species often must be used.

A significant source of uncertainty in the exposure scenario is that the waste sites are assumed to be uniformly contaminated and that all foodstuff is assumed to be contaminated. No provision is made for dilution of contaminated foodstuff by noncontaminated foodstuff. It was also assumed that contaminants are not passed through the gut but are completely retained (100% absorption efficiency).

To complete the QRA for the 100-NR-1 Source Operable Unit, transfer coefficients from non-Hanford specific plants were used for modeling the uptake of contaminants from soil to plants. The approach does not consider whether roots of a plant actually grow deep enough to contact a contaminant, and the model does not account for reduced concentrations from plant to seed (it was assumed the seed concentration is the same as the plant). For several of the sites, a concrete cover over the contaminated soil provides additional uncertainty with regard to access of the organism to contaminated material. The pocket mouse food consumption rate is generalized, and seasonal behavior (hibernation) that can reduce internal exposure and body burden is not considered.

Uncertainty associated with wildlife toxicity values is significant, particularly for nonradiological contaminants. The approach used in the QRA tends to build conservatism into the toxicity value. Wildlife NOEL were not available for several nonradioactive constituents. As a consequence, potential risks to the mouse following exposure to these constituents could not be addressed.

THIS PAGE INTENTIONALLY
LEFT BLANK

## Table 4-1 100-NR-1 Summary of LFI or Historical Data For 0-15 Feet

| Waste Site With LFI or Historical Data from 0-15 Feet | Summary of Data Availability and Data Uncertainty | | | | |
|---|---|---|---|---|---|
| | LFI Data | Data from the same Medium | Data to perform a QRA | Uncertainty in Contaminant Identification | Uncertainty in Contaminant Concentration(a) |
| 116-N-1 (1301-N) Crib and Trench | R,I,O | Yes | Quantitative | Low | Low |
| 116-N-3 (1325-N) Crib and Trench | R | | Quantitative | Low | Low |
| 120-N-1 Percolation Pond and South Settling Pond and 120-N-2 Surface Impoundment | I,O(b) | Yes | Yes<br>Quantitative | Low | Low |
| 116-N-2 Treatment Storage Facility | R,I,O | Yes | Quantitative | Low | Low |
| 1322-N/1322-NA Sample Buildings | R,I,O | Yes | Quantitative | Low | Low |
| 119-N Cooling Water Drain Line | I,O(b) | Yes | Quantitative | Low | Low |

(a) Low uncertainty in contaminant concentration is based on limited validated soil data set, usually one boring per site.

(b) Radionuclide data consisted of field screening for gross radiation; no specific contaminant soil data were available to perform risk estimation.

R - Radionuclide.

I - Inorganic.

O - Organic.

LFI - Limited field investigation.

QRA - Qualitative risk assessment.

**Table 4-2 100-NR-1 Summary of Human Health QRA for Quantitative Data Sites**

| Waste Site With LFI or Historical Data from 0-15 Feet | Human Health Risk Assessment Summary | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Frequent-Use Scenario | | | Occassional-Use Scenario | | | Commercial/Industrial-Use Scenario | | |
| | Qualitative Risk Estimation (a) | | Risk-Driving Contaminant and Pathway | Qualitative Risk Estimation (a) | | Risk-Driving Contaminant and Pathway | Qualitative Risk Estimation (a) | | Risk-Driving Contaminant and Pathway |
| | 1992 | 2018 | | 1992 | 2018 | | 1992 | 2018 | |
| 116-N-1 (1301-N) Crib and Trench | High | High | R, External | High | High | R, External | High | High | R, External |
| 116-N-3 (1325-N) Crib and Trench | High | High | R, External | High | High | R, External | High | High | R, External |
| 120-N-1 Percolation Pond<br>120-N-2 Surface Impoundment and South Settling Pond | Very Low | Very Low | | Very Low | Very Low | | Very Low | Very Low | |
| 116-N-2 Treatment Storage Facility | High | Medium | R, External | Medium | Low | R, External | Medium | Low | R, External |
| 1322-N/1322-NA Sample Buildings | Medium | Medium | R, External | Low | Low | R, External | Medium | Low | R, External |
| 119-N Cooling Water Drain Line | Very Low | Very Low | | Very Low | Very Low | | Very Low | Very Low | |

(a) Very Low = Very Low Qualitative Risk; Incremental Cancer Risk (ICR) < 10-6.
Low = Low Qualitative Risk; 10-6 < ICR < 10-4.
Medium = Medium Qualitative Risk; 10-4 < ICR < 10-2.
High = High Qualitative Risk; ICR > 10-2.

