U-006-404.16

5208

# FEASIBILITY STUDY REPORT FOR OPERABLE UNIT 4 VOLUME 4 OF 4 FINAL FEBRUARY 1994

02/22/94

DOE/EIS-0195D
DOE-FN/EPA
815
REPORT
OU4

5208

# FEASIBILITY STUDY REPORT FOR OPERABLE UNIT 4

**DOE/EIS - 0195D**

**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**
**FERNALD, OHIO**

**REMEDIAL INVESTIGATION AND FEASIBILITY STUDY**

**VOLUME 4 OF 4**

**FEBRUARY 1994**

**U.S. DEPARTMENT OF ENERGY**
**FERNALD FIELD OFFICE**

**FINAL**

5208

# FEASIBILITY STUDY REPORT FOR OPERABLE UNIT 4

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

VOLUME 4 OF 4

FEBRUARY 1994

U.S. DEPARTMENT OF ENERGY
FERNALD SITE OFFICE
DOE/EIS-0195D

FINAL

0001

5208

# TABLE OF CONTENTS


| | Page |
|---|---|
| List of Tables | vii |
| List of Figures | xi |
| Acronyms | xiii |
| English/Metric and Metric/English Equivalents | xv |
| Exposure Assessment Symbols | xvi |
| K.1.0 INTRODUCTION | K-1-1 |
| K.1.1 CRARE Objectives | K-1-2 |
| K.1.2 FEMP Site History | K-1-4 |
| K.1.3 Site Description | K-1-4 |
| K.1.3.1 Climate | K-1-4 |
| K.1.3.2 Topography and Surface Water Hydrology | K-1-6 |
| K.1.3.3 Geology and Hydrology | K-1-8 |
| K.1.3.4 Ecology | K-1-9 |
| K.1.3.5 Land Use | K-1-9 |
| K.1.3.6 Demographics | K-1-10 |
| K.1.4 Operable Units | K-1-10 |
| K.1.5 FEMP Remediation | K-1-11 |
| K.1.5.1 Removal Actions | K-1-11 |
| K.1.5.2 Updated LRAs | K-1-22 |
| K.1.6 CRARE Site-Wide Conceptual Model | K-1-23 |
| K.1.7 Organization of the CRARE | K-1-30 |
| K.2.0 CRARE PROGRAMMATIC APPROACH | K-2-1 |
| K.2.1 Assumptions | K-2-1 |
| K.2.2 Leading Remedial Alternatives | K-2-5 |
| K.2.2.1 Operable Unit 1 | K-2-6 |
| K.2.2.2 Operable Unit 2 | K-2-6 |
| K.2.2.3 Operable Unit 3 | K-2-7 |
| K.2.2.4 Operable Unit 4 | K-2-7 |
| K.2.2.5 Operable Unit 5 | K-2-8 |
| K.2.3 Vault Design | K-2-9 |
| K.2.3.1 Vault Description | K-2-9 |
| K.2.3.2 Venting of Heat and Gases from the Vault | K-2-12 |
| K.2.3.3 Stormwater Management Relating to the Vault | K-2-12 |
| K.2.3.4 RCRA-Type Cap Design | K-2-13 |
| K.2.4 CRARE and Modification of Preliminary Remediation Goals | K-2-13 |
| K.2.5 CRARE Technical Approach | K-2-13 |


0002

TABLE OF CONTENTS
(Continued)


| | | Page |
|---|---|---|
| K.3.0 | OVERVIEW OF CRARE INFORMATION AND DATA | K-3-1 |
| K.3.1 | Site Conditions After Remediation | K-3-1 |
| K.3.2 | Fate and Transport Modeling of Residual Contaminants | K-3-5 |
| K.3.2.1 | Groundwater and Surface Water Modeling | K-3-6 |
| K.3.2.2 | Site-Wide Air Pathway Analysis | K-3-7 |
| K.3.3 | Exposure and Intake Assessment Data | K-3-9 |
| K.4.0 | CONTAMINANTS OF CONCERN | K-4-1 |
| K.4.1 | Comparison of Lists | K-4-1 |
| K.4.2 | COC Selection Process | K-4-1 |
| K.4.3 | Initial Screening of COCs | K-4-3 |
| K.4.4 | Second Screening of COCs: Volatile Losses | K-4-9 |
| K.4.4.1 | Operable Units 1 and 3 | K-4-9 |
| K.4.4.2 | Operable Units 2 and 4 | K-4-9 |
| K.4.4.3 | Operable Unit 5 | K-4-9 |
| K.4.5 | Final Screening of COCs | K-4-15 |
| K.5.0 | EXPOSURE SCENARIOS | K-5-1 |
| K.5.1 | Characterization of Exposure Setting | K-5-2 |
| K.5.1.1 | Physical Environment | K-5-2 |
| K.5.1.2 | Postremediation Sources of Contaminants | K-5-4 |
| K.5.1.3 | Land Use | K-5-6 |
| K.5.1.4 | Potentially Exposed Populations | K-5-6 |
| K.5.2 | Detailed Conceptual Exposure Model | K-5-12 |
| K.5.2.1 | Source of Residual Contaminants | K-5-12 |
| K.5.2.2 | Release Mechanisms of Contained Wastes and Soils | K-5-13 |
| K.5.2.3 | Transport Pathways | K-5-14 |
| K.5.2.4 | Exposure Media | K-5-18 |
| K.5.3 | Exposure Pathways | K-5-19 |
| K.5.3.1 | Air Exposure Pathways | K-5-19 |
| K.5.3.2 | Exposure Pathways Attributable to Dermal Contact | K-5-19 |
| K.5.3.3 | Ingestion Exposure Pathways | K-5-20 |
| K.5.3.4 | Direct Exposure to Radiation | K-5-20 |

TABLE OF CONTENTS
(Continued)


| | Page |
|---|---|
| K.6.0 FATE AND TRANSPORT MODELING | K-6-1 |
| K.6.1 Water Transport Modeling | K-6-2 |
| K.6.1.1 Description of Approach | K-6-2 |
| K.6.1.2 Screening of COCs | K-6-7 |
| K.6.1.3 Descriptions of Source Terms | K-6-12 |
| K.6.1.3.1 COC Masses and Leachate Concentrations | K-6-12 |
| K.6.1.3.2 Soil and Capped Areas Infiltration Rates | K-6-22 |
| K.6.1.3.3 Vault Infiltration Rates | K-6-22 |
| K.6.1.4 Vadose Zone Modeling | K-6-28 |
| K.6.1.4.1 Vadose Zone Model Development | K-6-28 |
| K.6.1.4.2 Vadose Zone Model Results | K-6-32 |
| K.6.1.5 Surface Water Modeling | K-6-35 |
| K.6.1.5.1 Surface Water Model Development | K-6-36 |
| K.6.1.5.2 Surface Water Model Results | K-6-40 |
| K.6.1.6 Aquifer Modeling | K-6-44 |
| K.6.1.6.1 Aquifer Model Development | K-6-44 |
| K.6.1.6.2 Aquifer Model Results | K-6-47 |
| K.6.2 Air Transport Modeling | K-6-63 |
| K.6.2.1 Scenarios for Air Transport Analysis | K-6-64 |
| K.6.2.2 Sources and Contaminants | K-6-66 |
| K.6.2.3 Air Transport Models | K-6-66 |
| K.6.2.4 Particulate Contaminant Emission Rates | K-6-68 |
| K.6.2.4.1 Contaminated Soil Concentrations | K-6-68 |
| K.6.2.4.2 Suspended Particulate Emission Estimate | K-6-73 |
| K.6.2.5 Gaseous Contaminant Emission Rates | K-6-77 |
| K.6.2.6 Meteorological Data | K-6-83 |
| K.6.2.7 Receptor Locations | K-6-83 |
| K.6.2.8 Dispersion Coefficients | K-6-85 |
| K.6.2.9 Model Output Processing | K-6-85 |
| K.6.2.10 Results of Air Dispersion Modeling | K-6-86 |
| K.6.2.10.1 Current Land Use Scenario | K-6-86 |
| K.6.2.10.2 Future Land Use Scenarios | K-6-95 |
| K.6.3 Farm Products Fate Modeling | K-6-103 |
| K.6.3.1 Ingestion of Vegetables | K-6-103 |
| K.6.3.2 Ingestion of Meat and Dairy Products | K-6-105 |
| K.6.3.3 Results of Farm Product Fate Modeling | K-6-112 |


0004

- 5208

## TABLE OF CONTENTS
(Continued)


| | Page |
|---|---|
| K.7.0 TOXICITY ASSESSMENT | K-7-1 |
| K.7.1 Noncarcinogens | K-7-1 |
| K.7.2 Chemical Carcinogens | K-7-5 |
| K.7.3 Radiocarcinogens | K-7-5 |
| K.7.4 Radiation Exposure Pathways | K-7-10 |
| K.7.5 Toxicity Profiles: Radionuclides | K-7-13 |
| K.7.5.1 Actinium-227 | K-7-13 |
| K.7.5.2 Americium-241 | K-7-14 |
| K.7.5.3 Lead-210 | K-7-14 |
| K.7.5.4 Neptunium-237 | K-7-14 |
| K.7.5.5 Plutonium | K-7-14 |
| K.7.5.6 Protactinium-231 | K-7-16 |
| K.7.5.7 Radium and Radon | K-7-16 |
| K.7.5.8 Radon and Progeny | K-7-19 |
| K.7.5.9 Ruthenium-106 | K-7-22 |
| K.7.5.10 Strontium | K-7-22 |
| K.7.5.11 Technetium | K-7-23 |
| K.7.5.12 Thorium | K-7-23 |
| K.7.5.13 Uranium | K-7-27 |
| K.7.6 Toxicity Profiles: Chemicals | K-7-34 |
| K.7.6.1 2-Chlorophenol | K-7-34 |
| K.7.6.2 2-Methylnaphthalene | K-7-34 |
| K.7.6.3 4-Chlorophenyl-phenylether | K-7-35 |
| K.7.6.4 Ammonia | K-7-35 |
| K.7.6.5 Antimony | K-7-37 |
| K.7.6.6 Aroclors | K-7-38 |
| K.7.6.7 Arsenic | K-7-39 |
| K.7.6.8 Barium | K-7-40 |
| K.7.6.9 Beryllium | K-7-40 |
| K.7.6.10 Cadmium | K-7-41 |
| K.7.6.11 Chromium (VI) | K-7-41 |
| K.7.6.12 Cobalt | K-7-42 |
| K.7.6.13 Copper | K-7-44 |
| K.7.6.14 Cyanide | K-7-46 |
| K.7.6.15 DDT | K-7-46 |
| K.7.6.16 Di-n-octyl phthalate | K-7-48 |
| K.7.6.17 Dioxin/Furan | K-7-49 |

TABLE OF CONTENTS
(Continued)

Page

K.7.6.18 Lead K-7-51
K.7.6.19 Manganese K-7-53
K.7.6.20 Mercury K-7-53
K.7.6.21 Molybdenum K-7-54
K.7.6.22 Nickel K-7-55
K.7.6.23 Selenium K-7-55
K.7.6.24 Thallium, Soluble Salts K-7-56
K.7.6.25 Vanadium K-7-57
K.7.6.26 Zinc K-7-57

K.8.0 QUANTIFICATION OF CONTAMINANT EXPOSURE AND INTAKE K-8-1
K.8.1 Definitions K-8-1
K.8.2 Quantification Methods K-8-1
K.8.3 Results of Intake Quantification K-8-2

K.9.0 RISK CHARACTERIZATION K-9-1
K.9.1 Risk Characterization Methodology K-9-1
K.9.1.1 Hazardous Chemical Exposures K-9-1
K.9.1.1.1 Risk Characterization Methodology for Carcinogens K-9-1
K.9.1.1.2 Risk Characterization Methodology for Noncarcinogens K-9-2
K.9.1.2 Radiological Exposures K-9-4
K.9.1.2.1 Risk Characterization Methodology for Internal Exposures K-9-4
K.9.1.2.2 Risk Characterization Methodology for External Gamma Exposures K-9-4
K.9.2 Short-Term Risk Evaluation for Operable Unit 4 K-9-5
K.9.3 Residual Human Health Risks K-9-6
K.9.3.1 Risks Under Current Land Use Scenario K-9-8
K.9.3.2 Risks Under Future Land Use With Federal Ownership Scenario K-9-13
K.9.3.3 Risks Under Future Land Use Without Federal Ownership K-9-17

K.10.0 UNCERTAINTIES K-10-1
K.10.1 COC Selection K-10-2
K.10.2 Toxicological Information and Models K-10-4
K.10.3 Exposure Pathways K-10-7
K.10.4 Receptor Characterization and Exposure Assumptions K-10-8
K.10.4.1 Exposure Duration K-10-9

- 5208

# TABLE OF CONTENTS
(Continued)


| | Page |
|---|---|
| K.10.4.2 Exposure Frequency | K-10-9 |
| K.10.4.3 Exposure Time | K-10-9 |
| K.10.4.4 Body Weight | K-10-9 |
| K.10.4.5 Ingestion of Soil, Food, and Water | K-10-10 |
| K.10.4.6 Dermal Exposure Factors | K-10-10 |
| K.10.4.7 Inhalation Exposure | K-10-11 |
| K.10.5 Exposure Point Concentrations | K-10-11 |
| K.10.5.1 Air Concentrations | K-10-11 |
| K.10.5.2 Surface Water and Groundwater Concentrations | K-10-13 |
| K.10.6 Risk Characterization | K-10-17 |
| K.10.7 Summary | K-10-17 |
| K.11.0 RESULTS SUMMARY | K-11-1 |
| K.11.1 Site-Wide Sources of Contamination | K-11-1 |
| K.11.2 Identification of COCs | K-11-1 |
| K.11.3 Receptors | K-11-2 |
| K.11.4 Pathways | K-11-4 |
| K.11.5 Postremediation Residual Risk | K-11-4 |
| K.11.6 Operable Unit Contributions to Risk | K-11-11 |
| K.11.7 Summary of Uncertainties | K-11-13 |
| K.11.8 Recommendations | K-11-15 |
| K.12.0 REFERENCES | K-12-1 |


ATTACHMENTS


| | | |
|---|---|---|
| K.I | Input Files to ODAST Modeling | K-I-1 |
| K.II | U-238 Mass Loading Rates to the SWIFT III Model | K-II-1 |
| K.III | Air Emission and Dispersion Modeling Input and Output | K-III-1 |
| K.IV | Intake and Risk Calculations | K-IV-1 |
| K.V | Summary of the Justifications for Solid-Liquid Partition Coefficient and Percent Extractable of Uranium in Contaminated Soil | K-V-1 |


0007

## LIST OF TABLES


| | | Page |
|---|---|---|
| Table K.1-1 | CRARE Scenarios and Receptors | K-1-26 |
| Table K.1-2 | Operable Unit 4 Consistency of Land Use and Receptor Scenarios | K-1-31 |
| Table K.3-1 | Parameters Used in CRARE to Estimate COC Exposures for Current and Future Land Use Scenarios | K-3-12 |
| Table K.3-2 | Dermal Soil Absorption Coefficients Used in Exposure Model | K-3-16 |
| Table K.4.1 | Contaminants Eliminated During Initial Screening | K-4-4 |
| Table K.4-2 | Potential COCs in Each Medium for Each Operable Unit (After Initial Screening) | K-4-5 |
| Table K.4-3 | Potential COCs for Operable Units 1 and 3 (After Second Screening) | K-4-10 |
| Table K.4-4 | Potential COCs for Operable Units 2 and 4 (After Second Screening) | K-4-12 |
| Table K.4-5 | Potential COCs for Operable Unit 5 (Includes Sum of COCs in Operable Units 1 Through 4, After Second Screening) | K-4-14 |
| Table K.4-6 | Final Screening of Organic Chemicals | K-4-16 |
| Table K.4-7 | COCs Retained After Final Screening for All Operable Units | K-4-18 |
| Table K.6-1 | Screening of COCs for the Groundwater Pathway | K-6-10 |
| Table K.6-2 | Source Terms for COC Masses and Concentrations | K-6-19 |
| Table K.6-3 | Vadose Zone Model Parameters | K-6-31 |
| Table K.6-4 | Summary of Vadose Zone Modeling Results | K-6-33 |
| Table K.6-5 | COC Concentrations in Paddys Run at the South Boundary for Current Land Use Scenario | K-6-40 |
| Table K.6-6 | COC Concentrations in Paddys Run at the South Boundary for Future Land Use Scenarios | K-6-41 |
| Table K.6-7 | Summary of Surface Water Modeling Results | K-6-43 |
| Table K.6-8 | U-238 Groundwater Concentrations at Receptor Locations | K-6-56 |
| Table K.6-9 | Estimated Radionuclide Concentrations (pCi/g) in Surface Soil/Cover Soil: Current Scenario | K-6-69 |
| Table K.6-10 | Estimated Radionuclide Concentrations (pCi/g) in Surface Soil/Cover Soil: Future Scenarios | K-6-70 |
| Table K.6-11 | Estimated Chemical Concentrations (mg/kg) in Surface Soil/Cover Soil: Current Scenario | K-6-71 |
| Table K.6-12 | Estimated Chemical Concentrations (mg/kg) in Surface Soil/Cover Soil: Future Scenarios | K-6-72 |
| Table K.6-13 | Wind Speed Dependent $PM_{10}$ Emission Rates | K-6-77 |

## LIST OF TABLES
(Continued)


| | | Page |
|---|---|---|
| Table K.6-14 | Radionuclide Emission Fluxes (pCi/s/m$^2$) from Surface Soil/Cover Soil: Current Scenario | K-6-78 |
| Table K.6-15 | Radionuclide Emission Fluxes (pCi/s/m$^2$) from Surface Soil/Cover Soil: Future Scenarios | K-6-79 |
| Table K.6-16 | Chemical Contaminant Emission Fluxes ($\mu$g/s/m$^2$) from Surface Soil/Cover Soil: Current Scenario | K-6-80 |
| Table K.6-17 | Chemical Contaminant Emission Fluxes ($\mu$g/s/m$^2$) from Surface Soils/Cover Soil: Future Scenarios | K-6-81 |
| Table K.6-18 | Rn-222 Fluxes from RAECOM Model | K-6-82 |
| Table K.6-19 | Radionuclide Concentrations in Air (pCi/m3): Current Scenario | K-6-88 |
| Table K.6-20 | Chemical Concentrations in Air ($\mu$g/m$^3$): Current Scenario | K-6-89 |
| Table K.6-21 | Average On-Property Contaminant Concentrations in Air: Current Scenario | K-6-90 |
| Table K.6-22 | Modeled and Monitored Radionuclide Fenceline Concentrations in Air (pCi/m3) | K-6-95 |
| Table K.6-23 | Radionuclide Concentrations in Air (pCi/m$^3$): Future Scenarios | K-6-96 |
| Table K.6-24 | Chemical Concentrations in Air ($\mu$g/m$^3$): Future Scenarios | K-6-97 |
| Table K.6-25 | Average On-Property Contaminant Concentrations in Air: Future Scenarios | K-6-98 |
| Table K.6-26 | Summary of Parameters for Vegetable/Forage Uptake Models | K-6-106 |
| Table K.6-27 | Chemical and Radioactive COC Decay Constants | K-6-107 |
| Table K.6-28 | Transfer Coefficients | K-6-108 |
| Table K.6-29 | Farm Product COC Concentrations: Off-Site Resident Farm Receptors Current Land Use Scenario | K-6-113 |
| Table K.6-30 | Farm Product COC Concentrations: Off-Site Resident Farm Receptors Future Land Use With Federal Ownership | K-6-115 |
| Table K.6-31 | Farm Product COC Concentrations: Off-Site Resident Farm Receptors Future Land Use Without Federal Ownership | K-6-117 |
| Table K.6-32 | Farm Product COC Concentrations: On-Site Resident Farm Receptors Future Land Use With Federal Ownership | K-6-119 |
| Table K.7-1 | Reference Doses | K-7-2 |
| Table K.7-2 | Cancer Slope Factors for Chemicals | K-7-6 |
| Table K.7-3 | Cancer Slope Factors for Radionuclides | K-7-9 |
| Table K.8-1 | Summary of COC Intakes: Current Land Use Scenario | K-8-3 |

## LIST OF TABLES
(Continued)


| | | Page |
|---|---|---|
| Table K.8-2 | Summary of COC Intakes: Future Land Use, Government Scenario | K-8-6 |
| Table K.8-3 | Summary of COC Intakes: Future Land Use, Private Scenario | K-8-9 |
| Table K.9-1 | Summary of ILCR and HI for All Scenarios, All Pathways | K-9-7 |
| Table K.9-2 | Summary of Potential Health Effects: Groundskeeper (Current Land Use) | K-9-8 |
| Table K.9-3 | Summary of Potential Health Effects: Trespassing Child (Current Land Use) | K-9-9 |
| Table K.9-4 | Summary of Potential Health Effects: Off-Property Resident Farm Adult (Current Land Use) | K-9-10 |
| Table K.9-5 | Summary of Potential Health Effects: Off-Property Resident Farm Youth (Current Land Use) | K-9-11 |
| Table K.9-6 | Summary of Potential Health Effects: Off-Property Resident Farm Child (Current Land Use) | K-9-12 |
| Table K.9-7 | Summary of Potential Health Effects: Expanded Trespasser (Future Land Use With Federal Ownership) | K-9-13 |
| Table K.9-8 | Summary of Potential Health Effects: Off-Property Resident Farm Adult (Future Land Use With Federal Ownership) | K-9-14 |
| Table K.9-9 | Summary of Potential Health Effects: Off-Property Resident Farm Youth (Future Land Use With Federal Ownership) | K-9-15 |
| Table K.9-10 | Summary of Potential Health Effects: Off-Property Resident Farm Child (Future Land Use With Federal Ownership) | K-9-16 |
| Table K.9-11 | Summary of Potential Health Effects: On-Property Resident Farm Adult (Future Land Use Without Federal Ownership) | K-9-17 |
| Table K.9-12 | Summary of Potential Health Effects: On-Property Resident Farm Youth (Future Land Use Without Federal Ownership) | K-9-18 |
| Table K.9-13 | Summary of Potential Health Effects: On-Property Resident Farm Child (Future Land Use Without Federal Ownership) | K-9-19 |
| Table K.9-14 | Summary of Potential Health Effects: Off-Property Resident Farm Adult (Future Land Use Without Federal Ownership) | K-9-20 |
| Table K.9-15 | Summary of Potential Health Effects: Off-Property Resident Farm Youth (Future Land Use Without Federal Ownership) | K-9-21 |
| Table K.9-16 | Summary of Potential Health Effects: Off-Property Resident Child (Future Land Use Without Federal Ownership) | K-9-21 |
| Table K.10-1 | Major Parameters in CRARE Modeling and Their Effect on Aquifer Loading | K-10-15 |


0010

## LIST OF TABLES
(Continued)


| | | Page |
|---|---|---|
| Table K.11-1 | Summary of ILCR and HI for All Receptors, All Scenarios | K-11-5 |
| Table K.11-2 | Pathway Risks: Current Land Use Scenario | K-11-7 |
| Table K.11-3 | Pathway Risks: Future Land Use With Federal Ownership | K-11-8 |
| Table K.11-4 | Pathway Risks: Future Without Federal Ownership | K-11-9 |
| Table K.11-5 | Operable Unit Contributions to Risk | K-11-12 |
| Table K.11.6 | Summary of Uncertainties, Actions for Reduction | K-11-16 |

## LIST OF FIGURES

5208


| | | Page |
|---|---|---|
| Figure K.1-1 | Iterative Nature of the CRARE | K-1-3 |
| Figure K.1-2 | FEMP Site, Operable Unit 4 Detail | K-1-5 |
| Figure K.1-3 | Topographic Map of the FEMP | K-1-7 |
| Figure K.1-4 | Existing FEMP Detail | K-1-12 |
| Figure K.1-5 | Existing Detail, Operable Unit 1 | K-1-13 |
| Figure K.1-6 | Existing Detail, Operable Unit 2 | K-1-14 |
| Figure K.1-7 | Existing Detail, Operable Unit 3 | K-1-15 |
| Figure K.1-8 | Existing Detail, Operable Unit 4 | K-1-16 |
| Figure K.1-9 | Existing Detail, Operable Unit 5 (Soils) | K-1-17 |
| Figure K.1-10 | Overview of Contaminant Sources, Operable Units 1 through 5 | K-1-24 |
| Figure K.1-11 | Site Conceptual Model, Current Land Use | K-1-27 |
| Figure K.1-12 | Site Conceptual Model, Future Land Use With Federal Ownership | K-1-28 |
| Figure K.1-13 | Site Conceptual Model, Future Land Use Without Federal Ownership | K-1-29 |
| Figure K.2-1 | Typical Vault | K-2-11 |
| Figure K.3-1 | Site Conditions Postremediation | K-3-3 |
| Figure K.4-1 | COC Selection Process | K-4-2 |
| Figure K.5-1 | Primary Sources of Residual COCs at the Remediated FEMP | K-5-5 |
| Figure K.5-2 | Detailed Exposure Model, Current Land Use | K-5-15 |
| Figure K.5-3 | Detailed Exposure Model, Future Land Use With Federal Ownership | K-5-16 |
| Figure K.5-4 | Detailed Exposure Model, Future Land Use Without Federal Ownership | K-5-17 |
| Figure K.6-1 | Evaluation of Surface Water and Groundwater Pathways | K-6-5 |
| Figure K.6-2 | SWIFT III Groundwater Transport Grid | K-6-6 |
| Figure K.6-3 | Grid Locations of Elevated Uranium in FEMP Soils | K-6-14 |
| Figure K.6-4 | Infiltration Rates Through the Vault System | K-6-27 |
| Figure K.6-5 | Source Depletion for U-238 from the Production Area Soils | K-6-35 |
| Figure K.6-6 | Surface Water Basins and Recharge Areas to Groundwater | K-6-39 |
| Figure K.6-7 | Surface Water U-238 Concentration vs. Time at South Boundary Receptor Under the Future Land Use Scenario | K-6-43 |
| Figure K.6-8 | Initial Concentrations of U-238 in Aquifer After Remediation | K-6-48 |
| Figure K.6-9 | U-238 Groundwater Concentrations at 70 Years for Future Land Use Scenario | K-6-49 |


0012

5208

## LIST OF FIGURES
(Continued)


| | | Page |
|---|---|---|
| Figure K.6-10 | U-238 Groundwater Concentrations at 1000 Years | K-6-50 |
| Figure K.6-11 | U-234 Groundwater Concentrations at 1000 Years | K-6-51 |
| Figure K.6-12 | U-235 Groundwater Concentrations at 1000 Years | K-6-52 |
| Figure K.6-13 | U-236 Groundwater Concentrations at 1000 Years | K-6-53 |
| Figure K.6-14 | Groundwater Receptor Location | K-6-55 |
| Figure K.6-15 | Groundwater U-238 Concentration vs. Time for Off-Property Receptor A Under the Current Land Use Scenario | K-6-58 |
| Figure K.6-16 | Groundwater U-238 Concentrations vs. Time for Off-Property Receptor B Under the Future Land Use Scenario | K-6-58 |
| Figure K.6-17 | SR-90 Groundwater Concentrations at 20 Years for Future Land Use Scenario | K-6-59 |
| Figure K.6-18 | SR-90 Groundwater Concentrations at 70 Years for Future Land Use Scenario | K-6-60 |
| Figure K.6-19 | TC-99 Groundwater Concentration at Steady State | K-6-61 |
| Figure K.6-20 | Sequential Block Diagram of Air Transport Analysis | K-6-65 |
| Figure K.6-21 | Source Locations for Air Dispersion Model | K-6-67 |
| Figure K.6-22 | Receptor Grids for Air Dispersion Modeling | K-6-84 |
| Figure K.6-23 | Rn-222 Concentration in Air for Current Scenario | K-6-91 |
| Figure K.6-24 | U-234 Concentration in Air for Current Scenario | K-6-93 |
| Figure K.6-25 | U-238 Concentration in Air for Current Scenario | K-6-94 |
| Figure K.6-26 | Rn-222 Concentration in Air for Future Scenario | K-6-100 |
| Figure K.6-27 | U-234 Concentration in Air for Future Scenario | K-6-101 |
| Figure K.6-28 | U-238 Concentration in Air for Future Scenario | K-6-102 |
| Figure K.11-1 | Summary of the CRARE Risk Assessment Process | K-11-3 |
| Figure K.11-2 | Summary of FEMP Residual ILCR | K-11-6 |
| Figure K.11-3 | Summary of FEMP Hazard Index | K-11-6 |

# ACRONYMS

5208

| | |
|---|---|
| AAQS | Ambient Air Quality Standards |
| ARAR | applicable, relevant, and appropriate requirements |
| BEIR | biological effects of ionizing radiation |
| BGS | below ground surface |
| CAA | Clean Air Act |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| cfs | cubic feet per second |
| cm/s | centimeter per second |
| cm/yr | centimeter per year |
| COC | contaminant of concern |
| CRARE | Comprehensive Response Action Risk Evaluation |
| DOD | U.S. Department of Defense |
| DOE | U.S. Department of Energy |
| DOT | U.S. Department of Transportation |
| ECAO | U.S. Environmental Criteria and Assessment Office |
| EE/CA | engineering evaluation/cost analysis |
| EIS | environmental impact statement |
| EPA | Environmental Protection Agency |
| ERA | ecological risk assessment |
| FEMP | Fernald Environmental Management Project |
| FFCA | Federal Facility Compliance Agreement |
| FMPC | Feed Materials Production Center |
| FRG | final remedial goal |
| FS | feasibility study |
| FS/RA | feasibility study/risk assessment |
| GI | gastrointestinal |
| HDPE | high density polyethylene |
| HEAST | Health Effects Assessment Summary Tables |
| HI | hazard index |
| HQ | hazard quotient |
| IAWWT | interim advanced waste water treatment |
| ICRP | International Commission of Radiological Production |
| IRIS | Integrated Risk Information System |
| ISCLT2 | Industrial Source Complex, Long-Term, Version 2 |
| $K_d$ | solid-liquid partitioning coefficient |
| kg | kilogram |
| LC/DS | leachate collection/detection system |
| LET | linear energy transfer |
| LOAEL | lowest observed adverse effect level |
| LRA | leading remedial alternative |
| MAGLC | maximum allowable ground level concentration |
| MAV | mass-weighted average |
| MCL | maximum concentration level |
| MCLG | maximum concentration level goal |
| mg | milligram |
| mph | miles per hour |
| mrem | millirem |
| MSL | mean sea level |
| MUSLE | Modified Universal Soil Loss Equation |

0014

## ACRONYMS
(Continued)

| | |
|---|---|
| NCP | National Contingency Plan |
| NCRP | National Council on Radiation Protection |
| NEPA | National Environmental Policy Act |
| NESHAPS | National Emission Standards for Hazardous Air Pollutants |
| NOAEL | no observed adverse effect level |
| NPDES | National Pollutant Discharge Elimination System |
| NRC | Nuclear Regulatory Commission |
| NTS | Nevada Test Site |
| NWS | News Weather Service |
| ODAST | One-Dimensional Analytical Solute Transport |
| OEPA | Ohio Environmental Protection Agency |
| ORP | Office of Radiation Program |
| PAH | polycyclic aromatic hydrocarbons |
| PCB | polychlorinated biphenyl |
| pCi/g | picocurie per gram |
| pCi/l | picocurie per liter |
| ppm | parts per million |
| PRG | preliminary remedial goal |
| PRL | proposed remediation level |
| QA | quality assurance |
| RA | risk assessment |
| RAG | Risk Assessment Guidelines for Superfund |
| RAWPA | Risk Assessment Work Plan Addendum |
| RCRA | Resource Conservation and Recovery Act |
| RDA | recommended daily allowance |
| RfC | reference concentration |
| RfD | reference dose |
| RI | remedial investigation |
| RI/FS | remedial investigation/feasibility study |
| RIQO | risk information quality objective |
| RME | reasonable maximum exposure |
| ROD | record of decision |
| SARA | Superfund Amendment and Reauthorization Act |
| SOWC | Southern Ohio Water Company |
| SSOD | storm sewer outfall ditch |
| SWCR | Site-Wide Characterization Report |
| TBC | to be considered |
| TCLP | toxicity characteristic leaching procedure |
| TEF | toxicity equivalency factor |
| TFV | threshold fraction value |
| TSP | total suspended particulate |
| TWA | time-weighted average |
| UCL | upper confidence limit |
| UMTRA | Uranium Mill Tailings Remedial Action |
| UNSCEAR | United Nations Scientific Committee on the Effects of Atomic Radiation |
| USGS | U.S. Geological Survey |
| USLE | Universal Soil Loss Equation |
| VOC | volatile organic compound |

# ENGLISH/METRIC AND METRIC/ENGLISH EQUIVALENTS

In this document, units of measure are presented with the metric unit first, followed by the English equivalent in parentheses. In tables, the data are generally in English or metric units only. The following table lists the appropriate equivalents for English and metric units.

**English/Metric Equivalents**

| Multiply | By | To Obtain |
|---|---|---|
| acres | 0.4047 | hectares (ha) |
| cubic feet ($ft^3$) | 0.02832 | cubic meters ($m^3$) |
| cubic yards ($yd^3$) | 0.7646 | cubic meters ($m^3$) |
| degrees Fahrenheit (°F) -32 | 0.5555 | degrees Celsius (°C) |
| feet (ft) | 0.3048 | meters (m) |
| gallons (gal) | 3.785 | liters (l) |
| gallons (gal) | 0.003785 | cubic meters ($m^3$) |
| inches (in.) | 2.540 | centimeters (cm) |
| miles (mi) | 1.609 | kilometers (km) |
| pounds (lb) | 0.4536 | kilograms (kg) |
| short tons (tons) | 907.2 | kilograms (kg) |
| short tons (tons) | 0.9072 | metric tons (t) |
| square feet ($ft^2$) | 0.09290 | square meters ($m^2$) |
| square yards ($yd^2$) | 0.8361 | square meters ($m^2$) |
| square miles ($mi^2$) | 2.590 | square kilometers ($km^2$) |
| yards (yd) | 0.9144 | meters (m) |

**Metric/English Equivalents**

| Multiply | By | To Obtain |
|---|---|---|
| centimeters (cm) | 0.3937 | inches (in.) |
| cubic meters ($m^3$) | 35.31 | cubic feet ($ft^3$) |
| cubic meters ($m^3$) | 1.308 | cubic yards ($yd^3$) |
| cubic meters ($m^3$) | 264.2 | gallons (gal) |
| degrees Celsius (°C) + 17.78 | 1.8 | degrees Fahrenheit (°F) |
| hectares (ha) | 2.471 | acres |
| kilograms (kg) | 2.205 | pounds (lb) |
| kilograms (kg) | 0.001102 | short tons (tons) |
| kilometers (km) | 0.6214 | miles (mi) |
| liters (l) | 0.2642 | gallons (gal) |
| meters (m) | 3.281 | feet (ft) |
| meters (m) | 1.094 | yards (yd) |
| metric tons (t) | 1.102 | short tons (tons) |
| square kilometers ($km^2$) | 0.3861 | square miles ($mi^2$) |
| square meters ($m^2$) | 10.76 | square feet ($ft^2$) |
| square meters ($m^2$) | 1.196 | square yards ($yd^2$) |

# EXPOSURE ASSESSMENT SYMBOLS

Inhalation of Dusts, Volatiles, and Radon

$I_a$ = Intake from inhalation (pCi) or (mg/kg/day)
$C_a$ = Concentration in air (pCi/m$^3$) or (mg/m$^3$)
IR = Inhalation rate (m$^3$/hr)
ET = Exposure time (hr/day)
EF = Exposure frequency (days/yr)
ED = Exposure duration (yr)
BW = Body weight (kg)
AT = Averaging time (days); for noncarcinogens, AT equals (ED)(365 days/yr); for carcinogens, AT equals (70-year lifetime)(365 days/yr)

Ingestion of Drinking Water, Food Stuffs

$I_w$ = Intake from drinking water (pCi) or (mg/kg/day)
$C_w$ = Concentration in water (pCi/l) or (mg/l)
IR = Ingestion rate (l/day)
EF = Exposure frequency (days/yr)
ED = Exposure duration (yr)
FI = Fraction ingested from the contaminated source (unitless)
BW = Body weight (kg)
AT = Averaging time (days); for noncarcinogens, AT equals (ED)(365 days/yr); for carcinogens, AT equals (70-year lifetime)(365 days/yr)

Inhalation of Volatiles from Water While Showering

$I_a$ = Intake from inhalation (pCi) or (mg/kg/day)
$C_a$ = Concentration in air (pCi/m$^3$) or (mg/m$^3$)
IR = Inhalation rate (m$^3$/hr)
ET = Exposure time (hr/day)
EF = Exposure frequency (days/yr)
ED = Exposure duration (yr)
BW = Body weight (kg)
AT = Averaging time (days); for noncarcinogens, AT equals (ED)(365 days/yr); for carcinogens, AT equals (70-year lifetime)(365 days/yr)

Dermal Contact with Soil/Sediment and While Bathing or Swimming

$AB_w$ = Absorbed dose from contact with water (mg/kg/day)
$C_w$ = Concentration in water (mg/l)
SA = Skin surface area available for contact (cm$^2$)
PC = Dermal permeability constant (cm/hr)
ABS = Absorption factor (unitless)
AF = Skin adherence factor (mg/cm$^2$)

## EXPOSURE ASSESSMENT SYMBOLS
**(Continued)**

ET = Exposure time (hr/day)
ED = Exposure duration (yr)
EF = Exposure frequency (days/yr)
CF = Conversion factor (1l/1000 $cm^3$)
BW = Body weight (kg)
AT = Averaging time (days); for noncarcinogens, AT equals (ED)(365 days/yr); for carcinogens, AT equals (70-year lifetime)(365 days/yr)

Incidental Ingestion of Soil/Sediment and While Swimming

$I_s$ = Intake from soil or sediment (pCi) or (mg/kg/day)
$C_s$ = Concentration in soil or sediment (pCi/g) or (mg/kg)
IR = Ingestion rate (g/day) or (mg/day)
CF = Conversion factor 10-6 kg/mg
FI = Fraction ingested from contaminated source (unitless)
EF = Exposure frequency (days/yr)
ED = Exposure duration (yr)
BW = Body weight (kg)
AT = Averaging time (days); for noncarcinogens, AT equals (ED)(365 days/yr); for carcinogens, AT equals (70-year lifetime)(365 days/yr)

External Radiation Exposure

DE = Dose equivalent (mrem)
DR = Dose equivalent rate (mrem/hr)
EF - Exposure frequency (days/yr)
ETi = Exposure time, fraction spent indoors (unitless)
ETo = Exposure time, fraction spent indoors (unitless)
ED = Exposure duration (yr)
FD = Fraction of a day
FY = Fraction of a year
SHi = Building shielding factor for dose equivalent rate reduction indoors (unitless)
SHo = Building shielding factor for dose equivalent rate reduction outdoors (unitless)

0018

# SECTION K.1.0

# INTRODUCTION

## K.1.0 INTRODUCTION

In accordance with the Amended Consent Agreement, a Comprehensive Response Action Risk Evaluation (CRARE) will be prepared for each operable unit at the Fernald Environmental Management Project (FEMP) site. The CRAREs will analyze the potential cumulative, residual, human-health risks projected to remain on-site following implementation of the remedial actions for the five operable units. Each operable unit feasibility study (FS) report will include a CRARE as an appendix. This CRARE is the first to be prepared, the Operable Unit 4 CRARE.

The CRAREs will use as a starting point the leading remedial alternatives (LRAs) updated as a result of the comparative analysis of alternatives in the FSs. If the analysis has not yet been completed, the CRAREs will use the LRAs from the Site-Wide Characterization Report (SWCR). As the operable unit FSs are completed and more information becomes available, the original LRAs will be modified to reflect a more accurate understanding of the FEMP environment and to incorporate record of decision (ROD) remedial actions. These updated LRAs will be included in future CRAREs. As noted in the SWCR, "the LRA does not represent the pre-selection of the remedy and will be used solely for the purpose of estimating and evaluating the risks presented by the entire site." Because the CRAREs are based only on the information available at the time they are prepared, all but the final CRARE (Operable Unit 3) must be considered *preliminary* evaluations of final residual risk. One of the most important uses of the early CRAREs is to identify areas contributing the greatest risk and thus provide focus and direction to future data collection and analysis, as well as response actions to be considered for the other operable units.

The CRAREs for Operable Units 1 through 4 will address human health risk. Ecological risks associated with Operable Unit 4 are addressed in Appendix I of this FS report. Ecological risks for Operable Units 1 through 3 will be addressed for those operable units in their FS reports (site-wide baseline ecological risks can be found in the SWCR). A detailed, quantitative Ecological Risk Assessment (ERA) will be included in the Operable Unit 5 Remedial Investigation (RI). Therefore, the Operable Unit 5 RI/FS and final CRARE will be used to ensure that the human and ecological residual risk of the remediated FEMP is acceptable under the National Contingency Plan (NCP) and U.S. Environmental Protection Agency (EPA) guidance.

### K.1.1 CRARE OBJECTIVES

The objective of the CRARE is to estimate, from a site-wide perspective, the risk remaining after the FEMP has been remediated. This objective and other supporting objectives are depicted in Figure K.1-1. The figure also presents the iterative nature of the CRARE documents and demonstrates the scope of the Operable Unit 4 CRARE, according to the Risk Assessment Work Plan Addendum (RAWPA), dated June 1992 (DOE 1992i). The Operable Unit 4 CRARE focuses on long-term residual risks after the remedial activities at the site have been completed. Short-term risks are addressed to a lessor extent and are presented quantitatively for Operable Unit 4 in Appendix D. This information is integrated into a qualitative discussion addressing the remaining operable units. Eventually, after the FS and associated risk assessments are completed for each subsequent operable unit, the CRAREs may then include a more quantitative treatment of short-term transient risks and to some extent provide data to optimize the alternative remedial actions and their scheduled implementation.

Proposed remediation levels (PRLs) will ultimately be developed using an iterative process based on future operable unit RI/FS documents. Initial PRGs will be modified as the FSs proceed and operable-unit risk assessments are completed. It is important to note that the PRGs are set during the FS for each operable unit and are merely evaluated in the CRARE. The CRARE then integrates the information and provides a site-related risk evaluation.

This Operable Unit 4 CRARE:

- Quantifies operable-unit-specific contributions to site-wide potential public health concerns, which include both potential carcinogenic (radiological and chemical) and noncarcinogenic effects.
- Provides information to address modifications of site-wide preliminary remedial goals (PRGs), based on associated carcinogenic and noncarcinogenic effects to human receptors.
- Incorporates operable-unit-specific information from the Operable Unit 4 FS risk assessment and sets the protocol for future operable unit considerations.

0021

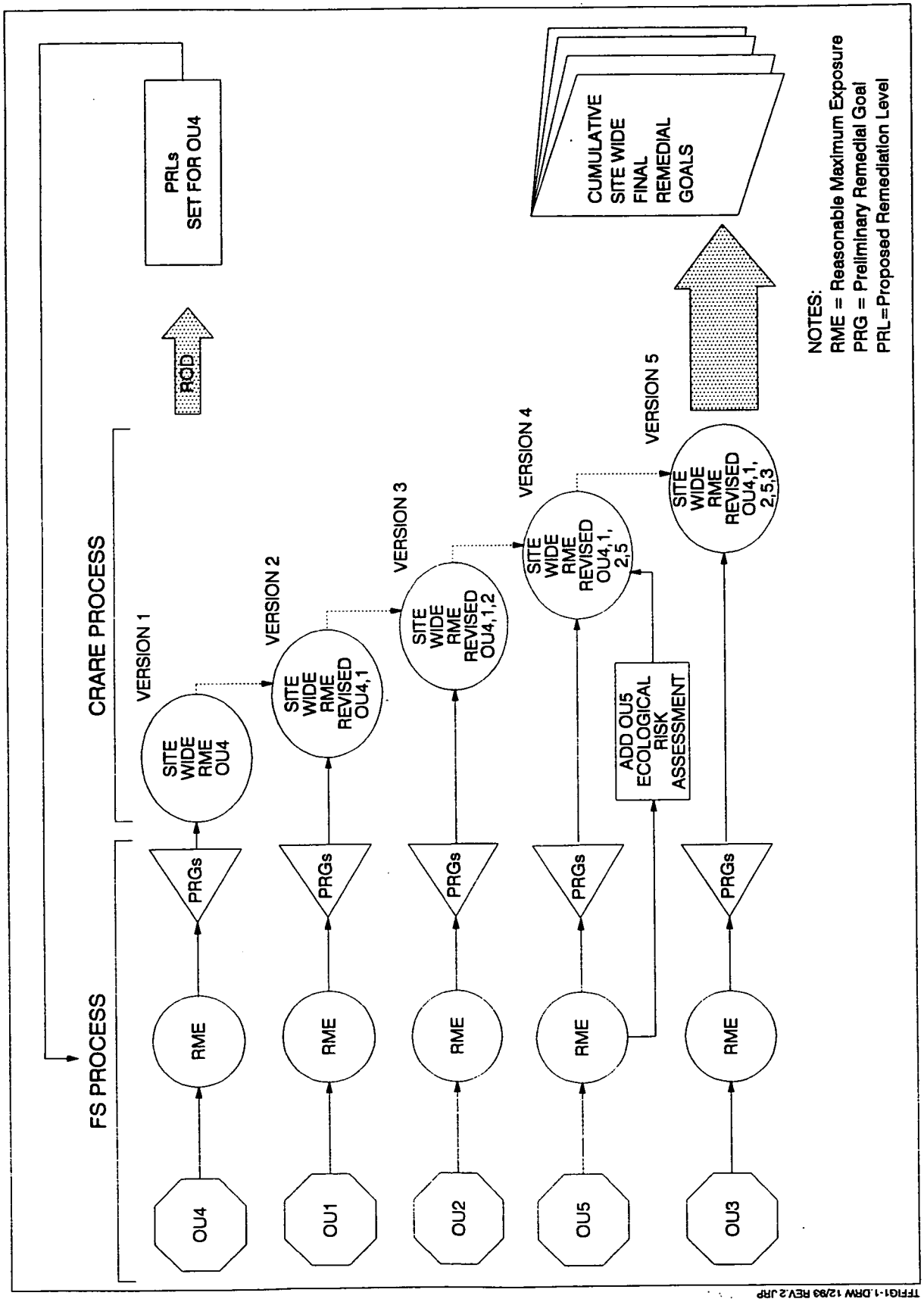



FIGURE K.1-1. ITERATIVE NATURE OF THE CRARE

04/42431 OU4 FD-IRVINE
TFFIG1-1.DRW 12/93 REV.2 JRP

0022

## K.1.2 FEMP SITE HISTORY

Formerly known as the Feed Materials Production Center, the FEMP (Figure K.1-2) is a contractor-operated federal facility where pure uranium metals were produced for the DOE from 1951 to 1989. No isotopic separation of uranium in the starting materials was performed. After production ceased, plant resources were focused on a cleanup program. In 1991, the FEMP was officially closed as a federal production facility, but the environmental studies and cleanup activities continued. The FEMP site is located on 425 hectares (1050 acres) in a rural area of Hamilton and Butler counties, approximately 29 kilometers (18 miles) northwest of Cincinnati, Ohio.

## K.1.3 SITE DESCRIPTION

This section summarizes the regional and site-specific environment of the FEMP, focusing on the climate, geology, topography, surface water, hydrology, ecology, land use, and demographics. Additional information can be found in Chapter 4 and Appendix I of this FS report.

### K.1.3.1 Climate

Information on the local climate has been gathered from an on-property meteorological system installed in 1986, and the National Weather Service Office at the Greater Cincinnati Airport. The *Interim Report-Air, Soil, Water, and Health Risk Assessment in the Vicinity of FEMP* (IT 1986) indicated that data obtained from monitoring stations at the airport sufficiently represent local climate conditions.

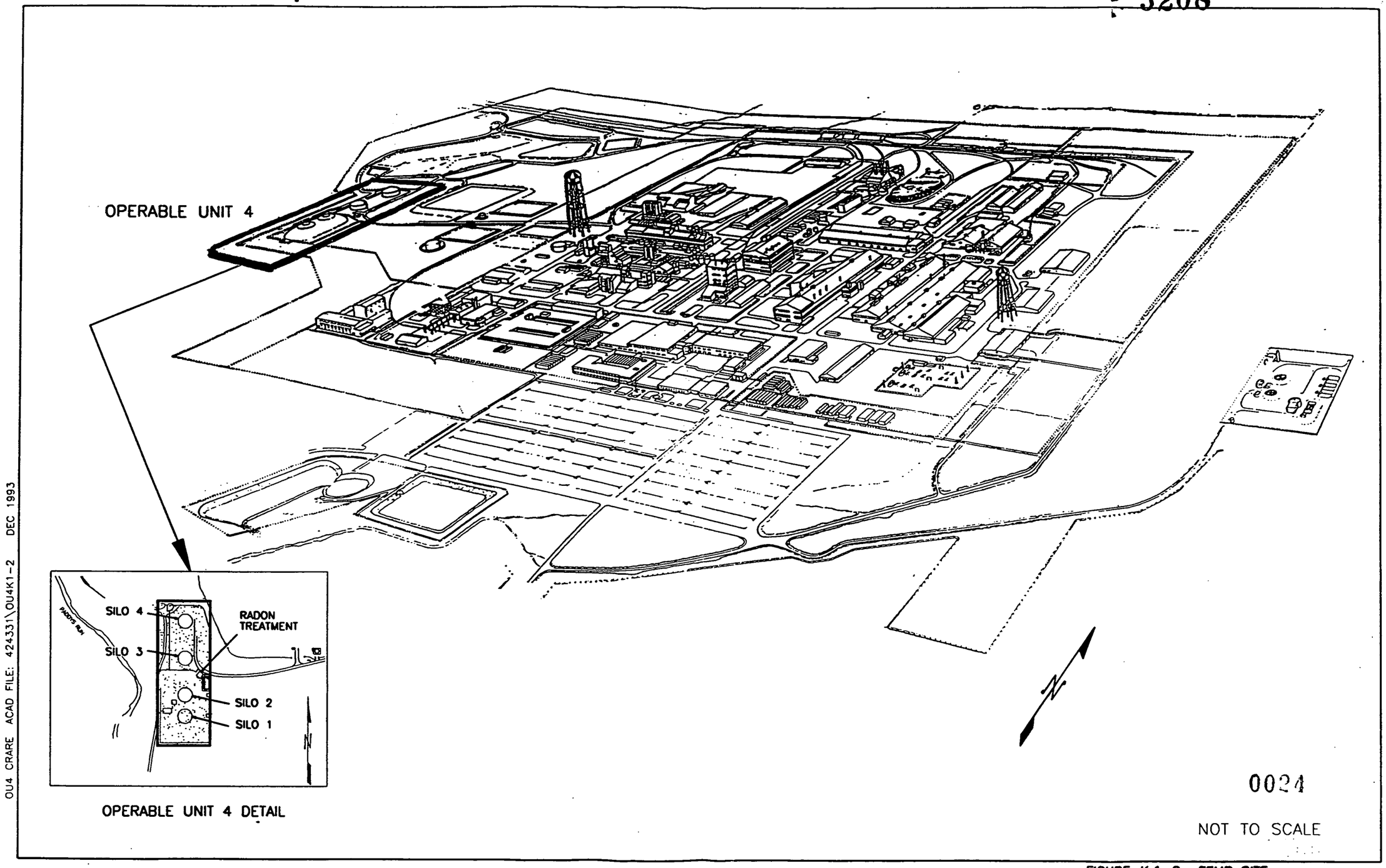
#### Winds

The prevailing winds are generally from the southwest and west-southwest. The average monthly wind speeds, based on National Weather Service meteorological data, range from 11 kilometers per hour (kpm) or 7 miles per hour (mph) in August to 17.6 kph (11 mph) in March. For more information, refer to the SWCR.

Six years of meteorological data collected on-site indicate that the mean annual wind speed at the FEMP is approximately 7.3 kph (4.5 mph). The on-site data also indicate that the prevailing wind direction is from the southwest.

0023

5208




OU4 CRARE ACAD FILE: 424331\OU4K1-2 DEC 1993

0024

FIGURE K.1-2 FEMP SITE
OPERABLE UNIT 4 DETAIL

Precipitation

The average annual precipitation for the Cincinnati area from 1960 through 1989 was 103 centimeters (40.6 inches). The highest precipitation typically occurs during the spring and early summer, the lowest in the late summer and fall. The average annual snowfall for 1960 through 1989 was 59.7 centimeters (23.5 inches). The total rainfall for the area in 1991 was 102 centimeters (40.1 inches), and the total snowfall was 23.6 centimeters (9.3 inches). The wettest months in 1991 were August and December, with 12.8 and 12.9 centimeters (5.04 and 5.08 inches) of rainfall, respectively.

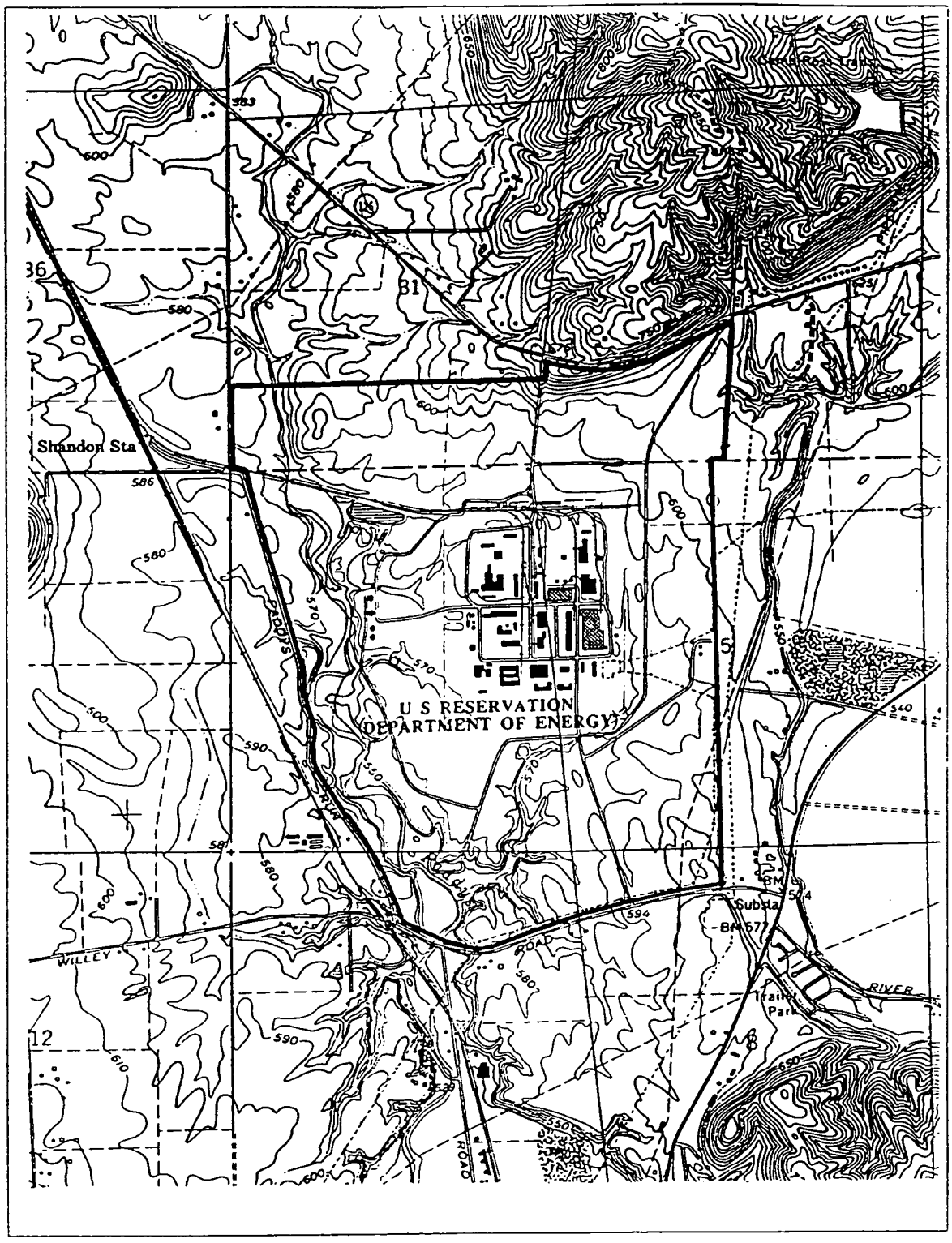
Temperature

The regional climate is defined as continental, with average monthly temperatures ranging from -1.55°C (29.2°F) in January to 24.3°C (75.7°F) in July. The highest temperature recorded from 1961 through 1989 was 39.4°C (103°F) in July 1988, and the lowest was -32°C (-25°F) in January 1977.

K.1.3.2 Topography and Surface Water Hydrology

The site topography and drainage channels are shown in Figure K.1-3. Maximum elevation along the northern boundary of the FEMP property is slightly more than 213.36 meters (700 feet) above mean sea level (MSL). The production and waste storage areas are on a relatively level plain at about 176.8 meters (580 feet) MSL. The plain slopes from 182.9 meters (600 feet) MSL along the eastern edge of the FEMP to 173.7 meters (570 feet) MSL at the K-65 silos, and then drops off towards Paddys Run stream at 167.64 (550 feet) MSL. All drainage on the property is generally from east to west into Paddys Run, which flows intermittently.

Paddys Run is a steep-sided stream that originates north of the FEMP and runs south along the western boundary of the facility. Paddys Run is approximately 14 kilometers (8.8 miles) long and drains an area of approximately 40.9 square kilometers (15.8 square miles). The stream is ungauged, but estimated flows for January through May range from 0.0057 to 0.113 cubic meters per second (cms) or 0.2 to 4.0 cubic feet per second (cfs). The stream is a tributary of the Great Miami River, which is three-quarters of a mile from the facility's eastern boundary at its closest point.




SOURCE
USGS (1981)
SHANDON, OHIO
QUADRANGLE

SCALE
1:24,000

OU4 CRARE CADFILE: 424331\OU4K1-3 DEC 1993

FIGURE K.1-3
TOPOGRAPHIC MAP OF THE FEMP

0026

The FEMP lies within the Great Miami River drainage basin but is above the river's present-day floodplain. The Great Miami River is the main surface water feature in the vicinity and is the receiving water for National Pollutant Discharge Elimination System (NPDES) permitted discharge from the facility. The river flows generally to the southwest and drains an area of approximately 702.4 square kilometers (3360 square miles).

The average discharge for the Great Miami River, based on 55 years of records, is 936 cms (3305 cfs). The maximum discharge ever recorded for the river occurred on March 26, 1913 and was estimated to be 9968.6 cms (352,000 cfs). The 10-year flood discharge has been calculated to be 2306.8 cms (81,455 cfs). The minimum daily discharge of 4.4 cms (155 cfs) was recorded on September 27, 1941.

K.1.3.3 Geology and Hydrology

At the FEMP, groundwater occurs in the glacial overburden as perched water, in a sand and gravel aquifer (the Great Miami Aquifer), and to a lesser extent in the underlying bedrock. Perched water occurs when water sinking through the earth from the surface is retarded above a very dense strata, in this case clay. This perched water either seeps slowly through the clay or flows horizontally to discharge sites in Paddys Run. At the FEMP, perched water is generally found between 0.3 and 3 meters (1 and 10 feet) below the surface (WMCO 1991).

The glacial overburden, which occurs under most of the FEMP property, is composed of the following: loess, fine-grained silt with small amounts of clay; lacustrine deposits, silt and clay with interbedded sand; till, heterogeneous mixture of silt, clay, sand, gravel, and boulder-sized materials; and glaciofluvial deposits, well-sorted sand and gravel. The thickness of the glacial overburden ranges from 1.5 to 15 meters (5 to 50 feet) within the FEMP study area, but most often averages between 6.1 and 9.1 meters (20 and 30 feet). With the exception of some scattered deposits, this material does not exist along the floodplain of the Great Miami River to the east and south of the FEMP. The only on-property areas that lack overburden are certain reaches of Paddys Run and the storm sewer outfall ditch, where the material has eroded away.

The presence of till and deposits of silt and clay classifies the overburden as an aquitard in most locations. However, perched water zones are formed from the lenses, beds, and irregularly shaped

deposits of sand and gravel interbedded within the till. A series of slug tests performed in the on-property wells screened in the perched-water zones found hydraulic conductivities ranging from 0.002 to 4.5 meters per day (0.0071 to 14.7 feet per day). Porosities range from 22.1 to 36.7 percent with a mean of 31 percent (Morris and Johnson 1967). Based on hydrograph analyses, the interconnection between perched-water zones is limited, indicating that the movement of water and contaminants within and among these units is limited. The till is considered to be saturated from the perched water zones down to the top of the glaciofluvial deposit. The upper portion of these deposits are unsaturated above the Great Miami Aquifer. Over an extended period of time, connections between the perched-water zones and the underlying Great Miami Aquifer are possible.

Water seeping through the clay layer passes through the glacial overburden and collects in the underlying aquifer. The Great Miami Aquifer, is about 24.4 meters (80 feet) beneath the FEMP and ranges between 38.1 and 53.3 meters (125 and 175 feet) in thickness. Flow in the aquifer is to the southeast and south, toward the Great Miami River.

K.1.3.4 Ecology

Plant and wildlife communities within FEMP boundaries have been extensively characterized by Facemire et al. (1990), who provide detailed data on species abundances. Habitats include grazed and ungrazed pastures, pine plantations, deciduous woodlands, riparian woodlands, and a "reclaimed" flyash pile, which overlaps the inactive flyash pile and South Field. The inactive flyash pile and South Field have been colonized by American elm, eastern cottonwood, black locust, redbud, and box elder. Herbaceous species are also present. Common mammals include the white-tailed deer, eastern cottontail rabbit, coyote, red fox, and several smaller animals such as the white-footed mouse, short-tailed shrew, and eastern chipmunk.

K.1.3.5 Land Use

Farming and raising dairy and beef cattle account for most land use in the area surrounding the FEMP. Major crops include field corn, sweet corn, soybeans, and winter wheat. Other important commercial activities include sand and gravel mining and potable water extraction from the Great Miami Aquifer. Many sand and gravel operations exist along the Great Miami River. The Southwest Ohio Water Company is located 2 kilometers (1.25 miles) upstream of the FEMP discharge line to the river.

K.1.3.6 Demographics

Scattered residences and several villages, including Fernald, New Baltimore, Ross, New Haven, and Shandon, are near the FEMP. Downtown Cincinnati is approximately 29 kilometers (18 miles) southeast, and the cities of Hamilton and Fairfield are approximately 9.7 to 13 kilometers (6 to 8 miles) to the northeast. More than 24,000 people live within 8 kilometers (5 miles) of the facility center, the nearest resident within 1.2 kilometers (0.75 miles). The Knollman Dairy Farm is on Willey Road, just outside the southeast corner of the FEMP property boundary. Several residences are located off Paddys Run Road, approximately 1.6 kilometers (1 mile) south of property boundaries.

K.1.4 OPERABLE UNITS

The FEMP was divided into five operable units under the original 1990 Consent Agreement, and the units were redefined under the Amended Consent Agreement. Figure K.1-4 shows the FEMP site as a whole. The five operable units are detailed in Figures K.1-5 through K.1-9; their revised definitions are presented below:

- Operable Unit 1:

  Waste Pits 1 through 6, the Clearwell, burn pit, berms, liners, and associated contaminated soil within the operable unit boundary. Waste Pits 3 and 5 and the Clearwell also contain water, including perched water (Figure K.1-5).

- Operable Unit 2:

  The active and inactive flyash piles, South Field lime sludge ponds, solid-waste landfill, berms, liners, and associated contaminated soil and perched water within the operable unit boundary (Figure K.1-6).

- Operable Unit 3:

  The production area and associated facilities and equipment including all structures, equipment, utilities, drums, tanks, solid waste, waste product, thorium, effluent lines, K-65 transfer line, wastewater treatment facilities, fire training facilities, scrap metal piles, feed stocks, and the coal pile (Figure K.1-7).

- Operable Unit 4:

  Silos 1, 2, 3, and 4, berms, decant tank system, radon, treatment system, and associated contaminated soil and perched water within the operable unit boundary (Figure K.1-8).

0029

5208

- Operable Unit 5:

  Perched and regional groundwater, surface water, soil not associated with other operable units (e.g., hot spots not previously identified). Also, soil beneath the Operable Unit 3 (Figure K.1-9).

## K.1.5 FEMP REMEDIATION

### K.1.5.1 Removal Actions

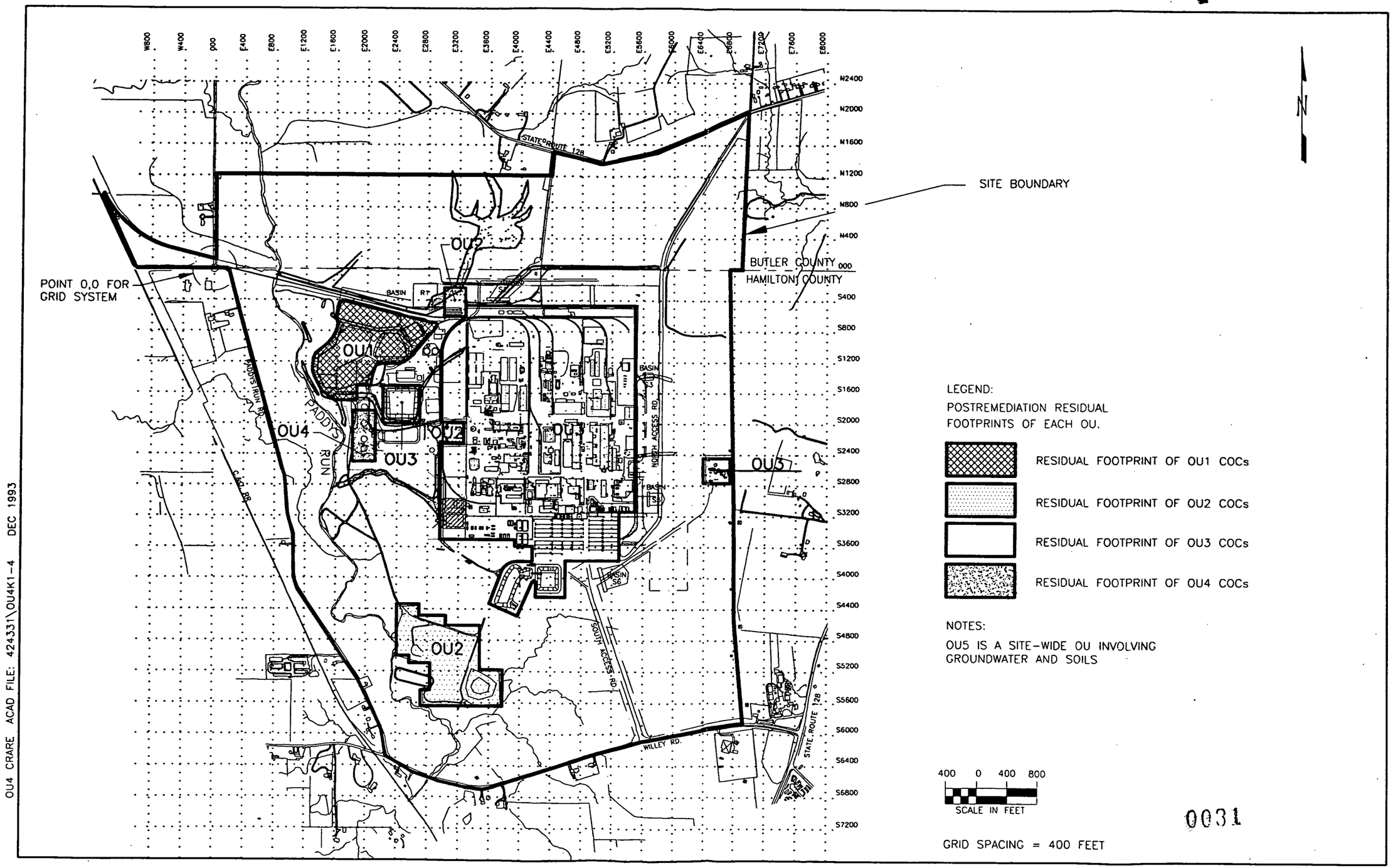
The RI/FS activities at the FEMP have led to the development and implementation of removal actions. As defined in the Amended Consent Agreement, removal actions abate, minimize, stabilize, mitigate, or eliminate the release or threatened release of hazardous substances, pollutants, contaminants, or hazardous constituents at the FEMP. A significant purpose of the SWCR and its associated baseline risk assessment is to provide data and risk analyses of the effects of any removal actions completed as of March 1993, the publishing date for SWCR data. Note that all removal actions will have been completed well before the time period considered by the CRARE.

Completed Actions

As of June 1993, the following removal actions had been completed.

Removal Action 4: Silos 1 and 2. As described by DOE (1990d) in its Engineering Evaluation/Cost Analysis (EE/CA), this removal action involved placing bentonite clay over the silo residues to reduce radon levels in the silos and to provide protection from releases to the environment in the event of silo dome collapse.

Removal Action 5: K-65 Decant Sump Tank. This removal action was completed in April 1991, when approximately 30 cubic meters (8000 gallons) of contaminated water were pumped from the K-65 decant sump tank and transferred to the holding tanks in FEMP Plants 2 and 3.




0031

FIGURE K.1-4 EXISTING FEMP DETAIL

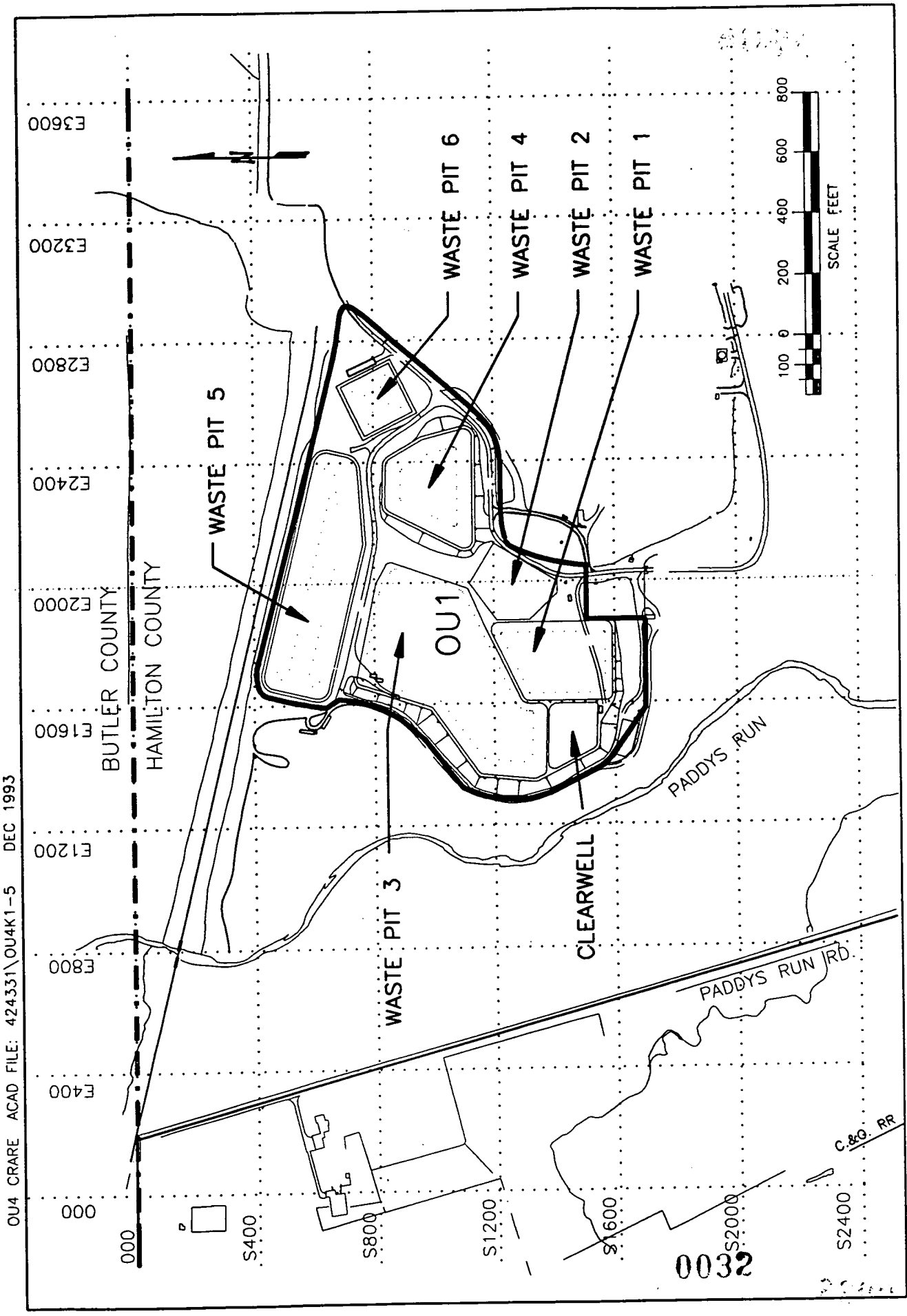
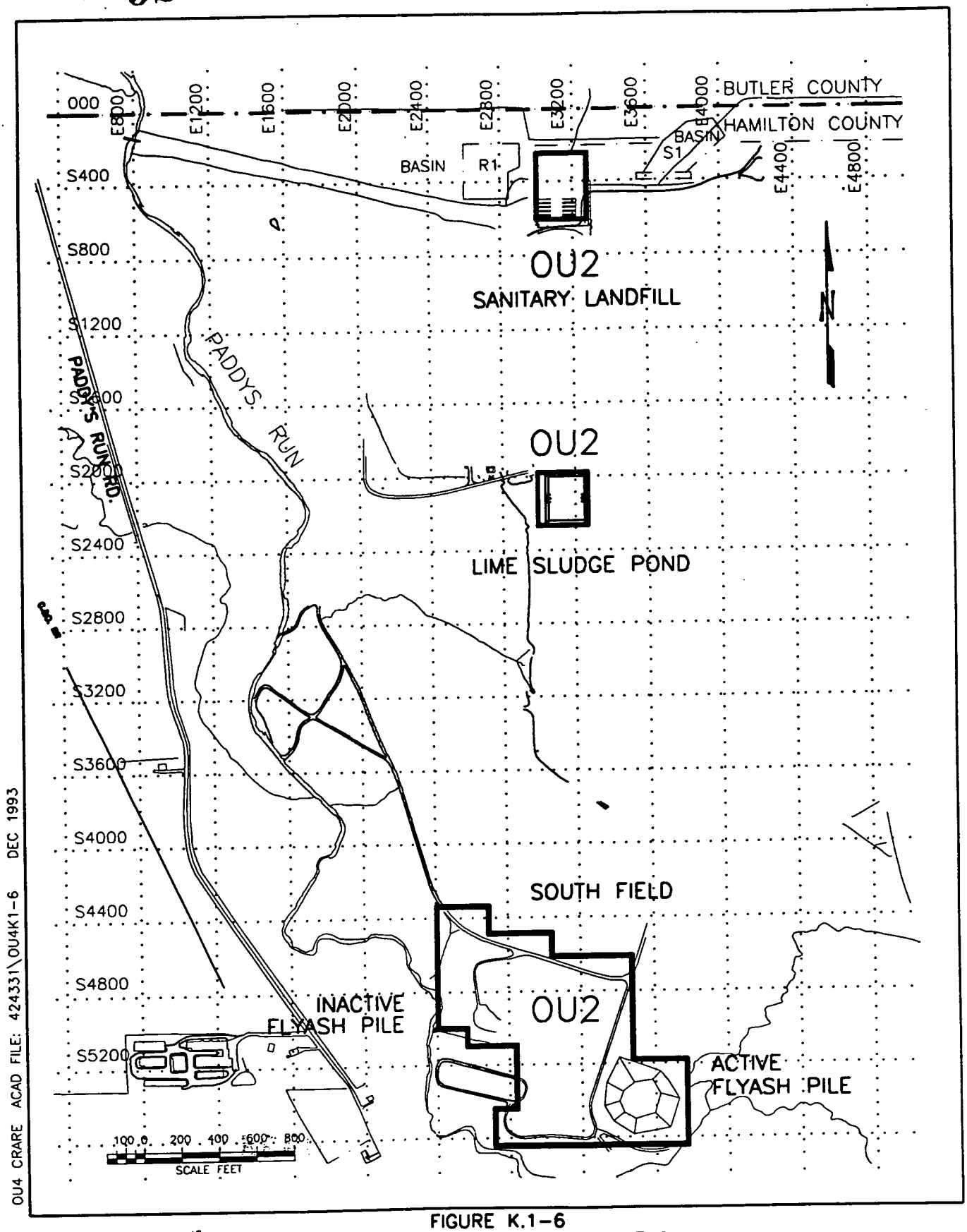



FIGURE K.1-5
EXISTING DETAIL, OPERABLE UNIT 1

0032

- 5208




OU4 CRARE ACAD FILE: 424331\OU4K1-6 DEC 1993

FIGURE K.1-6
EXISTING DETAIL, OPERABLE UNIT 2

0033

5208

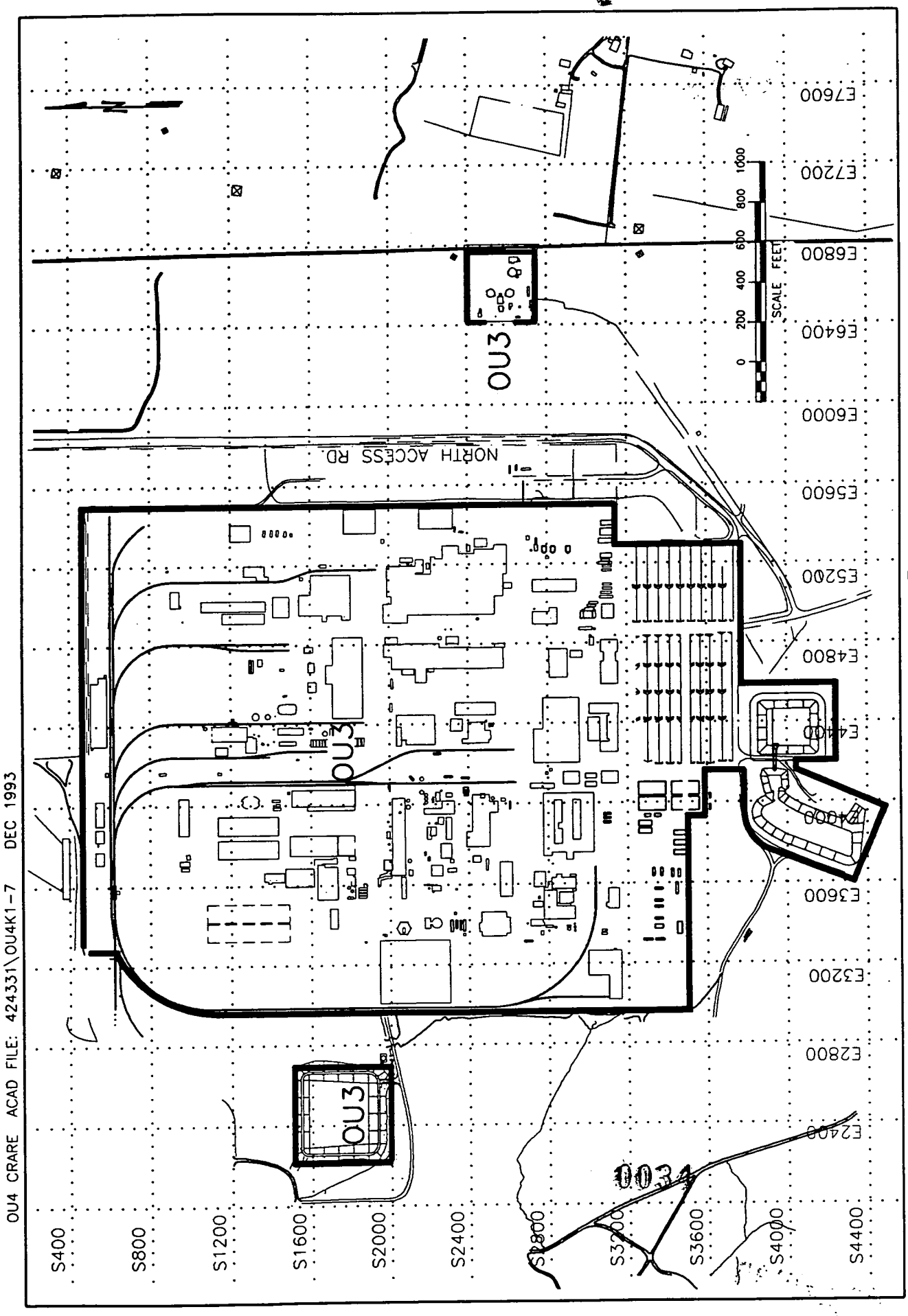
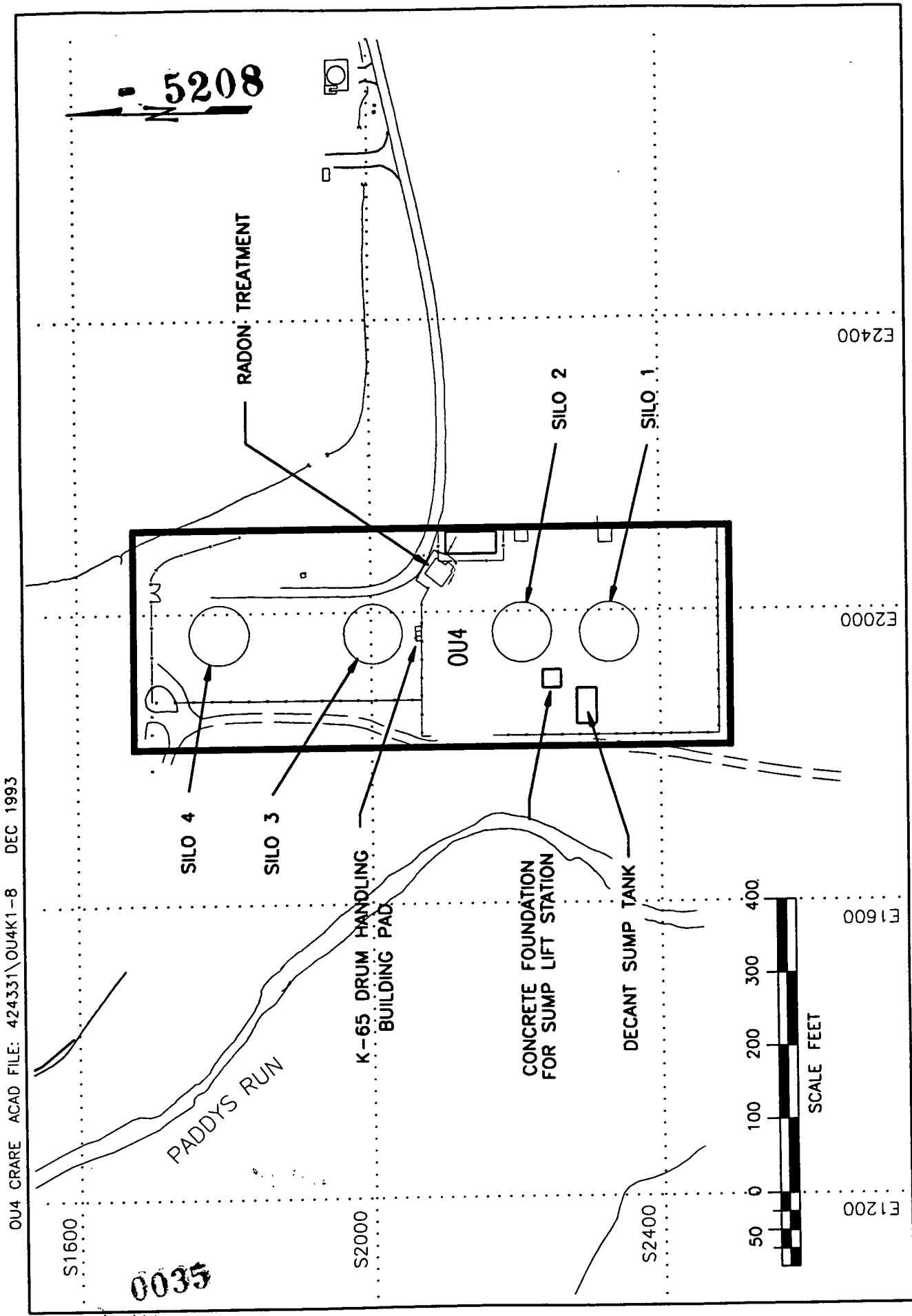



FIGURE K.1-7
EXISTING DETAIL, OPERABLE UNIT 3

0034




OU4 CRARE ACAD FILE: 424331\OU4K1-8 DEC 1993

FIGURE K.1-8
EXISTING DETAIL, OPERABLE UNIT 4

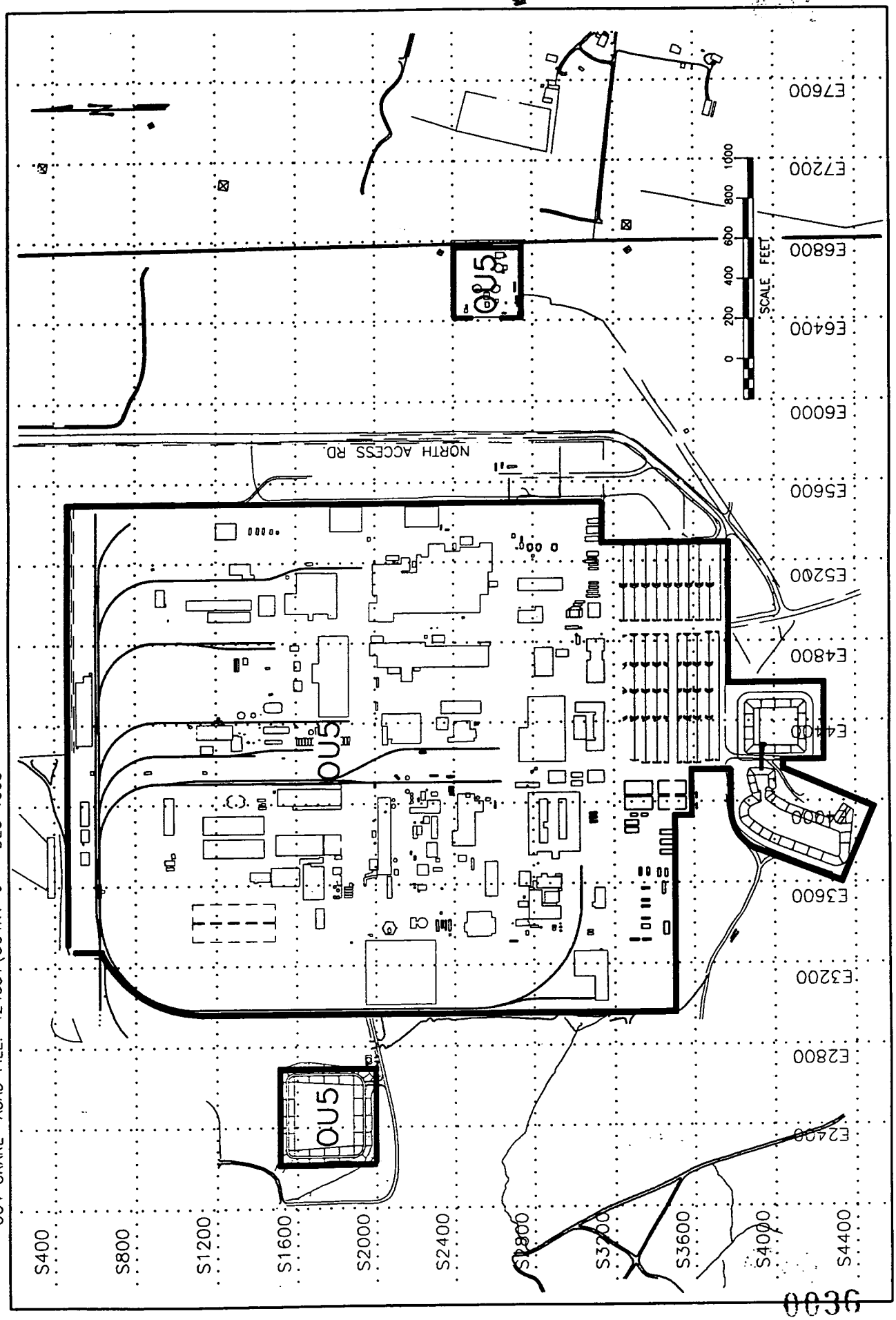



FIGURE K.1-9
EXISTING DETAIL, OPERABLE UNIT 5 (SOILS)

0036

Removal Action 8: Inactive Flyash Pile Control. Completed in December 1991, this removal action restricts access to the inactive flyash pile and South Field. A chain-link barrier and warning signs were erected around the perimeter.

Ongoing Actions

Several additional removal actions are under way and were not considered current conditions at the time the baseline environment was defined; however, they are included in the CRARE for reference. These ongoing or recently completed removal actions and their status follows.

Removal Action 1: Contaminated Water Beneath FEMP Buildings. This removal action was initiated to minimize the potential for uranium-contaminated perched groundwater (beneath FEMP Plants 2/3, 6, 8, and 9 in the production area) to infiltrate into the underlying aquifer. As of February 1, 1993, approximately 1136 cubic meters (300,000 gallons) had been extracted for treatment prior to discharge to the Great Miami River. Pumping and treating are ongoing until the advanced waste water treatment (AWWT) system is operational. Early 1995 is currently projected.

Removal Action 2: Waste Pit Area Runoff Control. This removal action, as described in the EE/CA (DOE 1990d), is intended to collect and treat potentially contaminated storm water runoff from the waste pit area, to prevent it from reaching Paddys Run. Project construction activities began in June 1991 and were completed in mid-1992, with the exception of the final report.

Removal Action 3: South Groundwater Contamination Plume. This removal action is intended to protect public health by limiting access to the use of uranium-contaminated groundwater in an area south of the FEMP site (DOE 1990d). The project consists of five parts:

- Part 1 included installing an alternate water source for two industries affected by the contamination plume. Production wells were installed outside the plume area, and a water supply system added to the affected area. Field work for testing the selected well site, and for determining the adequacy of the quality and quantity of extracted water, was completed in late September 1991. Part 1 construction was completed in 1992. A 60-day operating acceptance period was successfully completed in 1993.

- Part 2 involves installing a groundwater recovery well system to extract and pump groundwater from the South Plume back to the FEMP for monitoring and discharging to the Great Miami River, as described in the South Plume EE/CA (DOE 1990d). The groundwater recovery well system is scheduled to be operational by late August 1993. A new outfall effluent pipeline is being installed that will parallel the existing

pipeline to the Great Miami River. Part 2 also includes increasing the pump-out capacity at the Stormwater Retention Basin, to reduce the potential for its overflow.

- Part 2 construction began in July 1992; however, in September 1992, construction of the outfall pipeline was put on hold when contaminated soils were discovered. EPA approved the continued construction of the new pipeline while cleanup of contaminated materials was in process. Monitoring is underway to determine the extent of any remaining contamination. Construction of a dissolve oxygen system is nearing completion to address the low dissolved oxygen content of the extracted groundwater.

- Part 3 was the construction of an interim advanced wastewater treatment (IAWWT) system. The IAWWT system removes uranium from site wastewater streams and reduces the amount of uranium discharged into the Great Miami River. This system became operational in July 1992.

- Part 4 expands the FEMP groundwater monitoring and institutional controls to prevent the use of contaminated groundwater. This activity is being implemented through the site's existing groundwater monitoring program, which has been expanded to include more frequent monitoring of private wells located near areas of known contamination.

- Part 5 involves additional groundwater investigations in the vicinity of the South Plume. The activity will identify the location and extent of any residual contamination attributable to the FEMP in the aquifer south (down gradient) of the proposed recovery wells installed under Part 2.

Removal Action 6: Waste Pit 6 Residues. This action is intended to decrease radioactive dust and particles released from Waste Pit 6 into the air. In 1992, air monitors were placed to meet the site requirements for estimating the off-property releases of potentially harmful contaminants. This project was reactivated in 1992 to deal with additional residues on the eastern liner.

Removal Action 7: Plant 1 Pad Continuing Release. The purpose of this action is to protect surface soil and regional groundwater from continued releases of hazardous materials resulting from activities on the Plant 1 storage pad. This action is being conducted in three phases.

- Phase I, the implementation of run-on and runoff control measures and the installation of underground utilities, is complete.

- Phase II, the installation of a new covered concrete storage pad adjacent to the existing Plant 1 storage pad, was completed in December 1992.

- Phase III involves activities to upgrade the existing Plant 1 storage pad, including the installation of a polyethylene membrane and epoxy coating over the pad surface to

minimize contaminant migration to the environment. Phase III is scheduled for completion in early 1995.

Removal Action 9: Removal of Waste Inventories. This removal action involves the characterization, over-packaging, and disposition of low-level radioactive waste materials. The removal of waste inventories began in February 1993. The FEMP has approval from the DOE to dispose of waste at a western test site.

Removal Action 10: Active Flyash Pile Control. This action is intended to mitigate potential wind and water erosion at the active flyash disposal area. As an intermediate step, water was used during dry weather to reduce fugitive dust emissions. This removal action was completed in 1992.

Removal Action 12: Safe Shutdown. This removal is intended to ensure the safe and permanent shutdown of production facilities, including the removal of uranium and other process or raw materials generated in the former production area. Disposition of uranium product and recoverable residues is an integral part of safe shutdown activities. From July 1989, when the production mission ended, through December 31, 1992, 5 million kilograms (11.1 million pounds) of uranium product have been transferred from the FEMP. Appropriate documentation required by CERCLA and NEPA, including safety and risk assessments for current safety activities, were completed in May 1993.

Removal Action 13: Plant 1 Ore Silos. This removal action involves the dismantling of the Plant 1 ore silos and support structures. In 1991, materials from the silos leaked onto a concrete pad. Remaining materials in the silos will be removed, containerized, and placed in safe storage pending final disposition. The first silo was dismantled in July 1993.

Removal Action 14: Contaminated Soils Adjacent to Sewage Treatment Plant Incinerator. This removal action is intended to mitigate the potential for contaminant migration through characterization, removal, containerization, storage, and disposal of materials. The first phase included collecting samples from the 187 boxes of waste generated during the 1992 excavation activities. Analytical results became available in June 1993.

A work plan addendum detailing the need for additional excavations based on analytical results from the initial sampling was submitted to EPA in January 1993. Based on comments received, DOE

proposed that additional sampling be conducted north and east of the sewage treatment plant to establish the boundaries of contamination.

Removal Action 15: Scrap Metal Piles. This removal action is intended to eliminate the potential threat of material releases (e.g., scrap copper, recoverable ferrous and nonferrous scrap metals) to the environment due to wind or rain. Containerization of the scrap metal pile began in February 1993. As of May 1993, 16 metric tons (17.5 tons) of nonferrous metal and 316 metric tons (348 tons) of ferrous metal had been shipped off site. Containerization of the scrap copper pile was completed in March 1993. Nonrecoverable scrap metal is presently being packaged into appropriate containers and shipped off site for disposal under Removal Action 9 (Removal of Waste Inventories).

Removal Action 16: Collected Uncontrolled Production Area Runoff - Northeast. This removal action will collect stormwater runoff from perimeter areas of the 55-hectare (136-acre) former production area which are not presently draining into the stormwater retention basin.

Removal Action 20: Stabilization of Uranyl Nitrate Inventories. There are approximately 871 cubic meters (230,000 gallons) of acidic uranyl nitrate stored in 21 tanks in or near the Plant 2/3 Refinery. A 1991 inspection revealed that small leaks had developed in the piping system associated with the tanks. This removal action is designed to process the uranyl nitrate to a stable form. The uranyl nitrate inventory will be neutralized and converted to a solid form that can be drummed and properly stored in warehouses. This removal action is expected to be completed in early 1994.

Removal Action 22: Waste Pit Area Improvement. This removal action is intended to reduce the potential for wind or water erosion of contaminated materials from access roads and exposed surfaces. The south berm of Pit 4 will be stabilized. Drainage ditches along Pits 3, 4, 5, and 6 will be regraded. Roads between Pits 3, 4, 5, and 6 will be resurfaced. The pit area has been reseeded for erosion control. Some existing stormwater ditches in the waste pit area are being regraded to promote drainage. This removal action is scheduled for completion in August 1993.

Removal Action 24: Pilot Plant Sump. This removal action was initiated to address contaminated liquids and sludges remaining in an out-of-service sump at the Pilot Plant. The stainless steel sump will be removed and its associated piping will be disconnected. This removal action is scheduled for

5208

completion in October 1993.

Removal Action 25: Nitric Acid Tank Car and Area. This removal action was initiated to remove the residual contents of a nitric acid railroad tank car, decontaminate and dispose of the tank car, and address potentially contaminated surrounding soils related to the tank car. Activities for this removal action began in June 1993.

Minimum Additive Waste Stabilization. The Minimum Additive Waste Stabilization (MAWS) program has been transferred from Operable Unit 1 to Operable Unit 4. The MAWS program combines vitrification, water treatment, and soil washing processes to reduce waste volume and cost. Soil washing began in June 1993. The melter process to make glass from actual wastes is scheduled to be operational in September 1993.

K.1.5.2 Updated LRAs

Because each operable unit has its own RI/FS plan and schedule, it is imperative that FEMP environmental data be collected effectively and remedial efforts be coordinated so that site-wide risk assessment goals can be achieved. To ensure the acceptance of the postremediation site, risks must be estimated from a site-wide perspective, collectively considering the potential residual risks from the individual FSs. The CRARE program is designed to achieve this objective.

Each CRARE will be based on the LRAs from the SWCR, supplemented with the most current information available for each operable unit or revised based on RODs. CRARE findings will reflect the nature and levels of projected site-related risks after remediation at the time the report is prepared. The findings can be used as a tool to identify site components that have the highest uncertainty of risk and/or the highest estimated residual risk. This information can be used to improve the remedial engineering.

The source of quantitative human health risk information on Operable Unit 4 for this CRARE is found in Appendix D. Information on other operable units was developed using the SWCR (DOE 1993c), supplemented by direct communication with personnel from each operable unit and their subcontractors. The LRA for each operable unit was assessed, with the exception of Operable Unit 4. For Operable Unit 4, the updated LRA from Chapter 5 of this FS was evaluated. Baseline conditions

and other, lesser alternatives have not been addressed.

5208

The health effects quantified in the CRAREs include: 1) the excess lifetime cancer risk for exposure to chemical carcinogens, 2) the hazard quotient for exposure to noncarcinogens, and 3) the biological effects (including carcinogenicity, mutagenicity, and teratogenicity) to human receptors caused by exposure to radionuclides.

## K.1.6 CRARE SITE-WIDE CONCEPTUAL MODEL

The CRAREs examine specific time periods after the remediation of all operable units is complete. They are not intended to provide information on current risks. A key component of the CRAREs is the CRARE Site-Wide Conceptual Model, which examines current and future land uses for the periods immediately after and for up to 1000 years after all remedial actions are complete. The model depicts the final combination of FS remedial alternatives to ensure the FEMP achieves a residual risk that protects human health and the environment on a site-wide basis.

Figure K.1-10 provides an overview of the conceptual model for the five operable units from remedial action to remediated site conditions. For each operable unit, the conceptual model depicts the LRAs anticipated for implementation. Potential releases from the source areas form the basis for pathway evaluation. After site-wide remediation is complete, it is assumed that all existing structures would be removed. As shown in the figure, the remaining features and COC sources at the FEMP would be:

- Permanent disposal facilities known as vaults
- Capped areas
- Areas where treated soil has been placed
- Remaining surface soils

0042

OU4 CRARE ACAD FILE: 424331\OU4K1-10 DEC 1993

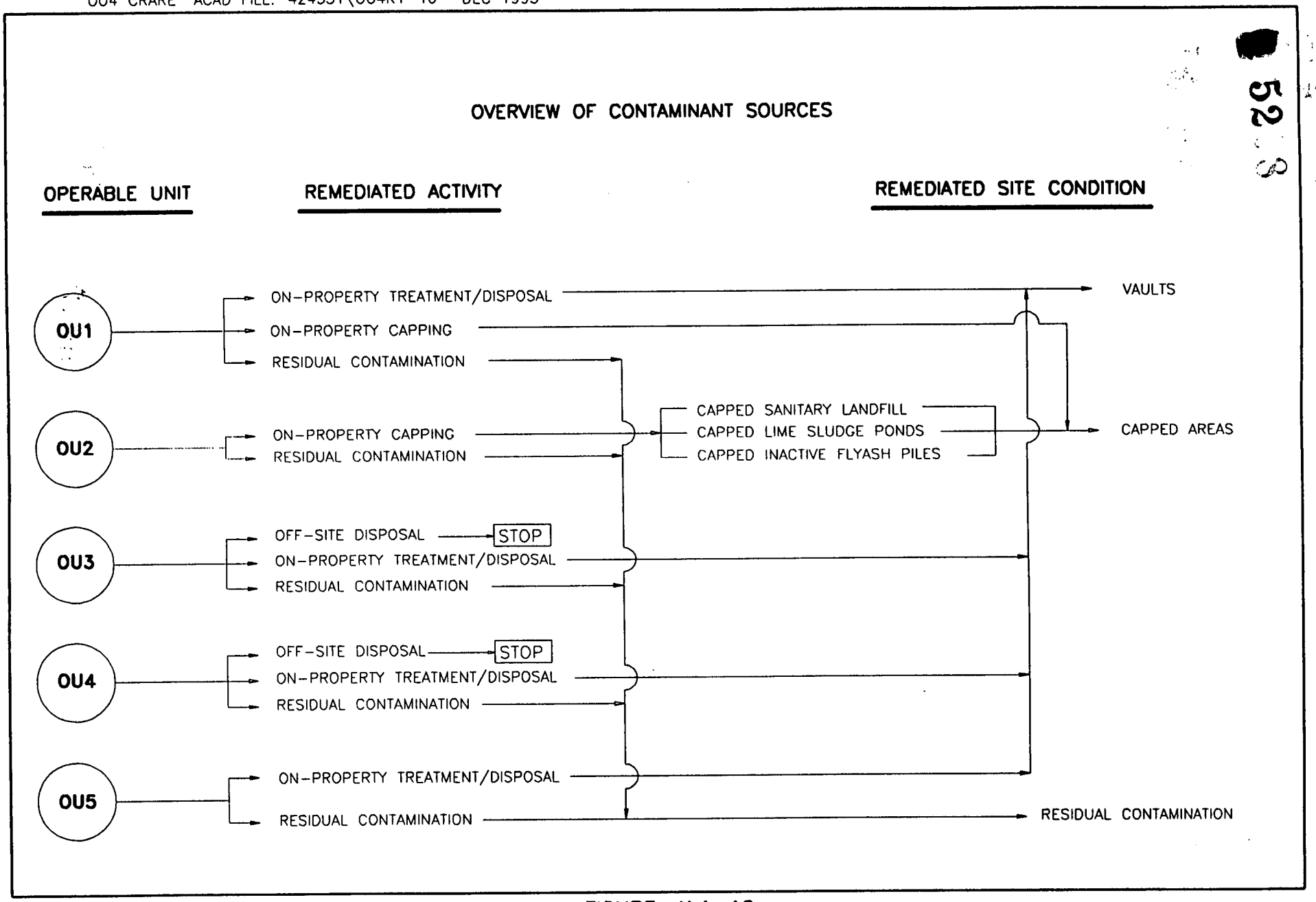



FIGURE K.1-10

OVERVIEW OF CONTAMINANT SOURCES, OPERABLE UNITS 1 THROUGH 5

The CRARE Site-Wide Conceptual Model graphically represents the sources, release mechanisms, transport-media and risk pathways for various human receptors under the Current and two Future Land Use scenarios of the five operable units. The Current Land Use scenario describes the FEMP for 70 years starting immediately after all remedial actions are complete. The 70-year period is based on the RAWPA, and is the life span of an individual. The scenario assumes DOE ownership, access control, and maintenance of the FEMP and associated remedial structures for 70 years. The only remaining treatment facility active on the site at the start of the 70 years should be the wastewater treatment plant in Operable Unit 5.

The two Future Land Use scenarios describe the FEMP for up to 1000 years after all remedial actions are complete: Future Land Use With Federal Ownership assumes continued government ownership and land use restrictions, while Future Land Use Without Federal Ownership assumes occupation by a resident farm. Both future scenarios assume no access control, maintenance, or treatment operations. Contaminant fate and transport have been modeled for 1000 years.

Figure K.1-11 presents the Current Land Use scenario and displays the risks and exposure pathways to seven types of human receptors. The center portions of the figure represent each exposure pathway by which radioactive or chemical contaminants of concern (COCs) migrate from their sources to human receptors on and off the FEMP. For each exposure pathway, the following elements are addressed:

- Contaminant sources
- Secondary sources
- Release mechanisms
- Transport media
- Exposure points
- Exposure routes
- Primary exposed populations (receptors)

0044

Figures K.1-12 and 13 present the scenarios covering the 1000-year postremediation period. Both of these Future Land Use scenarios assume no ongoing treatment activities. The scenario without federal ownership assumes a total loss of institutional controls.

Throughout the conceptual model, terminology for release mechanisms, transport media, exposure routes, etc. have used a limited set of technical terms in an effort to keep the model simple. As each operable unit is examined individually, the pathway model will become more complex, improving its ability to predict future situations. Receptors have been standardized in the model to reflect the three CRARE scenarios (Table K.1-1).

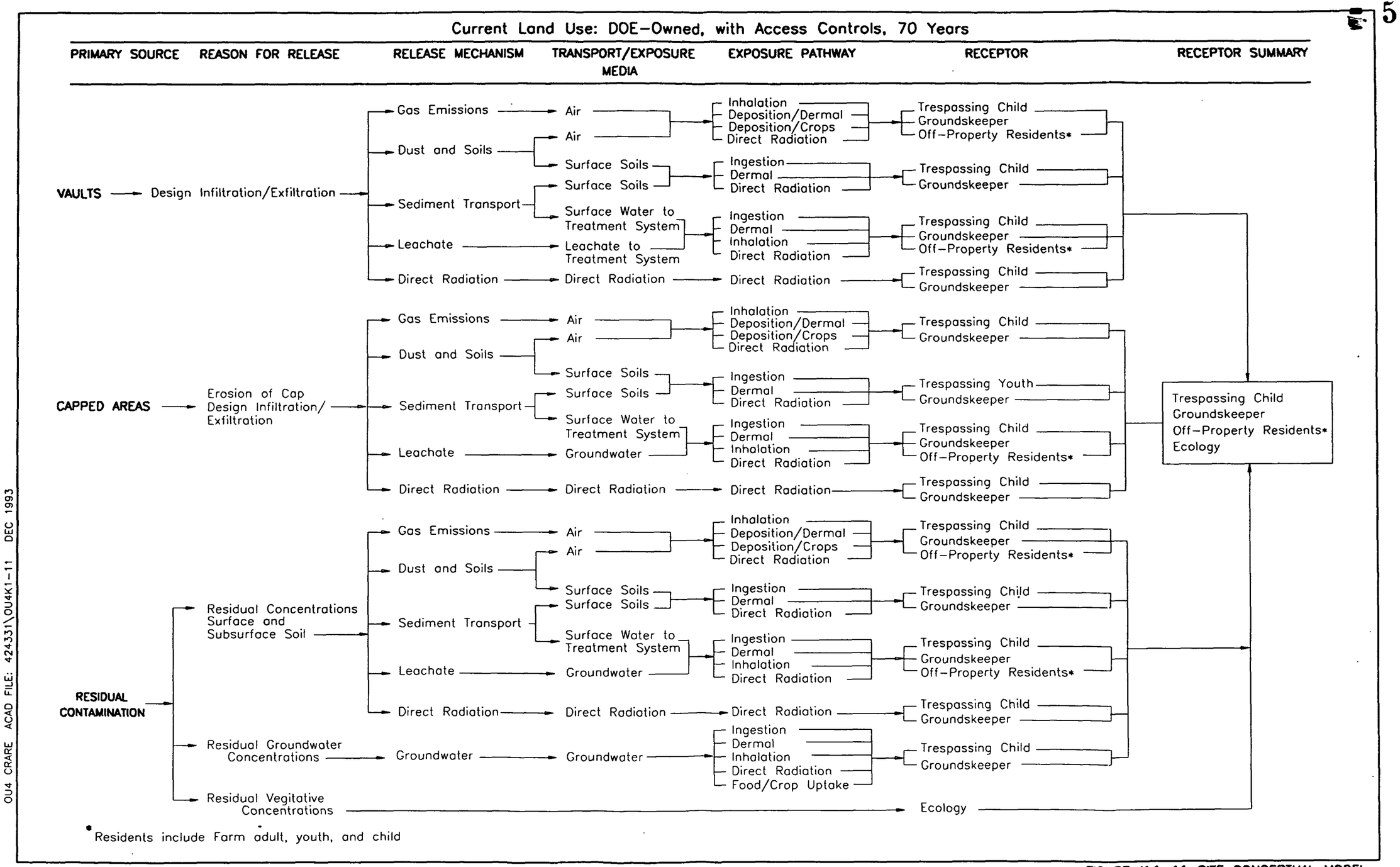
**TABLE K.1-1**

**CRARE SCENARIOS AND RECEPTORS**

| Scenario | Time Frame | RME Receptor |
|---|---|---|
| Current Land Use | For 70 years after remedial actions are complete | Groundskeeper<br>Trespassing child<br>Off-property resident farm<br>Adult<br>Youth<br>Child |
| Future Land Use With Federal Ownership | Up to 1000 years after remedial actions are complete | Expanded trespasser<br>Off-property resident farm<br>Adult<br>Youth<br>Child |
| Future Land Use Without Federal Ownership | Up to 1000 years after remedial actions are complete | On-property resident farm<br>Adult<br>Youth<br>Child<br><br>Off-property resident farm<br>Adult<br>Youth<br>Child |

These same receptors are used as the primary exposed population in the risk assessments for each of the five operable units. It is anticipated that by using standard receptors, the cumulative risks for all operable unit CRAREs can be added and compared without further work. A more detailed discussion of this concept is presented in Section K.5.1.4.

5208




OU4 CRARE ACAD FILE: 424331\OU4K1-11 DEC 1993

FIGURE K.1-11 SITE CONCEPTUAL MODEL, CURRENT LAND USE

0040

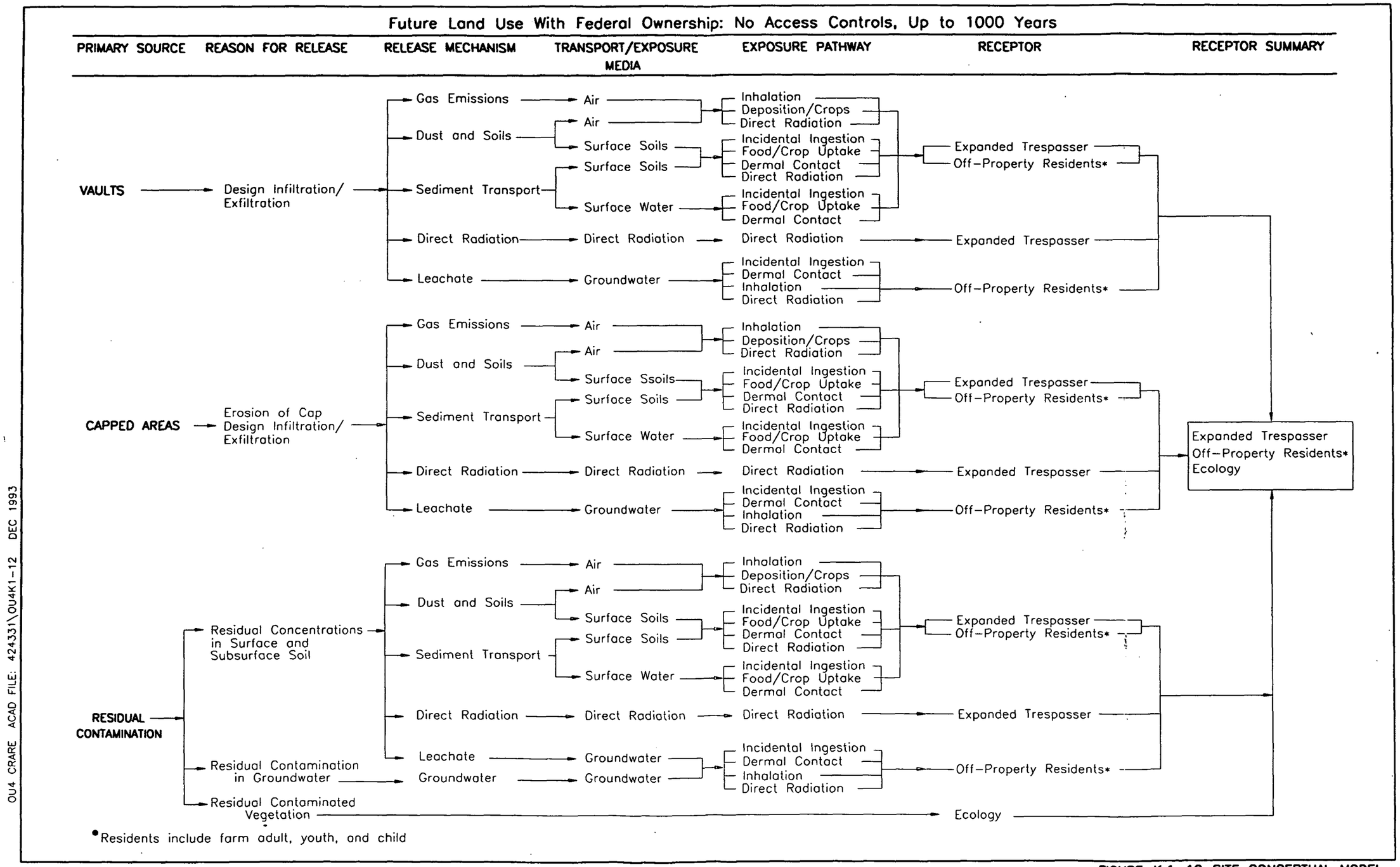
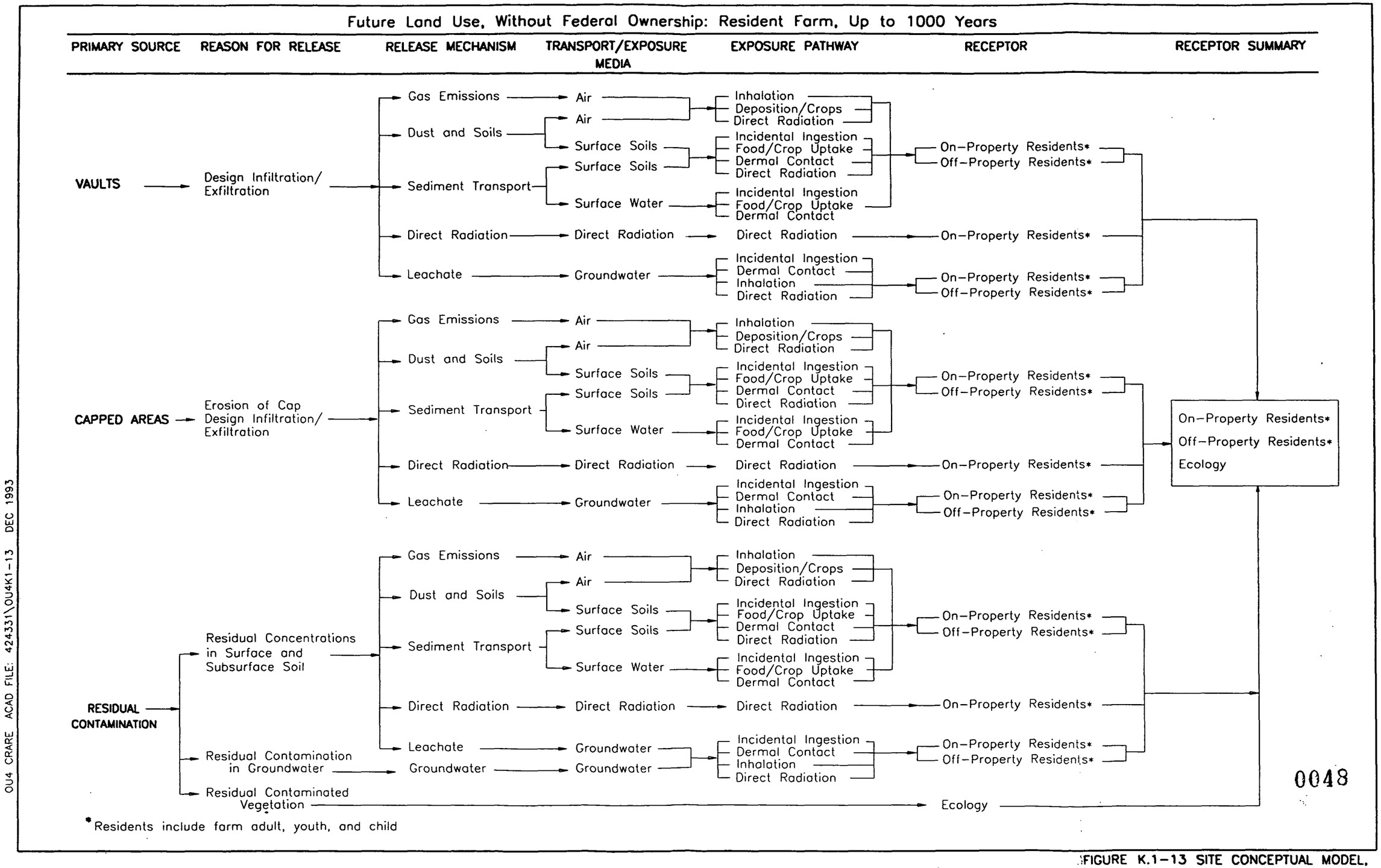



FIGURE K.1-12 SITE CONCEPTUAL MODEL, FUTURE LAND USE WITH FEDERAL OWNERSHIP

OU4 CRARE ACAD FILE: 424331\OU4K1-12 DEC 1993




OU4 CRARE ACAD FILE: 424331\OU4K1-13 DEC 1993

0048

FIGURE K.1-13 SITE CONCEPTUAL MODEL, FUTURE LAND USE WITHOUT FEDERAL OWNERSHIP

The pathways to be considered include soil ingestion, direct radiation, inhalation, exposure to all native vegetation, farm crops, invertebrate fish and wildlife, farm animals, milk, and subsequent human uptake. The conceptual model is presented as a basis to develop risk pathways for each CRARE. As the RI/FS process proceeds, the model will evolve to reflect the actual remedial action for each operable unit. This will be a dynamic process, subject to input from many parties at the FEMP site.

For the purposes of consistency, Table K.1-2 compares the land uses and receptors for the RI, FS, and CRARE. Because the CRAREs encompass a site-wide evaluation, they should differ slightly from the RI and FS, which are prepared for single operable units.

## K.1.7 ORGANIZATION OF THE CRARE

This CRARE is organized as follows for the step-wise progression of detailed information.

- K.1.0 Introduction:

  This section outlines the methodology to be used in preparing the FEMP CRAREs. It serves as a protocol with an emphasis on the procedures and techniques for characterizing the possible risks related to the remediated FEMP site.

- K.2.0 CRARE Programmatic Approach:

  This section describes the development of several factors and assumptions that have been employed for the CRARE. Some assumptions have significant bearing on the interpretation of the proposed approach. Generic site conditions, as well as data completeness, future facility management, demographics, and material containment assumptions, have been addressed. Additionally, the LRAs for Operable Unit 4 and the other operable units are presented.

- K.3.0 Overview of CRARE Information and Data:

  This section addresses the types and sources of data, site conditions after remediation, and introduction to fate and transport modeling, and the exposure parameters and other site-specific information used in the CRARE.

# TABLE K.1-2
# OPERABLE UNIT 4
# CONSISTENCY OF LAND USE AND RECEPTOR SCENARIOS

| Report | Land Use Description | Ownership | Access | Use | RECEPTORS | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Grounds -Keeper | Trespassing Child | Expanded Trespasser | Off-Property Farm | On-Property Farm | River User | Source of Contaminants |
| RI | Current Land Use With Access Controls | Federal | Limited | Industrial | | ● | | ● | | ● | OU4 |
| | Current Land Use Without Access Controls | Private | Unlimited | Industrial | ● | ● | | ● | | ● | OU4 |
| | Future Land Use | Private | Unlimited | Farm | | | | ● | ● | ● | OU4 |
| FS | Future Land Use With Federal Ownership | Federal | Unlimited | Gov't Reserve | | | ● | ● | | | OU4 |
| | Future Land Use Without Federal Ownership | Private | Unlimited | Farm | | | | ● | ● | | OU4 |
| CRARE | Current Land Use (With Access Controls) | Federal | Limited | Gov't Reserve | ● | ● | | ● | | | All OUs |
| | Future Land Use With Federal Ownership | Federal | Limited | Gov't Reserve | | | ● | ● | | | All OUs |
| | Future Land Use Without Federal Ownership | Private | Unlimited | Farm | | | | ● | ● | | All OUs |

Note: RI evaluates unremediated conditions.
FS evaluates remedial and postremedial conditions for the OU.
CRARE evaluates postremediation conditions for the entire site.



5208
0050

- K.4.0 Contaminants of Concern:

The COCs are developed in this section. The FS risk assessment was used to develop Operable Unit 4 COCs. For Operable Unit 2, the Operable Unit 2 RI was used. For all other operable units, the selection of COCs were excerpted from the SWCR, Appendix R.

- K.5.0 Exposure Scenarios:

This section defines the components of the exposure scenarios, discusses the steps involved in identifying and developing the scenarios, and covers the screening and selection of those currently identified. Selected exposure scenarios are those that are determined to require a quantitative evaluation of the risk assessment.

- K.6.0 Fate and Transport Modeling:

This section described the methodology to be used to quantitatively predict contaminant concentrations in the FEMP. It includes discussions of: 1) the fate and transport models to be used, 2) their required data and default parameter values, and 3) the technical approach that determines the appropriate model for each potential exposure assessment.

- K.7.0 Toxicity Assessment:

In this section, a toxicity assessment is presented for a qualitative evaluation of the scientific data to determine the nature and severity of the toxic properties associated with the radionuclides and COCs. This section includes a critical review and interpretation of toxicity data from epidemiological, clinical, and animal in vitro studies, and a quantitative estimation of the amount of exposure to a contaminant that may result in an adverse effect on a biological receptor. This defines the relationship between the dose received by a receptor and the incidence of the adverse effect.

- K.8.0 Quantification of Contaminant Exposure and Intake:

This section contains a description of the methodology to be employed to quantify long-term exposures for significant exposure pathways at the FEMP. This methodology employs the concept of the reasonable maximum exposure (RME). The RME is the maximum exposure reasonably expected to occur at the site. If the RME is determined to be acceptable, then it is likely that all other, lesser exposures at the site will also be acceptable. To be consistent with ongoing risk assessment work in the FS, the methodology in this section closely reflects those methodologies presented in the RAWPA.

- K.9.0 Risk Characterization:

Risk characterization is the final step in the CRARE process and involves combining the information developed in the toxicity and exposure assessments.

This information is integrated and presented as qualitative and quantitative estimates of health risk. This section presents the short-term risk and environmental assessment.

Potential carcinogenic effects are presented as the probability an individual will develop cancer over a lifetime of exposure, and are characterized by combining estimated intakes and dose-response information.

- K.10.0 Uncertainties:

  This section presents potential for the CRARE to under- or over-predict risk via a series of assumptions and numerical models.

- K.11.0 Results Summary:

  A summary of site-wide residual risk by receptor is presented for the current and future post-remediation scenarios. This section also summarizes the allocation of residual human health risk.

- K.12.0 References:

  Literature cited is presented in this section.

# SECTION K.2.0

# CRARE PROGRAMMATIC APPROACH

# K.2.O CRARE PROGRAMMATIC APPROACH

- 5208

While following the same general methodology of a baseline risk assessment, this CRARE is based on projected site conditions after remediation has been completed. In the baseline risk assessment, actual site conditions, including contaminant concentrations, are used with modeling to project concentrations, exposures, and risks to various receptors. For the CRARE, initial conditions are determined from the result of treatment and disposal alternatives described in each operable unit FS. Modeling must then be used to determine future concentrations, exposures, and risks to receptors under various land use scenarios.

Groundwater fate and transport modeling was used as part of the CRARE methodology to predict future groundwater concentrations resulting from migrations from residual soil contamination and the on-site disposal facilities. Future ambient air concentrations are predicted from air pathway transport modeling of soil and disposal area sources. Direct exposure (through air, soil, surface water, and groundwater pathways) and indirect exposure (via food pathways) from soils and water are modeled using projected soil and water contaminant concentrations. All of this is based on site physical conditions, topography, etc. projected from engineering estimates of the impact of the remedial alternatives. Sections K.3.0 through K.7.0 should be consulted for a detailed description of the CRARE methodology.

## K.2.1 ASSUMPTIONS

Throughout the course of the CRARE development, numerous factors and assumptions have been employed that have significant bearing on the interpretation of the resultant risk data. Assumptions concerning future site conditions, the completeness of data, future facility management, demographics, materials containment, and risk assessment methods have been addressed. The following assumptions are specific to this Operable Unit 4 CRARE.

### Future Site Conditions

- The vault design follows the concept described in £he SWCR.
- Site soil would be remediated for U-238 to an activity level not exceeding 60 pCi/g, based on the expanded trespasser receptors (appears as the recreational user in the SWCR Part III). The value of 60 pCi/g was selected as a target clean-up level and is likely to change as FSs for each of the operable units are

0054

completed. A more detailed discussion of the PRG selection is presented in Section K.3.1 of this CRARE.

- The FEMP property boundaries and operable unit boundaries define the source areas for the CRARE analysis. Impacts from non-FEMP off-site contaminants and related contaminant transport, and FEMP off-site disposal locations are not included in this CRARE but are discussed in Appendix I of this FS report.

- All volatile organic compounds (VOCs) have been effectively removed to a level no longer warranting air dispersion modeling after remedial action is complete (short-term and long-term adverse impacts are addressed in Appendix D of this FS report).

- VOCs and semivolatile organic compounds (SVOCs) would be reduced in the groundwater through the pump and treat operations of Operable Unit 5. This assumption is consistent with the Amended Consent Agreement relative to operable unit definitions. It is considered reasonable based on the low frequency of detection and low concentrations (ppb range) of these compounds, as reported in the SWCR. The SWCR evaluated COC concentrations in 85 off-site wells and identified 7 of them as containing elevated concentrations of VOCs or SVOCs. Five of these are located in the vicinity of the southern property boundary or the South Plume. Two wells are located along the northwestern, up gradient property boundary. Radionuclides are much more widespread in the South Plume and are the major focus of remediation there. Groundwater that is removed from the South Plume for treatment will eventually be discharged to the Great Miami River and not returned to the aquifer. It is probable that this process will reduce the existing VOC and SVOC concentrations to minimal levels as part of the effort to remediate the more extensive radionuclide contamination.

- The CRARE Site-Wide Conceptual Model describes site conditions immediately after and for a period up to 1000 years after remediation, according to the three land use scenarios described in Section K.1.6.

- The contaminated surface soil would be remediated to the PRGs for all contaminants of concern (COCs).

- The surface soil not covered by caps is assumed to be 85 percent vegetated per the Operable Unit 4 RI report, Appendix E.

Completeness of Data

- All hot spots have been identified as a result of sampling to date.

- All COCs considered for Operable Unit 4 are identified in the Operable Unit 4 RI report (DOE 1993d) and this FS report.

- COCs considered for Operable Units 1, 3, and 5 are identified in Appendix R of the SWCR.

- COCs considered for Operable Unit 2 are identified in the Operable Unit 2 RI report (DOE 1992g).

- The nature and extent of contamination for Operable Unit 4 are described in the Operable Unit 4 RI report, except for the limitations identified in that report.

- The nature and extent of contamination for Operable Units 1, 2, 3, and 5 are described by the data contained in the RI/FS database, as of March 1993. This database may contain nonvalidated data, which may have been used in this CRARE as the best available data.

- Physical properties used for groundwater transport modeling were taken from the SWCR. It is recognized that these are important parameters and current efforts are underway to obtain better and more complete data.

Future Facility Management

- For the Current Land Use scenario, maintenance would be performed on the facility and storage areas for 70 years after remediation. The necessity and duration of this maintenance would be considered in future assessments.

- The government would own the FEMP for up to 1000 years under the Future Land Use With Federal Ownership scenario, and therefore will control land use to prohibit residences, farms, or any land use other than recreational, but would not otherwise control the access.

- Under the Future Land Use Without Federal Ownership scenario the FEMP would revert to private ownership and would become a resident farm immediately after the remediation is complete. No further maintenance or control would occur for the 1000-year evaluation period.

Socioeconomics

The following socioeconomic conditions have been assumed for the purpose of performing a sitewide impact assessment consistent with NEPA:

- During the 1000-year evaluation period, the surrounding land use would remain primarily agricultural.

0050

- Population density changes for the 1000-year evaluation period are assumed not to be significant.

Demographics

- For the CRARE, the off-site resident farmer is at the point of maximum exposure - on the fence line - for both air and groundwater COC modeling. Predicting the actual location of populations 1000 years into the future is acknowledged to be highly speculative. However, even if the FEMP were surrounded by residential housing, the risk would be no greater than that of the resident farmer, because a farmer's exposure exceeds that of a resident.

Material Containment

- All material left on-property, not including soils left in place, would be contained in permanent on-property vaults or in capped areas for the duration of the 1000-year evaluation period.

- Soils would either be washed, capped, or removed to meet PRGs.

- Containment structures would be effective for a period of not less than 1000 years in preventing direct contact with disposed materials. All exposure results from residuals in the soils after remediation of each operable unit.

- Containment structures may leak and seep during the period immediately following remediation for up to 1000 years after remediation. Anticipated moisture infiltration rates through the concrete vaults are presented in Section K.6.1.3.3.

- The surface caps would use a RCRA-type cap design that would last 1000 years.

- Appendix D of this FS report addresses the risks from Operable Unit 4 facilities associated with large-scale, accidental releases caused by catastrophic events such as tornadoes, earthquakes, and 100-year storms. Other operable units would likewise have similar discussions within their respective FS reports.

Risk Assessment Methods

- The RAECOM model for estimating radon emissions from soil is considered to be conservative.

- Constituents adsorbed to soils in runoff remain adsorbed in the stream sediment.

- Constituents dissolved in runoff water remain in the water column in the receiving stream.

- Inputs from individual source areas can be summed to obtain site-wide inputs to receiving streams.

- This CRARE addresses long-term residual risks associated with the remediated FEMP site. Short-term risks, such as those related to remediation activities, are taken from the information in the Operable Unit 4 FS/RA documentation.

- This CRARE addresses human health risks. Ecological and environmental related risks are presented qualitatively in Chapter 4 and Appendix I of the Operable Unit 4 FS report. A quantitative site-wide ecological risk assessment will be performed as part of the Operable Unit 5 RI in accordance with the Amended Consent Agreement.

- Some groundwater COCs (Section K.4.0) are eliminated from quantitative risk assessment by risk screening calculations of groundwater in the vadose zone. For example, if carcinogenic risks are less than $1 \times 10^{-8}$ or the Hazard Index (HI) is less than 0.1, these COCs are eliminated.

- PRGs and LRAs for Operable Units 1, 2, 3, and 5 are identical to those identified in the SWCR. The updated LRAs for Operable Unit 4 are used in this CRARE.

- New RfDs and slope factors will not be developed as part of the CRAREs.

- Exposure parameters are taken from the values published in the Operable Unit 4 RI approved final report and are presented in Section K.3.0, Table K.3-1.

- Validated data is the primary source of exposure concentration estimates. Where validated data are not available, the highest detected concentration of a contaminant in a medium may be used.

- Based on the site operational history, it is assumed that 90 percent of the chromium that has been identified is not hexavalent; 10 percent, therefore, would be carried over as hexavalent in the risk assessment.

## K.2.2 LEADING REMEDIAL ALTERNATIVES

This section summarizes the LRAs for the operable units. The LRAs for the Operable Unit 4 CRARE have been updated to include current FS data.

It is important to note that for future CRAREs, the LRAs for the operable units that do not have completed FS documents may be changed to represent the current plans of each operable unit FS team. Major changes may be expected for some of the operable unit LRAs, with the development of new field data and new approaches to remediation. As an example, Operable Unit 2 is collecting new field data during the summer of 1993, and is currently evaluating several noncapping alternatives including excavation, treatment, and disposal. Also, Operable Unit 5 has initiated a program to

obtain additional data to more accurately determine the potential for groundwater contamination from residual soil contamination. Changes of this nature may result in significant changes to future CRARE transport modeling and risk assessment.

K.2.2.1 Operable Unit 1

Operable Unit 1 includes Waste Pits 1 through 6, the Burn Pit, and the Clearwell. Soil between the pits and contaminated soil adjacent to the boundary of Operable Unit 1 are also included, as is perched groundwater within the waste pit area. The Burn Pit and Pits 1, 2, 3, and 6 contain hazardous constituents and radiological substances. The Clearwell and Pits 4 and 5 contain a mixture of radiological and hazardous waste.

The LRA for Operable Unit 1 involves removing and treating waste material from Waste Pits 1 through 6, the Burn Pit, the Clearwell, and associated contaminated soil to achieve risk-based PRGs. Treated wastes would be disposed of in the on-property vaults. The excavated area would be filled with compacted soil. Remaining waste and contaminated soil in the unit would be stabilized and covered with a closure cap. The excavated material would be treated and placed within the on-property vault. For the purposes of future land use assumptions, this alternative assumes continued federal ownership of the land for up to 1000 years after remediation is complete.

K.2.2.2 Operable Unit 2

Operable Unit 2 includes the flyash piles and other South Field disposal areas, the lime sludge ponds, solid-waste landfill, berms, liners, and soil within the operable unit boundary.

The LRA for Operable Unit 2 includes localized excavations to remove and treat impacted media, and capping the waste units with a RCRA-type cap with appropriate radon emission controls. The waste units would be regraded and runoff/run-on controls employed. Direct contact with the waste and transport of waste would be prevented. Prior to capping, the inactive flyash pile would be relocated outside the Paddys Run flood plain. For the purposes of future land use assumptions, this alternative assumes continued federal ownership of the land for up to 1000 years after remediation is complete.

0059

- 5208

K.2.2.3 Operable Unit 3

Operable Unit 3 consists of the former production area and associated facilities and equipment. It incorporates all above- and below-grade improvements, including all structures, equipment, utilities, drums, tanks, solid waste, waste product, effluent lines, the K-65 transfer line, wastewater treatment facilities, fire training facilities, scrap metal piles, feed stocks, and the coal pile. The production area occupies about 55 hectares (136 acres) near the center of the FEMP and contains many buildings, scrap metal and soil piles, material containers, storage pads, a parking lot, roads, railroad tracks, and above- and underground tanks, utilities, and equipment. Several impoundments, ponds, and basins are also included.

For the Operable Unit 3 LRA, contaminated material would be removed, treated and/or decontaminated, and disposed of to reduce the potential for contaminant migration. Decontamination and treatment residue would require further treatment and disposal. Contaminated material would be disposed of in the vaults while clean material would be free-released for reuse or recycling. For the purposes of future land use assumptions, this alternative assumes continued federal ownership of the land for up to 1000 years after remediation is complete.

K.2.2.4 Operable Unit 4

Operable Unit 4 includes the structures and stored waste of Silos 1, 2, 3, and 4; the soil berms surrounding Silos 1 and 2, the decant tank, its contents and associated piping; the existing radon treatment system; and any contaminated subsoil underlying the silos.

The updated LRA for Operable Unit 4 includes removing the waste stored in Silos 1, 2, and 3, stabilized it via vitrification, and removing it to an off-property disposal facility. Contaminated soil and construction material from the silo berms, subsoil, and decant tank would be removed to the extent necessary to achieve risk-based PRGs and disposed of in an on-property vault. Silo 4 would be remediated as necessary along with Silos 1, 2, and 3. Silo 4 may also be used as a demonstration site for testing Silo 1, 2, and 3 waste and silo demolition techniques. These actions are presented the Comparative Analysis of Alternatives contained in Chapter 5 of this FS report. These alternatives are identified as 3A.1, 3B.1, and 2C. They are the alternatives that compared most favorably in the Chapter 5 discussion.

0060

The off-property disposal described in Alternative 3A.1 includes packaging, loading, and shipping the solidified K-65 material to the low-level radioactive disposal facility at the Nevada Test Site (NTS). The existing contaminated material would be removed from Silos 1 and 2 and treated, therefore leaving no residuals and no on-site residual risk associated with the silo contents. Any treatment of perched water will be addressed in Operable Unit 5 FS.

Similarly, under Alternative 3B.1, the stabilized Silo 3 metal oxide material would be packaged, loaded, and shipped to the NTS. Again, because the existing contaminated material would be removed from Silo 3 and treated, no residuals and therefore no residual risk from silo contents would remain.

Under Alternative 2C, demolition debris from Silos 1 through 4, the decant system, the berms surrounding Silos 1 and 2, and the soil removed during remediation would be disposed of in on-property vaults located in the northeast section of the FEMP. The vaults would be constructed on a reinforced concrete mat. The perimeter of the mat would be bounded by a curb with embedded pipes connected to the manholes of the underlying multimedia Leachate Collection/Detection System (LC/DS) to facilitate the collection of any contaminated leachate after final closure. The LC/DS would be composed of alternating composite soil liners and drainage layers to minimize the potential release of contaminated leachate to the groundwater and the underlying Great Miami Aquifer.

### K.2.2.5 Operable Unit 5

Operable Unit 5 includes groundwater, surface water, soil, sediments, flora, and fauna not included in Operable Units 1 through 4.

Under the LRA for Operable Unit 5, contaminated groundwater would be extracted, treated at an on-property facility, and discharged to the Great Miami River through the newly constructed effluent line. Treatment residuals would be disposed of on-property in a vault. The LRA also involves excavating contaminated sediment and soil necessary to meet risk-based PRGs, transporting the contaminated material to an on-property location for treatment using soil-washing, and returning the treated material as backfill. The soil-washing fluids would be recycled and the removed contaminants stabilized and disposed of in on-property vaults. For the purposes of future land use assumptions,

this alternative assumes continued federal ownership of the land for up to 1000 years after remediation is complete.

### K.2.3 VAULT DESIGN

As part of the RI/FS process, CERCLA requires that several remedial alternatives be developed and evaluated. For the FEMP, the RI/FS documentation for each operable unit provides recommendations of the most appropriate alternatives. Initial Screening of Alternatives reports have been prepared for Operable Units 1, 2, 4, and 5 identifying the remedial alternatives for each operable unit. In each case, an on-site disposal option has been included, under which some wastes or treated materials would be disposed of in on-property vaults. The following discussion describes the major design features of the vaults as they are currently envisioned. Other alternatives, such as in-situ remediation and off-property disposal, will be identified and possibly implemented as part of the RI/FS process for each operable unit. Accordingly, the vault concept may change based on results from each RI/FS. However, for purposes of this document, the following vault concept was used for the on-property disposal concept.

#### K.2.3.1 Vault Description

Fifty-nine vaults would provide long-term, on-property disposal of the radioactive, hazardous, and mixed waste generated during the FEMP remediation. The vaults would accommodate the different waste types, volumes, and generation rates for Operable Units 1 through 5, as noted in the SWCR (DOE 1993e). The current, total disposal capacity for the vaults is estimated at 1.83 million cubic meters (2.4 million cubic yards). This volume is subject to change since the estimate does not include any waste generated by decontaminating and decommissioning the Operable Unit 3 production facilities. As of August 20, 1993, operable unit waste volume estimates have been updated for internal review. These wastes volumes are for in-place wastes and are not equivalent to the wastes that result from remediation efforts; however, they are likely to result in increased estimates of waste volumes resulting from remediation. These volume calculations were not available in time for consideration in this CRARE, but they will be incorporated in subsequent CRAREs.

The vaults would be located on FEMP property near the northwestern and eastern perimeters. Each vault would consist of an above-grade, reinforced concrete structure capable of storing approximately 68,814 cubic meters (90,000 cubic yards) of waste.

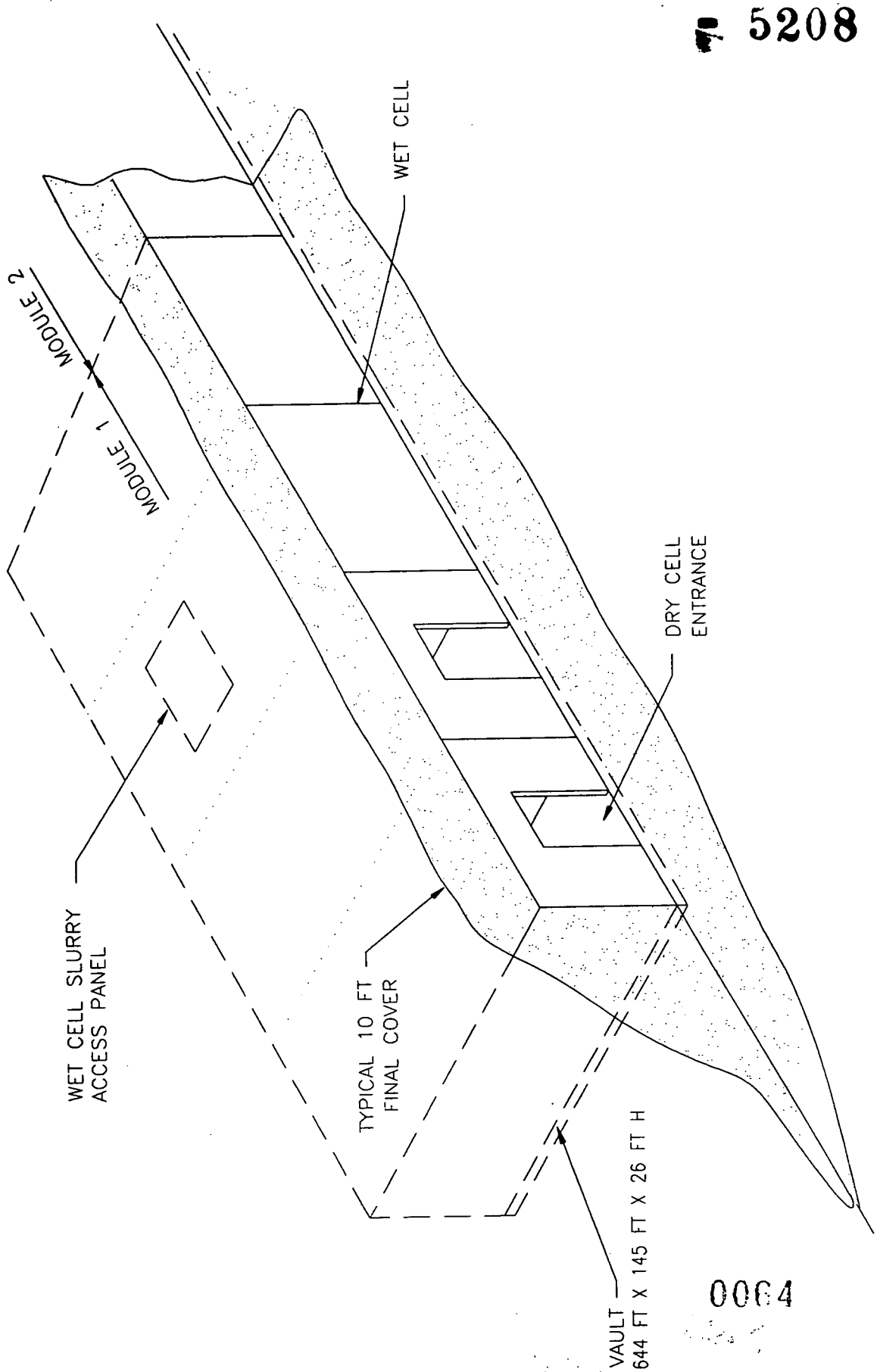
The floors and roofs of the vaults would be sloped. To facilitate leachate collection and leak detection of the 59 vaults, 58 would contain 3 modules each, with 4 cells in each module, for a total of 12 cells per vault. One vault would have only two modules and eight cells. Each disposal cell would contain a double liner system with leachate collection and leak detection capability. The liners selected would be chemically resistant to waste and leachate.

There are two design concepts for the vaults. The wet vault would accept waste in the form of a grout slurry that would solidify in the vault. The dry vault would accept waste in discrete containers. The structure of the wet and dry vaults is essentially the same, except that the wet vaults have access panels in their roofs through which slurry can be placed. Figure K.2-1 presents a typical vault System, showing both wet and dry vaults.

For the wet vaults, access panels would be provided through the concrete roof to allow the grout to be placed and inspected. For the dry vaults, a service opening would be provided for each disposal cell along one side of the vault to allow access for placing the containers. A forklift would be used to stack waste containers in the cells of the dry vaults. Active disposal cells would be ventilated to remove exhaust gases.

A high-density polyethylene (HDPE) Bump and tank system would be used to collect and detect leachate. Each cell would have its own leak detection Bump. The leachate collection and leak detection systems would both have piping that extends to the surface. This piping would provide access for instrumentation, pump-out, and cleaning of the tanks, sumps, and pipes. The leak detection systems would be routed to the facility support building. When a final cover is placed over the vault, manways would be installed from the final grade down to the top of the vault base slab surface.

5208




0064

FIGURE K.2-1
TYPICAL VAULT

OU4 CRARE ACAD FILE: 424331\OU4K2-1 DEC 1993

Vault access roads would be provided for both construction and operations service traffic. The roads would have two lanes: one for an unloading zone on the cell service entrance side of the vault, the other lane for through traffic. Access to each vault would be from aprons in front of the service entrance of each cell. These aprons would provide a staging area for unloading and transferring treated waste material into the dry vault cells, or a staging area for the wet vault slurry transfer system. Access roads adjacent to the vaults would be removed during final closure.

After filling a vault to capacity, interim closure would be performed. This consists of removing all temporary structures and sealing all vault openings. An engineered cover, consisting of compacted soil, gravel, cobblestone, sand, clay, and a synthetic liner material, would be placed over the vault. The cover would be designed to withstand estimated settlements and provide a long-term barrier. The cobblestone layer would act as an intruder barrier. The surface of the final cover would be sloped to promote drainage away from the vault.

The permeability of the cover would be no greater than that of the bottom liner and would be less than $10^{-7}$ centimeters per second. The cover system would have a minimum thickness of 5 meters (16.4 feet) or have an intruder barrier.

K.2.3.2 Venting of Heat and Gases from the Vault

During the placement of waste in the cells, gases would be vented using temporary removal systems. Upon closure, all temporary vent systems would be removed. The vaults would not contain a permanent venting system.

K.2.3.3 Stormwater Management Relating to the Vault

During remediation and for a 70-year period after remediation, if the Current Land Use scenario is implemented (with access controls), storm water runoff from the waste disposal operation areas, including the vaults, would be controlled by drainage ditches, culverts, sedimentation and retention basins, and lift stations. The system would be designed to handle peak discharge from a 24-hour, 25-year storm. To maintain the design capacity, provisions would be included to empty the storm water accumulating in the retention basin. The accumulated water would be pumped to a waste water treatment facility for treatment prior to discharge. Storm water runoff from closed and unregulated

areas would be allowed to flow off-property via man-made and natural water courses. Erosion structures would be used, if required.

K.2.3.4 RCRA-Type Cap Design

The RCRA-type cap would have a 1000-year design life that minimizes the release of contaminants to air and groundwater. This approach is included in the LRA for Operable Units 1 and 2. Both operable units would evaluate this concept in their individual FS reports.

Essentially, the evaluation of the RCRA-type cap in the CRARE provides for a low- to no-maintenance design. For each operable unit for which this type of cap is proposed in the CRARE, the feasibility of using it would be specifically evaluated in that unit's FS.

K.2.4 CRARE AND MODIFICATION OF PRELIMINARY REMEDIATION GOALS

The PRGs used as a starting point in the CRARE were derived in the SWCR (Section III) and are based on acceptable carcinogenic and noncarcinogenic risks attained at the on-property and the off-property RMEs, as well as on specific pathways of exposure developed in this CRARE. Modification to the PRGs may occur.

The EPA's Target Risk Range for remediation of carcinogens is $10^{-6}$ to $10^{-4}$. The noncarcinogenic risk benchmark established under CERCLA is a cumulative (all chemicals, all pathways HI of 1.0. According to the EPA the HI benchmark should be further examined for target organism/mechanism of action impact and will be in future CRAREs. The combined residual risk from all remediated operable units is to be quantitatively evaluated in the CRARE to ascertain if the residual risk remains protective of human health as expressed by these criteria.

K.2.5 CRARE TECHNICAL APPROACH

The methodology used in the CRARE is consistent with the Amended Consent Agreement, which states: "The cumulative residual risk contributions from the other operable units will be estimated based upon the selected alternative, or the Leading Remedial Alternative." In addition, the RAWPA states that a residual risk assessment will be performed after all RODs have been finalized. Figure 2.2-2 of the Addendum emphasizes the iterative nature of PRG selection. The CRARE as such does not select PRGs, it reports risks calculated using the PRGs from each operable unit. The overall

technical approach for the Operable Unit 4 CRARE has been developed within the context of the RI/FS process for the FEMP to determine if the LRAs for the operable units protect human health and the environment or, if they do not, to provide information as to the best path forward.

This CRARE has been prepared in conjunction with EPA, Ohio Environmental Protection Agency (OEPA), and DOE guidelines to assess the potential risk of exposure to radionuclides and hazardous chemicals. It follows the methodology presented in the RAWPA, which derived much of its methodology from the EPA Risk Assessment Guidance for Superfund (RAGS). However, deviations to the methodology discussed in the RAWPA are the result of 1) FERMCO's response to EPA Region V review comments on the SWCR, 2) releases of additional guidance documents after the submittal of the Addendum and the SWCR, and 3) technical information attained from literature other than that cited in the Addendum and SWCR. These deviations are summarized below.

- Groundwater PRGs for radionuclides were developed from a $10^{-6}$ target risk level and from applicable, relevant, and appropriate requirements (ARARs) and those to be considered (TBC). The ARARs/TBCs include maximum contaminant levels (MCLs) and proposed MCLs. In addition, the 4 mrem/year MCL for man-made beta and gamma emitters was interpreted to apply to alpha emitters. In this instance, PRGs were calculated using committed effective dose equivalents to a 4 mrem/year intake, assuming a drinking water rate of 730 l/year, and using dose conversion factors from EPA's Federal Guidance Report (EPA 1988g).

- In addition to calculating the PRGs for soil based on the residential land use scenario, PRGs have also been calculated assuming the Future Land Use Scenario and expanded trespassers. Values for both the residential and recreational scenarios were calculated using both a $10^{-6}$ target risk and a 100 mrem dose limit from 10 CFR 20, for allowable exposures to the general public.

- The soil ingestion rate for the on- and off-property resident farm adult was increased. The new rate of soil ingestion, 0.18g/day, was developed in response to EPA comments on the SWCR. This soil ingestion rate was based upon a standard adult soil ingestion rate of 100 mg/day and modified to account for farming activities (February 11, 1993 FERMCO memo). The derivation of the 180 mg/day soil ingestion rate is presented in detail in the Operable Unit 4 RI report (see also Section K.3.3).

- Skin surface area available for contact was increased for the child, youth, and adult receptors. This change reflects better characterization of the receptor's physical parameters and the availability of new data in the literature.

- The 60-pCi/g PRG is for U-238 *and not for the two daughters* as indicated in the SWCR Table 2-3. The SWCR is unclear with regard to the consideration of the two progeny of U-238 in the risk calculations.

In addition to the Operable Unit 4 FS report, information for this CRARE has been extracted from the RI report for Operable Unit 2 and the SWCR for the other operable units. This Operable Unit 4 CRARE reflects the Risk Information Data Quality Objectives and is sensitive to EPA's comments on the Operable Unit 2 RI report (DOE 1992g), the Operable Unit 4 RI report, and the SWCR (DOE 1993e). Additionally, this CRARE uses the fate and transport modeling concepts developed for Operable Unit 5.

{This page intentionally left blank}

# SECTION K.3.0

# OVERVIEW OF CRARE INFORMATION AND DATA

5208

## K.3.0 OVERVIEW OF CRARE INFORMATION AND DATA

Three types of site-wide data are used in this CRARE: 1) data that characterize the residual and vault contaminants, 2) data used to model the fate and transport of constituents, and 3) data used to estimate exposure.

Data generated as a result of RI/FS activities are considered primary sources in this CRARE because these are most current and most reliable. Data generated in studies of past site operations, and non-RI/FS data related to off-property soil, surface water, sediment, groundwater, etc. are considered secondary sources. Primary and secondary data were compared for corroboration. In general, secondary data were used in the CRARE only when acceptable-quality primary data were not available.

### K.3.1 SITE CONDITIONS AFTER REMEDIATION

As discussed in Section K.2.2, this CRARE assumes that the updated LRA for Operable Unit 4 (Alternatives 3A.1, 3B.1, and 2C from Chapter 5 of this FS report) will be implemented, as well as the LRAs for Operable Units 1, 2, 3, and 5. The LRAs are described in detail in Section III of the SWCR (March 1993) and are summarized in Section K.2.2 of this CRARE.

The remedial action for Operable Unit 5 would be the last implemented. Although the Operable Unit 3 record of decision (ROD) is actually the final ROD, Operable Unit 5 includes site-wide activities to pump and treat groundwater and to excavate, treat, and replace contaminated soil. The remediation of soil beneath the structures of Operable Unit 3, in particular, cannot begin until the structures have been removed. Also, the groundwater remediation is expected to take several years because of the large volume of water to be removed from the aquifer and treated. A total completion time for FEMP remediation is expected to require up to about 20 years.

When FEMP remediation is complete, the only structures remaining on the site will be the vaults, the RCRA-type caps, and the water treatment facility. The Operable Unit 4 disposal facilities are described in detail in Chapter 2 of this FS report. Under Alternative 2C (Chapter 3 of this FS report), only the northeast vaults would contain structural material, debris, and soil; these vaults are

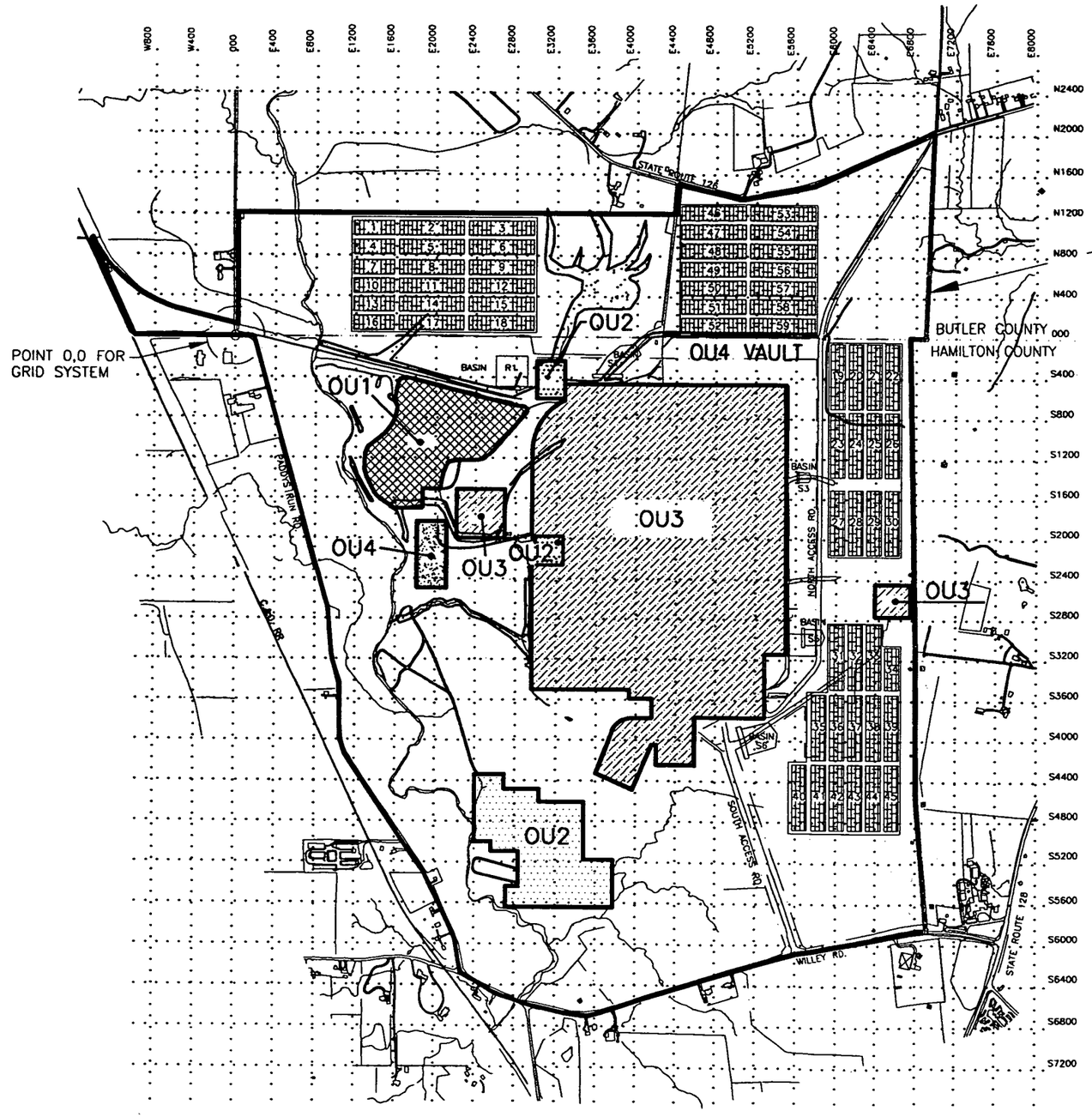
shown in Figure K.3-1 and described in Section K.2.3. According to the LRAs, waste from Operable Units 1, 3, and 5 would be disposed of in the on-property vaults, which would have leachate collection systems. In the Current Land Use scenario, the maintenance of these collection systems was assumed to continue for 70 years after remediation and to include the repair of leaks and the periodic removal and disposal of leachate. Therefore, no release of contaminated leachate was assumed for this 70-year period. It should be noted that the need for and the duration of this postremediation maintenance period may be further explored in other assessments. In the two Future Land Use scenarios, however, it was assumed that no maintenance would be performed for up to 1000 years.

Under the LRAs, all Operable Unit 2 areas, as well as those Operable Unit 1 areas that contain residual contaminated soil, would be capped with a RCRA-type surface cap. It was assumed that the top layer of the cap may erode, but the cap would retain its integrity for up to 1000 years, and substantial leaking and erosion would not occur.

After the remediation of Operable Units 1, 2, 3, and 4 is complete, some contaminated soil would likely remain in place. Under Operable Unit 5, soil that does not meet a specified remedial goal would be excavated, treated to meet that goal, and used as backfill. For U-238, the PRG of 60 picocuries per gram (pCi/g) was assumed to be consistent with the Operable Unit 4 FS proposed remediation level. The remediation goals for other COCs were assumed to be the PRGs as presented in the SWCR. Therefore, at the end of the remediation period, all remediated soil is assumed to be at the PRGs of the respective contaminants, and the residual soil is assumed to retain its current level of concentration and/or activity. The current characterization information suggests that uranium and radium will be the drivers for surface soil remediation.

The PRG for U-238 was selected based on the expanded trespasser (which is described in detail in Section 5.1.4) in the Future Land Use With Federal Ownership scenario. It is recognized that the RAWPA states that the initial remedial PRG should be based on an on-property resident land use. However, the SWCR indicates that the selection of LRAs for the operable units is based on continued government ownership and hence government control of land use, a reasonable assumption since the site is currently government owned. The LRA is defined in the Amended Consent Agreement and reiterated in the SWCR as "the remedial alternative which, based upon

5208




SITE BOUNDARY

LEGEND:

POSTREMEDIATION FOOTPRINTS OF EACH OU.

- FOOTPRINT OF OU1
- FOOTPRINT OF OU2
- FOOTPRINT OF OU3
- FOOTPRINT OF OU4
- ON-PROPERTY VAULT CONCEPT
- OU5 IS A SITE-WIDE OU INVOLVING GROUNDWATER AND SOILS.

NOTES:

SOILS BENEATH OU3 ARE CONSIDERED OU5

GRID SPACING = 400 FEET

400 0 400 800
SCALE IN FEET

0073

OU4 CRARE ACAD FILE: 424331\OU4K3-1 DEC 1993

FIGURE K.3-1 SITE CONDITIONS POSTREMEDIATION

all available data and best professional judgement, consistent with CERCLA, is the most likely to be selected as the response action for an operable unit. The LRA does not represent the pre-selection of a remedy and shall be used only for the purpose of estimating and evaluating the risk presented by the entire Site during the FS/Comprehensive Response Action Risk Evaluations for Operable Units 1-5." The CRARE approach for using LRAs is consistent with this definition.

While the LRA does not dictate what the PRG should be, it does indicate what level of clean-up the remedial technologies can possibly achieve. The current LRAs assume that residual contamination would remain after all alternatives have been completed, and some form of land use restrictions would be required. Based on this assumption, the most likely basis for the initial CRARE was to assume the recreational use of the FEMP as a future reasonable maximum land use. The PRG for the possible on-property resident farm adult was also estimated in the SWCR as 0.28 pCi/g, which is below background concentrations.

The preliminary results from the ongoing Operable Unit 5 soil washing studies indicate that a U-238 clean-up level of less than 60 pCi/g may not be achievable with current technology. Each individual FS, as it is completed, will refine the limits of this and other technologies. This preliminary result points toward a restricted future use of the FEMP with the expanded trespasser as the main receptor of concern. The identification of the expanded trespasser as the driving risk receptor follows the "as low as reasonably achievable" (ALARA) philosophy. The objective of the ALARA is to keep exposure to as low as practicable levels after taking into account social, technological, economic, and public policy issues.

The CRARE is regarded as a reporting document with alternative cleanup methods being presented and discussed in the main body of the FS report. The current methods of soil cleanup were presented in the SWCR, and Operable Unit 5 is performing on-going studies. As additional FSs are prepared, the updated information on soil remediation can be added. The current information regarding U-238 soil cleanup indicates that 60 pCi/g is the limit. A particular issue in the development of remedial goals is that the use of the on-property resident farmer may lead to a cleanup effort to background levels. Information regarding the selection of future land use can be found in the document, which was presented to EPA on December 1, 1993, on developing remedial levels for Operable Unit 4. This document has been included in the FS as Attachment D.II

Regarding groundwater an explicit assumption in the CRARE is that contaminants currently in the groundwater which present the potential of excess risk due to elevated concentrations will be remediated. The start of the CRARE period of evaluation is after all remedial actions have been concluded including groundwater cleanup. The target remediation levels are assumed to be risk based. Therefore the reduction of VOC and SVOCs should result in a decrease in overall risk.

VOCs and semivolatile organic compounds (SVOCs) would be reduced in the groundwater through the pump and treat operations of Operable Unit 5. This assumption is consistent with the Amended Consent Agreement relative to operable unit definitions. It is considered reasonable based on the low frequency of detection and low concentrations (ppb range) of these compounds. It is probable that this process will reduce the existing VOC and SVOC concentrations to minimal levels as part of the effort to remediate the more extensive radionuclide contamination.

It was assumed that groundwater in the Great Miami Aquifer would be remediated to the PRGs or lower for all contaminants. The PRG for U-238 in groundwater is 7 pCi/l, based on the proposed maximum concentration level (PMCL). Because uranium is the most widespread contaminant at the highest concentrations, it was assumed to be the most persistent contaminant during remediation. In addition, it is currently assumed that the soil PRGs of U-238 (60 pCi/g) and Ra-226 (5 pCi/g) would be the controlling factors of the soil washing process.

Material that would be removed from the site by the end of FEMP remediation includes the contents of Silos 1, 2, and 3 in Operable Unit 4, the structural material in Operable Unit 3 that can be decontaminated, and the treated groundwater from Operable Unit 5.

### K.3.2 FATE AND TRANSPORT MODELING OF RESIDUAL CONTAMINANTS

Section K.1.6 describes the CRARE Site-Wide Conceptual Model, which was used to establish potential sources, pathways, and contaminant receptors. Section K.2.1 discusses the major assumptions used to estimate conditions. After developing the conceptual model, fate and transport computer models were used to simulate the transport processes. A discussion of the computer models follows.

K.3.2.1 Groundwater and Surface Water Modeling

The SWCR (Section II, Part 3.2.1) describes the development of specific conceptual models for source terms, release mechanisms, and receptors, and the selection of numerical computer codes for RI/FS work at the FEMP. The CRARE fate and transport models use the same approaches and codes where appropriate. The principal differences between the baseline and CRARE numerical models are in the definition of source terms from the respective conceptual models. The same One-Dimensional Analytical Solute Transport (ODAST) and SWIFT III codes were used to model transport through the vadose zone and the aquifer, respectively. More detailed descriptions of ODAST and SWIFT III are presented in Section K.6.1.

The first step in defining source terms for groundwater numerical modeling is to establish the COCs to be evaluated in the assessment. The selected COCs are presented in Section K.4.0. Contaminants were considered whose estimated groundwater concentrations (either before or after ODAST modeling) were elevated enough to represent a carcinogenic risk via a drinking water pathway. Contaminants were not included as input to the SWIFT III groundwater model if they did not have high enough concentrations (as either source terms or after the ODAST modeling) to represent a carcinogenic risk of $10^{-8}$ or an HI of 0.1.

As defined in Section K.6.1, the source terms for the various areas of the site are the leachate from the vaults, the residual soil, and the capped areas. The ODAST results for these areas were used as direct inputs to the CRARE SWIFT III groundwater model.

An engineering study of the vaults and capped areas has been completed that estimates leakage rates through the structures over time. Preliminary Toxicity Characteristic Leaching Procedure (TCLP) tests were performed on various types of waste that would be stored in the vaults. The results were used to estimate the contaminant concentrations in the leachate and then used as input to the ODAST model to estimate transport through the vadose zone. TCLP results were not available for all types of waste. Geochemical modeling was used to estimate leachate concentrations where the TCLP results were not available.

For soil that is excavated, treated, and returned as backfill, U-238 was assumed to be at a concentration of 60 pCi/g and Ra-226 at 5 pCi/g. As previously stated, the other contaminant

concentrations were assumed to be at their respective PRGs or actual concentration levels, whichever is lower. Untreated residual soil was assumed to retain its current level of constituents. Geochemical modeling was used to estimate leachate concentrations from all contaminated soil, and the HELP model was used to estimate infiltration and runoff values for surface soil.

A simplified analytical approach, the Modified Universal Soils Loss Equation (MUSLE) model, was used to estimate runoff and contaminant transport from surface soils to Paddys Run. The flow in Paddys Run was used as a source term for groundwater in downstream areas where it recharges through coarse sediments. The ODAST model was not used in these areas.

For all source terms, the total mass of available contaminants was initially estimated for the start of the model time frame. As contaminants were transported away or decayed over time, these source masses were depleted. If they were exhausted before the end of the 1000 years, the source was deleted from that time forward.

The SWIFT III groundwater model used as input parameters the flow and contaminant concentration data from all of the ODAST simulations. Other general groundwater flow conditions were established previously in the SWCR. SWIFT III predicted the transport of the contaminants in the groundwater flow paths and developed contaminant concentration contours at specified times. From this data, specific receptor locations were selected as representative of potential risks to on- and off-property residents. Plots of concentration versus time for these locations were then developed to estimate the potential risks from groundwater contaminants originating at the FEMP.

K.3.2.2 Site-Wide Air Pathway Analysis

The objectives of the air quality impact analysis were to calculate the risk from estimated ground-level air contaminant concentrations from the LRAs. The ground level air contaminant concentrations were then used in the exposure analysis.

Air Emission and Dispersion Modeling

Air dispersion modeling conducted for risk assessment calculations used an EPA air quality dispersion model, the Industrial Source Complex, Long-Term, Version 2 (ISCLT2). Rn-222 emission rates were estimated using the RAECOM model, which converts Ra-226 soil concentrations to Rn-222

emission rates, consistent with the natural decay of Ra-226. Airborne particulate emission rates were estimated using methods presented in *Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites* (EPA 1985c). Only nonvolatile organic compounds were assumed to remain on-property after remediation; therefore, nonvolatile organic compound soil concentrations were used to analyze organic emission rates.

Sources

The air emissions from the LRAs for Operable Units 1, 2, 3, and 5 (identified in the SWCR), as well as the updated LRA for Operable Unit 4 (identified in the FS report), were modeled as source areas for risk assessment calculations. Operable Unit 1 has 8 sources; Operable Unit 2, 8 sources; Operable Unit 3, 21 sources; Operable Unit 4, 2 sources; Operable Unit 5, 157 sources; and the on-property vaults, 47 sources; for a total of 243 source areas. Two emission rates were analyzed for each source. The future emission case differs from the current case in that the future case amends a loss of topsoil and the first drainage layer from the vault and Operable Units 1 and 2 caps, and a total loss is Operable Unit 4 soil cover. More specific information about these sources appears in Section K.6.2.

As indicated in K.3.2.2, various models and methods were used to estimate air contaminant emission rates. Radon emissions were calculated using the RAECOM model. The contaminant concentrations in surface soil were used to develop suspended contaminant emission rates from the total suspended particulate emission rate. Contaminants in wind blown soil include radionuclides, inorganic compounds, and nonvolatile organic compounds.

Contaminant Concentrations

Contaminant soil concentrations for Operable Units 1 through 4 were obtained from various FEMP reports, including:

- *Remedial Investigation Report for Operable Unit 2* (Draft), October 1992
- *Remedial Investigation Report for Operable Unit 4* (Final), November 1993
- *Site-Wide Characterization Report* (Final), March 1993

The SWCR and the RI/FS database were used to estimate soil contaminant concentrations for Operable Unit 3. These reports were also used to estimate the Ra-226 concentration for waste

5208

disposed of in on-property vaults. The PRGs were used as concentration estimates for remediated soils, consistent with the groundwater modeling approaches presented in Section K.3.2.1.

Meteorological Data

Six continuous years of meteorological data from the FEMP, from 1987 through 1992, in stability array (STAR) format, were used to model air quality impacts.

Receptors

Air contaminant concentrations were modeled using a receptor grid, a system of fenceline receptors, and several discrete receptors. The receptor grid consisted of 900 receptor points covering the site and extending approximately 1200 meters (4000 feet) beyond the FEMP fenceline in each direction. The grid was used to develop airborne concentration isopleths for the FEMP and surrounding area. The maximum on-property impact location was determined from modeled results at the receptor grid points. The on-property residential and occupational worker exposures were developed from the grid point concentration values.

The fenceline receptor system consisted of 36 receptor points located around the FEMP at the fenceline. The maximum off-property impact location was determined from modeled results at these receptor points. The off-property residential exposure was developed from this maximum impact location (the nearest off-property resident is assumed to be at the maximum off-property impact location).

Discrete receptors included the Elda School and Ross High School in Ross, and the Crosby Township Elementary School between Fernald and New Haven. These receptors were used to determine impacts at sensitive receptors in the surrounding community.

## K.3.3 EXPOSURE AND INTAKE ASSESSMENT DATA

Exposure assessment evaluates the amount of contaminants a potential receptor may experience from contact with FEMP residual contaminants and how much would be taken into the body to cause adverse effects. The exposure assessment involves four stages:

1. Characterization of the exposure setting

0079

2. Identification of contaminant migration and receptor exposure pathways
3. Quantification of exposure
4. Assessment of contaminant intake doses

Section K.5.1.1 provides a detailed description of the exposure setting up to 1000 years after site remediation. Sections K.5.2 and K.5.3 characterize and identify the pathways in which site residual contaminants could reach human receptors. Section K.8.0 contains detailed presentations of the intake equations, data values, and sources of data used in the exposure assessment.

The exposure assessment data in this CRARE were selected according to the following hierarchy (in descending order of preference):

1. Site-specific data obtained from the site remediation database
2. RI/FS database and other regional and site-specific data from studies that complement the RI/FS characterization process
3. Generic exposure assessment data from EPA reference documents
4. Generic exposure assessment data from secondary sources, subject to EPA approval.

The parameters used to assess current and future potential contaminant exposures and intake are listed in Tables K.3-1 and K.3-2. A receptor's exposure to residual contaminants was quantified using methods, models, and parameters consistent with the Operable Unit 4 RI report, with exceptions noted below and in the tables. The parameters are based on the descriptions of the exposure pathways and receptor characteristics presented in Sections K.5.1., K.5.2, and K.5.3 of this CRARE.

The soil ingestion rate for the RME adult farmer is a site-specific time-weighted average value which is consistent with the value in the Operable Unit 4 RI (see Table D.3-12). It is based on specific activities performed during the course of the receptor's lifetime and the relative length of time spent in each activity. The first six years of this receptor's life are spent as a young child ingesting 0.2g/day for 350 days/year (a total of 420g). Between 18 and 70 years of age, the RME farmer is assumed to spend 50 years working a farm. Assuming the farmer follows the usual and recommended agricultural practices in Hamilton County, he will spend 100 days/year outdoors working the land, during which he is assumed to consume 0.48g day/of soil, (a total of 2400g).

During the remaining 250 days a year spent on the property, the resident ingests soil at a rate of 0.1g/day - adding another 1,250 grams of soil to the farmer's intake during this 50 years. During the remaining 14 years (12 years as an older child and 2 years as an adult), it is assumed that the soil ingestion rate is 0.1g/day for each of the 350 days/year spend on site (a total of 490g). The total soil ingestion, 4560g, divided by 25,550 days (365 days x 70 years) yields a time-weighted average intake of 0.18g/day.

## TABLE K.3-1

## PARAMETERS USED IN CRARE TO ESTIMATE COC EXPOSURES FOR CURRENT AND FUTURE LAND USE SCENARIOS[a]

| | RME Receptor | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | On-Property Resident Farm | | | Off-Property Resident Farm | | | Trespassing | Expanded Trespasser[b] | |
| | Groundskeeper | Adult | Youth | Child | Adult | Youth | Child | Child[b] | Childhood Years | Adulthood Years |
| **Exposure Pathway** | | | | | | | | | | |
| Inhalation of Dusts and Radon | | | | | | | | | | |
| IR ($m^3$/hr) | 0.83 | 0.83 | 0.83 | 0.5 | 0.83 | 0.83 | 0.5 | 0.83 | 0.83 | 0.83 |
| ET Indoors (hr/d) | 0 | 18.3 | 18.3 | 22 | 18.3 | 18.3 | 22 | 0 | 0 | 0 |
| ET Outdoors(hr/d) | 8 | 5.7 | 5.7 | 2 | 5.7 | 5.7 | 2 | 4 | 2 | 1 |
| EF (d/yr) | 250[c] | 350 | 350 | 350 | 350 | 350 | 350 | 52 | 120 | 40 |
| ED (yr) | 25 | 70 | 12 | 6 | 70 | 12 | 6 | 12 | 12 | 32 |
| BW (kg) | 70 | 70 | 43 | 15 | 70 | 43 | 15 | 43 | 43 | 70 |
| AT Noncancer (d) | 9125 | 25550 | 4380 | 2190 | 25550 | 4380 | 2190 | 4380 | 4380 | 11680 |
| AT Cancer (d) | 25550 | 25550 | 25550 | 25550 | 25550 | 25550 | 25550 | 25550 | 25550 | 25550 |
| Drinking Water | | | | | | | | | | |
| IR (l/d) | NA | 2 | 2 | 1.4 | 2 | 2 | 1.4 | NA | NA | NA |
| FI (unitless) | NA | 1 | 1 | 1 | 1 | 1 | 1 | NA | NA | NA |
| EF (d/yr) | NA | 350 | 350 | 350 | 350 | 350 | 350 | NA | NA | NA |
| ED (yr) | NA | 70 | 12 | 6 | 70 | 12 | 6 | NA | NA | NA |
| BW (kg) | NA | 70 | 43 | 15 | 70 | 43 | 15 | NA | NA | NA |
| AT Noncancer (d) | NA | 25550 | 4380 | 2190 | 25550 | 4380 | 2190 | NA | NA | NA |
| AT Cancer (d) | NA | 25550 | 25550 | 25550 | 25550 | 25550 | 25550 | NA | NA | NA |
| Incidental Ingestion while Wading | | | | | | | | | | |
| IR (l/hr) | NA | NA | 0.05 | NA | NA | NA | NA | 0.05 | 0.05 | 0.05 |
| FI (unitless) | NA | NA | 1 | NA | NA | NA | NA | 1 | 1 | 1 |
| ET (hr/d) | NA | NA | 0.5 | NA | NA | NA | NA | 0.5 | 0.5 | 0.5 |
| EF (d/yr) | NA | NA | 13[c] | NA | NA | NA | NA | 13[c] | 30 | 10 |



0082

5208

**TABLE K.3-1**
**(Continued)**

| | RME Receptor | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | On-Property Resident Farm | | | Off-Property Resident Farm | | | Trespassing | Expanded Trespasser[b] | |
| | Groundskeeper | Adult | Youth | Child | Adult | Youth | Child | Child[b] | Childhood Years | Adulthood Years |
| Incidental Ingestion while Wading (cont.) | | | | | | | | | | |
| ED (yr) | NA | NA | 12 | NA | NA | NA | NA | 12 | 12 | 32 |
| BW (kg) | NA | NA | 43 | NA | NA | NA | NA | 43 | 43 | 70 |
| AT Noncancer (d) | NA | NA | 4380 | NA | NA | NA | NA | 4380 | 4380 | 11680 |
| AT Cancer (d) | NA | NA | 25550 | NA | NA | NA | NA | 25550 | 25550 | 25550 |
| Incidental Ingestion of Soil/Sediment | | | | | | | | | | |
| IR (g/d) | 0.05[f] | 0.18[e] | 0.1 | 0.2 | NA | NA | NA | 0.1 | 0.1 | 0.1 |
| FI | 1 | 1 | 1 | 1 | NA | NA | NA | 0.25 | 0.1 | 0.05 |
| EF (d/yr) | 250[c] | 350 | 350 | 350 | NA | NA | NA | 52 | 120 | 40 |
| ED (yr) | 25 | 70 | 12 | 6 | NA | NA | NA | 12 | 12 | 32 |
| BW (kg) | 70 | 70 | 43 | 15 | NA | NA | NA | 43 | 43 | 70 |
| AT Noncancer (d) | 9125 | 25550 | 4380 | 2190 | NA | NA | NA | 4380 | 4380 | 11680 |
| AT Cancer (d) | 25550 | 25550 | 25550 | 25550 | NA | NA | NA | 25550 | 25550 | 25550 |
| Dermal Contact with Soil/Sediment | | | | | | | | | | |
| SA ($m^2$) | 0.58 | 0.58 | 0.42 | 0.2 | NA | NA | NA | 0.42 | 0.42 | 0.58 |
| AF ($mg/cm^2$) | 1.0 | 1.0 | 1.0 | 1.0 | NA | NA | NA | 1.0 | 1.0 | 1.0 |
| ABS (unitless) | CSV[d] | CSV | CSV | CSV | NA | NA | NA | CSV | CSV | CSV |
| EF (d/yr) | 250[c] | 350 | 350 | 350 | NA | NA | NA | 52 | 120 | 40 |
| ED (yr) | 25 | 70 | 12 | 6 | NA | NA | NA | 12 | 12 | 32 |
| BW (kg) | 70 | 70 | 43 | 15 | NA | NA | NA | 43 | 43 | 70 |
| AT Noncancer (d) | 9125 | 25550 | 4380 | 2190 | NA | NA | NA | 4380 | 4380 | 11680 |
| AT Cancer (d) | 25550 | 25550 | 25550 | 25550 | NA | NA | NA | 25550 | 25550 | 25550 |

**TABLE K.3-1**
**(Continued)**

| | RME Receptor | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | On-Property Resident Farm | | | Off-Property Resident Farm | | | Trespassing | Expanded Trespasser[b] | |
| | Groundskeeper | Adult | Youth | Child | Adult | Youth | Child | Child[b] | Childhood Years | Adulthood Years |
| Soils/Vaults External Radiation Exposure | | | | | | | | | | |
| ET Indoors (hr/d) | 0 | 18.3 | 18.3 | 22 | NA | NA | NA | NA | 0 | 0 |
| ET Outdoors(hr/d) | 8 | 5.7 | 5.7 | 2 | NA | NA | NA | 4 | 2 | 1 |
| EF (d/yr) | 250[c] | 350 | 350 | 350 | NA | NA | NA | 52 | 120 | 40 |
| ED (yr) | 25 | 70 | 12 | 6 | NA | NA | NA | 12 | 12 | 32 |
| SH Indoors (unitless) | 0.5 | 0.5 | 0.5 | 0.5 | NA | NA | NA | NA | 0.5 | 0.5 |
| SH Outdoors (unitless) | 0 | 0 | 0 | 0 | NA | NA | NA | 0 | 0 | 0 |
| Ingestion of Vegetables and Fruit | | | | | | | | | | |
| IR (g/d) | NA | 122 | 122 | 101.5 | 122 | 122 | 101.5 | NA | NA | NA |
| FI (unitless) | NA | 1 | 1 | 1 | 1 | 1 | 1 | NA | NA | NA |
| EF (d/yr) | NA | 350 | 350 | 350 | 350 | 350 | 350 | NA | NA | NA |
| ED (yr) | NA | 70 | 12 | 6 | 70 | 12 | 6 | NA | NA | NA |
| BW (kg) | NA | 70 | 43 | 15 | 70 | 43 | 15 | NA | NA | NA |
| AT Noncancer (d) | NA | 25550 | 4380 | 2190 | 25550 | 4380 | 2190 | NA | NA | NA |
| AT Cancer (d) | NA | 25550 | 25550 | 25550 | 25550 | 25550 | 25550 | NA | NA | NA |
| Ingestion of Meat | | | | | | | | | | |
| IR (g/d) | NA | 75 | 75 | 29 | 75 | 75 | 29 | NA | NA | NA |
| FI (unitless) | NA | 1 | 1 | 1 | 1 | 1 | 1 | NA | NA | NA |
| EF (d/yr) | NA | 350 | 350 | 350 | 350 | 350 | 350 | NA | NA | NA |
| ED (yr) | NA | 70 | 12 | 6 | 70 | 12 | 6 | NA | NA | NA |
| BW (kg) | NA | 70 | 43 | 15 | 70 | 43 | 15 | NA | NA | NA |
| AT Noncancer (d) | NA | 25550 | 4380 | 2190 | 25550 | 4380 | 2190 | NA | NA | NA |
| AT Cancer (d) | NA | 25550 | 25550 | 25550 | 25550 | 25550 | 25550 | NA | NA | NA |



0084
5208

# TABLE K.3-1
## (Continued)

| | RME Receptor | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | On-Property Resident Farm | | | Off-Property Resident Farm | | | Trespassing | Expanded Trespasser[b] | |
| | Groundskeeper | Adult | Youth | Child | Adult | Youth | Child | Child[b] | Childhood Years | Adulthood Years |
| Ingestion of Milk | | | | | | | | | | |
| IR (l/d) | NA | 0.3 | 0.3 | 0.9 | 0.3 | 0.3 | 0.9 | NA | NA | NA |
| FI (unitless) | NA | 1 | 1 | 1 | 1 | 1 | 1 | NA | NA | NA |
| EF (d/yr) | NA | 350 | 350 | 350 | 350 | 350 | 350 | NA | NA | NA |
| ED (yr) | NA | 70 | 12 | 6 | 70 | 12 | 6 | NA | NA | NA |
| BW (kg) | NA | 70 | 43 | 15 | 70 | 43 | 15 | NA | NA | NA |
| AT Noncancer (d) | NA | 25550 | 4380 | 2190 | 25550 | 4380 | 2190 | NA | NA | NA |
| AT Cancer (d) | NA | 25550 | 25550 | 25550 | 25550 | 25550 | 25550 | NA | NA | NA |

Acronyms used in this table:

ABS = Absorption factor
AF = Soil-to-skin adherence factor
AT = Averaging time
BW = Body weight
CSV = Chemical specific value
DR = Dose equivalent rate
ED = Exposure duration
EF = Exposure frequency
ET = Exposure time
FD = Fraction of day
FI = Fraction ingested from contaminated source
FY = Fraction of year
IR = Average inhalation rate or average ingestion rate based on pathway
NA = Not applicable
SA = Skin surface area available for contact
SH = Building shielding factor

[a]Except where qualified by other footnotes, the values in this table are from the FEMP OU4 RI approved final report.
[b]Justification and clarification for these scenarios is provided in the OU4 FS.
[c]This value is different from the OU4 RI baseline risk assessment due to the site-wide nature of the CRARE compared to the more limited area of the OU4 silos.
[d]The CSV values are presented in Table K.3-2.
[e]IR for the farmer is based on the explanation found in Section K.3-3.
[f]EPA (1990b), Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Supplemental Guidance, "Standard Exposure Factors", p. 28, Final Draft, OSWER Directive:9285.6-03.





0085

- 5208

## TABLE K.3-2

## DERMAL SOIL ABSORPTION COEFFICIENTS USED IN EXPOSURE MODEL[a]

| COC | Soil Absorption Coefficient (unitless) | COC | Soil Absorption Coefficient (unitless) |
|---|---|---|---|
| **Inorganics** | | **Semivolatile Organics** | |
| Antimony | $1.00 \times 10^{-2}$ | Di-n-octylphthalate | $3.00 \times 10^{-1}$ |
| Arsenic | $1.00 \times 10^{-3}$ | Dioxins/Furans[b] | $3.00 \times 10^{-2}$ |
| Barium | $1.00 \times 10^{-2}$ | | |
| Beryllium | $1.00 \times 10^{-2}$ | **Pesticide/PCBs** | |
| Cadmium | $1.00 \times 10^{-2}$ | Aroclor-1016[b] | $6.00 \times 10^{-2}$ |
| Chromium | $1.00 \times 10^{-2}$ | Aroclor-1221[b] | $6.00 \times 10^{-2}$ |
| Cobalt | $1.00 \times 10^{-2}$ | Aroclor-1242[b] | $6.00 \times 10^{-2}$ |
| Cyanide | ND | Aroclor-1248[b] | $6.00 \times 10^{-2}$ |
| Copper | $1.00 \times 10^{-3}$ | Aroclor-1254[b] | $6.00 \times 10^{-2}$ |
| Lead | $1.00 \times 10^{-2}$ | Aroclor-1260[b] | $6.00 \times 10^{-2}$ |
| Manganese | $1.00 \times 10^{-2}$ | 4,4'-DDT | $3.00 \times 10^{-1}$ |
| Mercury | $5.00 \times 10^{-2}$ | | |
| Molybdenum | $1.00 \times 10^{-2}$ | | |
| Nickel | $5.00 \times 10^{-4}$ | | |
| Selenium | $1.00 \times 10^{-2}$ | | |
| Thallium | $1.00 \times 10^{-2}$ | | |
| Vanadium | $1.00 \times 10^{-3}$ | | |
| Zinc | $1.00 \times 10^{-2}$ | | |

[a]Except where qualified by other footnotes, the values in this table are from the FEMP OU4 RI approved final report.
[b]EPA 1992f.

0086

# SECTION K.4.0

# CONTAMINANTS OF CONCERN

## K.4.0 CONTAMINANTS OF CONCERN - 5208

The principal radioactive constituents found in environmental media at the FEMP are uranium, radium, thorium, and their progeny. Principal hazardous waste constituents include heavy metals, chlorinated and non-chlorinated solvents, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs). The source areas of the nonradioactive constituents are typically smaller than those of the radioactive constituents.

### K.4.1 COMPARISON OF LISTS

A listing of site-wide potential COCs is presented in Appendix R of the SWCR. The list contains potential COCs, in the various media, that may be present at the FEMP. The SWCR list, which is based on detection in on-property samples, was combined with the lists of potential COCs from this Operable Unit 4 FS and the Operable Unit 2 RI to provide a new list, which was then used for the initial screening of potential COCs in this CRARE. Because the potential COCs for Operable Units 1 and 3 were obtained solely from the SWCR, it is important to note that SWCR data are subject to validation and may be supplemented by future sampling in these operable units.

### K.4.2 COC SELECTION PROCESS

It was assumed that constituents evaluated in the CRARE are all potential COCs, since this has occurred as part of the RI and FS. The CRARE is a postremediation time frame document. As such, total potential COCs will be reduced to reflect the screening in both the RI and the FS. Further, some contaminants will be removed, treated or contained such that exposure to humans and the environment is precluded. For this CRARE, the new site-wide list was screened three times as follows to eliminate contaminants that pose little to no risk to postremediation receptors:

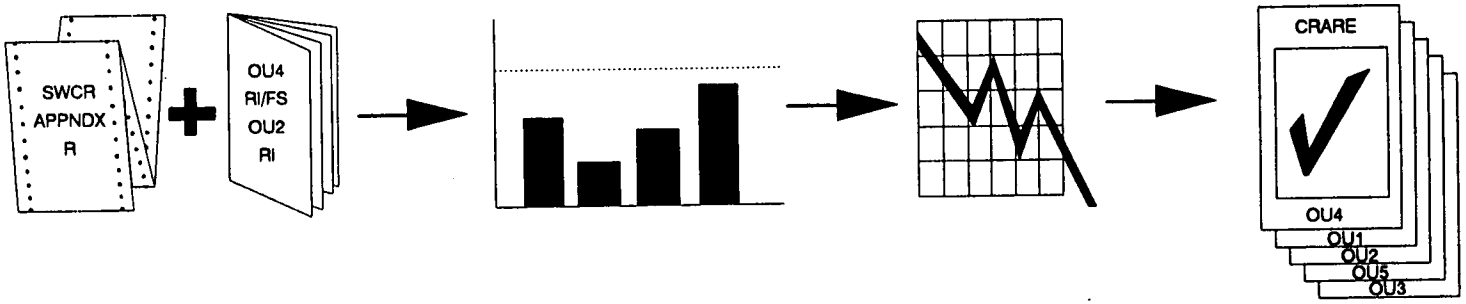
1. Initial screening:

   Eliminate laboratory artifacts, nutrients, and contaminants with off-site sources.

2. Second screening:

   Eliminate contaminants with vapor pressures above 10 millimeters (0.4 inches) of mercury at 20°C (68°F).

0088




**INITIAL CHEMICAL LISTING**

FROM:

- SITE-WIDE LIST, SWCR APPENDIX R
- OU4 RI/FS
- OU2 RI

**INITIAL SCREENING**

REMOVE:

- LAB ARTIFACTS
- NON-SITE RELATED CHEMICALS
- NUTRIENTS

**SECOND SCREENING**

REMOVE:

- VOLATILES WITH VAPOR PRESSURE >10 mm HG

**FINAL SCREENING**

REMOVE:

- ORGANICS THAT DEGRADE IN SOIL BY 99% WITHIN 70 YEARS
- ORGANICS IN WATER THAT WILL BE REMOVED BY THE OU 5 GROUNDWATER SURFACE PUMP AND TREAT SYSTEM

04/424331-RHCI FD-IRVINE
TFFIG4-1.DRW 12/93 OU4 CRARE

FIGURE K.4-1. COC SELECTION PROCESS

3. Final screening:

   Eliminate contaminants that would degrade sufficiently, based on their organic degradation rates in soil over time, or would be removed from the groundwater by pump and treat operations.

After completion of this screening process, the number of potential COCs have been reduced to a fewer number designated as COCs. This process for the CRAREs is illustrated in Figure K.4-1.

### K.4.3 INITIAL SCREENING OF POTENTIAL COCs

The following criteria were used during the initial screening process to eliminate COCs from the initial lists:

- Contaminant is a nontoxic, ubiquitous compound.
- Contaminant is detected in blanks associated with the site-related samples at sufficient levels (i.e., at or above the in-situ sample level) to indicate that the measurements of the site-related samples are probably artifacts.
- Contaminant is a general class of compounds unsuitable for use in a quantitative risk assessment (e.g., total petroleum hydrocarbons); these classes of compounds must be identified as individual contaminants.
- Contaminant is a nutrient or dietary requirement.

Table K.4-1 presents contaminants eliminated during the initial screening. Table K.4-2 presents the results of the initial screening process for radionuclides and chemicals.

## TABLE K.4-1

## CONTAMINANTS ELIMINATED DURING INITIAL SCREENING

| Radionuclides | Chemicals | |
|---|---|---|
| None | Alkalinity as $CaCO_3$ | Potassium |
| | Aluminum | Silicon |
| | Ammonia | Sodium |
| | Boron | Sulfate |
| | Calcium | Sulfide |
| | Chloride | Tetrachlorodibenzofuran |
| | Iron | Total dissolved solids |
| | Magnesium | Total Kjeldahl nitrogen |
| | Nitrate | Total organic carbon |
| | Oil and grease | Total organic nitrogen |
| | Phosphate | Total organic halides |
| | Phosphorous | |

0091

5208

## TABLE K.4-2

## POTENTIAL COCs IN EACH MEDIUM FOR EACH OPERABLE UNIT (AFTER INITIAL SCREENING)[a]

| Compound | OU1 | OU2 | OU3 | OU4 | OU5 |
|---|---|---|---|---|---|
| **Chemical** | | | | | |
| 1,1-Dichloroethane | SUB | SUB | SURF,SUB | | SUB,GW |
| 1,1-Dichloroethane | | SUB | SURF,SUB | | GW |
| 1,1,1-Trichloroethane | SUB | SUB | SURF,SUB | | SUB,GW |
| 1,1,2-Trichloro-1,2,2-trifluoroethane | | SUB | | | |
| 1,1,2-Trichloroethane | | | SURF,SUB | | GW |
| 1,1,2,2-Tetrachloroethane | SUB | | SURF,SUB | | |
| 1,2-Dichlorobenzene | | | | | GW |
| 1,2-Dichloroethane | | SUB | SUB | | GW |
| 1,2-Dichloroethylene | SUB | SUB | SURF,SUB | | SUB,GW |
| 1,4-Dioxane | | SUB | | | SUB |
| 2-Butanone | SUB | SUB | SURF,SUB | BERM,SURF | SUB,GW |
| 2-Chlorophenol | | SUB | | | SUB |
| 2-Hexanone | SUB | SUB | SURF,SUB | | SURF,SUB,GW |
| 2-Methylnaphthalene | SUB | SUB | SURF,SUB | | SUB |
| 2-Methylphenol | | SUB | | | |
| 2-Nitrophenol | | | | | GW |
| 2,3,4,6-Tetrachlorophenol | | | | | GW |
| 2,4-Dimethylphenol | SUB | SUB | | | GW |
| 2,6-Dinitrotoluene | | | | | GW |
| 3-Nitroaniline | | | | | GW |
| 3,3-Dichlorobenzidine | SUB | | | | |
| 4-Chloro-3-methylphenol | | SUB | SUB | | SUB |
| 4-Chlorophenyl-phenyl ether | SUB | | | | |
| 4-Methyl-2-pentanone | SUB | SUB | SURF,SUB | | SURF,SUB,GW |
| 4-Methylphenol | SUB | SUB | | | GW |
| 4-Nitrophenol | | SUB | | | SUB,GW |
| 4,4-DDT | SUB | | | | |
| 4,6-Dinitro-2-methylphenol | | | | | GW |
| Acenaphthene | SUB | SUB | SURF,SUB | SURF | SUB |
| Acetone | SUB | SUB | SURF,SUB | BERM,SURF | SURF,SUB,GW |
| Anthracene | SUB | SUB | SURF,SUB | SURF | SUB |
| Antimony | SURF,SUB | SUB | SURF,SUB | BERM,SURF | SURF,SUB,GW |
| Aroclor-1016 | SUB | | | | |
| Aroclor-1221 | | | SUB | | |
| Aroclor-1242 | SUB | SUB | | | |
| Aroclor-1248 | SUB | SUB | SUB | | |
| Aroclor-1254 | SURF,SUB | SUB | SURF,SUB | | SURF,SUB |

**TABLE K.4-2**
**(Continued)**

| Compound | OU1 | OU2 | OU3 | OU4 | OU5 |
|---|---|---|---|---|---|
| Aroclor-1260 | SURF,SUB | SUB | SURF,SUB | | SUB |
| Arsenic | SUB | SUB | SURF,SUB | BERM,SURF | SURF,SUB,GW |
| Barium | SUB | SUB | SURF,SUB | BERM,SURF | SUB,GW |
| Benzene | | SUB | SURF,SUB | | GW |
| Benzoic acid | | SUB | SURF,SUB | SURF | SUB,GW |
| Benzo(a)anthracene | SUB | SUB | SURF,SUB | SURF | SUB |
| Benzo(a)pyrene | SUB | SUB | SURF,SUB | SURF | SUB |
| Benzo(b)fluoranthene | SUB | SUB | SURF,SUB | SURF | SUB |
| Benzo(g,h,i)perylene | SUB | SUB | SURF,SUB | SURF | SUB |
| Benzo(k)fluoranthene | SUB | SUB | SURF,SUB | | SUB |
| Benzyl alcohol | | | | | GW |
| Beryllium | SUB | SUB | SURF,SUB | BERM,SURF | SUB,GW |
| Beta-BHC | | | SURF,SUB | | |
| Bis(2-ethylhexyl) phalate | SUB | SUB | SURF,SUB | SURF | SUB,GW |
| Bromochloromethane | | | | | GW |
| Bromodichloromethane | | | SUB | | SUB |
| Butylbenzyl phthalate | | SUB | SUB | | GW |
| Cadmium | SUB | SUB | | BERM,SURF | GW |
| Carbon disulfide | SUB | SUB | SURF,SUB | | SUB,GW |
| Carbon tetrachloride | SUB | | SUB | | GW |
| Chlordane | | SUB | | | |
| Chlorobenzene | SUB | SUB | SURF,SUB | | |
| Chloroethane | | | SUB | | GW |
| Chloroform | SUB | SUB | SURF,SUB | | SUB,GW |
| Chloromethane | | SUB | | | |
| Chromium | SUB | SUB | | BERM | GW |
| Chrysene | SUB | SUB | SURF,SUB | | SUB |
| Cobalt | SUB | SUB | SURF,SUB | | SUB,GW |
| Copper | SUB | SUB | SURF,SUB | BERM,SURF | SUB,GW |
| Cyanide | SURF,SUB | SUB | SURF,SUB | BERM,SURF | SURF,SUB,GW |
| Dibenzofuran | SUB | SUB | SURF,SUB | | SUB |
| Dibenzo(a,h)anthracene | SUB | SUB | SURF,SUB | SURF | SUB |
| Dibromochloromethane | | | | | SUB |
| Dichlorodifluoromethane | | SUB | | | |
| Diethyl phthalate | | SUB | SUB | | SUB,GW |
| Di-n-butyl phthalate | SUB | SUB | SURF,SUB | BERM,SURF | SUB,GW |
| Di-n-octyl phthalate | SUB | SUB | SUB | | |
| Ethyl parathion | SUB | | | | |
| Ethylbenzene | SUB | SUB | SURF,SUB | | SUB,GW |

- 5208

**TABLE K.4-2**
**(Continued)**

| Compound | OU1 | OU2 | OU3 | OU4 | OU5 |
|---|---|---|---|---|---|
| Fluoranthene | SUB | SUB | SURF,SUB | SURF | SUB |
| Fluorene | SUB | SUB | SURF,SUB | | SUB |
| Heptachlor epoxide | | | | | GW |
| Heptachlorodibenzo-p-dioxin | | SUB | | | |
| Heptachlorodibenzofuran | | SUB | | | |
| Indeno(1,2,3-cd)pyrene | SUB | SUB | SURF,SUB | SURF | SUB |
| Isophorone | | | | | GW |
| Lead | SUB | SUB | SURF,SUB | | SUB |
| Malathion | SUB | | | | |
| Manganese | SUB | SUB | SUB | | GW |
| Mercury | SUB | SUB | SURF,SUB | | SUB,GW |
| Methyl parathion | SUB | | | | |
| Methylene chloride | SUB | SUB | SURF,SUB | SURF | SURF,SUB,GW |
| Molybdenum | SUB | SUB | | BERM,SURF | SUB,GW |
| Naphthalene | SUB | SUB | SURF,SUB | | SUB,GW |
| Nickel | SURF,SUB | | SURF,SUB | BERM,SURF | SURF,SUB,GW |
| N-Nitrosodiethylamine | | | | | GW |
| N-Nitroso-di-n-propylamine | | | SUB | | |
| N-Nitrosodiphenylamine | SUB | SUB | SURF,SUB | | GW |
| Octachlorodibenzo-p-dioxin | | SUB | | | |
| Octachlorodibenzofuran | | SUB | | | |
| Pentachlorophenol | SUB | SUB | | | GW |
| Phenanthrene | SUB | SUB | SURF,SUB | SURF | SUB |
| Phenol | SUB | SUB | SURF,SUB | BERM,SURF | SUB,GW |
| Pyrene | SUB | SUB | SURF,SUB | SURF | SUB |
| Pyridine | | SUB | | | |
| Selenium | SUB | SUB | SURF,SUB | | SUB,GW |
| Styrene | | SUB | SURF,SUB | | |
| Tetrachloroethene | SUB | SUB | SURF,SUB | | SUB,GW |
| Thallium | | SUB | | BERM,SURF | GW |
| Toluene | SUB | SUB | SURF,SUB | BERM,SURF | SUB,GW |
| Total Xylenes | SUB | SUB | SURF,SUB | BERM | SUB,GW |
| Tributyl phosphate | | | SURF,SUB | | GW |
| Trichloroethene | SUB | SUB | SURF,SUB | | SUB,GW |
| Trichlorofluoromethane | | | | | GW |
| Vanadium | SUB | SUB | | BERM,SURF | SUB,GW |
| Vinyl acetate | | SUB | | | SUB,GW |
| Vinyl chloride | SUB | | SUB | | SUB,GW |
| Zinc | SUB | SUB | SURF,SUB | BERM,SURF | SUB,GW |

0094

208

**TABLE K.4-2**
**(Continued)**

| Compound | OU1 | OU2 | OU3 | OU4 | OU5 |
|---|---|---|---|---|---|
| **Radionuclide** | | | | | |
| Am-241 | SUB | | | | |
| Cs-137 | SURF,SUB | SURF | SURF,SUB | | SURF,SUB |
| Np-237 | SURF,SUB | SURF,SUB,GW | SUB | | GW |
| Pa-231 | | | | SUB | |
| Pb-210 | | SURF,SUB | | BERM | |
| Pu-238 | SURF,SUB | SUB,SURF | SURF,SUB | | SURF |
| Pu-239 | SURF,SUB | SURF,SUB | SURF,SUB | | SURF |
| Pu-240 | SURF,SUB | SURF,SUB | SURF,SUB | | SURF |
| Ra-226 | SURF,SUB | SUB,SURF | SURF,SUB | BERM,SURF | SURF,SUB,GW |
| Ra-228 | SURF,SUB | SUB,SURF | SURF,SUB | BERM,SURF | SURF,SUB,GW |
| Rn-222[b] | A | A | A | A | A |
| Ru-106 | SURF,SUB | | | | |
| Sr-90 | SURF,SUB | SUB,SURF | SURF,SUB | SURF | SURF,SUB,GW |
| Tc-99 | SURF,SUB | SURF | SURF,SUB | SURF | SURF,SUB,GW |
| Th-228 | SURF,SUB | SUB,SURF | SURF,SUB | BERM,SURF | SURF,SUB,GW |
| Th-230 | SURF,SUB | SUB,SURF | SURF,SUB | BERM,SURF | SURF,SUB |
| Th-232 | SURF,SUB | SUB,SURF | SURF,SUB | BERM,SURF | SURF,SUB,GW |
| U-234 | SURF,SUB | SUB,GW,SURF | SURF,SUB | BERM,SURF | SURF,SUB,GW |
| U-235 | SURF,SUB | SUB,SURF,GW | SURF,SUB | | SURF,SUB,GW |
| U-236 | SURF,SUB | SUB,SURF | SURF,SUB | | SURF,SUB,GW |
| U-238 | SURF,SUB | SUB,GW,SURF | SURF,SUB | BERM,SURF | SURF,SUB,GW |

[a]Abbreviations used in this table:

A = Air
BERM = Berm fill
GW = Groundwater
SUB = Subsurface soil
SURF = Surface soil

[b] Radon was the only COC detected in on-site air samples. However, all surface soil COC exposures through particulate inhalation are evaluated quantitatively in the CRARE.

## K.4.4 SECOND SCREENING OF POTENTIAL COCs: VOLATILE LOSSES

This section details the second potential COC screening procedures employed for each of the five operable units. The CRARE time frames for all scenarios begin after completion of all remedial actions at the FEMP. The time period needed to complete the remedial actions is assumed to be 30 years. Therefore, volatile chemicals for all operable units were eliminated because they would be lost to the atmosphere over the 70- or 1000-year postremediation time frames. Volatile chemicals are defined as those chemicals having greater than 10 millimeters (0.4 inches) of mercury vapor pressure at 20°C (68°F). This concept is based on the *Air/Superfund National Technical Guidance Series, Volume III* (EPA 1985a). Each operable unit is at a different stage of the remediation process and therefore requires a different degree of contaminant screening. The second potential COC screening as applied to each of the operable units is described below.

### K.4.4.1 Operable Units 1 and 3

The remaining contaminants for Operable Units 1 and 3 are presented in Table K.4-3. At this time, the contaminants for both are considered to be potential COCs. Further analysis and screening, including frequency-of-detection and concentration-toxicity analysis, shall be employed to further eliminate contaminants when the CRAREs for Operable Units 1 and 3 are prepared.

### K.4.4.2 Operable Units 2 and 4

The remaining potential COCs for Operable Units 2 and 4 are presented in Table K.4-4. Further data analysis may enable continued screening of potential COCs for Operable Unit 2. As expected, of all the operable unit sampling efforts, the Operable Unit 4 data are the most complete.

### K.4.4.3 Operable Unit 5

Operable Unit 5 is defined as those environmental media at the site that are not being addressed by the other operable units. According to the implementation schedule, the Operable Unit 5 remedial actions would be completed after finishing the actions for the other operable units. All potential COCs from the other operable units are assumed to be present in some residual concentration following remediation. Contaminants having passed the initial and second screenings were combined to produce the Operable Unit 5 potential COC list presented in Table K.4-5. Both validated and unvalidated data were used to compile this list. Further fate and transport modeling efforts will refine the Operable Unit 5 potential COCs.

## TABLE K.4-3

## POTENTIAL COCs FOR OPERABLE UNITS 1 AND 3 (AFTER SECOND SCREENING)

| Operable Unit 1 | | Operable Unit 3 | |
|---|---|---|---|
| **Radionuclide** | **Chemical** | **Radionuclide** | **Chemical** |
| Am-241 | 1,1,2,2-Tetrachloroethane | Cs-137 | 1,1,2,2-Tetrachloroethane |
| Cs-137 | 2-Hexanone | Np-237 | 2-Hexanone |
| Np-237 | 2-Methylnaphthalene | Pu-238 | 2-Methylnaphthalene |
| Pu-238 | 2-Nitrophenol | Pu-239 | 4-Chloro-3-Methylphenol |
| Pu-239 | 2,4-Dimethylphenol | Pu-240 | 4-Methyl-2-pentanone |
| Pu-240 | 3,3-Dichlorobenzidine | Ra-226 | Acenaphthene |
| Ra-226 | 4-Chlorophenyl-phenyl ether | Ra-228 | Anthracene |
| Ra-228 | 4-Methyl-2-pentanone | Rn-222 | Antimony |
| Rn-222 | 4-Methylphenol | Sr-90 | Aroclor-1221 |
| Ru-106 | 4,4-DDT | Tc-99 | Aroclor-1248 |
| Sr-90 | Acenaphthene | Th-228 | Aroclor-1254 |
| Tc-99 | Anthracene | Th-230 | Aroclor-1260 |
| Th-228 | Antimony | Th-232 | Arsenic |
| Th-230 | Aroclor-1016 | U-234 | Barium |
| Th-232 | Aroclor-1242 | U-235 | Benzoic acid |
| U-234 | Aroclor-1248 | U-236 | Benzo(a)anthracene |
| U-235 | Aroclor-1254 | U-238 | Benzo(a)pyrene |
| U-236 | Aroclor-1260 | | Benzo(b)fluoranthene |
| U-238 | Arsenic | | Benzo(g,h,i)perylene |
| | Barium | | Benzo(k)fluoranthene |
| | Benzo(a)anthracene | | Beryllium |
| | Benzo(a)pyrene | | Beta-BHC |
| | Benzo(b)fluoranthene | | Bis(2-ethylhexyl) phthalate |
| | Benzo(g,h,i)perylene | | Butylbenzyl phthalate |
| | Benzo(k)fluoranthene | | Cadmium |
| | Beryllium | | Chlorobenzene |
| | Bis(2-ethylhexyl) phthalate | | Chrysene |
| | Cadmium | | Cobalt |
| | Chlorobenzene | | Copper |
| | Chromium | | Cyanide |
| | Chrysene | | Dibenzofuran |
| | Cobalt | | Dibenzo(a,h)anthracene |
| | Copper | | Diethyl phthalate |
| | Cyanide | | Di-n-butyl phthalate |
| | Dibenzo(a,h)anthracene | | Di-n-octyl phthalate |
| | Dibenzofuran | | Ethylbenzene |
| | Di-n-butyl phthalate | | Fluoranthene |
| | Di-n-octyl phthalate | | Fluorene |

- 5208

**TABLE K.4-3**
**(Continued)**

| Operable Unit 1 | | Operable Unit 3 | |
|---|---|---|---|
| **Radionuclide** | **Chemical** | **Radionuclide** | **Chemical** |
| | Ethylparathion | | Indeno(1,2,3-cd) pyrene |
| | Ethylbenzene | | Lead |
| | Fluoranthene | | Manganese |
| | Fluorene | | Mercury |
| | Indeno(1,2,3-cd) pyrene | | Naphthalene |
| | Lead | | Nickel |
| | Malathion | | N-Nitroso-di-n-propylamine |
| | Manganese | | N-Nitrosodiphenylamine |
| | Mercury | | Phenanthrene |
| | Methyl parathion | | Phenol |
| | Molybdenum | | Pyrene |
| | Naphthalene | | Selenium |
| | Nickel | | Styrene |
| | N-Nitrosodiphenylamine | | Total xylenes |
| | Pentachlorophenol | | Tributylphosphate |
| | Phenanthrene | | Zinc |
| | Phenol | | |
| | Pyrene | | |
| | Selenium | | |
| | Total xylenes | | |
| | Vanadium | | |
| | Zinc | | |

0098

## TABLE K.4-4

## POTENTIAL COCs FOR OPERABLE UNITS 2 AND 4 (AFTER SECOND SCREENING)

| Operable Unit 2 | | Operable Unit 4 | |
|---|---|---|---|
| **Radionuclide** | **Chemical** | **Radionuclide** | **Chemical** |
| Cs-137 | 2-Chlorophenol | Pa-231 | Acenaphthene |
| Np-237 | 2-Hexanone | Pb-210 | Anthracene |
| Pb-210 | 2-Methylnaphthalene | Ra-226 | Antimony |
| Pu-238 | 2-Methylphenol | Ra-228 | Arsenic |
| Pu-239 | 2,4-Dimethylphenol | Rn-222 | Barium |
| Pu-240 | 4-Chloro-3-methylphenol | Sr-90 | Benzoic acid |
| Ra-226 | 4-Methyl-2-pentanone | Tc-99 | Benzo(a)anthracene |
| Ra-228 | 4-Methylphenol | Th-228 | Benzo(a)pyrene |
| Rn-222 | 4-Nitrophenol | Th-230 | Benzo(b) fluoranthene |
| Ru-106 | Acenaphthene | Th-232 | Benzo(g.h,i) perylene |
| Sr-90 | Anthracene | U-234 | Beryllium |
| Tc-99 | Antimony | U-238 | Bis(2-ethylhexyl) phthalate |
| Th-228 | Aroclor-1242 | | Cadmium |
| Th-230 | Aroclor-1248 | | Chromium |
| Th-232 | Aroclor-1254 | | Copper |
| U-234 | Aroclor-1260 | | Cyanide |
| U-235 | Arsenic | | Dibenzo(a,h)anthracene |
| U-236 | Barium | | Di-n-butyl phthalate |
| U-238 | Benzoic acid | | Fluoranthene |
| | Benzo(a)anthracene | | Indeno(1,2,3-cd) pyrene |
| | Benzo(a)pyrene | | Molybdenum |
| | Benzo(b)fluoranthene | | Nickel |
| | Benzo(g,h,i)perylene | | Phenanthrene |
| | Benzo(k)fluoranthene | | Phenol |
| | Beryllium | | Pyrene |
| | Bis(2-ethylhexyl) phthalate | | Thallium |
| | Butylbenzyl phthalate | | Total xylenes |
| | Cadmium | | Vanadium |
| | Chloradane | | Zinc |
| | Chlorobenzene | | |
| | Chloromethnae | | |
| | Chromium | | |
| | Chrysene | | |
| | Cobalt | | |
| | Copper | | |
| | Cyanide | | |

**TABLE K.4-4**
**(Continued)**

| Operable Unit 2 | | Operable Unit 4 | |
|---|---|---|---|
| **Radionuclide** | **Chemical** | **Radionuclide** | **Chemical** |
| | Dibenzofuran | | |
| | Dibenzo(a,h)anthracene | | |
| | Diethyl phthalate | | |
| | Di-n-butyl phthalate | | |
| | Di-n-octyl phthalate | | |
| | Ethylbenzene | | |
| | Fluoranthene | | |
| | Fluorene | | |
| | Heptachlorodibenzofuran | | |
| | Heptachlorodibenzo-p-dioxin | | |
| | Indeno(1,2,3-cd) pyrene | | |
| | Lead | | |
| | Manganese | | |
| | Mercury | | |
| | Molybdenum | | |
| | Naphthalene | | |
| | N-Nitrosodiphenylamine | | |
| | Octachlorodibenzofuran | | |
| | Octachlorodibenzo-p-dioxin | | |
| | Pentachlorophenol | | |
| | Phenanthrene | | |
| | Phenol | | |
| | Pyrene | | |
| | Selenium | | |
| | Styrene | | |
| | Thallium | | |
| | Total xylenes | | |
| | Vanadium | | |
| | Zinc | | |

## TABLE K.4-5

## POTENTIAL COCs FOR OPERABLE UNIT 5 (INCLUDES SUM OF COCs IN OPERABLE UNITS 1 THROUGH 4, AFTER SECOND SCREENING)

| Radionuclide | Chemical | |
|---|---|---|
| Am-241 | 1,2-Dichlorobenzene | Chrysene |
| Cs-137 | 1,1,2,2-Tetrachloroethane | Cobalt |
| Np-237 | 2-Chlorophenol | Copper |
| Pa-231 | 2-Hexanone | Cyanide |
| Pb-210 | 2-Methylnaphthalene | Dibenzo(a,h)anthracene |
| Pu-238 | 2-Methylphenol | Dibenzofuran |
| Pu-239 | 2-Nitrophenol | Diethyl phthalate |
| Pu-240 | 2,4-Dimethylphenol | Di-n-butyl phthalate |
| Ra-226 | 2,6-Dinitrotoluene | Di-n-octyl phthalate |
| Ra-228 | 2,3,4,6-Tetrachlorophenol | Ethylparathion |
| Rn-222 | 3-Nitroaniline | Ethylbenzene |
| Ru-106 | 3,3-Dichlorobenzidine | Fluoranthene |
| Sr-90 | 4-Chloro-3-methyphenol | Fluorene |
| Tc-99 | 4-Chlorophenyl-phenyl ether | Heptachlor epoxide |
| Th-228 | 4-Methyl-2-pentanone | Heptachlorodibenzofuran |
| Th-230 | 4-Methylphenol | Heptachlorodibenzo-p-dioxin |
| Th-232 | 4-Nitrophenol | Indeno(1,2,3-cd) pyrene |
| U-234 | 4,4-DDT | Isophorone |
| U-235 | 4,6-Nitro-2-methylphenol | Lead |
| U-236 | Acenaphthene | Malathion |
| U-238 | Anthracene | Manganese |
| | Antimony | Mercury |
| | Aroclors (1016, 1221, 1242, 1248, 1254, 1260) | Methyl parathion |
| | | Molybdenum |
| | Arsenic | Naphthalene |
| | Barium | Nickel |
| | Benzoic acid | N-Nitrosodiethylamine |
| | Benzo(a)anthracene | N-Nitroso-di-n-propylamine |
| | Benzo(a)pyrene | N-Nitrosodiphenylamine |
| | Benzo(b)fluoranthene | Octachlorodibenzofuran |
| | Benzo(g,h,i)perylene | Octachlorodibenzo-p-dioxin |
| | Benzo(k)fluoranthene | Pentachlorophenol |
| | Benzyl alcohol | Phenanthrene |
| | Beryllium | Phenol |
| | Beta-BHC | Pyrene |
| | Bis(2-ethylhexyl) phthalate | Selenium |
| | Butylbenzyl phthalate | Styrene |
| | Cadmium | Thallium |
| | Chlordane | Total xylenes |
| | Chlorobenzene | Tributylphosphate |
| | Chloromethane | Trichlorofluoromethane |
| | Chromium | Vanadium |
| | | Zinc |

0101

5208

## K.4.5 FINAL SCREENING OF POTENTIAL COCs

To reflect the forward-looking nature of the CRARE, the final screening addressed elimination of organic chemicals that would be degraded or removed from the site prior to the time period considered in the CRARE. Organic constituents which would sufficiently degrade before reaching the life span of the postremediation receptor or would be removed from groundwater through pump and treat operations were screened out. The half-lives of organic constituents remaining in the soil were examined and those which would degrade by 99 percent before reaching the 70-year life span of the postremediation receptor were eliminated from further consideration. For this final screening the concentration decay rate of organic constituents in soil, over time, was calculated using the formula below:

$$C/C_o = e^{-(\ln 2/T)t} \qquad (1)$$

where

$C_o$ = the initial concentration (UCL),
$T$ = the half-life in years, and
$t$ = time in years.

Half-life values for constituents in soil were obtained from the *Handbook of Environmental Degradation Rates* (Howard 1991). The highest half-life values were used. Those constituents were eliminated that showed a reduction in concentration of 99 percent or greater at or before 100 years. The 100 years represents the 30-year remedial action period plus the 70-year expected life time of an individual. For example, using the half-life in soil from Howard for DDT:

$$T = 5697.9 \text{ days}$$

where

$t$ = 100 years (36,500 days) following remediation, and
$C/C_o$ = 0.0118 or a 98.82 percent reduction.

Therefore, DDT was not eliminated.

In addition, organic constituents present in the groundwater were assumed to be removed from the site through a groundwater pump and treat operation. Thus, organics that were identified as potential COCs in groundwater only were eliminated from further consideration in the CRARE. Organic constituents which were potential COCs in media other than groundwater were not eliminated solely based on the pump and treat operation. Table K.4-6 lists the organic chemicals that were addressed in the final screening process. The table presents the half-life in soil of each compound and identifies those retained as COCs.

## TABLE K.4-6

## FINAL SCREENING OF ORGANIC CHEMICALS

| Organic Chemical | Half-life (days) | Retained or Screened Out |
|---|---|---|
| 1,1,2,2-Tetrachloroethane | 44 | Screened out |
| 1,2-Dichlorobenzene | 180 | Screened Out |
| 2-Chlorophenol | No Data | Retained |
| 2-Hexanone | 14[a] | Screened out |
| 2-Methylnaphthalene | No Data | Retained |
| 2-Methyphenol | 7 | Screened out |
| 2-Nitrophenol | 28 | Screened out |
| 2,3,4,6-Tetrachlorophenol | 180 | Screened out |
| 2,4-Dimethylphenol | 7 | Screened out |
| 2,6-Dinitrotoluene | 180 | Screened out |
| 3-Nitroaniline | ___[b] | Screened out |
| 3,3-Dichlorobenzidine | 180 | Screened out |
| 4-Chloro-3-methylphenol | 14[c] | Screened out |
| 4-Chlorophenyl-phenyl ether | No Data | Retained |
| 4-Methl-2-pentanone | 7 | Screened out |
| 4-Methylphenol | 0.67 | Screened out |
| 4-Nitrophenol | 1.21 | Screened out |
| 4,4-DDT | 5698 | Retained |
| 4,6-Dinitro-2-methylphenol | 21 | Screened out |
| Acenaphthene | 102 | Screened out |
| Anthracene | 460 | Screened out |
| Aroclor 1016 | No Data | Retained |
| Aroclor 1221 | No Data | Retained |
| Aroclor 1242 | No Data | Retained |
| Aroclor 1248 | No Data | Retained |
| Aroclor 1254 | No Data | Retained |
| Aroclor 1260 | No Data | Retained |
| Benzoic acid | 7 | Screened out |
| Benzo(a) anthracene | 680 | Screened out |
| Benzo(a)pyrene | 530 | Screened out |
| Benzo(b)fluoranthene | 610 | Screened out |
| Benzo(g,h,i) perylene | 650 | Screened out |
| Benzo(k)fluoranthene | 2140 | Screened out |
| Benzyl alcohol | ___[b] | Screened out |
| Beta-BHC | 124 | Screened out |
| Bis (2-ethylthexyl) phthalate | 23 | Screened out |
| Butylbenzyl phthalate | 7 | Screened out |
| Chlordane | 1386 | Screened out |

5208

**TABLE K.4-6**
**(Continued)**

| Organic Chemical | Half-life (days) | Retained or Screened Out |
|---|---|---|
| Chlorobenzene | 150 | Screened out |
| Chloromethane | 0.28 | Screened out |
| Chrysene | 1000 | Screened out |
| Dibenzofuran | 28 | Screened out |
| Dibenzo(a,h) anthracene | 940 | Screened out |
| Diethyl phthalate | 56 | Screened out |
| Di-n-butyl phthalate | 23 | Screened out |
| Di-n-octyl phthalate | 28 | Screened out |
| Ethyl parathion | 227 | Screened out |
| Ethyl benzene | 10 | Screened out |
| Fluoranthene | 440 | Screened out |
| Fluorene | 60 | Screened out |
| Heptachlor epoxide | 552 | Screened out |
| Heptachlorodibenzo-p-dioxin | No Data | Retained |
| Heptachlorodibenzofuran | No Data | Retained |
| Indeno(1,2,3-cd)pyrene | 730 | Screened out |
| Isophorone | 28 | Screened out |
| Malathion | 7 | Screened out |
| Methyl parathion | 360 | Screened out |
| Naphthalene | 48 | Screened out |
| N-Nitrosodiethylamine | 180 | Screened out |
| N-Nitroso-di-n-propylamine | 180 | Screened out |
| N-Nitrosodipheynlamine | 34 | Screened out |
| Octachlorodibenzo-p-dioxin | No Data | Retained |
| Octachlorodibenzofuran | No Data | Retained |
| Pentachlorophenol | 178 | Screened out |
| Phenanthrene | 200 | Screened out |
| Phenol | 10 | Screened out |
| Pyrene | 1900 | Screened out |
| Styrene | 28 | Screened out |
| Total xylenes | 28 | Screened out |
| Tributylphosphate | 140d | Screened out |
| Trichlorofluoromethane | 360 | Screened out |

[a]Half-life in soil assumed to be twice the value for 2-Butanone.
[b]Compounds removed from groundwater during pump and treat operation, not considered in CRARE.
[c]Half-life in soil assumed to be twice the value for 2-Methylphenol.
[d]Half-life in soil assumed to be 10 times its half-life in surface water/sediment (Montgomery 1991).

It should be noted that this screening assumption will be reevaluated for each operable unit as additional information concerning potential COCs becomes available. Each operable unit will propose specific methods for remediation of these organic contaminants. For example, the updated LRA for Operable Unit 4 provides for the removal of surface soil with disposal in the vaults.

Table K.4-7 shows the contaminants retained after implementing the final screening process.

**TABLE K.4-7**

**COCs RETAINED AFTER FINAL SCREENING FOR ALL OPERABLE UNITS**

| Radionuclide | Chemical | |
|---|---|---|
| Am-241 | 2-Chlorophenol | Cobalt |
| Cs-137 | 2-Methylnaphthalene | Copper |
| Np-237 | 4-Chlorophenyl-phenyl ester | Cyanide |
| Pa-231 | 4,4-DDT | Di-n-octyl phthalate |
| Pb-210 | Ammonia | Heptachlorodibenzofuran |
| Pu-238 | Antimony | Heptachlorodibenzo-p-dioxin |
| Pu-239 | Aroclor-1016 | Lead |
| Pu-240 | Aroclor-1221 | Manganese |
| Ra-226 | Aroclor-1242 | Mercury |
| Ra-228 | Aroclor-1248 | Molybdenum |
| Rn-222 | Aroclor-1254 | Nickel |
| Ru-106 | Aroclor-1260 | Octachlorodibenzofuran |
| Sr-90 | Arsenic | Octachlorodibenzo-p-dioxin |
| Tc-99 | Barium | Selenium |
| Th-228 | Beryllium | Thallium |
| Th-230 | Cadmium | Vanadium |
| Th-232 | Chromium | Zinc |
| U-234 | | |
| U-235 | | |
| U-236 | | |
| U-238 | | |

0105

# SECTION K.5.0

# EXPOSURE SCENARIOS

## K.5.0 EXPOSURE SCENARIOS

5208

This section discusses the steps taken to identify, screen, and develop the CRARE exposure scenarios. The exposure scenarios analyzed were defined assuming the implementation of the LRAs described in the SWCR and the updated LRAs resulting from the comparative analysis of alternatives in this Operable Unit 4 FS report. This approach is consistent with the Amended Consent Agreement. A quantitative risk analysis is presented in Section K.8.0.

The exposure scenarios developed for this CRARE describe three sets of conditions:

1. The Current Land Use scenario assumes government ownership, maintenance, and access control for 70 years after completion of all FEMP remedial actions.

2. The Future Land Use With Federal Ownership scenario describes the site up to 1000 years after remediation and assumes continued government ownership and land use control, but no other access control.

3. The Future Land Use Without Federal Ownership scenario also describes the site up to 1000 years after remediation, but assumes occupation by a resident farm.

These scenarios provide a basis for evaluating the potential exposures in the environment following the completion of remedial actions. However, their accuracy depends on the ability to predict site conditions well into the future. It should be recognized that projected land uses, as well as a description of the FEMP up to 1000 years hence, are highly speculative.

In general, each exposure scenario is made up of the same components: a source of contaminants, mechanisms that facilitate the transport of contaminants from the source through various environmental media, receptors in the local environment, and a route or mechanism of exposure for those receptors. Based on these components, three steps were involved in developing the exposure scenarios:

1. Characterization of the exposure setting

2. Identification of potential exposure pathways

3. Selection of site-specific exposure pathways to be quantitatively evaluated

In the development of the exposure scenarios the environmental setting of the FEMP years after the completion of remediation was evaluated . The characteristics of the site setting influenced the types of transport mechanisms and receptor activities selected.

## K.5.1 CHARACTERIZATION OF EXPOSURE SETTING

The characterization of the exposure setting relied on the definition of the operable units, the actions proposed in the LRAs, and the existing characterization information from the RIs to establish the nature of changes caused by each remedial action to each operable unit. The source areas of contamination considered for each operable unit were the original areas, plus new areas associated with the on-property disposal facilities. Material moved off-property during remediation was not considered in the compilation of risks.

### K.5.1.1 Physical Environment

This section describes the future physical environment of the site for up to 1000 years after remediation as it relates to the individual release mechanisms and pathways to be screened. This information was developed from the Operable Unit 4 RI/FS reports and the SWCR.

#### Surface Topography

The topography of the FEMP may be substantially altered after remediation. Man-made aboveground structures would be removed, and areas would be excavated, graded, and in some cases capped and vegetated. Vaults may be erected. Additionally, surface drainage ponds would be maintained during and possibly immediately after remediation, and then left unattended or backfilled for the remainder of the 1000-year evaluation period. In general, the overall FEMP site in the future would have fewer man-made obstructions and would eventually revert to woods, wetlands, and perhaps a mature forest.

#### Surface Hydrology

Surface water drainage would change on the FEMP due to the removal of man-made structures and nonporous areas. The addition of new, impervious areas have the potential to create new channels of surface water runoff. Wetlands have been identified on the FEMP and may continue to emerge, depending on climate and perched-water conditions. Paddys Run would be a potential source of exposure, as would newly formed and existing wetlands, ponds, and channel creeks. The storm water treatment system is a significant feature for the Current Land Use scenario.

5208

Demographics

Regardless of which scenario is implemented, the local surrounding land would remain primarily agricultural. New recreational areas, urban population centers, and commercial or industrial areas are not envisioned. For the purposes of this analysis, the same critical subpopulations (see Section K.5.1.4) were assumed to exist in the future scenarios. An expanded trespasser receptor has been quantified for the Future Land Use With Federal Ownership scenario. The expanded trespasser is a combination of an adult and child who use the site for recreational purposes. Both on- and off-property resident-farm receptors have been quantified for the Future Land Use Without Federal Ownership scenario. Appendix I of this FS report provides further discussion of future demographics and land uses.

Historical Significance

Known sites of archaeological significance within the boundaries of the FEMP, if any, will be identified during the on-going RI/FS process. The sites will be managed appropriately, pursuant to the National Historic Preservation Act (36 CFR 800, Section 106).

Geology and Hydrogeology

The geological and hydrological characteristics of the FEMP and its surrounding areas have been numerically modeled to reflect the proposed FEMP remediation plans. The assumptions that support this modeling appear in Section K.2.1. Descriptions of site conditions and the development of the computer models are in the SWCR. Groundwater is a viable pathway for the on- and off-property resident farm receptors (adult, youth, and child). Specific details on the postremediation groundwater conditions are referred to in this FS report and are summarized in Section K.6.1.6 of this CRARE.

Ecological Setting

In the Current Land Use scenario, 70 years after remediation, vegetation that has been planted at the operable unit residual footprints will be achieving successional maturity. The deciduous forest vegetation would be invading the site. Wildlife would progress from grassland species to an increasing abundance of deciduous forest species. In the area between the Operable Unit 4 and 1 vaults (the northern region of the FEMP), the wetland is anticipated to expand further with the increased runoff from the vaults. This loss of runoff area and the subsequent filling of the drainage

0109

and sedimentation ponds would eventually lead to the emerging wetland becoming a recipient drainage area.

In the Future Land Use scenarios, up to 1000 years after remediation, the deciduous forest invasions would have grown to a mature forest. In some areas, roots from trees may invade the capped areas and the former footprints of the operable units. The emerging wetlands may be fully developed, fluctuating with natural changes in the shallow water table. Contamination would be available to vegetation and terrestrial and aquatic species.

K.5.1.2 Postremediation Sources of Contaminants

This CRARE evaluates the residual human health risk of five operable units after remediation, with the focus on Operable Unit 4. This section focuses on the postremediation sources of contaminants and provides a basis for the developing the exposure pathways in Sections K.5.2 and K.5.3 (see Figure K.5-1). Sources of contaminants remaining at the FEMP after site remediation include:

- Residual contamination in the remediated areas of each operable unit, including contaminated soil, surface water, and groundwater.
- Operable Unit 4 vaults, including soil, debris, rubble, etc., removed from the operable unit during cleanup of the silos, berms, and temporary remedial facilities (vaults would have double liners, leachate collection, and runon and runoff control).
- Vaults for other operable unit material disposal.
- Capped areas for Operable Units 1 and 2.
- Remediated surface soils.

5208

OU4 CRARE ACAD FILE: 424331\OU4K5-1 DEC 1993

PRIMARY SOURCES OF RESIDUAL COCs AT THE REMEDIATED FEMP

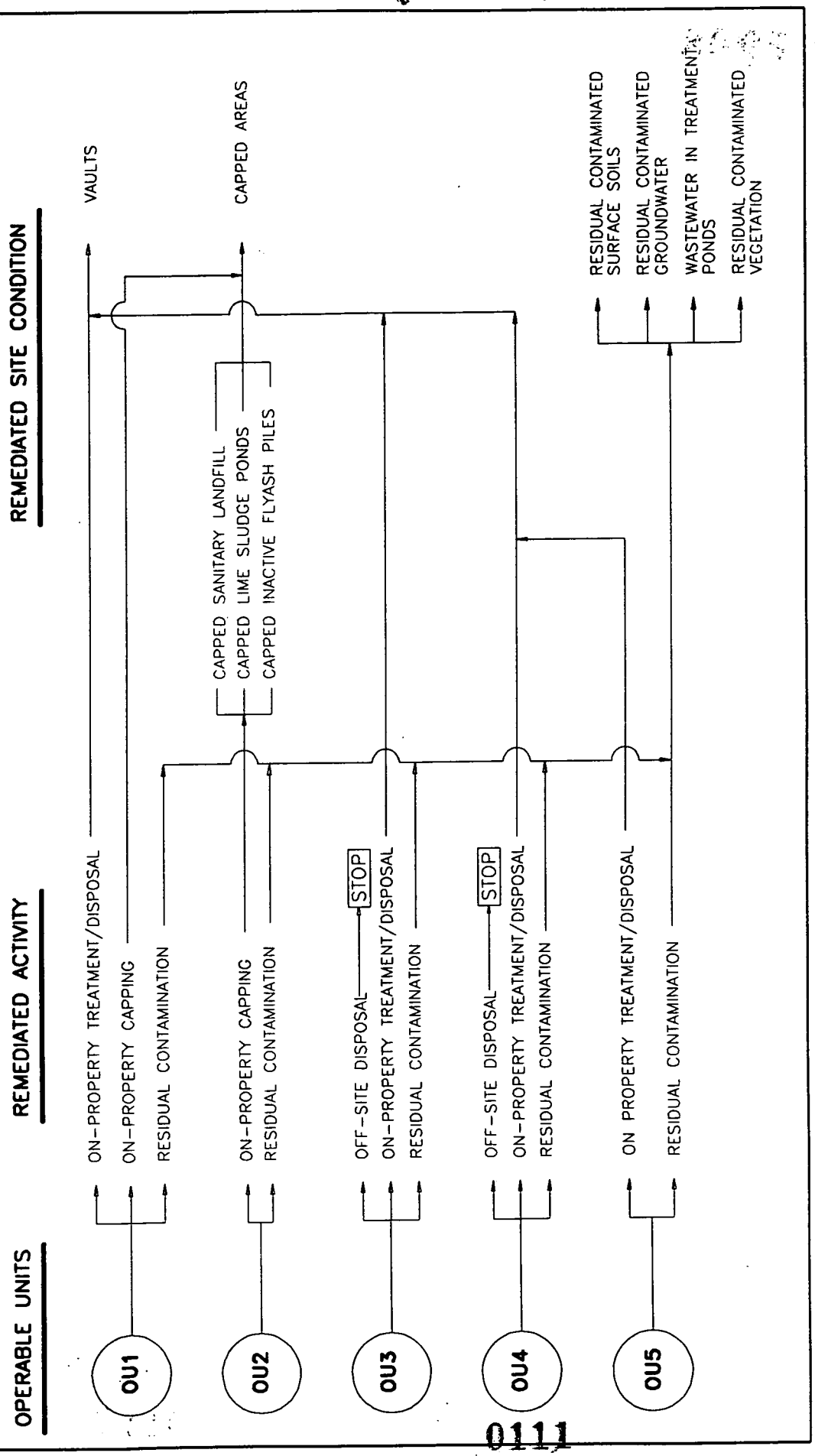



FIGURE K.5-1
PRIMARY SOURCES OF RESIDUAL
COCs AT THE REMEDIATED FEMP

0111

K.5.1.3 Land Use

Because of the uncertainty associated with future sociopolitical activities, three potential exposure scenarios have been evaluated. The Current Land Use scenario assumes that the government would control the FEMP for up to 70 years after site remediation. Under this assumption, access controls at the FEMP would remain in effect. At a minimum, a security fence would surround the entire FEMP property and would be regularly patrolled by a security force. Access controls are assumed to be effective in restricting intruders' access and short-term forays. Two Future Land Use scenarios (with and without federal ownership) have been evaluated for a period of up to 1000 years after remediation without access controls.

K.5.1.4 Potentially Exposed Populations

This section identifies future human populations in the vicinity of the FEMP that could be exposed to residual contaminants after the FEMP site is remediated. The locations and lifestyles of these populations have been examined to determine if they might be exposed.

Critical Subpopulations

Regardless of future demographic changes, certain subpopulations are believed to be more seriously effected by contaminant exposures. The higher risks may occur due to increased sensitivity, behavior patterns that can result in higher exposure, and/or current or past exposure from other sources. Subpopulations that may be more sensitive to environmental exposure include infants, children, elderly people, pregnant and nursing women, and people with chronic illnesses. These critical subpopulations (EPA 1992c) are discussed below without specific reference to their relative distance from the sources of contaminants at the site.

- Schools:

  Potentially critical subpopulations in schools include all students enrolled in kindergarten through high school classes.

- Daycare centers and preschools:

  Same as schools. Children enrolled in daycare centers and preschools, both part- and full-time, are regarded as a subpopulation more sensitive to environmental exposure than normal healthy adults.

- Hospitals, nursing homes, and retirement communities:

  Patients and residents in these institutions are part of the critical subpopulations with increased sensitivity to the residual contaminants at the remediated FEMP site.

- Residential areas with children:

  Children living in the immediate vicinity of the FEMP or within the impacted zones are assumed to have higher sensitivity to residual contaminants at the FEMP site.

- Major industries using chemicals:

  Employees working at facilities that use large quantities of chemicals are generally considered candidates for a critical subpopulation, because of their increased frequency of chemical exposures.

Locations of Reasonable Maximum Exposure

Receptor locations were selected based on the graphical representation of modeled air, soil, and water COC concentrations from remediated conditions. In keeping with the philosophy of evaluating the RME individual, the locations of highest on- and off-property exposures were assessed.

The RME locations were determined by first locating areas on and off the FEMP property which would receive elevated levels of COCs. The estimated COC concentrations in the environment were developed using computer modeling, as described in detail in Section K.6.0. Time-weighted exposure concentrations at these areas, along with exposure parameters from the Operable Unit 4 RI report, were then considered to define exposure pathways and to quantify the potential COC intake by the receptor.

The resulting intakes by potential receptors at various locations were then compared, and the location producing the highest intake was designated as the RME location. In the case of multiple pathways and contaminants, the resulting risks and hazard values were considered in the selection of the RME location.

Due to the multiple sources of COCs, the different patterns of COC fate and transport in the environment, and the variety of COC release mechanisms at the FEMP, a complex matrix of interdependent effects was found to exist among COCs, exposure pathways, and the resulting

exposure concentrations. Consequently, the selection of the site-wide RME locations required careful comparison of dispersion concentrations and estimated risk values.

In this CRARE, five hypothetical receptors were selected for the Current Land Use scenario, which assumes government ownership for 70 years after remediation. Each receptor represents a unique population and exposure scenario. As a whole, they cover a wide range of exposure scenarios for potentially impacted human receptors. The five receptors are:

1. Groundskeeper
2. Trespassing child
3. Off-property resident farm adult
4. Off-property resident farm youth
5. Off-property resident farm child

For the Future Land Use Use With Federal Ownership scenario, which assumes government ownership for up to 1000 years after the remediation, four receptors were selected:

1. Expanded trespasser
2. Off-property resident farm adult
3. Off-property resident farm youth
4. Off-property resident farm child

For the Future Land Use Without Federal Ownership scenario, which assumes private ownership for up to 1000 years after the remediation, six receptors were selected:

1. On-property resident farm adult
2. On-property resident farm youth
3. On-property resident farm child
4. Off-property resident farm adult
5. Off-property resident farm youth
6. Off-property resident farm child

The following paragraphs provide detailed discussions on the nature of the selected receptors and their respective pertinent exposure pathways.

<u>RME Receptors and Exposure Pathways</u>

<u>Groundskeeper</u>. A worker is assumed to be present on the property conducting groundskeeping and maintenance throughout the FEMP (not just for Operable Unit 4). No groundwater would be used by

this receptor. Exposure pathways include inhalation of fugitive dusts, volatile organics, and gases, dermal contact and incidental ingestion of site soil, and external radiation exposure while on site.

Trespassing Child. This hypothetical receptor addresses the potential exposures incurred by a child (age 7 through 18) who lives off-property but regularly trespasses onto the FEMP site. His exposure pathways include inhalation of fugitive dusts, volatile organics, and gases, dermal contact with and incidental ingestion of site soil, incidental ingestion of contaminated surface water while wading, and external radiation exposure while on site.

On-Property Resident Farm Adult. Consistent with the RME concept and to ensure that the estimated risk values are protective of human health and the environment, it was assumed that the remediated FEMP site can revert to residential and agricultural uses in the future and that an adult farmer resides on the site after it is remediated. Potential exposures to this receptor may result from direct radiation, residual contamination from remediated site footprints, and/or waste leaking from vaults.

Exposure pathways examined for this receptor include growing food, tending livestock, and performing general farm work. These activities may result in direct exposure to residual site contamination, consumption of contaminated produce, dairy products, and meat, ingestion of contaminated groundwater, dermal absorption through contact with residually contaminated soil, inhalation of gases, vapors, and dust, and incidental ingestion of soil. The selected RME location of this receptor is presented in Section K.6.1.6.2.

On-Property Resident Farm Youth. Pathways examined for this receptor include direct exposure to residual site contamination, consumption of contaminated produce, dairy products, and meat, ingestion of contaminated drinking water, incidental ingestion and dermal contact with residual contaminated soils, inhalation of gases, vapors, and dust, and incidental ingestion of surface water while wading in Paddys Run. The selected RME location for this receptor is presented in Section K.6.1.6.2.

On-Property Resident Farm Child. Young children (age 1 through 6) living on the property form a subpopulation of concern, because they may be more sensitive to a given exposure than are adults. A young child residing on the remediated FEMP could be exposed directly to residual site contaminants

remaining in soils, and could inhale gases, vapors, and dust. In the CRARE risk calculations, this hypothetical child of the on-property resident farm adult is assumed to drink water from an on-property well and to consume vegetables, fruit, meat, and dairy products produced on the property. The selected RME location of this receptor is presented in Section K.6.1.6.2.

Off-Property Resident Farm Adult. A farmer is assumed to live immediately adjacent to the remediated FEMP property boundary. The major concern for this receptor is the exposure received from regular use of groundwater from the Great Miami Aquifer (drinking and agricultural uses). This farmer could also be exposed to COCs from remote on-property residual sources, and/or other contaminants carried by the wind as gases, vapors, and dust. However, he would not be exposed to on-property soil from dermal contact, nor receive direct radiation from on-site soil. The selected RME location of this receptor is presented in Section K.6.1.6.2.

Off-Property Resident Farm Youth. This hypothetical youth (age 7 through 18) of the off-property resident farm adult is assumed to have the same diet as his parent. The youth could also be exposed to COCs from remote on-property residual sources, and/or other contaminants carried as gases, vapors, and dust. The selected RME location of this receptor is presented in Section K.6.1.6.2.

Off-Property Resident Farm Child. This hypothetical child (age 1 through 6) of the off-property resident farm adult is assumed to have the same diet as the parent. This child could also be exposed to COCs from remote on-property residual sources, and/or other contaminants carried by clouds of gases, vapors, and dust. The selected RME location of this receptor is presented in Section K.6.1.6.2.

Expanded Trespasser. This hypothetical composite individual is assumed to visit the site despite continued government ownership. Exposure pathways include inhalation of fugitive dusts, volatile organics, and gases, dermal contact with and incidental ingestion of site soil, incidental ingestion of surface water in Paddys Run, and external radiation exposure while on site. No specific location was assigned as the expanded trespasser may wander over the entire FEMP site, with the exception of the RCRA-type caps and vaults.

For the purposes of establishing a PRG for the Future Land Use With Federal Ownership, an on-property receptor was employed assuming a trespassing exposure scenario which includes both adult and child age groups. The frequency of exposure was expanded to account for the lack of access controls. This expanded trespassing scenario was employed becasue it represents an upper bound estimate of the exposures a receptor could reasonably be expected to receive. This assumes that the federal government would continue of ownership, thus precluding site development for residential, farming, industrial/commercial, and recreational use (e.g., ball fields, jogging trails, biking trails).

The expanded trespasser is an individual who visits the property during childhood, then during adulthood, perhaps for roaming, hiking, bird watching or similar activities. Due to the size of the site, fencing, and signs indicating No Trespassing and No Hunting, it is assumed that hunting is not a likely activity. The expanded trespasser is assumed to be exposed to soil contaminants via oral ingestion, dermal contact, inhalation of dusts, and external radiation. Groundwater PRGs were not developed for the expanded trespasser since there were no viable pathways of exposure.

Although a "home builder" receptor (construction intruder scenario) is identified as a legitimate receptor in the SWCR, it is not valid for this CRARE because of the relatively small area of Operable Unit 4. It was therefore not evaluated. Such an individual's exposure to COCs within the soil and within the capped waste areas would be identical to that experienced by the on-property resident farm adult, and an analysis of such would be redundant. This conclusion can be drawn since the RCRA-type cap and the disposal vaults are assumed to have specific barriers which would preclude this construction activity.

It was assumed that Paddys Run fish are not considered a pathway for chemical or radiological intake because of the composition of the fish populations. Paddys Run is a small, intermittent tributary of the Great Miami River and runs north to south along the western edge of the FEMP. Surveys of the Paddys Run fish population concluded that the stream does not support any sport fish in most of the stream sections. Surveys completed by Facemire et al. (1990), Miller et al. (1990), and those completed for the RI/FS in general, concluded the majority of the stream population was composed of members of the darter, minnow, and sunfish families. In Paddys Run, these fish are too small or not desirable for human consumption. Some sport fish can be found in Paddys Run at the confluence of the Great Miami River. However, because of fish movement and feeding patterns, these fish are

considered only in conjunction with the Great Miami River. Crayfish, which are present in Paddys Run, are primarily consumed by raccoons and as such will be addressed in the Ecological Risk Assessment for the Operable Unit 5 RI.

## K.5.2 DETAILED CONCEPTUAL EXPOSURE MODEL

A detailed conceptual exposure model is presented here which builds upon the CRARE Site-Wide Conceptual Model presented in Section K.1.6. This model has been developed to provide the basis for identifying and evaluating the potential risk to human health after the FEMP is remediated (Figures K.5-2 through K.5-4). The key objective of the model is to facilitate the analysis of exposure routes and receptors, focus on those pathways and sources that drive the potential impacts on human health risk, and screen out other exposure pathways that are likely to pose minor risks.

The model provides a consistent and comprehensive evaluation of the risk to human health by creating a framework for identifying the mechanisms by which human health may be affected by the remediated site. The elements necessary to construct a complete exposure pathway, and thus develop the conceptual model, are as follows:

- Sources of residual contaminants
- Release mechanisms
- Transport pathways
- Exposure pathways
- Receptors

The model traces the exposure pathways from the sources through the release mechanisms and exposure routes to the affected receptors. The model also indicates which exposure routes are carried through the quantitative risk assessment for each receptor under the Current and two Future Land Use scenarios.

### K.5.2.1 Source of Residual Contaminants

The remediated FEMP will contain several vaults, capped waste areas, surrounding soil, and surface and groundwater contamination. Figure K.5-1 lists the sources included in the conceptual exposure model (see Sections K.2.2 and K.2.3 for a detailed description of each). The model depicted in Figure K.5-2 is based on Figures K.1-9 and K.1-10 as presented in Section K.1.6. The conceptual model addresses these sources as reservoirs of residual contaminants, which can migrate to other environmental compartments or serve as a direct source of exposure. The sources of residual

contaminants at the remediated FEMP include leachate from capped areas and vaults, as well as residual contaminants in surface soil, surface water (in treatment ponds), groundwater, and vegetation.

K.5.2.2 Release Mechanisms of Contained Wastes and Soils

Figure K.5-1 outlines the five operable units, and identifies the residual on-property COC sources following the completion of remedial actions. It is anticipated that once remediation is complete, the site will have 59 vaults, 4 capped areas, and 8 operable unit footprints with residual wastes that have met the FS PRG objectives and are therefore left at the site (see Figure K.5-1).

Primary sources of COCs at the postremediation FEMP can be conceptually divided into those that will be enclosed or covered with a cap and those that will not. Capped sources include treated waste and waste material that are contained and/or capped at the FEMP. Uncapped sources include those wastes and soil that, due to their low residual contaminant concentrations, were left within the operable unit footprints (Figure K.5-1). Several mechanisms could allow these latter source contaminants to be accessed directly by a receptor or dispersed and made available for transport in the environment. The following paragraphs describe the release mechanisms considered in the CRARE conceptual exposure model (Figures K.5-2 through K.5-4).

Failure of On-Property Vaults or Capped Structures

This release mechanism postulates a failure of the disposal structures holding the treated wastes or a fracture of the capping materials. Once the integrity of these structures is breached, the wastes in or beneath them can be exposed to the environment and subjected to wind erosion, surface runoff, and water infiltration (Figures K.5-2 through K.5-4). Possible forces that can induce structural failure include physical impact or natural weathering forces. These forces can weaken, damage, and/or destroy the integrity of the structures, thus exposing treated or buried materials to the environment. The RCRA-type cap selected for evaluation in this CRARE is designed to remain intact for 1000 years. Therefore, during the entire period of the CRARE risk modeling, releases of bulk materials from vaults or capped areas and direct exposures to contained materials were assumed not to occur. Also during this period, infiltration and leachate generation were assumed to occur, but only in small amounts. An analysis of the proposed vault design was completed and water infiltration/exfiltration and emission venting was calculated due to eventual deterioration.

Surface Water Overflow

While the wastewater is being treated at the FEMP during the first 70 years after remediation is complete (as indicated in the Current Use Land scenario), it is possible that surface water runoff may carry the waste from the designated treatment areas and make it available for human uptake. Specifically, this release mechanism primarily affects water being treated at the wastewater treatment plant or contained in the retaining ponds. These collection structures may overflow during periods of heavy rainfall. The liquid spilling over the top of the treatment plant or ponds can flow overland and contaminate surface soil, sediments, or any water bodies that come in contact with the liquid or receive it.

K.5.2.3 Transport Pathways

Contaminated materials from those sources not contained (residual soils and waste materials, residual groundwater contamination, contaminated vegetation) may be released from the site without the failure of containment structures. Uncontained and contained COCs, if released from the vaults or capped areas, can travel by several transport pathways to reach various environmental media to which potential receptors may be exposed (Figure K.5-2). This section briefly discusses the four transport pathways.

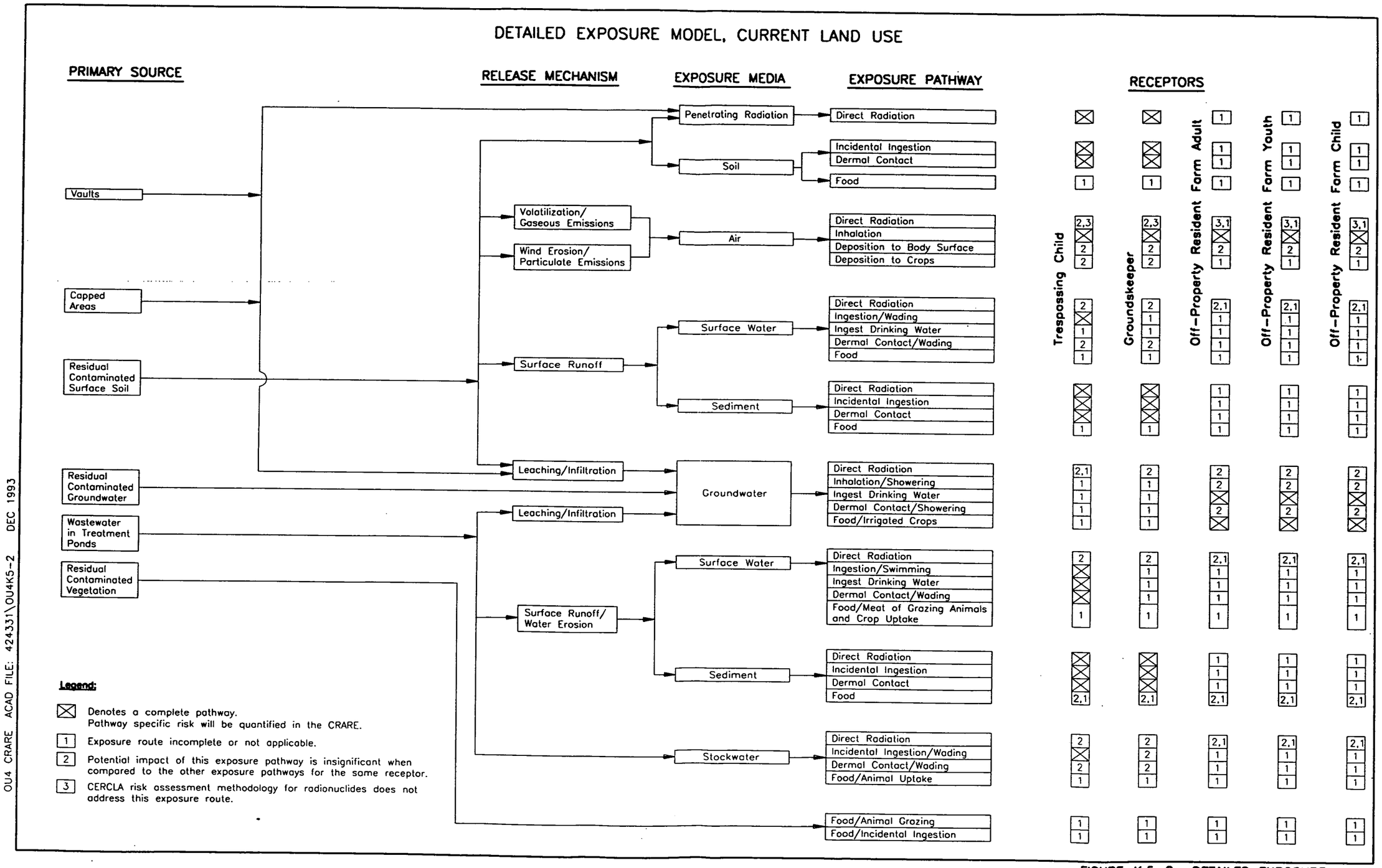
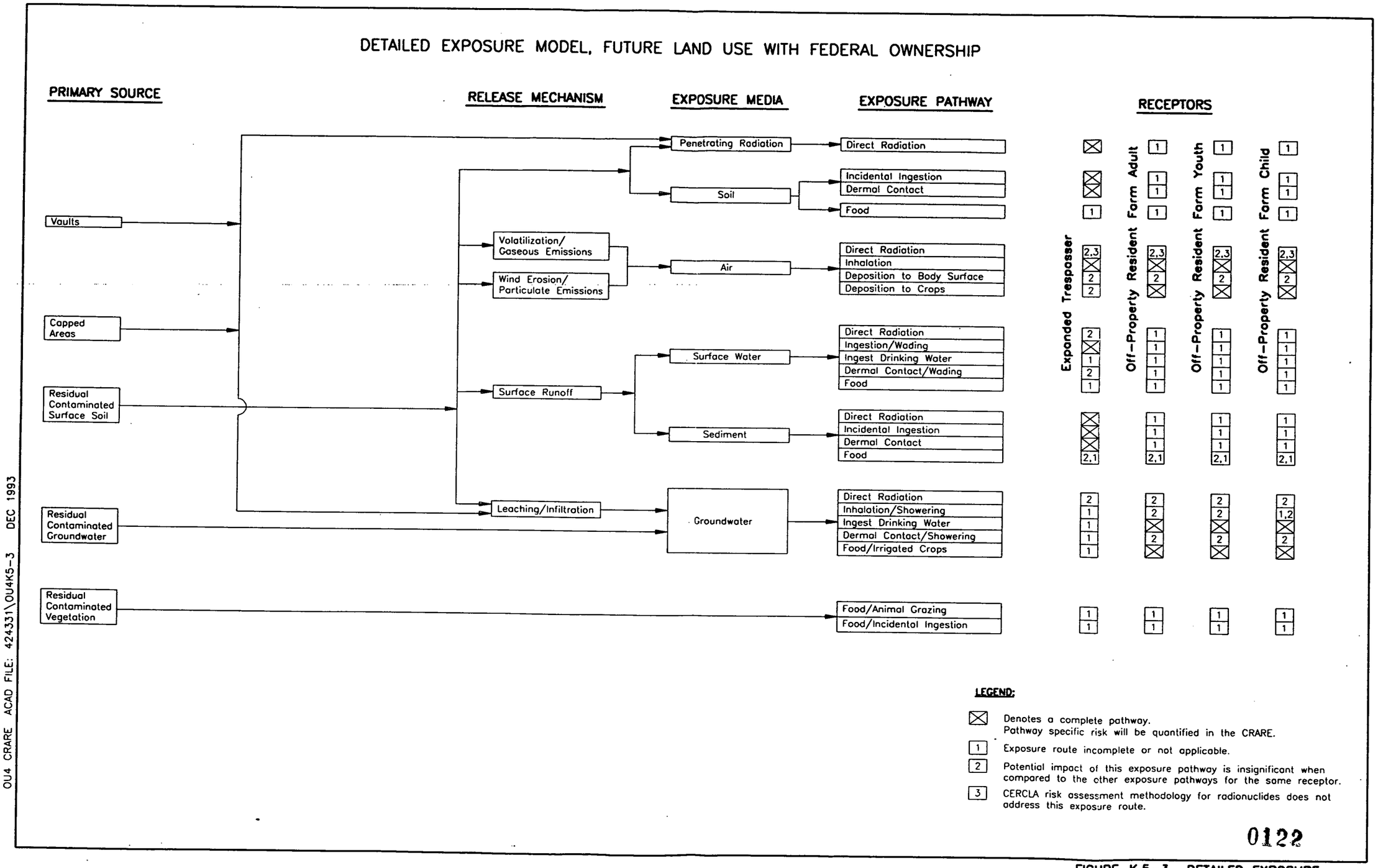
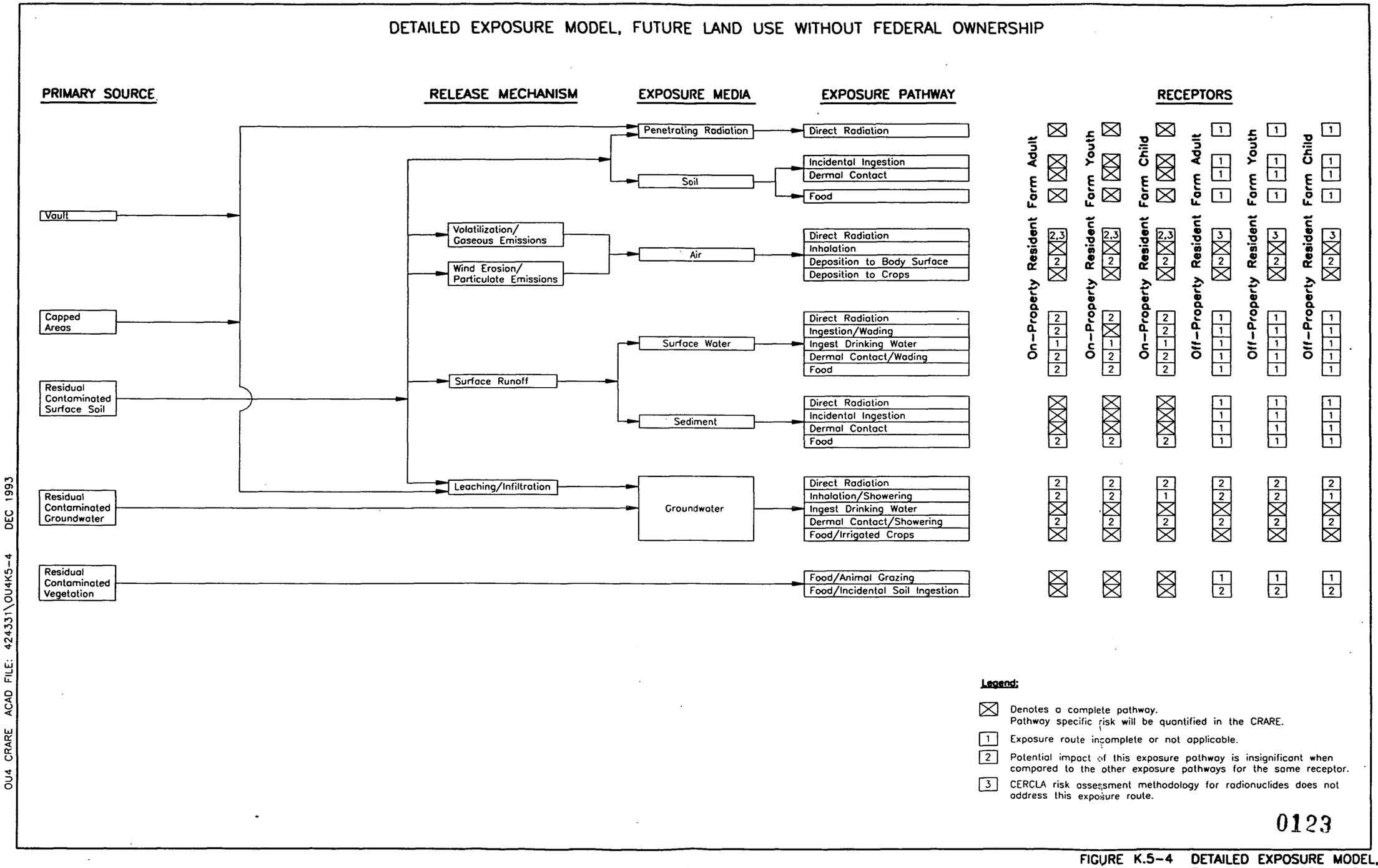



FIGURE K.5-2 DETAILED EXPOSURE MODEL, CURRENT LAND USE




OU4 CRARE ACAD FILE: 424331\OU4K5-3 DEC 1993

FIGURE K.5-3 DETAILED EXPOSURE MODEL, FUTURE LAND USE WITH FEDERAL OWNERSHIP




OU4 CRARE ACAD FILE: 424331\OU4K5-4 DEC 1993

FIGURE K.5-4 DETAILED EXPOSURE MODEL, FUTURE LAND USE WITHOUT FEDERAL OWNERSHIP

Air

Releases to air may occur through the generation of particulates by wind or surface soil disturbance. In addition, gaseous phase contaminants may be released through volatilization or radioactive decay (e.g., radon). Transport through the air is expected to be a major pathway for contaminants which are present in residual soils and waste materials left on-property after remediation.

Surface Water and Sediment Runoff

Surface water transports waste material by conveying dissolved and suspended solids to receptors as it flows across the surface of the ground and along any drainage features. It is assumed that no wastes in the capped areas or vaults will be exposed to permit surface sediment runoff. COCs in the surface soils will be subject to transport in surface water/sediment runoff. Runoff can transport contaminants to receiving surface water bodies to which receptors may come in contact directly (through wading, etc.) or indirectly (through stock or irrigation water).

Leaching and Infiltration

The FEMP has a humid climate with an average annual rainfall of about 102 centimeters (40 inches). A portion of this water percolates through subsurface soil and recharges the underlying aquifer. Percolation would also occur through the waste storage structures as a result of the natural weathering process. COCs in waste and soil would be dissolved and transported in this flow. However, degradation, retardation, and radioactive decay may reduce the concentrations that eventually reach the aquifer. Dilution would also occur in the groundwater flow. Eventually, the groundwater would complete the pathway with transport to a well from which a receptor can take water for home and farm use.

K.5.2.4 Exposure Media

The transport pathways just discussed would result in the occurrence of site-related contaminants in the various exposure media identified in Figures K.5-2 through K.5-4. The media to which receptors may be exposed include soil (either in-place residuals or materials transported from source areas by various mechanisms), surface water, sediment, and air. Indirect human exposures to contaminants in one or more of these media may occur through the ingestion of crops or livestock and related products (meat, milk) which have been exposed to contaminated soil or water. In the case of on-

property residual soil, no intermediate transport mechanism is necessary for on-property receptors; humans may be exposed directly to in-place materials.

## K.5.3 EXPOSURE PATHWAYS

There are numerous potential exposure pathways at the FEMP by which receptors can come in contact with contaminants. These pathways include ingestion, inhalation, and dermal contact with chemical contaminants and radionuclides. In the case of radionuclides, external exposures to radiation may also occur. On the right-hand side of Figures K.5-2 through K.5-4, the various combinations of exposure pathways and exposure media are tabulated. Each pathway and medium are evaluated for each of the exposed receptors under the different exposure scenarios. Pathways identified as being complete and significant are denoted with an "X," while those not expected to result in significant exposures for a given receptor are noted, along with an explanation of why these pathways were not included in the quantitative risk analysis for the CRARE (Figures K.5-2 through K.5-4).

### K.5.3.1 Air Exposure Pathways

A receptor's exposure via these pathways begins with wastes being transported by the ambient air, eventually reaching the receptor either by inhalation or direct radiation. Inhalation of airborne gases (such as radon) and resuspended particulates is a typical example of this type of exposure. The air exposure pathways are applicable to all on- and off-property receptors examined.

The significance of the air exposure pathway depends on the different characteristics of the receptor's daily activities. These pathways very often are receptor-specific. The significant air exposure pathways identified in this CRARE include inhalation of gases, radon, and resuspended particulate (Figures K.5-2 through K.5-4).

### K.5.3.2 Exposure Pathways Attributable to Dermal Contact

This group of pathways encompasses all of the receptor's activities that would result in direct contact with contaminated soil, sediment, and water. Potential sources of contamination for these exposures include exposed waste, soil, and sediment.

Exposure pathways via dermal contact included in the quantitative risk assessment are dermal contact with contaminated soil and sediment (Figures K.5-2 through K.5-4). As in the air exposure pathways described in Section K.5.3.1, many dermal contact exposure routes are receptor-specific.

K.5.3.3 Ingestion Exposure Pathways

Direct ingestion of soil, sediment, drinking water, and food are considered plausible for many receptors. Ingestion of substances containing waste can come from direct or indirect routes. For example, a receptor may ingest COCs from the aquifer in the drinking water, while wading in contaminated surface water, or by ingesting vegetation irrigated with contaminated water.

Eating meat or drinking milk from cattle or game that have ingested contaminated soil, waste stock water, or foliage while grazing on FEMP property is included in this CRARE risk analysis. Also included is ingestion of surface water by the trespassing child while wading. Exposure pathways such as ingestion of contaminated soil, surface water, sediment, groundwater, and crops are significant for the receptors investigated in this CRARE (Figure K.5-2).

K.5.3.4 Direct Exposure to Radiation

This pathway may be significant for receptors who come into close proximity to residual soils or wastes, such as the trespassing child or groundskeeper under the Current Land Use scenario or the on-property residents or expanded trespasser under the Future Land Use scenarios. Significant direct radiation pathways identified for one or more of the receptors include exposure to radiation originating from contaminated soil and sediment.

# SECTION K.6.0

# FATE AND TRANSPORT MODELING

## K.6.0 FATE AND TRANSPORT MODELING

Fate and transport computer models were used to predict the movement of residual contaminants through various media from the remediated FEMP to receptor locations. These models provide the only means of predicting COC concentrations at potential exposure locations because future COC concentration data are, by definition, not available. This CRARE employs the same model selection approach, criteria, and modeling parameter values as those specified in the RAWPA.

This section describes the methodology used to predict contaminant concentrations in different media for the FEMP Operable Unit 4 CRARE. Included are discussions of:

- Technical approaches used to select the appropriate model for each potential exposure assessment
- Fate and transport models used
- Required data and default parameter values
- Modeling results

The models were selected based on their appropriateness for a specific application in the CRARE process and the availability of required input information. In general, these models provided estimates of COC concentrations in environmental media (i.e., air, water, or soil) at potential exposure point locations, at various times in the future. The CRARE models also included assumptions on future FEMP site conditions. These assumed changes were derived primarily from the anticipated remedial actions for each operable unit. Due to the uncertainties associated with these models, all results have been carefully reviewed before including them in this CRARE.

The SWCR contains site-wide modeling that is similar to CRARE modeling. However, the SWCR modeling is intended to evaluate baseline conditions and does not account for changes in site conditions due to remedial actions. Each operable unit FS is planned to model the effects of all of the remedial alternatives for that operable unit in detail. The CRARE models will be consistent with these efforts by using the same modeling parameters as the FS, but will only address the anticipated LRA for each operable unit.

One key goal of the CRARE modeling effort is to ensure that all CRAREs use the same input parameters and default values, and that these data are consistent with EPA recommendations. Assumptions and parameters presented in this report may change, subject to EPA approval, as new information becomes available. As discussed in Section K.2.2, the LRAs for some operable units may change in future CRARE documents.

Due to the large number of potential exposure pathways at the FEMP (see Section K.1.6, Figures K.1-9 through K.1-11), the CRARE models have been grouped by transport medium as presented in the RAWPA. Detailed information on the model selection and parameters employed in quantifying fate and transport of contaminants in water are presented in Section K.6.1. This includes vadose zone, surface water and groundwater models. Section K.6.2 presents the air emission and transport models. Section K.6.3 presents modeling methodologies and results for the concentrations of residual contaminants in vegetables, meat, and dairy products.

## K.6.1 WATER TRANSPORT MODELING

This section includes a conceptual description of process of evaluating the groundwater and surface water contaminant transport pathways from source areas to receptors. Detailed discussions then follow on the selection of COCs, the development of source terms for modeling, and the use of vadose-zone, surface-water, and groundwater transport models.

### K.6.1.1 Description of Approach

The purpose of water transport modeling was to provide a predictive methodology for simulating the movement of contaminants in surface water, vadose zone water, and groundwater from source areas to receptors. Of the multiple pathways identified in the CRARE Site-Wide Conceptual Model (Section K.1.6), two are described here, surface water and groundwater. The key elements of these and other pathways are:

- Sources of residual contamination
- Release mechanisms
- Transport pathways
- Exposure pathways
- Receptors

This section provides detailed descriptions of the contaminant sources, release mechanisms and transport pathways, for both the surface water and the groundwater transport pathways, as well as the selection of receptor locations and the development of contaminant concentrations with time at these locations.

Surface water is an exposure medium because receptors were assumed to be located in Paddys Run downstream of the source areas. Surface water in Paddys Run also represents a portion of the groundwater pathway, since COCs in this surface water were assumed to infiltrate to groundwater, and then may be transported in the groundwater to potential receptors. The vadose zone was considered to be part of the groundwater pathway because no receptors of vadose zone water are identified in the exposure analysis scenarios discussed in Section K.5.0. Although perched water is present in the vadose zone beneath some areas of the FEMP, the SWCR (page 3-18) reports that "these perched water deposits are localized and do not contain water volumes sufficient to serve as sustained sources of potable water for a farm."

The source areas of groundwater and surface water contamination projected to remain at the FEMP include elements from all operable units. As discussed in Section K.2.2, this CRARE made the assumption that the updated LRA for Operable Unit 4 would be implemented, including Alternative 2C - Silo Demolition, Removal, and On-Property Disposal, for which vaults would be constructed in the northeast corner of the FEMP (northeast vaults) to contain structural material, debris, and soil. The LRAs for Operable Units 1, 2, 3 and 5 were also assumed to be implemented, as discussed in Section K.2.2. When FEMP remediation is complete, the only structures planned to remain on the site are the vaults and capped areas, as described in Section K.2.3 and Section K.3.1 (Figure K.3-1). In addition, a water treatment facility was assumed to be present in the current use scenario. Per the LRAs, waste from Operable Units 1, 3 and 5 would be disposed of in vaults. The vaults in the northwest corner of the FEMP (northwest vaults) were assumed to contain vitrified waste from Operable Unit 1 and the vitrified COC residues from the soil-washing processes for Operable Units 3 and 5. The vaults along the eastern boundary of the FEMP (northeast vaults) were assumed to contain Operable Unit 3 waste. Other source areas include the site-wide soil under Operable Unit 5, the residual soils within the Operable Unit 4 boundary, and the capped areas of Operable Units 1 and 2.

Figure K.6-1 shows the process, in conceptual terms, of evaluating the surface water and groundwater pathways. The CRARE Site-Wide Conceptual Model is described in Section K.1.6 and throughout this CRARE. The FEMP Conceptual Flow Model is the current, comprehensive, and consistent description of the hydrogeologic environment at the FEMP. This conceptual model is described in the SWCR and, most recently, in the Operable Unit 4 RI report. The conceptual model is an approximation and simplification of actual field conditions and is subject to modification as additional field data are developed. The data and interpretations presented in the SWCR and Operable Unit 4 RI report are briefly described and referenced below.

The CRARE Site-Wide Conceptual Model (Section K.1.6, Figures K.1-9 and 10) includes leachate as a release mechanism of concern for all of the primary sources. Figure K.6-1 shows the steps involved in estimating the flow rates and COC concentrations with time of the leachate from each of the source areas. Rainwater was the only source of inflowing water considered in the CRARE for the formation of leachate. Agricultural irrigation, residential watering, or industrial discharges were assumed not to occur at contaminated areas at the FEMP within the modeled period. The HELP Infiltration Model (as described in the SWCR) was used to estimate soil infiltration and runoff rates. Previous geochemical studies (using a geochemical model, EQ3/6), literature research, and a limited amount of bench-scale laboratory leach test data were used to estimate COC concentrations in the leachate.

The leachate data was then used as input to the vadose zone transport modeling. The ODAST model was used to mathematically simulate flow and transport through the vadose zone from each of the source areas. The time-variant output from ODAST was used as input to the SWIFT III groundwater model, which had previously been calibrated to simulate the current flow and contaminant characteristics at the site. Model calibration is discussed in ASI/IT (1990a) and IT (1990a).

Contaminant transport was simulated in the SWIFT III model over a rectangular area that is a subset of the area covered by the groundwater flow portion of the model. A grid system subdivides the transport area into 78 by 102 cells (Figure K.6-2). It was originally established in the SWCR to simulate the currently existing uranium plume in the groundwater. The transport cell areas were used in this CRARE to define the areas of source terms and vadose zone

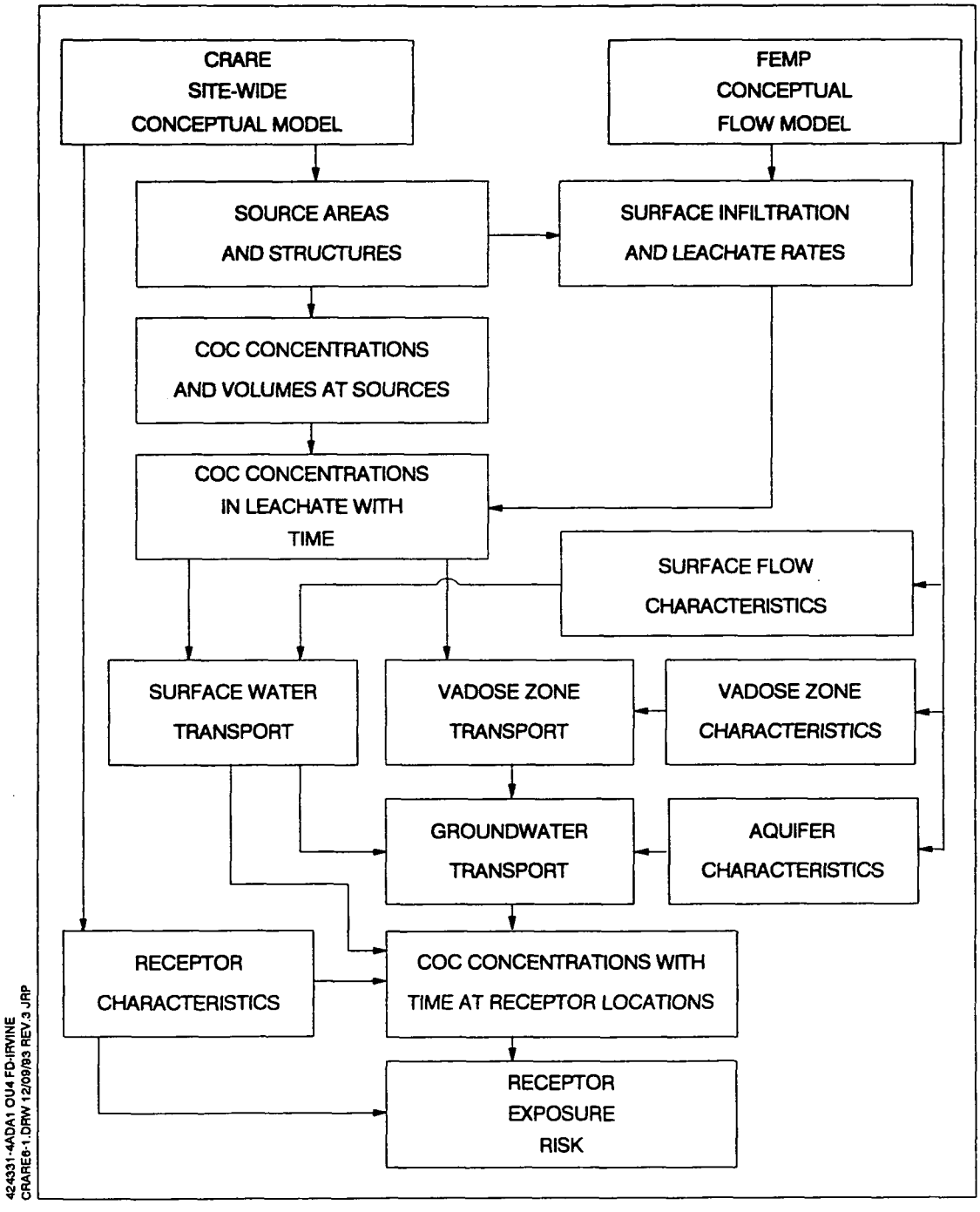



FIGURE K.6-1: EVALUATION of SURFACE WATER and GROUNDWATER PATHWAYS

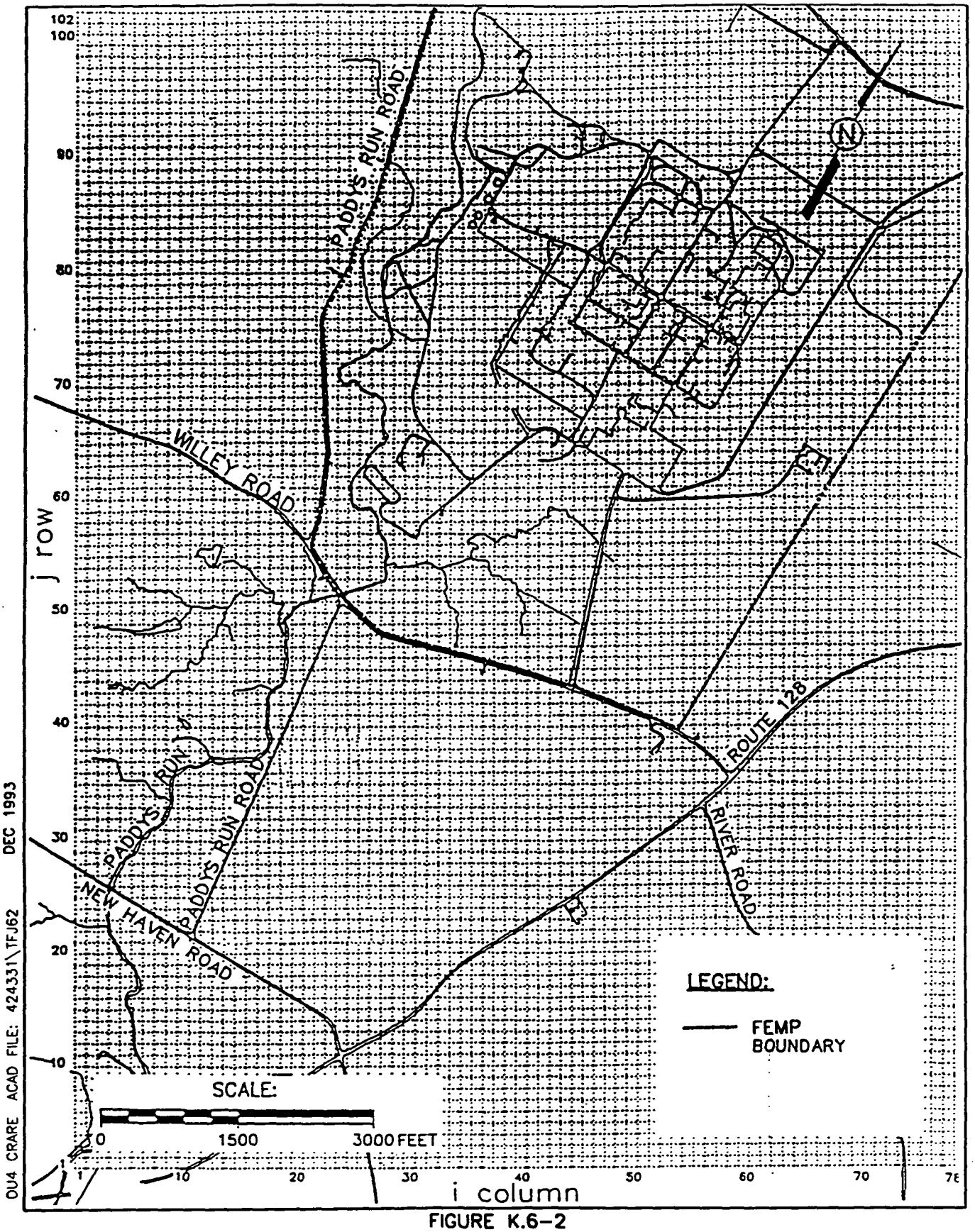



FIGURE K.6-2
SWIFT III GROUNDWATER TANSPORT GRID

transport modeling. This made the process of defining the COC input terms for the groundwater model more efficient, since the same area definitions were carried through the multiple modeling steps.

K.6.1.2 Screening of COCs

Section K.4.0 describes how a site-wide list of potential COCs was compiled for possible inclusion in the CRARE and then reduced through three screening procedures. Table K.4-10 (Section K.4.5) presents the final site-wide list of COCs that was retained after the screenings.

Additional screening of the COC list for the groundwater pathway was done, prior to determining source terms, to remove those COCs from the list that are predicted to not be transported in significant quantities by ODAST through the vadose zone within 1000 years. Retardation factors for COC transport were primarily used to establish this. COCs for which the number of sampling results were too limited to estimate a total mass were not analyzed further because the results would not be meaningful. This does not represent an assumption that these compounds are present in negligible quantities, but only that not enough information was available on which to base a meaningful analysis. However, they may be included in future CRAREs. The screening was done to reduce the computational time required for the vadose zone modeling.

The remainder of this section describes the screening process, including a listing of COCs eliminated and retained for the groundwater pathway.

The primary screening method employed a preliminary travel time screening. The basis of the travel time screening was that the concentration fronts of certain COCs, because of retardation by sorption, will not migrate through the vadose zone and reach the aquifer in 1000 years. Consequently, these COCs will not contribute to risk in the first 1000 years and can be eliminated from the analysis. The front was defined in such a manner that no significant amount of the COC is predicted to leave the vadose zone before the appearance of the front. The specific procedure for the travel-time screening is described below. Groundwater recharge from Paddys Run and the storm sewer outfall ditch, which have direct contact with the Great Miami Aquifer, were excluded from this screening.

The variables used in the screening step are minimum retardation factor ($R_{min}$) in the vadose zone, soil thickness (L), seepage velocity (V), and the axial dispersion coefficient ($D_L$). The soil thickness was taken as the distance from the top of the perched zone to the bottom of the glacial till. These materials were considered to be saturated. Data on all of these variables are provided in the SWCR. The mean travel time ($t_m$) of the concentration front through the vadose zone for a nondecaying COC can be calculated from the first three variables as:

$$t_m = R_{min} L/V \qquad (1)$$

A characteristic dispersion parameter can also be calculated as:

$$N_D = D_L/VL \qquad (2)$$

A fraction (M) can then be estimated to give a time before which the exiting concentrations will be negligible. The "M" factor must be used to compensate for the fact that some contamination will arrive before the mean travel time ($t_m$) because of dispersion. For example, if there is no dispersion (i.e., plug flow), M would equal one because, theoretically, the response front would be a square wave with a vertical rise from 0 to the maximum concentration at $t_m$. Brenner (1962) gives an analytical solution for a non-decaying solute with linear-equilibrium sorption (the ODAST assumption). Brenner provides extensive tabular output for the response front concentrations as a function of non-dimensional time (time/$t_m$) with $N_D$ varied parametrically. The value for M is that value of non-dimensional time selected from the applicable $N_D$ curve such that the front concentration is less than $10^{-4}$ times the peak concentration. The higher the value of $N_D$ the more relatively important is dispersion and the lower M must be to assure that significant concentration would not escape from the vadose zone. Consequently, as infiltration velocity is decreased by capping, etc., dispersion becomes relatively more important because velocity is in the denominator of the $N_D$ term. Thus, M for capped areas, etc. is low. M factors determined from the curves in Brenner (1962) were 0.1 for the capped areas in Operable Unit 2 and the vaults, and 0.5 for Operable Unit 3 and 4 soil areas.

If $Mt_m$ is set at 1000 years, exiting concentrations prior to 1000 years will be negligible. This can also be expressed as:

$$t_m = 1000/M. \quad (3)$$

Since $R_{min}$ is defined as:

$$R_{min} = t_m V/L, \quad (4)$$

a minimum screening retardation factor,

$$R_s = 1000 \times V/ML, \quad (5)$$

can be defined above which the mean travel time will be in excess of 1000/M years, and exiting concentrations for up to 1000 years will be negligible. The $R_s$ was calculated for each COC and compared to its $R_{min}$ to determine if the COC could be screened out. This analysis is conservative in that one dimensional flow was assumed, the minimum retardation factor that occurs in any vadose layer was used, and any depletion by biodegradation or decay was ignored.

Table K.6-1 illustrates the results of the travel-time screening for potential groundwater COCs. The areas used in this screening were Operable Units 2, 3, and 4, the northwest vaults (containing the Operable Unit 1 vitrified waste and the vitrified soil-washing residue), and the east vaults (containing the Operable Unit 3 waste). A "YES" value in any column means the COC was not screened out. A "NO" value means that the constituent was not expected to reach the aquifer in 1000 years, and that it was deleted from further consideration. An "ND" value means that values of the retardation factor were not available to permit calculation of travel times. However, the COCs identified as ND (the chlorodibenzofurans, heptachlorodibenzo-p-dioxin, n-nitropheny-lamine, and ammonia) were not analyzed further because the sampling data are too limited to define a source term for mass. They may be included in future revisions of the CRARE as additional field data are collected.

## TABLE K.6-1

## SCREENING OF COCs FOR THE GROUNDWATER PATHWAY

| COCs | OU2 | OU3 | OU4 | NW Vault | E Vault |
|---|---|---|---|---|---|
| **Radionuclides** | | | | | |
| Ac-227 | NO | NO | NO | NO | NO |
| Am-241 | NO | NO | NO | NO | NO |
| Cs-137 | NO | NO | NO | NO | NO |
| Np-237 | NO | NO | NO | NO | NO |
| Pa-231 | NO | NO | NO | NO | NO |
| Pb-210 | NO | NO | NO | NO | NO |
| Pu-238 | NO | NO | NO | NO | NO |
| Pu-239/240 | NO | NO | NO | NO | NO |
| Ra-226 | NO | NO | NO | NO | NO |
| Ra-228 | NO | NO | NO | NO | NO |
| Ru-106 | NO | NO | NO | NO | NO |
| Sr-90 | NO | NO | NO | YES | YES |
| Tc-99 | YES | YES | YES | YES | YES |
| Th-228 | NO | NO | NO | NO | NO |
| Th-230 | NO | NO | NO | NO | NO |
| Th-232 | NO | NO | NO | NO | NO |
| U-233 | YES | YES | YES | YES | YES |
| U-234 | YES | YES | YES | YES | YES |
| U-235 | YES | YES | YES | YES | YES |
| U-235/236 | YES | YES | YES | YES | YES |
| U-238 | YES | YES | YES | YES | YES |
| **Organics** | | | | | |
| 1,2,3,6,7,8-Hexachlorodibenzofuran | ND | ND | ND | ND | ND |
| 2-Chlorophenol | YES | YES | YES | YES | YES |
| 2-Methylnapthalene | NO | NO | NO | NO | NO |
| 4-Chlorophenyl-Phenylether | NO | NO | NO | NO | NO |
| 4,4-ddt | NO | NO | NO | NO | NO |
| Aroclor-1016 | NO | NO | NO | NO | NO |
| Aroclor-1221 | NO | NO | NO | NO | NO |
| Aroclor-1242 | NO | NO | NO | NO | NO |

See footnotes at end of table.

**TABLE K.6-1**
**(Continued)**

| COCs | OU2 | OU3 | OU4 | NW Vault | E Vault |
|---|---|---|---|---|---|
| **Organics (cont.)** | | | | | |
| Aroclor-1248 | NO | NO | NO | NO | NO |
| Aroclor-1254 | NO | NO | NO | NO | NO |
| Aroclor-1260 | NO | NO | NO | NO | NO |
| Benzo(a,h)Anthracene | NO | NO | NO | NO | NO |
| Cyanide | YES | YES | YES | YES | YES |
| Di-n-Octyl Phthalate | NO | NO | NO | NO | NO |
| Heptachlorodibenzofuran | ND | ND | ND | ND | ND |
| Heptachlorodibenzo-p-dioxin | ND | ND | ND | ND | ND |
| n-Nitrophenylamine | ND | ND | ND | ND | ND |
| Octachlorodibenzofuran | ND | ND | ND | ND | ND |
| **Inorganics** | | | | | |
| Ammonia | ND | ND | ND | ND | ND |
| Antimony | NO | NO | NO | NO | NO |
| Arsenic | NO | NO | NO | NO | NO |
| Barium | NO | NO | NO | NO | NO |
| Beryllium | NO | NO | NO | NO | NO |
| Cadmium | NO | NO | NO | NO | NO |
| Chromium | NO | NO | NO | NO | NO |
| Cobalt | NO | NO | NO | NO | NO |
| Copper | NO | NO | NO | NO | NO |
| Lead | NO | NO | NO | NO | NO |
| Manganese | NO | NO | NO | NO | NO |
| Mercury | NO | NO | NO | NO | NO |
| Molybdenum | NO | NO | NO | NO | NO |
| Nickel | NO | NO | NO | NO | NO |
| Selenium | NO | NO | NO | NO | NO |
| Thallium | NO | NO | NO | NO | NO |
| Vanadium | NO | NO | NO | NO | NO |
| Zinc | NO | NO | NO | NO | NO |

ND = Not Determined.
NO = COC eliminated from further consideration (not expected to reach aquifer in 1000 years).
YES = COC not screened out.

In summary, the COCs identified with "NO" or "ND" in all columns of Table K.6-1 were eliminated from the groundwater pathway, and the uranium isotopes, Tc-99, Sr-90, cyanide, and 2-chlorophenol were retained for ODAST and then SWIFT III modeling. Because of their chemical similarity, all of the uranium isotopes were assumed to be transported by water in approximately the same manner. Therefore, only the transport of U-238 has been modeled for this CRARE, since it is the most abundant isotope. The other isotopes were assumed to also be transported in the same ratios to U-238 as they are present in the source areas. The relative abundances of the uranium isotopes at the FEMP are as follows, in decreasing order:

- U-238 99.3 percent
- U-235 0.685 percent
- U-236 $9.63 \times 10^{-3}$ percent
- U-234 $8.96 \times 10^{-3}$ percent

These values were estimated from the uranium isotope distributions found in the RI/FS database.

K.6.1.3 Descriptions of Source Terms

Section K.6.1.1 describes how this CRARE uses the updated LRAs for Operable Unit 4 and the LRAs from the SWCR for Operable Units 1, 2, 3, and 5 to identify the source areas assumed to remain after remediation. These assumptions provide the basis for determining the locations and source terms for the release of COCs to the water pathways. Descriptions of the two Operable Unit 4 source areas, the northeast vaults and the Operable Unit 4 residual soils, are not included in this section, since they are described in the Operable Unit 4 FS report.

K.6.1.3.1 COC Masses and Leachate Concentrations

The determination of COC masses, initial concentrations, and the derived leachate concentrations for each of the Operable Unit 1, 2, 3, and 5 source areas is described below. The estimation of infiltration rates as part of the source terms is described in Section K.6.1.3.2 and K.6.1.3.3. The calculation of rainfall runoff as a source term to surface water flow is described in Section K.6.1.5.

Under Operable Unit 5, the area of potential soil contamination includes the entire FEMP (see Section K.3.1, Figure K.3-1). The areas for Operable Units 1, 2, and 4 were not included in the CRARE site-wide soils area because they are described separately as sources of COCs. The vaults were not included because the soils in these areas will be excavated for foundation construction. Soils within the Operable Unit 3 production area were generally expected to contain elevated levels of uranium, unless sampling results show otherwise. Soils outside the operable unit or vault boundaries, but within the FEMP, were assumed to have background levels of uranium unless analytical results were available to indicate the location and magnitude of contamination. Figure K.6-3 presents the grid squares where elevated levels of uranium are believed to be present in the soils. The Main Plant area includes subdivisions for Plant 2/3, Plant 6, and Plant 9. The forms of uranium and geochemical conditions are different in these three subareas than in the remainder of the Main Plant area (Lee and Marsh 1992). For other COCs, the Operable Unit 3 area was also assumed to be at background levels unless analytical results indicated otherwise. Only COCs in soils within the FEMP boundary were evaluated for this CRARE.

Data on the concentrations and extent of the COCs in soils were obtained from the RI/FS database. Plant 2/3, Plant 6, and Plant 9 areas have the deepest vertical extent of soil contamination in the Production Area. The estimated vertical extent of U-238 contaminated soil is 10 feet in the Plant 2/3, Plant 6, and Plant 9 subareas; and 3 feet for the remaining area. For U-238, all concentrations above 60 pCi/g were assigned that value to represent the results of the soil-washing remediation of Operable Unit 5. However, the 60-pCi/g value may be changed in future CRARE documents, depending on the results of treatability tests being conducted for the operable Unit 5 soil-washing process in the summer of 1993. The 60-pCi/g PRG for U-238 was selected from the SWCR.

Residual soil concentrations were separately defined for each subarea. Inside the Plant 2/3, Plant 6, and Plant 9 subareas, the majority of the soil is higher than the U-238 PRG, and therefore the assumption was made that all of this soil would be washed. The 60-pCi/g level was defined as the residual U-238 concentration for these three subareas.

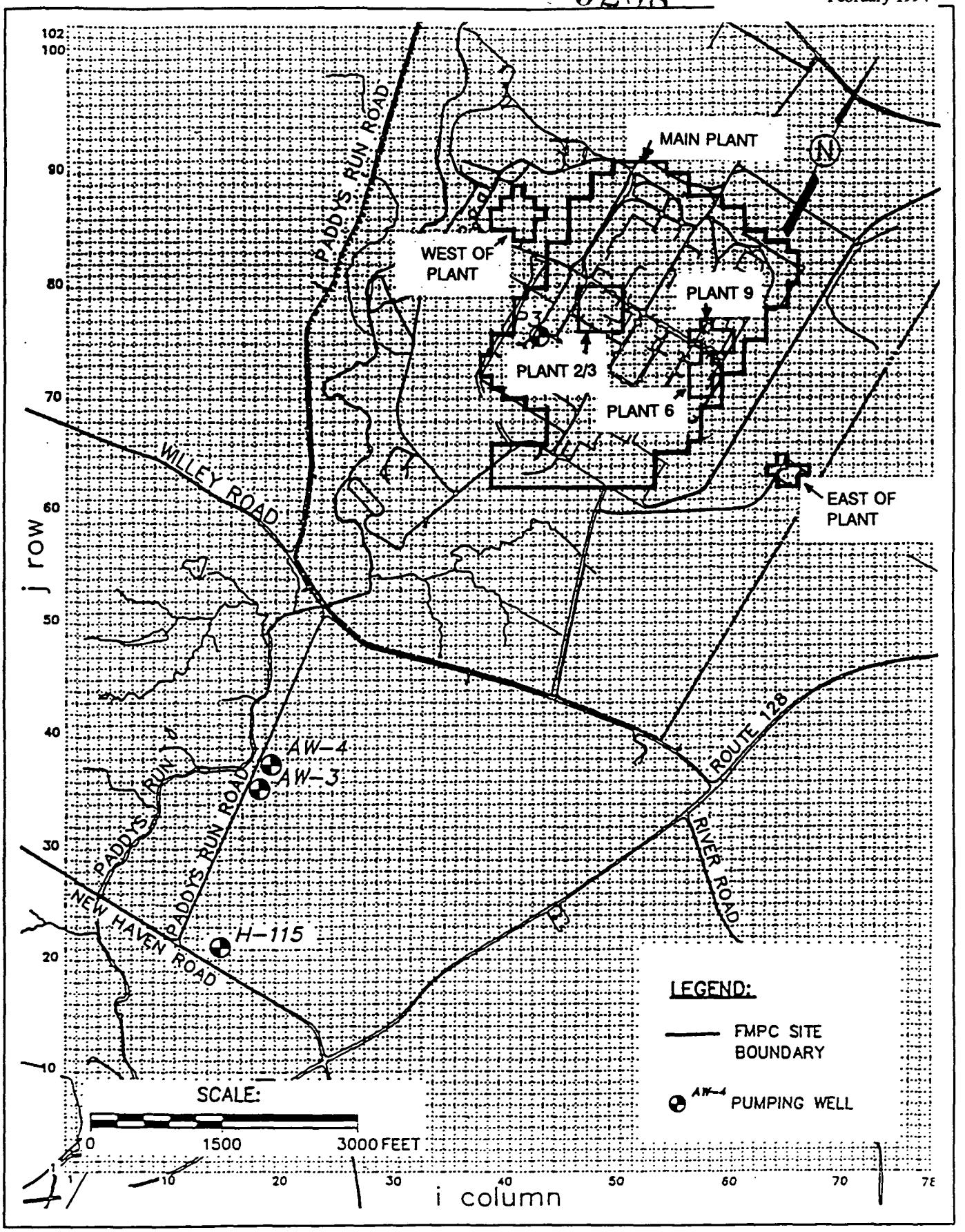



FIGURE K.6-3
GRID LOCATIONS OF ELEVATED URANIUM IN OPERABLE UNIT 5 SOILS

For the remaining portion of the Main Plant area, plus the west-of-plant and east-of-plant areas, only a portion of the soil is higher than the U-238 PRG and will require soil washing. Individual concentration values in the database above 60 pCi/g were assigned that value as representing washed soil. Concentrations below 60 pCi/g were assumed to remain the same (unwashed soil).

Data were not available on the effectiveness of the soil washing process for removing COCs other than uranium. However, it is reasonable to assume that other COC concentrations in the washed soil were reduced by the same fraction the U-238 was reduced, except that if the U-238 reduction exceeded 50 percent, the other COC reduction was set to 50 percent. In order to evaluate the impact of this assumption, a sensitivity test was run for Sr-90.

The sensitivity test included an additional simulation of Sr-90 transport with the ODAST and SWIFT III models. The only change for this simulation was that there were no reductions in Sr-90 concentrations for the soil washing assumption. All other aspects of the test simulation were the same as described in this and the following sections. When the sensitivity test results were compared to the results developed from the soil washing assumption, the peak groundwater concentrations during the test were approximately four times higher than those under the soil washing assumption. This represents a reasonable reduction in concentration for the soil washing process. Future editions of the CRARE will use the results of soil washing tests as they become available to estimate COC source terms, and then this algorithm will not be used.

A preliminary model screening run was performed at approximately one half of the 60 pCi/g U-238 PRG. All other contaminant concentrations for this modeling were appropriately scaled down from their existing soil concentrations consistent with the U-238 reduction predicted to result from their existing soil concentrations consistent with the U-238 reduction predicted to result from remediation. This screening run showed that the predicted levels of technetium, cyanide, and 2-chlorophenol in the aquifer would not yield risk results greater than $10^{-7}$, nor an HI greater than 0.1. Since it was demonstrated that a factor of 2 did not cause these COCs to be above screening levels, these COCs were not included in the final modeling run. It is not anticipated that including these COCs would change the final risk estimates resulting from modeling.

The database for each COC was then divided into two groups: 1) analytical results from soil samples collected from the surface to six inches in depth (surface results), and 2) analytical results from below six inches (subsurface results). The zero-to-six inch depth was selected because many of the surface soil samples in the database had been collected within that range. The surface soil databases were used to estimate COC source locations, soil concentrations, and masses for the surface water modeling. The subsurface soil databases were used for the same purposes for the vadose zone modeling. For each database the soil concentrations were averaged over depth and gridded on the SWIFT transport grid to obtain cell by cell concentrations. If analytical results were not available for soils in a cell, then the COC concentrations in that cell were assumed to be negligible. The assumption was also made that only 30 percent of the uranium in the untreated residual soils would be available for desorption and transport. For the washed soils, only 5 percent of the remaining uranium was assumed to be available for desorption and transport. These assumptions are based on soil washing tests conducted by Oak Ridge National Laboratory. They are discussed further in Attachment K.V. Uranium was the only COC for which reductions were made in the available mass for transport because soil washing data were not available for the other COCs. The process of evaluating the areas where there is soil data for the COCs followed four steps:

1. Average all sample results at each particular location over depth.

2. Average the depths over which contamination penetrated.

3. Grid the average results over the desired portion of the SWIFT solute transport grid. Use the "inverse distance" algorithm of SURFER (Golden Software, Inc. 1990).

4. Take the arithmetic average of the gridded results.

The leachate concentrations from the averaged soil results were obtained by dividing the soil concentration by the soil partitioning coefficient ($K_d$) for the COC. This approach assumes that the soil and the water passing through it are in reversible linear equilibrium with each other (the same assumption that SWIFT makes). This assumption does not take into account the effects of variations in ph, anions, and mineralogical composition on COC partitioning. The lower the flow of water, the more accurate is this assumption. Accuracy is also improved by having dilute concentrations well below solubility limits. $K_d$ values used for the CRARE modeling are discussed further in Sections K.6.1.4.1 and K.6.1.6.1, and in Attachment K.V. A comprehensive list of $K_d$ values for the FEMP

appears in the RAWPA, which also describes their derivation. $K_d$ is defined as the mass of solute on the soil solid per unit mass of solid, divided by the concentration of solute in solution.

The northwest vaults were assumed to contain the vitrified Operable Unit 1 waste materials and the soil washing residues. The nature of the leachate that would develop from the soil-washing residues has not been defined at this time. In order to establish a leachate concentration, these residues were assumed to be vitrified with the Operable Unit 1 waste. The mass of U-238 in this soil material was obtained as the difference between the gridded averages of the original RI/FS soil database and the modified RI/FS data base (in which all soil concentrations greater than 60 pCi/g were changed to 60 pCi/g) multiplied by the volume, based on the average depth. The source term for these wastes in the model was evenly distributed in the lower set of the northwest vaults, which are included within the solute transport grid (Figure K.6-2).

Testing of the vitrification process has been conducted on the Operable Unit 1 waste material, and preliminary TCLP leaching results on the vitrified material were available from IT Corporation. The U-238 TCLP data for glass samples for each pit were averaged to determine individual pit averages. Since the actual loading scheme had not been defined, projecting which portion of the northwest vaults would receive which pit material was not practical. Also, the vitrification process will cause some homogenization. Consequently, a mass weighted average (MAV) TCLP concentration was used for all the Operable Unit 1 material. The MAV TCLP was determined by:

$$TCLP_{Mav} = (TCLP_1 \times Mass_1 + TCLP_2 \times Mass_2 + \ldots.)/(Mass_1 + Mass_2 + \ldots.) \qquad (6)$$

The masses of U-238 for each pit were taken from the SWCR. The $TCLP_{Mav}$ was used as the leachate concentration term, which was multiplied by the percolation rate to give the initial loading rate for the vadose zone modeling. The loading rate was increased by multiplying by the ratio of the total area of the northwest vaults to the area of the lower northwest vaults that is located within the SWIFT solute transport grid. This increase in loading rate gives a conservative simulation of the northwest vaults since it loads all the material into the downgradient smaller area of the lower northwest vaults. Note, however that the depletion characteristics determined from using the complete northwest vaults were maintained.

0141

The TCLP results were assumed to be representative of leachate concentrations that would result from rainwater contacting the vitrified waste. This leachate was assumed to be unaffected by geochemical changes as it percolates through the vadose zone soils. The first assumption is conservative since the acidic TCLP leaching solution would probably dissolve more contaminant than would rainwater. The effect of the second assumption is more uncertain, since the geochemistry of the soil beneath the northwest vaults has not been quantitatively studied.

The leachate concentrations and masses of COCs for the Operable Unit 3 wastes in the east vaults were taken from the SWCR. For the Operable Unit 2 areas, which were assumed to be capped, the estimated leachate concentrations and masses were also taken from the SWCR. An exception to this is the leachate concentrations for the lime sludge ponds. Since the LRA for these ponds includes stabilization, TCLP results from treatability studies of cement stabilization for these wastes were used as leachate concentrations. The Operable Unit 1 area was also assumed to be capped after the waste pit materials and surrounding soils are removed. However, data are not available on the possible contamination that would remain after this removal action. Therefore, the leachate from this area was assumed to contain no COCs.

To summarize the results of this section, the mass values and initial leachate concentrations for each COC at each of the source areas are listed in Table K.6-2. These source terms were used as input to the vadose zone transport modeling described in Section K.6.1.4. Residual uranium in the perched water of the vadose zone at the end of remediation will eventually be transported down to groundwater. The mass of this uranium is listed in Table K.6-2, and it is discussed further in Section K.6.1.4.1. The input to the surface water transport modeling is listed separately in Section K.6.1.5. Residual uranium projected to remain in groundwater at the end of remediation is discussed in Section K.6.1.6.1. Masses for the isotopes other than U-238 are not shown in Table K.6-2 but were estimated by multiplying the U-238 masses by the ratios provided in Section K.6.1.2.

## TABLE K.6-2

## SOURCE TERMS FOR COC MASSES AND CONCENTRATIONS

| Source Area | Total Initial Mass (mg) | Initial Mobile Mass (mg) | Initial Leachate Concentration (mg/l) | Calculation Method |
|---|---|---|---|---|
| **U-238** | | | | |
| East Vault for OU-3 Wastes | $2.634 \times 10^{12}$ | $2.634 \times 10^{12}$ | $1.787 \times 10^{-3}$ | SWCR |
| OU-4 Vault | $5.653 \times 10^{8}$ | $5.653 \times 10^{8}$ | $7.000 \times 10^{0}$ | OU-4 FS |
| OU-4 Contaminated Soils | $1.083 \times 10^{7}$ | $1.083 \times 10^{7}$ | $1.500 \times 10^{0}$ | OU-4 FS |
| NW Vault for OU-1 Wastes | $4.136 \times 10^{12}$ | $4.136 \times 10^{12}$ | $1.320 \times 10^{1}$ | Mass Average of TCLP (Vitrification) and Database for OU-3 Soil |
| OU-2 | | | | |
| Solid Waste Landfill | $1.083 \times 10^{9}$ | $1.083 \times 10^{9}$ | $3.610 \times 10^{-3}$ | SWCR |
| North Lime Sludge Pond | $4.337 \times 10^{7}$ | $4.337 \times 10^{7}$ | $6.322 \times 10^{-4}$ | TCLP (Cementation) |
| South Lime Sludge Pond | $8.782 \times 10^{7}$ | $8.782 \times 10^{7}$ | $6.322 \times 10^{-4}$ | TCLP (Cementation) |
| Flyash and South Field | $6.467 \times 10^{9}$ | $6.467 \times 10^{9}$ | $4.320 \times 10^{-3}$ | SWCR |
| Site-Wide Soils | | | | |
| Main Plant Area | | | | |
| Plant 2/3 | $1.865 \times 10^{10}$ | $9.325 \times 10^{8}$ | $5.563 \times 10^{-1}$ | Database Kd |
| Plant 6 | $9.324 \times 10^{9}$ | $4.662 \times 10^{8}$ | $5.563 \times 10^{-1}$ | Database Kd |
| Plant 9 | $9.324 \times 10^{9}$ | $4.662 \times 10^{8}$ | $5.563 \times 10^{-1}$ | Database Kd |
| Remainder | $1.468 \times 10^{10}$ | $4.403 \times 10^{9}$ | $2.553 \times 10^{-2}$ | Database Kd |
| East Plant Area | $8.160 \times 10^{9}$ | $4.080 \times 10^{8}$ | $5.563 \times 10^{-1}$ | Database/Kd |
| West Plant Area | $1.748 \times 10^{10}$ | $8.742 \times 10^{8}$ | $5.563 \times 10^{-1}$ | Database/Kd |
| Perched Water | $7.527 \times 10^{6}$ | $7.527 \times 10^{6}$ | $2.010 \times 10^{-1}$ | 1000-Series Wells |

0146

5208

## TABLE K.6-2
## (Continued)

| Source Area | Total Initial Mass (mg) | Initial Mobile Mass (mg) | Initial Leachate Concentration (mg/l) | Calculation Method |
|---|---|---|---|---|
| **Sr-90** | | | | |
| East Vault for OU-3 Wastes | $7.922 \times 10^{-1}$ | $7.922 \times 10^{-1}$ | NC | Database |
| NW Vault for OU-1 Wastes | $1.031 \times 10^{1}$ | $1.031 \times 10^{1}$ | NC | Mass Average of TCLP (Vitrification) and Database for OU-3 Soil |
| OU-2 | | | | |
| Solid Landfill | $2.061 \times 10^{-1}$ | $2.061 \times 10^{-1}$ | NC | SWCR |
| North Lime Sludge Pond | $4.990 \times 10^{-2}$ | $4.990 \times 10^{-2}$ | NC | SWCR |
| Flyash and South Field | $1.058 \times 10^{0}$ | $1.058 \times 10^{0}$ | NC | SWCR |
| Site-Wide Soils | | | | |
| Main Plant Area | $7.977 \times 10^{0}$ | $7.977 \times 10^{0}$ | NC | Database |
| East Plant Area | $1.050 \times 10^{-1}$ | $1.050 \times 10^{-1}$ | NC | Database |
| West Plant Area | $2.240 \times 10^{-1}$ | $2.240 \times 10^{-1}$ | NC | Database |
| **Tc-99** | | | | |
| East Vault for OU-3 Wastes | $2.615 \times 10^{4}$ | $2.615 \times 10^{4}$ | $1.055 \times 10^{-3}$ | Database/Kd |
| NW Vault for OU-1 Wastes | $4.280 \times 10^{7}$ | $4.280 \times 10^{7}$ | $3.359 \times 10^{-6}$ | Mass Average of TCLP (Vitrification) and Database for OU-3 Soil |
| Site-Wide Soils | | | | |
| Main Plant Area | $1.818 \times 10^{5}$ | $1.818 \times 10^{5}$ | $1.055 \times 10^{-3}$ | Database/Kd |
| East Plant Area | $2.383 \times 10^{3}$ | $2.383 \times 10^{3}$ | $1.055 \times 10^{-3}$ | Database/Kd |
| West Plant Area | $5.107 \times 10^{3}$ | $5.107 \times 10^{3}$ | $1.055 \times 10^{-3}$ | Database/Kd |



FEMP-OU4CRARE-6 FINAL
February 1994
5208
0147

**TABLE K.6-2**
**(Continued)**

| Source Area | Total Initial Mass (mg) | Initial Mobile Mass (mg) | Initial Leachate Concentration (mg/l) | Calculation Method |
|---|---|---|---|---|
| **Cyanide** | | | | |
| OU-2 | | | | |
| Solid Landfill | $2.004 \times 10^{7}$ | $2.004 \times 10^{7}$ | $2.846 \times 10^{-1}$ | SWCR |
| Flyash and South Field | $4.605 \times 10^{7}$ | $4.605 \times 10^{7}$ | $1.554 \times 10^{-1}$ | SWCR |
| Site-Wide Soils | | | | |
| Main Plant Area | $3.221 \times 10^{8}$ | $3.221 \times 10^{8}$ | $5.315 \times 10^{0}$ | Database/Kd |
| East Plant Area | $4.222 \times 10^{6}$ | $4.222 \times 10^{6}$ | $5.315 \times 10^{0}$ | Database/Kd |
| West Plant Area | $9.049 \times 10^{6}$ | $9.049 \times 10^{6}$ | $5.315 \times 10^{0}$ | Database/Kd |
| **2-Chlorophenol** | | | | |
| East Vault for OU-3 Wastes | $1.087 \times 10^{7}$ | $1.087 \times 10^{7}$ | $1.900 \times 10^{-1}$ | Database/Kd |
| Flyash and South Field | $2.081 \times 10^{6}$ | $2.081 \times 10^{6}$ | $1.533 \times 10^{-2}$ | SWCR |
| Site-Wide Soils | | | | |
| Main Plant Area | $8.343 \times 10^{8}$ | $8.343 \times 10^{8}$ | $1.900 \times 10^{-1}$ | Database/Kd |
| East Plant Area | $1.094 \times 10^{7}$ | $1.094 \times 10^{7}$ | $1.900 \times 10^{-1}$ | Database/Kd |
| West Plant Area | $2.347 \times 10^{7}$ | $2.347 \times 10^{7}$ | $1.900 \times 10^{-1}$ | Database/Kd |

NC = Not Calculated



52
0148

K.6.1.3.2 Soil and Capped Areas Infiltration Rates

Section K.2.3.4 describes the type of cap assumed to be constructed over the Operable Unit 1 and 2 areas. Similar cap designs are now being developed (summer 1993) as part of the Operable Unit 1 feasibility study. Numerous HELP model simulations of this design were run by Operable Unit 1, and the results for the infiltration rates were very similar. An average value of 0.45 cm/year (0.177 in./year) was calculated from this data and used for the CRARE capped areas.

For the site-wide soils, information regarding the major portion of Production Area soils in the SWCR was used. The percolation rate of 19.1 cm/year (7.5 in./year) was determined from the seepage velocities given in Appendix O of the SWCR. This rate was originally developed by HELP modeling of surface soils. Operable Unit 5 has made the assumption that the infiltration rate through the washed and back-filled soil in localized areas (i.e., Plant 2/3, Plant 6, and Plant 9) will be reduced by up to one order of magnitude, if determined necessary. This reduction of infiltration can be achieved by vegetation, compacting the back-filled soil, and mixing the back-filled soil with low permeability materials. Therefore, the infiltration rate for these three areas was set at 1.9 cm/year (0.75 in./year) for the uranium transport modeling. This assumption is discussed further in Attachment K.V. For all other COCs the rate of 19.1 cm/yr was used site-wide.

K.6.1.3.3 Vault Infiltration Rates

This section summarizes an investigation of concrete vault degradation, conducted for this CRARE, to identify significant design factors and estimate infiltration rates through the vaults. Radon gas emissions from the vaults are addressed in Section K.6.2.5. A literature review found that groundwater flow through concrete vaults has been the subject of a number of research efforts, and that a wide range of modeling procedures based on many parameters are available. The underlying assumptions, key parameters, and processes that affect permeability are discussed in this section. Typical flow rates through vaults are then presented, along with membrane flaws and their effects. To develop a reasonable estimate of leakage, key assumptions were made:

- Maintenance of the vaults will stop after approximately 70 years.
- Concrete mix will be proportioned to minimize degradation and permeability.
- A geosynthetic membrane will be used that will completely deteriorate after 500 years.
- A perched water table on the top of the vaults will create an average annual pressure head of 10 centimeters (3.9 inches).

- Water entering the vaults will equal water exiting the vaults.

Permeability, resistance to degradation, and aging of concrete are directly related to the original mix. Mixing properties that affect the pertinent qualities of concrete include:

- The water-to-cement ratio
- The addition of pozzolanic materials
- The addition of superplasticizers
- Curing techniques
- Prestressing and post-tensioning

Configuration, layout of the vault, and natural processes are difficult to characterize but very important when considering the permeability of the vaults. Factors needing to be considered include:

- The drainage pattern of the site
- The connection details of roofing panels
- The infiltration of silts, clay, and other material that may fill the cracks.
- Expansive reactions in the concrete that could close up some of the cracks

Some factors that affect degradation and permeability of the concrete are:

- Sulfate attack
- Chloride ions corroding the reinforcing steel
- Alkali-aggregate reactions
- Alkali-carbonate reactions
- Freezing and thawing effects
- Microbiological attack, salt crystallization, and attack by radiation
- Creep and shrinkage of concrete
- Relaxation and stress relief in post-tensioning cables
- Inherent brittleness of low water/cement ratios in impermeable concrete mixes
- Cracking due to impact of placing backfill over vault
- Differential settlement of soil beneath of vaults

Of all these variables and mechanisms, only a few can actually be modeled. If more information regarding the concrete design and site conditions were available, a better estimate of degradation rate could be determined. Clifton and Knab (1989) formulated different parameters and concluded that concretes with low permeabilities are most likely to achieve service lives of around 500 years. From the literature gathered at the time of this report, it appears that longer service lives are possible, but have not been investigated. The most significant factors from the above lists are:

- The water-to-cement ratio of the mix design is crucial for determining permeability. However, the lower the ratio, the more brittle and susceptible to cracking the concrete becomes.

- The addition of pozzolonic materials significantly reduces the effect of degradation and cracking. Other additions such as superplasticizers and water reducers will improve workability at low water-to-cement ratios. Air entraining agents will reduce the amount of fluid migration into the concrete.

- Prestressing and post-tensioning can virtually eliminate the cracks in concrete. Yet, the long-term effects of stress relaxation may eliminate the function of the prestress. Creep can also promote prestress loss. Creep is the phenomenon in which concrete flows plasticly under load.

- Shrinkage is very important in concrete performance because concrete can shrink and crack substantially if not properly cured. However, 80 percent of shrinkage occurs in the first year.

- Sulfate attack can degrade concrete significantly. Most likely, the concrete will be mixed to resist this and other chemical processes.

- Alkali-aggregate and alkali-carbonate reactions can cause the concrete to crack because of the internal development of localized expansive stresses.

- Chloride attack does not directly degrade concrete, but it corrodes reinforcing steel leaving less steel to resist cracks. Also, steel corrosion is an expansive type of reaction that may cause internal stresses, cracking the concrete even further.

Cracking resistance is directly proportional to the area of steel. The American Concrete Institute (ACI) Building Code (ACI 1983) gives a relation for crack width based on the stress in the steel and the area of reinforcement. Once a crack ratio is established, relative permeability can be determined. Walton and Seitz (1991) cite an empirical relationship for permeability resulting from cracks:

$$K_f = b^3/(12s) \qquad (7)$$

where

$K_f$ = permeability,
$b$ = width, and
$s$ = crack spacing.

This relationship assumes that cracks extend through the entire concrete section. However, most cracking occurs on the tension side of the member, so this equation may be limited in its application.

Walton and Seitz (1991) state that the leakage rate through a well-engineered cover is about 0.5 centimeters per year, and go further to state that an engineered cover over the vault will only improve waste isolation performance if leakage rates can be reduced below 0.1 cm/year (0.04 in./year). As the concrete vault degrades and permeability increases, the moisture flux rate becomes dependent upon cover performance at higher leakage rates. Because the performance of the engineered cover is likely to degrade much more rapidly than the underlying concrete vault, it is unlikely that the engineered cover will contribute significantly to the waste isolation performance of the storage system. If the engineered cover leakage rate is 0.5 cm/year (1.97 in./year), the cover will be insignificant. A membrane liner in the fill will reduce this cover leakage rate. In turn, the concrete leakage rate will also be reduced.

Typical hydraulic conductivity values of a vault with no cover are given in some of the literature. Walton and Seitz (1991) approximate the hydraulic conductivity at $3.2 \times 10^{-3}$ to $3.2 \times 10^{-5}$ cm/year ($1.26 \times 10^{-3}$ to $1.26 \times 10^{-5}$ in./year) for a vault in good condition. A degraded vault has conductivities of $3.2 \times 10^{-1}$ to $3.2 \times 10^{-3}$ cm/year ($1.26 \times 10^{-1}$ to $1.26 \times 10^{-3}$ in./year). Values of $3.2 \times 10^{-4}$ and $3.2 \times 10^{-2}$ cm/year ($1.26 \times 10^{-4}$ and $1.26 \times 10^{-2}$ in./year) were chosen for this analysis to represent a vault at 100 years in good condition, and a vault at 500 years in poor condition. These preliminary values were based on the extensive research conducted by Walton and Seitz (1991) and represent a conservative approach. Site-specific values were not available due to the preliminary nature of the design. The effect of cracking was specifically excluded because Walton and Seitz (1991) indicate that concrete vaults can be designed to minimize the impact of cracks.

Given the hydraulic conductivities, it is necessary to establish the pressure head for perched water above a vault. The cover is a multi-layered composition of clay, sand, gravel, etc., designed to divert water away from the vault. After a period of time, this cover is expected to lose its effectiveness so that water will infiltrate as time goes on. Also, rainfall varies throughout the year. For the purpose of this study, an average pressure head was assumed to be 10 centimeters throughout the year. Under these assumptions, two leakage rates are established according to the data presented in Walton and Seitz (1991). The equation for one-dimensional flow is (Freeze and Cherry 1979):

$$q = K\Delta h/\Delta l \quad (8)$$

where

$q$ = leakage (specific discharge),
$K$ = hydraulic conductivity,
$\Delta h$ = difference in head between top and bottom surfaces of vault ceiling, and
$\Delta l$ = thickness of vault ceiling.

The thickness of the vault ceiling is not known, so the $\Delta h/\Delta l$ term was set to equal the 10 centimeter assumed head. This is a conservative assumption, since the ceiling thickness would probably be in the range of 5 to 50 centimeters (2 to 20 inches). The calculated rates are:

- At time = 100 years, leakage = 0.0032 cm/year (0.0013 in./year)
- At time = 500 years, leakage = 0.32 cm/year (0.13 in./year)

These rates were then used to estimate the preliminary time-leakage graph for the infiltration rate through a concrete vault without a cap, as shown in Figure K.6-4.

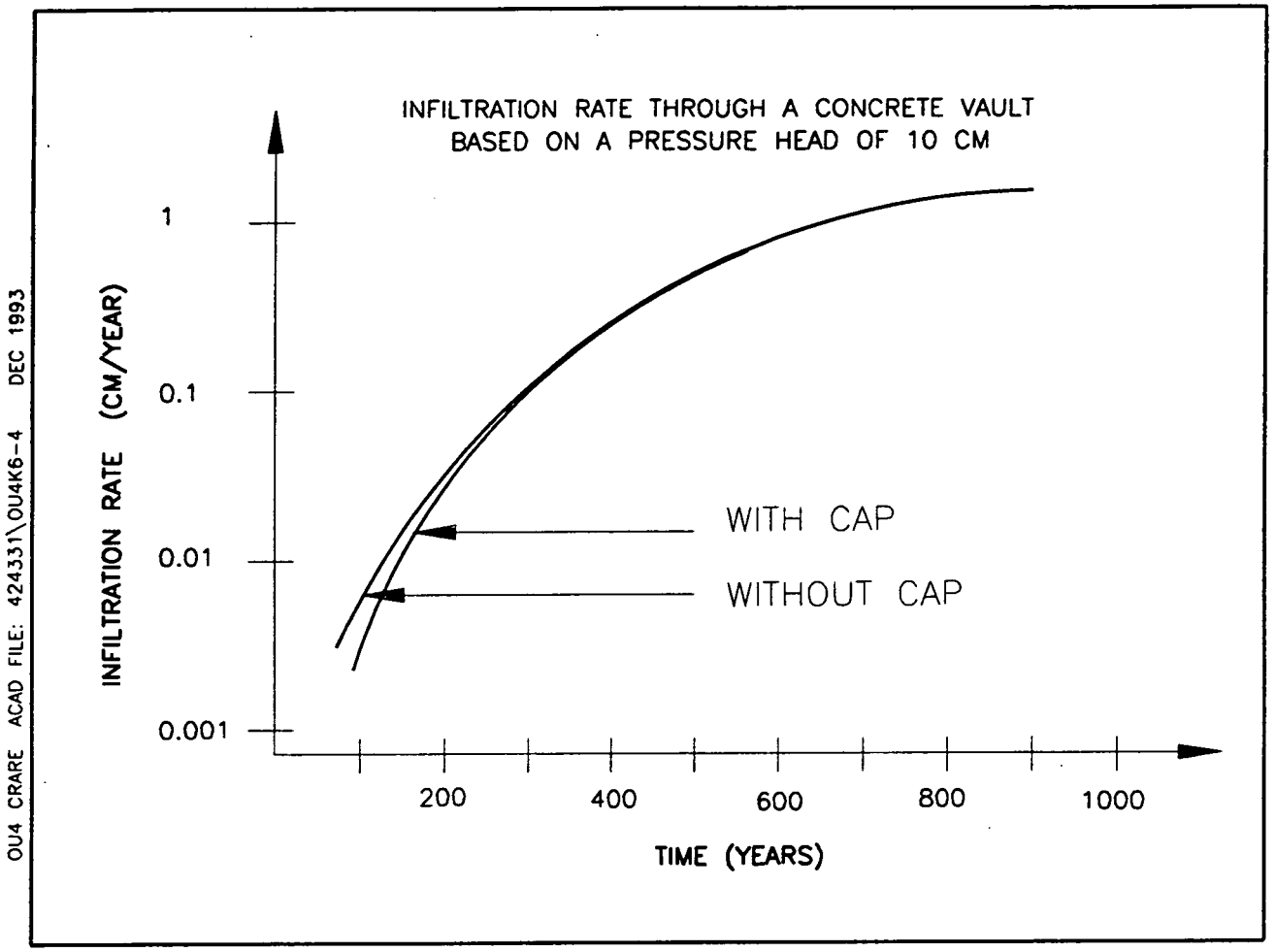
Because the vault designs have not yet been initiated, information about a capping membrane and its life expectancy were unavailable. Therefore, the following assumptions were made:

1. The membrane will exist for 500 years before there is 100 percent flow through it.

2. Flaws are assumed to progress linearly with time and are expressed as (area of flaw)/(total area).

**FIGURE K.6-4**

**INFILTRATION RATES THROUGH THE VAULT SYSTEM**




Walton and Seitz (1991) state that during construction and through time, the membranes will develop punctures, tears, leaks at seams, or flaws that allow the percolation of fluids. The following relation was developed based on their stated assumptions and judgement:

| Time (years) | Ratio of Area of Flaws to Total Area | Ratio of Flow with Membrane to Flow without Membrane |
|---|---|---|
| 0.00 | 0.00 | 0.00 |
| 100 | 0.20 | 0.60 |
| 200 | 0.40 | 0.90 |
| 300 | 0.60 | 0.96 |
| 400 | 0.80 | 0.99 |
| 500 | 1.00 | 1.00 |

0154

Based on the assumptions, the membrane is only effective during the first few hundred years of service. The preliminary time-leakage graph for infiltration with a cap based on this information is also shown in Figure K.6-4. Note the minor difference between the flow with the membrane and without the membrane. Because of the uncertainties involved in this analysis, the vault infiltration rate was set at a constant 1.3 cm/year (0.5 in./year). Studies currently being conducted by Operable Unit 1 indicate that lower values may be used in future editions of the CRARE.

K.6.1.4 Vadose Zone Modeling

The source terms that are defined for the groundwater pathway, according to the LRAs and Operable Unit 4 updated LRA, were used as input to the vadose zone model. The development of this model is described in the next section, followed by the model results.

K.6.1.4.1 Vadose Zone Model Development

A vadose zone is defined as the unsaturated zone above the groundwater table of the aquifer. In this zone, the interstices are occupied partially by water and partially by air. At the FEMP, two distinct deposits, or layers, have been identified that constitute the vadose zone. The uppermost layer (Layer 1) consists of dense, fine-grained glacial overburden that overlie the unsaturated outwash deposits. Within these till deposits, there are numerous water-bearing zones that have limited interconnection, the majority of which are of glaciofluvial origin and consist of small beds of highly sorted sands and gravels. These beds are probably the result of small meltwater streams that occurred along the ice margin and within the glacier itself. Movement of water and contaminants within these units may be limited due to their limited extent and interconnection. Overlying the Great Miami Aquifer at the FEMP are approximately 4.6 to 11 meters (15 to 35 feet) of unsaturated sand and gravel outwash deposits (Layer 2). These deposits are assumed to have the same hydraulic characteristics as the underlying saturated material since the deposits are essentially the same. Additional information on the hydrogeology of the FEMP is contained in the SWCR.

Vadose zone modeling was performed to estimate contaminant loading rates to the Great Miami Aquifer from a given source as a function of time. The overburden has a capacity for immobilization and retardation of contaminants due to adsorption, precipitation, biodegradation, and radioactive decay. This capacity to prevent or slow the movement of contaminants to the aquifer has been evaluated with respect to future risk.

A one-dimensional analytical model was selected to evaluate the flow in the vadose zone, ODAST, Version 2 (Javendel et al., 1984). The model was previously selected for use, as discussed in the SWCR, based upon the following factors:

- Analytical methods are the most efficient alternative when data necessary for the characterization of the system is sparse and uncertain.
- These methods are consistent with approaches used for similar radionuclide assessment models such as the flow portions of PRESTO (EPA 1987c and other site studies).
- The basis of the solution is well documented and the software code has been extensively verified.

ODAST was used for determining the fate and transport of the constituents in the unsaturated zone that were retained for study after the screening process of Section K.6.1.2. Based on the solution originally developed by Ogata and Banks (1961), ODAST calculates the normalized concentrations of a given constituent in a uniform flow field from a source having a constant or varying concentration in the initial layer. It evaluates the basic one-dimensional analytical solute transport equation as a function of seepage velocity, dispersion coefficient, source decay, retardation factor, depletion time, and source rate. ODAST has been extensively verified against the model STRIP1B (Batu 1989).

The current use of the ODAST analytical model is being re-evaluated by Operable Unit 5. Future editions of the CRARE may include the use of a two or three-dimensional numerical model for the vadose zone. The reason for this potential change would be the inability of analytical models to adequately simulate the complex flow patterns in the vadose zone.

The input flow rates and COC concentrations with time to the ODAST model are the source terms described in Section K.6.1.3. Source terms for the two Operable Unit 4 areas are described under Alternative 2C of the Operable Unit 4 FS. Two other sets of source terms, from Paddys Run and the storm sewer outfall ditch (SSOD), were input directly to the SWIFT III groundwater model. These are described in Section K.6.1.5. The vadose zone is thinner and consists primarily of coarse material in the areas of surface water recharge to groundwater; therefore, it is reasonable to assume that the contaminant retardation would be minimal.

A utility code, SWIFLOAD, was written to run ODAST on cell-by-cell or specified-area input. Input files for the ODAST modeling were developed to represent the same 38-by-38 meter (125-by-125-foot) grid cell layout of the SWIFT III model. This allowed the ODAST output to be used as input directly to SWIFT without additional manipulation.

The thickness of each soil layer was gridded and provided to SWIFLOAD on a cell-by-cell basis. The conductivities used for Layers 1 and 2 were 0.008 and 13.7 m/day (0.0264 and 45 ft/day) respectively. The Layer 1 conductivity was estimated by log averaging the 1000 series-well slug test results (as of February 1993) and dividing by 20 to account for the horizontal-to-vertical ratio. Because the FEMP site has two distinct layers in the vadose zone, ODAST was run for each to calculate the normalized concentration at the bottom of each layer for each time step. In general, dispersion through the lower layer did not come into effect until the constituent reached the bottom of the adjacent upper layer.

ODAST requires the input of a retardation factor ($R_f$), which is derived from the $K_d$ by the equation:

$$R_f = 1 + K_d \rho_b/\theta \qquad (9)$$

where

$R_f$ = retardation factor
$\rho_b$ = bulk density
$\theta$ = moisture content
$K_d$ = soil partitioning coefficient

Values for both $K_d$ and $R_f$ are provided in the SWCR and RAWPA. However, Operable Unit 5 has re-evaluated the available data for $K_d$ values of U-238, and has developed new values for Layer 1. For the Plant 2/3, Plant 6, and Plant 9 areas, the estimated $K_d$ is 16 ml/g. For the remaining area in the Main Plant area, the estimated $K_d$ is 235 ml/g. For all other areas outside the Main Plant area, the estimated $K_d$ is 16 ml/g. These values were changed from the $K_d$ of 1.8 ml/g presented in the SWCR for Layer 1. The Layer 2 $K_d$ of 1.4 ml/g has not been changed. Attachment K.V contains a discussion of these changes. The SWCR estimates that the bulk densities of Layers 1 and 2 are 1.78 and 1.60 g/cc, respectively, and the moisture contents are 28 and 14 percent, respectively. Table K.6-3 lists the specific $K_d$ and $R_f$ values for the groundwater pathway COCs, and also the radioactive decay constants or the biodegradation coefficients. These are also taken from the SWCR.

**TABLE K.6-3**

**VADOSE ZONE MODEL PARAMETERS**

| COC | | Layer 1 Kd (ml/g) | Layer 1 Rf (unitless) | Layer 2 Kd (ml/g) | Layer 2 Rf (unitless) | Radioactive or Organic Decay Constant ($day^{-1}$) |
|---|---|---|---|---|---|---|
| U-238 | | | | | | |
| | Plants 2/3, 6 and 9 | 16 | 102 | 1.4 | 17.9 | $4.25 \times 10^{-13}$ |
| | Main Plant | 235 | 1488 | 1.4 | 17.9 | $4.25 \times 10^{-13}$ |
| | Remainder of FEMP | 16 | 102 | 1.4 | 17.9 | $4.25 \times 10^{-13}$ |
| Sr-90 | | 10 | 64.6 | 2.5 | 29.6 | $6.64 \times 10^{-5}$ |
| Tc-99 | | .12 | 1.75 | .07 | 1.80 | $8.92 \times 10^{-9}$ |
| 2-Chlorophenol | | 2.7 | 18.2 | 1.2 | 14.3 | NA |
| Cyanide | | .042 | 1.27 | .018 | 1.21 | $9.5 \times 10^{-4}$ |

NA = Not Available
SOURCE: (DOE 1993e)

Uranium is present in the perched water within the vadose zone beneath the central portion of the FEMP. A portion of this perched water will be remediated, but not as a drinking water source. Therefore, a level of uranium will remain in the perched water at the end of FEMP remediation. ODAST, however, cannot start with U-238 already in transit through the soil column being modeled. Therefore, to approximate the residual contamination caused by the perched water source after its remediation, ODAST modeled the perched water areas starting 40 years before the zero time of the start of the SWIFT model. The 40 year period was selected as an approximation of the time from when the U-238 was released to the completion of remediation. This provided some contamination in the vadose zone as represented in ODAST at the conclusion of remediation. The ODAST input concentrations for these areas were provided by first averaging the 1000-series well sample results. However, remediation is planned to be conducted to reduce the higher COC concentrations in the perched water, although not necessarily to drinking water standards. Therefore, to approximate the effect of this remediation, an arbitrary standard of 100 times the drinking water standard was selected as the maximum perched water concentration after remediation. Any of the averaged results that exceeded this standard were then reduced to it to approximate the effects of the perched water remediation. At the zero time, the perched water inflows were stopped in the ODAST runs, and the source terms (Section K.6.1.3) were initiated.

Section K.5.0 describes how exposure scenarios have been developed for this CRARE. Two ODAST runs were completed for each COC, to simulate the Current Land Use and both Future Land Use

scenarios. The first of these was run for only a 70-year period and assumed that leachate from the vaults were captured and not allowed to infiltrate the vadose zone. The second scenario was run for 1000 years and assumed that all source areas were releasing COCs as described in this section.

K.6.1.4.2 Vadose Zone Model Results

Loading rates to the Great Miami Aquifer were estimated for each COC for the SWIFT cells at each source area using ODAST. Attachment K.II provides a listing of the mass loading rates for U-238 to the Great Miami Aquifer for 1000 years from each waste area. Table K.6-4 provides summaries of the total mass loading from the vadose zone modeling for the Current and Future Land Use scenarios. In the table, the values in the Mass Transport to Groundwater columns are generally less than the mass of the COC removed from the source area, because some of the COC remains in transit through the vadose zone at the end of the specified time period. Figure K.6-5 depicts the source depletion rate of U-238 from the soils. In SWCR studies, loading rates were found to be sensitive to changes in the leach rate of the waste, thickness of the vadose zone, dispersion coefficient, interstitial water velocity, retardation factor, radioactive decay factor, biodegradation, and depletion time of the source. The loading rates were used as input for SWIFT III to model the groundwater movement and solute transport in the Great Miami Aquifer. Section K.10.3 provides an analysis of the uncertainties related to modeling the groundwater pathway.

## TABLE K.6-4

## SUMMARY OF VADOSE ZONE MODELING RESULTS

| Source Area | Initial Mobile Mass (mg) | Current Land Use Scenario Mass Transport to Groundwater After 70 Years (mg) | Future Land Use Scenarios Mass Transport to Groundwater After 1000 Years (mg) | Future Land Use Scenario Remaining Mobile Mass At 1000 Years (mg) |
|---|---|---|---|---|
| **U-238** | | | | |
| East Vault for OU-3 Wastes | $2.634 \times 10^{12}$ | $0.000 \times 10^{0}$ | $0.000 \times 10^{0}$ | $2.630 \times 10^{12}$ |
| OU-4 Vault | $5.653 \times 10^{8}$ | $0.000 \times 10^{0}$ | $0.000 \times 10^{0}$ | $1.703 \times 10^{8}$ |
| OU-4 Contaminated Soils | $1.083 \times 10^{7}$ | $0.000 \times 10^{0}$ | $7.265 \times 10^{6}$ | $0.000 \times 10^{0}$ |
| NW Vault for OU-1 Wastes | $4.136 \times 10^{12}$ | $0.000 \times 10^{0}$ | $0.000 \times 10^{0}$ | $4.103 \times 10^{12}$ |
| OU-2 | | | | |
| Solid Waste Landfill | $1.083 \times 10^{9}$ | $0.000 \times 10^{0}$ | $0.000 \times 10^{0}$ | $1.083 \times 10^{9}$ |
| North Lime Sludge Pond | $4.337 \times 10^{7}$ | $0.000 \times 10^{0}$ | $0.000 \times 10^{0}$ | $4.336 \times 10^{7}$ |
| South Lime Sludge Pond | $8.782 \times 10^{7}$ | $0.000 \times 10^{0}$ | $0.000 \times 10^{0}$ | $8.781 \times 10^{7}$ |
| Flyash and South Field | $6.467 \times 10^{9}$ | $0.000 \times 10^{0}$ | $9.831 \times 10^{-4}$ | $6.466 \times 10^{9}$ |
| Site-Wide Soils | | | | |
| Main Plant Area | | | | |
| Plant 2/3 | $9.325 \times 10^{8}$ | $0.000 \times 10^{0}$ | $0.000 \times 10^{0}$ | $7.162 \times 10^{8}$ |
| Plant 6 | $4.662 \times 10^{8}$ | $0.000 \times 10^{0}$ | $8.165 \times 10^{-2}$ | $5.580 \times 10^{8}$ |
| Plant 9 | $4.662 \times 10^{8}$ | $0.000 \times 10^{0}$ | $0.000 \times 10^{0}$ | $3.580 \times 10^{8}$ |
| Remainder | $4.403 \times 10^{9}$ | $0.000 \times 10^{0}$ | $0.000 \times 10^{0}$ | $2.540 \times 10^{9}$ |
| East Plant Area | $4.403 \times 10^{8}$ | $0.000 \times 10^{0}$ | $5.943 \times 10^{7}$ | $2.912 \times 10^{7}$ |
| West Plant Area | $8.742 \times 10^{8}$ | $0.000 \times 10^{0}$ | $3.462 \times 10^{7}$ | $6.240 \times 10^{7}$ |
| Perched Water | $7.527 \times 10^{6}$ | $2.808 \times 10^{-5}$ | $7.481 \times 10^{6}$ | $0.000 \times 10^{0}$ |
| **Tc-99** | | | | |
| East Vault for OU-3 Wastes | $2.615 \times 10^{4}$ | NC | $2.557 \times 10^{4}$ | $0.000 \times 10^{0}$ |
| NW Vault for OU-1 Wastes | $4.280 \times 10^{7}$ | NC | $5.906 \times 10^{3}$ | $4.279 \times 10^{7}$ |





0160

5208

## TABLE K.6-4
## (Continued)

| Source Area | Initial Mobile Mass (mg) | Current Land Use Scenario Mass Transport to Groundwater After 70 Years (mg) | Future Land Use Scenarios Mass Transport to Groundwater After 1000 Years (mg) | Future Land Use Scenario Remaining Mobile Mass At 1000 Years (mg) |
|---|---|---|---|---|
| **Tc-99 (cont.)** | | | | |
| Site-Wide Soils | | | | |
| Main Plant Area | $1.818 \times 10^{5}$ | NC | $1.648 \times 10^{5}$ | $0.000 \times 10^{0}$ |
| East Plant Area | $2.383 \times 10^{3}$ | NC | $2.164 \times 10^{3}$ | $0.000 \times 10^{0}$ |
| West Plant Area | $5.107 \times 10^{3}$ | NC | $4.679 \times 10^{3}$ | $0.000 \times 10^{0}$ |
| **Cyanide** | | | | |
| OU-2 | | | | |
| Solid Waste Landfill | $2.004 \times 10^{7}$ | NC | $0.000 \times 10^{0}$ | $1.774 \times 10^{7}$ |
| Flyash and South Field | $4.605 \times 10^{7}$ | NC | $0.000 \times 10^{0}$ | $4.146 \times 10^{7}$ |
| Site-Wide Soils | | | | |
| Main Plant Area | $3.221 \times 10^{8}$ | NC | $8.200 \times 10^{5}$ | $0.000 \times 10^{0}$ |
| East Plant Area | $4.222 \times 10^{6}$ | NC | $8.229 \times 10^{2}$ | $0.000 \times 10^{0}$ |
| West Plant Area | $9.049 \times 10^{6}$ | NC | $7.466 \times 10^{3}$ | $0.000 \times 10^{0}$ |
| **2-Chlorophenol** | | | | |
| East Vault for OU-3 Wastes | $1.087 \times 10^{7}$ | NC | $0.000 \times 10^{0}$ | $1.085 \times 10^{7}$ |
| Flyash and South Field | $2.081 \times 10^{6}$ | NC | $7.602 \times 10^{2}$ | $1.137 \times 10^{2}$ |
| Site-Wide Soils | | | | |
| Main Plant Area | $8.343 \times 10^{8}$ | NC | $7.844 \times 10^{8}$ | $1.908 \times 10^{-6}$ |
| East Plant Area | $1.094 \times 10^{7}$ | NC | $1.008 \times 10^{7}$ | $2.502 \times 10^{-8}$ |
| West Plant Area | $2.347 \times 10^{7}$ | NC | $2.234 \times 10^{7}$ | $5.368 \times 10^{-8}$ |

NC = Not Calculated





5208

5208

## FIGURE K.6-5

## SOURCE DEPLETION FOR U-238 FROM THE PRODUCTION AREA SOILS

The loading rates of a constituent traveling to the aquifer from a given source vary over time. Typically, loading rates increase sharply during an initial time period and then stabilize or decrease, depending on the depletion time of the source. For longer depletion times, the source remains active longer during the simulation, and may approach a steady-state condition within the 1000-year simulation time of the Future Land Use scenarios.

### K.6.1.5 Surface Water Modeling

Surface water modeling was used for two purposes: to define source terms for the SWIFT III groundwater model, and to estimate contaminant concentrations in surface water bodies as an exposure medium. Potential exposures for a future recreational use of surface water include dermal contact and incidental ingestion.

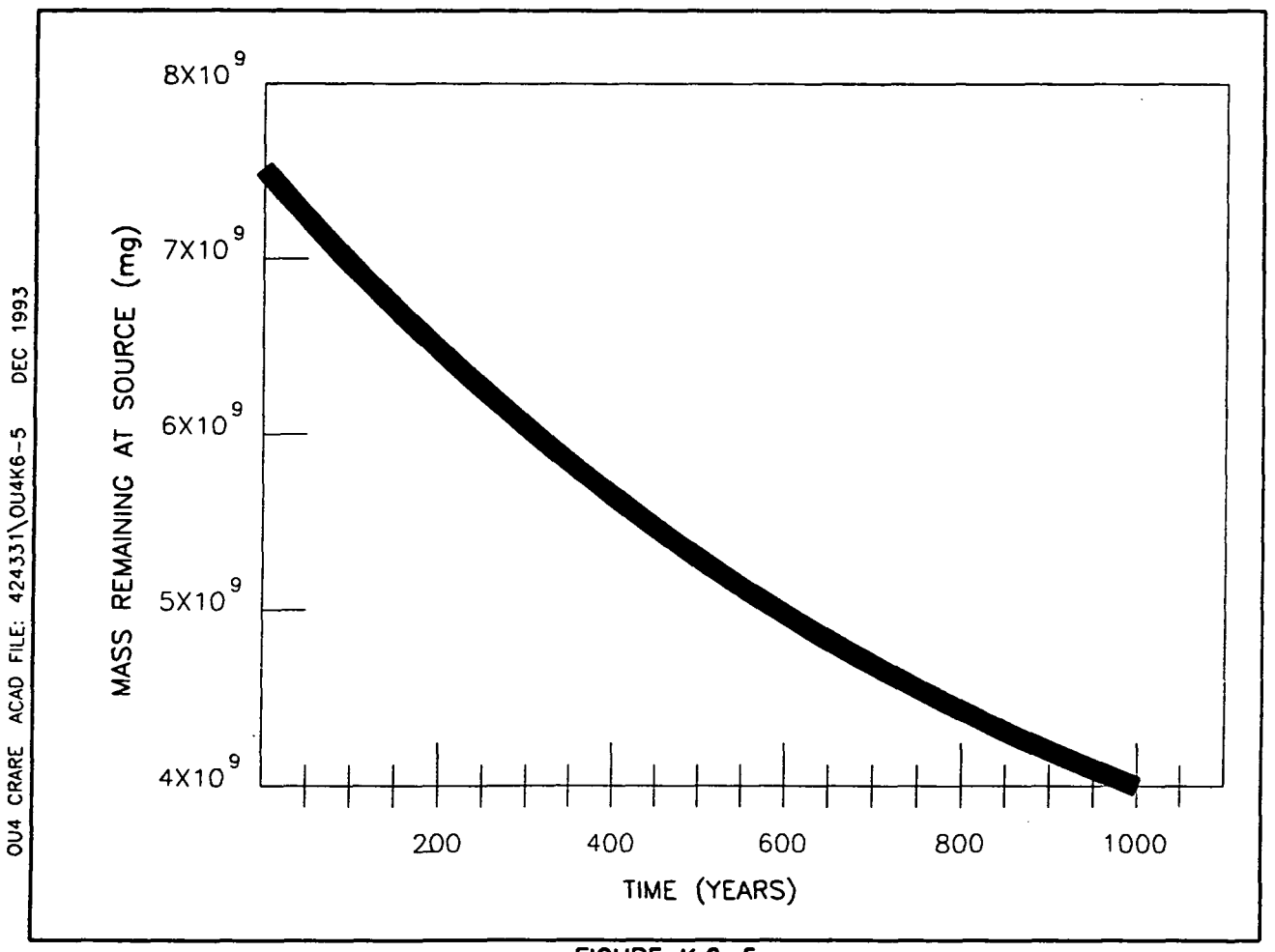



FIGURE K.6-5
SOURCE DEPLETION FOR U-238 FROM THE PRODUCTION AREA SOILS

0162

K.6.1.5.1 Surface Water Model Development

Surface soil was estimated to be the only source of surface water contamination for this CRARE. The vaults were not included as sources because they have been designed with floors recessed below ground level and leachate collection systems located beneath the floors. Leachate that contacts the waste will collect in these subsurface systems rather than exit to surface runoff. At the end of any maintenance period, the subsurface collection systems are expected to develop leaks such that all leachate will escape downward to groundwater. The capped areas of Operable Units 1 and 2 are expected to maintain the integrity of their caps so that no wastes are exposed to surface runoff. Soil erosion, in general, was not estimated in the SWCR to be a major factor affecting contaminant transport at the site.

As discussed in Section K.6.1.3.1, surface soil contaminant concentrations from the RI/FS database were used to estimate the extent and concentration of the COCs in soil. Surface soil information from the Operable Unit 4 FS was also used. Only the COCs that passed the screening of Section K.6.1.2 were evaluated for surface water transport. The same soil retention effects (characterized by $R_f$) that delay the release of COCs from the vadose zone soils also delay the release of the COCs from surface soils to surface water. The SWCR conducted surface water modeling for a wide range of COCs and reported that, with the exception of uranium, concentrations in the receiving streams were predicted to be generally very low.

The SWCR estimates that future surface water concentrations in the Great Miami River are below 1 pCi/l for all radionuclides except the uranium isotopes. Activity concentrations for U-234, U-235/236, and U-238 are estimated at 24, 1.3, and 28 pCi/l, respectively. Modeled concentrations for organic compounds range from $4.9 \times 10^{-11}$ to $1.1 \times 10^{-4}$ mg/l and are all below usual analytical detection levels. Modeled concentrations for inorganics except uranium range from $3.8 \times 10^{-7}$ to $1.4 \times 10^{-5}$ mg/l, also below analytical detection levels. The SWCR also includes risk assessments for surface water concentrations. Additional COCs may be evaluated for surface water transport in future versions of the CRARE.

After the source terms were identified, potential flow pathways were investigated. A topographic map of the FEMP was used to divide the study area into distinct drainage basins, each a watershed of the primary drainage features on the site. The FEMP is located on a gently sloping plateau bounded on the north and east sides by distinct drainage divides and on a third side by Paddys Run, a small

intermittent stream. Surface water transport of contaminants at the FEMP occurs intermittently, principally during rainstorms. Free-flowing surface water on the FEMP eventually flows down one of three drainage basins to the Great Miami River.

Two of the watersheds are those drained by Paddys Run or the SSOD, the primary drainage features on the property. The third, a small watershed in the northeast corner of the FEMP which drains to the east, was eliminated from further study because it contains no discernable sources. The Paddys Run watershed can be further subdivided into several smaller drainage basins.

Several areas are currently served by a system of engineered drainage features, such as ditches and runoff collection basins, as described in further detail by WEMCO (1991). The two most significant areas drained by this system are the production and the waste storage areas. Runoff from the production area, plus the incinerator area was assumed to continue to flow into the SSOD after FEMP remediation. Runoff from the silo area, waste storage area, and South Field was assumed to continue to enter Paddys Run. The principal drainage basins at the FEMP are shown on Figure K.6-6. To be conservative, the assumption has been made that stormwater runoff patterns in the future will be similar to present conditions. The same assumption was used for surface water runoff modeling in the SWCR.

The principal contaminant source area for drainage directly into Paddys Run is Operable Unit 4 and its surrounding soil. All other areas of contaminated soil drain into the SSOD, which in turn drains into Paddys Run several hundred feet before it exits the FEMP at the south boundary.

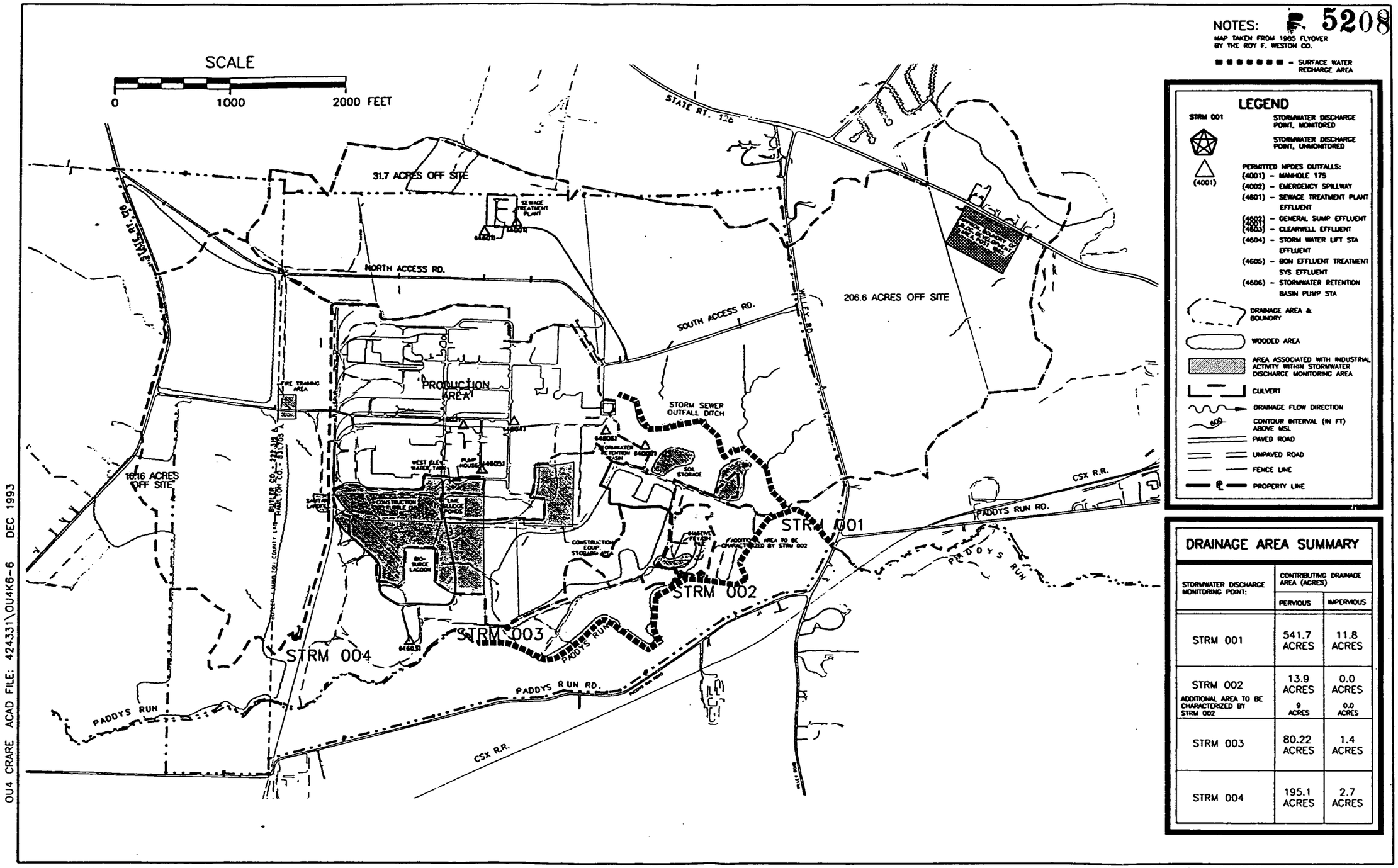
Stormwater management is not included as an ongoing activity for site-wide soils in the LRAs (Section K.2.2) after FEMP remediation. However, several stormwater retention structures are included in the design of the vaults (Parsons 1992), as discussed in Section K.2.3.3. Field data are not available on the percentage of FEMP runoff that recharges to groundwater. The conservative assumption was made that all COCs transported in surface water are recharged to groundwater before the surface water reaches the southern boundary of the FEMP. At approximately this point, per the SWCR, Paddys Run cuts below the water table and no longer recharges to groundwater.

In the SWCR study of baseline conditions, two models were selected to estimate contaminant concentrations in surface water and sediment at the FEMP: the Universal Soil Loss Equation (USLE) and the MUSLE. Both were obtained from the *Superfund Exposure Assessment Manual* (EPA 1988i)

and are described in detail in the RAWPA. The models calculate the total mass of soil lost each year from a study area. The USLE model is area-dependent and was used in situations requiring an estimate of the average annual runoff at the site. MUSLE, with event-specific runoff volume and flow-rate variables, was used to model expected runoff/erosion from specific events. Additional models were used to describe contaminant partitioning between soil and water in the receiving water body. These partitioning models, also described in the RAWPA, estimated the COC concentration in surface water runoff and in the soil carried with the runoff.

For the CRARE, the MUSLE model was used to estimate surface runoff and contaminant loading to Paddys Run and the SSOD on an event-specific basis. The modeling approach and parameters used were based on the approach and the data available in the SWCR. Parameters included surface area, slope, soil type, vegetation, flow patterns, and flow rates. The $K_d$ values presented in Table K.6-3 were used in all of the surface water modeling with one exception. The original $K_d$ of 1.8 ml/g for U-238 was used for the modeling of surface water as a source term to groundwater. This is not a significant variation, since the total peak increase of U-238 in groundwater due to surface water as a source is approximately 1 $\mu$g/l.

Because Paddys Run and the SSOD flow intermittently, event-specific concentrations were estimated in the SWCR to yield more realistic results of episodic contamination than would an average calculated over one or several years. When MUSLE was run for the SWCR using average rainfall data from the National Climate Database (NCDB 1992), the model indicated that all of the precipitation was retained by the soil with no net runoff predicted. This indicates that an average rainfall at the site yields negligible amounts of runoff. Therefore, a more extreme rainfall event was used for the SWCR and CRARE modeling to yield any runoff. A 1-year, 24-hour storm event (6.35 centimeters or 2.5 inches precipitation) was used to represent a more intense rainfall. This is comparable to the measured rainfall at the site for July 1988 of 17.5 centimeters (6.9 inches) attributed primarily to two storm events (WMCO 1989). One of these events was modeled per year to estimate average COC transport at the FEMP. Less frequent, more severe events were not modeled in the SWCR or this CRARE.




016

FIGURE K.6-6 SURFACE WATER BASINS AND RECHARGE AREAS TO GROUNDWATER

6

Section K.5.0 describes how exposure scenarios have been developed for this CRARE. Two MUSLE runs were completed for each COC to simulate the Current Land Use and both Future Land Use scenarios. The first run covered a 70-year period and assumed that all stormwater discharge to the SSOD was first captured in stormwater retention basins and then treated to remove the COCs. The only release of COCs to surface water under this scenario occurs from the smaller basins that drain directly to Paddys Run. The second MUSLE run, which addressed both Future Land Use scenarios, covered 1000 years and assumed that there was no capture and treatment of stormwater.

K.6.1.5.2 Surface Water Model Results

COC concentrations in surface water predicted to occur under the Current Land Use scenario are listed in Table K.6-5. Concentrations predicted to occur under the Future Land Use scenarios are listed in Table K.6-6, and the U-238 concentrations are shown on Figure K.6-7. The surface water modeling data and results as a source to groundwater are summarized in Table K.6-7. U-238 mass loading rates to groundwater are listed in Attachment K.V. The locations of the surface water recharge to groundwater are shown in Figure K.6-6. Concentrations are the highest for all COCs in the first year of the model, and then decline as the surface soil is depleted of contaminants.

**TABLE K.6-5**

**COC CONCENTRATIONS IN PADDYS RUN AT THE SOUTH BOUNDARY FOR CURRENT LAND USE SCENARIO**

| Time[a] (Years) | U-238 (mg/l) |
|---|---|
| 0 | $1.28 \times 10^{-5}$ |
| 10 | $1.23 \times 10^{-5}$ |
| 20 | $1.18 \times 10^{-5}$ |
| 30 | $1.14 \times 10^{-5}$ |
| 40 | $1.09 \times 10^{-5}$ |
| 50 | $1.05 \times 10^{-5}$ |
| 60 | $1.01 \times 10^{-5}$ |
| 70 | $9.67 \times 10^{-6}$ |

[a]Time starts when FEMP remediation is complete.