R - Radionuclide.
I - Inorganic.
O - Organic.
External - External radiation exposure.
LFI - Limited field investigation.
QRA - Qualitative risk assessment.

9413300.0232

Table 4-3 Summary of Human Health QRA for Waste Sites Without Quantitative Data for 0-15 Feet (page 1 of 4)

| Waste Site | Suspected Contaminants | Description and Notes | Risk Estimation | QRA Analysis |
|---|---|---|---|---|
| 118-N-1 Storage Space Silos | Co-60,Sr-90,CePr-144,Pu-239 | Contained irradiated fuel spacers. Three unplanned releases. Only records review necessary for IRM decision. | High | RBCs were calculated for suspected contaminants (Table 3-1). No further data necessary to make IRM decision. Remedial action to be integrated with 105-N basin draining. |
| 1304-N Emergency Dump Tank | Na-24,Mn-56 | Received emergency dumpings of radioactive coolant water. Six unplanned releases. Only records review necessary for IRM decision. | High | RBCs were calculated for suspected contaminants (Table 3-1). No further data necessary to make IRM decision. Remedial action planned following reactor decommissioning. |
| 116-N-4 Emergency Dump Basin | K-40,Mn-56,Fe-59,Co-58,Co-60,ZrNb-95,Ru-103,Sb-124,I-131,Cs-137,BaLa-140 | Received cooling and blowdown water and sludge containing radionuclides. Only records review necessary for IRM decision. | High | RBCs were calculated for suspected contaminants (Table 3-1). No further data necessary to make IRM decision. Remedial action planned following 105-N basin draining and residual materials removal. |
| 105-N Spent Fuel Storage Basin | I-131 | Containment basin for storage of spent fuel rods and spacers. Two unplanned releases. Only records review necessary for IRM decision. | High | RBCs were calculated for suspected contaminants (Table 3-1). No further data necessary to make IRM decision. Remedial action to be integrated with 105-N basin draining. |
| UN-100-N-6 Decontamination Drain Line | Mn-54,Co-60,Ru-103,Cs-137 | Leaks at four locations along line released approx. 1,800 gal of radioactive wastewater. | High | RBCs were calculated for suspected contaminants (Table 3-1). No further data necessary to make IRM decision. Characterization planned concurrent with remediation. |
| 1314-N Liquid Waste Loadout Station | Co-60,K-40,Cs-137,Ra-226, Th-228,Th-232,U-233/234, U-238, Benzo(a)pyrene, Phosphoric Acid, Diethylthiourea | 80- by 30-ft transfer station for spent radioactive internal decontamination solution. Unplanned releases of 175 and 1,000 gal. | High | Risk estimation is based on analogy to 116-N-2 Treatment Storage Facility. RBCs were calculated for COPCs identified by analogy to the 116-N-2 Treatment Storage Facility (Table 2-5). |

Table 4-3 Summary of Human Health QRA for Waste Sites Without Quantitative Data for 0-15 Feet (page 2 of 4)

| Waste Site | Suspected Contaminants | Description and Notes | Risk Estimation | QRA Analysis |
|---|---|---|---|---|
| 1143-N Paint Shop | Paint,Solvents,Lubrication Oil | Contained paint wastes and associated water, spent thinner, spent garnet sand, and paint chips. | Very Low | Risk estimation is based on no historical knowledge of radionuclide disposal or handling at the sites. LFI records review identified suspected contaminants. RBCs were calculated for solvents, paint, and oil constituents analyzed for at other sites (Table 2-5). |
| N-17 Paint Shop | Paint, Solvents,Lubrication Oil | Contained waste paint solvents and oils. | Very Low | |
| 105-N Lift Station Underground Storage Tank | Diesel Oil | 5,000-gal diesel storage tank. | Very Low | Risk estimation is based on no historical knowledge of radionuclide disposal or handling at the sites. RBCs were calculated for constituents of diesel analyzed for at other sites (Table 2-5c). |
| 182-N Underground Storage Tanks | Diesel Oil | Three 10,000-19,000 gal diesel oil USTs. | Very Low | |
| 184-N Day Tanks | Diesel Oil No.6(Bunker C)Oil | One 8,000-gal and two 350,000-gal tanks. Unplanned releases of 2,000 gal, 800 gal, and unknown amount. Oil was removed in all cases. | Very Low | |
| 166-N – 184-N Piping | Diesel Oil | Carried fuel oil. Two unplanned releases of 200 gal, one of 300 gal, one of 1,000 gal, and one of an unknown amount. | Very Low | |
| Drum Storage Area | Diesel Oil | Area between 166-N Fuel Oil Loading Station and 166-N Tank Farm. | Very Low | |
| 181-N Waste Oil Tank | Waste Oil | Managed waste oil from pump oil changes. | Very Low | Risk estimation is based on no historical information of radionuclide disposal or handling at these sites. RBCs were calculated for constituents of suspected contaminants analyzed for at other sites (Table 2-5c). |
| 182-N Unplanned Release to the Columbia River | Turbine Lube Oil | 5 gal release of turbine lube oil to river. | Very Low | |
| 1716-N Service Station USTs | Unleaded Gasoline | Two 1,000-4,000 gal unleaded gasoline USTs. Evidence of unplanned release found during removal of one tank. | Very Low | |
| 116-N Air Stack | | Released gaseous and particulate radionuclides from reactor operations to atmosphere. | Very Low | Risk estimation is based on no historical information of radionuclide disposal or handling at the site. |