0167

## TABLE K.6-6

## COC CONCENTRATIONS IN PADDYS RUN AT THE SOUTH BOUNDARY FOR FUTURE LAND USE SCENARIOS

| Time[a] (Years) | U-238 (mg/l) | Sr-90 (mg/l) | Tc-99 (mg/l) | Cyanide (mg/l) | 2-Chlorophenol (mg/l) |
|---|---|---|---|---|---|
| 0 | $9.01 \times 10^{-1}$ | $1.04 \times 10^{-11}$ | $3.126 \times 10^{-10}$ | $1.760 \times 10^{-2}$ | $1.688 \times 10^{-3}$ |
| 5 | NC | NC | NC | $1.883 \times 10^{-8}$ | NC |
| 10 | $5.93 \times 10^{-3}$ | $8.13 \times 10^{-12}$ | NC | $2.016 \times 10^{-14}$ | NC |
| 20 | $4.19 \times 10^{-3}$ | $6.38 \times 10^{-12}$ | $8.838 \times 10^{-18}$ | $2.308 \times 10^{-26}$ | $1.655 \times 10^{-3}$ |
| 40 | $2.59 \times 10^{-3}$ | $3.93 \times 10^{-12}$ | $2.499 \times 10^{-25}$ | NC | $1.623 \times 10^{-3}$ |
| 60 | $2.00 \times 10^{-3}$ | $2.42 \times 10^{-12}$ | $7.065 \times 10^{-33}$ | NC | $1.591 \times 10^{-3}$ |
| 80 | $1.72 \times 10^{-3}$ | $1.49 \times 10^{-12}$ | $1997 \times 10^{-40}$ | NC | $1.560 \times 10^{-3}$ |
| 100 | $1.55 \times 10^{-3}$ | $9.18 \times 10^{-13}$ | $5.647 \times 10^{-48}$ | NC | $1.530 \times 10^{-3}$ |
| 120 | $1.42 \times 10^{-3}$ | $5.65 \times 10^{-13}$ | $1.597 \times 10^{-55}$ | NC | $1.500 \times 10^{-3}$ |
| 140 | $1.31 \times 10^{-3}$ | $3.48 \times 10^{-13}$ | $4.514 \times 10^{-63}$ | NC | $1.471 \times 10^{-3}$ |
| 160 | $1.21 \times 10^{-3}$ | $2.14 \times 10^{-13}$ | $1.276 \times 10^{-70}$ | NC | $1.443 \times 10^{-3}$ |
| 180 | $1.11 \times 10^{-3}$ | $1.32 \times 10^{-13}$ | $3.608 \times 10^{-78}$ | NC | $1.415 \times 10^{-3}$ |
| 200 | $1.03 \times 10^{-3}$ | $8.13 \times 10^{-14}$ | $1.020 \times 10^{-85}$ | NC | $1.387 \times 10^{-3}$ |
| 220 | $9.48 \times 10^{-4}$ | $5.01 \times 10^{-14}$ | NC | NC | $1.360 \times 10^{-3}$ |
| 240 | $8.75 \times 10^{-4}$ | $3.09 \times 10^{-14}$ | NC | NC | $1.334 \times 10^{-3}$ |
| 260 | $8.08 \times 10^{-4}$ | $1.90 \times 10^{-14}$ | NC | NC | $1.308 \times 10^{-3}$ |
| 280 | $7.46 \times 10^{-4}$ | $1.17 \times 10^{-14}$ | NC | NC | $1.282 \times 10^{-3}$ |
| 300 | $6.88 \times 10^{-4}$ | $7.21 \times 10^{-15}$ | NC | NC | $1.257 \times 10^{-3}$ |
| 320 | $6.35 \times 10^{-4}$ | $4.44 \times 10^{-15}$ | NC | NC | $1.233 \times 10^{-3}$ |
| 340 | $5.86 \times 10^{-4}$ | $2.73 \times 10^{-15}$ | NC | NC | $1.209 \times 10^{-3}$ |
| 360 | $5.41 \times 10^{-4}$ | $1.68 \times 10^{-15}$ | NC | NC | $1.185 \times 10^{-3}$ |
| 380 | $4.99 \times 10^{-4}$ | $1.04 \times 10^{-15}$ | NC | NC | $1.162 \times 10^{-3}$ |
| 400 | $4.61 \times 10^{-4}$ | $6.39 \times 10^{-16}$ | NC | NC | $1.140 \times 10^{-3}$ |
| 420 | $4.25 \times 10^{-4}$ | NC | NC | NC | $1.118 \times 10^{-3}$ |
| 440 | $3.93 \times 10^{-4}$ | NC | NC | NC | $1.096 \times 10^{-3}$ |
| 460 | $3.62 \times 10^{-4}$ | NC | NC | NC | $1.075 \times 10^{-3}$ |
| 480 | $3.35 \times 10^{-4}$ | NC | NC | NC | $1.054 \times 10^{-3}$ |
| 500 | $3.09 \times 10^{-4}$ | NC | NC | NC | $1.033 \times 10^{-3}$ |
| 520 | $2.85 \times 10^{-4}$ | NC | NC | NC | $1.013 \times 10^{-3}$ |
| 540 | $2.63 \times 10^{-4}$ | NC | NC | NC | $9.934 \times 10^{-4}$ |
| 560 | $2.43 \times 10^{-4}$ | NC | NC | NC | $9.741 \times 10^{-4}$ |
| 580 | $2.24 \times 10^{-4}$ | NC | NC | NC | $9.551 \times 10^{-4}$ |
| 600 | $2.07 \times 10^{-4}$ | NC | NC | NC | $9.365 \times 10^{-4}$ |
| 620 | $1.91 \times 10^{-4}$ | NC | NC | NC | $9.183 \times 10^{-4}$ |
| 640 | $1.76 \times 10^{-4}$ | NC | NC | NC | $9.005 \times 10^{-4}$ |

**TABLE K.6-6**
**(Continued)**

| Time[a] (Years) | U-238 (mg/l) | Sr-90 (mg/l) | Tc-99 (mg/l) | Cyanide (mg/l) | 2-Chlorophenol (mg/l) |
|---|---|---|---|---|---|
| 660 | $1.63 \times 10^{-4}$ | NC | NC | NC | $8.830 \times 10^{-4}$ |
| 680 | $1.50 \times 10^{-4}$ | NC | NC | NC | $8.658 \times 10^{-4}$ |
| 700 | $1.39 \times 10^{-4}$ | NC | NC | NC | $8.490 \times 10^{-4}$ |
| 720 | $1.28 \times 10^{-4}$ | NC | NC | NC | $8.324 \times 10^{-4}$ |
| 740 | $1.18 \times 10^{-4}$ | NC | NC | NC | $8.163 \times 10^{-4}$ |
| 760 | $1.09 \times 10^{-4}$ | NC | NC | NC | $8.004 \times 10^{-4}$ |
| 780 | $1.01 \times 10^{-4}$ | NC | NC | NC | $7.848 \times 10^{-4}$ |
| 800 | $9.28 \times 10^{-5}$ | NC | NC | NC | $7.696 \times 10^{-4}$ |
| 820 | $8.56 \times 10^{-5}$ | NC | NC | NC | $7.546 \times 10^{-4}$ |
| 840 | $7.90 \times 10^{-5}$ | NC | NC | NC | $7.399 \times 10^{-4}$ |
| 860 | $7.29 \times 10^{-5}$ | NC | NC | NC | $7.255 \times 10^{-4}$ |
| 880 | $6.73 \times 10^{-5}$ | NC | NC | NC | $7.114 \times 10^{-4}$ |
| 900 | $6.21 \times 10^{-5}$ | NC | NC | NC | $6.976 \times 10^{-4}$ |
| 920 | $5.74 \times 10^{-5}$ | NC | NC | NC | $6.840 \times 10^{-4}$ |
| 940 | $5.29 \times 10^{-5}$ | NC | NC | NC | $6.707 \times 10^{-4}$ |
| 960 | $4.89 \times 10^{-5}$ | NC | NC | NC | $6.577 \times 10^{-4}$ |
| 980 | $4.51 \times 10^{-5}$ | NC | NC | NC | $6.449 \times 10^{-4}$ |
| 1000 | $4.16 \times 10^{-5}$ | NC | NC | NC | $6.324 \times 10^{-4}$ |

[a]Time starts when FEMP remediation is complete.

NC = Not Calculated

**FIGURE K.6-7**
**SURFACE WATER U-238 CONCENTRATION VS. TIME AT SOUTH BOUNDARY RECEPTOR UNDER THE FUTURE LAND USE SCENARIO**

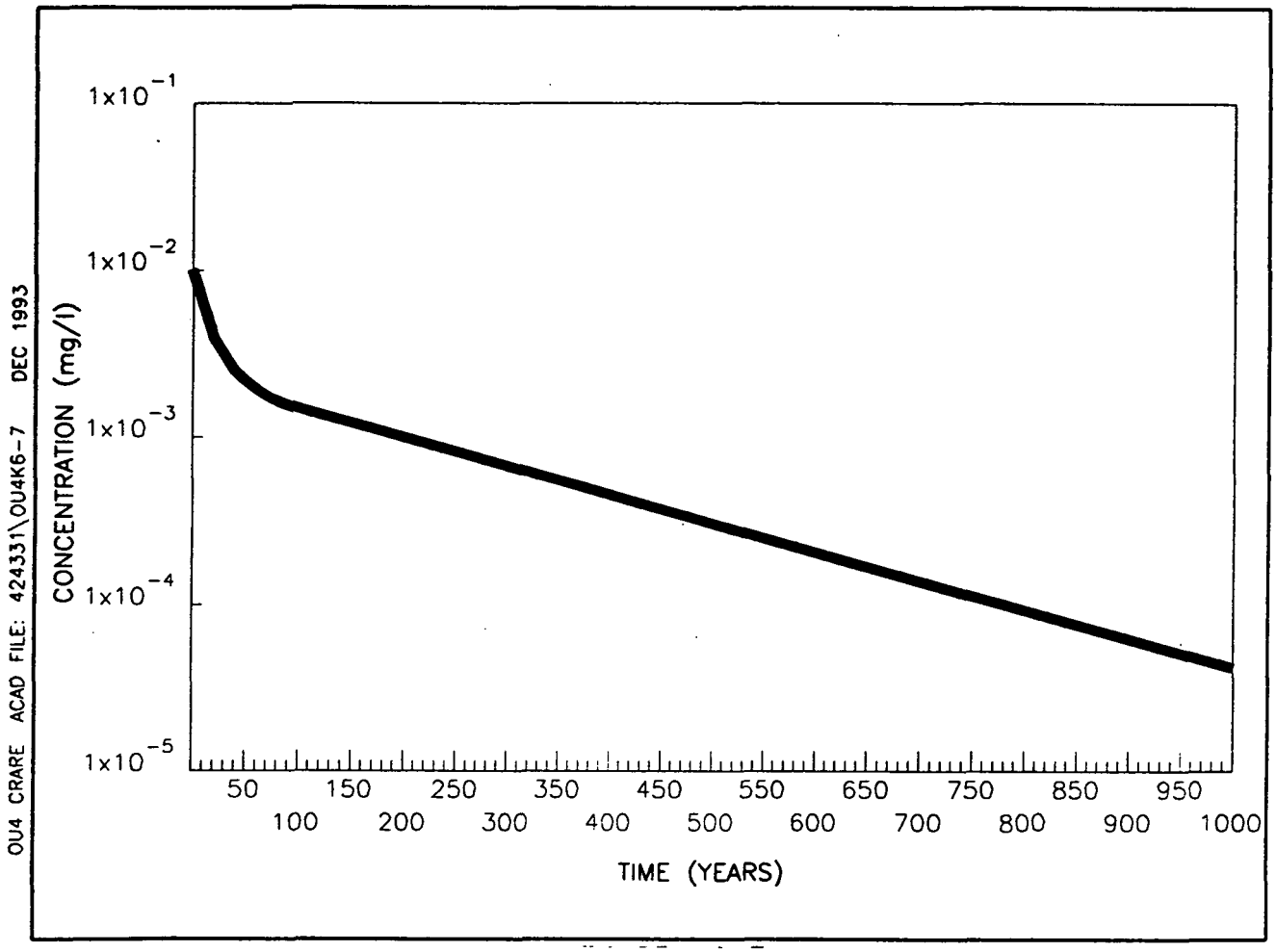



**TABLE K.6-7**
**SUMMARY OF SURFACE WATER MODELING RESULTS**

| Drainage Basin | Total Mass Transport to Groundwater (mg) | Initial Soil Concentration ($\mu$g/g) | Calculation Method |
|---|---|---|---|
| U-238 | | | |
| Paddys Run | $5.216 \times 10^{5}$ | $8.194 \times 10^{-2}$ | IT |
| SSOD | $1.078 \times 10^{8}$ | $1.693 \times 10^{1}$ | Database |
| Sr-90 | | | |
| SSOD | $3.484 \times 10^{-2}$ | $2.350 \times 10^{-9}$ | Database |
| Tc-99 | | | |
| SSOD | $5.464 \times 10^{4}$ | $1.266 \times 10^{-4}$ | Database |
| 2-Chlorophenol | | | |
| SSOD | $8.550 \times 10^{9}$ | $5.130 \times 10^{-1}$ | Database |
| Cyanide | | | |
| SSOD | $1.714 \times 10^{8}$ | $2.259 \times 10^{-1}$ | Database |

Because of its short half-life of two years, the only potentially significant source of cyanide in groundwater is surface water transport. Data on the derivation of biodegradation half-lives and decay

constants are provided in the SWCR. The cyanide being transported down through the vadose zone requires more than 30 years to reach the groundwater. However, only 0.003 percent of the cyanide would remain after 30 years, due to biodegradation. For 2-chlorophenol, approximately 90 percent of its mass was included in the surface soil database, for transport by surface water. Its much higher (than cyanide) $K_d$ of 2.7 ml/g indicates that it releases slower from the soils and will still be present at very low concentrations after 1000 years. The only potentially significant source of 2-chlorophenol in groundwater is also surface water transport. However, the surface water concentrations for these two compounds would be diluted by at least one order of magnitude in groundwater and as such would not represent a significant risk to receptors. These compounds were not, therefore, carried forward into groundwater modeling.

K.6.1.6 Aquifer Modeling

This section describes the prior development of the SWIFT III groundwater model as a standard approach for the FEMP site. The specific use of the model for this CRARE is also described, as are the modeling results.

K.6.1.6.1 Aquifer Model Development

CRARE groundwater modeling was performed with the previously-calibrated SWIFT groundwater flow model for the FEMP. This model uses the SWIFT III code, version 2.52, compiled for nearly optimized performance. All runs were conducted on a Power Box 486/50 MHz PC computer with EISA architecture, 128 megabytes of memory, and a 1 gigabyte hard drive. Run time for a 1000-year uranium run was approximately 35 hours. The SWIFT III model was previously calibrated using groundwater elevations obtained during the April 1986 monitoring period.

The site-wide groundwater modeling program was initiated to define groundwater transport in and around the FEMP. The selection, verification, calibration, and results of groundwater modeling are presented in two reports (IT 1990a and ASI/IT 1990a). SWIFT III is a finite-difference computer model of groundwater flow and solute transport. A detailed presentation of the model, its development, and the baseline input data was issued as part of the overall modeling report prepared under the RI/FS (ASI/IT 1990a). Only the most pertinent information is presented here. A comprehensive verification study of the SWIFT III code has also been completed and a report issued (IT 1990a).

The regional SWIFT model covers an area of 74.3 $km^2$ (28.7 $mi^2$), including the FEMP, the Southern Ohio Water Company (SOWC) collector wells, and a portion of the Great Miami River. The regional model's grid spacing varies between 76 and 610 meters (250 and 2000 feet), and has the closest grid spacing in the area of the SOWC collector wells. It was calibrated against field data using a steady-state flow condition, and calibration results were incorporated into the SWIFT local area model.

The local model covers a smaller area than the regional model and uses a tighter grid spacing, with grid cells 38 meters (125 feet) on a side. The smaller grid was established to include the area of the existing uranium plume, and extends from the northern part of the FEMP to approximately 460 meters (1500 feet) north of the Great Miami River (Figure K.6-2). The grid size was selected based on the need to simulate a dispersivity of 30 meters (100 feet) longitudinally, which was the preferred value, based on the solute transport calibration for uranium and also the literature review (IT 1990a). Using this dispersivity value, the grid size was selected to accommodate dispersivity values as low as 19 meters (62.5 feet), or half the distance of the local grid area of 38 meters (125 feet). Dispersivity is a constant value related to aquifer characteristics and not the solute being modeled. The relationship between the local and regional SWIFT models was established by imposing the steady-state flow field predicted by the regional model onto the local solute transport model.

$K_d$ values for the COCs are discussed in the SWCR and RAWPA. Values listed in Table K.6-3 for Layer 2 are the same as those used in SWIFT for the Great Miami Aquifer.

The regional and local models each contain five layers. The two uppermost layers represent the upper and lower parts of the upper Great Miami Aquifer that underlies the area. The middle layer represents a clay interbed present in the immediate vicinity of the FEMP, and the two lowermost layers represent the upper and lower parts of the lower Great Miami Aquifer. In regions where the clay interbed is not present, the middle layer has the same characteristics as the two upper layers. The layers extend laterally into bedrock at the edges of the buried valley that contains the aquifer. The number of aquifer cells in each layer was decreased with depth in the aquifer to simulate the narrowing bedrock valley. This was done using bedrock topography maps of the region and simulated the U-shaped buried valley that contains the Great Miami Aquifer.

The pumping wells in the area are spanned by both the regional and local models. These include (in both models) a FEMP production well and three industrial wells south of the FEMP. The FEMP

well was assumed to be shut down after the completion of remediation. Pumping from each of the industrial wells was assigned to the proper cell and layer in the model. In addition, the regional model also simulated the presence of two large-capacity collector wells owned by the SOWC and located by the Great Miami River. Although they were not directly included in the local model, they did influence its results by way of the boundary conditions brought in from the regional model.

The SWIFT groundwater flow model was previously calibrated by comparing hydraulic heads calculated by the model against heads measured in numerous monitoring wells throughout the FEMP and surrounding areas. This calibration was performed using the regional flow model. Reasonable estimates of hydraulic conductivity and recharge were initially input into the model and then varied within an acceptable range to adjust model-computed heads into agreement with observed monitoring well heads.

The model used varying hydraulic conductivity values for the five layers based on the results of the calibration. The uppermost and middle layers were assigned hydraulic conductivity values of 140 m/day (450 ft/day), and the lowermost layers 180 m/day (600 ft/day). In addition, a portion of the middle layer that underlies the FEMP was assigned $9 \times 10^{-5}$ m/day (0.0003 ft/day) to represent the clay interbed. This simulated the presence of low-permeability clay and created a semi-confining layer underneath part of the FEMP and its surrounding area.

Recharge rates set as a result of the regional model calibration were assigned to several different zones. In areas where the sand and gravel aquifer is overlain by glacial overburden, a recharge rate of 15 cm/year (6 in./year) was used. Regions where the Great Miami Aquifer is exposed at the surface use 36 cm/year (14 in./year), with Paddys Run channel being assigned a value of 81 cm/year (32 in./year) in the local model to simulate its increased infiltration. The calibrated recharge rate of 5 cm/year (2 in./year) for the area covered by the FEMP was used in the SWCR, and was also used in this CRARE. The loading rates of COCs with time to the SWIFT III model were determined by the ODAST vadose zone modeling or the MUSLE surface water modeling.

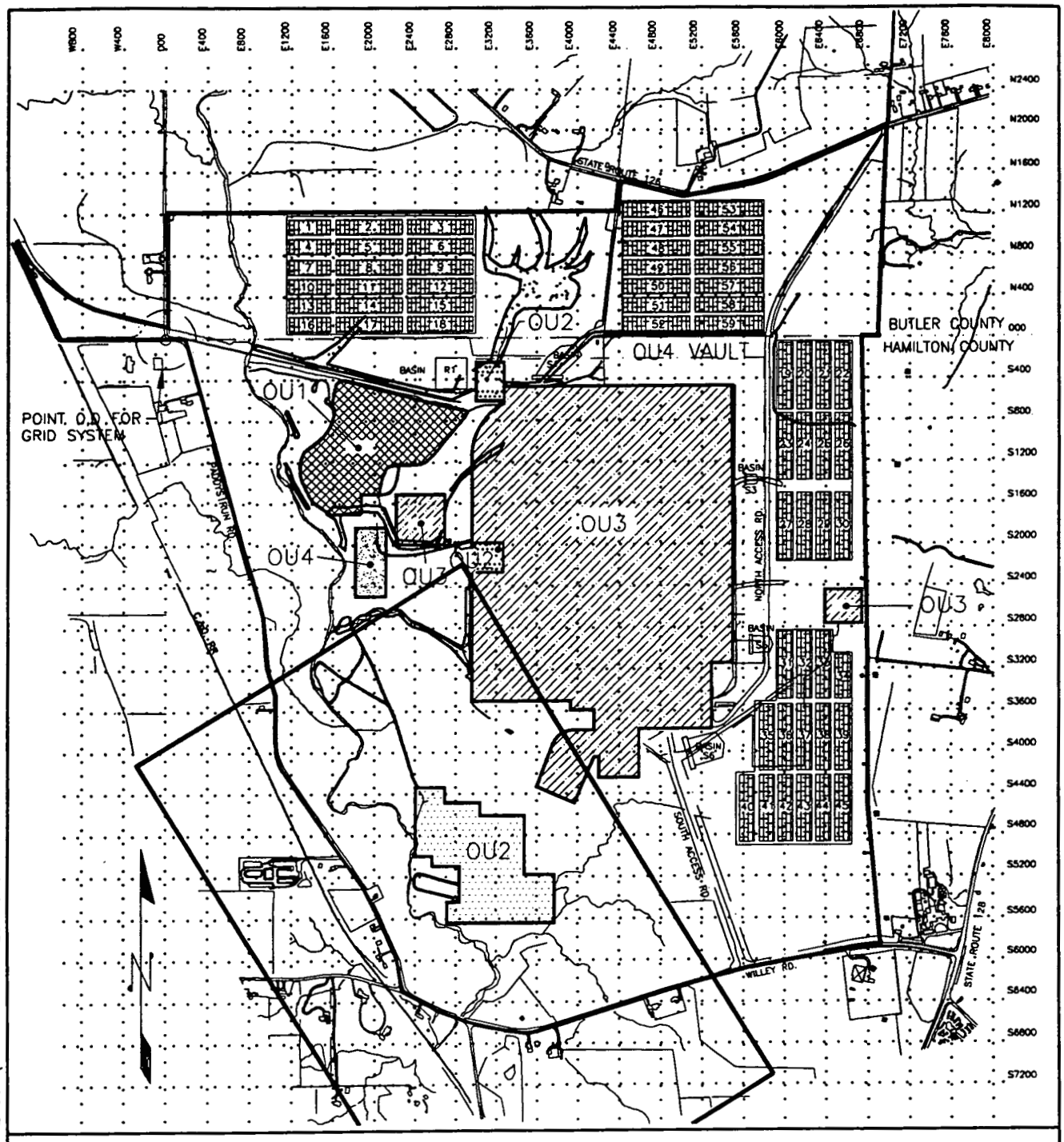
Initial background concentrations of each compound in the aquifer were set at zero, with the exception of uranium. Because it is the most widespread COC and has the highest concentrations, uranium was assumed to be the most persistent COC during remediation. The Great Miami Aquifer groundwater in an area beneath the current sources is assumed to still contain uranium at the drinking

water standard (7 pCi/l or 20.77 μg/l) at the end of FEMP remediation. This area is depicted in Figure K.6-8.

K.6.1.6.2 Aquifer Model Results

Groundwater transport modeling with the SWIFT III code was first run with U-238 as the COC. U-238 was selected because the baseline modeling in the SWCR had identified it as potentially the most widespread contaminant in groundwater that represented the greatest risk. Figures K.6-9 and K.6-10 present the projected COC concentration contours at 70 and 1000 years after the end of remediation for the Future Land Use scenarios. The initial background concentration of U-238 represents the origin of almost all of this COC represented on Figure K.6-9. After this initial background of U-238 is dispersed in the groundwater flow, the highest projected concentration of U-238 in the groundwater (9.3 ppb) occurs at 1000 years. Figure K.6-10 shows that the highest concentrations are centered on the East Plant Area soils.

Comparisons can be made between the uranium contours presented in Figures K.6-9 and K.6-10, and the similar figures for baseline conditions in the SWCR (Figures O.5-6 through O.5-10). The maximum concentrations and the maximum extent of COC are reduced in the CRARE results. This reflects the effects of remediation planned under the LRAs. Figures K.6-11, K.6-12 and K.6-13 depict the concentration contours for U-234, U-235 and U-236 at the same 1000 year peak. These figures were developed by applying the abundance ratios of these isotopes to the U-238 results, and not by separate modeling.



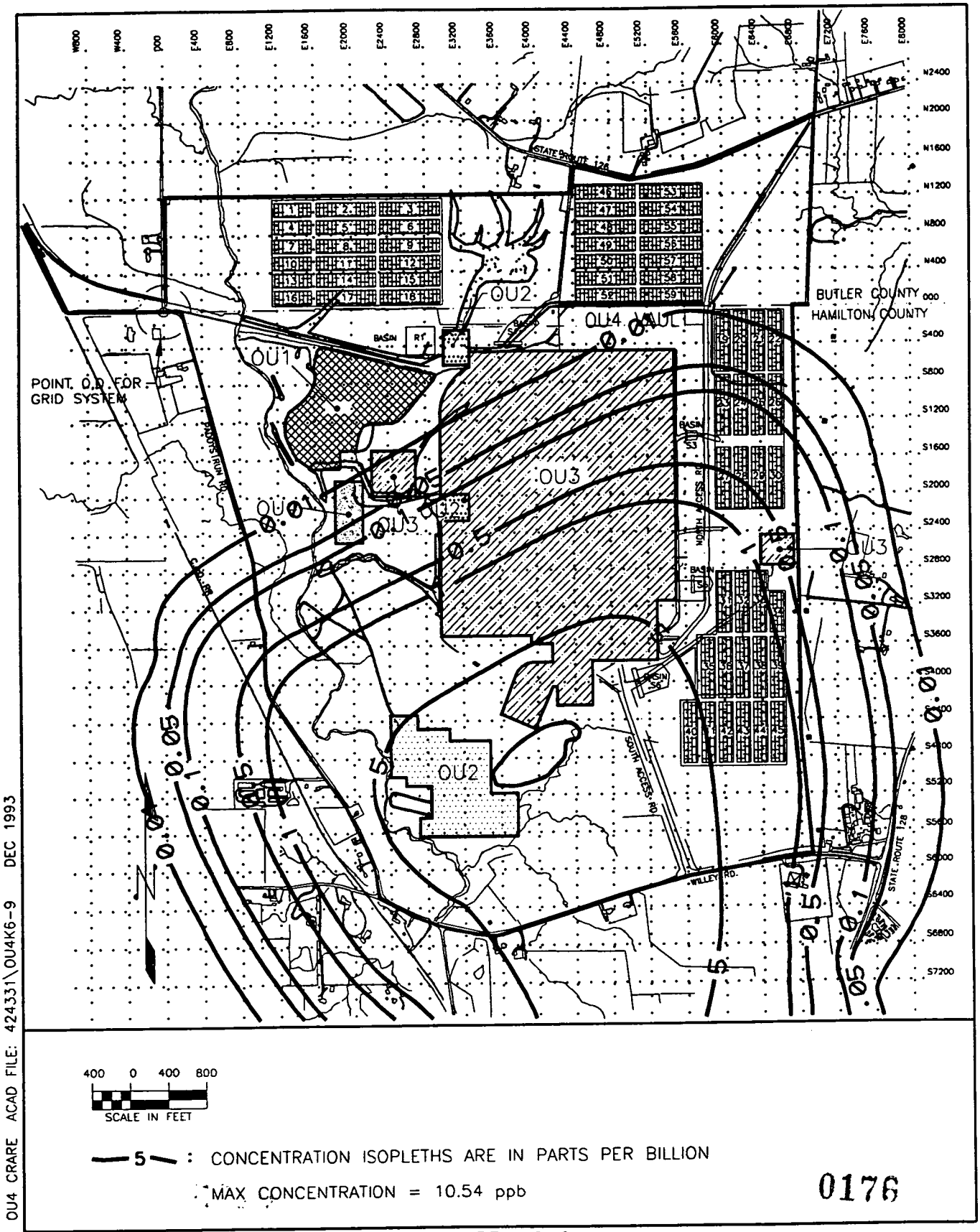

400 0 400 800
SCALE IN FEET

: CONCENTRATION ISOPLETHS ARE IN PARTS PER BILLION
INITIAL CONCENTRATION = 20.77 ppb

0175

OU4 CRARE ACAD FILE: 424331\OU4K6-8 DEC 1993

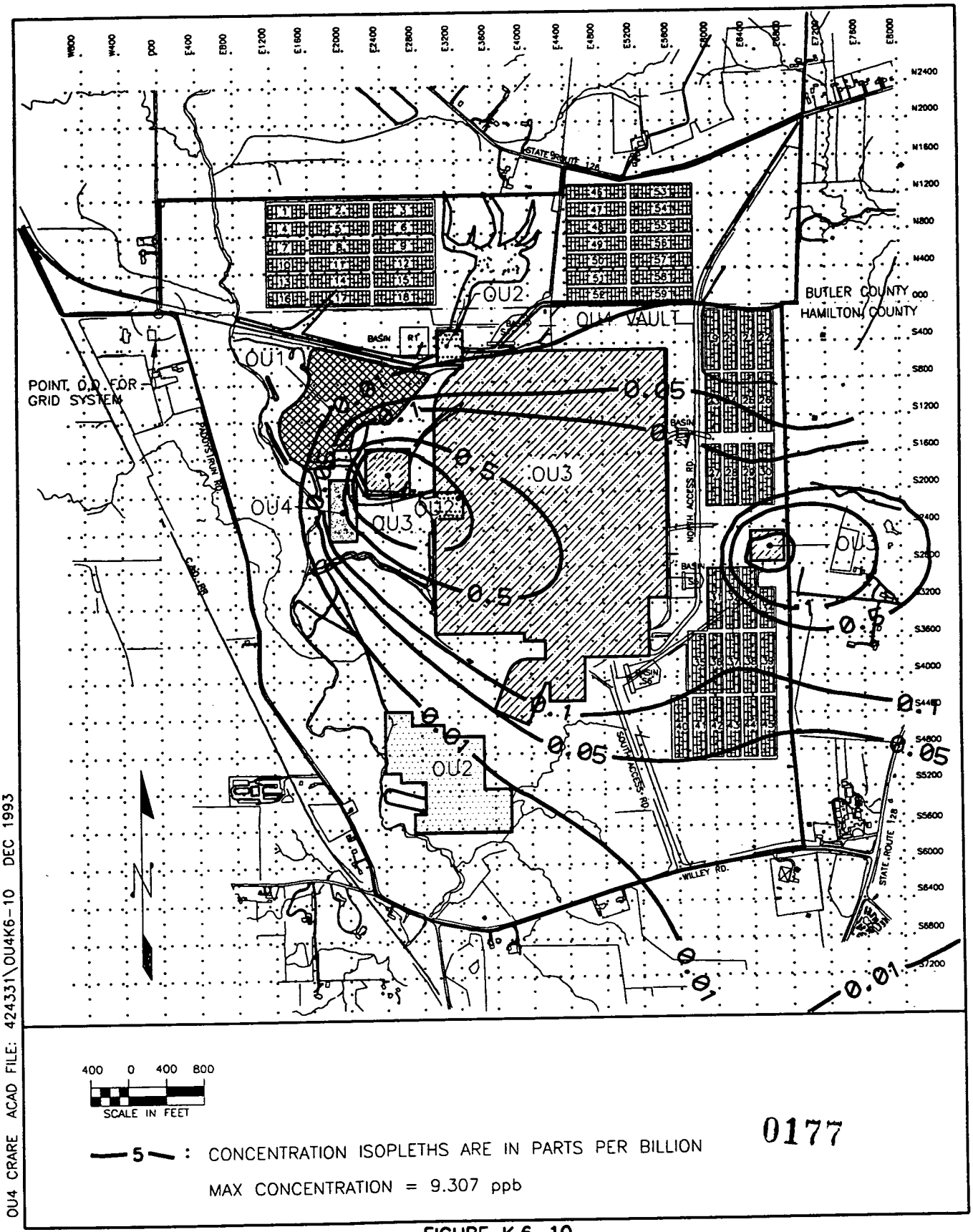
FIGURE K.6-8
INITIAL CONCENTRATIONS OF U-238 IN AQUIFER AFTER REMEDIATION




OU4 CRARE ACAD FILE: 424331\OU4K6-9 DEC 1993

0176

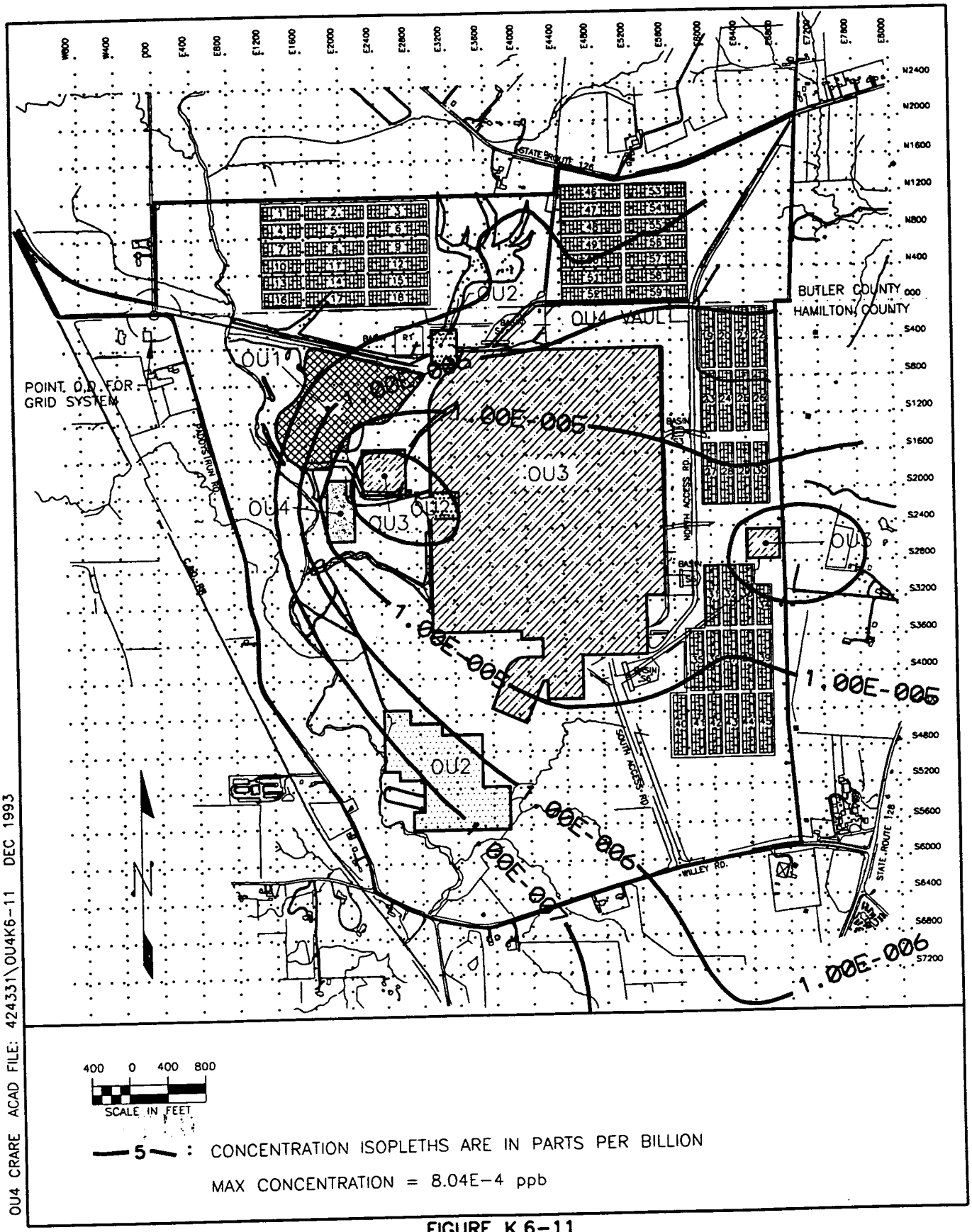
FIGURE K.6-9
U-238 GROUNDWATER CONCENTRATIONS AT 70 YEARS FOR FUTURE LAND USE SCENARIO




0177

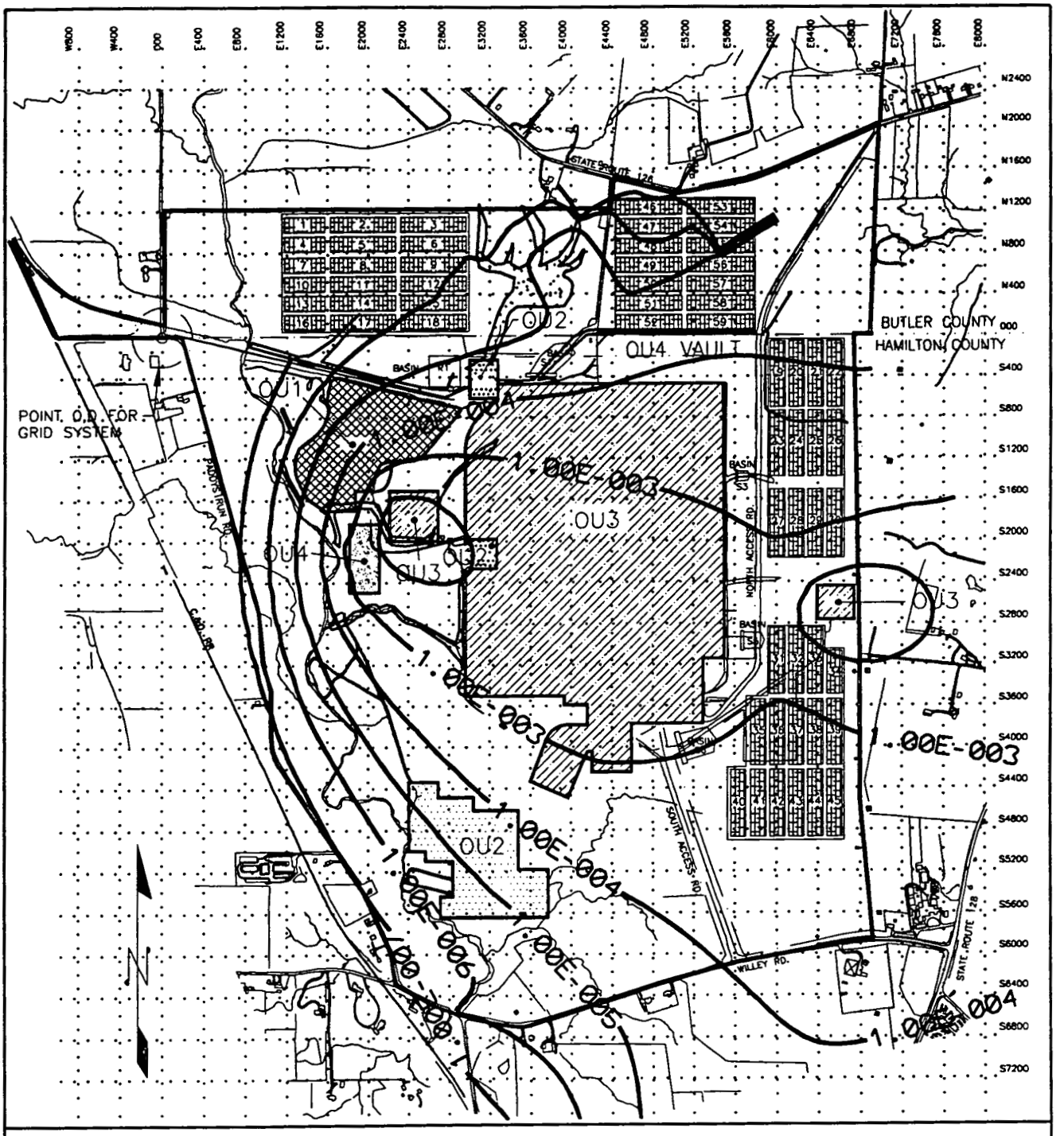
OU4 CRARE ACAD FILE: 424331\OU4K6-10 DEC 1993

FIGURE K.6-10
U-238 GROUNDWATER CONCENTRATIONS AT 1000 YEARS




OU4 CRARE ACAD FILE: 424331\OU4K6-11 DEC 1993

FIGURE K.6-11
U-234 GROUNDWATER CONCENTRATIONS AT 1000 YEARS



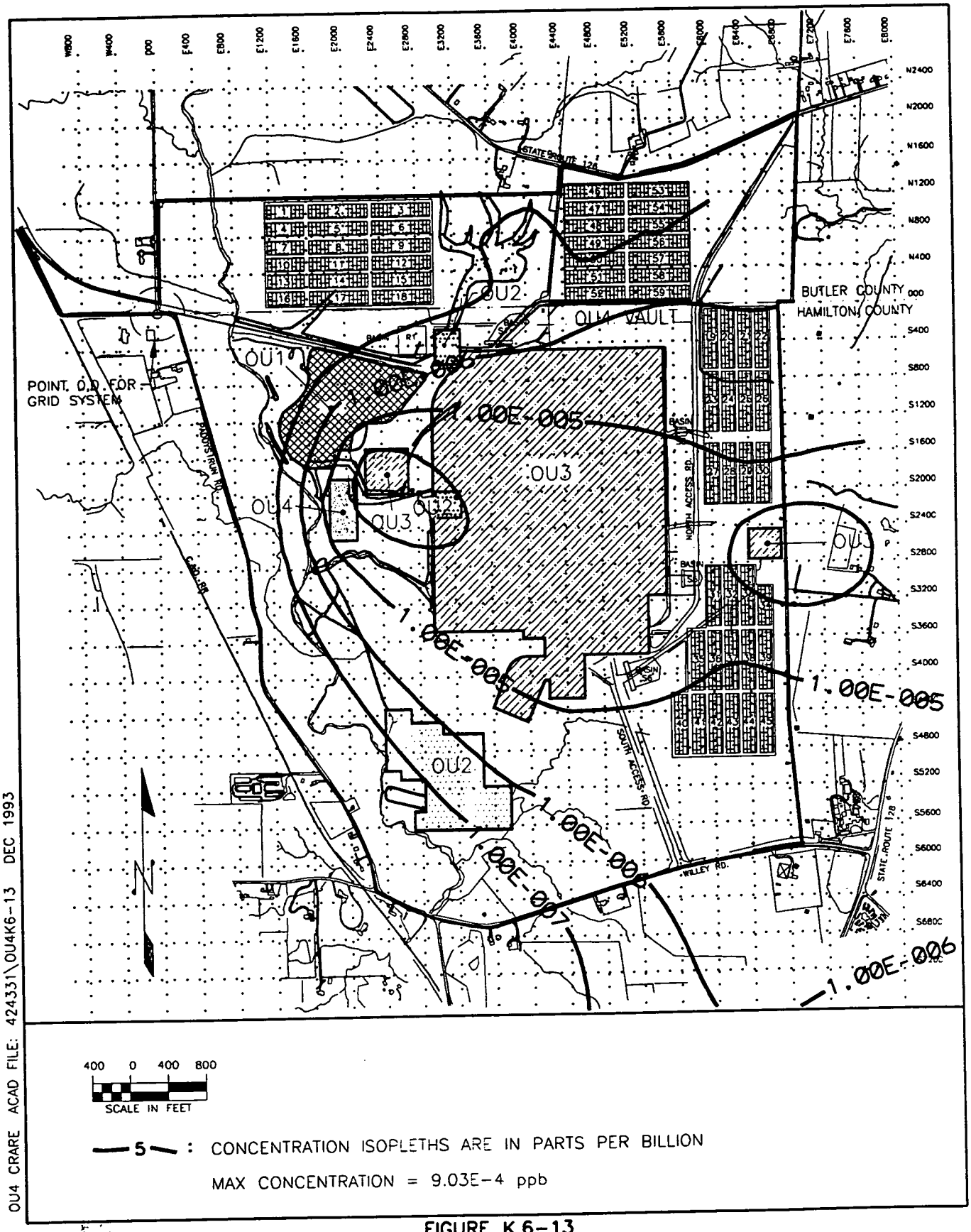

400 0 400 800
SCALE IN FEET

—5— : CONCENTRATION ISOPLETHS ARE IN PARTS PER BILLION

MAX CONCENTRATION = 6.42E-2 ppb

OU4 CRARE ACAD FILE: 424331\OU4K6-12 DEC 1993

FIGURE K.6-12
U-235 GROUNDWATER CONCENTRATIONS AT 1000 YEARS




OU4 CRARE ACAD FILE: 424331\OU4K6-13 DEC 1993

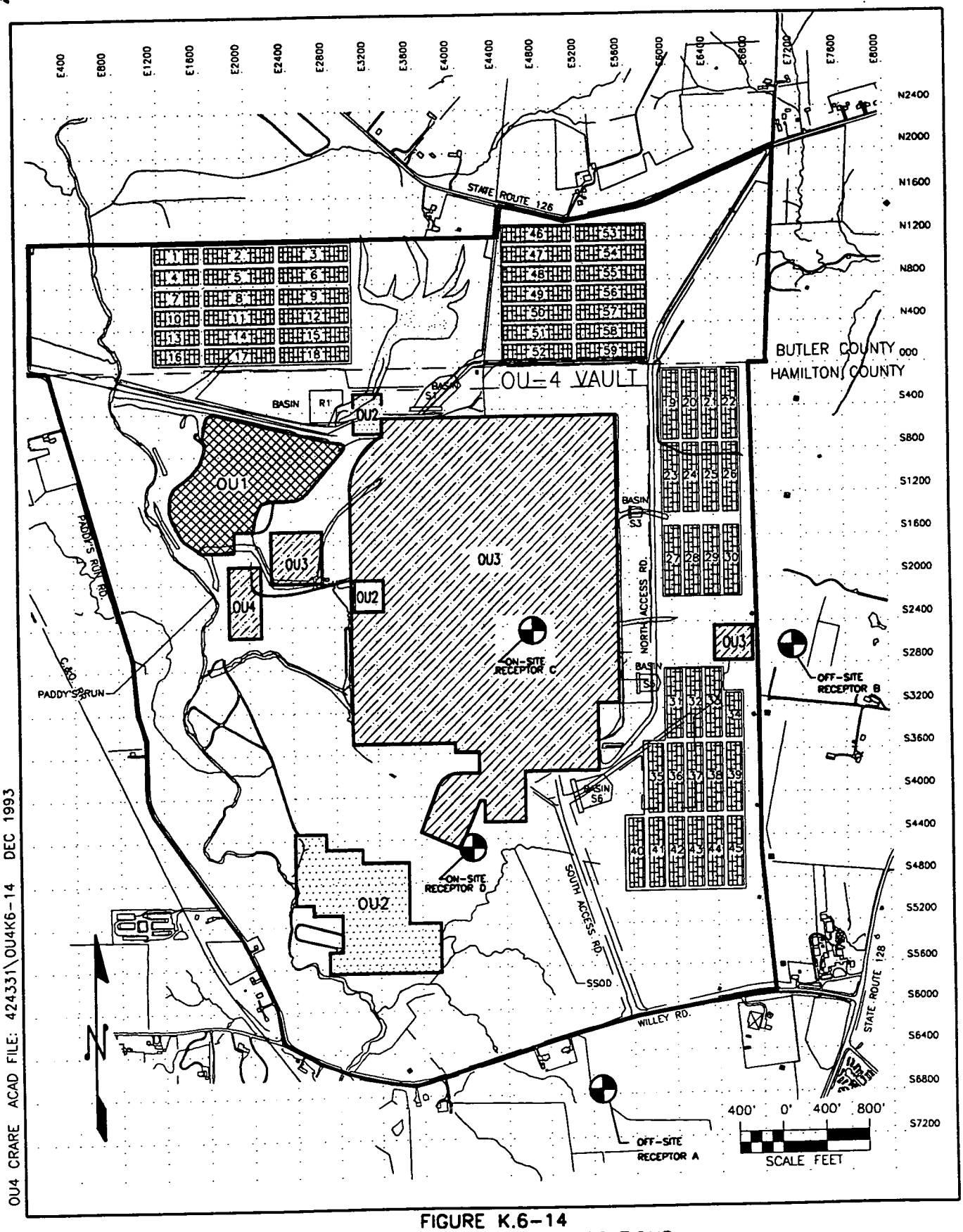
FIGURE K.6-13
U-236 GROUNDWATER CONCENTRATIONS AT 1000 YEARS

The uranium contour plots were reviewed and receptor locations were selected for both on- and off-property receptors. The process for selecting receptor locations is described further in Section K.5.1.4. The receptor locations are presented on Figure K.6-14. COC concentrations with time were then listed at each of the receptor points. Concentrations for two representative receptors, as used for the off-site (Receptor B) and on-site (Receptor C) Future Land Use scenarios, are presented in Table K.6-8 for U-238. The highest concentration at each receptor is underlined. The time of occurrence varies for each because of the movement of the contaminant plume in groundwater with time. Figures K.6-15 and K.6-16 are representative graphs of the changes in estimated groundwater U-238 concentrations with time for the two off-property receptors shown on Figure K.6-14. Section K.8.1 discusses how contaminant concentrations are carried forward into the risk assessment calculations.

Both Sr-90 and Tc-99 did not reach the groundwater in significant concentrations under the Current Land Use scenarios. For Sr-90 under the Future Land Use scenarios, the only significant source was the surface water runoff. Figures K.6-17 and K.6-18 show Sr-90 concentrations in groundwater at 20 and 70 years. The 20-year period represents the peak concentration in groundwater, with a maximum concentration of $1.98 \times 10^{-10}$ ppb. This does not represent a significant contribution to risk, so Sr-90 was not given further study in this evaluation of the groundwater pathway.

For Tc-99 the only significant source was projected to be the Operable Unit 1 wastes in the northwest vaults. Because of the low outflow rate from this structure, the groundwater Tc-99 concentrations were projected to reach a plateau after about 300 years and essentially do not change from then to 1000 years. Figure K.6-19 shows Tc-99 concentrations in groundwater under these steady-state conditions. The maximum Tc-99 concentration in the groundwater is $3.1 \times 10^{-5}$ ppb. This concentration represents a contribution to risk that is approximately 2 orders of magnitude below the risk associated with uranium in the groundwater. Therefore, Tc-99 was not given further study in the evaluation of the groundwater pathway.

The estimated contaminant concentrations in groundwater at each receptor point are evaluated further in Section K.8.0 to quantify the exposure values they represent. The risks represented by these and other exposures to the COCs are then characterized in Section K.9.0.




OU4 CRARE ACAD FILE: 424331\OU4K6-14 DEC 1993

FIGURE K.6-14
GROUNDWATER RECEPTOR LOCATIONS

## TABLE K.6-8

## U-238 GROUNDWATER CONCENTRATIONS AT RECEPTOR LOCATIONS

| Time (Years)[a] | On-Site Receptor C ($\mu$g/l)[b] | Off-Site Receptor B ($\mu$g/l)[b] |
|---|---|---|
| 0 | $0.0 \times 10^{0}$ | $0.0 \times 10^{0}$ |
| 20 | $8.3 \times 10^{-2}$ | $1.7 \times 10^{-7}$ |
| 40 | $1.3 \times 10^{0}$ | $2.2 \times 10^{-3}$ |
| 60 | $1.8 \times 10^{0}$ | $9.4 \times 10^{-2}$ |
| 80 | $1.2 \times 10^{0}$ | $4.9 \times 10^{-1}$ |
| 100 | $6.5 \times 10^{-1}$ | $9.4 \times 10^{-1}$ |
| 120 | $3.1 \times 10^{-1}$ | $1.1 \times 10^{0}$ |
| 140 | $1.4 \times 10^{-1}$ | $9.1 \times 10^{-1}$ |
| 160 | $6.1 \times 10^{-2}$ | $6.5 \times 10^{-1}$ |
| 180 | $2.7 \times 10^{-2}$ | $4.2 \times 10^{-1}$ |
| 200 | $1.2 \times 10^{-2}$ | $2.6 \times 10^{-1}$ |
| 220 | $6.1 \times 10^{-3}$ | $1.5 \times 10^{-1}$ |
| 240 | $4.3 \times 10^{-3}$ | $8.6 \times 10^{-2}$ |
| 260 | $4.6 \times 10^{-3}$ | $4.8 \times 10^{-2}$ |
| 280 | $5.9 \times 10^{-3}$ | $2.7 \times 10^{-2}$ |
| 300 | $7.4 \times 10^{-3}$ | $1.6 \times 10^{-6}$ |
| 320 | $8.4 \times 10^{-3}$ | $9.9 \times 10^{-3}$ |
| 340 | $8.8 \times 10^{-3}$ | $7.4 \times 10^{-3}$ |
| 360 | $8.8 \times 10^{-3}$ | $6.6 \times 10^{-3}$ |
| 380 | $8.4 \times 10^{-3}$ | $6.6 \times 10^{-3}$ |
| 400 | $8.0 \times 10^{-3}$ | $6.8 \times 10^{-3}$ |
| 420 | $7.6 \times 10^{-3}$ | $7.1 \times 10^{-3}$ |
| 440 | $7.4 \times 10^{-3}$ | $7.3 \times 10^{-3}$ |
| 460 | $7.4 \times 10^{-3}$ | $7.5 \times 10^{-3}$ |
| 480 | $7.5 \times 10^{-3}$ | $7.6 \times 10^{-3}$ |
| 500 | $7.9 \times 10^{-3}$ | $7.6 \times 10^{-3}$ |
| 520 | $8.3 \times 10^{-3}$ | $7.6 \times 10^{-3}$ |
| 540 | $8.9 \times 10^{-3}$ | $7.6 \times 10^{-3}$ |

| Time (Years)[a] | On-Site Receptor C ($\mu g/l$)[b] | Off-Site Receptor B ($\mu g/l$)[b] |
|---|---|---|
| 560 | $9.5 \times 10^{-3}$ | $7.7 \times 10^{-3}$ |
| 580 | $1.0 \times 10^{-2}$ | $7.7 \times 10^{-3}$ |
| 600 | $1.1 \times 10^{-2}$ | $8.1 \times 10^{-3}$ |
| 620 | $1.1 \times 10^{-2}$ | $8.9 \times 10^{-3}$ |
| 640 | $1.2 \times 10^{-2}$ | $1.1 \times 10^{-2}$ |
| 660 | $1.2 \times 10^{-2}$ | $1.5 \times 10^{-2}$ |
| 680 | $1.3 \times 10^{-2}$ | $2.4 \times 10^{-2}$ |
| 700 | $1.3 \times 10^{-2}$ | $4.1 \times 10^{-2}$ |
| 720 | $1.3 \times 10^{-2}$ | $7.1 \times 10^{-2}$ |
| 740 | $1.3 \times 10^{-2}$ | $1.2 \times 10^{-1}$ |
| 760 | $1.4 \times 10^{-2}$ | $1.9 \times 10^{-1}$ |
| 780 | $1.5 \times 10^{-2}$ | $3.0 \times 10^{-1}$ |
| 800 | $1.6 \times 10^{-2}$ | $4.6 \times 10^{-1}$ |
| 820 | $1.9 \times 10^{-2}$ | $6.6 \times 10^{-1}$ |
| 840 | $2.4 \times 10^{-2}$ | $9.2 \times 10^{-1}$ |
| 860 | $3.3 \times 10^{-2}$ | $1.2 \times 10^{0}$ |
| 880 | $4.5 \times 10^{-2}$ | $1.6 \times 10^{0}$ |
| 900 | $6.3 \times 10^{-2}$ | $2.0 \times 10^{0}$ |
| 920 | $8.8 \times 10^{-2}$ | $2.5 \times 10^{0}$ |
| 940 | $1.2 \times 10^{-1}$ | $2.9 \times 10^{0}$ |
| 960 | $1.7 \times 10^{-1}$ | $3.4 \times 10^{0}$ |
| 980 | $2.2 \times 10^{-1}$ | $3.9 \times 10^{0}$ |
| 1000 | $2.9 \times 10^{-1}$ | $4.3 \times 10^{0}$ |

[a]Time starts when FEMP remediation is complete.
[b]All concentration values have been rounded to two digits.
[c]Peak values.
[d]Receptor locations are shown on Figure K.6-14.

0184

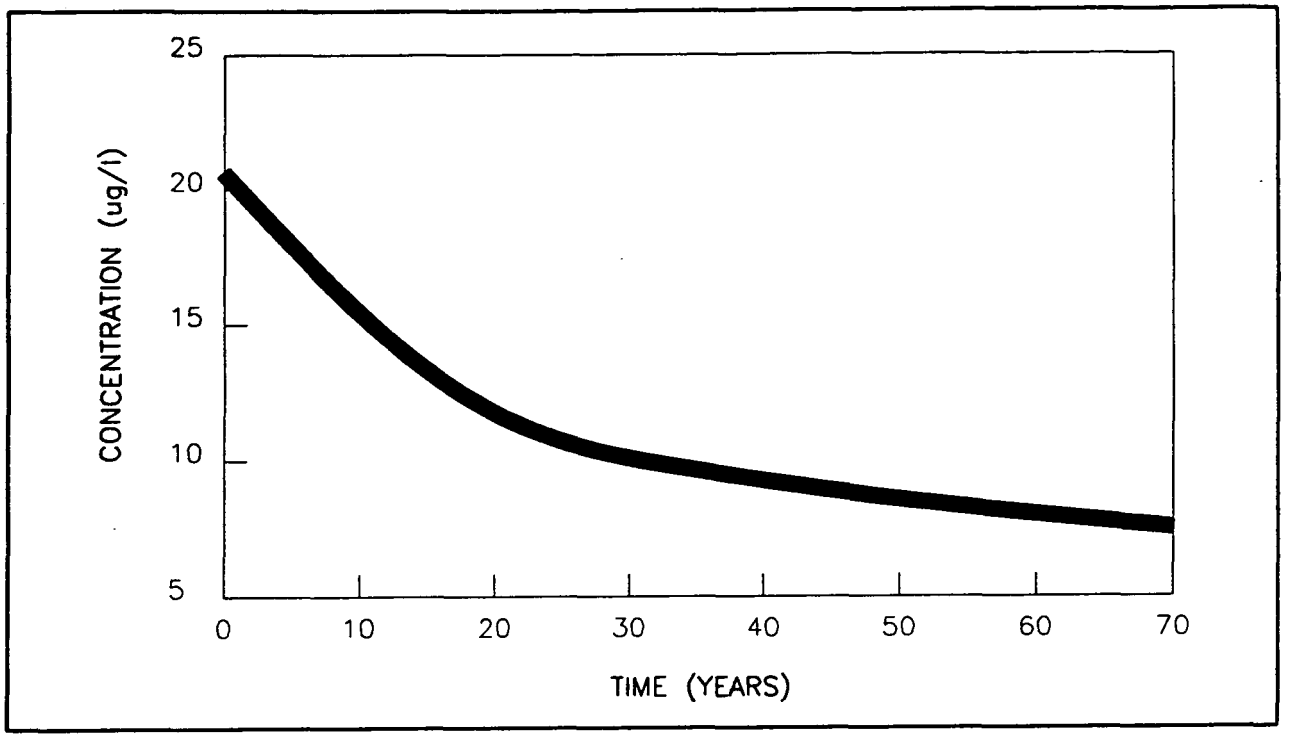



**FIGURE K.6-15**
**GROUNDWATER U-238 CONCENTRATION VS. TIME FOR OFF-PROPERTY RECEPTOR A UNDER THE CURRENT LAND USE SCENARIO**

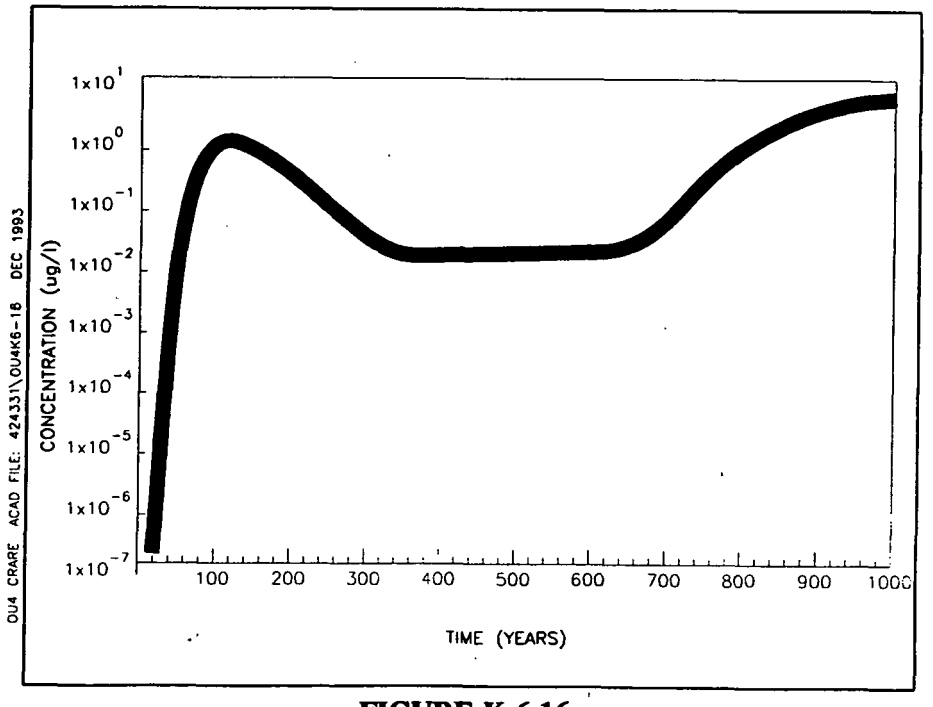
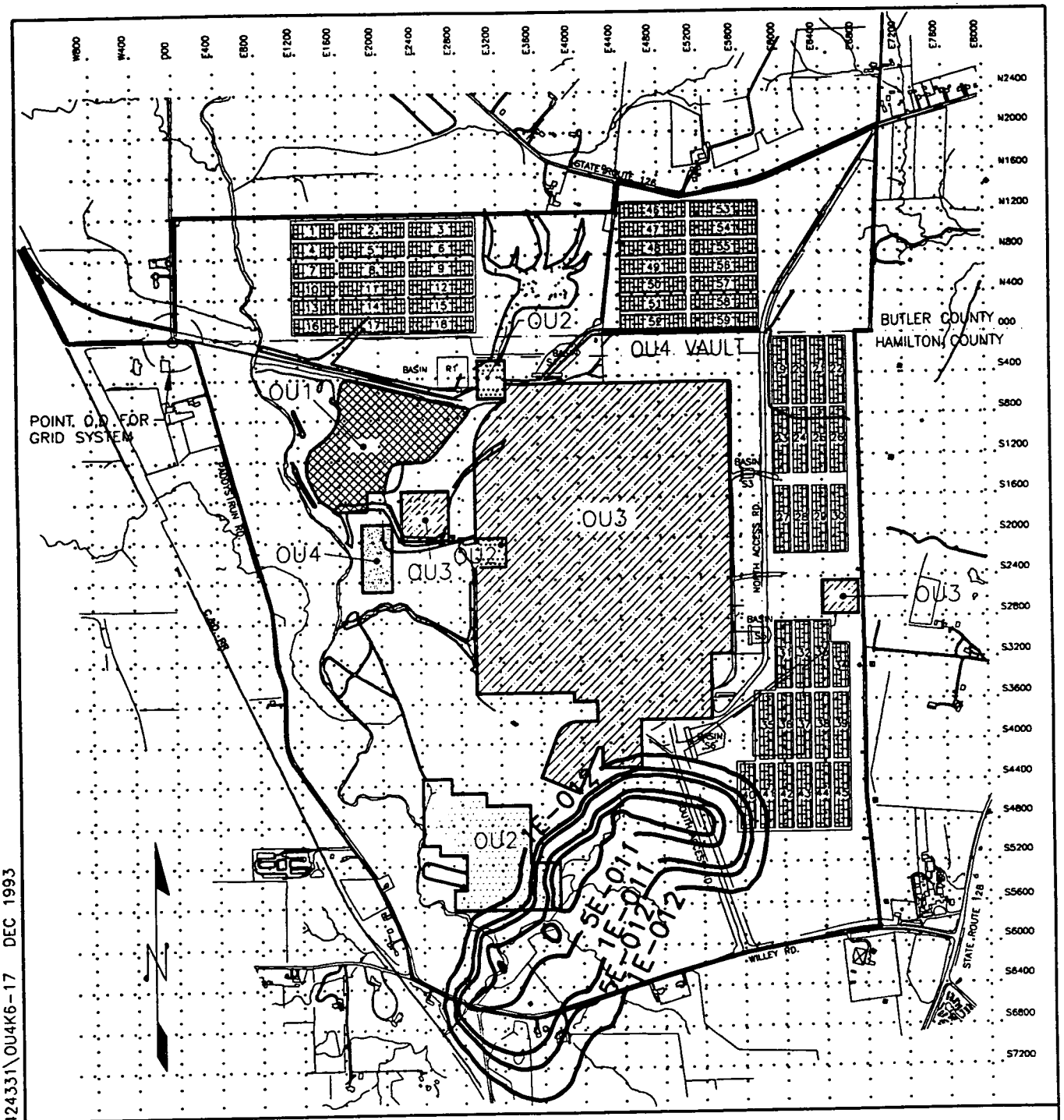



**FIGURE K.6-16**
**GROUNDWATER U-238 CONCENTRATIONS VS. TIME FOR OFF-PROPERTY RECEPTOR B UNDER THE FUTURE LAND USE SCENARIO**

0185



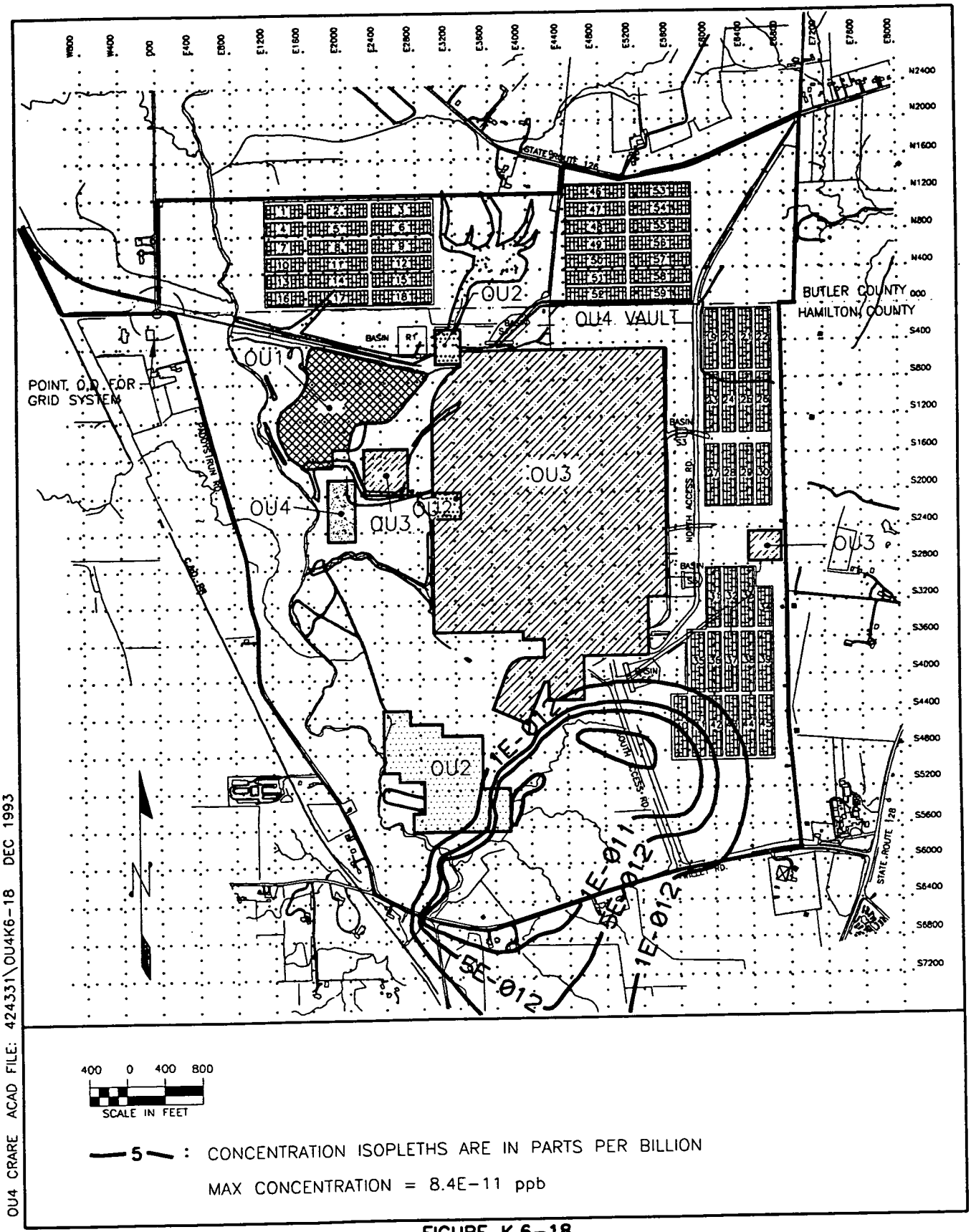

400 0 400 800
SCALE IN FEET

—5— : CONCENTRATION ISOPLETHS ARE IN PARTS PER BILLION

MAX CONCENTRATION = 8.4E-11 ppb

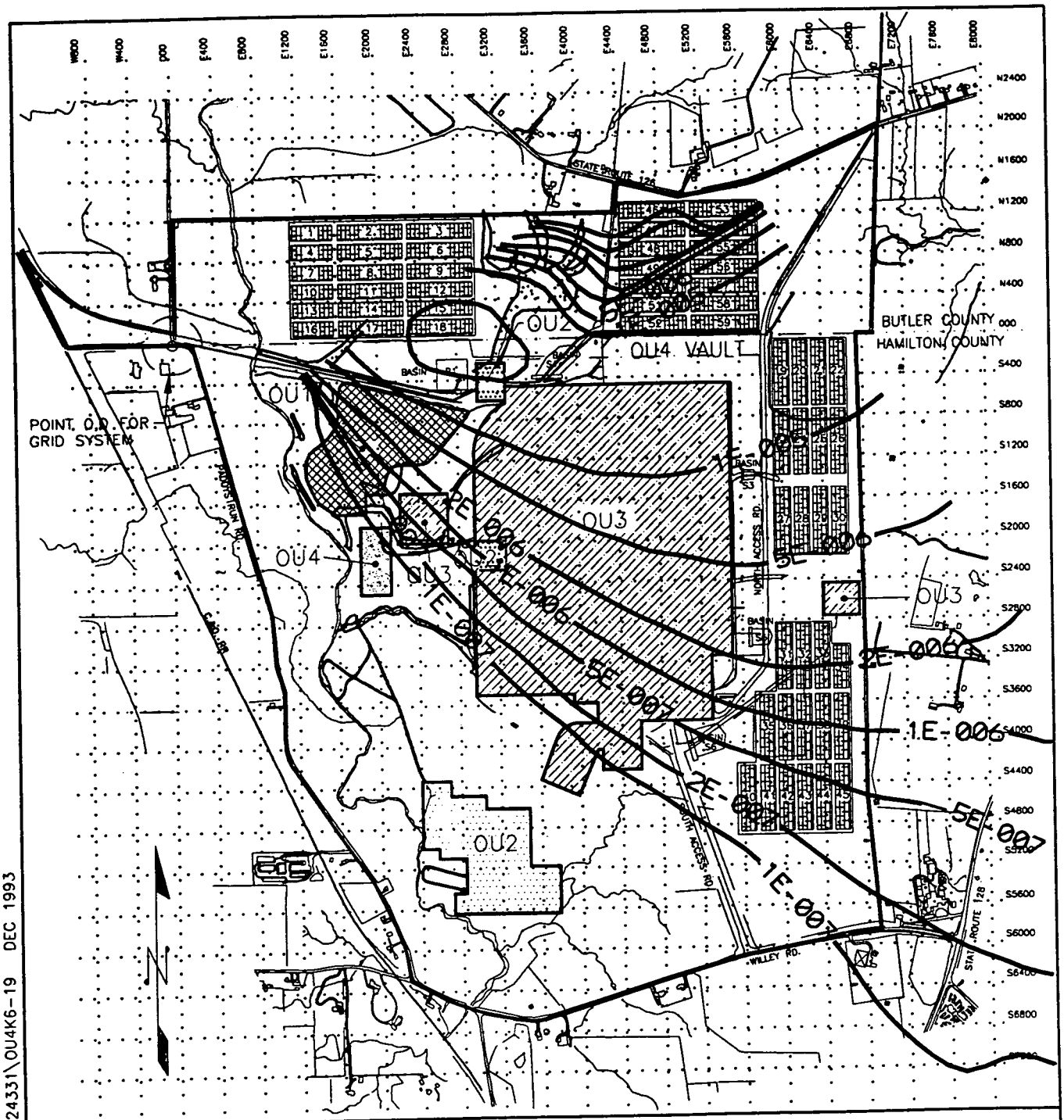
OU4 CRARE ACAD FILE: 424331\OU4K6-17 DEC 1993

FIGURE K.6-17
SR-90 GROUNDWATER CONCENTRATIONS AT 20 YEARS FOR FUTURE LAND USE SCENARIO




OU4 CRARE ACAD FILE: 424331\OU4K6-18 DEC 1993

FIGURE K.6-18
SR-90 GROUNDWATER CONCENTRATIONS AT 70 YEARS FOR FUTURE LAND USE SCENARIO




—5— : CONCENTRATION ISOPLETHS ARE IN PARTS PER BILLION

MAX CONCENTRATION = 3.1E-05 ppb

OU4 CRARE ACAD FILE: 424331\OU4K6-19 DEC 1993

FIGURE K.6-19
TC-99 GROUNDWATER CONCENTRATION AT STEADY STATE

- 5208

{This page intentionally left blank}

0189

## K.6.2 AIR TRANSPORT MODELING

This section presents the approach, methodology, and results of the CRARE air transport analysis. The objective of this analysis was to determine the maximum on- and off-property annual average ground-level air concentrations of contaminants released to the atmosphere from the remediated FEMP. These concentrations were used for the residual risk assessment described in this CRARE.

The analysis was conducted in accordance with EPA guidance (EPA 1989a). Two emission models and an air dispersion model were used to estimate air emissions from each source and to calculate annual average concentrations at several preselected receptor locations. One emission model predicted the quantity of exposed soil that would be resuspended by the wind, and the other emission model estimated the flux of Rn-222 gas from soil and waste containing Ra-226. Particulate-phase contaminants examined include radionuclides, inorganic compounds, and nonvolatile organic compounds. The only gas-phase contaminant evaluated in this analysis was Rn-222. VOCs were not analyzed as they would be lost to the atmosphere prior to the start of the postremediation periods analyzed in the CRARE. The air dispersion model accounted for dispersion and dilution of the contaminants under defined meteorological conditions, such as wind speed and direction, atmospheric stability, and mixing height. The meteorological parameters used were collected from an on-property meteorological station.

Five major steps were required to achieve the objective of this analysis:

1. Scenarios for the air transport analysis were defined.
2. Sources of air emissions and contaminants released were identified based on site-specific information.
3. The appropriate EPA regulatory air dispersion model was selected which best represented the site characteristics and the objective of the analysis.
4. Particulate or gaseous air emissions were estimated from site-specific soil contaminant concentrations, and additional inputs to the model such as meteorological data and receptor locations were determined.
5. Results of the air dispersion model were processed to determine the maximum on- and off-property annual average concentration for residual risk.

Figure K.6-20 presents the sequential block diagram of these steps and indicates the sections below that describe them.

Throughout the analysis, site-specific data were used where available. When such data were not available, conservative assumptions were made. Regulatory default options and values were used where applicable in the air emission and dispersion models. The intent of the assumptions was to make the results relevant to the site so that the risk associated with the air exposure pathway was realistic.

K.6.2.1 Scenarios for Air Transport Analysis

The residual risk from the remediated FEMP were evaluated for three general scenarios: the Current Land Use, the Future Land Use With Federal Ownership and the Future Land Without Federal Ownership. The two future scenarios do not include continued maintenance of the on-property disposal facilities or capped areas with the only distinction being the location of the receptors. Therefore, the air emissions for the future scenarios are assumed to be identical, leaving only two emissions cases to be analyzed: current and future.

The current emission case assumed that the RCRA-type caps over Operable Units 1 and 2 and the caps over the vaults will remain intact without the loss of cap thickness or cover soil depth. In addition, the cover soil over Operable Unit 4 was assumed to remain intact during the current scenario. The materials and soil imported for cap layers and cover soil were assumed to be uncontaminated and therefore will not contribute to airborne contaminant emissions. Only Rn-222 would be emitted from the capped or covered areas. This emission case assumed that treated soil from Operable Unit 5 will be placed back in the excavated areas of Operable Unit 5 without a cap or cover, resulting in Rn-222 and suspended particulate emissions from this operable unit. For this analysis, it was assumed that Operable Unit 5 consists of soil beneath Operable Unit 3 facilities and structures as well as soil in areas not associated with Operable Units 1, 2, or 4.

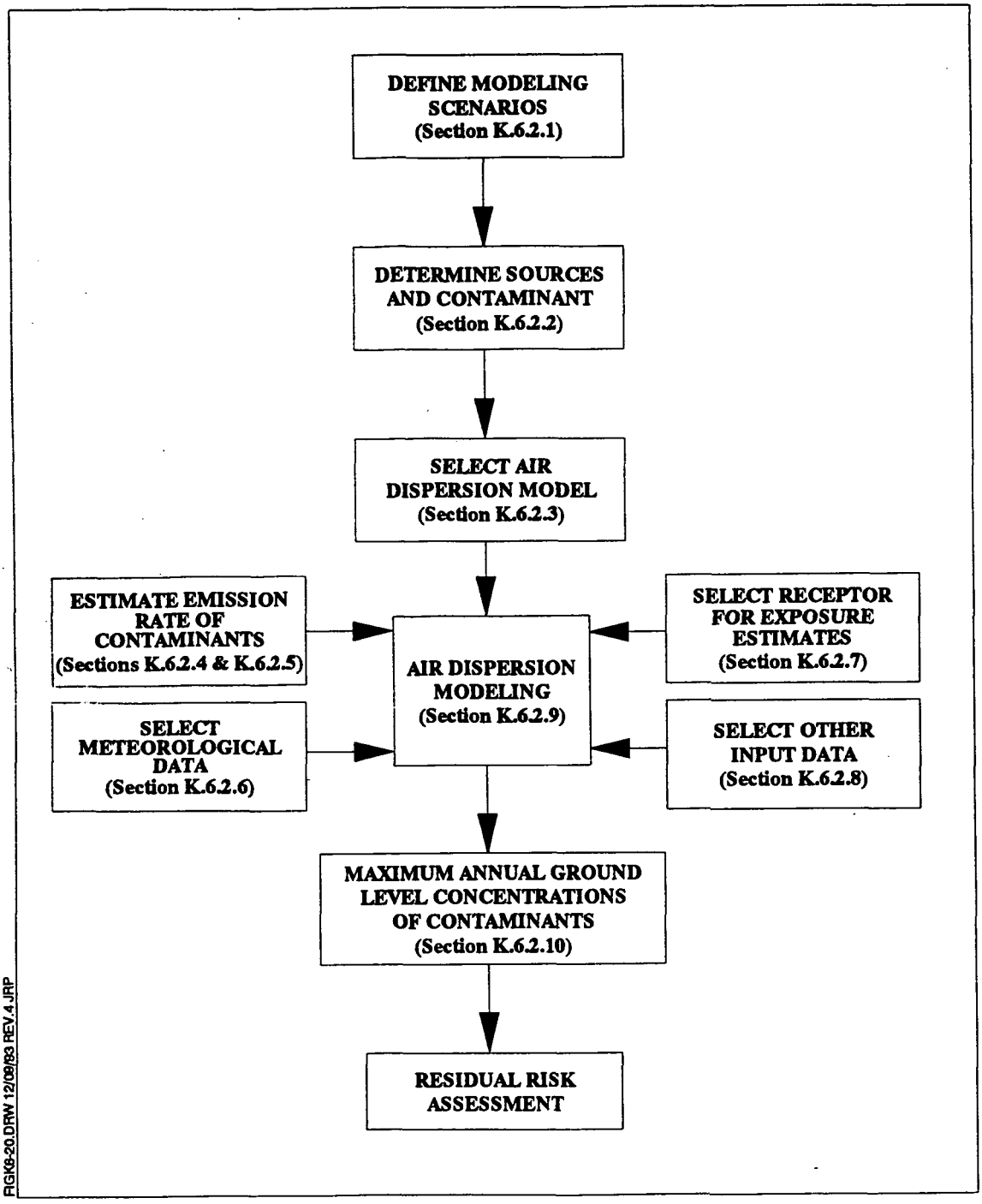



FIGURE K.6-20. SEQUENTIAL BLOCK DIAGRAM OF AIR TRANSPORT ANALYSIS

The future emission case is similar to the current case, except that the future case assumed the loss of the cover soil and first drainage layer from the vault and Operable Unit 1 and 2 caps, as well as a total loss of the Operable Unit 4 cover soil. These changes result in higher Rn-222 emissions from the vaults and Operable Units 1, 2, and 4. In addition, suspended particulate emissions were included for the exposed, contaminated soil in Operable Unit 4.

K.6.2.2 Sources and Contaminants

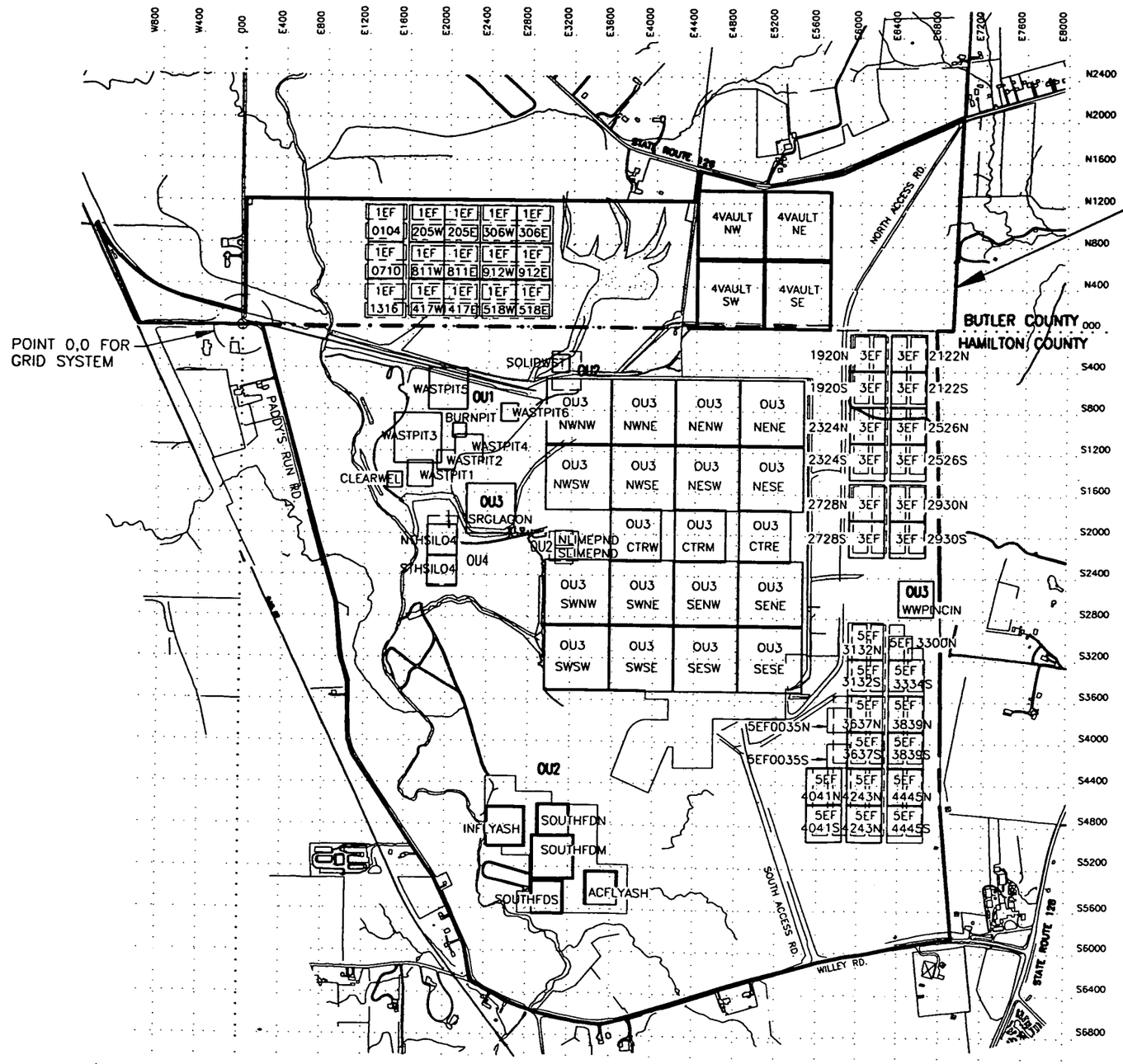
All sources considered for this study were analyzed as ground-level area sources. The particulate emission sources included the exposed soils in Operable Units 4 and 5. To analyze particulate emission impacts, 196 area sources were evaluated. The radon emission sources include the soil and unexcavated wastes in Operable Units 1, 2, 3, and 4, as well as wastes placed in the vaults. To analyze radon emission impacts, 243 area sources were developed. Figure K.6-21 shows the source locations and sizes used in the air dispersion model for areas associated with Operable Units 1 through 4 and the vaults. Not shown on the figure are the 157 area sources used to model the surface soils that are part of Operable Unit 5. Those area sources are each 121.9 x 121.9 meter (400 x 400 feet) squares and cover the remainder of the site. Also note that soil beneath Operable Unit 3 is considered part of Operable Unit 5.

K.6.2.3 Air Transport Models

The annual average contaminant concentrations were determined using ISCLT2. This model is recommended by EPA for air pathway analysis of Superfund sites (EPA 1989a).

The ISCLT2 model was designed by the EPA to assess the air quality impact of emissions from a wide variety of sources. It incorporates a steady-state gaussian plume equation that is applicable in flat or gently rolling terrain, for multiple point, area, and volume sources. The ISCLT2 model calculates the annual average concentration due to airborne emissions at user-selected receptors, based on sector-averaged statistical wind summaries. Data required for input to the model include source emission rates, the locations and configurations of sources, statistical summaries of wind speed, wind direction, and atmospheric stability, and the locations of the selected receptors.

- 5208




NOTES:

OU1 RESIDUAL SOIL SOURCE GROUP INCLUDES: WASTPIT1–WASTPIT6 (WASTE PITS 1–6), CLEARWEL (CLEARWELL), AND BURNPIT SOURCE AREAS.

OU2 SOLID WASTE LANDFILL SOURCE GROUP IS: SOLIDWST.

OU2 LIME SLUDGE POND SOURCE GROUP INCLUDES: NLIMEPND (NORTH LIME SLUDGE POND) AND SLIMEPND (SOUTH LIME SLUDGE POND) SOURCE AREAS.

OU2 INACTIVE FLYASH PILE SOURCE GROUP IS: INFLYASH.

OU2 ACTIVE FLYASH PILE SOURCE GROUP IS: ACFLYASH.

OU2 SOUTH FIELD SOURCE GROUPS ARE:
- SOUTHFDN (SOUTH FIELD, NORTH END)
- SOUTHFDM (SOUTH FIELD, MIDDLE)
- SOUTHFDS (SOUTH FIELD, SOUTH END).

OU4 RESIDUAL SOIL SOURCE GROUP INCLUDES: NTHSILO4 (SOILS AROUND SILOS 3 AND 4) AND STHSILO4 (SOILS AROUND SILOS 1 AND 2) SOURCE AREAS.

OU5 TREATED SOIL SOURCE GROUP INCLUDES: OU3CTRE & OU3CTRW (PLANTS 2/3, 6, AND 9)

OU5 RESIDUAL SOIL SOURCE GROUP INCLUDES: OU3NENE–OU3SWSW, OU3CTRM (FORMER PRODUCTION AREA), SRGLAGON (SURGE LAGOON), AND WWPINCIN (WASTEWATER TREATMENT PLANT) SOURCE AREAS.

OU5 SURFACE SOIL SOURCE GROUP INCLUDES: UNDST001–UNDST157 (SURFACE SOIL NOT ASSOCIATED WITH OU1–4) SOURCE AREAS (NOT SHOWN).

SOURCE GROUP FOR OU1 WASTE DISPOSED ON–PROPERTY INCLUDES: 1EF0104–1EF1518W (VAULTS CONTAINING OU1 WASTES) SOURCE AREAS.

SOURCE GROUP FOR OU3 WASTE DISPOSED ON–PROPERTY INCLUDES: 3EF1920N–3EF2930S (VAULTS CONTAINING OU3 WASTES) SOURCE AREAS.

SOURCE GROUP FOR OU4 WASTE DISPOSED ON–PROPERTY INCLUDES: 4VAULTNE–4VAULTSW (VAULTS CONTAINING OU4 WASTES) SOURCE AREAS.

SOURCE GROUP FOR OU5 WASTE DISPOSED ON–PROPERTY INCLUDES: 5EF3132N–5EF4445S (VAULTS CONTAINING OU5 WASTES) SOURCE AREAS.

SITE PLAN
CRARE BASE MAP

400' 0' 400' 800'
SCALE FEET

0194

OU4 CRARE ACAD FILE: 424331\OU4K6-21 DEC 1993

FIGURE K.6–21 SOURCE LOCATIONS FOR AIR DISPERSION MODEL

K.6.2.4 Particulate Contaminant Emission Rates

Radionuclide, inorganic, and nonvolatile organic contaminants were assumed to be present in the suspended particulate matter emitted from the site. The emission rate for each contaminant in this particulate matter was calculated from the concentration of the contaminant in the exposed soil and from the estimated site-wide average emission rate of particulate matter less than 10 micrometers in diameter ($PM_{10}$).

K.6.2.4.1 Contaminated Soil Concentrations

The radionuclide contaminant concentrations used for the current and future scenarios are presented in Tables K.6-9 and K.6-10, respectively. The chemical contaminant concentrations used for the current and future scenarios are presented in Tables K.6-11 and K.6-12, respectively. Contaminant soil concentrations were selected from data in the RI/FS database and data presented in the following documents:

- *Site-Wide Characterization Report*, Final, March 1993
- *Remedial Investigation Report for Operable Unit 4*, Final, November, 1993
- *Feasibility Study Report for Operable Unit 4*, Appendix A

The data presented in the SWCR was used to supplement the data presented in the Operable Unit 4 RI and FS, and the RI/FS database. Because this analysis assumed that the site has been remediated, any soil concentrations exceeding the PRG levels identified in the SWCR were reset to the PRG level. This procedure directly affected the soil concentrations of Cs-137, Pb-210, radium, thorium, and uranium isotopes used in the analysis.

The soil beneath Operable Unit 3 (the former production area) was divided into two source groups for the air transport analysis. The areas beneath Plants 2/3, 6, and 9 were assumed to have been excavated to a depth greater than or equal to 3 meters (10 feet) and backfilled with treated soil. These areas represent one of the Operable Unit 5 production area soil source groups. The remaining portion of the production area soil represented the second source group.

Risk-based PRGs for the expanded trespasser were used to set the concentrations of Cs-137, Pb-210, and U-238 in soil beneath the Operable Unit 3 excavated areas to 1, 70, and 60 pCi/g, respectively. The 5 pCi/g limits in the SWCR (Part III, pages 2-21 and 2-22) for Ra-226, Ra-228,

## TABLE K.6-9

## ESTIMATED RADIONUCLIDE CONCENTRATIONS (pCi/g) IN SURFACE SOIL/COVER SOIL: CURRENT SCENARIO

| Radionuclide | OU4: Top Soil[a] | OU5 Residual: Soil in Areas Beneath Plants 2/3, 6, and 9 | OU5 Residual: Rest of Former Production Area Surface Soil | OU5 Residual: Remainder of the FEMP Surface Soil | Clean Top Soil[a] (on RCRA-Type Caps and over disposal vaults) |
|---|---|---|---|---|---|
| Am-241 | 0.00 | NC | NC | NC | 0.00 |
| Cs-137 | 0.00 | $1.00 \times 10^{0}$ [b] | $1.00 \times 10^{0}$ [b] | $6.16 \times 10^{-1}$ [g] | 0.00 |
| Np-237 | 0.00 | $6.96 \times 10^{-1}$ [c] | $6.96 \times 10^{-1}$ [c] | NC | 0.00 |
| Pa-231 | 0.00 | $2.43 \times 10^{0}$ [c] | $2.43 \times 10^{0}$ [c] | NC | 0.00 |
| Pb-210 | 0.00 | $7.00 \times 10^{1}$ [b] | $7.00 \times 10^{1}$ [b] | NC | 0.00 |
| Pu-238 | 0.00 | $2.95 \times 10^{0}$ [c] | $2.95 \times 10^{0}$ [c] | $3.33 \times 10^{-1}$ [g] | 0.00 |
| Pu-239 | 0.00 | $1.12 \times 10^{0}$ [c] | $1.12 \times 10^{0}$ [c] | $3.42 \times 10^{-1}$ [g] | 0.00 |
| Pu-240 | 0.00 | $1.12 \times 10^{0}$ [c] | $1.12 \times 10^{0}$ [c] | $3.42 \times 10^{-1}$ [g] | 0.00 |
| Ra-226 | 0.00 | $5.00 \times 10^{0}$ [d] | $1.09 \times 10^{0}$ [i] | $1.14 \times 10^{0}$ [i] | 0.00 |
| Ra-228 | 0.00 | $5.00 \times 10^{0}$ [d] | $1.39 \times 10^{0}$ [i] | $1.21 \times 10^{0}$ [i] | 0.00 |
| Ru-106 | 0.00 | NC | NC | NC | 0.00 |
| Sr-90 | 0.00 | $5.17 \times 10^{0}$ [c] | $5.17 \times 10^{0}$ [c] | $9.05 \times 10^{-1}$ [g] | 0.00 |
| Tc-99 | 0.00 | $3.80 \times 10^{1}$ [c] | $3.80 \times 10^{0}$ [c] | $1.34 \times 10^{0}$ [g] | 0.00 |
| Th-228 | 0.00 | $5.00 \times 10^{0}$ [e] | $1.61 \times 10^{0}$ [i] | $2.16 \times 10^{0}$ [i] | 0.00 |
| Th-230 | 0.00 | $5.00 \times 10^{0}$ [d] | $2.40 \times 10^{0}$ [i] | $2.11 \times 10^{0}$ [i] | 0.00 |
| Th-232 | 0.00 | $5.00 \times 10^{0}$ [d] | $1.33 \times 10^{0}$ [i] | $1.09 \times 10^{0}$ [i] | 0.00 |
| U-234 | 0.00 | $1.00 \times 10^{2}$ [f] | $5.46 \times 10^{1}$ [f] | $8.82 \times 10^{0}$ [f] | 0.00 |
| U-235 | 0.00 | $2.66 \times 10^{0}$ [f] | $1.45 \times 10^{0}$ [f] | $2.34 \times 10^{-1}$ [f] | 0.00 |
| U-236 | 0.00 | $1.10 \times 10^{0}$ [f] | $5.98 \times 10^{-1}$ [f] | $9.66 \times 10^{-2}$ [f] | 0.00 |
| U-238 | 0.00 | $6.00 \times 10^{1}$ [b] | $3.27 \times 10^{1}$ [h] | $5.28 \times 10^{0}$ [h] | 0.00 |

NC = Not characterized.
[a]Assumes that clean top soil does not contribute to air contaminant emissions.
[b]From SWCR, Part III, Table 2-3 (risk-based PRG for recreational user), March 1993.
[c]From SWCR, Appendix R, Tables R.5-16 through R.5-25 and R.6-51 through R.6-65 (UCLs for former Production Areas), March 1993.
[d]From SWCR, Part III, Table 2-3 (ARAR PRG), March 1993.
[e]Assumed from Th-230 and Th-232 PRGs.
[f]Based on uranium concentrations of 0.00896, 0.685, 0.00963, and 99.3 wt%, and specific activities of 6.22E09, 2.16E06, 6.34E07, and 3.36E05 pCi/g for U-234, U-235, U-236, and U-238, respectively.
[g]From SWCR, Appendix R. Tables R.5-27 and R.5-28 (UCLs for Non-OU areas), March 1993.
[h]From RI/FS sample database used for groundwater modeling (provided to Fluor Daniel by Parsons, July 1993).
[i]From RI/FS sample database(provided to Fluor Daniel by FERMCO, March 1993).

## TABLE K.6-10

## ESTIMATED RADIONUCLIDE CONCENTRATIONS (pCi/g) IN SURFACE SOIL/COVER SOIL: FUTURE SCENARIOS

| Radionuclide | OU4: Surface Soil[a] | OU5 Residual: Soil in Areas Beneath Plants 2/3, 6, and 9 | OU5 Residual: Rest of Former Production Area Surface Soil | OU5 Residual: Remainder of the FEMP Surface Soil | Clean Top Soil[l] (on RCRA-Type Caps and over disposal vaults) |
|---|---|---|---|---|---|
| Am-241 | NC | NC | NC | NC | 0.00 |
| Cs-137 | $2.30 \times 10^{-1}$ [a] | $1.00 \times 10^{0}$ [b] | $1.00 \times 10^{0}$ [b] | $6.16 \times 10^{-1}$ [k] | 0.00 |
| Np-237 | NC | $6.96 \times 10^{-1}$ [i] | $6.96 \times 10^{-1}$ [i] | NC | 0.00 |
| Pa-231 | $2.53 \times 10^{-1}$ [a] | $2.43 \times 10^{0}$ [i] | $2.43 \times 10^{0}$ [i] | NC | 0.00 |
| Pb-210 | $7.00 \times 10^{1}$ [b] | $7.00 \times 10^{1}$ [b] | $7.00 \times 10^{1}$ [b] | NC | 0.00 |
| Pu-238 | NC | $2.95 \times 10^{0}$ [i] | $2.95 \times 10^{0}$ [i] | $3.33 \times 10^{-1}$ [k] | 0.00 |
| Pu-239 | NC | $1.12 \times 10^{0}$ [i] | $1.12 \times 10^{0}$ [i] | $3.42 \times 10^{-1}$ [k] | 0.00 |
| Pu-240 | NC | $1.12 \times 10^{0}$ [i] | $1.12 \times 10^{0}$ [i] | $3.42 \times 10^{-1}$ [k] | 0.00 |
| RA-226 | $5.00 \times 10^{0}$ [c] | $5.00 \times 10^{0}$ [c] | $1.09 \times 10^{0}$ [m] | $1.14 \times 10^{0}$ [m] | 0.00 |
| Ra-228 | $2.40 \times 10^{0}$ [d] | $5.00 \times 10^{0}$ [c] | $1.39 \times 10^{0}$ [m] | $1.21 \times 10^{0}$ [m] | 0.00 |
| Ru-106 | NC | NC | NC | NC | 0.00 |
| Sr-90 | $1.80 \times 10^{0}$ [e] | $5.17 \times 10^{0}$ [i] | $5.17 \times 10^{0}$ [i] | $9.05 \times 10^{-1}$ [k] | 0.00 |
| Tc-99 | $2.40 \times 10^{0}$ [e] | $3.80 \times 10^{1}$ [i] | $3.80 \times 10^{0}$ [i] | $1.34 \times 10^{0}$ [k] | 0.00 |
| Th-228 | $5.00 \times 10^{0}$ [f] | $5.00 \times 10^{0}$ [f] | $1.61 \times 10^{0}$ [m] | $2.16 \times 10^{0}$ [m] | 0.00 |
| Th-230 | $5.00 \times 10^{0}$ [c] | $5.00 \times 10^{0}$ [c] | $2.40 \times 10^{0}$ [m] | $2.11 \times 10^{0}$ [m] | 0.00 |
| Th-232 | $5.00 \times 10^{0}$ [c] | $5.00 \times 10^{0}$ [c] | $1.33 \times 10^{0}$ [m] | $1.09 \times 10^{0}$ [m] | 0.00 |
| U-234 | $1.21 \times 10^{1}$ [d] | $1.00 \times 10^{2}$ [j] | $5.46 \times 10^{1}$ [j] | $8.82 \times 10^{0}$ [j] | 0.00 |
| U-235 | $2.49 \times 10^{0}$ [g] | $2.66 \times 10^{0}$ [j] | $1.45 \times 10^{0}$ [j] | $2.34 \times 10^{-1}$ [j] | 0.00 |
| U-236 | $2.49 \times 10^{0}$ [g] | $1.10 \times 10^{0}$ [j] | $5.98 \times 10^{-1}$ [j] | $9.66 \times 10^{-2}$ [j] | 0.00 |
| U-238 | $1.23 \times 10^{1}$ [h] | $6.00 \times 10^{1}$ [b] | $3.27 \times 10^{1}$ [n] | $5.28 \times 10^{0}$ [n] | 0.00 |

NC = Not characterized.
[a]From OU4 FS Report, Appendix A, Table A.3-9 (Berm Soil), June 1993.
[b]From SWCR, Part III, Table 2-3 (risk-based PRG for recreational user), March 1993.
[c]From SWCR, Part III, Table 2-3 (ARAR PRG), March 1993.
[d]From OU4 FS Report, Appendix A, Table A.3-7 (Surface Soil), June 1993.
[e]From OU4 FS Report, Appendix A, Table A.3-8 (Surface Soil), June 1993.
[f]Assumed from Th-230 and Th-232 PRGs.
[g]From OU4 FS Report, Appendix A, Table A.3-13 (Subsoil), June 1993.
[h]From OU4 RI Report, Appendix D, Table D.2-7 (Surface Soil), April 1993.
[i]From SWCR, Appendix R, Tables R.5-16 through R.5-25 and R.6-51 through R.6-65 (UCLs for former Production Areas), March 1993.
[j]Based on uranium concentrations of 0.00896, 0.685, 0.00963, and 99.3 wt%, and specific activities of 6.22E09, 2.16E06, 6.34E07, and 3.36E05 pCi/g for U-234, U-235, U-236, and U-238 respectively.
[k]From SWCR, Appendix R. Tables R.5-27 and R.5-28 (UCLs for Non-OU areas), March 1993.
[l]Assumes that clean layers in RCRA-type cap do not contribute to air contaminant emissions.
[m]From RI/FS sample database (provided to Fluor Daniel by FERMCO, March 1993).
[n]From RI/FS sample database used for groundwater modeling (provided to Fluor Daniel by Parsons, July 1993).

0197

## TABLE K.6-11

## ESTIMATED CHEMICAL CONCENTRATIONS (mg/kg) IN SURFACE SOIL/COVER SOIL: CURRENT SCENARIO

| Chemical | OU4: Top Soil[a] | OU5 Residual: Soil in Areas Beneath Plants 2/3, 6, and 9[b] | OU5 Residual: Rest of Former Production Area Surface Soil[b] | OU5 Residual: Remainder of the FEMP Surface Soil[c] | Clean Top Soil[a] (on RCRA-Type Caps and over disposal vaults) |
|---|---|---|---|---|---|
| 2-Chlorophenol | 0.00 | NC | NC | NC | 0.00 |
| 2-Methyl-naphthalene | 0.00 | $2.18 \times 10^{-1}$ | $2.18 \times 10^{-1}$ | NC | 0.00 |
| 4-Chlorophenyl-phenylether | 0.00 | NC | NC | NC | 0.00 |
| 4,4-DDT | 0.00 | NC | NC | NC | 0.00 |
| Antimony | 0.00 | $3.11 \times 10^{1}$ | $3.11 \times 10^{1}$ | $2.73 \times 10^{1}$ | 0.00 |
| Aroclor-1016 | 0.00 | NC | NC | NC | 0.00 |
| Aroclor-1221 | 0.00 | $8.30 \times 10^{-2}$ | $8.30 \times 10^{-2}$ | NC | 0.00 |
| Aroclor-1242 | 0.00 | NC | NC | NC | 0.00 |
| Aroclor-1248 | 0.00 | $5.50 \times 10^{-2}$ | $5.50 \times 10^{-2}$ | NC | 0.00 |
| Aroclor-1254 | 0.00 | $2.46 \times 10^{0}$ | $2.46 \times 10^{0}$ | $1.06 \times 10^{-1}$ | 0.00 |
| Aroclor-1260 | 0.00 | $2.80 \times 10^{0}$ | $2.80 \times 10^{0}$ | NC | 0.00 |
| Arsenic | 0.00 | $2.56 \times 10^{1}$ | $2.56 \times 10^{1}$ | $9.44 \times 10^{0}$ | 0.00 |
| Barium | 0.00 | $3.61 \times 10^{3}$ | $3.61 \times 10^{3}$ | $7.58 \times 10^{1}$ | 0.00 |
| Beryllium | 0.00 | $2.40 \times 10^{0}$ | $2.40 \times 10^{0}$ | $7.99 \times 10^{-1}$ | 0.00 |
| Cadmium | 0.00 | $6.90 \times 10^{0}$ | $6.90 \times 10^{0}$ | $5.11 \times 10^{0}$ | 0.00 |
| Chromium | 0.00 | $7.55 \times 10^{1}$ | $7.55 \times 10^{1}$ | $1.79 \times 10^{1}$ | 0.00 |
| Cobalt | 0.00 | $2.09 \times 10^{1}$ | $2.09 \times 10^{1}$ | $1.08 \times 10^{1}$ | 0.00 |
| Copper | 0.00 | $1.28 \times 10^{2}$ | $1.28 \times 10^{2}$ | $2.01 \times 10^{1}$ | 0.00 |
| Cyanide | 0.00 | $1.44 \times 10^{1}$ | $1.44 \times 10^{1}$ | $1.06 \times 10^{-1}$ | 0.00 |
| Di-n-octyl phthalate | 0.00 | $2.31 \times 10^{-1}$ | $2.31 \times 10^{-1}$ | NC | 0.00 |
| Heptachlorodibenzo-furan | 0.00 | NC | NC | NC | 0.00 |
| Heptachlorodibenzo-p-dioxin | 0.00 | NC | NC | NC | 0.00 |
| Lead | 0.00 | $4.40 \times 10^{2}$ | $4.40 \times 10^{2}$ | $2.97 \times 10^{1}$ | 0.00 |
| Manganese | 0.00 | $8.33 \times 10^{2}$ | $8.33 \times 10^{2}$ | $5.10 \times 10^{2}$ | 0.00 |
| Mercury | 0.00 | $1.30 \times 10^{0}$ | $1.30 \times 10^{0}$ | NC | 0.00 |
| Molybdenum | 0.00 | $4.60 \times 10^{0}$ | $4.60 \times 10^{0}$ | $4.33 \times 10^{0}$ | 0.00 |
| Nickel | 0.00 | $5.89 \times 10^{1}$ | $5.89 \times 10^{1}$ | $2.92 \times 10^{1}$ | 0.00 |
| Octachlorodibenzo-furan | 0.00 | NC | NC | NC | 0.00 |
| Octachlorodibenzo-p-dioxin | 0.00 | NC | NC | NC | 0.00 |
| Selenium | 0.00 | $3.71 \times 10^{-1}$ | $3.71 \times 10^{-1}$ | NC | 0.00 |
| Thallium | 0.00 | $6.83 \times 10^{-1}$ | $6.83 \times 10^{-1}$ | $2.81 \times 10^{-1}$ | 0.00 |
| Vanadium | 0.00 | $3.56 \times 10^{1}$ | $3.56 \times 10^{1}$ | $2.45 \times 10^{1}$ | 0.00 |
| Zinc | 0.00 | $3.35 \times 10^{2}$ | $3.35 \times 10^{2}$ | $5.29 \times 10^{1}$ | 0.00 |

NC = Not Characterized.
[a]Assumes that clean top soil does not contribute to air contaminant emissions.
[b]From SWCR, Appendix R, Tables R.5-33 through R.5-38 and R.6-55 through R.6-70 (UCLs for former Production Areas), March 1993.
[c]From SWCR, Appendix R, Tables R.5-41 and R.5-42 (UCLs for Remainder of FEMP), March 1993.

## TABLE K.6-12

## ESTIMATED CHEMICAL CONCENTRATIONS (mg/kg) IN SURFACE SOIL/COVER SOIL: FUTURE SCENARIOS

| Chemical | OU4: Surface Soil | OU5 Residual: Soil in Areas Beneath Plants 2/3, 6, and 9[f] | OU5 Residual: Rest of Former Production Area Surface Soil[f] | OU5 Residual: Remainder of the FEMP Surface Soil[g] | Clean Top Soil[h] (on RCRA-Type Caps and over disposal vaults) |
|---|---|---|---|---|---|
| 2-Chlorophenol | NC | NC | NC | NC | 0.00 |
| 2-Methyl-naphthalene | NC | $2.18 \times 10^{-1}$ | $2.18 \times 10^{-1}$ | NC | 0.00 |
| 4-Chlorophenyl-phenylether | NC | NC | NC | NC | 0.00 |
| 4,4-DDT | NC | NC | NC | NC | 0.00 |
| Antimony | $3.01 \times 10^{-1}$ [a] | $3.11 \times 10^{1}$ | $3.11 \times 10^{1}$ | $2.73 \times 10^{1}$ | 0.00 |
| Aroclor-1016 | NC | NC | NC | NC | 0.00 |
| Aroclor-1221 | NC | $8.30 \times 10^{-2}$ | $8.30 \times 10^{-2}$ | NC | 0.00 |
| Aroclor-1242 | NC | NC | NC | NC | 0.00 |
| Aroclor-1248 | NC | $5.50 \times 10^{-2}$ | $5.50 \times 10^{-2}$ | NC | 0.00 |
| Aroclor-1254 | $3.00 \times 10^{-1}$ [b] | $2.46 \times 10^{0}$ | $2.46 \times 10^{0}$ | $1.06 \times 10^{-1}$ | 0.00 |
| Aroclor-1260 | NC | $2.80 \times 10^{0}$ | $2.80 \times 10^{0}$ | NC | 0.00 |
| Arsenic | $8.00 \times 10^{0}$ [c] | $2.56 \times 10^{1}$ | $2.56 \times 10^{1}$ | $9.44 \times 10^{0}$ | 0.00 |
| Barium | $8.94 \times 10^{1}$ [c] | $3.61 \times 10^{3}$ | $3.61 \times 10^{3}$ | $7.58 \times 10^{1}$ | 0.00 |
| Beryllium | $8.66 \times 10^{-1}$ [a] | $2.40 \times 10^{0}$ | $2.40 \times 10^{0}$ | $7.99 \times 10^{-1}$ | 0.00 |
| Cadmium | $5.68 \times 10^{0}$ [a] | $6.90 \times 10^{0}$ | $6.90 \times 10^{0}$ | $5.11 \times 10^{0}$ | 0.00 |
| Chromium | $2.84 \times 10^{1}$ [c] | $7.55 \times 10^{1}$ | $7.55 \times 10^{1}$ | $1.79 \times 10^{1}$ | 0.00 |
| Cobalt | $1.33 \times 10^{1}$ [c] | $2.09 \times 10^{1}$ | $2.09 \times 10^{1}$ | $1.08 \times 10^{1}$ | 0.00 |
| Copper | $2.38 \times 10^{1}$ [c] | $1.28 \times 10^{2}$ | $1.28 \times 10^{2}$ | $2.01 \times 10^{1}$ | 0.00 |
| Cyanide | $1.98 \times 10^{0}$ [d] | $1.44 \times 10^{1}$ | $1.44 \times 10^{1}$ | $1.06 \times 10^{-1}$ | 0.00 |
| Di-n-octyl phthalate | $6.56 \times 10^{-1}$ [e] | $2.31 \times 10^{-1}$ | $2.31 \times 10^{-1}$ | NC | 0.00 |
| Heptachlorodibenzo-furan | NC | NC | NC | NC | 0.00 |
| Heptachlorodibenzo-p-dioxin | NC | NC | NC | NC | 0.00 |
| Lead | $1.48 \times 10^{1}$ [a] | $4.40 \times 10^{2}$ | $4.40 \times 10^{2}$ | $2.97 \times 10^{1}$ | 0.00 |
| Manganese | $6.65 \times 10^{2}$ | $8.33 \times 10^{2}$ | $8.33 \times 10^{2}$ | $5.10 \times 10^{2}$ | 0.00 |
| Mercury | $1.20 \times 10^{-1}$ [d] | $1.30 \times 10^{0}$ | $1.30 \times 10^{0}$ | NC | 0.00 |
| Molybdenum | $1.33 \times 10^{1}$ [c] | $4.60 \times 10^{0}$ | $4.60 \times 10^{0}$ | $4.33 \times 10^{0}$ | 0.00 |
| Nickel | $3.24 \times 10^{1}$ [c] | $5.89 \times 10^{1}$ | $5.89 \times 10^{1}$ | $2.92 \times 10^{1}$ | 0.00 |
| Octachlorodibenzo-furan | NC | NC | NC | NC | 0.00 |
| Octachlorodibenzo-p-dioxin | NC | NC | NC | NC | 0.00 |
| Selenium | $5.70 \times 10^{0}$ [d] | $3.71 \times 10^{-1}$ | $3.71 \times 10^{-1}$ | NC | 0.00 |
| Thallium | $7.10 \times 10^{-1}$ [c] | $6.83 \times 10^{-1}$ | $6.83 \times 10^{-1}$ | $2.81 \times 10^{-1}$ | 0.00 |
| Vanadium | $2.84 \times 10^{1}$ [c] | $3.56 \times 10^{1}$ | $3.56 \times 10^{1}$ | $2.45 \times 10^{1}$ | 0.00 |
| Zinc | $5.96 \times 10^{1}$ [c] | $3.35 \times 10^{2}$ | $3.35 \times 10^{2}$ | $5.29 \times 10^{1}$ | 0.00 |

NC = Not Characterized.
[a]From OU4 RI Report, Appendix D, Table D.2-7 (Surface Soil), April 1993.
[b]From OU4 FS Report, Appendix A, Table A.3-6 (Surface Soil), June 1993.
[c]From OU4 RI Report, Appendix D, Table D.2-6 (Berm Soil), April 1993.
[d]From OU4 FS Report, Appendix A, Table A.3-14 (Subsoil), June 1993.
[e]From OU4 FS Report, Appendix A, Table A.3-11 (Berm Soil), June 1993.
[f]From SWCR, Appendix R, Tables R.5-33 through R.5-38 and R.6-55 through R.6-70 (UCLs for former Production Areas), March 1993.
[g]From SWCR, Appendix R, Tables R.5-41 and R.5-42 (UCLs for Remainder of FEMP), March 1993.
[h]Assumes that clean layers in RCRA-type cap do not contribute to air contaminant emissions.

Th-230, and Th-232 were used to set the concentrations of radium and thorium isotopes in these excavated areas. The remaining portion of Operable Unit 3 was assumed to be surface soil (0 to 0.5 m) which did not exceed the PRG levels. Hot spot excavation was assumed to be used to reduce soil concentrations below these levels. The 95 percent UCL on the mean was calculated from RI/FS sample data for Ra-226, Ra-228, Th-228, Th-230, Th-232 and U-238 in this area.

The risk-based PRG (expanded trespasser) for Pb-210 was also used for the residual soil of Operable Unit 4 under the future scenarios. In addition, the 5 pCi/g limits in the SWCR for Ra-226, Ra-228, Th-230, and Th-232 were used to set the concentrations of radium and thorium isotopes in the residual soil of Operable Unit 4.

The remainder of the FEMP (Operable Unit 5) was assumed to be surface soil (0 to 0.5 meters) which did not exceed the PRG levels. As with the former production area, hot spot excavation was assumed to be used to reduce soil concentrations below these levels. The 95 percent UCL on the mean was calculated from RI/FS sample data for Ra-226, Ra-228, Th-228, Th-230, Th-232, and U-238 in the surface soil of Operable Unit 5.

For all areas, the average composition of total uranium on the site was used to estimate concentrations of U-234, U-235, and U-236 from the U-238 concentration (60 pCi/g) in treated (washed) and untreated soil. The approximate composition is 0.0896, 0.685, 0.0093 and 99.3 percent (by weight) of U-234, U-235, U-236, and U-238, respectively. Since soil washing is a chemical process, the relative abundance of the uranium isotopes will not change.

For COCs which did not exceed the PRG value, the UCL contaminant concentration in a given area or operable unit was used for that area or operable unit. This approach assumed that FEMP contamination after remediation will not be worse than currently measured levels. This approach is also extremely conservative, because no credit was taken for the effect of soil treatment, and the highest values used would not typically represent the average concentration for the modeled sources.

K.6.2.4.2 Suspended Particulate Emission Estimate

The method used to estimate $PM_{10}$ emission rates for the FEMP is based on EPA guidance for estimating wind erosion rates from flat soil surfaces at hazardous waste sites (EPA 1985d). The EPA methodology assumes that a minimum wind speed is required for the suspension of respirable dust,

and the emission rate is a nonlinear function of the "Threshold Friction Velocity" (TFV) and the erosion potential of the site, which depends on the particle size distribution of the soil. Very fine soils (those with small modal diameters) have low TFVs and high potential for erosion by wind.

The modal diameter of FEMP surface soil was estimated from relatively coarse particle size distributions for clay, silt, sand, and gravel (Mulder 1993, ORNL 1992a). From the data in these reports, the modal diameter occurs in the silt fraction, which is between (0.002 and 0.075 mm or 0.000001 and 0.00003 in.). The mass-mean diameter of the silt fraction, 0.048 mm, was calculated from (EPA 1992e):

$$d_{mm} = [0.25(d_l^3+d_l^2d_u+d_ld_u^2+d_u^3]^{1/3} \qquad (10)$$

where

$d_{mm}$ = mass mean diameter (mm),
$d_l$ = lower bound diameter for particle size range (mm), and
$d_u$ = upper bound diameter for particle size range (mm).

The typical 50 percent particle size diameter (D50) is approximately 0.0206 mm (0.00001 in.) for surface soil (Mulder 1993). Using the smaller diameter between the mass-mean and D50 value provides the more conservative emission rate estimate. Assuming that the D50 value is approximately equal to the surface soil modal diameter, the TFV can be determined from the EPA guidance document (EPA 1985d, Figure 3-4). The relationship between the modal diameter and the TFV can be represented by the equation:

$$\log (TFV) = 1.812 + 0.4161 \log (d_p) \qquad (11)$$

where

TFV = threshold friction velocity (cm/s) near the soil surface, and
$d_p$ = modal diameter of soil sample (mm).

The calculated TFV is approximately 12.9 cm/s (5 in./s) based on a modal diameter of 0.0206 mm (0.00001 in.). The calculated TFV should be corrected based on the surface roughness, crustiness, and quantity of nonerodible elements. The ratio of the corrected TFV to the uncorrected TFV is a nonlinear function of the ratio of the silhouette area of the roughness elements to the total area of bare loose soil (EPA 1985d). For this CRARE, no correction was applied to the calculated TFV based on the assumption that the exposed surface would behave like dry, loose silt. This assumption is

obviously conservative since the site has enough clay in the soil to form a nonerodible crust, the surface contains nonerodible elements, and the vegetation present will significantly increase the TFV necessary to resuspend surface soil.

The calculated TFV is less than the 75 cm/s (30 in./s); therefore, the FEMP surface soil was considered to have an "unlimited" erosion potential (EPA 1985d). The equation for respirable particulate emissions of soils with unlimited erosion potential takes the following form:

$$E_{10} = 0.036 \times (1-V) \times [(u/u_t)^3] \times F(y) \qquad (12)$$

where

| | | |
|---|---|---|
| $E_{10}$ | = | annual average $PM_{10}$ emission rate per unit area of contaminated surface ($g/hr/m^2$), |
| $PM_{10}$ | = | particulate matter with a diameter $\leq$ 10 meters, |
| V | = | fraction of soil covered by vegetation, |
| u | = | mean annual wind speed (m/s), |
| $u_t$ | = | TFV at the height of "u" (m/s), |
| y | = | $0.886 \times u_t / u$, |
| F(y) | = | 1.91 for $y < 0.5$, |
| F(y) | = | $0.18 \times (y^3 + 12y) \times EXP(-y^2)$ for $y > 2$, and |
| F(y) | = | See Figure 4-3, EPA 1985b, for $0.5 < y < 2$. |

Currently, Operable Unit 4 is 80 to 85 percent covered with vegetation. After remediation, the FEMP will be planted with appropriate vegetation for emission control and aesthetics. The region easily supports plant life, and a 100 percent vegetative cover is expected over the postremediated site, with or without continued maintenance. For this air transport analysis, the site was conservatively assumed to be 85 percent covered with vegetation. The 85 percent value is in line with EPA estimates of control efficiencies for vegetative covers (EPA 1987a).

The TFV must be corrected to the anemometer height (10 meters) used to collect site wind speed data. The corrected TFV is calculated from the following equation (EPA 1985b):

$$U_t/TFV = (1/0.4) \ln (Z/Z_o) \qquad (13)$$

where

| | | |
|---|---|---|
| Z | = | anemometer height (m), and |
| $Z_o$ | = | surface roughness height (m). |

The surface at the FEMP will be covered with grass and other vegetation after completion of remedial actions. Using an approximated value of 0.03 meters (0.1 feet) for grassland (EPA 1985b) as $Z_o$, the value of $U_t$ was calculated to be 1.87 m/s (6 ft/s).

The methodology used to calculate the emissions for soil with unlimited erosion potential is based on multiplying the emission rate for a single mean annual wind speed value by an estimated annual wind speed probability distribution. This method allows for rapid calculation of annual $PM_{10}$ emissions knowing only the mean annual wind speed.

However, the ISCLT2 model calculates dispersion for six wind speed categories (EPA 1992e). The use of a single emission rate for dispersion under all six wind speed categories will overestimate the concentrations for low wind speeds and underestimate concentrations at high wind speeds. The frequency of wind speeds in the lower wind speed categories is much greater than the frequency of wind speeds in the upper wind speed categories. Therefore, using a single emission rate for all wind speed categories in ISCLT2 will tend to overestimate the ground level $PM_{10}$ concentrations. Evidence indicates (EPA 1985b) that no substantial fugitive particulate emissions occur for wind speeds less than 5 m/s (16.4 ft/s or 12 mph). These wind speeds include the lower three wind speed categories analyzed by ISCLT2.

For this analysis, the unlimited potential emission rate equation previously presented was used to calculate $PM_{10}$ emissions for each of the ISCLT2 wind speed categories. This procedure generates particulate emission rates for the lower wind speed categories, which is more conservative than simply setting the emissions to zero for these categories. The calculated emission rates are presented in Table K.6-13.

The current and future particulate radionuclide emissions for each of the defined sources are presented in Tables K.6-14 and K.6-15, respectively. The chemical contaminant emissions for each of the sources modeled are presented in Tables K.6-16 and K.6-17, respectively. The emission rates presented in Tables K.6-14 through K.6-17 were based on a wind speed of 12.5 m/s (41 ft/s). Emission rates for lower wind speeds are determined by multiplying the emission rates in these tables by the ratio presented in the last column of Table K.6-13.

**TABLE K.6-13**

**WIND SPEED DEPENDENT $PM_{10}$ EMISSION RATES**

| ISCLT2 Wind Speed Category | Representative Wind Speed (m/s) | $PM_{10}$ Emission Rate ($g/s/m^2$) | Ratio of $PM_{10}$ Emission at Wind Speed to $PM_{10}$ Emission at 12.5 m/s Wind Speed |
|---|---|---|---|
| 1 | 1.5 | $1.13 \times 10^{-6}$ | 0.0013 |
| 2 | 2.5 | $6.60 \times 10^{-6}$ | 0.0077 |
| 3 | 4.5 | $3.98 \times 10^{-5}$ | 0.0466 |
| 4 | 7.0 | $1.50 \times 10^{-4}$ | 0.1756 |
| 5 | 9.5 | $3.75 \times 10^{-4}$ | 0.4390 |
| 6 | 12.5 | $8.54 \times 10^{-4}$ | 1.0000 |

K.6.2.5 Gaseous Contaminant Emission Rates

Emissions of Rn-222 were estimated for all scenarios. No other gaseous emissions were estimated. Volatile and semivolatile organics were assumed to have decayed to negligible levels prior to the time period studied by this analysis. Radionuclides, nonvolatile organics, and inorganics were assumed to be transported with the particulates emitted from the site.

Rn-222 emissions of were determined from the Ra-226 concentrations in the contaminated soil or waste using the RAECOM model algorithms developed for the NRC (NRC 1984). The model accounts for the half-lives of radon and radium as well as the density, porosity, moisture content, and depth of contaminated layers and cover layers in estimating Rn-222 emission rates. The model converts Ra-226 soil concentrations (in pCi/g) to Rn-222 fluxes (in $pCi/s/m^2$). The basic equations are presented in the RAWPA. The porosity and moisture content values as well as depths for contaminated and cover layers used in the groundwater transport analysis (Section K.6.1) were also used in the RAECOM model. The Ra-226 concentrations and the current and future Rn-222 fluxes from each emission source are presented in Table K.6-18. The RAECOM calculated emission rates are presented in Attachment K.III. All areas within the FEMP property which have Ra-226 contamination, including the capped areas and disposal vaults were assumed to emit some Rn-222.

## TABLE K.6-14

## RADIONUCLIDE EMISSION FLUXES (pCi/s/m$^2$) FROM SURFACE SOIL/COVER SOIL: CURRENT SCENARIO[a]

| Radionuclide | OU4: Top Soil[b] | OU5 Residual: Soil in Areas Beneath Plants 2/3, 6, and 9 | OU5 Residual: Rest of Former Production Area Surface Soil | OU5 Residual: Remainder of the FEMP Surface Soil | Clean Top Soil[b] (on RCRA-Type Caps and over disposal vaults) |
|---|---|---|---|---|---|
| Am-241 | 0.00 | NC | NC | NC | 0.00 |
| Cs-137 | 0.00 | $8.54 \times 10^{-4}$ | $8.54 \times 10^{-4}$ | $5.26 \times 10^{-4}$ | 0.00 |
| Np-237 | 0.00 | $5.94 \times 10^{-4}$ | $5.94 \times 10^{-4}$ | NC | 0.00 |
| Pa-231 | 0.00 | $2.08 \times 10^{-3}$ | $2.08 \times 10^{-3}$ | NC | 0.00 |
| Pb-210 | 0.00 | $5.98 \times 10^{-2}$ | $5.98 \times 10^{-2}$ | NC | 0.00 |
| Pu-238 | 0.00 | $2.52 \times 10^{-3}$ | $2.52 \times 10^{-3}$ | $2.84 \times 10^{-4}$ | 0.00 |
| Pu-239 | 0.00 | $9.56 \times 10^{-4}$ | $9.56 \times 10^{-4}$ | $2.92 \times 10^{-4}$ | 0.00 |
| Pu-240 | 0.00 | $9.56 \times 10^{-4}$ | $9.56 \times 10^{-4}$ | $2.92 \times 10^{-4}$ | 0.00 |
| RA-226 | 0.00 | $4.27 \times 10^{-3}$ | $9.31 \times 10^{-4}$ | $9.74 \times 10^{-4}$ | 0.00 |
| Ra-228 | 0.00 | $4.27 \times 10^{-3}$ | $1.19 \times 10^{-3}$ | $1.03 \times 10^{-3}$ | 0.00 |
| Ru-106 | 0.00 | NC | NC | NC | 0.00 |
| Sr-90 | 0.00 | $4.41 \times 10^{-3}$ | $4.41 \times 10^{-3}$ | $7.73 \times 10^{-4}$ | 0.00 |
| Tc-99 | 0.00 | $3.25 \times 10^{-2}$ | $3.25 \times 10^{-2}$ | $1.15 \times 10^{-3}$ | 0.00 |
| Th-228 | 0.00 | $4.27 \times 10^{-3}$ | $1.37 \times 10^{-3}$ | $1.84 \times 10^{-3}$ | 0.00 |
| Th-230 | 0.00 | $4.27 \times 10^{-3}$ | $2.05 \times 10^{-3}$ | $1.80 \times 10^{-3}$ | 0.00 |
| Th-232 | 0.00 | $4.27 \times 10^{-3}$ | $1.14 \times 10^{-3}$ | $9.31 \times 10^{-4}$ | 0.00 |
| U-234 | 0.00 | $8.56 \times 10^{-2}$ | $4.66 \times 10^{-2}$ | $7.53 \times 10^{-3}$ | 0.00 |
| U-235 | 0.00 | $2.27 \times 10^{-3}$ | $1.24 \times 10^{-3}$ | $2.00 \times 10^{-4}$ | 0.00 |
| U-236 | 0.00 | $9.38 \times 10^{-4}$ | $5.11 \times 10^{-4}$ | $8.25 \times 10^{-5}$ | 0.00 |
| U-238 | 0.00 | $5.12 \times 10^{-2}$ | $2.79 \times 10^{-2}$ | $4.51 \times 10^{-3}$ | 0.00 |

NC = Not characterized.
[a]Based on a PM10 Emission Rate of $8.54 \times 10^{-4}$ g/s/m$^2$ for a 12.5 m/s wind and contaminant concentration in surface soil.
[b]Assumes that clean top soil does not contribute to air contaminant emissions.

0205

## TABLE K.6-15

## RADIONUCLIDE EMISSION FLUXES (pCi/s/m$^2$) FROM SURFACE SOIL/COVER SOIL: FUTURE SCENARIOS[a]

| Radionuclide | OU4: Surface Soil | OU5 Residual: Soil in Areas Beneath Plants 2/3, 6, and 9 | OU5 Residual: Rest of Former Production Area Surface Soil | OU5 Residual: Remainder of the FEMP Surface Soil | Clean Top Soil[b] (on RCRA-Type Caps and over disposal vaults) |
|---|---|---|---|---|---|
| Am-241 | NC | NC | NC | NC | 0.00 |
| Cs-137 | $1.96 \times 10^{-4}$ | $8.54 \times 10^{-4}$ | $8.54 \times 10^{-4}$ | $5.26 \times 10^{-4}$ | 0.00 |
| Np-237 | NC | $5.94 \times 10^{-4}$ | $5.94 \times 10^{-4}$ | NC | 0.00 |
| Pa-231 | $2.16 \times 10^{-2}$ | $2.08 \times 10^{-3}$ | $2.08 \times 10^{-3}$ | NC | 0.00 |
| Pb-210 | $5.98 \times 10^{-2}$ | $5.98 \times 10^{-2}$ | $5.98 \times 10^{-2}$ | NC | 0.00 |
| Pu-238 | NC | $2.52 \times 10^{-3}$ | $2.52 \times 10^{-3}$ | $2.84 \times 10^{-4}$ | 0.00 |
| Pu-239 | NC | $9.56 \times 10^{-4}$ | $9.56 \times 10^{-4}$ | $2.92 \times 10^{-4}$ | 0.00 |
| Pu-240 | NC | $9.56 \times 10^{-4}$ | $9.56 \times 10^{-4}$ | $2.92 \times 10^{-4}$ | 0.00 |
| RA-226 | $4.27 \times 10^{-3}$ | $4.27 \times 10^{-3}$ | $9.31 \times 10^{-4}$ | $9.74 \times 10^{-4}$ | 0.00 |
| Ra-228 | $2.05 \times 10^{-3}$ | $4.27 \times 10^{-3}$ | $1.19 \times 10^{-3}$ | $1.03 \times 10^{-3}$ | 0.00 |
| Ru-106 | NC | NC | NC | NC | 0.00 |
| Sr-90 | $1.54 \times 10^{-3}$ | $4.41 \times 10^{-3}$ | $4.41 \times 10^{-3}$ | $7.73 \times 10^{-4}$ | 0.00 |
| Tc-99 | $2.05 \times 10^{-3}$ | $3.25 \times 10^{-2}$ | $3.25 \times 10^{-2}$ | $1.15 \times 10^{-3}$ | 0.00 |
| Th-228 | $4.27 \times 10^{-3}$ | $4.27 \times 10^{-3}$ | $1.37 \times 10^{-3}$ | $1.84 \times 10^{-3}$ | 0.00 |
| Th-230 | $4.27 \times 10^{-3}$ | $4.27 \times 10^{-3}$ | $2.05 \times 10^{-3}$ | $1.80 \times 10^{-3}$ | 0.00 |
| Th-232 | $4.27 \times 10^{-3}$ | $4.27 \times 10^{-3}$ | $1.14 \times 10^{-3}$ | $9.31 \times 10^{-4}$ | 0.00 |
| U-234 | $1.03 \times 10^{-2}$ | $8.56 \times 10^{-2}$ | $4.66 \times 10^{-2}$ | $7.53 \times 10^{-3}$ | 0.00 |
| U-235 | $2.13 \times 10^{-3}$ | $2.27 \times 10^{-3}$ | $1.24 \times 10^{-3}$ | $2.00 \times 10^{-4}$ | 0.00 |
| U-236 | $2.13 \times 10^{-3}$ | $9.38 \times 10^{-4}$ | $5.11 \times 10^{-4}$ | $8.25 \times 10^{-5}$ | 0.00 |
| U-238 | $1.05 \times 10^{-2}$ | $5.12 \times 10^{-2}$ | $2.79 \times 10^{-2}$ | $4.51 \times 10^{-3}$ | 0.00 |

NC = Not characterized.
[a]Based on a PM10 Emission Rate of $8.54 \times 10^{-4}$ g/s/m$^2$ for a 12.5 m/s wind and contaminant concentration in surface soil.
[b]Assumes that clean top soil does not contribute to air contaminant emissions.

## TABLE K.6-16

## CHEMICAL CONTAMINANT EMISSION FLUXES ($\mu g/s/m^2$) FROM SURFACE SOIL/COVER SOIL: CURRENT SCENARIO[a]

| Chemical | OU4: Top Soil[b] | OU5 Residual: Soil in Areas Beneath Plants 2/3, 6, and 9 | OU5 Residual: Rest of Former Production Area Surface Soil | OU5 Residual: Remainder of the FEMP Surface Soil | Clean Top Soil[b] (on RCRA-Type Caps and over disposal vaults) |
|---|---|---|---|---|---|
| 2-Chlorophenol | 0.00 | NC | NC | NC | 0.00 |
| 2-Methyl-naphthalene | 0.00 | $1.86 \times 10^{-4}$ | $1.86 \times 10^{-4}$ | NC | 0.00 |
| 4-Chlorophenyl-phenylether | 0.00 | NC | NC | NC | 0.00 |
| 4,4-DDT | 0.00 | NC | NC | NC | 0.00 |
| Antimony | 0.00 | $2.66 \times 10^{-2}$ | $2.66 \times 10^{-2}$ | $2.33 \times 10^{-2}$ | 0.00 |
| Aroclor-1016 | 0.00 | NC | NC | NC | 0.00 |
| Aroclor-1221 | 0.00 | $7.09 \times 10^{-5}$ | $7.09 \times 10^{-5}$ | NC | 0.00 |
| Aroclor-1242 | 0.00 | NC | NC | NC | 0.00 |
| Aroclor-1248 | 0.00 | $4.70 \times 10^{-5}$ | $4.70 \times 10^{-2}$ | NC | 0.00 |
| Aroclor-1254 | 0.00 | $2.10 \times 10^{-3}$ | $2.10 \times 10^{-3}$ | $9.05 \times 10^{-5}$ | 0.00 |
| Aroclor-1260 | 0.00 | $2.39 \times 10^{-3}$ | $2.39 \times 10^{-3}$ | NC | 0.00 |
| Arsenic | 0.00 | $2.19 \times 10^{-2}$ | $2.19 \times 10^{-2}$ | $8.06 \times 10^{-3}$ | 0.00 |
| Barium | 0.00 | $3.08 \times 10^{0}$ | $3.08 \times 10^{0}$ | $6.47 \times 10^{-2}$ | 0.00 |
| Beryllium | 0.00 | $2.05 \times 10^{-3}$ | $2.05 \times 10^{-3}$ | $6.82 \times 10^{-4}$ | 0.00 |
| Cadmium | 0.00 | $5.89 \times 10^{-3}$ | $5.89 \times 10^{-3}$ | $4.36 \times 10^{-3}$ | 0.00 |
| Chromium | 0.00 | $6.45 \times 10^{-2}$ | $6.45 \times 10^{-2}$ | $1.53 \times 10^{-2}$ | 0.00 |
| Cobalt | 0.00 | $1.78 \times 10^{-2}$ | $1.78 \times 10^{-2}$ | $9.25 \times 10^{-3}$ | 0.00 |
| Copper | 0.00 | $1.09 \times 10^{-1}$ | $1.09 \times 10^{-1}$ | $1.72 \times 10^{-2}$ | 0.00 |
| Cyanide | 0.00 | $1.23 \times 10^{-2}$ | $1.23 \times 10^{-2}$ | $9.05 \times 10^{-5}$ | 0.00 |
| Di-n-octyl phthalate | 0.00 | $1.97 \times 10^{-4}$ | $1.97 \times 10^{-4}$ | NC | 0.00 |
| Heptachlorodibenzo-furan | 0.00 | NC | NC | NC | 0.00 |
| Heptachlorodibenzo-p-dioxin | 0.00 | NC | NC | NC | 0.00 |
| Lead | 0.00 | $3.76 \times 10^{-1}$ | $3.76 \times 10^{-1}$ | $2.54 \times 10^{-2}$ | 0.00 |
| Manganese | 0.00 | $7.11 \times 10^{-1}$ | $7.11 \times 10^{-1}$ | $4.36 \times 10^{-1}$ | 0.00 |
| Mercury | 0.00 | $1.11 \times 10^{-3}$ | $1.11 \times 10^{-3}$ | NC | 0.00 |
| Molybdenum | 0.00 | $3.93 \times 10^{-3}$ | $3.93 \times 10^{-3}$ | $3.70 \times 10^{-3}$ | 0.00 |
| Nickel | 0.00 | $5.03 \times 10^{-2}$ | $5.03 \times 10^{-2}$ | $2.49 \times 10^{-2}$ | 0.00 |
| Octachlorodibenzo-furan | 0.00 | NC | NC | NC | 0.00 |
| Octachlorodibenzo-p-dioxin | 0.00 | NC | NC | NC | 0.00 |
| Selenium | 0.00 | $3.17 \times 10^{-4}$ | $3.17 \times 10^{-4}$ | NC | 0.00 |
| Thallium | 0.00 | $5.83 \times 10^{-4}$ | $5.83 \times 10^{-4}$ | $2.40 \times 10^{-4}$ | 0.00 |
| Vanadium | 0.00 | $3.04 \times 10^{-2}$ | $3.04 \times 10^{-2}$ | $2.09 \times 10^{-2}$ | 0.00 |
| Zinc | 0.00 | $2.86 \times 10^{-1}$ | $2.86 \times 10^{-1}$ | $4.52 \times 10^{-2}$ | 0.00 |

NC = Not characterized.
[a]Based on a PM10 Emission Rate of $8.54 \times 10^{-4}$ g/s/m$^2$ for a 12.5 m/s wind and contaminant concentration in surface soil.
[b]Assumes that clean top soil does not contribute to air contaminant emissions.

## TABLE K.6-17

## CHEMICAL CONTAMINANT EMISSION FLUXES ($\mu g/s/m^2$) FROM SURFACE SOILS/COVER SOIL: FUTURE SCENARIOS[a]

| Chemical | OU4: Surface Soil | OU5 Residual: Soil in Areas Beneath Plants 2/3, 6, and 9 | OU5 Residual: Rest of Former Production Area Surface Soil | OU5 Residual: Remainder of the FEMP Surface Soil | Clean Top Soil[b] (on RCRA-Type Caps and over disposal vaults) |
|---|---|---|---|---|---|
| 2-Chlorophenol | NC | NC | NC | NC | 0.00 |
| 2-Methyl-naphthalene | NC | $1.86 \times 10^{-4}$ | $1.86 \times 10^{-4}$ | NC | 0.00 |
| 4-Chlorophenyl-phenylether | NC | NC | NC | NC | 0.00 |
| 4,4-DDT | NC | NC | NC | NC | 0.00 |
| Antimony | $2.57 \times 10^{-2}$ | $2.66 \times 10^{-2}$ | $2.66 \times 10^{-2}$ | $2.33 \times 10^{-2}$ | 0.00 |
| Aroclor-1016 | NC | NC | NC | NC | 0.00 |
| Aroclor-1221 | NC | $7.09 \times 10^{-5}$ | $7.09 \times 10^{-5}$ | NC | 0.00 |
| Aroclor-1242 | NC | NC | NC | NC | 0.00 |
| Aroclor-1248 | NC | $4.70 \times 10^{-5}$ | $4.70 \times 10^{-5}$ | NC | 0.00 |
| Aroclor-1254 | $2.56 \times 10^{-5}$ | $2.10 \times 10^{-3}$ | $2.10 \times 10^{-3}$ | $9.05 \times 10^{-5}$ | 0.00 |
| Aroclor-1260 | NC | $2.39 \times 10^{-3}$ | $2.39 \times 10^{-3}$ | NC | 0.00 |
| Arsenic | $6.83 \times 10^{-3}$ | $2.19 \times 10^{-2}$ | $2.19 \times 10^{-2}$ | $8.06 \times 10^{-3}$ | 0.00 |
| Barium | $7.63 \times 10^{-2}$ | $3.08 \times 10^{0}$ | $3.08 \times 10^{0}$ | $6.47 \times 10^{-2}$ | 0.00 |
| Beryllium | $7.40 \times 10^{-4}$ | $2.05 \times 10^{-3}$ | $2.05 \times 10^{-3}$ | $6.82 \times 10^{-4}$ | 0.00 |
| Cadmium | $4.85 \times 10^{-3}$ | $5.89 \times 10^{-3}$ | $5.89 \times 10^{-3}$ | $4.36 \times 10^{-3}$ | 0.00 |
| Chromium | $2.43 \times 10^{-2}$ | $6.45 \times 10^{-2}$ | $6.45 \times 10^{-2}$ | $1.53 \times 10^{-2}$ | 0.00 |
| Cobalt | $1.14 \times 10^{-2}$ | $1.78 \times 10^{-2}$ | $1.78 \times 10^{-2}$ | $9.25 \times 10^{-3}$ | 0.00 |
| Copper | $2.03 \times 10^{-2}$ | $1.09 \times 10^{-1}$ | $1.09 \times 10^{-1}$ | $1.72 \times 10^{-2}$ | 0.00 |
| Cyanide | $1.69 \times 10^{-3}$ | $1.23 \times 10^{-2}$ | $1.23 \times 10^{-2}$ | $9.05 \times 10^{-5}$ | 0.00 |
| Di-n-octyl phthalate | $5.60 \times 10^{-4}$ | $1.97 \times 10^{-4}$ | $1.97 \times 10^{-4}$ | NC | 0.00 |
| Heptachlorodibenzo-furan | NC | NC | NC | NC | 0.00 |
| Heptachlorodibenzo-p-dioxin | NC | NC | NC | NC | 0.00 |
| Lead | $1.26 \times 10^{-2}$ | $3.76 \times 10^{-1}$ | $3.76 \times 10^{-1}$ | $2.54 \times 10^{-2}$ | 0.00 |
| Manganese | $5.68 \times 10^{-1}$ | $7.11 \times 10^{-1}$ | $7.11 \times 10^{-1}$ | $4.36 \times 10^{-1}$ | 0.00 |
| Mercury | $1.20 \times 10^{-4}$ | $1.11 \times 10^{-3}$ | $1.11 \times 10^{-3}$ | NC | 0.00 |
| Molybdenum | $1.44 \times 10^{-2}$ | $3.93 \times 10^{-3}$ | $3.93 \times 10^{-3}$ | $3.70 \times 10^{-3}$ | 0.00 |
| Nickel | $2.77 \times 10^{-2}$ | $5.03 \times 10^{-2}$ | $5.03 \times 10^{-2}$ | $2.49 \times 10^{-2}$ | 0.00 |
| Octachlorodibenzo-furan | NC | NC | NC | NC | 0.00 |
| Octachlorodibenzo-p-dioxin | NC | NC | NC | NC | 0.00 |
| Selenium | $4.87 \times 10^{-3}$ | $3.17 \times 10^{-4}$ | $3.17 \times 10^{-4}$ | NC | 0.00 |
| Thallium | $6.06 \times 10^{-4}$ | $5.83 \times 10^{-4}$ | $5.83 \times 10^{-4}$ | $2.40 \times 10^{-4}$ | 0.00 |
| Vanadium | $2.43 \times 10^{-2}$ | $3.04 \times 10^{-2}$ | $3.04 \times 10^{-2}$ | $2.09 \times 10^{-2}$ | 0.00 |
| Zinc | $5.09 \times 10^{-2}$ | $2.86 \times 10^{-1}$ | $2.86 \times 10^{-1}$ | $4.52 \times 10^{-2}$ | 0.00 |

NC = Not characterized.
[a]Based on a PM10 Emission Rate of $8.54 \times 10^{-4}$ $g/s/m^2$ for a 12.5 m/s wind and contaminant concentration in surface soil.
[b]Assumes that clean top soil does not contribute to air contaminant emissions.

## TABLE K.6-18
## Rn-222 FLUXES FROM RAECOM MODEL

| Emission Source | Ra-226 Concentration (pCi/g) | Rn-222 Flux ($pCi/s/m^2$) | |
|---|---|---|---|
| | | Current | Future |
| OU1 Residual Soil | 5.00 | $2.50 \times 10^{-4}$ | $3.13 \times 10^{-2}$ |
| OU2 Solid Waste Landfill | 1.03 | $5.15 \times 10^{-5}$ | $6.44 \times 10^{-3}$ |
| OU2 Lime Sludge Ponds | 17.40 | $8.69 \times 10^{-4}$ | $1.09 \times 10^{-1}$ |
| OU2 Inactive Flyash Pile | 48.90 | $2.44 \times 10^{-3}$ | $3.06 \times 10^{-1}$ |
| OU2 Active Flyash Pile | 3.88 | $1.94 \times 10^{-4}$ | $2.43 \times 10^{-2}$ |
| OU2 South Field (North End) | 60.11 | $2.28 \times 10^{-3}$ | $2.80 \times 10^{-1}$ |
| OU2 South Field (Middle) | 9.12 | $3.46 \times 10^{-4}$ | $4.25 \times 10^{-2}$ |
| OU2 South Field (South End) | 146.91 | $5.57 \times 10^{-3}$ | $6.85 \times 10^{-1}$ |
| OU4 Residual Soil | 5.00 | $8.05 \times 10^{-1}$ | $2.14 \times 10^{0}$ |
| OU5 Soil (Beneath Plants 2/3, 6, 9) | 5.00 | $2.14 \times 10^{0}$ | $2.14 \times 10^{0}$ |
| OU5 Soil (Beneath rest of OU3 areas) | 1.09 | $2.01 \times 10^{-1}$ | $2.01 \times 10^{-1}$ |
| OU5 Surface Soil (remainder of the FEMP) | 1.14 | $2.10 \times 10^{-1}$ | $2.10 \times 10^{-1}$ |
| OU1 Wastes (in NW vaults) | 342.00 | $2.86 \times 10^{-16}$ | $6.81 \times 10^{-15}$ |
| OU3 Wastes (in E vaults) | 134.00 | $1.12 \times 10^{-16}$ | $2.67 \times 10^{-15}$ |
| OU4 Wastes (in NE vaults) | 37.30 | $1.95 \times 10^{-16}$ | $4.64 \times 10^{-15}$ |
| OU5 Wastes (in E vaults) | 134.00 | $1.12 \times 10^{-16}$ | $2.67 \times 10^{-15}$ |

K.6.2.6 Meteorological Data

Meteorological data characterizing the transport and dispersion conditions of an area are needed as input to the ISCLT2 model. These data include wind speed, wind direction, atmospheric stability, ambient air temperature, and mixing height. Measurements for all of these meteorological parameters, except mixing height, have been recorded at the FEMP site as part of a comprehensive environmental monitoring program since August 1986.

Direct measurements of wind speed, wind direction, and ambient air temperature were taken at a height of 10 meters (30 feet) above the ground. Atmospheric stability was derived from direct measurements of the standard deviation of the horizontal wind direction ($\sigma_\theta$) during the day and the low-level temperature difference ($\Delta T$) at night. Measurements of $\sigma_\theta$ were taken at a height of 60 meters (180 feet) above the ground. The temperature difference was calculated from air temperature measurements taken at 60 and 10 meters (180 and 30 feet) above the ground. Site-specific hourly measurements were obtained for 1987 through 1992. The annual summaries of the joint frequency distribution of wind speed, wind direction, and atmospheric stability for years 1987 through 1992 are presented in Attachment K.III. A six-year composite joint frequency distribution is also presented in Attachment K.III. The composite distribution was used in the ISCLT2 dispersion model.

Mixing heights were determined from twice daily atmospheric soundings made by the National Weather Service (NWS). The nearest NWS station is in Dayton, Ohio.

K.6.2.7 Receptor Locations

As previously stated, the objective of the air transport analysis was to determine the maximum on-and off-property contaminant concentrations for risk assessment calculations. A rectangular receptor grid was used to determine the maximum on-property concentrations and approximate locations. The grid consisted of 900 receptor points in a 152.4 x 152.4 meter (500 x 500 foot) pattern which extended approximately 1200 meters (4000 feet) beyond the FEMP property.
The FEMP coordinate system was used for origin and location.

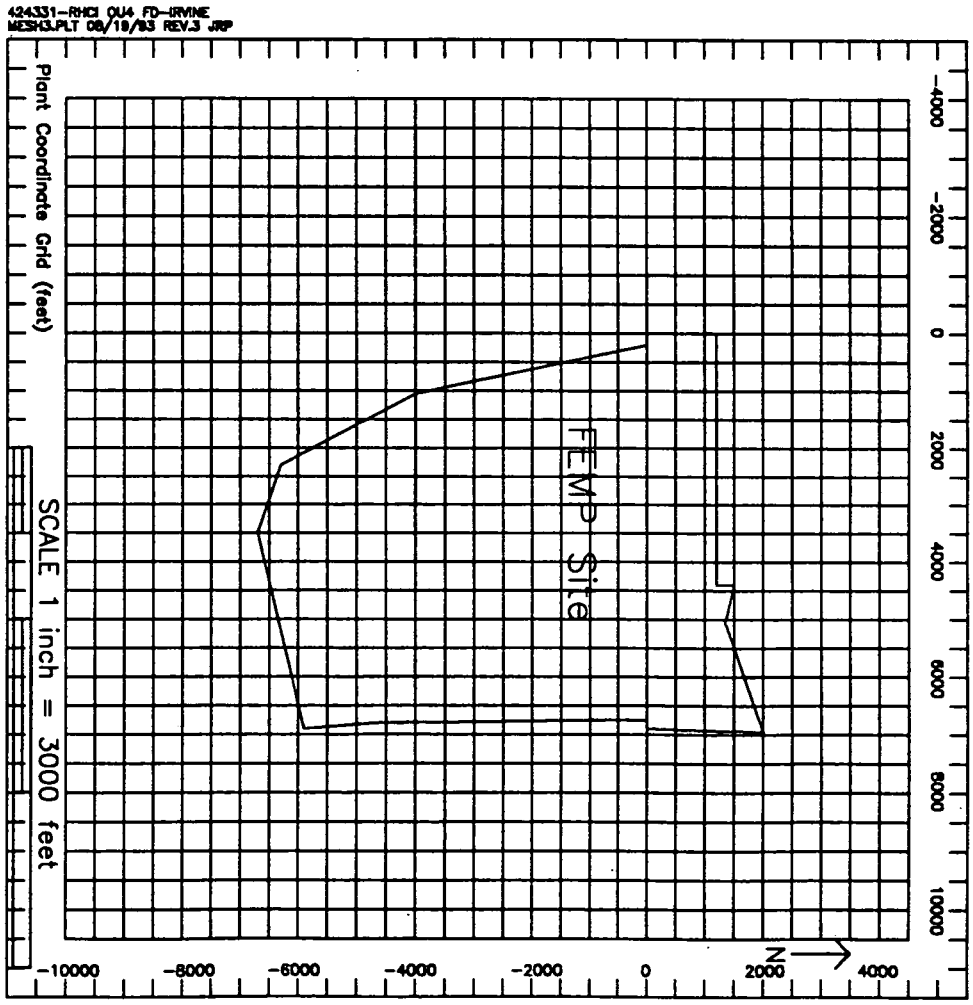
Thirty-six fenceline receptor points located around the FEMP were included in the air transport analysis to identify the maximum off-property receptor. These fenceline receptor locations were

determined from the intersection of the FEMP fenceline and imaginary lines extending in 36 directions at 10-degree intervals from a point along the centerline and halfway between Silos 1 and 2 in Operable Unit 4. The analysis results for the fenceline receptor with the highest air quality impacts are reported as the maximum off-property concentrations in Section K.6.10. This receptor was typically located along the FEMP eastern fenceline. In addition, several discrete locations were identified to represent sensitive receptors. These locations included three schools: Elda, Ross High, and Township.

Figure K.6-22 shows the layout of the receptor grid considered in the air dispersion modeling. Because the concentrations were used primarily to estimate inhalation pathway risk for outdoor

**FIGURE K.6-22**

**RECEPTOR GRIDS FOR AIR DISPERSION MODELING**




0211

activities, the receptors were assumed to be 1.5 meters (5 feet) above the ground to simulate a typical person's breathing height for outdoor activities (EPA 1989l). The variation of ground level concentration within 0 to 1.5 meters is negligible.

K.6.2.8 Dispersion Coefficients

The selection of rural or urban dispersion coefficients for use in the ISCLT2 model was based on a land-use typing procedure to determine whether the characteristics of the area around the FEMP are primarily rural or urban. The procedure involved classifying the land use within an area circumscribed by a 3 kilometer (1.9 mile) radius about the site. Urban dispersion coefficients were recommended for use if land-use types of heavy industrial, light-to-moderate industrial, commercial, single-compact residential, and multi-compact residential account for 50 percent or more of the area. Otherwise, rural dispersion coefficients were recommended.

A review of U.S. Geological Survey (USGS) maps and a site survey of the area indicated that industrial, commercial, and compact residential land use comprise no more than 10 percent of the area within a 3 kilometer (1.9 mile) radius of the site. Therefore, the area was classified as rural for the purpose of air dispersion modeling, indicating the use of rural dispersion coefficients would be appropriate.

K.6.2.9 Model Output Processing

The air dispersion modeling analysis was simplified by running the ISCLT2 model, which assumed a unit emission rate of 1.0 g/s/m$^2$ or 1.0 pCi/s/m$^2$ for each area source. The source group and plot file options of the ISCLT2 program were used to group sources and write the grouped results to a plot file. The ISCLT2 source group results were multiplied by the contaminant emission rates listed in Tables K.6-14 through K.6-18 to determine the contaminant-specific annual concentrations presented in Section K.6.2.10. Spreadsheets were used to calculate the contaminant-specific concentrations from the ISCLT2 model output and emissions data in Tables K.6-14 through K.6-18.

The 243 area sources were combined into 16 source groups:

1. Operable Unit 1 residual soil (covered with a RCRA-type cap)
2. Operable Unit 2 solid waste landfill (covered with a RCRA-type cap)

3. Operable Unit 2 lime sludge ponds (covered with a RCRA-type cap)
4. Operable Unit 2 inactive flyash pile (covered with a RCRA-type cap)
5. Operable Unit 2 active flyash pile (covered with a RCRA-type cap)
6. Operable Unit 2 South Field, north end (covered with a RCRA-type cap)
7. Operable Unit 2 South Field, middle (covered with a RCRA-type cap)
8. Operable Unit 2 South Field, south end (covered with a RCRA-type cap)
9. Operable Unit 4 residual soil
10. Operable Unit 5 treated soil beneath Plants 2/3, 6, and 9
11. Operable Unit 5 residual soil beneath the rest of the former production area
12. Operable Unit 5 surface soil for remainder of FEMP
13. Operable Unit 1 wastes disposed in on-property vaults
14. Operable Unit 3 wastes disposed in on-property vaults
15. Operable Unit 4 wastes disposed in on-property vaults
16. Operable Unit 5 wastes disposed in on-property vaults

K.6.2.10 Results of Air Dispersion Modeling

This section presents the modeled air concentration for each contaminant and each scenario. In addition, the modeled concentrations of several radionuclides are compared to the monitored air concentrations from previous years to determine the effectiveness of mitigation measures and to identify the magnitude of uncertainties in the analysis.

K.6.2.10.1 Current Land Use Scenario

The modeled maximum annual average radionuclide air concentrations are presented in Table K.6-19 and chemical concentrations in Table K.6-20. The values presented are the maximum on-property concentration, maximum off-property (fenceline) concentration, and maximum concentration at a sensitive receptor for each contaminant. In addition to these maximum values, Table K.6-21 presents the average on-property concentrations for areas not covered by a RCRA-type cap or used for the on-property disposal vaults. The average values were used to estimate risks to the groundskeeper and

trespasser under the current scenario. These receptors were assumed to roam or wander over the property and would not stay in one localized area.

Gaseous Rn-222 emissions resulted in the highest activity concentrations of any radionuclide analyzed by at least three orders of magnitude. The maximum on-property, fenceline, and sensitive receptor concentrations of Rn-222 were modeled at 9.43, 4.02, and 0.334 pCi/m$^3$, respectively. Isopleths of current scenario Rn-222 concentrations are shown on Figure K.6-23. The maximum value is approximately three orders of magnitude below the EPA action level of 4000 pCi/m$^3$ (4 pCi/l) for indoor radon concentrations. The maximum value is also two orders of magnitude below the annual average U.S. residential radon concentration of 1250 pCi/m$^3$ (Marcinowski and Napolitano 1993).

Approximately 98 percent of the modeled Rn-222 concentrations were associated with Operable Unit 5. The remediated soil in the former production area accounted for approximately 56 percent of the maximum on-property concentration; the surface soil on the rest of the former production area accounted for approximately 21 percent; and surface soil on the remainder of the FEMP accounted for approximately 22 percent. The remediated soil in the former production area accounted for approximately 22 percent of the maximum fenceline concentration; the surface soil on the rest of the former production area accounted for approximately 27 percent; and surface soil on the remainder of the FEMP accounted for approximately 49 percent.

## TABLE K.6-19

## RADIONUCLIDE CONCENTRATIONS IN AIR (pCi/m3): CURRENT SCENARIO[a]

| Radionuclide | Maximum On-Property | Maximum Off-Property | Maximum Sensitive Receptor |
|---|---|---|---|
| Am-241 | NC | NC | NC |
| Cs-137 | $7.80 \times 10^{-5}$ | $4.60 \times 10^{-5}$ | $4.10 \times 10^{-6}$ |
| Np-237 | $3.60 \times 10^{-5}$ | $1.60 \times 10^{-5}$ | $7.50 \times 10^{-7}$ |
| Pa-231 | $1.25 \times 10^{-4}$ | $5.50 \times 10^{-5}$ | $2.60 \times 10^{-6}$ |
| Pb-210 | $3.59 \times 10^{-3}$ | $1.59 \times 10^{-3}$ | $7.60 \times 10^{-5}$ |
| Pu-238 | $1.65 \times 10^{-4}$ | $8.00 \times 10^{-5}$ | $4.70 \times 10^{-6}$ |
| Pu-239 | $7.20 \times 10^{-5}$ | $3.90 \times 10^{-5}$ | $2.80 \times 10^{-6}$ |
| Pu-240 | $7.20 \times 10^{-5}$ | $3.90 \times 10^{-5}$ | $2.80 \times 10^{-6}$ |
| Ra-226 | $1.43 \times 10^{-4}$ | $8.00 \times 10^{-5}$ | $7.00 \times 10^{-6}$ |
| Ra-228 | $1.59 \times 10^{-4}$ | $8.70 \times 10^{-5}$ | $7.60 \times 10^{-6}$ |
| Rn-222 | $9.43 \times 10^{0}$ | $4.02 \times 10^{0}$ | $3.34 \times 10^{-1}$ |
| Ru-106 | NC | NC | NC |
| Sr-90 | $3.03 \times 10^{-4}$ | $1.52 \times 10^{-4}$ | $9.80 \times 10^{-6}$ |
| Tc-99 | $2.00 \times 10^{-3}$ | $9.15 \times 10^{-4}$ | $4.60 \times 10^{-5}$ |
| Th-228 | $2.09 \times 10^{-4}$ | $1.43 \times 10^{-4}$ | $1.20 \times 10^{-5}$ |
| Th-230 | $2.40 \times 10^{-4}$ | $1.49 \times 10^{-4}$ | $1.30 \times 10^{-5}$ |
| Th-232 | $1.51 \times 10^{-4}$ | $8.00 \times 10^{-5}$ | $7.00 \times 10^{-6}$ |
| U-234 | $3.60 \times 10^{-3}$ | $1.65 \times 10^{-3}$ | $1.03 \times 10^{-4}$ |
| U-235 | $9.60 \times 10^{-5}$ | $4.40 \times 10^{-5}$ | $2.70 \times 10^{-6}$ |
| U-236 | $4.00 \times 10^{-5}$ | $1.80 \times 10^{-5}$ | $1.10 \times 10^{-6}$ |
| U-238 | $2.16 \times 10^{-3}$ | $9.87 \times 10^{-4}$ | $6.20 \times 10^{-5}$ |

NC = Not characterized.
[a]Assumes that Ra-226, Ra-228, Th-230, and Th-232 concentrations in OU3, OU4, and OU5 soil have been reduced to 5 pCi/g :(from SWCR, Part III, Table 2-3) or less; and U-238 concentrations have been reduced to 60 pCi/g (risk-based PRG for recreational user from SWCR, Part III, Table 2-3) or less. Assumes that RCRA-type caps on OU1 and OU2 are completely intact. Assumes that the on-property disposal vaults remain intact. Assumes that clean top soil covers the OU4 area.

## TABLE K.6-20

## CHEMICAL CONCENTRATIONS IN AIR ($\mu g/m^3$): CURRENT SCENARIO[a]

| Chemical | Maximum On-Property | Maximum Off-Property | Maximum Sensitive Receptor |
|---|---|---|---|
| 2-Chlorophenol | NC | NC | NC |
| 2-Methyl-naphthalene | $1.10 \times 10^{-5}$ | $4.99 \times 10^{-6}$ | $2.37 \times 10^{-7}$ |
| 4-Chlorophenyl-phenylether | NC | NC | NC |
| 4,4-DDT | NC | NC | NC |
| Antimony | $2.79 \times 10^{-3}$ | $1.94 \times 10^{-3}$ | $1.69 \times 10^{-4}$ |
| Aroclor 1016 | NC | NC | NC |
| Aroclor 1221 | $4.23 \times 10^{-6}$ | $1.86 \times 10^{-6}$ | $9.30 \times 10^{-8}$ |
| Aroclor 1242 | NC | NC | NC |
| Aroclor 1248 | $2.79 \times 10^{-6}$ | $1.27 \times 10^{-6}$ | $6.00 \times 10^{-8}$ |
| Aroclor 1254 | $1.27 \times 10^{-4}$ | $6.00 \times 10^{-5}$ | $3.13 \times 10^{-6}$ |
| Aroclor 1260 | $1.44 \times 10^{-4}$ | $6.34 \times 10^{-5}$ | $3.04 \times 10^{-4}$ |
| Arsenic | $1.69 \times 10^{-3}$ | $9.30 \times 10^{-4}$ | $7.36 \times 10^{-5}$ |
| Barium | $1.89 \times 10^{-1}$ | $8.51 \times 10^{-2}$ | $4.23 \times 10^{-3}$ |
| Beryllium | $1.61 \times 10^{-4}$ | $8.46 \times 10^{-5}$ | $6.43 \times 10^{-6}$ |
| Cadmium | $5.75 \times 10^{-4}$ | $3.72 \times 10^{-4}$ | $3.21 \times 10^{-5}$ |
| Chromium | $4.65 \times 10^{-3}$ | $2.45 \times 10^{-3}$ | $1.69 \times 10^{-4}$ |
| Cobalt | $1.52 \times 10^{-3}$ | $9.30 \times 10^{-4}$ | $7.53 \times 10^{-5}$ |
| Copper | $7.44 \times 10^{-3}$ | $3.72 \times 10^{-3}$ | $2.37 \times 10^{-4}$ |
| Cyanide | $7.44 \times 10^{-4}$ | $3.30 \times 10^{-4}$ | $1.61 \times 10^{-5}$ |
| Di-n-octyl phthalate | $1.18 \times 10^{-5}$ | $5.24 \times 10^{-6}$ | $2.54 \times 10^{-7}$ |
| Heptachlorodibenzo-furan | NC | NC | NC |
| Heptachlorodibenzo-p-dioxin | NC | NC | NC |
| Lead | $2.38 \times 10^{-2}$ | $1.12 \times 10^{-2}$ | $6.09 \times 10^{-4}$ |
| Manganese | $6.52 \times 10^{-2}$ | $3.86 \times 10^{-2}$ | $3.38 \times 10^{-3}$ |
| Mercury | $6.68 \times 10^{-5}$ | $2.96 \times 10^{-5}$ | $1.44 \times 10^{-6}$ |
| Molybdenum | $4.31 \times 10^{-4}$ | $2.96 \times 10^{-4}$ | $2.62 \times 10^{-5}$ |
| Nickel | $4.31 \times 10^{-3}$ | $2.45 \times 10^{-3}$ | $2.03 \times 10^{-4}$ |
| Octachlorodibenzofuran | NC | NC | NC |
| Octachlorodibenzo-p-dioxin | NC | NC | NC |
| Selenium | $1.94 \times 10^{-5}$ | $8.46 \times 10^{-6}$ | $4.06 \times 10^{-7}$ |
| Thallium | $4.74 \times 10^{-5}$ | $2.62 \times 10^{-5}$ | $2.11 \times 10^{-6}$ |
| Vanadium | $2.87 \times 10^{-3}$ | $1.78 \times 10^{-3}$ | $1.61 \times 10^{-4}$ |
| Zinc | $1.94 \times 10^{-2}$ | $9.64 \times 10^{-3}$ | $6.09 \times 10^{-4}$ |

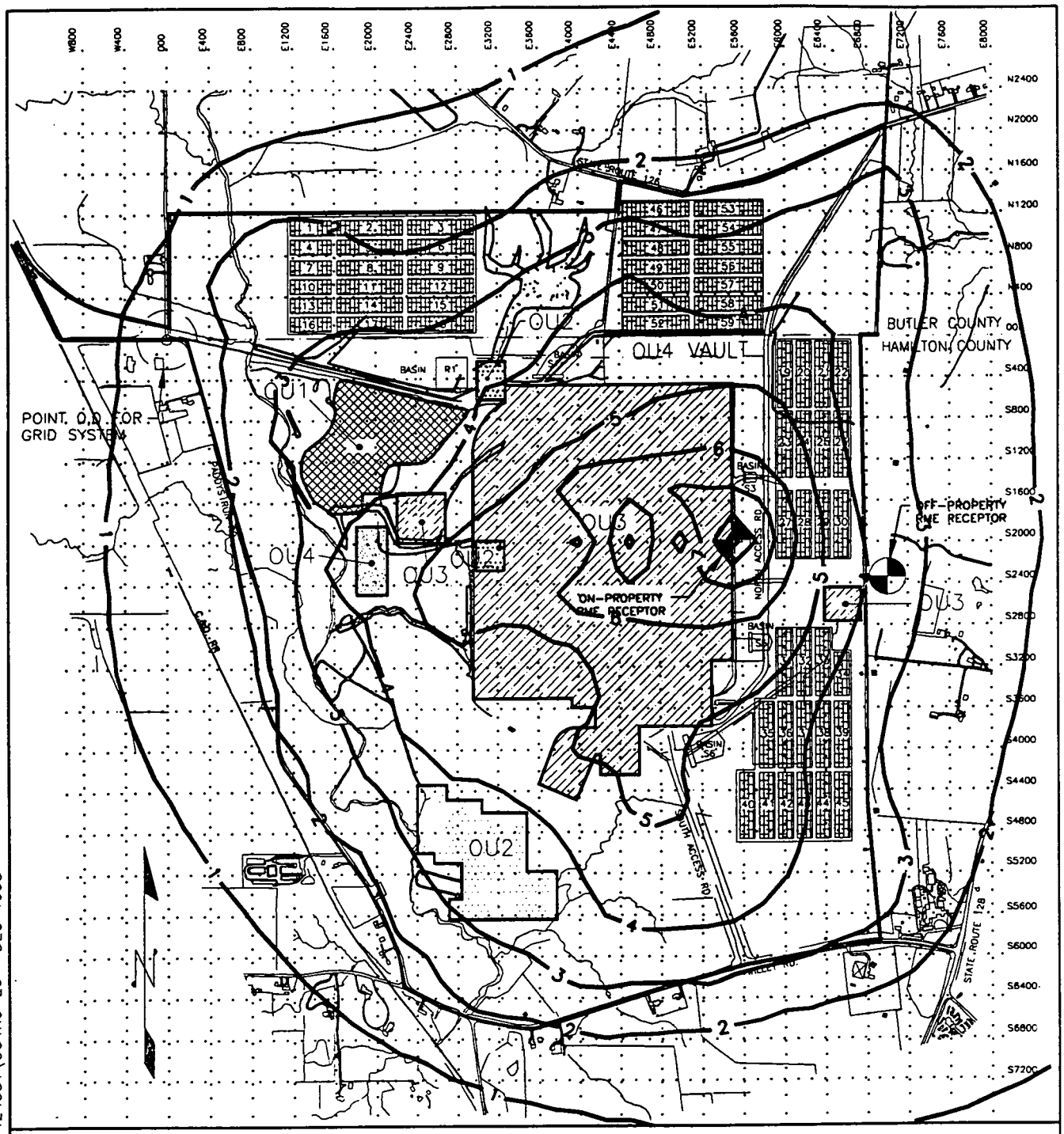
NC = Not characterized.
[a]Assumes that Ra-226, Ra-228, Th-228, Th-230, and Th-232 concentrations in OU3, OU4, and OU5 soil have been reduced to 5 pCi/g (ARAR from SWCR, Part III, Table 2-3); and U-238 concentrations have been reduced to 60 pCi/g (risk-based PRG for recreational user from SWCR, Part III, Table 2-3). Assumes that RCRA-type caps on OU1 and OU2 are completely intact. Assumes that the on-property disposal vaults remain intact. Assumes that clean top soil covers the OU4 area.

## TABLE K.6-21

## AVERAGE ON-PROPERTY CONTAMINANT CONCENTRATIONS IN AIR: CURRENT SCENARIO

| Radionuclide | Concentration ($pCi/m^3$) | Chemical | Concentration ($\mu g/m^3$) |
|---|---|---|---|
| Am-241 | NC | 2-Chlorophenol | NC |
| Cs-137 | $4.74 \times 10^{-5}$ | 2-Methyl-naphthalene | $3.29 \times 10^{-6}$ |
| Np-237 | $1.05 \times 10^{-5}$ | 4-Chlorophenyl-phenylether | NC |
| Pa-231 | $3.66 \times 10^{-5}$ | 4,4-DDT | NC |
| Pb-210 | $1.05 \times 10^{-3}$ | Antimony | $1.91 \times 10^{-3}$ |
| Pu-238 | $6.18 \times 10^{-5}$ | Aroclor 1016 | NC |
| Pu-239 | $3.48 \times 10^{-5}$ | Aroclor 1221 | $1.25 \times 10^{-6}$ |
| Pu-240 | $3.48 \times 10^{-5}$ | Aroclor 1242 | NC |
| Ra-226 | $8.07 \times 10^{-5}$ | Aroclor 1248 | $8.29 \times 10^{-7}$ |
| Ra-228 | $8.84 \times 10^{-5}$ | Aroclor 1254 | $4.25 \times 10^{-5}$ |
| Rn-222 | $3.98 \times 10^{-5}$ | Aroclor 1260 | $4.22 \times 10^{-5}$ |
| Ru-106 | NC | Arsenic | $8.84 \times 10^{-4}$ |
| Sr-90 | $1.25 \times 10^{-4}$ | Barium | $5.84 \times 10^{-2}$ |
| Tc-99 | $6.42 \times 10^{-4}$ | Beryllium | $7.84 \times 10^{-5}$ |
| Th-228 | $1.41 \times 10^{-4}$ | Cadmium | $3.74 \times 10^{-4}$ |
| Th-230 | $1.50 \times 10^{-4}$ | Chromium | $2.09 \times 10^{-3}$ |
| Th-232 | $8.15 \times 10^{-5}$ | Cobalt | $8.87 \times 10^{-4}$ |
| U-234 | $1.33 \times 10^{-3}$ | Copper | $3.00 \times 10^{-3}$ |
| U-235 | $3.55 \times 10^{-5}$ | Cyanide | $2.23 \times 10^{-4}$ |
| U-236 | $1.47 \times 10^{-5}$ | Di-n-octyl phthalate | $3.47 \times 10^{-6}$ |
| U-238 | $7.99 \times 10^{-4}$ | Heptachlorodibenzo-furan | NC |
| | | Heptachlorodibenzo-p-dioxin | NC |
| | | Lead | $8.20 \times 10^{-3}$ |
| | | Manganese | $3.95 \times 10^{-2}$ |
| | | Mercury | $1.97 \times 10^{-5}$ |
| | | Molybdenum | $2.98 \times 10^{-4}$ |
| | | Nickel | $2.43 \times 10^{-3}$ |
| | | Octachlorodibenzofuran | NC |
| | | Octachlorodibenzo-p-dioxin | NC |
| | | Selenium | $5.59 \times 10^{-6}$ |
| | | Thallium | $2.52 \times 10^{-5}$ |
| | | Vanadium | $1.83 \times 10^{-3}$ |
| | | Zinc | $7.85 \times 10^{-3}$ |

NC = Not characterized.




OU4 CRARE ACAD FILE: 424331\OU4K6-23 DEC 1993

FIGURE K.6-23
RN-222 CONCENTRATION IN AIR FOR CURRENT SCENARIO

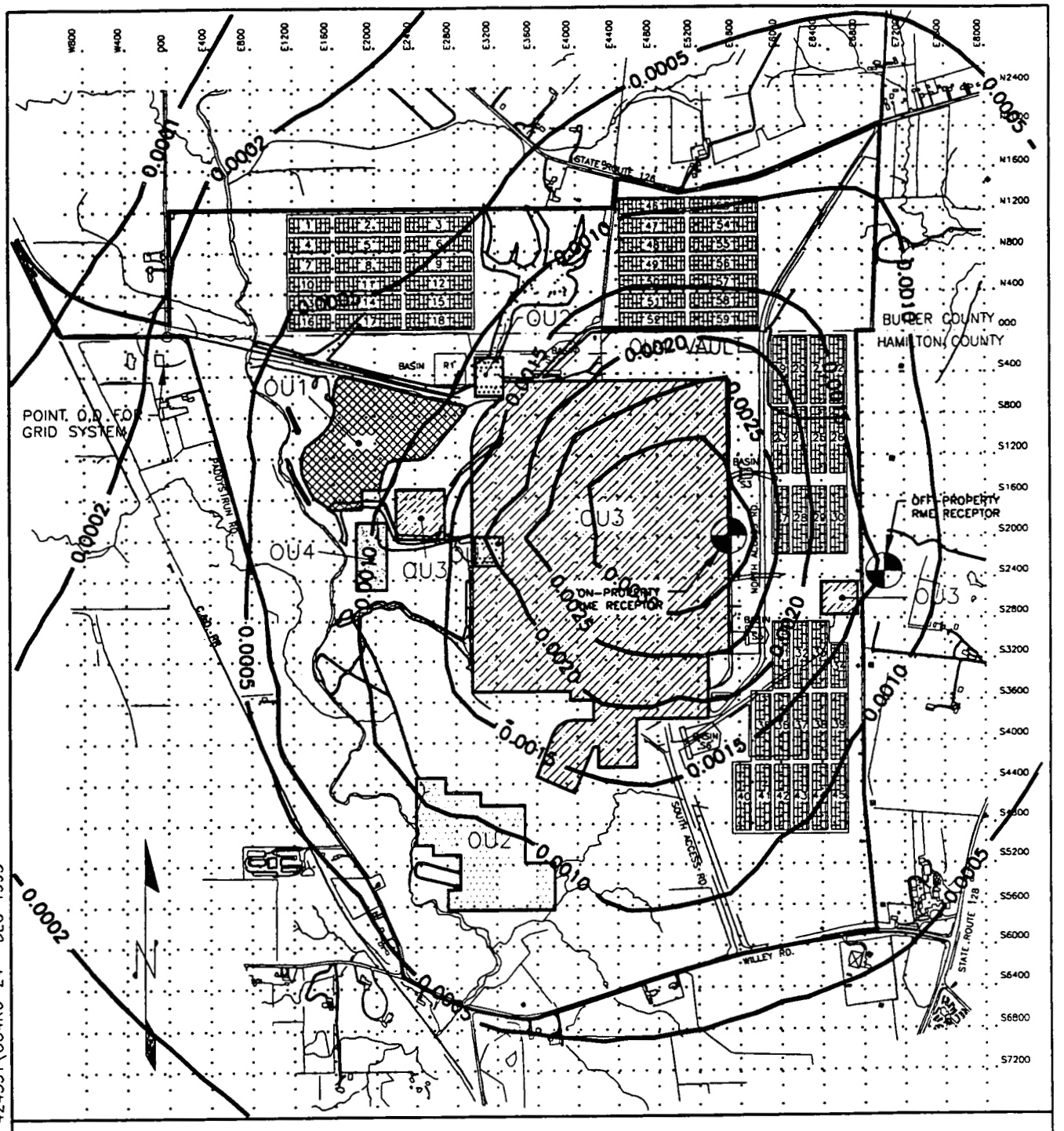
0218

The average monitored fenceline concentrations of Rn-222 were approximately 240, 230, and 310 pCi/$m_3$ (corrected for background levels) during 1989, 1990, and 1991, respectively DOE 1991a and DOE 1992a. This analysis indicates that implementing the LRA's would result in mitigating approximately 95 to 97 percent of existing Rn-222 emission impacts.

Modeled concentrations of U-234 and U-238 typically represented the next-highest radionuclide activity concentrations, after Rn-222. The maximum on-property, fenceline, and sensitive receptor concentrations of U-234 were modeled at 0.0036, 0.0017, and 0.00010 pCi/$m^3$, respectively. The maximum on-property, fenceline, and sensitive receptor concentrations of U-238 were 0.0022, 0.00099, and 0.000062 pCi/$m^3$, respectively. Isopleths of current scenario U-234 and U-238 concentrations are presented on Figures K.6-24 and K.6-25, respectively.

One hundred percent of the modeled U-234 and U-238 concentrations were associated with Operable Unit 5. The remediated soil in the former production area accounted for approximately 27 percent of the maximum on-property uranium concentrations; the surface soil on the rest of the former production area accounted for approximately 62 percent; and the surface soil on the remainder of the FEMP accounted for approximately 11 percent. The remediated soil in the former production area accounted for approximately 10 percent of the maximum fenceline concentration; the surface soil on the rest of the former production area accounted for approximately 70 percent; and the surface soil on the remainder of the FEMP accounted for approximately 20 percent.

The maximum monitored fenceline concentration of U-234 was approximately 0.0013 pCi/$m^3$ and of U-238 approximately 0.0012 pCi/$m^3$ during 1990 (DOE 1991a). Monitored and modeled fenceline results for several radionuclides are presented in Table K.6-22. These results indicate that the modeled concentrations are approximately one order of magnitude higher than concentrations currently monitored at the FEMP. Uncertainties in the particle size distributions, wind entrainment emission rates, and contaminant soil concentrations may account for this apparent overprediction by the model. In particular, the assumptions that no soil crust forms on the property and that no nonerodible elements exist on the FEMP served to overestimate the total particulate emissions. The vegetative cover estimate and modal diameter assumed may also have served to overestimate particulate emissions. See Sections K.10.0 and K.11.0 for additional discussion of uncertainty.



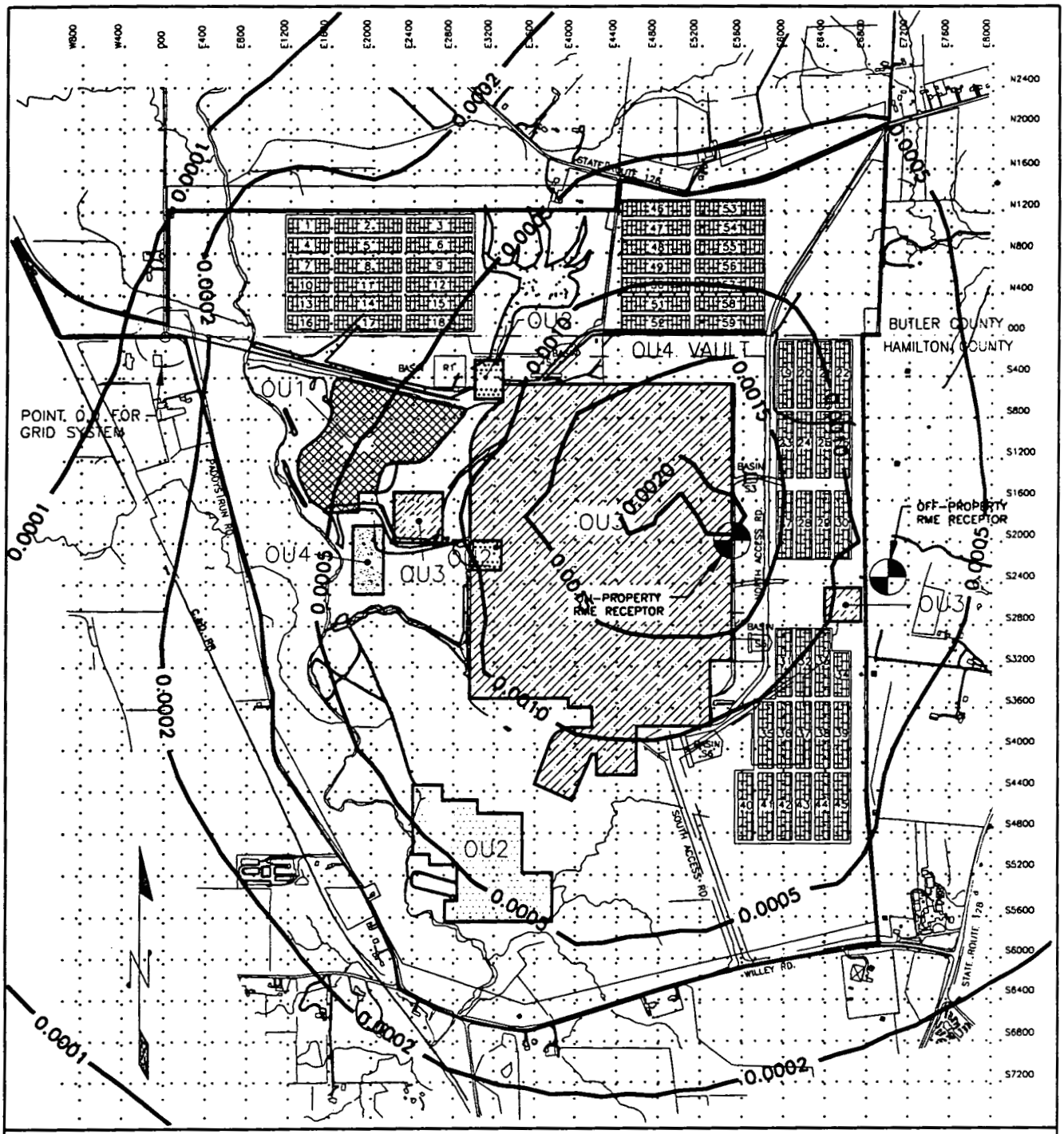

400 0 400 800
SCALE IN FEET

—5— : CONCENTRATION ISOPLETHS ARE IN PICOCURIES PER CUBIC METER

MAX ON-PROPERTY CONC. = 0.00360 pCi/m³

OU4 CRARE ACAD FILE: 424331\OU4K6-24 DEC 1993

FIGURE K.6-24
U-234 CONCENTRATION IN AIR FOR CURRENT SCENARIO




400 0 400 800
SCALE IN FEET

0221

—5— : CONCENTRATION ISOPLETHS ARE IN PICOCURIES PER CUBIC METER

MAX ON-PROPERTY CONC. = 0.00216 pCi/m³

OU4 CRARE ACAD FILE: 424331\OU4K6-25 DEC 1993

FIGURE K.6-25
U-238 CONCENTRATION IN AIR FOR CURRENT SCENARIO

**TABLE K.6-22**
**MODELED AND MONITORED RADIONUCLIDE FENCELINE CONCENTRATIONS IN AIR (pCi/m3)**

| Radionuclide | Modeled Current Scenario | Modeled Future Scenarios | 1990 Monitored Values |
|---|---|---|---|
| Cs-137 | $4.60 \times 10^{-5}$ | $4.60 \times 10^{-5}$ | $<5.9 \times 10^{-5}$ |
| Np-237 | $1.60 \times 10^{-5}$ | $1.60 \times 10^{-5}$ | $<1.4 \times 10^{-6}$ |
| Pu-238 | $8.00 \times 10^{-5}$ | $8.00 \times 10^{-5}$ | $<1.2 \times 10^{-6}$ |
| Pu-239 | $3.90 \times 10^{-5}$ | $3.90 \times 10^{-5}$ | $<1.1 \times 10^{-6}$ |
| Pu-240 | $3.90 \times 10^{-5}$ | $3.90 \times 10^{-5}$ | $<1.1 \times 10^{-6}$ |
| Ra-226 | $8.00 \times 10^{-5}$ | $8.10 \times 10^{-5}$ | $<1.6 \times 10^{-6}$ |
| Ra-228 | $8.70 \times 10^{-5}$ | $8.80 \times 10^{-5}$ | $<1.2 \times 10^{-5}$ |
| Sr-90 | $1.52 \times 10^{-4}$ | $1.52 \times 10^{-4}$ | $3.8 \times 10^{-6}$ |
| Tc-99 | $9.15 \times 10^{-4}$ | $9.15 \times 10^{-4}$ | $<1.1 \times 10^{-4}$ |
| Th-228 | $1.43 \times 10^{-4}$ | $1.44 \times 10^{-4}$ | $<5.8 \times 10^{-6}$ |
| Th-230 | $1.49 \times 10^{-4}$ | $1.50 \times 10^{-4}$ | $6.9 \times 10^{-6}$ |
| Th-232 | $8.00 \times 10^{-5}$ | $8.10 \times 10^{-5}$ | $<5.8 \times 10^{-6}$ |
| U-234 | $1.65 \times 10^{-3}$ | $1.65 \times 10^{-3}$ | $1.3 \times 10^{-4}$ |
| U-235 | $4.40 \times 10^{-5}$ | $4.40 \times 10^{-5}$ | $4.8 \times 10^{-6}$ |
| U-236 | $1.80 \times 10^{-5}$ | $1.90 \times 10^{-5}$ | $1.7 \times 10^{-6}$ |
| U-238 | $9.87 \times 10^{-4}$ | $9.89 \times 10^{-4}$ | $1.2 \times 10^{-4}$ |

SOURCE: DOE 1991a

K.6.2.10.2 Future Land Use Scenarios

The modeled maximum annual average radionuclide concentrations under the Future Land Use scenarios are presented in Table K.6-23 and chemical concentrations in Table K.6-24. The values presented are the maximum on-property concentration, maximum off-property (fenceline) concentration, and maximum concentration at a sensitive receptor for each contaminant. In addition to these maximum values, Table K.6-25 presents the average on-property concentrations for areas not covered by a RCRA-type cap or used for the on-property vaults. The average values were used to estimate risks to the recreational user under the Future Land Use With Federal Ownership scenario. This receptor is assumed to roam or wander over the property and would not stay in one localized area.

Because the major contributor (approximately 99 percent) to all contaminant concentrations under the future scenarios was Operable Unit 5, no significant difference exists between the current and Future Land Use scenario impacts. The future scenarios showed a minor increase of Rn-222 emissions from Operable Units 1, 2, 4, and the vaults, as well as addition of particulate emissions from Operable Unit 4 soil. These increases typically resulted in changes of 1 to 2 percent occurring in the concentration results.

## TABLE K.6-23

## RADIONUCLIDE CONCENTRATIONS IN AIR (pCi/m$^3$): FUTURE SCENARIOS[a]

| Radionuclide | Maximum On-Property | Maximum Off-Property | Maximum Sensitive Receptor |
|---|---|---|---|
| Am-241 | NC | NC | NC |
| Cs-137 | $7.80 \times 10^{-5}$ | $4.60 \times 10^{-5}$ | $4.10 \times 10^{-6}$ |
| Np-237 | $3.60 \times 10^{-5}$ | $1.60 \times 10^{-5}$ | $7.50 \times 10^{-7}$ |
| Pa-231 | $1.66 \times 10^{-4}$ | $6.00 \times 10^{-5}$ | $3.40 \times 10^{-6}$ |
| Pb-210 | $3.61 \times 10^{-3}$ | $1.60 \times 10^{-3}$ | $7.70 \times 10^{-5}$ |
| Pu-238 | $1.65 \times 10^{-4}$ | $8.00 \times 10^{-5}$ | $4.70 \times 10^{-6}$ |
| Pu-239 | $7.20 \times 10^{-5}$ | $3.90 \times 10^{-5}$ | $2.80 \times 10^{-6}$ |
| Pu-240 | $7.20 \times 10^{-5}$ | $3.90 \times 10^{-5}$ | $2.80 \times 10^{-6}$ |
| Ra-226 | $1.45 \times 10^{-4}$ | $8.10 \times 10^{-5}$ | $7.20 \times 10^{-6}$ |
| Ra-228 | $1.59 \times 10^{-4}$ | $8.80 \times 10^{-5}$ | $7.70 \times 10^{-6}$ |
| Rn-222 | $9.59 \times 10^{0}$ | $4.12 \times 10^{0}$ | $3.48 \times 10^{-1}$ |
| Ru-106 | NC | NC | NC |
| Sr-90 | $3.03 \times 10^{-4}$ | $1.52 \times 10^{-4}$ | $9.90 \times 10^{-6}$ |
| Tc-99 | $2.00 \times 10^{-3}$ | $9.15 \times 10^{-4}$ | $4.60 \times 10^{-5}$ |
| Th-228 | $2.11 \times 10^{-4}$ | $1.44 \times 10^{-4}$ | $1.30 \times 10^{-5}$ |
| Th-230 | $2.42 \times 10^{-4}$ | $1.50 \times 10^{-4}$ | $1.30 \times 10^{-5}$ |
| Th-232 | $1.53 \times 10^{-4}$ | $8.10 \times 10^{-5}$ | $7.10 \times 10^{-6}$ |
| U-234 | $3.61 \times 10^{-3}$ | $1.65 \times 10^{-3}$ | $1.04 \times 10^{-4}$ |
| U-235 | $9.60 \times 10^{-5}$ | $4.40 \times 10^{-5}$ | $2.80 \times 10^{-6}$ |
| U-236 | $4.00 \times 10^{-5}$ | $1.90 \times 10^{-5}$ | $1.20 \times 10^{-6}$ |
| U-238 | $2.16 \times 10^{-3}$ | $9.89 \times 10^{-4}$ | $6.20 \times 10^{-5}$ |

NC = Not characterized.

[a]Assumes that Ra-226, Ra-228, Th-228, Th-230, and Th-232 concentrations in OU3, OU4, and OU5 soil have been reduced to 5 pCi/g (From SWCR, Part III, Table 2-3); and U-238 concentrations have been reduced to 60 pCi/g (risk-based PRG for recreational user from SWCR, Part III, Table 2-3). Assumes that RCRA-type caps on OU1 and OU2 are intact, although the top soil and drainage layer are no longer present. Assumes that the on-property disposal vaults remain intact, although the top soil and drainage layer are no longer present. Assumes that no cover remains over OU4 soil.

## TABLE K.6-24

## CHEMICAL CONCENTRATIONS IN AIR ($\mu g/m^3$): FUTURE SCENARIOS[a]

| Chemical | Maximum On-Property | Maximum Off-Property | Maximum Sensitive Receptor |
|---|---|---|---|
| 2-Chlorophenol | NC | NC | NC |
| 2-Methyl-naphthalene | $1.10 \times 10^{-5}$ | $4.99 \times 10^{-6}$ | $2.37 \times 10^{-7}$ |
| 4-Chlorophenyl-phenylether | NC | NC | NC |
| 4,4-DDT | NC | NC | NC |
| Antimony | $2.79 \times 10^{-3}$ | $1.94 \times 10^{-3}$ | $1.69 \times 10^{-4}$ |
| Aroclor 1016 | NC | NC | NC |
| Aroclor 1221 | $4.23 \times 10^{-6}$ | $1.86 \times 10^{-6}$ | $9.30 \times 10^{-8}$ |
| Aroclor 1242 | NC | NC | NC |
| Aroclor 1248 | $2.79 \times 10^{-6}$ | $1.27 \times 10^{-6}$ | $6.00 \times 10^{-8}$ |
| Aroclor 1254 | $1.27 \times 10^{-4}$ | $6.00 \times 10^{-5}$ | $3.13 \times 10^{-6}$ |
| Aroclor 1260 | $1.44 \times 10^{-4}$ | $6.34 \times 10^{-5}$ | $3.04 \times 10^{-6}$ |
| Arsenic | $1.69 \times 10^{-3}$ | $9.30 \times 10^{-4}$ | $7.36 \times 10^{-5}$ |
| Barium | $1.89 \times 10^{-1}$ | $8.51 \times 10^{-2}$ | $4.23 \times 10^{-3}$ |
| Beryllium | $1.61 \times 10^{-4}$ | $8.46 \times 10^{-5}$ | $6.43 \times 10^{-6}$ |
| Cadmium | $5.83 \times 10^{-4}$ | $3.72 \times 10^{-4}$ | $3.21 \times 10^{-5}$ |
| Chromium | $4.65 \times 10^{-3}$ | $2.45 \times 10^{-3}$ | $1.69 \times 10^{-4}$ |
| Cobalt | $1.52 \times 10^{-3}$ | $9.30 \times 10^{-4}$ | $7.61 \times 10^{-5}$ |
| Copper | $7.44 \times 10^{-3}$ | $3.72 \times 10^{-3}$ | $2.37 \times 10^{-4}$ |
| Cyanide | $7.44 \times 10^{-4}$ | $3.30 \times 10^{-4}$ | $1.61 \times 10^{-5}$ |
| Di-n-octyl phthalate | $1.18 \times 10^{-5}$ | $5.33 \times 10^{-6}$ | $2.62 \times 10^{-7}$ |
| Heptachlorodibenzo-furan | NC | NC | NC |
| Heptachlorodibenzo-p-dioxin | NC | NC | NC |
| Lead | $2.38 \times 10^{-2}$ | $1.12 \times 10^{-2}$ | $6.09 \times 10^{-4}$ |
| Manganese | $6.54 \times 10^{-2}$ | $3.88 \times 10^{-2}$ | $3.38 \times 10^{-3}$ |
| Mercury | $6.68 \times 10^{-5}$ | $2.96 \times 10^{-5}$ | $1.44 \times 10^{-6}$ |
| Molybdenum | $4.31 \times 10^{-4}$ | $3.04 \times 10^{-4}$ | $2.62 \times 10^{-5}$ |
| Nickel | $4.31 \times 10^{-3}$ | $2.45 \times 10^{-3}$ | $2.03 \times 10^{-4}$ |
| Octachlorodibenzofuran | NC | NC | NC |
| Octachlorodibenzo-p-dioxin | NC | NC | NC |
| Selenium | $3.55 \times 10^{-5}$ | $9.30 \times 10^{-6}$ | $5.83 \times 10^{-7}$ |
| Thallium | $4.74 \times 10^{-5}$ | $2.62 \times 10^{-5}$ | $2.11 \times 10^{-6}$ |
| Vanadium | $2.87 \times 10^{-3}$ | $1.78 \times 10^{-3}$ | $1.61 \times 10^{-4}$ |
| Zinc | $1.95 \times 10^{-2}$ | $9.72 \times 10^{-3}$ | $6.17 \times 10^{-4}$ |

NC = Not characterized.
[a]Assumes that Ra-226, Ra-228, Th-228, Th-230, and Th-232 concentrations in OU3, OU4, and OU5 soil have been reduced to 5 pCi/g (ARAR from SWCR, Part III, Table 2-3); and U-238 concentrations have been reduced to 60 pCi/g (risk-based PRG for recreational user from SWCR, Part III, Table 2-3). Assumes that RCRA-type caps on OU1 and OU2 are intact, although the top soil and drainage layer are no longer present. Assumes that the on-property disposal vaults remain intact, although the top soil and drainage layer are no longer present. Assumes that no cover remains over OU4 soil.

## TABLE K.6-25

## AVERAGE ON-PROPERTY CONTAMINANT CONCENTRATIONS IN AIR: FUTURE SCENARIOS

| Radionuclide | Concentration ($pCi/m^3$) | Chemical | Concentration ($\mu g/m^3$) |
|---|---|---|---|
| Am | NC | 2-Chlorophenol | NC |
| Cs-137 | $4.75 \times 10^{-5}$ | 2-Methyl-naphthalene | $3.29 \times 10^{-6}$ |
| Np-237 | $1.05 \times 10^{-5}$ | 4-Chlorophenyl-phenylether | NC |
| Pa-231 | $5.10 \times 10^{-5}$ | 4,4-DDT | NC |
| Pb-210 | $1.09 \times 10^{-3}$ | Antimony | $1.93 \times 10^{-3}$ |
| Pu-238 | $6.18 \times 10^{-5}$ | Aroclor 1016 | NC |
| Pu-239 | $3.48 \times 10^{-5}$ | Aroclor 1221 | $1.25 \times 10^{-6}$ |
| Pu-240 | $3.48 \times 10^{-5}$ | Aroclor 1242 | NC |
| Ra-226 | $8.36 \times 10^{-5}$ | Aroclor 1248 | $8.29 \times 10^{-7}$ |
| Ra-228 | $8.97 \times 10^{-5}$ | Aroclor 1254 | $4.26 \times 10^{-5}$ |
| Rn-222 | $4.28 \times 10^{0}$ | Aroclor 1260 | $4.22 \times 10^{-5}$ |
| Ru-106 | NC | Arsenic | $8.87 \times 10^{-4}$ |
| Sr-90 | $1.26 \times 10^{-4}$ | Barium | $5.85 \times 10^{-2}$ |
| Tc-99 | $6.44 \times 10^{-4}$ | Beryllium | $7.88 \times 10^{-5}$ |
| Th-228 | $1.44 \times 10^{-4}$ | Cadmium | $3.77 \times 10^{-4}$ |
| Th-230 | $1.53 \times 10^{-4}$ | Chromium | $2.10 \times 10^{-3}$ |
| Th-232 | $8.43 \times 10^{-5}$ | Cobalt | $8.93 \times 10^{-4}$ |
| U-234 | $1.34 \times 10^{-3}$ | Copper | $3.01 \times 10^{-3}$ |
| U-235 | $3.69 \times 10^{-5}$ | Cyanide | $2.24 \times 10^{-4}$ |
| U-236 | $1.61 \times 10^{-5}$ | Di-n-octyl phthalate | $3.85 \times 10^{-6}$ |
| U-238 | $8.06 \times 10^{-4}$ | Heptachlorodibenzo-furan | NC |
| | | Heptachlorodibenzo-p-dioxin | NC |
| | | Lead | $8.20 \times 10^{-3}$ |
| | | Manganese | $3.99 \times 10^{-2}$ |
| | | Mercury | $1.97 \times 10^{-5}$ |
| | | Molybdenum | $3.05 \times 10^{-4}$ |
| | | Nickel | $2.45 \times 10^{-3}$ |
| | | Octachlorodibenzofuran | NC |
| | | Octachlorodibenzo-p-dioxin | NC |
| | | Selenium | $8.85 \times 10^{-6}$ |
| | | Thallium | $2.55 \times 10^{-5}$ |
| | | Vanadium | $1.84 \times 10^{-3}$ |
| | | Zinc | $7.89 \times 10^{-3}$ |

NC = Not characterized.

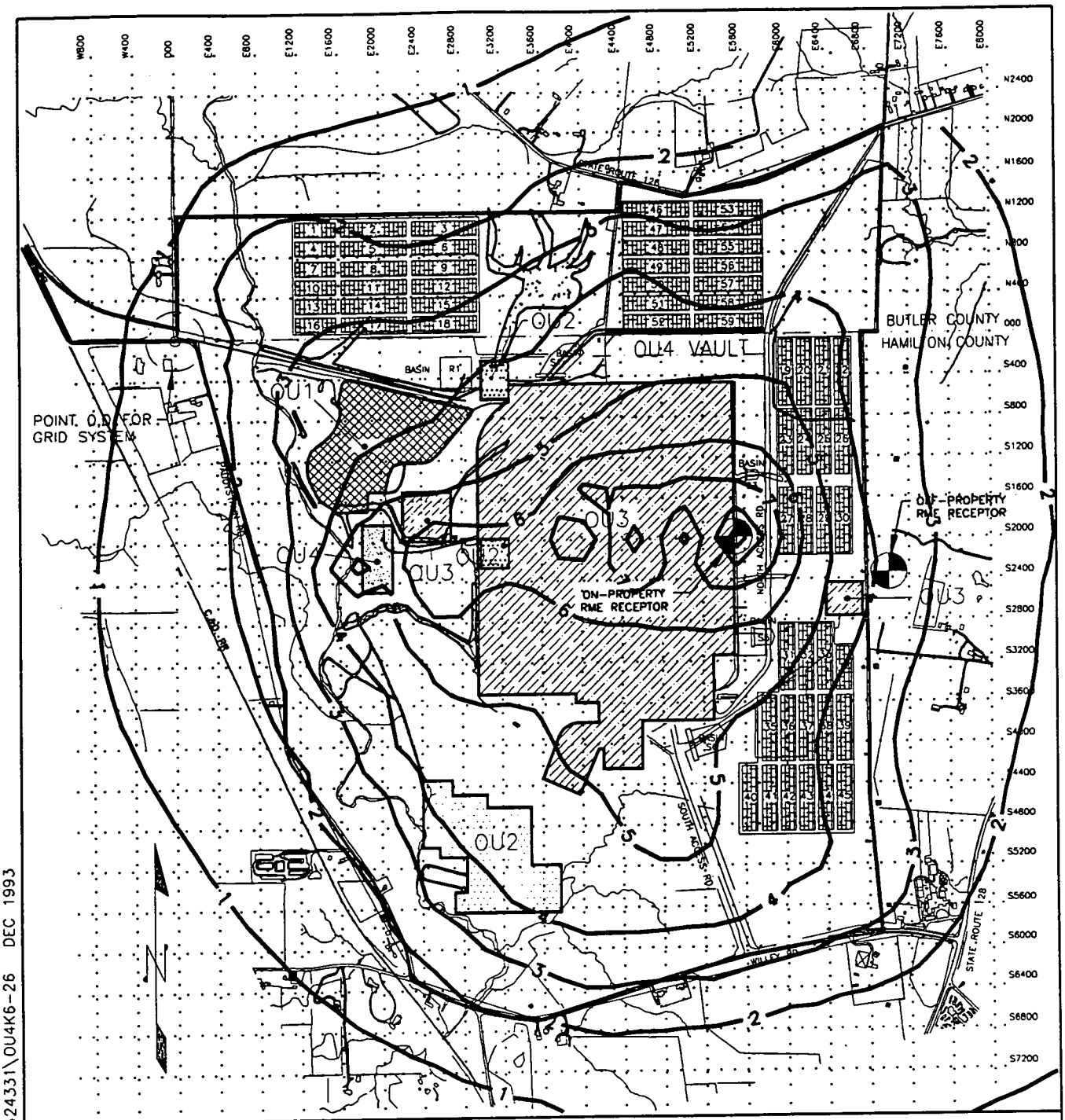
As with the current scenario, the future scenario gaseous Rn-222 emissions resulted in the highest concentrations of any contaminant analyzed by at least three orders of magnitude. The maximum on-property, fenceline, and sensitive receptor concentrations of Rn-222 were modeled at 9.59, 4.12, and 0.35 pCi/m$^3$, respectively. Isopleths of Rn-222 concentrations for future scenario are shown on Figure K.6-26. Again, the maximum value is approximately three orders of magnitude below the EPA action level of 4000 pCi/m$^3$ (4 pCi/l) for indoor radon concentrations.

Approximately 98 percent of the modeled Rn-222 concentrations were associated with Operable Unit 5. The remediated soil in the former production area accounted for approximately 56 percent of the maximum on-property concentration; the surface soil on the rest of the former production area accounted for approximately 21 percent; and surface soil on the remainder of the FEMP accounted for approximately 22 percent. The remediated soil in the former production area accounted for approximately 22 percent of the maximum fenceline concentration; the surface soil on the rest of the former production area accounted for approximately 27 percent; and surface soil on the remainder of the FEMP accounted for approximately 49 percent.

Modeled concentrations of U-234 and U-238 typically represent the next-highest radionuclide impacts, after Rn-222. The maximum on-property, fenceline, and sensitive receptor concentrations of U-234 were modeled at 0.0036, 0.0017, and 0.00010 pCi/m$^3$, respectively. The maximum on-property, fenceline, and sensitive receptor concentrations of U-238 are 0.0022, 0.00099, and 0.000062 pCi/m$^3$, respectively. Isopleths of U-234 and U-238 concentrations for future scenarios are presented on Figures K.6-27 and K.6-28, respectively.

Almost 100 percent of the modeled U-234 and U-238 concentrations were associated with Operable Unit 5. The remediated soil in the former production area accounted for approximately 27 percent of the maximum on-property uranium concentrations; the surface soil on the rest of the former production area accounted for approximately 62 percent; and the surface soil on the remainder of the FEMP accounted for approximately 11 percent. The remediated soil in the former production area accounted for approximately 10 percent of the maximum fenceline concentration; the surface soil on the rest of the former production area accounted for approximately 70 percent; and the surface soil on the remainder of the FEMP accounted for approximately 20 percent.

- 5208




0227

400 0 400 800
SCALE IN FEET

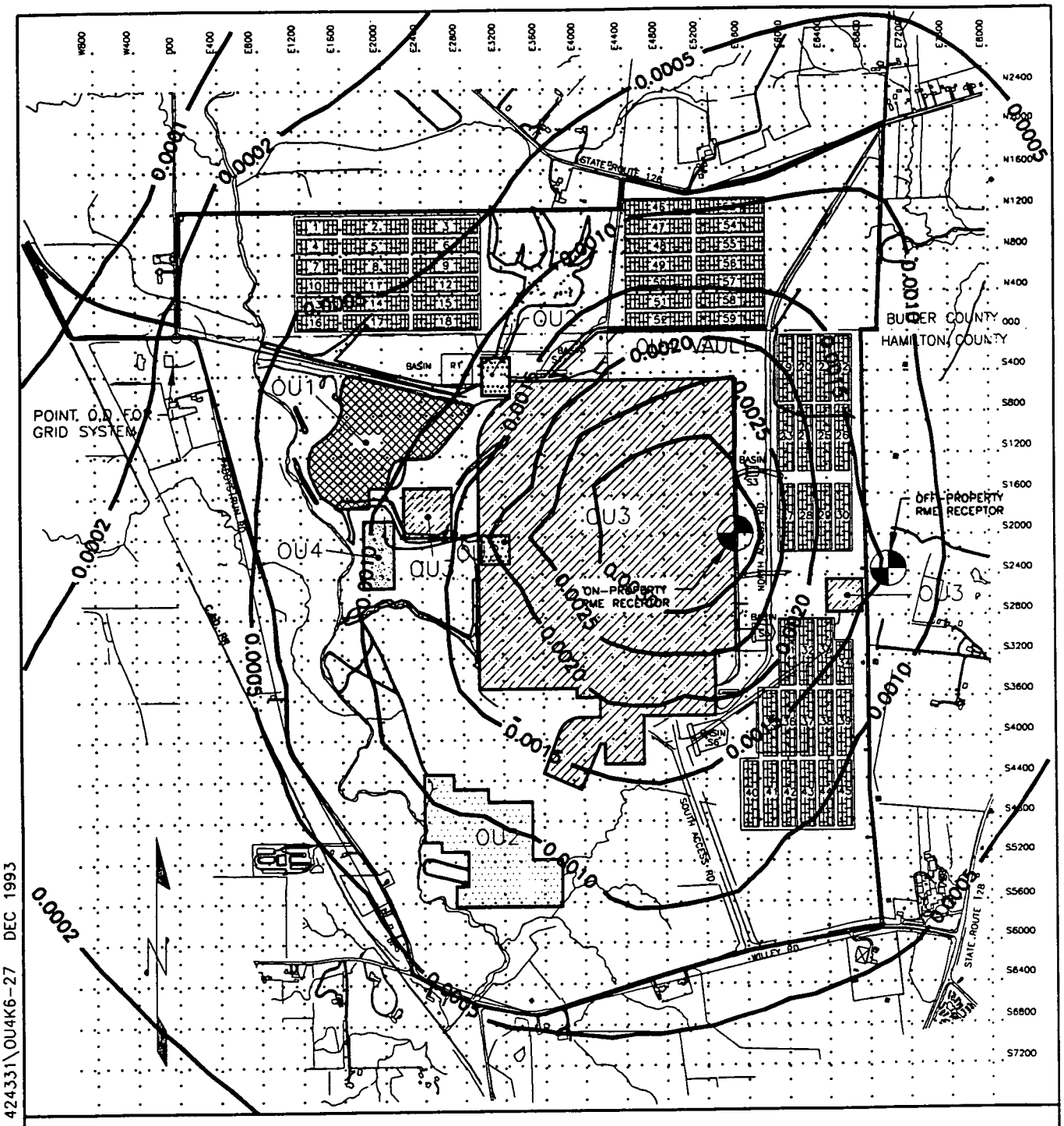
—5— : CONCENTRATION ISOPLETHS ARE IN PICOCURIES PER CUBIC METER

MAX ON-PROPERTY CONC. = 9.59 pCi/m³

OU4 CRARE ACAD FILE: 424331\OU4K6-26 DEC 1993

FIGURE K.6-26
RN-222 CONCENTRATION IN AIR FOR FUTURE SCENARIO

- 5208




400 0 400 800
SCALE IN FEET

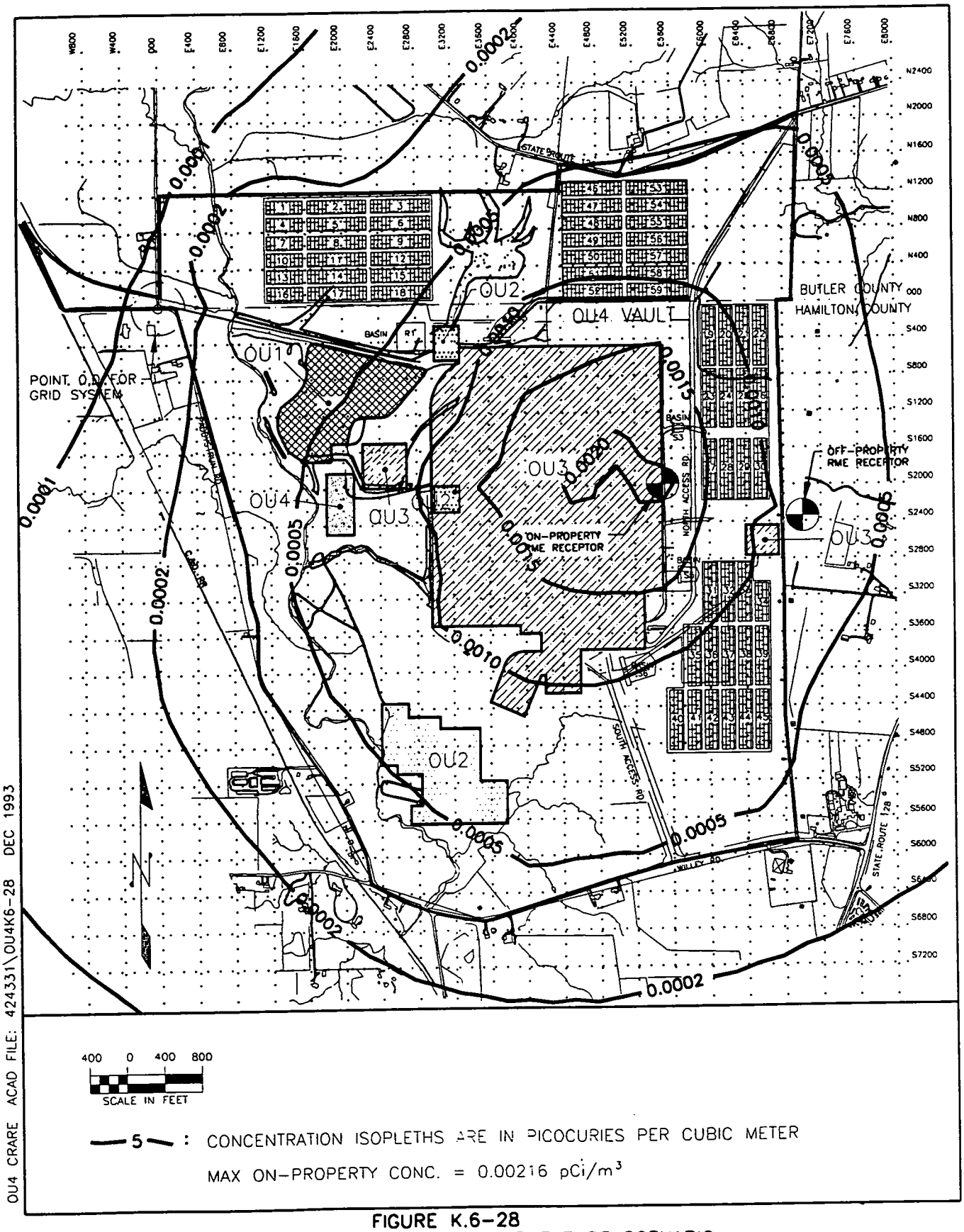
—5— : CONCENTRATION ISOPLETHS ARE IN PICOCURIES PER CUBIC METER

MAX ON-PROPERTY CONC. = 0.00361 pCi/m$^3$

OU4 CRARE ACAD FILE: 424331\OU4K6-27 DEC 1993

FIGURE K.6-27
U-234 CONCENTRATION IN AIR FOR FUTURE SCENARIO

0228




OU4 CRARE ACAD FILE: 424331\OU4K6-28 DEC 1993

FIGURE K.6-28
U-238 CONCENTRATION IN AIR FOR FUTURE SCENARIO

## K.6.3 FARM PRODUCTS FATE MODELING

This section describes the equations used to estimate exposure to chemicals and radionuclides from ingestion of contaminated farm products.

### K.6.3.1 Ingestion of Vegetables

The equations used to estimate exposure to chemicals and radionuclides via ingestion of vegetables irrigated with contaminated water are from the NRC (NRC 1977) and the EPA (EPA 1989e). This process involves estimating the concentration of the contaminant on and in the plant as a result of foliar deposition and root uptake. The model used to estimate the concentration in and on vegetation irrigated with contaminated water is (NRC 1977):

$$C_{ivw} = d_w \left[ \frac{r_w(1 - e^{-\lambda_{Ei} t_e})}{Y \lambda_{Ei}} + \frac{f_w B_{iv(2)} (1 - e^{-\lambda_{ri} t_{bw}})}{\rho \lambda_{ri}} \right] e^{-\lambda_{ri} t_h} \tag{14}$$

For vegetation exposed to atmospheric fallout of dust, the equation becomes (NRC 1977):

$$C_{ivd} = d_d \left[ \frac{r_d(1 - e^{-\lambda_{Ei} t_e})}{Y \lambda_{Ei}} + \frac{f_d B_{iv(2)} (1 - e^{-\lambda_{ri} t_{bd}})}{\rho \lambda_{ri}} \right] e^{-\lambda_{ri} t_h} \tag{15}$$

where

| | | |
|---|---|---|
| $\lambda_{Ei}$ | = | effective depletion constant of i[th] contaminant on the plant surface ($hr^{-1}$), |
| $\lambda_{ri}$ | = | radioactive or chemical decay constant of i[th] contaminant ($hr^{-1}$), from Howard 1991, |
| $B_{iv(2)}$ | = | dry soil to wet plant (vegetables, forage, and fruit) transfer coefficient of i[th], contaminant ($C_{iv}/C_s$), |
| $C_{ivd}$ | = | concentration of i[th] contaminant in plants as a result of deposition of contaminated dust on plants (pCi/kg or mg/kg), |
| $C_{ivw}$ | = | concentration of i[th] contaminant in plants as a result of irrigating plants with contaminated water (pCi/kg or mg/kg), |
| $d_d$ | = | dust deposition rate ($pCi/m^2/hr$ or $mg/m^2/hr$), |
| $d_w$ | = | irrigation deposition rate ($pCi/m^2/hr$ or $mg/m^2/hr$), |
| $f_w$ | = | fraction of year plant is irrigated (unitless), |
| $f_d$ | = | fraction of year plant is downwind (unitless), |
| $\rho$ | = | effective dry surface density of the soil ($kg/m^2$), |
| $r_d$ | = | fraction of deposited dust retained on plant surface (unitless), |

$r_w$ = fraction of water borne material retained on plant surface (unitless),
$t_{bd}$ = period soil is exposed to airborne emissions (hr),
$t_{bw}$ = period soil is exposed to contaminated water (hr),
$t_e$ = growing season (hr),
$t_h$ = duration of period between harvest and consumption (hr), and
Y = agricultural yield (kg/m$^2$),

and

$$d_w = (C_{iw})(I) \quad (16)$$
$$d_d = (C_{id})(v_d) \quad (17)$$

where

$C_{iw}$ = concentration of i$^{th}$ contaminant in irrigation water (pCi/l or mg/l),
I = irrigation rate (l/m$^2$/hr),
$C_{id}$ = concentration of i$^{th}$ contaminant in dust (pCi/g or mg/g), and
$v_d$ = deposition velocity for dust (g/m$^2$/hr), Attachment K.III.

In addition to exposure to contaminated irrigation water and dust, vegetables and livestock feed may be contaminated by root uptake from contaminated soil. The contribution by this pathway is estimated by the irrigation model; however, this pathway is also considered for areas that are not irrigated with contaminated water but that exhibit surface soil contamination from historical deposition on the soil by other means. The following equation was used to estimate the contaminant concentration in the plant from root uptake of contaminants in the soil.

$$C_{ivs} = (C_s)(B_{iv(2)})(e^{-\lambda_n t_h}) \quad (18)$$

where

$C_{ivs}$ = concentration of i$^{th}$ contaminant in plants as a result of root uptake from contaminated soil (pCi/kg or mg/kg), and
$C_s$ = concentration of i$^{th}$ contaminant in dry soil at harvest time (pCi/kg or mg/kg).

The total concentration of contaminants in vegetables ($C_{iv}$) is estimated using the following equation:

$$C_{iv} = C_{ivw} + C_{ivd} + C_{ivs} \quad (19)$$

Equations of the same form were used to estimate the contaminant concentration in livestock feed, substituting concentration factors for livestock feed in place of those for vegetables ingested by man.

0231

A summary of parameters used in the vegetable, forage, and fruit uptake models is presented in Table K.6-26. Radioactive or chemical decay constants are presented in Table K.6-27. Transfer coefficients of contaminants from dry soil to wet plant material are presented in Table K.6-28.

K.6.3.2 Ingestion of Meat and Dairy Products

Prior to the determination of intake following ingestion of animal products by humans, the concentration of chemicals and radionuclides in animal products must be estimated. The concentration of a contaminant in animal products, such as beef or milk, was estimated using the following equation (NRC 1977):

$$C_{iA} = F_{iA}[(C_{if})(Q_f) + (C_{iAw})(Q_{Aw})]\ e^{(-\lambda_{ri} t_{iA})} \qquad (20)$$

where

- $C_{iA}$ = concentration of $i^{th}$ contaminant in the animal product (pCi/l for milk, pCi/kg for beef or mg/l for milk, mg/kg for beef),
- $F_{iA}$ = element (stable) transfer coefficient that relates the daily intake by an animal to the concentration of $i^{th}$ contaminant in an edible portion of the animal product (day/l for milk, day/kg for beef),
- $C_{if}$ = concentration of $i^{th}$ contaminant in forage (pCi/kg or mg/kg),
- $Q_f$ = consumption rate of contaminated forage by an animal (kg/day),
- $C_{iAw}$ = concentration of $i^{th}$ contaminant in livestock water (pCi/l or mg/l),
- $Q_{Aw}$ = consumption rate of contaminated water by an animal (l/day),
- $\lambda_{ri}$ = decay constant of $i^{th}$ contaminant ($hr^{-1}$), and
- $t_{iA}$ = delay between harvest of animal product (milk or meat) and consumption (hr).

Transfer coefficients of contaminants to milk or beef ($F_{iA}$) are presented in Table K.6-28.

## TABLE K.6-26

## SUMMARY OF PARAMETERS FOR VEGETABLE/FORAGE UPTAKE MODELS

| Parameter[a] | Value | Units | Reference |
|---|---|---|---|
| Irrigation Rate (I): | 0.081 | $l/m^2/hr$ | USDA 1970 |
| Fraction of Deposited Dust Retained on Crops ($r_d$): | 0.25 | unitless | NRC 1977 |
| Fraction of Water Borne Material Retained on Crops ($r_w$): | 0.20 | unitless | NRC 1977 |
| Effective Depletion Constant of Contaminant on Plant Surface ($\lambda_{Ei}$): | 0.0021 | $hr^{-1}$ | NRC 1977 |
| Growing Season for Vegetables and Fruit Crops ($t_{ec}$): | 1440 | hr | NRC 1977 |
| Growing Season for Forage ($t_{eg}$): | 720 | hr | NRC 1977 |
| Agricultural Yield of Vegetables and Fruit Crop (Y): | 1.5 | $kg/m^2$ | USDA 1979 |
| Agricultural Yield of Forage (Y): | 0.8 | $kg/m^2$ | USDA 1979 |
| Fraction of Year Plants are Downwind ($f_d$): | MD[b] | unitless | — |
| Fraction of Year Plans are Irrigated ($f_w$): | 1.0[c] | unitless | NRC 1977 |
| Period Soil is Exposed to Contaminated Water ($t_{bw}$): | 8760 | hr | Assumed |
| Period Soil is Exposed to Airborne Emissions ($t_{bd}$): | 8760 | hr | Assumed |
| Effective Dry Surface Density of the Soil ($\rho$): | 150 | $kg/m^2$ | kg/m[d] |
| Delay between Harvest and Consumption of Vegetables ($t_{hv}$): | 24 | hr | NRC 1977 |
| Delay between Harvest and Consumption of Vegetables and Fruit ($t_{hc}$): | 720 | hr | Assumed |
| Delay between Harvest and Consumption of Forage ($t_{hg}$): | 0 | hr | NRC 1977 |
| Delay between Milking and Consumption ($t_{iA}$): | 48 | hr | NRC 1977 |
| Delay between Slaughter and Consumption | 480 | hr | NRC 1977 |

[a] See the uncertanty analysis (Section K.10.0) for more information on these parameters.
[b] CRARE modeled RME location.
[c] The raction of time plants are irrigated is implicitly included in the irrigation rate. To avoid using this parameter twice in Equation 7-9, $f_d$ has been set to 1.0.
[d] Corresponds to a density of 1.5 $g/cm^3$ and a depth of 10 cm. Moist bulk densities of surface soil range from 1.4 to 1.55 $g/cm^3$ at the FEMP (USDA 1982).

- 5208

## TABLE K.6-27

## CHEMICAL AND RADIOACTIVE COC DECAY CONSTANTS

| Chemical | Decay Constant ($hr^{-1}$) | Source | Radionuclide | Decay Constant ($hr^{-1}$) | Source |
|---|---|---|---|---|---|
| Antimony | $1.00 \times 10^{-14}$ | a | Ac-227 | $8.72 \times 10^{-5}$ | a |
| Aroclor-1016 | $1.00 \times 10^{-14}$ | a | Am-241 | $183 \times 10^{-7}$ | b |
| Aroclor-1221 | $1.00 \times 10^{-14}$ | a | Cs-137 | $2.62 \times 10^{-6}$ | b |
| Aroclor-1242 | $1.00 \times 10^{-14}$ | a | Np-237 | $3.70 \times 10^{-11}$ | b |
| Aroclor-1248 | $1.00 \times 10^{-14}$ | a | Pa-231 | $5.80 \times 10^{-8}$ | a |
| Aroclor-1254 | $1.00 \times 10^{-14}$ | a | Pb-210 | $8.53 \times 10^{-5}$ | a |
| Aroclor-1260 | $1.00 \times 10^{-14}$ | a | Pu-238 | $9.01 \times 10^{-7}$ | b |
| Arsenic | $1.00 \times 10^{-14}$ | a | Pu-239 | $3.28 \times 10^{-9}$ | b |
| Barium | $1.00 \times 10^{-14}$ | a | Pu-240 | $1.20 \times 10^{-8}$ | b |
| Beryllium | $1.00 \times 10^{-14}$ | a | Ra-226 | $9.93 \times 10^{-4}$ | a |
| Cadmium | $1.00 \times 10^{-14}$ | a | Ra-228 | $9.93 \times 10^{-4}$ | a |
| Chromium | $1.00 \times 10^{-14}$ | a | Rn-222 | NA | |
| Cobalt | $1.00 \times 10^{-14}$ | a | Ru-106 | $9.99 \times 10^{-1}$ | b |
| Copper | $1.00 \times 10^{-14}$ | a | Sr-90 | $1.00 \times 10^{0}$ | b |
| Cyanide | $1.00 \times 10^{-14}$ | a | Tc-99 | $1.00 \times 10^{0}$ | b |
| D-n-octyl phthalate | $1.00 \times 10^{-14}$ | a | Th-228 | $9.93 \times 10^{-4}$ | a |
| Heptachlorodibenzofuran | $1.00 \times 10^{-14}$ | a | Th-230 | $2.47 \times 10^{-8}$ | a |
| Heptachlorodibenzo-p-dioxin | $1.00 \times 10^{-14}$ | a | Th-232 | $1.36 \times 10^{-13}$ | a |
| Lead | $1.00 \times 10^{-14}$ | a | U-233 | $4.96 \times 10^{-10}$ | b |
| Manganese | $1.00 \times 10^{-14}$ | a | U-234 | $7.77 \times 10^{-9}$ | a |
| Mercury | $1.00 \times 10^{-14}$ | a | U-235 | $2.70 \times 10^{-12}$ | a |
| Molybdenum | $1.00 \times 10^{-14}$ | a | U-236 | $3.38 \times 10^{-12}$ | b |
| Nickel | $1.00 \times 10^{-14}$ | a | U-238 | $4.25 \times 10^{-13}$ | a |
| Octachlorodibenzofuran | $1.00 \times 10^{-14}$ | a | | | |
| Selenium | $1.00 \times 10^{-14}$ | a | | | |
| Thallium | $1.00 \times 10^{-14}$ | a | | | |
| Vanadium | $1.00 \times 10^{-14}$ | a | | | |
| Zinc | $1.00 \times 10^{-14}$ | a | | | |
| 2-Chlorophenol | $1.00 \times 10^{-14}$ | a | | | |
| 2-Methylnaphthalene | $1.00 \times 10^{-14}$ | a | | | |
| 4-Chlorophenyl- p phenylether | $1.00 \times 10^{-14}$ | a | | | |
| 4,4-DDT | $1.00 \times 10^{-14}$ | a | | | |

[a]DOE (1993d)
[b]Grove Engineering (1991)
NA = Non Applicable

0234

## TABLE K.6-28

## TRANSFER COEFFICIENTS

| COC | Beef (Fia) | Source | Milk (Fia) | Source | Forage $B_{(IV2)}$ | Source | Vegetable $B_{(IV1)}$ | Source |
|---|---|---|---|---|---|---|---|---|
| **Chemical** | | | | | | | | |
| Antimony | $1.00 \times 10^{-3}$ | a | $1.00 \times 10^{-4}$ | c | $2.00 \times 10^{-1}$ | a | $3.00 \times 10^{-2}$ | a |
| Aroclor-1016 | $6.00 \times 10^{-4}$ | a | $6.03 \times 10^{-3}$ | c | $1.55 \times 10^{-2}$ | e | $1.10 \times 10^{-1}$ | a |
| Aroclor-1221 | $1.58 \times 10^{-5}$ | b | $5.01 \times 10^{-6}$ | c | $9.32 \times 10^{-1}$ | e | $9.32 \times 10^{-1}$ | e |
| Aroclor-1242 | $3.00 \times 10^{-4}$ | a | $3.02 \times 10^{-3}$ | c | $2.31 \times 10^{-2}$ | e | $1.60 \times 10^{-1}$ | a |
| Aroclor-1248 | $1.00 \times 10^{-2}$ | a | $1.02 \times 10^{-2}$ | c | $1.14 \times 10^{-2}$ | e | $2.20 \times 10^{-2}$ | a |
| Aroclor-1254 | $7.40 \times 10^{-2}$ | a | $1.60 \times 10^{-2}$ | c | $8.78 \times 10^{-3}$ | e | $7.10 \times 10^{-3}$ | a |
| Aroclor-1260 | $3.20 \times 10^{-2}$ | a | $6.46 \times 10^{-2}$ | c | $3.93 \times 10^{-3}$ | e | $1.10 \times 10^{-2}$ | a |
| Arsenic | $2.00 \times 10^{-3}$ | a | $6.00 \times 10^{-5}$ | d | $4.00 \times 10^{-2}$ | d | $4.00 \times 10^{-2}$ | a |
| Barium | $1.50 \times 10^{-4}$ | a | $3.50 \times 10^{-4}$ | d | $1.50 \times 10^{-1}$ | d | $1.50 \times 10^{-1}$ | a |
| Beryllium | $1.00 \times 10^{-3}$ | a | $9.00 \times 10^{-7}$ | d | $1.00 \times 10^{-2}$ | d | $1.00 \times 10^{-2}$ | a |
| Cadmium | $5.50 \times 10^{-3}$ | a | $1.00 \times 10^{-3}$ | d | $5.50 \times 10^{-1}$ | d | $5.50 \times 10^{-1}$ | a |
| Chromium | $5.50 \times 10^{-3}$ | d | $1.50 \times 10^{-3}$ | d | $7.50 \times 10^{-3}$ | d | $7.50 \times 10^{-3}$ | d |
| Cobalt | $2.00 \times 10^{-2}$ | a | $2.00 \times 10^{-3}$ | d | $2.00 \times 10^{-2}$ | d | $2.00 \times 10^{-2}$ | a |
| Copper | $1.00 \times 10^{-2}$ | a | $1.50 \times 10^{-3}$ | d | $4.00 \times 10^{-1}$ | d | $4.00 \times 10^{-1}$ | a |
| Cyanide | $5.63 \times 10^{-8}$ | | NA | | NA | | $3.50 \times 10^{-1}$ | a |
| D-n-octyl phthalate | $3.98 \times 10^{1}$ | a | $1.26 \times 10^{1}$ | d | $1.86 \times 10^{-4}$ | d | $2.00 \times 10^{-4}$ | a |
| Heptachlorodibenzofuran | NA | | NA | | NA | | NA | |
| Heptachlorodibenzo-p-dioxin | NA | | NA | | NA | | NA | |
| Lead | $3.00 \times 10^{-4}$ | a | $2.50 \times 10^{-4}$ | d | $4.50 \times 10^{-2}$ | d | $4.50 \times 10^{-2}$ | a |
| Manganese | $4.00 \times 10^{-4}$ | a | $3.50 \times 10^{-4}$ | d | $2.50 \times 10^{-1}$ | d | $2.50 \times 10^{-1}$ | a |
| Mercury | $2.50 \times 10^{-1}$ | a | $4.50 \times 10^{-4}$ | d | $9.00 \times 10^{-1}$ | d | $9.00 \times 10^{-1}$ | a |
| **Chemical (cont.)** | | | | | | | | |
| Molybdenum | $6.00 \times 10^{-3}$ | a | $1.50 \times 10^{-3}$ | d | $2.50 \times 10^{-1}$ | d | $6.00 \times 10^{-2}$ | d |
| Nickel | $6.00 \times 10^{-3}$ | a | $1.00 \times 10^{-3}$ | d | $6.00 \times 10^{-2}$ | d | $6.00 \times 10^{-2}$ | a |





5208
0235

**TABLE K.6-28**
**(Continued)**

| COC | Beef (Fia) | Source | Milk (Fia) | Source | Forage $B_{(IV2)}$ | Source | Vegetable $B_{(IV1)}$ | Source |
|---|---|---|---|---|---|---|---|---|
| Octachlorodibenzofuran | NA | | NA | | NA | | NA | |
| Selenium | $1.50 \times 10^{-2}$ | a | $4.00 \times 10^{-3}$ | d | $2.50 \times 10^{-2}$ | d | $2.50 \times 10^{-2}$ | a |
| Thallium | $4.00 \times 10^{-2}$ | a | $2.00 \times 10^{-3}$ | d | $4.00 \times 10^{-3}$ | d | $4.00 \times 10^{-3}$ | a |
| Vanadium | $2.50 \times 10^{-3}$ | a | $2.00 \times 10^{-5}$ | d | $5.50 \times 10^{-3}$ | d | $5.50 \times 10^{-3}$ | a |
| Zinc | $1.00 \times 10^{-1}$ | a | $1.00 \times 10^{-2}$ | d | $1.50 \times 10^{0}$ | d | $1.50 \times 10^{0}$ | a |
| 2-Chlorophenol | NA | | NA | | NA | | NA | |
| 2-Methylnaphthalene | $1.82 \times 10^{-4}$ | a | $1.02 \times 10^{-4}$ | c | $1.63 \times 10^{-1}$ | e | $2.28 \times 10^{-1}$ | a |
| 4-Chlorophenyl-phenylether | NA | | NA | | NA | | NA | |
| 4,4-DDT | $1.45 \times 10^{-2}$ | a | $2.40 \times 10^{-3}$ | d | $1.58 \times 10^{-2}$ | d | $1.80 \times 10^{-2}$ | a |
| **Radionuclide** | | | | | | | | |
| Ac-227 | $6.00 \times 10^{-2}$ | a | $2.00 \times 10^{-5}$ | d | $3.50 \times 10^{-3}$ | d | $3.50 \times 10^{-4}$ | a |
| Am-241 | NA | | NA | | NA | | NA | |
| Cs-137 | $2.00 \times 10^{-2}$ | a | $7.00 \times 10^{-3}$ | d | $8.00 \times 10^{-2}$ | d | $8.00 \times 10^{-2}$ | a |
| Np-237 | $5.50 \times 10^{-5}$ | a | $5.00 \times 10^{-6}$ | d | $1.00 \times 10^{-1}$ | d | $1.00 \times 10^{-2}$ | a |
| Pa-231 | $8.00 \times 10^{-2}$ | a | $5.00 \times 10^{-4}$ | d | $2.50 \times 10^{-3}$ | d | $2.50 \times 10^{-4}$ | a |
| Pb-210 | NA | | NA | | NA | | NA | |
| Pu-238 | $5.00 \times 10^{-7}$ | a | $1.00 \times 10^{-7}$ | d | $4.50 \times 10^{-4}$ | d | $4.50 \times 10^{-4}$ | a |
| Pu-239 | $5.00 \times 10^{-7}$ | a | $1.00 \times 10^{-7}$ | d | $4.50 \times 10^{-4}$ | d | $4.50 \times 10^{-4}$ | a |
| Pu-240 | $5.00 \times 10^{-7}$ | a | $1.00 \times 10^{-7}$ | d | $4.50 \times 10^{-4}$ | d | $4.50 \times 10^{-4}$ | a |

0236

5208

**TABLE K.6-28**
**(Continued)**

| COC | Beef (Fia) | Source | Milk (Fia) | Source | Forage B (IV2) | Source | Vegetable B (IV1) | Source |
|---|---|---|---|---|---|---|---|---|
| **Radionuclide (cont.)** | | | | | | | | |
| Ra-226 | $2.50 \times 10^{-4}$ | a | $4.50 \times 10^{-4}$ | d | $1.50 \times 10^{-2}$ | d | $1.50 \times 10^{-2}$ | a |
| Ra-228 | $2.50 \times 10^{-4}$ | a | $4.50 \times 10^{-4}$ | d | $1.50 \times 10^{-2}$ | d | $1.50 \times 10^{-2}$ | a |
| Rn-222 | NA | | NA | | NA | | NA | |
| Ru-106 | NA | | $6.00 \times 10^{-7}$ | d | $7.50 \times 10^{-2}$ | d | $2.00 \times 10^{-2}$ | a |
| Sr-90 | $3.00 \times 10^{-4}$ | a | $1.50 \times 10^{-3}$ | d | $2.50 \times 10^{0}$ | d | $2.50 \times 10^{0}$ | a |
| Tc-99 | $8.50 \times 10^{-3}$ | a | $1.00 \times 10^{-2}$ | d | $9.50 \times 10^{0}$ | d | $9.50 \times 10^{0}$ | a |
| Th-228 | $6.00 \times 10^{-6}$ | a | $5.00 \times 10^{-6}$ | d | $8.50 \times 10^{-4}$ | d | $8.50 \times 10^{-4}$ | a |
| Th-230 | $6.00 \times 10^{-6}$ | a | $5.00 \times 10^{-6}$ | d | $8.50 \times 10^{-4}$ | d | $8.50 \times 10^{-4}$ | a |
| Th-232 | $6.00 \times 10^{-6}$ | a | $5.00 \times 10^{-6}$ | d | $8.50 \times 10^{-4}$ | d | $8.50 \times 10^{-4}$ | a |
| U-233 | $2.00 \times 10^{-4}$ | a | $6.00 \times 10^{-4}$ | d | $8.50 \times 10^{-3}$ | d | $8.50 \times 10^{-4}$ | a |
| U-234 | $2.00 \times 10^{-4}$ | a | $6.00 \times 10^{-4}$ | d | $8.50 \times 10^{-3}$ | d | $8.50 \times 10^{-3}$ | a |
| U-235 | $2.00 \times 10^{-4}$ | a | $6.00 \times 10^{-4}$ | d | $8.50 \times 10^{-3}$ | d | $8.50 \times 10^{-3}$ | a |
| U-236 | $2.00 \times 10^{-4}$ | a | $6.00 \times 10^{-4}$ | d | $8.50 \times 10^{-3}$ | d | $8.50 \times 10^{-3}$ | a |
| U-238 | $2.00 \times 10^{-4}$ | a | $6.00 \times 10^{-4}$ | d | $8.50 \times 10^{-3}$ | d | $8.50 \times 10^{-3}$ | a |

[a]SWCR
[b]Log of bioconcentration factor in beef (Log Bb) calculated from geometric mean regression model: Log Bb = -7.6 + Log Kow (RAWPA)
[c]Log of Biotransfer factor in milk (Log Bm) calculated from geometric mean regression model: Log Bm = -8.10 + Log Kow (RAWPA)
[d]RAWPA
[e]Log of bioconcentration factor in vegetation (Log Bv) calculated from geometric mean regression model: Log Bv = 1.588 - 0.578 Log Kow (RAWPA)
[f]Not Available

0237

- 5208

In addition to intake from irrigated forage and water, cows may receive a significant intake from soil ingestion if the soil is also a source of contamination (Zach and Mayoh 1984). The following equation was used to estimate the concentration in the animal product from soil ingestion (EPA 1989e):

$$C_{iA} = F_{iA}[(C_s)(Q_s)]e^{(-\lambda_n t_{iA})} \quad (21)$$

where

$C_s$ = concentration of contaminant in soil (pCi/kg or mg/kg), and
$Q_s$ = consumption rate of soil by livestock (kg/day).

Animal Consumption Rates

The following parameters were used to quantify the intake of contaminants in food and water by beef and milk cattle at or near the FEMP:

| Animal | $Q_f$ Feed or Forage[a] (kg wet weight/day) | $Q_{Aw}$ Water[a] (l/day) | $Q_s$ Soil[b] (kg/day) |
|---|---|---|---|
| Milk cow | 50 | 60 | 0.5 |
| modified[c] | 25 | | |
| Beef cattle | 50 | 50 | 0.5 |
| modified[c] | 25 | | |

[a](NCR 1977)
[b](Zach and Mayoh 1984)
[c]Modified assuming that pastureland is not irrigated due to the cost involved and based on data from the Bureau of Census (Bureau of Census 1989). Pasture forage is assumed to be supplemented with stored feed that was irrigated with contaminated water, and the animal diet consists of equal parts of pasture grass and stored feed totaling 50 kg/day wet weight.

Radionuclide and Nonradioactive Transfer Factors

Transfer coefficients for radioelements and nonradioactive metals were taken from Baes et al. (1984), Till and Meyer (1983) and DOE (1989). The radiological properties of atoms do not effect their elemental transfer in the environment. The soil-to-plant concentration factors for edible plants ingested by humans and vegetative plants ingested by cattle used in intake models, in the absence of site-specific information, are listed in Table K.6-28. These factors are the ratios of the dry-weight

0238

concentration of an element in the reproductive or vegetative portions of the plant to the dry-weight concentration of the element in soil. Edible portions of the plant include grain kernels, fruits, and tubers. These portions are most representative of the plant foods ingested by humans. The list of elements is not all inclusive. The cited references were used to obtain values for additional constituents of concern in individual risk assessments as needed.

Transfer coefficients for organic chemicals were taken from Travis and Arms (1988). If a transfer coefficient was not readily available, the following regression equations based on the relationship between transfer and the octanol-water partition coefficient ($K_{ow}$) were used to estimate transfer coefficients (Travis and Arms 1988):

| | |
|---|---|
| $B_{iv(2)}$ (vegetables) | $\log B_{iv} = 1.588 - 0.578 \log K_{ow}$ |
| $F_{iA}$ (milk) | $\log F_{iA} = -8.10 + \log K_{ow}$ |
| $F_{iA}$ (beef) | $\log F_{iA} = -7.6 + \log K_{ow}$ |

Chemical-specific $K_{ow}$ values are available from several sources. The major source used for $K_{ow}$ values was Hansch and Leo (1979).

Concentrations in the aboveground vegetative part of plants were estimated using the following equation (Baes et al. 1984):

$$C_{iv} = (C_s)(B_{iv(1)}) \qquad (22)$$

where

$C_{iv}$ = concentration of the $i^{th}$ contaminant in vegetation (mg/kg dry wt),
$C_s$ = maximum concentration in soil (mg/kg dry wt), and
$B_{iv(1)}$ = soil to plant transfer factor of the $i^{th}$ contaminant (mg/kg dry wt plant per mg/kg dry wt soil).

K.6.3.3 Results of Farm Product Fate Modeling

Tables K.6-29 through K.6-32 present a summary of modeling results for the contaminant concentrations in vegetables, meat, and dairy products under the Current Land Use and two Future Land Use (with and without federal ownership) scenarios. These values have been incorporated into Section K.8.0.

0239

## TABLE K.6-29

## FARM PRODUCT COC CONCENTRATIONS: OFF-SITE RESIDENT FARM RECEPTORS CURRENT LAND USE SCENARIO

| COC | Meat Concentrations (mg/kg) | Dairy Product Concentrations (mg/kg) | Vegetable Concentrations (mg/kg) |
|---|---|---|---|
| **Chemical** | | | |
| Antimony | $6.71 \times 10^{-6}$ | $6.71 \times 10^{-7}$ | $1.64 \times 10^{-4}$ |
| Aroclor-1016 | | | |
| Aroclor-1221 | $5.63 \times 10^{-11}$ | $1.79 \times 10^{-11}$ | $8.40 \times 10^{-8}$ |
| Aroclor-1242 | | | |
| Aroclor-1248 | $1.91 \times 10^{-8}$ | $1.95 \times 10^{-8}$ | $4.68 \times 10^{-8}$ |
| Aroclor-1254 | $7.95 \times 10^{-6}$ | $1.72 \times 10^{-6}$ | $2.62 \times 10^{-6}$ |
| Aroclor-1260 | $3.11 \times 10^{-6}$ | $6.29 \times 10^{-6}$ | $2.38 \times 10^{-6}$ |
| Arsenic | $5.72 \times 10^{-6}$ | $1.72 \times 10^{-7}$ | $6.97 \times 10^{-5}$ |
| Barium | $2.19 \times 10^{-5}$ | $5.10 \times 10^{-5}$ | $3.53 \times 10^{-3}$ |
| Beryllium | $2.48 \times 10^{-7}$ | $2.23 \times 10^{-10}$ | $6.06 \times 10^{-6}$ |
| Cadmium | $8.09 \times 10^{-6}$ | $1.47 \times 10^{-6}$ | $3.51 \times 10^{-5}$ |
| Chromium | | | |
| Cobalt | $5.94 \times 10^{-5}$ | $5.94 \times 10^{-6}$ | $7.24 \times 10^{-5}$ |
| Copper | $9.46 \times 10^{-5}$ | $1.42 \times 10^{-5}$ | $2.27 \times 10^{-4}$ |
| Cyanide | $2.94 \times 10^{-11}$ | | $1.37 \times 10^{-5}$ |
| Di-n-octyl phthalate | $3.19 \times 10^{-4}$ | $1.01 \times 10^{-4}$ | $1.96 \times 10^{-7}$ |
| Heptachlorodibenzofuran | | | |
| Heptachlorodibenzo-p-dioxin | | | |
| Lead | $6.51 \times 10^{-6}$ | $5.42 \times 10^{-6}$ | $5.28 \times 10^{-4}$ |
| Manganese | $5.69 \times 10^{-5}$ | $4.98 \times 10^{-5}$ | $3.43 \times 10^{-3}$ |
| Mercury | $1.38 \times 10^{-5}$ | $2.49 \times 10^{-8}$ | $1.31 \times 10^{-6}$ |
| Molybdenum | $6.32 \times 10^{-6}$ | $1.58 \times 10^{-6}$ | $2.57 \times 10^{-5}$ |
| Nickel | $4.91 \times 10^{-5}$ | $8.19 \times 10^{-6}$ | $1.99 \times 10^{-4}$ |
| Octachlorodibenzofuran | | | |
| Selenium | $1.95 \times 10^{-7}$ | $5.19 \times 10^{-8}$ | $3.16 \times 10^{-7}$ |
| Thallium | $3.27 \times 10^{-6}$ | $1.64 \times 10^{-7}$ | $2.00 \times 10^{-6}$ |
| Vanadium | $1.57 \times 10^{-5}$ | $1.26 \times 10^{-7}$ | $1.54 \times 10^{-4}$ |
| Zinc | $3.10 \times 10^{-3}$ | $3.10 \times 10^{-4}$ | $7.19 \times 10^{-4}$ |
| 2-Chlorophenol | | | |
| 2-Methylnaphthalene | $1.43 \times 10^{-9}$ | $8.03 \times 10^{-10}$ | $1.93 \times 10^{-7}$ |
| 4-Chlorophenyl-phenylether | | | |
| 4,4-DDT | | | |

**TABLE 6-29**
**(Continued)**

| COC | Meat Concentrations (pCi/kg) | Dairy Product Concentrations (pCi/kg) | Vegetable Concentrations (pCi/kg) |
|---|---|---|---|
| **Radionuclide** | | | |
| Ac-227 | | | |
| Am-241 | | | |
| Cs-137 | $3.29 \times 10^{-3}$ | $1.15 \times 10^{-3}$ | $4.01 \times 10^{-3}$ |
| Np-237 | $1.34 \times 10^{-6}$ | $1.22 \times 10^{-7}$ | $5.83 \times 10^{-4}$ |
| Pa-231 | $6.78 \times 10^{-3}$ | $4.24 \times 10^{-5}$ | $2.07 \times 10^{-3}$ |
| Pb-210 | | | $5.93 \times 10^{-2}$ |
| Pu-238 | $8.54 \times 10^{-8}$ | $1.71 \times 10^{-8}$ | $4.17 \times 10^{-3}$ |
| Pu-239 | $5.50 \times 10^{-8}$ | $1.10 \times 10^{-8}$ | $2.68 \times 10^{-3}$ |
| Pu-240 | $5.50 \times 10^{-8}$ | $1.10 \times 10^{-8}$ | $2.68 \times 10^{-3}$ |
| Ra-226 | $7.01 \times 10^{-5}$ | $1.26 \times 10^{-4}$ | $6.84 \times 10^{-3}$ |
| Ra-228 | $4.71 \times 10^{-5}$ | $1.30 \times 10^{-4}$ | $7.23 \times 10^{-3}$ |
| Rn-222 | | | |
| Ru-106 | | | |
| Sr-90 | | $7.85 \times 10^{-25}$ | $3.38 \times 10^{-13}$ |
| Tc-99 | | $2.28 \times 10^{-23}$ | $1.47 \times 10^{-12}$ |
| Th-228 | $1.88 \times 10^{-6}$ | $2.41 \times 10^{-6}$ | $1.21 \times 10^{-2}$ |
| Th-230 | $3.14 \times 10^{-6}$ | $2.62 \times 10^{-6}$ | $1.28 \times 10^{-2}$ |
| Th-232 | $1.66 \times 10^{-6}$ | $1.38 \times 10^{-6}$ | $6.76 \times 10^{-3}$ |
| U-233 | | | |
| U-234 | $5.25 \times 10^{-1}$ | $1.59 \times 10^{0}$ | $5.59 \times 10^{1}$ |
| U-235 | $1.38 \times 10^{-2}$ | $4.24 \times 10^{-2}$ | $1.48 \times 10^{0}$ |
| U-236 | $5.71 \times 10^{-3}$ | $1.75 \times 10^{-2}$ | $6.15 \times 10^{-1}$ |
| U-238 | $3.11 \times 10^{-1}$ | $9.55 \times 10^{-1}$ | $3.35 \times 10^{1}$ |

## TABLE K.6-30

## FARM PRODUCT COC CONCENTRATIONS: OFF-SITE RESIDENT FARM RECEPTORS FUTURE LAND USE WITH FEDERAL OWNERSHIP

| COC | Meat Concentrations (mg/kg) | Dairy Product Concentrations (mg/kg) | Vegetable Concentrations (mg/kg) |
|---|---|---|---|
| **Chemical** | | | |
| Antimony | $6.75 \times 10^{-6}$ | $6.75 \times 10^{-7}$ | $1.65 \times 10^{-4}$ |
| Aroclor-1016 | | | |
| Aroclor-1221 | $5.63 \times 10^{-11}$ | $1.79 \times 10^{-11}$ | $8.40 \times 10^{-8}$ |
| Aroclor-1242 | | | |
| Aroclor-1248 | $1.91 \times 10^{-8}$ | $1.95 \times 10^{-8}$ | $4.68 \times 10^{-8}$ |
| Aroclor-1254 | $7.96 \times 10^{-6}$ | $1.72 \times 10^{-6}$ | $2.63 \times 10^{-6}$ |
| Aroclor-1260 | $3.11 \times 10^{-6}$ | $6.29 \times 10^{-6}$ | $2.38 \times 10^{-6}$ |
| Arsenic | $5.75 \times 10^{-6}$ | $1.73 \times 10^{-7}$ | $7.01 \times 10^{-5}$ |
| Barium | $2.21 \times 10^{-5}$ | $5.15 \times 10^{-5}$ | $3.57 \times 10^{-3}$ |
| Beryllium | $2.50 \times 10^{-7}$ | $2.25 \times 10^{-10}$ | $6.09 \times 10^{-6}$ |
| Cadmium | $8.14 \times 10^{-6}$ | $1.48 \times 10^{-6}$ | $3.53 \times 10^{-5}$ |
| Chromium | | | |
| Cobalt | $5.99 \times 10^{-5}$ | $5.99 \times 10^{-6}$ | $7.30 \times 10^{-5}$ |
| Copper | $9.49 \times 10^{-5}$ | $1.42 \times 10^{-5}$ | $2.28 \times 10^{-4}$ |
| Cyanide | $2.95 \times 10^{-11}$ | | $1.37 \times 10^{-5}$ |
| Di-n-octyl phthalate | $3.54 \times 10^{-4}$ | $1.12 \times 10^{-4}$ | $2.17 \times 10^{-7}$ |
| Heptachlorodibenzofuran | | | |
| Heptachlorodibenzo-p-dioxin | | | |
| Lead | $6.51 \times 10^{-6}$ | $5.42 \times 10^{-6}$ | $5.28 \times 10^{-4}$ |
| Manganese | $5.74 \times 10^{-5}$ | $5.02 \times 10^{-5}$ | $3.47 \times 10^{-3}$ |
| Mercury | $1.39 \times 10^{-5}$ | $2.50 \times 10^{-8}$ | $1.31 \times 10^{-6}$ |
| Molybdenum | $6.43 \times 10^{-6}$ | $1.61 \times 10^{-6}$ | $2.61 \times 10^{-5}$ |
| Nickel | $4.94 \times 10^{-5}$ | $8.23 \times 10^{-6}$ | $2.00 \times 10^{-4}$ |
| Octachlorodibenzofuran | | | |
| Selenium | $3.12 \times 10^{-7}$ | $8.32 \times 10^{-8}$ | $5.07 \times 10^{-7}$ |
| Thallium | $3.31 \times 10^{-6}$ | $1.65 \times 10^{-7}$ | $2.02 \times 10^{-6}$ |
| Vanadium | $1.58 \times 10^{-5}$ | $1.27 \times 10^{-7}$ | $1.55 \times 10^{-4}$ |
| Zinc | $3.12 \times 10^{-3}$ | $3.12 \times 10^{-4}$ | $7.24 \times 10^{-4}$ |
| 2-Chlorophenol | | | |
| 2-Methylnaphthalene | $1.30 \times 10^{-9}$ | $7.27 \times 10^{-10}$ | $1.75 \times 10^{-7}$ |
| 4-Chlorophenyl-phenylether | | | |
| 4,4-DDT | | | |

**K.6-30**
**(Continued)**

| COC | Meat Concentrations (pCi/kg) | Dairy Product Concentrations (pCi/kg) | Vegetable Concentrations (pCi/kg) |
|---|---|---|---|
| **Radionuclide** | | | |
| Ac-227 | | | |
| Am-241 | | | |
| Cs-137 | $3.29 \times 10^{-3}$ | $1.15 \times 10^{-3}$ | $4.01 \times 10^{-3}$ |
| Np-237 | $1.34 \times 10^{-6}$ | $1.22 \times 10^{-7}$ | $5.83 \times 10^{-4}$ |
| Pa-231 | $9.54 \times 10^{-3}$ | $5.96 \times 10^{-5}$ | $2.91 \times 10^{-3}$ |
| Pb-210 | | | $6.16 \times 10^{-2}$ |
| Pu-238 | $8.54 \times 10^{-8}$ | $1.71 \times 10^{-8}$ | $4.17 \times 10^{-3}$ |
| Pu-239 | $5.50 \times 10^{-8}$ | $1.10 \times 10^{-8}$ | $2.68 \times 10^{-3}$ |
| Pu-240 | $5.50 \times 10^{-8}$ | $1.10 \times 10^{-8}$ | $2.68 \times 10^{-3}$ |
| Ra-226 | $7.17 \times 10^{-5}$ | $1.29 \times 10^{-4}$ | $7.00 \times 10^{-3}$ |
| Ra-228 | $4.75 \times 10^{-5}$ | $1.31 \times 10^{-4}$ | $7.29 \times 10^{-3}$ |
| Rn-222 | | | |
| Ru-106 | | | |
| Sr-90 | | $7.89 \times 10^{-25}$ | $3.40 \times 10^{-13}$ |
| Tc-99 | | $2.29 \times 10^{-23}$ | $1.48 \times 10^{-12}$ |
| Th-228 | $1.91 \times 10^{-6}$ | $2.44 \times 10^{-6}$ | $1.22 \times 10^{-2}$ |
| Th-230 | $3.18 \times 10^{-6}$ | $2.65 \times 10^{-6}$ | $1.29 \times 10^{-2}$ |
| Th-232 | $1.70 \times 10^{-6}$ | $1.42 \times 10^{-6}$ | $6.92 \times 10^{-3}$ |
| U-233 | | | |
| U-234 | $2.99 \times 10^{-3}$ | $9.12 \times 10^{-3}$ | $3.33 \times 10^{-1}$ |
| U-235 | $7.99 \times 10^{-5}$ | $2.44 \times 10^{-4}$ | $8.91 \times 10^{-3}$ |
| U-236 | $3.34 \times 10^{-5}$ | $1.02 \times 10^{-4}$ | $3.73 \times 10^{-3}$ |
| U-238 | $1.79 \times 10^{-3}$ | $5.47 \times 10^{-3}$ | $2.00 \times 10^{-1}$ |

0243

## TABLE K.6-31

## FARM PRODUCT COC CONCENTRATIONS: OFF-SITE RESIDENT FARM RECEPTORS FUTURE LAND USE WITHOUT FEDERAL OWNERSHIP

| COC | Meat Concentrations (mg/kg) | Dairy Product Concentrations (mg/kg) | Vegetable Concentrations (mg/kg) |
|---|---|---|---|
| **Chemical** | | | |
| Antimony | $6.75 \times 10^{-6}$ | $6.75 \times 10^{-7}$ | $1.65 \times 10^{-4}$ |
| Aroclor-1016 | | | |
| Aroclor-1221 | $5.63 \times 10^{-11}$ | $1.79 \times 10^{-11}$ | $8.40 \times 10^{-8}$ |
| Aroclor-1242 | | | |
| Aroclor-1248 | $1.91 \times 10^{-8}$ | $1.95 \times 10^{-8}$ | $4.68 \times 10^{-8}$ |
| Aroclor-1254 | $7.96 \times 10^{-6}$ | $1.72 \times 10^{-6}$ | $2.63 \times 10^{-6}$ |
| Aroclor-1260 | $3.11 \times 10^{-6}$ | $6.29 \times 10^{-6}$ | $2.38 \times 10^{-6}$ |
| Arsenic | $5.75 \times 10^{-6}$ | $1.73 \times 10^{-7}$ | $7.01 \times 10^{-5}$ |
| Barium | $2.21 \times 10^{-5}$ | $5.15 \times 10^{-5}$ | $3.57 \times 10^{-3}$ |
| Beryllium | $2.50 \times 10^{-7}$ | $2.25 \times 10^{-10}$ | $6.09 \times 10^{-6}$ |
| Cadmium | $8.14 \times 10^{-6}$ | $1.48 \times 10^{-6}$ | $3.53 \times 10^{-5}$ |
| Chromium | | | |
| Cobalt | $5.99 \times 10^{-5}$ | $5.99 \times 10^{-6}$ | $7.30 \times 10^{-5}$ |
| Copper | $9.49 \times 10^{-5}$ | $1.42 \times 10^{-5}$ | $2.28 \times 10^{-4}$ |
| Cyanide | $2.95 \times 10^{-11}$ | | $1.37 \times 10^{-5}$ |
| Di-n-octyl phthalate | $3.54 \times 10^{-4}$ | $1.12 \times 10^{-4}$ | $2.17 \times 10^{-7}$ |
| Heptachlorodibenzofuran | | | |
| Heptachlorodibenzo-p-dioxin | | | |
| Lead | $6.51 \times 10^{-6}$ | $5.42 \times 10^{-6}$ | $5.28 \times 10^{-4}$ |
| Manganese | $5.74 \times 10^{-5}$ | $5.02 \times 10^{-5}$ | $3.47 \times 10^{-3}$ |
| Mercury | $1.39 \times 10^{-5}$ | $2.50 \times 10^{-8}$ | $1.31 \times 10^{-6}$ |
| Molybdenum | $6.43 \times 10^{-6}$ | $1.61 \times 10^{-6}$ | $2.61 \times 10^{-5}$ |
| Nickel | $4.94 \times 10^{-5}$ | $8.23 \times 10^{-6}$ | $2.00 \times 10^{-4}$ |
| Octachlorodibenzofuran | | | |
| Selenium | $3.12 \times 10^{-7}$ | $8.32 \times 10^{-8}$ | $5.07 \times 10^{-7}$ |
| Thallium | $3.31 \times 10^{-6}$ | $1.65 \times 10^{-7}$ | $2.02 \times 10^{-6}$ |
| Vanadium | $1.58 \times 10^{-5}$ | $1.27 \times 10^{-7}$ | $1.55 \times 10^{-4}$ |
| Zinc | $3.12 \times 10^{-3}$ | $3.12 \times 10^{-4}$ | $7.24 \times 10^{-4}$ |
| 2-Chlorophenol | | | |
| 2-Methylnaphthalene | $1.30 \times 10^{-9}$ | $7.27 \times 10^{-10}$ | $1.75 \times 10^{-7}$ |
| 4-Chlorophenyl-phenylether | | | |
| 4,4-DDT | | | |

**TABLE K.6-31**
**(Continued)**

| COC | Meat Concentrations (pCi/kg) | Dair Product Concentrations (pCi/kg) | Vegetable Concentrations (pCi/kg) |
|---|---|---|---|
| **Radionuclide** | | | |
| Ac-227 | | | |
| Am-241 | | | |
| Cs-137 | $3.29 \times 10^{-3}$ | $1.15 \times 10^{-3}$ | $4.01 \times 10^{-3}$ |
| Np-237 | $1.34 \times 10^{-6}$ | $1.22 \times 10^{-7}$ | $5.83 \times 10^{-4}$ |
| Pa-231 | $9.54 \times 10^{-3}$ | $5.96 \times 10^{-5}$ | $2.91 \times 10^{-3}$ |
| Pb-210 | | | $6.16 \times 10^{-2}$ |
| Pu-238 | $8.54 \times 10^{-8}$ | $1.71 \times 10^{-8}$ | $4.17 \times 10^{-3}$ |
| Pu-239 | $5.50 \times 10^{-8}$ | $1.10 \times 10^{-8}$ | $2.68 \times 10^{-3}$ |
| Pu-240 | $5.50 \times 10^{-8}$ | $1.10 \times 10^{-8}$ | $2.68 \times 10^{-3}$ |
| Ra-226 | $7.17 \times 10^{-5}$ | $1.29 \times 10^{-4}$ | $7.00 \times 10^{-3}$ |
| Ra-228 | $4.75 \times 10^{-5}$ | $1.31 \times 10^{-4}$ | $7.29 \times 10^{-3}$ |
| Rn-222 | | | |
| Ru-106 | | | |
| Sr-90 | | $7.89 \times 10^{-25}$ | $3.40 \times 10^{-13}$ |
| Tc-99 | | $2.29 \times 10^{-23}$ | $1.48 \times 10^{-12}$ |
| Th-228 | $1.91 \times 10^{-6}$ | $2.44 \times 10^{-6}$ | $1.22 \times 10^{-2}$ |
| Th-230 | $3.18 \times 10^{-6}$ | $2.65 \times 10^{-6}$ | $1.29 \times 10^{-2}$ |
| Th-232 | $1.70 \times 10^{-6}$ | $1.42 \times 10^{-6}$ | $6.92 \times 10^{-3}$ |
| U-233 | | | |
| U-234 | $2.99 \times 10^{-3}$ | $9.12 \times 10^{-3}$ | $3.33 \times 10^{-1}$ |
| U-235 | $7.99 \times 10^{-5}$ | $2.44 \times 10^{-4}$ | $8.91 \times 10^{-3}$ |
| U-236 | $3.34 \times 10^{-5}$ | $1.02 \times 10^{-4}$ | $3.73 \times 10^{-3}$ |
| U-238 | $1.79 \times 10^{-3}$ | $5.47 \times 10^{-3}$ | $2.00 \times 10^{-1}$ |

## TABLE K.6-32

## FARM PRODUCT COC CONCENTRATIONS: ON-SITE RESIDENT FARM RECEPTORS FUTURE LAND USE WITH FEDERAL OWNERSHIP

| COC | Meat Concentrations (mg/kg) | Dairy Product Concentrations (mg/kg) | Vegetable Concentrations (mg/kg) |
|---|---|---|---|
| **Chemical** | | | |
| Antimony | $3.41 \times 10^{-1}$ | $3.41 \times 10^{-2}$ | $9.75 \times 10^{-1}$ |
| Aroclor-1016 | | | |
| Aroclor-1221 | $2.16 \times 10^{-5}$ | $6.48 \times 10^{-6}$ | $2.70 \times 10^{-2}$ |
| Aroclor-1242 | | | |
| Aroclor-1248 | $3.32 \times 10^{-4}$ | $2.37 \times 10^{-4}$ | $4.77 \times 10^{-4}$ |
| Aroclor-1254 | $6.78 \times 10^{-2}$ | $1.47 \times 10^{-2}$ | $6.93 \times 10^{-3}$ |
| Aroclor-1260 | $2.25 \times 10^{-2}$ | $4.55 \times 10^{-2}$ | $1.10 \times 10^{-2}$ |
| Arsenic | $8.30 \times 10^{-2}$ | $2.49 \times 10^{-3}$ | $6.64 \times 10^{-1}$ |
| Barium | $1.64 \times 10^{-0}$ | $3.84 \times 10^{-0}$ | $2.06 \times 10^{2}$ |
| Beryllium | $1.49 \times 10^{-3}$ | $1.34 \times 10^{-6}$ | $1.49 \times 10^{-2}$ |
| Cadmium | $9.96 \times 10^{-1}$ | $1.81 \times 10^{-1}$ | $3.56 \times 10^{0}$ |
| Chromium | | | |
| Cobalt | $4.80 \times 10^{-1}$ | $4.80 \times 10^{-2}$ | $3.20 \times 10^{-1}$ |
| Copper | $1.49 \times 10^{-7}$ | $1.91 \times 10^{-0}$ | $2.48 \times 10^{2}$ |
| Cyanide | $1.79 \times 10^{-0}$ | | $1.86 \times 10^{0}$ |
| Di-n-octyl phthalate | | $5.67 \times 10^{-1}$ | $1.79 \times 10^{-5}$ |
| Heptachlorodibenzofuran | | | |
| Heptachlorodibenzo-p-dioxin | | | |
| Lead | $1.50 \times 10^{-1}$ | $1.25 \times 10^{-1}$ | $8.19 \times 10^{0}$ |
| Manganese | $3.63 \times 10^{-0}$ | $3.18 \times 10^{0}$ | $1.75 \times 10^{2}$ |
| Mercury | $5.37 \times 10^{-0}$ | $9.66 \times 10^{-3}$ | $4.25 \times 10^{-1}$ |
| Molybdenum | $3.97 \times 10^{-1}$ | $9.93 \times 10^{-2}$ | $3.05 \times 10^{-1}$ |
| Nickel | $9.24 \times 10^{-1}$ | $1.54 \times 10^{-1}$ | $2.64 \times 10^{0}$ |
| Octachlorodibenzofuran | | | |
| Selenium | $4.67 \times 10^{-3}$ | $1.25 \times 10^{-3}$ | $4.45 \times 10^{-3}$ |
| Thallium | $1.31 \times 10^{-2}$ | $6.54 \times 10^{-4}$ | $1.87 \times 10^{-3}$ |
| Vanadium | $6.18 \times 10^{-2}$ | $4.95 \times 10^{-4}$ | $1.76 \times 10^{-1}$ |
| Zinc | $1.22 \times 10^{3}$ | $1.22 \times 10^{-2}$ | $2.43 \times 10^{2}$ |
| 2-Chlorophenol | | | |
| 2-Methylnaphthalene | $1.25 \times 10^{-4}$ | $7.02 \times 10^{-5}$ | $1.81 \times 10^{-2}$ |
| 4-Chlorophenyl-phenylether | | | |
| 4,4-DDT | | | |

**TABLE K.6-32**
**(Continued)**

| COC | Meat Concentrations (pCi/kg) | Dairy Product Concentrations (pCi/kg) | Vegetable Concentrations (pCi/kg) |
|---|---|---|---|
| **Radionuclide** | | | |
| Ac-227 | | | |
| Am-241 | | | |
| Cs-137 | $3.37 \times 10^{-3}$ | $1.18 \times 10^{-3}$ | $4.07 \times 10^{-3}$ |
| Np-237 | $1.42 \times 10^{-6}$ | $1.29 \times 10^{-7}$ | $5.86 \times 10^{-}$ |
| Pa-231 | $9.59 \times 10^{-3}$ | $6.00 \times 10^{-5}$ | $2.91 \times 10^{-3}$ |
| Pb-210 | | | $6.16 \times 10^{-2}$ |
| Pu-238 | $8.57 \times 10^{-8}$ | $1.72 \times 10^{-8}$ | $4.17 \times 10^{-3}$ |
| Pu-239 | $5.51 \times 10^{-8}$ | $1.10 \times 10^{-8}$ | $2.68 \times 10^{-3}$ |
| Pu-240 | $5.51 \times 10^{-8}$ | $1.10 \times 10^{-8}$ | $2.68 \times 10^{-3}$ |
| Ra-226 | $7.23 \times 10^{-5}$ | $1.30 \times 10^{-4}$ | $7.03 \times 10^{-3}$ |
| Ra-228 | $4.79 \times 10^{-5}$ | $1.32 \times 10^{-4}$ | $7.32 \times 10^{-3}$ |
| Rn-222 | | | |
| Ru-106 | | | |
| Sr-90 | | $1.48 \times 10^{-24}$ | $5.85 \times 10^{-13}$ |
| Tc-99 | | $1.23 \times 10^{-22}$ | $6.79 \times 10^{-12}$ |
| Th-228 | $1.92 \times 10^{-6}$ | $2.45 \times 10^{-6}$ | $1.22 \times 10^{-2}$ |
| Th-230 | $3.19 \times 10^{-6}$ | $2.66 \times 10^{-6}$ | $1.29 \times 10^{-2}$ |
| Th-232 | $1.71 \times 10^{-6}$ | $1.42 \times 10^{-6}$ | $6.92 \times 10^{-3}$ |
| U-233 | | | |
| U-234 | $4.23 \times 10^{-2}$ | $1.30 \times 10^{-1}$ | $4.56 \times 10^{0}$ |
| U-235 | $1.13 \times 10^{-3}$ | $3.45 \times 10^{-3}$ | $1.21 \times 10^{-1}$ |
| U-236 | $4.63 \times 10^{-4}$ | $1.42 \times 10^{-3}$ | $5.00 \times 10^{-2}$ |
| U-238 | $2.53 \times 10^{-2}$ | $7.76 \times 10^{-2}$ | $2.73 \times 10^{0}$ |

0247

# SECTION K.7.0

# TOXICITY ASSESSMENT

# K.7.0 TOXICITY ASSESSMENT

This toxicity assessment examines information concerning the potential effects of exposure to COCs. The COCs described in this section apply to the FEMP as a whole; they are the result of the Section K.4.0 screening process and are used in the Section K.6.0 fate and transport models. Those COCs that were screened out have been omitted from this discussion (see Section K.4.0 for a complete list).

For this CRARE, the goal was to quantitatively estimate the relationship between COC exposure and the severity or probability of human biological effect. Throughout this assessment, potential health effects caused by concurrent exposure to multiple COCs were assumed to be additive in nature. This assumption of additivity ignores possible synergisms or antagonisms among chemicals. However, data to assess interactions are lacking. In the absence of adequate information, EPA guidelines indicate that carcinogenic risks and noncancer hazard indices (HIs) should be treated as additive (EPA 1986b and 1989l).

This section contains a compilation of chronic noncarcinogenic and carcinogenic risk parameters followed by detailed toxicity profiles of the major COCs. The toxicity profiles emphasize chronic noncarcinogenic and carcinogenic health effects. Subchronic health effects are also addressed as necessary for the major COCs. The toxicity assessment for ecological effects will be provided in future operable unit CRAREs when such effects are evaluated.

## K.7.1 NONCARCINOGENS

Reference doses (RfDs) and dose-response data for noncarcinogenic effects associated with exposure to the COCs are presented in Table K.7-1. Since the RfD is usually based on data from exposure studies using animal models, an uncertainty factor has been incorporated to provide a safety factor for the extrapolation from animals to humans. When available, RfDs for both the ingestion and inhalation pathways are presented. The sources for reference dose values and dose-response data were the IRIS database (EPA 1993b) and the HEAST compiled by EPA (1992c). IRIS was used as the primary source for toxicity information. HEAST was used only if IRIS values were unavailable (EPA 1989b). Noncarcinogenic risks were characterized only for the contaminants and pathways for which pathway-specific RfD values were available; no cross-route extrapolation of noncarcinogenic risks were performed (DOE 1993c).

# TABLE K.7-1
# REFERENCE DOSES[a]

| Chemicals | Chronic Oral Reference Dose (mg/kg/day) | Chronic Inhalation Reference Dose (mg/kg/day) | Reference Concentration (mg/m³) | Effect of Concern | | Uncertainty Factor | |
|---|---|---|---|---|---|---|---|
| | | | | Oral | Inhalation | Oral | Inhalation |
| **Inorganics** | | | | | | | |
| Ammonia | $9.7 \times 10^{-1}$ | $2.9 \times 10^{-2}$ | $1\ 10^{-1}$ | Taste Threshold | Nasal Cavity Rhinitis | 1 | 30 |
| Antimony | $4 \times 10^{-4}$ | ND | ND | Reduced Lifespan; Altered Blood Chemistries | ND | 1000 | ND |
| Arsenic | $3 \times 10^{-4}$ | ND | ND | Keratosis; Hyperpigmentation | ND | 3 | ND |
| Barium | $7 \times 10^{-2}$ | $1.4 \times 10^{-4}$ | $5 \times 10^{-4}$ | Increased Blood Pressure | Fetotoxcity | 3 | 1000 |
| Beryllium (Soluble Salts) | $5 \times 10^{-3}$ | ND | ND | None Observed | ND | 100 | ND |
| Cadmium (Food) | $1 \times 10^{-3}$ | ND | ND | Renal Damage | Cancer | 10 | ND |
| Cadmium (Water) | $5 \times 10^{-4}$ | ND | ND | Renal Damage | Cancer | 10 | ND |
| Chromium (VI) | $5 \times 10^{-3}$ | ND | ND | None Reported | ND | 500 | 300 |
| Cobalt | $6 \times 10^{-2}$ | $3 \times 10^{-7}$ | $1 \times 10^{-6}$ | Cardiomyopathy | Lung Lesions | ND | ND |
| Copper | ND | ND | ND | GI System Irritation | ND | ND | ND |
| Cyanide | $2 \times 10^{-2}$ | ND | ND | Weight Loss; Thyroid Effects; Myelin Degeneration | ND | 100 | ND |
| Lead and Compounds (Inorganic) | ND | ND | ND | CNS Effects | CNS Effects | ND | ND |
| Manganese (Oral and Food) | $1.4 \times 10^{-1}$ | $1.1 \times 10^{-4}$ | $4 \times 10^{-4}$ | No Effect | Respiratory Symptoms; Psychomotor Disturbances | 1 | 300 |
| Manganese (Water) | $5 \times 10^{-3}$ | ND | ND | CNS Effects | ND | 1 | ND |

See footnotes at end of table.





0250
5208

**TABLE K.7-1**
**(Continued)**

| Chemicals | Chronic Oral Reference Dose (mg/kg/day) | Chronic Inhalation Reference Dose (mg/kg/day) | Reference Concentration (mg/m³) | Effect of Concern | | Uncertainty Factor | |
|---|---|---|---|---|---|---|---|
| | | | | Oral | Inhalation | Oral | Inhalation |
| **Inorganics (cont.)** | | | | | | | |
| Mercury, Inorganic | $3 \times 10^{-4}$ | $8.6 \times 10^{-5}$ | $3 \times 10^{-4}$ | Kidney Effects | Neurotoxicity | 1000 | 30 |
| Molybdenum | $5 \times 10^{-3}$ | ND | ND | Increased Uric Acid Levels | ND | 30 | ND |
| Nickel | $2 \times 10^{-2}$ | ND | ND | Reduced Body Weight and Organ Weight | Cancer | 300 | ND |
| Selenium | $5 \times 10^{-3}$ | ND | ND | Selenosis | ND | 3 | ND |
| Thallium (Sulfate) | $8 \times 10^{-5}$ [b] | ND | ND | Increased SGOT and Serum LDH Levels; Alopecia | ND | 3000 | ND |
| Vanadium | $7 \times 10^{-3}$ | ND | ND | None Observed | ND | 100 | ND |
| Zinc | $3 \times 10^{-1}$ | ND | ND | Decrease in Erythrocyte Superoxide Dismutose Activity | ND | 3 | ND |
| **Semivolatiles** | | | | | | | |
| 2-Chlorophenol | $5 \times 10^{-3}$ | ND | ND | Reproductive Effects | ND | 1000 | ND |
| 2-Methylnapthalene | ND | ND | ND | ND | ND | ND | ND |
| 2-Methylphenol (o-cresol | $5 \times 10^{-2}$ | ND | ND | Reduced Body Weight Gain; Neurotoxicity | ND | 1000 | ND |
| 4-Chlorophenyl-phenylether | ND | ND | ND | ND | ND | ND | ND |
| 4-Methylphenol (p-cresol) | $5 \times 10^{-2}$ | ND | ND | Reduced Body Weight Gain; Neurotoxicity | ND | 1000 | ND |
| Acenaphthene | $6 \times 10^{-2}$ | ND | ND | Hepatotoxicity | ND | 3000 | ND |
| Anthracene | $3 \times 10^{-1}$ | ND | ND | No Effects | ND | 3000 | ND |
| Benzo(a)anthracene | ND | ND | ND | ND | ND | ND | ND |
| Di-n-octyl phthalate | $2 \times 10^{-2}$ | ND | ND | Elevated Liver and Kidney Weights; Increased SGOT and SGPT | ND | 1000 | ND |

See footnotes at end of table.



0251
- 5208

## TABLE K.7-1
## (Continued)

| Chemicals | Chronic Oral Reference Dose (mg/kg/day) | Chronic Inhalation Reference Dose (mg/kg/day) | Reference Concentration ($mg/m^3$) | Effect of Concern | | Uncertainty Factor | |
|---|---|---|---|---|---|---|---|
| | | | | Oral | Inhalation | Oral | Inhalation |
| **Semivolatiles (cont.)** | | | | | | | |
| TCDD, 2, 3, 7, 8 | ND | ND | ND | Developmental Toxicity | ND | ND | ND |
| N-nitrosodiphenylamine | ND | ND | ND | ND | ND | ND | ND |
| See footnotes at end of table. | | | | | | | |
| **Pesticides / PCBs** | | | | | | | |
| Polychlorinated Biphenyls | ND[c] | ND | ND | ND | ND | ND | ND |
| DDT | $5 \times 10^{-4}$ | ND | ND | Liver Lesions | ND | 100 | ND |

[a]The values in this table, except where noted in other footnotes, are from the FEMP OU4 RI approved final report.
[b]In compliance with the guidance from Pat Van Leeuwen, Toxicologist, EPA stated in a letter dated October 28, 1993, to Jim Saric (EPA) the most current IRIS value has been used.
[c]IRIS, HEAST 1993.

CNS = Central nervous system
ND = No data available





- 5208
0252

## K.7.2 CHEMICAL CARCINOGENS

The incremental lifetime cancer risk (ILCR) due to exposure to a chemical was calculated as the product of the lifetime chronic daily intake (mg/kg/day) and the cancer slope factor of that chemical. The values used for carcinogenic slope factors (Table K.7-2) came entirely from EPA sources (IRIS and HEAST) and were defined by EPA's Carcinogen Assessment Group (CAG).

In developing the cancer slope factors, the EPA gave preference to human epidemiology studies; however, the slope factors for most chemicals were in fact derived from animal exposure studies. An inherent assumption in the EPA's approach is that there is no threshold for a carcinogenic effect. That is, smaller doses result in a smaller risk, but any dose, no matter how small, carries some risk. The dose-related number of tumors and the time of incidence of tumors were fitted using a linear multi-stage model. A slope factor describing the linear relationship of lifetime risk to dose was computed using the 95 percent UCL of this slope. This approach is inherently conservative because of the no-threshold assumption and the use of the 95 percent UCL. Cancer slope factor values are pathway-specific, and cross-route extrapolations of risk were not performed (DOE 1993c).

## K.7.3 RADIOCARCINOGENS

The principal adverse biological effects associated with ionizing radiation from radioactive substances in the environment are mutagenicity, teratogenicity, and carcinogenicity:

- Mutagenicity is the ability to induce genetic mutations in the nuclei of either somatic or reproductive cells.
- Teratogenicity is the ability to induce or increase the incidence of congenital malformations, which are permanent structural or functional deviations produced during embryonic growth and development.
- Carcinogenicity is the ability to produce neoplastic changes which result in tumors.

The guidance for the EPA Superfund risk assessment clearly states that carcinogenicity is considered to be the limiting deleterious effect at the radiation dose levels expected at the remediated FEMP. The carcinogenic effects may then be used as the sole basis for assessing the radiation-related human health risks of a site contaminated with radionuclides (EPA 1989l).

## TABLE K.7-2

## CANCER SLOPE FACTORS FOR CHEMICALS[a]

| Chemical | Oral Cancer Slope Factor [(mg/kg/day)-1] | Inhalation Cancer Slope Factor [(mg/kg/day)-1] | Unit Risk $(\mu g/m^3)^{-1}$ | Tumor Site | | Cancer Classification |
|---|---|---|---|---|---|---|
| | | | | Oral | Inhalation | |
| **Inorganics** | | | | | | |
| Ammonia | ND | ND | ND | ND | ND | ND |
| Antimony | ND | ND | ND | ND | ND | ND |
| Arsenic | $1.75 \times 10^{0}$ | $1.5 \times 10^{1}$ | $4.3 \times 10^{-3}$ | Skin, Lung | Respiratory System | A |
| Barium | ND | ND | ND | ND | ND | ND |
| Beryllium | $4.3 \times 10^{0}$ | $8.4 \times 10^{0}$ | $2.4 \times 10^{-3}$ | Total Tumors | Lung | B2 |
| Cadmium | ND | $6.3 \times 10^{0}$ | $1.8 \times 10^{-3}$ | ND | Respiratory System | B1 |
| Chromium (VI) | ND | $4.1 \times 10^{1}$ [b] | $1.2 \times 10^{-2}$ | ND | Lung | A |
| Cobalt | ND | ND | ND | ND | ND | ND |
| Copper | ND | ND | ND | ND | ND | D |
| Cyanide | ND | ND | ND | ND | ND | D |
| Lead (Inorganic) | ND | ND | ND | ND | ND | B2 |
| Manganese | ND | ND | ND | ND | ND | D |
| Mercury (Inorganic) | ND | ND | ND | ND | ND | D |
| Molybdenum | ND | ND | ND | ND | ND | ND |
| Nickel (Refinery Dust) | ND | 0.84 | $2.4 \times 10^{-4}$ | ND | Respiratory System | A |
| Selenium (Selenium Sulfide) | ND | ND | ND | Liver, Lung | ND | B2 |
| Thallium | ND | ND | ND | ND | ND | D |
| Vanadium | ND | ND | ND | ND | ND | ND |
| Zinc | ND | ND | ND | ND | ND | D |
| **Semivolatiles** | | | | | | |
| 2-Chlorophenol | ND | ND | ND | ND | ND | ND |
| 2-Methylnapthalene | ND | ND | ND | ND | ND | ND |
| 2-Methylphenol (o-cresol) | ND | ND | ND | ND | ND | C |
| 4-Chlorophenyl-phenylether | ND | ND | ND | ND | ND | ND |

See footnotes at end of table.

| **Semivolatiles (cont.)** | | | | | | |
|---|---|---|---|---|---|---|
| 4-Methylphenol (p-cresol) | ND | ND | ND | ND | ND | C |

Table K.7-2
(Continued)

| Chemical | Oral Cancer Slope Factor [(mg/kg/day)-1] | Inhalation Cancer Slope Factor [(mg/kg/day)-1] | Unit Risk $(\mu g/m^3)^{-1}$ | Tumor Site | | Cancer Classification |
|---|---|---|---|---|---|---|
| | | | | Oral | Inhalation | |
| Acenaphthene | ND | ND | ND | ND | ND | ND |
| Anthracene | ND | ND | ND | ND | ND | D |
| Benzo(a)anthracene | $7.3 \times 10^0$ | $6.1 \times 10^0$ | ND | ND | ND | B2 |
| Di-n-octyl phthalate | ND | ND | ND | ND | ND | ND |
| TCDD, 2, 3, 7, 8 | $1.5 \times 10^5$ | $1.5 \times 10^5$ | $3.3 \times 10^{-5}$ $(pg/m^3)^{-1}$ | Respiratory System, Liver | ND | B2 |
| N-nitrosodiphenylamine | $4.9 \times 10^{-3}$ | ND | ND | Urinary Bladder | ND | B2 |
| **Pesticides / PCBs** | | | | | | |
| Polychlorinated Biphenyls | $7.7 \times 10^0$ | ND | ND | Liver | ND | B2 |
| DDT | $3.4 \times 10^{-1}$ | $3.4 \times 10^{-1}$ | $9.7 \times 10^{-5}$ | Liver | Liver | B2 |

[a] Except where qualified by other footnotes, the values in this table are from the FEMP OU4 RI approved final report.
[b] EPA, HEAST, March 1993.

ND = No data available



0255
5208
FEMP-OU4CRARE-6-FINAL
February 1994

Each radionuclide produces a unique radiation spectrum and can affect different organs in the human body. The EPA has calculated the annual radiation dose equivalent from each radionuclide to each organ in each year of life, per unit intake or external exposure, over a lifetime. The average excess number of all types of radiation-induced fatal cancers that occur in a year can then estimated for the corresponding dose equivalents received during that year and relevant preceding years. The excess number of radiation-induced fatal cancers is derived from epidemiological data, extrapolation from high radiation doses to low doses, and mathematical models for projecting risk over a lifetime. Because the EPA is concerned with assessing cancer incidence, each radionuclide slope factor has been calculated by dividing the excess fatal cancer risk for that radionuclide by the mortality-to-incidence risk ratio (EPA 1989l) for the types of cancer induced by that radionuclide. This mortality-to-incidence risk ratio is not incorporated into the cancer potency factors derived by EPA for chemical carcinogens; therefore, the basis for cancer risk estimates for radionuclides and chemical carcinogens is not the same.

The relationship between cancer incidence and exposure to radioactive materials is quantified by using mathematical extrapolation models, which estimate the largest possible linear slope (within the 95 percent UCL) at low extrapolated doses consistent with the data. This "radiocarcino-genicity slope factor" is characterized as the "maximum likelihood estimate of the age-averaged lifetime total excess cancer risk per unit intake or exposure" (EPA 1991f). For this reason, the true risk to humans, although not identifiable, is not likely to be the upperbound estimate. It may in fact be lower.

The EPA Office of Radiation Programs (ORP) has calculated cancer slope factors for radionuclides of potential concern at Superfund sites. These values are listed in the HEAST (not IRIS) and are subject to revision. The slope factors are presented in Table K.7-3.

5208

## TABLE K.7-3

## CANCER SLOPE FACTORS FOR RADIONUCLIDES

| Radionuclide | ICRP Lung Class[a] | Inhalation Risk/(pCi) | Ingestion Risk/(pCi) | External Exposure (Risk/year per pCi/g soil) |
|---|---|---|---|---|
| U-233 | Y | $2.7 \times 10^{-8}$ | $1.6 \times 10^{-11}$ | $4.2 \times 10^{-11}$ |
| U-234 | Y | $2.6 \times 10^{-8}$ | $1.6 \times 10^{-11}$ | $3.0 \times 10^{-11}$ |
| U-235 | Y | $2.5 \times 10^{-8}$ | $1.6 \times 10^{-11}$ | $2.4 \times 10^{-7}$ |
| U-235 + Progeny | Y | $2.5 \times 10^{-8}$ | $1.6 \times 10^{-11}$ | $2.4 \times 10^{-7}$ |
| U-236 | Y | $2.5 \times 10^{-8}$ | $1.5 \times 10^{-11}$ | $2.4 \times 10^{-11}$ |
| U-238 | Y | $2.4 \times 10^{-8}$ | $1.6 \times 10^{-11}$ | $2.1 \times 10^{-11}$ |
| U-238 + Progeny | Y | $5.2 \times 10^{-8}$ | $2.8 \times 10^{-11}$ | $3.6 \times 10^{-8}$ |
| Th-228 | Y | $7.7 \times 10^{-8}$ | $1.1 \times 10^{-11}$ | $5.5 \times 10^{-10}$ |
| Th-228 + Progeny | Y | $7.8 \times 10^{-8}$ | $5.5 \times 10^{-11}$ | $5.6 \times 10^{-6}$ |
| Th-230 | Y | $2.9 \times 10^{-8}$ | $1.3 \times 10^{-11}$ | $5.4 \times 10^{-11}$ |
| Th-232 | Y | $2.8 \times 10^{-8}$ | $1.2 \times 10^{-11}$ | $2.6 \times 10^{-11}$ |
| Ra-226 | W | $3.0 \times 10^{-9}$ | $1.2 \times 10^{-10}$ | $1.2 \times 10^{-8}$ |
| Ra-226 + Progeny | W | $3.0 \times 10^{-9}$ | $1.2 \times 10^{-10}$ | $6.0 \times 10^{-6}$ |
| Ra-228 | W | $6.6 \times 10^{-10}$ | $1.0 \times 10^{-10}$ | $0.0 \times 10^{0}$ |
| Ra-228 + Progeny | W | $6.9 \times 10^{-10}$ | $1.0 \times 10^{-10}$ | $2.9 \times 10^{-6}$ |
| Pa-231 | Y | $3.6 \times 10^{-8}$ | $9.2 \times 10^{-11}$ | $2.6 \times 10^{-8}$ |
| Ru-106 | Y | $4.4 \times 10^{-10}$ | $9.5 \times 10^{12}$ | $0.0 \times 10^{0}$ |
| Ac-227 | Y | $8.0 \times 10^{-8}$ | $2.8 \times 10^{-10}$ | $2.6 \times 10^{-11}$ |
| Ac-227 + Progeny | Y | $8.8 \times 10^{-8}$ | $3.5 \times 10^{-10}$ | $8.5 \times 10^{-7}$ |
| Am-241 | W | $3.2 \times 10^{-8}$ | $2.4 \times 10^{-10}$ | $4.9 \times 10^{-9}$ |
| Pb-210 | D | $1.3 \times 10^{-9}$ | $5.1 \times 10^{-10}$ | $1.3 \times 10^{-10}$ |
| Pb-210 + Progeny | D | $4.0 \times 10^{-9}$ | $6.6 \times 10^{-10}$ | $1.6 \times 10^{-10}$ |
| Sr-90 | D | $5.6 \times 10^{-11}$ | $3.3 \times 10^{-11}$ | $0.0 \times 10^{0}$ |
| Sr-90 + Progeny | D | $6.2 \times 10^{-11}$ | $3.6 \times 10^{-11}$ | $0.0 \times 10^{0}$ |
| Tc-99 | W | $8.3 \times 10^{-12}$ | $1.3 \times 10^{-12}$ | $6.0 \times 10^{-13}$ |
| Cs-137 | D | $1.9 \times 10^{-11}$ | $2.8 \times 10^{-11}$ | $00 \times 10^{0}$ |
| Cs-137 + Progeny | D | $1.9 \times 10^{-11}$ | $2.8 \times 10^{-11}$ | $2.0 \times 10^{-6}$ |
| Np-237 | W | $2.9 \times 10^{-8}$ | $2.2 \times 10^{-10}$ | $7.8 \times 10^{-9}$ |
| Np-237 + Progeny | W | $2.9 \times 10^{-8}$ | $2.2 \times 10^{-10}$ | $4.3 \times 10^{-7}$ |
| Pu-238 | Y | $3.9 \times 10^{-8}$ | $2.2 \times 10^{-10}$ | $2.8 \times 10^{-11}$ |
| Pu-239 | Y | $3.8 \times 10^{-8}$ | $2.3 \times 10^{-10}$ | $1.7 \times 10^{-11}$ |
| Pu-240 | Y | $3.8 \times 10^{-8}$ | $2.3 \times 10^{-10}$ | $2.7 \times 10^{-11}$ |
| Rn-222 | Y | $7.3 \times 10^{-13}$ | $1.4 \times 10^{-12}$ | $1.2 \times 10^{-9}$ |
| Rn-222 + Progeny | Y | $7.7 \times 10^{-12}$ | $1.7 \times 10^{-12}$ | $5.9 \times 10^{-6}$ |

[a] Classification recommended by the ICRP for half-time of clearance from the lung: Y = years, W = weeks, D = days.
[b] No data available
SOURCE: HEAST (EPA 1992d)

0257

## K.7.4 RADIATION EXPOSURE PATHWAYS

EPA and DOE use different methodologies to evaluate human health risk from radiation. The purpose of this section is to distinguish these two methods and define radiation considerations for the analysis used in this CRARE. The pathways of exposure and the mathematical models used to evaluate the potential health risks associated with radionuclides in the environment are similar to those used for evaluating COCs. Radionuclides found at contaminated sites behave in the environment like their nonradioactive isotopes. Consequently, the types of data needed for a radiation risk assessment are similar to those required for a chemical risk assessment. The primary differences lie in the procedures used to characterize the radionuclide contaminants.

Exposure pathways for radionuclides include both internal and external pathways. Intakes by inhalation, ingestion, and dermal absorption are the important internal pathways.

The quantification of the amount of energy deposited in living tissue due to internal and external exposure to ionizing radiation is termed "radiation dosimetry." The amount of energy deposited in living tissue is of concern because the potential adverse effects of radiation are proportional to energy deposition. Therefore, the term "dose," used regarding radiation exposure, is defined as the energy imparted to a unit mass of tissue, whereas chemical dose means the mass of chemical absorbed into an organism.

Despite the fundamental difference between the way exposures are expressed for radionuclides and chemicals, the approach to exposure assessment is the same. An exposure assessment for radionuclides involves three steps: 1) characterization of the exposure setting, 2) identification of the exposure pathways, and 3) quantification of exposure. The primary differences in conducting exposure assessments for radionuclides as compared to chemicals are: 1) consideration of external exposures, 2) conversion of radiation exposures to dose equivalents, and 3) modification of fate and transport models for radiation exposure.

Toxicity assessment for radionuclides generally follows a two-step process. The first step, hazard identification, is used to determine whether exposure can increase the incidence of an adverse health effect. The second step, dose response assessment, is used to quantify the toxicity information and characterize the relationship between the dose of the contaminant administered or received and the incidence of adverse health effects in the exposed population.

Exposure to a radioactive substance is assumed to be hazardous. An extensive body of literature exists on radiation carcinogenesis in man and animals. Ionizing radiation can be considered pancarcinogenic (i.e., it acts as a complete carcinogen in that it serves as both initiator and promotor and can induce cancers in almost any tissue or organ).

With regards to the mutagenic effects of radiation, very little quantitative data are available, particularly low-dose exposures. The bulk of evidence supporting the mutagenic character of ionizing radiation comes from extensive studies using animal models, which have demonstrated all forms of radiation mutagenesis. Mutation rates calculated from these studies have been extrapolated to humans and form the basis for estimating the genetic impact of ionizing radiation on humans.

Radiation is a well-known teratogenic agent. The developing fetus is much more sensitive to radiation than is the mother. The age of the fetus at the time of exposure is the most important factor in determining the extent and type of damage from radiation. The malformations produced in the embryo depend on which cells, tissues, or organs in the fetus are most actively differentiating at the time of radiation exposure. Embryos are relatively resistant to radiation-induced teratogenic effects during the later stages of their development and are most sensitive from just after implantation until approximately 8 weeks into term. The greatest risk of brain damage for the human fetus occurs from 8 to 15 weeks into term.

The dose-response assessment of radionuclides is straight-forward compared to that of chemicals. The type of effects and the likelihood of possible adverse health effects occurring from radiation exposure depends on the radiation dose. The probability of adverse health effects increases with the dose of radiation, but the severity of the effects is independent of dose.

Estimates of human health effects are based primarily on single, acute, high doses of radiation. The current model used to describe these effects as a function of dose is called the linear quadratic model. This model assumes that there is no threshold for the induction of cancer or genetic effects. It is assumed that any radiation dose could give rise to a cancer or genetic effect. This is a conservative assumption and a conservative model. There is very little data on the effects of radiation at low doses or on the effects of chronic, long-term exposure in humans.

Human Health Effects

Two major international groups have been responsible for collecting and evaluating data on the human health effects of ionizing radiation, the Committee on the Biological Effects of Ionizing Radiations (BEIR) of the National Research Council, and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). These groups have issued a series of reports presenting the data and recommendations on risk values. The EPA is responsible for developing guidelines for radiation risk assessment in the United States and has relied on the published evaluations of these groups, along with those of the International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurements (NCRP). The following discussion contains a brief overview of effects of ionizing radiation on human health, and the relative risks associated with these effects.

Carcinogenic Effects. Radiation effects are usually separated into low and high linear energy transfer (LET) effects for risk evaluation. LET refers to the rate at which energy is lost as the particle or gamma ray travels through matter. Low LET radiation include x-rays and gamma rays. High LET radiation includes alpha particles and some beta particles. High LET radiation is more cytotoxic and oncogenic than low LET radiation. The EPA (1989) has estimated the following cancer risks factors for estimating risks associated with radiation exposure:

| Risk | Exposure Period | Radiation | Risk Factor $(rem)^{-1}$ |
|---|---|---|---|
| Fatal Cancers | Lifetime | Low LET | $3.9 \times 10^{-4}$ |
| | | High LET | $3.1 \times 10^{-3}$ |
| All Cancers | Lifetime | Low LET | $6.2 \times 10^{-4}$ |
| | | High LET | $5.0 \times 10^{-3}$ |
| Fatal Cancers | In utero | Low LET | $6.0 \times 10^{-4}$ |

Cancer slope factors for individual radionuclides are presented as Table K.7-3.

Genetic Effects. Genetic effects have been studied extensively using animal models and in the Japanese atomic-bomb survivors. A comparison of the survivor data has consistently led to estimates of genetic effects that imply lower risks in humans than in animals (NRC 1990). Taking into account the confidence intervals associated with the various data, the difference between humans and animals remains, indicating that humans are less sensitive to radiation induction of mutations in germ cells,

and that risks derived from animal data will be conservative if applied to humans. Because of this, BEIR V and UNSCEAR have based their evaluation of genetic risk on the lower 95 percent confidence limit for Japanese atomic-bomb survivor data, which is also consistent with the range of doubling doses observed in mice. A doubling dose is the dose required to double the incidence of genetic defects in a population.

The doubling dose for humans is currently estimated to be 100 rem (NRC 1990). Genetic effects expected per rem per 30-year generation, based on this doubling dose, fall into the range of less than 1 to about 100 per million liveborn offspring for multi-generations. The natural incidence for genetic anomalies ranges from 400 to 30,000 per million liveborn offspring (NRC 1990).

The EPA has recommended (1989) a genetic risk of 2600 effects per rad per 30-year generation for low LET radiation where 1 rad equals approximately 1 rem, and 6900 per rad per 30-year generation for high LET radiation (alpha and beta radiation) where 1 rad equals approximately 0.05 to 1 rem (depending on energy, LET, etc). These risks are based on the older BEIR III report. This is slightly more restrictive than the current BEIR V estimates.

Teratogenic Effects. Teratogenic effects are somatic effects resulting from exposure in utero to ionizing radiation. These effects, which are not passed on to other generations, can include severe mental retardation, microcephaly, and structural or limb abnormalities. Extrapolating the results of animal studies to humans has proved difficult because of the significant differences in fetal development rates. The EPA (1989) uses an estimate of 4000 effects per rad of exposure during weeks 8 to 15 of gestation for low LET radiation (primarily gamma radiation).

## K.7.5 TOXICITY PROFILES: RADIONUCLIDES

This section presents toxicity information for radionuclide compounds. It was assumed that all radionuclides are present in the soils as oxides or carbonates. This represents a conservative assumption because radionuclides clear slowly from environmental media.

### K.7.5.1 Actinium-227

This compound is currently under investigation. Little or no information is available at this time; however, as information becomes available, it will be incorporated into future CRAREs. The EPA has derived slope factors, and they are presented in Table K.7-3.

0261

K.7.5.2 Americium-241

This compound is currently under investigation. Little or no information is available at this time; however, as information becomes available, it will be incorporated into future CRAREs. The EPA has derived slope factors, and they are presented in Table K.7-3.

K.7.5.3 Lead-210

This compound is currently under investigation. Little or no information is available at this time; however, as information becomes available, it will be incorporated into future CRAREs. The EPA has derived slope factors, and they are presented in Table J.7-3.

K.7.5.4 Neptunium-237

This compound is currently under investigation. Little or no information is available at this time; however, as information becomes available, it will be incorporated into future CRAREs. The EPA has derived slope factors, and they are presented in Table K.7-3.

K.7.5.5 Plutonium

There are no reports on the chemical toxicity of plutonium; however, the fibrosis observed in the lungs of exposed animals and humans could be due to chemical interactions. The radiologic toxicity of plutonium involves bone necrosis, bone and lung cancer, and detrimental effects on the reproductive system. Also, toxic effects are observed in offspring of pregnant animals exposed to plutonium. No ingestion data specific to plutonium are available.

Among the plutonium isotopes, the short-lived Pu-241 is especially toxic because of the high energy associated with its alpha particle emission. The toxicity of plutonium compounds is based primarily on the very high radiotoxicity of the plutonium atom and secondarily upon whatever atoms or combinations of atoms they might contain (Sax 1989). When inhaled, plutonium is retained in the lungs with an effective half-life that varies from hundreds of days for plutonium oxides to tens of days for more soluble forms. A significant portion of the plutonium oxide that leaves the lungs is translocated to the tracheobronchial lymph nodes. Plutonium solubilized within the lungs is translocated to the liver and skeleton where it is very tenaciously retained (Klaassen 1986).

In a classic long-term toxicity study performed by Bair et al., the effects of inhaled plutonium oxide were studied in beagle dogs for up to 10 years following inhalation exposure. At the highest levels of

deposited activity, the dogs died within several hundred days with radiation pneumonitis and pulmonary fibrosis; at later times death was related to severe pulmonary fibrosis, and beyond 1000 days, although pulmonary fibrosis was still prominent, death was due to primary pulmonary neoplasia. The most common neoplasm was bronchioloalveolar carcinoma (Klaassen 1986). Hahn et al. (1983), using data reported by Bair and Thomas (1976), calculated the risk factor for Pu-239 alpha irradiation of the lungs to be 600 lung tumors per million rad to lung, or, assuming an RBE of 20, 30 lung tumors per millirem to lung.

Human data for plutonium exposure are available. Among workers contaminated, the case histories have been documented of 26 men who worked with plutonium during World War II. The initial body burden of these workers was between 540 and 229,500 pCi (reported as between 20 and 8500 Becquerel), and 11 of them received doses exceeding the maximum allowed by the International Commission for Radiological Protection. After a medical follow up of 37 years, 2 members of this group died of myocardial infarction and accidental trauma, respectively, compared to the 6.6 deaths expected on the basis of the adjusted rates for white males. Their 1982 exam provided no evidence that 37 years of exposure to internally deposited plutonium had adverse effects on their health (Seiler 1988).

Less toxicity data are available on trans-plutonium radionuclides such as americium and curium; however, the data that are available indicate a qualitative similarity to the toxicity of plutonium. McClellan, et al. (1972) noted that inhaled americium and curium, even as oxides, appeared more soluble than inhaled plutonium and rapidly translocated to the liver and skeleton. (Klaassen 1986)

Carcinogenicity

The EPA classifies all radionuclides as weight-of-evidence Group A substances (human carcinogens), based on their characteristic of emitting ionizing radiation and on the extensive epidemiologic data associating exposure with radiogenic cancers in humans (EPA 1992d). The carcinogenicity of Pu-238 (the predominate plutonium isotope at the FEMP) from internal exposure is due to alpha particles. The EPA (1992d) has reported cancer potency slope factors for the plutonium isotopes, and these are presented in Table K.7-3.

0263

K.7.5.6 Protactinium-231

Pharmacokinetics

Experiments with laboratory animals treated orally with different forms of protactinium yielded absorption efficiencies ranging from 0.01 to 1 percent (Burkart and Kopp 1988). The EPA (1992d) reported a gastrointestinal absorption factor of 0.001 equivalent to 0.1 percent. Quantitative inhalation data for protactinium have not been located, but one case of human inhalation yielded a lung clearance half-life 1000 days (Burkart and Kopp 1988). An ICRP lung class designation of "Y" indicates that clearing inhaled protactinium would be expected to take years.

Absorbed protactinium is distributed principally to the skeleton, and to a lesser extent to the liver and kidneys. Protactinium in the blood is excreted directly (Burkart and Kopp 1988), but the route and rate of excretion are not specified.

Noncarcinogenic Toxicity

Data regarding the noncarcinogenic effects of protactinium have not been located.

Carcinogenicity

The EPA classifies all radionuclides as weight-of-evidence Group A substances (human carcinogens), based on their characteristic of emitting ionizing radiation and on the extensive epidemiologic data associating exposure with radiogenic cancers in humans (EPA 1992d). The carcinogenicity of protactinium-231 is due to its emission of alpha particles (Burkart and Kopp 1988). The EPA (1992d) presents cancer potency slope factors for protactinium-231 of $9.2 \times 10^{-11}$ per pCi for ingestion, $3.6 \times 10^{-8}$ per pCi for inhalation, and $2.6 \times 10^{-8}$ per pCi yr/g for external exposure.

K.7.5.7 Radium and Radon

Toxicity

No chemical toxic effects of exposure to radium has been documented, and the EPA has not developed an RfD for radium; therefore, the health hazard for radium is associated with potential radiocarcinogenic effects.

Carcinogenicity

Four isotopes of radium occur naturally, Ra-223 (actinium series), Ra-224 and Ra-228 (thorium series), and Ra-226 (uranium series); radium is ubiquitous in the earth's crust and common in

groundwater, mineral deposits, soil, food products, and common building materials. Ra-226 has the longest half-life (1600 years) of the radium isotopes and decays by alpha particle emission. Ra-223 and Ra-224 are also alpha-particle emitters, and Ra-228 is a beta-particle emitter. The primary uses of radium are for manufacturing luminous dials and instrument faces and for internal radiation therapy. Thus, the bulk of human data on the effects of radium intake are available from studies of radium-dial painters and medical patients who have been administered therapeutic doses of radium.

Radium introduced into the body generates decay products, including gaseous isotopes of radon. Rn-222 generated in the body persists long enough that it easily diffuses into the bloodstream and accumulates in the sinuses, significantly reducing the alpha dose to the radium accumulating tissues but increasing the dose in the sinuses. Ultimately the bone tissues are the principal site of radium accumulation because of the similar chemistry of radium and calcium (NAS 1988). In the bone tissues, radium is initially deposited in endosteal bone surface tissue. There is then a redistribution to the bone volume, where the radium resides with a long retention time.

Dose Response Data - Human and Animal

The following discussion of the health effects of radium exposure is summarized from the report of the BEIR IV Committee on radon and other alpha emitters (NAS 1988). The epidemiological studies of humans were initially stimulated by the appearance of cancer and other adverse health effects associated with occupational exposures to Ra-224, Ra-226, and Ra-228 (by the radium-dial painters). The dial painters had the potential to ingest significant quantities of radium that were known to be harmful. The second most significant study group comprised ankylosing spondylitis patients, who were administered doses of radium solutions for therapeutic reasons. Most of the other studies focused on bone cancer, cancer of the paranasal sinuses, and cancer of the mastoid air cells, because the association of these effects with radium exposure was well known.

Although epidemiological investigations have documented the association between radium exposure and carcinogenic effects, there has been considerable debate over the dose-response relationship involved. Bone cancer incidence has been evaluated as a function of a variety of parameters that represent a measure of radium exposure, such as absorbed dose to the skeleton, pure radium equivalents, and cumulative rad-years (Evans 1966). The results indicated a nonlinear relationship fits the data. A separate analysis of the same bone cancer induction data confirmed the finding of a nonlinear fit (Mays and Lloyd 1972). The conclusion from both of these analyses is that a linear

nonthreshold relationship is likely to significantly over-predict cancer incidence at low doses. Later reassessments presented a linear-quadratic-exponential dose-response relationship (Rowland et al. 1971, 1978a, 1978b, 1983) and a dependence of incidence on the square of radium intake normalized to body weight (Marshall and Groer 1977).

Two extensive studies of ankylosing spondylitis patients treated in Germany with solutions of Ra-224 are most noteworthy. In the first, a 900-patient cohort treated with a Ra-224 colloid during the period from 1946 to 1951 with a follow-up period for more than 30 years, revealed bone cancer incidence associated with the high absorbed doses from the therapeutic treatments (Spiess 1969; Spiess and Mays 1970, 1973). In the second study, a cohort of about 1400 patients treated with small doses of Ra-224 for ankylosing spondylitis showed a similar association between dose and cancer induction (Spiess 1969; Spiess and Mays 1970, 1973). The analyses were consistent with a variety of dose-response relationships; however, none can be disproved because of the scatter in the data.

Cancers of the paranasal sinuses and the mastoid air cells have been associated with exposure to Ra-226 and Ra-228 since the 1930s (Martland 1939). These effects were initially seen in the radium-dial painters, who received high absorbed doses from the quantities of radium they ingested. Excess incidence is evident when compared to the natural incidence, which is very low. After exposure to radium, these types of cancers were expressed later than bone cancers (Evans et al. 1969; Finkel et al. 1969; Rowland et al. 1971; Rundo et al. 1986).

As discussed above, Rn-222 generated in the body persists long enough that it easily diffuses into the bloodstream and accumulates in the sinuses, significantly increasing the dose in the sinuses. Studies of cancers of the sinuses and mastoid cells conducted in beagle dogs injected with a variety of alpha-emitting radionuclides revealed excess incidence of these cancers (Schlenker 1980). Not all of the tumors were induced by alpha emitters that produce a gaseous decay product; therefore, a gaseous decay product was not essential to induction. Nevertheless, the risk of these cancers from Ra-226 and its decay products (including Rn-222) is considered significantly greater than from other alpha-emitting radionuclides.

The incidence of leukemia and other blood diseases among the radium-dial painters has been linked to radium ingestion. Martland (1931) demonstrated development of anemias and leukopenia (low leukocyte count) in the dial painters. Evans' study (1966) included leukemia and anemia as possible

effects of radium accumulation in the body. Finkel et al. (1969) discovered cases of leukemia and aplastic anemia in studies of the radium-dial painters exposed from 1918 to 1933. Among a cohort of 634 female dial painters first employed before 1930, three deaths were attributed to leukemia (Polednak 1978). This final study exceeded expectations because the natural incidence of leukemia is very low. An epidemiological study of 1285 women employed as dial painters before 1930, and 1185 employed between 1930 and 1949 (when radium contamination and exposures were much lower) revealed standard mortality ratios of 73 and 221, respectively (Stebbings et al. 1984). However, the most comprehensive and definitive study of U.S. dial painters include all workers employed before 1970 (Spiers et al. 1983). Ten cases of leukemia were found among the worker cohort of 2940 persons. The expected number of natural cases for this group would be 9.2. The study concluded that the incidence in the cohort does not differ significantly from natural incidence (Spiers et al. 1983). In summary, the accumulation of very high levels of radium is associated with severe anemias and leukemia (NAS 1988). However, at lower levels of accumulation, such as those experienced by the majority of U.S. radium-dial painters, especially in later years, the accumulated radium does not appear to significantly increase the risk of leukemia (NAS 1988).

The BEIR IV Committee presented a cancer risk factor of 200 x $10^{-6}$ per rad for bone sarcomas from protracted exposure to radium in its report on radon and other alpha emitters (NAS 1988).

K.7.5.8 Radon and Progeny

Toxicity

There are no known toxic effects of exposure to radon gas or its short-lived progeny. However, short-lived radon progeny decays to relatively long-lived lead. Because lead is a chemical toxicant, significant accumulations of radon pose a potential source of lead for exposure pathways to receptors.

Carcinogenicity

Exposure to air contaminated with radon gas and associated airborne progeny has been linked to increased risk of lung cancer. The risk is attributed to inhalation of the short-lived progeny of radon that are attached to particulates, which lodge in the lung passages and produce a radiation dose that causes lung cancer. Radon progeny that do not lodge in the lung passages are exhaled, and do not deliver a radiation dose. Lung cancer results when the bronchial epithelium of the lung passages is exposed to alpha particles emitted from decaying radon progeny (i.e., Po-214 and Po-218) lodged in the lung passages.

Three isotopes of radon are of potential concern, one associated with each of the three natural decay series. Rn-222, Rn-220, and Rn-219 are members of the uranium, thorium, and actinium decay series, respectively. Rn-222 is the isotope of primary concern because its half-life 3.82 days and mobility as an inert gas facilitate its outdoor and indoor migration, thus potentially exposing receptors to elevated concentrations of Rn-222 and its short-lived progeny. Rn-220 (half-life, 55.6 seconds) and Rn-219 (3.96 seconds) are generally of less concern because their very short half-lives often result in decay before these can migrate and accumulate in elevated quantities where receptors may be exposed. For example, all three isotopes of radon may be of concern in the air in buildings that contain the appropriate parent radionuclides (in the form of surface contamination or drummed material, for example). At the FEMP, however, Rn-220 and Rn-219 are not expected to be released from a source such as the K-65 silos because their short half-lives cause them to decay before migrating out of the waste matrix or out of the containment provided by the silos.

Dose Response Data - Human and Animal

The following discussion regarding the health effects of exposure to radon and radon progeny is summarized from the report of the BEIR IV Committee on radon and other alpha emitters (NAS 1988). The radiological effect of concern from exposure is lung cancer.

The lung cancer hazard associated with working in underground mines was first recognized by Harting and Hesse in 1879 as a result of autopsies of European miners (Harting and Hesse 1879). The most important human populations studied with regard to radon progeny exposure were the underground miners exposed to widely differing concentrations of airborne Rn-222 progeny in mines (NCRP 1984). The lung cancer mortality risk estimates for radon progeny exposure published by the BEIR IV Committee (NAS 1988) were based on an epidemiological study of these underground miner populations. The assessment of the risk from exposure to radon progeny by the BEIR IV Committee represents the most recent comprehensive examination of estimated health risks associated with exposure.

The BEIR IV Committee relied heavily on data from four principal studies of miners: Ontario uranium miners, Saskatchewan uranium miners, Swedish metal miners, and Colorado Plateau uranium miners. Underground miners exposed to radon progeny (in the mines) have an increased risk of lung cancer, as demonstrated in these epidemiological study populations. Animal models experimentally exposed to airborne radon progeny also developed lung cancers. To supplement the information

available from the human epidemiological studies, animal model studies have provided information on the dose-response relationship and the effects of variations in the exposure rate, physical characteristics of the lungs, and air quality. Thus, both human epidemiological data and animal experimental data indicate that exposure to radon progeny induces lung cancer. The data also describe the relationship between exposure and health effect as a function of influencing factors.

In its study of the human epidemiological data, the BEIR IV Committee has reevaluated the primary data (i.e., exposure histories and mortality) for the four principal epidemiological study groups of underground miners exposed to radon progeny. From this reevaluation, the committee has estimated the risk of developing fatal lung cancer. The risk from lifetime exposure to radon progeny is 350 x $10^{-6}$ excess fatal lung cancers per cumulative working level month (WLM) as exposure. The WLM is defined as the cumulative exposure to an airborne concentration of short-lived radon progeny (equal to one working level) for a period of one working month. It must be noted that this estimate, quantified as fatal lung cancer risk, was based primarily on epidemiological studies of humans and is expressed per unit cumulative exposure to progeny ($WLM^{-1}$). The EPA slope factors addressing cancer incidence were based on calculated radiation doses to organs and tissues and are expressed per unit radioactivity intake ($pCi^{-1}$). Thus, the EPA and BEIR IV risk estimates are not directly comparable. The EPA cancer slope factors were used to assess risk attributable to radon and radon progeny exposure. It is also noted that EPA has adopted a nominal risk estimate of 360 x $10^{-6}$ per WLM for use in NESHAPS (EPA 1989l). This estimate was based primarily on EPA's consideration of the BEIR IV assessment; however, EPA did average radon risk estimates derived from BEIR IV and ICRP models to calculate the estimate of 360 x $10^{-6}$ per WLM.

Although the carcinogenicity of radon progeny is established and the hazards of exposure during mining are well recognized, the hazards of exposure in other environments have not yet been adequately quantified (NAS 1988). A few exploratory epidemiological studies of lung cancer risk associated with radon progeny exposure in homes have been conducted; however, the results are inconclusive and inadequate for the purpose of risk estimation (NAS 1988).

The model developed by the BEIR IV Committee may be used to estimate risks under other environmental conditions to which persons may be routinely exposed; however, it must be recognized that the committee's model was based on epidemiological evaluations of occupational exposure conditions in underground mines. Therefore, assumptions must be made regarding the similarity of

exposed populations, levels of exposure, and factors such as cigarette smoking, when using the model for nonoccupational conditions such as the indoor home environment.

Using the BEIR IV risk factor (NAS 1988) of 350 x $10^{-6}$ $WLM^{-1}$ for lung cancer mortality from inhalation of Rn-222 and progeny, and by assuming 51.5 working months per year (8760 hours per year divided by 170 hours worked per month), 100 pCi Rn/liter air, short-lived Rn-222 progeny present in 50 percent equilibrium, and an inhalation rate of 20 $m^3$/day for 365 days/year, one can derive a lung cancer mortality risk factor of 1.2 x $10^{-11}$ per pCi. The EPA cancer slope factor from HEAST for inhalation of Rn-222 plus progeny is 7.7 x $10^{-12}$ per pCi (EPA 1992d). It must be noted that the BEIR IV risk estimate pertains to lung cancer mortality, while the EPA cancer slope factors all pertain to cancer induction rather than cancer fatality.

K.7.5.9 Ruthenium-106

Ruthenium-106 is not a COC in this CRARE. A toxicity assessment will be provided in future CRAREs, as needed, for those operable units in which Ru-106 is a COC. The EPA has derived slope factors, which are presented in Table K.7-3.

K.7.5.10 Strontium

Pharmacokinetics

Wenning and Kirsch (1988) reported that the gastrointestinal absorption of soluble strontium compounds ranges from 5 to 25 percent of the ingested dose and the EPA (1992d) has derived a gastrointestinal absorption efficiency factor of 0.3. Insoluble strontium compounds are absorbed to about 5 percent. Data regarding inhalation or dermal absorption has not been located.

Strontium is an alkaline earth metal similar in chemical behavior to calcium (Wenning and Kirsch 1988). About 99 percent of the body burden is in the skeleton. Excretion is principally in the urine.

Noncarcinogenic Toxicity

Stable strontium has induced rachitic changes in the bones, particularly of the young (EPA 1992d). Presumably, Sr-90 would also induce rachitic changes in bone. The concern at FEMP Operable Unit 4, however, is with the radiological effects (carcinogenicity) of Sr-90, rather than the noncarcinogenic toxicity.

Carcinogenicity

The EPA (1992d) has assigned stable strontium to cancer weight-of-evidence Group D, indicating it is not classifiable as to humans carcinogenicity. Quantitative cancer risk estimates were not derived for Group D substances. The EPA classifies all radionuclides as Group A substances (human carcinogens), based on their characteristic of emitting ionizing radiation and on the extensive epidemiologic data associating exposure with radiogenic cancers in humans (EPA 1992d). The EPA (1992d) has derived cancer potency slope factors for Sr-90, and its radioactive decay product of 3.6 x $10^{-11}$ per pCi for ingestion and 6.2 x $10^{-11}$ per pCi for inhalation exposure. There is no slope factor for external exposure to Sr-90, which does not emit penetrating radiation (gamma- or x-rays).

K.7.5.11 Technetium

Noncancer Toxicity

No isotopes of technetium are stable (Clarke and Podbielski 1988). Lethality due to radiation toxicity usually occurs before the nonradiologic effects of technetium become manifest; hence, little is known of the metabolic effects of the element.

Carcinogenicity

The EPA classifies all radionuclides as weight-of-evidence Group A substances (human carcinogens), based on their characteristic of emitting ionizing radiation and on the extensive epidemiologic data associating exposure with radiogenic cancers in humans (EPA 1992d). The internal carcinogenicity of Tc-99 is due to its emission of beta particles (Clarke and Podbielski 1988). The EPA (1992d) has derived cancer potency slope factors for Tc-99 of 1.3 x $10^{12}$ per pCi for ingestion, 8.3 x $10^{-12}$ per pCi for inhalation, and 6.0 x $10^{-13}$ per pCi yr/g for external exposure.

K.7.5.12 Thorium

Toxicity

No toxic effects of exposure to thorium have been documented, and the EPA has not developed an RfD for thorium; therefore, the health hazard for thorium is associated with its potential radiocarcinogenic effects.

Carcinogenicity

Natural thorium is present in the earth's crust as a primordial element. The-232 isotope accounts for approximately 100 percent of the mass abundance of thorium; however, the other isotopes of thorium

exist as members of the three natural decay series. The half-life of The-232 is very long (approximately 10 billion years); thus the specific activity is relatively low and the rate of decay is slow. The-232 decays by alpha particle emission, as do most of the progeny in the thorium natural decay series.

Thorium has historically been used as a medical imaging agent, because it is a heavy atom that provides contrast in radiographic imaging. In this role thorium has been used commercially as Thorotrast, a 25-percent colloidal solution of thorium dioxide. The following discussion of the health effects from thorium exposure is summarized from the report of the BEIR IV Committee on radon and other alpha emitters (NAS 1988).

Thorotrast has been used extensively in the United States, Europe, and Japan as an intravascular contrast agent for cerebral and limb angiography. Thorotrast has also been injected into the spleen for hepatolienography and into nasal and paranasal sinuses. These uses of Thorotrast result in deposition of the thorium (and subsequent decay products) in tissues and organs of the body, most frequently in the reticuloendothelial tissues in bone (NAS 1988). Once deposited in these tissues, alpha particle emissions from the decay of The-232 and its progeny irradiate the tissues for long periods of time at low-dose rates.

Dose-Response Data - Human

The data on human health effects of thorium exposure are based primarily on epidemiological studies of Thorotrast patients. The five long-term studies include German, Portuguese, Japanese, Danish, and American patients. In the German study (van Kaick et al. 1978a and b, 1983, 1984, 1986), 5159 Thorotrast patients and 5151 controls were followed since 1933 and 1935, respectively. The Thorotrast patients underwent intravascular injections of Thorotrast to enhance the imaging of cerebral and limb angiography. The results of the follow-up analysis indicated an excess of malignant cancers, most notably liver cancers and leukemias, among the patients relative to the controls.

The Portuguese study (Abbatt 1973; da Motta et al. 1979; Horta et al. 1978) involved about 2500 Thorotrast patients and 2000 controls with a follow-up period of about 30 years. The patients were exposed to Thorotrast from 1929 to 1955, with roughly 60 percent receiving Thorotrast doses for cerebral angiography. The results of the study show a significant excess of malignant cancer deaths

among the patients compared to the control group. Particularly notable were the excess patient liver malignancies compared to the controls.

The Japanese study (Kato et al. 1979, 1983; Mori et al. 1979a, 1979b, 1983, 1986) included 282 Thorotrast patients who were administered Thorotrast for angiography and hepatolienography during World War II. The follow-up period spanned 38 to 46 years, and results revealed that patient mortality from malignant liver cancers, other malignant cancers, blood diseases, and cirrhosis of the liver was significantly higher than in the control group.

The Danish study (Faber 1973, 1977, 1978, 1979, 1983, 1986) involved 1319 Thorotrast injected with Thorotrast from 1935 to 1946. The epidemiological analysis revealed excess gastrointestinal malignancies, liver malignancies, malignancies of the lung, and leukemia deaths in patients compared to control individuals. The excess of liver malignancies and leukemias was most notable in the study.

The American study (Falk et al. 1979) is a preliminary epidemiological assessment of Thorotrast patients exposed from 1964 to 1974. All patients had received Thorotrast for either hepatolienography or cerebral angiography. A liver cancer incidence was evident in the investigation and is reportedly continuing to increase. Further follow-up of these individuals is needed.

All five of these human epidemiological studies indicated an excess of malignant cancers among the Thorotrast patients compared to the controls. The excess malignancies were predominantly of the liver and blood (leukemia) types.

Estimation of Excess Risk from Thorotrast Administration

The human epidemiological evidence from the studies of Thorotrast patients represents the primary source of data from which estimates of risk have been derived (NAS 1988). These data can be used to derive estimates of risk for liver cancer and leukemia; however, such estimates strictly apply only to conditions of intravascular Thorotrast injection. The BEIR IV committee derived a risk estimate of up to 300 x $10^{-6}$ per rad of alpha particle radiation to the liver, and emphasized that these estimates are for Thorotrast, not thorium. The emphasis is because the dosimetry of other isotopes of thorium differs from that of The-232 in the Thorotrast colloid form. BEIR IV also derived a risk estimate of up to 60 x $10^{-6}$ per rad of alpha radiation to bone marrow for leukemia, and a value of up to 120 x $10^{-6}$ per rad of alpha radiation to the skeleton without marrow for bone cancer (NAS 1988).

Dose Response Data - Animal

Experimental studies of animals administered modified Thorotrast solutions provide insight into the possible influence of Thorotrast on carcinogenicity in humans from a "foreign body effect" (i.e., from the colloid solution), or a toxicological effect of the thorium in addition to a radiation dose effect. Studies of mice administered Thorotrast solutions fortified with The-230 to increase the specific activity of alpha emission delivering radiation dose to tissues, conventional Thorotrast, and zirconium dioxide solution (Zirconotrast) have provided evidence of increased carcinogenicity of Thorotrast relative to Zirconotrast (Bensted 1967). Rabbits injected with The-230 enriched Thorotrast revealed a shortened latency period associated with the higher specific activity solution (Faber 1973). In mice, rabbits, rats, and dogs, the metabolic distribution of Thorotrast and other colloid solutions (including zirconium and hafnium dioxide colloids has indicated that 1) the organ distribution of the Thorotrast and associated progeny in these animals is comparable to that in humans (Riedel et al. 1979, 1983) and 2) the other colloids fail to reveal significantly different effects attributable to their distributions compared to the Thorotrast (Riedel et al. 1979, 1983).

A study of dose response and possible foreign body effect in rats (Wesch et al. 1973, 1983) was conducted by administering different The-230 enrichments of Thorotrast (causing variations in dose rate) and by administering different volumes of Thorotrast (dilutions maintaining constant dose rate). The results demonstrated that the frequency of cancers follows a linear dependence with dose rate. However, varying the volume of Thorotrast administered did not correlate with frequency of induction. Although cancer risk did not increase with the volume of Thorotrast at a constant dose rate, the latent period was shortened (Wesch et al. 1973; 1983).

In additional studies of rats injected with Zirconotrast enriched with The-228, the number of induced cancers increased, and the induced cancers were similar to those induced in humans by Thorotrast (Wesch 1986). The frequency of cancer induction was found to be dose-rate dependent, and the Zirconotrast without The-228 did not induce excess cancers (Wesch 1986).

In summary, the animal experimental evidence indicates that Thorotrast induces cancers as a result of the radiation dose delivered by the solution. The physical presence of particles in the colloid solution and the chemical effect of the thorium are not likely to influence the induction of cancer (NAS 1988). The EPA derived slope factors are presented in Table K.7-3.

K.7.5.13 Uranium

Pharmacokinetics

In general, uranium compounds are not easily absorbed across the human gastrointestinal tract. Soluble uranium compounds demonstrate the best absorption. In a study in which patients drank a solution of uranyl nitrate hexahydrate, a water soluble compound, only 0.5 to 5 percent of the dose was absorbed (Hursh et al. 1969). Recent uranium metabolic models estimated absorption from the gastrointestinal tract to the blood to be 0.6 percent (Wrenn et al. 1987). Although human data concerning absorption by dermal exposure are sparse, water-insoluble uranium compounds were not absorbed in significant quantities across the skin (Yuile 1973) and are not believed to pose a significant risk to humans by this exposure route.

Once absorbed into the bloodstream, uranium compounds are metabolically converted to uranyl ions. The uranyl ion acts as a ligand in the systemic circulation, binding to the plasma proteins and bicarbonate. Although this uranyl-bicarbonate complex is stable at the pH of the plasma, the pH of urine favors dissociation of the complex. This leaves the uranyl ion free to bind to the tissues in the proximal tubule wall of the nephrons of the kidneys, resulting in cellular necrosis (Leggett 1989).

As well as being the only soft tissue that stores uranium in any appreciable quantity, the kidneys are the main organs of excretion (Hursh and Spoor 1973). Approximately 70 percent of an intake of uranium has been estimated to be excreted by the kidneys within 24 hours of intake (Berlin and Rudell 1979). Uranium that is not excreted is stored in the kidneys and bones. Binding to the bone is thought to be caused by the affinity of uranium for the phosphate groups in the bone structure.

Toxicity

Dose-Response Data - Human

Exposure to uranium, a chemical toxicant, leads to nephritis in the kidneys. Data human on exposure to uranium compounds were collected from 1940 to 1960 in acute studies on terminal and volunteer patients. Single injections of 70 to 100 $\mu$g/kg of uranium nitrate to terminally ill patients resulted in proteinuria and increased levels of catalase in the urine (Berlin and Rudell 1979; Luessenhop et al. 1958). In another study, patients were given uranyl nitrate injections ranging from 6.3 to 71 $\mu$g/kg. One of the early signs of renal damage, the appearance of the enzyme catalase in the urine, occurred in patients receiving 55 to 71 $\mu$g/kg (Hursh and Spoor, 1973; Leggett, 1989).

Dose-Response Data - Animal Models

Animal models have demonstrated a of variation of responses in acute intravenous toxicity studies. Rabbits and guinea pigs appear to be the most sensitive. The acute intravenous toxicity of soluble uranium compounds such as uranyl nitrate has been shown to be very high; the approximate dose at which 50 percent of the test organisms do not survive ($LD_{50}$) for rabbits is 0.1 mg/kg, for guinea pigs 0.3 mg/kg, for rats 1 mg/kg, and for mice 10 to 20 mg/kg (Stokinger 1982).

In chronic animal studies sublethal threshold doses of uranium have been demonstrated (Leggett 1989). Although the exact mechanism of tolerance is not known, it is believed that regenerated kidney tissue is associated with tolerance. When uranium exposure ceases, the regenerated epithelium transforms into normal renal tubular tissue (Yuile 1973).

An extensive chronic feeding study was performed on rabbits, rats, and dogs for periods of 30 days, 1 year, and 2 years (Maynard and Hodge 1949). These animals received uranium doses of 2.8, 14, and 71 mg/kg/day in the diet. Rabbits were maintained for 30 days, dogs for 1 year, and rats for 1 to 2 years. For all species, water soluble compounds were more toxic than insoluble compounds. The lowest observed adverse effect levels (LOAELs) were established for all compounds and each species (Maynard and Hodge 1949). In all cases, the LOAEL could be established within the first 30 days (EPA 1991f). Of the three species, rabbits appeared to be the most sensitive, with renal damage exhibited at all administered dose levels. The renal damage was judged to be only moderate at the lower doses, but moderately severe at the highest dose. Based on this study, the EPA has established the lowest uranium dose of 2.8 mg/kg/day as the LOAEL (EPA 1991f).

Basis for Reference Dose

The EPA (1991f) has established an RfD for uranium of 3 $\mu$g/kg/day. In lieu of a no observed adverse effect level (NOAEL), the RfD was based on the LOAEL of 2.8 mg/kg/day (Maynard and Hodge 1949) and an uncertainty factor of 1000. The uncertainty factor accounts for intraspecies and interspecies variability in toxicological response and for the use of the LOAEL rather than an NOAEL. No factor was included for the short duration of the exposure (30 days), because it has been shown that chronic nephrotoxic effects can be adequately characterized with experiments of acute/subacute duration (EPA 1991f).

Carcinogenicity

Uranium can induce cancer as a result of intake into the body through inhalation or ingestion pathways. The induction of cancer results when organs and tissues of the body are exposed to alpha particles emitted from decaying uranium atoms. Alpha particles are energetic emissions that cause molecular ionizations in a very dense pattern along a short path through matter. The effect of an alpha particle is highly localized due to the short path length traveled (low penetrability) and the ability of the particle to produce many ionizations. The ionization events cause biological damage believed to be responsible for inducing cells to become cancerous. Although other energetic emissions from radioactive decay of atoms (such as beta particles and gamma rays) also cause molecular ionizations, these radiations do not produce the density of ionizations that alpha particles produce. The dense pattern of ionizations caused by alpha particles and the low penetrability of alpha particles are the factors that determine uranium is an internal exposure hazard. Alpha particles are not an external exposure hazard because they do not penetrate sensitive tissues from outside the body. The outer layers of the skin stop the alpha particles before they can penetrate and damage sensitive tissues of inner layers.

The type of uranium (i.e., natural, enriched, or depleted) under consideration is important because different types of uranium have different specific activities (the amount of radioactivity per unit mass). The value of the specific activity of the uranium reflects the number of alpha particles emitted per unit mass. This has a direct impact on the magnitude of the radiological dose delivered internally after the uranium enters the body. Naturally occurring uranium and uranium processed from natural uranium is a mixture of U-234, U-235, and U-238. The difference between natural, enriched, and depleted uranium is defined by the percent U-235 mass enrichment. The higher the U-235 enrichment, the higher the specific activity of the mixture.

Dose-Response Data - Human

The following discussion of data concerning human health effects of uranium exposure is summarized from the report of the BEIR IV Committee on radon and other alpha emitters (NAS 1988). Convincing epidemiological evidence of uranium-induced radiocarcinogenic effects in humans is difficult to obtain. Available epidemiological evidence has come from studies of workers involved in uranium mining and milling operations. It has been noted for some time that uranium workers are at risk of increased cancer mortality; however, inhalation of airborne radon progeny rather than uranium particulates is considered the predominant source of radiation damage to the respiratory tract in

uranium miners. Simultaneous exposures to radon progeny and other elements present in uranium ore are considered confounding factors in those studies of uranium miners intended specifically to examine the radiological effects of exposure to uranium.

Risk estimation for exposure to uranium is based heavily on the carcinogenic effects of other alpha-emitting radionuclides and on animal experiments involving exposure to uranium. Available human epidemiological studies are discussed below.

Epidemiological surveys of uranium workers began in the United States in 1950 (Miller et al. 1956), and reports of increased cancer risk among uranium millers in Europe began appearing in 1959 (Rockstroh 1959). In contrast, other studies have reported little evidence of a health hazard to workers in the uranium processing industry (Ely 1959). The BEIR IV committee (NAS 1988) cautioned that the validity of epidemiological studies on uranium effects must be considered in the context of the power or ability of the studies to detect an effect if one existed. This is important with regard to all of the available epidemiological studies on uranium effects.

An early U.S. Public Health Service study of uranium miners and millers in the Colorado Plateau reported no increase in mortality in the cohort of uranium millers studied (Wagoner et al. 1964). A more detailed study with longer follow-up of the same cohort (Archer et al. 1973) revealed that the number of deaths available for analysis was almost equal to the expected number of deaths determined among controls. Interpretation of the results is complicated because, 1) exposure data were not presented, 2) the excess cases included three diagnostic categories, 3) precautions were not taken (or not stated) to exclude individuals with underground mining exposure through previous employment, 4) and the analysis was not performed in relation to the length of exposure. Because of its weak epidemiological power, the study did not provide strong evidence that uranium has a specific effect.

Several studies of uranium workers exposed to enriched uranium have been performed. A study of workers at the enrichment facility in Oak Ridge between 1943 and 1947 indicated that the mortality of the study cohort was not increased for lung cancer, bone cancer, or nephrotoxic disorders (Polednak and Frome 1986). This study is weakened by data based on exposures of short duration (typically 1 to 2 years), which does not provide conclusive evidence concerning health effects from long-term (chronic) exposure. A subsequent study of a cohort from the same population examined the lung cancer risk from inhaling uranium dust (Cookfair et al. 1983). The results indicated an increased risk

among the group of workers hired at, or over age 45, and the increased magnitude of risk was greater for higher exposures.

The findings of a retrospective study of uranium mill workers from the Colorado Plateau conducted to examine the health risks of uranium exposure in the absence of uranium mining (Waxweiler et al. 1983) were not statistically significant and are mitigated by the small number of deaths for workers employed for at least five years. The results did not reveal an increase in lung cancer deaths nor conclusively demonstrate an increased nephrotoxic effect.

Past epidemiological studies have failed to conclusively demonstrate health effects from chronic exposure to uranium dust involved in uranium mining and milling operations. However, this does not necessarily mean that the epidemiological data conclusively demonstrate the absence of effect. This is because the power of the studies was limited, weakened by short worker exposure durations, inadequate estimates of uranium exposures, and insufficient worker follow-up time to adequately evaluate long-term effects.

In conclusion, chronic exposure to uranium should be controlled on the basis of nephrotoxicity more than by radiocarcinogenicity from alpha particle emissions (NAS 1988). Quantification of the risk from chronic exposure to uranium alpha particles cannot be determined from published epidemiological studies because of confounding factors and the limited power of the studies to detect increased rates of cancer incidence or mortality (NAS 1988). Therefore, the BEIR IV Committee's a risk estimate for uranium was based on the carcinogenic effects of other alpha emitting radionuclides and animal experiments involving exposure to uranium. The most probable radiogenic effect is an increase in bone sarcomas. The likelihood of sarcomas from exposure to naturally occurring uranium is considered low and demonstratable only if a linear dose-response relationship is assumed (Mays et al. 1985). If the dose-response relationship is quadratic, then virtually no effect would be expected from naturally occurring uranium. Assuming a linear dose-response relationship and a constant nonoccupational uranium intake of 1 pCi/day, then the risk of bone sarcoma induction over a lifetime is estimated to be $1.5 \times 10^{-6}$ or 1.5 bone sarcomas per million persons (Mays et al. 1985). This is compared to a natural incidence of 750 bone sarcomas in the absence of excess exposure.

Assuming a constant nonoccupational uranium intake rate of 1 pCi/day, an exposure frequency of 365 days/year, and a lifetime of 70 years, then a lifetime uranium intake of nearly 26,000 pCi is

calculated. Using the risk factor from Mays (Mays et al. 1985) and dividing by the calculated lifetime intake, one can derive a risk factor of 5.9 x $10^{-11}$ per pCi. A comparison of this risk factor with the cancer slope factors from HEAST for ingestion of U-234, U-235, and U-238 indicates that the ratios of the HEAST values to the former value are 2.4, 2.2, and 2.2, respectively.

Dose-Response Data - Animal Models

The following discussion of experimental data concerning adverse health effects of uranium exposure in animal models is summarized from the report of the BEIR IV Committee on radon and other alpha emitters (NAS 1988). The effect of bone cancer induction is addressed first, followed by the effect of lung cancer induction.

The discussion of human epidemiological evidence presented above identifies the bone surfaces as the most probable target tissue for exposure to uranium, and bone sarcoma as the carcinogenic effect of concern. Radiocarcinogenic effects, including bone sarcoma and head carcinoma, have also been observed in animals and humans from exposure to isotopes of radium, and studies involving exposure of mice to high specific activity U-232 and U-233 have also revealed an increase in bone sarcomas. Soviet researchers have demonstrated that highly enriched uranium, which has a high specific activity, induces bone sarcomas in rats. These results indicate that the intake of high specific activity, alpha-particle-emitting radionuclides increases the risk of these cancers in animals. It would be reasonable to expect high specific activity uranium to induce bone sarcomas in humans; however, the likelihood that low specific activity, naturally occurring uranium induces bone sarcomas is low.

As stated in the discussion of human epidemiological evidence presented above an estimate of the excess risk of bone sarcoma in humans from chronic ingestion of uranium has been developed (Mays et al. 1985). This risk estimate was based on a linear dose-response relationship for Ra-226. Therefore, it was assumed that the response to alpha particles from uranium exposure is similar to the response to alpha particles from Ra-226. This assumption depends in part on the metabolic behavior of uranium relative to radium. There is evidence indicating that uranium seeks bone tissue in a manner similar but not identical to that of radium. U-233 administered to beagle dogs has been shown to initially deposit nonuniformly on bone surfaces; however, redistribution occurred (within approximately one year) to produce a distribution through the bone volume that was similar to the distribution of radium (Stevens et al. 1980). Distribution of uranium throughout the bone volume in

dogs has also been reported by Rowland and Farnham (1969) and Bruenger (personal communication with BEIR IV Committee, 1986 not available in bibliography).

Another concern is the induction of malignant tumors in the lungs from exposure to uranium by inhalation. As previously discussed, uranium emits alpha particles, which can deposit a highly localized radiation dose to sensitive tissues in the passages of the respiratory tract if particulate uranium is deposited in those passageways. The effects of inhaling of insoluble forms of uranium have been studied in rats, dogs, and monkeys for both short and prolonged exposure scenarios (Leach et al. 1970, 1973). The affected sites were the tissues of the lungs and the pulmonary lymph nodes. Chronic inhalation of uranium in these studies produced fibrosis of lung tissue and induction of malignant lung tumors. Data from those studies involving dogs have been reanalyzed (Durbin and Wrenn 1975), leading to the conclusion that neoplastic changes (tumor induction) began in the epithelial cells of the lungs in 21 percent of the dogs after a cumulative lung dose of 160 rads.

Another study exposed rats to U-232 and U-233 (as uranyl nitrate) by inhalation, revealing an increase in malignant lung tumors and bone sarcomas (Ballou et al. 1980). However, the significance of the bone sarcomas (osteosarcomas) is questionable because the rats exposed to control aerosols also developed these tumors. The osteosarcomas are not statistically significant because of their appearance in the control rats. The results of this study of high specific activity U-232 and U-233 uranyl nitrate could lead to the reasonable expectation that such exposure could induce malignant lung tumors in humans. However, the findings of this work do not provide the data needed to convincingly extrapolate a risk coefficient for human exposure.

## K.7.6 TOXICITY PROFILES: CHEMICALS

### K.7.6.1 2-Chlorophenol

Pharmacokinetics

Chlorophenols are absorbed from the gastrointestinal tract and parenteral sites of injection and are excreted as conjugates of sulfuric and glucuronic acid (Clayton 1981). Various chlorophenols are formed as intermediated metabolites during the microbiological degradation of the herbicides 2,1-D and 2,4,5-T and the pesticides Silvex, Ronnel, lindane, and benzene hexachloride (EPA 1980a).

A study using the rat model observed a tumor incidence increase (69 percent) in those rats receiving 5 ppm of 2-chlorophenol and ethylnitrosourea, as compared to an observed 58 percent in rats receiving ethylnitrosourea only. The effects of 2-chlorophenol on reproduction might be related to the transplacental transfer of 2-chlorophenol (Exon 1983).

Toxicity

Ingestion of 2-chlorophenol causes an increase, then decrease in respiration, blood pressure, and urinary output; fever; increased bowel action; motor weakness; collapse with convulsions; and death. Additional observations observed include damage to the lungs, liver, and kidneys, as well as contact dermatitis (Windholtz 1983). Acute exposures by all routes may cause muscular weakness, gastroenteric disturbances, severe depression, and collapse. Although 2-chlorophenol primarily affects the central nervous system, it may also cause edema of the lungs and injuries to the pancreas and spleen.

In other studies, rats exhibited restlessness and an increased rate of respiration within a few minutes after administration of o-chlorophenol, followed by motor weakness. Tremors, clonic convulsions, dyspnea, and coma set in promptly and continued until death (Clayton 1981). In the rat, monochlorphenols also caused marked injury to the kidneys with red blood cell casts in tubules, fatty infiltration of the liver, and hemorrhages in the intestines.

### K.7.6.2 2-Methylnaphthalene

This compound is currently under investigation. Little or no information was available when this CRARE was prepared; however, as information becomes available, it will be incorporated into further CRAREs.

K.7.6.3 4-Chlorophenyl-phenylether

This compound is currently under investigation. Little or no information was available when this CRARE was prepared; however, as information becomes available, it will be incorporated into further CRAREs. The EPA has not derived RfDs, RfCs or slope factors for this compound.

K.7.6.4 Ammonia

Pharmacokinetics

Ammonia is absorbed by inhalation, ingestion, and probably percutaneously at concentrations high enough to cause skin injury (data are not available on absorption of low concentration, through skin). Excretion is primarily by way of the kidneys; a small amount has been observed to pass through sweat glands (Clayton 1981). Once absorbed, ammonia is converted to an ammonium ion as the hydroxide and as salts, especially as carbonates. The ammonium salts are rapidly converted to urea maintaining an isotonic system (Clayton 1981). Ammonium ions are produced in the body as protein metabolites. Those produced by deamination are rapidly converted in the liver into relatively harmless urea and excreted by the kidneys or are used to make new amino acids. Ammonium ions are also produced in the kidneys, conserving fixed base, thus maintaining electrolyte balance (NIOSH 1974).

The relationship between ammonia production and muscle activity has been studied. The immediate source of ammonia from muscle appears to be a result of the deamination of adenosine monophosphate and is more apparent in fast-twitch than in slow-twitch fibers. More recently, increases in blood ammonia levels have been reported in rats after swimming, and in humans after arm work, maximal cycle ergometry, and treadmill exercise. Elevated blood ammonia has also been linked to a surprising variety of functional, metabolic, and neurological disturbances other than those caused by exercise and fatigue, including the development of hepatic comas, convulsions from ammonia toxicity precipitated by high pressure oxygen breathing, epileptic seizures, and decreased neuronal excitability. In addition, several genetic disorders are characterized by elevated blood ammonia concentrations. Symptoms of neural disability in all of the above conditions have been related to the concentration of ammonia in the blood (Mutch 1983).

Ammonia is a toxic molecule that is the principal by-product of amino acid metabolism. The transport of ammonia in nontoxic form protects the brain against high circulating levels. The interorgan transport of this molecule and the orchestration between tissues is related primarily to the

essential role of nitrogen in the maintenance of body nutrition economy and overall metabolic homeostasis. Efficient handling and disposal of ammonia requires a cooperative effort between tissues to maintain nitrogen homeostasis. The liver is the central organ of ammonia metabolism, but other organs play a key role in the interorgan exchange of this molecule. Alterations in ammonia metabolism occur during critical illness. These changes are adaptive and are designed to maintain metabolic homeostasis. Interorgan cooperation in ammonia metabolism is necessary to insure the proper integration of the metabolic processes that contribute to and are essential for survival during critical illness (Souba 1987).

Ammonia disrupts primarily the Krebs cycle. The adverse effects on the central nervous system and ATP deficiency during the intoxication have often resulted in animal death (Khmel'nitskii 1984).

Toxicity

Ammonia in an aqueous environment exists in equilibrium between the ionized ammonium cation and the nonionized ammonia. This equilibrium can be affected by buffers, pH, temperature, and salinity. Thus in many cases, it is not possible to assign the associated toxicity to the ionized or nonionized form of the ammonia-nitrogen.

Ammonia has a greater tendency than other alkalies to penetrate and damage the iris, and to cause cataracts from severe burns. Iritis may be accompanied by hypopyon or hemorrhages, extensive loss of pigment, and severe glaucoma (Grant 1986).

An experiment was conducted on six volunteers inhaling ammonia at 21 and 35-mg/m$^3$ for 10 minutes. Five reported faint to moderate irritation, while one reported no irritation at 35-mg/m$^3$. Another group was exposed for 5 minutes to 22, 35, 50, and 94-mg/m$^3$. The 94-mg/m$^3$ level caused eye irritation with lacrimation, nose, and throat irritation, and in one volunteer, chest irritation (Clayton 1981).

During a controlled experiment, volunteers were exposed to about 500 ppm ammonia for 30 minutes. Observations included irregular, minute ventilation with a cyclic pattern of hyperpnea, increases in blood pressure and pulse rate, variable lacrimation, and general complaints of upper respiratory irritation. Some symptoms persisted for 24 hours following exposure (Silverman 1979).

EPA (Heast 1992) has derived a chronic oral RfD in drinking water of 34 mg/l based on the human taste threshold and on a uncertainty factor of 1. The equivalent chronic oral RfD is 0.97 mg/kg/day assuming a 70 kg adult ingests 2 liters of water per day. EPA (1993) has derived a RfC of $1 \times 10^{-1}$ mg/m$^3$ based on lack of evidence of decreased pulmonary function in an occupational study, and on an uncertainty factor of 30. The equivalent chronic inhalation RfD is 0.029 mg/kg/day, assuming a 70 kg adult inhales 20m$^3$ of air per day.

Carcinogenicity

The EPA (1993) reports no data for a carcinogenicity assessment for ammonia.

K.7.6.5 Antimony

Toxicity

Chronic oral exposure studies in animal models include two briefly reported lifetime drinking water studies with potassium antimony tartrate in rats and mice that reported reduced longevity in both species and reduced mean heart weight and altered blood chemistry in the rats (EPA 1992d). A verified chronic oral RfD of 0.0004 mg/kg/day was based on the rat study and an uncertainty factor of 1000.

Chronic effects from occupational exposure include irritation of the respiratory tract, pneumoconiosis, pustular eruptions of the skin called "antimony spots," allergic contact dermatitis, and cardiac effects, including abnormalities of the ECG and myocardial changes (Elinder and Friberg 1986). Cardiac effects were also observed in rats and rabbits exposed by inhalation for six weeks, and in animals (dogs and possibly other species) treated by intravenous injection. Inhalation RfC values are not available from US EPA. The heart, respiratory tract, and skin are the principal target organs for antimony.

Carcinogenicity

Data were not located regarding the human carcinogenicity of antimony. Antimony fed to rats did not produce excess tumors (Goyer 1991), but a high frequency of lung tumors was observed in rats exposed by inhalation to antimony trioxide for one year (Elinder and Friberg 1986). The EPA (1991c) has not evaluated the carcinogenicity of antimony.

K.7.6.6 Aroclors

Toxicity

Aroclors-1016, -1221, -1242, -1248, -1254, -1260 are commercially mixtures of polychorinated biphenyls (PCBs). Target organs for PCBs include the skin, liver, fetus, and neonate. Epidemiologic studies of women in the United States have associated oral PCB exposure with low birth weight or retarded musculoskeletal or neurobehavioral development of their infants (ATSDR 1991). Oral studies in animals have established the liver as the target organ in all species, and the thyroid as an additional target organ in the rat. Effects observed in monkeys included gastritis, anemia, chloracne-like dermatitis, and immunosuppression. Oral exposure in animal models induced developmental effects, including retarded neurobehavioral and learning development in monkeys. Neither verified nor provisional chronic oral RfD values were located for any of the Aroclors.

Occupational exposure to PCBs have been associated with upper respiratory tract and ocular irritation, loss of appetite, liver enlargement, increased serum concentrations of liver enzymes, skin irritation, rashes and chloracne, and in heavily exposed female workers, decreased birth weight of their infants (ATSDR 1991). However, concurrent exposure to contaminants have confounded the interpretation of the occupational exposure studies. Animal models exposed by inhalation to Aroclor-1254 vapors exhibited moderate liver degeneration, decreased body weight gain, and slight renal tubular degeneration. Neither verified nor provisional chronic inhalation RfC values are available.

Carcinogenicity

The EPA (1991c) has classified the PCBs as cancer weight-of-evidence Group B2 substances (probable human carcinogens), based on inadequate data for humans but sufficient data for animals. The human data consists of several epidemiologic occupational and accidental oral exposure studies with serious limitations, including poorly quantified concentrations of PCBs and durations of exposure, and probable exposures to other potential carcinogens (EPA 1992d).

It is known that PCB congeners vary greatly as to their potency in producing biological effects. There is some evidence that mixtures containing more highly chlorinated biphenyls are more potent inducers of heptatocellular carcinoma in rats than mixtures containing less chlorine by weight (EPA 1993a).

The animal data consists of several oral studies in rats and mice with various Aroclors, Kanechlors or Clophens (commercial PCB mixtures manufactured in the United States, Japan, and Germany, respectively) that reported increased incidence of liver tumors in both species (EPA 1992d). The EPA (1991c) has presented a verified oral slope factor of 7.7 per mg/kg/day for all PCBs, based on liver tumors in rats treated with Aroclor-1260.

K.7.6.7 Arsenic

Toxicity

The only noncarcinogenic effects in humans clearly attributable to chronic oral exposure to arsenic are dermal hyperpigmentation and keratosis, as revealed by studies of several hundred Chinese exposed to naturally occurring arsenic in well water (EPA 1992d). Similar effects were observed in persons exposed to high levels of arsenic in water in the western hemisphere. Occupational (predominantly inhalation) exposure was also associated with neurological deficits, anemia, and cardiovascular effects (Ishinishi et al. 1986). The EPA (1991e) has presented an RfD of 0.0003 mg/kg/day for chronic oral exposure, based on a NOAEL from the Chinese data and an uncertainty factor of 1. The principal target organs for arsenic are the skin, nervous system, blood and cardiovascular system.

Carcinogenicity

Inorganic arsenic is clearly a carcinogen in humans (EPA 1992d). Inhalation exposure was associated with increased risk of lung cancer in persons employed as smelter workers, in arsenical pesticide applicators, and in a population residing near a pesticide manufacturing plant. Oral exposure to high levels in well water was associated with increased risk of skin cancer. The EPA (1991c) has classified inorganic arsenic in cancer weight-of-evidence Group A (human carcinogen). An inhalation slope factor of 50 per mg/kg/day, based on absorbed arsenic, was derived from occupational data. Applying an absorption factor of 0.3 yielded an inhalation slope factor of 15 per mg/kg/day, based on an ambient or inhaled dose. The slope factor based on the inhaled, rather than absorbed, dose is the correct parameter to use in risk assessments. Assuming a human inhales 20 $m^3$ of air per day and weighs 70 kilograms, the EPA (1991c) estimated an inhalation unit risk of 0.0043 $\mu g/m^3$. EPA (1993) proposed an inorganic arsenic ingestion unit risk of $5.0 \times 10^{-5}$ per mg/l. The equivalent oral slope factor is 1.75 per mg/kg/day assuming a 70 kg adult ingests 2 liters per day. "The uncertainties associated with ingested inorganic arsenic are such that estimates could be revised downward as much as an order of magnitude, relative to the risk estimates associated with most other carcinogens.

0287

K.7.6.8 Barium

Toxicity

The acute oral toxicity of barium is manifested by gastrointestinal upset, altered cardiac performance and transient hypertension, and convulsions and muscular paralysis (Reeves 1986). Repeated oral exposures have been associated with hypertension. Occupational exposure to insoluble barium sulfate induced benign pneumoconiosis (ACGIH 1991). The EPA (1993) has derived a verified chronic oral RfD of 0.07 mg/kg/day, based on increased blood pressure in subchronic to chronic human drinking water studies and on an uncertainty factor of 3. A provisional chronic inhalation RfC of 0.0005 $mg/m^3$ was based on a NOEL for fetotoxicity of 0.8 $mg/m^3$ in a four-month, intermittent-exposure inhalation study with barium carbonate in the rat, and on an uncertainty factor of 1000 (EPA, HEAST 1992). The equivalent chronic inhalation RfD value is 0.00014 mg/kg/day, assuming humans inhale 20 $m^3$ of air per day and weigh 70 kilograms. Barium is principally a muscle toxin. Its targets are the gastrointestinal system, skeletal muscle, and the cardiovascular system. The fetus also appears to be a target.

Carcinogenicity

The EPA (1993) reports no data for a carcinogenicity assessment for barium.

K.7.6.9 Beryllium

Toxicity

Beryllium has a low order of toxicity when ingested because it is poorly absorbed from the gastrointestinal tract (Reeves 1986). Occupational exposure has induced dermatitis, acute pneumonitis, and chronic pulmonary granulomatosis (berylliosis). Berylliosis was also observed in humans living in the vicinity of a beryllium plant. Pulmonary effects also occurred in laboratory animals subjected to inhalation exposure. A verified chronic oral RfD value of 0.005 mg/kg/day was based on a NOAEL of 0.54 mg/kg/day in a lifetime drinking water study with beryllium sulfate in the rat, and on an uncertainty factor of 100 (EPA 1991c). The target organs for inhalation exposure appear to be the lungs; target organs for oral exposure are not identified.

Carcinogenicity

The EPA (1991c) has classified beryllium in cancer weight-of-evidence Group B2 (probable human carcinogen), based on inadequate human data but sufficient animal data. The human data consist of occupational studies that weakly associate exposure with increased risk of lung cancer, but

confounding variables were not controlled and the studies lacked sensitivity. A significant increase in lung tumors occurred in three strains of rats and in rhesus monkeys subjected to inhalation exposure or intratracheal instillation of a variety of beryllium compounds. Osteogenic sarcomas were induced in rabbits and mice, but not in rats or guinea pigs injected intravenously with various beryllium compounds. Oral studies in animals models yielded inconclusive results. The EPA (1991c) derived an oral slope factor of 4.3 per mg/kg/day from a slight but statistically nonsignificant increase in total tumors in a lifetime drinking water study with beryllium sulfate in the rat. An inhalation unit risk of 0.0024 per $\mu g/m^3$, equivalent to 8.4 per mg/kg/day (assuming humans inhale 20 $m^3$ of air per day and weigh 70 kilograms), was derived from a human occupational study.

K.7.6.10 Cadmium

Toxicity

The EPA (1991c) has presented verified chronic oral RfD values of 0.0005 mg/kg/day for cadmium ingested in water and 0.001 mg/kg/day for cadmium ingested in food. Medium-specific oral RfD values reflected the assumption that cadmium is more efficiently absorbed from water than from food. The RfD values were based on a NOAEL for proteinuria (a sensitive indicator of renal toxicity), determined from several human exposure studies, and on an uncertainty factor of 10. Occupational exposure to fumes of cadmium induced metal fume fever (ACGIH 1991). The principal target organs for oral exposure to cadmium are the kidneys.

Carcinogenicity

Cadmium is classified as an EPA cancer weight-of-evidence Group B1 substance (probable human carcinogen), based on limited evidence from occupational studies and sufficient evidence of carcinogenicity in rats and mice following inhalation exposure or parenteral injection (EPA 1991c). There is insufficient information to classify cadmium as carcinogenic to humans by the oral route. A provisional inhalation slope factor of 6.3 per mg/kg/day and a unit risk of 0.0018 per $\mu g/m^3$ (assuming inhale 20 $m^3$ of air per day and humans weigh 70) was based on the incidence of lung cancer in cadmium smelter workers.

K.7.6.11 Chromium (VI)

Toxicity

Little chromium (VI) exists in biological materials, except shortly after exposure, because reduction to chromium (III) occurs rapidly (Langård and Norseth 1986). Chromium (III) is considered a

nutritionally essential trace element and is considerably less toxic than chromium (VI). Acute oral exposure of humans to high doses of chromium (VI) induces neurological effects, gastrointestinal hemorrhage and fluid loss, and kidney and liver effects. Parenteral dosing of animals with chromium (VI) was selectively toxic to the kidney tubules. A NOAEL of 2.4 mg Cr(VI)/kg/day in a one-year drinking water study in rats with potassium permanganate, along with an uncertainty factor of 500, formed the basis of a verified RfD for chronic oral exposure of 0.005 mg/kg/day (EPA 1991c).

Occupational (inhalation and dermal) exposure to chromium (VI) induced ulcerative and allergic contact dermatitis, irritation of the upper respiratory tract including ulceration of the mucosa and perforation of the nasal septum, and possibly kidney effects (ACGIH 1991). Currently an inhalation RFC and RFD are not available for chromium (VI) from EPA.

Target organs for dermal and inhalation exposure include the skin and respiratory mucosa.

Carcinogenicity

The EPA (1991e) has classified chromium (VI) in cancer weight-of-evidence Group A (human carcinogen), based on the consistent observation of increased risk of lung cancer in occupational studies of workers in chromate production and the chrome pigment industry. Parenteral dosing of animals with chromium (VI) compounds consistently induced injection-site tumors. There is no evidence that oral exposure to chromium (VI) induces cancer. A verified inhalation unit risk of 0.012 per $\mu g/m^3$, equivalent to 41 per mg/kg/day (assuming humans inhale 20 $m^3$ of air per day and weigh 70 kilograms), was based on increased risk of lung cancer deaths in chromate production workers.

K.7.6.12 Cobalt

Toxicity

Acute, high oral or parenteral doses of cobalt in humans and animals induced myocardial degeneration, often leading to mortality, erythropoiesis, enlarged thyroid, and in animals, renal tubular degeneration (Elinder and Friberg 1986). Chronic ingestion from the consumption of beer containing high concentrations of cobalt has been associated with a condition called "beer-drinkers cardiomyopathy," which includes polycythemia, goiter, and marked myocardial degeneration and mortality. The therapeutic use of 0.16 to 0.32 mg Co/kg/day in anemic, anephric dialysis patients for 12 to 32 weeks induced a significant but reversible rise in blood hemoglobin concentration (EPA 1992d).

Occupational (inhalation and dermal) exposure has been associated with allergic dermatitis, chronic interstitial pneumonitis, reversibly impaired lung function, occupational asthma, and myocardial effects (ACGIH 1991). Cobalt has been determined to be the etiologic factor in hard metal disease, the syndrome of respiratory symptoms and pneumoconiosis associated with inhalation exposure to dusts containing tungsten carbide with cobalt powder as a binder (Elinder and Friberg 1986). The lowest occupational air concentration of cobalt associated with hard metal disease was 0.003 mg Co/m$^3$ (Sprince et al. 1988). It should be noted that the workers were also exposed to tungsten and sometimes to titanium, tantalum, and niobium (Elinder and Friberg 1986). Similar lung effects have been seen in animals exposed to cobalt by inhalation.