9413300.0233

Table 4-3 Summary of Human Health QRA for Waste Sites Without Quantitative Data for 0-15 Feet (page 3 of 4)

| Waste Site | Suspected Contaminants | Description and Notes | Risk Estimation | QRA Analysis |
|---|---|---|---|---|
| | | Routinely released chemicals and particulates from boiler stacks. | Very Low | Risk estimation is based on no historical information indicating radionuclide disposal or handling at site. |
| | | Radioactive soil and asphalt dropped in area and subsequently removed. | Very Low | Risk estimation is based on very limited cleanup information. RBCs were calculated for radionuclides detected at other sites (Table 2-5a). |
| Radionuclides | | Septic tank and seepage pit for 163-N,183-N,1127-N, and 1128-N Buildings. | Very Low | Risk estimation is based on no historical information of radionuclide disposal or handling at the sites. |
| | | Septic tank and drainfield serving Building 182-N. | Very Low | |
| | | 500-gal cesspool for 107-N and construction personnel. | Very Low | |
| | Radionuclides | Primary septic system for 100-N area, handling approx. 330,000 gal/day of sanitary sewage. Radioactive contamination has been detected at the surface. | Very Low | Risk estimation is based on no historical information of radionuclide disposal or handling at the site. Surface radiation detected at the site is assumed to be part of the 116-N-2 Treatment Storage Facility. |
| 124-N-5 Septic Tank | | Septic tank and drainfield. | Very Low | Risk estimation is based on no historical knowledge of radionuclide disposal or handling at these sites. |
| 124-N-6 Septic Tank | | Septic tank and drainfield. | Very Low | |
| 124-N-7 Septic Tank | | Septic tank and drainfield. | Very Low | |
| 124-N-8 Septic Tank | | Septic tank. | Very Low | |
| 124-N-9 Septic Tank | | Septic tank. | Very Low | |
| 124-N-10 Sewer System | | Lift stations and three lagoons handling sanitary sewage | Very Low | |

Table 4-3 Summary of Human Health QRA for Waste Sites Without Quantitative Data for 0-15 Feet (page 4 of 4)

| Waste Site | Suspected Contaminants | Description and Notes | Risk Estimation | QRA Analysis |
|---|---|---|---|---|
| 120-N-4 Nonhazardous and Nonradioactive Storage Area | | Curbed concrete pad that held oils and liquids. | Very Low | Risk estimation is based on no historical information of radionuclide disposal or handling at the site. |
| 128-N-1 Burn Pit | | Undetermined area for burning of office and lunchroom trash and tumbleweeds using fuel oil as starter. | Very Low | Risk estimation is based on no historical information of radionuclide disposal or handling at the site. |
| 181-N Inlet Screen Backwash Water Outfall | | Discharged backwash water and solids from raw water intake to the river. | Very Low | Risk estimation is based on no historical information of radionuclide disposal to soil or handling at the site. |
| 260-cm (102-in) Outfall Line | | Discharged secondary cooling water to the river. | Very Low | |
| 182-N Tank Farm Overflow | | NPDES discharge point 005. | Very Low | |
| 182-N Drain System | | NPDES discharge point 006. Periodic release of low-level radionuclides from emergency core cooling system pumps. | Very Low | |
| 116-N-8 Hazardous and Mixed Waste Storage Area | | Paved and curbed concrete pad for storing drums containing radiation-contaminated oil and miscellaneous process chemicals. RCRA satellite accumulation area. | Very Low | Risk estimation is based on no historical knowledge of spills or releases to soil. |
| HGP Burn Pit | | Approx. 10-$yd^2$ trash burning pit. | Very Low | Risk estimation is based on no historical information of radionuclide disposal or handling at these sites. |
| Grass Dump | | Approx. 10-$yd^2$ pit for dumping grass clippings. Unknown if other materials were disposed of here. | Very Low | |
| Construction Debris Dump | | Intermediate area along roads south and east of HGP where construction debris was disposed of. | Very Low | |