The developmental toxicity of cobalt was tested in rodents treated orally with cobalt chloride (EPA 1992c). Unspecified maternal effects were reported in rats treated with 5.4 to 21.8 mg Co/kg/day from gestation day 14 through lactation day 21. Effects on the offspring included stunted growth at 5.4 mg Co/kg/day and reduced survival at 21.8 mg Co/kg/day. In rats treated with 6.2, 12.4 or 24.8 mg Co/kg/day on gestation days 6 through 15, maternal effects included reduced food consumption and body weight gain and altered hematologic parameters, although it is unclear at what dose levels these effects occurred. There were no effects on fetal survival, although an insignificant increase in fetal stunting was observed in rats treated with $\geq$12.4 mg Co/kg/day. In mice, treatment with 81.7 mg Co/kg/day caused reduced maternal weight gain, but had no fetal effects.

Several studies reported testicular degeneration and atrophy in rats treated with cobalt chloride in the diet or drinking water at concentrations equivalent to doses of 5.7 to 30.2 mg Co/kg/day (EPA 1992c).

Cobalt is nutritionally essential as a cofactor in cyanocobalamin, i.e., vitamin B12 (EPA 1992c). The element is ubiquitous and universally present in the diet. Average daily adult dietary intakes of cobalt range from 0.16 to 0.58 mg/day (0.002 to 0.008 mg/kg/day, assuming adults weigh 70 kilograms) (Tipton et al. 1966; Schroeder et al. 1967). In 9- to 12-year-old children, dietary intakes of cobalt range from 0.3 to 1.77 mg/day (Murthy et al. 1971; NRC 1989). Assuming an average weight for children in this age range of 28 kilograms (NRC 1989), the dietary intakes are equivalent to 0.01 to 0.06 mg/kg/day.

The EPA (1992c) concluded that the oral toxicity data were insufficient to derive an oral RfD for cobalt. The relatively well-characterized dietary intake data, however, can provide useful guidance. The EPA (1992c) noted that the upper range of dietary intake for children, 0.06 mg/kg/day, was below the level associated with enhanced erythropoiesis in anephric patients. Therefore, the upper range of dietary intake, 0.06 mg Co/kg/day, can be considered a guidance level for the oral intake of cobalt and can be used in place of an oral RfD in CERCLA and RCRA risk assessments.

The EPA (1990) has derived an interim inhalation RfC from the LOAEL of 0.003 mg Co/$m^3$ associated with hard metal disease in occupationally exposed humans. Correcting for intermittent occupational exposure (10 $m^3$ of air inhaled per work day/20 $m^3$ of air inhaled per day x 5 work days per week/7 days per week) yielded an adjusted LOAEL of 0.001 mg/$m^3$. Applying an uncertainty factor of 1000 ([the 10 for use of a LOAEL, 10 to protect sensitive individuals, and 10 to account for the disparity between the latency period and exposure duration — not further explained]) resulted in an interim chronic RfC of $1 \times 10^{-6}$ mg/$m^3$. Assuming humans inhale 20 $m^3$ of air per day and weigh 70 kilograms, the RfC is equivalent to $2.9 \times 10^{-7}$ mg/kg/day, rounded to $3 \times 10^{-7}$ mg/kg/day.

Important target organs in orally exposed humans are the heart, erythrocyte, and thyroid. Target organs for occupational exposure are the skin, lungs, and heart.

Carcinogenicity

The carcinogenicity of cobalt has not yet been evaluated by the EPA (1992b, 1992c).

K.7.6.13 Copper

Estimates of the absorption of copper from the gastrointestinal tract range from 15 to 97 percent, with an average of approximately 60 percent (ATSDR 1989d). Several factors, including the dose of copper, the presence of other metals in the diet, the form of copper administered, and the presence of substances that inhibit uptake (vitamin C, phytate, fiber), influence the extent of gastrointestinal absorption. The 15-percent estimate is considered sufficiently conservative and well-documented for use in estimating the dermal RfD from an oral RfD.

Quantitative data were not located regarding the uptake of copper from the respiratory tract. The observation of elevated plasma copper levels in some workers in a heavily polluted industrial

atmosphere indicated respiratory tract uptake does occur (Aaseth and Norseth 1986). Data were not located regarding the dermal uptake of copper.

Circulating copper is taken up by the liver, transferred to the ceruloplasmin, (high molecular weight protein), reenters the circulation, and accumulates in liver, heart, brain, kidneys, and muscles (Aaseth and Norseth 1986). Excretion is principally through the bile.

Noncarcinogenic Toxicity

Copper is a nutritionally essential element that functions as a cofactor in several enzyme systems (Aaseth and Norseth 1986). Acute exposure to large oral doses of copper salts has been associated with gastrointestinal disturbances, hemolysis, and liver and kidney lesions. Chronic oral toxicity in humans has not been reported. Chronic oral exposure of animals has been associated with an iron-deficiency type of anemia, hemolysis, and lesions in the liver and kidneys. Occupational exposure has induced metal fume fever, and in cases of chronic exposure to high levels, hemolysis and anemia (ACGIH 1991). Neither oral nor inhalation RfD or RfC values were available for copper from the US EPA. The target organs for copper are the erythrocyte, liver, and kidneys, and for inhalation exposure, the lung.

The EPA (1992) has concluded that the health effects data were inadequate for deriving a chronic oral RfD for copper. The current drinking water maximum contaminant level goal (MCLG) for copper is 1.3 mg/l, which was based on an LOAEL for gastrointestinal effects in acutely exposed humans, and an uncertainty factor of 2. The MCLG is equivalent to a daily intake from water of 2.6 mg/day, assuming a drinking water ingestion rate of 2 l/day. The MCLG of 1.3 mg/L is an inappropriate basis for deriving a toxicity value for use in CERCLA risk assessment, for three main reasons:

1. The MCLG is based on the effects resulting from acute exposure, and it is not reasonable to assume that a toxicity value designed to protect against effects from short-term exposure would sufficiently protect against effects from chronic exposure.

2. The estimated safe and adequate daily dietary intake of copper for adults is 1.5 to 3.0 mg/day (NRC 1989), which exceeds the equivalent daily intake from drinking water estimated from the MCLG.

3. The estimated adult daily intake of copper from food is 2.0 to 4.0 mg/day (EPA 1985a), which also exceeds the equivalent daily intake from drinking water estimated from the MCLG.

0293

Carcinogenicity

Copper is in cancer weight-of-evidence Group D, meaning it is not classifiable as to human carcinogenicity (EPA 1992c). Quantitative risk estimates are not derived from Group D chemicals.

K.7.6.14 Cyanide

Toxicity

Acute exposure to cyanide induces histotoxic hypoxia (inability of the tissues to use oxygen); death is due to central respiratory arrest (Smith 1991). Chronic dietary exposure to cyanide has induced reduced body weight gain, decreased thyroid activity, myelin degeneration, and reduced fertility in rats (EPA 1992d). The EPA (1993) has presented a verified RfD of 0.02 mg/kg/day for oral exposure to cyanide, based on a NOAEL in a two-year study of rats that consumed food fumigated with hydrogen cyanide, and on an uncertainty factor of 100. The target organs for chronic oral exposure to cyanide appear to be the thyroid and nervous system.

Carcinogenicity

The EPA (1991c) classified cyanide as a cancer weight-of-evidence Group D substance (not classifiable as to humans carcinogenicity).

K.7.6.15 DDT

Pharmacokinetics

Dichlorodiphenyltrichlorothane (DDT) is readily absorbed when dissolved in oils, fats, or lipid solvents, but is poorly absorbed as dry powder or aqueous suspension. Once absorbed, DDT concentrates in adipose tissue. Storage in fat is protective because it decreases the amount of chemicals at the site of toxic action, the brain. At a constant rate of intake, concentrations in adipose tissue reach a steady state and remain relatively constant. When exposure ceases, DDT is slowly eliminated. The rate of elimination is estimated to be 1 percent of stored DDT excreted per day (Gilman 1985).

After absorption in mammals, DDT degrades by dehydrochlorination to unsaturated DDE and by substitution of hydrogen for one chlorine atom yielding DDD. DDD is further metabolized through a series of intermediates yielding DDA. DDA is relatively water soluble and excreted primarily in the urine. Ingestion studies of DDT administered to volunteers demonstrated that within 24 hours, urinary DDA excretion increased detectably. Excretion of DDT as DDA appeared to be totally

dependent on preferential reductive dechlorination of DDT to DDD (rather than DDE) and then to DDA (Clayton 1981).

Toxicity

Dermal exposure has been associated with no illness and usually no irritation. Subcutaneous injection of colloidal suspensions of DDT in saline up to 30 ppm caused no irritation. Studies of DDT-impregnated clothing have found it to cause no irritation (Hayes 1982). The earliest symptom of acute DDT poisoning is paresthesia of the mouth and lower part of the face. This is followed by paresthesia of same areas and of the tongue and then dizziness, and tremors of extremities, confusion, malaise, headache, fatigue, and delayed vomiting. Vomiting is probably of central origin and not due to local irritation. Convulsions occur only in severe poisoning. Onset may be as soon as 30 minutes after ingestion of a large dose or as late as 6 hours after smaller but still-toxic doses. Recovery from mild poisoning usually is essentially complete in 24 hours, but recovery from severe poisoning requires several days (Hayes 1982).

There is no documented evidence that dietary absorption of DDT, alone or in combination with insecticides of the aldrin-toxaphene group, has caused cancer in the general population. No evidence has been presented that DDT has caused cancer among the millions of individuals (almost entirely men) who have been handling or spraying DDT (as dust, solution, and suspension) in all parts of the world and under all possible climatic conditions (Clayton 1981).

DDT is a mixture of p,p'-DDT and related compounds. One of the more important of the DDT isomers is o,p'-DDT. These agents have prominent estrogenic effects that have been well-characterized in a number of assay systems (Johnson, et al. 1988). The estrogenicity of DDT has lead to the supposition that it may adversely affect reproductive outcome by causing birth defects, increasing pregnancy complications, or affecting fertility (RTC 1990).

A verified chronic oral RfD value of 0.0005 mg/kg/day (EPA 1993) was based on a NOEL of 0.05 mg/kg/day in a 27 week rat feeding study and on an uncertainty factor of 100.

Carcinogenicity

The EPA (1993) has classified DDT in cancer weight-of-evidence Group B 2 (probable human carcinogen) based on the observation of tumors (generally of the liver) in seven studies in various

mouse strains and in three studies in rats. The EPA (1993) derived an oral slope factor of $3.4 \times 10^{-1}$ per mg/kg/day from liver tumors in oral (diet) studies in the mouse and the rat. An inhalation unit risk of $9.7 \times 10^{-5}$ per mg/m$^3$, equivalent to 0.34 per mg/kg/day (assuming a 70 kg adult inhales 20m$^3$ of air/day), was derived from the same oral (diet) studies.

K.7.6.16 Di-n-octyl phthalate

Pharmacokinetics

In general, phthalic acid esters are readily absorbed across the intestinal tract, intraperitoneal cavity, and lungs. Evidence also indicates that these esters can be absorbed through the skin (EPA/ECOA 1980a).

With an oral dose of di-n-octyl phthalate, greater than 90 percent of the phthalate ester or its degradation compounds were eliminated within 24 hours through urine and feces. Of the initial dose, 1 percent remained in the body and traces were still detectable at 21 days (Ikeda 1980).

Absorbed esters of phthalic acid esters distribute rapidly to various organs and tissues (i.e., liver, kidneys, bile) of both humans and animals (EPA/ECOA 1980a). Studies on the metabolism of di-in-octyl phthalate by rat liver and kidney homogenates have demonstrated that the lower the molecular weight, the faster the rate of metabolism (RCS 1980).

Several studies have been performed using three routes of exposure: 1) ingestion, 2) absorption through skin, and 3) injection. Observations in all three routes included take up, distribution, metabolism, and excretion (EPA/ECOA 1980).

In vivo and in vitro studies of phthalates have revealed a ready loss of one alkyl residue to yield a monophthalate, but only a minor loss of both alkyl residues to yield phthalic acid. Instead, the monophthalate is partially excreted without further modification and partially undergoes hydroxylation in the side chain. No products of ring hydroxylation have been identified (Chemical Society 1977).

Toxicity

The acute oral toxicity of alkyl phthalates is low and decreases with an increasing molecular weight (EPA/ECOA 1980a). Therefore, the only hazard of importance in handling consists of possible eye,

skin, and/or mucous membrane irritation from phthalate anhydride, which may occur during synthetization (ILO 1971).

K.7.6.17 Dioxin/Furan

No data were located regarding the pharmacokinetics of the polychlorinated dibenzo-p-dioxins (PCDDs) or (PCDFs) of concern; however, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) has been used as a surrogate for other structurally similar members of these chemical classes. Estimates of the gastrointestinal absorption of TCDD ranged from 50 to 86 percent of the administered dose in rats; comparable data were obtained for rates and hamsters (Fries and Morrow 1975; Nolan et al. 1979; Olson et al. 1986). In rats treated dermally with 26 ng TCDD in methanol dermal absorption after 24 hours approximated 40 percent of that absorbed by the gastrointestinal tract after an equivalent dose in ethanol (Poiger and Schlatter 1980). Dermal absorption from vaseline or polyethylene glycol vehicles was substantially less than from methanol, but quantitative estimates cannot be made from the available data.

In rodents given single oral or intrapeitonel doses, or treated for two years with TCDD in the diet, the highest concentrations and greatest tissue depots occurred in the liver, followed closely by adipose tissue (Piper et al. 1973; Poiger and Schlatter 1979; Rose et al. 1976; Kociba et al. 1976). Concentrations in other tissues were considerably lower than those in fat. Mouse liver continued to sequester TCDD more efficiently with prolonged exposure (Teitelbaum and Poland 1978). In nonhuman primates and guinea pigs, however, greater TCDD concentrations and tissue depots occurred in the adipose tissue than in the liver (Nolan et al. 1979; Van Miller et al. 1976). Data obtained at necropsy from one woman potentially exposed to TCDD showed concentrations in adipose tissue about an order of magnitude higher than levels in the liver (Facchetti et al. 1980). Radioactivity from intravenous dosing with [$^{14}$C]2,3,7,8-TCDD has been shown to cross the placenta of rats and mice; concentrations of fetal tissues were lower than in maternal tissues (Moore et al. 1976; Nau and Bass 1981).

In rodents and guinea pigs, TCDD was metabolized by microsomal mixed-function oxidase enzymes to hydroxylated derivatives that were conjugated with glucuronide or sulfate for excretion via the bile or urine, respectively (Neal et al. 1982; Olson and Bittner 1983). The hydroxylation of several different PCDDs in the rat was postulated to involve formation of arene oxide intermediates (EPA 1985a). In rats, the metabolism of TCDD was inducible but relatively slow, about four orders of

magnitude slower than the metabolism of benzo(a)pyrene. There was considerable species variation in the rate of metabolism of TCDD.

Studies with [$^{14}$C],-2,3,7,8-TCDD showed that fecal excretion accounted for 39 to 99 percent of the total (fecal and urinary) excretion of radioactivity (EPA 1985a). Elimination half-lives (assuming first order kinetics) ranged from 11 to 30 days, inversely correlated with species sensitivity to TCDD. There was considerable interspecies variation in the relative importance of fecal versus urinary excretion and in the elimination half-lives.

Noncarcinogenic Toxicity

The only effect in humans clearly attributable to TCDD was chloracne (ATSDR 1989b). The available data, however, also associated exposure to TCDD with hepatotoxicity and neurotoxicity in humans. In animals, TCDD toxicity is most commonly manifested as a wasting syndrome with thymic atrophy terminating in death, with a large number of organ systems showing nonspecific effects. Chronic treatment of animals with TCDD or a mixture of two isomers of hexachlorodibenzo-p-dioxin resulted in liver damage. Immunologic effects may be among the more sensitive endpoints of exposure to the PCDDs in animals. TCDD is a developmental and reproductive toxicant in animal models. Data were not located regarding the noncarcinogenic toxicity of unsubstituted dibenzofuran or the other PCDFs. No verified or provisional noncarcinogenic toxicity values were located for any of the chemicals of concern in these classes (EPA 1992b, 1992c).

Carcinogenicity

The EPA (1992b) has verified dibenzofuran as a cancer weight-of-evidence Group D compound (not classifiable as to carcinogenicity to humans), based on a lack of cancer data in humans or animals. Data regarding the humans carcinogenicity of TCDD obtained from epidemiologic studies of workers exposed to pesticides or to other chlorinated chemicals known to be contaminated with TCDD, are conflicting (ATSDR 1989b). The interpretation of these studies is clouded, because exposure to TCDD was not quantified, multiple routes of exposure (dermal, inhalation, oral) were involved, and the workers were exposed to other potentially carcinogenic compounds. TCDD, however, is clearly carcinogenic in animal models, inducing thyroid, lung, and liver tumors in orally treated rats and mice (EPA 1985a). Similarly, oral treatment with a mixture of two hexachlorodibenzo-p-dioxin isomers induced liver tumors in rats and mice. On the basis of the animal data, TCDD and the hexachlorodibenzo-p-dioxins were assigned to EPA cancer weight-of-evidence Group B2 (probable

human carcinogen). Although the PCDDs and PCDFs of concern were not classified, they are treated as probable human carcinogens, for which slope factors are derived.

The EPA (1992b) has presented provisional oral and inhalation slope factors for TCDD of 150,000 per mg/kg/day, based on the incidence of liver and lung tumors in an oral study in rats (Kociba et al. 1978). In the absence of satisfactory congener-specific cancer data, the EPA (1989g) derived toxicity equivalency factors (TEFs) for the other PCDDs and PCDFs, by assuming that all manifestations of toxicity for all members of these classes are mediated by a common mechanism (i.e., binding to the intraculluar AH receptor of target cells). For polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofurans; 2,3,7,8-TCDD toxicity equivalents will be calculated using the appropriate 1-TEFs/89 Toxicity Equivalent Factors (EPA 1989g).

Considerable uncertainty surrounds the carcinogenic potential of the PCDDs and PCDFs of concern. Although TCDD is classified as a weight-of-evidence Group B2 substance, the homologues of concern are not classified. The appropriateness of estimating cancer potency of (i.e., regulating as carcinogens) compounds not assigned to a cancer weight-of-evidence group is questionable (EPA 1986b).

There is uncertainty about the slope factor for TCDD. Additional uncertainty is introduced by the use of the TEFs themselves, most of which were derived not from cancer data, but from in vitro data such as enzyme induction, which is only hypothetically related to a carcinogenic role. For example, the TEF of 0.001 for octabhlorodibenzo-p-dioxins (OCDDs) and octachlorodibenzofurans (OCDFs) is based on the appearance of "dioxin-like" effects and detectable levels of OCDD late in a 13-week study of male rats treated with OCDD (Couture et al. 1988) and on in vitro evidence of enzyme induction (EPA 1989g). Before the Couture et al. (1988), paper was available, the TEF for these homologues, based on limited in vivo and in vitro data, was 0.0.

K.7.6.18 Lead

Toxicity

The noncarcinogenic toxicity of lead has been well characterized through decades of medical observation and scientific research (EPA 1992b). The primary effects of long-term exposure to levels expected to be encountered in the environment are neurological and hematological. Some of the effects on the blood, particularly changes in levels of certain blood enzymes, and subtle

neurobehavioral changes in children appear to occur at levels so low as to be considered nonthreshold effects. In part for this reason the RfD/RfC Work Group considered inappropriate the derivation of an RfC or RfD for inhalation exposure, or an RfD for oral exposure (EPA 1993). The principal target organs of lead are the central nervous system and the hematopoietic system.

The EPA has developed an uptake/biokinetic model to predict blood lead levels in populations exposed to lead in air, diet, drinking water, indoor dust, soil and paint. This makes it possible to evaluate the effects of regulatory decisions concerning each medium on blood lead levels and potential health effects. The model is used to estimate lead uptake and subsequent blood lead levels in young children, who are the most sensitive subpopulation for exposure to lead. It accepts user input of variables pertaining to site-specific exposure to lead through air, diet, water, soil, dust, and paint (EPA 1990). In the absence of data on site-specific residential exposure variables, this model is not applicable to the Operable Unit 4 CRARE.

OSWER Directive No. 9355.4-02 (EPA 1989u) established a soil cleanup level for lead of 500 to 1000 ppm, based on recommendations by the Centers for Disease Control designed to protect children from blood lead concentrations above background, which are associated with lead-induced neurological effects. In the absence of current measures of residential exposure and other site-specific variables, the OSWER directive (EPA 1989u) appears to be the soundest and most defensible basis for evaluating the toxicity of exposure to lead in soil.

Carcinogenicity

Lead is assigned to cancer weight-of-evidence Group B2 (probable human carcinogen), based on inadequate human evidence but sufficient animal evidence (EPA 1991c). Rat and mouse bioassays have shown statistically significant increases in renal tumors following dietary and subcutaneous exposure to several soluble lead salts. The EPA has declined to quantitatively estimate risk for oral exposure to lead because many factors (i.e., age, general health, nutritional status, existing body burden, and duration of exposure) influence the bioavailability of ingested lead, introducing a great deal of uncertainty into any estimate of risk (EPA 1992b).

K.7.6.19 Manganese

Toxicity

The EPA (1993) has presented a verified chronic (food) oral RfD of 0.14 mg/kg/day of manganese, based on a NOEL for humans in chronic dietary intake studies and an uncertainty factor of 1, plus a chronic oral (water) RfD of 0.005 mg/kg/day based on a NOEL for humans in a chronic water ingestion study and an uncertainty factor of 1. The EPA (1993) has also presented a chronic inhalation RfC of 0.0004 mg/m$^3$, based on a LOAEL for respiratory symptoms and psychomotor disturbances in occupationally exposed humans, and on an uncertainty factor of 300. The inhalation RfC is equivalent to 0.00011 mg/kg/day (assuming humans inhale 20 m$^3$ of air per day and weigh 70 kilograms. The central nervous system and respiratory tract are the target organs of inhalation exposure to manganese.

Carcinogenicity

The EPA (1993) has classified manganese in cancer weight-of-evidence Group D (not classifiable as to humans carcinogenicity).

K.7.6.20 Mercury

Toxicity

Acute oral exposure to high doses of inorganic mercury causes severe damage to the gastrointestinal mucosa, which may lead to bloody diarrhea, shock, circulatory collapse, and death (Berlin 1986). Acute sublethal poisoning induces severe kidney damage, while chronic exposure induces an autoimmune glomerular disease and renal tubular injury. The EPA (1991c) has presented a verified RfD of 0.0003 mg/mg/day for chronic oral exposure to inorganic mercury, based on kidney effects in rats and an uncertainty factor of 1000. The form of mercury used in these studies was not described. Occupational exposure has induced neurotoxicity (Berlin 1986). The EPA (1991c) has also presented a verified chronic inhalation RfC of 0.0003 mg/m$^3$, based on occupational data and an uncertainty factor of 30. The RfC is equivalent to 8.6 x $10^{-5}$ mg/kg/day (assuming humans inhale 20 m$^3$ of air per day and weigh 70 kilograms). Target organs for inorganic mercury include the gastrointestinal tract, the central nervous system and kidneys.

Carcinogenicity

The EPA (1991c) has classified mercury in cancer weight-of-evidence Group D (not classifiable as to humans carcinogenicity).

0301

K.7.6.21 Molybdenum

Molybdenum is a nutritionally essential trace element (Friberg and Lener 1986). Its most important oxidation states are +2, +3, +4, and +6.

Pharmacokinetics

Molybdenum from soluble compounds is readily absorbed from the gastrointestinal or respiratory tracts (Friberg and Lener 1986). Estimates of gastrointestinal absorption in humans average around 50 percent, with a range of 38 to 72 percent observed in young women, and 77 percent reported for school children. The form or oxidation state of molybdenum used in these studies was not specified. Estimates of gastrointestinal absorption in laboratory animals have ranged from 40 to 85 percent for hexavalent molybdenum. The 38 percent estimate of gastrointestinal absorption is considered sufficiently conservative and well-documented for use in estimating a dermal RfD from an oral RfD.

Inhalation uptake studies with guinea pigs showed that molybdenum disulfide was essentially unabsorbed, but that hexavalent molybdenum was absorbed to an appreciable (unquantified) extent (Friberg and Lener 1986).

Absorbed molybdenum was distributed primarily to the kidneys, liver, and bone in several animal models (Friberg and Lener 1986). Molybdenum appears to accumulate in the liver, cartilage of the long bones, and skin. In humans and most animal models, the kidneys are the principal organs of excretion. The excretion of molybdenum is affected by the level of copper and sulfate in the diet.

Noncarcinogenic Toxicity

Chronic molybdenum poisoning in livestock (teart) has resulted from a molybdenum-copper imbalance and is characterized by anemia, gastrointestinal disturbances, bone disorders, and growth depression (Friberg and Lener 1986). In laboratory animals, excess molybdenum has induced effects in the liver, kidneys, and spleen. Gout-like symptoms were observed in humans living in a high-molybdenum, low-copper area. A few cases of pneumoconiosis were reported in occupationally exposed workers. The EPA (1992b) has derived a provisional chronic oral RfD of 0.005 mg/kg/day, based on an LOAEL in humans exposed to high levels in water and diet, and on an uncertainty factor of 30. The effects of concern were increased urinary excretion of uric acid, decreased copper levels in the blood, and pain and swelling in the joints. Target organs for molybdenum toxicity include the erythrocyte, joints, liver, and kidneys.

K.7.6.22 Nickel

Toxicity

The EPA (1991e) has presented a verified RfD of 0.02 for chronic oral exposure to nickel, based on a NOAEL for decreased organ and body weights in a two-year dietary study with nickel sulfate in rats. An uncertainty factor of 300 was used. In a subchronic study with nickel chloride in water, clinical signs of toxicity included lethargy, ataxia, irregular breathing, reduced body temperature, salivation, and discolored extremities (EPA 1992b). These clinical signs suggest the central nervous system may be a target for the toxicity of nickel.

Carcinogenicity

Occupational exposure to nickel has been associated with increased risk of nasal, laryngeal, and lung cancer (ATSDR 1988). Rats inhaling nickel subsulfide increased their incidence of lung tumors. The EPA (1991e) has assigned nickel to cancer weight-of-evidence Group A (human carcinogen) and for nickel refinery dust has presented an inhalation slope factor of 0.84 per mg/kg/day and an inhalation unit risk of 0.00024 per $\mu g/m^3$. The quantitative estimates were derived from the human occupational studies.

K.7.6.23 Selenium

Toxicity

Selenium is a nutritionally essential trace element that is an integral part of the enzyme glutathione peroxidase and other proteins (Högberg and Alexander 1986). NRC (1989) recommended dietary allowances (RDAs) for humans range from 10-75 $\mu$g/day. Chronic ingestion of 5 mg/day (0.071 mg/kg/day, assuming humans weigh 70 kilograms) induced selenosis in humans, characterized by abnormal hair and nail formation (Högberg and Alexander 1986). Effects in domestic grazing animals exposed to high levels of selenium included emaciation, lameness, and loss of hair and hooves. The EPA (1991c) has derived a verified RfD of 0.005 mg/kg/day for chronic oral exposure to selenium, based on effects in humans exposed to selenium in high selenium areas. An uncertainty factor of 15 was used. The principal target organs for selenium are the skin, including the nails and hair, and in animals, the hooves and joints.

Carcinogenicity

An impressive body of data indicates that selenium exerts an anticarcinogenic effect (Högberg and Alexander 1986). In laboratory animals, selenium supplementation decreased the incidence of

chemical-induced cancers. In humans, the incidence of lymphomas and cancers of the breast, digestive tract, and lungs were lower in geographic areas with high soil selenium levels. Occupational data suggest that selenium may protect against lung cancer. Several animal tests with various deficiencies in design and conduct equivocally associated exposure to selenium with cancer induction. In a well-controlled oral experiment, selenium sulfide was associated with an increase in the incidence of liver tumors in rats, and with liver and lung tumors in mice. On the basis of this study, the EPA (1991c) has assigned selenium sulfide to cancer weight-of-evidence Group B2 (probable human carcinogen). Quantitative risk estimates were not derived.

K.7.6.24 Thallium, Soluble Salts

Toxicity

Thallium is highly toxic; acute ingestion in humans or laboratory animals induces gastroenteritis, neurological dysfunction, and renal and liver damage (Kazantzis 1986). Chronic ingestion of more moderate doses characteristically causes alopecia. Thallium was once used medicinally to induce alopecia in cases of ringworm of the scalp, sometimes with disastrous results. In industrial exposure (inhalation, oral, dermal), neurologic signs precede alopecia, suggesting that the nervous system is more sensitive than the hair follicle. The EPA (1991c) has derived a chronic oral RfD of $8 \times 10^{-5}$ mg/kg/day based on increased incidence of alopecia and increased serum levels of liver enzymes indicative of hepatocellular damage in rats treated with thallium sulfate for 90 days. An uncertainty factor of 3000 was used. Chronic oral RfDs have also been developed for thallium acetate, thallium carbonate, thallium selenite, thallium chloride and thallium mononitrate based on the study performed with thallium sulfate. These oral RfDs are calculated by analogy to thallium sulfate by correcting for molecular weight differences. These RfDs range from $8 \times 10^{-5}$ to $9 \times 10^{-5}$ mg/kg/day. Target organs for thallium include the gastrointestinal tract (acute exposure), central nervous system, skin, kidneys and liver.

Carcinogenicity

The EPA (1991c) has assigned several thallium compounds (thallium acetate, thallium carbonate, thallium chloride, thallium nitrate, and thallium sulfate) to cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans).

K.7.6.25 Vanadium

Toxicity

The oral toxicity of vanadium and its compounds to humans is very low (Lagerkvist et al. 1986), probably because little vanadium is absorbed from the gastrointestinal tract. Effects in humans exposed by inhalation include upper and lower respiratory tract irritation. A provisional chronic oral RfD of 0.007 mg/kg/day was derived from a NOEL in the rat in a lifetime drinking water study with vanadyl sulfate, and from an uncertainty factor of 100 (EPA 1991c). A target organ could not be identified for oral exposure, but the respiratory tract is the target organ for inhalation exposure.

Carcinogenicity

No information was located regarding the carcinogenicity of vanadium.

K.7.6.26 Zinc

Toxicity

Zinc is a nutritionally essential trace element required for the proper function of many metalloenzymes and DNA polymerase, which is required for cell division (Elinder 1986). Acute oral exposure to high doses induces gastrointestinal irritation, while chronic oral toxicity may be manifested as anemia, resulting from impaired gastrointestinal absorption of copper. The inhalation of dust or vapor by occupationally exposed humans has induced pneumonitis and metal fume fever. A chronic oral RfD for zinc of 0.3 mg/kg/day was based on a LOAEL for a decrease in erythrocytc superoxide dismutose in adult female humans after a 10 week zinc diet supplement study and on an uncertainty factor of 3 (EPA 1991c). The primary target organs for zinc include the gastrointestinal tract for oral exposure and the lungs for inhalation exposure.

Carcinogenicity

The EPA (1991c) has assigned zinc to cancer weight-of-evidence Group D (not classifiable as to human carcinogenicity).

{This page intentionally left blank}

# SECTION K.8.0

# QUANTIFICATION OF CONTAMINANT EXPOSURE AND INTAKE

# K.8.0 QUANTIFICATION OF CONTAMINANT EXPOSURE AND INTAKE

This section defines the quantification methods used for evaluating cancer risks and the potential for adverse noncancer health effects. Minimum and maximum results calculated for intake of COCs contributing to the calculated risks are presented at the end of this section.

## K.8.1 DEFINITIONS

Exposure is defined as the contact of an organism with a chemical or physical agent. When exposure occurs through the inhalation or ingestion pathways, some of the contaminant is taken into the body. The amount of contaminant ingested or inhaled is referred to as the contaminant intake. The fraction of the contaminant absorbed into the body (across the membranes of the gastrointestinal or respiratory system, or through the skin after dermal contact) is referred to as the dose or the absorbed dose of contaminant. In the animal studies often used to develop toxicity values for risk assessment, the intake of contaminants is considered to be equivalent to the administered dose. Toxicity values (RfDs and cancer slope factors) are generally developed in terms of contaminant intake, rather than absorbed doses, particularly for the ingestion and inhalation pathways.

## K.8.2 QUANTIFICATION METHODS

In evaluating cancer risks and the potential for adverse noncancer health effects, it was necessary to estimate contaminant intake for the exposed receptor. For both cancer and noncancer risk assessment, average long-term daily intakes were used to estimate risk. The chronic daily intakes (CDIs) of contaminants were estimated as follows:

$$CDI = \frac{C \times CR \times EFD}{BW} \times \frac{1}{AT} \qquad (1)$$

where

| | | |
|---|---|---|
| CDI | = | chronic daily intake (mg/kg body weight/day), |
| C | = | chemical concentration in exposure medium (mg/l), |
| CR | = | contact rate with exposure medium (l/day), |
| EFD | = | exposure frequency and duration (days/year, years), |
| BW | = | body weight (kg), and |
| AT | = | average time, e.g., the period over which exposure is averaged (days). |

In the case of cancer risk assessment, the average lifetime daily intake was used to estimate the incremental lifetime cancer risk (ILCR), and AT equalled a full 70-year lifespan. For noncancer risk assessment, intake was evaluated over the period during which exposures occur, and AT equalled the

duration of exposure. In the case of dermal exposures, time-weighted absorbed doses, rather than intakes, were calculated as described in Section K.7.2. Otherwise, time-weighted average doses were calculated in the same manner as the contaminant intakes described above.

The exposure parameters used to assess receptor contaminant intakes and doses are discussed in Section K.5.2. The exposure factor values used are summarized in Table K.3-1. The exposure parameters were based on those used in the Operable Unit 4 RI. Specifically, the receptor intakes of COCs were quantified using the methods, models, and parameters specified in the RAWPA (DOE 1992i) and in the SWCR (DOE 1993e) with the exceptions noted below. These deviations are the direct result of 1) FERMCO's response to EPA Region V review comments on the SWCR and 2) technical information obtained from literature other than that cited in the Addendum and SWCR. The new parameter value and the impact on receptor exposure and COC intake are summarized below:

- The soil ingestion rate for the on-property farm adult increased from 0.109 g/day in the SWCR to 0.18 g/day in this report. This new time-weighted average value includes ingestion from occupational exposures (Operable Unit 4 RI report and the derivation is also presented in Section K.3.3 of this CRARE). This increased ingestion exposures for this receptor by a factor of 1.65.

- The soil ingestion rate used for the groundskeeper was 0.05 g/day, consistent with the value used in the Operable Unit 4 RI.

## K.8.3 RESULTS OF INTAKE QUANTIFICATION

Table K.8-1 presents the minimum and maximum calculated intake of COCs for all viable exposure pathways for the Current Land Use scenario. Tables K.8-2 and K.8-3 present the same information for the two Future Land Use scenarios (with and without federal ownership). All exposure calculations were carried through the CDI or exposure step for all COCs. These tables present the minimum and maximum calculated intakes for only those COCs contributing to the calculated risks. The tables in Attachment K.IV present all CDIs whether or not toxicity factors (RfDs, RfCs, and cancer slope factors) were available. The summary tables do not carry forward the CDIs for COCs without toxicity factors. However, the uncertainty analysis in Section K.10.0 covers the impact of these chemicals. Attachment K.IV presents the intake and calculation worksheets. These intake estimates are used in Section K.9.0, in conjunction with contaminant toxicity data (from Section K.7.0), to quantify the risks resulting from exposures.

## TABLE K.8-1

## SUMMARY OF COC INTAKES: CURRENT LAND USE SCENARIO

| RME Receptor | Exposure Pathways | Minimum CDI[a] (mg/kg/day) (pCi) | Minimum Compound | Maximum CDI[a] (mg/kg/day) (pCi) | Maximum Compound | Attachment K.IV Table Reference |
|---|---|---|---|---|---|---|
| Trespassing Child | Inhalation of Particulates | | | | | |
| | Chemicals | $9.1 \times 10^{-12}$ | Aroclor-1248 | $6.4 \times 10^{-7}$ | Barium | 1 |
| | Radionuclides | $2.2 \times 10^{-2}$ | Np-237 | $8.2 \times 10^{3}$ | Rn-222 | 2 |
| | Ingestion of Soil | | | | | |
| | Chemicals | $1.8 \times 10^{-9}$ | Aroclor-1248 | $1.9 \times 10^{-5}$ | Barium | 3 |
| | Radionuclides | $4.0 \times 10^{0}$ | U-236 | $5.2 \times 10^{2}$ | U-234 | 4 |
| | Ingestion while Wading | | | | | |
| | Radionuclides | $2.7 \times 10^{-4}$ | U-236 | $2.4 \times 10^{-2}$ | U-234 | 5 |
| | Dermal Contact with Soil | | | | | |
| | Chemicals | $3.1 \times 10^{-9}$ | Aroclor-1248 | $1.9 \times 10^{-4}$ | Barium | 6 |
| | External Radiation | $1.5 \times 10^{-1}$ | Pu-240 | $2.0 \times 10^{1}$ | Pb-210 | 7 |
| Groundskeeper | Inhalation of Particulates | | | | | |
| | Chemicals | $1.9 \times 10^{-11}$ | Aroclor-1248 | $3.8 \times 10^{-6}$ | Barium | 8 |
| | Radionuclides | $5.4 \times 10^{-2}$ | Np-237 | $2.1 \times 10^{4}$ | Rn-222 | 9 |
| | Ingestion of Soil | | | | | |
| | Chemicals | $3.8 \times 10^{-9}$ | Aroclor-1248 | $6.7 \times 10^{-4}$ | Barium | 10 |
| | Radionuclides | $8.1 \times 10^{1}$ | U-236 | $1.0 \times 10^{4}$ | U-234 | 11 |
| | Dermal Contact with Soil | | | | | |
| | Chemicals | $2.6 \times 10^{-8}$ | Aroclor-1248 | $7.8 \times 10^{-4}$ | Barium | 12 |
| | External Radiation | $3.9 \times 10^{0}$ | Np-237 | $5.6 \times 10^{2}$ | U-234 | 13 |
| Off-Property Resident Farm Adult | Inhalation of Particulates | | | | | |
| | Chemicals | $3.5 \times 10^{-10}$ | Aroclor-1248 | $2.3 \times 10^{-5}$ | Barium | 14 |
| | Radionuclides | $7.8 \times 10^{0}$ | Np-237 | $2.0 \times 10^{6}$ | Rn-222 | 15 |

See footnotes at end of table.





5208

010

**TABLE K.8-1**
**(Continued)**

| RME Receptor | Exposure Pathways | Minimum CDI[a] (mg/kg/day) (pCi) | Minimum Compound | Maximum CDI[a] (mg/kg/day) (pCi) | Maximum Compound | Attachment K.IV Table Reference |
|---|---|---|---|---|---|---|
| | Ingestion of Drinking Water | | | | | |
| | Radionuclides | $3.3 \times 10^{3}$ | U-236 | $3.0 \times 10^{5}$ | U-234 | 16 |
| | Ingestion of Meat | | | | | |
| | Chemicals | $3.2 \times 10^{-14}$ | Cyanide | $3.2 \times 10^{-6}$ | Zinc | 17 |
| | Radionuclides | $1.0 \times 10^{-4}$ | Pu-240 | $9.7 \times 10^{2}$ | U-234 | 18 |
| | Ingestion of Dairy Products | | | | | |
| | Chemicals | $9.2 \times 10^{-13}$ | Beryllium | $1.3 \times 10^{-6}$ | Zinc | 19 |
| | Radionuclides | $5.8 \times 10^{-21}$ | Sr-90 | $1.2 \times 10^{4}$ | U-234 | 20 |
| | Ingestion of Vegetables | | | | | |
| | Chemicals | $7.8 \times 10^{-11}$ | Aroclor-1248 | $5.9 \times 10^{-6}$ | Barium | 21 |
| | Radionuclides | $1.0 \times 10^{-9}$ | Sr-90 | $1.7 \times 10^{5}$ | U-234 | 22 |
| Off-Property Resident Farm Youth | Inhalation of Particulates | | | | | |
| | Chemicals | $1.4 \times 10^{-10}$ | Aroclor-1221 | $3.8 \times 10^{-5}$ | Barium | 23 |
| | Radionuclides | $1.3 \times 10^{0}$ | Np-237 | $3.4 \times 10^{5}$ | Rn-222 | 24 |
| | Ingestion of Drinking Water | | | | | |
| | Radionuclides | $5.6 \times 10^{2}$ | U-236 | $5.1 \times 10^{4}$ | U-234 | 25 |
| | Ingestion of Meat | | | | | |
| | Chemicals | $8.4 \times 10^{-15}$ | Cyanide | $5.2 \times 10^{-6}$ | Zinc | 26 |
| | Radionuclides | $1.7 \times 10^{-5}$ | Pu-240 | $1.7 \times 10^{2}$ | U-234 | 27 |
| | Ingestion of Dairy Products | | | | | |
| | Chemicals | $2.1 \times 10^{-14}$ | Aroclor-1221 | $2.1 \times 10^{-6}$ | Zinc | 28 |
| | Radionuclides | $9.9 \times 10^{-22}$ | Sr-90 | $2.0 \times 10^{3}$ | U-234 | 29 |

See footnotes at end of table.



0311

FEMP-OU4CRARE-6 FINAL
February 1994
52008

**TABLE K.8-1**
**(Continued)**

| RME Receptor | Exposure Pathways | Minimum CDI[a] (mg/kg/day) (pCi) | Minimum Compound | Maximum CDI[a] (mg/kg/day) (pCi) | Maximum Compound | Attachment K.IV Table Reference |
|---|---|---|---|---|---|---|
| | Ingestion of Vegetables | | | | | |
| | Chemicals | $2.2 \times 10^{-11}$ | Aroclor-1248 | $9.6 \times 10^{-6}$ | Barium | 30 |
| | Radionuclides | $1.7 \times 10^{-10}$ | Sr-90 | $2.9 \times 10^{4}$ | U-234 | 31 |
| Off-Property Resident Farm Child | Inhalation of Particulates | | | | | |
| | Chemicals | $8.4 \times 10^{-11}$ | Beryllium | $6.5 \times 10^{-5}$ | Barium | 32 |
| | Radionuclides | $4.0 \times 10^{-1}$ | Np-237 | $1.0 \times 10^{5}$ | Rn-222 | 33 |
| | Ingestion of Drinking Water | | | | | |
| | Radionuclides | $2.0 \times 10^{2}$ | U-236 | $1.8 \times 10^{4}$ | U-234 | 34 |
| | Ingestion of Meat | | | | | |
| | Chemicals | $4.7 \times 10^{-15}$ | Cyanide | $5.7 \times 10^{-6}$ | Zinc | 35 |
| | Radionuclides | $3.3 \times 10^{-6}$ | Pu-240 | $3.2 \times 10^{1}$ | U-234 | 36 |
| | Ingestion of Dairy Products | | | | | |
| | Chemicals | $8.8 \times 10^{-14}$ | Aroclor-1221 | $1.8 \times 10^{-5}$ | Zinc | 37 |
| | Radionuclides | $1.5 \times 10^{-21}$ | Sr-90 | $3.0 \times 10^{3}$ | U-234 | 38 |
| | Ingestion of Vegetables | | | | | |
| | Chemicals | $2.6 \times 10^{-11}$ | Aroclor-1248 | $2.3 \times 10^{-5}$ | Barium | 39 |
| | Radionuclides | $7.2 \times 10^{-11}$ | Sr-90 | $1.2 \times 10^{4}$ | U-234 | 40 |

[a]CDI = chronic daily intake





5208
0312

## TABLE K.8-2

## SUMMARY OF COC INTAKES: FUTURE LAND USE, GOVERNMENT SCENARIO

| RME Receptor | Exposure Pathways | Minimum CDI[a] (mg/kg/day) (pCi) | Minimum Compound | Maximum CDI[a] (mg/kg/day) (pCi) | Maximum Compound | Attachment K.IV Table Reference |
|---|---|---|---|---|---|---|
| Expanded Trespasser | Inhalation of Particulates | | | | | |
| | Chemicals | $2.3 \times 10^{-12}$ | Aroclor-1248 | $8.2 \times 10^{-7}$ | Barium | 41 |
| | Radionuclides | $1.8 \times 10^{-3}$ | Np-237 | $7.4 \times 10^{2}$ | Tc-99 | 42 |
| | Ingestion of Soil | | | | | |
| | Chemicals | $3.0 \times 10^{-10}$ | Aroclor-1248 | $7.4 \times 10^{-5}$ | Barium | 43 |
| | Radionuclides | $5.1 \times 10^{0}$ | Np-237 | $6.7 \times 10^{2}$ | U-234 | 44 |
| | Ingestion while Wading | | | | | |
| | Radionuclides | $9.8 \times 10^{-1}$ | U-235 | $3.7 \times 10^{1}$ | U-234 | 45 |
| | Dermal Contact with Soil | | | | | |
| | Chemicals | $1.3 \times 10^{-8}$ | Aroclor-1248 | $5.6 \times 10^{-4}$ | Barium | 46 |
| | External Radiation | $1.2 \times 10^{-1}$ | Np-237 | $1.5 \times 10^{1}$ | U-234 | 47 |
| Off-Property Resident Farm Adult | Inhalation of Particulates | | | | | |
| | Chemicals | $3.5 \times 10^{-10}$ | Aroclor-1248 | $2.3 \times 10^{-5}$ | Barium | 48 |
| | Radionuclides | $7.8 \times 10^{0}$ | Np-237 | $2.0 \times 10^{6}$ | Rn-222 | 49 |
| | Ingestion of Drinking Water | | | | | |
| | Radionuclides | $1.1 \times 10^{-1}$ | Sr-90 | $7.5 \times 10^{4}$ | U-234 | 50 |
| | Ingestion of Meat | | | | | |
| | Chemicals | $3.0 \times 10^{-14}$ | Cyanide | $3.2 \times 10^{-6}$ | Zinc | 51 |
| | Radionuclides | $1.0 \times 10^{-4}$ | Pu-240 | $1.8 \times 10^{1}$ | Pa-231 | 52 |
| | Ingestion of Dairy Products | | | | | |
| | Chemicals | $7.4 \times 10^{-14}$ | Aroclor-1221 | $1.3 \times 10^{-6}$ | Zinc | 53 |
| | Radionuclides | $5.8 \times 10^{-21}$ | Sr-90 | $6.7 \times 10^{1}$ | U-234 | 54 |

See footnote at end of table.



0313

5208

FEMP-OU4CRARE-6 FINAL
February 1994

**TABLE K.8-2**
**(Continued)**

| RME Receptor | Exposure Pathways | Minimum CDI[a] (mg/kg/day) (pCi) | Minimum Compound | Maximum CDI[a] (mg/kg/day) (pCi) | Maximum Compound | Attachment K.IV Table Reference |
|---|---|---|---|---|---|---|
| | Ingestion of Vegetables | | | | | |
| | Chemicals | $7.8 \times 10^{-11}$ | Aroclor-1248 | $6.0 \times 10^{-6}$ | Barium | 55 |
| | Radionuclides | $1.0 \times 10^{-9}$ | Sr-90 | $1.0 \times 10^{3}$ | U-234 | 56 |
| Off-Property Resident Farm Youth | Inhalation of Particulates | | | | | |
| | Chemicals | $9.7 \times 10^{-11}$ | Aroclor-1248 | $3.8 \times 10^{-5}$ | Barium | 57 |
| | Radionuclides | $1.3 \times 10^{0}$ | Np-237 | $3.5 \times 10^{5}$ | Rn-222 | 58 |
| | Ingestion of Drinking Water | | | | | |
| | Radionuclides | $1.8 \times 10^{-2}$ | Sr-90 | $1.3 \times 10^{4}$ | U-234 | 59 |
| | Ingestion of Meat | | | | | |
| | Chemicals | $8.5 \times 10^{-15}$ | Cyanide | $5.2 \times 10^{-6}$ | Zinc | 60 |
| | Radionuclides | $1.7 \times 10^{-5}$ | Pu-240 | $3.0 \times 10^{0}$ | Pa-231 | 61 |
| | Ingestion of Dairy Products | | | | | |
| | Chemicals | $2.1 \times 10^{-14}$ | Aroclor-1221 | $2.1 \times 10^{-6}$ | Zinc | 62 |
| | Radionuclides | $9.9 \times 10^{-22}$ | Sr-90 | $6.9 \times 10^{0}$ | U-238 | 63 |
| | Ingestion of Vegetables | | | | | |
| | Chemicals | $2.2 \times 10^{-11}$ | Aroclor-1248 | $9.7 \times 10^{-6}$ | Barium | 64 |
| | Radionuclides | $1.7 \times 10^{-10}$ | Sr-90 | $1.7 \times 10^{2}$ | U-234 | 65 |
| Off-Property Resident Farm Child | Inhalation of Particulates | | | | | |
| | Chemicals | $8.4 \times 10^{-11}$ | Aroclor-1248 | $6.5 \times 10^{-5}$ | Barium | 66 |
| | Radionuclides | $4.0 \times 10^{-1}$ | Np-237 | $1.7 \times 10^{5}$ | Rn-222 | 67 |

See footnote at end of table.

| | | | | | | |
|---|---|---|---|---|---|---|
| | Ingestion of Drinking Water | | | | | |
| | Radionuclides | $6.4 \times 10^{-3}$ | Sr-90 | $4.5 \times 10^{3}$ | U-234 | 68 |



0214
5208

**TABLE K.8-2**
**(Continued)**

| RME Receptor | Exposure Pathways | Minimum CDI[a] (mg/kg/day) (pCi) | Minimum Compound | Maximum CDI[a] (mg/kg/day) (pCi) | Maximum Compound | Attachment K.IV Table Reference |
|---|---|---|---|---|---|---|
| | Ingestion of Meat | | | | | |
| | Chemicals | $4.7 \times 10^{-15}$ | Cyanide | $5.8 \times 10^{-6}$ | Zinc | 69 |
| | Radionuclides | $3.3 \times 10^{-6}$ | Pu-240 | $5.8 \times 10^{-1}$ | Pa-231 | 70 |
| | Ingestion of Dairy Products | | | | | |
| | Chemicals | $8.8 \times 10^{-14}$ | Aroclor-1221 | $1.8 \times 10^{-5}$ | Zinc | 71 |
| | Radionuclides | $1.5 \times 10^{-21}$ | Sr-90 | $1.7 \times 10^{1}$ | U-234 | 72 |
| | Ingestion of Vegetables | | | | | |
| | Chemicals | $2.6 \times 10^{-11}$ | Aroclor-1248 | $2.3 \times 10^{-5}$ | Barium | 73 |
| | Radionuclides | $7.3 \times 10^{-11}$ | Sr-90 | $7.1 \times 10^{1}$ | U-234 | 74 |

[a]CDI = chronic daily intake



FEMP-OU4CRARE-6 FINAL
February 1994

- 5208

0315

## TABLE K.8-3

## SUMMARY OF COC INTAKES: FUTURE LAND USE, PRIVATE SCENARIO

| RME Receptor Pathways | Exposure Pathways | | Minimum CDI[a] (mg/kg/day) (pCi) | Minimum Compound | Maximum CDI (mg/kg/day) (pCi) | Maximum Compound | Attachment K.IV Table Reference |
|---|---|---|---|---|---|---|---|
| On-Property Resident Farm Adult | Inhalation of Particulates | | | | | | |
| | | Chemicals | $7.6 \times 10^{-10}$ | Aroclor-1248 | $5.2 \times 10^{-5}$ | Barium | 75 |
| | | Radionuclides | $1.8 \times 10^{1}$ | Np-237 | $4.7 \times 10^{6}$ | Rn-222 | 76 |
| | Ingestion of Soil | | | | | | |
| | | Chemicals | $1.5 \times 10^{-7}$ | Aroclor-1248 | $8.9 \times 10^{-3}$ | Barium | 77 |
| | | Radionuclides | $3.1 \times 10^{3}$ | Np-237 | $4.4 \times 10^{5}$ | U-234 | 78 |
| | Ingestion of Drinking Water | | | | | | |
| | | Radionuclides | $2.9 \times 10^{-1}$ | Sr-90 | $3.3 \times 10^{4}$ | U-234 | 79 |
| | Dermal Contact with Soil | | | | | | |
| | | Chemicals | $2.9 \times 10^{-7}$ | Aroclor-1248 | $2.9 \times 10^{-3}$ | Barium | 80 |
| | External Radiation | | $4.1 \times 10^{1}$ | Np-237 | $5.9 \times 10^{3}$ | U-234 | 81 |
| | Ingestion of Meat | | | | | | |
| | | Chemicals | $1.5 \times 10^{-10}$ | Copper | $1.3 \times 10^{0}$ | Zinc | 82 |
| | | Radionuclides | $1.0 \times 10^{-4}$ | Pu-240 | $7.8 \times 10^{1}$ | U-234 | 83 |
| | Ingestion of Dairy Products | | | | | | |
| | | Chemicals | $5.5 \times 10^{-9}$ | Beryllium | $5.0 \times 10^{-1}$ | Zinc | 84 |
| | | Radionuclides | $1.1 \times 10^{-20}$ | Sr-90 | $9.6 \times 10^{2}$ | U-234 | 85 |
| | Ingestion of Vegetables | | | | | | |
| | | Chemicals | $3.0 \times 10^{-8}$ | Di-n-octyl phthalate | $4.1 \times 10^{-1}$ | Zinc | 86 |
| | | Radionuclides | $1.7 \times 10^{-9}$ | Sr-90 | $1.4 \times 10^{4}$ | U-234 | 87 |
| See footnote at end of table. | | | | | | | |
| On-Property Resident Farm Youth | Inhalation of Particulates | | | | | | |
| | | Chemicals | $2.1 \times 10^{-10}$ | Aroclor-1248 | $8.4 \times 10^{-5}$ | Barium | 88 |
| | | Radionuclides | $3.0 \times 10^{0}$ | Np-237 | $8.1 \times 10^{5}$ | Rn-222 | 89 |





5208

0316

**TABLE K.8-3**
**(Continued)**

| RME Receptor Pathways | Exposure Pathways | | Minimum CDI[a] (mg/kg/day) (pCi) | Minimum Compound | Maximum CDI (mg/kg/day) (pCi) | Maximum Compound | Attachment K.IV Table Reference |
|---|---|---|---|---|---|---|---|
| | Ingestion of Soil | | | | | | |
| | | Chemicals | $2.3 \times 10^{-8}$ | Aroclor-1248 | $8.1 \times 10^{-3}$ | Barium | 90 |
| | | Radionuclides | $2.9 \times 10^{2}$ | Np-237 | $4.2 \times 10^{4}$ | U-234 | 91 |
| | Ingestion of Drinking Water | | | | | | |
| | | Radionuclides | $4.9 \times 10^{-2}$ | Sr-90 | $5.6 \times 10^{3}$ | U-234 | 92 |
| | Dermal Contact with Soil | | | | | | |
| | | Chemicals | $5.8 \times 10^{-7}$ | Aroclor-1248 | $3.4 \times 10^{-3}$ | Barium | 93 |
| | Incidental Ingestion while Wading | | | | | | |
| | | Radionuclides | $6.3 \times 10^{-1}$ | U-236 | $5.7 \times 10^{1}$ | U-234 | 94 |
| | Ingestion of Meat | | | | | | |
| | | Chemicals | $4.3 \times 10^{-11}$ | Copper | $2.0 \times 10^{0}$ | Zinc | 95 |
| | | Radionuclides | $1.7 \times 10^{-5}$ | Pu-240 | $1.3 \times 10^{1}$ | U-234 | 96 |
| | Ingestion of Dairy Products | | | | | | |
| | | Chemicals | $1.5 \times 10^{-9}$ | Beryllium | $8.2 \times 10^{-1}$ | Zinc | 97 |
| | | Radionuclides | $1.9 \times 10^{-21}$ | Sr-90 | $1.6 \times 10^{2}$ | U-234 | 98 |
| | Ingestion of Vegetables | | | | | | |
| | | Chemicals | $8.3 \times 10^{-9}$ | Di-n-octyl phthalate | $6.7 \times 10^{-1}$ | Copper | 99 |
| | | Radionuclides | $3.0 \times 10^{-10}$ | Sr-90 | $2.3 \times 10^{3}$ | U-234 | 100 |
| | External Radiation | | $7.0 \times 10^{0}$ | Np-237 | $1.0 \times 10^{3}$ | U-234 | 101 |

See footnote at end of table.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| On-Property Resident Farm Child | Inhalation of Particulates | | | | | | |
| | | Chemicals | $1.8 \times 10^{-10}$ | Aroclor-1248 | $1.4 \times 10^{-4}$ | Barium | 102 |
| | | Radionuclides | $9.1 \times 10^{-1}$ | Np-237 | $2.4 \times 10^{5}$ | Rn-222 | 103 |



0317

- 5208

**TABLE K.8-3**
**(Continued)**

| RME Receptor Pathways | Exposure Pathways | | Minimum CDI[a] (mg/kg/day) (pCi) | Minimum Compound | Maximum CDI (mg/kg/day) (pCi) | Maximum Compound | Attachment K.IV Table Reference |
|---|---|---|---|---|---|---|---|
| | Ingestion of Soil | | | | | | |
| | | Chemicals | $6.6 \times 10^{-8}$ | Aroclor-1248 | $4.6 \times 10^{-2}$ | Barium | 104 |
| | | Radionuclides | $2.9 \times 10^{2}$ | Np-237 | $4.2 \times 10^{4}$ | U-234 | 105 |
| | Ingestion of Drinking Water | | | | | | |
| | | Radionuclides | $1.7 \times 10^{-2}$ | Sr-90 | $2.0 \times 10^{3}$ | U-234 | 106 |
| | Dermal Contact with Soil | | | | | | |
| | | Chemicals | $5.9 \times 10^{-8}$ | Aroclor-1248 | $4.6 \times 10^{-3}$ | Barium | 107 |
| | External Radiation | | $2.2 \times 10^{0}$ | Np-237 | $3.1 \times 10^{2}$ | U-234 | 108 |
| | Ingestion of Meat | | | | | | |
| | | Chemicals | $2.4 \times 10^{-11}$ | Copper | $2.3 \times 10^{0}$ | Zinc | 109 |
| | | Radionuclides | $3.4 \times 10^{-6}$ | Pu-240 | $2.6 \times 10^{0}$ | U-234 | 110 |
| | Ingestion of Dairy Products | | | | | | |
| | | Chemicals | $6.6 \times 10^{-9}$ | Beryllium | $7.0 \times 10^{0}$ | Zinc | 111 |
| | | Radionuclides | $2.8 \times 10^{-21}$ | Sr-90 | $2.5 \times 10^{2}$ | U-234 | 112 |
| | Ingestion of Vegetables | | | | | | |
| | | Chemicals | $1.0 \times 10^{-8}$ | Di-n-octyl phthalate | $1.6 \times 10^{0}$ | Copper | 113 |
| | | Radionuclides | $1.3 \times 10^{-10}$ | Tc-99 | $9.8 \times 10^{2}$ | U-234 | 114 |

See footnote at end of table.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Off-Property Resident Farm Adult | Inhalation of Particulates | | | | | | |
| | | Chemicals | $3.5 \times 10^{-10}$ | Aroclor-1248 | $2.3 \times 10^{-5}$ | Barium | 115 |
| | | Radionuclides | $7.8 \times 10^{0}$ | Np-237 | $2.0 \times 10^{6}$ | Rn-222 | 116 |

0318

5208

TABLE K.8-3
(Continued)

| RME Receptor Pathways | Exposure Pathways | Minimum CDI[a] (mg/kg/day) (pCi) | Minimum Compound | Maximum CDI (mg/kg/day) (pCi) | Maximum Compound | Attachment K.IV Table Reference |
|---|---|---|---|---|---|---|
| | Ingestion of Drinking Water | | | | | |
| | Radionuclides | $1.1 \times 10^{-1}$ | Sr-90 | $7.5 \times 10^{4}$ | U-234 | 117 |
| | Ingestion of Meat | | | | | |
| | Chemicals | $3.0 \times 10^{-14}$ | Cyanide | $3.2 \times 10^{-6}$ | Zinc | 118 |
| | Radionuclides | $1.0 \times 10^{-4}$ | Pu-240 | $1.8 \times 10^{1}$ | Pa-231 | 119 |
| | Ingestion of Dairy Products | | | | | |
| | Chemicals | $7.4 \times 10^{-14}$ | Aroclor-1221 | $1.3 \times 10^{-6}$ | Zinc | 120 |
| | Radionuclides | $5.8 \times 10^{-21}$ | Sr-90 | $6.7 \times 10^{1}$ | U-234 | 121 |
| | Ingestion of Vegetables | | | | | |
| | Chemicals | $7.8 \times 10^{-11}$ | Aroclor-1248 | $6.0 \times 10^{-6}$ | Barium | 122 |
| | Radionuclides | $1.0 \times 10^{-9}$ | Sr-90 | $1.0 \times 10^{3}$ | U-234 | 123 |
| Off-Property Resident Farm Youth | Inhalation of Particulates | | | | | |
| | Chemicals | $9.7 \times 10^{-11}$ | Aroclor-1248 | $3.8 \times 10^{-5}$ | Barium | 124 |
| | Radionuclides | $1.3 \times 10^{0}$ | Np-237 | $3.5 \times 10^{5}$ | Rn-222 | 125 |
| | Ingestion of Drinking Water | | | | | |
| | Radionuclides | $1.8 \times 10^{-2}$ | Sr-90 | $1.3 \times 10^{4}$ | U-234 | 126 |
| | Ingestion of Meat | | | | | |
| | Chemicals | $8.5 \times 10^{-15}$ | Cyanide | $5.2 \times 10^{-6}$ | Zinc | 127 |
| | Radionuclides | $1.7 \times 10^{-5}$ | Pu-240 | $3.0 \times 10^{0}$ | Pa-231 | 128 |

See footnote at end of table.

| | | | | | | |
|---|---|---|---|---|---|---|
| | Ingestion of Dairy Products | | | | | |
| | Chemicals | $2.1 \times 10^{-14}$ | Aroclor-1221 | $2.1 \times 10^{-6}$ | Zinc | 129 |
| | Radionuclides | $9.9 \times 10^{-22}$ | Sr-90 | $6.9 \times 10^{0}$ | U-238 | 130 |



0319
5208
FEMP-OU4CRARE-6 FINAL
February 1994

**TABLE K.8-3**
**(Continued)**

| RME Receptor Pathways | Exposure Pathways | | Minimum CDI[a] (mg/kg/day) (pCi) | Minimum Compound | Maximum CDI (mg/kg/day) (pCi) | Maximum Compound | Attachment K.IV Table Reference |
|---|---|---|---|---|---|---|---|
| | Ingestion of Vegetables | | | | | | |
| | | Chemicals | $2.2 \times 10^{-11}$ | Aroclor-1248 | $9.7 \times 10^{-6}$ | Barium | 131 |
| | | Radionuclides | $1.7 \times 10^{-10}$ | Sr-90 | $1.7 \times 10^{2}$ | U-234 | 132 |
| Off-Property Resident Farm Child | Inhalation of Particulates | | | | | | |
| | | Chemicals | $8.4 \times 10^{-11}$ | Aroclor-1248 | $6.5 \times 10^{-5}$ | Barium | 133 |
| | | Radionuclides | $4.0 \times 10^{-1}$ | Np-237 | $1.7 \times 10^{5}$ | Rn-222 | 134 |
| | Ingestion of Drinking Water | | | | | | |
| | | Radionuclides | $6.4 \times 10^{-3}$ | Sr-90 | $4.5 \times 10^{3}$ | U-234 | 135 |
| | Ingestion of Meat | | | | | | |
| | | Chemicals | $4.7 \times 10^{-15}$ | Cyanide | $5.8 \times 10^{-6}$ | Zinc | 136 |
| | | Radionuclides | $3.3 \times 10^{-6}$ | Pu-240 | $5.8 \times 10^{-1}$ | Pa-231 | 137 |
| | Ingestion of Dairy Products | | | | | | |
| | | Chemicals | $8.8 \times 10^{-14}$ | Aroclor-1221 | $1.8 \times 10^{-5}$ | Zinc | 138 |
| | | Radionuclides | $1.5 \times 10^{-21}$ | Sr-90 | $1.7 \times 10^{1}$ | U-234 | 139 |
| | Ingestion of Vegetables | | | | | | |
| | | Chemicals | $2.6 \times 10^{-11}$ | Aroclor-1248 | $2.3 \times 10^{-5}$ | Barium | 140 |
| | | Radionuclides | $7.3 \times 10^{-11}$ | Sr-90 | $7.1 \times 10^{1}$ | U-234 | 141 |

[a]CDI = chronic daily intake



0320
- 208

{This page intentionally left blank}

# SECTION K.9.0

# RISK CHARACTERIZATION

# K.9.0 RISK CHARACTERIZATION

Risk characterization is the final step in the CRARE process, combining the information developed in the toxicity assessment (Section K.7.0) and the exposure assessment (Section K.8.0). The potential of a COC to cause carcinogenic effects is presented as the incremental lifetime cancer risk (ICLR). Potential noncarcinogenic effects are presented as hazard quotients (HQs) or hazard indices (HIs), as defined in Section K.9.1.2.

Upper-bound risk estimates for receptors are presented either qualitatively or quantitatively, depending on the quality of the input parameters. Section K.9.1 describes the methodology employed to characterize health risks. Short-term risks associated with remediation are summarized in Section K.9.2. The residual human health risks, by exposure pathway, appear in Section K.9.3. Uncertainties associated with the risk characterization are examined in Section K.10.0.

## K.9.1 RISK CHARACTERIZATION METHODOLOGY

In this CRARE, the potential risks to humans following exposure to postremediation residual COCs (radionuclides and nonradioactive chemicals) have been estimated using methods established by the EPA. The EPA has provided guidance documents and databases for characterizing human health risk, and these have been used as major sources in preparing CRARE risk assessments:

- *Risk Assessment Guidance for Superfund*
- *Health Effects Assessment Summary Tables*
- *Exposure Factors Handbook*
- *Integrated Risk Information System*

### K.9.1.1 Hazardous Chemical Exposures

Risks from nonradionuclide COCs have been estimated for carcinogenic and/or noncarcinogenic effects. Some carcinogens may also pose a noncarcinogenic toxic hazard, and whenever a RfD was available, a noncarcinogenic HQ was calculated. Effects due to exposures from these chemicals have been characterized for both types of health effects.

#### K.9.1.1.1 Risk Characterization Methodology for Carcinogens

The risk attributed to a carcinogen was estimated as the ILCR of an individual as a result of exposure to the substance. At low doses, the risk of developing cancer was estimated as follows (EPA 1989a):

$$Risk = (CDI)(SF) \quad (1)$$

where

| | | |
|---|---|---|
| Risk | = | risk of cancer incidence, expressed as a unitless probability, |
| CDI | = | chronic daily intake averaged over 70 years (mg/kg/day), and |
| SF | = | slope factor $(mg/kg/day)^{-1}$. |

For dermal exposure, cancer risks were calculated using adjusted toxicity factors based on absorbed doses of contaminants rather than contaminant intakes. For a given pathway with simultaneous exposure of a receptor to several carcinogens, the following equation was used to sum cancer risks:

$$Risk_p = Risk\ (chem_1) + Risk\ (chem_2) + \ldots Risk\ (chem_i) \quad (2)$$

where

| | | |
|---|---|---|
| $Risk_p$ | = | total pathway risk of cancer incidence, and |
| Risk $(chem_i)$ | = | risk associated with an individual carcinogenic chemical. |

In compliance with EPA guidance (EPA 1989a), the ILCR values estimated in this CRARE for the potentially exposed receptor were compared to an incremental upper-bound lifetime cancer risk to an individual of $10^{-4}$ to $10^{-6}$. A cancer risk of $10^{-6}$ served as the point of departure for risk evaluation (Federal Register 1990).

K.9.1.1.2 Risk Characterization Methodology for Noncarcinogens

The risk associated with exposure to noncarcinogenic hazardous COCs was evaluated by comparing an exposure level or intake to a reference dose (RfD). It is recognized that this methodology for assessing the human health effect for noncarcinogens does not give a measure of risk as is calculated for the carcinogens. Even so, for convenience the term "risk" will continue to be used when discussing these evaluations. The ratio of intake RfD for a single contaminant is the HQ and is defined as (EPA 1989a):

$$HQ = I/RfD \quad (3)$$

where

| | | |
|---|---|---|
| HQ | = | hazard quotient (unitless), |
| I | = | intake of a chemical (mg/kg/day), and |
| RfD | = | reference dose (mg/kg/day). |

When using this equation to estimate potential noncarcinogenic risk, the intake and RfD must be for exposures of equivalent duration (e.g., subchronic, chronic, or fewer than two weeks). For this CRARE, COC exposures have been evaluated in all cases on a chronic basis, using chronic RfD values. Analogous to cancer risks, dermal noncancer risks were assessed using absorbed dose rather than intake.

In the case of simultaneous exposure of a receptor to several chemicals, an HI was calculated as the sum of the HQs by:

$$HI = I_i/RfD_1 + I_2/RfD_2 + \ldots I_i/RfD_i \quad (4)$$

where

| | | |
|---|---|---|
| $I_i$ | = | intake for the $i^{th}$ toxicant, and |
| $RfD_i$ | = | reference dose for the $i^{th}$ toxicant. |

An HI is an indicator of the potential for adverse effects associated with chronic exposures. In effect, HIs assume dose additivity for all COCs (EPA 1989a).

In compliance with EPA guidance (EPA 1989a), the noncarcinogenic HIs summed across pathways were compared to "unity." An HI of unity indicates that the exposure intake is equal to the RfD. If the HI is greater than 1 or "above unity," there is concern for potential health effects. Major categories of noncarcinogenic health effects include neurotoxicity, developmental toxicity, reproductive toxicity, immunotoxicity, and adverse effects on target organs, such as hepatic, renal, respiratory, cardiovascular, and dermal/ocular problems (EPA 1989d).

K.9.1.2 Radiological Exposures

The procedures for estimating the total lifetime excess cancer risks due to continuous, lifetime exposure (i.e., a 70-year average life span) to radionuclides are described in this section.

K.9.1.2.1 Risk Characterization Methodology for Internal Exposures

Risk characterization for internal exposures to radionuclides (intake via inhalation or ingestion) was calculated as follows:

$$\text{Risk} = (I)(SF) \qquad (5)$$

where

| | | |
|---|---|---|
| Risk | = | risk of cancer incidence, expressed as a unitless probability, |
| I | = | lifetime radionuclide intake (pCi), and |
| SF | = | slope factor $(pCi)^{-1}$. |

The slope factor is either a HEAST value for a particular radionuclide or the sum of the HEAST slope factors for that radionuclide and its short-lived progeny to account for ingrowth during storage and/or environmental transport.

K.9.1.2.2 Risk Characterization Methodology for External Gamma Exposures

For this CRARE, risk characterization for external exposure to gamma-emitting radionuclides in contaminated surface soil was calculated as follows:

$$\text{Risk} = (SF)[(C_s)(EF)(ED)(ET)(1\text{-}SH)] \qquad (6)$$

where

| | | |
|---|---|---|
| Risk | = | risk of cancer incidence, expressed as a unitless probability, |
| $C_s$ | = | radionuclide soil concentration (pCi/g), |
| SF | = | radionuclide slope factor (risk/yr/pCi/g) from EPA (1991a), |
| ET | = | fraction of day exposed (unitless), |
| ED | = | exposure duration (years), |
| EF | = | modifying factor, fraction of year exposed (unitless), and |
| SH | = | shielding factor (unitless). |

External slope factors do not include contributions from decay products (radioactive progeny). In some cases, these contributions were substantial and required the inclusion of progeny products in the

overall risk calculation. Progeny product concentrations were determined using Rad Decay, a radionuclide library and decay software program. Parent isotopes were decayed over a period of interest to predict future levels.

## K.9.2 SHORT-TERM RISK EVALUATION FOR OPERABLE UNIT 4

The Operable Unit 4 FS risk evaluation (Appendix D) considered short-term health risks from construction, transportation, chemical exposure, and radionuclide exposure. The evaluation of short-term risks for the other operable units is not available, as their FSs are not complete. Therefore, this CRARE presents only a summary of the Operable Unit 4 short-term risk assessment. As each FS is completed, its CRARE will present the summaries of the previous short-term risk assessments. Note that this CRARE is based on updated LRAs (DOE 1993e).

The receptors, exposure media, and exposure pathways considered in Appendix D are:

- A nonremediation worker exposed to radon in the air and contaminated soil particulates in the air. This receptor is equivalent to the CRARE groundskeeper.
- A trespassing child exposed to contaminated soil particulates in the air, and direct contact with surface soils.
- The off-property resident farm adult exposed to radon in the air and contaminated soil particulates in the air.

Groundwater was not considered a complete pathway for short-term risks. Risks due to accidents were considered for remedial workers, workers involved in the transport of wastes or soils by truck and train, and the general public. A complete description of these risks for each considered alternative of Operable Unit 4 is found in Appendix D of this FS. Similar risks may be found for the other operable units, but have not yet been quantified.

The greatest health risk is from exposure of the nonremediation worker to total suspended particulate from the berm and surface soils. The radiological ILCR is $3.3 \times 10^{-7}$ and the chemical ILCR is $2.5 \times 10^{-10}$. The total ILCR is, therefore, lower than the departure point of $1 \times 10^{-6}$. Since the risk to the remediation worker is less than the departure point, the risk to the off-property public would also be insignificant because of the additional dilution of dust in the air for the off-property receptor. The HI is less than $10^{-4}$, which is below the benchmark of 1.0 and would not present a concern to the public. The radon risk to the nonremediation worker while the treatment facility is operating is $5.8 \times 10^{-7}$.

If the trespassing child comes into contact with operable unit soils, the ILCR is $3.8 \times 10^{-7}$ for radiological ILCR and $2.5 \times 10^{-6}$ for chemical risk. While the cancer risk is within the target risk range, it is unlikely that a child would be present during remedial activities on a controlled-access site and consequently would not be exposed to the operable unit materials. Similarly, the HI for noncarcinogenic risks is 0.14, which is below the target of 1.0.

Engineering controls will be used during remedial activities to limit radon release to as low as reasonably achievable (ALARA) levels. The target level at the fenceline is 4 pCi/l (indoor air quality). Engineering evaluations have estimated that the on-property radon concentration would be 0.12 pCi/l during treatment plant operation, and 0.002 pCi/l at the fence line. For three years of operation this represents risk estimates of $5.8 \times 10^{-7}$ and $3.3 \times 10^{-7}$, respectively.

In summary, it appears that remedial activities would cause no adverse risks to off-property receptors. It is anticipated that similar short-term risks for construction activities, transportation, and potential contaminant release would occur for the other operable units. These will be addressed in each succeeding FS.

### K.9.3 RESIDUAL HUMAN HEALTH RISKS

This section presents the ILCR and HI estimates for all receptors, by pathway, under each of the three land use scenarios. Table K.9-1 summarizes this information. Complete calculation sheets of the risk values can be found in Attachment K.IV.

The tables in Sections K.9.3.1 through K.9.3.3 present the risk values in a uniform format: the top portion presents the HI values derived from each exposure pathway applicable to the receptor; the bottom portion presents the ILCR values for the receptor by applicable pathways. The ILCR values resulting from exposures to pathways that include both radionuclides and carcinogenic COCs are presented separately to present the magnitude of risk contributed by each.

While reviewing these risk values, please note that a receptor can be exposed to different COCs via different exposure pathways for each scenario. Major contributors to this phenomenon include changes in site accessibility and physical conditions, and COC migration in the environment (see Section K.5.0 for a detailed discussion).

# TABLE K.9-1

## SUMMARY OF ILCR AND HI FOR ALL SCENARIOS, ALL PATHWAYS

**Current Land Use**

| RME Receptor | ILCR | HI |
|---|---|---|
| Groundskeeper | $4.7 \times 10^{-4}$ | $4.2 \times 10^{-1}$ |
| Trespassing Child | $2.0 \times 10^{-5}$ | $7.8 \times 10^{-2}$ |
| Off-Property Resident Farm | | |
| Adult | $1.0 \times 10^{-4}$ | $1.1 \times 10^{0}$ |
| Youth | $1.9 \times 10^{-5}$ | $1.8 \times 10^{0}$ |
| Child | $7.5 \times 10^{-6}$ | $3.1 \times 10^{0}$ |

**Future Land Use With Federal Ownership**

| RME Receptor | ILCR | HI |
|---|---|---|
| Expanded Trespasser | $2.7 \times 10^{-5}$ | $1.2 \times 10^{-1}$ |
| Off-Property Resident Farm | | |
| Adult | $9.0 \times 10^{-5}$ | $1.1 \times 10^{0}$ |
| Youth | $1.6 \times 10^{-5}$ | $1.8 \times 10^{0}$ |
| Child | $6.6 \times 10^{-6}$ | $3.1 \times 10^{0}$ |

**Future Land Use Without Federal Ownership**

| RME Receptor | ILCR | HI |
|---|---|---|
| On-Property Resident Farm | | |
| Adult | $1.1 \times 10^{-2}$ | $6.4 \times 10^{1}$ |
| Youth | $2.3 \times 10^{-3}$ | $1.0 \times 10^{2}$ |
| Child | $3.6 \times 10^{-3}$ | $2.4 \times 10^{2}$ |
| Off-Property Resident Farm | | |
| Adult | $9.0 \times 10^{-5}$ | $1.1 \times 10^{0}$ |
| Youth | $1.6 \times 10^{-5}$ | $1.8 \times 10^{0}$ |
| Child | $6.6 \times 10^{-6}$ | $3.1 \times 10^{0}$ |

K.9.3.1 Risks Under Current Land Use Scenario

Groundskeeper

Table K.9-2 presents the exposure pathway contribution to the total HI and ILCR for the groundskeeper receptor in the Current Land Use scenario. The total HI is seen to be less than 1.0, with the major contributors being the inhalation of particulates ($2.4 \times 10^{-1}$). The ILCR for this receptor is an estimated $4.7 \times 10^{-4}$, with the major contributors being external radiation ($4.4 \times 10^{-4}$), dermal contact with soil and sediment ($2.1 \times 10^{-5}$), and incidental ingestion of soil and sediment ($6.3 \times 10^{-6}$ and $8.9 \times 10^{-6}$ for radionuclides and chemicals, respectively). The principal contributors to the external radiation cancer risk are Ra-226 ($1.7 \times 10^{-4}$) and Th-228 ($1.6 \times 10^{-4}$).

**TABLE K.9-2**

**SUMMARY OF POTENTIAL HEALTH EFFECTS: GROUNDSKEEPER (CURRENT LAND USE)**

| Exposure Pathway | RME Receptor HI |
|---|---|
| Inhalation of Particulates (Chemicals) | $2.4 \times 10^{-1}$ |
| Incidental Ingestion of Soil/Sediment (Chemicals) | $9.7 \times 10^{-2}$ |
| Dermal Contact with Soil/Sediment (Chemicals) | $8.4 \times 10^{-2}$ |
| RME Individual HI: | $4.2 \times 10^{-1}$ |

| Exposure Pathway | RME Receptor ILCR |
|---|---|
| Inhalation of Particulates (Chemicals) | $6.2 \times 10^{-7}$ |
| Inhalation of Particulates (Radionuclides) | $7.1 \times 10^{-7}$ |
| Incidental Ingestion of Soil/Sediment (Chemicals) | $8.9 \times 10^{-6}$ |
| Incidental Ingestion of Soil/Sediment (Radionuclides) | $6.3 \times 10^{-6}$ |
| Dermal Contact with Soil/Sediment (Chemicals) | $2.1 \times 10^{-5}$ |
| Direct Radiation Exposure | $4.4 \times 10^{-4}$ |
| RME Individual ILCR: | $4.7 \times 10^{-4}$ |

Trespassing Child

HI and ILCR values associated with the trespassing child are presented in Table K.9-3. The predicted total ILCR ($2.0 \times 10^{-5}$) is within the target risk range, and the HI ($7.8 \times 10^{-2}$) is below the level of concern. The major contributors are the same as those for the groundskeeper.

**TABLE K.9-3**

**SUMMARY OF POTENTIAL HEALTH EFFECTS: TRESPASSING CHILD (CURRENT LAND USE)**

| Exposure Pathway | RME Receptor HI |
|---|---|
| Inhalation of Particulates (Chemicals) | $4.1 \times 10^{-2}$ |
| Incidental Ingestion of Soil/Sediment (Chemicals) | $1.6 \times 10^{-2}$ |
| Dermal Contact with Soil/Sediment (Chemicals) | $2.1 \times 10^{-2}$ |
| RME Individual HI: | $7.8 \times 10^{-2}$ |

| Exposure Pathway | RME Receptor ILCR |
|---|---|
| Inhalation of Particulates (Chemicals) | $5.1 \times 10^{-8}$ |
| Inhalation of Particulates (Radionuclides) | $2.8 \times 10^{-7}$ |
| Incidental Ingestion while Wading (Radionuclides) | $8.2 \times 10^{-13}$ |
| Incidental Ingestion of Soil/Sediment (Chemicals) | $7.2 \times 10^{-7}$ |
| Incidental Ingestion of Soil/Sediment (Radionuclides) | $3.2 \times 10^{-7}$ |
| Dermal Contact with Soil/Sediment (Chemicals) | $2.4 \times 10^{-6}$ |
| Direct Radiation Exposure | $1.6 \times 10^{-5}$ |
| RME Individual ILCR: | $2.0 \times 10^{-5}$ |

Off-Property Resident Farm Adult

The risk results for this receptor are presented in Table K.9-4. Inhalation of particles is seen to present an HI of 1.1, with the principal contributors being cobalt ($8.5 \times 10^{-1}$) and barium ($1.7 \times 10^{-1}$). The estimated total ILCR ($1.0 \times 10^{-4}$) is at the upper end of the target risk range ($1.0 \times 10^{-6}$ to $1.0 \times 10^{-4}$). The principal contributors are the risks due to inhalation ($8.7 \times 10^{-5}$), ingestion of drinking water ($9.9 \times 10^{-6}$), and ingestion of vegetables and fruit ($6.0 \times 10^{-6}$).

**TABLE K.9-4**

**SUMMARY OF POTENTIAL HEALTH EFFECTS: OFF-PROPERTY RESIDENT FARM ADULT (CURRENT LAND USE)**

| Exposure Pathway | RME Receptor HI |
|---|---|
| Inhalation of Particulates (Chemicals) | $1.1 \times 10^{0}$ |
| Ingestion of Meat (Chemicals) | $1.8 \times 10^{-4}$ |
| Ingestion of Dairy Products (Chemicals) | $6.3 \times 10^{-5}$ |
| Ingestion of Vegetables and Fruit (Chemicals) | $1.4 \times 10^{-3}$ |
| RME Individual HI: | $1.1 \times 10^{0}$ |

| Exposure Pathway | RME Receptor ILCR |
|---|---|
| Inhalation of Particulates (Chemical) | $8.0 \times 10^{-6}$ |
| Inhalation of Particulates (Radionuclides) | $7.8 \times 10^{-5}$ |
| Ingestion of Drinking Water (Radionuclides) | $9.9 \times 10^{-6}$ |
| Ingestion of Meat (Chemicals) | $9.9 \times 10^{-8}$ |
| Ingestion of Meat (Radionuclides) | $3.3 \times 10^{-8}$ |
| Ingestion of Dairy Products (Chemicals) | $2.6 \times 10^{-7}$ |
| Ingestion of Dairy Products (Radionuclides) | $3.9 \times 10^{-7}$ |
| Ingestion of Vegetables and Fruit (Chemicals) | $3.1 \times 10^{-7}$ |
| Ingestion of Vegetables and Fruit (Radionuclides) | $5.7 \times 10^{-6}$ |
| RME Individual ILCR: | $1.0 \times 10^{-4}$ |

Off-Property Resident Farm Youth

As presented in Table K.9-5, the predicted total ILCR for this receptor ($1.9 \times 10^{-5}$) is within the target risk range of $1 \times 10^{-6}$ to $1 \times 10^{-4}$, with the principal contributors being the same as those for the off-property resident farm adult (Table K.9-5). The total HI (1.8), due almost entirely to inhalation of particulates, exceeds the target of 1.0. The COCs contributing to this level are cobalt (1.4), barium ($2.7 \times 10^{-1}$) and manganese ($1.6 \times 10^{-1}$).

**TABLE K.9-5**

**SUMMARY OF POTENTIAL HEALTH EFFECTS: OFF-PROPERTY RESIDENT FARM YOUTH (CURRENT LAND USE)**

| Exposure Pathway | RME Receptor HI |
|---|---|
| Inhalation of Particulates (Chemicals) | $1.8 \times 10^{0}$ |
| Ingestion of Meat (Chemicals) | $2.9 \times 10^{-4}$ |
| Ingestion of Dairy Products (Chemicals) | $1.0 \times 10^{-4}$ |
| Ingestion of Vegetables and Fruit (Chemicals) | $2.3 \times 10^{-3}$ |
| RME Individual HI: | $1.8 \times 10^{0}$ |

| Exposure Pathway | RME Receptor ILCR |
|---|---|
| Inhalation of Particulates (Chemicals) | $2.2 \times 10^{-6}$ |
| Inhalation of Particulates (Radionuclides) | $1.3 \times 10^{-5}$ |
| Ingestion of Drinking Water (Radionuclides) | $1.7 \times 10^{-6}$ |
| Ingestion of Meat (Chemicals) | $2.8 \times 10^{-8}$ |
| Ingestion of Meat (Radionuclides) | $5.7 \times 10^{-9}$ |
| Ingestion of Dairy Products (Chemicals) | $7.1 \times 10^{-8}$ |
| Ingestion of Dairy Products (Radionuclides) | $6.7 \times 10^{-8}$ |
| Ingestion of Vegetables and Fruit (Chemicals) | $8.7 \times 10^{-8}$ |
| Ingestion of Vegetables and Fruit (Radionuclides) | $9.8 \times 10^{-7}$ |
| RME Individual ILCR: | $1.9 \times 10^{-5}$ |

Off-Property Resident Farm Child

A total ILCR of 7.5 x $10^{-6}$ is predicted for this receptor, with inhalation of COCs contributing to more than 75 percent of the ILCR (Table K.9-6). The total ILCR is within the target risk range, with the principal contributors being the same as those for the off-property resident farm adult. The total HI (3.1) is due entirely to inhalation of particulates and is above the target value. Principal contributors are cobalt (2.4), barium (1.1), 4.7 x $10^{-1}$ and manganese (2.7 x $10^{-1}$).

**TABLE K.9-6**

**SUMMARY OF POTENTIAL HEALTH EFFECTS:**
**OFF-PROPERTY RESIDENT FARM CHILD (CURRENT LAND USE)**

| Exposure Pathway | RME Receptor HI |
|---|---|
| Inhalation of Particulates (Chemicals) | 3.1 x $10^{0}$ |
| Ingestion of Meat (Chemicals) | 3.2 x $10^{-4}$ |
| Ingestion of Dairy Products (Chemicals) | 8.8 x $10^{-4}$ |
| Ingestion of Vegetables and Fruit (Chemicals) | 5.6 x $10^{-3}$ |
| RME Individual HI: | 3.1 x $10^{0}$ |

| Exposure Pathway | RME Receptor ILCR |
|---|---|
| Inhalation of Particulates (Chemicals) | 1.9 x $10^{-6}$ |
| Inhalation of Particulates (Radionuclides) | 4.0 x $10^{-6}$ |
| Ingestion of Drinking Water (Radionuclides) | 5.9 x $10^{-7}$ |
| Ingestion of Meat (Chemicals) | 1.5 x $10^{-8}$ |
| Ingestion of Meat (Radionuclides) | 1.1 x $10^{-9}$ |
| Ingestion of Dairy Products (Chemicals) | 3.1 x $10^{-7}$ |
| Ingestion of Dairy Products (Radionuclides) | 1.0 x $10^{-7}$ |
| Ingestion of Vegetables and Fruit (Chemicals) | 1.0 x $10^{-7}$ |
| Ingestion of Vegetables and Fruit (Radionuclides) | 4.1 x $10^{-7}$ |
| RME Individual ILCR: | 7.5 x $10^{-6}$ |

K.9.3.2 Risks Under Future Land Use With Federal Ownership Scenario

Expanded Trespasser

A total ILCR of $2.7 \times 10^{-5}$ is predicted for this receptor, with direct radiation exposure ($1.6 \times 10^{-5}$) and dermal contact with soil and sediment while on-site ($9.9 \times 10^{-6}$) contributing 93 percent of the ILCR. This falls within the $10^{-6}$ to $10^{-4}$ target range (Table K.9-7). The total HI is $1.2 \times 10^{-1}$, below the 1.0 target level.

**TABLE K.9-7**

**SUMMARY OF POTENTIAL HEALTH EFFECTS: EXPANDED TRESPASSER (FUTURE LAND USE WITH FEDERAL OWNERSHIP)**

| Exposure Pathway | RME Receptor HI |
|---|---|
| Inhalation of Particulates (Chemicals) | $5.3 \times 10^{-2}$ |
| Incidental Ingestion of Soil/Sediment (Chemicals) | $1.1 \times 10^{-2}$ |
| Dermal Contact with Soil/Sediment (Chemicals) | $6.1 \times 10^{-2}$ |
| RME Individual HI: | $1.2 \times 10^{-1}$ |

| Exposure Pathway | RME Receptor ILCR |
|---|---|
| Inhalation of Particulates (Chemicals) | $7.5 \times 10^{-8}$ |
| Inhalation of Particulates (Radionuclides) | $2.4 \times 10^{-8}$ |
| Incidental Ingestion while Wading (Radionuclides) | $5.2 \times 10^{-9}$ |
| Incidental Ingestion of Soil/Sediment (Chemicals) | $7.0 \times 10^{-7}$ |
| Incidental Ingestion of Soil/Sediment (Radionuclides) | $4.1 \times 10^{-7}$ |
| Dermal Contact with Soil/Sediment (Chemicals) | $9.9 \times 10^{-6}$ |
| Direct Radiation Exposure | $1.6 \times 10^{-5}$ |
| RME Individual ILCR: | $2.7 \times 10^{-5}$ |

0335

Off-Property Resident Farm Adult

The ILCRs for chemical and radioactive COCs are presented in Table K.9-8, with the total for all pathways equal to less than $1 \times 10^{-4}$. A total ILCR of $9.0 \times 10^{-5}$ is predicted for this receptor, with the principal contributors being inhalation ($8.7 \times 10^{-5}$). The total HI is 1.1 and is driven by the inhalation of cobalt ($8.5 \times 10^{-1}$) and barium ($1.7 \times 10^{-1}$). This exceeds the target level of 1.0.

**TABLE K.9-8**

**SUMMARY OF POTENTIAL HEALTH EFFECTS: OFF-PROPERTY RESIDENT FARM ADULT (FUTURE LAND USE WITH FEDERAL OWNERSHIP)**

| Exposure Pathway | RME Receptor HI |
|---|---|
| Inhalation of Particulates (Chemicals) | $1.1 \times 10^{0}$ |
| Ingestion of Meat (Chemicals) | $1.8 \times 10^{-4}$ |
| Ingestion of Dairy Products (Chemicals) | $6.6 \times 10^{-5}$ |
| Ingestion of Vegetables and Fruit (Chemicals) | $1.4 \times 10^{-3}$ |
| RME Individual HI: | $1.1 \times 10^{0}$ |

| Exposure Pathway | RME Receptor ILCR |
|---|---|
| Inhalation of Particulates (Chemicals) | $8.0 \times 10^{-6}$ |
| Inhalation of Particulates (Radionuclides) | $7.9 \times 10^{-5}$ |
| Ingestion of Drinking Water (Radionuclides) | $2.5 \times 10^{-6}$ |
| Ingestion of Meat (Chemicals) | $9.9 \times 10^{-8}$ |
| Ingestion of Meat (Radionuclides) | $2.0 \times 10^{-9}$ |
| Ingestion of Dairy Products (Chemicals) | $2.6 \times 10^{-7}$ |
| Ingestion of Dairy Products (Radionuclides) | $2.7 \times 10^{-9}$ |
| Ingestion of Vegetables and Fruit (Chemicals) | $3.1 \times 10^{-7}$ |
| Ingestion of Vegetables and Fruit (Radionuclides) | $1.7 \times 10^{-7}$ |
| RME Individual ILCR: | $9.0 \times 10^{-5}$ |

Off-Property Resident Farm Youth

A total ILCR of $1.6 \times 10^{-5}$ is predicted for this receptor, with the inhalation of particulates (radionuclides) contributing over 87 percent of the total ILCR (Table K.9-9). The total HI (1.8) exceeds the target level of 1.0, with the inhalation pathway contributing 100 percent of the total. The contributors are the same for this receptor in the Current Land Use scenario.

**TABLE K.9-9**

**SUMMARY OF POTENTIAL HEALTH EFFECTS: OFF-PROPERTY RESIDENT FARM YOUTH (FUTURE LAND USE WITH FEDERAL OWNERSHIP)**

| Exposure Pathway | RME Receptor HI |
|---|---|
| Inhalation of Particulates (Chemicals) | $1.8 \times 10^{0}$ |
| Ingestion of Meat (Chemicals) | $2.9 \times 10^{-4}$ |
| Ingestion of Dairy Products (Chemicals) | $1.1 \times 10^{-4}$ |
| Ingestion of Vegetables and Fruit (Chemicals) | $2.4 \times 10^{-3}$ |
| RME Individual HI: | $1.8 \times 10^{0}$ |

| Exposure Pathway | RME Receptor ILCR |
|---|---|
| Inhalation of Particulates (Chemicals) | $2.2 \times 10^{-6}$ |
| Inhalation of Particulates (Radionuclides) | $1.4 \times 10^{-5}$ |
| Ingestion of Drinking Water (Radionuclides) | $4.3 \times 10^{-7}$ |
| Ingestion of Meat (Chemicals) | $2.8 \times 10^{-8}$ |
| Ingestion of Meat (Radionuclides) | $3.4 \times 10^{-10}$ |
| Ingestion of Dairy Products (Chemicals) | $7.1 \times 10^{-8}$ |
| Ingestion of Dairy Products (Radionuclides) | $4.7 \times 10^{-10}$ |
| Ingestion of Vegetables and Fruit (Chemicals) | $8.8 \times 10^{-8}$ |
| Ingestion of Vegetables and Fruit (Radionuclides) | $2.9 \times 10^{-8}$ |
| RME Individual ILCR: | $1.6 \times 10^{-5}$ |

Off-Property Resident Farm Child

A total ILCR of 6.6 x $10^{-6}$ is predicted for this receptor, with inhalation of COCs contributing more than 90 percent of the ILCR (Table K.9-10). The total ILCR is within the acceptable range. The total HI (3.1) is due to inhalation of particulates from cobalt (2.4), barium (4.7 x $10^{-1}$) and manganese (2.7 x $10^{-1}$).

**TABLE K.9-10**

**SUMMARY OF POTENTIAL HEALTH EFFECTS: OFF-PROPERTY RESIDENT FARM CHILD (FUTURE LAND USE WITH FEDERAL OWNERSHIP)**

| Exposure Pathway | RME Receptor HI |
|---|---|
| Inhalation of Particulates (Chemicals) | 3.1 x $10^{0}$ |
| Ingestion of Meat (Chemicals) | 3.3 x $10^{-4}$ |
| Ingestion of Dairy Products (Chemicals) | 9.2 x $10^{-4}$ |
| Ingestion of Vegetables and Fruit (Chemicals) | 5.6 x $10^{-3}$ |
| RME Individual HI: | 3.1 x $10^{0}$ |

| Exposure Pathway | RME Receptor ILCR |
|---|---|
| Inhalation of Particulates (Chemicals) | 1.9 x $10^{-6}$ |
| Inhalation of Particulates (Radionuclides) | 4.1 x $10^{-6}$ |
| Ingestion of Drinking Water (Radionuclides) | 1.5 x $10^{-7}$ |
| Ingestion of Meat (Chemicals) | 1.5 x $10^{-8}$ |
| Ingestion of Meat (Radionuclides) | 6.6 x $10^{-11}$ |
| Ingestion of Dairy Products (Chemicals) | 3.1 x $10^{-7}$ |
| Ingestion of Dairy Products (Radionuclides) | 7.0 x $10^{-10}$ |
| Ingestion of Vegetables and Fruit (Chemicals) | 1.0 x $10^{-7}$ |
| Ingestion of Vegetables and Fruit (Radionuclides) | 1.2 x $10^{-8}$ |
| RME Individual ILCR: | 6.6 x $10^{-6}$ |

K.9.3.3 Risks Under Future Land Use Without Federal Ownership

On-Property Resident Farm Adult

HI and ILCR values for this receptor are presented in Table K.9-11. Ingestion of vegetables and fruits has the highest HI value ($3.1 \times 10^1$), with the principal contributors being cadmium ($1.2 \times 10^1$), barium (4.9), arsenic (3.7), manganese (2.1), and mercury (2.4), each having an HI greater than 1.0. The ingestion of meat pathway has an HI of $2.6 \times 10^1$, with the principal contributors including mercury ($1.8 \times 10^1$, zinc (4.2), and cadmium (2.0). The total HI is $6.4 \times 10^1$.

**TABLE K.9-11**

**SUMMARY OF POTENTIAL HEALTH EFFECTS: ON-PROPERTY RESIDENT FARM ADULT (FUTURE LAND USE WITHOUT FEDERAL OWNERSHIP)**

| Exposure Pathway | RME Receptor HI |
|---|---|
| Inhalation of Particulates (Chemicals) | $1.9 \times 10^0$ |
| Incidental Ingestion of Soil/Sediment (Chemicals) | $6.5 \times 10^{-1}$ |
| Dermal Contact with Soil/Sediment (Chemicals) | $1.6 \times 10^{-1}$ |
| Ingestion of Meat (Chemicals) | $2.6 \times 10^1$ |
| Ingestion of Dairy Products (Chemicals) | $4.3 \times 10^0$ |
| Ingestion of Vegetables and Fruit (Chemicals) | $3.1 \times 10^1$ |
| RME Individual HI: | $6.4 \times 10^1$ |

| Exposure Pathway | RME Receptor ILCR |
|---|---|
| Inhalation of Particulates (Chemicals) | $1.5 \times 10^{-5}$ |
| Inhalation of Particulates (Radionuclides) | $1.7 \times 10^{-4}$ |
| Ingestion of Drinking Water (Radionuclides) | $1.1 \times 10^{-6}$ |
| Incidental Ingestion of Soil/Sediment (Chemicals) | $2.4 \times 10^{-4}$ |
| Incidental Ingestion of Soil/Sediment (Radionuclides) | $2.5 \times 10^{-4}$ |
| Incidental Dermal Contact with Soil/Sediment (Chemicals) | $2.1 \times 10^{-4}$ |
| Ingestion of Meat (Chemicals) | $8.7 \times 10^{-4}$ |
| Ingestion of Meat (Radionuclides) | $4.4 \times 10^{-9}$ |
| Ingestion of Dairy Products (Chemicals) | $1.9 \times 10^{-3}$ |
| Ingestion of Dairy Products (Radionuclides) | $3.2 \times 10^{-8}$ |
| Ingestion of Vegetables and Fruit (Chemicals) | $2.3 \times 10^{-3}$ |
| Ingestion of Vegetables and Fruit (Radionuclides) | $5.9 \times 10^{-7}$ |
| Direct Radiation Exposure | $4.6 \times 10^{-3}$ |
| RME Individual ILCR: | $1.1 \times 10^{-2}$ |

The total ILCR ($1.1 \times 10^{-2}$) for this receptor exceeds $1 \times 10^{-4}$, with external radiation exposure ($4.6 \times 10^{-3}$), ingestion of dairy products, and vegetables and fruit pathways contributing over 80 percent of the total (Table K.9-11 above). The primary contributors to the external radiation exposure are Th-228 and Ra-226.

On-Property Resident Farm Youth

The ILCRs for chemical and radioactive COCs are presented in (Table K.9-12). The total ILCR ($2.3 \times 10^{-3}$) exceeds the target range of $1 \times 10^{-6}$ to $1 \times 10^{-4}$. Ingestion of vegetables and fruits ($6.4 \times 10^{-4}$), of meat (chemicals) ($2.0 \times 10^{-4}$), ingestion of dairy products (chemicals) at $5.3 \times 10^{-4}$, and direct radiation exposure at $7.9 \times 10^{-4}$ contribute over 90 percent of the ILCR.

**TABLE K.9-12**

**SUMMARY OF POTENTIAL HEALTH EFFECTS: ON-PROPERTY RESIDENT FARM YOUTH (FUTURE LAND USE WITHOUT FEDERAL OWNERSHIP)**

| Exposure Pathway | RME Receptor HI |
|---|---|
| Inhalation of Particulates (Chemicals) | $3.1 \times 10^{0}$ |
| Incidental Ingestion of Soil/Sediment (Chemicals) | $5.9 \times 10^{-1}$ |
| Dermal Contact with Soil/Sediment (Chemicals) | $1.8 \times 10^{-1}$ |
| Ingestion of Meat (Chemicals) | $4.3 \times 10^{1}$ |
| Ingestion of Dairy Products (Chemicals) | $6.9 \times 10^{0}$ |
| Ingestion of Vegetables and Fruit (Chemicals) | $5.0 \times 10^{1}$ |
| RME Individual HI: | $1.0 \times 10^{2}$ |

| Exposure Pathway | RME Receptor ILCR |
|---|---|
| Inhalation of Particulates (Chemicals) | $4.0 \times 10^{-6}$ |
| Inhalation of Particulates (Radionuclides) | $2.9 \times 10^{-5}$ |
| Ingestion of Drinking Water (Radionuclides) | $1.9 \times 10^{-7}$ |
| Incidental Ingestion of Soil/Sediment (Chemicals) | $3.7 \times 10^{-5}$ |
| Incidental Ingestion of Soil/Sediment (Radionuclides) | $2.4 \times 10^{-5}$ |
| Dermal Contact with Soil/Sediment (Chemicals) | $4.2 \times 10^{-5}$ |
| Incidental Ingestion While Wading (Radionuclides) | $8.1 \times 10^{-9}$ |
| Ingestion of Meat (Chemicals) | $2.4 \times 10^{-4}$ |
| Ingestion of Meat (Radionuclides) | $7.6 \times 10^{-10}$ |
| Ingestion of Dairy Products (Chemicals) | $5.4 \times 10^{-4}$ |
| Ingestion of Dairy Products (Radionuclides) | $5.5 \times 10^{-9}$ |
| Ingestion of Vegetables and Fruit (Chemicals) | $6.4 \times 10^{-4}$ |
| Ingestion of Vegetables and Fruit (Radionuclides) | $1.0 \times 10^{-7}$ |
| External Radiation Exposure | $7.9 \times 10^{-4}$ |
| RME Individual ILCR: | $2.3 \times 10^{-3}$ |

A total HI of $1.0 \times 10^2$ (Table K.9-12 above) is predicted for this receptor, with ingestion of vegetables and fruits ($5.0 \times 10^1$), ingestion of meat ($4.3 \times 10^1$), ingestion of dairy products (6.9), and inhalation of particulates (3.1), all exceeding the target level of 1.0.

On-Property Resident Farm Child

As shown in Table K.9-13, there are six pathways applicable to noncarcinogenic exposure, five of which with a total HI value of more than the target level of 1.0. HI values for the five pathways range from $1.2 \times 10^2$ for ingestion of vegetables and fruits (with cadmium, barium, arsenic, manganese, mercury, and zinc each exceeding 1.0) to $5.4 \times 10^0$ for incidental inhalation of particulates (with cobalt and barium each exceeding 1.0).

**TABLE K.9-13**

**SUMMARY OF POTENTIAL HEALTH EFFECTS: ON-PROPERTY RESIDENT FARM CHILD (FUTURE LAND USE WITHOUT FEDERAL OWNERSHIP)**

| Exposure Pathway | RME Receptor HI |
|---|---|
| Inhalation of Particulates (Chemicals) | $5.4 \times 10^0$ |
| Incidental Ingestion of Soil/Sediment (Chemicals) | $3.4 \times 10^0$ |
| Dermal Contact with Soil/Sediment (Chemicals) | $2.5 \times 10^{-1}$ |
| Ingestion of Meat (Chemicals) | $4.7 \times 10^1$ |
| Ingestion of Dairy Products (Chemicals) | $6.0 \times 10^1$ |
| Ingestion of Vegetables and Fruit (Chemicals) | $1.2 \times 10^2$ |
| RME Individual HI: | $2.4 \times 10^2$ |

| Exposure Pathway | RME Receptor ILCR |
|---|---|
| Inhalation of Particulates (Chemicals) | $3.5 \times 10^{-6}$ |
| Inhalation of Particulates (Radionuclides) | $8.7 \times 10^{-6}$ |
| Ingestion of Drinking Water (Radionuclides) | $6.6 \times 10^{-8}$ |
| Incidental Ingestion of Soil/Sediment (Chemicals) | $1.1 \times 10^{-4}$ |
| Incidental Ingestion of Soil/Sediment (Radionuclides) | $2.4 \times 10^{-5}$ |
| Incidental Dermal Contact with Soil/Sediment (Chemicals) | $2.9 \times 10^{-5}$ |
| Ingestion of Meat (Chemicals) | $1.3 \times 10^{-4}$ |
| Ingestion of Meat (Radionuclides) | $1.5 \times 10^{-10}$ |
| Ingestion of Dairy Products (Chemicals) | $2.3 \times 10^{-3}$ |
| Ingestion of Dairy Products (Radionuclides) | $8.3 \times 10^{-9}$ |
| Ingestion of Vegetables and Fruit (Chemicals) | $7.6 \times 10^{-4}$ |
| Ingestion of Vegetables and Fruit (Radionuclides) | $4.2 \times 10^{-8}$ |
| Direct Radiation Exposure | $2.4 \times 10^{-4}$ |
| RME Individual ILCR: | $3.6 \times 10^{-3}$ |

A total ILCR of 2.9 x $10^{-3}$ (Table K.9-13 above) is estimated for this receptor. The highest COC-induced ILCR to this receptor is 2.3 x $10^{-3}$ from the ingestion of dairy products (chemicals, specifically Aroclor-1260 and 1254). The following pathways have ILCR values above 1 x $10^{-6}$: inhalation of chemicals and radionuclides, incidental ingestion of soil and sediment (chemicals and radionuclides), incidental dermal contact with soil and sediment (chemicals), direct radiation, ingestion of meat (chemicals and radionuclides), and ingestion of vegetables and fruits (chemicals).

Off-Property Resident Farm Adult, Youth and Child

The results for these three receptors are given in Tables K.9-14 through K.9-16. They are identical to those for the Future Land Use With Federal Ownership scenario.

**TABLE K.9-14**

**SUMMARY OF POTENTIAL HEALTH EFFECTS: OFF-PROPERTY RESIDENT FARM ADULT (FUTURE LAND USE WITHOUT FEDERAL OWNERSHIP)**

| Exposure Pathway | RME Receptor HI |
|---|---|
| Inhalation of Particulates (Chemicals) | 1.1 x $10^{0}$ |
| Ingestion of Meat (Chemicals) | 1.8 x $10^{-4}$ |
| Ingestion of Dairy Products (Chemicals) | 6.6 x $10^{-5}$ |
| Ingestion of Vegetables and Fruit (Chemicals) | 1.4 x $10^{-3}$ |
| RME Individual HI: | 1.1 x $10^{0}$ |

| Exposure Pathway | RME Receptor ILCR |
|---|---|
| Inhalation of Particulates (Chemicals) | 8.0 x $10^{-6}$ |
| Inhalation of Particulates (Radionuclides) | 7.9 x $10^{-5}$ |
| Ingestion of Drinking Water (Radionuclides) | 2.5 x $10^{-6}$ |
| Ingestion of Meat (Chemicals) | 9.9 x $10^{-8}$ |
| Ingestion of Meat (Radionuclides) | 2.0 x $10^{-9}$ |
| Ingestion of Dairy Products (Chemicals) | 2.6 x $10^{-7}$ |
| Ingestion of Dairy Products (Radionuclides) | 2.7 x $10^{-9}$3.1 x $10^{-7}$ |
| Ingestion of Vegetables and Fruit (Chemicals) | 1.7 x $10^{-7}$ |
| Ingestion of Vegetables and Fruit (Radionuclides) | |
| RME Individual ILCR: | 9.0 x $10^{-5}$ |

## TABLE K.9-15

## SUMMARY OF POTENTIAL HEALTH EFFECTS: OFF-PROPERTY RESIDENT FARM YOUTH (FUTURE LAND USE WITHOUT FEDERAL OWNERSHIP)

| Exposure Pathway | RME Receptor HI |
|---|---|
| Inhalation of Particulates (Chemicals) | $1.8 \times 10^{0}$ |
| Ingestion of Meat (Chemicals) | $2.9 \times 10^{-4}$ |
| Ingestion of Dairy Products (Chemicals) | $1.1 \times 10^{-4}$ |
| Ingestion of Vegetables and Fruit (Chemicals) | $2.4 \times 10^{-3}$ |
| RME Individual HI: | $1.8 \times 10^{0}$ |

| Exposure Pathway | RME Receptor ILCR |
|---|---|
| Inhalation of Particulates (Chemicals) | $2.2 \times 10^{-6}$ |
| Inhalation of Particulates (Radionuclides) | $1.4 \times 10^{-5}$ |
| Ingestion of Drinking Water (Radionuclides) | $4.3 \times 10^{-7}$ |
| Ingestion of Meat (Chemicals) | $2.8 \times 10^{-8}$ |
| Ingestion of Meat (Radionuclides) | $3.4 \times 10^{-10}$ |
| Ingestion of Dairy Products (Chemicals) | $7.1 \times 10^{-8}$ |
| Ingestion of Dairy Products (Radionuclides) | $4.7 \times 10^{-10}$ |
| Ingestion of Vegetables and Fruit (Chemicals) | $8.8 \times 10^{-8}$ |
| Ingestion of Vegetables and Fruit (Radionuclides) | $2.9 \times 10^{-8}$ |
| RME Individual ILCR: | $1.6 \times 10^{-5}$ |

## TABLE K.9-16
## SUMMARY OF POTENTIAL HEALTH EFFECTS: OFF-PROPERTY RESIDENT CHILD (FUTURE LAND USE WITHOUT FEDERAL OWNERSHIP

| Exposure Pathway | RME Receptor HI |
|---|---|
| Inhalation of Particulates (Chemicals) | $3.1 \times 10^{0}$ |
| Ingestion of Meat (Chemicals) | $3.3 \times 10^{-4}$ |
| Ingestion of Dairy Products (Chemicals) | $9.2 \times 10^{-4}$ |
| Ingestion of Vegetables and Fruit (Chemicals) | $5.6 \times 10^{-3}$ |
| RME Individual HI: | $3.1 \times 10^{0}$ |

| Exposure Pathway | RME Receptor ILCR |
|---|---|
| Inhalation of Particulates (Chemicals) | $1.9 \times 10^{-6}$ |
| Inhalation of Particulates (Radionuclides) | $4.1 \times 10^{-6}$ |
| Ingestion of Drinking Water (Radionuclides) | $1.5 \times 10^{-7}$ |
| Ingestion of Meat (Chemicals) | $1.5 \times 10^{-8}$ |
| Ingestion of Meat (Radionuclides) | $6.6 \times 10^{-11}$ |
| Ingestion of Dairy Products (Chemicals) | $3.1 \times 10^{-7}$ |
| Ingestion of Dairy Products (Radionuclides) | $7.0 \times 10^{-10}$ |
| Ingestion of Vegetables and Fruit (Chemicals) | $1.0 \times 10^{-7}$ |
| Ingestion of Vegetables and Fruit (Radionuclides) | $1.2 \times 10^{-8}$ |
| RME Individual ILCR: | $6.6 \times 10^{-6}$ |

- 5208

{This page intentionally left blank}

# SECTION K.10.0

# UNCERTAINTIES

## K.10.0 UNCERTAINTIES

In relying on multiple assumptions and models, all risk assessments contain elements of uncertainty. The purpose of examining the uncertainty is to provide information relative to the accuracy of the risk estimates and thus aid in the formation of risk management decisions. For the major categories of uncertainty relevant to the CRARE, questions were asked to examine the sources of uncertainty in the risk evaluation:

- COC Selection:

  Are all COCs correctly identified?

- Toxicological Information and Models:

  How good is the current information concerning the toxic properties and dose-response characteristics of the COCs?

- Exposure Pathways:

  Are all potential pathways for transporting contaminants from the site environmental media to the receptors identified?

- Receptor Characterization and Exposure Assumptions:

  Are land use scenarios realistic, and are all potential receptors valid?

- Exposure Point Concentrations:

  Are the models for estimating COC transport from the site media to the receptor, and for estimating the contaminant exposures and intakes, realistic and reasonable?

- Risk Characterization:

  What uncertainties are associated with summing cancer risks or HIs for multiple substances?

A baseline risk assessment uses existing site conditions to estimate current potential exposures and risks. The CRAREs estimate all exposure point concentrations using models and assumptions to estimate postremediation site conditions. CRARE results have much more inherent uncertainty with regard to exposure patterns, exposed populations, and exposure concentrations. Even more important for this Operable Unit 4 CRARE, however, is that the remedial alternatives for the other operable

units have not yet undergone a thorough analysis. One purpose of this uncertainty analysis is therefore to identify data quality objectives that have not been met or need to be strengthened. As previously mentioned, this CRARE is the first of five planned reports. Some uncertainties identified in this report will be reduced when subsequent editions of the CRARE are prepared as part of the other operable unit FSs.

## K.10.1 COC SELECTION

A major concern in this CRARE is the reliability of COC identification, both in terms of ensuring that all COCs have been identified and that chemical or radionuclides have not been incorrectly identified as COCs. The accuracy of COC identification is directly related to the quality of COC characterization data, including contaminant identification, location, and concentrations. The characterization was defined by the design of the sampling and analysis plan, which described the sampling locations and analytical protocols.

The sources of chemical analytic data for the CRARE were the SWCR (for Operable Units 1, 3, and 5), the Operable Unit 2 RI, and the Operable Unit 4 RI/FS. The data in the SWCR were not all obtained through sampling plans designed as part of the CERCLA process. There were three stages of sampling, and the analytical protocols and data validation techniques differed between stages. Consequently, data deficiencies have been identified that must be corrected in the individual operable unit RI, and will be included in their CRAREs when the information becomes available.

Data deficiencies also are found in the Operable Unit 2 RI. The extent of contamination in the subunits of Operable Unit 2 was incompletely defined, and a major portion of the data was not validated according to CERCLA standards. This deficiency is being corrected in the revised Operable Unit 2 RI report.

The Operable Unit 4 RI report was prepared following CERCLA guidelines, and the data were validated. Whenever possible, COC identification was based on data collected according to a CERCLA sampling plan.

As described in the Operable Unit 4 RI report (DOE 1993d), the selection of COCs for Operable Unit 4 is subject to less uncertainty than for other operable units. This is because the primary source for

Operable Unit 4 is the relatively isolated waste contained in Silos 1, 2, and 3. Uncertainty does exist, however, because the soil samples may not represent conditions at the surface. Samples of nonradioactive chemicals were taken at depths of 0 to 2 feet during the waste pit runoff sampling program, and from 0 to 5 feet during the K-65 berm sampling program. The cumulative impact of these uncertainties on the results of the CRARE exposure and risk assessments is unclear. However, the uncertainties concerning the representativeness of the Operable Unit 4 soil data can be expected to have a small impact on the risk assessment compared to other uncertainties in the risk assessment process. This is because the levels of contamination in the soil are comparatively low and the likelihood of not detecting a contaminant which would contribute significantly to risks is also low.

Uncertainty is inherent in the K-65 silo sampling data due to the heterogeneity of the waste forms and the bias introduced in the sampling program. The program did not include random samples. In fact, it intentionally selected samples exhibiting the greatest radiological contamination from each boring zone to ensure detection of any significant concentrations of radionuclides. However, any uncertainty in the silo data will have no impact on the COC selection for this CRARE, as the silo materials will be removed from the FEMP property.

There are also specific areas of data deficiencies related to other operable units, including:

- The presence or absence of dioxins in the incinerator flyash in Operable Unit 2 has not been conclusively established.
- The extent and type of contamination in the subsurface soils surrounding the process trench running from the plant areas to the silos have not been characterized.

In summary, it is unlikely that major COC contributors to overall site risk have been overlooked. Despite the described shortcomings of some of the chemical concentration data gathered at the FEMP, there is still a very large and comprehensive database of site contaminant data. The evaluation of these data have identified a large number of contaminants present on the site, and confirm the general pattern of contamination as indicated by past site operations. It is clear that the major contaminants (uranium and other radionuclides, nonradionuclide inorganics, and organics) that could credibly contribute to site risks have been identified. If additional COCs are identified in future RI/FS efforts (which is not likely), they will be included in future CRAREs.

## K.10.2 TOXICOLOGICAL INFORMATION AND MODELS

Toxicological information is not operable-unit-specific and therefore is not discussed separately for each operable unit. EPA-supplied RfDs and cancer slope factors were used throughout the risk assessment. Toxicological constants were not derived for any of the COCs evaluated in this CRARE risk assessment. Because of this, the toxicological evaluations (upon which the CRARE risk assessment is based) contribute no more uncertainty than that present in comparable CERCLA documents. However, because this uncertainty arises out of the application of guidelines recommended by the agencies involved, these sources of uncertainty are beyond the control of the FEMP investigation personnel.

There are many sources of uncertainty in the cancer slope factors or unit risks and noncarcinogenic RfDs or RfCs provided by the EPA. The three major sources are:

1. Interspecies extrapolations:

   Animal-to-human extrapolation, used in the absence of quantitative pharmacokinetic, dosimetric, or mechanistic data, is usually based on a consideration of interspecies differences in body weight, surface area, or basal metabolic rate.

2. Intraspecies or individual variation:

   Most toxicity experiments are performed with animals that are very similar in age and genotype, so that intragroup biological variation is minimal. The human population of concern may reflect a great deal of heterogeneity, however, including unusual sensitivity to the COCs.

   Even toxicity data from human occupational exposures reflect a bias because only those individuals sufficiently healthy to attend work regularly, and those not unusually sensitive to the COCs, are likely to be occupationally exposed.

3. Key study and database quality:

   The quality of key studies (from which the quantitative estimate is derived) and the quality of the literature databases add to the uncertainty. For carcinogenic effects, the uncertainty associated with some quality factors (e.g., group size) is expressed within the 95 percent upper bound of the slope factor. For noncarcinogenic effects, additional uncertainty factors may be applied in the derivation of the RfD or RfC to reflect the poor quality of the key studies or gaps in the database.

As described in the Operable Unit 4 RI report (DOE 1993d), considerable uncertainty is associated with the qualitative (hazard assessment) and quantitative (dose-response) evaluations of Superfund risk assessments. The hazard assessment characterizes the nature and strength of the evidence of causation, or the likelihood that a chemical that induces adverse effects in animals would also induce adverse effects in humans. The hazard assessment of carcinogenicity is evaluated as a weight-of-evidence determination, using either the IARC (1987) or EPA (1986b) approaches. Positive results in animal cancer tests suggest that humans may also exhibit a carcinogenic response, but the animal data cannot necessarily be used to predict the target tissue in humans. In the hazard assessment of noncarcinogenic effects, positive animal test results may suggest the nature of the human effects, including the target tissues and type of effects (EPA 1989g).

Another source of uncertainty regarding the quantitative risk estimation for carcinogenicity is the method by which data from high doses in animal studies are extrapolated to the dose-range expected for environmentally exposed humans. The linear multi-stage model, which is used in almost all quantitative estimations of human risk from animal data, is based on the nonthreshold assumption of carcinogenesis. An impressive body of evidence, however, suggests that epigenetic carcinogens, as well as many genotoxic carcinogens, have a threshold below which they are noncarcinogenic (Williams and Weisberger 1991). The linear multi-stage model is therefore generally regarded as being extremely conservative for many chemicals.

Adding to the conservativeness of this approach is the fact that the EPA-derived slope factors found in IRIS have been set at the 95 percent UCL of the linear slope of the multi-stage model. Thus, risks estimated using the slope factors may be greatly overestimated. This consideration applies to both radiological and chemical estimates of carcinogenic risk. Of particular concern in this regard are the slope factors derived by EPA for the evaluation of risks due to external exposure to radiation. As discussed in Section K.7.3, these values were derived using very conservative assumptions about exposure conditions, and are likely to provide very conservative risk estimates.

The methods used to define RfD values for chemical contaminants also incorporate a large degree of conservatism. Sets of multiplicative uncertainty factors were used in deriving RfDs to adjust the results of animal and human toxicologic studies to take into account the nature of the endpoint (NOAEL to LOAEL) seen in the studies, differences in response to different dose schedules, the

presence of sensitive populations, and the possible differences between human and animal sensitivity to contaminant exposures. Each uncertainty factor may take a value as high as 10, and thus RfD values for COCs typically have been set between 100 and 1000 times lower than the lowest dose seen in animal studies. If the human and animal responses to contaminant exposures are not as dissimilar as reflected in the uncertainty factors (or if humans are less sensitive, rather than more sensitive to contaminants), it is the possible that the use of RfDs greatly overstates the potential for adverse health effects in humans.

The level of uncertainty in the toxicologic data for different chemicals varies because information concerning some constituents and their associated health effects is comparatively scarce, while for others much more information is available from health effects studies. Also, different amounts of data may be available concerning the different types of effects for a given COC. For example, uranium has been established as a chemical toxicant (kidneys are the major target organ) based on human and animal studies. The RfD for uranium was based on the results of animal studies and was calculated by applying an uncertainty factor of 1000 to a LOAEL for nephrotoxicity in rabbits to provide a margin of safety for extrapolation to humans. The uncertainty factor consists of three factors of 10 each, for: 1) estimation of a NOAEL from a LOAEL, 2) extrapolation from animals to humans, and 3) the possible range of sensitivities among exposed humans.

There is even greater uncertainty regarding uranium carcinogenicity. As an alpha-particle emitter, uranium is considered to be a carcinogen; however, as discussed in Section K.7.0, epidemiological evidence of uranium-induced excess cancers is very difficult to obtain. This is largely because the human data available on the radiocarcinogenic effects of uranium exposure are for miners who were also simultaneously exposed to radon and its progeny, which are confounding factors. The studies of humans sometimes lack quantitative information concerning uranium exposure, including potential exposure through previous employment, concurrent smoking patterns, or concurrent radon exposure levels, all of which are needed to definitively determine the risk attributable to uranium exposure. These facts weaken the power of the human studies to detect any excess cancer risk. The human studies of cancer from exposure to uranium frequently reveal a slight excess risk, if any, above the natural risk. These uncertainties are not well known or easily quantified.

Uncertainties in the interpretation of toxicologic data especially affect the results of the risk assessment for inhalation exposure to metals. HI values associated with particulate inhalation exceed 1.0 for several receptors. Almost all of the HI values result from estimated exposures to cobalt and chromium via the inhalation pathway. Similarly, mercury and zinc are the major contributors to the HI values from exposures via the food pathways. In the case of cobalt, exposure concentrations result in contaminant intakes which barely exceed the inhalation RfD values. The inhalation RfD for cobalt ($3.0 \times 10^{-7}$ mg/kg/day) was derived using maximum values for all possible uncertainty factors, based on a single epidemiologic study of a disease from exposures to the hard metal and not from cobalt compounds. It is extremely unlikely that humans are actually as sensitive to cobalt exposures as reflected in this RfD. The RfD value is almost certainly well below normal background inhalation exposures received by members of the general population, and the RfD value for cobalt makes it more than one thousand times more toxic than mercury by the inhalation pathway. Thus, a cobalt HQ greater than 1.0 for some populations must be interpreted very cautiously, and probably does not reflect significant concerns over adverse effects.

Chemical speciation is an issue in evaluating the inhalation pathway risk estimates for chromium exposures. From the SWCR, chromium present in soils was assumed to be reported as total chromium. An assumption that this on-site chromium was entirely $Cr^{+6}$ would be inconsistent with the prevailing redox and chemical conditions in environmental media at the FEMP. It is likely that only a small portion of the chromium present (1 percent or less) is actually hexavalent. In this CRARE, it was assumed that 10 percent of the chromium was presented as hexavalent chromium. This failure to adequately characterize on-site chromium species contributes uncertainty to the inhalation pathway risks associated with chromium exposures, since hexavalent chromium species are much more toxic than the trivalent species. In the case of noncarcinogenic health effects, trivalent chromium is estimated to be on the order of 50 times less toxic than hexavalent chromium. In addition, trivalent chromium species are not thought to have any carcinogenic activity in humans, whereas the hexavalent chromium compounds are regarded as potent human carcinogens.

### K.10.3 EXPOSURE PATHWAYS

The exposure pathways evaluated within the CRARE risk assessment were initially proposed in the SWCR and further reviewed during the Operable Unit 4 RI. The major source of uncertainty in predicting future exposures at the FEMP is the future disposition of the property itself. Because it is

not possible to accurately predict future land uses or the condition of the site, conservative (rather than the most likely) future conditions were evaluated, as stipulated by the NCP. It has been assumed that the FEMP would not become a residential area. This is a conservative assumption, as the farm scenarios used in this CRARE have a greater chance of excess exposure due to the inclusion of the indirect pathways of vegetable, beef, and milk consumption.

In future CRAREs, additional data will be gathered to support a more detailed evaluation of the indirect human exposure pathways. Depending upon the findings of the RI/FS for the other operable units, the evaluation of the indirect pathways may be expanded to include contributions to exposure concentrations through other transport mechanisms (particulate deposition, surface water runoff), as well as the possible inclusion of additional groundwater COCs which may be subject to bioconcentration.

### K.10.4 RECEPTOR CHARACTERIZATION AND EXPOSURE ASSUMPTIONS

Receptor characterization is not operable-unit-specific and therefore is not discussed separately for each operable unit. The default values for characterizing FEMP receptors are presented in the RAWPA (DOE 1992i). For this CRARE, receptor scenarios (one Current and two Future Land Use scenarios) were selected to represent the highest potential exposure. Exposure factors were based on surveys of physiological and lifestyle profiles across the United States and the attributes and activities studied generally have a broad distribution. To account for most of this distribution, this risk assessment follows the EPA's recommendation to use the 95th percentile for most exposure factors. In addition, the exposure factors are consistent with EPA Region V guidance. This introduces a conservative bias into the results. Future CRAREs may evaluate the degree of conservative bias introduced by the 95th percentile approach through the use of a receptor and pathway-specific Monte Carlo simulation. This simulation will be used only for uncertainty purposes, per Region V guidance.

As previously stated, nine RME receptors were chosen for the CRARE.

- Groundskeeper
- Trespassing child
- Expanded trespasser
- Off-property resident farm adult, youth, and child
- On-property resident farm adult, youth, and child

Other receptors may be exposed to FEMP COCs; however, the conservative exposure scenarios addressed in this report make it likely that no actual exposed population will receive greater exposures than those estimated in the CRARE. A brief discussion of the uncertainty in selected exposure factors follows.

K.10.4.1 Exposure Duration

For FEMP risk assessments, it was assumed that the farm residents would occupy the land for a full lifetime exposure period (70 years). This is a conservative approach, but at most it overestimates the risk by a factor of three relative to representative residential tenure in the area. It was also assumed that all workers would occupy their jobs for 25 years, a realistic estimate of exposure duration given the stability of the surrounding communities. The exposure durations for all individuals are also realistic, based on community stability.

K.10.4.2 Exposure Frequency

It was assumed the farm residents would occupy the property for 350 days per year, a realistic assumption, especially for a farming family. Likewise, workers were assumed to work for 250 days a year, the normal number of annual workdays. What is uncertain, however, is the number of days a trespassing child or expanded trespasser would be on FEMP property. The assumptions were 52 days for the trespassing child, 120 days for the expanded trespasser as a youth and 40 days as an adult. These are conservative but reasonable assumptions and only moderately affects the results of the risk assessment.

K.10.4.3 Exposure Time

The farm residents were assumed to spend 24 hours per day on the property. This is a slightly conservative assumption as it does not take into account school time, shopping time, work, and other activities. What is uncertain is the time a worker, trespassing child, or expanded trespasser would spend in contact with the property media. The exposure times chosen are realistic but could underestimate the exposure. The most-effected pathways are direct contact and inhalation.

K.10.4.4 Body Weight

The body weights used in this CRARE were derived from standard tables for U.S. body-weight distributions. The values were selected from the distribution midpoints because of the uncertainty

regarding those distributions. Individual variances for adults are likely to be less than a factor of 2. And although children have a wide range of body weights, the uncertainty is at most a factor of 2 or 3 (plus or minus).

K.10.4.5 Ingestion of Soil, Food, and Water

There has been considerable discussion in the scientific literature concerning the appropriate oral ingestion rate of soil and dust for adults and children. Current EPA guidance recommends 100 mg/day for adults, 200 mg/day for children under the age of 6, and 50 mg/day for an industrial worker not engaged in construction work. Since the FEMP risk assessments also considered a farmer who would be exposed to great quantities of dust through farming activities, a value of 180 mg/day was used. These values are realistic as a multi-year average, but the soil ingestion rates could potentially be much higher for shorter-term exposures. If anything, these ingestion rates may be underestimated, but by less than a factor of 2 for multi-year exposures.

The consumption of drinking water was set to the EPA Region V default values, which are conservative estimates. Over multi-year exposures, these values are not likely to vary widely and may be overestimated by a factor of less than 2. Most likely, the consumption of drinking water will be less than the default values

The rate and type of food consumption vary highly from locality to locality and from individual to individual. The estimates of food consumption used in the FEMP risk assessments are national averages and may not be appropriate for some of the individual exposed to FEMP COCs. The values presented represent conservative estimates and are not likely to vary by more than a factor of 2 for the average individual. However, it was assumed that the farm residents' diet will consist 100 percent of products from their farm. This may overestimate the risk by a factor of 3. The greatest uncertainty is in the assumption of food consumption for children. The direction and magnitude of uncertainty are unknown.

K.10.4.6 Dermal Exposure Factors

Four critical assumptions have been made relating to the assessment of dermal exposure to soils: 1) the amount of exposed skin surface area, 2) the quantity of soil adhering to the skin, 3) the length of time the soil adheres to the skin, and 4) the partitioning rate of the COC from the soil across the skin

barrier. The same factors influence the evaluation of the dermal exposure to water. The four factors vary widely from individual exposure to exposure and may contribute substantially to the uncertainty in risk assessment of these pathways. In general, the assumptions used to estimate dermal absorption are consistent with the conservative default values defined in recent EPA guidance. In addition, the adjustment of toxicity values for use in the dermal pathway risk assessment, particularly in the case of inorganic contaminants, was performed using conservative assumptions about contaminant intake, and likely contributes a further degree of conservatism to the characterization of dermal pathway risks.

### K.10.4.7 Inhalation Exposure

Multiple breathing rates were used in estimating doses via inhalation. The receptors are typical for different exposed groups, including small children, adults at home, and adults at work. Each of these receptors has a wide range of breathing rates, which vary on a daily basis. The extent of the range is a factor of 3 for any defined level of activity. The breathing rates chosen for this evaluation are at the upper end of the distribution but do not represent the maximum.

## K.10.5 EXPOSURE POINT CONCENTRATIONS

The values used to represent exposure point concentrations were designed to provide conservative estimates of exposure, thus ensuring a conservative evaluation of the risk. All CRARE exposure point soil concentrations are projected to be PRGs, existing soil concentrations, or modeled values, except for Operable Units 1 and 2, which are proposed to be capped (clean soil was assumed with no contaminants present). The uncertainty of exposure point concentrations estimated by models depends on input parameters (diffusion coefficients, groundwater flow, air flow, etc.), model characteristics, release mechanisms, and source terms. CRARE input parameters were based on site information together with professional judgment and were designed to be conservative. The input parameters and models were based on the RAWPA and SWCR. The exposure parameters were taken from the Operable Unit 4 RI approved final report.

### K.10.5.1 Air Concentrations

The major contributors to uncertainty in CRARE air modeling are the release estimates for particulate and gaseous (radon) emissions and the concentrations and extent of COCs in the surface soil. The components of uncertainty include:

- Wind speed and direction

- Climate conditions (temperature, moisture, etc.)
- Surface soil COC concentrations
- Release of particulates to the air from soils, including frictional velocity concerns
- Volatilization
- Radon release

The uncertainties associated with variations in meteorologic and climatologic conditions are contained to a large degree in the air quality models used to evaluate contaminant transport. Six years of actual climatic data from the site provide a large database upon which long-term air quality modeling can be based. The overall level of uncertainty associated with the meteorologic models is probably relatively low relative compared to the contribution of other factors.

The particulate COC concentrations depend on the estimated surface soil contamination, soil characteristics, and the percentage of vegetative cover. The estimated surface soil concentrations in Operable Unit 4 and in the Operable Unit 5 areas beneath Plants 2/3, 6, and 9 were fixed at the PRG levels for COCs which initially exceeded the PRG level. The COCs affected by this step were Cs-137 and Pb-210 as well as isotopes of radium, thorium, and uranium. The particulate COC concentrations in surface soil beneath the rest of the former production area and in the remainder of the FEMP were based on the RI/FS sample database for isotopes of radium, thorium, and uranium. All other COC soil and waste concentrations were based on UCL values presented in previous reports. Not all COC soil concentrations were characterized for all areas. When COC soil concentration was not available for a given source, the contribution to the COC air concentration from that source was not calculated. The overall approach is considered realistic, with some potential for underestimation due to the lack of COC data for several source areas.

The vegetative cover for the surface areas was assumed to be at 85 percent, which is realistic for this area of southern Ohio. In fact, using 85 percent may underestimate the dust production if the FEMP becomes a farm.

The controlling factors in radon air concentrations are the extent of Ra-226 in the surface soils and the layers of cover for the capped areas. As previously stated, the extent of Ra-226 contamination in

the surface soils is incompletely characterized, as are the data concerning the fate of Ra-226 after soil washing. It was assumed that all capped areas would remain intact for 1000 years and no significant radon release would occur. Overall, the predicted air concentrations are realistic but not conservative.

The methods used to combine the particulate generation and air quality models may also contribute significantly to the uncertainty in the inhalation pathway risk assessment. As discussed in Section K.6.0, the particulate emission rate was determined using the unlimited erosion potential equation from EPA's *Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites* developed for estimated annual $PM_{10}$ emission rates from the annual mean wind speed. The equation used includes a distribution function which accounts for actual winds ranging above and below the annual mean wind speed. As described in Section K.6.0, this equation was applied to six wind speed categories, using a single wind speed to represent each category. While the concept of applying a distribution function when using a single wind speed to represent a wind speed range may be appropriate, the actual distribution function developed for the mean annual wind speed may not be applicable to the six wind speed categories. The direction of any bias associated with this uncertainty is an underestimation. However, the methodology in Section K.6.0 does assume that particulate emissions occur, even when the representative wind speed falls below the threshold friction velocity (i.e., the wind velocity needed to resuspend surface particulate matter).

The use of the unlimited erosion potential equation was based on relatively coarse particle size distributions. The equation does not account for moisture content, crustiness of the surface, and nonerodible elements present on the surface. The FEMP surface is probably more characteristic of an area with "limited" erosion potential: an inhomogeneous field covered with gravel, rocks, or clumps of vegetation that has a moderate moisture content and tends to form a hard crust when dried. The bias of using the unlimited erosion potential equation is clearly in the conservative direction.

K.10.5.2 Surface Water and Groundwater Concentrations

The need to predict surface water and groundwater concentrations for 1000 years into the future represents a major source of uncertainty in the CRARE. In evaluating future water concentrations, the same models were used (MUSLE, ODAST, and SWIFT III) as in the baseline risk assessment. The level of uncertainty associated with the modeling is large but cannot be easily quantified. Table

K.10-1 identifies the major parameters used in the CRARE modeling and provides estimates of their relative effect on the loading of COCs to the aquifer.

To assure that groundwater exposure concentrations are estimated conservatively, the RME exposure locations were set at the points of highest groundwater concentration. In addition, the exposure concentration estimates for the Future Land Use scenarios were estimated based on the concentrations seen in the 70-year period with the highest modeled groundwater contaminant concentrations.

Other components of uncertainty in the water modeling are the partitioning coefficient ($K_d$) values of COCs in the vadose zone and the aquifer, and the source terms for release. The $K_d$ uncertainty is of most importance when modeling over hundreds of years. The vadose layers provide a time delay to contamination reaching the aquifer, except that in the model, the contamination in surface runoff is assumed to reach the aquifer without delay. This delay in the vadose zone transport is evidenced by time shifting of the peak concentration in the aquifer.

## TABLE K.10-1

## MAJOR PARAMETERS IN CRARE MODELING AND THEIR EFFECT ON AQUIFER LOADING

| Parameter | Concentration[a] | Time[b] | Duration[c] | Confidence[d] |
|---|---|---|---|---|
| **Source Term** | | | | |
| Quantities in Wastes | | | Medium + | Medium |
| Concentration in Wastes | Major + | | | Medium |
| Quantities in Soils | | | Medium + | Medium |
| Concentration in Soils | Major + | | | Medium |
| **Surface Runoff Model (MUSLE)** | | | | |
| $K_d$ of Soils | Major– | | | Low |
| $R_t$ - Total Storm Rainfall | Major– | | | Low |
| $T_f$ - Storm Duration | Small– | | | Low |
| $D_d$ - Overland Distance | | Small + | | High |
| K - Soil Erodibility Factor | Small + | | | Low |
| $\lambda$ - Source Decay Factor | Small– | | Small– | Hi/Low |
| **Vadose Zone Models (HELP, ODAST)** | | | | |
| D - Dispersion Coefficient | Small– | | Small + | Low |
| V - Seepage Velocity | | Medium– | Major– | Low |
| R - Retardation Factor | Small– | Major + | | Low |
| $\alpha$ - Depletion Factor | | | Medium– | Low |
| $T_o$ - Depletion Time | | | Major + | Low |
| $\lambda$ - Source Decay Factor | Small– | | Small– | Hi/Low |
| **Aquifer Model (SWIFT)** | | | | |
| $H_H$ - Horizontal Conductivity | Medium– | Medium– | | Medium |
| $K_v$ - Vertical Conductivity | Medium– | Medium– | | Low |
| $\alpha_H$ - Horizontal Dispersivity | Medium– | Medium– | | Low |
| $\alpha_T$ - Transverse Dispersivity | Small– | Small– | | Low |
| R - Retardation Factor | Medium + | Major + | | Low |

[a]Maximum level of concentration in the aquifer.
[b]Time of occurrence of peak concentration in the aquifer.
[c]Time duration of release.
[d]Level of confidence in parameter values.
[e]High level of confidence in decay factors for radionuclides and low level of confidence in decay factors for organic contaminants.
+ = Small, medium, or major positive effect, i.e., increase in parameter value will increase the value of the dependent variable.
– = Small, medium, or major negative effect, i.e., increase in parameter value will decrease the value of the dependent variable.

However, surface runoff is not a major contributor. The two vadose layers are essentially in series (e.g., contamination must pass through vadose layers 1 and 2 before reaching the aquifer). The average travel time, $T_n$, through each layer is $R_nL_n/V_n$:

where

$n$ = layer,
$R_n$ = retardation factor $(1+K_{dob}/O)$, for layer n,
$L_n$ = thickness of layer, and
$V_n$ = seepage velocity in layer n.

Thus, the travel time in each layer is directly proportionate to the $K_d$ of that layer. For many contaminants, the $K_d$ of vadose layer 1 is so much larger than that of layer 2, which is dominant. The $K_d$ can vary according to the COC chemistry, the pH of water, concentrations of other components (chloride, sulfate, etc.), and soil characteristics (sand, clay, porosity, etc.). The $K_d$ values for this CRARE were generally based on values from the literature, as summarized in the RAWPA. The uncertainty would be reduced by determining operable-unit-specific $K_d$ values.

Additional uncertainty derives from the release mechanisms of the sources into the vadose zone. An important component in the release mechanism is the exfiltration rate (the rate at which the water moves through the source area). Engineering calculations were used to estimate this rate for the engineered areas.

The major operable-unit-specific sources of groundwater uncertainty with respect to source terms are summarized by operable unit as follows:

- Operable Unit 1:

  Magnitude of COCs, vault design, and exfiltration rate.

- Operable Unit 2:

  Extent of COCs, concentrations of COCs, and exfiltration rate.

- Operable Unit 3:

  Little information is available on the nature, magnitude, and locations of COCs beneath and within the buildings; in general, the concentrations of COCs are uncertain. The vault design and exfiltration rate is also uncertain.

- Operable Unit 4:

  Uncertainty in the concentrations and distributions of subsurface COCs.

- Operable Unit 5:

  Site-wide surface soil contamination and perched water plume are not well-characterized. Characteristics of flow and transport in the vadose zone are probably more complex than modeled by ODAST. The extent of floral and faunal contamination and the geochemistry of water percolating through the remediated soils have not been well established.

In order to reduce the uncertainty associated with characterizing flow and transport in the vadose zone, Operable Unit 5 is currently conducting a multi-faceted field investigation that includes slug and pumping tests, lysimeter installation and sampling, packer tests, and yield tests. This program is described further in Parsons (1993). Operable Unit 5 is also evaluating whether the ODAST model should be replaced with a 2- or 3-dimensional model.

## K.10.6 RISK CHARACTERIZATION

Throughout this risk assessment, potential health effects caused by the simultaneous exposure to multiple on-site COCs were assumed to be additive in nature. Uncertainties associated with summing cancer risks or HIs for multiple substances are of particular concern in the risk characterization step. The assumption of dose additivity ignores possible synergisms or antagonisms among chemicals and assumes similarity in mechanisms of action and metabolism. However, data to quantitatively assess chemical interactions are generally lacking. In the absence of adequate information on chemical interactions, EPA guidelines indicate that carcinogenic risks and noncancer HIs should be treated as additive. These assumptions are made to help prevent an underestimation of cancer risk or potential noncancer health effects at a site (EPA 1986, 1989).

## K.10.7 SUMMARY

As subsequent CRAREs are completed, major sources of uncertainty will be further characterized and possible courses of action will be developed to reduce overall uncertainty.

0362

5208

{This page intentionally left blank}

# SECTION K.11.0

# RESULTS SUMMARY

# K.11.0 RESULTS SUMMARY

This Operable Unit 4 CRARE presents a risk evaluation for all FEMP COCs transported via the direct pathways of air, soil, groundwater, surface water, and radiation, as well as the indirect pathway of farm product consumption. Figure K.11-1 summarizes the risk evaluation process used for this CRARE and presents the major inputs to the risk evaluation, which include source evaluation (data collection and validation), COC identification, toxicity assessment, exposure assessment, and risk characterization. The results have been summarized by the following categories:

- Site-wide sources of contamination
- Identification of COCs
- Receptor characterization
- Pathways of exposure
- Postremediation residual risk characterization
- Operable unit contribution to risk
- Impact of uncertainty on the risk estimates

*The conclusion reached by applying this CRARE risk evaluation process is that the FEMP would appear to be unsuitable as a family farm even after remediation is complete.*

## K.11.1 SITE-WIDE SOURCES OF CONTAMINATION

The primary sources of contamination remaining after site remediation include the vaults, operable unit residual footprints, site soil, and the capped areas of Operable Units 1 and 2. The site soil is the major source for all risk estimates. Section K.11.7 discusses the uncertainties associated with these sources of residual risk.

## K.11.2 IDENTIFICATION OF COCs

Potential COCs detected on-property were identified using Appendix R of the SWCR, the Operable Unit 4 RI/FS report, and the Operable Unit 2 RI report. A multi-step screening process identified those COCs that would be present on FEMP property during the 70- and 1000-year postremediation time frames. Volatile organic chemicals were eliminated from consideration as COCs because evaporation would rapidly remove these compounds from the FEMP during the time periods under evaluation. Similarly, other organic compounds were removed from consideration after evaluating their organic decay rates in water and soil. The remaining COCs (presented in Section K.4.0) were

then used in fate and transport modeling of air, surface water, groundwater, and farm products. During the groundwater fate and transport analysis (Section K.6.0), the COCs were further screened using preliminary techniques to determine if significant quantities of COCs would reach groundwater within the 1000-year time frame. It is unlikely that any major COCs were overlooked.

The detailed risk analysis indicates that the major radionuclides of concern are U-238, U-234, Th-228, Rn-222, and Ra-226. The principal contributors to the chemical risk are Aroclors, cobalt, and arsenic. The principal contributors to the noncarcinogenic HI are cobalt, barium, mercury, and cadmium.

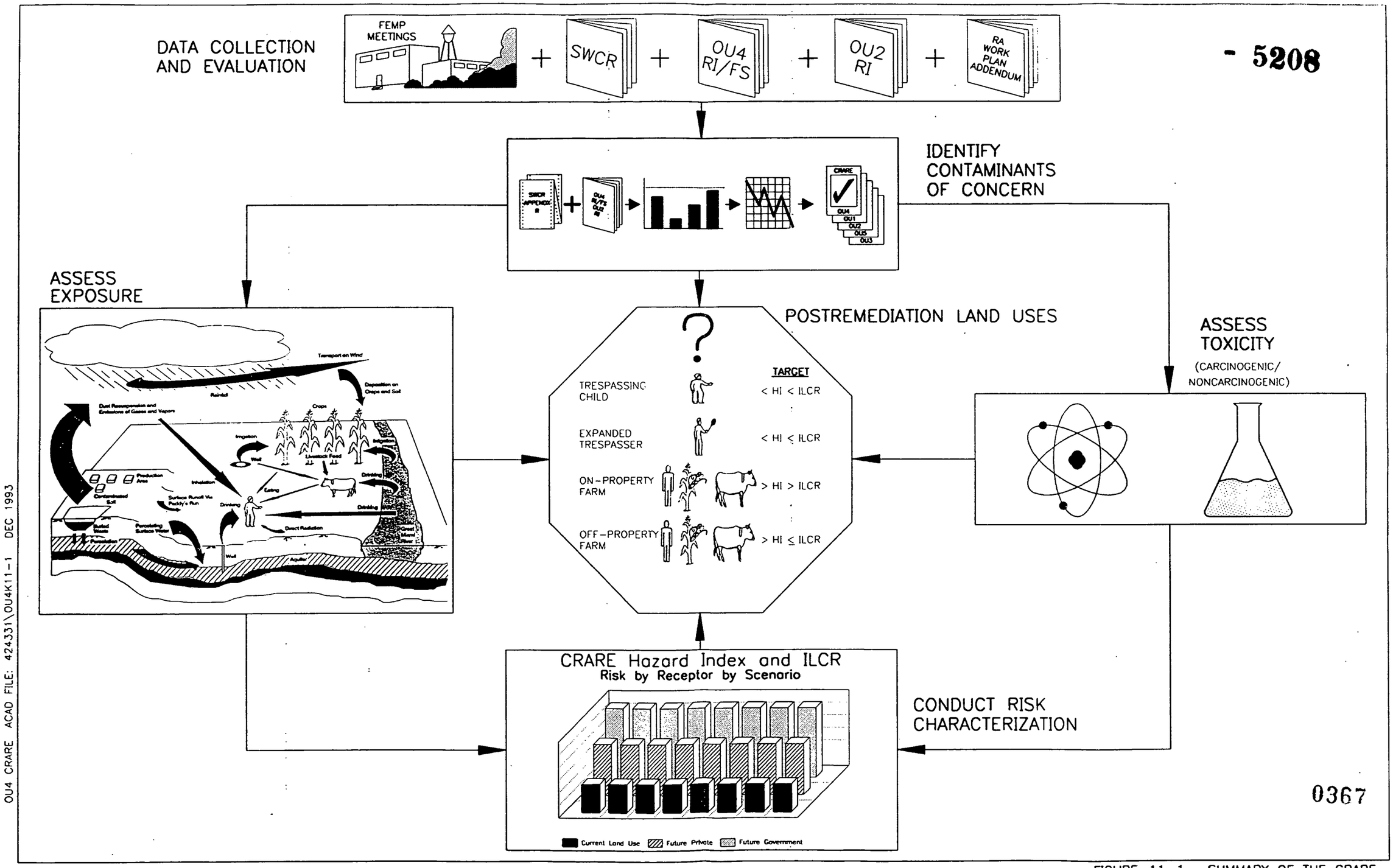
### K.11.3 RECEPTORS

Six on-property and three off-property RME receptors have been evaluated.

| On-Property | Off-Property |
|---|---|
| • Resident farm adult | • Resident farm adult |
| • Resident farm youth | • Resident farm youth |
| • Resident farm child | • Resident farm child |
| • Expanded Trespasser | |
| • Trespassing child | |
| • Groundskeeper | |

These receptors represent a wide array of potential land uses. Even though the FEMP was not evaluated for residential-only land use, it must be pointed out that the use of resident farm receptors (who consume the farm produce) is more conservative than the use of a residential-only receptor. For the evaluation of carcinogenic risk, all adult farmers were assumed to be exposed for their entire 70-year life spans. The risk estimate for the on-property resident farmer is the most-elevated and exceeded the target risk range by at least an order of magnitude. Risks for the trespassing child and expanded trespasser are within the target risk range for both carcinogenic and noncarcinogenic effects. The risks for the groundskeeper are within the target range for the noncarcinogenic effects and are slightly above the carcinogenic target level. The risks for the off-property farmer are borderline for all exposure scenarios, with the noncarcinogenic HI causing the most concern.

- 5208




OU4 CRARE ACAD FILE: 424331\OU4K11-1 DEC 1993

0367

FIGURE 11-1 SUMMARY OF THE CRARE RISK ASSESSMENT PROCESS

## K.11.4 PATHWAYS

- 5208

The pathways considered in this CRARE are:

- Inhalation of radon gas and particulates
- Incidental ingestion of soil and sediment
- Dermal contact with soil and sediment
- External radiation exposure
- Ingestion of groundwater
- Ingestion of farm products (milk, meat, and vegetables)
- Ingestion of surface water

For this CRARE, the major pathways of concern were found to be the inhalation of fugitive particulates, the consumption of drinking water, and the indirect pathway of particulate deposition on vegetables. External radiation was a significant pathway of concern for all on-property receptors. The major uncertainty relating to the inhalation pathway is the resuspension rate of fugitive particulates. The specific concern for this factor is discussed in Section K.11.7.

## K.11.5 POSTREMEDIATION RESIDUAL RISK

The estimated risks from the FEMP are summarized in Table K.11-1 and presented in graphical format in Figures K.11-2 and K.11-3. Table K.11-1 presents a 52-year adult exposure combined with the child and youth to produce a calculated lifetime cancer risk. This number represents a more-accurate 70-year lifetime exposure.

Tables K.11-2 through K.11-4 present a breakdown of the risks associated with each receptor by pathways and subsequent major contributing COCs. The adult farm resident has been selected to represent the on- and off-property residence under all three scenarios. The adult off-property resident has not been included under the Future Land Use Without Federal Ownership scenario as the risk is the same as under the Future Land Use With Federal Ownership scenario. The residential risks from the remediated FEMP are summarized below.

0368

## TABLE K.11-1

## SUMMARY OF ILCR AND HI FOR ALL RECEPTORS, ALL SCENARIOS

### Current Land Use

| RME Receptor | ILCR | HI |
|---|---|---|
| Groundskeeper | $4.7 \times 10^{-4}$ | $4.2 \times 10^{-1}$ |
| Trespassing Child | $2.0 \times 10^{-5}$ | $7.8 \times 10^{-2}$ |
| Off-Property Resident Farm | | |
| Adult[a] | $1.0 \times 10^{-4}$ | $1.1 \times 10^{0}$ |
| Youth | $1.9 \times 10^{-5}$ | $1.8 \times 10^{0}$ |
| Child | $7.5 \times 10^{-5}$ | $3.1 \times 10^{0}$ |
| Lifetime | $1.7 \times 10^{-4}$ | NA |

### Future Land Use With Federal Ownership

| RME Receptor | ILCR | HI |
|---|---|---|
| Expanded Trespasser | $2.7 \times 10^{-5}$ | $1.2 \times 10^{-1}$ |
| Off-Property Resident Farm | | |
| Adult[a] | $9.0 \times 10^{-5}$ | $1.1 \times 10^{0}$ |
| Youth | $1.6 \times 10^{-5}$ | $1.8 \times 10^{0}$ |
| Child | $6.6 \times 10^{-6}$ | $3.1 \times 10^{0}$ |
| Lifetime | $8.9 \times 10^{-5}$ | NA |

### Future Land Use Without Federal Ownership

| RME Receptor | ILCR | HI |
|---|---|---|
| On-Property Resident Farm | | |
| Adult[a] | $1.1 \times 10^{-2}$ | $6.4 \times 10^{1}$ |
| Youth | $2.3 \times 10^{-3}$ | $1.0 \times 10^{2}$ |
| Child | $3.6 \times 10^{-3}$ | $2.4 \times 10^{2}$ |
| Lifetime | $1.4 \times 10^{-2}$ | NA |
| Off-Property Resident Farm | | |
| Adult[a] | $9.0 \times 10^{-5}$ | $1.1 \times 10^{0}$ |
| Youth | $1.6 \times 10^{-5}$ | $1.8 \times 10^{0}$ |
| Child | $6.6 \times 10^{-6}$ | $3.1 \times 10^{0}$ |
| Lifetime | $8.9 \times 10^{-5}$ | NA |

[a] The resident farm adult ILCR values are based on a 70-year exposure period. To obtain the total lifetime risk, the adult values were multiplied by 52/70 before adding to the youth and child risks.

NA = Not applicable or not available

0369

5208

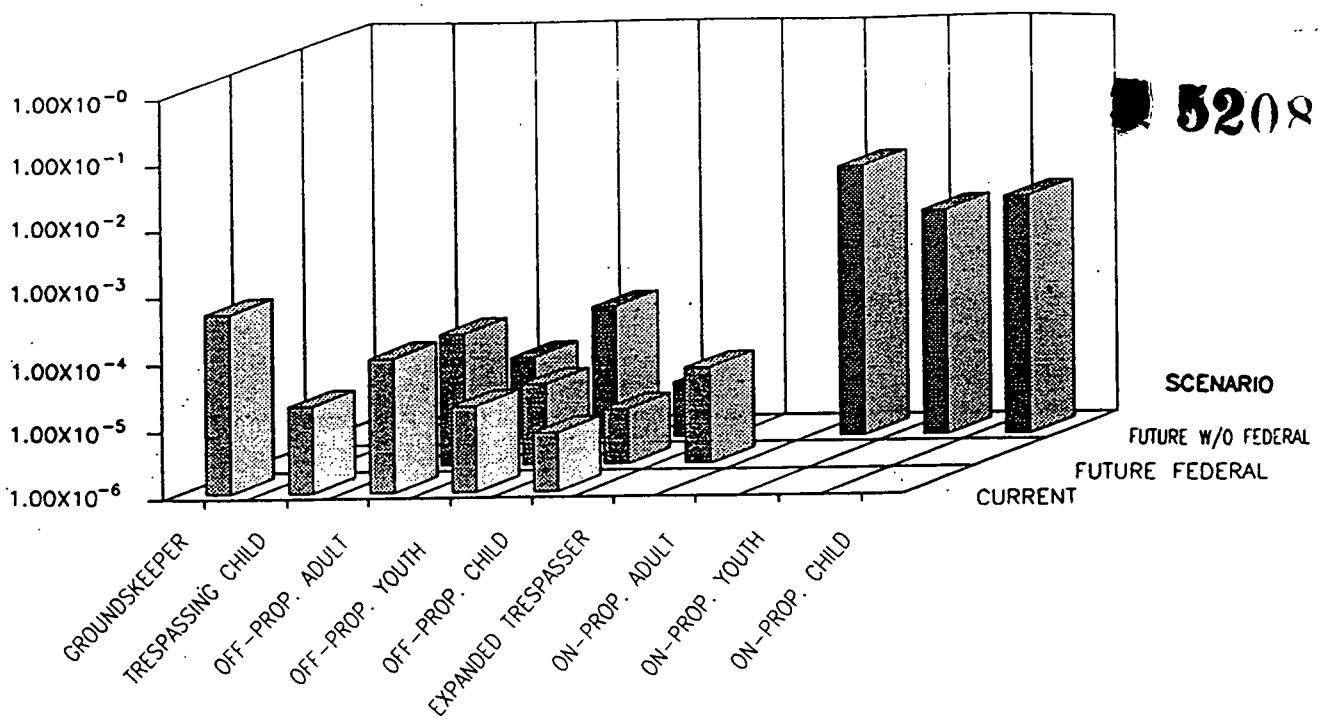
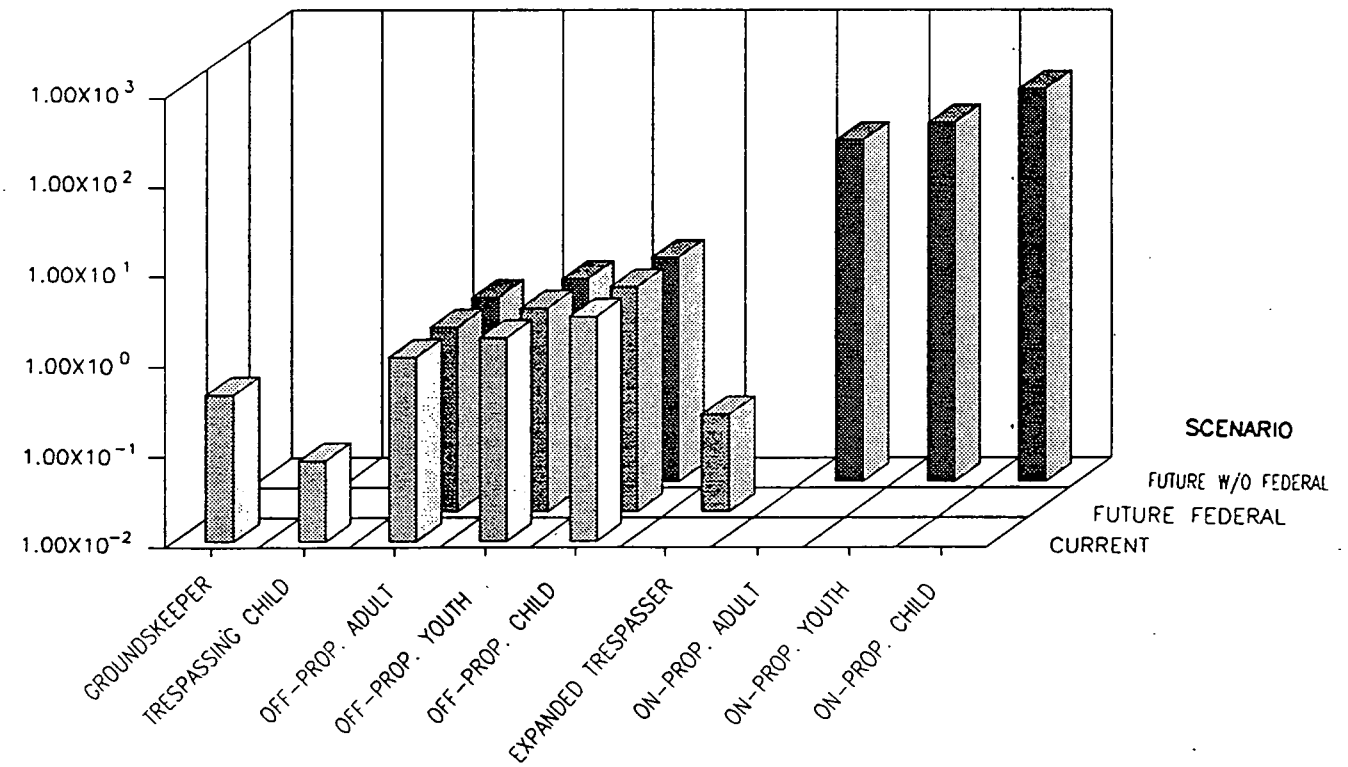



FIGURE K.11-2
SUMMARY OF FEMP RESIDUAL ILCR




0370

FIGURE K.11-3
SUMMARY OF FEMP HAZARD INDEX

# TABLE K.11-2
# PATHWAY RISKS: CURRENT LAND USE SCENARIO

| | Groundskeeper | | | | Trespassing Child | | | | Off-Property Farm Adult | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pathway** | **HI** | | **ILCR** | | **HI** | | **ILCR** | | **HI** | | **ILCR** | |
| **Inhalation** | Co | $1.9 \times 10^{-1}$ | As | $3.1 \times 10^{-7}$ | Co | $3.3 \times 10^{-2}$ | As | $2.5 \times 10^{-8}$ | Co | $8.5 \times 10^{-1}$ | As | $3.8 \times 10^{-6}$ |
| | Ba | $2.7 \times 10^{-2}$ | Cr | $2.0 \times 10^{-7}$ | Ba | $4.6 \times 10^{-3}$ | Cr | $1.6 \times 10^{-8}$ | Ba | $1.7 \times 10^{-1}$ | Cr | $2.8 \times 10^{-6}$ |
| | | | U-238 | $2.2 \times 10^{-7}$ | | | U-238 | $8.6 \times 10^{-8}$ | | | U-238 | $2.5 \times 10^{-5}$ |
| | | | U-234 | $1.8 \times 10^{-7}$ | | | U-234 | $7.2 \times 10^{-8}$ | | | U-234 | $2.1 \times 10^{-5}$ |
| | | | Rn-222 | $1.6 \times 10^{-7}$ | | | Rn-222 | $6.3 \times 10^{-8}$ | | | Rn-222 | $1.5 \times 10^{-5}$ |
| | Total | $2.4 \times 10^{-1}$ | Total | $1.3 \times 10^{-6}$ | Total | $4.1 \times 10^{-2}$ | Total | $3.3 \times 10^{-7}$ | Total | $1.1 \times 10^{0}$ | Total | $8.6 \times 10^{-5}$ |
| **Ingestion (Soil)** | Sb | $3.9 \times 10^{-2}$ | Aroclor-1254 | $1.3 \times 10^{-6}$ | Sb | $6.7 \times 10^{-3}$ | Aroclor-1260 | $1.1 \times 10^{-7}$ | NA | | NA | |
| | As | $2.7 \times 10^{-2}$ | Aroclor-1260 | $1.4 \times 10^{-6}$ | As | $4.6 \times 10^{-3}$ | Aroclor-1254 | $1.1 \times 10^{-7}$ | | | | |
| | | | As | $5.0 \times 10^{-6}$ | | | As | $4.1 \times 10^{-7}$ | | | | |
| | | | Sr-90 | $2.7 \times 10^{-7}$ | | | Sr-90 | $1.3 \times 10^{-8}$ | | | | |
| | | | Pb-210 | $5.2 \times 10^{-6}$ | | | Pb-210 | $2.6 \times 10^{-7}$ | | | | |
| | Total | $9.7 \times 10^{-2}$ | Total | $1.5 \times 10^{-5}$ | Total | $1.6 \times 10^{-2}$ | Total | $1.0 \times 10^{-6}$ | | | | |
| **Dermal (Soil)** | As | $3.1 \times 10^{-3}$ | Aroclor-1260 | $9.6 \times 10^{-6}$ | Sb | $1.1 \times 10^{-2}$ | Aroclor-1260 | $1.1 \times 10^{-6}$ | NA | | NA | |
| | Ba | $1.1 \times 10^{-2}$ | Aroclor-1254 | $9.5 \times 10^{-6}$ | Ba | $2.7 \times 10^{-3}$ | Aroclor-1254 | $1.1 \times 10^{-6}$ | | | | |
| | Sb | $4.6 \times 10^{-2}$ | | | | | | | | | | |
| | | | | | Total | $2.1 \times 10^{-2}$ | | | | | | |
| | Total | $8.4 \times 10^{-2}$ | Total | $2.1 \times 10^{-5}$ | | | Total | $2.4 \times 10^{-6}$ | | | | |
| **Drinking Water** | NA | | NA | | NA | | NA | | NA | | U-238 | $5.0 \times 10^{-6}$ |
| | | | | | | | | | | | U-234 | $4.8 \times 10^{-6}$ |
| | | | | | | | | | | | Total | $9.9 \times 10^{-6}$ |
| **Ingestion (Meat)** | NA | | NA | | NA | | NA | | Tl | $4.2 \times 10^{-5}$ | Arocl-1254 | $6.3 \times 10^{-8}$ |
| | | | | | | | | | Hq | $4.7 \times 10^{-5}$ | Arocl-1260 | $2.5 \times 10^{-8}$ |
| | | | | | | | | | | | U-238 | $1.6 \times 10^{-8}$ |
| | | | | | | | | | | | U-234 | $1.5 \times 10^{-8}$ |
| | | | | | | | | | Total | $1.8 \times 10^{-4}$ | Total | $1.3 \times 10^{-7}$ |
| **Ingestion Dairy** | NA | | NA | | NA | | NA | | DOP[b] | $2.1 \times 10^{-5}$ | Arocl-1260 | $2.0 \times 10^{-7}$ |
| | | | | | | | | | Cd | $1.2 \times 10^{-5}$ | Arocl-1254 | $5.4 \times 10^{-8}$ |
| | | | | | | | | | | | U-238 | $2.0 \times 10^{-7}$ |
| | | | | | | | | | | | U-234 | $1.9 \times 10^{-7}$ |
| | | | | | | | | | Total | $6.3 \times 10^{-5}$ | Total | $6.5 \times 10^{-7}$ |
| **Ingestion (Vegetables and Fruit)** | NA | | NA | | NA | | NA | | Sb | $6.9 \times 10^{-4}$ | As | $2.0 \times 10^{-7}$ |
| | | | | | | | | | As | $3.9 \times 10^{-4}$ | Arocl-1254 | $3.4 \times 10^{-8}$ |
| | | | | | | | | | | | Arocl-1260 | $3.1 \times 10^{-8}$ |
| | | | | | | | | | | | U-238 | $2.8 \times 10^{-6}$ |
| | | | | | | | | | | | U-234 | $2.7 \times 10^{-6}$ |
| | | | | | | | | | Total | $1.4 \times 10^{-3}$ | Total | $6.0 \times 10^{-6}$ |
| **Direct Radiation** | NA | | Ra-226 | $1.7 \times 10^{-4}$ | NA | | Ra-226 | $8.6 \times 10^{-6}$ | NA | | NA | |
| | | | Th-228 | $1.6 \times 10^{-4}$ | | | Th-228 | $4.3 \times 10^{-6}$ | | | | |
| | | | Ra-228 | $8.1 \times 10^{-5}$ | | | Ra-228 | $2.3 \times 10^{-6}$ | | | | |
| | | | Total | $4.4 \times 10^{-4}$ | | | Total | $1.6 \times 10^{-5}$ | | | | |
| **Ingestion (Wading)** | NA | | NA | | NA | | U-238 | $4.1 \times 10^{-13}$ | NA | | NA | |
| | | | | | | | U-234 | $3.9 \times 10^{-13}$ | | | | |
| | | | | | Total | | Total | $8.2 \times 10^{-13}$ | | | | |
| | Total | $4.2 \times 10^{-1}$ | Total | $4.7 \times 10^{-4}$ | Total | $7.8 \times 10^{-2}$ | Total | $2.0 \times 10^{-5}$ | Total | $1.1 \times 10^{0}$ | Total | $1.0 \times 10^{-4}$ |

# TABLE K.11-3
## PATHWAY RISKS:
## FUTURE LAND USE WITH FEDERAL OWNERSHIP

| | Expanded Trespasser | | | | Off-Property Farm Adult | | | |
|---|---|---|---|---|---|---|---|---|
| **Pathway** | **HI** | | **ILCR** | | **HI** | | **ILCR** | |
| **Inhalation** | Co | $4.2 \times 10^{-2}$ | As | $3.7 \times 10^{-8}$ | Co | $8.5 \times 10^{-1}$ | As | $3.8 \times 10^{-6}$ |
| | Ba | $5.8 \times 10^{-3}$ | Cr | $2.4 \times 10^{-8}$ | Ba | $1.7 \times 10^{-1}$ | Cr | $2.8 \times 10^{-6}$ |
| | | | U-238 | $7.2 \times 10^{-9}$ | | | U-238 | $2.8 \times 10^{-6}$ |
| | | | U-234 | $6.0 \times 10^{-9}$ | | | U-234 | $2.5 \times 10^{-5}$ |
| | | | Rn-222 | $5.7 \times 10^{-9}$ | | | Rn-234 | $2.1 \times 10^{-5}$ |
| | | | | | | | Rn-222 | $1.6 \times 10^{-5}$ |
| | Total | $5.3 \times 10^{-2}$ | Total | $9.9 \times 10^{-8}$ | Total | $1.1 \times 10^{0}$ | Total | $8.7 \times 10^{-5}$ |
| **Ingestion (Soil)** | Sb | $4.4 \times 10^{-3}$ | Aroclor-1260 | $1.1 \times 10^{-7}$ | NA | | NA | |
| | As | $3.0 \times 10^{-3}$ | As | $4.0 \times 10^{-7}$ | | | | |
| | Ba | $1.1 \times 10^{-3}$ | Pb-210 | $3.4 \times 10^{-7}$ | | | | |
| | | | Sr-90 | $1.7 \times 10^{-8}$ | | | | |
| | Total | $1.1 \times 10^{-2}$ | Total | $1.1 \times 10^{-6}$ | | | | |
| **Dermal (Soil)** | Sb | $3.3 \times 10^{-2}$ | Aroclor-1260 | $4.5 \times 10^{-6}$ | NA | | NA | |
| | As | $2.3 \times 10^{-3}$ | Aroclor-1254 | $4.3 \times 10^{-6}$ | | | | |
| | Total | $6.1 \times 10^{-2}$ | Total | $9.9 \times 10^{-6}$ | | | | |
| **Drinking Water** | NA | | NA | | NA | | U-238 | $1.3 \times 10^{-6}$ |
| | | | | | | | U-234 | $1.2 \times 10^{-6}$ |
| | | | | | Total | | Total | $2.5 \times 10^{-6}$ |
| **Ingestion (Meat)** | NA | | NA | | Tl | $4.3 \times 10^{-5}$ | Arocl-1254 | $6.3 \times 10^{-8}$ |
| | | | | | Hq | $4.8 \times 10^{-5}$ | Arocl-1260 | $2.5 \times 10^{-8}$ |
| | | | | | | | Pa-231 | $1.6 \times 10^{-9}$ |
| | | | | | | | Cs-137 | $1.7 \times 10^{-10}$ |
| | | | | | Total | $1.8 \times 10^{-4}$ | Total | $1.0 \times 10^{-7}$ |
| **Ingestion (Dairy)** | NA | | NA | | DOP[b] | $2.3 \times 10^{-5}$ | Arocl-1260 | $2.0 \times 10^{-7}$ |
| | | | | | Cd | $1.2 \times 10^{-5}$ | Arocl-1254 | $5.4 \times 10^{-8}$ |
| | | | | | | | U-238 | $1.1 \times 10^{-9}$ |
| | | | | | | | U-234 | $1.1 \times 10^{-9}$ |
| | | | | | Total | $6.6 \times 10^{-5}$ | Total | $2.6 \times 10^{-7}$ |
| **Ingestion (Vegetables and Fruit)** | NA | | NA | | Sb | $6.9 \times 10^{-4}$ | As | $2.1 \times 10^{-7}$ |
| | | | | | As | $3.9 \times 10^{-4}$ | Arocl-1254 | $3.4 \times 10^{-8}$ |
| | | | | | | | Arocl-1260 | $3.1 \times 10^{-8}$ |
| | | | | | | | Pb-210 | $1.2 \times 10^{-7}$ |
| | | | | | | | U-238 | $1.7 \times 10^{-8}$ |
| | | | | | | | U-234 | $1.6 \times 10^{-8}$ |
| | | | | | Total | $1.4 \times 10^{-3}$ | Total | $4.8 \times 10^{-7}$ |
| **Direct Radiation** | NA | | Th-228 | $7.2 \times 10^{-6}$ | NA | | NA | |
| | | | Ra-226 | $5.2 \times 10^{-6}$ | | | | |
| | | | Ra-228 | $2.7 \times 10^{-6}$ | | | | |
| | Total | | Total | $1.6 \times 10^{-5}$ | | | | |
| **Ingestion (Wading)** | | | Sr-90 | $4.0 \times 10^{-9}$ | NA | | NA | |
| | | | U-238 | $6.2 \times 10^{-10}$ | | | | |
| | | | U-234 | $5.9 \times 10^{-10}$ | | | | |
| | Total | | Total | $5.2 \times 10^{-9}$ | | | | |
| | Total | $1.2 \times 10^{-1}$ | Total | $2.7 \times 10^{-5}$ | Total | $1.1 \times 10^{0}$ | Total | $9.0 \times 10^{-5}$ |

0372

5208

# TABLE K.11-4
## PATHWAY RISKS: FUTURE WITHOUT FEDERAL OWNERSHIP[a]

| | On-Property Farm Adult | | | |
|---|---|---|---|---|
| **Pathway** | **HI** | | **ILCR** | |
| **Inhalation** | Ba | $3.7 \times 10^{-1}$ | As | $6.9 \times 10^{-6}$ |
| | Co | $1.4 \times 10^{0}$ | Cr | $5.2 \times 10^{-6}$ |
| | | | Rn-222 | $3.6 \times 10^{-5}$ |
| | | | U-238 | $5.5 \times 10^{-5}$ |
| | Total | $1.9 \times 10^{0}$ | Total | $1.9 \times 10^{-4}$ |
| **Ingestion (Soil)** | Sb | $1.9 \times 10^{-1}$ | As | $1.1 \times 10^{-4}$ |
| | As | $2.1 \times 10^{-1}$ | Arocl-1260 | $5.3 \times 10^{-5}$ |
| | Ba | $1.3 \times 10^{-1}$ | Pa-231 | $1.0 \times 10^{-5}$ |
| | | | Pb-210 | $2.0 \times 10^{-4}$ |
| | Total | $6.5 \times 10^{-1}$ | Total | $4.9 \times 10^{-4}$ |
| **Dermal (Soil)** | Sb | $6.2 \times 10^{-2}$ | Arocl-1254 | $9.0 \times 10^{-5}$ |
| | As | $6.8 \times 10^{-3}$ | Arocl-1260 | $1.0 \times 10^{-4}$ |
| | Ba | $4.1 \times 10^{-2}$ | | |
| | Total | $1.6 \times 10^{-1}$ | Total | $2.1 \times 10^{-4}$ |
| **Drinking Water** | NA | | U-238 | $5.3 \times 10^{-7}$ |
| | | | U-234 | $5.5 \times 10^{-7}$ |
| | | | Total | $1.1 \times 10^{-6}$ |
| **Ingestion (Meat)** | Cd | $2.0 \times 10^{0}$ | Arocl-1254 | $5.4 \times 10^{-4}$ |
| | Hg | $1.8 \times 10^{1}$ | Arocl-1260 | $1.8 \times 10^{-4}$ |
| | Zn | $4.2 \times 10^{0}$ | U-234 | $1.2 \times 10^{-9}$ |
| | | | U-238 | $1.3 \times 10^{-9}$ |
| | Total | $2.6 \times 10^{1}$ | Total | $8.7 \times 10^{-4}$ |
| **Ingestion (Dairy)** | Cd | $1.5 \times 10^{0}$ | Arocl-1254 | $4.7 \times 10^{-4}$ |
| | Zn | $1.7 \times 10^{0}$ | Arocl-1260 | $1.4 \times 10^{-3}$ |
| | | | U-234 | $1.5 \times 10^{-8}$ |
| | | | U-238 | $1.6 \times 10^{-8}$ |
| | Total | $4.3 \times 10^{0}$ | Total | $1.9 \times 10^{-3}$ |
| **Ingestion (Vegetables and Fruit)** | Ba | $4.9 \times 10^{0}$ | Arocl-1260 | $1.4 \times 10^{-4}$ |
| | Cd | $1.2 \times 10^{1}$ | As | $1.9 \times 10^{-3}$ |
| | | | Pb-210 | $1.2 \times 10^{-7}$ |
| | | | U-234 | $2.2 \times 10^{-7}$ |
| | | | U-238 | $2.3 \times 10^{-7}$ |
| | Total | $3.1 \times 10^{1}$ | Total | $2.3 \times 10^{-3}$ |
| **Direct Radiation** | NA | | Ra-226 | $1.8 \times 10^{-3}$ |
| | | | Th-228 | $1.6 \times 10^{-3}$ |
| | Total | | Total | $4.6 \times 10^{-3}$ |
| **Ingestion (Wading)** | NA | | NA | |
| | Total | $6.4 \times 10^{1}$ | Total | $1.1 \times 10^{-2}$ |

[a]Not shown: The off-property farm adult, which is identical under the Future Land Use With Federal Ownership scenario (see Table K.11-3).
[b]DOP = Di-n-octyl phthalate
NA = Not Applicable

0373

Current Land Use Scenario

Table K.11-2 summarizes the pathway-specific risks for the Current Land Use receptors. The off-property farm receptors have a life-time cancer risk at the $10^{-4}$ risk level, primarily due to the inhalation of particulate and, to a lesser extent, the consumption of groundwater from the south plume. Carcinogenic risks for the trespassing child are within the $10^{-6}$ to $10^{-4}$ range. The major pathway is direct radiation exposure from Th-228, Ra-226, and Ra-228. The groundskeeper is above the target risk range by roughly a factor of 5, primarily due to direct radiation exposure from Ra-226 and Th-228.

The noncarcinogenic HIs are below 1.0 for the groundskeeper and the trespassing child, and are above 1.0 for the off-property resident farm receptors. This is primarily due to the inhalation of particulate containing metals such as cobalt and barium.

Future Land Use With Federal Ownership Scenario

The risks for receptors under the Future Land Use With Federal Ownership scenario are summarized by pathway in Table K.11-3. The risk results for the off-property receptors are similar to those found in the Current Land Use scenario. Carcinogenic risks are within the range of $10^{-6}$ to $10^{-4}$ with the major pathways being inhalation of particulate containing uranium and the ingestion of drinking water.

Noncarcinogenic HIs exceed the 1.0 target level for the farm receptors due to inhalation of cobalt and barium in particulate matter.

The carcinogenic risk and noncarcinogenic HI for the expanded trespasser are within the target ranges. The major contributors through the direct radiation exposure pathway are Th-228, Ra-226, and Ra-228.

Future Land Use Without Federal Ownership Scenario

Table K.11-4 summarizes the risks under the Future Land Use Without Federal Ownership scenario. Carcinogenic risks exceed the target level of $10^{-6}$ to $10^{-4}$ for the on-property resident farm receptors (adult, youth, and child) due to ingestion of farm food products (Aroclor 1260 and arsenic), incidental ingestion of soil (arsenic and Pb-210), dermal contact with soils (Aroclor 1260), and external radiation from Ra-226 and Th-228). The inhalation of particulate containing uranium isotopes also give risks above the $10^{-4}$ level for all on-property receptors.

The on-property farm receptors (adult, youth, and child) all exceed the HI of 1.0, primarily due to intake through ingestion of meat, vegetables, and dairy products grown on the FEMP. The principal COCs are mercury, cadmium, barium, arsenic, and zinc.

The off-property resident farm receptors (adult, youth, and child) have the same risk as for the Future Land Use With Federal Ownership scenario for both the HI and the ILCR.

The elevated HIs for the on-property farm receptors are due to inhalation, and should be considered conservative. This can be attributed to the use of conservative toxicity factors for cobalt and barium as well as the conservative nature of the dust resuspension model. In fact, these HIs may be overestimated by a factor of 100. The presence of the Aroclors is due to the very conservative biotransfer factors in the foodchain modeling. See Section K.11.7 for more information.

## K.11.6 OPERABLE UNIT CONTRIBUTIONS TO RISK

Table K.11-5 presents the contributions to total risk by the various operable units, and by the transport pathways of air, ground/surface water, and soil. The partitioning was performed by calculating the relative portions of FEMP remediated materials remaining on site.

### Operable Unit 4 Contributions to FEMP Residual Risk

Operable Unit 4 contributes very little to the carcinogenic and noncarcinogenic risks. The majority of the COCs from Operable Unit 4 will be removed off-site or isolated in the vaults, away from human contact and the environment. Less than 4 percent of radionuclide emissions are from Operable Unit 4 under the Current Land Use scenario.