**Table 4-4 Environmental Hazard Quotients Summary for Radionuclides by Waste Site**

| Waste Site | Dose Rate Exceeds 1 rad/day (EHQ of 1) (0-6 feet) | Dose Rate Exceeds 1 rad/day (EHQ of 1) (6-15 feet) |
|---|---|---|
| 116-N-2 | No | No |
| 119-N | NDA | NDA |
| 120-N Group | NDA | NDA |
| 1322-N/1322-NA | No | No |
| 116-N-3 (1325-N) Trench | Yes | NDA |
| 116-N-1 (1301-N) Trench | Yes | No(a) |

(a) Soil samples from wells outside trench area.
NDA - No data available.
EHQ - environmental hazard quotient

**Table 4-5 Summary of Contaminants at Sites Which Exceed the EHQ of 1 for Wildlife**

| Waste Site | Cadmium | Lead | Zinc | Radionuclide |
|---|---|---|---|---|
| 116-N-2 | X | | | |
| 119-N | | | | |
| 120-N Group | | | X | |
| 1322-N<br>1322-NA | | X | X | |
| 116-N-3 Trench<br>(1325-N) | | | | X |
| 116-N-1<br>Trench<br>(1301-N) | X(a) | | | X(b) |

(a) Sample from outside 116-N-1 Trench in nearby well-bore.
(b) Maximum samples from inside trench sediments.
EHQ - environmental hazard quotient

# 5.0 REFERENCES

Baes, C. F. III, R. D. Sharp, A. L. Sjoreen, and R. W. Shor, 1984, *A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture*, ORNL-5786, Oak Ridge National Laboratory, Oak Ridge, TN.

Baker, D. A. and J. K. Soldat, 1992, *Methods for Estimating Doses to Organisms from Radioactive Materials Released into the Aquatic Environment*, PNL-8150, Pacific Northwest Laboratory, Richland, Washington.

Bechtold, R.A., 1992, *Data Validation Procedures for Chemical Analyses*, WHC-SD-EN-SPP-002, Westinghouse Hanford Company, Richland, Washington.

Cataldo, D. A. and R. E. Wildung, 1978, "Soil and Plant Factors Influencing the Accumulation of Heavy Metals by Plants," *Environ. Health Perspect*, 27: 149-159.

Coughtrey, P. J., D. Jackson, C. H. Jones, P. Kane, and M. C. Thorne, 1983 and 1985, *Radionuclide Distribution and Transport in Terrestrial and Aquatic Ecosystems*, Volumes 1-6, A. A. Balkema Publishers, Rotterdam, Netherlands.

Digregorio, D., T. Kitchings, and P. Van Voris, 1978, "Radionuclide Transfer in Terrestrial Animals," *Health Physics*, 34: 3-31.

DOE, 1993, *Site-Wide Characterization Report, Fernald Environmental Management Project*, FEMP-SWCR-6 FINAL, U.S. Department of Energy, Fernald Field Office, Fernald, Ohio.

DOE-RL, 1991a, *Hanford Past-Practice Strategy*, DOE/RL-91-40, Revision 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1991b, *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-NR-1 Operable Unit*, DOE/RL-90-22, Draft B, Hanford Site, Richland, Washington.

DOE-RL, 1992, *Remedial Investigation/Feasibility Study Work Plan for the 100-FR-1 Operable Unit, Hanford Site, Richland, Washington*, DOE/RL-90-33, Revision 0, U.S. Department of Energy, Richland, Washington.

DOE-RL, 1993a, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*, DOE/RL-92-24, Revision 1, Draft, U.S. Department of Energy, Richland, Washington.

DOE-RL, 1993b, *Limited Field Investigation Report for the 100-NR-1 Source Operable Unit,Hanford Site, Richland, Washington*, DOE/RL-93-80, Revision 0, Draft, U.S. Department of Energy, Richland, Washington.

DOE-RL, 1993c, *1301-N/1325-N Liquid Waste Disposal Facilities Closure Plan*, DOE/RL-93-93, Revision 0, Draft, U.S. Department of Energy, Richland, Washington.

DOE-RL 1994, *Hanford Site Risk Assessment Methodology*, DOE/RL-91-45, Revision 3, U.S. Department of Energy, Richland, Washington (in preparation).

Ecker, R.M., W.H. Walters, and F.L. Thompson, 1983, *N Reactor Thermal Plume Characterization Study During Dual-Purpose Mode of Operation: Part I - Field Investigation; Part II - Computer Simulation*, UNI-2620, Pacific Northwest Laboratory, Richland, Washington.

Ecology, EPA, and DOE-RL, 1992, *Hanford Federal Facility Agreement and Consent Order*, Washington Department of Ecology, Olympia, Washington, U.S. Environmental Protection Agency, Region X, Seattle, Washington, and U.S. Department of Energy, Richland Operations Office, Richland, Washington.

EPA, 1988, *Superfund Exposure Assessment Manual*, EPA/540/1-88-001, OSWER Directive 9285.5-1, April, 1988, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC.

EPA, 1989, *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A), Interim Final*, EPA/540/1-89/002, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, DC, December.

EPA, 1990, *Health Effects Assessment Summary Tables: Fourth Quarter FY-1990*, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC.

EPA, 1991a, *Risk Assessment Guidance for Superfund: Volume 1, Human Health Evaluation Manual, Part B: Development of Risk-Based Remediation Goals; Review Draft*, OSWER 9285.7-01B, U.S. Environmental Protection Agency, Washington, DC.

EPA, 1991b, *Integrated Risk Information System (IRIS)*, computer database, U.S. Environmental Protection Agency, Office of Research and Development, Office of Health and Environmental Assessment, Cincinnati, Ohio.

EPA, 1991c, *Interim Oral RfD for Copper*, U.S. Environmental Protection Agency, Superfund Health Risk Technical Support Center, Cincinnati, Ohio.

EPA, 1992a, *Health Effects Assessment Summary Tables: Annual FY-1992*, PHEA/ECAO-CIN-821, March 1992, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC.

EPA, 1992b, *Carcinogenicity Information for Tetrachloroethylene and Trichloroethylene*, U.S. Environmental Protection Agency, Superfund Health Risk Technical Support Center, Cincinnati, Ohio.

EPA, 1993a, *Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons*, EPA/600/R-93/089, U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC, July.

EPA, 1993b, *Health Effects Assessment Summary Tables, Annual Report (HEAST)*, OHEA/ECAO-CIN-909, EPA 540-R-93-058, U.S. Environmental Protection Agency, Office of Research and Development, Office of Health and Environmental Assessment, Cincinnati, Ohio, March.

EPA, 1993c, *Integrated Risk Information System*, Access date: August 31, 1993, U.S. Department of Health and Human Services, National Library of Medicine Toxicology Data Network (TOXNET), Bethesda, Maryland.

Hanford Future Site Users Working Group (HFSUWG), 1992, *Future for Hanford: Uses and Cleanup*, Richland, Washington.

IAEA, 1992, *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards*, STI/DOC/10/332, Technical Report Series No. 332, International Atomic Energy Agency, Vienna, Austria.

ICRP, 1959, *Recommendations of the International Commission on Radiological Protection*, ICRP Publication 2 International Commission Radiological Parameters, International Commission on Radiological Protection (ICRP), Pergamon Press, Oxford, England.

Miller, M. L., J. J. Fix, and P. E. Bramson, 1977, *Radiochemical Analyses of Soil and Vegetation Samples Taken from the Hanford Environs, 1971-1976*, BNWL-2249, Pacific Northwest Laboratory, Richland, Washington.

NCRP, 1987, *Exposure for the Population in the United States and Canada from National Background Radiation*, National Council on Radiation Protection and Measurements, Bethesda, Maryland.

Ophel, I. L., M. Hoppenheit, R. Ichikawa, A. G. Klimov, S. Kobayashi, Y. Nishiwaki, and M. Saiki 1976, "Effects of Ionizing Radiation on Aquatic Organisms and Ecosystems," *IAEA Technical Report 172*, pp. 57-88.