### Operable Units 1 and 2 Contributions to FEMP Residual Risk

The nature of the RCRA-type caps for residual waste in these two operable units precludes these sources from contributing significant risk to human health or the environment. These operable units are estimated to contribute less than 0.01 percent of total site risk to any one receptor under any scenario evaluated.

### Operable Unit 3 and 5 Contributions to FEMP Residual Risk

Operable Unit 5 contamination is associated with almost all of the residual risk after FEMP remediation. Under the Current Land Use scenario, approximately 99 percent of radionuclide

# TABLE K.11-5

## OPERABLE UNIT CONTRIBUTIONS TO RISK

### Contributions to Radiological Risk: Air/Radiation Exposure

| | Contribution (%) | | | | |
|---|---|---|---|---|---|
| **RME Receptor** | **OU1** | **OU2** | **OU3** | **OU4** | **OU5** |
| Expanded Trespasser | <0.01 | <0.01 | <0.01 | 1.92 | 98.08 |
| Off-Site Resident | <0.01 | <0.01 | <0.01 | 0.73 | 99.27 |
| On-Site Resident | <0.01 | <0.01 | <0.01 | 0.54 | 99.46 |

### Contributions to Radiological and Chemical Risk: COC Mass Loading in Ground/Surface Water

| | Contribution (%) | | | | |
|---|---|---|---|---|---|
| **RME Receptor** | **OU1** | **OU2** | **OU3** | **OU4** | **OU5** |
| COC Mass/Total Mass (mg/l) | <0.01 | <0.01 | <0.01 | 3.60 | 96.40 |

### Contributions to Carcinogenic Risk: Ingestion of and Dermal Contact with Soil

| | Contribution (%) | | | | |
|---|---|---|---|---|---|
| **RME Receptor** | **OU1** | **OU2** | **OU3** | **OU4** | **OU5** |
| Expanded Trespasser | <0.01 | <0.01 | <0.01 | 1.93 | 98.07 |
| On-Site Resident | <0.01 | <0.01 | <0.01 | 1.93 | 98.07 |

emissions are from Operable Unit 5 (the former production area soils and the remaining FEMP surface soil). The soil beneath the former production area accounts for approximately 60 percent of the off-property resident risk. It also accounts for 35 percent of the on-property groundskeeper and trespasser risk associated with direct inhalation of radionuclides.

Under the two Future Land Use scenarios, atmospheric emissions from Operable Unit 5 result in the largest contributions to inhalation pathway cancer risks. Over 99 percent of the total radionuclide emissions are from Operable Unit 5 areas, indicating that this operable unit is the major contributor to the inhalation pathway risks. The soil beneath the former production area accounts for approximately 75 percent of the on-property resident cancer risk, 60 percent of the off-property resident risk, and 35 percent of the expanded trespasser's cancer risk associated with direct inhalation of radionuclides. Surface soil from the remainder of the FEMP accounts for the remaining risks.

Current groundwater modeling predicts that the highest cancer risk in this pathway will be associated with COCs leaching from the site-wide soil, which will be addressed by Operable Unit 5. An important consideration is that the accuracy of the groundwater modeling depends on the representativeness of the geochemical and vadose zone transport modeling. These processes are affected by many parameters, some of which vary by orders of magnitude across the site. Additional field investigations of vadose zone parameters are planned in the summer of 1993 for Operable Unit 5. The use of a numerical, multi-dimensional vadose zone model, rather than the analytical ODAST model, is also being evaluated. These developments should reduce the uncertainty associated with the geochemical and vadose zone simulations, and may cause major changes in the groundwater modeling results.

## K.11.7 SUMMARY OF UNCERTAINTIES

The preparation of this CRARE for Operable Unit 4 employed conservative assumptions and the best scientific and engineering judgement, consistent with the EPA guidance expressed in RAGS (EPA 1989l). The risk principals and equation found in the RAWPA were used throughout this analysis. The exposure parameters found in the Operable Unit 4 RI were used in this CRARE. Deviations are summarized in Section K.2.5. Results of the CRARE have identified points of departure from target risk ranges, as discussed in the NCP.

Inhalation of particulate and radon is a principal component of the carcinogenic and noncarcinogenic

risks that exceed the target ranges. Another significant contributor is the deposition of dusts on crops and the subsequent uptake of COCs into the foodchain by plants. The two major elements of uncertainty in these pathways include the dust emission rate and food consumption parameters. The development of emission factors for air modeling and the use of the modeling results for the subsequent inhalation intake are likely overestimated. This potential overestimate is inherent in the RAWPA emission rate model, which was developed for short-term emissions. After using these models, it appears that some tend to misrepresent the actual scenario. For example, the assumptions used in the Rapid Assessment Model for particulate emission generation may be inappropriate and may not reflect the true nature of the long term scenarios evaluated in the CRARE.

The critical assumptions in this model are the percent of vegetative cover, the resuspension rate at different wind speeds, and the surface characteristics of exposed soils. In this CRARE, a percent vegetative cover of 85 percent was assumed, which is a realistic value. The model is not designed to accurately produce different emission rates with different wind speeds and classes because the algorithm is designed for annual averages. The algorithm's effect on the varying emissions is unknown. A potential source of over- conservatism is the assumption that the uncovered surfaces were relatively smooth and consisted of loose, fine, silty particles.

One hundred percent of the food consumed by the on- and off-property farmers was assumed to come from their farms. This assumption is both conservative and unlikely. The nature of the uncertainties associated with the RAWPA and other assumptions for the CRARE are summarized below and in Table K.11-6. Essentially, the uncertainties can be characterized by the following:

<u>COC Selection</u>. There are no major uncertainties in the selection of COCs for any of the pathways' receptors.

<u>Toxicological Information and Models</u>. The inhalation pathway risks are likely to be overestimated due to the conservatism of the inhalation RfDs and cancer slope factors. It is unlikely that any major exposure pathways have not been evaluated.

<u>Exposure Pathways</u>. It is unlikely that any major exposure pathways have not been evaluated.

Receptor Characterization. Due to the range of receptors selected, it is unlikely that a significant receptor has been left out. It must be noted that the use of a resident farm receptor is more conservative than the use of a residential receptor.

Exposure Point Concentrations. Preliminary calculations have indicated that the fugitive particulate emissions model may be overestimating emissions. The applicability of the model needs to be further investigated and will be addressed in the Operable Unit 1 CRARE. The surface characteristics of the remediated FEMP need to be more fully characterized. The major uncertainty relating to groundwater modeling is due to source term uncertainty and the quantity of material leaching out of the disposal areas over time. This is also an uncertainty relating to rate of leaching (i.e., partitioning factors) from surface soil materials.

## K.11.8 RECOMMENDATIONS

Because the majority of the FEMP residual risk is associated with Operable Unit 5, future CRAREs should focus on refining and completing information on this unit. For example, more accurate modeling of COC concentrations less than the PRGs for the Operable Unit 5 soils would decrease risk. Additional recommended measures to reduce uncertainty in the CRARE are presented in Table K.11-6.

Further research should be conducted on groundwater modeling parameters (e.g., $K_d$) that are FEMP or operable-unit-specific. With better $K_d$ values, groundwater modeling would become more accurate and probably less conservative. Bench-scale testing of how remediated soil conditions will change may be warranted. Investigations should be conducted into the physical characteristics of the remediated soils and into developing an appropriate fugitive particulate emission model for long-term risk analysis.

## TABLE K.11-6

## SUMMARY OF UNCERTAINTIES, ACTIONS FOR REDUCTION

| Uncertainty Problem | Specification of Problem | Direction and Extent of Uncertainty | Effects on the Reported Risks | Actions for Reduction of Uncertainty |
|---|---|---|---|---|
| **COC Selection** | | | | |
| 1. Species of Contaminants | Not all COCs have been identified. | Low order of uncertainty. Probably localized in small areas:<br>• Incinerator ash (TCDD, PCDD TCDF, PCDF) activities<br>• OU 3/4 trench | Probably underestimates risks by a factor less than 10. | Specific review of existing histories to determine if investigation of these three areas is warranted. |
| 2. Quality of COC Information | Not all quantities are known and validated in various media. | Moderate order of uncertainty involving material volumes. Specific areas to address would include pipe/trench between OU4 and OU3 and OU3 soils. | Varied. Can overestimate or underestimate risk by more than 1 order of magnitude. | Focus calculations on known waste volumes and predict by facility capacities. |
| **Toxicological Information and Models** | Extrapolation of data missing RfDs or slope factors. | Underestimates COCs not quantified. | Varied. Can range from less than a factor of 10 to 1 order of magnitude. | Contact EPA ECAO to derive constants. |
| | Conservative derivation of slope factors and RfDs. | Overestimates risks for all COCs. | May overestimate risk by 2 to 3 orders of magnitude. | These are EPA derived values. |
| | Linear dose-response modeling. | Overestimates risks for some contaminants. | May overestimate risks by several orders of magnitude. | Carefully evaluate toxicity data and risk results. |
| **Exposure Pathways** | Improbable pathways to receptors; lack of institutional controls after 70 years. | Depending on the land use, the receptors may represent an overestimate. | Moderate. Possibly 1 order of magnitude. | Establish end land use and guiding receptor for FEMP with EPA. |
| **Receptor Characterization** | | | | |
| 1. Expanded Trespasser | Exposure of 120 days per year may be excessive. | Mild overestimate for drinking water exposures by using a maximum concentration and swimming in Paddys Run, etc. | Overestimates by less than a factor of 3. | Propose to eliminate unlikely pathways. |
| 2. Resident Farm Receptors | Assumption that 100% of food is derived from the farm. | Overestimate. | Possibly a factor of 3. | Consider a reduction of consumption. |



0380

FINAL
February 1994

## TABLE K.11-6
## (Continued)

| Uncertainty Problem | Specification of Problem | Direction and Extent of Uncertainty | Effects on the Reported Risks | Actions for Reduction of Uncertainty |
|---|---|---|---|---|
| | Estimation of exposure parameters. | In general, the exposure parameters are mild overestimates. | Mild. Less than 1 order of magnitude. | Better characterization of living habits of receptors. |
| **Exposure Point Concentration** | | | | |
| 1. Air Concentrations | Surface soil concentrations. | Unknown due to lack of data. | Unknown. | Collect more data concerning surface soils and remediated soils. |
| | Dust emission rate relating to vegetative cover and particle size. | Vegetative cover assumptions may cause underestimate, particularly relating to farming activities. May be offset if particle size distribution shows low potential for particulate generation. | Mild. Less than 1 order of magnitude. | Gather site-specific soil particle size distribution data. |
| | Temporal correlation between particulate generation and dispersion not accounted for. | Overestimate of air particulate expansion. | Probably moderate. 1 order of magnitude or less. | Perform refined air modeling for particulates using short-term generation rates. |
| 2. Groundwater Concentration | Migration rate. | Overestimate due to selecting small $K_d$ values. This affects both concentrations and time of peak. | Moderate. 1 to 2 orders of magnitude. | Perform studies of site-specific $K_d$ relating to specific media. |
| | Leachate concentrations. | Overestimate due to conservative assumptions, also availability of contaminants. | Moderate. 1 to 2 orders of magnitude. | Perform studies of leaching of contaminants from remediated and unremediated materials. |
| | Source term. | Direction is unknown due to the overall uncertainty in the extent of contamination. Could be an underestimate. | Moderate. Could vary both plus and minus 1 order of magnitude. | Improve characterization. |
| 3. Farm Product Concentrations | Toxicity of COC on Farm Product. | Could be an overestimate. | Unknown. | Specific review of data on COC toxicity on farm products. |



0381

- 5208

**TABLE K.11-6**
**(Continued)**

| | On-Property Farm Adult | | | |
|---|---|---|---|---|
| **Pathway** | **HI** | | **ILCR** | |
| **Inhalation** | Ba | $5.2 \times 10^{-1}$ | As | $6.9 \times 10^{-6}$ |
| | Co | $1.4 \times 10^{0}$ | Cr | $5.2 \times 10^{-6}$ |
| | | | Rn-222 | $3.6 \times 10^{-5}$ |
| | | | U-238 | $5.5 \times 10^{-5}$ |
| | Total | $2.3 \times 10^{0}$ | Total | $1.9 \times 10^{-4}$ |
| • • • | • • • | | • • • | |
| | Total | $7.1 \times 10^{1}$ | Total | $8.4 \times 10^{-3}$ |





5208

0382

# SECTION K.12.0

# REFERENCES

## K.12.0 REFERENCES

Aaseth, J., T. Norseth, 1986, "Copper," Handbook on the Toxicology of Metals, L. Friberg, G.F. Nordberg, and V.B. Vouk, eds., 2nd ed., Volume 2: Specific Metals, Elsevier Science Publishers B.V., New York, NY, pp. 233-254.

Abbatt, J.D., 1973, "Human Leukemic Risk Data Derived from Portuguese Thorotrast Experience," Radionuclide Carcinogenesis, CONF-72055, C.D. Sander, R.H. Busch, J.E. Ballou, and J.E. Mahlum, eds., U.S. Atomic Energy Commission, Washington, DC., pp. 451-464.

ACI Committee 318, 1983, Building Code Requirements for Reinforced Concrete (ACI 318-89), American Concrete Institute, Detroit.

Advanced Sciences, Inc./International Technology Corporation (ASI/IT), 1988a, "RCRA Groundwater Monitoring Report, Vol. 6 - Round 6 Sampling."

Advanced Sciences, Inc./International Technology Corporation (ASI/IT), 1988b, "Remedial Investigation and Feasibility Study, FMPC, Fernald, OH, Work Plan," Vols. I through V, ASI/IT, Ross, OH.

Advanced Sciences, Inc./International Technology Corporation (ASI/IT), 1989, "Geochemical Program Issues 3 and 5 Report," prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Advanced Sciences, Inc./International Technology Corporation (ASI/IT), 1990a, "Groundwater Report, Draft, prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Advanced Sciences, Inc./International Technology Corporation (ASI/IT), 1990b, "Task Plan for the K-65 Silos Resampling at FMPC," Fernald, OH, prepared for U.S. DOE, Oak Ridge, TN.

Advanced Sciences, Inc./International Technology Corporation (ASI/IT), 1990c, "Remedial Investigation and Feasibility Study, FMPC, Fernald, OH, Work Plan Addendum OU4."

Advanced Sciences, Inc./International Technology Corporation (ASI/IT), 1990d, "Biological Sampling, Analysis, and Resources Report."

Advanced Sciences, Inc./International Technology Corporation (ASI/IT), 1990e, "Engineering Evaluation/Cost Analysis, Waste Pit Area, Storm Water Runoff Control," FMPC, Fernald, OH, prepared for U.S. DOE, Oak Ridge Operations, Oak Ridge, TN.

Advanced Sciences, Inc./International Technology Corporation (ASI/IT), 1991, "Remedial Investigation and Feasibility Study for Operable Unit 2, Task 12 Report", U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Advanced Sciences Incorporated (ASI), 1987, "Independent Safety Review Draft, Final Safety analysis Report for K-65 Storage Silos radon Mitigation and Dome Reinforcement," prepared for Westinghouse Materials Co. of Ohio, Cincinnati, OH.

Advanced Sciences Incorporated (ASI), 1989, "Conceptual Study for Waste Tumulus".

Agency for Toxic Substances and Disease Registry (ATSDR), 1987, "Toxicological Profile for Benzo[a]Pyrene," U.S. Public Health Service, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR), 1988, "Toxicological Profile for Nickel," U.S. Public Health Services, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR), 1989, "Toxicological Profile for Copper," Draft for Public Comment, U.S. Public Health Services, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR), 1989a, "Toxicological Profile for Selected PCBs (Aroclor-1260, -1254, -1248, -1242, -1232, -1221, and -1016)," U.S. Public Health Service, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR), 1989b, "Toxicological Profile for 2,3,7,8-Tetrachlorodibenzo-p-dioxin," U.S. Public Health Service, Atlanta, GA.

Agency for Toxic Substances and Disease Registry (ATSDR), 1991, "Toxicological Profile for Selected PCBs (Aroclor-1260, -1260, -1254, -1248, -1242, -1232, -1221, and -1016)," U.S. Public Health Service, Atlanta, GA.

Albro, P.W. and L. Fishbein, 1972, "Intestinal Absorption of Polychlorinated Biphenyls in Rats," Bulletin of Environmental Contamination and Toxicology, Volume 8, pp. 26-31. (Cited in ATSDR, 1991).

Algermissen, S.T., 1969, "Seismic Risk Studies in the United States," in Proceeding of the Fourth World Conference on Earthquake Engineering, Chilean Association for Seismology and Earthquake Engineering, Santiago, Chile, pp. 1-10.

Allen, J.R., D.H. Norbach and I.C. Hsu, 1974, "Tissue Modifications in Monkeys as Related to Absorption, Distribution, and Excretion of Polychlorinated Biphenyls," Archives of Environmental Contamination and Toxicology, Volume 2, pp. 86-95.

Amano, M., K. Yagi, H. Nakajima, R. Takehara, H. Sakai and G. Umeda, 1984, "Statistical Observations About the Causes of Death of Patients with Oil Poisoning," Japan, Hygiene, Volume 49, pp. 1-5. (Cited in U.S. EPA, 1988).

American Society for Testing and Materials (ASTM), 1973, "Biological Methods for the Assessment of Water Quality", J. Cairns Jr. and K.L. Dickson, eds., ASTM Sp. Tech. Pub. 528.

American Society for Testing and Materials (ASTM), 1991, Annual Book of ASTM Standards. Section 14, General Methods and Instrumentation, Vol. 14.02. Designation: E178-80 (Reapproved 1989), "Standard Practice for Dealing with Outlying Observations", pp. 157-173

American Conference of Governmental Industrial Hygienists (ACGIH), 1986, "Documentation of the Threshold Limit Values and Biological Exposure Indices," 5th ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, American Concrete Institute.

American Conference of Governmental Industrial Hygienists (ACGIH), 1991, "Documentation of the Threshold Limit Values and Biological Exposure Indices," 5th ed., ACGIH, Cincinnati, OH.

Andelman, J.B., 1990, & "Total Exposure to Volatile Organic Chemicals in Potable Water", N.M. Ram, R.F. Christmam, K.P. Cantor, eds., Lewis Publishers, Chelsea, MI.

Anderson, D.M., 1982, "Plant Communities of Ohio," Unpublished Manuscript, Ohio Department of Natural Resources, Division of Natural Areas and Preserves, Columbus, OH.

Archer, V.E., J.K. Wagoner, and F.E. Lundin, 1973, "Cancer Mortality Among Uranium Mill Workers," Journal of Occupational Medicine, Vol. 15, pp. 11-14.

ATEC Associates, Inc., 1982, "Topographic Survey and Geotechnical Investigation, FMPC Water Pollution Control," n.p.

Auer Jr., A.H., 1978, "Correlation of Land Use and Cover with Meteorological Anomalies," Journal of Applied Meteorology, 17:636-643.

Baes, C.F., 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.

Bailey, R., 1978, Ecoregions of the United States, U.S. Forest Service, Ogden, UT.

Ball, D., U.S. Army Corps of Engineers, Oct. 1991, Personal Communication.

Ballou, J.E., R.A. Gies, G.E. Dagle, M.D. Tolley, and A.C. Case, 1980, "Deposition and Late Effects of Inhaled $^{232}UO_2(NO_3)$ in Rats," PNL Annual Report 1980 (Biomedical Sciences) PNL-3700 P & L, Richland, WA. p. 142ff.

Barari A., L.S. Hedges, 1986, "Movement of Water in Glacial Till," International Association of Hydrogeologist, Memours, Vol. XVII, Part 1, Preceding, Hydrology of Rocks of Low Permeability, Tucson, AZ.

Battelle Laboratories, Inc., "Environmental Report of the Feed Materials Production Center," Final Report to NLO, Battelle Laboratories, Columbus, OH.

Battelle Laboratories, Inc., National Lead Co. of Ohio, and the U.S. Department of Energy, 1977, "Environmental Impact Assessment - Feed Materials Production Center, Fernald, Ohio," U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Batu, V., 1989, "A Generalized Two-Dimensional Analytical Solution for Hydrodynamic Dispersion in Bounded Media with the First-Type Boundary Condition at the Source," Water Resources Research, Vol. 25, No. 6 pp. 1125-1132.

Bauer, B.H., B.A. Branson and S.T. Colwell, 1978, "Fishes of Paddys Run Creek and the Dry Fork of the Whitewater River, Southwestern Ohio," Ohio J. Science Vol. 78, No. 3, pp. 144-148.

Beavers, J.E., W.E. Manrod and W.C. Stoddart, 1982, "Recommended Seismic Hazard Levels for the Oak Ridge, Tennessee; Paducah, Kentucky; Fernald, Ohio; and Portsmouth, Ohio; Department of Energy Reservations," Revision 1, K/BD-1025/RI, Oak Ridge National Laboratory, Oak Ridge, TN.

Bechtel National, Inc., 1990a, "K-65 Residue Removal Action at the FMPC, Fernald, Ohio," prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Bechtel National, Inc., 1990b, "Study and Evaluation of K-65 Silos for the FMPC at Fernald, Ohio," Job No. 14501, prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Bensted, J.P.M., 1967, "Experimental Studies in Mice on the Late Effects of Radioactive and Nonradioactive Contrast Media," American New York Academy of Sciences, Vol. 145, pp. 728-733.

Benthe, H.F., J. Knop and A. Schmoldt, 1972, "Absorption and Distribution of Polychlorinated Biphenyls (PCBs) After Inhalatory Application," Archives of Toxicology, Volume 29, pp. 85-95. (Cited in ATSDR 1991).

Berlin, M. and B. Rudell, 1979, "Uranium," Handbook on Toxicology of Metals, edited by L. Friberg et al., North-Holland Biomedical Press.

Berry, E.E., V.M. Malhotra, "Fly Ash for Use in Concrete - A Critical Review," ACI Journal, Title 77-8.

Bertazzi, P.A., L. Riboldi, A. Pesatori, it al., 1987, "Cancer Mortality of Capacitor Manufacturing Workers," American Journal of Industrial Medicine, Volume 11, pp. 165-176. (Cited in U.S. EPA 1988, 1992a; ATSDR, 1991).

Bleavins, M.R., W.J. Breslin, R.J. Aulerich et al., 1984, "Placental and Mammary Transfer of a Polychlorinated Biphenyl Mixture (Aroclor 1254) in the European Ferret (Mustela putorius furo)," Environmental Toxicology and Chemistry, Volume 3, pp. 637-644. (Cited in ATSDR, 1991).

Bomback, M.W., D.A. Fleming, T.A. Dugan, R.W. Keys, R.B. Grant, 1986, "History of FMPC Radionuclide Discharges," FMPC-2058, National Lead Co. of Ohio, Cincinnati, OH, prepared for the U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Bomback, M.W., D.A. Fleming, T.A. Dugan, R.W. Keys, R.B. Grant, 1987, "History of FMPC Radionuclide Discharges," FMPC-2082, prepared by Westinghouse Materials Co. of Ohio.

Bowers, J.F., et al, 1979, "Industrial Source Complex (ISC) Dispersion Model User's Guide," Vols. I & II, U.S. EPA, EPA 450/4-79-030, Washington, D.C.

Bowers, T.S., K.L. Von Damm, and J.M. Edmond, 1985, "Chemical Evolution of Mid-Ocean Ridge Hot Springs," Geochemica et Cosmochimica Acta, Volume 49, pp. 2239-2252.

Braun, E.L., 1950, Deciduous Forests of Eastern North America, The Free Press, New York, NY.

Brockman, S.C., 1988, "Glacial Geologic Mapping in Hamilton County, Ohio: Report of Progress on the Final Phase," Ohio Department of Natural Resources, Division of Geological Survey, 15pp.

Brown, D.P., 1987, "Mortality of Workers Exposed to Polychlorinated Biphenyls: An Update," Arch. Environ. Health, Volume 42, pp. 333-339. (Cited in U.S. EPA, 1992a; ATSDR, 1991).

Brown, J.F. and R.W. Lawton, 1984, "Polychlorinated Biphenyls(PCB) Partitioning Between Adipose Tissue and Serum," Bulletin of Environmental Contamination and Toxicology, Volume 33, pp. 277-280. (Cited in ATSDR, 1991).

Buhler, F.P. Schmid and C.H. Schlatter, 1988, "Kinetics of PCB Elimination in Man", Chemosphere, Volume 17, pp. 1717-1726. (Cited in ATSDR, 1991).

Bureau of Census, 1989, "1987 Census of Agriculture."

Burkart, W., P. Kopp, 1988, "Protactinium," Handbook on Toxicity of Inorganic Compounds, H.G. Seiler, H. Sigel, A. Sigel, eds., Marcel Dekker, Inc., New York, NY, pp. 551-553.

Camargo Associates, Ltd., 1866, "K-65 Silos Study and Evaluation for the Feed Materials Production Center," Sections I through IX.

Camp Dresser & McKee, Woolpert Consultants and Ernst & Winney, 1989, "Long-Range Projections for Cincinnati and Hamilton County," Hamilton County Metropolitan Sewer District and City of Cincinnati Department of Public Works, Cincinnati, OH.

Catalytic Construction Company, Inc., no date, "K-65 Operations Manual".

Cember, H., 1983, Introduction to Health Physics, Pergamon Press, New York, NY.

Chemical Society, 1977, "Foreign Compound Metabolism in Mammals - A Review of Literature Published During 1974 and 1975," Volume 4 London: The Chemical Society.

Chen, P.H., M.L. Luo, C.K. Wong and C.J. Chen, 1982, "Comparative Rates of Elimination of Some Individual Polychlorinated Bipuenyls from the Blood of PCB Poisoned Patients in Taiwan," Food Chemistry and Toxicology, Volume 20, pp. 417-425. (Cited in ATSDR, 1989).

Cincinnati Nature Center, 1978, "Birds of the Cincinnati Area (20 mile radius of downtown Cincinnati)," Cincinnati Nature Center, Milford, OH.

Clapp, R.B. and G.M. Hornberger, 1978, "Empirical Equations for Some Soil Hydraulic Properties," Water Resources Research, Vol. 14, pp. 601-604.

Clark, T.R., L. Elikan, C.A. Hill, B.L. Speicher, 1989, "History of FMPC Radionuclide Discharges-Revised Estimates of Uranium and Thorium Air Emissions from 1951-1987," Addendum to FMPC-2082, Westinghouse Materials Co., of Ohio, Cincinnati, OH, prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Clarke, M.J., L. Podbielski, 1988, "Technetium," Handbook on Toxicity of Inorganic Compounds, H.G. Sieler, H. Sigel, A. Sigel, eds., Marcel Dekker, Inc., New York, NY, pp. 665-667.

Clay, D.R. and R.J. Guimond, 1990, "Remediation Goals for Radionuclides at the Maxey Flat

Superfund Site," Memorandum from D.R. Clay, Assistant Administrator, U.S. EPA Office of Solid Waste and Emergency Response and R.J. Guimond, Director, U.S. EPA Office of Radiation Programs to G.C. Tidwell, Regional Administrator U.S. EPA, Region IV.

Clayton G.D. - Clayton F.E., 1981, "Patty's Industrial Hygiene and Toxicology"; 3rd ed., Volumes I-III, New York: John Wiley & Sons.

Cleary, R.W., D.W. Miller and G.F. Pinder, 1991, "Groundwater Pollution and Hydrology," Groundwater Associates of Princeton, coordinated by Omni Environmental Corporation, Princeton, NJ, pp. 5-48.

Clement International, 1990, "Development of Relative Potency Estimates for PAHs and Hydrocarbon Combusions Product Fractions Compared to Benzo[a]pyrene and Their Use in Carcinogenic Risk Assessments," prepared for the U.S. EPA, Washington, D.C.

Clifton, J.R., L.I. Knab, 1989, "Service Life of Concrete," U.S. Department of Commerce Report NISTIR 89-4086.

Committee on Biological Effects of Ionizing Radiation, National Research Council, 1990, "Health Effects of Exposure to Low-Levels of Ionization Radiation," BIERV, National Academy Press, Washington, D.C.

Cookfair, D.L., W.L. Beck, C. Shy, C.C. Lushbaugh, and C.L. Sowder, 1983, "Lung Cancer Among Workers at Uranium Processing Plant," Proceedings of the Health Physics Society, presented at Epidemiology Applied to Health Physics, pp. 398-406.

Couture, L.A., M.R. Elwell and L.S. Birnbaum, 1988, "Dioxin-like Effects Observed in Male Rats Following Exposure to Octachlorodibenzo-p-dioxin (OCDD) During a 13-Week Study," Toxicology and Applied Pharmacology, Volume 93, pp. 31-46.

Cowan, C.W., 1978, First Farmers of the Middle Ohio Valley, Cincinnati Museum of Natural History, Cincinnati, OH.

Cowgill, U., K. Keating and T. Takahashi, 1985, "Fecundity and Longevity of Ceriodaphnia dubia/affinis: Relation to Diet at Two Different Temperatures," J. of Crustacean Biology, Vol. 5, pp. 420-429.

Cravens, S.J., L.C. Ruedisili, 1987, "Water Movement in Till of East-Central South Dakota," Groundwater, Vol. 25, No. 5, Dublin, OH.

Cross, W.P., R.E. Hedges, 1959, "Flow Duration of Ohio Streams," Bulletin 31, Ohio Department of Natural Resources, Div. of Water, Columbus, OH.

Culot, M.V.J., H.G. Olson and K.J. Schiager, 1976, "Effective Diffusion Coefficient of Radon in Concrete, Theory and Method for Field Measurements," Health Physics, Vol. 30, pp. 263-270.

da Motta, L.C., J. da Silva Horta, and M.H. Tavares, 1979, "Prospective Epidemiological Study of Thorotrast-Exposed Patients in Portugal," Environmental Research, Vol. 18, p. 152-172.

Dames and Moore, 1985a, "Department of Energy Feed Materials Production Center, Groundwater Study - Task C Report," Dames and Moore, White Plains, NY, prepared for National Lead of Ohio, Inc., Cincinnati, OH.

Dames and Moore, 1985b, "Groundwater Study-Task A Report," prepared for National Lead Company of Ohio, Cincinnati, OH.

Dames and Moore, 1986a, "Addendum Report," prepared for Westinghouse Materials Company of Ohio, Cincinnati, OH.

Dames and Moore, 1986b, "RCRA Groundwater Monitoring Report," Volumes 1 through 5, prepared for Westinghouse Materials Company of Ohio, Cincinnati, OH.

Denny J.S., 1987, "Guidelines for the Culture of Fathead Minnows Pimephales promelas for Use in Toxicity Tests," U.S. EPA, Evironmental Research Laboratory, Duluth, MN.

dePercin, et al., 1991, "Design Treatability Studies for CERCLA Sites: Three Critical Issues," Journal of the Air and Waste Management Assn., Volume 41, No. 45.

Detorree, J.F., B.S. Ausmus, E.P. Stambaugh, A.A. Lawrence and K.R. Yates, 1981, "Preliminary Assessment of Alternatives for Processing and Disposal of the Afrimet Residues," BMI-2083, UC-11, prepared for the U.S. DOE, Remedial Action Program, by Battelle Columbus Laboratories, Columbus, OH.

Dove, G.D., S.E. Norris, 1951, "Conditions Governing the Occurrence of Groundwater in the Fernald Area, Ohio, with Reference to the Possibilities of Contamination by Disposal of Chemical Wastes," U.S. Geological Survey, Groundwater Branch, Columbus, OH.

Dove, G.D., 1961, "A Hydrolic Study of the Valley-Fill Deposits in the Venice Area, Ohio," Technical Report No. 4, Ohio Department of Natural Resources, Div. of Water., Columbus, OH.

Driscoll, F.G., 1986 Groundwater and Wells, 2nd ed., Johnson Division, St. Paul, MN.

Durbin, P.W., and M.E. Wrenn, 1975, "Metabolism and Effects of Uranium in Animals," M.E. Wrenn, ed., Conference on Occupational Health Experience with Uranium, ERDA-93, U.S. Energy Research and Development Administration, Washington, DC., pp. 67-129.

Durrell, R.H., 1961, "The Pleistocene Geology of the Cincinnati Area," Field Trip 3 in Geological Soc. of America Guidebook for Field Trips, Cincinnati Meeting, Geological Soc. of America, New York, NY, pp. 47-57.

Eisler, R., 1985, "Cadmium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review," Contaminant Hazard Review Report No. 2, U.S. Fish and Wildlife Service, Patuxent, MD.

Elinder, C.G., L. Friberg, 1986a, "Antimony," Handbook on the Toxicology of Metals, L. Friberg, G.F. Nordberg, V.B. Vouk, eds., 2nd ed., Volume 2: Specific Metals, Elsevier Science Publishers B.V., New York, NY, pp. 26-42.

Elinder, C.G., L. Friberg, 1986b, "Cobalt," Handbook on the toxicology of Metals, L. Friberg, G.F. Nordberg, V.B. Vouk, eds., 2nd ed., Volume 2: Specific Metals, Elsevier Science Publishers B.V., New York, NY, pp. 211-232.

Elinder, C.G., 1986, "Zinc," Handbook on the toxicology of Metals, L. Friberg, G.F. Nordberg, V.B. Vouk, eds., 2nd ed., Volume 2: Specific Metals, Elsevier Science Publishers B.V., New York, NY, pp. 664-679.

Ely, T.S., 1959, "Medical Findings Summary," Symposiums on Occupational Health Experience and Practices in the Uranium Industry, HASL-58, Office of Technical Services, Department of Commerce, Washington, DC.

Emissions from 1951-1987, "Addendum to FMPC-2082," Westinghouse Materials Co. of Ohio, Cincinnati, OH, prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Engle, R.L. et al, 1966, "ISOSHLD, A Computer Code For General Purpose Isotope Shielding Analysis," BNWL-2316, Richland, WA.

Evans, R.D., 1966, "The Effect of Skeletally Deposited Alpha-Ray Emitters in Man," British Journal of Radiology, Vol. 39, pp. 881-895.

Evans, R.D., A.T. Keane, R.J. Kolenkow, W.R. Neal, and M.M. Shanahan, 1969, "Radiogenic Tumors and the Radium and Mesothorium Cases Studied at M.I.T.," Delayed Effects of Bond-Seeking Radionuclides, C.W. Mays, W.S.S. Jee, R.D. Lloyd, B.J. Stover, J.H. Dougherty, and G.N. Taylor, eds. University of Utah Press, Salt Lake City, UT, pp. 157-194.

Exon, J.H., Koller, J.D., 1983, "Water Chlorination: Environmental Impact Health Effects" (Book 2), pp. 1177-88.

Faber, M., 1973, "Proceedings of the Third International Meeting on the Toxicity of Thorotrast," Riso Report, Danish Atomic Energy Commission, M. Faber, ed., Copenhagen, Denmark, pp. 137-147.

Faber, M., 1977, "Epidemiology of Thorotrast Malignancies in Man," Review paper prepared for the Work Health Organization Scientific Group on the Long-Term Effects of Radium and Thorium in Man, World Health Organization Working Paper 12, World Health Organization, Geneva, Switzerland.

Faber, M., 1978, "Malignancies in Danish Thorotrast Patients," Health Physics, Vol. 35, pp. 154-158.

Faber, M., 1979, "Twenty-Eight Years of Continuous Follow-up of Patients Injected with Thorotrast for Cerebral Angiography," Environmental Research, Vol. 18, pp. 37-43.

Faber, M., 1983, "Current (1981) Status of the Danish Thorotrast Study," Health Physics, Vol. 44, Suppl. 1, pp. 259-260.

Faber, M., 1986, "Observations on the Danish Thorotrast Patients," Strahlentherapie, Vol. 80, pp. 140-142.

Facchetti, S., A. Formari and M. Montagna, 1980, "Distribution of 2,3,7,8-Tetrachlorodibenzo-p-dioxin in the Tissues of a Person Exposed to the Toxic Cloud at Seveso (Italy)," Advances in Mass Spectrometry, Volume 8B, pp. 1405-1414. (Cited in U.S. EPA, 1985).

Facemire, C.F., S.I. Guttman, D.R. Osborne and R.H. Sperger, 1990, "Biological and Ecological Site Characterization of the Feed Materials Production Center," FMPC-SUB 018, prepared for Westinghouse Materials Co. of Ohio, Cincinnati, OH.

Falk, H., N.C. Telles, K.G. Ishak, L.B. Thomas, and H. Popper, 1979, "Epidemiology of Thorotrast-Induced Hepatic Angiosarcoma in the United States," Environmental Research, Vol. 18. pp. 65-73.

Federal Emergency Management Agency (FEMA), 1981, "Flood Insurance Rate Map, County of Butler, Ohio (Unincorporated Areas)," Panels 115 and 135 of 155, National Flood Insurance Program, FEMA, n.p.

Federal Emergency Management Agency (FEMA), 1982, "Flood Insurance Rate Map, County of Hamilton, Ohio (Unincorporated Areas)," Panels 5, 10, 30, and 35 of 105, National Flood Insurance Program, FEMA, n.p.

Federal Highway Administration (FHA), Federal Highway Statistics Report, 1988, Office of Highway Information Management, Washington, D.C.

Federal Interagency Committee for Wetland Delineation (FICWD), 1989, "Federal Manual for Identifying and Delineating Jurisdictional Wetlands," U.S. Army Corps of Engineers, U.S. EPA, U.S. Fish and Wildlife Service, and U.S. Soil Conservation Service, Washington, D.C.

Federal Register, 1988, "Buried Valley Aquifer System, Ohio (Southern Portion) Sole Source Aquifer Petition: Final Determination," Federal Register Vol. 53, No. 131, pages 25670 to 25673, Washington, D.C.

Federal Register, 1990, "Remedial Investigation - Base Risk Assessment," Federal Register Vol. 55, No. 46, pages 8709-8719.

Feed Materials Production Center (FMPC), 1988, "A Closer Look at Uranium Metal Production: A Technical Overview," Fernald, OH.

Fennemna, N.M., 1916, "The Geology of Cincinnati and Vicinity," Geological Survey of Ohio, Bulletin 19, Ohio Div. of Geological Survey, Columbus, OH.

Finkel, A.J., C.E. Miller, and R.J. Hasterlik, 1969, "Radium-Induced Malignant Tumors in Man," Delayed Effects of Bone-Seeking Radionuclides, J. Mays, R.D. Lloyd, B.J. Stover, J.H. Dougherty, and G.N. Taylor, eds., University of Utah Press, Salt Lake City, UT, pp. 195-225.

Fleming, D.A., K.N. Ross, 1984, "FMPC Environmental Monitoring Annual Report for 1983," NLCO-2018, National Lead Co. of Ohio, Cincinnati, OH, prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Ford, J.P., 1974, "Bedrock Geology of the Cincinnati West Quadrangle and Part of the Covington Quadrangle, Hamilton County, Ohio," Report of Investigations No. 93, Ohio Department of Natural Resources, Div. of Geological Survey, Columbus, OH.

Frazier, J.R. 1989, "Sampling and Radiological Analyses of Sediment from Paddys Run and the Storm Sewer Outfall Ditch," Memorandum from J.R. Frazier to R. Galbraith (dated September 7, 1989).

Freeze, R.A. and J.A. Cherry, 1979, Groundwater, Prentice-Hall, NY.

Friberg, L., J. Lener, 1986, "Molybdenum," Handbook on the Toxicology of Metals, L. Friberg, G.F. Nordberg, V.B. Vouk, eds., 2nd ed., Volume 2: Specific Metals, Elsevier Science Publishers B.V., New York, NY, pp. 446-461.

Friedlander, Gerhard et al., 1981, Nuclear and Radiochemistry, Third Edition, New York, NY.

Fries, G.F. and G.S. Morrow, 1975, "Retention and Excretion of 2,3,7,8-Tetrachlorodibenzo-p-dioxin by Rats," Journal of Agricultural and Food Chemistry, Volume 23, pp. 265-269. (Cited in U.S. EPA, 1985).

Gaffey, W.R., 1983, "The Epidemiology of PCBs," Ini D'Itri, F.M. and M.A. Kamrin, eds. PCBs: Human and Environmental Hazards, Butterworth Publishers, Boston, MA, pp. 279-298.

Gamble, H.B. and R.H. Downing, 1982, "Effects of the Accident at Three Mile Island on Residential Property Values and Sales," Pennsylvania State University, University Park, PA.

Gas Research Institute (GRI), 1988, "Management of Manufactured Gas Plant Sites," Volume III, prepared by Atlantic Environmental Services, Inc. for the Gas Research Institute.

Geotrans, Inc., 1985, "Preliminary Characterization of the Groundwater Flow System Near the Feed Materials Production Center, Great Miami River Valley-Fill Aquifer, Fernald, Ohio," Geotrans, Columbus, OH.

Geotrans, Inc., 1987, "Data Input Guide for SWIFT #II, The Sandia Waste Isolation Flow and Transport Model for Fractured Media, Release 2.16, Modifications to NUREG/CR-3162," Geotrans, Herndon, VA.

Gerritse, R.G., R. Vriesema, J.W. Dalenberg, H.P. DeRoos, 1982, "Effect of Sewage Sludge on Trace-Element Mobility in Soils," J. Environmental Quality, 11:359-364.

Gilbert, R.O., 1987, "Statistical Methods for Environmental Pollution Monitoring", Van Nostrand Reinhold, New York, NY.

Gill, V.R., 1988, "Analytical Results of the K-65 Probe Samples," [Letter from V.R. Gill to B.L. Speicher, WMCO:AN:88-162, (dated August 29, 1988)].

Gillham, R.W., H.D. Shama, M.R. Reddy, E.L. Cooper and J.A. Cherry, 1981, "Barium and Radium Migration in Unconsolidated Canadian Geological Materials," AECB Report, INFO-0048.

Gilman A.G., Goodman, L.S., Gilman, A., 1985, "Goodman and Gilman's: The Pharmacological Basis of Therapeutics," 7th ed., Macmillan Publishing Co., Inc. New York

Gleason, H.A. and A. Cronquist, 1963, Manual of Vascular Plants of the Eastern United States and Adjacent Canada, D. Van Nostrand Co., New York, NY.

Glover, P.A., F.J. Miner and W.O. Polzer, 1976, "Plutonium and Americium Behavior in Soil/Water Environment," BNWL-2117, Proc. of the Act.-Sed. React. Working Meeting.

Golden Software, Inc., 1990, "Surfer," Version 4, Golden, CO.

Gore, J.A., 1985, Restoration of Rivers and Streams, Butterworth Publishing, Boston, MA.

Goulden, C.E. and L. Henry, 1984, Daphnia Bioassay Workshop, Academy of Natural Resources, Philadelphia, PA.

Goyer, R.A., 1991, " Toxic Effects on Metals," Casarett and Doull's Toxicology, The Basic Science of Poisons, M.O. Amdur, J. Doull, C.D. Klaassen, Eds, 4th ed., Pergamon Press, New York, NY, pp. 623-680.

Grant, W.M., 1986, "Toxicology of the Eye," 3rd ed., Charles C. Thomas Publisher, Springfield, IL.

Greater Cincinnati Chamber of Commerce, 1990, Metropolitan Area Promotional Data Sheets, Greater Cincinnati Chamber of Commerce, Cincinnati, OH.

Greene, J.C., C.L. Bartels, W.J. Warren-Hicks, B.R. Parkhurst, G.L. Linder, S.A. Peterson, and W.E. Miller, 1988, "Protocols for Short-Term Toxicity Screening of Hazardous Waste Sites," EPA/600/3-88/029, U.S. EPA, Environmental Research Laboratory, Ecotoxicology Branch, Duluth, MN.

Grove Engineering, Inc., 1988, "Microshield Version 3," Grove Engineering Inc., Rockville, MD.

Grove Engineering, Inc., 1991, "Radioactive Nuclide Library and Decay Software," Version 4.

Grumski, J.T., 1987, "Conceptual Design Report: K-65 Storage Silo Radon Mitigating and Dome Reinforcement Study, Revision 1," (dated May 13, 1987).

Grumski, J.T., 1987, "Feasibility Investigation for Control of Radon Emission from Tank K-65 Silos, Revision 1," dated July 30, 1987, Westinghouse Materials Co. of Ohio, Cincinnati, OH.

Gustavsson, P., C. Hogstedt and C. Rappe, 1986, "Short-term Mortality and Cancer Incidence in Capacitor Manufacturing Workers Exposed to Polychlorinated Biphenyls (PCBs): Mammalian and Environmental Toxin Series," Volume A, Polychlorinated Biphenyls (PCBs): Mammalian and Environmental Toxicology, New York, Springer-Verlag, pp. 77-95.

Guttman, S.I., 1990, "Characterization of the Tree Frog Null Allele," FMPC-SUB 032, prepared for Westinghouse Materials Company of Ohio, Cincinnati, OH.

Guttman, S.I., 1991, "Characterization of the Tree Frog Null Allele," draft report, prepared for Westinghouse Materials Company of Ohio, Cincinnati, OH.

Haith, D.A., 1980, "A Mathematical Model for Estimating Pesticide Losses in Runoff" J. of Environmental Quality, Vol. 9, No. 3, pp. 428-433.

Hall, C.W., 1988, "Practical Limits to Pump and Treat Technology for Aquifer Remediation," Groundwater Quality Protection Preconference Workshop Proceeding, Water Pollution Control Federation: Dallas, pp. 7-12.

Hansch, D. and A. Leo, 1979, Substituent Constants for Correlation Analysis in Chemistry and Biology, John Wiley and Sons, New York, NY.

Haque, K.E., 1988, "Radium (226) Removal from a Contaminated Soil," for presentation at Workshop on Extractive Treatment of Excavated Soil, U.S. EPA, Edison, NJ.

Harrington, C.D., A.E. Ruehle, 1959, "Uranium Production Technology," D. Van Nostrand Company, Inc., Princeton, NJ.

Harrison, W.H., D.C. Teychenne, 1981, "Sulphate Resistance of Buried Concrete: Second Interim Report on Long-Term Investigation at Torthwick Pack," Building Research Establishment.

Harting, F.H., and W. Hesse, 1879, "Der Lungenkrebs, die Bergkrankheit in de Schneeberger Gruben," Vierteljahrsschr. f. Gerichtl. Med. u. Offentl. Gensundheitswesen, Vol. 30, pp. 296-309, Vol. 31, pp. 102-132, 313-337.

Hayes, W.J., Jr., 1982, "Pesticides Studied In Man," Baltimore, MD, Williams and Watkins.

Healy, J.W., 1980, "Review of Resuspension Models, Transuranic Elements in the Environment," DOE/TIC-22800, U.S. DOE, Office of Health and Environmental Research, Washington, D.C.

Heath, Ralph C., 1983, "Basic Groundwater Hydrology," U.S. Geological Survey, Water Supply Paper 2220, Reston, VA, 84 pp.

Henderson, G.E. and E. Jones, 1982, Planning For An Individual Water System, 4th ed., J.H. Turner, ed., American Assoc. of Vocational Instructional Material, Athens, GA.

Hendry, M.J., 1988, "Hydrogeology of Clay Till in a Prairie Region of Canada," Groundwater, Vol. 25, No. 5 (dated September-October 1987), Dublin, OH.

Hershfield, D.M., 1961, "Rainfall Frequency Atlas of the United States for Duration from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years," U.S. Department of Agriculture, available from the U.S. Government Printing Office.

Hillel, D., 1982, Introduction to Soil Physics, Academic Press, Inc., Orlando, FL.

Hogberg, J., J. Alexander, 1986, "Selenium," Handbook on the Toxicology of Metals, L. Friberg, G.F. Nordberg, V.B. Vouk, eds., 2nd ed., Volume 2: Specific Metals, Elsevier Science Publishers B.V., New York, NY, pp. 482-520.

Horning, W.B. and C.I. Weber, eds., 1985, "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms," EPA/600/4-85/014, U.S. EPA, Cincinnati, OH.

Horta, J. da Silva, M.E. Horta, L.C. da Motta, and M.H. Tavares, 1978, "Malignancies in Portuguese Thorotrast Patients," Health Physics, Vol. 35, pp. 137-152.

Houck, I.E., 1921, "Rainfall and Runoff in the Miami Valley," Technical Reports Part VIII, Miami Conservancy District, Dayton, OH.

Howard, P.H., 1990, "Handbook of Environmental Fate and Exposure Data for Organic Chemicals," Vols. 1 and 2, Lewis Publishers, Inc., Chelsea, MI.

Howard, P.H., 1991, "Handbook of Environmental Degradation Rates," Lewis Publishers, Inc., Chelsea, MI.

Hursh, J.B., W.R. Neuman, T. Toribara, H. Wilson, and C. Waterhouse, 1969, "Ingestion of Uranium by Man," Health Physics, Volume 17, pp. 619-621.

Hursh, J.B. and N.L. Spoor, 1973, "Data on Man," Uranium, Plutonium and the Transuranic Elements, C.H. Hodge, J.N. Stannard and J.B. Hursh, eds.

Ikeda, G.J. et al, 1980, Fed Cosmet Toxicol 16:409-13 (1978) as cited in National Research Councel Canada, "Phthalate Esters in the Aquatic Environment," p. 74 (1980) NRCC No. 17583.

Indiana Business Research Center, 1988, "Indiana County Population Projection: 1985-2020," School of Business, Indiana University, Indianapolis, IN.

Indiana Department of Employment and Training Services, 1992, "Labor Force Estimates, December 1991," Department of Employment and Training Services, Indianapolis, IN.

Institute for Evaluating Health Risks, 1991, "Reassessment of Liver Findings in Five PCB Studies in Rats," Washington, D.C.

INTERA, 1983, "Geochemical Models Suitable for Performance Assessment of Nuclear Waste Storage: Comparison of PHREEQE and EQ3/EQ6," ONWI-473, INTERA Environmental Consultants, Houston, TX.

International Agency for Research on Cancer (IARC), 1980, "IAMR Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man," Vol. 23: Some Metals and Metallic Compounds, World Health Organization, Lyon, France. (Cited in EPA 1992).

International Agency for Research on Cancer (IARC), 1982, "IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans," Supplement 4, Vol. 23: Some Metals and Metallic Compounds, World Health Organization, Lyon, France

International Agency for Research Cancer (IARC), 1987, "IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man," Volume 23: Some Metals and Metallic Compounds, World Health Organization, Lyon, France. (Cited in EPA 1993).

International Commission on Radiological Protection (ICRP), 1975, "Report of the Task Group on Reference Man," ICRP Publication 23, Pergamon Press, Oxford, England.

International Labour Office, 1971, "Encyclopedia of Occupational Health and Safety," Volumes I & II, McGraw-Hill Book Co., New York.

International Technology Corp. (IT), 1986, "Final Interim Report - Air, Soil, Water, and Health Risk Assessment in the Vicinity of the FMPC, Fernald, OH," report and data package prepared for the U.S. DOE in support of the Fernald litigation, Oak Ridge Operations Office, Oak Ridge, TN.

International Technology Corp. (IT), 1987, "Addendum to Interim Report - Air, Soil, Water, and Health Risk Assessment in the Vicinity of the FMPC, Fernald, Ohio," prepared for the U.S. DOE, Oak Ridge, TN.

International Technology Corp. (IT), 1988, "Final Report, Hydrogeologic Study of the FMPC Discharge to the Great Miami River (Zone of Influence Report)," prepared for Westinghouse Materials Company of Ohio, and U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

International Technology Corp. (IT) and ASI, 1988a, DOE/FMPC RCRA "Groundwater Monitoring Report," Volume 6, Round Six Sampling.

International Technology Corp. (IT) and ASI, 1988b, "Implementation Plan for the K-65 and Metal Oxide Residue Sampling Project."

International Technology Corp. (IT), 1989, "Assessment of Radiation Dose and Cancer Risk for Emissions from 1951 through 1984, Feed Materials Production Center, Fernald, Ohio," prepared for U.S. DOE, Oak Ridge operations Office, Oak Ridge, TN.

International Technology Corp. (IT), 1990a, "Fernald RI/FS Groundwater Modeling, Flow and Solute Transport Computer Code Verification, Final Report," prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

International Technology Corp. (IT), 1990b, "Radiological and Chemical Baseline Risk Assessment Operable Unit 4, (Draft)," prepared by IT Corp. for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

International Technology Corp. (IT), 1991, "Initial Screening of Alternatives for Operable Unit 1, Task 12 Report, Feed Materials Production Center, Fernald, Ohio, Remedial Investigation and Feasibility Study," prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Ishinishi, N., D. Tsuchiya, M. Vahter, B.A. Fowler, 1986, "Arsenic," Handbook on the Toxicology of Metals, L. Friberg, G.F. Nordberg, V.B. Vouk, eds., 2nd ed., Volume 2: Specific Metals, Elsevier Science Publishers B.V., New York, NY, pp. 43-83.

Ito, N., H. Nagasaki, M. Arai et al., 1973, "Histopathologic Studies on Liver Tumorigenesis in Rats Treated with Polychlorinated Biphenyls and its Promoting Effect on Liver Tumors Induced by Benzene Hexachloride," Journal of the National Cancer Institute, Volume 51, pp. 1637-1646. (Cited in U.S. EPA 1992a).

Iverson, S.L. and B.N. Turner, 1976, "Effects of Acute Radiation on Survival of Captive and Free-Ranging Meadow Voles," pp. 359-362 in C.E. Cushing (ed.) Radioecology and Energy Resources, Dowden, Hutchinson, and Ross, Inc., Stroudsburg, PA, pp. 401.

Jackson, K.J., 1988, "Verification and Validation Studies of the Addition of Pitzer's Equations to the EQ3/6 Brine Model" UCRL-53841, Lawrence Livermore National Laboratory, Livermore, CA.

Jacobson, J.L., G.G. Fein, S.W. Jacobson, et al., 1984, "The Transfer of Polychlorinated Biphenyls (PCBs) and Polybrominated Biphenyls (PBBs) Across the Human Placenta and Into Maternal Milk," Journal of Public Health, Volume 74, pp. 378-379. (Cited in ATSDR 1991).

Javandel, I., C. Doughty, and C.F. Tsang, 1984, "Groundwater Transport: Handbook of Mathematical Models," American Geophysical Union Water Resources Monograph Series 10, p. 228, Washington, D.C.

Jensen, S. and G. Sundstrom, 1974, "Structures and Levels of Most Chlorobiquenyls in Two Technical PCB Products and In Human Adipose Tissue," Ambio, Volume 3, pp. 70-76. (Cited in ATSDR 1991).

Jezerinac, R.F., 1986, "Endangered and Threatened Crayfishes (Decapoda: Cambaridae) of Ohio," Ohio State University, Newark, OH.

Johnson, D.C., et al., 1988, "Multiple Estrogenic Action of O,P'-DDT: Initiation and Maintenance of Pregnancy in the Rat," Toxicology, Vol. 53, pp. 79-87.

Karl, C.L., 1953, [Memorandum to G.W. Wunder, National Lead of Ohio Plant Manager, Subject: K-65 Storage Tanks].

Kato, Y., T. Mori, and T. Kumatori, 1979, "Thorotrast Dosimetric Study in Japan," Environmental Research, Vol. 18, pp. 32-36.

Kato, Y., T. Mori, and T. Kumatori, 1983, "Estimated Absorbed Dose in Tissues and Radiation Effects in Japanese Thorotrast Patients," Health Physics, Vol. 44, Suppl. 1, pp. 273-279.

Kazantzis, G., 1986, "Thallium," Handbook on the Toxicology of Metals, L. Friberg, G.F.

Nordberg, V.B. Vouk, eds., 2nd ed., Volume 2: Specific Metals, Elsevier Science Publishers B.V., New York, NY, pp. 549-567.

Kenton County Airport Board, 1990, Greater Cincinnati Airport Annual Report, Greater Cincinnati Airport, Kenton County, KY.

Kentucky Department Of Employment Services, 1992, "Kentucky Labor Force Estimates, December 1991," Commonwealth of Kentucky Cabinet for Human Resources, Frankfort, KY.

Kerrisk, J.F., 1981, "Chemical Equilibrium Calculations for Aqueous Geothermal Brines," LA-8851-MS, Los Alamos National Laboratory, Los Alamos, NM.

Khmel'nitskii, G.A., 1984, Veterinariya (Moscow) 1:64-5.

Killough, G.G. and L.R. McKay, 1976, "A Methodology for Calculating Radiation Doses from Radioactivity Released to the Environment," ORNL-4992, Oak Ridge National Laboratory, Oak Ridge, TN.

Kimbrough, R.D. and R.E. Linder, 1974, "Induction of Adenofibrosis and Hepatomas in the Liver of Balb/cJ Mice by Polychlorinated Biphenyls (Aroclor 1254)," Journal of the National Cancer Institute, Volume 43, pp. 547-552. (Cited in U.S. EPA 1992).

Kincaid, C.T. and J.R. Morey, 1984, "Geohydrochemical Model for Solute Migration, Volume 2: Preliminary Evaluation of Selected Computer Codes," EPRI EA-3417, Electric Power Research Institute, Palo Alto, CA.

Kitchen, J., Ohio Historical Society, 1990, [Letter to B. Shroff, Subject: Review of Remedial Activities at the FMPC].

Klechkovskii, V.M., G.G. Polikarpov, and R.M. Aleksakhin, 1973, Radioecology, John Wiley and Sons, New York, pp. 371.

Knobloch, K., S. Szendzikowski and A. Slusarczyk-Zalobona, 1969, "Acute and Subacute Toxicity of Acenaphthene and Acenaphthylene," Med. Pracy (Polish), Volume 20, pp. 210-222. (Cited in U.S. EPA 1992a).

Kocher, D.C., 1981, "Radioactive Decay Data Tables," DOE/TIC-11026, U.S. DOE, Washington, D.C.

Kociba, R.J., P.A. Keeler, C.N. Park and P.J. Gehring, 1976, "2,3,7,8-Tetrachlorodibenzo-p-dioxin Results of a 13-week Oral Toxicity Study in Rats," Toxicology and Applied Pharmacology, Volume 35, pp. 553-573. (Cited in U.S EPA, 1985).

Kociba, R.J., D.G. Keyes, J.E. Bower, et al, 1978, "Results of a Two-year Chronic Toxicity and Oncogenicity Study of 2,3,7,8-Tetrachlorodibenzo-p-dioxin in Rats," Journal of the National Cancer Institute, Volume 46, pp. 279-303. (Cited in U.S EPA 1985, 1992).

Koopmans, L.H., 1987, Introduction to Contemporary Statistical Methods, Duxbury Press, Boston, MA.

Korver, R.M. and J.B. Sprague, 1989, "Zinc Avoidance by Fathead Minnows (Pimephales promelas): Computerized Tracking and Greater Ecological Relevance," Canadian J. Fisheries and Aquatic Sciences, Vol. 46, pp. 494-502.

Kotin, P., et al., 1969, "Distribution, Retention and Elimination of $C^{14}$-3,4-benzopyrene After Administration to Mice and Rats," Journal of the National Cancer Institute, Volume 23, pp. 541 (Cited in the U.S. EPA 1980).

Krewski, D., T. Thorslund and J. Withey, 1989, "Carcinogenic Risk Assessment of Complex Mixtures," Toxicology and Industrial Health, Volume 5, pp. 851-867.

Kuwabara, K., T. Yakushiji, T. Watanabe et al., 1979, "Increase in the Human Blood PCB Levels Promptly Following Ingestion of Fish Containing PCBs," Bulletin of Environmental Contamination and Toxicology, Volume 21, pp. 273-278. (Cited in ATSDR 1991).

Lagerkvist, B., G.F. Nordberg, V. Vouk, 1986, "Vanadium," Handbook on the Toxicology of Metals, L. Friberg, G.F. Nordberg, V.B. Vouk, eds., 2nd ed., Volume 2: Specific Metals, Elsevier Science Publishers B.V., New York, NY, pp. 638-663.

Langard, S. T. Norseth, 1986, "Chromium," Handbook on the Toxicology of Metals, L. Friberg, G.F. Nordberg, V.B. Vouk, eds., 2nd ed., Volume 2: Specific Metals, Elsevier Science Publishers B.V., New York, NY, pp. 185-210.

LaVoie, E.J., S. Amin, S.S. Hecht, K. Furuya and D. Hoffmann, 1982, "Tumor Initiating Activity of Dihydrodiols of Benzo[b]fluoranthene, Benzo[j]fluoranthene and Benzo[k]fluoranthene," Carcinogenesis, Volume 3, No. 1, pp. 49-52. (Cited in U.S. EPA 1992a).

Leach, L.J., E.A. Maynard, H.C. Hodge, J.K. Scott., C.L. Yuile, G.E. Sylvester, and H.B. Wilson, 1970, "A Five-Year Inhalation Study with Natural Uranium Dioxide ($UO_2$) Dust - I. Retention and Biologic Effect in the Monkey, Dog, and Rat," Health Physics, Vol. 18, pp. 599-612.

Leach, L.J., C.L. Yuile, H.C. Hodge, G.E. Sylvester, and H.B. Wilson, 1973, "A Five-Year Inhalation Study with Natural Uranium Dioxide ($UO_2$) Dust - II. Postexposure Retention and Biologic Effects in the Monkey, Dog, and Rat," Health Physics, Vol. 25, pp. 239-258.

Lee, S.Y., J.D. Marsh, 1992, "Characterization of Uranium Contaminated Soils from DOE FEMP Site: Result of Phase I Characterization," Oak Ridge National Laboratory, ORNL/TM-11980.

Lee, S.Y., M. Elless, F. Hoffman, 1993, "Solubility Measurement of Uranium in Uranium-Contaminated Soils," Oak Ridge National Laboratory, ORNL/TM-12901.

Leggett, R.W., 1989, "The Behavior and Chemical Toxicity of U in the Kidney: A Reassessment," Health Physics, Volume 57, No. 3, pp. 365-383.

Leow, J.A., 1985, "Top of Rock Map of Butler County, Ohio," Open File Map 224, Ohio Department of Natural Resources, Div. of Geological Survey, Columbus, OH.

Lewtas, J., 1988, "Genotoxicity of Complex Mixtures: Strategies for the Identification and Comparative Assessment of Airborne Mutagens and Carcinogens from Combustion Sources," Fundamentals of Applied Toxicology, Volume 10, pp. 571-589.

Lin, T.Y., N.H. Burns, 1981, "Design of Prestressed Concrete Structures," John Wiley and Sons, New York.

Litz, J.E., 1974, "Treatment of Pitchblende Residues for Recovery of Metal Values," Hazen Research, Inc., for Cotter Corporation, Canon City, CO.

Looney, S.W. and T.R. Gulledge, 1985, "Use of the Correlation Coefficient with Normal Probability Plots", The American Statistician, Vol. 39, pp. 75-79.

Luce, W.R., Ohio Historical Society, 1987, [Letter to J. Reafsnyder, Subject: Review of Archaeological Properties at the FEMP].

Luessenhop, A.J., J.C. Gallimore, W.H. Sweet, E.G. Struxness, and J. Robinson, 1958, "The Toxicity in Man of Hexavalent Uranium Following Intravenous Administration," American Journal of Roentgenology, Volume 79, pp. 83-100.

Mackay, D.M. and J.A Cherry, 1989, "Groundwater Contamination: Pump and Treat Remediation," Environmental Science and Technology, Vol. 23, No. 6, pp. 630-636.

Marcinowski, F. and S. Napolitano, 1993, "Reducing Risks from Radon," J. Air and Waste Management Association, Vol. 43, pp. 955-962.

Marshall, J.H., and P.G. Groer, 1977, "A Theory of the Induction of Bone Cancer by Alpha Radiation," Radiation Research, Vol. 71, pp. 149-192.

Martland, H.S., 1931, "The Occurrence of Malignancy in Radioactive Persons," American Journal of Cancer, Vol. 15, pp. 2435-2516.

Martland, H.S., 1939, "Occupational Tumors, Bones," Encyclopedia of Health and Hygiene, International Labor Organization, Geneva, Switzerland.

Mason, W.T., 1973, An Introduction to the Identification of Chironomid Larvae, Analytical Quality Control Laboratory, National Environmental Research Center/U.S. EPA, Cincinnati, OH.

Masuda, Y., R. Kagawa, H. Kuroki et al., 1978, "Transfer of Polychlorinated Biphenyls from Mothers to Fetuses and Infants," Food. Cosmet. Toxicol, Volume 17, pp. 623-627. (Cited in ATSDR 1991).

Maynard, E.A. and H.C. Hodge, 1949, "Studies of the Toxicity of Various Uranium Compounds When Fed to Experimental Animals," The Pharmacology and Toxicology of Uranium Compounds, C. Voegtlin and H.C. Hodge, eds., Volume 1.

Mays, C.W., and R.D. Lloyd, 1972, "Bone Sarcoma Incidence vs. Alpha Particle Dose," Radiobiology of Plutonium, B.J. Stover and W.S.S. Jee, eds., The J.W. Press, Salt Lake City, UT, pp. 409-430.

Mays, C.W., R.E. Rowland, and A.F. Stehney, 1985, "Cancer Risk from the Lifetime Intake of Radium and Uranium Isotopes," Health Physics, Volume 48, pp. 635-647.

McConnell, E.E., G.W. Lucier, R.C. Rumbaugh, et al., 1984, "Dioxin in Soil: Bioavailability After Ingestion by Rats and Guinea Pigs," Science, Volume 223, pp. 1077-1079. (Cited in U.S. EPA 1985).

Merritt, R.W. and K.W. Cummins, eds. 1984, "An Introduction to the Aquatic Insects of North America," 2nd ed., Kendall/Hunt Publishing Co., Dubuque, IA.

Miami Conservancy District, 1985, "Hydrologic Data for the Hamilton-New Baltimore Area 1984," Water Conservation Subdistrict of the Miami Conservancy District, Dayton, OH.

Miller, M.C., G. Gibeau, M. Kelly, J. Schneider and T. Linnabary,m 1987, "Final Report: Status of Fishery at Three Stations in the Great Miami River," prepared for Westinghouse Material Company of Ohio, Cincinnati, OH.

Miller, M.C., R. Repasky, W. Rowe, R. Davenport, R. Bixby, and J. Engman, 1989, "Final Report: Electrofishing Survey of the Great Miami River," prepared for Westinghouse Material Company of Ohio, Cincinnati, OH.

Miller, M.C., L. Ross, W. Rowe, R. Bixby, R. Davenport, and J. Engman, 1990, "Electrofishing Survey of the Great Miami River," prepared for Westinghouse Materials Company of Ohio, Cincinnati, OH.

Miller, S.E., D.A. Holiday, and H.N. Doyle, 1956, "Health Protection of Uranium Miners and Millers," Archives of Industrial Health, Vol. 15, pp. 48-55.

Mills, W.B., D.B. Porcella, M.J. Ungs, S.A. Gherini, K.V. Summers, Lingfung Mok, G.L. Rupp, G.L. Bowie and D.A. Haith, 1985, "Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water, Revised 1985, Parts 1 and 2," EPA/600/6-85/002. U.S. EPA, Office of Research and Development, Environmental Research Laboratory, Athens, GA.

Mills, W.B., J.D. Dean, D.B. Porcella, et al., 1982, "Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants: Parts 1, 2, and 3,:" EPA/600/6-82/004. U.S. EPA, Office of Research and Development, Environmental Research Laboratory, Athens, GA.

Monsanto Research Corporation, 1985, "Radon and Radon Flux Measurements at the Feed Materials Production Center, Fernald, OH," prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Montgomery, J.H. and L.M. Welkom, 1990, Groundwater Chemicals Desk Reference, Lewis Publishers, Inc., Chelsea, MI.

Montgomery, J.H., 1991 Groundwater Chemicals Desk Reference, Vol. 2, Lewis Publishers, Inc., Chelsea, MI.

Moore, J.A., M.W. Harris and P.W. Albro, 1976, "Tissue Distribution of ($^{14}$C)tetrachlorodibenzo-p-dioxin in Pregnant and Neonatal Rats," Toxicology and Applied Pharmacology, Volume 37, pp. 146-147. (Cited in U.S. EPA, 1985).

Moore, R.E., George G. Killough, John E. Till, Kathleen R. Meyer and Duane W. Schmidt, 1989, "MICROAIRDOS Version 2.0, User's Manual and Documentation," Radiological Assessments Corporation, Neeses, SC.

Mori, T., Y. Kato, T. Shimamine, and S. Watanabe, 1979a, "Statistical Analysis of Japanese Thorotrast-Administered Autopsy Cases," Environmental Research, International Meeting on the Toxicity of Thorotrast and Other Alpha-Emitting Heavy Elements, Lisbon, Portugal, Vol. 18, pp. 231-244.

Mori, T., Y. Kato, T. Maruyama, and S. Takahashi, 1979b, "Epidemiological Follow-up Study of Japanese Thorotrast Cases," Environmental Research, Vol. 18, pp. 44-54.

Mori, T., Y. Kato, T. Kumatori, S. Hatakeyama, and T. Maruyama, 1983, "Epidemiological Follow-up Study of Japanese Thorotrast Cases - 1980," Health Physics, Vol. 44, Suppl. 1, pp. 261-272.

Mori, T., Y. Kato, T. Kumatori, S. Hatakeyama, T. Maruyama, R. Kamiyama, W. Mori, H. Irie, and S. Iwata, 1986, "Present Status of Medical Study on Thorotrast-Administered Patients in Japan," Strahlentherapie, Vol. 80, pp. 123-134.

Morris, D.A. and A.I. Johnson, 1967, "Summary of Hydrologic and Physical Properties of Rock and Soil Materials, as Analyzed by the Hydrologic Laboratory of the U.S. Geological Survey," U.S. Geological Survey Water-Supply Paper 1839-D, 42 pp.

Mulder, T., International Technology Corp., August 2, 1993, [Memorandum to S. Wolinski, FERMCO CRU4, Subject: Grain Size of Soil at the FEMP.]

Murthy, G.K., U. Rhea, J.T. Peeler, 1971, "Cobalt Cardiomyopathy: Clinical Aspects," Environmental Science and Technology, Volume 5, pp 436-442.

Mutch, B.J., Banister E.W., 1983, Med Sci Sports Exerc 15 (1): 41-50.

Myrick, T.E., B.A. Berven and F.F. Haywood, 1983, "Determination of Concentrations of Selected Radionuclides in Surface Soil in the U.S.," Health Physics, Volume 48, pp. 635-647.

National Academy of Sciences (NAS), 1984, "Toxicity Testing: Strategies to Determine Needs and Priorities," National Academy Press, Washington, D.C.

National Academy of Sciences (NAS), 1988, "Committee on the Biological Effects of Ionizing Radiations (BEIR V), Health Risks of Radon and Other Internally Deposited Alpha-Emitters," National Academy of Sciences, National Academy Press, Washington, D.C.

National Academy of Sciences (NAS), 1990, "Committee on the Biological Effects of Ionizing Radiation (BEIR V), Health Effects of Exposure to Low Levels of Ionizing Radiation," National Academy Press, Washington, D.C.

National Cancer Institute (NCI), 1978, "Bioassay of Aroclor 1254 for Possible Carcinogenicity," NCI-GC-TR-38. (Cited in U.S. EPA 1992).

National Council on Radiation Protection and Measurements (NCRPM), 1984a, "Exposure from the Uranium Series with Emphasis on Radon and its Daughters," NCRP Report No. 77.

National Council on Radiation Protection and Measurements (NCRPM), 1984b, "Evaluation of Occupational and Environmental Exposures to Radon and Radon Daughters in the United States," NCRP Report No. 78.

National Council on Radiation Protection and Measurements (NCRPM), 1984c, "Radiological Assessment: Predicting the Transport, Bioaccumulation, and Uptake by Man of Radionuclides Released to the Environment," NCRP Report No. 76.

National Council on Radiation Protection and Measurements (NCRPM), 1986, "Screening Techniques for Determining Compliance with Environmental Standards," NCRP Commentary No. 3.

National Council on Radiation Protection and Measurements (NCRPM), 1987, "Ionizing Radiation Exposure of the Population of the United States," NCRP Report No. 93.

National Council on Radiation Protection and Measurements (NCRPM), 1989, "Comparative Carcinogenicity of Ionizing Radiation and Chemicals," NCRP Report No. 96.

National Institute for Occupational Safety and Health (NIOSH), 1974, Criteria Document, DHEW Pub., NIOSH 74-136.

National Lead Company of Ohio (NLCO), 1953, [Memorandum from R.C. Heatherton, Subject: Leakage of K-65 Storage Tank No. 1].

National Lead Company of Ohio (NLCO), 1965-1985, "Aquifer Contamination Control Reports," various authors: C.F. Facemire, R.B. Weidener, M.W. Boback, and R.H. Starkey.

National Lead Company of Ohio (NLCO), 1977a, "Feed Material Production Center Environmental Monitoring Annual Report for 1976," National Lead of Ohio, Inc., Cincinnati, OH.

National Lead Company of Ohio (NLCO), 1977b, "Study of Radioactive Storage Areas at the Feed Materials Production Center," Report to U.S. Energy Research and Development Administration, Oak Ridge Operations Office, Oak Ridge, TN.

National Lead Company of Ohio (NLCO), 1978, "Feed Materials Production Center Environmental Monitoring Annual Report for 1978," National Lead of Ohio, Inc., Cincinnati, OH.

National Lead Company of Ohio (NLCO), 1979, "Feed Materials Production Center Environmental Monitoring Annual Report for 1978," National Lead of Ohio, Inc., Cincinnati, OH.

National Lead Company of Ohio (NLCO), 1980a, "Feed Materials Production Center Environmental Monitoring Annual Report for 1979," National Lead of Ohio, Inc., Cincinnati, OH.

National Lead Company of Ohio (NLCO), 1980b, "Scoping Investigation of Short-Term and Long-Term Storage Costs for Afrimet Residues, NFSS and FMPC."

National Lead Company of Ohio (NLCO), 1980c, Waste Water Quality Report, NPDES Permit Parameters, Data Summary, National Lead Co. of Ohio, Cincinnati, OH.

National Lead Company of Ohio (NLCO), 1981, "Feed Materials Production Center Environmental Monitoring Annual Report for 1980," National Lead of Ohio, Inc., Cincinnati, OH.

National Lead Company of Ohio (NLCO), 1982, "Feed Materials Production Center Environmental Monitoring Annual Report for 1981," National Lead of Ohio, Inc., Cincinnati, OH.

National Lead Company of Ohio (NLCO), 1983a, [Letter from R.M. Spenceley, Plant Manger, to M.R. Theisen, Director, Weapons Division, U.S. DOE, Oak Ridge Operations, Oak Ridge, TN. Subject: Non-FMPC sources of Radioactivity in Environmental Samples, Item 2].

National Lead Company of Ohio (NLCO), 1983b, "Feed Materials Production Center Environmental Monitoring Annual Report for 1982," National Lead of Ohio, Inc., Cincinnati, OH.

National Lead Company of Ohio (NLCO), 1984, "Feed Material Production Center Environmental Monitoring Annual Report for 1983," National Lead of Ohio, Inc., Cincinnati, OH.

National Lead Company of Ohio (NLCO), 1985a, "History of FMPC Radionuclide Discharge" WMCO (1986) (Revision).

National Lead Company of Ohio (NLCO), 1985b, "Feed Materials Production Center Environmental Monitoring Annual Report for 1984," National Lead of Ohio, Inc., Cincinnati, OH.

National Oceanic and Atmospheric Administration (NOAA), 1987, "Meteorological Site Survey of the Feed Material Production Center, Fernald, Ohio," draft prepared by the Atmospheric Turbulence and Diffusion Division, Air Resources Laboratory, NOAA, Oak Ridge, TN.

National Toxicology Program, 1980, "Unpublished Subchronic Toxicity Study: Naphthalene (c52904), Fisher-344 Rats," prepared by Battelle's Columbus Laboratories Under Subcontract No. 76-34-106002. (Cited in U.S. EPA 1992).

Nau, H. and R. Bass, 1981, "Transfer of 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) to the Mouse Embryo and Fetus," Toxicology, Volume 20, pp. 299-308. (Cited in U.S. EPA 1985).

Neal, T.J., 1968, "A Comparison of Two Muskrat Populations," Iowa State J. Sci. Vol. 43:193-210.

Nebecker, A.V., M.A. Cairns, J.H. Gakstatter, K.W. Malleg, G.S. Schuytema and D.F. Krawcyzk, 1984, "Biological Methods for Determining Toxicity of Contaminated Freshwater Sediments to Invertebrates," Environmental Toxicology and Chemistry, Vol. 3, pp. 617-630.

Newell, A.J., D.W. Johnson, and L.K. Allen, 1987, "Niagara River Biota Contamination Project: Fish Flesh Criteria for Piscivorous Wildlife," Technical Report 87-3, New York State Department of Environmental Conservation.

Nolan, R.J., F.A. Smith and J.G. Hefner, 1979, "Elimination and Tissue Distribution of 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) in Female Guinea Pigs Following a Single Oral Dose," Toxicology and Applied Pharmacology, Volume 48, pp. JA162. (Cited in U.S. EPA 1985).

Norbach, D.H. and R.H. Weltman, 1985, "Polychlorinated Biphenyl Induction of Hepatocellular Carcinoma in the Sprague-Dawley Rat," Environmental Health Perspectives, Volume 60, pp. 97-105. (Cited in U.S. EPA 1992a).

Nordstrom, D.K., 1979, "A Comparison of Computerized Chemical Models for Equilibrium Calculation on Aqueous Systems," ACS Symposium Series, Vol. 93., pp. 857-892, American Chemical Society, Washington, D.C.

Noyes, J.H., 1958, [Letter to C.L. Karl, U.S. Atomic Energy Commission, September 25, 1958, response to Noyes letters dated August 28, 1958 and July 15, 1958, Subject: Lease of Facilities to African Metals].

Oak Ridge Associated Universities (ORAU), 1985, "Environmental Program Review of the Feed Materials Production Center, Fernald, Ohio," prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Oak Ridge National Lab (ORNL), 1992a, "Characterization of Uranium Contaminated Soils from DOE Fernald Environmental Management Project Site: Results of Phase I Characterization," ORNL/TM-11980.

Oak Ridge National Lab (ORNL), 1992b, Waste Surface Mapping of the Fernald K-65 Silos Using a Structural Light Measurement System," ORNL/TM-12185.

Office of Health and Environmental Assessment, U. S. EPA, EPA/600/8-85/002.

Office of the Superintendent of Northwest School District, August 13, 1992, Personal Communication.

Office of the Superintendent of Ross School District, August 13, 1992, Personal Communication.

Office of the Superintendent of Southwest School District, August 13, 1992, Personal Communication.

Ogata, A. and R.B. Banks, 1961, "A Solution of the Differential Equation of Longitudinal Dispersion in Porous Media," U.S. Geological Survey, Professional Paper 411-A, Reston, VA.

Ohio Agricultural Research and Development Center, 1980, "Soil Survey of Butler County, Ohio," USDA, ODNR and Ohio Agricultural Research and Development Center.

0406

Ohio Bureau of Employment Services, 1992, "Labor Force Estimates, December 1991, "Ohio Bureau of Employment Services, Columbus, OH.

Ohio Bureau of Employment Services, 1992, "Persons Seeking Jobs through Ohio Bureau of Employment Services, by Occupational Category, Sex, County, and Local Office, December 1991."

Ohio Data Users Center, 1991, "Ohio Population by Governmental Unit, 1980-1990," Ohio Department of Development, Columbus, OH.

Ohio Data Users Center, 1991, "STF1 State Data Center Profile Series: Ohio 1990," Ohio Department of Development, Columbus, OH.

Ohio Department of Health, 1988, "Study of Radioactivity in Drinking Water and Other Environmental Media in the Vicinity of the U.S. Department of Energy's Feed Materials Production Center and Portsmouth Gaseous Diffusion Plant," prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Ohio Department of Natural Resources, 1974, "Endangered Wild Animals in Ohio," Publication 316, ODNR, Division of Wildlife, Columbus, OH.

Ohio Department of Natural Resources, 1982, "Rare Species of Native Ohio Wild Animals," ODNR, Division of Natural Areas and Preserves, Columbus, OH.

Ohio Department of Natural Resources, 1986, "Known Locations of Cave Salamanders," [Letter from Mr. D.S. Case, Division of Wildlife, Columbus, OH.]

Ohio Environmental Protection Agency (OEPA), 1977-1983, "Water Quality Data Sheets," samples collected from private wells in the vicinity of the FMPC, OEPA, Columbus, OH.

Ohio Environmental Protection Agency (OEPA), 1982, "Comprehensive Water Quality Report for the Great Miami River," OEPA, Southwest District Office, Dayton, OH.

Ohio Environmental Protection Agency (OEPA), 1987, "Biological Criteria for the Protection of Aquatic Life: Volume II: Users Manual for Biological Field Assessment of Ohio Surface Waters," OEPA, Columbus, OH.

Ohio Environmental Protection Agency (OEPA), 1988a, "Ohio Water Quality Inventory, 1988 305(b) Report," Volume II, OEPA, Columbus, OH.

Ohio Environmental Protection Agency (OEPA), 1988b, "Biological Criteria for the Protection of Aquatic Life: Volume II, Users Manual for Biological Field Assessment of Ohio Surface Waters," OEPA, Ecological Assessment Section, Columbus, OH.

Ohio Environmental Protection Agency (OEPA), 1989a, "Great Miami River Intensive Stream Survey," OEPA, Southwest District Office, Dayton, OH.

Ohio Environmental Protection Agency (OEPA), 1989b, "Addendum to: Biological Criteria for the Protection of Aquatic Life: Volume II, Users Manual for Biological Field Assessment of Ohio Surface Waters," OEPA, Ecological Assessment Section, Columbus, OH.

Ohio Environmental Protection Agency (OEPA), 1990a, "Draft Closure Plan Review Guidance," OEPA, Division of Solid Waste and Hazardous Waste Management, Columbus, OH.

Ohio Environmental Protection Agency (OEPA), 1990b, "Ohio Water Quality Standards," OAC3745-1, OEPA, Columbus, OH.

Ohio Environmental Protection Agency (OEPA), 1990c, "Review of New Sources of Air Toxic Emissions-Draft," Division of Air Pollution Control, June 1990, Columbus, OH.

Ohio Environmental Protection Agency (OEPA), 1991, "How Clean is Clean Policy," OEPA, Division of Emergency and Remedial Response, Dayton, OH.

Ohio-Kentucky-Indiana Regional Council of Governments, 1987a, "1985 Regional Traffic County Directory - Butler, Clermont, and Warren Counties," Ohio-Kentucky-Indiana Regional Council of Governments, Cincinnati, OH.

Ohio-Kentucky-Indiana Regional Council of Governments, 1987b, "1985 Regional Traffic County Directory - Hamilton County," Ohio-Kentucky-Indiana Regional Council of Governments, Cincinnati, OH.

Ohio-Kentucky-Indiana Regional Council of Governments, 1987c, "OKI Regional Traffic Flow Map, 1985 Average Daily Traffic," Ohio-Kentucky-Indiana Regional Council of Governments, Cincinnati, OH.

Ohio-Kentucky-Indiana Regional Council of Governments, 1988a, "Transportation Analysis Zone Projections for the Year 2010: Population and Households," Ohio-Kentucky-Indiana Regional Council of Governments, Cincinnati, OH.

Ohio-Kentucky-Indiana Regional Council of Governments, 1988b, "Petition for Sole Source Aquifer Designation of the Great Miami Buried Valley Aquifer in Butler, Clermont, and Warren Counties, Ohio," Ohio-Kentucky-Indiana Regional Council of Governments, Cincinnati, OH.

Ohio-Kentucky-Indiana Regional Council of Governments, 1988c, "Potential Sources of Groundwater Pollution in Butler, Clermont, and Warren Counties, Ohio," Ohio-Kentucky-Indiana Regional Council of Governments, Cincinnati, OH.

Ohio-Kentucky-Indiana Regional Council of Governments, 1989, "Transportation Analysis Zone Projections for the Year 2010: Employment and Labor Force," Ohio-Kentucky-Indiana Regional Council of Governments, Cincinnati, OH.

Ohio River Valley Water Sanitation Commission, 1989, "Quality Monitor, 1989," ORSANCO, Cincinnati, OH.

Ohio River Valley Water Sanitation Commission, 1990, "Quality Monitor, 1990," ORSANCO, Cincinnati, OH.

Ohio River Valley Water Sanitation Commission, 1991, "Quality Monitor, 1991," ORSANCO, Cincinnati, OH.

Olson, J.R., T.A. Gasiewicz and R.A. Neal, 1980, "Tissue Distribution, Excretion, and Metabolism of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in the Golden Syrian Hamster," Toxicology and Applied Pharmacology, Volume 56, pp. 78-85. (Cited in U.S. EPA 1985).

Olson, J.R., and W.E. Bitner, 1983, "Comparative Metabolism and Elimination of 2,3,7,8-Tetrachlorodibenzo-p-dioxin, Toxicologist, Volume 3, pp. 103. (Cited in U.S. EPA 1985).

Osborne, D.R. and F.A. Jones, 1991, "Reproduction and Growth in American Robins at the Feed Materials Production Center," FMPC SUB-031, prepared for Westinghouse Materials Company of Ohio, Cincinnati, OH.

Owen, D.B., 1962, "Handbook of Statistical Tables," Addison-Wesley, Palo Alto, CA.

Parrish, F.K., 1975, "Keys to Water Quality Indicative Organisms of the Southeastern United States," 2nd ed., Office of Research Development, U.S. EPA, Cincinnati, OH.

Parsons, 1991, "Preconceptual Design Study - On-site, Low-Level Waste Disposal Facility," Fairfield: Parsons.

Parsons, 1992, "Conceptual Design Report for the Remediation of Waste Pit Area Removal, Treatment, and On-Site Disposal," FEMP, Fernald, OH.

Parsons, 1993, "FEMP Glacial Till/Vadose Zone Hydraulic Investigations Work Plan," FEMP, Fernald, OH

Pearson, E.S. and H.O. Hartley, 1966, "Biometrika Tables for Statisticians," Volume 1, 3rd ed., Cambridge Univ. Press, London.

Peckarsky, B.L., P.R. Fraissinet, M.A. Penton, and D.J. Conklin, Jr., 1990, "Freshwater Macroinvertebrates of Northeastern North America," Cornell University Press, Ithaca, NY.

Peltier, W.H. and C.I. Weber, eds., 1985, "Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms," EPA/600/4-85/013, U.S. EPA, Cincinnati, OH.

Pennak, R.W., 1978, "Freshwater Invertebrates of the United States," Ronald Press Company, New York, NY.

Pennsylvania State University, 1979, "Effects of Nuclear Power Plants on Community Growth and Residential Property Values," Pennsylvania State Univ., University Park, PA.

Philipose, K.E., R.F. Fieldman, J.J. Beaudoin, 1991, "Durability Predictions from Rate of Diffusion Testing of Normal Portland Cement, Fly Ash, and Slag Concrete," Waste Management Systems, Canada.

Pielou, E.C., 1977, "Mathematical Ecology," John Wiley and Sons, New York, NY.

Piper, W.N., R.Q. Rose and P.J. Gehring, 1973, "Excretion and Tissue Distribution of 2,3,7,8-Tetrachlorodibenzo-p-dioxin in the Rat," Environmental Health Perspectives, Volume 5, pp.241-244. (Cited in U.S. EPA 1985).

Plummer, P., Miami Conservancy District, Dayton, Ohio, July 24, 1990, Personal Communication.

Poiger, H. and C. Schlatter, 1979, "Biological Degradation of TCDD in Rats," Nature, Volume 281, pp. 706-707. (Cited in U.S. EPA 1985).

Poiger, H. and C. Schlatter, 1980, "Influence of Solvents and Adsorbents on Dermal and Intestinal Absorption of TCDD," Food Cosmet. Toxicol; Volume 18, pp. 477-481. (Cited in U.S. EPA 1985).

Polednak, A.P., 1978, "Bone Cancer Among Female Radium Dial Workers-Latency Periods and Incidence Rates by Time After Exposure," Journal of the National Cancer Institute, Vol. 60, pp. 77-82.

Polednak, A.P., and E.L. Frome, 1986, "Mortality Among Men Employed Between 1943 and 1947 at a Uranium Processing Plant," Journal of Occupational Medicine, Vol. 23, pp. 169-178.

Popock, S.J., Shaper, A.G., Walker, M., Wale, C.J., Clayton, B., Delves, T., Lacey, R.F., Packham R.F., and Powell, P., 1983, "Effect of Tap Water Lead, Waterhardness, Alcohol, and Cigarettes on Blood Lead Concentrations," Journal of Epidemiology and Community Health, Volume 37, pp.1-7.

Radford, E.P. and K.G. St. C.air Renard, 1984, "Lung Cancer in Swedish Iron Ore Miners Exposed to Low Doses of Radon Daughters," New England J. of Medicine, Vol. 310, No. 23, pp. 1485-1494.

Raj, D. and J.M Zachara, 1984, "Chemical Attenuation Rates, Coefficients, and Constants in Leachate Migration," Volume 1: A Critical Review, EA-3356, Electric Power Research Institute, Palo Alto, CA.

Rajendran, R., J.B. Patro, A.K. Sridharan, and M. Sampath, 1979, "Solvent Extraction of Uranyl Nitrate with Tributyl Phosphate, in Symposium on Solvent Extraction of Metals," Department of Atomic Energy, Bombay, India.

Real Estate Counseling Group of Connecticut, Inc. and Financial Consulting Group of Ohio, 1987, "Patterns of Real Estate Market Behavior Around the Feed Materials Production Center, Fernald, Ohio," Cincinnati, OH.

Reding, M.E. and S.I. Guttman, 1991, "Radionuclide Contamination as an Influence on the Morphology and Genetic Structure of Periodical Cicada (Magicicada cassini) Populations," American Midland Naturalist, Vol. 126, pp. 322-337.

Reed, P.B., Jr., 1988, "National List of Plant Species that Occur in Wetlands: National Summary," Biological Report 88 (24), U.S. Fish and Wildlife Service, Washington, D.C.

Rees, E.O., et al., 1971, "A Study of the Mechanism of Intestinal Absorption of Benzo(a)pyrene," Biochemical and Biophysical Act, Volume 255, pp. 96. (Cited in U.S. EPA 1980a).

Reeves, A.L., 1986, "Barium," Handbook on the Toxicology of Metals, L. Friberg, G.F. Nordberg, V.B. Vouk, eds., 2nd ed., Volume 2: Specific Metals, Elsevier Science Publishers B.V., New York, NY, pp. 84-94.

Reidel, W., R. Hirschberg, A. Kaul, S. Schmier, and U. Walter, 1979, "Comparative Investigations on the Biokinetics of Colloidal Thorium, Zirconium, and Nafnium Dioxides in Animals," Environmental Research, Vol. 18, pp. 127-139.

Reidel, W., W. Dalheimer, A. Said, and U. Walter, 1983, "Recent Results of the Physical and Biological Properties of Thorotrast Equivalent Colloids," Health Physics, Vol. 44, Suppl. 1, pp. 293-298.

Reid, G.W., 1965, Southwest Water Works Journal, 46:18, as presented in Practical Handbook of Environmental Control, C.P. Straub, ed., CRC Press, Inc., Boca Raton, FL.

Reproduction Toxicology Center, 1990, "Reproductive Toxicity Database (REPROTOX)," Washington, DC: Reproduction Toxicology Center.

Rockstroh, H., 1959, "Zur Atiologie des Bronchialkrebses in Arsen Verarbeitenden Nickelhutten. Beitrag zur Syncarcinogenese des Berufkrebes," Arch. Geschwulstforsch, Vol. 14, pp. 151-162.

Rogers and Associates Engineering Corporation, 1990, "A Unified Theory of Radon Transport in Porous Media - Model Benchmark and Soil Parameter Evaluations," prepared for U.S. DOE.

Rose, J.Q., J.C. Ramsey, T.H. Wentzler, R.A. Hummel and P.J. Gehring, 1975, "The Fate of 2,3,7,8-Tetrachlorodibenzo-p-dioxin Following Single and Repeated Oral Doses to the Rat," Toxicology and Applied Pharmacology, Volume 36, pp. 290-226. (Cited in U.S. EPA 1985).

Rowe, J.N. and J.A. Springer, 1986, "Asbestos Lung Cancer Risks: Comparison of Animal and Human Extrapolations," Risk Analysis, Vol. 6, pp. 171-179.

Rowland, R.E., and J.E. Farnham, 1969, "The Deposition of Uranium in Bone," Health Physics, Vol. 17, pp. 139-144.

Rowland, R.E., A.T. Keane, and P.M. Failla, 1971, "The Appearance Times of Radium-Induced Malignancies," Radiological Physics Division Annual Report, Report No. ANL-7860, Part II, Argonne National Laboratory, Argonne, IL, pp. 20-22.

Rowland, R.E., A.F. Stehney, and H.F. Lucas, Jr., 1978a, "Dose-Response Relationships for Female Radium Dial Workers," Radiation Research, Vol. 76, pp. 368-383.

Rowland, R.E., A.F. Stehney, A.M. Brues, M.S. Littman, A.T. Keane, B.C. Pattern, and M.M. Shanahan, 1978b, "Current Status of the Study of $^{226}$Ra and $^{228}$Ra in Humans at the Center for Human Radiobiology," Health Physics, Vol. 35, pp. 159-166.

Rowland, R.E., A.F. Stehney, and H.F. Lucas, 1983, "Dose-Response Relationships for Radium-Induced Bone Sarcomas," Health Physics, Vol, 44, Suppl. 1, pp. 15-31.

Royal Chemical Society (RCS), 1981, "Foreign Compound Metabolism in Mammals - A Review of Literature Published During 1978 and 1979," Volume 5 London: The Royal Chemical Society.

Royal Society of Canada, 1976, "Glacial Till," Special Publication 12, Royal Society of Canada, R.F. Leggett editor, Ottawa Ontario.

Rundo, J., A.T. Keane, H.F. Lucas, R.A. Schlenker, J.H. Stebbings, and A.F. Stehney, 1986, "Current (1984) Status of the Study of 226Ra and $^{228}$Ra in Humans at the Center for Human Radiobiology," Radiobiology of Radium and Thorotrast, W. Gossner, G.B. Gerber, U. Hagen, and A. Luz, eds., Urban and Schwarzenberg, Munich, West Germany, pp. 14-21.

Safe, S., 1980, "Metabolism, Uptake, Storage and Bioaccumulation of Halogenated Aromatic Pollutants" In: R.D. Kimbrough, (ed). Halogenated Biphenyls, Terphenyls, Naphthalenes, Dibenzodioxins and Related Products, Amsterdam: Elsevier Science Publishers, pp. 81-107. (Cited in ATSDR 1991).

Saric, J.A., U.S. Environmental Protection Agency, December 2, 1991, [Letter to J.R. Craig, U.S. DOE, Subject: Risk Assessment Work Plan Addendum.]

Saric, J.A., U.S. Environmental Protection Agency, March 11, 1992, [Letter to J.R. Craig, U.S. DOE, Subject: Draft Final Risk Assessment Work Plan Addendum.]

Schaeffer, E., H. Grein and W. Goessner, 1984, "Pathology of Chronic Polychlorinated Biphenyl (PCB) Feeding in Rats," Toxicology and Applied Pharmacology, Volume 75, pp. 278-288. (Cited in U.S. EPA 1992a).

Schaum, J., U.S. Environmental Protection Agency, October 24, 1991 [Memorandum to Cindy Sonich-Mullin].

Schlede, E., et al., 1970, "Effect of Enzyme Induction on the Metabolism and Tissue Distribution of Benzo(a)pyrene," Cancer Research, Volume 30, pp. 2893. (Cited in U.S. EPA, 1980a).

Schlede, E., et al., 1970, "Stimulatory Effect of Benzo(a)pyrene and Phenobarbital Pretreatment on the Biliary Excretion of Benzo(a)pyrene Metabolites in the Rat," Cancer Research, Volume 30, pp. 2898. (Cited in U.S. EPA 1980a).

Schlenker, R.A., 1980, "Dosimetry of Paranasal Sinus and Mastoid Epithelia in Radium-Exposed Humans," Radiological and Environmental Research Division Annual Report, No. ALN-80-115, Part II, Argonne National Laboratory, Argonne, IL, pp. 1-21.

Schmahl, D., 1955, "Examination of the Carcinogenic Action of Naphthalene and Anthracene in Rats," Z. Krebsforsch, Volume 60, pp. 697-710. (Cited in U.S. EPA 1992a).

Schnellmann, R.G., C.W. Putnam and I.G. Sipes, 1983, "Metabolism of 2,2'3,3'6,6'-Hexachlorobiphenyl and 2,2'4,4'5,5'-Hexachlorobiphenyl by Human Hepatic Microsomes," Biochemistry and Pharmacology, Volume 32, pp. 3233-3239. (Cited in ATSDR 1991).

Schnellmann, R.G., R.F. Volp, C.W.Putnam et al., 1984, "The Hydroxylation, Dechlorination, and Glucuronidation of 4,4'-dichlorobiphenyl (4-DCB) by Human Hepatic Microsomes," Biochemistry and Pharmacology, Volume 33, pp. 3503-3509.

Schrage, L., 1991, "LINDO User's Manual," Scientific Press, San Francisco, CA.

Schroeder, H.A., A.P. Nason, I.H. Tipton, 1967, "Essential Trace Elements in Man: Cobalt," Journal of Chronic Diseases, Volume 20, pp. 869-890.

Schwartz, P.M., S.W. Jacobson, G. Fein et al., 1983, "Lake Michigan Fish Consumption as a Source of Polychlorinated Biphenyls in Human Cord Serum, Maternal Serum, and Milk," American Journal of Public Health, Volume 73, pp. 293-296. (Cited in ATSDR 1991).

Sedam, A.C., 1984, "Occurrence of Uranium in Groundwater in the Vicinity of the U.S. DOE Feed Materials Production Center, Fernald, Ohio," U.S. Geological Survey Administrative Report, Columbus, OH.

Shacklette, H.T. and J.G. Boerngen, 1984, "Elemental Concentrations in Soils and Other Surficial Materials of the Coterminous United States," U.S. Geological Survey Professional Paper 1270, U.S. Department of the Interior, Washington, D.C.

Shanks, P.A. and R.A. Vogel, 1988, "The K-65 Waste Storage Silos at the Feed Materials Production Center," FMPC-2142, Westinghouse Materials Co. of Ohio.

Sheehan, P.J. and R.W. Winner, 1984, "Comparison of Gradient Studies in Heavy-Metal-Polluted Streams," In: P.J. Sheehan, D.R. Miller, G.C. Butler and P. Bourdeau (eds.) 1984 SCOPE, Effects of Pollutants at the Ecosystem Level, John Wiley and Sons, Ltd., New York, NY.

Shelford, V.E., 1963, The Ecology of North America, University of Illinois Press, Urbana, IL.

Sheppard, M., D.I. Beals, D.H. Thibault and P. O'Connor, 1984, "Soil Nuclide Distribution Coefficients and Their Statistical Distributions," Whiteshell Nuclear Research Establishment.

Silverman L. et al, 1979, "Industrial Hygienists" Toxicology 31:74-8 (1949) as cited in NIOSH, Criteria Document: Ammonia p. 56 (1979) DHEW Publisher NIOSH 74-136.

Sinks, T., A.B. Smith, R. Rinsky et al, 1991, "Health Hazard Evaluation Report," Westinghouse Electric Corporation, Bloomington, IN, Cincinnati, OH: Hazard Evaluations and Technical Assistance Branch, NIOSH, HETA 89-116-2094. (Cited in ATSDR 1991).

Sitton, M.D., 1988, "Site Analysis, Feed Material Production Center, Fernald, Ohio, Interim

Report," TS-PIC-88088, The Bionetics Corporation, Warrenton, Virginia, prepared for the U.S. EPA, Environmental Photographic Interpretation Center, Warrenton, VA.

Solebello, L.P., 1991, "Mineralogy of Soil Core Samples, Feed Materials Production Center, Fernald, Ohio," Contract Report by McCrone Assoc., Inc., Westmont, IL.

Souba W.W., 1987, Parenter Entreal Nutr 11(6):569-79.

Southwestern Ohio Air Pollution Control Agency, 1990, 1990 Air Quality Data, (SWOAPCA), Technical Services Section, Cincinnati, OH.

Spenceley, R.M., National Lead of Ohio, Inc., 1983, [Letter to M.R. Theisen, U.S. DOE, Subject: Non-FMPC sources of radioactivity in environmental samples].

Spieker, and S.F. Norris, 1962 "Groundwater Movement and Contamination at the AEC Feed Materials Production Center Located Near Fernald, Ohio," U.S. Geological Survey Technical Report for the U.S. Atomic Energy Commission.

Spieker, A.M., 1968a, "Effect of Increased Pumping of the Groundwater in the Fairfield-New Baltimore Area, Ohio - A Prediction by Analog-Model Study," U.S. Geological Survey Professional Paper 605-C, available from U.S. Government Printing Office, Washington, D.C.

Spieker, A.M., 1968b, "Future Development of the Groundwater Resource in the Lower Great Miami River, Ohio - Problems and Alternative Solutions," U.S. Geological Survey Professional Paper 605-D, available from U.S. Government Printing Office, Washington, D.C.

Spieker, A.M., 1968c, "Groundwater Hydrology and Geology of the Lower Great Miami River Valley, Ohio," U.S. Geological Survey Professional Paper 605-A, available from U.S. Government Printing Office, Washington, DC.

Spiers, F.W., H.F. Lucas, J. Rundo, and G.A. Anast, 1983, "Leukemia Incidence in the U.S. Dial Workers," Health Physics, Vol. 44, Supl. 1, pp. 65-72.

Spiess, H., 1969, "$^{224}$Ra-Induced Tumors in Children and Adults," Delayed Effects of Bone-Seeking Radionuclides, C.W. Mays, W.S.S. Jee, R.D. Lloyd, B.J. Stover, J.H. Dougherty, and G.N. Taylor, eds., University of Utah Press, Salt Lake City, UT, pp. 227-247.

Spiess, H., and C.W. Mays, 1973, "Protraction Effect on Bone Sarcoma Induction of $^{224}$Ra in Children and Adults," Radionuclides Carcinogenesis, CONF-720505, C.L. Sanders, R.H. Busch, J.E. Ballou, and D.D. Mahlum, eds., NTIS, Springfield, VA, pp. 437-450.

Sprince, N.L., L.C. Oliver, E.A. Eisen, et al., 1988, "Cobalt Exposure and Lung Disease in Tungsten Carbide Production: A Cross-Sectional Study of Current Workers," Am. Rev. Respir. Dis., Volume 138, pp. 1220-1226.

Starkey, R.H., C. Watson, R.C. Coates, E.B. Riestenberg and J.W. Robinson, 1962, "Report of FMPC Ground Contamination Study Committee," FMPC-110, National Lead of Ohio, Cincinnati, OH.

Stebbings, J.H., H.F. Lucas, and A.F. Stehney, 1984, "Mortality from Cancers of Major Sites in Female Radium Dial Workers," American Journal of Industrial Medicine, Vol. 5, pp. 435-459.

Stein, J.R., ed., 1973, "Handbook of Psychological Methods: Culture Methods and Growth Measurements," Cambridge Univ. Press, Cambridge, UK.

Stevens, W., F.W. Bruenger, D.R. Atherton, J.M. Smith, and G.N. Taylor, 1980, "The Distribution and Retention of Hexavalent $^{233}U$ in the Beagle," Radiation Research, Vol. 83, pp. 109-126.

Stokinger, H.E., 1982, "Uranium," Patty's Industrial Hygiene and Toxicology, Third Edition.

Summers, K., S. Gherini and C. Chen, 1980, "Methodology to Evaluate the Potential for Groundwater Contamination from Geothermal Fluid Releases," EPA-600/7-80-117.

Suter, G. 1991, "Screening Level Risk Assessment for Off-Site Ecological Effects in Surface Waters Downstream from the U.S. DOE, Oak Ridge Reservation," ORNL/ER-8, prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Swinford, M. (in preparation), "Bedrock Geology of Hamilton County, Ohio," Ohio Department of Natural Resources, Div. of Geological Survey, Columbus, OH.

Talmage, S.S. and B.T. Walton, 1991, "Small Mamals as Monitors of Environmental Contaminants," Reviews of Environmental Contamination and Toxicology, Vol. 119, pp. 47-145.

Tanabe, S., Y. Nakagawa and R. Tatsukawa, 1981, "Absorption Efficiency and Biological half-life of Individual Chlorobiphenyls in Rats Treated with Kanechlor Products," Agricultural and Biological Chemistry, Volume 45, pp. 717-726. (Cited in ATSDR 1991).

Teitelbaum, P.J. and A.P. Poland, 1978, "Studies of the Hepatic Uptake of 2,3,7,8-Tetrachlorodibenzo-p-dioxin in the Mouse," Procedures of the American Society for Experimental Biology, Volume 37, pp. 692. (Cited in U.S. EPA 1985).

Thibault, D.H., M.I. Sheppard and P.A. Smith, 1990, "A Critical Compilation and Review of Default Soil Solid/Liquid Partition Coefficients, $K_d$, for Use in Environmental Assessments," AECL-10125, Whiteshell Nuclear Research Center.

Thorslund, T. and G. Charnley, 1988, "Comparative Potency Approach for Estimating the Cancer Risk Associated with Exposure to Mixtures of Polycyclic Aromatic Hydrocarbons," ICF-Clement Associates, Washington, D.C. (Cited in Krewski, et al., 1989; Cited as Clement Associates 1988 in U.S. EPA 1991).

Till, J.E. and H.R. Meyer, 1983, "Radiological Assessment, A Textbook on Environmental Dose Analysis," NUREG/CR-3332, ORNL-5968, prepared for the U.S. NRC, Washington, D.C.

Tipton, I.H., P.L. Stewart, P.G. Martin, 1966, "Trace Elements in Diets and Excreta, Health Physics, Volume 12, pp. 1638-1689.

Trautman, M.B., 1957, The Fishes of Ohio, Ohio State University Press, Columbus, OH.

Trautman, M.B., 1981, The Fishes of Ohio, 2nd ed., Ohio State University Press, Columbus, OH.

Trautman, M.B. and M.A. Trautman, 1968, "Annotated List of the Birds of Ohio", Ohio J. Science, 68:257-332.

Travis, C.C. and A.D. Arms, 1988, "Bioconcentration of Organics in Beef, Milk, and Vegetation," Environmental Science and Technology, Vol. 22, No. 3, pp. 271-274.

Travis, C.C. and C.B. Doty, 1990, "Can Contaminated Aquifers at Superfund Sites Be Remediated?" Environmental Science and Technology, Vol. 24, No. 10, pp. 1465.

Treon, J.F., F.P. Cleveland, J.W. Cappel et al., 1956, "The Toxicity of the Vapours of Aroclor 1242 and Aroclor 1254," American Industrial Hygiene Association, Volume Q, No. 17, pp. 204-213. (Cited in ATSDR 1991).

Troxel, G.E., H.e. Davis, and J.W. Kelley, 1968, Composition and Properties of Concrete, 2nd Ed., McGraw Hill Book Co., New York, NY.

Tuutti, K., 1982, "Corrosion of Steel in Concrete," Swedish Cement and Concrete Research Institute, Stockholm.

U.S. Army Corps of Engineers in conjunction with U.S. Environmental Protection Agency, Region II, 1985, "Guidance for Performing Tests on Dredged Material to be Disposed of in Ocean Waters," COE/EPA, New York, NY.

U.S. Department of Agriculture USDA, Soil Conservation Service, 1970, "Ohio Irrigation Guide," USDA, Washington, D.C.

U.S. Department of Agriculture USDA, Soil Conservation Service, 1979, "Soil Survey of Hamilton County, Ohio," USDA, Washington, D.C.

U.S. Department of Agriculture USDA, 1980a, "Nationwide Food Consumption Survey 1977-1978," Preliminary Report No. 2, USDA, Washington, D.C.

U.S. Department of Agriculture USDA, Soil Conservation Service, 1980b, "Soil Survey of Butler County, Ohio," USDA, SCS, Washington, D.C.

U.S. Department of Agriculture USDA, Soil Conservation Service, 1982, "Soil Survey of Hamilton County, Ohio," USDA, SCS, Washington, D.C.

U.S. Department of Agriculture USDA, 1986a, "National Food Consumption Survey - Continuing Survey of Food Intakes by Individuals: Women 19-50 Years and their Children 1-5 Years, 1 Day," NFCS, CSFII Report No. 85-1, USDA, Washington, D.C.

U.S. Department of Agriculture USDA, 1986b, "National Food Consumption Survey - Continuing Survey of Food Intakes by Individuals: Men 19-50 Years, 1 Day," NFCS, CSFII Report No. 85-3, USDA, Washington, D.C.

U.S. Department of Agriculture USDA, Soil Conservation Service, 1987a, "Field Office Technical Guide for Butler County, Ohio," Section IId, USDA, SCS, Washington, D.C.

U.S. Department of Agriculture USDA, Soil Conservation Service, 1987b, "Hydric Soils of the United States (Ohio)," in cooperation with the National Technical Committee for Hydric Soils, USDA, SCS, Washington, D.C.

U.S. Department of Commerce, Bureau of the Census, 1991a, "Selected Population and Housing Characteristics for the United States: 1990," U.S. Department of Commerce, Washington, D.C.

U.S. Department of Commerce, Bureau of Economic Analysis, 1991b, "Local Area Personal Income Full-Time and Part-Time Employees by Major Industry for Counties and Metropolitan Areas," U.S. Department of Commerce, Washington, D.C.

U.S. Department of Commerce, Bureau of Economic Analysis, 1991c, "Local Area Personal Income by Major Source and Earnings by Industry for Counties and Metropolitan Areas," U.S. Department of Commerce, Washington, D.C.

U.S. Department of Energy (DOE), "Annual Reports of Toxic Chemical Releases to Air and Other Media, as Required by Section 313 of Title III: Emergency Planning and Community Right-to-Know Act of 1986, Public Law 99-499," prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Department of Energy (DOE), 1983, "Pathway Analysis and Radiation Dose Estimates for Radioactive Residues at Formerly Utilized MED/AEC Sites," DOE ORO-832, U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Department of Energy (DOE), 1985a, "Procedures for Sampling Radium Contaminated Soils," GJ/TMC-13 UC-70, U.S. Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Department of Energy (DOE), 1985b, "Report of Historic Uranium Releases from Current DOE Oak Ridge Operations Office Facilities," U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Department of Energy (DOE), 1986a, "Guideline on Air Quality Models (Revised)," Office of Air Quality planning and Standards, EPA 450/2-78-027R, U.S. EPA, 1986.

U.S. Department of Energy (DOE), 1986b, "Industrial Source Complex (ISC), Dispersion Model User's Guide," Second Edition, Volume 1, PB86-234259, 1986.

U.S. Department of Energy (DOE), 1986c, "The PATHRAE-4AD Performance Assessment Code for the Land Disposal of Radioactive Wastes," U.S. DOE, Savannah River Laboratory, Aiken, SC.

U.S. Department of Energy (DOE), 1986d, "The PATHRAE-HAZ Performance Assessment Code for the Land Disposal of Radioactive Wastes," U.S. DOE, Savannah River Laboratory, Aiken, SC.

U.S. Department of Energy (DOE), 1987a, "Data Quality Objectives for Remedial Response Activities."

U.S. Department of Energy (DOE), 1987b, "Remedial Investigation and Feasibility Study, Feed Materials Production Center, Fernald, Ohio, Task 1 Report: Description of Current Situation," U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Department of Energy (DOE), 1988a, "FMPC Sampling and Analysis Report," U.S. DOE, Oak Ridge Operations, Oak Ridge, TN.

U.S. Department of Energy (DOE), 1988b, "GENII - The Hanford Environmental Radiation Dosimetry Software System, Volume 1: Conceptual Representation," prepared by Battelle Pacific Northwest Laboratory, Richland, WA.

U.S. Department of Energy (DOE), 1988c, "GENII - The Hanford Environmental Radiation Dosimetry Software System," Volume 2: Users Manual, prepared by Battelle Pacific Northwest Laboratory, Richland, WA.

U.S. Department of Energy (DOE), 1988d, "Preliminary Draft Environmental Impact Statement: Renovations and Remedial Actions, Feed Materials Production Center, Fernald, Ohio," Vol. 2, prepared by Oak Ridge National Laboratory, Oak Ridge, TN.

U.S. Department of Energy (DOE), 1988e, "Remedial Investigation and Feasibility Study, Feed Materials Production Center, Development of Alternatives (Task 12) for the Feasibility Study, Revision 1," U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Department of Energy (DOE), 1988f, "Remedial Investigation and Feasibility Study, Feed Materials Production Center, Fernald, Ohio," Quality Assurance Project Plan, Volume 5," U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Department of Energy (DOE), 1989 to 1991, "Annual Reports of Highest Off-site Dose from Airborne Radionuclides, as Required by 40CFR61, Subpart H: NESHAPS," prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Department of Energy (DOE), 1989a, "A Manual for Implementing Residual Radioactive Material Guidelines," ANL/ES-160, DOE/CH/8901, Argonne National Laboratory, Argonne, IL.

U.S. Department of Energy (DOE), 1989b, "Draft 4; Environmental Impact Statement, Feed Materials Production Center Renovation and Site Evaluation", DOE/EIS-0142D, Oak Ridge National Laboratory, Oak Ridge, TN.

U.S. Department of Energy (DOE), 1989c, "General Quantitative Risk Assessment Guidelines for Noncancer Health Effects," prepared by the Office of Health and Environmental Assessment, Cincinnati, OH, for the Risk Assessment Forum, ECAO-CIN-538.

U.S. Department of Energy (DOE), 1990a, "A Probabilistic Risk Assessment for the K-65 Silos at the FMPC," FMPC/SUB-029 UC-702.

U.S. Department of Energy (DOE), 1990b, "Engineering Evaluation/Cost Analysis, K-65 Silos Removal Action, Feed Materials Production Center," U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Department of Energy (DOE), 1990c, "Engineering Evaluation/Cost Analysis, Waste Pit Area Storm Water Runoff Control, Feed Materials Production Center," U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Department of Energy (DOE), 1990d, "Engineering Evaluation/Cost Analysis, South Plume, Feed Materials Production Center," U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Department of Energy (DOE), 1990e, "Remedial Investigation Report for Operable Unit 1, Task 6 Report," Vol. 1 of 2, (draft), U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Department of Energy (DOE), 1990f, "Groundwater Report, Feed Materials Production Center, Fernald, Ohio, Remedial Investigation and Feasibility Study," (draft), U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Department of Energy (DOE), 1990g, "Initial Screening of Alternatives for Operable Unit 4, Task 12 Report, Feed Materials Production Center, Fernald, Ohio," (final), U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Department of Energy (DOE), 1990h, "Remedial Investigation Report for Operable Unit 4, Task 6 Report," Vol. 1 of 2, (draft), U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Department of Energy (DOE), 1990i, "Residual Radioactive Contamination from Decommissioning, Technical Basis for Translating Contamination Levels to Annual Dose," draft report for comment, prepared by Battelle Pacific Northwest Laboratory, Richland, WA.

U.S. Department of Energy (DOE), 1991a, "Annual Environmental Report for Calendar Year 1990," FMPC-2245; Special UC-707, U.S. DOE, Fernald Office, Fernald, OH.

U.S. Department of Energy (DOE), 1991b, "Remedial Investigation Report for Operable Unit 5, Task 6 Report," (draft), U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Department of Energy (DOE), 1991c, "Initial Screening of Alternatives for Operable Unit 2, Task 12 Report, Feed Materials Production Center, Fernald, Ohio," U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Department of Energy (DOE), 1992a, "Annual Site Environmental Report for Calendar Year 1991," FMPC-2275; Special UC-707, U.S. DOE, Fernald Office, Fernald, OH.

U.S. Department of Energy (DOE), 1992b, "CERCLA/RCRA Background Soil Study," FEMP, Fernald, OH, Draft, U.S. DOE, Fernald Field Office, Fernald, OH.

U.S. Department of Energy (DOE), 1992c, "Operable Unit 3 Work Plan Addendum," U.S. DOE, Fernald Field Office, Cincinnati, OH.

U.S. Department of Energy (DOE), 1992d, "RCRA/CERCLA Background Soil Study Sampling and Analysis Plan, Fernald Environmental Management Project, Fernald, Ohio, Remedial Investigation and Feasibility Study," U.S. DOE, Fernald Office, Fernald, OH.

0419

U.S. Department of Energy (DOE), 1992e, "Removal Site Evaluation - K65 Silos Radon Treatment System," U.S. DOE, Fernald Field Office, Fernald, OH.

U.S. Department of Energy (DOE), 1992f, "Remedial Investigation and Feasibility Study, Fernald Environmental Management Project, Fernald Ohio, Risk Assessment Work Plan Addendum," U.S. DOE, Fernald Office, Fernald, OH.

U.S. Department of Energy (DOE), 1992g, "Remedial Investigation Report for Operable Unit 2, FEMP, Fernald, OH, Remedial Investigation and Feasibility Study Draft Report," U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Department of Energy (DOE), 1992h, "Remedial Investigation Report for Operable Unit 4, Task 6 Report," (draft), U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Department of Energy (DOE), 1992i, "Risk Assessment Work Plan Addendum, Fernald Environmental Management Project, Remedial Investigation/Feasibility Study," U.S. DOE, Fernald Field Office, Cincinnati, OH.

U.S. Department of Energy (DOE), 1993a, "Development and Application of the ECTran Model to support RI/FS at the FEMP," prepared by Halliburton NUS, Fernald Environmental Management Program, U.S. DOE Field Office, Fernald, OH.

U.S. Department of Energy (DOE), 1993b, "Groundwater Modeling Report - Summary of Model Development, Appendix A," prepared by IT Corporation, Fernald Environmental Management Program, U.S. DOE, Fernald Field Office, Fernald, OH.

U.S. Department of Energy (DOE) 1993c, [Letter to U.S. EPA Region V, August 12,1993, response to comments for Operable Unit 4, from Jack Craig at U.S. DOE Fernald Field Office, Fernald, OH].

U.S. Department of Energy (DOE), 1993d, "Remedial Investigation Report for Operable Unit 4 (Final)," U.S. DOE, Fernald Field Office, Fernald, OH.

U.S. Department of Energy (DOE), 1993e, "Site-Wide Characterization Report, FEMP, Fernald, Ohio, Remedial Investigation and Feasibility Study," U.S. DOE, Fernald Office, Fernald, OH.

U.S. Department of Health, Education and Welfare, 1970, "Radiological Health Handbook," HEW, Bureau of Radiological Health", Rockville, MD.

U.S. Department of Labor, Bureau of Labor Statistics, 1988, "Reports on Survey of Occupational Injuries and Illnesses," U.S. DOE, Washington, D.C.

U.S. Department of Labor, Occupational Safety and Health Administration, 1991, "Occupational Safety and Health Standards," 29 CFR 1910, available from the U.S. Government Printing Office, Washington, D.C.

U.S. Department of Transportation, 1989, "49 CFR Parts 171, 172, 173, 174, 175, 176, 177, and 178: Transportation Regulations; Compatibility with Regulations of the International Atomic Energy Agency (IAEA): Notice of Proposed Rule," Federal Register, Volume 54, No. 218, available from the U.S. Government Printing Office, Washington, DC.

U.S. Department of Transportation Federal Highway Administration, Office of Motor Carriers, 1986, "Accidents of Motor Carriers of Property," Publication No. FHWA-MC-88-008, DOT, Washington, DC.

U.S. Department of Transportation Federal Railroad Administration, Office of Safety, 1988, "Accident/Incident Bulletin." Publication No. 157, U.S. DOT, Washington, DC.

U.S. Environmental Protection Agency (EPA)/ECOA, 1980a, "Ambient Water Quality Criteria Document: Phthalate Esters," EPA 440/5-80-067.

U.S. Environmental Protection Agency (EPA)/ECOA, 1980b, "Atlas Document for Phthalate Esters."

U.S. Environmental Protection Agency (EPA)/ECOA, 1990, Memorandum dated October 9, 1990 from Pei-Pung Hurst (ECOA) Cincinnati, OH, to R. Riccio, EPA Region III, Philadelphia, PA, Subject: Toxicity of Cobalt, (Halby Chemical/Wilmington, DE).

U.S. Environmental Protection Agency (EPA), no date, "Instructions for Reference Toxicants-Sodium Dodecyl Sulfate," U.S. EPA, EMSL, Cincinnati, OH.

U.S. Environmental Protection Agency (EPA), no date, "Instructions for Copper Sulfate Reference Toxicants," U.S. EPA, EMSL, Cincinnati, OH.

U.S. Environmental Protection Agency (EPA), 1977, "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Specific Methods," EPA-60/4-77-027a, U.S. EPA Office of Research and Development, Environmental Monitoring Systems Laboratory, Research Triangle Park, NC.

U.S. Environmental Protection Agency (EPA), 1979a, AIRDOS-EPA: "A Computerized Methodology for Estimating Environmental Concentrations and Doses to Man from Airborne Releases of Radionuclides," PB80-147838, U.S. EPA, Office of Radiation Programs, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1979b, "Multimedia Health Assessment Document for Polycyclic Organic Matter," prepared under contract by J. Santodonato et al., Syracuse Research Corporation. (Cited in U.S. EPA 1980a).

U.S. Environmental Protection Agency (EPA), 1979c, "Naphthalene: Ambient Water Quality Criteria (Draft)." (Cited in U.S. EPA, 1980a).

U.S. Environmental Protection Agency (EPA), 1979d, "Polynuclear Aromatic Hydrocarbons: Ambient Water Quality Criteria (Draft)." (Cited in U.S. EPA 1980a).

U.S. Environmental Protection Agency (EPA), 1980a, "Ambient Water Quality Criteria Document: Chlorinated Phenols," EPA 440/5-80-032.

U.S. Environmental Protection Agency (EPA), 1980b, "Ambient Water Quality Criteria for Polynuclear Aromatic Hydrocarbons," EPA 440/5-80-069, Office of Water Regulations and Standards, Washington, D.C. (Cited in ATSDR 1987).

U.S. Environmental Protection Agency (EPA), 1980c, "Identification and Listing of Hazardous Waste Under RCRA, Subtitle C, Section 3001," Health and Environmental Effects Profiles, Office of Solid Waste, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1980d, "Upgrading Environmental Radiation Data," EPA 520/1-80-012, prepared by Health Physics Society Committee, Report HPSR-1 (1980), for the Office of Radiation Programs, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1983, "Environmental Protection Agency Standards for Protection Against Uranium Mill Tailings," 40CFR192, as amended by 48FR45946, October 7, 1983, available from U.S. Government Printing Office, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1984a, "The Hydrologic Evaluation of Landfill Performance (HELP) Model," EPA/503-SW-84-009, Office of Solid Waste and Emergency Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1984b, "SESOIL - A Seasonal Soil Compartment Model," EPA/SWDF-86/005a, U.S. EPA Office of Toxic Substances, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1985a, Air/Superfund National Technical Guidance Series, Volume III.

U.S. Environmental Protection Agency (EPA), 1985b, "Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources," including Supplement E, October 1992, AP-42 Volume I, Office of Air and Radiation and Office of Air Quality Planning and Standards, Research Triangle Park, NC.

U.S. Environmental Protection Agency (EPA), 1985c, "Health Document for Polychlorinated Dibenzo-p-dioxins," EPA/600/8-84/014F, Office of Health and Environmental Assessment, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1985d, "Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites," EPA/600/8-85/002, Office of Health and Environmental Assessment, U.S. EPA, Washington, DC.

U.S. Environmental Protection Agency (EPA), 1986a, "Effects of Radiation on Aquatic Organisms and Radiobiological Methodologies for Effects Assessment," EPA/5201/1-85-016, Office of Radiation Programs, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1986b, "Guidelines for Carcinogen Risk Assessment", Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1986c, "Guidelines for the Health Risk Assessment of Chemical Mixtures," 51 Fed. Reg. 34014, September 26, 1986.

0422

U.S. Environmental Protection Agency (EPA), 1986d, "Hazardous Waste Management System: Identification and Listing of Hazardous Waste; Toxicity Characteristics Revisions: Final Rule," 40 CFR 261, Federal Register Vol. 55, No. 61, available from the U.S. Government Printing Office, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1986e, "Quality Criteria for Water 1986," EPA/44015/86-001, U.S. EPA Office of Water Regulations and Standards, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1987a, "A Method for Estimating Fugitive Particulate Emissions from Hazardous Waste Sites," EPA 600/2-87-066, U.S. EPA Office of Research and Development, Cincinnati, OH.

U.S. Environmental Protection Agency (EPA), 1987b, "Industrial Source Complex (ISC) Model User's Guide - Second Edition (revised)," EPA 450/4-88-002a, Office of Air Quality Planning and Standards, U.S. EPA, Research Triangle Park, NC.

U.S. Environmental Protection Agency (EPA), 1987c, "Low-Level and NARM Radioactive Wastes, Model Documentation PRESTO-EPA-POP, Volume 1, Methodology Manual; Volume II, Users Manual," EPA 520/1-87-024-1 AND 2, Office of Radiation Programs, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1988a, "Drinking Water Criteria Document for Polychlorinated Bipuenyls," ECAO-CIN-414, prepared by the Environmental Criteria and Assessment Office, Cincinnati, OH, for the Office of Water, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1988b, "The Effects of Acute Radiation on Reproductive Success of the Polychaete Worm Neanthes arenaceodentata," EPA/520/1-88/003, U.S. EPA, Office of Radiation Programs, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1988c, "The Effects of Chronic Radiation on Reproductive Success of the Polychaete Worm Neanthes arenaceodentata," EPA/520/1-88/004, U.S. EPA, Office of Radiation Programs, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1988d, "Guidance For Conducting Remedial Investigations and Feasibility Studies Under CERCLA," EPA/540/G-89/004, U.S. EPA Region V, Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1988e, "Laboratory Data Validation - Functional Guidelines For Evaluating Inorganic Analyses," U.S. EPA Hazardous Site Evaluation Division, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1988f, "Laboratory Data Validation - Functional Guidelines For Evaluating Organic Analyses," U.S. EPA Hazardous Site Evaluation Division, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1988g, "Limiting Values of Radionuclides Intake and Air Concentrations and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," Federal Guidance Report No. 11, EPA/520/1-88/020.

U.S. Environmental Protection Agency (EPA), 1988h, "ROD Annual Report, FY 1987," U.S. EPA Hazardous Site Control Division, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1988i, "Selection Criteria for Mathematical Models Used in Exposure Assessments: Ground-Water Models," EPA/600/8-88/075 U.S. EPA Office of Health and Environment Assessment, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1988j, "Superfund Exposure Assessment Manual," EPA/540/1-88/001, Office of Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1988k, "Thirteen-Week Mouse Oral Subchronic Toxicity Study," prepared by Toxicity Research Laboratories, Ltd., Muskegon, MI, for Office of Solid Waste, Washington, D.C. (Cited in U.S. EPA, 1992a).

U.S. Environmental Protection Agency (EPA), 1989a, "Air/Superfund National Technical Guidance Study Series, Volume IV - Procedures for Dispersion Modeling and Air Monitoring for Superfund Air Pathway Analysis," EPA/450/1-89/004, Office of Air Quality Planning and Standards, U.S. EPA, Research Triangle Park.

U.S. Environmental Protection Agency (EPA), 1989b, "Determining Soil Response Action Levels Based on Potential Contaminant Migration to Groundwater," EPA/540/2-89/057, U.S. EPA, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1989c, "Environmental Protection Agency National Primary Drinking Water Regulations," 40 CFR 141, as amended by 54FR27526, 27562, June 29, 1989 and 54FR30001, July 17, 1989, Bureau of National Affairs, Inc., Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1989d, "Evaluation of Groundwater Extraction Remedies," EPA/504/0289/054, U.S. EPA Office of Solid Waste and Emergency Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1989e, "Exposure Factors Handbook," EPA/600/8-89/043, U.S. EPA Office of Health and Environmental Assessment, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1989f, "Interim Final Guidance for Soil Ingestion Rates," OSWER Directive 9850.4, U.S. EPA, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1989g, "Interim Methods for Development of Inhalation Reference Doses," EPA/600/8-88/066F, U.S. EPA Office of Health and Environmental Assessment, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1989h, "Interim Procedures for Estimating Risks Associated with exposures to Mixtures of Chlorinated Dibenzo-p-dioxins and - Dibenzofurans (CDDs and CDFs) and 1989 Update," prepared by the Risk Assessment Forum for the Office of Health and Environmental Assessment, EPA/625/3-89/016, U.S. EPA Washington, D.C.

0424

U.S. Environmental Protection Agency (EPA), 1989i, "Mouse Oral Subchronic Study with Acenaphthene," Study Conducted by Hazelton Laboratories, Inc., for the Office of Solid Waste, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1989j, "Mouse Oral Subchronic Toxicity of Pyrene," Study Conducted by Research Laboratories, Muskegon, MI, for the Office of Solid Waste, Washington, D.C. (Cited in U.S. EPA 1992b).

U.S. Environmental Protection Agency (EPA), 1989k, "Mouse Oral Subchronic Toxicity Study," prepared by Toxicity Research Laboratories, Ltd., Muskegon, MI, for the Office of Solid Waste, Washington, D.C. (Cited in U.S. EPA 1992b).

U.S. Environmental Protection Agency (EPA), 1989l, "Risk Assessment Guidance for Superfund, Human Health Evaluation Manual," Part A, Interim Final, EPA/540/1-89/002, U.S. EPA, Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1989m, "Risk Assessment Guidance for Superfund, Volume II: Environmental Evaluation Manual," EPA/540/1-89/001, U.S. EPA, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1989n, "Risk Assessment Methodology Environmental Impact Statement NESHAPS for Radionuclides, Background Information Document - Volume 1," Office of Radiation Programs, EPA/520/1-89/005, U.S. EPA, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1989o, "ROD Annual Report, FY 1988," EPA/540/8-89/006, U.S. EPA, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1989p, "Statistical Analysis of Ground Water Monitoring Data at RCRA Facilities, Interim Final Guidance," U.S. EPA Office of Solid Waste, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1989q, "Statistical Methods for Evaluating the Attainment of Cleanup Standards, Volume 1: Soils and Solid Media," EPA/530-SW-89-026, U.S. EPA Office of Solid Waste, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1989r, "Subchronic Toxicity in Mice with Anthracene, Final Report," Hazelton Laboratories America, Inc., prepared for Office of Solid Waste, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1989s, "Users Guide for AIRDOS-PC, Version 3.0," EPA/520/6-89/035, U.S. EPA Office of Radiation Programs, Las Vegas Facility, Las Vegas, NV.

U.S. Environmental Protection Agency (EPA), 1989t, "Users Guide for the SYSCPG Program. A PC Version of the PRESTO-EPA-CPG Operation System," EPA/520/1-89/017, U.S. EPA Office of Radiation Programs, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1989u, "OSWER Directive No. 9355.4-02: Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites," Memorandum from H.L. Longest II and B. Diamond to the EPA Regional Directors.

U.S. Environmental Protection Agency (EPA), 1990a, "1989 Update to the Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-dioxin and -Dibenzofurans (CDDs and CDFs), Part II," U.S. EPA, Risk Assessment Forum, Washington D.C.

U.S. Environmental Protection Agency (EPA), 1990b, "40 CFR Parts 264, 265, 270 and 271, Corrective Action Solid Waste Management Units at Hazardous Waste Management Facilities: Proposed Rule," Federal Register, Vol. 55, No. 145, available from the U.S. Government Printing Office, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1990c, "EPA Treatability Database," U.S. EPA, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1990d, "Guidance for Data Useability in Risk Assessment," Interim Final, EPA/540/G-90/008, U.S. EPA, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1990e, "ROD Annual Report, FY 1989," EPA/540/8-90/006, U.S. EPA, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1990f, "National Oil and Hazardous Substances Pollution Contingency Plan," Final Rule, FR Vol. 55, No. 46, March 8, 1990, available from U.S. Government Printing Office, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1990g, "Statistical Methods for Evaluating the Attainment of Cleanup Standards, Volume 3 (Draft)," U.S. EPA, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1990h, "Users Guide for Lead: A PC Software Application of Uptake/Biokinetic Model, Version 0.40," ECAO-CIN, U.S. EPA Environmental Criteria and Assessment Office of Health and Environmental Assessment, Cincinnati, OH.

U.S. Environmental Protection Agency (EPA), 1991, OSWER Standard Default Exposure Parameters.

U.S. Environmental Protection Agency (EPA), 1991a, "Drinking Water Criteria Document for Polycyclic Aromatic Hydrocarbons (PAHs)," prepared by the Environmental Criteria and Assessment Office, Cincinnati, OH, for the Office of Water, Washington, D.C

U.S. Environmental Protection Agency (EPA), 1991b, "Future Residential Land Use Ground Water Exposure Point Concentrations for the Baseline Risk Assessment," [Memorandum from John Kelly to Remedial and Enforcement Response Branch RPMs and Supervisors, May 10, 1991, Region V, Chicago, IL.]

U.S. Environmental Protection Agency (EPA), 1991c, "Health Effects Assessment Summary Tables, FY - 1991," OERR 9200.6-303(91-1), U.S. EPA, Washington, DC.

U.S. Environmental Protection Agency (EPA), 1991d, "Interim Guidance for Dermal Exposure Assessment," EPA/600/8-91/011A, U.S. EPA Office of Research and Development, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1991e, "National Primary Drinking Water Regulations; Radionuclides; Proposed Rule," 40 CFR 141 and 142, Federal Register, Vol. 56, July 18, 1991 available from U.S. Government Printing Office, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1991f, "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Part B, Development of Risk-Based Preliminary Remediation Goals, Interim," Publication 9285.7-01B, U.S. EPA Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1991g, "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Supplemental Guidance, Standard Default Exposure Factors, Interim Final," U.S. EPA Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1991h, "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Part C, Risk Evaluation of Remedial Alternatives, Interim," Publication 9285.7-01C, U.S. EPA Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1991i, "Superfund Fact Sheet Proposed Plan, Maxey Flats Disposal Site, Fleming County, KY," U.S. EPA, Region 14, Atlanta, GA.

U.S. Environmental Protection Agency (EPA), 1991j, "User's Guide for CAP 88-PC, Version 1.0" EPA520/6-91/022, U.S. EPA Office of Radiation Programs, Las Vegas, NV.

U.S. Environmental Protection Agency (EPA), 1992a, "Guidance for Conducting Treatability Studies Under CERCLA," EPA/540/R-92/071a, Office of Solid Waste and Emergency Response, U.S. EPA, Washington, DC.

U.S. Environmental Protection Agency (EPA), 1992b, "Guidance for Exposure Assessment; Notice," Federal Register, Volume 57, No. 104, pp. 22888-22938.

U.S. Environmental Protection Agency (EPA), 1992c, "Guidance on Risk Characterization for Risk Assessors and Risk Managers," [Memorandum dated February 26, 1992].

U.S. Environmental Protection Agency (EPA), 1992d, "Health Effects Assessment Summary Tables, Annual Update FY 1992," including Supplement A, July 1992, prepared by the Environmental Criteria Assessment Office, Cincinnati, OH, for the Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1992e, "User's Guide for the Industrial Source Complex (ISC2) Dispersion Model, Volume II - Description of Model Algorithms," including Addendum A, September 1992, EPA-540/4-92-008b, Office of Air Planning and Standards, Research Triangle Park, NC.

U.S. Environmental Protection Agency (EPA), 1992f, "Dermal Exposure Assessment: Principles and Applications," EPA/600/8-91/011B, Office of Research and Development, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1993a, "Integrated Risk Information System (IRIS)," computer database, U.S. EPA, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1993b, "Residual Sampling for K-65 Silos Sampling and Analysis Plan," U.S. DOE, Feed Materials Production Center, Fernald, OH.

U.S. Geological Survey (USGS), 1990, "Water Quality Data Collected for National Stream Quality Accounting Network," data printout for Gauge Number 03274600, Great Miami River at New Baltimore, OH, for 1974 to 1982, USGS, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC), 1977, "Calculation of Annual doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Regulatory Guide 1.109, U.S. NRC, Office of Standards Development, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC), 1984, "Radon Attenuation Handbook for Uranium Mill Tailing Cover Design," NUREG/CR-3533, Office of Nuclear Regulatory Research, U.S. NRC, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC), 1989, "10 CFR Part 91: Transportation Regulations: Compatibility with the International Atomic Energy Agency (IAEA): Proposed Rule," Federal Register, Vol. 53, No. 110, available from U.S. Government Printing Office, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC), 1991a, "Standards for Protection Against Radiation," 10CFR20, available from U.S. Government Printing Office, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC), 1991b, "Technical Position on Waste Form (Rev. 1)," prepared by Low-Level Waste Management Branch, Division of Low-Level Waste Management and Decommissioning, for the NRC Office of Nuclear Material Safety and Safeguards, Washington, DC.

United Nations Scientific Committee on the Effects on Atomic Radiation (UNSCEAR), 1977, "Sources and Effects of Ionizing Radiation," Report to the General Assembly, with Annexes, United Nations Scientific Committee on the Effects of Atomic Radiation, New York, NY.

United Nations Scientific Committee on the Effects on Atomic Radiation (UNSCEAR), 1982, "Ionizing Radiation: Sources and Biological Effects," Report to the General Assembly, with Annexes, United Nations Scientific Committee on the Effects of Atomic Radiation, New York, NY.

United Nations Scientific Committee on the Effects on Atomic Radiation (UNSCEAR), 1988, "Sources, Effects and Risks of Ionizing Radiation," Report to the General Assembly, with Annexes, United Nations Scientific Committee on the Effects of Atomic Radiation, New York, NY.

University of Cincinnati College of Engineering, May 11, 1990, "A Baseline Risk Assessment for the K-65 Silos Using EPA Methodology for Applicability to the EE/CA," Revision 1.

Urban Studies Center, Population Studies Program, 1988, "How Many Kentuckians: Population Forecasts, 1985-2020, 1988 Edition", College of Urban and Public Affairs, University of Louisville, KY.

Van der Leeden, F., F.L. Troise and D.K. Todd, 1990, The Water Encyclopedia, 2nd ed., Lewis Publishers, Inc., Chelsea, MI.

Van Genuchten, R., 1978, "Calculation of the Unsaturated Hydraulic Conductivity with a New Closed Form Analytical Model," Research Report 78-WR-08, Princeton University, Princeton, NJ.

Vanich, et al., 1976, "The Fate of Intratracheally Instilled Benzo(a)pyrene in the Isolated Perfused Rat Lung of Both Control and 20-methylcholanthrene Pretreated," Research Communications in Chemical Pathology and Pharmacology, Volume 13, pp. 259. (Cited in U.S. EPA 1980a).

van Kaick, G., A. Kaul, D. Lorenz, H. Muth, K. Wegener, H. Wesch, 1978a, "Late Effects and Tissue Dose in Thorotrast Patients-Recent Results of the German Thorotrast Study," Late Biological Effects of Ionizing Radiation, International Atomic Energy Agency, Vienna, Austria, Volume 1, pp. 263-276.

van Kaick, G., A. Kaul, D. Lorenz, H. Muth, 1978b, "Malignancies in German Thorotrast Patients and Estimated Tissue Dose," Health Physics, Volume 35, pp. 127-136.

van Kaick, G., H. Muth, A. Kaul, H. Immich, D. Liebermann, D. Lorenz, W.J. Lorenz, H. Luhrs, K.E. Scheer, G. Wagner, K. Wegener, and H. Wesch, 1983, "Recent Results of the German Thorotrast Study - Epidemiological Results and Dose Effect Relationships in Thorotrast Patients," Health Physics, Volume 44, Suppl. 1, pp. 299-306.

van Kaick, G., H. Muth, A. Kaul, H. Immich, D. Liebermann, W.J. Lorenz, D. Lorenz, W.J. Luhrs, K.E. Scheer, G. Wagner, K. Wegener, H. Wesch, 1984a, "Results of the German Thorotrast Study," Radiation Carcinogenesis, Epidemiology and Biological Significance, J.D. Boice, Jr. and J.F. Fraumeni, Jr., eds., Raven, New York.

van Kaick, G., H. Muth, A. Kaul, 1984b, "The German Thorotrast Study," Results of Epidemiological, Clinical and Biophysical Examinations on Radiation-Induced Late Effects in Man Caused by Incorporated Colloidal Thorium Dioxide (Thorotrast), Report No. EUR 9504 EN, Commission of the European Communities, Luxembourg, Germany.

van Kaick, G., H. Muth, A. Kaul, H. Immich, D. Liebermann, W.J. Lorenz, H. Luhrs, K.E. Scheer, G. Wagner, K. Wegener, H. Wesch, 1986, "Report on the German Thorotrast Study," Strahlentherapie, Volume 80, pp. 114-118.

Van Miller, J.P., R.J. Marlar, J.R. Allen, 1976, "Tissue Distribution and Excretion of Tritiated Tetrachlorodibenzo-p-dioxin in Non-human Primates and Rats," Food Cosmet. Toxicol, Volume 14, pp. 31-34 (Cited in U.S. EPA 1985).

Verschueren, K., 1989, "Handbook of Environmental Data on Organic Chemicals," 2nd ed., Van Nostrand Reinhold, New York, NY.

Vitor Corporation of America, New York, 1952, "Summation Report: Recovery of Radium from K-65 Residue," Document No. KLX-1222.

Vogel, R.A., 1989, [Letter from R.A. Vogel to Thomas A. Tank, WMCO:SWE:89-006 (dated April 21, 1989), Subject: Transmittal of Information.]

Vormelker, J., 1985, "Top of Rock Map of Hamilton County, Ohio," Open File Map 229, Ohio Department of Natural Resources, Div. of Geological Survey, Columbus, OH.

Wagoner, J.K., V.E. Archer, B.E. Carroll, and D.A. Holaday, 1964, "Cancer Mortality Patterns Amongst U.S. Uranium Miners and Millers, 1950 through 1962," Journal of the National Cancer Institute, Vol. 32, pp. 787-801.

Walker, A.C., 1986, "Groundwater Resources of Hamilton County," map available from the Ohio Department of Natural Resources, Div. of Water, Columbus, OH.

Walton, J.C., and R.R. Seitz, 1991, "Performance of Intact and Partially Degraded Concrete Barriers in Limiting Fluid Flow," NUREG/CR-516 EGG-2614.

Walton, W.C. and E.J. Schaefer, 1956, "Report to the Southwestern Ohio Water Company on Evaluation of the Potential Yield of the Aquifer in the Big Bend Area, Ohio," Mimeographed Report.

Warren-Hicks, W., B.R. Parkhurst and S.S. Baker, 1989, "Ecological Assessments of Hazardous Waste Sites: A Field and Laboratory Reference Document," EPA/600/3-89/013, U.S. EPA, Washington, D.C.

Watkins, J.S. and A.M. Spieker, 1971, "Seismic Reduction Survey of Pleistocene Drainage Channels in the Lower Great Miami River Valley, Ohio," Professional Paper 605-B, USGS, Columbus, OH.

Waxweiler, R.J., V.E. Archer, R.J. Roscoe, A. Watanabe, and J.J. Thun, 1983, "Mortality Patterns Among a Retrospective Cohort of Uranium Mill Workers," Proceedings of the Health Physics Society, presented at Epidemiology Applied to Health Physics, pp. 428-435.

Weber, C.I., 1973, "Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents," EPA-670/4-73-001, U.S. EPA, Cincinnati, OH.

Weber, C.I., W.H. Peltier, T.J. Norberg-King, W.B. Horning, F.A. Kessler, J.R. Menkedick, T.W. Neiheisel, P.A. Lewis, D.J. Klemm, Q.H. Pickering, E.L. Robinson, J.M. Lzaorchak, L.J. Wymer, and R.W. Freyberg, 1989, "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms," 2nd ed., EPA/600/4-89/001, U.S. EPA, Cincinnati, OH.

Webster, C.D., H.J. Serazin, and M.J. Knapp, 1988, "A Report on the Acute Toxicity of U.S. Department of Energy Feed Materials Production Center at Fernald Outfall 001 Effluents to Pimephales promelas and Ceriodaphnia affinis/dubia," Bioassay Report No. 88-565-SW, Surface Water Monitoring Section, Div. Water Quality Monitoring and Assessment, Ohio EPA, Dayton, OH.

Webster, R.C., D.A.W. Bucks, H.I. Maibach et. al., 1983, "Polychlorinated Biphenyls (PCBs): Dermal Absorption, Systemic Elimination, and Dermal Wash Efficiency," Journal of Toxicology and Environmental Health, Volume 12, pp. 511-519. (Cited in ATSDAR 1991).

Webster, R.C., H.I. Maibach, D.A. Bucks et. al., 1990, "Percutaneous Absorption and Skin Decontamination of PCBs: In Vitro Studies with Human Skin and In Vivo Studies in the Rhesus Monkey," Journal of Toxicology and Environmental Health, Volume 12, pp. 511-519. (Cited in ATSDR 1991).

Wenning, R. N. Kirsch, 1988, "Stronium," Handbook on Toxicity of Inorganic Compounds, H.G. Sieler, H. Sigel, A. Sigel, eds., Marcel Dekker, Inc., New York, NY, pp. 631-638.

Wesch, H., H. Kampmann, and K. Wegener, 1973, "Assessment of Organ Distribution of Thorium by Neutron-Activation-Analysis," Proceedings of the Third International Meeting on the Toxicity of Thorotrast, Riso Report 294, M. Faber, ed., Danish Atomic Energy Commission, Copenhagen, Denmark, pp. 52-60.

Wesch, H., U.W. Riedel, K. Hasenohrl, K. Wegener, A. Kaul, H. Muth, H. Immich, and G. van Kaick, 1983, "Recent Results of the German Thorotrast Study - Statistical Evaluation of Animal Experiments With Regard to the Nonradiation Effect in Human Thorotrastosis," Health Physics, Vol. 44, Suppl. 1, pp. 317-321.

Wesch, H., U.W. Riedel, K. Hasenohrl, K. Wegener, A. Kaul, H. Muth, and G. van Kaick, 1986, "German Thorotrast Study: Results of the Long-Term Animal Studies on the Effect of Incorporated Radioactive and Nonradioactive Particles," Strahlentherapie, Vol. 80, pp. 186-188.

Westinghouse Materials Company of Ohio (WMCO), 1986a, "History of FMPC Radionuclide Discharge," Revision, WMCO, Cincinnati, OH, prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Westinghouse Materials Company of Ohio (WMCO), 1986b, "Feed Materials Production Center Environmental Monitoring Annual Report for 1985," FMPC-2047, WMCO, Cincinnati, OH, prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Westinghouse Materials Company of Ohio (WMCO), 1987, "Feed Materials Production Center Environmental Monitoring Annual Report for 1986," FMPC-2076, WMCO, Cincinnati, OH, prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Westinghouse Materials Company of Ohio (WMCO), 1988a, "Feed Materials Production Center Environmental Monitoring Annual Report for 1987," FMPC-2135, WMCO, Cincinnati, OH, prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Westinghouse Materials Company of Ohio (WMCO), 1988b, "Fugitive Dust Emissions from FMPC Waste Pits," Ref. WMCO:EVP:88-153, "Air Emission Update," WMCO, Cincinnati, OH, prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Westinghouse Materials Company of Ohio (WMCO), 1988c, "Hydrogeologic Study of FMPC Discharge to the Great Miami River, Final Report," WMCO, Cincinnati, OH, prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Westinghouse Materials Company of Ohio (WMCO), 1989, "Feed Materials Production Center Environmental Monitoring Annual Report for 1988," FMPC-2173, WMCO, Cincinnati, OH, prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Westinghouse Materials Company of Ohio (WMCO), 1990a, "Conceptual Design Report - Above-Ground Engineered Storage," Fernald: WMCO.

Westinghouse Materials Company of Ohio (WMCO), 1990b, "Annual Environmental Report for Calendar Year 1989," FMPC-2200, WMCO, Cincinnati, OH, prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Westinghouse Materials Company of Ohio (WMCO), 1990c, "Feed Materials Production Center Environmental Monitoring Annual Report for 1989," FMPC-2200, WMCO, Cincinnati, OH, prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Westinghouse Materials Company of Ohio (WMCO), 1990d, "Effluent Radiation Reports" and "Discharge Monitoring Reports" for Manhole 176, Sept. 1988, May 1989, June 1989, Jan. 1990, Apr. 1990, and May 1990, [memo from S.M. Beckman, WMCO:EC(AW):90-134, to C. Duke, July 20, 1990].

Westinghouse Materials Company of Ohio (WMCO), 1991, "Feed Materials Production Center Environmental Monitoring Annual Report for 1990," FMPC-2245, WMCO, Cincinnati, Ohio, prepared for the U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Westinghouse Materials Company of Ohio (WMCO), 1992, "Feed Materials Production Center Environmental Monitoring Annual Report for 1991," WMCO, Cincinnati, OH, prepared for U.S. DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Weston, R.F., 1986a, "Department of Energy Feed Materials Production Center, Fernald, OH - Site Characterization of the Waste Storage Areas, Part 1: Evaluation of Current Situation," Weston, Inc., West Chester, PA, prepared for WMCO.

Weston, R.F., 1986b, "Site Characterization of the Waste Storage Areas," Part 2, Vols. 1 and 2, support documentation, prepared for WMCO.

Weston, R.F., 1987a, "Characterization Investigation Study, Volume 1: Geophysical Survey," prepared for Westinghouse Materials Company of Ohio, U.S. DOE Feed Materials Production Center, Fernald, OH.

Weston, R.F., 1987b, "Characterization Investigation Study, Volume 2: Chemical and Radiological Survey of Surface Soils," prepared for Westinghouse Materials Company of Ohio, U.S. DOE Feed Materials Production Center, Fernald, OH.

Weston, R.F., 1987c, "Characterization Investigation Study, Volume 3: Radiological Survey of Surface Soils," prepared for Westinghouse Materials Company of Ohio, U.S. DOE Feed Materials Production Center, Fernald, OH.

Wetzel, R.G., 1975, Limnology, W.B. Saunders Company, Philadelphia, PA.

Whittemore, A.S. and A. McMillan, 1983, "Lung Cancer Mortality Among U.S. Uranium Miners: A Reappraisal," J. of National Cancer Institute, Vol. 71, pp. 489-499.

Wilhm, J.L., 1967, "Comparison of Some Diversity Indices Applied to Populations of Benthic Macroinvertebrates in a Stream Receiving Organic Wastes," J. Water Pollution Control Federation, Vol. 39, pp. 1673-1783.

Wilhm, J.L. and T.C. Dorris, 1968, "Species Diversity of Benthic Macroinvertebrates in a Stream Receiving Domestic and Oil Refining Influents," American Midland Naturalist, Vol. 76, No. 2, pp. 427-449

Windholtz, M., S. Budavari, 1983, The Merck Index, 10th d., Rahway, NJ, Merck & Co.

Wolery, T.J., 1983, "EQ3NR, A Computer Program for Geochemical Aqueous Speciation-Solubility Calculations:User's Guide and Documentation," UCRL-53414, Lawrence Livermore National Laboratory, Livermore, CA.

Wolery, T.J., 1984, "EQ6, A Computer Program for Reaction-Path Modeling of Aqueous Geochemical Systems: User's Guide and Documentation," UCRL-51Draft, Lawrence Livermore National Laboratory, Livermore, CA.

Wolery, T.J. and S.A. Daveler, 1989, "EQ6, A Computer Program for Reaction-Path Modeling of Aqueous Geochemical Systems: User's Guide and Documentation," Draft, Distribution Category UC-70, Lawrence Livermore National Laboratory, Livermore, CA.

Wolff, M.S., 1985, "Occupational Exposure to Polychlorinated Biphenyls (PCBs)," Environmental Health Perspectives, Volume 60, pp. 133-138. (Cited in ATSDR 1991).

Wolff, M.S., J. Thornton, A. Fischbein et al., 1982, "Disposition of Polychlorinated Biphenyl Congeners in Occupationally Exposed Persons," Toxicology and Applied Pharmacology, Volume 62, pp. 294-306. (Cited in ATSDR 1991).

Wrenn, M.E., P.W. Durbin, D.L. Wilis, N.P. Singh, 1987, "The Potential Toxicity of U in Water," Journal of the American Water Works Association, Volume 79, pp. 177-184.

Yuile, C.L., 1973, "Animal Experiments (Chapter 3)," Uranium, Plutonium, and the Transuranic Elements, Hodge, Stannard, and Hursh, eds.

Zach, R. and K.R. Mayoh, 1984, "Soil Ingestion by Cattle: A Neglected Pathway," Health Physics, Vol. 46, No. 2, pp. 426-431.

# ATTACHMENT K.I

# INPUT FILES TO ODAST MODELING

# U-238 Input File for ODAST Model

- 5208

{This page intentionally left blank}

# U-238 INPUT FILE FOR ODAST MODEL



```
1
EWMF FOR CRU-4
    1     1          0.0    0
    1 5.653E+08  7.00E+00 8.476E+01 9.453E+00 U-238
    2
   70    71    85    85
   69    71    86    86
    0
EWMF FOR CRU-3
    2     2          0.    0
    1 2.634E+12 1.787E-03  8.476E+01 9.453E+00 U-238
   31
   72    73    82    82
   71    71    81    82
   76    76    79    80
   75    75    78    80
   72    74    77    81
   70    71    78    80
   69    69    78    78
   73    73    75    76
   72    72    73    76
   69    71    72    77
   70    70    69    71
   69    69    68    71
   66    68    67    72
   65    65    68    71
   64    64    68    70
   63    63    69    69
   60    61    63    63
   59    62    62    62
   59    63    61    61
   58    63    59    60
   56    57    59    59
   55    63    58    58
   54    62    57    57
   54    61    55    56
   51    53    55    55
   50    60    53    53
   49    59    52    52
   50    59    51    51
   52    58    50    50
   53    57    49    49
   55    56    48    48
    0
EWMF FOR CRU-1
    3     3          0.0    0
    1 4.136E+12 1.320E+01 8.476E+01 9.453E+00 U-238
    8
   43    44   102   102
   45    45   101   102
   46    47   100   102
   48    49    99   102
   50    53    98   102
   51    52    97    97
   54    54    99   102
   55    55   101   102
    0
CRU-2 : SOLID WASTE LANDFILL
```

52

```
    4     4        0.0    0
    1 1.083E+09 3.610E-03 8.476E+01 9.453E+00 U-238
    3
   51    52    93    93
   50    52    92    92
   50    51    91    91
    0
CRU-2 : NORTH LIME SLUDGE POND
    5     5        0.0    0
    1 4.337E+07 6.322E-04  8.476E+01 9.453E+00 U-238
    1
   42    43    81    81
    0
CRU-2 : SOUTH LIME SLUDGE POND
    6     6        0.0    0
    1 8.782E+07 6.322E-04  8.476E+01 9.453E+00 U-238
    1
   42    43    80    80
    0
CRU-2 : FLYASH AND SOUTH FIELD
    7     7        0.0     0
    1 6.467E+09 4.320E-03  8.476E+01 9.453E+00 U-238
   10
   30    31    65    65
   29    31    64    64
   29    32    63    63
   31    33    62    62
   30    33    61    61
   30    32    60    60
   30    31    59    59
   29    30    58    58
   30    30    57    57
   32    33    55    57
    0
CRU-3 : WEST OF PLANT AREA
    8     8        0.0   0
    1 8.742E+08 5.563E-01  8.476E+01 9.453E+00 U-238
    5
   41    41    88    88
   40    42    87    87
   39    43    86    86
   39    42    85    85
   41    42    84    84
    0
CRU-3 : EAST OF PLANT AREA
    9     9        0.0   0
    1 4.080E+08 5.563E-01  8.476E+01 9.453E+00 U-238
    3
   65    65    64    64
   64    67    63    63
   65    66    62    62
    0
CRU-4 : SILOS 1 2 & 3
   10    10        0.0   0
    1 1.083E+07  1.50E-00  8.476E+01 9.453E+00 U-238
    4
   36    37    87    87
   39    37    86    86
```

```
   34    36    84    84
   34    35    83    83
    0
CRU-3 : PLANT 2/3 AREA
   11    11        0.0    0
    1 9.325E+08 5.563E-01  8.476E+01 9.453E+00 U-238
    1
   47    50    76    79
    0
CRU-3 : PLANT 6 AREA
   12    12        0.0    0
    1 4.662E+08 5.563E-01  8.476E+01 9.453E+00 U-238
    3
   57    58    70    72
   58    58    73    73
   59    59    72    72
    0
CRU-3 : PLANT 9 AREA
   13    13        0.0    0
    1 4.662E+08 5.563E-01  8.476E+01 9.453E+00 U-238
    3
   58    60    74    75
   57    57    75    75
   58    58    76    76
    0
CRU-3 : OTHER MAIN PLANT BUILDINGS
   14    14        0.0    0
    1 4.403E+09 2.553E-02  1.231E+03 9.453E+00 U-238
   27
   52    54    89    90
   51    56    66    88
   57    58    86    87
   59    60    86    86
   57    62    84    85
   57    63    77    83
   64    65    79    83
   64    64    78    78
   59    63    76    76
   74    75    74    75
   59    61    73    73
   60    61    72    72
   59    60    70    71
   57    58    68    69
   57    57    65    67
   54    56    64    65
   50    50    87    88
   49    50    80    86
   47    48    81    83
   47    48    80    80
   45    46    76    80
   44    50    70    75
   48    50    68    69
   49    50    67    67
   44    44    86    88
   43    43    71    76
   42    42    72    74
    0
```



0439

```
15    15          0.0  1
 1 7.527e+06 0.201e+00  8.476E+01 9.453E+00 U-238
 1
20    64    56   102
 0
```

5208

0440

- 5208

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| EWMF FOR CRU-4 | | | | | | | |
| 1 | 0.5118 | .039 | .02642 | .340 | .09 | 45.00 | .39 |
| EWMF FOR CRU-3 | | | | | | | |
| 2 | 0.5118 | .039 | .02642 | .340 | .09 | 45.00 | .39 |
| EWMF FOR CRU-1 | | | | | | | |
| 3 | 1.4890 | .039 | .02642 | .340 | .09 | 45.00 | .39 |
| CRU-2 : SOLID WASTE LANDFILL | | | | | | | |
| 4 | 0.1752 | .039 | .02642 | .340 | .09 | 45.00 | .39 |
| CRU-2 : NORTH LIME SLUDGE POND | | | | | | | |
| 5 | 0.1752 | .039 | .02642 | .340 | .09 | 45.00 | .39 |
| CRU-2 : SOUTH LIME SLUDGE POND | | | | | | | |
| 6 | 0.1752 | .039 | .02642 | .340 | .09 | 45.00 | .39 |
| CRU-2 : FLYASH AND SOUTH FIELD | | | | | | | |
| 7 | 0.1752 | .039 | .02642 | .340 | .09 | 45.00 | .39 |
| CRU-3 : WEST OF PLANT AREA | | | | | | | |
| 8 | 7.5000 | .039 | .02642 | .340 | .09 | 45.00 | .39 |
| CRU-3 : EAST OF PLANT AREA | | | | | | | |
| 9 | 7.5000 | .039 | .02642 | .340 | .09 | 45.00 | .39 |
| CRU-4 : SILO 1 2 & 3 | | | | | | | |
| 10 | 6.0000 | .039 | .02642 | .340 | .09 | 45.00 | .39 |
| CRU-3 : PLANT 2/3 AREA | | | | | | | |
| 11 | 0.7500 | .039 | .02642 | .340 | .09 | 45.00 | .39 |
| CRU-3 : PLANT 6 AREA | | | | | | | |
| 12 | 0.7500 | .039 | .02642 | .340 | .09 | 45.00 | .39 |
| CRU-3 : PLANT 9 AREA | | | | | | | |
| 13 | 0.7500 | .039 | .02642 | .340 | .09 | 45.00 | .39 |
| CRU-3 : OTHER MAIN PLANT AREA | | | | | | | |
| 14 | 7.5000 | .039 | .02642 | .340 | .09 | 45.00 | .39 |
| perched water | | | | | | | |
| 15 | 7.5000 | .039 | .02642 | .340 | .09 | 45.00 | .39 |

5208

# TC-99 Input File for ODAST Model

0443

= 5208

{This page intentionally left blank}

52 08

# TC-99 INPUT FILE FOR ODAST MODEL

```
1
EWMF FOR CRU-3
  1   1     100.  0
  1 2.615E+04 1.055E-03    Tc-99
 31
 72  73  82  82
 71  71  81  82
 76  76  79  80
 75  75  78  80
 72  74  77  81
 70  71  78  80
 69  69  78  78
 73  73  75  76
 72  72  73  76
 69  71  72  77
 70  70  69  71
 69  69  68  71
 66  68  67  72
 65  65  66  71
 64  64  68  70
 63  63  69  69
 60  61  63  63
 59  62  62  62
 59  63  61  61
 58  63  59  60
 56  57  59  59
 55  63  58  58
 54  62  57  57
 54  61  55  56
 51  53  55  55
 50  60  53  53
 49  59  52  52
 50  59  51  51
 52  58  50  50
 53  57  49  49
 55  56  48  48
  0
EWMF FOR CRU-1
  2   2     100.0  0
  1 4.280E+07 3.359E-06    Tc-99
  8
 43  44  102  102
 45  45  101  102
 46  47  100  102
 48  49   99  102
 50  53   98  102
 51  52   97   97
 54  54   99  102
 55  55  101  102
  0
CRU-3 : WEST OF PLANT AREA
  3   3     0.0  0
  1 5.107E+03 1.055E-03    Tc-99
```

0445

```
 5
41  41  88  88
40  42  87  87
39  43  86  86
39  42  85  85
41  42  84  84
 0
CRU-3 : EAST OF PLANT AREA
 4   4      0.0  0
 1 2.383E+03 1.055E-03    Tc-99
 3
65  65  64  64
64  67  63  63
65  66  62  62
 0
CRU-3 : MAIN PLANT BUILDINGS
 5   5      0.0  0
 1 1.818E+05 1.055E+00    Tc-99
17
39  52  62  65
44  57  66  83
42  43  69  79
41  41  70  78
40  40  70  76
39  39  71  75
38  38  72  73
53  56  65  65
53  53  62  64
58  59  69  87
60  61  72  86
62  63  75  84
64  65  78  83
66  66  80  82
46  57  84  87
48  56  88  89
50  54  90  90
 0
```

5208

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| EWMF FOR CRU-3 | | | | | | | |
| 1 | 0.5118 | .039 | .02642 | .340 | .09 | 45.00 | .39 |
| EWMF FOR CRU-1 | | | | | | | |
| 2 | 1.4890 | .039 | .02642 | .340 | .09 | 45.00 | .39 |
| CRU-3 : WEST OF PLANT AREA | | | | | | | |
| 3 | 7.5336 | .039 | .02642 | .340 | .09 | 45.00 | .39 |
| CRU-3 : EAST OF PLANT AREA | | | | | | | |
| 4 | 7.5336 | .039 | .02642 | .340 | .09 | 45.00 | .39 |
| CRU-3 : MAIN PLANT BUILDINGS | | | | | | | |
| 5 | 7.5336 | .039 | .02642 | .340 | .09 | 45.00 | .39 |

0447

1 20. 8.9116E-09 1.75E+00 1.80E+00 Tc-99

- 5208

5208

# 2-Chlorophenol Input File for ODAST Model

0449

208

{This page intentionally left blank}

- 5208

# 2-CHLOROPHENOL INPUT FILE FOR ODAST MODEL

```
1
EWMF FOR CRU-3
  1   1     100.  0
  1 1.087E+07 0.190E+00    2chloro
 31
 72  73  82  82
 71  71  81  82
 76  76  79  80
 75  75  78  80
 72  74  77  81
 70  71  78  80
 69  69  78  78
 73  73  75  76
 72  72  73  76
 69  71  72  77
 70  70  69  71
 69  69  68  71
 66  68  67  72
 65  65  68  71
 64  64  68  70
 63  63  69  69
 60  61  63  63
 59  62  62  62
 59  63  61  61
 58  63  59  60
 56  57  59  59
 55  63  58  58
 54  62  57  57
 54  61  55  56
 51  53  55  55
 50  60  53  53
 49  59  52  52
 50  59  51  51
 52  58  50  50
 53  57  49  49
 55  56  48  48
  0
CRU-2 : ACTIVE FLYASH PILE
  2   2     0.0   0
  1 2.081E+06 1.533E-02    2chloro
  1
 32  33  55  57
  0
CRU-3 : WEST OF PLANT AREA
  3   3     0.0   0
  1 2.347E+07 0.190E+00    2chloro
  5
 41  41  88  88
 40  42  87  87
 39  43  86  86
 39  42  85  85
 41  42  84  84
  0
```

0451

5208

```
CRU-3 : EAST OF PLANT AREA
  4   4       0.0   0
  1 1.094E+07 0.190E+00     2chloro
  3
 65  65  64  64
 64  67  63  63
 65  66  62  62
  0
CRU-3 : MAIN PLANT BUILDINGS
  5   5       0.0   0
  1 8.343E+08 0.190E+00     2chloro
 17
 39  52  62  65
 44  57  66  83
 42  43  69  79
 41  41  70  78
 40  40  70  76
 39  39  71  75
 38  38  72  73
 53  56  65  65
 53  53  62  64
 58  59  69  87
 60  61  72  86
 62  63  75  84
 64  65  78  83
 66  66  80  82
 46  57  84  87
 48  56  88  89
 50  54  90  90
  0
```

- 5208

EWMF FOR CRU-3

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | 0.5118 | .039 | .02642 | .340 | .09 | 45.00 | .39 |

CRU-2 : FLYASH AND SOUTH FIELD

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2 | 0.6026 | .039 | .02642 | .340 | .09 | 45.00 | .39 |

CRU-3 : WEST OF PLANT AREA

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3 | 7.5336 | .039 | .02642 | .340 | .09 | 45.00 | .39 |

CRU-3 : EAST OF PLANT AREA

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4 | 7.5336 | .039 | .02642 | .340 | .09 | 45.00 | .39 |

CRU-3 : MAIN PLANT BUILDINGS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5 | 7.5336 | .039 | .02642 | .340 | .09 | 45.00 | .39 |

1453

1 20. 0.000E+00 1.82E+01 1.43E+01 2chloro

- 5208

# Cyanide Input File for ODAST Model

0455

{This page intentionally left blank}

5208

# CYANIDE INPUT FILE FOR ODAST MODEL

```
1
CRU-2 : SOLID WASTE LANDFILL
  1   1      0.0  0
  1 2.004E+07 2.846E-01     CYANIDE
  3
 51  52  93  93
 50  52  92  92
 50  51  91  91
  0
CRU-2 : FLYASH AND SOUTH FIELD
  2   2      0.0  0
  1 4.605E+07 1.554E-01     CYANIDE
  4
 30  31  65  65
 29  31  64  64
 29  31  63  63
 32  33  55  57
  0
CRU-3 : WEST OF PLANT AREA
  3   3      0.0  0
  1 9.049E+06 5.315E+00     CYANIDE
  5
 41  41  88  88
 40  42  87  87
 39  43  86  86
 39  42  85  85
 41  42  84  84
  0
CRU-3 : EAST OF PLANT AREA
  4   4      0.0  0
  1 4.222E+06 5.315E+00     CYANIDE
  3
 65  65  64  64
 64  67  63  63
 65  66  62  62
  0
CRU-3 : MAIN PLANT BUILDINGS
  5   5      0.0  0
  1 3.221E+08 5.315E+00     CYANIDE
 17
 39  52  62  65
 44  57  66  83
 42  43  69  79
 41  41  70  78
 40  40  70  76
 39  39  71  75
 38  38  72  73
 53  56  65  65
 53  53  62  64
 58  59  69  87
 60  61  72  86
 62  63  75  84
 64  65  76  83
```

0457

| | | | |
|---|---|---|---|
| 66 | 66 | 80 | 82 |
| 46 | 57 | 84 | 87 |
| 48 | 56 | 88 | 89 |
| 50 | 54 | 90 | 90 |
| 0 | | | |

5208

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CRU-2 : SOLID WASTE LANDFILL | | | | | | | |
| 1 | 0.3327 | .039 | .02642 | .340 | .09 | 45.00 | .39 |
| CRU-2 : FLYASH AND SOUTH FIELD | | | | | | | |
| 2 | 0.6026 | .039 | .02642 | .340 | .09 | 45.00 | .39 |
| CRU-3 : WEST OF PLANT AREA | | | | | | | |
| 3 | 7.5336 | .039 | .02642 | .340 | .09 | 45.00 | .39 |
| CRU-3 : EAST OF PLANT AREA | | | | | | | |
| 4 | 7.5336 | .039 | .02642 | .340 | .09 | 45.00 | .39 |
| CRU-3 : MAIN PLANT BUILDINGS | | | | | | | |
| 5 | 7.5336 | .039 | .02642 | .340 | .09 | 45.00 | .39 |

0459

| | | | | | |
|---|---|---|---|---|---|
| 1 | 5. | 9.500E-04 | 1.27E+00 | 1.21E+00 | CYANIDE |

5208

# ATTACHMENT K.II

## U-238 MASS LOADING RATES TO THE SWIFT III MODEL

U-238 MASS LOADING RATES TO THE SWIFT III MODEL

- 5208

| | |
|---|---|
| TIME = 10.0 (YEARS) | (LB/DAY) |
| EXTRA LOADING | 0.17896E-01 |
| TIME = 20.0 (YEARS) | |
| EXTRA LOADING | 0.13023E-01 |
| TIME = 30.0 (YEARS) | |
| EXTRA LOADING | 0.94523E-02 |
| TIME = 40.0 (YEARS) | |
| EXTRA LOADING | 0.68477E-02 |
| TIME = 50.0 (YEARS) | |
| EXTRA LOADING | 0.49992E-02 |
| TIME = 60.0 (YEARS) | |
| EXTRA LOADING | 0.36171E-02 |
| TIME = 70.0 (YEARS) | |
| 1 EWMF FOR CRU-4 | 0.00000E+00 |
| 2 EWMF FOR CRU-3 | 0.00000E+00 |
| 3 EWMF FOR CRU-1 | 0.00000E+00 |
| 4 CRU-2 : SOLID WASTE | 0.00000E+00 |
| 5 CRU-2 : NORTH LIME S | 0.00000E+00 |
| 6 CRU-2 : SOUTH LIME S | 0.00000E+00 |
| 7 CRU-2 : FLYASH AND S | 0.00000E+00 |
| 8 CRU-3 : WEST OF PLAN | 0.00000E+00 |
| 9 CRU-3 : EAST OF PLAN | 0.00000E+00 |
| 10 CRU-4 : SILOS 1 2 & | 0.00000E+00 |
| 11 CRU-3 : PLANT 2/3 AR | 0.00000E+00 |
| 12 CRU-3 : PLANT 6 AREA | 0.00000E+00 |
| 13 CRU-3 : PLANT 9 AREA | 0.00000E+00 |
| 14 CRU-3 : OTHER MAIN P | 0.00000E+00 |
| 15 perchwater | 0.16963E-13 |
| EXTRA LOADING | 0.26298E-02 |
| TIME = 80.0 | |
| 1 EWMF FOR CRU-4 | 0.00000E+00 |
| 2 EWMF FOR CRU-3 | 0.00000E+00 |
| 3 EWMF FOR CRU-1 | 0.00000E+00 |
| 4 CRU-2 : SOLID WASTE | 0.00000E+00 |
| 5 CRU-2 : NORTH LIME S | 0.00000E+00 |

0462

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

- 5808

| | | |
|---|---|---|
| 6 | CRU-2 : SOUTH LIME S | 0.00000E+00 |
| 7 | CRU-2 : FLYASH AND S | 0.59580E-12 |
| 8 | CRU-3 : WEST OF PLAN | 0.00000E+00 |
| 9 | CRU-3 : EAST OF PLAN | 0.00000E+00 |
| 10 | CRU-4 : SILOS 1 2& | 0.00000E+00 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.00000E+00 |
| 12 | CRU-3 : PLANT 6 AREA | 0.00000E+00 |
| 13 | CRU-3 : PLANT 9 AREA | 0.00000E+00 |
| 14 | CRU-3 : OTHER MAIN P | 0.00000E+00 |
| 15 | perchwater | 0.30754E-11 |
| | EXTRA LOADING | 0.19073E-02 |

TIME = 90.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.00000E+00 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |
| 4 | CRU-2 : SOLID WASTE | 0.00000E+00 |
| 5 | CRU-2 : NORTH LIME S | 0.00000E+00 |
| 6 | CRU-2 : SOUTH LIME S | 0.00000E+00 |
| 7 | CRU-2 : FLYASH AND S | 0.83391E-10 |
| 8 | CRU-3 : WEST OF PLAN | 0.00000E+00 |
| 9 | CRU-3 : EAST OF PLAN | 0.00000E+00 |
| 10 | CRU-4 : SILOS 1 2 & | 0.00000E+00 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.00000E+00 |
| 12 | CRU-3 : PLANT 6 AREA | 0.00000E+00 |
| 13 | CRU-3 : PLANT 9 AREA | 0.00000E+00 |
| 14 | CRU-3 : OTHER MAIN P | 0.00000E+00 |
| 15 | perchwater | 0.33513E-09 |
| | EXTRA LOADING | 0.13863E-02 |

TIME = 100.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.00000E+00 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |
| 4 | CRU-2 : SOLID WASTE | 0.00000E+00 |
| 5 | CRU-2 : NORTH LIME S | 0.00000E+00 |
| 6 | CRU-2 : SOUTH LIME S | 0.00000E+00 |
| 7 | CRU-2 : FLYASH AND S | 0.23798E-08 |
| 8 | CRU-3 : WEST OF PLAN | 0.00000E+00 |
| 9 | CRU-3 : EAST OF PLAN | 0.00000E+00 |
| 10 | CRU-4 : SILOS 1 2 & | 0.00000E+00 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.00000E+00 |
| 12 | CRU-3 : PLANT 6 AREA | 0.00000E+00 |
| 13 | CRU-3 : PLANT 9 AREA | 0.00000E+00 |
| 14 | CRU-3 : OTHER MAIN P | 0.00000E+00 |
| 15 | perchwater | 0.93251E-08 |
| | EXTRA LOADING | 0.10082E-02 |

0463

5208

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

TIME = 110.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.00000E+00 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |
| 4 | CRU-2 : SOLID WASTE | 0.00000E+00 |
| 5 | CRU-2 : NORTH LIME S | 0.00000E+00 |
| 6 | CRU-2 : SOUTH LIME S | 0.00000E+00 |
| 7 | CRU-2 : FLYASH AND S | 0.23918E-07 |
| 8 | CRU-3 : WEST OF PLAN | 0.00000E+00 |
| 9 | CRU-3 : EAST OF PLAN | 0.00000E+00 |
| 10 | CRU-4 : SILOS 1 2 & | 0.00000E+00 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.00000E+00 |
| 12 | CRU-3 : PLANT 6 AREA | 0.00000E+00 |
| 13 | CRU-3 : PLANT 9 AREA | 0.00000E+00 |
| 14 | CRU-3 : OTHER MAIN P | 0.00000E+00 |
| 15 | perchwater | 0.92785E-07 |
| | EXTRA LOADING | 0.73098E-03 |

TIME = 120.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.00000E+00 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |
| 4 | CRU-2 : SOLID WASTE | 0.00000E+00 |
| 5 | CRU-2 : NORTH LIME S | 0.00000E+00 |
| 6 | CRU-2 : SOUTH LIME S | 0.00000E+00 |
| 7 | CRU-2 : FLYASH AND S | 0.11966E-06 |
| 8 | CRU-3 : WEST OF PLAN | 0.00000E+00 |
| 9 | CRU-3 : EAST OF PLAN | 0.00000E+00 |
| 10 | CRU-4 : SILOS 1 2 & | 0.00000E+00 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.00000E+00 |
| 12 | CRU-3 : PLANT 6 AREA | 0.00000E+00 |
| 13 | CRU-3 : PLANT 9 AREA | 0.00000E+00 |
| 14 | CRU-3 : OTHER MAIN P | 0.26299E-11 |
| 15 | perchwater | 0.46248E-06 |
| | EXTRA LOADING | 0.52933E-03 |

TIME = 130.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.00000E+00 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |
| 4 | CRU-2 : SOLID WASTE | 0.00000E+00 |
| 5 | CRU-2 : NORTH LIME S | 0.00000E+00 |
| 6 | CRU-2 : SOUTH LIME S | 0.00000E+00 |
| 7 | CRU-2 : FLYASH AND S | 0.37334E-06 |
| 8 | CRU-3 : WEST OF PLAN | 0.00000E+00 |
| 9 | CRU-3 : EAST OF PLAN | 0.00000E+00 |
| 10 | CRU-4 : SILOS 1 2 & | 0.80784E-12 |

0464

5208

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

| | | |
|---|---|---|
| 11 | CRU-3 : PLANT 2/3 AR | 0.00000E+00 |
| 12 | CRU-3 : PLANT 6 AREA | 0.00000E+00 |
| 13 | CRU-3 : PLANT 9 AREA | 0.00000E+00 |
| 14 | CRU-3 : OTHER MAIN P | 0.42218E-10 |
| 15 | perchwater | 0.14513E-05 |
| | EXTRA LOADING | 0.38565E-03 |

TIME = 140.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.00000E+00 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |
| 4 | CRU-2 : SOLID WASTE | 0.00000E+00 |
| 5 | CRU-2 : NORTH LIME S | 0.00000E+00 |
| 6 | CRU-2 : SOUTH LIME S | 0.00000E+00 |
| 7 | CRU-2 : FLYASH AND S | 0.84340E-06 |
| 8 | CRU-3 : WEST OF PLAN | 0.00000E+00 |
| 9 | CRU-3 : EAST OF PLAN | 0.00000E+00 |
| 10 | CRU-4 : SILOS 1 2 & | 0.91769E-11 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.00000E+00 |
| 12 | CRU-3 : PLANT 6 AREA | 0.14503E-11 |
| 13 | CRU-3 : PLANT 9 AREA | 0.00000E+00 |
| 14 | CRU-3 : OTHER MAIN P | 0.39239E-09 |
| 15 | perchwater | 0.33336E-05 |
| | EXTRA LOADING | 0.28021E-03 |

TIME = 150.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.00000E+00 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |
| 4 | CRU-2 : SOLID WASTE | 0.00000E+00 |
| 5 | CRU-2 : NORTH LIME S | 0.00000E+00 |
| 6 | CRU-2 : SOUTH LIME S | 0.00000E+00 |
| 7 | CRU-2 : FLYASH AND S | 0.15235E-05 |
| 8 | CRU-3 : WEST OF PLAN | 0.00000E+00 |
| 9 | CRU-3 : EAST OF PLAN | 0.00000E+00 |
| 10 | CRU-4 : SILOS 1 2 & | 0.64165E-10 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.00000E+00 |
| 12 | CRU-3 : PLANT 6 AREA | 0.22571E-10 |
| 13 | CRU-3 : PLANT 9 AREA | 0.00000E+00 |
| 14 | CRU-3 : OTHER MAIN P | 0.24656E-08 |
| 15 | perchwater | 0.61903E-05 |
| | EXTRA LOADING | 0.20333E-03 |

TIME = 160.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.00000E+00 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |

5208

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

| | | |
|---|---|---|
| 4 | CRU-2 : SOLID WASTE | 0.00000E+00 |
| 5 | CRU-2 : NORTH LIME S | 0.00000E+00 |
| 6 | CRU-2 : SOUTH LIME S | 0.00000E+00 |
| 7 | CRU-2 : FLYASH AND S | 0.23514E-05 |
| 8 | CRU-3 : WEST OF PLAN | 0.00000E+00 |
| 9 | CRU-3 : EAST OF PLAN | 0.00000E+00 |
| 10 | CRU-4 : SILOS 1 2 & | 0.31006E-09 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.21995E-12 |
| 12 | CRU-3 : PLANT 6 AREA | 0.19161E-09 |
| 13 | CRU-3 : PLANT 9 AREA | 0.00000E+00 |
| 14 | CRU-3 : OTHER MAIN P | 0.11556E-07 |
| 15 | perchwater | 0.99249E-05 |
| | EXTRA LOADING | 0.14788E-03 |