Rose, K. S. B., 1992, "Lower Limits of Radiosensitivity in Organisms, Excluding Man," *Journal of Environmental Radioactivity*, Vol. 15, pp. 113-133.

Rouston, R. C. and D. A. Cataldo, 1978, "A Growth Chamber Study of the Effect of Soil Concentration and Plant Age on the Uptake of Sr and Cs by Tumbleweed," *Communications in Soil Science and Plant Analysis*, 9(3).

Schleien, B., 1992, *The Health Physics and Radiological Health Handbook*, Scinta, Inc., Silver Spring, Maryland.

Suter, G. W. II, S. M. Bartell, T. Mill, D. Mackay, and Sally Paterson, 1993, *Ecological Risk Assessment*, Lewis Publishers, 121 South Main Street, Chelsea, Michigan.

UNC, 1980, *Radiological Surveillance Report for the 100-N Area Environment--1980*, UNI-1581, UNC Nuclear Industries, Richland, Washington, October 3.

UNC, 1981, *UNC Environmental Surveillance Report for the 100 Areas -- FY 1981*, UNI-1849, UNC Nuclear Industries, Richland, Washington, October 29.

UNC, 1982, *UNC Environmental Surveillance Report for the 100 Areas -- FY 1982*, UNI-2226, UNC Nuclear Industries, Richland, Washington, December 14.

UNC, 1983, *UNC Environmental Surveillance Report for the 100 Areas -- FY 1983*, UNI-2640, UNC Nuclear Industries, Richland, Washington, October 31.

UNC, 1984, *UNC Environmental Surveillance Report for the 100 Areas -- 1984*, UNI-3069, UNC Nuclear Industries, Richland, Washington, December 21.

UNC, 1986, *UNC Environmental Surveillance Report for the 100 Areas -- 1985*, UNI-3760, UNC Nuclear Industries, Richland, Washington, February 27.

WHC, 1988, *Westinghouse Hanford Company Environmental Surveillance Annual Report--100 Areas, Calendar Year 1987*, WHC-EP-0161, Westinghouse Hanford Company, Richland, Washington, July.

WHC, 1990, *Sample Management Administration Manual*, WHC-CM-5-3, Westinghouse Hanford Company.

WHC, 1992, *Qualitative Risk Assessment for the 100-BC-1 Source Operable Unit*, WHC-SD-EN-RA-003, Revision 0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993a, *Qualitative Risk Assessment for the Hanford Site 100-NR-2 Operable Unit*, WHC-SD-EN-RA-008, Revision 0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993b, *Qualitative Risk Assessment for the Hanford Site 100-FR-1 Operable Unit*, WHC-SD-EN-RA-013, Revision 0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993c, *Data Validation Report for the 100-NR-1 Operable Unit Borehole Samples*, WHC-SD-EN-TI-156, Revision 0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993d, *Data Validation Report for the 100-NR-1 Operable Test Pit*, WHC-SD-EN-TI-157, Revision 0, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993e, *Data Validation Report for the 100-NR-1 Operable Unit Task-2 Source Sampling*, WHC-SD-EN-TI-190, Revision 0, Westinghouse Hanford Company, Richland, Washington.

Whicker, F. W. and V. Schultz, 1982, *Radioecology: Nuclear Energy and the Environment*, Volume II, CRC Press, Inc., Boca Raton, Florida.

THIS PAGE INTENTIONALLY
LEFT BLANK

## DISTRIBUTION

| | |
|---|---|
| R. L. Donahoe | H4-79 |
| S. R. Durfee | T7-05 |
| G. R. Eidam | H4-79 |
| R. Gauthier | X5-54 |
| R. J. Gimera | X5-54 |
| A. P. Goforth | H6-08 |
| M. E. Greenidge | H4-79 |
| D. E. Herman | T7-27 |
| M. R. Hood | X0-17 |
| A. L. Langstaff | H6-01 |
| M. J. Lauterbach | H6-01 |
| E. D. Marvin | H4-79 |
| J. C. Plastino | X5-57 |
| T. P. Rudolph | R3-54 |
| E. F. Shorey | H4-79 |
| J. E. Walsh | G3-02 |
| J. P. Zoric | X0-21 |
| EPIC (2) | H6-08 |
| ERC | H6-07 |
| ERE Project File | H6-08 |
| ER Program Office | H6-27 |
| Document Control | H4-79 |
| Resource Center | N3-05 |

THIS PAGE INTENTIONALLY
LEFT BLANK