TIME = 170.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.00000E+00 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |
| 4 | CRU-2 : SOLID WASTE | 0.00000E+00 |
| 5 | CRU-2 : NORTH LIME S | 0.00000E+00 |
| 6 | CRU-2 : SOUTH LIME S | 0.00000E+00 |
| 7 | CRU-2 : FLYASH AND S | 0.32403E-05 |
| 8 | CRU-3 : WEST OF PLAN | 0.00000E+00 |
| 9 | CRU-3 : EAST OF PLAN | 0.00000E+00 |
| 10 | CRU-4 : SILOS 1 2 & | 0.11302E-08 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.20917E-11 |
| 12 | CRU-3 : PLANT 6 AREA | 0.10567E-08 |
| 13 | CRU-3 : PLANT 9 AREA | 0.12760E-12 |
| 14 | CRU-3 : OTHER MAIN P | 0.42483E-07 |
| 15 | perchwater | 0.14348E-04 |
| | EXTRA LOADING | 0.10713E-03 |

TIME = 180.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.21798E-14 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |
| 4 | CRU-2 : SOLID WASTE | 0.00000E+00 |
| 5 | CRU-2 : NORTH LIME S | 0.00000E+00 |
| 6 | CRU-2 : SOUTH LIME S | 0.00000E+00 |
| 7 | CRU-2 : FLYASH AND S | 0.40939E-05 |
| 8 | CRU-3 : WEST OF PLAN | 0.00000E+00 |
| 9 | CRU-3 : EAST OF PLAN | 0.00000E+00 |
| 10 | CRU-4 : SILOS 1 2 & | 0.33034E-08 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.13525E-10 |
| 12 | CRU-3 : PLANT 6 AREA | 0.41764E-08 |

0466

U-238 MASS LOADING RATES TO THE SWIFT III MODEL - 5208
(Continued)

| | | |
|---|---|---|
| 13 | CRU-3 : PLANT 9 AREA | 0.14710E-11 |
| 14 | CRU-3 : OTHER MAIN P | 0.12704E-06 |
| 15 | perchwater | 0.19216E-04 |
| | EXTRA LOADING | 0.77719E-04 |

TIME = 190.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.45057E-13 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |
| 4 | CRU-2 : SOLID WASTE | 0.00000E+00 |
| 5 | CRU-2 : NORTH LIME S | 0.00000E+00 |
| 6 | CRU-2 : SOUTH LIME S | 0.00000E+00 |
| 7 | CRU-2 : FLYASH AND S | 0.48027E-05 |
| 8 | CRU-3 : WEST OF PLAN | 0.00000E+00 |
| 9 | CRU-3 : EAST OF PLAN | 0.00000E+00 |
| 10 | CRU-4 : SILOS 1 2 & | 0.81045E-08 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.63356E-10 |
| 12 | CRU-3 : PLANT 6 AREA | 0.12730E-07 |
| 13 | CRU-3 : PLANT 9 AREA | 0.99813E-11 |
| 14 | CRU-3 : OTHER MAIN P | 0.31869E-06 |
| 15 | perchwater | 0.24207E-04 |
| | EXTRA LOADING | 0.56714E-04 |

TIME = 200.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.50467E-12 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |
| 4 | CRU-2 : SOLID WASTE | 0.00000E+00 |
| 5 | CRU-2 : NORTH LIME S | 0.00000E+00 |
| 6 | CRU-2 : SOUTH LIME S | 0.00000E+00 |
| 7 | CRU-2 : FLYASH AND S | 0.52575E-05 |
| 8 | CRU-3 : WEST OF PLAN | 0.00000E+00 |
| 9 | CRU-3 : EAST OF PLAN | 0.00000E+00 |
| 10 | CRU-4 : SILOS 1 2 & | 0.17272E-07 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.23633E-09 |
| 12 | CRU-3 : PLANT 6 AREA | 0.31620E-07 |
| 13 | CRU-3 : PLANT 9 AREA | 0.50924E-10 |
| 14 | CRU-3 : OTHER MAIN P | 0.68920E-06 |
| 15 | perchwater | 0.28969E-04 |
| | EXTRA LOADING | 0.41086E-04 |

TIME = 210.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.39500E-11 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |
| 4 | CRU-2 : SOLID WASTE | 0.00000E+00 |
| 5 | CRU-2 : NORTH LIME S | 0.00000E+00 |

5208

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

| | | |
|---|---|---|
| 6 | CRU-2 : SOUTH LIME S | 0.00000E+00 |
| 7 | CRU-2 : FLYASH AND S | 0.53934E-05 |
| 8 | CRU-3 : WEST OF PLAN | 0.00000E+00 |
| 9 | CRU-3 : EAST OF PLAN | 0.00000E+00 |
| 10 | CRU-4 : SILOS 1 2 & | 0.32824E-07 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.73493E-09 |
| 12 | CRU-3 : PLANT 6 AREA | 0.66743E-07 |
| 13 | CRU-3 : PLANT 9 AREA | 0.20251E-09 |
| 14 | CRU-3 : OTHER MAIN P | 0.13159E-05 |
| 15 | perchwater | 0.33271E-04 |
| | EXTRA LOADING | 0.29834E-04 |

TIME = 220.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.23101E-10 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |
| 4 | CRU-2 : SOLID WASTE | 0.00000E+00 |
| 5 | CRU-2 : NORTH LIME S | 0.00000E+00 |
| 6 | CRU-2 : SOUTH LIME S | 0.00000E+00 |
| 7 | CRU-2 : FLYASH AND S | 0.52192E-05 |
| 8 | CRU-3 : WEST OF PLAN | 0.00000E+00 |
| 9 | CRU-3 : EAST OF PLAN | 0.00000E+00 |
| 10 | CRU-4 : SILOS 1 2 & | 0.56750E-07 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.19650E-08 |
| 12 | CRU-3 : PLANT 6 AREA | 0.12360E-06 |
| 13 | CRU-3 : PLANT 9 AREA | 0.66122E-09 |
| 14 | CRU-3 : OTHER MAIN P | 0.22632E-05 |
| 15 | perchwater | 0.37104E-04 |
| | EXTRA LOADING | 0.21677E-04 |

TIME = 230.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.10623E-09 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |
| 4 | CRU-2 : SOLID WASTE | 0.00000E+00 |
| 5 | CRU-2 : NORTH LIME S | 0.00000E+00 |
| 6 | CRU-2 : SOUTH LIME S | 0.00000E+00 |
| 7 | CRU-2 : FLYASH AND S | 0.48044E-05 |
| 8 | CRU-3 : WEST OF PLAN | 0.00000E+00 |
| 9 | CRU-3 : EAST OF PLAN | 0.00000E+00 |
| 10 | CRU-4 : SILOS 1 2 & | 0.90660E-07 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.46298E-08 |
| 12 | CRU-3 : PLANT 6 AREA | 0.20577E-06 |
| 13 | CRU-3 : PLANT 9 AREA | 0.18359E-08 |
| 14 | CRU-3 : OTHER MAIN P | 0.35647E-05 |
| 15 | perchwater | 0.40649E-04 |
| | EXTRA LOADING | 0.15754E-04 |

0468

- 5208

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

TIME = 240.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.39988E-09 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |
| 4 | CRU-2 : SOLID WASTE | 0.59821E-15 |
| 5 | CRU-2 : NORTH LIME S | 0.00000E+00 |
| 6 | CRU-2 : SOUTH LIME S | 0.00000E+00 |
| 7 | CRU-2 : FLYASH AND S | 0.42429E-05 |
| 8 | CRU-3 : WEST OF PLAN | 0.00000E+00 |
| 9 | CRU-3 : EAST OF PLAN | 0.00000E+00 |
| 10 | CRU-4 : SILOS 1 2 & | 0.13544E-06 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.98018E-08 |
| 12 | CRU-3 : PLANT 6 AREA | 0.31363E-06 |
| 13 | CRU-3 : PLANT 9 AREA | 0.44527E-08 |
| 14 | CRU-3 : OTHER MAIN P | 0.52092E-05 |
| 15 | perchwater | 0.44156E-04 |
| | EXTRA LOADING | 0.11427E-04 |

TIME = 250.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.12727E-08 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |
| 4 | CRU-2 : SOLID WASTE | 0.78163E-14 |
| 5 | CRU-2 : NORTH LIME S | 0.00000E+00 |
| 6 | CRU-2 : SOUTH LIME S | 0.00000E+00 |
| 7 | CRU-2 : FLYASH AND S | 0.36224E-05 |
| 8 | CRU-3 : WEST OF PLAN | 0.00000E+00 |
| 9 | CRU-3 : EAST OF PLAN | 0.00000E+00 |
| 10 | CRU-4 : SILOS 1 2 & | 0.19104E-06 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.18944E-07 |
| 12 | CRU-3 : PLANT 6 AREA | 0.44363E-06 |
| 13 | CRU-3 : PLANT 9 AREA | 0.96380E-08 |
| 14 | CRU-3 : OTHER MAIN P | 0.71339E-05 |
| 15 | perchwater | 0.47845E-04 |
| | EXTRA LOADING | 0.83180E-05 |

TIME = 260.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.35160E-08 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |
| 4 | CRU-2 : SOLID WASTE | 0.46097E-13 |
| 5 | CRU-2 : NORTH LIME S | 0.00000E+00 |
| 6 | CRU-2 : SOUTH LIME S | 0.00000E+00 |
| 7 | CRU-2 : FLYASH AND S | 0.30090E-05 |
| 8 | CRU-3 : WEST OF PLAN | 0.16769E-11 |
| 9 | CRU-3 : EAST OF PLAN | 0.00000E+00 |
| 10 | CRU-4 : SILOS 1 2 & | 0.25639E-06 |

U-238 MASS LOADING RATES TO THE SWIFT III MODEL - 5208
(Continued)

| | | |
|---|---|---|
| 11 | CRU-3 : PLANT 2/3 AR | 0.33856E-07 |
| 12 | CRU-3 : PLANT 6 AREA | 0.58810E-06 |
| 13 | CRU-3 : PLANT 9 AREA | 0.18939E-07 |
| 14 | CRU-3 : OTHER MAIN P | 0.92279E-05 |
| 15 | perchwater | 0.51837E-04 |
| | EXTRA LOADING | 0.60495E-05 |

TIME = 270.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.86137E-08 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |
| 4 | CRU-2 : SOLID WASTE | 0.22797E-12 |
| 5 | CRU-2 : NORTH LIME S | 0.00000E+00 |
| 6 | CRU-2 : SOUTH LIME S | 0.00000E+00 |
| 7 | CRU-2 : FLYASH AND S | 0.24445E-05 |
| 8 | CRU-3 : WEST OF PLAN | 0.91338E-11 |
| 9 | CRU-3 : EAST OF PLAN | 0.31936E-11 |
| 10 | CRU-4 : SILOS 1 2 & | 0.32957E-06 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.56536E-07 |
| 12 | CRU-3 : PLANT 6 AREA | 0.73613E-06 |
| 13 | CRU-3 : PLANT 9 AREA | 0.34248E-07 |
| 14 | CRU-3 : OTHER MAIN P | 0.11346E-04 |
| 15 | perchwater | 0.56142E-04 |
| | EXTRA LOADING | 0.43691E-05 |

TIME = 280.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.19043E-07 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |
| 4 | CRU-2 : SOLID WASTE | 0.96557E-12 |
| 5 | CRU-2 : NORTH LIME S | 0.96875E-16 |
| 6 | CRU-2 : SOUTH LIME S | 0.15040E-15 |
| 7 | CRU-2 : FLYASH AND S | 0.19502E-05 |
| 8 | CRU-3 : WEST OF PLAN | 0.29135E-10 |
| 9 | CRU-3 : EAST OF PLAN | 0.11155E-10 |
| 10 | CRU-4 : SILOS 1 2 & | 0.40814E-06 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.88969E-07 |
| 12 | CRU-3 : PLANT 6 AREA | 0.87517E-06 |
| 13 | CRU-3 : PLANT 9 AREA | 0.57622E-07 |
| 14 | CRU-3 : OTHER MAIN P | 0.13334E-04 |
| 15 | perchwater | 0.60668E-04 |
| | EXTRA LOADING | 0.31802E-05 |

TIME = 290.0

0470

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.38539E-07 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |

- 5208

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

| | | |
|---|---|---|
| 4 | CRU-2 : SOLID WASTE | 0.35660E-11 |
| 5 | CRU-2 : NORTH LIME S | 0.57797E-15 |
| 6 | CRU-2 : SOUTH LIME S | 0.87063E-15 |
| 7 | CRU-2 : FLYASH AND S | 0.15330E-05 |
| 8 | CRU-3 : WEST OF PLAN | 0.85492E-10 |
| 9 | CRU-3 : EAST OF PLAN | 0.33830E-10 |
| 10 | CRU-4 : SILOS 1 2 & | 0.48953E-06 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.13288E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.99331E-06 |
| 13 | CRU-3 : PLANT 9 AREA | 0.90993E-07 |
| 14 | CRU-3 : OTHER MAIN P | 0.15051E-04 |
| 15 | perchwater | 0.65246E-04 |
| | EXTRA LOADING | 0.23106E-05 |

TIME = 300.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.72233E-07 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |
| 4 | CRU-2 : SOLID WASTE | 0.11664E-10 |
| 5 | CRU-2 : NORTH LIME S | 0.29544E-14 |
| 6 | CRU-2 : SOUTH LIME S | 0.43291E-14 |
| 7 | CRU-2 : FLYASH AND S | 0.11905E-05 |
| 8 | CRU-3 : WEST OF PLAN | 0.21537E-09 |
| 9 | CRU-3 : EAST OF PLAN | 0.90718E-10 |
| 10 | CRU-4 : SILOS 1 2 & | 0.57144E-06 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.18945E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.10812E-05 |
| 13 | CRU-3 : PLANT 9 AREA | 0.13582E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.16396E-04 |
| 15 | perchwater | 0.69670E-04 |
| | EXTRA LOADING | 0.16762E-05 |

TIME = 310.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.12659E-06 |
| 3 | EWMF FOR CRU-1 | 0.00000E+00 |
| 4 | CRU-2 : SOLID WASTE | 0.34232E-10 |
| 5 | CRU-2 : NORTH LIME S | 0.13153E-13 |
| 6 | CRU-2 : SOUTH LIME S | 0.18792E-13 |
| 7 | CRU-2 : FLYASH AND S | 0.91515E-06 |
| 8 | CRU-3 : WEST OF PLAN | 0.49855E-09 |
| 9 | CRU-3 : EAST OF PLAN | 0.21845E-09 |
| 10 | CRU-4 : SILOS 1 2 & | 0.65211E-06 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.25917E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.11335E-05 |

U-238 MASS LOADING RATES TO THE SWIFT III MODEL 208
(Continued)

| | | |
|---|---|---|
| 13 | CRU-3 : PLANT 9 AREA | 0.19277E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.17319E-04 |
| 15 | perchwater | 0.73729E-04 |
| | EXTRA LOADING | 0.12183E-05 |

TIME = 320.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.20909E-06 |
| 3 | EWMF FOR CRU-1 | 0.99447E-11 |
| 4 | CRU-2 : SOLID WASTE | 0.91167E-10 |
| 5 | CRU-2 : NORTH LIME S | 0.51739E-13 |
| 6 | CRU-2 : SOUTH LIME S | 0.72212E-13 |
| 7 | CRU-2 : FLYASH AND S | 0.69760E-06 |
| 8 | CRU-3 : WEST OF PLAN | 0.10693E-08 |
| 9 | CRU-3 : EAST OF PLAN | 0.47852E-09 |
| 10 | CRU-4 : SILOS 1 2 & | 0.73045E-06 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.34164E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.11489E-05 |
| 13 | CRU-3 : PLANT 9 AREA | 0.26140E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.17815E-04 |
| 15 | perchwater | 0.77240E-04 |
| | EXTRA LOADING | 0.88642E-06 |

TIME = 330.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.32759E-06 |
| 3 | EWMF FOR CRU-1 | 0.64451E-10 |
| 4 | CRU-2 : SOLID WASTE | 0.22256E-09 |
| 5 | CRU-2 : NORTH LIME S | 0.18205E-12 |
| 6 | CRU-2 : SOUTH LIME S | 0.24868E-12 |
| 7 | CRU-2 : FLYASH AND S | 0.52801E-06 |
| 8 | CRU-3 : WEST OF PLAN | 0.21484E-08 |
| 9 | CRU-3 : EAST OF PLAN | 0.96420E-09 |
| 10 | CRU-4 : SILOS 1 2 & | 0.80614E-06 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.43563E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.11299E-05 |
| 13 | CRU-3 : PLANT 9 AREA | 0.34006E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.17926E-04 |
| 15 | perchwater | 0.80073E-04 |
| | EXTRA LOADING | 0.64276E-06 |

TIME = 340.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.48952E-06 |
| 3 | EWMF FOR CRU-1 | 0.17204E-09 |
| 4 | CRU-2 : SOLID WASTE | 0.50240E-09 |
| 5 | CRU-2 : NORTH LIME S | 0.57925E-12 |

5208

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

| | | |
|---|---|---|
| 6 | CRU-2 : SOUTH LIME S | 0.77567E-12 |
| 7 | CRU-2 : FLYASH AND S | 0.39726E-06 |
| 8 | CRU-3 : WEST OF PLAN | 0.40662E-08 |
| 9 | CRU-3 : EAST OF PLAN | 0.18039E-08 |
| 10 | CRU-4 : SILOS 1 2 & | 0.87971E-06 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.53910E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.10818E-05 |
| 13 | CRU-3 : PLANT 9 AREA | 0.42596E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.17720E-04 |
| 15 | perchwater | 0.82155E-04 |
| | EXTRA LOADING | 0.46631E-06 |

TIME = 350.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.70084E-06 |
| 3 | EWMF FOR CRU-1 | 0.42234E-09 |
| 4 | CRU-2 : SOLID WASTE | 0.10567E-08 |
| 5 | CRU-2 : NORTH LIME S | 0.16826E-11 |
| 6 | CRU-2 : SOUTH LIME S | 0.22122E-11 |
| 7 | CRU-2 : FLYASH AND S | 0.29738E-06 |
| 8 | CRU-3 : WEST OF PLAN | 0.72965E-08 |
| 9 | CRU-3 : EAST OF PLAN | 0.31585E-08 |
| 10 | CRU-4 : SILOS 1 2 & | 0.95272E-06 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.64941E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.10111E-05 |
| 13 | CRU-3 : PLANT 9 AREA | 0.51535E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.17279E-04 |
| 15 | perchwater | 0.83479E-04 |
| | EXTRA LOADING | 0.33902E-06 |

TIME = 360.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.96510E-06 |
| 3 | EWMF FOR CRU-1 | 0.95285E-09 |
| 4 | CRU-2 : SOLID WASTE | 0.20844E-08 |
| 5 | CRU-2 : NORTH LIME S | 0.45007E-11 |
| 6 | CRU-2 : SOUTH LIME S | 0.58166E-11 |
| 7 | CRU-2 : FLYASH AND S | 0.22165E-06 |
| 8 | CRU-3 : WEST OF PLAN | 0.12469E-07 |
| 9 | CRU-3 : EAST OF PLAN | 0.52112E-08 |
| 10 | CRU-4 : SILOS 1 2 & | 0.10281E-05 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.76347E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.92498E-06 |

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

- 5208

| | | |
|---|---|---|
| 13 | CRU-3 : PLANT 9 AREA | 0.60389E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.16691E-04 |
| 15 | perchwater | 0.84089E-04 |
| | EXTRA LOADING | 0.24618E-06 |

TIME = 370.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.12826E-05 |
| 3 | EWMF FOR CRU-1 | 0.19558E-08 |
| 4 | CRU-2 : SOLID WASTE | 0.38787E-08 |
| 5 | CRU-2 : NORTH LIME S | 0.11164E-10 |
| 6 | CRU-2 : SOUTH LIME S | 0.14199E-10 |
| 7 | CRU-2 : FLYASH AND S | 0.16459E-06 |
| 8 | CRU-3 : WEST OF PLAN | 0.20378E-07 |
| 9 | CRU-3 : EAST OF PLAN | 0.81488E-08 |
| 10 | CRU-4 : SILOS 1 2 & | 0.11105E-05 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.87798E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.83018E-06 |
| 13 | CRU-3 : PLANT 9 AREA | 0.68713E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.16035E-04 |
| 15 | perchwater | 0.84066E-04 |
| | EXTRA LOADING | 0.17896E-06 |

TIME = 380.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.16499E-05 |
| 3 | EWMF FOR CRU-1 | 0.37922E-08 |
| 4 | CRU-2 : SOLID WASTE | 0.68428E-08 |
| 5 | CRU-2 : NORTH LIME S | 0.25844E-10 |
| 6 | CRU-2 : SOUTH LIME S | 0.32382E-10 |
| 7 | CRU-2 : FLYASH AND S | 0.12183E-06 |
| 8 | CRU-3 : WEST OF PLAN | 0.31969E-07 |
| 9 | CRU-3 : EAST OF PLAN | 0.12137E-07 |
| 10 | CRU-4 : SILOS 1 2 & | 0.12074E-05 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.98962E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.73246E-06 |
| 13 | CRU-3 : PLANT 9 AREA | 0.76089E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.15380E-04 |
| 15 | perchwater | 0.83517E-04 |
| | EXTRA LOADING | 0.12981E-06 |

TIME = 390.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.20597E-05 |
| 3 | EWMF FOR CRU-1 | 0.70485E-08 |
| 4 | CRU-2 : SOLID WASTE | 0.11496E-07 |
| 5 | CRU-2 : NORTH LIME S | 0.56172E-10 |

0474

5208

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

| | | |
|---|---|---|
| 6 | CRU-2 : SOUTH LIME S | 0.69408E-10 |
| 7 | CRU-2 : FLYASH AND S | 0.89929E-07 |
| 8 | CRU-3 : WEST OF PLAN | 0.48296E-07 |
| 9 | CRU-3 : EAST OF PLAN | 0.17290E-07 |
| 10 | CRU-4 : SILOS 1 2 & | 0.13296E-05 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.10952E-05 |
| 12 | CRU-3 : PLANT 6 AREA | 0.63641E-06 |
| 13 | CRU-3 : PLANT 9 AREA | 0.82168E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.14778E-04 |
| 15 | perchwater | 0.82552E-04 |
| | EXTRA LOADING | 0.94173E-07 |

TIME = 400.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.25008E-05 |
| 3 | EWMF FOR CRU-1 | 0.12395E-07 |
| 4 | CRU-2 : SOLID WASTE | 0.18466E-07 |
| 5 | CRU-2 : NORTH LIME S | 0.11523E-09 |
| 6 | CRU-2 : SOUTH LIME S | 0.14053E-09 |
| 7 | CRU-2 : FLYASH AND S | 0.66224E-07 |
| 8 | CRU-3 : WEST OF PLAN | 0.70460E-07 |
| 9 | CRU-3 : EAST OF PLAN | 0.23649E-07 |
| 10 | CRU-4 : SILOS 1 2 & | 0.14922E-05 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.11917E-05 |
| 12 | CRU-3 : PLANT 6 AREA | 0.54541E-06 |
| 13 | CRU-3 : PLANT 9 AREA | 0.86697E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.14268E-04 |
| 15 | perchwater | 0.81278E-04 |
| | EXTRA LOADING | 0.68477E-07 |

TIME = 410.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.29595E-05 |
| 3 | EWMF FOR CRU-1 | 0.20893E-07 |
| 4 | CRU-2 : SOLID WASTE | 0.28457E-07 |
| 5 | CRU-2 : NORTH LIME S | 0.22411E-09 |
| 6 | CRU-2 : SOUTH LIME S | 0.27000E-09 |
| 7 | CRU-2 : FLYASH AND S | 0.48666E-07 |
| 8 | CRU-3 : WEST OF PLAN | 0.99525E-07 |
| 9 | CRU-3 : EAST OF PLAN | 0.31157E-07 |
| 10 | CRU-4 : SILOS 1 2 & | 0.17154E-05 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.12767E-05 |
| 12 | CRU-3 : PLANT 6 AREA | 0.46168E-06 |

5208

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

| | | |
|---|---|---|
| 13 | CRU-3 : PLANT 9 AREA | 0.89529E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.13872E-04 |
| 15 | perchwater | 0.79785E-04 |
| | EXTRA LOADING | 0.49572E-07 |

TIME = 420.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.34196E-05 |
| 3 | EWMF FOR CRU-1 | 0.33898E-07 |
| 4 | CRU-2 : SOLID WASTE | 0.42201E-07 |
| 5 | CRU-2 : NORTH LIME S | 0.41498E-09 |
| 6 | CRU-2 : SOUTH LIME S | 0.49422E-09 |
| 7 | CRU-2 : FLYASH AND S | 0.35698E-07 |
| 8 | CRU-3 : WEST OF PLAN | 0.13642E-06 |
| 9 | CRU-3 : EAST OF PLAN | 0.39655E-07 |
| 10 | CRU-4 : SILOS 1 2 & | 0.20240E-05 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.13479E-05 |
| 12 | CRU-3 : PLANT 6 AREA | 0.38648E-06 |
| 13 | CRU-3 : PLANT 9 AREA | 0.90631E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.13603E-04 |
| 15 | perchwater | 0.78147E-04 |
| | EXTRA LOADING | 0.36129E-07 |

TIME = 430.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.38644E-05 |
| 3 | EWMF FOR CRU-1 | 0.53094E-07 |
| 4 | CRU-2 : SOLID WASTE | 0.60392E-07 |
| 5 | CRU-2 : NORTH LIME S | 0.73423E-09 |
| 6 | CRU-2 : SOUTH LIME S | 0.86496E-09 |
| 7 | CRU-2 : FLYASH AND S | 0.26145E-07 |
| 8 | CRU-3 : WEST OF PLAN | 0.18183E-06 |
| 9 | CRU-3 : EAST OF PLAN | 0.48882E-07 |
| 10 | CRU-4 : SILOS 1 2 & | 0.24478E-05 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.14037E-05 |
| 12 | CRU-3 : PLANT 6 AREA | 0.32029E-06 |
| 13 | CRU-3 : PLANT 9 AREA | 0.90067E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.13458E-04 |
| 15 | perchwater | 0.76415E-04 |
| | EXTRA LOADING | 0.26221E-07 |

TIME = 440.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.42773E-05 |
| 3 | EWMF FOR CRU-1 | 0.80486E-07 |
| 4 | CRU-2 : SOLID WASTE | 0.83607E-07 |
| 5 | CRU-2 : NORTH LIME S | 0.12454E-08 |

0476

- 5208

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

| | | |
|---|---|---|
| 6 | CRU-2 : SOUTH LIME S | 0.14521E-08 |
| 7 | CRU-2 : FLYASH AND S | 0.19121E-07 |
| 8 | CRU-3 : WEST OF PLAN | 0.23611E-06 |
| 9 | CRU-3 : EAST OF PLAN | 0.58496E-07 |
| 10 | CRU-4 : SILOS 1 2 & | 0.30201E-05 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.14431E-05 |
| 12 | CRU-3 : PLANT 6 AREA | 0.26303E-06 |
| 13 | CRU-3 : PLANT 9 AREA | 0.87985E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.13432E-04 |
| 15 | perchwater | 0.74625E-04 |
| | EXTRA LOADING | 0.19073E-07 |

TIME = 450.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.46434E-05 |
| 3 | EWMF FOR CRU-1 | 0.11836E-06 |
| 4 | CRU-2 : SOLID WASTE | 0.11222E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.20311E-08 |
| 6 | CRU-2 : SOUTH LIME S | 0.23451E-08 |
| 7 | CRU-2 : FLYASH AND S | 0.13968E-07 |
| 8 | CRU-3 : WEST OF PLAN | 0.29921E-06 |
| 9 | CRU-3 : EAST OF PLAN | 0.68103E-07 |
| 10 | CRU-4 : SILOS 1 2 & | 0.37773E-05 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.14655E-05 |
| 12 | CRU-3 : PLANT 6 AREA | 0.21423E-06 |
| 13 | CRU-3 : PLANT 9 AREA | 0.84594E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.13510E-04 |
| 15 | perchwater | 0.72797E-04 |
| | EXTRA LOADING | 0.13821E-07 |

TIME = 460.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.49501E-05 |
| 3 | EWMF FOR CRU-1 | 0.16918E-06 |
| 4 | CRU-2 : SOLID WASTE | 0.14633E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.31933E-08 |
| 6 | CRU-2 : SOUTH LIME S | 0.36531E-08 |
| 7 | CRU-2 : FLYASH AND S | 0.10192E-07 |
| 8 | CRU-3 : WEST OF PLAN | 0.37061E-06 |
| 9 | CRU-3 : EAST OF PLAN | 0.77289E-07 |
| 10 | CRU-4 : SILOS 1 2 & | 0.47567E-05 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.14709E-05 |
| 12 | CRU-3 : PLANT 6 AREA | 0.17318E-06 |
| 13 | CRU-3 : PLANT 9 AREA | 0.80139E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.13674E-04 |
| 15 | perchwater | 0.70939E-04 |
| | EXTRA LOADING | 0.10040E-07 |

- 5208

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

TIME = 470.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.51877E-05 |
| 3 | EWMF FOR CRU-1 | 0.23550E-06 |
| 4 | CRU-2 : SOLID WASTE | 0.18572E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.48516E-08 |
| 6 | CRU-2 : SOUTH LIME S | 0.55015E-08 |
| 7 | CRU-2 : FLYASH AND S | 0.74303E-08 |
| 8 | CRU-3 : WEST OF PLAN | 0.44932E-06 |
| 9 | CRU-3 : EAST OF PLAN | 0.85666E-07 |
| 10 | CRU-4 : SILOS 1 2 & | 0.59942E-05 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.14598E-05 |
| 12 | CRU-3 : PLANT 6 AREA | 0.13904E-06 |
| 13 | CRU-3 : PLANT 9 AREA | 0.74881E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.13904E-04 |
| 15 | perchwater | 0.69056E-04 |
| | EXTRA LOADING | 0.73098E-08 |

TIME = 480.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.53502E-05 |
| 3 | EWMF FOR CRU-1 | 0.31976E-06 |
| 4 | CRU-2 : SOLID WASTE | 0.22980E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.71388E-08 |
| 6 | CRU-2 : SOUTH LIME S | 0.80273E-08 |
| 7 | CRU-2 : FLYASH AND S | 0.54123E-08 |
| 8 | CRU-3 : WEST OF PLAN | 0.53391E-06 |
| 9 | CRU-3 : EAST OF PLAN | 0.92902E-07 |
| 10 | CRU-4 : SILOS 1 2 & | 0.75222E-05 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.14332E-05 |
| 12 | CRU-3 : PLANT 6 AREA | 0.11093E-06 |
| 13 | CRU-3 : PLANT 9 AREA | 0.69076E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.14177E-04 |
| 15 | perchwater | 0.67147E-04 |
| | EXTRA LOADING | 0.52933E-08 |

TIME = 490.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.54352E-05 |
| 3 | EWMF FOR CRU-1 | 0.42412E-06 |
| 4 | CRU-2 : SOLID WASTE | 0.27765E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.10193E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.11370E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.39395E-08 |
| 8 | CRU-3 : WEST OF PLAN | 0.62255E-06 |
| 9 | CRU-3 : EAST OF PLAN | 0.98772E-07 |
| 10 | CRU-4 : SILOS 1 2 & | 0.93673E-05 |

0478

5208

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

| | | |
|---|---|---|
| 11 | CRU-3 : PLANT 2/3 AR | 0.13925E-05 |
| 12 | CRU-3 : PLANT 6 AREA | 0.88003E-07 |
| 13 | CRU-3 : PLANT 9 AREA | 0.62965E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.14472E-04 |
| 15 | perchwater | 0.65213E-04 |
| | EXTRA LOADING | 0.38488E-08 |

TIME = 500.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.54435E-05 |
| 3 | EWMF FOR CRU-1 | 0.55027E-06 |
| 4 | CRU-2 : SOLID WASTE | 0.32803E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.14148E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.15662E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.28656E-08 |
| 8 | CRU-3 : WEST OF PLAN | 0.71312E-06 |
| 9 | CRU-3 : EAST OF PLAN | 0.10322E-06 |
| 10 | CRU-4 : SILOS 1 2 & | 0.11548E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.13395E-05 |
| 12 | CRU-3 : PLANT 6 AREA | 0.69449E-07 |
| 13 | CRU-3 : PLANT 9 AREA | 0.56759E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.14768E-04 |
| 15 | perchwater | 0.63256E-04 |
| | EXTRA LOADING | 0.27979E-08 |

TIME = 510.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.53792E-05 |
| 3 | EWMF FOR CRU-1 | 0.69921E-06 |
| 4 | CRU-2 : SOLID WASTE | 0.37947E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.19123E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.21014E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.20833E-08 |
| 8 | CRU-3 : WEST OF PLAN | 0.80332E-06 |
| 9 | CRU-3 : EAST OF PLAN | 0.10641E-06 |
| 10 | CRU-4 : SILOS 1 2 & | 0.14073E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.12762E-05 |
| 12 | CRU-3 : PLANT 6 AREA | 0.54544E-07 |
| 13 | CRU-3 : PLANT 9 AREA | 0.50636E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.15043E-04 |
| 15 | perchwater | 0.61279E-04 |
| | EXTRA LOADING | 0.20291E-08 |

TIME = 520.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.52487E-05 |
| 3 | EWMF FOR CRU-1 | 0.87111E-08 |



0479

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

5208

| | | |
|---|---|---|
| 4 | CRU-2 : SOLID WASTE | 0.43036E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.25207E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.27505E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.15138E-08 |
| 8 | CRU-3 : WEST OF PLAN | 0.89076E-06 |
| 9 | CRU-3 : EAST OF PLAN | 0.10893E-06 |
| 10 | CRU-4 : SILOS 1 2 & | 0.16940E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.12046E-05 |
| 12 | CRU-3 : PLANT 6 AREA | 0.42649E-07 |
| 13 | CRU-3 : PLANT 9 AREA | 0.44736E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.15281E-04 |
| 15 | perchwater | 0.59290E-04 |
| | EXTRA LOADING | 0.14746E-08 |

TIME = 530.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.50603E-05 |
| 3 | EWMF FOR CRU-1 | 0.10651E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.47903E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.32449E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.35170E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.10995E-08 |
| 8 | CRU-3 : WEST OF PLAN | 0.97315E-06 |
| 9 | CRU-3 : EAST OF PLAN | 0.11198E-06 |
| 10 | CRU-4 : SILOS 1 2 & | 0.20137E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.11268E-05 |
| 12 | CRU-3 : PLANT 6 AREA | 0.33212E-07 |
| 13 | CRU-3 : PLANT 9 AREA | 0.39166E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.15466E-04 |
| 15 | perchwater | 0.57296E-04 |
| | EXTRA LOADING | 0.10713E-08 |

TIME = 540.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.48238E-05 |
| 3 | EWMF FOR CRU-1 | 0.12794E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.52388E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.40847E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.43987E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.79830E-09 |
| 8 | CRU-3 : WEST OF PLAN | 0.10484E-05 |
| 9 | CRU-3 : EAST OF PLAN | 0.11782E-06 |
| 10 | CRU-4 : SILOS 1 2 & | 0.23639E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.10451E-05 |
| 12 | CRU-3 : PLANT 6 AREA | 0.25766E-07 |

0480

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

5208

| | | |
|---|---|---|
| 13 | CRU-3 : PLANT 9 AREA | 0.33999E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.15584E-04 |
| 15 | perchwater | 0.55308E-04 |
| | EXTRA LOADING | 0.77719E-09 |

TIME = 550.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.45492E-05 |
| 3 | EWMF FOR CRU-1 | 0.15110E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.56346E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.50343E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.53876E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.57942E-09 |
| 8 | CRU-3 : WEST OF PLAN | 0.11146E-05 |
| 9 | CRU-3 : EAST OF PLAN | 0.13041E-06 |
| 10 | CRU-4 : SILOS 1 2 & | 0.27412E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.96119E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.19919E-07 |
| 13 | CRU-3 : PLANT 9 AREA | 0.29280E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.15625E-04 |
| 15 | perchwater | 0.53334E-04 |
| | EXTRA LOADING | 0.56294E-09 |

TIME = 560.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.42469E-05 |
| 3 | EWMF FOR CRU-1 | 0.17559E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.59659E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.60815E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.64695E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.42043E-09 |
| 8 | CRU-3 : WEST OF PLAN | 0.11706E-05 |
| 9 | CRU-3 : EAST OF PLAN | 0.15642E-06 |
| 10 | CRU-4 : SILOS 1 2 & | 0.31413E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.87701E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.15350E-07 |
| 13 | CRU-3 : PLANT 9 AREA | 0.25028E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.15583E-04 |
| 15 | perchwater | 0.51384E-04 |
| | EXTRA LOADING | 0.41044E-09 |

TIME = 570.0

0481

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.39267E-05 |
| 3 | EWMF FOR CRU-1 | 0.20093E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.62233E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.72083E-07 |

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

5208

| | | |
|---|---|---|
| 6 | CRU-2 : SOUTH LIME S | 0.76241E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.30499E-09 |
| 8 | CRU-3 : WEST OF PLAN | 0.12155E-05 |
| 9 | CRU-3 : EAST OF PLAN | 0.20679E-06 |
| 10 | CRU-4 : SILOS 1 2 & | 0.35594E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.79408E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.11794E-07 |
| 13 | CRU-3 : PLANT 9 AREA | 0.21244E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.15454E-04 |
| 15 | perchwater | 0.49468E-04 |
| | EXTRA LOADING | 0.29785E-09 |

TIME = 580.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.35975E-05 |
| 3 | EWMF FOR CRU-1 | 0.22656E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.64013E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.83913E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.88264E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.22119E-09 |
| 8 | CRU-3 : WEST OF PLAN | 0.12495E-05 |
| 9 | CRU-3 : EAST OF PLAN | 0.29901E-06 |
| 10 | CRU-4 : SILOS 1 2 & | 0.39900E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.71370E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.90360E-08 |
| 13 | CRU-3 : PLANT 9 AREA | 0.17914E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.15236E-04 |
| 15 | perchwater | 0.47591E-04 |
| | EXTRA LOADING | 0.21635E-09 |

TIME = 590.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.32676E-05 |
| 3 | EWMF FOR CRU-1 | 0.25188E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.64973E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.96028E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.10047E-06 |
| 7 | CRU-2 : FLYASH AND S | 0.16038E-09 |
| 8 | CRU-3 : WEST OF PLAN | 0.12737E-05 |
| 9 | CRU-3 : EAST OF PLAN | 0.46031E-06 |
| 10 | CRU-4 : SILOS 1 2 & | 0.44277E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.63692E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.69053E-08 |
| 13 | CRU-3 : PLANT 9 AREA | 0.15012E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.14931E-04 |
| 15 | perchwater | 0.45758E-04 |
| | EXTRA LOADING | 0.15712E-09 |

0482

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

5208

TIME = 600.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.29435E-05 |
| 3 | EWMF FOR CRU-1 | 0.27628E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.65121E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.10812E-06 |
| 6 | CRU-2 : SOUTH LIME S | 0.11254E-06 |
| 7 | CRU-2 : FLYASH AND S | 0.11627E-09 |
| 8 | CRU-3 : WEST OF PLAN | 0.12907E-05 |
| 9 | CRU-3 : EAST OF PLAN | 0.73154E-06 |
| 10 | CRU-4 : SILOS 1 2 & | 0.48670E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.56454E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.52644E-08 |
| 13 | CRU-3 : PLANT 9 AREA | 0.12507E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.14545E-04 |
| 15 | perchwater | 0.43973E-04 |
| | EXTRA LOADING | 0.11427E-09 |

TIME = 610.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.26309E-05 |
| 3 | EWMF FOR CRU-1 | 0.29915E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.64495E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.11987E-06 |
| 6 | CRU-2 : SOUTH LIME S | 0.12416E-06 |
| 7 | CRU-2 : FLYASH AND S | 0.84275E-10 |
| 8 | CRU-3 : WEST OF PLAN | 0.13049E-05 |
| 9 | CRU-3 : EAST OF PLAN | 0.11719E-05 |
| 10 | CRU-4 : SILOS 1 2 & | 0.53030E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.49713E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.40043E-08 |
| 13 | CRU-3 : PLANT 9 AREA | 0.10363E-06 |
| 14 | CRU-3 : OTHER MAIN P | 0.14083E-04 |
| 15 | perchwater | 0.42237E-04 |
| | EXTRA LOADING | 0.82760E-10 |

TIME = 620.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.23341E-05 |
| 3 | EWMF FOR CRU-1 | 0.31992E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.63156E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.13097E-06 |
| 6 | CRU-2 : SOUTH LIME S | 0.13500E-06 |
| 7 | CRU-2 : FLYASH AND S | 0.61060E-10 |
| 8 | CRU-3 : WEST OF PLAN | 0.13237E-05 |
| 9 | CRU-3 : EAST OF PLAN | 0.18648E-05 |
| 10 | CRU-4 : SILOS 1 2 & | 0.57310E-04 |

0483

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

- 5208

| | | |
|---|---|---|
| 11 | CRU-3 : PLANT 2/3 AR | 0.43503E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.30395E-08 |
| 13 | CRU-3 : PLANT 9 AREA | 0.85421E-07 |
| 14 | CRU-3 : OTHER MAIN P | 0.13554E-04 |
| 15 | perchwater | 0.40548E-04 |
| | EXTRA LOADING | 0.60075E-10 |

TIME = 630.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.20561E-05 |
| 3 | EWMF FOR CRU-1 | 0.33809E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.61184E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.14110E-06 |
| 6 | CRU-2 : SOUTH LIME S | 0.14477E-06 |
| 7 | CRU-2 : FLYASH AND S | 0.44229E-10 |
| 8 | CRU-3 : WEST OF PLAN | 0.13585E-05 |
| 9 | CRU-3 : EAST OF PLAN | 0.29240E-05 |
| 10 | CRU-4 : SILOS 1 2 & | 0.61472E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.37840E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.23027E-08 |
| 13 | CRU-3 : PLANT 9 AREA | 0.70068E-07 |
| 14 | CRU-3 : OTHER MAIN P | 0.12968E-04 |
| 15 | perchwater | 0.38907E-04 |
| | EXTRA LOADING | 0.43691E-10 |

TIME = 640.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.17992E-05 |
| 3 | EWMF FOR CRU-1 | 0.35323E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.58671E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.15000E-06 |
| 6 | CRU-2 : SOUTH LIME S | 0.15322E-06 |
| 7 | CRU-2 : FLYASH AND S | 0.32038E-10 |
| 8 | CRU-3 : WEST OF PLAN | 0.14263E-05 |
| 9 | CRU-3 : EAST OF PLAN | 0.45011E-05 |
| 10 | CRU-4 : SILOS 1 2 & | 0.65484E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.32725E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.17412E-08 |
| 13 | CRU-3 : PLANT 9 AREA | 0.57209E-07 |
| 14 | CRU-3 : OTHER MAIN P | 0.12335E-04 |
| 15 | perchwater | 0.37308E-04 |
| | EXTRA LOADING | 0.31760E-10 |

0484

TIME = 650.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.15642E-05 |
| 3 | EWMF FOR CRU-1 | 0.36502E-05 |

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

5208

| | | |
|---|---|---|
| 4 | CRU-2 : SOLID WASTE | 0.55719E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.15746E-06 |
| 6 | CRU-2 : SOUTH LIME S | 0.16015E-06 |
| 7 | CRU-2 : FLYASH AND S | 0.23209E-10 |
| 8 | CRU-3 : WEST OF PLAN | 0.15522E-05 |
| 9 | CRU-3 : EAST OF PLAN | 0.67925E-05 |
| 10 | CRU-4 : SILOS 1 2 & | 0.69326E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.28146E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.13144E-08 |
| 13 | CRU-3 : PLANT 9 AREA | 0.46507E-07 |
| 14 | CRU-3 : OTHER MAIN P | 0.11667E-04 |
| 15 | perchwater | 0.35749E-04 |
| | EXTRA LOADING | 0.23064E-10 |

TIME = 660.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.13517E-05 |
| 3 | EWMF FOR CRU-1 | 0.37325E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.52431E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.16330E-06 |
| 6 | CRU-2 : SOUTH LIME S | 0.16540E-06 |
| 7 | CRU-2 : FLYASH AND S | 0.16813E-10 |
| 8 | CRU-3 : WEST OF PLAN | 0.17723E-05 |
| 9 | CRU-3 : EAST OF PLAN | 0.10046E-04 |
| 10 | CRU-4 : SILOS 1 2 & | 0.72982E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.24079E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.99066E-09 |
| 13 | CRU-3 : PLANT 9 AREA | 0.37651E-07 |
| 14 | CRU-3 : OTHER MAIN P | 0.10974E-04 |
| 15 | perchwater | 0.34225E-04 |
| | EXTRA LOADING | 0.16762E-10 |

TIME = 670.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.11613E-05 |
| 3 | EWMF FOR CRU-1 | 0.37783E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.48905E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.16742E-06 |
| 6 | CRU-2 : SOUTH LIME S | 0.16889E-06 |
| 7 | CRU-2 : FLYASH AND S | 0.12179E-10 |
| 8 | CRU-3 : WEST OF PLAN | 0.21370E-05 |
| 9 | CRU-3 : EAST OF PLAN | 0.14568E-04 |
| 10 | CRU-4 : SILOS 1 2 & | 0.76447E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.20496E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.74550E-09 |

0485

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

5208

| | | |
|---|---|---|
| 13 | CRU-3 : PLANT 9 AREA | 0.30362E-07 |
| 14 | CRU-3 : OTHER MAIN P | 0.10267E-04 |
| 15 | perchwater | 0.32733E-04 |
| | EXTRA LOADING | 0.12183E-10 |

TIME = 680.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.99216E-06 |
| 3 | EWMF FOR CRU-1 | 0.37876E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.45238E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.16976E-06 |
| 6 | CRU-2 : SOUTH LIME S | 0.17058E-06 |
| 7 | CRU-2 : FLYASH AND S | 0.88219E-11 |
| 8 | CRU-3 : WEST OF PLAN | 0.27161E-05 |
| 9 | CRU-3 : EAST OF PLAN | 0.20726E-04 |
| 10 | CRU-4 : SILOS 1 2 & | 0.79723E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.17361E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.56022E-09 |
| 13 | CRU-3 : PLANT 9 AREA | 0.24393E-07 |
| 14 | CRU-3 : OTHER MAIN P | 0.95565E-05 |
| 15 | perchwater | 0.31267E-04 |
| | EXTRA LOADING | 0.88221E-11 |

TIME = 690.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.84320E-06 |
| 3 | EWMF FOR CRU-1 | 0.37615E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.41515E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.17034E-06 |
| 6 | CRU-2 : SOUTH LIME S | 0.17051E-06 |
| 7 | CRU-2 : FLYASH AND S | 0.63901E-11 |
| 8 | CRU-3 : WEST OF PLAN | 0.36031E-05 |
| 9 | CRU-3 : EAST OF PLAN | 0.28952E-04 |
| 10 | CRU-4 : SILOS 1 2 & | 0.82816E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.14637E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.42042E-09 |
| 13 | CRU-3 : PLANT 9 AREA | 0.19529E-07 |
| 14 | CRU-3 : OTHER MAIN P | 0.88514E-05 |
| 15 | perchwater | 0.29826E-04 |
| | EXTRA LOADING | 0.64276E-11 |

TIME = 700.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.71300E-06 |
| 3 | EWMF FOR CRU-1 | 0.37022E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.37811E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.16921E-06 |

0486

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

52

| | | |
|---|---|---|
| 6 | CRU-2 : SOUTH LIME S | 0.16877E-06 |
| 7 | CRU-2 : FLYASH AND S | 0.46285E-11 |
| 8 | CRU-3 : WEST OF PLAN | 0.49219E-05 |
| 9 | CRU-3 : EAST OF PLAN | 0.39742E-04 |
| 10 | CRU-4 : SILOS 1 2 & | 0.85739E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.12286E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.31511E-09 |
| 13 | CRU-3 : PLANT 9 AREA | 0.15583E-07 |
| 14 | CRU-3 : OTHER MAIN P | 0.81600E-05 |
| 15 | perchwater | 0.28405E-04 |
| | EXTRA LOADING | 0.46631E-11 |

TIME = 710.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.60000E-06 |
| 3 | EWMF FOR CRU-1 | 0.36124E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.34190E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.16648E-06 |
| 6 | CRU-2 : SOUTH LIME S | 0.16546E-06 |
| 7 | CRU-2 : FLYASH AND S | 0.33525E-11 |
| 8 | CRU-3 : WEST OF PLAN | 0.68325E-05 |
| 9 | CRU-3 : EAST OF PLAN | 0.53651E-04 |
| 10 | CRU-4 : SILOS 1 2 & | 0.88506E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.10268E-06 |
| 12 | CRU-3 : PLANT 6 AREA | 0.23590E-09 |
| 13 | CRU-3 : PLANT 9 AREA | 0.12395E-07 |
| 14 | CRU-3 : OTHER MAIN P | 0.74891E-05 |
| 15 | perchwater | 0.27004E-04 |
| | EXTRA LOADING | 0.33860E-11 |

TIME = 720.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.50259E-06 |
| 3 | EWMF FOR CRU-1 | 0.34956E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.30704E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.16230E-06 |
| 6 | CRU-2 : SOUTH LIME S | 0.16075E-06 |
| 7 | CRU-2 : FLYASH AND S | 0.24283E-11 |
| 8 | CRU-3 : WEST OF PLAN | 0.95387E-05 |
| 9 | CRU-3 : EAST OF PLAN | 0.71290E-04 |
| 10 | CRU-4 : SILOS 1 2 & | 0.91135E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.85457E-07 |
| 12 | CRU-3 : PLANT 6 AREA | 0.17641E-09 |
| 13 | CRU-3 : PLANT 9 AREA | 0.98293E-08 |
| 14 | CRU-3 : OTHER MAIN P | 0.68447E-05 |
| 15 | perchwater | 0.25620E-04 |
| | EXTRA LOADING | 0.24576E-11 |

0487

52

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

TIME = 730.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.41914E-06 |
| 3 | EWMF FOR CRU-1 | 0.33556E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.27392E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.15684E-06 |
| 6 | CRU-2 : SOUTH LIME S | 0.15483E-06 |
| 7 | CRU-2 : FLYASH AND S | 0.17589E-11 |
| 8 | CRU-3 : WEST OF PLAN | 0.13294E-04 |
| 9 | CRU-3 : EAST OF PLAN | 0.93306E-04 |
| 10 | CRU-4 : SILOS 1 2 & | 0.93642E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.70846E-07 |
| 12 | CRU-3 : PLANT 6 AREA | 0.13178E-09 |
| 13 | CRU-3 : PLANT 9 AREA | 0.77725E-08 |
| 14 | CRU-3 : OTHER MAIN P | 0.62311E-05 |
| 15 | perchwater | 0.24254E-04 |
| | EXTRA LOADING | 0.17854E-11 |

TIME = 740.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.34809E-06 |
| 3 | EWMF FOR CRU-1 | 0.31964E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.24285E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.15030E-06 |
| 6 | CRU-2 : SOUTH LIME S | 0.14789E-06 |
| 7 | CRU-2 : FLYASH AND S | 0.12740E-11 |
| 8 | CRU-3 : WEST OF PLAN | 0.18408E-04 |
| 9 | CRU-3 : EAST OF PLAN | 0.12038E-03 |
| 10 | CRU-4 : SILOS 1 2 & | 0.96042E-04 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.58511E-07 |
| 12 | CRU-3 : PLANT 6 AREA | 0.98349E-10 |
| 13 | CRU-3 : PLANT 9 AREA | 0.61293E-08 |
| 14 | CRU-3 : OTHER MAIN P | 0.56519E-05 |
| 15 | perchwater | 0.22906E-04 |

TIME = 750.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.28791E-06 |
| 3 | EWMF FOR CRU-1 | 0.30223E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.21401E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.14287E-06 |
| 6 | CRU-2 : SOUTH LIME S | 0.14015E-06 |
| 7 | CRU-2 : FLYASH AND S | 0.92291E-12 |
| 8 | CRU-3 : WEST OF PLAN | 0.25253E-04 |
| 9 | CRU-3 : EAST OF PLAN | 0.15319E-03 |
| 10 | CRU-4 : SILOS 1 2 & | 0.98350E-04 |

0488

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

5208

| | | |
|---|---|---|
| 11 | CRU-3 : PLANT 2/3 AR | 0.48148E-07 |
| 12 | CRU-3 : PLANT 6 AREA | 0.73326E-10 |
| 13 | CRU-3 : PLANT 9 AREA | 0.48210E-08 |
| 14 | CRU-3 : OTHER MAIN P | 0.51093E-05 |
| 15 | perchwater | 0.21578E-04 |

TIME = 760.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.23723E-06 |
| 3 | EWMF FOR CRU-1 | 0.28373E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.18752E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.13477E-06 |
| 6 | CRU-2 : SOUTH LIME S | 0.13180E-06 |
| 7 | CRU-2 : FLYASH AND S | 0.66861E-12 |
| 8 | CRU-3 : WEST OF PLAN | 0.34267E-04 |
| 9 | CRU-3 : EAST OF PLAN | 0.19242E-03 |
| 10 | CRU-4 : SILOS 1 2 & | 0.10058E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.39482E-07 |
| 12 | CRU-3 : PLANT 6 AREA | 0.54621E-10 |
| 13 | CRU-3 : PLANT 9 AREA | 0.37825E-08 |
| 14 | CRU-3 : OTHER MAIN P | 0.46046E-05 |
| 15 | perchwater | 0.20272E-04 |

TIME = 770.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.19474E-06 |
| 3 | EWMF FOR CRU-1 | 0.26454E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.16341E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.12619E-06 |
| 6 | CRU-2 : SOUTH LIME S | 0.12305E-06 |
| 7 | CRU-2 : FLYASH AND S | 0.48447E-12 |
| 8 | CRU-3 : WEST OF PLAN | 0.45957E-04 |
| 9 | CRU-3 : EAST OF PLAN | 0.23870E-03 |
| 10 | CRU-4 : SILOS 1 2 & | 0.10273E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.32267E-07 |
| 12 | CRU-3 : PLANT 6 AREA | 0.40654E-10 |
| 13 | CRU-3 : PLANT 9 AREA | 0.29608E-08 |
| 14 | CRU-3 : OTHER MAIN P | 0.41383E-05 |
| 15 | perchwater | 0.18991E-04 |

TIME = 780.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.15931E-06 |
| 3 | EWMF FOR CRU-1 | 0.24502E-05 |

0489

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

5208

| | | |
|---|---|---|
| 4 | CRU-2 : SOLID WASTE | 0.14165E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.11732E-06 |
| 6 | CRU-2 : SOUTH LIME S | 0.11407E-06 |
| 7 | CRU-2 : FLYASH AND S | 0.35115E-12 |
| 8 | CRU-3 : WEST OF PLAN | 0.60900E-04 |
| 9 | CRU-3 : EAST OF PLAN | 0.29262E-03 |
| 10 | CRU-4 : SILOS 1 2 & | 0.10481E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.26286E-07 |
| 12 | CRU-3 : PLANT 6 AREA | 0.30233E-10 |
| 13 | CRU-3 : PLANT 9 AREA | 0.23124E-08 |
| 14 | CRU-3 : OTHER MAIN P | 0.37100E-05 |
| 15 | perchwater | 0.17737E-04 |

TIME = 790.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.12988E-06 |
| 3 | EWMF FOR CRU-1 | 0.22549E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.12218E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.10834E-06 |
| 6 | CRU-2 : SOUTH LIME S | 0.10504E-06 |
| 7 | CRU-2 : FLYASH AND S | 0.25466E-12 |
| 8 | CRU-3 : WEST OF PLAN | 0.79740E-04 |
| 9 | CRU-3 : EAST OF PLAN | 0.35467E-03 |
| 10 | CRU-4 : SILOS 1 2 & | 0.10682E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.21347E-07 |
| 12 | CRU-3 : PLANT 6 AREA | 0.22464E-10 |
| 13 | CRU-3 : PLANT 9 AREA | 0.18020E-08 |
| 14 | CRU-3 : OTHER MAIN P | 0.33187E-05 |
| 15 | perchwater | 0.16516E-04 |

TIME = 800.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.10554E-06 |
| 3 | EWMF FOR CRU-1 | 0.20625E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.10487E-06 |
| 5 | CRU-2 : NORTH LIME S | 0.99390E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.96109E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.18488E-12 |
| 8 | CRU-3 : WEST OF PLAN | 0.10318E-03 |
| 9 | CRU-3 : EAST OF PLAN | 0.42524E-03 |
| 10 | CRU-4 : SILOS 1 2 & | 0.10875E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.17285E-07 |
| 12 | CRU-3 : PLANT 6 AREA | 0.16678E-10 |
| 13 | CRU-3 : PLANT 9 AREA | 0.14015E-08 |
| 14 | CRU-3 : OTHER MAIN P | 0.29631E-05 |
| 15 | perchwater | 0.15329E-04 |

0490

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

5208

TIME = 810.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.85498E-07 |
| 3 | EWMF FOR CRU-1 | 0.18754E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.89601E-07 |
| 5 | CRU-2 : NORTH LIME S | 0.90611E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.87390E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.13447E-12 |
| 8 | CRU-3 : WEST OF PLAN | 0.13199E-03 |
| 9 | CRU-3 : EAST OF PLAN | 0.50461E-03 |
| 10 | CRU-4 : SILOS 1 2 & | 0.11061E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.13956E-07 |
| 12 | CRU-3 : PLANT 6 AREA | 0.12377E-10 |
| 13 | CRU-3 : PLANT 9 AREA | 0.10878E-08 |
| 14 | CRU-3 : OTHER MAIN P | 0.26414E-05 |
| 15 | perchwater | 0.14181E-04 |

TIME = 820.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.69055E-07 |
| 3 | EWMF FOR CRU-1 | 0.16954E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.76217E-07 |
| 5 | CRU-2 : NORTH LIME S | 0.82111E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.78990E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.98129E-13 |
| 8 | CRU-3 : WEST OF PLAN | 0.16697E-03 |
| 9 | CRU-3 : EAST OF PLAN | 0.59289E-03 |
| 10 | CRU-4 : SILOS 1 2 & | 0.11237E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.11237E-07 |
| 12 | CRU-3 : PLANT 6 AREA | 0.91843E-11 |
| 13 | CRU-3 : PLANT 9 AREA | 0.84277E-09 |
| 14 | CRU-3 : OTHER MAIN P | 0.23514E-05 |
| 15 | perchwater | 0.13076E-04 |

TIME = 830.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.55615E-07 |
| 3 | EWMF FOR CRU-1 | 0.15244E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.64556E-07 |
| 5 | CRU-2 : NORTH LIME S | 0.73978E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.70991E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.72038E-13 |
| 8 | CRU-3 : WEST OF PLAN | 0.20896E-03 |
| 9 | CRU-3 : EAST OF PLAN | 0.69005E-08 |

0491

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

52

| | | |
|---|---|---|
| 10 | CRU-4 : SILOS 1 2 & | 0.11402E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.90238E-08 |
| 12 | CRU-3 : PLANT 6 AREA | 0.68185E-11 |
| 13 | CRU-3 : PLANT 9 AREA | 0.65175E-09 |
| 14 | CRU-3 : OTHER MAIN P | 0.20910E-05 |
| 15 | perchwater | 0.12016E-04 |

TIME = 840.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.44667E-07 |
| 3 | EWMF FOR CRU-1 | 0.13633E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.54457E-07 |
| 5 | CRU-2 : NORTH LIME S | 0.66281E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.63451E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.53435E-13 |
| 8 | CRU-3 : WEST OF PLAN | 0.25880E-03 |
| 9 | CRU-3 : EAST OF PLAN | 0.79588E-03 |
| 10 | CRU-4 : SILOS 1 2 & | 0.11555E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.72280E-08 |
| 12 | CRU-3 : PLANT 6 AREA | 0.50698E-11 |
| 13 | CRU-3 : PLANT 9 AREA | 0.50316E-09 |
| 14 | CRU-3 : OTHER MAIN P | 0.18578E-05 |
| 15 | perchwater | 0.11004E-04 |

TIME = 850.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.35780E-07 |
| 3 | EWMF FOR CRU-1 | 0.12130E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.45758E-07 |
| 5 | CRU-2 : NORTH LIME S | 0.59067E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.56413E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.40340E-13 |
| 8 | CRU-3 : WEST OF PLAN | 0.31735E-03 |
| 9 | CRU-3 : EAST OF PLAN | 0.91002E-03 |
| 10 | CRU-4 : SILOS 1 2 & | 0.11694E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.57755E-08 |
| 12 | CRU-3 : PLANT 6 AREA | 0.37836E-11 |
| 13 | CRU-3 : PLANT 9 AREA | 0.38781E-09 |
| 14 | CRU-3 : OTHER MAIN P | 0.16495E-05 |
| 15 | perchwater | 0.10042E-04 |

TIME = 860.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.28588E-07 |

0492

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

-. 5208

| | | |
|---|---|---|
| 3 | EWMF FOR CRU-1 | 0.10739E-05 |
| 4 | CRU-2 : SOLID WASTE | 0.38304E-07 |
| 5 | CRU-2 : NORTH LIME S | 0.52367E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.49900E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.31334E-13 |
| 8 | CRU-3 : WEST OF PLAN | 0.38540E-03 |
| 9 | CRU-3 : EAST OF PLAN | 0.10319E-02 |
| 10 | CRU-4 : SILOS 1 2 & | 0.11818E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.46040E-08 |
| 12 | CRU-3 : PLANT 6 AREA | 0.28468E-11 |
| 13 | CRU-3 : PLANT 9 AREA | 0.29843E-09 |
| 14 | CRU-3 : OTHER MAIN P | 0.14639E-05 |
| 15 | perchwater | 0.91329E-05 |

TIME = 870.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.22786E-07 |
| 3 | EWMF FOR CRU-1 | 0.94626E-06 |
| 4 | CRU-2 : SOLID WASTE | 0.31948E-07 |
| 5 | CRU-2 : NORTH LIME S | 0.46198E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.43923E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.25418E-13 |
| 8 | CRU-3 : WEST OF PLAN | 0.46375E-03 |
| 9 | CRU-3 : EAST OF PLAN | 0.11609E-02 |
| 10 | CRU-4 : SILOS 1 2 & | 0.11925E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.36617E-08 |
| 12 | CRU-3 : PLANT 6 AREA | 0.21773E-11 |
| 13 | CRU-3 : PLANT 9 AREA | 0.22931E-09 |
| 14 | CRU-3 : OTHER MAIN P | 0.12987E-05 |
| 15 | perchwater | 0.82771E-05 |

TIME = 880.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.18119E-07 |
| 3 | EWMF FOR CRU-1 | 0.82994E-06 |
| 4 | CRU-2 : SOLID WASTE | 0.26554E-07 |
| 5 | CRU-2 : NORTH LIME S | 0.40560E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.38480E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.21896E-13 |
| 8 | CRU-3 : WEST OF PLAN | 0.55308E-03 |
| 9 | CRU-3 : EAST OF PLAN | 0.12960E-02 |
| 10 | CRU-4 : SILOS 1 2 & | 0.12013E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.29059E-08 |
| 12 | CRU-3 : PLANT 6 AREA | 0.17172E-01 |

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

5208

| | | |
|---|---|---|
| 13 | CRU-3 : PLANT 9 AREA | 0.17594E-09 |
| 14 | CRU-3 : OTHER MAIN P | 0.11519E-05 |
| 15 | perchwater | 0.74756E-05 |

TIME = 890.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.14375E-07 |
| 3 | EWMF FOR CRU-1 | 0.72468E-06 |
| 4 | CRU-2 : SOLID WASTE | 0.21997E-07 |
| 5 | CRU-2 : NORTH LIME S | 0.35447E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.33558E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.20306E-13 |
| 8 | CRU-3 : WEST OF PLAN | 0.65400E-03 |
| 9 | CRU-3 : EAST OF PLAN | 0.14364E-02 |
| 10 | CRU-4 : SILOS 1 2 & | 0.12080E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.23013E-08 |
| 12 | CRU-3 : PLANT 6 AREA | 0.14280E-11 |
| 13 | CRU-3 : PLANT 9 AREA | 0.13480E-09 |
| 14 | CRU-3 : OTHER MAIN P | 0.10215E-05 |
| 15 | perchwater | 0.67283E-05 |

TIME = 900.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.11380E-07 |
| 3 | EWMF FOR CRU-1 | 0.63005E-06 |
| 4 | CRU-2 : SOLID WASTE | 0.18163E-07 |
| 5 | CRU-2 : NORTH LIME S | 0.30841E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.29137E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.20357E-13 |
| 8 | CRU-3 : WEST OF PLAN | 0.76701E-03 |
| 9 | CRU-3 : EAST OF PLAN | 0.15809E-02 |
| 10 | CRU-4 : SILOS 1 2 & | 0.12126E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.18187E-08 |
| 12 | CRU-3 : PLANT 6 AREA | 0.12868E-11 |
| 13 | CRU-3 : PLANT 9 AREA | 0.10315E-09 |
| 14 | CRU-3 : OTHER MAIN P | 0.90580E-06 |
| 15 | perchwater | 0.60349E-05 |

TIME = 910.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.89906E-08 |
| 3 | EWMF FOR CRU-1 | 0.54550E-06 |
| 4 | CRU-2 : SOLID WASTE | 0.14951E-07 |
| 5 | CRU-2 : NORTH LIME S | 0.26719E-07 |

0494

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

5208

| | | |
|---|---|---|
| 6 | CRU-2 : SOUTH LIME S | 0.25192E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.21894E-13 |
| 8 | CRU-3 : WEST OF PLAN | 0.89248E-03 |
| 9 | CRU-3 : EAST OF PLAN | 0.17283E-02 |
| 10 | CRU-4 : SILOS 1 2 & | 0.12149E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.14345E-08 |
| 12 | CRU-3 : PLANT 6 AREA | 0.12849E-11 |
| 13 | CRU-3 : PLANT 9 AREA | 0.78823E-10 |
| 14 | CRU-3 : OTHER MAIN P | 0.80308E-06 |
| 15 | perchwater | 0.53945E-05 |

TIME = 920.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.70883E-08 |
| 3 | EWMF FOR CRU-1 | 0.47040E-06 |
| 4 | CRU-2 : SOLID WASTE | 0.12270E-07 |
| 5 | CRU-2 : NORTH LIME S | 0.23052E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.21693E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.24870E-13 |
| 8 | CRU-3 : WEST OF PLAN | 0.10306E-02 |
| 9 | CRU-3 : EAST OF PLAN | 0.18773E-02 |
| 10 | CRU-4 : SILOS 1 2 & | 0.12148E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.11294E-08 |
| 12 | CRU-3 : PLANT 6 AREA | 0.14284E-11 |
| 13 | CRU-3 : PLANT 9 AREA | 0.60160E-10 |
| 14 | CRU-3 : OTHER MAIN P | 0.71191E-06 |
| 15 | perchwater | 0.48058E-05 |

TIME = 930.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.55776E-08 |
| 3 | EWMF FOR CRU-1 | 0.40407E-06 |
| 4 | CRU-2 : SOLID WASTE | 0.10040E-07 |
| 5 | CRU-2 : NORTH LIME S | 0.19809E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.18606E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.29325E-13 |
| 8 | CRU-3 : WEST OF PLAN | 0.11815E-02 |
| 9 | CRU-3 : EAST OF PLAN | 0.20267E-02 |
| 10 | CRU-4 : SILOS 1 2 & | 0.12123E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.88749E-09 |
| 12 | CRU-3 : PLANT 6 AREA | 0.17381E-11 |
| 13 | CRU-3 : PLANT 9 AREA | 0.45861E-10 |
| 14 | CRU-3 : OTHER MAIN P | 0.63096E-06 |
| 15 | perchwater | 0.42670E-05 |

0495

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

- 5208

TIME = 940.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.43807E-08 |
| 3 | EWMF FOR CRU-1 | 0.34578E-06 |
| 4 | CRU-2 : SOLID WASTE | 0.81934E-08 |
| 5 | CRU-2 : NORTH LIME S | 0.16957E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.15897E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.35374E-13 |
| 8 | CRU-3 : WEST OF PLAN | 0.13450E-02 |
| 9 | CRU-3 : EAST OF PLAN | 0.21752E-02 |
| 10 | CRU-4 : SILOS 1 2 & | 0.12071E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.69618E-09 |
| 12 | CRU-3 : PLANT 6 AREA | 0.22503E-11 |
| 13 | CRU-3 : PLANT 9 AREA | 0.34921E-10 |
| 14 | CRU-3 : OTHER MAIN P | 0.55905E-06 |
| 15 | perchwater | 0.37761E-05 |

TIME = 950.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.34344E-08 |
| 3 | EWMF FOR CRU-1 | 0.29483E-06 |
| 4 | CRU-2 : SOLID WASTE | 0.66682E-08 |
| 5 | CRU-2 : NORTH LIME S | 0.14462E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.13533E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.43206E-13 |
| 8 | CRU-3 : WEST OF PLAN | 0.15208E-02 |
| 9 | CRU-3 : EAST OF PLAN | 0.23214E-02 |
| 10 | CRU-4 : SILOS 1 2 & | 0.11995E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.54518E-09 |
| 12 | CRU-3 : PLANT 6 AREA | 0.30192E-11 |
| 13 | CRU-3 : PLANT 9 AREA | 0.26561E-10 |
| 14 | CRU-3 : OTHER MAIN P | 0.49515E-06 |
| 15 | perchwater | 0.33309E-05 |

TIME = 960.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.26878E-08 |
| 3 | EWMF FOR CRU-1 | 0.25050E-06 |
| 4 | CRU-2 : SOLID WASTE | 0.54128E-08 |
| 5 | CRU-2 : NORTH LIME S | 0.12290E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.11480E-07 |
| 7 | CRU-2 : FLYASH AND S | 0.53076E-13 |
| 8 | CRU-3 : WEST OF PLAN | 0.17085E-02 |
| 9 | CRU-3 : EAST OF PLAN | 0.24641E-02 |
| 10 | CRU-4 : SILOS 1 2 & | 0.11892E-03 |

0496

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

5208

| | | |
|---|---|---|
| 11 | CRU-3 : PLANT 2/3 AR | 0.42623E-09 |
| 12 | CRU-3 : PLANT 6 AREA | 0.41200E-11 |
| 13 | CRU-3 : PLANT 9 AREA | 0.20179E-10 |
| 14 | CRU-3 : OTHER MAIN P | 0.43833E-06 |
| 15 | perchwater | 0.29287E-05 |

TIME = 970.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.21000E-08 |
| 3 | EWMF FOR CRU-1 | 0.21212E-06 |
| 4 | CRU-2 : SOLID WASTE | 0.43829E-08 |
| 5 | CRU-2 : NORTH LIME S | 0.10407E-07 |
| 6 | CRU-2 : SOUTH LIME S | 0.97049E-08 |
| 7 | CRU-2 : FLYASH AND S | 0.65517E-13 |
| 8 | CRU-3 : WEST OF PLAN | 0.19075E-02 |
| 9 | CRU-3 : EAST OF PLAN | 0.26021E-02 |
| 10 | CRU-4 : SILOS 1 2 & | 0.11764E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.33270E-09 |
| 12 | CRU-3 : PLANT 6 AREA | 0.56534E-11 |
| 13 | CRU-3 : PLANT 9 AREA | 0.15314E-10 |
| 14 | CRU-3 : OTHER MAIN P | 0.38778E-06 |
| 15 | perchwater | 0.25669E-05 |

TIME = 980.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.16380E-08 |
| 3 | EWMF FOR CRU-1 | 0.17902E-06 |
| 4 | CRU-2 : SOLID WASTE | 0.35403E-08 |
| 5 | CRU-2 : NORTH LIME S | 0.87839E-08 |
| 6 | CRU-2 : SOUTH LIME S | 0.81771E-08 |
| 7 | CRU-2 : FLYASH AND S | 0.80739E-13 |
| 8 | CRU-3 : WEST OF PLAN | 0.21169E-02 |
| 9 | CRU-3 : EAST OF PLAN | 0.27344E-02 |
| 10 | CRU-4 : SILOS 1 2 & | 0.11611E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.25930E-09 |
| 12 | CRU-3 : PLANT 6 AREA | 0.77519E-11 |
| 13 | CRU-3 : PLANT 9 AREA | 0.11610E-10 |
| 14 | CRU-3 : OTHER MAIN P | 0.34280E-06 |
| 15 | perchwater | 0.22429E-05 |

TIME = 990.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.12757E-08 |
| 3 | EWMF FOR CRU-1 | 0.15061E-06 |

U-238 MASS LOADING RATES TO THE SWIFT III MODEL
(Continued)

- 5208

| | | |
|---|---|---|
| 4 | CRU-2 : SOLID WASTE | 0.28531E-08 |
| 5 | CRU-2 : NORTH LIME S | 0.73896E-08 |
| 6 | CRU-2 : SOUTH LIME S | 0.68678E-08 |
| 7 | CRU-2 : FLYASH AND S | 0.99083E-13 |
| 8 | CRU-3 : WEST OF PLAN | 0.23359E-02 |
| 9 | CRU-3 : EAST OF PLAN | 0.28598E-02 |
| 10 | CRU-4 : SILOS 1 2 & | 0.11433E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.20179E-09 |
| 12 | CRU-3 : PLANT 6 AREA | 0.10587E-10 |
| 13 | CRU-3 : PLANT 9 AREA | 0.87938E-11 |
| 14 | CRU-3 : OTHER MAIN P | 0.30276E-06 |
| 15 | perchwater | 0.19537E-05 |

TIME = 1000.0

| | | |
|---|---|---|
| 1 | EWMF FOR CRU-4 | 0.00000E+00 |
| 2 | EWMF FOR CRU-3 | 0.99204E-09 |
| 3 | EWMF FOR CRU-1 | 0.12631E-06 |
| 4 | CRU-2 : SOLID WASTE | 0.22940E-08 |
| 5 | CRU-2 : NORTH LIME S | 0.61971E-08 |
| 6 | CRU-2 : SOUTH LIME S | 0.57502E-08 |
| 7 | CRU-2 : FLYASH AND S | 0.12125E-12 |
| 8 | CRU-3 : WEST OF PLAN | 0.25632E-02 |
| 9 | CRU-3 : EAST OF PLAN | 0.29776E-02 |
| 10 | CRU-4 : SILOS 1 2 & | 0.11233E-03 |
| 11 | CRU-3 : PLANT 2/3 AR | 0.15681E-09 |
| 12 | CRU-3 : PLANT 6 AREA | 0.14379E-10 |
| 13 | CRU-3 : PLANT 9 AREA | 0.66546E-11 |
| 14 | CRU-3 : OTHER MAIN P | 0.26712E-06 |
| 15 | perchwater | 0.16968E-05 |

0498

# ATTACHMENT K.III

## AIR EMISSION AND DISPERSION MODELING INPUT AND OUTPUT

# Raecom Model Input and Output

5208

{This page intentionally left blank}



0501

OU1 Residual w/RCRA–Type Cap (Conventional): Ra–226 @ 5 pCi/g (PRG)
(Diffusion Coefficients calculated by RAECOM)

| Component | Units | Soil/Waste | (Fill) Cover1 | (Bentonite) Cover2 | (Drainage) Cover3 | (Cobbles) Cover4 | (Gravel) Cover5 | (Top Soil) Cover6 |
|---|---|---|---|---|---|---|---|---|
| R | pCi/g | 5 | NA | NA | NA | NA | NA | NA |
| $RHO_i$ | $g/cm^3$ | 1.5 | 1.6 | 0.88 | 1.6 | 1.6 | 1.6 | 1.6 |
| E | dimensionless | 0.22 | NA | NA | NA | NA | NA | NA |
| LAMDA | $sec^{-1}$ | 2.1E–06 | NA | NA | NA | NA | NA | NA |
| $X_i$ | cm | --- | 75 | 10 | 30 | 90 | 15 | 105 |
| $Xt_i$ | cm | 600 | 675 | 685 | 715 | 805 | 820 | 925 |
| $P_i$ | dimensionless | 0.35 | 0.463 | 0.4 | 0.417 | 0.417 | 0.417 | 0.463 |
| $MC_i$ | dry wt % | 13 | 23.2 | 35.6 | 4.5 | 4.5 | 4.5 | 23.2 |
| K | dimensionless | 0.26 | NA | NA | NA | NA | NA | NA |
| Precip. | inches | NA | NA | NA | NA | NA | NA | NA |
| Evap. | inches | NA | NA | NA | NA | NA | NA | NA |
| $Fcm_i$ | frac.<200 mesh | NA | NA | NA | NA | NA | NA | NA |
| $DC_i=F(M_i,P_i)$ | $cm^2/sec$ | 7.99E–03 | 1.50E–03 | 1.55E–03 | 3.95E–02 | 3.95E–02 | 3.95E–02 | 1.50E–03 |
| $DC_i$ (User) | $cm^2/sec$ | NA | 1.50E–03 | 1.55E–03 | 3.95E–02 | 3.95E–02 | 3.95E–02 | 1.50E–03 |
| $DCt_i$ | $cm^2/sec$ | 7.99E–03 | 1.89E–03 | 1.78E–03 | 9.20E–03 | 2.38E–02 | 2.54E–02 | 1.14E–03 |
| $B_i$ | $cm^{-1}$ | --- | 0.0374 | 0.0368 | 0.0073 | 0.0073 | 0.0073 | 0.0374 |
| $Bt_i$ | $cm^{-1}$ | 0.0162 | 0.0333 | 0.0343 | 0.0151 | 0.0094 | 0.0091 | 0.0429 |
| $M_i=F(MC_i)$ | dimensionless | 0.557 | 0.802 | 0.783 | 0.173 | 0.173 | 0.173 | 0.802 |
| $M_i=F(Precip)$ | dimensionless | NA | NA | NA | NA | NA | NA | NA |
| $M_i$ | dimensionless | 0.557 | 0.802 | 0.783 | 0.173 | 0.173 | 0.173 | 0.802 |
| $A_i$ | $cm^2/sec$ | --- | 5.31E–05 | 4.38E–05 | 5.23E–03 | 5.23E–03 | 5.23E–03 | 5.31E–05 |
| $At_i$ | $cm^2/sec$ | 3.38E–04 | 8.00E–05 | 7.55E–05 | 3.89E–04 | 8.44E–04 | 7.19E–04 | 1.51E–04 |
| $\tanh(Xt_iBt_i)$ | | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| $J_i$ | $pCi/(m^2 \cdot sec)$ | 2.137 | 7.331E–02 | 4.649E–02 | 4.425E–02 | 3.127E–02 | 2.979E–02 | 2.498E–04 |

Rate used in ISCLT2 for Future Scenario

Rate used in ISCLT2 for Current Scenario

Reference: Radon Attenuation Handbook for Uranium Mill Tailings Cover Design, V.C. Rogers and K.K. Nielson, NUREG/CR–3533 (PNL–4878), April 1984.

208

FERMCO
FEMP

Fluor Daniel, Inc.
Contract 04424331
07/09/93

OU2 Residual w/RCRA–Type Cap (Conventional): Sanitary Waste Landfill
(Diffusion Coefficients calculated by RAECOM)

| Component | Units | Soil/Waste | (Fill) Cover1 | (Bentonite) Cover2 | (Drainage) Cover3 | (Cobbles) Cover4 | (Gravel) Cover5 | (Top Soil) Cover6 |
|---|---|---|---|---|---|---|---|---|
| R | pCi/g | 1.03 | NA | NA | NA | NA | NA | NA |
| $RHO_i$ | $g/cm^3$ | 1.5 | 1.6 | 0.88 | 1.6 | 1.6 | 1.6 | 1.6 |
| E | dimensionless | 0.22 | NA | NA | NA | NA | NA | NA |
| LAMDA | $sec^{-1}$ | 2.1E–06 | NA | NA | NA | NA | NA | NA |
| $X_i$ | cm | --- | 75 | 10 | 30 | 90 | 15 | 105 |
| $Xt_i$ | cm | 300 | 375 | 385 | 415 | 505 | 520 | 625 |
| $P_i$ | dimensionless | 0.35 | 0.463 | 0.4 | 0.417 | 0.417 | 0.417 | 0.463 |
| $MC_i$ | dry wt % | 13 | 23.2 | 35.6 | 4.5 | 4.5 | 4.5 | 23.2 |
| K | dimensionless | 0.26 | NA | NA | NA | NA | NA | NA |
| Precip. | inches | NA | NA | NA | NA | NA | NA | NA |
| Evap. | inches | NA | NA | NA | NA | NA | NA | NA |
| $Fcm_i$ | frac.<200 mesh | NA | NA | NA | NA | NA | NA | NA |
| $DC_i=F(M_i,P_i)$ | $cm^2/sec$ | 7.99E–03 | 1.50E–03 | 1.55E–03 | 3.95E–02 | 3.95E–02 | 3.95E–02 | 1.50E–03 |
| $DC_i$ (User) | $cm^2/sec$ | NA | 1.50E–03 | 1.55E–03 | 3.95E–02 | 3.95E–02 | 3.95E–02 | 1.50E–03 |
| $DCt_i$ | $cm^2/sec$ | 7.99E–03 | 1.89E–03 | 1.78E–03 | 9.20E–03 | 2.38E–02 | 2.54E–02 | 1.14E–03 |
| $B_i$ | $cm^{-1}$ | --- | 0.0374 | 0.0368 | 0.0073 | 0.0073 | 0.0073 | 0.0374 |
| $Bt_i$ | $cm^{-1}$ | 0.0162 | 0.0333 | 0.0343 | 0.0151 | 0.0094 | 0.0091 | 0.0429 |
| $M_i=F(MC_i)$ | dimensionless | 0.557 | 0.802 | 0.783 | 0.173 | 0.173 | 0.173 | 0.802 |
| $M_i=F(Precip)$ | dimensionless | NA | NA | NA | NA | NA | NA | NA |
| $M_i$ | dimensionless | 0.557 | 0.802 | 0.783 | 0.173 | 0.173 | 0.173 | 0.802 |
| $A_i$ | $cm^2/sec$ | --- | 5.31E–05 | 4.38E–05 | 5.23E–03 | 5.23E–03 | 5.23E–03 | 5.31E–05 |
| $At_i$ | $cm^2/sec$ | 3.38E–04 | 8.00E–05 | 7.55E–05 | 3.89E–04 | 8.44E–04 | 7.19E–04 | 1.51E–04 |
| $\tanh(Xt_i Bt_i)$ | | 0.9999 | 1.0000 | 1.0000 | 1.0000 | 0.9998 | 0.9998 | 1.0000 |
| $J_i$ | $pCi/(m^2 \cdot sec)$ | 0.440 | 1.510E–02 | 9.576E–03 | 9.116E–03 | 6.442E–03 | 6.136E–03 | 5.146E–05 |

Rate used in ISCLT2 for Future Scenario

Rate used in ISCLT2 for Current Scenario

Reference: Radon Attenuation Handbook for Uranium Mill Tailings Cover Design, V.C. Rogers and K.K. Nielson, NUREG/CR–3533 (PNL–4878), April 1984.

OU2 Residual w/RCRA–Type Cap (Conventional): Lime Sludge Ponds
(Diffusion Coefficients calculated by RAECOM)

| Component | Units | Soil/Waste | (Fill) Cover1 | (Bentonite) Cover2 | (Drainage) Cover3 | (Cobbles) Cover4 | (Gravel) Cover5 | (Top Soil) Cover6 |
|---|---|---|---|---|---|---|---|---|
| R | pCi/g | 17.4 | NA | NA | NA | NA | NA | NA |
| $RHO_i$ | $g/cm^3$ | 1.5 | 1.6 | 0.88 | 1.6 | 1.6 | 1.6 | 1.6 |
| E | dimensionless | 0.22 | NA | NA | NA | NA | NA | NA |
| LAMDA | $sec^{-1}$ | 2.1E–06 | NA | NA | NA | NA | NA | NA |
| $X_i$ | cm | --- | 75 | 10 | 30 | 90 | 15 | 105 |
| $Xt_i$ | cm | 300 | 375 | 385 | 415 | 505 | 520 | 625 |
| $P_i$ | dimensionless | 0.35 | 0.463 | 0.4 | 0.417 | 0.417 | 0.417 | 0.463 |
| $MC_i$ | dry wt % | 13 | 23.2 | 35.6 | 4.5 | 4.5 | 4.5 | 23.2 |
| K | dimensionless | 0.26 | NA | NA | NA | NA | NA | NA |
| Precip. | inches | NA | NA | NA | NA | NA | NA | NA |
| Evap. | inches | NA | NA | NA | NA | NA | NA | NA |
| $Fcm_i$ | frac.<200 mesh | NA | NA | NA | NA | NA | NA | NA |
| $DC_i=F(M_i,P_i)$ | $cm^2/sec$ | 7.99E–03 | 1.50E–03 | 1.55E–03 | 3.95E–02 | 3.95E–02 | 3.95E–02 | 1.50E–03 |
| $DC_i$ (User) | $cm^2/sec$ | NA | 1.50E–03 | 1.55E–03 | 3.95E–02 | 3.95E–02 | 3.95E–02 | 1.50E–03 |
| $DCt_i$ | $cm^2/sec$ | 7.99E–03 | 1.89E–03 | 1.78E–03 | 9.20E–03 | 2.38E–02 | 2.54E–02 | 1.14E–03 |
| $B_i$ | $cm^{-1}$ | --- | 0.0374 | 0.0368 | 0.0073 | 0.0073 | 0.0073 | 0.0374 |
| $Bt_i$ | $cm^{-1}$ | 0.0162 | 0.0333 | 0.0343 | 0.0151 | 0.0094 | 0.0091 | 0.0429 |
| $M_i=F(MC_i)$ | dimensionless | 0.557 | 0.802 | 0.783 | 0.173 | 0.173 | 0.173 | 0.802 |
| $M_i=F(Precip)$ | dimensionless | NA | NA | NA | NA | NA | NA | NA |
| $M_i$ | dimensionless | 0.557 | 0.802 | 0.783 | 0.173 | 0.173 | 0.173 | 0.802 |
| $A_i$ | $cm^2/sec$ | --- | 5.31E–05 | 4.38E–05 | 5.23E–03 | 5.23E–03 | 5.23E–03 | 5.31E–05 |
| $At_i$ | $cm^2/sec$ | 3.38E–04 | 8.00E–05 | 7.55E–05 | 3.89E–04 | 8.44E–04 | 7.19E–04 | 1.51E–04 |
| $tanh(Xt_iBt_i)$ | | 0.9999 | 1.0000 | 1.0000 | 1.0000 | 0.9998 | 0.9998 | 1.0000 |
| $J_i$ | $pCi/(m^2 \cdot sec)$ | 7.437 | 2.551E–01 | 1.618E–01 | 1.540E–01 | 1.088E–01 | 1.037E–01 | 8.694E–04 |

Rate used in ISCLT2 for Future Scenario

Rate used in ISCLT2 for Current Scenario

Reference: Radon Attenuation Handbook for Uranium Mill Tailings Cover Design, V.C. Rogers and K.K. Nielson, NUREG/CR–3533 (PNL–4878), April 1984.

OU2 Residual w/RCRA–Type Cap (Conventional): Inactive Flyash Pile
(Diffusion Coefficients calculated by RAECOM)

| Component | Units | Soil/Waste | (Fill) Cover1 | (Bentonite) Cover2 | (Drainage) Cover3 | (Cobbles) Cover4 | (Gravel) Cover5 | (Top Soil) Cover6 |
|---|---|---|---|---|---|---|---|---|
| R | pCi/g | 48.9 | NA | NA | NA | NA | NA | NA |
| $RHO_i$ | $g/cm^3$ | 1.5 | 1.6 | 0.88 | 1.6 | 1.6 | 1.6 | 1.6 |
| E | dimensionless | 0.22 | NA | NA | NA | NA | NA | NA |
| LAMDA | $sec^{-1}$ | 2.1E–06 | NA | NA | NA | NA | NA | NA |
| $X_i$ | cm | --- | 75 | 10 | 30 | 90 | 15 | 105 |
| $Xt_i$ | cm | 300 | 375 | 385 | 415 | 505 | 520 | 625 |
| $P_i$ | dimensionless | 0.35 | 0.463 | 0.4 | 0.417 | 0.417 | 0.417 | 0.463 |
| $MC_i$ | dry wt % | 13 | 23.2 | 35.6 | 4.5 | 4.5 | 4.5 | 23.2 |
| K | dimensionless | 0.26 | NA | NA | NA | NA | NA | NA |
| Precip. | inches | NA | NA | NA | NA | NA | NA | NA |
| Evap. | inches | NA | NA | NA | NA | NA | NA | NA |
| $Fcm_i$ | frac.<200 mesh | NA | NA | NA | NA | NA | NA | NA |
| $DC_i=F(M_i,P_i)$ | $cm^2/sec$ | 7.99E–03 | 1.50E–03 | 1.55E–03 | 3.95E–02 | 3.95E–02 | 3.95E–02 | 1.50E–03 |
| $DC_i$ (User) | $cm^2/sec$ | NA | 1.50E–03 | 1.55E–03 | 3.95E–02 | 3.95E–02 | 3.95E–02 | 1.50E–03 |
| $DCt_i$ | $cm^2/sec$ | 7.99E–03 | 1.89E–03 | 1.78E–03 | 9.20E–03 | 2.38E–02 | 2.54E–02 | 1.14E–03 |
| $B_i$ | $cm^{-1}$ | --- | 0.0374 | 0.0368 | 0.0073 | 0.0073 | 0.0073 | 0.0374 |
| $Bt_i$ | $cm^{-1}$ | 0.0162 | 0.0333 | 0.0343 | 0.0151 | 0.0094 | 0.0091 | 0.0429 |
| $M_i=F(MC_i)$ | dimensionless | 0.557 | 0.802 | 0.783 | 0.173 | 0.173 | 0.173 | 0.802 |
| $M_i=F(Precip)$ | dimensionless | NA | NA | NA | NA | NA | NA | NA |
| $M_i$ | dimensionless | 0.557 | 0.802 | 0.783 | 0.173 | 0.173 | 0.173 | 0.802 |
| $A_i$ | $cm^2/sec$ | --- | 5.31E–05 | 4.38E–05 | 5.23E–03 | 5.23E–03 | 5.23E–03 | 5.31E–05 |
| $At_i$ | $cm^2/sec$ | 3.38E–04 | 8.00E–05 | 7.55E–05 | 3.89E–04 | 8.44E–04 | 7.19E–04 | 1.51E–04 |
| $\tanh(Xt_iBt_i)$ | | 0.9999 | 1.0000 | 1.0000 | 1.0000 | 0.9998 | 0.9998 | 1.0000 |
| $J_i$ | $pCi/(m^2*sec)$ | 20.900 | 7.169E–01 | 4.546E–01 | 4.328E–01 | 3.059E–01 | 2.913E–01 | 2.443E–03 |

Rate used in ISCLT2 for Future Scenario

Rate used in ISCLT2 for Current Scenario

Reference: Radon Attenuation Handbook for Uranium Mill Tailings Cover Design, V.C. Rogers and K.K. Nielson, NUREG/CR–3533 (PNL–4878), April 1984.

OU2 Residual w/RCRA–Type Cap (Conventional): Active Flyash Pile
(Diffusion Coefficients calculated by RAECOM)

| Component | Units | Soil/Waste | (Fill) Cover1 | (Bentonite) Cover2 | (Drainage) Cover3 | (Cobbles) Cover4 | (Gravel) Cover5 | (Top Soil) Cover6 |
|---|---|---|---|---|---|---|---|---|
| R | pCi/g | 3.88 | NA | NA | NA | NA | NA | NA |
| $RHO_i$ | $g/cm^3$ | 1.5 | 1.6 | 0.88 | 1.6 | 1.6 | 1.6 | 1.6 |
| E | dimensionless | 0.22 | NA | NA | NA | NA | NA | NA |
| LAMDA | $sec^{-1}$ | 2.1E–06 | NA | NA | NA | NA | NA | NA |
| $X_i$ | cm | --- | 75 | 10 | 30 | 90 | 15 | 105 |
| $Xt_i$ | cm | 300 | 375 | 385 | 415 | 505 | 520 | 625 |
| $P_i$ | dimensionless | 0.35 | 0.463 | 0.4 | 0.417 | 0.417 | 0.417 | 0.463 |
| $MC_i$ | dry wt % | 13 | 23.2 | 35.6 | 4.5 | 4.5 | 4.5 | 23.2 |
| K | dimensionless | 0.26 | NA | NA | NA | NA | NA | NA |
| Precip. | inches | NA | NA | NA | NA | NA | NA | NA |
| Evap. | inches | NA | NA | NA | NA | NA | NA | NA |
| $Fcm_i$ | frac.<200 mesh | NA | NA | NA | NA | NA | NA | NA |
| $DC_i=F(M_i,P_i)$ | $cm^2/sec$ | 7.99E–03 | 1.50E–03 | 1.55E–03 | 3.95E–02 | 3.95E–02 | 3.95E–02 | 1.50E–03 |
| $DC_i$ (User) | $cm^2/sec$ | NA | 1.50E–03 | 1.55E–03 | 3.95E–02 | 3.95E–02 | 3.95E–02 | 1.50E–03 |
| $DCt_i$ | $cm^2/sec$ | 7.99E–03 | 1.89E–03 | 1.78E–03 | 9.20E–03 | 2.38E–02 | 2.54E–02 | 1.14E–03 |
| $B_i$ | $cm^{-1}$ | --- | 0.0374 | 0.0368 | 0.0073 | 0.0073 | 0.0073 | 0.0374 |
| $Bt_i$ | $cm^{-1}$ | 0.0162 | 0.0333 | 0.0343 | 0.0151 | 0.0094 | 0.0091 | 0.0429 |
| $M_i=F(MC_i)$ | dimensionless | 0.557 | 0.802 | 0.783 | 0.173 | 0.173 | 0.173 | 0.802 |
| $M_i$=F(Precip) | dimensionless | NA | NA | NA | NA | NA | NA | NA |
| $M_i$ | dimensionless | 0.557 | 0.802 | 0.783 | 0.173 | 0.173 | 0.173 | 0.802 |
| $A_i$ | $cm^2/sec$ | --- | 5.31E–05 | 4.38E–05 | 5.23E–03 | 5.23E–03 | 5.23E–03 | 5.31E–05 |
| $At_i$ | $cm^2/sec$ | 3.38E–04 | 8.00E–05 | 7.55E–05 | 3.89E–04 | 8.44E–04 | 7.19E–04 | 1.51E–04 |
| $\tanh(Xt_iBt_i)$ | | 0.9999 | 1.0000 | 1.0000 | 1.0000 | 0.9998 | 0.9998 | 1.0000 |
| $J_i$ | $pCi/(m^2 \cdot sec)$ | 1.658 | 5.688E–02 | 3.607E–02 | 3.434E–02 | 2.427E–02 | 2.311E–02 | 1.939E–04 |

Rate used in ISCLT2 for Future Scenario

Rate used in ISCLT2 for Current Scenario

Reference: Radon Attenuation Handbook for Uranium Mill Tailings Cover Design, V.C. Rogers and K.K. Nielson, NUREG/CR–3533 (PNL–4878), April 1984.

OU2 Residual w/RCRA–Type Cap (Conventional): South Field (North End)
(Diffusion Coefficients calculated by RAECOM)

| Component | Units | Soil/Waste | (Fill) Cover1 | (Bentonite) Cover2 | (Drainage) Cover3 | (Cobbles) Cover4 | (Gravel) Cover5 | (Top Soil) Cover6 |
|---|---|---|---|---|---|---|---|---|
| R | pCi/g | 60.11 | NA | NA | NA | NA | NA | NA |
| $RHO_i$ | $g/cm^3$ | 1.5 | 1.6 | 0.88 | 1.6 | 1.6 | 1.6 | 1.6 |
| E | dimensionless | 0.22 | NA | NA | NA | NA | NA | NA |
| LAMDA | $sec^{-1}$ | 2.1E–06 | NA | NA | NA | NA | NA | NA |
| $X_i$ | cm | --- | 75 | 10 | 30 | 90 | 15 | 105 |
| $Xt_i$ | cm | 30 | 105 | 115 | 145 | 235 | 250 | 355 |
| $P_i$ | dimensionless | 0.35 | 0.463 | 0.4 | 0.417 | 0.417 | 0.417 | 0.463 |
| $MC_i$ | dry wt % | 13 | 23.2 | 35.6 | 4.5 | 4.5 | 4.5 | 23.2 |
| K | dimensionless | 0.26 | NA | NA | NA | NA | NA | NA |
| Precip. | inches | NA | NA | NA | NA | NA | NA | NA |
| Evap. | inches | NA | NA | NA | NA | NA | NA | NA |
| $Fcm_i$ | frac.<200 mesh | NA | NA | NA | NA | NA | NA | NA |
| $DC_i=F(M_i,P_i)$ | $cm^2/sec$ | 7.99E–03 | 1.50E–03 | 1.55E–03 | 3.95E–02 | 3.95E–02 | 3.95E–02 | 1.50E–03 |
| $DC_i$ (User) | $cm^2/sec$ | NA | 1.50E–03 | 1.55E–03 | 3.95E–02 | 3.95E–02 | 3.95E–02 | 1.50E–03 |
| $DCt_i$ | $cm^2/sec$ | 7.99E–03 | 1.89E–03 | 1.78E–03 | 9.20E–03 | 2.38E–02 | 2.54E–02 | 1.14E–03 |
| $B_i$ | $cm^{-1}$ | --- | 0.0374 | 0.0368 | 0.0073 | 0.0073 | 0.0073 | 0.0374 |
| $Bt_i$ | $cm^{-1}$ | 0.0162 | 0.0333 | 0.0343 | 0.0151 | 0.0094 | 0.0091 | 0.0429 |
| $M_i=F(MC_i)$ | dimensionless | 0.557 | 0.802 | 0.783 | 0.173 | 0.173 | 0.173 | 0.802 |
| $M_i=F(Precip)$ | dimensionless | NA | NA | NA | NA | NA | NA | NA |
| $M_i$ | dimensionless | 0.557 | 0.802 | 0.783 | 0.173 | 0.173 | 0.173 | 0.802 |
| $A_i$ | $cm^2/sec$ | --- | 5.31E–05 | 4.38E–05 | 5.23E–03 | 5.23E–03 | 5.23E–03 | 5.31E–05 |
| $At_i$ | $cm^2/sec$ | 3.38E–04 | 8.00E–05 | 7.55E–05 | 3.89E–04 | 8.44E–04 | 7.19E–04 | 1.51E–04 |
| $tanh(Xt_iBt_i)$ | | 0.4513 | 0.9982 | 0.9993 | 0.9753 | 0.9761 | 0.9790 | 1.0000 |
| $J_i$ | $pCi/(m^2 \cdot sec)$ | 11.597 | 6.543E–01 | 4.152E–01 | 3.952E–01 | 2.803E–01 | 2.672E–01 | 2.278E–03 |
| | | | | | | Rate used in ISCLT2 for Future Scenario | | Rate used in ISCLT2 for Current Scenario |

Reference: Radon Attenuation Handbook for Uranium Mill Tailings Cover Design, V.C. Rogers and K.K. Nielson, NUREG/CR–3533 (PNL–4878), April 1984.

OU2 Residual w/RCRA–Type Cap (Conventional): South Field (Middle)
(Diffusion Coefficients calculated by RAECOM)

| Component | Units | Soil/Waste | (Fill) Cover1 | (Bentonite) Cover2 | (Drainage) Cover3 | (Cobbles) Cover4 | (Gravel) Cover5 | (Top Soil) Cover6 |
|---|---|---|---|---|---|---|---|---|
| R | pCi/g | 9.12 | NA | NA | NA | NA | NA | NA |
| $RHO_i$ | $g/cm^3$ | 1.5 | 1.6 | 0.88 | 1.6 | 1.6 | 1.6 | 1.6 |
| E | dimensionless | 0.22 | NA | NA | NA | NA | NA | NA |
| LAMDA | $sec^{-1}$ | 2.1E–06 | NA | NA | NA | NA | NA | NA |
| $X_i$ | cm | --- | 75 | 10 | 30 | 90 | 15 | 105 |
| $Xt_i$ | cm | 30 | 105 | 115 | 145 | 235 | 250 | 355 |
| $P_i$ | dimensionless | 0.35 | 0.463 | 0.4 | 0.417 | 0.417 | 0.417 | 0.463 |
| $MC_i$ | dry wt % | 13 | 23.2 | 35.6 | 4.5 | 4.5 | 4.5 | 23.2 |
| K | dimensionless | 0.26 | NA | NA | NA | NA | NA | NA |
| Precip. | inches | NA | NA | NA | NA | NA | NA | NA |
| Evap. | inches | NA | NA | NA | NA | NA | NA | NA |
| $Fcm_i$ | frac.<200 mesh | NA | NA | NA | NA | NA | NA | NA |
| $DC_i=F(M_i,P_i)$ | $cm^2/sec$ | 7.99E–03 | 1.50E–03 | 1.55E–03 | 3.95E–02 | 3.95E–02 | 3.95E–02 | 1.50E–03 |
| $DC_i$ (User) | $cm^2/sec$ | NA | 1.50E–03 | 1.55E–03 | 3.95E–02 | 3.95E–02 | 3.95E–02 | 1.50E–03 |
| $DCt_i$ | $cm^2/sec$ | 7.99E–03 | 1.89E–03 | 1.78E–03 | 9.20E–03 | 2.38E–02 | 2.54E–02 | 1.14E–03 |
| $B_i$ | $cm^{-1}$ | --- | 0.0374 | 0.0368 | 0.0073 | 0.0073 | 0.0073 | 0.0374 |
| $Bt_i$ | $cm^{-1}$ | 0.0162 | 0.0333 | 0.0343 | 0.0151 | 0.0094 | 0.0091 | 0.0429 |
| $M_i=F(MC_i)$ | dimensionless | 0.557 | 0.802 | 0.783 | 0.173 | 0.173 | 0.173 | 0.802 |
| $M_i=F(Precip)$ | dimensionless | NA | NA | NA | NA | NA | NA | NA |
| $M_i$ | dimensionless | 0.557 | 0.802 | 0.783 | 0.173 | 0.173 | 0.173 | 0.802 |
| $A_i$ | $cm^2/sec$ | --- | 5.31E–05 | 4.38E–05 | 5.23E–03 | 5.23E–03 | 5.23E–03 | 5.31E–05 |
| $At_i$ | $cm^2/sec$ | 3.38E–04 | 8.00E–05 | 7.55E–05 | 3.89E–04 | 8.44E–04 | 7.19E–04 | 1.51E–04 |
| $\tanh(Xt_iBt_i)$ | | 0.4513 | 0.9982 | 0.9993 | 0.9753 | 0.9761 | 0.9790 | 1.0000 |
| $J_i$ | $pCi/(m^2*sec)$ | 1.759 | 9.927E–02 | 6.299E–02 | 5.996E–02 | 4.252E–02 | 4.054E–02 | 3.457E–04 |

Rate used in ISCLT2 for Future Scenario

Rate used in ISCLT2 for Current Scenario

Reference: Radon Attenuation Handbook for Uranium Mill Tailings Cover Design, V.C. Rogers and K.K. Nielson, NUREG/CR–3533 (PNL–4878), April 1984.

OU2 Residual w/RCRA–Type Cap (Conventional): South Field (South End)
(Diffusion Coefficients calculated by RAECOM)

| Component | Units | Soil/Waste | (Fill) Cover1 | (Bentonite) Cover2 | (Drainage) Cover3 | (Cobbles) Cover4 | (Gravel) Cover5 | (Top Soil) Cover6 |
|---|---|---|---|---|---|---|---|---|
| R | pCi/g | 146.91 | NA | NA | NA | NA | NA | NA |
| $RHO_i$ | $g/cm^3$ | 1.5 | 1.6 | 0.88 | 1.6 | 1.6 | 1.6 | 1.6 |
| E | dimensionless | 0.22 | NA | NA | NA | NA | NA | NA |
| LAMDA | $sec^{-1}$ | 2.1E–06 | NA | NA | NA | NA | NA | NA |
| $X_i$ | cm | --- | 75 | 10 | 30 | 90 | 15 | 105 |
| $Xt_i$ | cm | 30 | 105 | 115 | 145 | 235 | 250 | 355 |
| $P_i$ | dimensionless | 0.35 | 0.463 | 0.4 | 0.417 | 0.417 | 0.417 | 0.463 |
| $MC_i$ | dry wt % | 13 | 23.2 | 35.6 | 4.5 | 4.5 | 4.5 | 23.2 |
| K | dimensionless | 0.26 | NA | NA | NA | NA | NA | NA |
| Precip. | inches | NA | NA | NA | NA | NA | NA | NA |
| Evap. | inches | NA | NA | NA | NA | NA | NA | NA |
| $Fcm_i$ | frac.<200 mesh | NA | NA | NA | NA | NA | NA | NA |
| $DC_i=F(M_i,P_i)$ | $cm^2/sec$ | 7.99E–03 | 1.50E–03 | 1.55E–03 | 3.95E–02 | 3.95E–02 | 3.95E–02 | 1.50E–03 |
| $DC_i$ (User) | $cm^2/sec$ | NA | 1.50E–03 | 1.55E–03 | 3.95E–02 | 3.95E–02 | 3.95E–02 | 1.50E–03 |
| $DCt_i$ | $cm^2/sec$ | 7.99E–03 | 1.89E–03 | 1.78E–03 | 9.20E–03 | 2.38E–02 | 2.54E–02 | 1.14E–03 |
| $B_i$ | $cm^{-1}$ | --- | 0.0374 | 0.0368 | 0.0073 | 0.0073 | 0.0073 | 0.0374 |
| $Bt_i$ | $cm^{-1}$ | 0.0162 | 0.0333 | 0.0343 | 0.0151 | 0.0094 | 0.0091 | 0.0429 |
| $M_i=F(MC_i)$ | dimensionless | 0.557 | 0.802 | 0.783 | 0.173 | 0.173 | 0.173 | 0.802 |
| $M_i=F(Precip)$ | dimensionless | NA | NA | NA | NA | NA | NA | NA |
| $M_i$ | dimensionless | 0.557 | 0.802 | 0.783 | 0.173 | 0.173 | 0.173 | 0.802 |
| $A_i$ | $cm^2/sec$ | --- | 5.31E–05 | 4.38E–05 | 5.23E–03 | 5.23E–03 | 5.23E–03 | 5.31E–05 |
| $At_i$ | $cm^2/sec$ | 3.38E–04 | 8.00E–05 | 7.55E–05 | 3.89E–04 | 8.44E–04 | 7.19E–04 | 1.51E–04 |
| $\tanh(Xt_iBt_i)$ | | 0.4513 | 0.9982 | 0.9993 | 0.9753 | 0.9761 | 0.9790 | 1.0000 |
| $J_i$ | $pCi/(m^2*sec)$ | 28.342 | 1.599E+00 | 1.015E+00 | 9.659E–01 | 6.850E–01 | 6.530E–01 | 5.568E–03 |

Rate used in ISCLT2 for Future Scenario

Rate used in ISCLT2 for Current Scenario

Reference: Radon Attenuation Handbook for Uranium Mill Tailings Cover Design, V.C. Rogers and K.K. Nielson, NUREG/CR–3533 (PNL–4878), April 1984.

OU4 Residual w/Clean Soil Cover: Ra-226 @ 5 pCi/g (PRG)
(Diffusion Coefficients calculated by RAECOM)

| Component | Units | Soil/Waste | (Top Soil) Cover1 | Cover2 | Cover3 | Cover4 | Cover5 | Cover6 |
|---|---|---|---|---|---|---|---|---|
| R | pCi/g | 5 | NA | NA | NA | NA | NA | NA |
| $RHO_i$ | $g/cm^3$ | 1.5 | 1.6 | NA | NA | NA | NA | NA |
| E | dimensionless | 0.22 | NA | NA | NA | NA | NA | NA |
| LAMDA | $sec^{-1}$ | 2.1E-06 | NA | NA | NA | NA | NA | NA |
| $X_i$ | cm | --- | 15 | NA | NA | NA | NA | NA |
| $Xt_i$ | cm | 300 | 315 | NA | NA | NA | NA | NA |
| $P_i$ | dimensionless | 0.35 | 0.463 | NA | NA | NA | NA | NA |
| $MC_i$ | dry wt % | 13 | 23.2 | NA | NA | NA | NA | NA |
| K | dimensionless | 0.26 | NA | NA | NA | NA | NA | NA |
| Precip. | inches | NA | NA | NA | NA | NA | NA | NA |
| Evap. | inches | NA | NA | NA | NA | NA | NA | NA |
| $Fcm_i$ | frac.<200 mesh | NA | NA | NA | NA | NA | NA | NA |
| $DC_i=F(M_i,P_i)$ | $cm^2/sec$ | 7.99E-03 | 1.50E-03 | NA | NA | NA | NA | NA |
| $DC_i$ (User) | $cm^2/sec$ | NA | 1.50E-03 | NA | NA | NA | NA | NA |
| $DCt_i$ | $cm^2/sec$ | 7.99E-03 | 5.20E-03 | NA | NA | NA | NA | NA |
| $B_i$ | $cm^{-1}$ | --- | 0.0374 | NA | NA | NA | NA | NA |
| $Bt_i$ | $cm^{-1}$ | 0.0162 | 0.0201 | NA | NA | NA | NA | NA |
| $M_i=F(MC_i)$ | dimensionless | 0.557 | 0.802 | NA | NA | NA | NA | NA |
| $M_i=F(Precip)$ | dimensionless | NA | NA | NA | NA | NA | NA | NA |
| $M_i$ | dimensionless | 0.557 | 0.802 | NA | NA | NA | NA | NA |
| $A_i$ | $cm^2/sec$ | --- | 5.31E-05 | NA | NA | NA | NA | NA |
| $At_i$ | $cm^2/sec$ | 3.38E-04 | 2.20E-04 | NA | NA | NA | NA | NA |
| $tanh(Xt_iBt_i)$ | | 0.9999 | 1.0000 | NA | NA | NA | NA | NA |
| $J_i$ | $pCi/(m^2*sec)$ | 2.137 | 8.051E-01 | NA | NA | NA | NA | NA |

Rate used in ISCLT2 for Future Scenario

Rate used in ISCLT2 for Current Scenario

Reference: Radon Attenuation Handbook for Uranium Mill Tailings Cover Design, V.C. Rogers and K.K. Nielson, NUREG/CR-3533 (PNL-4878), April 1984.

FERMCO
FEMP

Fluor Daniel, Inc.
Contract 04424331
08/18/93

OU5 Residual After Soil Washing (OU3 Excavated Areas): Ra-226 @ 5 pCi/g (PRG)
(Diffusion Coefficients calculated by RAECOM)

| Component | Units | Soil/Waste | Cover1 | Cover2 | Cover3 | Cover4 | Cover5 | Cover6 |
|---|---|---|---|---|---|---|---|---|
| R | pCi/g | 5 | NA | NA | NA | NA | NA | NA |
| $RHO_i$ | $g/cm^3$ | 1.5 | NA | NA | NA | NA | NA | NA |
| E | dimensionless | 0.22 | NA | NA | NA | NA | NA | NA |
| LAMDA | $sec^{-1}$ | 2.1E-06 | NA | NA | NA | NA | NA | NA |
| $X_i$ | cm | --- | NA | NA | NA | NA | NA | NA |
| $Xt_i$ | cm | 300 | NA | NA | NA | NA | NA | NA |
| $P_i$ | dimensionless | 0.35 | NA | NA | NA | NA | NA | NA |
| $MC_i$ | dry wt % | 13 | NA | NA | NA | NA | NA | NA |
| K | dimensionless | 0.26 | NA | NA | NA | NA | NA | NA |
| Precip. | inches | NA | NA | NA | NA | NA | NA | NA |
| Evap. | inches | NA | NA | NA | NA | NA | NA | NA |
| $Fcm_i$ | frac.<200 mesh | NA | NA | NA | NA | NA | NA | NA |
| $DC_i=F(M_i,P_i)$ | $cm^2/sec$ | 7.99E-03 | NA | NA | NA | NA | NA | NA |
| $DC_i$ (User) | $cm^2/sec$ | NA | NA | NA | NA | NA | NA | NA |
| $DCt_i$ | $cm^2/sec$ | 7.99E-03 | NA | NA | NA | NA | NA | NA |
| $B_i$ | $cm^{-1}$ | --- | NA | NA | NA | NA | NA | NA |
| $Bt_i$ | $cm^{-1}$ | 0.0162 | NA | NA | NA | NA | NA | NA |
| $M_i=F(MC_i)$ | dimensionless | 0.557 | NA | NA | NA | NA | NA | NA |
| $M_i=F(Precip)$ | dimensionless | NA | NA | NA | NA | NA | NA | NA |
| $M_i$ | dimensionless | 0.557 | NA | NA | NA | NA | NA | NA |
| $A_i$ | $cm^2/sec$ | --- | NA | NA | NA | NA | NA | NA |
| $At_i$ | $cm^2/sec$ | 3.38E-04 | NA | NA | NA | NA | NA | NA |
| $\tanh(Xt_iBt_i)$ | | 0.9999 | NA | NA | NA | NA | NA | NA |
| $J_i$ | $pCi/(m^2 \cdot sec)$ | 2.137 | NA | NA | NA | NA | NA | NA |

Rate used in ISCLT2
for All Scenarios

Reference: Radon Attenuation Handbook for Uranium Mill Tailings Cover Design, V.C. Rogers and K.K. Nielson, NUREG/CR-3533 (PNL-4878), April 1984.

OU5 Surface Soil (OU3 untreated surface soil): Ra-226 @ 1.09 pCi/g (PRG)
(Diffusion Coefficients calculated by RAECOM)

| Component | Units | Soil/Waste | Cover1 | Cover2 | Cover3 | Cover4 | Cover5 | Cover6 |
|---|---|---|---|---|---|---|---|---|
| R | pCi/g | 1.09 | NA | NA | NA | NA | NA | NA |
| $RHO_i$ | $g/cm^3$ | 1.5 | NA | NA | NA | NA | NA | NA |
| E | dimensionless | 0.22 | NA | NA | NA | NA | NA | NA |
| LAMDA | $sec^{-1}$ | 2.1E-06 | NA | NA | NA | NA | NA | NA |
| $X_i$ | cm | --- | NA | NA | NA | NA | NA | NA |
| $Xt_i$ | cm | 35 | NA | NA | NA | NA | NA | NA |
| $P_i$ | dimensionless | 0.463 | NA | NA | NA | NA | NA | NA |
| $MC_i$ | dry wt % | 23.2 | NA | NA | NA | NA | NA | NA |
| K | dimensionless | 0.26 | NA | NA | NA | NA | NA | NA |
| Precip. | inches | NA | NA | NA | NA | NA | NA | NA |
| Evap. | inches | NA | NA | NA | NA | NA | NA | NA |
| $Fcm_i$ | frac.<200 mesh | NA | NA | NA | NA | NA | NA | NA |
| $DC_i=F(M_i,P_i)$ | $cm^2/sec$ | 2.53E-03 | NA | NA | NA | NA | NA | NA |
| $DC_i$ (User) | $cm^2/sec$ | NA | NA | NA | NA | NA | NA | NA |
| $DCt_i$ | $cm^2/sec$ | 2.53E-03 | NA | NA | NA | NA | NA | NA |
| $B_i$ | $cm^{-1}$ | --- | NA | NA | NA | NA | NA | NA |
| $Bt_i$ | $cm^{-1}$ | 0.0288 | NA | NA | NA | NA | NA | NA |
| $M_i=F(MC_i)$ | dimensionless | 0.752 | NA | NA | NA | NA | NA | NA |
| $M_i=F(Precip)$ | dimensionless | NA | NA | NA | NA | NA | NA | NA |
| $M_i$ | dimensionless | 0.752 | NA | NA | NA | NA | NA | NA |
| $A_i$ | $cm^2/sec$ | --- | NA | NA | NA | NA | NA | NA |
| $At_i$ | $cm^2/sec$ | 1.07E-04 | NA | NA | NA | NA | NA | NA |
| $tanh(Xt_iBt_i)$ | | 0.7653 | NA | NA | NA | NA | NA | NA |
| $J_i$ | $pCi/(m^2*sec)$ | 0.201 | NA | NA | NA | NA | NA | NA |

Rate used in ISCLT2
for All Scenarios

Reference: Radon Attenuation Handbook for Uranium Mill Tailings Cover Design, V.C. Rogers and K.K. Nielson, NUREG/CR-3533 (PNL-4878), April 1984.







5208

0512

OU5 Surface Soil (Remainder of the FEMP): Ra-226 @ 1.14 pCi/g (PRG)
(Diffusion Coefficients calculated by RAECOM)

| Component | Units | Soil/Waste | Cover1 | Cover2 | Cover3 | Cover4 | Cover5 | Cover6 |
|---|---|---|---|---|---|---|---|---|
| R | pCi/g | 1.14 | NA | NA | NA | NA | NA | NA |
| $RHO_i$ | $g/cm^3$ | 1.5 | NA | NA | NA | NA | NA | NA |
| E | dimensionless | 0.22 | NA | NA | NA | NA | NA | NA |
| LAMDA | $sec^{-1}$ | 2.1E-06 | NA | NA | NA | NA | NA | NA |
| $X_i$ | cm | --- | NA | NA | NA | NA | NA | NA |
| $Xt_i$ | cm | 35 | NA | NA | NA | NA | NA | NA |
| $P_i$ | dimensionless | 0.463 | NA | NA | NA | NA | NA | NA |
| $MC_i$ | dry wt % | 23.2 | NA | NA | NA | NA | NA | NA |
| K | dimensionless | 0.26 | NA | NA | NA | NA | NA | NA |
| Precip. | inches | NA | NA | NA | NA | NA | NA | NA |
| Evap. | inches | NA | NA | NA | NA | NA | NA | NA |
| $Fcm_i$ | frac.<200 mesh | NA | NA | NA | NA | NA | NA | NA |
| $DC_i=F(M_i,P_i)$ | $cm^2/sec$ | 2.53E-03 | NA | NA | NA | NA | NA | NA |
| $DC_i$ (User) | $cm^2/sec$ | NA | NA | NA | NA | NA | NA | NA |
| $DCt_i$ | $cm^2/sec$ | 2.53E-03 | NA | NA | NA | NA | NA | NA |
| $B_i$ | $cm^{-1}$ | --- | NA | NA | NA | NA | NA | NA |
| $Bt_i$ | $cm^{-1}$ | 0.0288 | NA | NA | NA | NA | NA | NA |
| $M_i=F(MC_i)$ | dimensionless | 0.752 | NA | NA | NA | NA | NA | NA |
| $M_i=F(Precip)$ | dimensionless | NA | NA | NA | NA | NA | NA | NA |
| $M_i$ | dimensionless | 0.752 | NA | NA | NA | NA | NA | NA |
| $A_i$ | $cm^2/sec$ | --- | NA | NA | NA | NA | NA | NA |
| $At_i$ | $cm^2/sec$ | 1.07E-04 | NA | NA | NA | NA | NA | NA |
| $tanh(Xt_iBt_i)$ | | 0.7653 | NA | NA | NA | NA | NA | NA |
| $J_i$ | $pCi/(m^2*sec)$ | 0.210 | NA | NA | NA | NA | NA | NA |

Rate used in ISCLT2
for All Scenarios

Reference: Radon Attenuation Handbook for Uranium Mill Tailings Cover Design, V.C. Rogers and K.K. Nielson, NUREG/CR-3533 (PNL-4878), April 1984.

OU1 On–Property Disposal Facility (Vault–type): OU1 Wastes (Stabilized)
(Diffusion Coefficients calculated by RAECOM)

| Component | Units | Soil/Waste | (Concrete) Cover1 | (Fill) Cover2 | (Clay) Cover3 | (Cobble) Cover4 | (Drainage) Cover5 | (Top Soil) Cover6 |
|---|---|---|---|---|---|---|---|---|
| R | pCi/g | 342 | NA | NA | NA | NA | NA | NA |
| $RHO_i$ | $g/cm^3$ | 1.5 | 2 | 1.6 | 1.9 | 1.6 | 1.6 | 1.6 |
| E | dimensionless | 0.0352 | NA | NA | NA | NA | NA | NA |
| LAMDA | $sec^{-1}$ | 2.1E–06 | NA | NA | NA | NA | NA | NA |
| $X_i$ | cm | --- | 35 | 15 | 90 | 90 | 30 | 60 |
| $Xt_i$ | cm | 823 | 858 | 873 | 963 | 1053 | 1083 | 1143 |
| $P_i$ | dimensionless | 0.35 | 0.05 | 0.463 | 0.43 | 0.417 | 0.417 | 0.463 |
| $MC_i$ | dry wt % | 13 | 2.5 | 23.2 | 36.6 | 4.5 | 4.5 | 23.2 |
| K | dimensionless | 0.26 | NA | NA | NA | NA | NA | NA |
| Precip. | inches | NA | NA | NA | NA | NA | NA | NA |
| Evap. | inches | NA | NA | NA | NA | NA | NA | NA |
| $Fcm_i$ | frac.<200 mesh | NA | NA | NA | NA | NA | NA | NA |
| $DC_i=F(M_i,P_i)$ | $cm^2/sec$ | 7.99E–03 | 2.37E–05 | 1.50E–03 | 4.92E–05 | 3.95E–02 | 3.95E–02 | 1.50E–03 |
| $DC_i$ (User) | $cm^2/sec$ | NA | 2.37E–05 | 1.50E–03 | 4.92E–05 | 3.95E–02 | 3.95E–02 | 1.50E–03 |
| $DCt_i$ | $cm^2/sec$ | 7.99E–03 | 2.40E–05 | 6.57E–04 | 4.92E–05 | 1.90E–02 | 2.31E–02 | 3.45E–03 |
| $B_i$ | $cm^{-1}$ | --- | 0.2976 | 0.0374 | 0.2066 | 0.0073 | 0.0073 | 0.0374 |
| $Bt_i$ | $cm^{-1}$ | 0.0162 | 0.2961 | 0.0565 | 0.2066 | 0.0105 | 0.0095 | 0.0247 |
| $M_i=F(MC_i)$ | dimensionless | 0.557 | 1.000 | 0.802 | 1.000 | 0.173 | 0.173 | 0.802 |
| $M_i=F(Precip)$ | dimensionless | NA | NA | NA | NA | NA | NA | NA |
| $M_i$ | dimensionless | 0.557 | 1.000 | 0.802 | 1.000 | 0.173 | 0.173 | 0.802 |
| $A_i$ | $cm^2/sec$ | --- | 4.01E–09 | 5.31E–05 | 6.15E–07 | 5.23E–03 | 5.23E–03 | 5.31E–05 |
| $At_i$ | $cm^2/sec$ | 3.38E–04 | 1.01E–06 | 2.78E–05 | 2.08E–06 | 3.22E–06 | 8.18E–04 | 4.31E–05 |
| $tanh(Xt_iBt_i)$ | | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| $J_i$ | $pCi/(m^2 \cdot sec)$ | 23.391 | 4.815E–06 | 3.872E–06 | 8.427E–15 | 6.812E–15 | 6.617E–15 | 2.862E–16 |

Rate used in ISCLT2 for Future Scenario

Rate used in ISCLT2 for Current Scenario

Reference: Radon Attenuation Handbook for Uranium Mill Tailings Cover Design, V.C. Rogers and K.K. Nielson, NUREG/CR–3533 (PNL–4878), April 1984.

OU3 On–Property Disposal Facility (Vault–type): OU3 Wastes (Boxed)
(Diffusion Coefficients calculated by RAECOM)

| Component | Units | Soil/Waste | (Concrete) Cover1 | (Fill) Cover2 | (Clay) Cover3 | (Cobble) Cover4 | (Drainage) Cover5 | (Top Soil) Cover6 |
|---|---|---|---|---|---|---|---|---|
| R | pCi/g | 134 | NA | NA | NA | NA | NA | NA |
| $RHO_i$ | $g/cm^3$ | 1.5 | 2 | 1.6 | 1.9 | 1.6 | 1.6 | 1.6 |
| E | dimensionless | 0.22 | NA | NA | NA | NA | NA | NA |
| LAMDA | $sec^{-1}$ | 2.1E–06 | NA | NA | NA | NA | NA | NA |
| $X_i$ | cm | --- | 35 | 15 | 90 | 90 | 30 | 60 |
| $Xt_i$ | cm | 823 | 858 | 873 | 963 | 1053 | 1083 | 1143 |
| $P_i$ | dimensionless | 0.35 | 0.05 | 0.463 | 0.43 | 0.417 | 0.417 | 0.463 |
| $MC_i$ | dry wt % | 13 | 2.5 | 23.2 | 36.6 | 4.5 | 4.5 | 23.2 |
| K | dimensionless | 0.26 | NA | NA | NA | NA | NA | NA |
| Precip. | inches | NA | NA | NA | NA | NA | NA | NA |
| Evap. | inches | NA | NA | NA | NA | NA | NA | NA |
| $Fcm_i$ | frac.<200 mesh | NA | NA | NA | NA | NA | NA | NA |
| $DC_i=F(M_i,P_i)$ | $cm^2/sec$ | 7.99E–03 | 2.37E–05 | 1.50E–03 | 4.92E–05 | 3.95E–02 | 3.95E–02 | 1.50E–03 |
| $DC_i$ (User) | $cm^2/sec$ | NA | 2.37E–05 | 1.50E–03 | 4.92E–05 | 3.95E–02 | 3.95E–02 | 1.50E–03 |
| $DCt_i$ | $cm^2/sec$ | 7.99E–03 | 2.40E–05 | 6.57E–04 | 4.92E–05 | 1.90E–02 | 2.31E–02 | 3.45E–03 |
| $B_i$ | $cm^{-1}$ | --- | 0.2976 | 0.0374 | 0.2066 | 0.0073 | 0.0073 | 0.0374 |
| $Bt_i$ | $cm^{-1}$ | 0.0162 | 0.2961 | 0.0565 | 0.2066 | 0.0105 | 0.0095 | 0.0247 |
| $M_i=F(MC_i)$ | dimensionless | 0.557 | 1.000 | 0.802 | 1.000 | 0.173 | 0.173 | 0.802 |
| $M_i$=F(Precip) | dimensionless | NA | NA | NA | NA | NA | NA | NA |
| $M_i$ | dimensionless | 0.557 | 1.000 | 0.802 | 1.000 | 0.173 | 0.173 | 0.802 |
| $A_i$ | $cm^2/sec$ | --- | 4.01E–09 | 5.31E–05 | 6.15E–07 | 5.23E–03 | 5.23E–03 | 5.31E–05 |
| $At_i$ | $cm^2/sec$ | 3.38E–04 | 1.01E–06 | 2.78E–05 | 2.08E–06 | 3.22E–06 | 8.18E–04 | 4.31E–05 |
| $\tanh(Xt_iBt_i)$ | | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| $J_i$ | $pCi/(m^2 \cdot sec)$ | 57.280 | 1.179E–05 | 9.482E–06 | 2.064E–14 | 1.668E–14 | 1.621E–14 | 7.008E–16 |

Rate used in ISCLT2 for Future Scenario

Rate used in ISCLT2 for Current Scenario

Reference: Radon Attenuation Handbook for Uranium Mill Tailings Cover Design, V.C. Rogers and K.K. Nielson, NUREG/CR–3533 (PNL–4878), April 1984.

OU4 On–Property Disposal Facility (Vault–type): OU4 Wastes (Boxed)
(Diffusion Coefficients calculated by RAECOM)

| Component | Units | Soil/Waste | (Concrete) Cover1 | (Fill) Cover2 | (Clay) Cover3 | (Cobble) Cover4 | (Drainage) Cover5 | (Top Soil) Cover6 |
|---|---|---|---|---|---|---|---|---|
| R | pCi/g | 37.3 | NA | NA | NA | NA | NA | NA |
| $RHO_i$ | $g/cm^3$ | 1.5 | 2 | 1.6 | 1.9 | 1.6 | 1.6 | 1.6 |
| E | dimensionless | 0.22 | NA | NA | NA | NA | NA | NA |
| LAMDA | $sec^{-1}$ | 2.1E–06 | NA | NA | NA | NA | NA | NA |
| $X_i$ | cm | --- | 35 | 15 | 90 | 90 | 30 | 60 |
| $Xt_i$ | cm | 823 | 858 | 873 | 963 | 1053 | 1083 | 1143 |
| $P_i$ | dimensionless | 0.35 | 0.05 | 0.463 | 0.43 | 0.417 | 0.417 | 0.463 |
| $MC_i$ | dry wt % | 13 | 2.5 | 23.2 | 36.6 | 4.5 | 4.5 | 23.2 |
| K | dimensionless | 0.26 | NA | NA | NA | NA | NA | NA |
| Precip. | inches | NA | NA | NA | NA | NA | NA | NA |
| Evap. | inches | NA | NA | NA | NA | NA | NA | NA |
| $Fcm_i$ | frac.<200 mesh | NA | NA | NA | NA | NA | NA | NA |
| $DC_i=F(M_i,P_i)$ | $cm^2/sec$ | 7.99E–03 | 2.37E–05 | 1.50E–03 | 4.92E–05 | 3.95E–02 | 3.95E–02 | 1.50E–03 |
| $DC_i$ (User) | $cm^2/sec$ | NA | 2.37E–05 | 1.50E–03 | 4.92E–05 | 3.95E–02 | 3.95E–02 | 1.50E–03 |
| $DCt_i$ | $cm^2/sec$ | 7.99E–03 | 2.40E–05 | 6.57E–04 | 4.92E–05 | 1.90E–02 | 2.31E–02 | 3.45E–03 |
| $B_i$ | $cm^{-1}$ | --- | 0.2976 | 0.0374 | 0.2066 | 0.0073 | 0.0073 | 0.0374 |
| $Bt_i$ | $cm^{-1}$ | 0.0162 | 0.2961 | 0.0565 | 0.2066 | 0.0105 | 0.0095 | 0.0247 |
| $M_i=F(MC_i)$ | dimensionless | 0.557 | 1.000 | 0.802 | 1.000 | 0.173 | 0.173 | 0.802 |
| $M_i=F(Precip)$ | dimensionless | NA | NA | NA | NA | NA | NA | NA |
| $M_i$ | dimensionless | 0.557 | 1.000 | 0.802 | 1.000 | 0.173 | 0.173 | 0.802 |
| $A_i$ | $cm^2/sec$ | --- | 4.01E–09 | 5.31E–05 | 6.15E–07 | 5.23E–03 | 5.23E–03 | 5.31E–05 |
| $At_i$ | $cm^2/sec$ | 3.38E–04 | 1.01E–06 | 2.78E–05 | 2.08E–06 | 3.22E–06 | 8.18E–04 | 4.31E–05 |
| $\tanh(Xt_iBt_i)$ | | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| $J_i$ | $pCi/(m^2 \cdot sec)$ | 15.944 | 3.282E–06 | 2.639E–06 | 5.744E–15 | 4.644E–15 | 4.511E–15 | 1.951E–16 |

Rate used in ISCLT2 for Future Scenario

Rate used in ISCLT2 for Current Scenario

Reference: Radon Attenuation Handbook for Uranium Mill Tailings Cover Design, V.C. Rogers and K.K. Nielson, NUREG/CR–3533 (PNL–4878), April 1984.

OU5 On-Property Disposal Facility (Vault-type): OU5 Wastes (Stabilized)
(Diffusion Coefficients calculated by RAECOM)

| Component | Units | Soil/Waste | (Concrete) Cover1 | (Fill) Cover2 | (Clay) Cover3 | (Cobble) Cover4 | (Drainage) Cover5 | (Top Soil) Cover6 |
|---|---|---|---|---|---|---|---|---|
| R | pCi/g | 134 | NA | NA | NA | NA | NA | NA |
| $RHO_i$ | $g/cm^3$ | 1.5 | 2 | 1.6 | 1.9 | 1.6 | 1.6 | 1.6 |
| E | dimensionless | 0.0352 | NA | NA | NA | NA | NA | NA |
| LAMDA | $sec^{-1}$ | 2.1E-06 | NA | NA | NA | NA | NA | NA |
| $X_i$ | cm | --- | 35 | 15 | 90 | 90 | 30 | 60 |
| $Xt_i$ | cm | 823 | 858 | 873 | 963 | 1053 | 1083 | 1143 |
| $P_i$ | dimensionless | 0.35 | 0.05 | 0.463 | 0.43 | 0.417 | 0.417 | 0.463 |
| $MC_i$ | dry wt % | 13 | 2.5 | 23.2 | 36.6 | 4.5 | 4.5 | 23.2 |
| K | dimensionless | 0.26 | NA | NA | NA | NA | NA | NA |
| Precip. | inches | NA | NA | NA | NA | NA | NA | NA |
| Evap. | inches | NA | NA | NA | NA | NA | NA | NA |
| $Fcm_i$ | frac.<200 mesh | NA | NA | NA | NA | NA | NA | NA |
| $DC_i=F(M_i,P_i)$ | $cm^2/sec$ | 7.99E-03 | 2.37E-05 | 1.50E-03 | 4.92E-05 | 3.95E-02 | 3.95E-02 | 1.50E-03 |
| $DC_i$ (User) | $cm^2/sec$ | NA | 2.37E-05 | 1.50E-03 | 4.92E-05 | 3.95E-02 | 3.95E-02 | 1.50E-03 |
| $DCt_i$ | $cm^2/sec$ | 7.99E-03 | 2.40E-05 | 6.57E-04 | 4.92E-05 | 1.90E-02 | 2.31E-02 | 3.45E-03 |
| $B_i$ | $cm^{-1}$ | --- | 0.2976 | 0.0374 | 0.2066 | 0.0073 | 0.0073 | 0.0374 |
| $Bt_i$ | $cm^{-1}$ | 0.0162 | 0.2961 | 0.0565 | 0.2066 | 0.0105 | 0.0095 | 0.0247 |
| $M_i=F(MC_i)$ | dimensionless | 0.557 | 1.000 | 0.802 | 1.000 | 0.173 | 0.173 | 0.802 |
| $M_i=F(Precip)$ | dimensionless | NA | NA | NA | NA | NA | NA | NA |
| $M_i$ | dimensionless | 0.557 | 1.000 | 0.802 | 1.000 | 0.173 | 0.173 | 0.802 |
| $A_i$ | $cm^2/sec$ | --- | 4.01E-09 | 5.31E-05 | 6.15E-07 | 5.23E-03 | 5.23E-03 | 5.31E-05 |
| $At_i$ | $cm^2/sec$ | 3.38E-04 | 1.01E-06 | 2.78E-05 | 2.08E-06 | 3.22E-06 | 8.18E-04 | 4.31E-05 |
| $\tanh(Xt_i Bt_i)$ | | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| $J_i$ | $pCi/(m^2 \cdot sec)$ | 9.165 | 1.887E-06 | 1.517E-06 | 3.302E-15 | 2.669E-15 | 2.593E-15 | 1.121E-16 |
| | | | | | | Rate used in ISCLT2 for Future Scenario | | Rate used in ISCLT2 for Current Scenario |

Reference: Radon Attenuation Handbook for Uranium Mill Tailings Cover Design, V.C. Rogers and K.K. Nielson, NUREG/CR-3533 (PNL-4878), April 1984.

- 5208

**On-Property Meteorological Data**

0518

5208

{This page intentionally left blank}

# JOINT FREQUENCY DISTRIBUTION OF THE COMPOSITE 1987–19 5208
# ON–PROPERTY WIND DATA

| Wind Direction | Wind Speed, mph 1 – 3 | 4 – 7 | 8 – 12 | 13 – 18 | 19 – 24 | > 24 |
|---|---|---|---|---|---|---|
| Stability A | | | | | | |
| N | 0.000254 | 0.000920 | 0.000659 | 0.000158 | 0.000000 | 0.000000 |
| NNE | 0.000497 | 0.001240 | 0.000772 | 0.000217 | 0.000000 | 0.000000 |
| NE | 0.001052 | 0.002404 | 0.000768 | 0.000152 | 0.000000 | 0.000000 |
| ENE | 0.001865 | 0.003169 | 0.001406 | 0.000041 | 0.000000 | 0.000000 |
| E | 0.001145 | 0.001309 | 0.000216 | 0.000063 | 0.000000 | 0.000022 |
| ESE | 0.000863 | 0.000419 | 0.000046 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.000420 | 0.000262 | 0.000000 | 0.000000 | 0.000000 | 0.000022 |
| SSE | 0.000578 | 0.000294 | 0.000043 | 0.000022 | 0.000000 | 0.000000 |
| S | 0.000827 | 0.001039 | 0.000754 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.001314 | 0.003519 | 0.002883 | 0.000087 | 0.000000 | 0.000000 |
| SW | 0.001794 | 0.004185 | 0.003313 | 0.000214 | 0.000000 | 0.000000 |
| WSW | 0.001869 | 0.003824 | 0.002558 | 0.000046 | 0.000000 | 0.000000 |
| W | 0.001135 | 0.003264 | 0.002861 | 0.000273 | 0.000000 | 0.000000 |
| WNW | 0.000843 | 0.001509 | 0.001772 | 0.000378 | 0.000000 | 0.000000 |
| NW | 0.000746 | 0.001239 | 0.001099 | 0.000112 | 0.000000 | 0.000000 |
| NNW | 0.000519 | 0.001171 | 0.000875 | 0.000115 | 0.000023 | 0.000000 |
| Stability B | | | | | | |
| N | 0.000104 | 0.000758 | 0.000530 | 0.000085 | 0.000000 | 0.000000 |
| NNE | 0.000123 | 0.000408 | 0.000487 | 0.000107 | 0.000000 | 0.000000 |
| NE | 0.000392 | 0.000835 | 0.000602 | 0.000023 | 0.000000 | 0.000000 |
| ENE | 0.000370 | 0.001203 | 0.000413 | 0.000115 | 0.000000 | 0.000000 |
| E | 0.000623 | 0.000495 | 0.000161 | 0.000023 | 0.000000 | 0.000000 |
| ESE | 0.000245 | 0.000314 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.000275 | 0.000104 | 0.000020 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.000368 | 0.000185 | 0.000064 | 0.000023 | 0.000000 | 0.000000 |
| S | 0.000476 | 0.000743 | 0.000211 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.000659 | 0.001526 | 0.001230 | 0.000089 | 0.000000 | 0.000000 |
| SW | 0.000872 | 0.001839 | 0.001689 | 0.000084 | 0.000000 | 0.000000 |
| WSW | 0.000741 | 0.001546 | 0.001144 | 0.000063 | 0.000000 | 0.000000 |
| W | 0.000727 | 0.001076 | 0.001159 | 0.000157 | 0.000000 | 0.000000 |
| WNW | 0.000394 | 0.000785 | 0.000722 | 0.000156 | 0.000000 | 0.000000 |
| NW | 0.000376 | 0.000953 | 0.000936 | 0.000114 | 0.000000 | 0.000000 |
| NNW | 0.000356 | 0.000671 | 0.000793 | 0.000045 | 0.000000 | 0.000000 |

- 5208

JOINT FREQUENCY DISTRIBUTION OF THE COMPOSITE 1987–1992
ON–PROPERTY WIND DATA
(Continued)

| Wind Direction | Wind Speed, mph 1 – 3 | 4 – 7 | 8 – 12 | 13 – 18 | 19 – 24 | > 24 |
|---|---|---|---|---|---|---|
| Stability C | | | | | | |
| N | 0.000338 | 0.000854 | 0.000799 | 0.000167 | 0.000000 | 0.000000 |
| NNE | 0.000352 | 0.000943 | 0.000673 | 0.000113 | 0.000000 | 0.000000 |
| NE | 0.000429 | 0.001440 | 0.000753 | 0.000112 | 0.000000 | 0.000000 |
| ENE | 0.000911 | 0.001635 | 0.000349 | 0.000207 | 0.000000 | 0.000000 |
| E | 0.000952 | 0.000732 | 0.000130 | 0.000044 | 0.000000 | 0.000000 |
| ESE | 0.000664 | 0.000425 | 0.000022 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.000495 | 0.000311 | 0.000040 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.000282 | 0.000446 | 0.000127 | 0.000021 | 0.000000 | 0.000000 |
| S | 0.000438 | 0.001073 | 0.000443 | 0.000020 | 0.000000 | 0.000000 |
| SSW | 0.000652 | 0.001921 | 0.001289 | 0.000091 | 0.000022 | 0.000000 |
| SW | 0.001214 | 0.002723 | 0.001686 | 0.000179 | 0.000000 | 0.000000 |
| WSW | 0.001121 | 0.002410 | 0.001072 | 0.000158 | 0.000000 | 0.000000 |
| W | 0.000813 | 0.001237 | 0.001137 | 0.000297 | 0.000000 | 0.000000 |
| WNW | 0.000562 | 0.001373 | 0.000964 | 0.000198 | 0.000000 | 0.000000 |
| NW | 0.000532 | 0.001302 | 0.001198 | 0.000107 | 0.000023 | 0.000000 |
| NNW | 0.000428 | 0.001029 | 0.000932 | 0.000025 | 0.000000 | 0.000000 |
| Stability D | | | | | | |
| N | 0.002679 | 0.009515 | 0.007308 | 0.000614 | 0.000000 | 0.000000 |
| NNE | 0.004126 | 0.010130 | 0.006390 | 0.000941 | 0.000000 | 0.000000 |
| NE | 0.006305 | 0.011931 | 0.005425 | 0.000407 | 0.000000 | 0.000000 |
| ENE | 0.008833 | 0.016054 | 0.007859 | 0.001141 | 0.000000 | 0.000000 |
| E | 0.005844 | 0.004942 | 0.000807 | 0.000045 | 0.000000 | 0.000000 |
| ESE | 0.004455 | 0.001896 | 0.000022 | 0.000022 | 0.000000 | 0.000000 |
| SE | 0.003348 | 0.002192 | 0.000227 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.003825 | 0.003383 | 0.001028 | 0.000132 | 0.000000 | 0.000000 |
| S | 0.004533 | 0.006139 | 0.003209 | 0.000401 | 0.000000 | 0.000000 |
| SSW | 0.007852 | 0.013454 | 0.007588 | 0.001444 | 0.000000 | 0.000000 |
| SW | 0.009954 | 0.014680 | 0.006676 | 0.000965 | 0.000135 | 0.000000 |
| WSW | 0.010412 | 0.010125 | 0.005083 | 0.001547 | 0.000071 | 0.000000 |
| W | 0.008663 | 0.011035 | 0.009489 | 0.001660 | 0.000000 | 0.000000 |
| WNW | 0.005730 | 0.010995 | 0.008658 | 0.001190 | 0.000000 | 0.000000 |
| NW | 0.005187 | 0.008468 | 0.006722 | 0.000640 | 0.000069 | 0.000000 |
| NNW | 0.004266 | 0.009196 | 0.005041 | 0.000739 | 0.000046 | 0.000000 |

5208

JOINT FREQUENCY DISTRIBUTION OF THE COMPOSITE 1987–1992
ON–PROPERTY WIND DATA
(Continued)

| Wind Direction | Wind Speed, mph 1 – 3 | 4 – 7 | 8 – 12 | 13 – 18 | 19 – 24 | > 24 |
|---|---|---|---|---|---|---|
| Stability E | | | | | | |
| N | 0.004705 | 0.003797 | 0.000611 | 0.000064 | 0.000000 | 0.000158 |
| NNE | 0.003303 | 0.002687 | 0.000837 | 0.000133 | 0.000000 | 0.000000 |
| NE | 0.003922 | 0.002676 | 0.000389 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.010600 | 0.007249 | 0.000912 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.009102 | 0.001928 | 0.000109 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.005077 | 0.000744 | 0.000023 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.005555 | 0.001164 | 0.000284 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.006483 | 0.003077 | 0.001044 | 0.000151 | 0.000000 | 0.000000 |
| S | 0.008536 | 0.007401 | 0.003438 | 0.000531 | 0.000000 | 0.000000 |
| SSW | 0.014204 | 0.013881 | 0.006741 | 0.001289 | 0.000000 | 0.000000 |
| SW | 0.024094 | 0.016707 | 0.005566 | 0.000549 | 0.000023 | 0.000000 |
| WSW | 0.021916 | 0.008161 | 0.002941 | 0.000581 | 0.000000 | 0.000000 |
| W | 0.015769 | 0.008744 | 0.003853 | 0.000433 | 0.000000 | 0.000000 |
| WNW | 0.011490 | 0.006993 | 0.003036 | 0.000357 | 0.000000 | 0.000000 |
| NW | 0.009547 | 0.003884 | 0.001265 | 0.000132 | 0.000000 | 0.000000 |
| NNW | 0.007635 | 0.002713 | 0.001003 | 0.000126 | 0.000000 | 0.000000 |
| Stability F | | | | | | |
| N | 0.004921 | 0.000118 | 0.000000 | 0.000000 | 0.000023 | 0.000045 |
| NNE | 0.004800 | 0.000022 | 0.000023 | 0.000000 | 0.000000 | 0.000000 |
| NE | 0.004593 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.008510 | 0.000909 | 0.000039 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.012723 | 0.000194 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.008461 | 0.000020 | 0.000000 | 0.000000 | 0.000022 | 0.000000 |
| SE | 0.005656 | 0.000211 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.005117 | 0.000131 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.007414 | 0.000338 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.013086 | 0.001075 | 0.000098 | 0.000022 | 0.000000 | 0.000000 |
| SW | 0.021801 | 0.001575 | 0.000025 | 0.000000 | 0.000000 | 0.000000 |
| WSW | 0.029953 | 0.001192 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| W | 0.031017 | 0.000345 | 0.000020 | 0.000000 | 0.000000 | 0.000000 |
| WNW | 0.031082 | 0.000066 | 0.000022 | 0.000000 | 0.000000 | 0.000000 |
| NW | 0.024893 | 0.000184 | 0.000061 | 0.000000 | 0.000000 | 0.000000 |
| NNW | 0.011908 | 0.000354 | 0.000039 | 0.000000 | 0.000000 | 0.000000 |

0522

# JOINT FREQUENCY DISTRIBUTION OF THE 1987 ON-PROPERTY WIND DATA

| Wind Direction | Wind Speed, mph 1 – 3 | 4 – 7 | 8 – 12 | 13 – 18 | 19 – 24 | > 24 |
|---|---|---|---|---|---|---|
| Stability A | | | | | | |
| N | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NNE | 0.000138 | 0.000000 | 0.000138 | 0.000138 | 0.000000 | 0.000000 |
| NE | 0.000138 | 0.000000 | 0.000138 | 0.000138 | 0.000000 | 0.000000 |
| ENE | 0.000138 | 0.000276 | 0.000828 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.000000 | 0.000552 | 0.000690 | 0.000138 | 0.000000 | 0.000000 |
| ESE | 0.000138 | 0.000276 | 0.000276 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.000000 | 0.000000 | 0.000138 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.000000 | 0.000414 | 0.001517 | 0.000000 | 0.000000 | 0.000000 |
| SW | 0.000000 | 0.001241 | 0.003447 | 0.000414 | 0.000000 | 0.000000 |
| WSW | 0.000000 | 0.000966 | 0.002344 | 0.000000 | 0.000000 | 0.000000 |
| W | 0.000000 | 0.000828 | 0.001379 | 0.000000 | 0.000000 | 0.000000 |
| WNW | 0.000000 | 0.000276 | 0.000690 | 0.000414 | 0.000000 | 0.000000 |
| NW | 0.000138 | 0.000138 | 0.000276 | 0.000552 | 0.000000 | 0.000000 |
| NNW | 0.000000 | 0.000000 | 0.000414 | 0.000414 | 0.000138 | 0.000000 |
| Stability B | | | | | | |
| N | 0.000000 | 0.000414 | 0.000138 | 0.000000 | 0.000000 | 0.000000 |
| NNE | 0.000000 | 0.000276 | 0.000552 | 0.000000 | 0.000000 | 0.000000 |
| NE | 0.000000 | 0.000828 | 0.002344 | 0.000138 | 0.000000 | 0.000000 |
| ENE | 0.000276 | 0.000828 | 0.000276 | 0.000690 | 0.000000 | 0.000000 |
| E | 0.000276 | 0.000690 | 0.000276 | 0.000138 | 0.000000 | 0.000000 |
| ESE | 0.000000 | 0.000828 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.000000 | 0.000138 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.000138 | 0.000276 | 0.000138 | 0.000138 | 0.000000 | 0.000000 |
| S | 0.000138 | 0.000138 | 0.000138 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.000138 | 0.000966 | 0.002069 | 0.000276 | 0.000000 | 0.000000 |
| SW | 0.000276 | 0.001241 | 0.002758 | 0.000138 | 0.000000 | 0.000000 |
| WSW | 0.000552 | 0.001103 | 0.002069 | 0.000000 | 0.000000 | 0.000000 |
| W | 0.000138 | 0.000966 | 0.001379 | 0.000138 | 0.000000 | 0.000000 |
| WNW | 0.000000 | 0.000690 | 0.000828 | 0.000276 | 0.000000 | 0.000000 |
| NW | 0.000276 | 0.001103 | 0.000828 | 0.000552 | 0.000000 | 0.000000 |
| NNW | 0.000000 | 0.000138 | 0.000414 | 0.000000 | 0.000000 | 0.000000 |

0523

5208

JOINT FREQUENCY DISTRIBUTION OF THE 1987 ON-PROPERTY WIND DATA

(Continued)

| Wind Direction | Wind Speed, mph 1 – 3 | 4 – 7 | 8 – 12 | 13 – 18 | 19 – 24 | > 24 |
|---|---|---|---|---|---|---|
| Stability C | | | | | | |
| N | 0.000276 | 0.000690 | 0.000828 | 0.000000 | 0.000000 | 0.000000 |
| NNE | 0.000138 | 0.000690 | 0.000966 | 0.000000 | 0.000000 | 0.000000 |
| NE | 0.000276 | 0.001241 | 0.001379 | 0.000414 | 0.000000 | 0.000000 |
| ENE | 0.000690 | 0.002069 | 0.000552 | 0.001241 | 0.000000 | 0.000000 |
| E | 0.000414 | 0.001241 | 0.000276 | 0.000138 | 0.000000 | 0.000000 |
| ESE | 0.000552 | 0.000690 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.000276 | 0.000276 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.000138 | 0.000276 | 0.000138 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.000414 | 0.000828 | 0.000414 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.000414 | 0.001517 | 0.000828 | 0.000138 | 0.000000 | 0.000000 |
| SW | 0.001379 | 0.003861 | 0.001931 | 0.000276 | 0.000000 | 0.000000 |
| WSW | 0.001103 | 0.003723 | 0.001379 | 0.000414 | 0.000000 | 0.000000 |
| W | 0.000414 | 0.001241 | 0.001103 | 0.000414 | 0.000000 | 0.000000 |
| WNW | 0.000414 | 0.001241 | 0.001241 | 0.000276 | 0.000000 | 0.000000 |
| NW | 0.000276 | 0.000966 | 0.000828 | 0.000276 | 0.000138 | 0.000000 |
| NNW | 0.000276 | 0.001379 | 0.001103 | 0.000000 | 0.000000 | 0.000000 |
| Stability D | | | | | | |
| N | 0.002925 | 0.005653 | 0.009790 | 0.000828 | 0.000000 | 0.000000 |
| NNE | 0.002386 | 0.009790 | 0.010893 | 0.004137 | 0.000000 | 0.000000 |
| NE | 0.004759 | 0.015856 | 0.010893 | 0.001931 | 0.000000 | 0.000000 |
| ENE | 0.008523 | 0.024266 | 0.017648 | 0.005240 | 0.000000 | 0.000000 |
| E | 0.006661 | 0.005791 | 0.001517 | 0.000138 | 0.000000 | 0.000000 |
| ESE | 0.003883 | 0.002620 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.003053 | 0.002482 | 0.000552 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.002777 | 0.002896 | 0.001517 | 0.000552 | 0.000000 | 0.000000 |
| S | 0.004307 | 0.005102 | 0.002069 | 0.000276 | 0.000000 | 0.000000 |
| SSW | 0.005162 | 0.012271 | 0.004137 | 0.001655 | 0.000000 | 0.000000 |
| SW | 0.006155 | 0.019441 | 0.009238 | 0.000828 | 0.000552 | 0.000000 |
| WSW | 0.007242 | 0.013650 | 0.006756 | 0.003861 | 0.000276 | 0.000000 |
| W | 0.005719 | 0.013512 | 0.014477 | 0.003723 | 0.000000 | 0.000000 |
| WNW | 0.004335 | 0.013374 | 0.007997 | 0.001517 | 0.000000 | 0.000000 |
| NW | 0.002940 | 0.009927 | 0.007997 | 0.001655 | 0.000414 | 0.000000 |
| NNW | 0.004596 | 0.008824 | 0.006067 | 0.002482 | 0.000276 | 0.000000 |

0524

- 5208

JOINT FREQUENCY DISTRIBUTION OF THE 1987 ON-PROPERTY WIND DATA

(Continued)

| Wind Direction | Wind Speed, mph 1 – 3 | 4 – 7 | 8 – 12 | 13 – 18 | 19 – 24 | > 24 |
|---|---|---|---|---|---|---|
| Stability E | | | | | | |
| N | 0.003487 | 0.005240 | 0.000690 | 0.000138 | 0.000000 | 0.000000 |
| NNE | 0.002508 | 0.003172 | 0.001793 | 0.000276 | 0.000000 | 0.000000 |
| NE | 0.003203 | 0.003723 | 0.000828 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.012519 | 0.011996 | 0.001931 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.011648 | 0.003172 | 0.000276 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.006381 | 0.002069 | 0.000138 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.004860 | 0.002620 | 0.000966 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.006661 | 0.002896 | 0.001241 | 0.000552 | 0.000000 | 0.000000 |
| S | 0.006945 | 0.004412 | 0.002620 | 0.000138 | 0.000000 | 0.000000 |
| SSW | 0.009055 | 0.011582 | 0.004412 | 0.000414 | 0.000000 | 0.000000 |
| SW | 0.014228 | 0.022336 | 0.006205 | 0.001103 | 0.000138 | 0.000000 |
| WSW | 0.021367 | 0.008411 | 0.004137 | 0.001103 | 0.000000 | 0.000000 |
| W | 0.013201 | 0.009652 | 0.003999 | 0.000276 | 0.000000 | 0.000000 |
| WNW | 0.007369 | 0.006343 | 0.002344 | 0.000138 | 0.000000 | 0.000000 |
| NW | 0.009712 | 0.003723 | 0.001931 | 0.000276 | 0.000000 | 0.000000 |
| NNW | 0.008185 | 0.002896 | 0.001379 | 0.000138 | 0.000000 | 0.000000 |
| Stability F | | | | | | |
| N | 0.006570 | 0.000138 | 0.000000 | 0.000000 | 0.000138 | 0.000138 |
| NNE | 0.005994 | 0.000000 | 0.000138 | 0.000000 | 0.000000 | 0.000000 |
| NE | 0.006280 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.012646 | 0.002482 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.017288 | 0.000552 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.013558 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.006860 | 0.000276 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.004287 | 0.000138 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.005709 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.010019 | 0.000828 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SW | 0.020476 | 0.001931 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| WSW | 0.026874 | 0.001241 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| W | 0.028415 | 0.000414 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| WNW | 0.025413 | 0.000276 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NW | 0.022554 | 0.000138 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NNW | 0.014281 | 0.000276 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |

5208

# JOINT FREQUENCY DISTRIBUTION OF THE 1988 ON-PROPERTY WIND DATA

| Wind Direction | Wind Speed, mph 1 – 3 | 4 – 7 | 8 – 12 | 13 – 18 | 19 – 24 | > 24 |
|---|---|---|---|---|---|---|
| Stability A | | | | | | |
| N | 0.000137 | 0.000775 | 0.000646 | 0.000259 | 0.000000 | 0.000000 |
| NNE | 0.000658 | 0.000775 | 0.002453 | 0.001162 | 0.000000 | 0.000000 |
| NE | 0.000790 | 0.001033 | 0.001421 | 0.000775 | 0.000000 | 0.000000 |
| ENE | 0.000002 | 0.000130 | 0.000388 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000130 |
| ESE | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000130 |
| SSE | 0.000000 | 0.000000 | 0.000259 | 0.000130 | 0.000000 | 0.000000 |
| S | 0.000522 | 0.000130 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.001045 | 0.000388 | 0.001162 | 0.000130 | 0.000000 | 0.000000 |
| SW | 0.000532 | 0.001291 | 0.003615 | 0.000259 | 0.000000 | 0.000000 |
| WSW | 0.000145 | 0.001808 | 0.002712 | 0.000000 | 0.000000 | 0.000000 |
| W | 0.000536 | 0.001808 | 0.003615 | 0.000517 | 0.000000 | 0.000000 |
| WNW | 0.000787 | 0.000646 | 0.002066 | 0.000646 | 0.000000 | 0.000000 |
| NW | 0.000395 | 0.000517 | 0.001033 | 0.000000 | 0.000000 | 0.000000 |
| NNW | 0.000396 | 0.000646 | 0.000646 | 0.000000 | 0.000000 | 0.000000 |
| Stability B | | | | | | |
| N | 0.000130 | 0.001033 | 0.000388 | 0.000000 | 0.000000 | 0.000000 |
| NNE | 0.000130 | 0.000259 | 0.001162 | 0.000517 | 0.000000 | 0.000000 |
| NE | 0.000130 | 0.001033 | 0.000775 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.000000 | 0.000517 | 0.000517 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.000388 | 0.000259 | 0.000388 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.000130 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.000259 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.000130 | 0.000000 | 0.000130 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.000388 | 0.001033 | 0.001550 | 0.000259 | 0.000000 | 0.000000 |
| SW | 0.000775 | 0.001550 | 0.002066 | 0.000130 | 0.000000 | 0.000000 |
| WSW | 0.000517 | 0.001550 | 0.001550 | 0.000259 | 0.000000 | 0.000000 |
| W | 0.000130 | 0.000904 | 0.002324 | 0.000259 | 0.000000 | 0.000000 |
| WNW | 0.000517 | 0.000904 | 0.002324 | 0.000388 | 0.000000 | 0.000000 |
| NW | 0.000517 | 0.000388 | 0.001162 | 0.000130 | 0.000000 | 0.000000 |
| NNW | 0.000646 | 0.000904 | 0.001033 | 0.000000 | 0.000000 | 0.000000 |

0526

- 5208

JOINT FREQUENCY DISTRIBUTION OF THE 1988 ON-PROPERTY WIND DATA

(Continued)

| Wind Direction | Wind Speed, mph 1 – 3 | 4 – 7 | 8 – 12 | 13 – 18 | 19 – 24 | > 24 |
|---|---|---|---|---|---|---|
| Stability C | | | | | | |
| N | 0.000388 | 0.001033 | 0.000775 | 0.000517 | 0.000000 | 0.000000 |
| NNE | 0.000388 | 0.001162 | 0.001421 | 0.000259 | 0.000000 | 0.000000 |
| NE | 0.000000 | 0.001937 | 0.000646 | 0.000259 | 0.000000 | 0.000000 |
| ENE | 0.000259 | 0.001421 | 0.000646 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.000388 | 0.000646 | 0.000388 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.000646 | 0.000259 | 0.000130 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.000130 | 0.000388 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.000259 | 0.000517 | 0.000388 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.000388 | 0.000775 | 0.000388 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.000517 | 0.001550 | 0.000904 | 0.000259 | 0.000130 | 0.000000 |
| SW | 0.000517 | 0.003228 | 0.001679 | 0.000259 | 0.000000 | 0.000000 |
| WSW | 0.001162 | 0.003228 | 0.001679 | 0.000259 | 0.000000 | 0.000000 |
| W | 0.000259 | 0.001550 | 0.001937 | 0.000259 | 0.000000 | 0.000000 |
| WNW | 0.000646 | 0.001421 | 0.002712 | 0.000517 | 0.000000 | 0.000000 |
| NW | 0.000517 | 0.001162 | 0.001550 | 0.000130 | 0.000000 | 0.000000 |
| NNW | 0.000130 | 0.001033 | 0.000904 | 0.000000 | 0.000000 | 0.000000 |
| Stability D | | | | | | |
| N | 0.001814 | 0.008134 | 0.004132 | 0.000517 | 0.000000 | 0.000000 |
| NNE | 0.002718 | 0.007359 | 0.006843 | 0.000517 | 0.000000 | 0.000000 |
| NE | 0.003624 | 0.011748 | 0.005810 | 0.000388 | 0.000000 | 0.000000 |
| ENE | 0.005952 | 0.016654 | 0.004906 | 0.000130 | 0.000000 | 0.000000 |
| E | 0.005687 | 0.004906 | 0.001162 | 0.000130 | 0.000000 | 0.000000 |
| ESE | 0.004265 | 0.002195 | 0.000130 | 0.000130 | 0.000000 | 0.000000 |
| SE | 0.002715 | 0.002841 | 0.000388 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.004266 | 0.004132 | 0.002324 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.004136 | 0.004003 | 0.002324 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.006981 | 0.008908 | 0.007617 | 0.004390 | 0.000000 | 0.000000 |
| SW | 0.009309 | 0.013943 | 0.009812 | 0.002841 | 0.000259 | 0.000000 |
| WSW | 0.011635 | 0.014460 | 0.006585 | 0.001033 | 0.000000 | 0.000000 |
| W | 0.008404 | 0.012136 | 0.011490 | 0.001808 | 0.000000 | 0.000000 |
| WNW | 0.004398 | 0.009812 | 0.012781 | 0.002066 | 0.000000 | 0.000000 |
| NW | 0.004783 | 0.005681 | 0.006197 | 0.000517 | 0.000000 | 0.000000 |
| NNW | 0.003363 | 0.007359 | 0.005164 | 0.000388 | 0.000000 | 0.000000 |

52

JOINT FREQUENCY DISTRIBUTION OF THE 1988 ON-PROPERTY WIND DATA

(Continued)

| Wind Direction | Wind Speed, mph 1 – 3 | 4 – 7 | 8 – 12 | 13 – 18 | 19 – 24 | > 24 |
|---|---|---|---|---|---|---|
| Stability E | | | | | | |
| N | 0.003498 | 0.003357 | 0.001291 | 0.000130 | 0.000000 | 0.000000 |
| NNE | 0.003366 | 0.002066 | 0.001291 | 0.000130 | 0.000000 | 0.000000 |
| NE | 0.002852 | 0.003873 | 0.000517 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.008552 | 0.009683 | 0.002582 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.006341 | 0.002195 | 0.000259 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.004012 | 0.001679 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.004528 | 0.001033 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.005695 | 0.002712 | 0.001421 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.005054 | 0.006068 | 0.006197 | 0.001937 | 0.000000 | 0.000000 |
| SSW | 0.010625 | 0.011490 | 0.013169 | 0.003615 | 0.000000 | 0.000000 |
| SW | 0.014386 | 0.018074 | 0.009296 | 0.001291 | 0.000000 | 0.000000 |
| WSW | 0.015540 | 0.012523 | 0.006455 | 0.001421 | 0.000000 | 0.000000 |
| W | 0.013607 | 0.016009 | 0.005035 | 0.000259 | 0.000000 | 0.000000 |
| WNW | 0.008809 | 0.008650 | 0.002970 | 0.000388 | 0.000000 | 0.000000 |
| NW | 0.006862 | 0.004390 | 0.001550 | 0.000130 | 0.000000 | 0.000000 |
| NNW | 0.004921 | 0.003486 | 0.001162 | 0.000259 | 0.000000 | 0.000000 |
| Stability F | | | | | | |
| N | 0.006109 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000130 |
| NNE | 0.005850 | 0.000130 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NE | 0.005719 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.008846 | 0.001162 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.015468 | 0.000259 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.008968 | 0.000000 | 0.000000 | 0.000000 | 0.000130 | 0.000000 |
| SE | 0.007410 | 0.000130 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.005851 | 0.000259 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.010141 | 0.000388 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.016906 | 0.001421 | 0.000000 | 0.000130 | 0.000000 | 0.000000 |
| SW | 0.028615 | 0.003228 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| WSW | 0.034336 | 0.003615 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| W | 0.034318 | 0.000904 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| WNW | 0.035742 | 0.000000 | 0.000130 | 0.000000 | 0.000000 | 0.000000 |
| NW | 0.021966 | 0.000130 | 0.000130 | 0.000000 | 0.000000 | 0.000000 |
| NNW | 0.011832 | 0.000646 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |

0528

5208

# JOINT FREQUENCY DISTRIBUTION OF THE 1989 ON-PROPERTY WIND DATA

| Wind Direction | Wind Speed, mph 1 – 3 | 4 – 7 | 8 – 12 | 13 – 18 | 19 – 24 | > 24 |
|---|---|---|---|---|---|---|
| Stability A | | | | | | |
| N | 0.000000 | 0.000479 | 0.000598 | 0.000240 | 0.000000 | 0.000000 |
| NNE | 0.000000 | 0.000359 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NE | 0.000000 | 0.000837 | 0.000240 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.000120 | 0.001435 | 0.001077 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.000000 | 0.001077 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.000120 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.000000 | 0.000837 | 0.001794 | 0.000120 | 0.000000 | 0.000000 |
| SW | 0.000000 | 0.002631 | 0.002272 | 0.000240 | 0.000000 | 0.000000 |
| WSW | 0.000000 | 0.002990 | 0.002392 | 0.000000 | 0.000000 | 0.000000 |
| W | 0.000120 | 0.001435 | 0.002511 | 0.000120 | 0.000000 | 0.000000 |
| WNW | 0.000240 | 0.000837 | 0.000359 | 0.000359 | 0.000000 | 0.000000 |
| NW | 0.000479 | 0.000957 | 0.000120 | 0.000000 | 0.000000 | 0.000000 |
| NNW | 0.000120 | 0.000240 | 0.001196 | 0.000000 | 0.000000 | 0.000000 |
| Stability B | | | | | | |
| N | 0.000120 | 0.000598 | 0.001077 | 0.000359 | 0.000000 | 0.000000 |
| NNE | 0.000000 | 0.000479 | 0.000120 | 0.000000 | 0.000000 | 0.000000 |
| NE | 0.000359 | 0.000598 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.000240 | 0.002153 | 0.000598 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.000718 | 0.000240 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.000120 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.000000 | 0.000000 | 0.000120 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.000240 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.000000 | 0.000359 | 0.000120 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.000359 | 0.001435 | 0.001077 | 0.000000 | 0.000000 | 0.000000 |
| SW | 0.000718 | 0.001674 | 0.001913 | 0.000120 | 0.000000 | 0.000000 |
| WSW | 0.000120 | 0.003109 | 0.001196 | 0.000120 | 0.000000 | 0.000000 |
| W | 0.000598 | 0.001196 | 0.000718 | 0.000000 | 0.000000 | 0.000000 |
| WNW | 0.000359 | 0.000718 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NW | 0.000240 | 0.000598 | 0.000240 | 0.000000 | 0.000000 | 0.000000 |
| NNW | 0.000240 | 0.000479 | 0.000718 | 0.000120 | 0.000000 | 0.000000 |

- 5208

# JOINT FREQUENCY DISTRIBUTION OF THE 1989 ON-PROPERTY WIND DATA

(Continued)

| Wind Direction | Wind Speed, mph 1 – 3 | 4 – 7 | 8 – 12 | 13 – 18 | 19 – 24 | > 24 |
|---|---|---|---|---|---|---|
| Stability C | | | | | | |
| N | 0.000000 | 0.001077 | 0.001196 | 0.000359 | 0.000000 | 0.000000 |
| NNE | 0.000479 | 0.000837 | 0.000479 | 0.000120 | 0.000000 | 0.000000 |
| NE | 0.000359 | 0.001674 | 0.001316 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.001316 | 0.002153 | 0.000120 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.001316 | 0.000957 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.000479 | 0.000598 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.000359 | 0.000718 | 0.000240 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.000000 | 0.000359 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.000000 | 0.001077 | 0.000359 | 0.000120 | 0.000000 | 0.000000 |
| SSW | 0.000479 | 0.001674 | 0.001196 | 0.000000 | 0.000000 | 0.000000 |
| SW | 0.000837 | 0.003229 | 0.002033 | 0.000120 | 0.000000 | 0.000000 |
| WSW | 0.001077 | 0.002750 | 0.001316 | 0.000000 | 0.000000 | 0.000000 |
| W | 0.000598 | 0.001435 | 0.000837 | 0.000120 | 0.000000 | 0.000000 |
| WNW | 0.000240 | 0.001316 | 0.000718 | 0.000000 | 0.000000 | 0.000000 |
| NW | 0.000359 | 0.001196 | 0.000718 | 0.000000 | 0.000000 | 0.000000 |
| NNW | 0.000240 | 0.001196 | 0.000718 | 0.000000 | 0.000000 | 0.000000 |
| Stability D | | | | | | |
| N | 0.003468 | 0.012674 | 0.011359 | 0.001794 | 0.000000 | 0.000000 |
| NNE | 0.006218 | 0.014587 | 0.011957 | 0.000598 | 0.000000 | 0.000000 |
| NE | 0.007772 | 0.016858 | 0.009207 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.009326 | 0.021880 | 0.006696 | 0.000120 | 0.000000 | 0.000000 |
| E | 0.006815 | 0.006337 | 0.000479 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.005620 | 0.002392 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.004066 | 0.002392 | 0.000120 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.003707 | 0.001674 | 0.000479 | 0.000120 | 0.000000 | 0.000000 |
| S | 0.004305 | 0.007294 | 0.002392 | 0.000240 | 0.000000 | 0.000000 |
| SSW | 0.007772 | 0.014348 | 0.006337 | 0.000479 | 0.000000 | 0.000000 |
| SW | 0.011120 | 0.015065 | 0.006218 | 0.000718 | 0.000000 | 0.000000 |
| WSW | 0.010761 | 0.008609 | 0.005381 | 0.000240 | 0.000000 | 0.000000 |
| W | 0.008609 | 0.007294 | 0.005500 | 0.000479 | 0.000000 | 0.000000 |
| WNW | 0.004066 | 0.009207 | 0.007294 | 0.001077 | 0.000000 | 0.000000 |
| NW | 0.005739 | 0.008848 | 0.007772 | 0.000837 | 0.000000 | 0.000000 |
| NNW | 0.004185 | 0.008968 | 0.003826 | 0.000479 | 0.000000 | 0.000000 |

0530

JOINT FREQUENCY DISTRIBUTION OF THE 1989 ON-PROPERTY WIND DATA

(Continued)

| Wind Direction | Wind Speed, mph 1 – 3 | 4 – 7 | 8 – 12 | 13 – 18 | 19 – 24 | > 24 |
|---|---|---|---|---|---|---|
| Stability E | | | | | | |
| N | 0.004916 | 0.005022 | 0.000837 | 0.000000 | 0.000000 | 0.000000 |
| NNE | 0.004076 | 0.003826 | 0.000359 | 0.000240 | 0.000000 | 0.000000 |
| NE | 0.004674 | 0.003229 | 0.000240 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.011264 | 0.006815 | 0.000598 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.008025 | 0.001913 | 0.000120 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.003233 | 0.000120 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.004551 | 0.000957 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.006350 | 0.003348 | 0.000359 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.007790 | 0.005381 | 0.002153 | 0.000240 | 0.000000 | 0.000000 |
| SSW | 0.015102 | 0.011478 | 0.007055 | 0.001674 | 0.000000 | 0.000000 |
| SW | 0.025648 | 0.019608 | 0.006696 | 0.000359 | 0.000000 | 0.000000 |
| WSW | 0.023479 | 0.009087 | 0.001794 | 0.000000 | 0.000000 | 0.000000 |
| W | 0.015100 | 0.010044 | 0.004663 | 0.000000 | 0.000000 | 0.000000 |
| WNW | 0.011508 | 0.010163 | 0.005859 | 0.000957 | 0.000000 | 0.000000 |
| NW | 0.009466 | 0.005381 | 0.001674 | 0.000120 | 0.000000 | 0.000000 |
| NNW | 0.006590 | 0.003229 | 0.000718 | 0.000359 | 0.000000 | 0.000000 |
| Stability F | | | | | | |
| N | 0.001871 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NNE | 0.002869 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NE | 0.003617 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.005269 | 0.000718 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.010226 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.008355 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.005487 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.006360 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.007488 | 0.000120 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.013115 | 0.000479 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SW | 0.025979 | 0.000957 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| WSW | 0.040429 | 0.000598 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| W | 0.044155 | 0.000240 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| WNW | 0.038912 | 0.000120 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NW | 0.022956 | 0.000240 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NNW | 0.008735 | 0.000120 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |

- 5208

# JOINT FREQUENCY DISTRIBUTION OF THE 1990 ON-PROPERTY WIND DATA

| Wind Direction | Wind Speed, mph 1 – 3 | 4 – 7 | 8 – 12 | 13 – 18 | 19 – 24 | > 24 |
|---|---|---|---|---|---|---|
| Stability A | | | | | | |
| N | 0.000150 | 0.000599 | 0.000150 | 0.000449 | 0.000000 | 0.000000 |
| NNE | 0.000449 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NE | 0.000449 | 0.000898 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.001646 | 0.001946 | 0.000300 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.000599 | 0.000749 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.000749 | 0.000150 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.000300 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.000150 | 0.000300 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.000000 | 0.000300 | 0.000150 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.000150 | 0.002095 | 0.002993 | 0.000150 | 0.000000 | 0.000000 |
| SW | 0.000599 | 0.002095 | 0.001347 | 0.000000 | 0.000000 | 0.000000 |
| WSW | 0.001048 | 0.001796 | 0.001198 | 0.000150 | 0.000000 | 0.000000 |
| W | 0.000599 | 0.001347 | 0.002245 | 0.000150 | 0.000000 | 0.000000 |
| WNW | 0.000449 | 0.000599 | 0.000300 | 0.000000 | 0.000000 | 0.000000 |
| NW | 0.000000 | 0.000749 | 0.000599 | 0.000000 | 0.000000 | 0.000000 |
| NNW | 0.000599 | 0.000449 | 0.000449 | 0.000150 | 0.000000 | 0.000000 |
| Stability B | | | | | | |
| N | 0.000006 | 0.000449 | 0.000000 | 0.000150 | 0.000000 | 0.000000 |
| NNE | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NE | 0.000305 | 0.000150 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.000007 | 0.000599 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.000308 | 0.000449 | 0.000300 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.000006 | 0.000449 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.000455 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.000152 | 0.000000 | 0.000150 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.000169 | 0.001497 | 0.001347 | 0.000000 | 0.000000 | 0.000000 |
| SW | 0.000321 | 0.001497 | 0.000749 | 0.000000 | 0.000000 | 0.000000 |
| WSW | 0.000470 | 0.001347 | 0.000449 | 0.000000 | 0.000000 | 0.000000 |
| W | 0.000462 | 0.000599 | 0.001198 | 0.000300 | 0.000000 | 0.000000 |
| WNW | 0.000159 | 0.000599 | 0.000449 | 0.000150 | 0.000000 | 0.000000 |
| NW | 0.000016 | 0.001347 | 0.001347 | 0.000000 | 0.000000 | 0.000000 |
| NNW | 0.000164 | 0.001048 | 0.000898 | 0.000150 | 0.000000 | 0.000000 |

- 5208

JOINT FREQUENCY DISTRIBUTION OF THE 1990 ON-PROPERTY WIND DATA

(Continued)

| Wind Direction | Wind Speed, mph 1 – 3 | 4 – 7 | 8 – 12 | 13 – 18 | 19 – 24 | > 24 |
|---|---|---|---|---|---|---|
| Stability C | | | | | | |
| N | 0.000150 | 0.000749 | 0.000300 | 0.000000 | 0.000000 | 0.000000 |
| NNE | 0.000150 | 0.000300 | 0.000449 | 0.000300 | 0.000000 | 0.000000 |
| NE | 0.000150 | 0.000898 | 0.000449 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.000898 | 0.001646 | 0.000300 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.000449 | 0.000449 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.000000 | 0.000150 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.000749 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.000449 | 0.000449 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.000150 | 0.000749 | 0.000300 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.000000 | 0.002095 | 0.002245 | 0.000150 | 0.000000 | 0.000000 |
| SW | 0.000449 | 0.002245 | 0.002544 | 0.000300 | 0.000000 | 0.000000 |
| WSW | 0.000749 | 0.002095 | 0.001198 | 0.000150 | 0.000000 | 0.000000 |
| W | 0.000449 | 0.000898 | 0.001497 | 0.000749 | 0.000000 | 0.000000 |
| WNW | 0.000749 | 0.000749 | 0.000150 | 0.000150 | 0.000000 | 0.000000 |
| NW | 0.000599 | 0.001946 | 0.001946 | 0.000000 | 0.000000 | 0.000000 |
| NNW | 0.000599 | 0.001497 | 0.001048 | 0.000150 | 0.000000 | 0.000000 |
| Stability D | | | | | | |
| N | 0.001232 | 0.011672 | 0.005986 | 0.000300 | 0.000000 | 0.000000 |
| NNE | 0.003625 | 0.008979 | 0.002395 | 0.000150 | 0.000000 | 0.000000 |
| NE | 0.006323 | 0.008081 | 0.003592 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.006787 | 0.013468 | 0.007333 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.005565 | 0.005088 | 0.000599 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.005705 | 0.001198 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.003606 | 0.001946 | 0.000300 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.003016 | 0.005836 | 0.000749 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.004372 | 0.007781 | 0.007033 | 0.001646 | 0.000000 | 0.000000 |
| SSW | 0.006492 | 0.015263 | 0.016011 | 0.001646 | 0.000000 | 0.000000 |
| SW | 0.008739 | 0.014066 | 0.007183 | 0.001048 | 0.000000 | 0.000000 |
| WSW | 0.009318 | 0.006135 | 0.003891 | 0.003292 | 0.000150 | 0.000000 |
| W | 0.007525 | 0.008829 | 0.010924 | 0.002844 | 0.000000 | 0.000000 |
| WNW | 0.004677 | 0.009876 | 0.009577 | 0.001497 | 0.000000 | 0.000000 |
| NW | 0.005126 | 0.009427 | 0.009427 | 0.000000 | 0.000000 | 0.000000 |
| NNW | 0.003787 | 0.013617 | 0.007482 | 0.000599 | 0.000000 | 0.000000 |

0533

- 5208

JOINT FREQUENCY DISTRIBUTION OF THE 1990 ON-PROPERTY WIND DATA

(Continued)

| Wind Direction | Wind Speed, mph 1 – 3 | 4 – 7 | 8 – 12 | 13 – 18 | 19 – 24 | > 24 |
|---|---|---|---|---|---|---|
| Stability E | | | | | | |
| N | 0.007112 | 0.006285 | 0.000599 | 0.000000 | 0.000000 | 0.000000 |
| NNE | 0.004224 | 0.003592 | 0.000749 | 0.000150 | 0.000000 | 0.000000 |
| NE | 0.005082 | 0.002095 | 0.000749 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.010191 | 0.007033 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.012229 | 0.001646 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.006220 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.006887 | 0.000449 | 0.000150 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.007742 | 0.003741 | 0.001198 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.009848 | 0.011522 | 0.005537 | 0.000749 | 0.000000 | 0.000000 |
| SSW | 0.016128 | 0.022146 | 0.009727 | 0.001048 | 0.000000 | 0.000000 |
| SW | 0.036086 | 0.017657 | 0.006734 | 0.000300 | 0.000000 | 0.000000 |
| WSW | 0.026367 | 0.008081 | 0.003442 | 0.000599 | 0.000000 | 0.000000 |
| W | 0.022151 | 0.007033 | 0.006884 | 0.001946 | 0.000000 | 0.000000 |
| WNW | 0.017586 | 0.007931 | 0.005238 | 0.000300 | 0.000000 | 0.000000 |
| NW | 0.011238 | 0.005986 | 0.001946 | 0.000150 | 0.000000 | 0.000000 |
| NNW | 0.009955 | 0.003442 | 0.001198 | 0.000000 | 0.000000 | 0.000000 |
| Stability F | | | | | | |
| N | 0.002873 | 0.000449 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NNE | 0.003796 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NE | 0.003163 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.007275 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.012177 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.006010 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.003488 | 0.000150 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.004437 | 0.000150 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.006984 | 0.000449 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.011621 | 0.001347 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SW | 0.018447 | 0.001796 | 0.000150 | 0.000000 | 0.000000 | 0.000000 |
| WSW | 0.030282 | 0.001347 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| W | 0.026893 | 0.000150 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| WNW | 0.031154 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NW | 0.025145 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NNW | 0.008416 | 0.000599 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |

- 5208

# JOINT FREQUENCY DISTRIBUTION OF THE 1991 ON-PROPERTY WIND DATA

| Wind Direction | Wind Speed, mph 1 – 3 | 4 – 7 | 8 – 12 | 13 – 18 | 19 – 24 | > 24 |
|---|---|---|---|---|---|---|
| Stability A | | | | | | |
| N | 0.000987 | 0.002838 | 0.001851 | 0.000000 | 0.000000 | 0.000000 |
| NNE | 0.000741 | 0.003824 | 0.000741 | 0.000000 | 0.000000 | 0.000000 |
| NE | 0.002838 | 0.007402 | 0.002221 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.008142 | 0.010855 | 0.004071 | 0.000247 | 0.000000 | 0.000000 |
| E | 0.004811 | 0.003824 | 0.000371 | 0.000124 | 0.000000 | 0.000000 |
| ESE | 0.003208 | 0.001851 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.001851 | 0.000864 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.002591 | 0.001111 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.002961 | 0.003084 | 0.002344 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.004811 | 0.011595 | 0.006291 | 0.000124 | 0.000000 | 0.000000 |
| SW | 0.006785 | 0.011595 | 0.005181 | 0.000371 | 0.000000 | 0.000000 |
| WSW | 0.007895 | 0.009128 | 0.004811 | 0.000124 | 0.000000 | 0.000000 |
| W | 0.004071 | 0.010979 | 0.004935 | 0.000617 | 0.000000 | 0.000000 |
| WNW | 0.002714 | 0.004688 | 0.005798 | 0.000494 | 0.000000 | 0.000000 |
| NW | 0.002591 | 0.002591 | 0.001851 | 0.000000 | 0.000000 | 0.000000 |
| NNW | 0.001481 | 0.003208 | 0.001481 | 0.000124 | 0.000000 | 0.000000 |
| Stability B | | | | | | |
| N | 0.000247 | 0.001111 | 0.000987 | 0.000000 | 0.000000 | 0.000000 |
| NNE | 0.000371 | 0.000371 | 0.000617 | 0.000124 | 0.000000 | 0.000000 |
| NE | 0.000494 | 0.000864 | 0.000494 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.000987 | 0.001234 | 0.000494 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.000864 | 0.000741 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.000741 | 0.000371 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.000247 | 0.000247 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.000741 | 0.000124 | 0.000247 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.001727 | 0.001481 | 0.000371 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.001481 | 0.002097 | 0.000864 | 0.000000 | 0.000000 | 0.000000 |
| SW | 0.001604 | 0.002591 | 0.001234 | 0.000000 | 0.000000 | 0.000000 |
| WSW | 0.001604 | 0.000987 | 0.001481 | 0.000000 | 0.000000 | 0.000000 |
| W | 0.001851 | 0.001727 | 0.000864 | 0.000247 | 0.000000 | 0.000000 |
| WNW | 0.000741 | 0.000617 | 0.000494 | 0.000124 | 0.000000 | 0.000000 |
| NW | 0.000617 | 0.000864 | 0.000741 | 0.000000 | 0.000000 | 0.000000 |
| NNW | 0.000494 | 0.000864 | 0.000987 | 0.000000 | 0.000000 | 0.000000 |

- 5208

JOINT FREQUENCY DISTRIBUTION OF THE 1991 ON-PROPERTY WIND DATA

(Continued)

| Wind Direction | Wind Speed, mph 1 – 3 | 4 – 7 | 8 – 12 | 13 – 18 | 19 – 24 | > 24 |
|---|---|---|---|---|---|---|
| Stability C | | | | | | |
| N | 0.000741 | 0.000987 | 0.000987 | 0.000124 | 0.000000 | 0.000000 |
| NNE | 0.000247 | 0.001604 | 0.000371 | 0.000000 | 0.000000 | 0.000000 |
| NE | 0.000371 | 0.001357 | 0.000494 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.001357 | 0.000987 | 0.000124 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.001727 | 0.000864 | 0.000000 | 0.000124 | 0.000000 | 0.000000 |
| ESE | 0.001481 | 0.000617 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.000864 | 0.000247 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.000371 | 0.000247 | 0.000000 | 0.000124 | 0.000000 | 0.000000 |
| S | 0.000494 | 0.001234 | 0.000371 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.000494 | 0.001974 | 0.001974 | 0.000000 | 0.000000 | 0.000000 |
| SW | 0.001974 | 0.002714 | 0.000987 | 0.000000 | 0.000000 | 0.000000 |
| WSW | 0.000864 | 0.001604 | 0.000741 | 0.000124 | 0.000000 | 0.000000 |
| W | 0.002097 | 0.001234 | 0.000741 | 0.000124 | 0.000000 | 0.000000 |
| WNW | 0.000617 | 0.001974 | 0.000371 | 0.000124 | 0.000000 | 0.000000 |
| NW | 0.000494 | 0.001481 | 0.000494 | 0.000000 | 0.000000 | 0.000000 |
| NNW | 0.000617 | 0.000124 | 0.001111 | 0.000000 | 0.000000 | 0.000000 |
| Stability D | | | | | | |
| N | 0.002678 | 0.009869 | 0.007155 | 0.000247 | 0.000000 | 0.000000 |
| NNE | 0.004653 | 0.008142 | 0.002714 | 0.000247 | 0.000000 | 0.000000 |
| NE | 0.006752 | 0.006291 | 0.002344 | 0.000124 | 0.000000 | 0.000000 |
| ENE | 0.007986 | 0.005181 | 0.007031 | 0.001357 | 0.000000 | 0.000000 |
| E | 0.004735 | 0.002097 | 0.000494 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.002736 | 0.000371 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.002247 | 0.001481 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.002996 | 0.002097 | 0.000864 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.003520 | 0.006045 | 0.002838 | 0.000247 | 0.000000 | 0.000000 |
| SSW | 0.010789 | 0.015296 | 0.007772 | 0.000494 | 0.000000 | 0.000000 |
| SW | 0.014497 | 0.012582 | 0.003948 | 0.000000 | 0.000000 | 0.000000 |
| WSW | 0.011602 | 0.007155 | 0.004935 | 0.000741 | 0.000000 | 0.000000 |
| W | 0.007674 | 0.013816 | 0.008882 | 0.000987 | 0.000000 | 0.000000 |
| WNW | 0.008996 | 0.007525 | 0.005798 | 0.000987 | 0.000000 | 0.000000 |
| NW | 0.005014 | 0.006538 | 0.001974 | 0.000124 | 0.000000 | 0.000000 |
| NNW | 0.004405 | 0.008142 | 0.003578 | 0.000247 | 0.000000 | 0.000000 |

JOINT FREQUENCY DISTRIBUTION OF THE 1991 ON-PROPERTY WIND DATA

(Continued)

| Wind Direction | Wind Speed, mph 1 – 3 | 4 – 7 | 8 – 12 | 13 – 18 | 19 – 24 | > 24 |
|---|---|---|---|---|---|---|
| Stability E | | | | | | |
| N | 0.004311 | 0.001111 | 0.000247 | 0.000000 | 0.000000 | 0.000000 |
| NNE | 0.002417 | 0.000987 | 0.000124 | 0.000000 | 0.000000 | 0.000000 |
| NE | 0.003187 | 0.001604 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.009926 | 0.004194 | 0.000124 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.007586 | 0.000987 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.004289 | 0.000124 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.005314 | 0.000864 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.004461 | 0.002221 | 0.000864 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.010342 | 0.005921 | 0.002468 | 0.000124 | 0.000000 | 0.000000 |
| SSW | 0.013744 | 0.011595 | 0.004318 | 0.000987 | 0.000000 | 0.000000 |
| SW | 0.026036 | 0.008758 | 0.002344 | 0.000124 | 0.000000 | 0.000000 |
| WSW | 0.024452 | 0.005551 | 0.001111 | 0.000247 | 0.000000 | 0.000000 |
| W | 0.015464 | 0.003824 | 0.001357 | 0.000000 | 0.000000 | 0.000000 |
| WNW | 0.010153 | 0.003084 | 0.000741 | 0.000124 | 0.000000 | 0.000000 |
| NW | 0.009732 | 0.001111 | 0.000371 | 0.000000 | 0.000000 | 0.000000 |
| NNW | 0.007961 | 0.000864 | 0.000617 | 0.000000 | 0.000000 | 0.000000 |
| Stability F | | | | | | |
| N | 0.005192 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NNE | 0.004919 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NE | 0.004373 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.007718 | 0.000617 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.011204 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.007105 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.004099 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.006012 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.007118 | 0.000124 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.013690 | 0.000247 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SW | 0.018049 | 0.000124 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| WSW | 0.023774 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| W | 0.025700 | 0.000124 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| WNW | 0.028692 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NW | 0.030209 | 0.000124 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NNW | 0.015056 | 0.000247 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |

# JOINT FREQUENCY DISTRIBUTION OF THE 1992 ON-PROPERTY WIND DATA

| Wind Direction | Wind Speed, mph 1 – 3 | 4 – 7 | 8 – 12 | 13 – 18 | 19 – 24 | > 24 |
|---|---|---|---|---|---|---|
| Stability A | | | | | | |
| N | 0.000252 | 0.000828 | 0.000709 | 0.000000 | 0.000000 | 0.000000 |
| NNE | 0.000995 | 0.002482 | 0.001300 | 0.000000 | 0.000000 | 0.000000 |
| NE | 0.002100 | 0.004254 | 0.000591 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.001143 | 0.004372 | 0.001773 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.001463 | 0.001655 | 0.000237 | 0.000119 | 0.000000 | 0.000000 |
| ESE | 0.000963 | 0.000237 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.000370 | 0.000709 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.000725 | 0.000355 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.001478 | 0.002718 | 0.001891 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.001882 | 0.005790 | 0.003545 | 0.000000 | 0.000000 | 0.000000 |
| SW | 0.002848 | 0.006262 | 0.004018 | 0.000000 | 0.000000 | 0.000000 |
| WSW | 0.002129 | 0.006262 | 0.001891 | 0.000000 | 0.000000 | 0.000000 |
| W | 0.001485 | 0.003190 | 0.002482 | 0.000237 | 0.000000 | 0.000000 |
| WNW | 0.000869 | 0.002009 | 0.001418 | 0.000355 | 0.000000 | 0.000000 |
| NW | 0.000875 | 0.002482 | 0.002718 | 0.000119 | 0.000000 | 0.000000 |
| NNW | 0.000516 | 0.002482 | 0.001064 | 0.000000 | 0.000000 | 0.000000 |
| Stability B | | | | | | |
| N | 0.000119 | 0.000946 | 0.000591 | 0.000000 | 0.000000 | 0.000000 |
| NNE | 0.000237 | 0.001064 | 0.000473 | 0.000000 | 0.000000 | 0.000000 |
| NE | 0.001064 | 0.001536 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.000709 | 0.001891 | 0.000591 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.001182 | 0.000591 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.000473 | 0.000237 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.000946 | 0.000237 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.000828 | 0.000709 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.000709 | 0.002482 | 0.000355 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.001418 | 0.002127 | 0.000473 | 0.000000 | 0.000000 | 0.000000 |
| SW | 0.001536 | 0.002482 | 0.001418 | 0.000119 | 0.000000 | 0.000000 |
| WSW | 0.001182 | 0.001182 | 0.000119 | 0.000000 | 0.000000 | 0.000000 |
| W | 0.001182 | 0.001064 | 0.000473 | 0.000000 | 0.000000 | 0.000000 |
| WNW | 0.000591 | 0.001182 | 0.000237 | 0.000000 | 0.000000 | 0.000000 |
| NW | 0.000591 | 0.001418 | 0.001300 | 0.000000 | 0.000000 | 0.000000 |
| NNW | 0.000591 | 0.000591 | 0.000709 | 0.000000 | 0.000000 | 0.000000 |

JOINT FREQUENCY DISTRIBUTION OF THE 1992 ON-PROPERTY WIND DATA

(Continued)

| Wind Direction | Wind Speed, mph 1 – 3 | 4 – 7 | 8 – 12 | 13 – 18 | 19 – 24 | > 24 |
|---|---|---|---|---|---|---|
| Stability C | | | | | | |
| N | 0.000473 | 0.000591 | 0.000709 | 0.000000 | 0.000000 | 0.000000 |
| NNE | 0.000709 | 0.001064 | 0.000355 | 0.000000 | 0.000000 | 0.000000 |
| NE | 0.001418 | 0.001536 | 0.000237 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.000946 | 0.001536 | 0.000355 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.001418 | 0.000237 | 0.000119 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.000828 | 0.000237 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.000591 | 0.000237 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.000473 | 0.000828 | 0.000237 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.001182 | 0.001773 | 0.000828 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.002009 | 0.002718 | 0.000591 | 0.000000 | 0.000000 | 0.000000 |
| SW | 0.002127 | 0.001064 | 0.000946 | 0.000119 | 0.000000 | 0.000000 |
| WSW | 0.001773 | 0.001064 | 0.000119 | 0.000000 | 0.000000 | 0.000000 |
| W | 0.001064 | 0.001064 | 0.000709 | 0.000119 | 0.000000 | 0.000000 |
| WNW | 0.000709 | 0.001536 | 0.000591 | 0.000119 | 0.000000 | 0.000000 |
| NW | 0.000946 | 0.001064 | 0.001655 | 0.000237 | 0.000000 | 0.000000 |
| NNW | 0.000709 | 0.000946 | 0.000709 | 0.000000 | 0.000000 | 0.000000 |
| Stability D | | | | | | |
| N | 0.003960 | 0.009098 | 0.005435 | 0.000000 | 0.000000 | 0.000000 |
| NNE | 0.005161 | 0.011933 | 0.003545 | 0.000000 | 0.000000 | 0.000000 |
| NE | 0.008607 | 0.012760 | 0.000709 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.014433 | 0.014887 | 0.003545 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.005605 | 0.005435 | 0.000591 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.004523 | 0.002600 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.004402 | 0.002009 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.006190 | 0.003663 | 0.000237 | 0.000119 | 0.000000 | 0.000000 |
| S | 0.006560 | 0.006617 | 0.002600 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.009921 | 0.014651 | 0.003663 | 0.000000 | 0.000000 | 0.000000 |
| SW | 0.009914 | 0.012997 | 0.003663 | 0.000355 | 0.000000 | 0.000000 |
| WSW | 0.011921 | 0.010752 | 0.002954 | 0.000119 | 0.000000 | 0.000000 |
| W | 0.014057 | 0.010634 | 0.005672 | 0.000119 | 0.000000 | 0.000000 |
| WNW | 0.007911 | 0.016187 | 0.008507 | 0.000000 | 0.000000 | 0.000000 |
| NW | 0.007527 | 0.010397 | 0.006971 | 0.000709 | 0.000000 | 0.000000 |
| NNW | 0.005262 | 0.008271 | 0.004136 | 0.000237 | 0.000000 | 0.000000 |

0539

# JOINT FREQUENCY DISTRIBUTION OF THE 1992 ON-PROPERTY WIND DATA

(Continued)

| Wind Direction | Wind Speed, mph 1 – 3 | 4 – 7 | 8 – 12 | 13 – 18 | 19 – 24 | > 24 |
|---|---|---|---|---|---|---|
| Stability E | | | | | | |
| N | 0.004909 | 0.001773 | 0.000000 | 0.000119 | 0.000000 | 0.000946 |
| NNE | 0.003228 | 0.002482 | 0.000709 | 0.000000 | 0.000000 | 0.000000 |
| NE | 0.004538 | 0.001536 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.011159 | 0.003781 | 0.000237 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.008792 | 0.001655 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.006330 | 0.000473 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.007196 | 0.001064 | 0.000591 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.007995 | 0.003545 | 0.001182 | 0.000355 | 0.000000 | 0.000000 |
| S | 0.011243 | 0.011106 | 0.001655 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.020584 | 0.015005 | 0.001773 | 0.000000 | 0.000000 | 0.000000 |
| SW | 0.028202 | 0.013824 | 0.002127 | 0.000119 | 0.000000 | 0.000000 |
| WSW | 0.020312 | 0.005317 | 0.000709 | 0.000119 | 0.000000 | 0.000000 |
| W | 0.015106 | 0.005908 | 0.001182 | 0.000119 | 0.000000 | 0.000000 |
| WNW | 0.013523 | 0.005790 | 0.001064 | 0.000237 | 0.000000 | 0.000000 |
| NW | 0.010279 | 0.002718 | 0.000119 | 0.000119 | 0.000000 | 0.000000 |
| NNW | 0.008205 | 0.002363 | 0.000946 | 0.000000 | 0.000000 | 0.000000 |
| Stability F | | | | | | |
| N | 0.006913 | 0.000119 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NNE | 0.005377 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NE | 0.004412 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ENE | 0.009315 | 0.000473 | 0.000237 | 0.000000 | 0.000000 | 0.000000 |
| E | 0.009985 | 0.000355 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| ESE | 0.006775 | 0.000119 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SE | 0.006598 | 0.000709 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSE | 0.003762 | 0.000237 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| S | 0.007051 | 0.000946 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| SSW | 0.013175 | 0.002127 | 0.000591 | 0.000000 | 0.000000 | 0.000000 |
| SW | 0.019260 | 0.001418 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| WSW | 0.024046 | 0.000355 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| W | 0.026645 | 0.000237 | 0.000119 | 0.000000 | 0.000000 | 0.000000 |
| WNW | 0.026606 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| NW | 0.026547 | 0.000473 | 0.000237 | 0.000000 | 0.000000 | 0.000000 |
| NNW | 0.013136 | 0.000237 | 0.000237 | 0.000000 | 0.000000 | 0.000000 |

{This page intentionally left blank}

# Example ISCLT2 Model Input and Output

5208

{This page intentionally left blank}

```
CO STARTING
CO TITLEONE OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data
CO TITLETWO OU1,3,4 PM10        FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93
CO MODELOPT DFAULT CONC RURAL
CO AVERTIME ANNUAL
CO POLLUTID OTHER
CO TERRHGTS FLAT
** Set receptor height to inhalation level, 1.5 m above ground
CO FLAGPOLE 1.5
CO RUNORNOT RUN
CO FINISHED

SO STARTING
SO EMISUNIT 1.0 (g/s)/m2-or-(pCi/s)/m2 g/m3-or-pCi/m3

**           SCR ID  SRCTYP   XS    YS     ZS
**          -------- ------ ------ ------ ------
SO LOCATION BRDRORIG  AREA    608.  -695.    0.
SO LOCATION WASTPIT1  AREA    492.  -472.    0.
SO LOCATION WASTPIT2  AREA    579.  -422.    0.
SO LOCATION WASTPIT3  AREA    451.  -402.    0.
SO LOCATION WASTPIT4  AREA    634.  -357.    0.
SO LOCATION WASTPIT5  AREA    553.  -244.    0.
SO LOCATION WASTPIT6  AREA    768.  -277.    0.
SO LOCATION WASTPIT7  AREA    626.  -326.    0.
SO LOCATION WASTPIT8  AREA    431.  -476.    0.
SO LOCATION SWSWPROD  AREA    901. -1071.    0.
SO LOCATION SWSEPROD  AREA   1091. -1071.    0.
SO LOCATION SWNWPROD  AREA    901.  -881.    0.
SO LOCATION SWNEPROD  AREA   1091.  -881.    0.
SO LOCATION SESWPROD  AREA   1282. -1071.    0.
SO LOCATION SESEPROD  AREA   1472. -1071.    0.
SO LOCATION SENWPROD  AREA   1282.  -881.    0.
SO LOCATION SENEPROD  AREA   1472.  -881.    0.
SO LOCATION NWSWPROD  AREA    901.  -538.    0.
SO LOCATION NWSEPROD  AREA   1091.  -538.    0.
SO LOCATION NWNWPROD  AREA    901.  -348.    0.
SO LOCATION NWNEPROD  AREA   1091.  -348.    0.
SO LOCATION NESWPROD  AREA   1282.  -538.    0.
SO LOCATION NESEPROD  AREA   1472.  -538.    0.
SO LOCATION NENWPROD  AREA   1282.  -348.    0.
SO LOCATION NENEPROD  AREA   1472.  -348.    0.
SO LOCATION PRODHOT1  AREA   1091.  -690.    0.
SO LOCATION CTRMPROD  AREA   1282.  -690.    0.
SO LOCATION PRODHOT2  AREA   1472.  -690.    0.
SO LOCATION SRGLPROD  AREA    671.  -610.    0.
SO LOCATION WWPIPROD  AREA   1948.  -846.    0.
SO LOCATION STHSILO4  AREA    554.  -767.    0.
SO LOCATION NTHSILO4  AREA    554.  -677.    0.

** Area Source  SRC ID  EMISSION HGT LENGTH
**                       pCi/s/m2
** Units                or g/s/m2  m    m
** Parameters: -------- -------- --- ------
SO SRCPARAM    BRDRORIG    0.0    0.    1.
```

```
SO SRCPARAM    WASTPIT1    1.0    0.   76.
SO SRCPARAM    WASTPIT2    1.0    0.   56.
SO SRCPARAM    WASTPIT3    1.0    0.  144.
SO SRCPARAM    WASTPIT4    1.0    0.   83.
SO SRCPARAM    WASTPIT5    1.0    0.  118.
SO SRCPARAM    WASTPIT6    1.0    0.   51.
SO SRCPARAM    WASTPIT7    1.0    0.   40.
SO SRCPARAM    WASTPIT8    1.0    0.   45.
SO SRCPARAM    SWSWPROD    1.0    0.  191.
SO SRCPARAM    SWSEPROD    1.0    0.  191.
SO SRCPARAM    SWNWPROD    1.0    0.  191.
SO SRCPARAM    SWNEPROD    1.0    0.  191.
SO SRCPARAM    SESWPROD    1.0    0.  191.
SO SRCPARAM    SESEPROD    1.0    0.  191.
SO SRCPARAM    SENWPROD    1.0    0.  191.
SO SRCPARAM    SENEPROD    1.0    0.  191.
SO SRCPARAM    NWSWPROD    1.0    0.  191.
SO SRCPARAM    NWSEPROD    1.0    0.  191.
SO SRCPARAM    NWNWPROD    1.0    0.  191.
SO SRCPARAM    NWNEPROD    1.0    0.  191.
SO SRCPARAM    NESWPROD    1.0    0.  191.
SO SRCPARAM    NESEPROD    1.0    0.  191.
SO SRCPARAM    NENWPROD    1.0    0.  191.
SO SRCPARAM    NENEPROD    1.0    0.  191.
SO SRCPARAM    PRODHOT1    1.0    0.  152.
SO SRCPARAM    CTRMPROD    1.0    0.  152.
SO SRCPARAM    PRODHOT2    1.0    0.  152.
SO SRCPARAM    SRGLPROD    1.0    0.  143.
SO SRCPARAM    WWPIPROD    1.0    0.  105.
SO SRCPARAM    STHSILO4    1.0    0.   90.
SO SRCPARAM    NTHSILO4    1.0    0.   90.

** Set emission rates dependent on wind speed.
** Row 1 = A, Row 2 = B, etc. WS-->  1.5    2.5    4.5    7.0    9.5   12.5 m/s
SO EMISFACT WASTPIT1-WASTPIT8 STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
SO EMISFACT WASTPIT1-WASTPIT8 STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
SO EMISFACT WASTPIT1-WASTPIT8 STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
SO EMISFACT WASTPIT1-WASTPIT8 STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
SO EMISFACT WASTPIT1-WASTPIT8 STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
SO EMISFACT WASTPIT1-WASTPIT8 STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
SO EMISFACT CEGEPROD-WWSWPROD STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
SO EMISFACT CEGEPROD-WWSWPROD STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
SO EMISFACT CEGEPROD-WWSWPROD STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
SO EMISFACT CEGEPROD-WWSWPROD STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
SO EMISFACT CEGEPROD-WWSWPROD STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
SO EMISFACT CEGEPROD-WWSWPROD STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
SO EMISFACT PRODHOT1-PRODHOT2 STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
SO EMISFACT PRODHOT1-PRODHOT2 STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
SO EMISFACT PRODHOT1-PRODHOT2 STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
SO EMISFACT PRODHOT1-PRODHOT2 STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
SO EMISFACT PRODHOT1-PRODHOT2 STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
SO EMISFACT PRODHOT1-PRODHOT2 STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
SO EMISFACT NTHSILO4-STHSILO4 STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
SO EMISFACT NTHSILO4-STHSILO4 STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
SO EMISFACT NTHSILO4-STHSILO4 STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
SO EMISFACT NTHSILO4-STHSILO4 STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
```

```
SO EMISFACT NTHSILO4-STHSILO4 STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000
SO EMISFACT NTHSILO4-STHSILO4 STAR 0.0013 0.0077 0.0466 0.1756 0.4390 1.0000

** Set Deposition Velocity = 0.005 m/s (based on Sehmel, 1980)
SO SETVELOC WASTPIT1-WASTPIT8 0.005
SO SETVELOC CEGEPROD-WWSWPROD 0.005
SO SETVELOC PRODHOT1-PRODHOT2 0.005
SO SETVELOC NTHSILO4-STHSILO4 0.005

** Set Mass Fraction = 1, Only analyzing particles <= 0.010 mm
SO MASSFRAX WASTPIT1-WASTPIT8 1.0
SO MASSFRAX CEGEPROD-WWSWPROD 1.0
SO MASSFRAX PRODHOT1-PRODHOT2 1.0
SO MASSFRAX NTHSILO4-STHSILO4 1.0

** Set Reflection Coefficient = 0.85 (from ISC2 User's Guide, Volume II)
SO REFLCOEF WASTPIT1-WASTPIT8 0.85
SO REFLCOEF CEGEPROD-WWSWPROD 0.85
SO REFLCOEF PRODHOT1-PRODHOT2 0.85
SO REFLCOEF NTHSILO4-STHSILO4 0.85

** USE SOURCE GROUPS FOR EACH OU:
SO SRCGROUP OU1CONPM WASTPIT1-WASTPIT8
SO SRCGROUP OU3CONPM CEGEPROD-WWSWPROD
SO SRCGROUP OU3HOTPM PRODHOT1-PRODHOT2
SO SRCGROUP OU4CONPM NTHSILO4-STHSILO4
SO FINISHED

RE STARTING
** 500 ft x 500 ft COARSE GRID (Input as meters)
RE GRIDCART COARSE1 STA
RE GRIDCART COARSE1 XYINC -1219.2 30 152.4 -3048. 30 152.4
RE GRIDCART COARSE1 END

** FEMP Property Line Receptors
**                                    DEGREES
** Boundary              10    20    30    40    50    60    70    80    90
** Distances:          ----- ----- ----- ----- ----- ----- ----- ----- -----
RE BOUNDARY BRDRORIG  1077. 1130. 1230. 1456. 1984. 1741. 1551. 1486. 1469.
**
** Boundary             100   110   120   130   140   150   160   170   180
** Distances:          ----- ----- ----- ----- ----- ----- ----- ----- -----
RE BOUNDARY BRDRORIG  1498. 1572. 1718. 1753. 1562. 1470. 1433. 1322.  960.
**
** Boundary             190   200   210   220   230   240   250   260   270
** Distances:          ----- ----- ----- ----- ----- ----- ----- ----- -----
RE BOUNDARY BRDRORIG   767.  660.  558.  441.  397.  416.  339.  339.  350.
**
** Boundary             280   290   300   310   320   330   340   350   360
** Distances:          ----- ----- ----- ----- ----- ----- ----- ----- -----
RE BOUNDARY BRDRORIG   380.  418.  488.  565.  797. 1195. 1133. 1076. 1060.

** Sensitive Receptors
** Elda Elementary
RE DISCCART  5334.  1676.  1.5
** Ross Middle and High
```

```
RE DISCCART  5944.  2896.  1.5
** Township School
RE DISCCART  -122. -3048.  1.5
** Paddy's Run @ OU1
RE DISCCART  335.  -366.   0.
** Paddy's Run @ OU4
RE DISCCART  518.  -671.   0.
** Paddy's Run @ South Field
RE DISCCART  732.  -1463.  0.
** Paddy's Run @ North Property Line
RE DISCCART  183.  366.    0.
** Paddy's Run @ South Property Line
RE DISCCART  732.  -1951.  0.
RE FINISHED

ME STARTING
ME INPUTFIL C:\ISC2\LT\DATA\FEMP8792.STR FREE
ME ANEMHGHT 10.
ME SURFDATA 93814 87-92 FERNALD
ME UAIRDATA 13840 87-92 DAYTON

** Stability Class:  A    B    C    D    E    F
**                   ---- ---- ---- ---- ---- ----
ME AVETEMPS ANNUAL 290. 290. 290. 284. 280. 280.

** Wind Speed Class:   1     2     3     4     5     6
**                   ----- ----- ----- ----- ----- -----
ME AVEMIXHT ANNUAL A 1854. 1995. 1698. 1524. 1730. 2313.
ME AVEMIXHT ANNUAL B 1236. 1330. 1132. 1016. 1153. 1542.
ME AVEMIXHT ANNUAL C 1236. 1330. 1132. 1016. 1153. 1542.
ME AVEMIXHT ANNUAL D 1236. 1330. 1132. 1016. 1153. 1542.
ME AVEMIXHT ANNUAL E 5000. 5000. 5000. 5000. 5000. 5000.
ME AVEMIXHT ANNUAL F 5000. 5000. 5000. 5000. 5000. 5000.
ME FINISHED

OU STARTING
OU RECTABLE SRCGRP
OU MAXTABLE 10 SRCGRP
OU PLOTFILE ANNUAL OU1CONPM OU1CONPM.PLT
OU PLOTFILE ANNUAL OU3CONPM OU3CONPM.PLT
OU PLOTFILE ANNUAL OU3HOTPM OU3HOTPM.PLT
OU PLOTFILE ANNUAL OU4CONPM OU4CONPM.PLT
OU FINISHED


 *** Message Summary For ISC2 Model Setup ***

 --------- Summary of Total Messages --------

A Total of          0 Fatal Error Message(s)
A Total of          2 Warning Message(s)
A Total of          0 Informational Message(s)


   ******** FATAL ERROR MESSAGES ********
              ***  NONE  ***
```

- 5208

```
*******   WARNING MESSAGES   *******
SO W320   55 APARM : Source Parameter May Be Out-of-Range for Parameter     QS
RE W216  144 RECART: FLAG Input Inconsistent With Option: Defaults Used COARSE1
*****************************************
*** SETUP Finishes Successfully ***
*****************************************
```

0548

- 5208

```
*** ISCLT2 - VERSION 93109 ***     *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data     ***        08/10/93
                                   *** OU1,3,4 PM10          FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93    ***        07:27:34
                                                                                                                         PAGE   1
*** MODELING OPTIONS USED:  CONC   RURAL  FLAT   FLGPOL DFAULT

                                         ***     MODEL SETUP OPTIONS SUMMARY      ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Model Is Setup For Calculation of Average CONCentration Values.

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
          1. Final Plume Rise.
          2. Stack-tip Downwash.
          3. Buoyancy-induced Dispersion.
          4. Default Wind Profile Exponents.
          5. Default Vertical Potential Temperature Gradients.
          6. "Upper Bound" Values For Supersquat Buildings.
          7. No Exponential Decay for RURAL Mode

**Model Assumes Receptors on FLAT Terrain.

**Model Accepts FLAGPOLE Receptor Heights.

**Model Calculates   1 STAR Average(s) for the Following Months:  0  0  0  0  0  0  0  0  0  0  0  0
                                               Seasons/Quarters:  0  0  0  0
                                                    and Annual:  1

**Model Assumes  1 STAR Summaries In Data File for the Averaging Periods Identified Above

**This Run Includes:   32 Source(s);     4 Source Group(s); and    944 Receptor(s)

**The Model Assumes A Pollutant Type of:  OTHER

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
        Model Outputs Tables of Long Term Values by Receptor (RECTABLE Keyword)
        Model Outputs Tables of Maximum Long Term Values (MAXTABLE Keyword)
        Model Outputs External File(s) of Long Term Values for Plotting (PLOTFILE Keyword)

**Misc. Inputs:  Anem. Hgt. (m) =    10.00 ;    Decay Coef. =   0.0000     ;   Rot. Angle =      0.0
                 Emission Units = (G/S)/M2-OR-(PCI/S)/M2                   ;  Emission Rate Unit Factor =    1.0000
                 Output Units   = G/M3-OR-PCI/M3

**Input Runstream File: \isc2\lt\data\134conpm.inp            ;  **Output Print File: \isc2\lt\data\134conpm.out
*** ISCLT2 - VERSION 93109 ***     *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data     ***        08/10/93
                                   *** OU1,3,4 PM10          FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93    ***        07:27:34
                                                                                                                         PAGE   2
*** MODELING OPTIONS USED:  CONC   RURAL  FLAT   FLGPOL DFAULT


                                         *** AREA SOURCE DATA ***
```

| SOURCE ID | NUMBER PART. CATS. | EMISSION RATE (USER UNITS /METER**2) | COORD (SW CORNER) X (METERS) | Y (METERS) | BASE ELEV. (METERS) | RELEASE HEIGHT (METERS) | WIDTH OF AREA (METERS) | EMISSION RATE SCALAR VARY BY |
|---|---|---|---|---|---|---|---|---|
| BRDRORIG | 0 | 0.00000E+00 | 608.0 | -695.0 | 0.0 | 0.00 | 1.00 | |
| WASTPIT1 | 1 | 0.10000E+01 | 492.0 | -472.0 | 0.0 | 0.00 | 76.00 | STAR |
| WASTPIT2 | 1 | 0.10000E+01 | 579.0 | -422.0 | 0.0 | 0.00 | 56.00 | STAR |
| WASTPIT3 | 1 | 0.10000E+01 | 451.0 | -402.0 | 0.0 | 0.00 | 144.00 | STAR |
| WASTPIT4 | 1 | 0.10000E+01 | 634.0 | -357.0 | 0.0 | 0.00 | 83.00 | STAR |
| WASTPIT5 | 1 | 0.10000E+01 | 553.0 | -244.0 | 0.0 | 0.00 | 118.00 | STAR |
| WASTPIT6 | 1 | 0.10000E+01 | 768.0 | -277.0 | 0.0 | 0.00 | 51.00 | STAR |
| WASTPIT7 | 1 | 0.10000E+01 | 626.0 | -326.0 | 0.0 | 0.00 | 40.00 | STAR |
| WASTPIT8 | 1 | 0.10000E+01 | 431.0 | -476.0 | 0.0 | 0.00 | 45.00 | STAR |
| SWSWPROD | 1 | 0.10000E+01 | 901.0 | -1071.0 | 0.0 | 0.00 | 191.00 | STAR |
| SWSEPROD | 1 | 0.10000E+01 | 1091.0 | -1071.0 | 0.0 | 0.00 | 191.00 | STAR |
| SWNWPROD | 1 | 0.10000E+01 | 901.0 | -881.0 | 0.0 | 0.00 | 191.00 | STAR |
| SWNEPROD | 1 | 0.10000E+01 | 1091.0 | -881.0 | 0.0 | 0.00 | 191.00 | STAR |
| SESWPROD | 1 | 0.10000E+01 | 1282.0 | -1071.0 | 0.0 | 0.00 | 191.00 | STAR |
| SESEPROD | 1 | 0.10000E+01 | 1472.0 | -1071.0 | 0.0 | 0.00 | 191.00 | STAR |
| SENWPROD | 1 | 0.10000E+01 | 1282.0 | -881.0 | 0.0 | 0.00 | 191.00 | STAR |
| SENEPROD | 1 | 0.10000E+01 | 1472.0 | -881.0 | 0.0 | 0.00 | 191.00 | STAR |
| NWSWPROD | 1 | 0.10000E+01 | 901.0 | -538.0 | 0.0 | 0.00 | 191.00 | STAR |
| NWSEPROD | 1 | 0.10000E+01 | 1091.0 | -538.0 | 0.0 | 0.00 | 191.00 | STAR |
| NWNWPROD | 1 | 0.10000E+01 | 901.0 | -348.0 | 0.0 | 0.00 | 191.00 | STAR |
| NWNEPROD | 1 | 0.10000E+01 | 1091.0 | -348.0 | 0.0 | 0.00 | 191.00 | STAR |
| NESWPROD | 1 | 0.10000E+01 | 1282.0 | -538.0 | 0.0 | 0.00 | 191.00 | STAR |
| NESEPROD | 1 | 0.10000E+01 | 1472.0 | -538.0 | 0.0 | 0.00 | 191.00 | STAR |
| NENWPROD | 1 | 0.10000E+01 | 1282.0 | -348.0 | 0.0 | 0.00 | 191.00 | STAR |
| NENEPROD | 1 | 0.10000E+01 | 1472.0 | -348.0 | 0.0 | 0.00 | 191.00 | STAR |
| PRODHOT1 | 1 | 0.10000E+01 | 1091.0 | -690.0 | 0.0 | 0.00 | 152.00 | STAR |
| CTRMPROD | 1 | 0.10000E+01 | 1282.0 | -690.0 | 0.0 | 0.00 | 152.00 | STAR |
| PRODHOT2 | 1 | 0.10000E+01 | 1472.0 | -690.0 | 0.0 | 0.00 | 152.00 | STAR |
| SRGLPROD | 1 | 0.10000E+01 | 671.0 | -610.0 | 0.0 | 0.00 | 143.00 | STAR |
| WWPIPROD | 1 | 0.10000E+01 | 1948.0 | -846.0 | 0.0 | 0.00 | 105.00 | STAR |
| STHSILO4 | 1 | 0.10000E+01 | 554.0 | -767.0 | 0.0 | 0.00 | 90.00 | STAR |
| NTHSILO4 | 1 | 0.10000E+01 | 554.0 | -677.0 | 0.0 | 0.00 | 90.00 | STAR |

*** ISCLT2 - VERSION 93109 ***  *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data ***  08/10/93
*** OU1,3,4 PM10  FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 ***  07:27:34
PAGE 3

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** SOURCE IDs DEFINING SOURCE GROUPS ***

| GROUP ID | SOURCE IDs |
|---|---|
| OU1CONPM | WASTPIT1, WASTPIT2, WASTPIT3, WASTPIT4, WASTPIT5, WASTPIT6, WASTPIT7, WASTPIT8, |
| OU3CONPM | SWSWPROD, SWSEPROD, SWNWPROD, SWNEPROD, SESWPROD, SESEPROD, SENWPROD, SENEPROD, NWSWPROD, NWSEPROD, NWNWPROD, NWNEPROD, |

```
          NESWPROD, NESEPROD, NENWPROD, NENEPROD, CTRMPROD, SRGLPROD, WWPIPROD,

OU3HOTPM  PRODHOT1, PRODHOT2,

OU4CONPM  STHSILO4, NTHSILO4,

*** ISCLT2 - VERSION 93109 ***    *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data    ***        08/10/93
                                  *** OU1,3,4 PM10        FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93    ***        07:27:34
                                                                                                                      PAGE   4
*** MODELING OPTIONS USED:  CONC   RURAL  FLAT   FLGPOL DFAULT

                                          *** SOURCE PARTICULATE DATA ***


        *** SOURCE ID = WASTPIT1; SOURCE TYPE =   AREA   ***

        MASS FRACTION =
         1.00000,

        SETTLING VELOCITY(METERS/SEC) =
         0.00500,

        SURFACE REFLECTION COEFFICIENT =
         0.85000,


        *** SOURCE ID = WASTPIT2; SOURCE TYPE =   AREA   ***

        MASS FRACTION =
         1.00000,

        SETTLING VELOCITY(METERS/SEC) =
         0.00500,

        SURFACE REFLECTION COEFFICIENT =
         0.85000,


        *** SOURCE ID = WASTPIT3; SOURCE TYPE =   AREA   ***

        MASS FRACTION =
         1.00000,

        SETTLING VELOCITY(METERS/SEC) =
         0.00500,

        SURFACE REFLECTION COEFFICIENT =
         0.85000,

*** ISCLT2 - VERSION 93109 ***    *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data    ***        08/10/93
                                  *** OU1,3,4 PM10        FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93    ***        07:27:34
                                                                                                                      PAGE   5
```

```
*** MODELING OPTIONS USED:  CONC   RURAL  FLAT   FLGPOL DFAULT

                                        *** SOURCE PARTICULATE DATA ***


      *** SOURCE ID = WASTPIT4; SOURCE TYPE =   AREA   ***

      MASS FRACTION =
       1.00000,

      SETTLING VELOCITY(METERS/SEC) =
       0.00500,

      SURFACE REFLECTION COEFFICIENT =
       0.85000,


      *** SOURCE ID = WASTPIT5; SOURCE TYPE =   AREA   ***

      MASS FRACTION =
       1.00000,

      SETTLING VELOCITY(METERS/SEC) =
       0.00500,

      SURFACE REFLECTION COEFFICIENT =
       0.85000,


      *** SOURCE ID = WASTPIT6; SOURCE TYPE =   AREA   ***

      MASS FRACTION =
       1.00000,

      SETTLING VELOCITY(METERS/SEC) =
       0.00500,

      SURFACE REFLECTION COEFFICIENT =
       0.85000,

*** ISCLT2 - VERSION 93109 ***    *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data    ***      08/10/93
                                  *** OU1,3,4 PM10        FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93    ***      07:27:34
                                                                                                                   PAGE   6
*** MODELING OPTIONS USED:  CONC   RURAL  FLAT   FLGPOL DFAULT

                                        *** SOURCE PARTICULATE DATA ***


      *** SOURCE ID = WASTPIT7; SOURCE TYPE =   AREA   ***

      MASS FRACTION =
       1.00000,
```

5208

```
SETTLING VELOCITY(METERS/SEC) =
 0.00500,

SURFACE REFLECTION COEFFICIENT =
 0.85000,

*** SOURCE ID = WASTPIT8; SOURCE TYPE =   AREA   ***

MASS FRACTION =
 1.00000,

SETTLING VELOCITY(METERS/SEC) =
 0.00500,

SURFACE REFLECTION COEFFICIENT =
 0.85000,

*** SOURCE ID = SWSWPROD; SOURCE TYPE =   AREA   ***

MASS FRACTION =
 1.00000,

SETTLING VELOCITY(METERS/SEC) =
 0.00500,

SURFACE REFLECTION COEFFICIENT =
 0.85000,
```

```
*** ISCLT2 - VERSION 93109 ***    *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data    ***    08/10/93
                                  *** OU1,3,4 PM10        FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93    ***    07:27:34
                                                                                                                 PAGE   7

*** MODELING OPTIONS USED:  CONC   RURAL  FLAT   FLGPOL DFAULT

                                        *** SOURCE PARTICULATE DATA ***
```

```
*** SOURCE ID = SWSEPROD; SOURCE TYPE =   AREA   ***

MASS FRACTION =
 1.00000,

SETTLING VELOCITY(METERS/SEC) =
 0.00500,

SURFACE REFLECTION COEFFICIENT =
 0.85000,

*** SOURCE ID = SWNWPROD; SOURCE TYPE =   AREA   ***

MASS FRACTION =
 1.00000,
```

```
SETTLING VELOCITY(METERS/SEC) =
 0.00500,

SURFACE REFLECTION COEFFICIENT =
 0.85000,

*** SOURCE ID = SWNEPROD; SOURCE TYPE =   AREA   ***

MASS FRACTION =
 1.00000,

SETTLING VELOCITY(METERS/SEC) =
 0.00500,

SURFACE REFLECTION COEFFICIENT =
 0.85000,
```

```
*** ISCLT2 - VERSION 93109 ***    *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data    ***    08/10/93
                                  *** OU1,3,4 PM10        FD Contr No. 04/424331-RMCI J.PEHRSON 8/09/93    ***    07:27:34
*** MODELING OPTIONS USED:  CONC   RURAL  FLAT   FLGPOL DFAULT                                                PAGE   8

                                        *** SOURCE PARTICULATE DATA ***
```

```
*** SOURCE ID = SESWPROD; SOURCE TYPE =   AREA   ***

MASS FRACTION =
 1.00000,

SETTLING VELOCITY(METERS/SEC) =
 0.00500,

SURFACE REFLECTION COEFFICIENT =
 0.85000,

*** SOURCE ID = SESEPROD; SOURCE TYPE =   AREA   ***

MASS FRACTION =
 1.00000,

SETTLING VELOCITY(METERS/SEC) =
 0.00500,

SURFACE REFLECTION COEFFICIENT =
 0.85000,

*** SOURCE ID = SENWPROD; SOURCE TYPE =   AREA   ***

MASS FRACTION =
 1.00000,
```

```
        SETTLING VELOCITY(METERS/SEC) =
         0.00500,

        SURFACE REFLECTION COEFFICIENT =
         0.85000,

*** ISCLT2 - VERSION 93109 ***    *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data    ***      08/10/93
                                  *** OU1,3,4 PM10        FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93    ***      07:27:34
*** MODELING OPTIONS USED:  CONC   RURAL  FLAT   FLGPOL DFAULT                                                      PAGE   9

                                                  *** SOURCE PARTICULATE DATA ***


       *** SOURCE ID = SENEPROD; SOURCE TYPE =   AREA   ***

       MASS FRACTION =
        1.00000,

       SETTLING VELOCITY(METERS/SEC) =
        0.00500,

       SURFACE REFLECTION COEFFICIENT =
        0.85000,


       *** SOURCE ID = NWSWPROD; SOURCE TYPE =   AREA   ***

       MASS FRACTION =
        1.00000,

       SETTLING VELOCITY(METERS/SEC) =
        0.00500,

       SURFACE REFLECTION COEFFICIENT =
        0.85000,


       *** SOURCE ID = NWSEPROD; SOURCE TYPE =   AREA   ***

       MASS FRACTION =
        1.00000,

       SETTLING VELOCITY(METERS/SEC) =
        0.00500,

       SURFACE REFLECTION COEFFICIENT =
        0.85000,

*** ISCLT2 - VERSION 93109 ***    *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data    ***      08/10/93
                                  *** OU1,3,4 PM10        FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93    ***      07:27:34
*** MODELING OPTIONS USED:  CONC   RURAL  FLAT   FLGPOL DFAULT                                                      PAGE  10
```

```
                    *** SOURCE PARTICULATE DATA ***

     *** SOURCE ID = NWNWPROD; SOURCE TYPE =   AREA   ***

     MASS FRACTION =
      1.00000,

     SETTLING VELOCITY(METERS/SEC) =
      0.00500,

     SURFACE REFLECTION COEFFICIENT =
      0.85000,

     *** SOURCE ID = NWNEPROD; SOURCE TYPE =   AREA   ***

     MASS FRACTION =
      1.00000,

     SETTLING VELOCITY(METERS/SEC) =
      0.00500,

     SURFACE REFLECTION COEFFICIENT =
      0.85000,

     *** SOURCE ID = NESWPROD; SOURCE TYPE =   AREA   ***

     MASS FRACTION =
      1.00000,

     SETTLING VELOCITY(METERS/SEC) =
      0.00500,

     SURFACE REFLECTION COEFFICIENT =
      0.85000,
*** ISCLT2 - VERSION 93109 ***    *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data    ***    08/10/93
                                  *** OU1,3,4 PM10       FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93    ***    07:27:34
                                                                                                                PAGE  11
*** MODELING OPTIONS USED:  CONC   RURAL  FLAT   FLGPOL DFAULT

                    *** SOURCE PARTICULATE DATA ***

     *** SOURCE ID = NESEPROD; SOURCE TYPE =   AREA   ***

     MASS FRACTION =
      1.00000,

     SETTLING VELOCITY(METERS/SEC) =
```

```
 0.00500,

SURFACE REFLECTION COEFFICIENT =
 0.85000,


*** SOURCE ID = NENWPROD; SOURCE TYPE =   AREA   ***

MASS FRACTION =
 1.00000,

SETTLING VELOCITY(METERS/SEC) =
 0.00500,

SURFACE REFLECTION COEFFICIENT =
 0.85000,


*** SOURCE ID = NENEPROD; SOURCE TYPE =   AREA   ***

MASS FRACTION =
 1.00000,

SETTLING VELOCITY(METERS/SEC) =
 0.00500,

SURFACE REFLECTION COEFFICIENT =
 0.85000,
```

```
*** ISCLT2 - VERSION 93109 ***    *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data    ***    08/10/93
                                  *** OU1,3,4 PM10        FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93    ***    07:27:34
                                                                                                                  PAGE  12
*** MODELING OPTIONS USED:  CONC   RURAL  FLAT   FLGPOL DFAULT

                                                *** SOURCE PARTICULATE DATA ***


*** SOURCE ID = PRODHOT1; SOURCE TYPE =   AREA   ***

MASS FRACTION =
 1.00000,

SETTLING VELOCITY(METERS/SEC) =
 0.00500,

SURFACE REFLECTION COEFFICIENT =
 0.85000,


*** SOURCE ID = CTRMPROD; SOURCE TYPE =   AREA   ***

MASS FRACTION =
 1.00000,
```

```
SETTLING VELOCITY(METERS/SEC) =
 0.00500,

SURFACE REFLECTION COEFFICIENT =
 0.85000,

*** SOURCE ID = PRODHOT2; SOURCE TYPE =   AREA   ***

MASS FRACTION =
 1.00000,

SETTLING VELOCITY(METERS/SEC) =
 0.00500,

SURFACE REFLECTION COEFFICIENT =
 0.85000,
```

```
*** ISCLT2 - VERSION 93109 ***    *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data    ***    08/10/93
                                  *** OU1,3,4 PM10        FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93    ***    07:27:34
                                                                                                                 PAGE  13

*** MODELING OPTIONS USED:  CONC   RURAL  FLAT   FLGPOL DFAULT

                                        *** SOURCE PARTICULATE DATA ***
```

```
*** SOURCE ID = SRGLPROD; SOURCE TYPE =   AREA   ***

MASS FRACTION =
 1.00000,

SETTLING VELOCITY(METERS/SEC) =
 0.00500,

SURFACE REFLECTION COEFFICIENT =
 0.85000,

*** SOURCE ID = WWPIPROD; SOURCE TYPE =   AREA   ***

MASS FRACTION =
 1.00000,

SETTLING VELOCITY(METERS/SEC) =
 0.00500,

SURFACE REFLECTION COEFFICIENT =
 0.85000,

*** SOURCE ID = STHSILO4; SOURCE TYPE =   AREA   ***

MASS FRACTION =
 1.00000,
```

SETTLING VELOCITY(METERS/SEC) =
0.00500,

SURFACE REFLECTION COEFFICIENT =
0.85000,

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 14

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** SOURCE PARTICULATE DATA ***

*** SOURCE ID = NTHSILO4; SOURCE TYPE = AREA ***

MASS FRACTION =
1.00000,

SETTLING VELOCITY(METERS/SEC) =
0.00500,

SURFACE REFLECTION COEFFICIENT =
0.85000,

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 15

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

* SOURCE EMISSION RATE SCALARS WHICH VARY WITH STABILITY AND WIND SPEED (STAR) *

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

SOURCE ID = WASTPIT1 ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

SOURCE ID = WASTPIT2 ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

| | | | | | | |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

SOURCE ID = WASTPIT3 ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |



*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

* SOURCE EMISSION RATE SCALARS WHICH VARY WITH STABILITY AND WIND SPEED (STAR) *

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

SOURCE ID = WASTPIT4 ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

SOURCE ID = WASTPIT5 ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

SOURCE ID = WASTPIT6 ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

| | | | | | | |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

```
*** ISCLT2 - VERSION 93109 ***    *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data    ***    08/10/93
                                  *** OU1,3,4 PM10        FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93    ***    07:27:34
                                                                                                                  PAGE  17

*** MODELING OPTIONS USED:  CONC   RURAL  FLAT   FLGPOL DFAULT

                    * SOURCE EMISSION RATE SCALARS WHICH VARY WITH STABILITY AND WIND SPEED (STAR) *

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

SOURCE ID = WASTPIT7 ;  SOURCE TYPE =   AREA   :
```

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

```
SOURCE ID = WASTPIT8 ;  SOURCE TYPE =   AREA   :
```

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

```
SOURCE ID = SWSWPROD ;  SOURCE TYPE =   AREA   :
```

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

```
*** ISCLT2 - VERSION 93109 ***    *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data    ***    08/10/93
                                  *** OU1,3,4 PM10        FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93    ***    07:27:34
                                                                                                                  PAGE  18

*** MODELING OPTIONS USED:  CONC   RURAL  FLAT   FLGPOL DFAULT

                    * SOURCE EMISSION RATE SCALARS WHICH VARY WITH STABILITY AND WIND SPEED (STAR) *

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

- 5208

SOURCE ID = SWSEPROD ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

SOURCE ID = SWNWPROD ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

SOURCE ID = SWNEPROD ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 19

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

* SOURCE EMISSION RATE SCALARS WHICH VARY WITH STABILITY AND WIND SPEED (STAR) *

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

SOURCE ID = SESWPROD ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

SOURCE ID = SESEPROD ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

SOURCE ID = SENWPROD ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 20

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

* SOURCE EMISSION RATE SCALARS WHICH VARY WITH STABILITY AND WIND SPEED (STAR) *

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

SOURCE ID = SENEPROD ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

SOURCE ID = NWSWPROD ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

SOURCE ID = NWSEPROD ; SOURCE TYPE = AREA :

- 5208

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

*** ISCLT2 - VERSION 93109 ***     *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data ***     08/10/93
*** OU1,3,4 PM10     FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 ***     07:27:34
PAGE 21

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

* SOURCE EMISSION RATE SCALARS WHICH VARY WITH STABILITY AND WIND SPEED (STAR) *

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

SOURCE ID = NWNWPROD ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

SOURCE ID = NWNEPROD ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

SOURCE ID = NESWPROD ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

0564

*** ISCLT2 - VERSION 93109 ***     *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data ***     08/10/93
*** OU1,3,4 PM10     FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 ***     07:27:34
PAGE 22

- 5208

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

* SOURCE EMISSION RATE SCALARS WHICH VARY WITH STABILITY AND WIND SPEED (STAR) *

SOURCE ID = NESEPROD ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

SOURCE ID = NEWWPROD ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

SOURCE ID = NENEPROD ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 23

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

* SOURCE EMISSION RATE SCALARS WHICH VARY WITH STABILITY AND WIND SPEED (STAR) *

SOURCE ID = PRODHOT1 ; SOURCE TYPE = AREA :

| WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

SOURCE ID = CTRMPROD ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

SOURCE ID = PRODHOT2 ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |



*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

* SOURCE EMISSION RATE SCALARS WHICH VARY WITH STABILITY AND WIND SPEED (STAR) *

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

SOURCE ID = SRGLPROD ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

SOURCE ID = WWPIPROD ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

- 5208

| | | | | | | |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

SOURCE ID = STHSILO4 ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

*** ISCLT2 - VERSION 93109 ***    *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data ***    08/10/93
*** OU1,3,4 PM10    FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 ***    07:27:34
PAGE 25

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

* SOURCE EMISSION RATE SCALARS WHICH VARY WITH STABILITY AND WIND SPEED (STAR) *

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

SOURCE ID = NTHSILO4 ; SOURCE TYPE = AREA :

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY B | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY C | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY D | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY E | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |
| STABILITY CATEGORY F | 0.13000E-02 | 0.77000E-02 | 0.46600E-01 | 0.17560E+00 | 0.43900E+00 | 0.10000E+01 |

*** ISCLT2 - VERSION 93109 ***    *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data ***    08/10/93
*** OU1,3,4 PM10    FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 ***    07:27:34
PAGE 26

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** GRIDDED RECEPTOR NETWORK SUMMARY ***

*** NETWORK ID: COARSE1 ; NETWORK TYPE: GRIDCART ***

*** X-COORDINATES OF GRID ***
(METERS)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| -1219.2, | -1066.8, | -914.4, | -762.0, | -609.6, | -457.2, | -304.8, | -152.4, | 0.0, | 152.4, |
| 304.8, | 457.2, | 609.6, | 762.0, | 914.4, | 1066.8, | 1219.2, | 1371.6, | 1524.0, | 1676.4, |
| 1828.8, | 1981.2, | 2133.6, | 2286.0, | 2438.4, | 2590.8, | 2743.2, | 2895.6, | 3048.0, | 3200.4, |

*** Y-COORDINATES OF GRID ***
(METERS)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| -3048.0, | -2895.6, | -2743.2, | -2590.8, | -2438.4, | -2286.0, | -2133.6, | -1981.2, | -1828.8, | -1676.4, |
| -1524.0, | -1371.6, | -1219.2, | -1066.8, | -914.4, | -762.0, | -609.6, | -457.2, | -304.8, | -152.4, |
| 0.0, | 152.4, | 304.8, | 457.2, | 609.6, | 762.0, | 914.4, | 1066.8, | 1219.2, | 1371.6, |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 27

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** NETWORK ID: COARSE1 ; NETWORK TYPE: GRIDCART ***

* RECEPTOR FLAGPOLE HEIGHTS IN METERS *

| Y-COORD (METERS) | X-COORD (METERS) -1219.20 | -1066.80 | -914.40 | -762.00 | -609.60 | -457.20 | -304.80 | -152.40 | 0.00 |
|---|---|---|---|---|---|---|---|---|---|
| 1371.60 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 1219.20 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 1066.80 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 914.40 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 762.00 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 609.60 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 457.20 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 304.80 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 152.40 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 0.00 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -152.40 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -304.80 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -457.20 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -609.60 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -762.00 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -914.40 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -1066.80 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -1219.20 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -1371.60 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -1524.00 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -1676.40 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -1828.80 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -1981.20 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -2133.60 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -2286.00 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -2438.40 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -2590.80 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -2743.20 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -2895.60 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -3048.00 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 28





5208

0568

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** NETWORK ID: COARSE1 ; NETWORK TYPE: GRIDCART ***

* RECEPTOR FLAGPOLE HEIGHTS IN METERS *

| Y-COORD (METERS) | X-COORD (METERS) 152.40 | 304.80 | 457.20 | 609.60 | 762.00 | 914.40 | 1066.80 | 1219.20 | 1371.60 |
|---|---|---|---|---|---|---|---|---|---|
| 1371.60 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 1219.20 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 1066.80 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 914.40 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 762.00 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 609.60 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 457.20 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 304.80 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 152.40 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 0.00 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -152.40 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -304.80 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -457.20 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -609.60 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -762.00 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -914.40 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -1066.80 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -1219.20 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -1371.60 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -1524.00 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -1676.40 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -1828.80 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -1981.20 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -2133.60 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -2286.00 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -2438.40 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -2590.80 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -2743.20 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -2895.60 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -3048.00 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 29

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** NETWORK ID: COARSE1 ; NETWORK TYPE: GRIDCART ***

* RECEPTOR FLAGPOLE HEIGHTS IN METERS *

| Y-COORD (METERS) | X-COORD (METERS) 1524.00 | 1676.40 | 1828.80 | 1981.20 | 2133.60 | 2286.00 | 2438.40 | 2590.80 | 2743.20 |
|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1371.60 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 1219.20 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 1066.80 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 914.40 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 762.00 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 609.60 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 457.20 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 304.80 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 152.40 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| 0.00 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -152.40 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -304.80 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -457.20 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -609.60 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -762.00 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -914.40 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -1066.80 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -1219.20 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -1371.60 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -1524.00 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -1676.40 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -1828.80 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -1981.20 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -2133.60 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -2286.00 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -2438.40 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -2590.80 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -2743.20 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -2895.60 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| -3048.00 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 30

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** NETWORK ID: COARSE1 ; NETWORK TYPE: GRIDCART ***

* RECEPTOR FLAGPOLE HEIGHTS IN METERS *

| Y-COORD (METERS) | X-COORD (METERS) 2895.60 | 3048.00 | 3200.40 |
|---|---|---|---|
| 1371.60 | 1.50 | 1.50 | 1.50 |
| 1219.20 | 1.50 | 1.50 | 1.50 |
| 1066.80 | 1.50 | 1.50 | 1.50 |
| 914.40 | 1.50 | 1.50 | 1.50 |
| 762.00 | 1.50 | 1.50 | 1.50 |
| 609.60 | 1.50 | 1.50 | 1.50 |
| 457.20 | 1.50 | 1.50 | 1.50 |
| 304.80 | 1.50 | 1.50 | 1.50 |
| 152.40 | 1.50 | 1.50 | 1.50 |
| 0.00 | 1.50 | 1.50 | 1.50 |
| -152.40 | 1.50 | 1.50 | 1.50 |

| | | | |
|---|---|---|---|
| -304.80 | 1.50 | 1.50 | 1.50 |
| -457.20 | 1.50 | 1.50 | 1.50 |
| -609.60 | 1.50 | 1.50 | 1.50 |
| -762.00 | 1.50 | 1.50 | 1.50 |
| -914.40 | 1.50 | 1.50 | 1.50 |
| -1066.80 | 1.50 | 1.50 | 1.50 |
| -1219.20 | 1.50 | 1.50 | 1.50 |
| -1371.60 | 1.50 | 1.50 | 1.50 |
| -1524.00 | 1.50 | 1.50 | 1.50 |
| -1676.40 | 1.50 | 1.50 | 1.50 |
| -1828.80 | 1.50 | 1.50 | 1.50 |
| -1981.20 | 1.50 | 1.50 | 1.50 |
| -2133.60 | 1.50 | 1.50 | 1.50 |
| -2286.00 | 1.50 | 1.50 | 1.50 |
| -2438.40 | 1.50 | 1.50 | 1.50 |
| -2590.80 | 1.50 | 1.50 | 1.50 |
| -2743.20 | 1.50 | 1.50 | 1.50 |
| -2895.60 | 1.50 | 1.50 | 1.50 |
| -3048.00 | 1.50 | 1.50 | 1.50 |

```
*** ISCLT2 - VERSION 93109 ***    *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data    ***    08/10/93
                                  *** OU1,3,4 PM10        FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93    ***    07:27:34
                                                                                                                 PAGE  31

*** MODELING OPTIONS USED:  CONC   RURAL  FLAT   FLGPOL DFAULT

                                        *** DISCRETE CARTESIAN RECEPTORS ***
                                         (X-COORD, Y-COORD, ZELEV, ZFLAG)
                                                  (METERS)

  (  5334.0,    1676.0,      0.0,      1.5);        (  5944.0,    2896.0,      0.0,      1.5);
  (  -122.0,   -3048.0,      0.0,      1.5);        (   335.0,    -366.0,      0.0,      0.0);
  (   518.0,    -671.0,      0.0,      0.0);        (   732.0,   -1463.0,      0.0,      0.0);
  (   183.0,     366.0,      0.0,      0.0);        (   732.0,   -1951.0,      0.0,      0.0);

*** ISCLT2 - VERSION 93109 ***    *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data    ***    08/10/93
                                  *** OU1,3,4 PM10        FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93    ***    07:27:34
                                                                                                                 PAGE  32

*** MODELING OPTIONS USED:  CONC   RURAL  FLAT   FLGPOL DFAULT

                                        *** BOUNDARY RECEPTOR LOCATIONS ***
                                   (DISCRETE RECEPTORS AT 10 DEGREE SECTORS)

BOUNDARY RECEPTORS FOR SOURCE ID: BRDRORIG
    OF SOURCE TYPE:   AREA  ; WITH ORIGIN AT (    608.00,    -695.00,       0.00)
SEC.   XCOORD      YCOORD    ZELEV  ZFLAG   SEC.   XCOORD      YCOORD    ZELEV  ZFLAG   SEC.   XCOORD      YCOORD    ZELEV  ZFLAG
  1    795.02,    365.64,   0.00,   1.5     2    994.48,    366.85,   0.00,   1.5     3   1223.00,    370.21,   0.00,   1.5
  4   1543.90,    420.36,   0.00,   1.5     5   2127.83,    580.29,   0.00,   1.5     6   2115.75,    175.50,   0.00,   1.5
  7   2065.46,   -164.53,   0.00,   1.5     8   2071.42,   -436.96,   0.00,   1.5     9   2077.00,   -695.00,   0.00,   1.5
 10   2083.24,   -955.13,   0.00,   1.5    11   2085.20,  -1232.66,   0.00,   1.5    12   2095.83,  -1554.00,   0.00,   1.5
 13   1950.88,  -1821.81,   0.00,   1.5    14   1612.03,  -1891.56,   0.00,   1.5    15   1343.00,  -1968.06,   0.00,   1.5
 16   1098.11,  -2041.58,   0.00,   1.5    17    837.56,  -1996.92,   0.00,   1.5    18    608.00,  -1655.00,   0.00,   1.5
 19    474.81,  -1450.35,   0.00,   1.5    20    382.27,  -1315.20,   0.00,   1.5    21    329.00,  -1178.24,   0.00,   1.5
 22    324.53,  -1032.83,   0.00,   1.5    23    303.88,   -950.19,   0.00,   1.5    24    247.73,   -903.00,   0.00,   1.5
```

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | 289.44, | -810.94, | 0.00, | 1.5 | 26 | 274.15, | -753.87, | 0.00, | 1.5 | 27 | 258.00, | -695.00, | 0.00, | 1.5 |
| 28 | 233.77, | -629.01, | 0.00, | 1.5 | 29 | 215.21, | -552.04, | 0.00, | 1.5 | 30 | 185.38, | -451.00, | 0.00, | 1.5 |
| 31 | 175.18, | -331.83, | 0.00, | 1.5 | 32 | 95.70, | -84.46, | 0.00, | 1.5 | 33 | 10.50, | 339.90, | 0.00, | 1.5 |
| 34 | 220.49, | 369.67, | 0.00, | 1.5 | 35 | 421.15, | 364.65, | 0.00, | 1.5 | 36 | 608.00, | 365.00, | 0.00, | 1.5 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 33

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

* SOURCE-RECEPTOR COMBINATIONS LESS THAN 1.0 METER OR 3*ZLB *
IN DISTANCE. CALCULATIONS MAY NOT BE PERFORMED.

| SOURCE ID | - - RECEPTOR LOCATION - - XR (METERS) | YR (METERS) | DISTANCE (METERS) |
|---|---|---|---|
| WASTPIT3 | 457.2 | -304.8 | -10.78 |
| WASTPIT5 | 609.6 | -152.4 | -33.89 |
| WASTPIT8 | 457.2 | -457.2 | -20.16 |
| SWSWPROD | 914.4 | -914.4 | -5.42 |
| SWSWPROD | 1066.8 | -914.4 | -14.62 |
| SWSEPROD | 1219.2 | -1066.8 | -10.78 |
| SWSEPROD | 1219.2 | -914.4 | -38.46 |
| SWNWPROD | 914.4 | -762.0 | -22.36 |
| SWNWPROD | 1066.8 | -762.0 | -33.64 |
| SWNEPROD | 1219.2 | -762.0 | -67.49 |
| SESWPROD | 1371.6 | -1066.8 | -16.27 |
| SESWPROD | 1371.6 | -914.4 | -46.38 |
| SESEPROD | 1524.0 | -1066.8 | -6.63 |
| SESEPROD | 1524.0 | -914.4 | -32.76 |
| SENWPROD | 1371.6 | -762.0 | -83.53 |
| SENEPROD | 1524.0 | -762.0 | -58.32 |
| NWSWPROD | 914.4 | -457.2 | -24.35 |
| NWSWPROD | 1066.8 | -457.2 | -35.94 |
| NWSEPROD | 1219.2 | -457.2 | -71.91 |
| NWNWPROD | 914.4 | -304.8 | -10.42 |
| NWNWPROD | 1066.8 | -304.8 | -20.14 |
| NWNEPROD | 1219.2 | -304.8 | -46.08 |
| NWNEPROD | 1219.2 | -152.4 | -2.45 |
| NESWPROD | 1371.6 | -457.2 | -91.92 |
| NESEPROD | 1524.0 | -457.2 | -61.84 |
| NENWPROD | 1371.6 | -304.8 | -55.13 |
| NENWPROD | 1371.6 | -152.4 | -7.49 |
| NENEPROD | 1524.0 | -304.8 | -39.73 |
| PRODHOT1 | 1219.2 | -609.6 | -33.37 |
| CTRMPROD | 1371.6 | -609.6 | -71.46 |
| PRODHOT2 | 1524.0 | -609.6 | -61.36 |
| SRGLPROD | 762.0 | -609.6 | -6.95 |
| WWPIPROD | 1981.2 | -762.0 | -22.30 |
| STHSIL04 | 609.6 | -762.0 | -9.40 |
| NTHSIL04 | 609.6 | -609.6 | -26.00 |

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** AVERAGE SPEED FOR EACH WIND SPEED CATEGORY ***
(METERS/SEC)

1.50, 2.50, 4.30, 6.80, 9.50, 12.50,

*** WIND PROFILE EXPONENTS ***

| STABILITY CATEGORY | WIND SPEED CATEGORY 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| A | .70000E-01 | .70000E-01 | .70000E-01 | .70000E-01 | .70000E-01 | .70000E-01 |
| B | .70000E-01 | .70000E-01 | .70000E-01 | .70000E-01 | .70000E-01 | .70000E-01 |
| C | .10000E+00 | .10000E+00 | .10000E+00 | .10000E+00 | .10000E+00 | .10000E+00 |
| D | .15000E+00 | .15000E+00 | .15000E+00 | .15000E+00 | .15000E+00 | .15000E+00 |
| E | .35000E+00 | .35000E+00 | .35000E+00 | .35000E+00 | .35000E+00 | .35000E+00 |
| F | .55000E+00 | .55000E+00 | .55000E+00 | .55000E+00 | .55000E+00 | .55000E+00 |

*** VERTICAL POTENTIAL TEMPERATURE GRADIENTS ***
(DEGREES KELVIN PER METER)

| STABILITY CATEGORY | WIND SPEED CATEGORY 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| A | .00000E+00 | .00000E+00 | .00000E+00 | .00000E+00 | .00000E+00 | .00000E+00 |
| B | .00000E+00 | .00000E+00 | .00000E+00 | .00000E+00 | .00000E+00 | .00000E+00 |
| C | .00000E+00 | .00000E+00 | .00000E+00 | .00000E+00 | .00000E+00 | .00000E+00 |
| D | .00000E+00 | .00000E+00 | .00000E+00 | .00000E+00 | .00000E+00 | .00000E+00 |
| E | .20000E-01 | .20000E-01 | .20000E-01 | .20000E-01 | .20000E-01 | .20000E-01 |
| F | .35000E-01 | .35000E-01 | .35000E-01 | .35000E-01 | .35000E-01 | .35000E-01 |

*** AVERAGE AMBIENT AIR TEMPERATURE (KELVIN) ***

| | STABILITY CATEGORY A | STABILITY CATEGORY B | STABILITY CATEGORY C | STABILITY CATEGORY D | STABILITY CATEGORY E | STABILITY CATEGORY F |
|---|---|---|---|---|---|---|
| ANNUAL | 290.0000 | 290.0000 | 290.0000 | 284.0000 | 280.0000 | 280.0000 |



*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** AVERAGE MIXING LAYER HEIGHT (METERS) ***

ANNUAL

| | WIND SPEED CATEGORY 1 | WIND SPEED CATEGORY 2 | WIND SPEED CATEGORY 3 | WIND SPEED CATEGORY 4 | WIND SPEED CATEGORY 5 | WIND SPEED CATEGORY 6 |
|---|---|---|---|---|---|---|
| STABILITY CATEGORY A | 1854.0000 | 1995.0000 | 1698.0000 | 1524.0000 | 1730.0000 | 2313.0000 |
| STABILITY CATEGORY B | 1236.0000 | 1330.0000 | 1132.0000 | 1016.0000 | 1153.0000 | 1542.0000 |
| STABILITY CATEGORY C | 1236.0000 | 1330.0000 | 1132.0000 | 1016.0000 | 1153.0000 | 1542.0000 |
| STABILITY CATEGORY D | 1236.0000 | 1330.0000 | 1132.0000 | 1016.0000 | 1153.0000 | 1542.0000 |
| STABILITY CATEGORY E | 5000.0000 | 5000.0000 | 5000.0000 | 5000.0000 | 5000.0000 | 5000.0000 |
| STABILITY CATEGORY F | 5000.0000 | 5000.0000 | 5000.0000 | 5000.0000 | 5000.0000 | 5000.0000 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 36

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY ***

FILE: C:\ISC2\LT\DATA\FEMP8792.STR FORMAT: FREE
SURFACE STATION NO.: 93814 UPPER AIR STATION NO.: 13840
NAME: FERNALD NAME: DAYTON
YEAR: -8792 YEAR: -8792

ANNUAL: STABILITY CATEGORY A

| DIRECTION (DEGREES) | WIND SPEED CATEGORY 1 ( 1.500 M/S) | WIND SPEED CATEGORY 2 ( 2.500 M/S) | WIND SPEED CATEGORY 3 ( 4.300 M/S) | WIND SPEED CATEGORY 4 ( 6.800 M/S) | WIND SPEED CATEGORY 5 ( 9.500 M/S) | WIND SPEED CATEGORY 6 (12.500 M/S) |
|---|---|---|---|---|---|---|
| 0.000 | 0.00025400 | 0.00092000 | 0.00065900 | 0.00015800 | 0.00000000 | 0.00000000 |
| 22.500 | 0.00049700 | 0.00124000 | 0.00077200 | 0.00021700 | 0.00000000 | 0.00000000 |
| 45.000 | 0.00105200 | 0.00240400 | 0.00076800 | 0.00015200 | 0.00000000 | 0.00000000 |
| 67.500 | 0.00186500 | 0.00316900 | 0.00140600 | 0.00004100 | 0.00000000 | 0.00000000 |
| 90.000 | 0.00114500 | 0.00130900 | 0.00021600 | 0.00006300 | 0.00000000 | 0.00002200 |
| 112.500 | 0.00086300 | 0.00041900 | 0.00004600 | 0.00000000 | 0.00000000 | 0.00000000 |
| 135.000 | 0.00042000 | 0.00026200 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00002200 |
| 157.500 | 0.00057800 | 0.00029400 | 0.00004300 | 0.00002200 | 0.00000000 | 0.00000000 |
| 180.000 | 0.00082700 | 0.00103900 | 0.00075400 | 0.00000000 | 0.00000000 | 0.00000000 |
| 202.500 | 0.00131400 | 0.00351900 | 0.00288300 | 0.00008700 | 0.00000000 | 0.00000000 |
| 225.000 | 0.00179400 | 0.00418500 | 0.00331300 | 0.00021400 | 0.00000000 | 0.00000000 |
| 247.500 | 0.00186900 | 0.00382400 | 0.00255800 | 0.00004600 | 0.00000000 | 0.00000000 |
| 270.000 | 0.00113500 | 0.00326400 | 0.00286100 | 0.00027300 | 0.00000000 | 0.00000000 |
| 292.500 | 0.00084300 | 0.00150900 | 0.00177200 | 0.00037800 | 0.00000000 | 0.00000000 |
| 315.000 | 0.00074600 | 0.00123900 | 0.00109900 | 0.00011200 | 0.00000000 | 0.00000000 |
| 337.500 | 0.00051900 | 0.00117100 | 0.00087500 | 0.00011500 | 0.00002300 | 0.00000000 |

ANNUAL: STABILITY CATEGORY B

| DIRECTION (DEGREES) | WIND SPEED CATEGORY 1 ( 1.500 M/S) | WIND SPEED CATEGORY 2 ( 2.500 M/S) | WIND SPEED CATEGORY 3 ( 4.300 M/S) | WIND SPEED CATEGORY 4 ( 6.800 M/S) | WIND SPEED CATEGORY 5 ( 9.500 M/S) | WIND SPEED CATEGORY 6 (12.500 M/S) |
|---|---|---|---|---|---|---|
| 0.000 | 0.00010400 | 0.00075800 | 0.00053000 | 0.00008500 | 0.00000000 | 0.00000000 |
| 22.500 | 0.00012300 | 0.00040800 | 0.00048700 | 0.00010700 | 0.00000000 | 0.00000000 |
| 45.000 | 0.00039200 | 0.00083500 | 0.00060200 | 0.00002300 | 0.00000000 | 0.00000000 |
| 67.500 | 0.00037000 | 0.00120300 | 0.00041300 | 0.00011500 | 0.00000000 | 0.00000000 |
| 90.000 | 0.00062300 | 0.00049500 | 0.00016100 | 0.00002300 | 0.00000000 | 0.00000000 |
| 112.500 | 0.00024500 | 0.00031400 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 135.000 | 0.00027500 | 0.00010400 | 0.00002000 | 0.00000000 | 0.00000000 | 0.00000000 |
| 157.500 | 0.00036800 | 0.00018500 | 0.00006400 | 0.00002300 | 0.00000000 | 0.00000000 |
| 180.000 | 0.00047600 | 0.00074300 | 0.00021100 | 0.00000000 | 0.00000000 | 0.00000000 |
| 202.500 | 0.00065900 | 0.00152600 | 0.00123000 | 0.00008900 | 0.00000000 | 0.00000000 |
| 225.000 | 0.00087200 | 0.00183900 | 0.00168900 | 0.00008400 | 0.00000000 | 0.00000000 |
| 247.500 | 0.00074100 | 0.00154600 | 0.00114400 | 0.00006300 | 0.00000000 | 0.00000000 |
| 270.000 | 0.00072700 | 0.00107600 | 0.00115900 | 0.00015700 | 0.00000000 | 0.00000000 |
| 292.500 | 0.00039400 | 0.00078500 | 0.00072200 | 0.00015600 | 0.00000000 | 0.00000000 |
| 315.000 | 0.00037600 | 0.00095300 | 0.00093600 | 0.00011400 | 0.00000000 | 0.00000000 |
| 337.500 | 0.00035600 | 0.00067100 | 0.00079300 | 0.00004500 | 0.00000000 | 0.00000000 |

*** ISCLT2 - VERSION 93109 ***  *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data ***  08/10/93
*** OU1,3,4 PM10  FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 ***  07:27:34
PAGE 37

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY ***

FILE: C:\ISC2\LT\DATA\FEMP8792.STR  FORMAT: FREE
SURFACE STATION NO.: 93814  UPPER AIR STATION NO.: 13840
NAME: FERNALD  NAME: DAYTON
YEAR: -8792  YEAR: -8792

ANNUAL: STABILITY CATEGORY C

| DIRECTION (DEGREES) | WIND SPEED CATEGORY 1 ( 1.500 M/S) | WIND SPEED CATEGORY 2 ( 2.500 M/S) | WIND SPEED CATEGORY 3 ( 4.300 M/S) | WIND SPEED CATEGORY 4 ( 6.800 M/S) | WIND SPEED CATEGORY 5 ( 9.500 M/S) | WIND SPEED CATEGORY 6 (12.500 M/S) |
|---|---|---|---|---|---|---|
| 0.000 | 0.00033800 | 0.00085400 | 0.00079900 | 0.00016700 | 0.00000000 | 0.00000000 |
| 22.500 | 0.00035200 | 0.00094300 | 0.00067300 | 0.00011300 | 0.00000000 | 0.00000000 |
| 45.000 | 0.00042900 | 0.00144000 | 0.00075300 | 0.00011200 | 0.00000000 | 0.00000000 |
| 67.500 | 0.00091100 | 0.00163500 | 0.00034900 | 0.00020700 | 0.00000000 | 0.00000000 |
| 90.000 | 0.00095200 | 0.00073200 | 0.00013000 | 0.00004400 | 0.00000000 | 0.00000000 |
| 112.500 | 0.00066400 | 0.00042500 | 0.00002200 | 0.00000000 | 0.00000000 | 0.00000000 |
| 135.000 | 0.00049500 | 0.00031100 | 0.00004000 | 0.00000000 | 0.00000000 | 0.00000000 |
| 157.500 | 0.00028200 | 0.00044600 | 0.00012700 | 0.00002100 | 0.00000000 | 0.00000000 |
| 180.000 | 0.00043800 | 0.00107300 | 0.00044300 | 0.00002000 | 0.00000000 | 0.00000000 |
| 202.500 | 0.00065200 | 0.00192100 | 0.00128900 | 0.00009100 | 0.00002200 | 0.00000000 |
| 225.000 | 0.00121400 | 0.00272300 | 0.00168600 | 0.00017900 | 0.00000000 | 0.00000000 |
| 247.500 | 0.00112100 | 0.00241000 | 0.00107200 | 0.00015800 | 0.00000000 | 0.00000000 |
| 270.000 | 0.00081300 | 0.00123700 | 0.00113700 | 0.00029700 | 0.00000000 | 0.00000000 |
| 292.500 | 0.00056200 | 0.00137300 | 0.00096400 | 0.00019800 | 0.00000000 | 0.00000000 |
| 315.000 | 0.00053200 | 0.00130200 | 0.00119800 | 0.00010700 | 0.00002300 | 0.00000000 |
| 337.500 | 0.00042800 | 0.00102900 | 0.00093200 | 0.00002500 | 0.00000000 | 0.00000000 |

ANNUAL: STABILITY CATEGORY D

| DIRECTION (DEGREES) | WIND SPEED CATEGORY 1 ( 1.500 M/S) | WIND SPEED CATEGORY 2 ( 2.500 M/S) | WIND SPEED CATEGORY 3 ( 4.300 M/S) | WIND SPEED CATEGORY 4 ( 6.800 M/S) | WIND SPEED CATEGORY 5 ( 9.500 M/S) | WIND SPEED CATEGORY 6 (12.500 M/S) |
|---|---|---|---|---|---|---|
| 0.000 | 0.00267900 | 0.00951500 | 0.00730800 | 0.00061400 | 0.00000000 | 0.00000000 |
| 22.500 | 0.00412600 | 0.01013000 | 0.00639000 | 0.00094100 | 0.00000000 | 0.00000000 |
| 45.000 | 0.00630500 | 0.01193100 | 0.00542500 | 0.00040700 | 0.00000000 | 0.00000000 |
| 67.500 | 0.00883300 | 0.01605400 | 0.00785900 | 0.00114100 | 0.00000000 | 0.00000000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 90.000 | 0.00584400 | 0.00494200 | 0.00080700 | 0.00004500 | 0.00000000 | 0.00000000 |
| 112.500 | 0.00445500 | 0.00189600 | 0.00002200 | 0.00002200 | 0.00000000 | 0.00000000 |
| 135.000 | 0.00334800 | 0.00219200 | 0.00022700 | 0.00000000 | 0.00000000 | 0.00000000 |
| 157.500 | 0.00382500 | 0.00338300 | 0.00102800 | 0.00013200 | 0.00000000 | 0.00000000 |
| 180.000 | 0.00453300 | 0.00613900 | 0.00320900 | 0.00040100 | 0.00000000 | 0.00000000 |
| 202.500 | 0.00785200 | 0.01345400 | 0.00758800 | 0.00144400 | 0.00000000 | 0.00000000 |
| 225.000 | 0.00995400 | 0.01468000 | 0.00667600 | 0.00096500 | 0.00013500 | 0.00000000 |
| 247.500 | 0.01041200 | 0.01012500 | 0.00508300 | 0.00154700 | 0.00007100 | 0.00000000 |
| 270.000 | 0.00866300 | 0.01103500 | 0.00948900 | 0.00166000 | 0.00000000 | 0.00000000 |
| 292.500 | 0.00573000 | 0.01099500 | 0.00865800 | 0.00119000 | 0.00000000 | 0.00000000 |
| 315.000 | 0.00518700 | 0.00846800 | 0.00672200 | 0.00064000 | 0.00006900 | 0.00000000 |
| 337.500 | 0.00426600 | 0.00919600 | 0.00504100 | 0.00073900 | 0.00004600 | 0.00000000 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 38

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY ***

FILE: C:\ISC2\LT\DATA\FEMP8792.STR FORMAT: FREE
SURFACE STATION NO.: 93814 UPPER AIR STATION NO.: 13840
NAME: FERNALD NAME: DAYTON
YEAR: -8792 YEAR: -8792

ANNUAL: STABILITY CATEGORY E

| DIRECTION (DEGREES) | WIND SPEED CATEGORY 1 ( 1.500 M/S) | WIND SPEED CATEGORY 2 ( 2.500 M/S) | WIND SPEED CATEGORY 3 ( 4.300 M/S) | WIND SPEED CATEGORY 4 ( 6.800 M/S) | WIND SPEED CATEGORY 5 ( 9.500 M/S) | WIND SPEED CATEGORY 6 (12.500 M/S) |
|---|---|---|---|---|---|---|
| 0.000 | 0.00470500 | 0.00379700 | 0.00061100 | 0.00006400 | 0.00000000 | 0.00015800 |
| 22.500 | 0.00330300 | 0.00268700 | 0.00083700 | 0.00013300 | 0.00000000 | 0.00000000 |
| 45.000 | 0.00392200 | 0.00267600 | 0.00038900 | 0.00000000 | 0.00000000 | 0.00000000 |
| 67.500 | 0.01060000 | 0.00724900 | 0.00091200 | 0.00000000 | 0.00000000 | 0.00000000 |
| 90.000 | 0.00910200 | 0.00192800 | 0.00010900 | 0.00000000 | 0.00000000 | 0.00000000 |
| 112.500 | 0.00507700 | 0.00074400 | 0.00002300 | 0.00000000 | 0.00000000 | 0.00000000 |
| 135.000 | 0.00555500 | 0.00116400 | 0.00028400 | 0.00000000 | 0.00000000 | 0.00000000 |
| 157.500 | 0.00648300 | 0.00307700 | 0.00104400 | 0.00015100 | 0.00000000 | 0.00000000 |
| 180.000 | 0.00853600 | 0.00740100 | 0.00343800 | 0.00053100 | 0.00000000 | 0.00000000 |
| 202.500 | 0.01420400 | 0.01388100 | 0.00674100 | 0.00128900 | 0.00000000 | 0.00000000 |
| 225.000 | 0.02409400 | 0.01670700 | 0.00556600 | 0.00054900 | 0.00002300 | 0.00000000 |
| 247.500 | 0.02191600 | 0.00816100 | 0.00294100 | 0.00058100 | 0.00000000 | 0.00000000 |
| 270.000 | 0.01576900 | 0.00874400 | 0.00385300 | 0.00043300 | 0.00000000 | 0.00000000 |
| 292.500 | 0.01149000 | 0.00699300 | 0.00303600 | 0.00035700 | 0.00000000 | 0.00000000 |
| 315.000 | 0.00954700 | 0.00388400 | 0.00126500 | 0.00013200 | 0.00000000 | 0.00000000 |
| 337.500 | 0.00763500 | 0.00271300 | 0.00100300 | 0.00012600 | 0.00000000 | 0.00000000 |

ANNUAL: STABILITY CATEGORY F

| DIRECTION (DEGREES) | WIND SPEED CATEGORY 1 ( 1.500 M/S) | WIND SPEED CATEGORY 2 ( 2.500 M/S) | WIND SPEED CATEGORY 3 ( 4.300 M/S) | WIND SPEED CATEGORY 4 ( 6.800 M/S) | WIND SPEED CATEGORY 5 ( 9.500 M/S) | WIND SPEED CATEGORY 6 (12.500 M/S) |
|---|---|---|---|---|---|---|
| 0.000 | 0.00492100 | 0.00011800 | 0.00000000 | 0.00000000 | 0.00002300 | 0.00004500 |
| 22.500 | 0.00480000 | 0.00002200 | 0.00002300 | 0.00000000 | 0.00000000 | 0.00000000 |







5209

| | | | | | | |
|---|---|---|---|---|---|---|
| 45.000 | 0.00459300 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| 67.500 | 0.00851000 | 0.00090900 | 0.00003900 | 0.00000000 | 0.00000000 | 0.00000000 |
| 90.000 | 0.01272300 | 0.00019400 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| 112.500 | 0.00846100 | 0.00002000 | 0.00000000 | 0.00000000 | 0.00002200 | 0.00000000 |
| 135.000 | 0.00565600 | 0.00021100 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| 157.500 | 0.00511700 | 0.00013100 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| 180.000 | 0.00741400 | 0.00033800 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| 202.500 | 0.01308600 | 0.00107500 | 0.00009800 | 0.00002200 | 0.00000000 | 0.00000000 |
| 225.000 | 0.02180100 | 0.00157500 | 0.00002500 | 0.00000000 | 0.00000000 | 0.00000000 |
| 247.500 | 0.02995300 | 0.00119200 | 0.00000000 | 0.00000000 | 0.00000000 | 0.00000000 |
| 270.000 | 0.03101700 | 0.00034500 | 0.00002000 | 0.00000000 | 0.00000000 | 0.00000000 |
| 292.500 | 0.03108200 | 0.00006600 | 0.00002200 | 0.00000000 | 0.00000000 | 0.00000000 |
| 315.000 | 0.02489300 | 0.00018400 | 0.00006100 | 0.00000000 | 0.00000000 | 0.00000000 |
| 337.500 | 0.01190800 | 0.00035400 | 0.00003900 | 0.00000000 | 0.00000000 | 0.00000000 |

SUM OF FREQUENCIES, FTOTAL = 1.00000

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 39

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: OU1CONPM ***
INCLUDING SOURCE(S): WASTPIT1, WASTPIT2, WASTPIT3, WASTPIT4, WASTPIT5, WASTPIT6, WASTPIT7, WASTPIT8,

*** NETWORK ID: COARSE1 ; NETWORK TYPE: GRIDCART ***

** CONC OF OTHER IN G/M3-OR-PCI/M3 **

| Y-COORD (METERS) | X-COORD (METERS) -1219.20 | -1066.80 | -914.40 | -762.00 | -609.60 | -457.20 | -304.80 | -152.40 | 0.00 |
|---|---|---|---|---|---|---|---|---|---|
| 1371.60 | 0.000034 | 0.000039 | 0.000045 | 0.000052 | 0.000060 | 0.000070 | 0.000084 | 0.000112 | 0.000144 |
| 1219.20 | 0.000034 | 0.000040 | 0.000046 | 0.000054 | 0.000062 | 0.000073 | 0.000086 | 0.000117 | 0.000155 |
| 1066.80 | 0.000035 | 0.000039 | 0.000047 | 0.000055 | 0.000065 | 0.000077 | 0.000091 | 0.000119 | 0.000163 |
| 914.40 | 0.000037 | 0.000041 | 0.000046 | 0.000056 | 0.000067 | 0.000081 | 0.000097 | 0.000119 | 0.000173 |
| 762.00 | 0.000039 | 0.000044 | 0.000048 | 0.000056 | 0.000069 | 0.000084 | 0.000104 | 0.000126 | 0.000181 |
| 609.60 | 0.000043 | 0.000047 | 0.000052 | 0.000059 | 0.000069 | 0.000088 | 0.000110 | 0.000139 | 0.000183 |
| 457.20 | 0.000050 | 0.000054 | 0.000059 | 0.000066 | 0.000073 | 0.000087 | 0.000115 | 0.000149 | 0.000196 |
| 304.80 | 0.000058 | 0.000064 | 0.000071 | 0.000079 | 0.000087 | 0.000099 | 0.000117 | 0.000160 | 0.000217 |
| 152.40 | 0.000065 | 0.000072 | 0.000082 | 0.000094 | 0.000109 | 0.000125 | 0.000143 | 0.000177 | 0.000253 |
| 0.00 | 0.000074 | 0.000083 | 0.000094 | 0.000108 | 0.000127 | 0.000152 | 0.000186 | 0.000230 | 0.000304 |
| -152.40 | 0.000091 | 0.000104 | 0.000120 | 0.000141 | 0.000168 | 0.000204 | 0.000257 | 0.000346 | 0.000487 |
| -304.80 | 0.000127 | 0.000148 | 0.000175 | 0.000211 | 0.000260 | 0.000327 | 0.000428 | 0.000592 | 0.000874 |
| -457.20 | 0.000161 | 0.000190 | 0.000227 | 0.000276 | 0.000343 | 0.000438 | 0.000587 | 0.000848 | 0.001321 |
| -609.60 | 0.000192 | 0.000226 | 0.000271 | 0.000331 | 0.000417 | 0.000550 | 0.000730 | 0.001013 | 0.001382 |
| -762.00 | 0.000219 | 0.000259 | 0.000314 | 0.000392 | 0.000483 | 0.000598 | 0.000725 | 0.000849 | 0.001100 |
| -914.40 | 0.000247 | 0.000293 | 0.000348 | 0.000404 | 0.000460 | 0.000509 | 0.000572 | 0.000696 | 0.000814 |
| -1066.80 | 0.000262 | 0.000293 | 0.000320 | 0.000349 | 0.000383 | 0.000419 | 0.000489 | 0.000545 | 0.000558 |
| -1219.20 | 0.000238 | 0.000257 | 0.000277 | 0.000299 | 0.000320 | 0.000365 | 0.000397 | 0.000401 | 0.000461 |
| -1371.60 | 0.000212 | 0.000226 | 0.000240 | 0.000254 | 0.000283 | 0.000303 | 0.000304 | 0.000342 | 0.000408 |
| -1524.00 | 0.000188 | 0.000198 | 0.000207 | 0.000227 | 0.000240 | 0.000240 | 0.000266 | 0.000300 | 0.000369 |
| -1676.40 | 0.000166 | 0.000172 | 0.000187 | 0.000196 | 0.000195 | 0.000214 | 0.000239 | 0.000271 | 0.000325 |
| -1828.80 | 0.000146 | 0.000157 | 0.000163 | 0.000162 | 0.000177 | 0.000195 | 0.000214 | 0.000250 | 0.000278 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| -1981.20 | 0.000134 | 0.000139 | 0.000138 | 0.000149 | 0.000163 | 0.000178 | 0.000195 | 0.000231 | 0.000237 |
| -2133.60 | 0.000119 | 0.000118 | 0.000127 | 0.000138 | 0.000150 | 0.000162 | 0.000182 | 0.000204 | 0.000209 |
| -2286.00 | 0.000103 | 0.000110 | 0.000119 | 0.000129 | 0.000139 | 0.000149 | 0.000172 | 0.000180 | 0.000187 |
| -2438.40 | 0.000097 | 0.000104 | 0.000112 | 0.000120 | 0.000128 | 0.000140 | 0.000157 | 0.000160 | 0.000168 |
| -2590.80 | 0.000092 | 0.000098 | 0.000105 | 0.000112 | 0.000119 | 0.000133 | 0.000142 | 0.000146 | 0.000153 |
| -2743.20 | 0.000087 | 0.000093 | 0.000098 | 0.000104 | 0.000111 | 0.000126 | 0.000127 | 0.000133 | 0.000139 |
| -2895.60 | 0.000082 | 0.000087 | 0.000092 | 0.000097 | 0.000106 | 0.000115 | 0.000117 | 0.000123 | 0.000128 |
| -3048.00 | 0.000078 | 0.000083 | 0.000087 | 0.000092 | 0.000102 | 0.000105 | 0.000108 | 0.000113 | 0.000118 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 40

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: OU1CONPM ***
INCLUDING SOURCE(S): WASTPIT1, WASTPIT2, WASTPIT3, WASTPIT4, WASTPIT5, WASTPIT6, WASTPIT7, WASTPIT8,

*** NETWORK ID: COARSE1 ; NETWORK TYPE: GRIDCART ***

** CONC OF OTHER IN G/M3-OR-PCI/M3 **

| Y-COORD (METERS) | X-COORD (METERS) 152.40 | 304.80 | 457.20 | 609.60 | 762.00 | 914.40 | 1066.80 | 1219.20 | 1371.60 |
|---|---|---|---|---|---|---|---|---|---|
| 1371.60 | 0.000173 | 0.000204 | 0.000258 | 0.000341 | 0.000390 | 0.000436 | 0.000474 | 0.000545 | 0.000532 |
| 1219.20 | 0.000191 | 0.000230 | 0.000297 | 0.000400 | 0.000461 | 0.000516 | 0.000576 | 0.000639 | 0.000597 |
| 1066.80 | 0.000214 | 0.000261 | 0.000346 | 0.000477 | 0.000553 | 0.000620 | 0.000727 | 0.000737 | 0.000679 |
| 914.40 | 0.000241 | 0.000300 | 0.000410 | 0.000581 | 0.000677 | 0.000777 | 0.000916 | 0.000845 | 0.000776 |
| 762.00 | 0.000261 | 0.000349 | 0.000494 | 0.000725 | 0.000850 | 0.001029 | 0.001099 | 0.000994 | 0.000893 |
| 609.60 | 0.000284 | 0.000417 | 0.000613 | 0.000938 | 0.001118 | 0.001420 | 0.001324 | 0.001173 | 0.001099 |
| 457.20 | 0.000314 | 0.000494 | 0.000792 | 0.001277 | 0.001616 | 0.001873 | 0.001637 | 0.001506 | 0.001252 |
| 304.80 | 0.000346 | 0.000580 | 0.001089 | 0.001855 | 0.002577 | 0.002519 | 0.002253 | 0.001783 | 0.001306 |
| 152.40 | 0.000354 | 0.000727 | 0.001583 | 0.003104 | 0.004201 | 0.003799 | 0.002829 | 0.001967 | 0.001504 |
| 0.00 | 0.000467 | 0.000938 | 0.002449 | 0.006719 | 0.007975 | 0.005641 | 0.003538 | 0.002315 | 0.001685 |
| -152.40 | 0.000757 | 0.001524 | 0.005231 | 0.008991 | 0.016157 | 0.008086 | 0.004248 | 0.002591 | 0.001729 |
| -304.80 | 0.001488 | 0.003179 | 0.004869 | 0.021072 | 0.022478 | 0.008686 | 0.004259 | 0.002680 | 0.001880 |
| -457.20 | 0.002167 | 0.004431 | 0.010518 | 0.020126 | 0.010135 | 0.005597 | 0.003514 | 0.002380 | 0.001711 |
| -609.60 | 0.002079 | 0.003123 | 0.004760 | 0.005569 | 0.004393 | 0.003314 | 0.002502 | 0.001880 | 0.001463 |
| -762.00 | 0.001387 | 0.001744 | 0.002373 | 0.002591 | 0.002260 | 0.002000 | 0.001618 | 0.001374 | 0.001151 |
| -914.40 | 0.000885 | 0.001239 | 0.001419 | 0.001526 | 0.001432 | 0.001286 | 0.001159 | 0.001018 | 0.000883 |
| -1066.80 | 0.000712 | 0.000886 | 0.000987 | 0.001047 | 0.000979 | 0.000902 | 0.000801 | 0.000778 | 0.000713 |
| -1219.20 | 0.000610 | 0.000653 | 0.000734 | 0.000777 | 0.000701 | 0.000693 | 0.000626 | 0.000573 | 0.000572 |
| -1371.60 | 0.000496 | 0.000513 | 0.000577 | 0.000607 | 0.000541 | 0.000548 | 0.000513 | 0.000460 | 0.000439 |
| -1524.00 | 0.000404 | 0.000422 | 0.000470 | 0.000492 | 0.000444 | 0.000434 | 0.000423 | 0.000391 | 0.000363 |
| -1676.40 | 0.000333 | 0.000356 | 0.000391 | 0.000408 | 0.000372 | 0.000352 | 0.000357 | 0.000338 | 0.000310 |
| -1828.80 | 0.000287 | 0.000305 | 0.000331 | 0.000344 | 0.000317 | 0.000302 | 0.000298 | 0.000289 | 0.000270 |
| -1981.20 | 0.000250 | 0.000264 | 0.000285 | 0.000296 | 0.000273 | 0.000262 | 0.000252 | 0.000252 | 0.000240 |
| -2133.60 | 0.000221 | 0.000232 | 0.000248 | 0.000257 | 0.000239 | 0.000230 | 0.000219 | 0.000220 | 0.000212 |
| -2286.00 | 0.000197 | 0.000205 | 0.000219 | 0.000226 | 0.000211 | 0.000204 | 0.000196 | 0.000191 | 0.000189 |
| -2438.40 | 0.000177 | 0.000183 | 0.000194 | 0.000200 | 0.000188 | 0.000183 | 0.000176 | 0.000168 | 0.000170 |
| -2590.80 | 0.000160 | 0.000165 | 0.000174 | 0.000179 | 0.000169 | 0.000165 | 0.000159 | 0.000153 | 0.000150 |
| -2743.20 | 0.000145 | 0.000150 | 0.000157 | 0.000162 | 0.000153 | 0.000149 | 0.000145 | 0.000139 | 0.000134 |
| -2895.60 | 0.000132 | 0.000136 | 0.000143 | 0.000147 | 0.000139 | 0.000136 | 0.000132 | 0.000128 | 0.000123 |
| -3048.00 | 0.000121 | 0.000125 | 0.000131 | 0.000134 | 0.000127 | 0.000125 | 0.000121 | 0.000118 | 0.000113 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 41

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: OU1CONPM ***
INCLUDING SOURCE(S): WASTPIT1, WASTPIT2, WASTPIT3, WASTPIT4, WASTPIT5, WASTPIT6, WASTPIT7,
WASTPIT8,

*** NETWORK ID: COARSE1 ; NETWORK TYPE: GRIDCART ***

** CONC OF OTHER IN G/M3-OR-PCI/M3 **

| Y-COORD (METERS) | X-COORD (METERS) 1524.00 | 1676.40 | 1828.80 | 1981.20 | 2133.60 | 2286.00 | 2438.40 | 2590.80 | 2743.20 |
|---|---|---|---|---|---|---|---|---|---|
| 1371.60 | 0.000499 | 0.000468 | 0.000436 | 0.000406 | 0.000392 | 0.000359 | 0.000314 | 0.000285 | 0.000262 |
| 1219.20 | 0.000557 | 0.000517 | 0.000477 | 0.000459 | 0.000417 | 0.000361 | 0.000325 | 0.000296 | 0.000271 |
| 1066.80 | 0.000626 | 0.000573 | 0.000549 | 0.000493 | 0.000421 | 0.000375 | 0.000339 | 0.000307 | 0.000278 |
| 914.40 | 0.000705 | 0.000671 | 0.000595 | 0.000499 | 0.000438 | 0.000391 | 0.000351 | 0.000315 | 0.000285 |
| 762.00 | 0.000843 | 0.000736 | 0.000605 | 0.000522 | 0.000459 | 0.000406 | 0.000361 | 0.000323 | 0.000294 |
| 609.60 | 0.000940 | 0.000752 | 0.000635 | 0.000549 | 0.000477 | 0.000422 | 0.000380 | 0.000345 | 0.000310 |
| 457.20 | 0.000968 | 0.000795 | 0.000671 | 0.000583 | 0.000517 | 0.000453 | 0.000401 | 0.000352 | 0.000309 |
| 304.80 | 0.001040 | 0.000874 | 0.000749 | 0.000634 | 0.000541 | 0.000463 | 0.000395 | 0.000352 | 0.000318 |
| 152.40 | 0.001191 | 0.000966 | 0.000784 | 0.000641 | 0.000534 | 0.000468 | 0.000414 | 0.000370 | 0.000333 |
| 0.00 | 0.001256 | 0.000956 | 0.000778 | 0.000659 | 0.000566 | 0.000492 | 0.000433 | 0.000385 | 0.000345 |
| -152.40 | 0.001309 | 0.001040 | 0.000852 | 0.000713 | 0.000607 | 0.000524 | 0.000458 | 0.000405 | 0.000361 |
| -304.80 | 0.001410 | 0.001110 | 0.000903 | 0.000752 | 0.000637 | 0.000548 | 0.000477 | 0.000421 | 0.000375 |
| -457.20 | 0.001284 | 0.001017 | 0.000835 | 0.000701 | 0.000597 | 0.000516 | 0.000452 | 0.000400 | 0.000357 |
| -609.60 | 0.001154 | 0.000946 | 0.000775 | 0.000649 | 0.000559 | 0.000487 | 0.000428 | 0.000381 | 0.000341 |
| -762.00 | 0.000986 | 0.000837 | 0.000718 | 0.000617 | 0.000532 | 0.000462 | 0.000408 | 0.000365 | 0.000328 |
| -914.40 | 0.000760 | 0.000694 | 0.000624 | 0.000557 | 0.000495 | 0.000438 | 0.000391 | 0.000348 | 0.000313 |
| -1066.80 | 0.000642 | 0.000565 | 0.000508 | 0.000470 | 0.000435 | 0.000401 | 0.000363 | 0.000330 | 0.000302 |
| -1219.20 | 0.000533 | 0.000490 | 0.000440 | 0.000403 | 0.000369 | 0.000342 | 0.000323 | 0.000303 | 0.000281 |
| -1371.60 | 0.000440 | 0.000416 | 0.000387 | 0.000354 | 0.000329 | 0.000305 | 0.000283 | 0.000264 | 0.000251 |
| -1524.00 | 0.000350 | 0.000351 | 0.000335 | 0.000315 | 0.000292 | 0.000274 | 0.000257 | 0.000241 | 0.000226 |
| -1676.40 | 0.000296 | 0.000286 | 0.000288 | 0.000276 | 0.000263 | 0.000245 | 0.000233 | 0.000220 | 0.000208 |
| -1828.80 | 0.000257 | 0.000247 | 0.000240 | 0.000241 | 0.000233 | 0.000223 | 0.000210 | 0.000200 | 0.000191 |
| -1981.20 | 0.000225 | 0.000218 | 0.000210 | 0.000204 | 0.000206 | 0.000199 | 0.000192 | 0.000182 | 0.000174 |
| -2133.60 | 0.000199 | 0.000194 | 0.000188 | 0.000182 | 0.000177 | 0.000178 | 0.000173 | 0.000167 | 0.000159 |
| -2286.00 | 0.000180 | 0.000173 | 0.000169 | 0.000164 | 0.000159 | 0.000155 | 0.000156 | 0.000152 | 0.000147 |
| -2438.40 | 0.000164 | 0.000155 | 0.000152 | 0.000149 | 0.000145 | 0.000140 | 0.000137 | 0.000138 | 0.000135 |
| -2590.80 | 0.000148 | 0.000142 | 0.000138 | 0.000135 | 0.000132 | 0.000129 | 0.000125 | 0.000122 | 0.000123 |
| -2743.20 | 0.000135 | 0.000131 | 0.000125 | 0.000123 | 0.000121 | 0.000118 | 0.000115 | 0.000112 | 0.000110 |
| -2895.60 | 0.000122 | 0.000120 | 0.000115 | 0.000113 | 0.000111 | 0.000109 | 0.000107 | 0.000104 | 0.000101 |
| -3048.00 | 0.000110 | 0.000110 | 0.000107 | 0.000104 | 0.000102 | 0.000101 | 0.000099 | 0.000097 | 0.000095 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 42

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: OU1CONPM ***
INCLUDING SOURCE(S): WASTPIT1, WASTPIT2, WASTPIT3, WASTPIT4, WASTPIT5, WASTPIT6, WASTPIT7,
WASTPIT8,

*** NETWORK ID: COARSE1 ; NETWORK TYPE: GRIDCART ***

** CONC OF OTHER IN G/M3-OR-PCI/M3 **

| Y-COORD (METERS) | X-COORD (METERS) 2895.60 | 3048.00 | 3200.40 |
|---|---|---|---|
| 1371.60 | 0.000241 | 0.000222 | 0.000205 |
| 1219.20 | 0.000248 | 0.000227 | 0.000209 |
| 1066.80 | 0.000253 | 0.000231 | 0.000212 |
| 914.40 | 0.000258 | 0.000236 | 0.000220 |
| 762.00 | 0.000272 | 0.000248 | 0.000227 |
| 609.60 | 0.000279 | 0.000250 | 0.000224 |
| 457.20 | 0.000276 | 0.000253 | 0.000233 |
| 304.80 | 0.000289 | 0.000264 | 0.000243 |
| 152.40 | 0.000301 | 0.000274 | 0.000251 |
| 0.00 | 0.000311 | 0.000282 | 0.000258 |
| -152.40 | 0.000325 | 0.000294 | 0.000267 |
| -304.80 | 0.000336 | 0.000303 | 0.000276 |
| -457.20 | 0.000321 | 0.000291 | 0.000265 |
| -609.60 | 0.000308 | 0.000280 | 0.000255 |
| -762.00 | 0.000297 | 0.000271 | 0.000248 |
| -914.40 | 0.000285 | 0.000261 | 0.000239 |
| -1066.80 | 0.000273 | 0.000249 | 0.000229 |
| -1219.20 | 0.000260 | 0.000240 | 0.000222 |
| -1371.60 | 0.000238 | 0.000226 | 0.000210 |
| -1524.00 | 0.000212 | 0.000201 | 0.000193 |
| -1676.40 | 0.000196 | 0.000185 | 0.000175 |
| -1828.80 | 0.000181 | 0.000172 | 0.000164 |
| -1981.20 | 0.000167 | 0.000160 | 0.000153 |
| -2133.60 | 0.000153 | 0.000148 | 0.000142 |
| -2286.00 | 0.000141 | 0.000136 | 0.000132 |
| -2438.40 | 0.000131 | 0.000126 | 0.000122 |
| -2590.80 | 0.000121 | 0.000118 | 0.000113 |
| -2743.20 | 0.000111 | 0.000109 | 0.000106 |
| -2895.60 | 0.000099 | 0.000100 | 0.000099 |
| -3048.00 | 0.000092 | 0.000091 | 0.000091 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 43

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: OU1CONPM ***
INCLUDING SOURCE(S): WASTPIT1, WASTPIT2, WASTPIT3, WASTPIT4, WASTPIT5, WASTPIT6, WASTPIT7, WASTPIT8,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF OTHER IN G/M3-OR-PCI/M3 **

| X-COORD (M) | Y-COORD (M) | CONC | X-COORD (M) | Y-COORD (M) | CONC |
|---|---|---|---|---|---|
| 5334.00 | 1676.00 | 0.000086 | 5944.00 | 2896.00 | 0.000068 |
| -122.00 | -3048.00 | 0.000114 | 335.00 | -366.00 | 0.004612 |

| | | | | | |
|---|---|---|---|---|---|
| 518.00 | -671.00 | 0.003814 | 732.00 | -1463.00 | 0.000488 |
| 183.00 | 366.00 | 0.000374 | 732.00 | -1951.00 | 0.000285 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 44

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: OU1CONPM ***
INCLUDING SOURCE(S): WASTPIT1, WASTPIT2, WASTPIT3, WASTPIT4, WASTPIT5, WASTPIT6, WASTPIT7, WASTPIT8,

** CONC OF OTHER IN G/M3-OR-PCI/M3 **

BOUNDARY RECEPTOR NETWORK OF SOURCE ID: BRDRORIG
OF SOURCE TYPE: AREA ; WITH ORIGIN AT ( 608.00, -695.00, 0.00)

| (SEC.) | X-COORD | Y-COORD | CONC | (SEC.) | X-COORD | Y-COORD | CONC | (SEC.) | X-COORD | Y-COORD | CONC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 795.0, | 365.6, | 0.002265 | 2 | 994.5, | 366.9, | 0.002033 | 3 | 1223.0, | 370.2, | 0.001687 |
| 4 | 1543.9, | 420.4, | 0.000945 | 5 | 2127.8, | 580.3, | 0.000483 | 6 | 2115.8, | 175.5, | 0.000543 |
| 7 | 2065.5, | -164.5, | 0.000655 | 8 | 2071.4, | -437.0, | 0.000646 | 9 | 2077.0, | -695.0, | 0.000573 |
| 10 | 2083.2, | -955.1, | 0.000498 | 11 | 2085.2, | -1232.7, | 0.000376 | 12 | 2095.8, | -1554.0, | 0.000292 |
| 13 | 1950.9, | -1821.8, | 0.000243 | 14 | 1612.0, | -1891.6, | 0.000238 | 15 | 1343.0, | -1968.1, | 0.000246 |
| 16 | 1098.1, | -2041.6, | 0.000237 | 17 | 837.6, | -1996.9, | 0.000265 | 18 | 608.0, | -1655.0, | 0.000418 |
| 19 | 474.8, | -1450.3, | 0.000525 | 20 | 382.3, | -1315.2, | 0.000582 | 21 | 329.0, | -1178.2, | 0.000704 |
| 22 | 324.5, | -1032.8, | 0.000962 | 23 | 303.9, | -950.2, | 0.001141 | 24 | 247.7, | -903.0, | 0.001113 |
| 25 | 289.4, | -810.9, | 0.001472 | 26 | 274.2, | -753.9, | 0.001716 | 27 | 258.0, | -695.0, | 0.002052 |
| 28 | 233.8, | -629.0, | 0.002356 | 29 | 215.2, | -552.0, | 0.002848 | 30 | 185.4, | -451.0, | 0.002464 |
| 31 | 175.2, | -331.8, | 0.001816 | 32 | 95.7, | -84.5, | 0.000493 | 33 | 10.5, | 339.9, | 0.000219 |
| 34 | 220.5, | 369.7, | 0.000415 | 35 | 421.2, | 364.7, | 0.000840 | 36 | 608.0, | 365.0, | 0.001580 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 45

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: OU3CONPM ***
INCLUDING SOURCE(S): SWSWPROD, SWSEPROD, SWNWPROD, SWNEPROD, SESWPROD, SESEPROD, SENWPROD, SENEPROD, NWSWPROD, NWSEPROD, NWNWPROD, NWNEPROD, NESWPROD, NESEPROD, NENWPROD, NENEPROD, CTRMPROD, SRGLPROD, WWPIPROD,

*** NETWORK ID: COARSE1 ; NETWORK TYPE: GRIDCART ***

** CONC OF OTHER IN G/M3-OR-PCI/M3 **

| Y-COORD (METERS) | X-COORD (METERS) -1219.20 | -1066.80 | -914.40 | -762.00 | -609.60 | -457.20 | -304.80 | -152.40 | 0.00 |
|---|---|---|---|---|---|---|---|---|---|
| 1371.60 | 0.000240 | 0.000261 | 0.000287 | 0.000323 | 0.000364 | 0.000407 | 0.000456 | 0.000519 | 0.000605 |
| 1219.20 | 0.000244 | 0.000267 | 0.000293 | 0.000325 | 0.000368 | 0.000419 | 0.000471 | 0.000531 | 0.000627 |
| 1066.80 | 0.000251 | 0.000272 | 0.000300 | 0.000331 | 0.000371 | 0.000424 | 0.000487 | 0.000553 | 0.000642 |
| 914.40 | 0.000265 | 0.000283 | 0.000308 | 0.000341 | 0.000379 | 0.000428 | 0.000495 | 0.000575 | 0.000663 |
| 762.00 | 0.000289 | 0.000306 | 0.000326 | 0.000355 | 0.000395 | 0.000441 | 0.000501 | 0.000588 | 0.000691 |
| 609.60 | 0.000312 | 0.000334 | 0.000358 | 0.000385 | 0.000420 | 0.000468 | 0.000525 | 0.000600 | 0.000713 |
| 457.20 | 0.000337 | 0.000362 | 0.000390 | 0.000422 | 0.000460 | 0.000509 | 0.000574 | 0.000646 | 0.000743 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 304.80 | 0.000371 | 0.000395 | 0.000424 | 0.000461 | 0.000504 | 0.000557 | 0.000628 | 0.000723 | 0.000828 |
| 152.40 | 0.000410 | 0.000440 | 0.000473 | 0.000510 | 0.000554 | 0.000612 | 0.000687 | 0.000789 | 0.000933 |
| 0.00 | 0.000448 | 0.000485 | 0.000527 | 0.000574 | 0.000627 | 0.000689 | 0.000764 | 0.000864 | 0.001017 |
| -152.40 | 0.000523 | 0.000572 | 0.000630 | 0.000698 | 0.000777 | 0.000871 | 0.000986 | 0.001128 | 0.001314 |
| -304.80 | 0.000629 | 0.000693 | 0.000769 | 0.000861 | 0.000975 | 0.001114 | 0.001285 | 0.001504 | 0.001788 |
| -457.20 | 0.000746 | 0.000828 | 0.000925 | 0.001042 | 0.001186 | 0.001368 | 0.001601 | 0.001902 | 0.002310 |
| -609.60 | 0.000858 | 0.000957 | 0.001074 | 0.001217 | 0.001392 | 0.001611 | 0.001899 | 0.002288 | 0.002828 |
| -762.00 | 0.001004 | 0.001124 | 0.001267 | 0.001442 | 0.001663 | 0.001947 | 0.002316 | 0.002800 | 0.003452 |
| -914.40 | 0.001169 | 0.001314 | 0.001492 | 0.001711 | 0.001990 | 0.002332 | 0.002759 | 0.003297 | 0.003889 |
| -1066.80 | 0.001309 | 0.001479 | 0.001684 | 0.001932 | 0.002225 | 0.002558 | 0.002928 | 0.003363 | 0.003934 |
| -1219.20 | 0.001437 | 0.001618 | 0.001828 | 0.002047 | 0.002287 | 0.002574 | 0.002921 | 0.003360 | 0.003967 |
| -1371.60 | 0.001533 | 0.001690 | 0.001860 | 0.002058 | 0.002293 | 0.002576 | 0.002908 | 0.003341 | 0.003838 |
| -1524.00 | 0.001550 | 0.001695 | 0.001861 | 0.002055 | 0.002271 | 0.002521 | 0.002834 | 0.003152 | 0.003459 |
| -1676.40 | 0.001548 | 0.001685 | 0.001837 | 0.002006 | 0.002186 | 0.002393 | 0.002599 | 0.002793 | 0.003029 |
| -1828.80 | 0.001524 | 0.001645 | 0.001763 | 0.001885 | 0.002027 | 0.002165 | 0.002291 | 0.002455 | 0.002672 |
| -1981.20 | 0.001461 | 0.001544 | 0.001630 | 0.001728 | 0.001825 | 0.001919 | 0.002039 | 0.002197 | 0.002365 |
| -2133.60 | 0.001355 | 0.001415 | 0.001490 | 0.001565 | 0.001636 | 0.001727 | 0.001844 | 0.001965 | 0.002071 |
| -2286.00 | 0.001242 | 0.001301 | 0.001360 | 0.001414 | 0.001483 | 0.001572 | 0.001663 | 0.001736 | 0.001837 |
| -2438.40 | 0.001149 | 0.001195 | 0.001236 | 0.001290 | 0.001359 | 0.001429 | 0.001485 | 0.001554 | 0.001659 |
| -2590.80 | 0.001059 | 0.001092 | 0.001134 | 0.001188 | 0.001244 | 0.001287 | 0.001339 | 0.001417 | 0.001511 |
| -2743.20 | 0.000973 | 0.001006 | 0.001050 | 0.001094 | 0.001128 | 0.001171 | 0.001228 | 0.001303 | 0.001391 |
| -2895.60 | 0.000900 | 0.000936 | 0.000971 | 0.000999 | 0.001034 | 0.001080 | 0.001136 | 0.001207 | 0.001297 |
| -3048.00 | 0.000840 | 0.000870 | 0.000892 | 0.000921 | 0.000960 | 0.001003 | 0.001060 | 0.001130 | 0.001218 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 46

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: OU3CONPM ***
INCLUDING SOURCE(S): SWSWPROD, SWSEPROD, SWNWPROD, SWNEPROD, SESWPROD, SESEPROD, SENWPROD,
SENEPROD, NWSWPROD, NWSEPROD, NWNWPROD, NWNEPROD, NESWPROD, NESEPROD, NENWPROD, NENEPROD, CTRMPROD, SRGLPROD, WMPIPROD,

*** NETWORK ID: COARSE1 ; NETWORK TYPE: GRIDCART ***

** CONC OF OTHER IN G/M3-OR-PCI/M3 **

| Y-COORD (METERS) | X-COORD (METERS) 152.40 | 304.80 | 457.20 | 609.60 | 762.00 | 914.40 | 1066.80 | 1219.20 | 1371.60 |
|---|---|---|---|---|---|---|---|---|---|
| 1371.60 | 0.000723 | 0.000880 | 0.001063 | 0.001274 | 0.001507 | 0.001851 | 0.002240 | 0.002635 | 0.003058 |
| 1219.20 | 0.000744 | 0.000914 | 0.001119 | 0.001366 | 0.001644 | 0.002063 | 0.002529 | 0.002998 | 0.003510 |
| 1066.80 | 0.000771 | 0.000950 | 0.001184 | 0.001463 | 0.001801 | 0.002314 | 0.002888 | 0.003450 | 0.004103 |
| 914.40 | 0.000803 | 0.000989 | 0.001251 | 0.001575 | 0.001983 | 0.002617 | 0.003338 | 0.004036 | 0.004877 |
| 762.00 | 0.000834 | 0.001029 | 0.001323 | 0.001704 | 0.002201 | 0.002987 | 0.003908 | 0.004832 | 0.005891 |
| 609.60 | 0.000866 | 0.001084 | 0.001397 | 0.001854 | 0.002454 | 0.003468 | 0.004652 | 0.005963 | 0.007305 |
| 457.20 | 0.000893 | 0.001150 | 0.001477 | 0.002018 | 0.002776 | 0.004122 | 0.005720 | 0.007565 | 0.009299 |
| 304.80 | 0.000961 | 0.001211 | 0.001603 | 0.002219 | 0.003203 | 0.005016 | 0.007491 | 0.010050 | 0.012340 |
| 152.40 | 0.001097 | 0.001319 | 0.001803 | 0.002508 | 0.003815 | 0.006490 | 0.010418 | 0.014269 | 0.017684 |
| 0.00 | 0.001240 | 0.001516 | 0.002018 | 0.002958 | 0.004839 | 0.009643 | 0.016459 | 0.022977 | 0.027067 |
| -152.40 | 0.001588 | 0.002036 | 0.002738 | 0.004191 | 0.007291 | 0.011545 | 0.022595 | 0.027488 | 0.034355 |
| -304.80 | 0.002184 | 0.002777 | 0.003826 | 0.006290 | 0.012576 | 0.014667 | 0.026890 | 0.040366 | 0.046095 |
| -457.20 | 0.002892 | 0.003812 | 0.005400 | 0.009222 | 0.016505 | 0.023239 | 0.028541 | 0.041930 | 0.051422 |
| -609.60 | 0.003612 | 0.004796 | 0.006822 | 0.011238 | 0.012416 | 0.027224 | 0.039843 | 0.047823 | 0.051415 |
| -762.00 | 0.004342 | 0.005502 | 0.007328 | 0.010399 | 0.015398 | 0.019085 | 0.026943 | 0.041493 | 0.048839 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| -914.40 | 0.004641 | 0.005818 | 0.007479 | 0.010094 | 0.015098 | 0.019214 | 0.025453 | 0.036987 | 0.042250 |
| -1066.80 | 0.004766 | 0.005862 | 0.007310 | 0.009665 | 0.014039 | 0.020203 | 0.024867 | 0.027575 | 0.030091 |
| -1219.20 | 0.004680 | 0.005527 | 0.006832 | 0.008656 | 0.011403 | 0.015188 | 0.018994 | 0.021605 | 0.022221 |
| -1371.60 | 0.004354 | 0.005013 | 0.005963 | 0.007122 | 0.008492 | 0.010081 | 0.011842 | 0.012944 | 0.013478 |
| -1524.00 | 0.003837 | 0.004372 | 0.004972 | 0.005653 | 0.006478 | 0.007481 | 0.008409 | 0.008904 | 0.009141 |
| -1676.40 | 0.003348 | 0.003741 | 0.004099 | 0.004611 | 0.005181 | 0.005861 | 0.006351 | 0.006697 | 0.006842 |
| -1828.80 | 0.002927 | 0.003162 | 0.003467 | 0.003886 | 0.004279 | 0.004745 | 0.005096 | 0.005295 | 0.005407 |
| -1981.20 | 0.002530 | 0.002718 | 0.003010 | 0.003321 | 0.003622 | 0.003967 | 0.004252 | 0.004321 | 0.004412 |
| -2133.60 | 0.002209 | 0.002403 | 0.002647 | 0.002885 | 0.003121 | 0.003395 | 0.003601 | 0.003626 | 0.003706 |
| -2286.00 | 0.001972 | 0.002149 | 0.002354 | 0.002547 | 0.002738 | 0.002945 | 0.003088 | 0.003114 | 0.003164 |
| -2438.40 | 0.001782 | 0.001947 | 0.002112 | 0.002280 | 0.002421 | 0.002578 | 0.002686 | 0.002716 | 0.002742 |
| -2590.80 | 0.001632 | 0.001779 | 0.001919 | 0.002050 | 0.002154 | 0.002277 | 0.002363 | 0.002400 | 0.002416 |
| -2743.20 | 0.001510 | 0.001634 | 0.001754 | 0.001849 | 0.001934 | 0.002026 | 0.002103 | 0.002139 | 0.002152 |
| -2895.60 | 0.001407 | 0.001509 | 0.001603 | 0.001677 | 0.001743 | 0.001819 | 0.001892 | 0.001919 | 0.001932 |
| -3048.00 | 0.001311 | 0.001396 | 0.001470 | 0.001530 | 0.001579 | 0.001646 | 0.001714 | 0.001734 | 0.001746 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 47

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: OU3CONPM ***
INCLUDING SOURCE(S): SWSWPROD, SWSEPROD, SWNWPROD, SWNEPROD, SESWPROD, SESEPROD, SENWPROD,
SENEPROD, NWSWPROD, NWSEPROD, NWNWPROD, NWNEPROD, NESWPROD, NESEPROD, NENWPROD, NENEPROD, CTRMPROD, SRGLPROD, WWPIPROD,

*** NETWORK ID: COARSE1 ; NETWORK TYPE: GRIDCART ***

** CONC OF OTHER IN G/M3-OR-PCI/M3 **

| Y-COORD (METERS) | X-COORD (METERS) 1524.00 | 1676.40 | 1828.80 | 1981.20 | 2133.60 | 2286.00 | 2438.40 | 2590.80 | 2743.20 |
|---|---|---|---|---|---|---|---|---|---|
| 1371.60 | 0.003505 | 0.003844 | 0.004089 | 0.004276 | 0.004371 | 0.004320 | 0.004147 | 0.003956 | 0.003741 |
| 1219.20 | 0.004061 | 0.004449 | 0.004712 | 0.004881 | 0.004926 | 0.004792 | 0.004577 | 0.004310 | 0.004032 |
| 1066.80 | 0.004765 | 0.005195 | 0.005460 | 0.005605 | 0.005584 | 0.005359 | 0.005041 | 0.004676 | 0.004371 |
| 914.40 | 0.005668 | 0.006157 | 0.006368 | 0.006513 | 0.006375 | 0.005989 | 0.005523 | 0.005106 | 0,004731 |
| 762.00 | 0.006854 | 0.007362 | 0.007587 | 0.007659 | 0.007242 | 0.006658 | 0.006091 | 0.005586 | 0.005027 |
| 609.60 | 0.008421 | 0.008960 | 0.009225 | 0.008958 | 0.008204 | 0.007447 | 0.006723 | 0.006001 | 0.005259 |
| 457.20 | 0.010679 | 0.011339 | 0.011249 | 0.010405 | 0.009369 | 0.008351 | 0.007328 | 0.006366 | 0.005610 |
| 304.80 | 0.014172 | 0.014561 | 0.013734 | 0.012303 | 0.010810 | 0.009283 | 0.007963 | 0.006916 | 0.006061 |
| 152.40 | 0.019495 | 0.019275 | 0.017347 | 0.014909 | 0.012439 | 0.010276 | 0.008730 | 0.007419 | 0.006290 |
| 0.00 | 0.029163 | 0.027738 | 0.022769 | 0.017849 | 0.013839 | 0.011209 | 0.009219 | 0.007651 | 0.006469 |
| -152.40 | 0.038521 | 0.040877 | 0.029432 | 0.020407 | 0.015345 | 0.012278 | 0.009847 | 0.008172 | 0.006915 |
| -304.80 | 0.048526 | 0.048050 | 0.033631 | 0.022574 | 0.016968 | 0.013204 | 0.010621 | 0.008776 | 0.007398 |
| -457.20 | 0.052615 | 0.043042 | 0.034289 | 0.023953 | 0.018142 | 0.013937 | 0.010968 | 0.008909 | 0.007446 |
| -609.60 | 0.056757 | 0.048360 | 0.033138 | 0.024923 | 0.019279 | 0.014127 | 0.010934 | 0.008675 | 0.007146 |
| -762.00 | 0.049916 | 0.043594 | 0.033134 | 0.021212 | 0.022054 | 0.014037 | 0.010750 | 0.008740 | 0.007304 |
| -914.40 | 0.043310 | 0.041696 | 0.029937 | 0.022839 | 0.017123 | 0.012641 | 0.010021 | 0.008324 | 0.007104 |
| -1066.80 | 0.028246 | 0.029843 | 0.022631 | 0.016613 | 0.013089 | 0.010673 | 0.008765 | 0.007460 | 0.006444 |
| -1219.20 | 0.021541 | 0.018685 | 0.015385 | 0.012670 | 0.010466 | 0.008792 | 0.007613 | 0.006508 | 0.005655 |
| -1371.60 | 0.013019 | 0.011888 | 0.010567 | 0.009489 | 0.008398 | 0.007401 | 0.006565 | 0.005901 | 0.005187 |
| -1524.00 | 0.009028 | 0.008561 | 0.007763 | 0.007168 | 0.006576 | 0.006049 | 0.005482 | 0.005043 | 0.004658 |
| -1676.40 | 0.006726 | 0.006478 | 0.006118 | 0.005692 | 0.005269 | 0.004963 | 0.004619 | 0.004256 | 0.003975 |
| -1828.80 | 0.005339 | 0.005081 | 0.004884 | 0.004705 | 0.004369 | 0.004127 | 0.003941 | 0.003695 | 0.003440 |
| -1981.20 | 0.004406 | 0.004185 | 0.003982 | 0.003912 | 0.003704 | 0.003494 | 0.003350 | 0.003226 | 0.003060 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| -2133.60 | 0.003697 | 0.003541 | 0.003354 | 0.003289 | 0.003160 | 0.003017 | 0.002879 | 0.002789 | 0.002706 |
| -2286.00 | 0.003155 | 0.003034 | 0.002901 | 0.002824 | 0.002729 | 0.002616 | 0.002519 | 0.002433 | 0.002366 |
| -2438.40 | 0.002731 | 0.002639 | 0.002532 | 0.002475 | 0.002397 | 0.002296 | 0.002212 | 0.002150 | 0.002090 |
| -2590.80 | 0.002389 | 0.002318 | 0.002232 | 0.002186 | 0.002130 | 0.002052 | 0.001966 | 0.001905 | 0.001867 |
| -2743.20 | 0.002117 | 0.002054 | 0.001986 | 0.001951 | 0.001902 | 0.001854 | 0.001774 | 0.001708 | 0.001667 |
| -2895.60 | 0.001899 | 0.001836 | 0.001780 | 0.001754 | 0.001710 | 0.001676 | 0.001620 | 0.001554 | 0.001504 |
| -3048.00 | 0.001718 | 0.001655 | 0.001607 | 0.001584 | 0.001552 | 0.001519 | 0.001484 | 0.001429 | 0.001377 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 48

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: OU3CONPM ***
INCLUDING SOURCE(S): SWSWPROD, SWSEPROD, SWNWPROD, SWNEPROD, SESWPROD, SESEPROD, SENWPROD,
SENEPROD, NWSWPROD, NWSEPROD, NWNWPROD, NWNEPROD, NESWPROD, NESEPROD, NENWPROD, NENEPROD, CTRMPROD, SRGLPROD, WMPIPROD,

*** NETWORK ID: COARSE1 ; NETWORK TYPE: GRIDCART ***

** CONC OF OTHER IN G/M3-OR-PCI/M3 **

| Y-COORD (METERS) | X-COORD (METERS) 2895.60 | 3048.00 | 3200.40 |
|---|---|---|---|
| 1371.60 | 0.003526 | 0.003316 | 0.003117 |
| 1219.20 | 0.003786 | 0.003539 | 0.003266 |
| 1066.80 | 0.004063 | 0.003724 | 0.003370 |
| 914.40 | 0.004295 | 0.003853 | 0.003485 |
| 762.00 | 0.004459 | 0.004004 | 0.003627 |
| 609.60 | 0.004683 | 0.004217 | 0.003804 |
| 457.20 | 0.005012 | 0.004464 | 0.003988 |
| 304.80 | 0.005283 | 0.004620 | 0.004077 |
| 152.40 | 0.005411 | 0.004721 | 0.004184 |
| 0.00 | 0.005582 | 0.004894 | 0.004345 |
| -152.40 | 0.005969 | 0.005226 | 0.004606 |
| -304.80 | 0.006312 | 0.005464 | 0.004774 |
| -457.20 | 0.006295 | 0.005406 | 0.004724 |
| -609.60 | 0.006074 | 0.005270 | 0.004647 |
| -762.00 | 0.006215 | 0.005379 | 0.004719 |
| -914.40 | 0.006115 | 0.005325 | 0.004680 |
| -1066.80 | 0.005638 | 0.004990 | 0.004441 |
| -1219.20 | 0.005030 | 0.004522 | 0.004071 |
| -1371.60 | 0.004610 | 0.004139 | 0.003765 |
| -1524.00 | 0.004229 | 0.003827 | 0.003490 |
| -1676.40 | 0.003742 | 0.003468 | 0.003213 |
| -1828.80 | 0.003230 | 0.003065 | 0.002879 |
| -1981.20 | 0.002865 | 0.002705 | 0.002571 |
| -2133.60 | 0.002588 | 0.002443 | 0.002315 |
| -2286.00 | 0.002311 | 0.002224 | 0.002113 |
| -2438.40 | 0.002043 | 0.002002 | 0.001935 |
| -2590.80 | 0.001820 | 0.001786 | 0.001754 |
| -2743.20 | 0.001640 | 0.001605 | 0.001577 |
| -2895.60 | 0.001477 | 0.001457 | 0.001429 |
| -3048.00 | 0.001341 | 0.001321 | 0.001306 |

```
*** ISCLT2 - VERSION 93109 ***     *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data    ***      08/10/93
                                   *** OU1,3,4 PM10        FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93    ***      07:27:34
*** MODELING OPTIONS USED:  CONC   RURAL  FLAT   FLGPOL DFAULT                                                      PAGE  49

                          *** THE ANNUAL AVERAGE CONCENTRATION   VALUES FOR SOURCE GROUP: OU3CONPM ***
                              INCLUDING SOURCE(S):      SWSWPROD, SWSEPROD, SWNWPROD, SWNEPROD, SESWPROD, SESEPROD, SENWPROD,
      SENEPROD, NWSWPROD, NWSEPROD, NWNWPROD, NWNEPROD, NESWPROD, NESEPROD, NENWPROD, NENEPROD, CTRMPROD, SRGLPROD, WWPIPROD,

                                   *** DISCRETE CARTESIAN RECEPTOR POINTS ***

                                 ** CONC OF OTHER    IN G/M3-OR-PCI/M3                          **

     X-COORD (M)  Y-COORD (M)        CONC                    X-COORD (M)  Y-COORD (M)        CONC
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
        5334.00       1676.00       0.001181                  5944.00       2896.00       0.000888
        -122.00      -3048.00       0.001145                   335.00       -366.00       0.003346
         518.00       -671.00       0.008502                   732.00      -1463.00       0.007018
         183.00        366.00       0.000970                   732.00      -1951.00       0.003671

*** ISCLT2 - VERSION 93109 ***     *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data    ***      08/10/93
                                   *** OU1,3,4 PM10        FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93    ***      07:27:34
*** MODELING OPTIONS USED:  CONC   RURAL  FLAT   FLGPOL DFAULT                                                      PAGE  50

                          *** THE ANNUAL AVERAGE CONCENTRATION   VALUES FOR SOURCE GROUP: OU3CONPM ***
                              INCLUDING SOURCE(S):      SWSWPROD, SWSEPROD, SWNWPROD, SWNEPROD, SESWPROD, SESEPROD, SENWPROD,
      SENEPROD, NWSWPROD, NWSEPROD, NWNWPROD, NWNEPROD, NESWPROD, NESEPROD, NENWPROD, NENEPROD, CTRMPROD, SRGLPROD, WWPIPROD,

                                 ** CONC OF OTHER    IN G/M3-OR-PCI/M3                          **

BOUNDARY RECEPTOR NETWORK OF SOURCE ID: BRDRORIG
    OF SOURCE TYPE:   AREA  ; WITH ORIGIN AT (    608.00,    -695.00,       0.00)
(SEC.) X-COORD    Y-COORD       CONC      (SEC.) X-COORD    Y-COORD       CONC      (SEC.) X-COORD    Y-COORD       CONC
  1     795.0,     365.6,     0.003239     2     994.5,     366.9,     0.005646     3    1223.0,     370.2,     0.008869
  4    1543.9,     420.4,     0.011540     5    2127.8,     580.3,     0.008452     6    2115.8,     175.5,     0.012362
  7    2065.5,    -164.5,     0.017489     8    2071.4,    -437.0,     0.020140     9    2077.0,    -695.0,     0.024699
 10    2083.2,    -955.1,     0.017378    11    2085.2,   -1232.7,     0.010814    12    2095.8,   -1554.0,     0.006409
 13    1950.9,   -1821.8,     0.004784    14    1612.0,   -1891.6,     0.004789    15    1343.0,   -1968.1,     0.004471
 16    1098.1,   -2041.6,     0.003990    17     837.6,   -1996.9,     0.003717    18     608.0,   -1655.0,     0.004711
 19     474.8,   -1450.3,     0.005514    20     382.3,   -1315.2,     0.005749    21     329.0,   -1178.2,     0.005780
 22     324.5,   -1032.8,     0.006034    23     303.9,    -950.2,     0.005878    24     247.7,    -903.0,     0.005291
 25     289.4,    -810.9,     0.005505    26     274.2,    -753.9,     0.005238    27     258.0,    -695.0,     0.004858
 28     233.8,    -629.0,     0.004293    29     215.2,    -552.0,     0.003718    30     185.4,    -451.0,     0.003026
 31     175.2,    -331.8,     0.002372    32      95.7,     -84.5,     0.001283    33      10.5,     339.9,     0.000814
 34     220.5,     369.7,     0.001019    35     421.2,     364.7,     0.001449    36     608.0,     365.0,     0.002119

*** ISCLT2 - VERSION 93109 ***     *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data    ***      08/10/93
                                   *** OU1,3,4 PM10        FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93    ***      07:27:34
*** MODELING OPTIONS USED:  CONC   RURAL  FLAT   FLGPOL DFAULT                                                      PAGE  51

                          *** THE ANNUAL AVERAGE CONCENTRATION   VALUES FOR SOURCE GROUP: OU3HOTPM ***
                              INCLUDING SOURCE(S):      PRODHOT1, PRODHOT2,
```

*** NETWORK ID: COARSE1 ; NETWORK TYPE: GRIDCART ***

** CONC OF OTHER IN G/M3-OR-PCI/M3 **

| Y-COORD (METERS) | X-COORD (METERS) -1219.20 | -1066.80 | -914.40 | -762.00 | -609.60 | -457.20 | -304.80 | -152.40 | 0.00 |
|---|---|---|---|---|---|---|---|---|---|
| 1371.60 | 0.000016 | 0.000017 | 0.000020 | 0.000022 | 0.000024 | 0.000028 | 0.000031 | 0.000035 | 0.000039 |
| 1219.20 | 0.000017 | 0.000018 | 0.000019 | 0.000022 | 0.000025 | 0.000027 | 0.000032 | 0.000036 | 0.000041 |
| 1066.80 | 0.000018 | 0.000019 | 0.000020 | 0.000021 | 0.000025 | 0.000029 | 0.000032 | 0.000038 | 0.000043 |
| 914.40 | 0.000018 | 0.000020 | 0.000021 | 0.000023 | 0.000024 | 0.000029 | 0.000033 | 0.000037 | 0.000045 |
| 762.00 | 0.000019 | 0.000020 | 0.000022 | 0.000024 | 0.000026 | 0.000028 | 0.000034 | 0.000039 | 0.000044 |
| 609.60 | 0.000021 | 0.000022 | 0.000023 | 0.000025 | 0.000027 | 0.000030 | 0.000033 | 0.000040 | 0.000047 |
| 457.20 | 0.000024 | 0.000025 | 0.000026 | 0.000027 | 0.000029 | 0.000031 | 0.000035 | 0.000039 | 0.000048 |
| 304.80 | 0.000026 | 0.000028 | 0.000030 | 0.000032 | 0.000033 | 0.000035 | 0.000038 | 0.000041 | 0.000047 |
| 152.40 | 0.000028 | 0.000030 | 0.000033 | 0.000036 | 0.000039 | 0.000042 | 0.000045 | 0.000048 | 0.000052 |
| 0.00 | 0.000031 | 0.000033 | 0.000036 | 0.000039 | 0.000043 | 0.000048 | 0.000054 | 0.000059 | 0.000065 |
| -152.40 | 0.000034 | 0.000037 | 0.000040 | 0.000043 | 0.000048 | 0.000052 | 0.000059 | 0.000068 | 0.000079 |
| -304.80 | 0.000037 | 0.000040 | 0.000044 | 0.000048 | 0.000053 | 0.000059 | 0.000066 | 0.000075 | 0.000086 |
| -457.20 | 0.000040 | 0.000044 | 0.000049 | 0.000054 | 0.000060 | 0.000068 | 0.000077 | 0.000089 | 0.000103 |
| -609.60 | 0.000061 | 0.000068 | 0.000076 | 0.000086 | 0.000098 | 0.000114 | 0.000133 | 0.000159 | 0.000192 |
| -762.00 | 0.000070 | 0.000079 | 0.000089 | 0.000101 | 0.000116 | 0.000134 | 0.000158 | 0.000189 | 0.000229 |
| -914.40 | 0.000081 | 0.000091 | 0.000102 | 0.000117 | 0.000134 | 0.000156 | 0.000183 | 0.000219 | 0.000266 |
| -1066.80 | 0.000090 | 0.000102 | 0.000115 | 0.000131 | 0.000150 | 0.000175 | 0.000207 | 0.000255 | 0.000318 |
| -1219.20 | 0.000099 | 0.000111 | 0.000126 | 0.000143 | 0.000167 | 0.000198 | 0.000239 | 0.000274 | 0.000314 |
| -1371.60 | 0.000107 | 0.000120 | 0.000138 | 0.000160 | 0.000184 | 0.000206 | 0.000231 | 0.000251 | 0.000272 |
| -1524.00 | 0.000116 | 0.000132 | 0.000147 | 0.000162 | 0.000177 | 0.000189 | 0.000202 | 0.000216 | 0.000233 |
| -1676.40 | 0.000121 | 0.000131 | 0.000140 | 0.000148 | 0.000157 | 0.000167 | 0.000178 | 0.000189 | 0.000210 |
| -1828.80 | 0.000114 | 0.000120 | 0.000126 | 0.000133 | 0.000141 | 0.000149 | 0.000156 | 0.000172 | 0.000185 |
| -1981.20 | 0.000105 | 0.000110 | 0.000115 | 0.000121 | 0.000126 | 0.000132 | 0.000143 | 0.000153 | 0.000153 |
| -2133.60 | 0.000096 | 0.000100 | 0.000105 | 0.000109 | 0.000113 | 0.000122 | 0.000128 | 0.000129 | 0.000141 |
| -2286.00 | 0.000088 | 0.000092 | 0.000095 | 0.000098 | 0.000105 | 0.000110 | 0.000110 | 0.000119 | 0.000124 |
| -2438.40 | 0.000081 | 0.000084 | 0.000086 | 0.000091 | 0.000095 | 0.000095 | 0.000102 | 0.000106 | 0.000110 |
| -2590.80 | 0.000074 | 0.000076 | 0.000080 | 0.000083 | 0.000083 | 0.000089 | 0.000092 | 0.000095 | 0.000102 |
| -2743.20 | 0.000068 | 0.000071 | 0.000074 | 0.000073 | 0.000078 | 0.000081 | 0.000083 | 0.000089 | 0.000095 |
| -2895.60 | 0.000064 | 0.000066 | 0.000065 | 0.000070 | 0.000071 | 0.000073 | 0.000078 | 0.000084 | 0.000089 |
| -3048.00 | 0.000059 | 0.000059 | 0.000062 | 0.000064 | 0.000065 | 0.000070 | 0.000074 | 0.000078 | 0.000084 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 52

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: OU3HOTPM ***
INCLUDING SOURCE(S): PRODHOT1, PRODHOT2,

*** NETWORK ID: COARSE1 ; NETWORK TYPE: GRIDCART ***

** CONC OF OTHER IN G/M3-OR-PCI/M3 **

| Y-COORD (METERS) | X-COORD (METERS) 152.40 | 304.80 | 457.20 | 609.60 | 762.00 | 914.40 | 1066.80 | 1219.20 | 1371.60 |
|---|---|---|---|---|---|---|---|---|---|
| 1371.60 | 0.000044 | 0.000058 | 0.000068 | 0.000081 | 0.000100 | 0.000113 | 0.000140 | 0.000173 | 0.000190 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1219.20 | 0.000046 | 0.000058 | 0.000073 | 0.000084 | 0.000108 | 0.000125 | 0.000156 | 0.000196 | 0.000216 |
| 1066.80 | 0.000048 | 0.000056 | 0.000078 | 0.000091 | 0.000113 | 0.000139 | 0.000176 | 0.000224 | 0.000247 |
| 914.40 | 0.000051 | 0.000058 | 0.000079 | 0.000100 | 0.000119 | 0.000155 | 0.000200 | 0.000258 | 0.000287 |
| 762.00 | 0.000054 | 0.000063 | 0.000077 | 0.000110 | 0.000129 | 0.000168 | 0.000231 | 0.000303 | 0.000338 |
| 609.60 | 0.000054 | 0.000067 | 0.000079 | 0.000115 | 0.000146 | 0.000182 | 0.000271 | 0.000360 | 0.000404 |
| 457.20 | 0.000058 | 0.000068 | 0.000086 | 0.000117 | 0.000166 | 0.000198 | 0.000316 | 0.000440 | 0.000493 |
| 304.80 | 0.000060 | 0.000074 | 0.000088 | 0.000114 | 0.000187 | 0.000233 | 0.000369 | 0.000552 | 0.000618 |
| 152.40 | 0.000058 | 0.000077 | 0.000098 | 0.000119 | 0.000199 | 0.000288 | 0.000443 | 0.000718 | 0.000881 |
| 0.00 | 0.000070 | 0.000079 | 0.000105 | 0.000138 | 0.000190 | 0.000365 | 0.000593 | 0.000955 | 0.001324 |
| -152.40 | 0.000091 | 0.000103 | 0.000115 | 0.000161 | 0.000219 | 0.000410 | 0.000865 | 0.001499 | 0.002027 |
| -304.80 | 0.000104 | 0.000127 | 0.000160 | 0.000194 | 0.000288 | 0.000515 | 0.001378 | 0.002765 | 0.003232 |
| -457.20 | 0.000123 | 0.000148 | 0.000191 | 0.000262 | 0.000383 | 0.000693 | 0.002751 | 0.007088 | 0.005826 |
| -609.60 | 0.000238 | 0.000305 | 0.000408 | 0.000575 | 0.000896 | 0.001786 | 0.003149 | 0.000969 | 0.008327 |
| -762.00 | 0.000285 | 0.000364 | 0.000502 | 0.000751 | 0.001204 | 0.002135 | 0.004616 | 0.006313 | 0.006162 |
| -914.40 | 0.000343 | 0.000454 | 0.000621 | 0.000789 | 0.001128 | 0.001627 | 0.002267 | 0.002710 | 0.002974 |
| -1066.80 | 0.000389 | 0.000461 | 0.000551 | 0.000692 | 0.000848 | 0.001046 | 0.001373 | 0.001545 | 0.001627 |
| -1219.20 | 0.000354 | 0.000392 | 0.000467 | 0.000545 | 0.000592 | 0.000821 | 0.000878 | 0.000984 | 0.001058 |
| -1371.60 | 0.000295 | 0.000343 | 0.000388 | 0.000401 | 0.000508 | 0.000581 | 0.000607 | 0.000753 | 0.000710 |
| -1524.00 | 0.000264 | 0.000293 | 0.000299 | 0.000342 | 0.000419 | 0.000423 | 0.000500 | 0.000574 | 0.000508 |
| -1676.40 | 0.000229 | 0.000233 | 0.000262 | 0.000294 | 0.000334 | 0.000341 | 0.000422 | 0.000449 | 0.000409 |
| -1828.80 | 0.000187 | 0.000208 | 0.000220 | 0.000254 | 0.000277 | 0.000298 | 0.000355 | 0.000360 | 0.000339 |
| -1981.20 | 0.000169 | 0.000178 | 0.000191 | 0.000229 | 0.000233 | 0.000264 | 0.000294 | 0.000302 | 0.000287 |
| -2133.60 | 0.000147 | 0.000153 | 0.000178 | 0.000197 | 0.000205 | 0.000236 | 0.000246 | 0.000258 | 0.000246 |
| -2286.00 | 0.000129 | 0.000141 | 0.000166 | 0.000171 | 0.000187 | 0.000203 | 0.000212 | 0.000224 | 0.000213 |
| -2438.40 | 0.000119 | 0.000133 | 0.000149 | 0.000151 | 0.000171 | 0.000176 | 0.000186 | 0.000196 | 0.000187 |
| -2590.80 | 0.000110 | 0.000126 | 0.000132 | 0.000140 | 0.000154 | 0.000155 | 0.000166 | 0.000173 | 0.000166 |
| -2743.20 | 0.000104 | 0.000117 | 0.000118 | 0.000131 | 0.000137 | 0.000139 | 0.000148 | 0.000155 | 0.000149 |
| -2895.60 | 0.000099 | 0.000105 | 0.000109 | 0.000121 | 0.000122 | 0.000126 | 0.000134 | 0.000139 | 0.000134 |
| -3048.00 | 0.000094 | 0.000095 | 0.000103 | 0.000109 | 0.000111 | 0.000115 | 0.000121 | 0.000126 | 0.000121 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 53

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: OU3HOTPM ***
INCLUDING SOURCE(S): PRODHOT1, PRODHOT2,

*** NETWORK ID: COARSE1 ; NETWORK TYPE: GRIDCART ***

** CONC OF OTHER IN G/M3-OR-PCI/M3 **

| Y-COORD (METERS) | X-COORD (METERS) 1524.00 | 1676.40 | 1828.80 | 1981.20 | 2133.60 | 2286.00 | 2438.40 | 2590.80 | 2743.20 |
|---|---|---|---|---|---|---|---|---|---|
| 1371.60 | 0.000234 | 0.000256 | 0.000277 | 0.000312 | 0.000306 | 0.000316 | 0.000314 | 0.000292 | 0.000277 |
| 1219.20 | 0.000267 | 0.000293 | 0.000327 | 0.000350 | 0.000342 | 0.000364 | 0.000341 | 0.000319 | 0.000300 |
| 1066.80 | 0.000309 | 0.000339 | 0.000391 | 0.000392 | 0.000400 | 0.000407 | 0.000371 | 0.000348 | 0.000334 |
| 914.40 | 0.000362 | 0.000412 | 0.000459 | 0.000443 | 0.000472 | 0.000448 | 0.000410 | 0.000392 | 0.000365 |
| 762.00 | 0.000431 | 0.000510 | 0.000527 | 0.000528 | 0.000554 | 0.000495 | 0.000469 | 0.000434 | 0.000384 |
| 609.60 | 0.000534 | 0.000639 | 0.000612 | 0.000644 | 0.000624 | 0.000574 | 0.000526 | 0.000460 | 0.000430 |
| 457.20 | 0.000695 | 0.000759 | 0.000736 | 0.000799 | 0.000730 | 0.000655 | 0.000565 | 0.000524 | 0.000441 |
| 304.80 | 0.000926 | 0.000915 | 0.000945 | 0.000977 | 0.000842 | 0.000715 | 0.000657 | 0.000540 | 0.000443 |
| 152.40 | 0.001206 | 0.001139 | 0.001304 | 0.001155 | 0.000940 | 0.000852 | 0.000681 | 0.000542 | 0.000477 |
| 0.00 | 0.001583 | 0.001688 | 0.001726 | 0.001314 | 0.001161 | 0.000902 | 0.000710 | 0.000608 | 0.000533 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| -152.40 | 0.002331 | 0.002546 | 0.002113 | 0.001769 | 0.001306 | 0.000984 | 0.000817 | 0.000684 | 0.000560 |
| -304.80 | 0.003796 | 0.004127 | 0.003132 | 0.002142 | 0.001470 | 0.001140 | 0.000854 | 0.000666 | 0.000535 |
| -457.20 | 0.007349 | 0.007837 | 0.004211 | 0.002365 | 0.001551 | 0.001082 | 0.000825 | 0.000677 | 0.000568 |
| -609.60 | 0.002696 | 0.011235 | 0.004993 | 0.002644 | 0.001806 | 0.001329 | 0.001025 | 0.000825 | 0.000680 |
| -762.00 | 0.006532 | 0.006102 | 0.003468 | 0.002162 | 0.001471 | 0.001064 | 0.000830 | 0.000680 | 0.000570 |
| -914.40 | 0.003031 | 0.002760 | 0.002138 | 0.001647 | 0.001272 | 0.001031 | 0.000798 | 0.000640 | 0.000529 |
| -1066.80 | 0.001662 | 0.001559 | 0.001275 | 0.001166 | 0.000955 | 0.000808 | 0.000709 | 0.000621 | 0.000523 |
| -1219.20 | 0.001057 | 0.001004 | 0.000957 | 0.000763 | 0.000743 | 0.000636 | 0.000555 | 0.000505 | 0.000463 |
| -1371.60 | 0.000796 | 0.000640 | 0.000704 | 0.000621 | 0.000544 | 0.000538 | 0.000466 | 0.000407 | 0.000379 |
| -1524.00 | 0.000614 | 0.000516 | 0.000489 | 0.000505 | 0.000445 | 0.000412 | 0.000411 | 0.000364 | 0.000323 |
| -1676.40 | 0.000473 | 0.000431 | 0.000380 | 0.000395 | 0.000368 | 0.000347 | 0.000324 | 0.000325 | 0.000293 |
| -1828.80 | 0.000374 | 0.000366 | 0.000316 | 0.000319 | 0.000301 | 0.000289 | 0.000279 | 0.000263 | 0.000264 |
| -1981.20 | 0.000307 | 0.000300 | 0.000277 | 0.000261 | 0.000265 | 0.000234 | 0.000237 | 0.000230 | 0.000218 |
| -2133.60 | 0.000263 | 0.000249 | 0.000244 | 0.000219 | 0.000226 | 0.000211 | 0.000196 | 0.000199 | 0.000194 |
| -2286.00 | 0.000227 | 0.000210 | 0.000212 | 0.000197 | 0.000192 | 0.000191 | 0.000173 | 0.000167 | 0.000170 |
| -2438.40 | 0.000199 | 0.000185 | 0.000182 | 0.000178 | 0.000164 | 0.000170 | 0.000158 | 0.000150 | 0.000145 |
| -2590.80 | 0.000176 | 0.000164 | 0.000157 | 0.000161 | 0.000148 | 0.000148 | 0.000145 | 0.000135 | 0.000131 |
| -2743.20 | 0.000157 | 0.000147 | 0.000140 | 0.000141 | 0.000136 | 0.000129 | 0.000133 | 0.000123 | 0.000119 |
| -2895.60 | 0.000141 | 0.000133 | 0.000127 | 0.000125 | 0.000126 | 0.000115 | 0.000118 | 0.000114 | 0.000108 |
| -3048.00 | 0.000127 | 0.000121 | 0.000116 | 0.000112 | 0.000113 | 0.000108 | 0.000105 | 0.000106 | 0.000099 |

*** ISCLT2 - VERSION 93109 ***  *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data ***  08/10/93
*** OU1,3,4 PM10  FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 ***  07:27:34
PAGE 54

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: OU3HOTPM ***
INCLUDING SOURCE(S): PRODHOT1, PRODHOT2,

*** NETWORK ID: COARSE1 ; NETWORK TYPE: GRIDCART ***

** CONC OF OTHER IN G/M3-OR-PCI/M3 **

| Y-COORD (METERS) | X-COORD (METERS) 2895.60 | 3048.00 | 3200.40 |
|---|---|---|---|
| 1371.60 | 0.000261 | 0.000252 | 0.000238 |
| 1219.20 | 0.000288 | 0.000271 | 0.000246 |
| 1066.80 | 0.000312 | 0.000281 | 0.000268 |
| 914.40 | 0.000326 | 0.000309 | 0.000272 |
| 762.00 | 0.000361 | 0.000315 | 0.000273 |
| 609.60 | 0.000369 | 0.000316 | 0.000284 |
| 457.20 | 0.000371 | 0.000329 | 0.000293 |
| 304.80 | 0.000387 | 0.000346 | 0.000312 |
| 152.40 | 0.000422 | 0.000380 | 0.000338 |
| 0.00 | 0.000463 | 0.000402 | 0.000341 |
| -152.40 | 0.000461 | 0.000385 | 0.000336 |
| -304.80 | 0.000459 | 0.000400 | 0.000352 |
| -457.20 | 0.000484 | 0.000418 | 0.000366 |
| -609.60 | 0.000572 | 0.000489 | 0.000424 |
| -762.00 | 0.000486 | 0.000420 | 0.000367 |
| -914.40 | 0.000455 | 0.000396 | 0.000349 |
| -1066.80 | 0.000441 | 0.000377 | 0.000332 |
| -1219.20 | 0.000419 | 0.000374 | 0.000325 |
| -1371.60 | 0.000351 | 0.000330 | 0.000305 |

| | | | |
|---|---|---|---|
| -1524.00 | 0.000295 | 0.000277 | 0.000261 |
| -1676.40 | 0.000264 | 0.000245 | 0.000227 |
| -1828.80 | 0.000241 | 0.000221 | 0.000207 |
| -1981.20 | 0.000220 | 0.000203 | 0.000188 |
| -2133.60 | 0.000184 | 0.000186 | 0.000174 |
| -2286.00 | 0.000166 | 0.000159 | 0.000160 |
| -2438.40 | 0.000147 | 0.000144 | 0.000138 |
| -2590.80 | 0.000127 | 0.000128 | 0.000126 |
| -2743.20 | 0.000116 | 0.000112 | 0.000114 |
| -2895.60 | 0.000106 | 0.000103 | 0.000100 |
| -3048.00 | 0.000097 | 0.000095 | 0.000093 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 55

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: OU3HOTPM ***
INCLUDING SOURCE(S): PRODHOT1, PRODHOT2,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF OTHER IN G/M3-OR-PCI/M3 **

| X-COORD (M) | Y-COORD (M) | CONC | X-COORD (M) | Y-COORD (M) | CONC |
|---|---|---|---|---|---|
| 5334.00 | 1676.00 | 0.000088 | 5944.00 | 2896.00 | 0.000066 |
| -122.00 | -3048.00 | 0.000079 | 335.00 | -366.00 | 0.000139 |
| 518.00 | -671.00 | 0.000510 | 732.00 | -1463.00 | 0.000439 |
| 183.00 | 366.00 | 0.000064 | 732.00 | -1951.00 | 0.000241 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 56

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: OU3HOTPM ***
INCLUDING SOURCE(S): PRODHOT1, PRODHOT2,

** CONC OF OTHER IN G/M3-OR-PCI/M3 **

BOUNDARY RECEPTOR NETWORK OF SOURCE ID: BRDRORIG
OF SOURCE TYPE: AREA ; WITH ORIGIN AT ( 608.00, -695.00, 0.00)

| (SEC.) | X-COORD | Y-COORD | CONC | (SEC.) | X-COORD | Y-COORD | CONC | (SEC.) | X-COORD | Y-COORD | CONC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 795.0, | 365.6, | 0.000188 | 2 | 994.5, | 366.9, | 0.000249 | 3 | 1223.0, | 370.2, | 0.000501 |
| 4 | 1543.9, | 420.4, | 0.000773 | 5 | 2127.8, | 580.3, | 0.000641 | 6 | 2115.8, | 175.5, | 0.000932 |
| 7 | 2065.5, | -164.5, | 0.001534 | 8 | 2071.4, | -437.0, | 0.001813 | 9 | 2077.0, | -695.0, | 0.001862 |
| 10 | 2083.2, | -955.1, | 0.001270 | 11 | 2085.2, | -1232.7, | 0.000731 | 12 | 2095.8, | -1554.0, | 0.000447 |
| 13 | 1950.9, | -1821.8, | 0.000320 | 14 | 1612.0, | -1891.6, | 0.000345 | 15 | 1343.0, | -1968.1, | 0.000290 |
| 16 | 1098.1, | -2041.6, | 0.000278 | 17 | 837.6, | -1996.9, | 0.000242 | 18 | 608.0, | -1655.0, | 0.000301 |
| 19 | 474.8, | -1450.3, | 0.000337 | 20 | 382.3, | -1315.2, | 0.000391 | 21 | 329.0, | -1178.2, | 0.000422 |
| 22 | 324.5, | -1032.8, | 0.000481 | 23 | 303.9, | -950.2, | 0.000472 | 24 | 247.7, | -903.0, | 0.000401 |
| 25 | 289.4, | -810.9, | 0.000376 | 26 | 274.2, | -753.9, | 0.000343 | 27 | 258.0, | -695.0, | 0.000315 |
| 28 | 233.8, | -629.0, | 0.000280 | 29 | 215.2, | -552.0, | 0.000215 | 30 | 185.4, | -451.0, | 0.000122 |
| 31 | 175.2, | -331.8, | 0.000109 | 32 | 95.7, | -84.5, | 0.000079 | 33 | 10.5, | 339.9, | 0.000047 |
| 34 | 220.5, | 369.7, | 0.000066 | 35 | 421.2, | 364.7, | 0.000082 | 36 | 608.0, | 365.0, | 0.000116 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 57

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: OU4CONPM ***
INCLUDING SOURCE(S): STHSILO4, NTHSILO4,

*** NETWORK ID: COARSE1 ; NETWORK TYPE: GRIDCART ***

** CONC OF OTHER IN G/M3-OR-PCI/M3 **

| Y-COORD (METERS) | X-COORD (METERS) -1219.20 | -1066.80 | -914.40 | -762.00 | -609.60 | -457.20 | -304.80 | -152.40 | 0.00 |
|---|---|---|---|---|---|---|---|---|---|
| 1371.60 | 0.000009 | 0.000011 | 0.000012 | 0.000014 | 0.000016 | 0.000018 | 0.000022 | 0.000028 | 0.000034 |
| 1219.20 | 0.000009 | 0.000011 | 0.000012 | 0.000014 | 0.000016 | 0.000019 | 0.000021 | 0.000030 | 0.000036 |
| 1066.80 | 0.000009 | 0.000011 | 0.000012 | 0.000015 | 0.000017 | 0.000020 | 0.000022 | 0.000031 | 0.000039 |
| 914.40 | 0.000009 | 0.000011 | 0.000013 | 0.000015 | 0.000017 | 0.000020 | 0.000024 | 0.000029 | 0.000042 |
| 762.00 | 0.000010 | 0.000011 | 0.000013 | 0.000015 | 0.000018 | 0.000021 | 0.000025 | 0.000030 | 0.000046 |
| 609.60 | 0.000010 | 0.000011 | 0.000012 | 0.000015 | 0.000019 | 0.000022 | 0.000027 | 0.000033 | 0.000044 |
| 457.20 | 0.000011 | 0.000012 | 0.000013 | 0.000015 | 0.000019 | 0.000024 | 0.000028 | 0.000035 | 0.000043 |
| 304.80 | 0.000012 | 0.000013 | 0.000014 | 0.000016 | 0.000018 | 0.000023 | 0.000031 | 0.000037 | 0.000048 |
| 152.40 | 0.000013 | 0.000014 | 0.000015 | 0.000018 | 0.000020 | 0.000023 | 0.000031 | 0.000041 | 0.000052 |
| 0.00 | 0.000015 | 0.000017 | 0.000018 | 0.000020 | 0.000022 | 0.000026 | 0.000030 | 0.000042 | 0.000060 |
| -152.40 | 0.000018 | 0.000019 | 0.000022 | 0.000025 | 0.000028 | 0.000031 | 0.000034 | 0.000042 | 0.000063 |
| -304.80 | 0.000020 | 0.000023 | 0.000025 | 0.000029 | 0.000033 | 0.000040 | 0.000048 | 0.000056 | 0.000067 |
| -457.20 | 0.000023 | 0.000026 | 0.000030 | 0.000034 | 0.000040 | 0.000048 | 0.000058 | 0.000076 | 0.000105 |
| -609.60 | 0.000029 | 0.000034 | 0.000040 | 0.000047 | 0.000057 | 0.000071 | 0.000091 | 0.000124 | 0.000179 |
| -762.00 | 0.000041 | 0.000049 | 0.000058 | 0.000071 | 0.000088 | 0.000113 | 0.000150 | 0.000212 | 0.000320 |
| -914.40 | 0.000051 | 0.000060 | 0.000072 | 0.000088 | 0.000110 | 0.000141 | 0.000189 | 0.000277 | 0.000414 |
| -1066.80 | 0.000059 | 0.000070 | 0.000084 | 0.000103 | 0.000131 | 0.000173 | 0.000219 | 0.000270 | 0.000324 |
| -1219.20 | 0.000066 | 0.000079 | 0.000096 | 0.000118 | 0.000141 | 0.000159 | 0.000178 | 0.000203 | 0.000257 |
| -1371.60 | 0.000074 | 0.000086 | 0.000098 | 0.000107 | 0.000117 | 0.000130 | 0.000142 | 0.000169 | 0.000182 |
| -1524.00 | 0.000072 | 0.000077 | 0.000084 | 0.000091 | 0.000099 | 0.000106 | 0.000122 | 0.000128 | 0.000139 |
| -1676.40 | 0.000064 | 0.000068 | 0.000073 | 0.000078 | 0.000082 | 0.000092 | 0.000095 | 0.000103 | 0.000118 |
| -1828.80 | 0.000057 | 0.000060 | 0.000063 | 0.000066 | 0.000073 | 0.000074 | 0.000079 | 0.000090 | 0.000102 |
| -1981.20 | 0.000050 | 0.000052 | 0.000054 | 0.000059 | 0.000060 | 0.000063 | 0.000071 | 0.000079 | 0.000094 |
| -2133.60 | 0.000044 | 0.000045 | 0.000049 | 0.000049 | 0.000052 | 0.000058 | 0.000064 | 0.000070 | 0.000086 |
| -2286.00 | 0.000038 | 0.000041 | 0.000042 | 0.000044 | 0.000048 | 0.000053 | 0.000058 | 0.000064 | 0.000073 |
| -2438.40 | 0.000035 | 0.000036 | 0.000037 | 0.000041 | 0.000044 | 0.000048 | 0.000052 | 0.000062 | 0.000062 |
| -2590.80 | 0.000031 | 0.000032 | 0.000035 | 0.000038 | 0.000041 | 0.000044 | 0.000048 | 0.000055 | 0.000056 |
| -2743.20 | 0.000028 | 0.000030 | 0.000033 | 0.000035 | 0.000038 | 0.000040 | 0.000046 | 0.000048 | 0.000050 |
| -2895.60 | 0.000027 | 0.000029 | 0.000031 | 0.000033 | 0.000035 | 0.000037 | 0.000043 | 0.000043 | 0.000046 |
| -3048.00 | 0.000025 | 0.000027 | 0.000029 | 0.000031 | 0.000033 | 0.000035 | 0.000038 | 0.000039 | 0.000041 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 58

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: OU4CONPM ***
INCLUDING SOURCE(S): STHSILO4, NTHSILO4,

*** NETWORK ID: COARSE1 ; NETWORK TYPE: GRIDCART ***

** CONC OF OTHER IN G/M3-OR-PCI/M3 **

| Y-COORD (METERS) | X-COORD (METERS) 152.40 | 304.80 | 457.20 | 609.60 | 762.00 | 914.40 | 1066.80 | 1219.20 | 1371.60 |
|---|---|---|---|---|---|---|---|---|---|
| 1371.60 | 0.000039 | 0.000045 | 0.000051 | 0.000070 | 0.000078 | 0.000088 | 0.000096 | 0.000102 | 0.000110 |
| 1219.20 | 0.000043 | 0.000050 | 0.000057 | 0.000080 | 0.000090 | 0.000101 | 0.000110 | 0.000117 | 0.000133 |
| 1066.80 | 0.000047 | 0.000056 | 0.000064 | 0.000092 | 0.000104 | 0.000117 | 0.000128 | 0.000137 | 0.000149 |
| 914.40 | 0.000052 | 0.000063 | 0.000073 | 0.000108 | 0.000123 | 0.000138 | 0.000150 | 0.000172 | 0.000165 |
| 762.00 | 0.000057 | 0.000071 | 0.000084 | 0.000128 | 0.000147 | 0.000166 | 0.000179 | 0.000208 | 0.000186 |
| 609.60 | 0.000064 | 0.000081 | 0.000098 | 0.000155 | 0.000179 | 0.000202 | 0.000231 | 0.000233 | 0.000213 |
| 457.20 | 0.000073 | 0.000093 | 0.000117 | 0.000193 | 0.000223 | 0.000251 | 0.000305 | 0.000270 | 0.000245 |
| 304.80 | 0.000076 | 0.000109 | 0.000141 | 0.000247 | 0.000286 | 0.000333 | 0.000365 | 0.000319 | 0.000283 |
| 152.40 | 0.000072 | 0.000134 | 0.000177 | 0.000332 | 0.000386 | 0.000496 | 0.000435 | 0.000380 | 0.000354 |
| 0.00 | 0.000079 | 0.000161 | 0.000232 | 0.000476 | 0.000558 | 0.000686 | 0.000550 | 0.000498 | 0.000378 |
| -152.40 | 0.000097 | 0.000161 | 0.000326 | 0.000741 | 0.000986 | 0.000895 | 0.000782 | 0.000549 | 0.000397 |
| -304.80 | 0.000105 | 0.000184 | 0.000499 | 0.001303 | 0.001822 | 0.001420 | 0.000894 | 0.000612 | 0.000476 |
| -457.20 | 0.000146 | 0.000248 | 0.000717 | 0.003363 | 0.003506 | 0.001891 | 0.001131 | 0.000739 | 0.000495 |
| -609.60 | 0.000291 | 0.000557 | 0.001742 | 0.004631 | 0.006400 | 0.002383 | 0.001246 | 0.000780 | 0.000550 |
| -762.00 | 0.000564 | 0.001157 | 0.003190 | 0.002924 | 0.004862 | 0.002193 | 0.001191 | 0.000754 | 0.000534 |
| -914.40 | 0.000616 | 0.000961 | 0.001578 | 0.002276 | 0.001824 | 0.001287 | 0.000917 | 0.000658 | 0.000472 |
| -1066.80 | 0.000445 | 0.000538 | 0.000824 | 0.000989 | 0.000884 | 0.000713 | 0.000583 | 0.000446 | 0.000383 |
| -1219.20 | 0.000290 | 0.000363 | 0.000460 | 0.000583 | 0.000495 | 0.000408 | 0.000397 | 0.000349 | 0.000281 |
| -1371.60 | 0.000203 | 0.000297 | 0.000304 | 0.000385 | 0.000303 | 0.000320 | 0.000253 | 0.000255 | 0.000235 |
| -1524.00 | 0.000168 | 0.000215 | 0.000224 | 0.000274 | 0.000224 | 0.000233 | 0.000194 | 0.000180 | 0.000182 |
| -1676.40 | 0.000153 | 0.000160 | 0.000174 | 0.000208 | 0.000174 | 0.000165 | 0.000164 | 0.000145 | 0.000136 |
| -1828.80 | 0.000129 | 0.000131 | 0.000140 | 0.000165 | 0.000141 | 0.000131 | 0.000139 | 0.000119 | 0.000114 |
| -1981.20 | 0.000103 | 0.000110 | 0.000116 | 0.000134 | 0.000117 | 0.000110 | 0.000108 | 0.000102 | 0.000096 |
| -2133.60 | 0.000087 | 0.000093 | 0.000098 | 0.000112 | 0.000098 | 0.000094 | 0.000088 | 0.000092 | 0.000082 |
| -2286.00 | 0.000076 | 0.000081 | 0.000084 | 0.000095 | 0.000084 | 0.000081 | 0.000076 | 0.000077 | 0.000071 |
| -2438.40 | 0.000067 | 0.000070 | 0.000073 | 0.000082 | 0.000073 | 0.000071 | 0.000067 | 0.000064 | 0.000065 |
| -2590.80 | 0.000059 | 0.000062 | 0.000064 | 0.000071 | 0.000064 | 0.000062 | 0.000060 | 0.000056 | 0.000059 |
| -2743.20 | 0.000053 | 0.000055 | 0.000057 | 0.000063 | 0.000057 | 0.000055 | 0.000053 | 0.000051 | 0.000049 |
| -2895.60 | 0.000048 | 0.000050 | 0.000051 | 0.000056 | 0.000051 | 0.000050 | 0.000048 | 0.000046 | 0.000044 |
| -3048.00 | 0.000043 | 0.000045 | 0.000046 | 0.000050 | 0.000046 | 0.000045 | 0.000044 | 0.000042 | 0.000040 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 59

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: OU4CONPM ***
INCLUDING SOURCE(S): STHSILO4, NTHSILO4,

*** NETWORK ID: COARSE1 ; NETWORK TYPE: GRIDCART ***

** CONC OF OTHER IN G/M3-OR-PCI/M3 **

| Y-COORD (METERS) | X-COORD (METERS) 1524.00 | 1676.40 | 1828.80 | 1981.20 | 2133.60 | 2286.00 | 2438.40 | 2590.80 | 2743.20 |
|---|---|---|---|---|---|---|---|---|---|
| 1371.60 | 0.000114 | 0.000107 | 0.000102 | 0.000097 | 0.000091 | 0.000086 | 0.000081 | 0.000078 | 0.000071 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1219.20 | 0.000124 | 0.000118 | 0.000111 | 0.000105 | 0.000098 | 0.000092 | 0.000089 | 0.000080 | 0.000072 |
| 1066.80 | 0.000138 | 0.000130 | 0.000122 | 0.000114 | 0.000106 | 0.000102 | 0.000091 | 0.000081 | 0.000075 |
| 914.40 | 0.000154 | 0.000144 | 0.000133 | 0.000123 | 0.000119 | 0.000105 | 0.000093 | 0.000085 | 0.000077 |
| 762.00 | 0.000173 | 0.000159 | 0.000146 | 0.000140 | 0.000122 | 0.000107 | 0.000097 | 0.000088 | 0.000080 |
| 609.60 | 0.000195 | 0.000177 | 0.000169 | 0.000145 | 0.000125 | 0.000112 | 0.000100 | 0.000091 | 0.000082 |
| 457.20 | 0.000221 | 0.000209 | 0.000176 | 0.000149 | 0.000131 | 0.000116 | 0.000104 | 0.000093 | 0.000083 |
| 304.80 | 0.000266 | 0.000219 | 0.000181 | 0.000157 | 0.000137 | 0.000120 | 0.000106 | 0.000094 | 0.000087 |
| 152.40 | 0.000281 | 0.000226 | 0.000192 | 0.000164 | 0.000142 | 0.000124 | 0.000112 | 0.000102 | 0.000090 |
| 0.00 | 0.000293 | 0.000242 | 0.000201 | 0.000175 | 0.000155 | 0.000134 | 0.000115 | 0.000100 | 0.000090 |
| -152.40 | 0.000316 | 0.000267 | 0.000227 | 0.000189 | 0.000155 | 0.000133 | 0.000118 | 0.000105 | 0.000095 |
| -304.80 | 0.000367 | 0.000283 | 0.000224 | 0.000188 | 0.000162 | 0.000141 | 0.000124 | 0.000110 | 0.000099 |
| -457.20 | 0.000359 | 0.000289 | 0.000238 | 0.000200 | 0.000171 | 0.000148 | 0.000129 | 0.000114 | 0.000102 |
| -609.60 | 0.000410 | 0.000323 | 0.000262 | 0.000218 | 0.000184 | 0.000158 | 0.000138 | 0.000121 | 0.000108 |
| -762.00 | 0.000399 | 0.000315 | 0.000257 | 0.000214 | 0.000181 | 0.000156 | 0.000136 | 0.000119 | 0.000106 |
| -914.40 | 0.000351 | 0.000283 | 0.000233 | 0.000196 | 0.000168 | 0.000146 | 0.000128 | 0.000113 | 0.000101 |
| -1066.80 | 0.000325 | 0.000269 | 0.000218 | 0.000183 | 0.000158 | 0.000138 | 0.000122 | 0.000109 | 0.000097 |
| -1219.20 | 0.000241 | 0.000219 | 0.000200 | 0.000176 | 0.000150 | 0.000130 | 0.000115 | 0.000103 | 0.000093 |
| -1371.60 | 0.000201 | 0.000178 | 0.000158 | 0.000144 | 0.000135 | 0.000124 | 0.000110 | 0.000098 | 0.000088 |
| -1524.00 | 0.000172 | 0.000151 | 0.000137 | 0.000125 | 0.000113 | 0.000103 | 0.000098 | 0.000093 | 0.000086 |
| -1676.40 | 0.000138 | 0.000132 | 0.000118 | 0.000109 | 0.000101 | 0.000093 | 0.000086 | 0.000080 | 0.000075 |
| -1828.80 | 0.000107 | 0.000109 | 0.000105 | 0.000095 | 0.000089 | 0.000084 | 0.000078 | 0.000073 | 0.000068 |
| -1981.20 | 0.000092 | 0.000087 | 0.000088 | 0.000086 | 0.000079 | 0.000075 | 0.000071 | 0.000066 | 0.000063 |
| -2133.60 | 0.000079 | 0.000076 | 0.000072 | 0.000073 | 0.000072 | 0.000067 | 0.000064 | 0.000060 | 0.000057 |
| -2286.00 | 0.000069 | 0.000067 | 0.000064 | 0.000061 | 0.000062 | 0.000061 | 0.000057 | 0.000055 | 0.000052 |
| -2438.40 | 0.000060 | 0.000059 | 0.000057 | 0.000055 | 0.000053 | 0.000053 | 0.000053 | 0.000050 | 0.000048 |
| -2590.80 | 0.000053 | 0.000052 | 0.000051 | 0.000050 | 0.000048 | 0.000046 | 0.000046 | 0.000046 | 0.000043 |
| -2743.20 | 0.000049 | 0.000047 | 0.000046 | 0.000045 | 0.000044 | 0.000042 | 0.000040 | 0.000041 | 0.000041 |
| -2895.60 | 0.000045 | 0.000042 | 0.000041 | 0.000041 | 0.000040 | 0.000039 | 0.000037 | 0.000036 | 0.000036 |
| -3048.00 | 0.000040 | 0.000038 | 0.000037 | 0.000037 | 0.000036 | 0.000035 | 0.000034 | 0.000033 | 0.000032 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 60

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: OU4CONPM ***
INCLUDING SOURCE(S): STHSILO4, NTHSILO4,

*** NETWORK ID: COARSE1 ; NETWORK TYPE: GRIDCART ***

** CONC OF OTHER IN G/M3-OR-PCI/M3 **

| Y-COORD (METERS) | X-COORD (METERS) 2895.60 | 3048.00 | 3200.40 |
|---|---|---|---|
| 1371.60 | 0.000064 | 0.000060 | 0.000056 |
| 1219.20 | 0.000067 | 0.000062 | 0.000057 |
| 1066.80 | 0.000069 | 0.000064 | 0.000059 |
| 914.40 | 0.000071 | 0.000065 | 0.000060 |
| 762.00 | 0.000073 | 0.000066 | 0.000061 |
| 609.60 | 0.000074 | 0.000067 | 0.000062 |
| 457.20 | 0.000075 | 0.000069 | 0.000064 |
| 304.80 | 0.000080 | 0.000072 | 0.000065 |
| 152.40 | 0.000079 | 0.000072 | 0.000066 |
| 0.00 | 0.000082 | 0.000075 | 0.000069 |

| | | | |
|---|---|---|---|
| -152.40 | 0.000086 | 0.000078 | 0.000072 |
| -304.80 | 0.000089 | 0.000081 | 0.000074 |
| -457.20 | 0.000092 | 0.000083 | 0.000076 |
| -609.60 | 0.000097 | 0.000087 | 0.000079 |
| -762.00 | 0.000095 | 0.000086 | 0.000078 |
| -914.40 | 0.000091 | 0.000082 | 0.000075 |
| -1066.80 | 0.000088 | 0.000080 | 0.000073 |
| -1219.20 | 0.000084 | 0.000077 | 0.000071 |
| -1371.60 | 0.000080 | 0.000074 | 0.000068 |
| -1524.00 | 0.000077 | 0.000070 | 0.000065 |
| -1676.40 | 0.000072 | 0.000068 | 0.000063 |
| -1828.80 | 0.000064 | 0.000060 | 0.000058 |
| -1981.20 | 0.000059 | 0.000055 | 0.000052 |
| -2133.60 | 0.000054 | 0.000051 | 0.000049 |
| -2286.00 | 0.000050 | 0.000048 | 0.000045 |
| -2438.40 | 0.000046 | 0.000044 | 0.000042 |
| -2590.80 | 0.000042 | 0.000041 | 0.000039 |
| -2743.20 | 0.000039 | 0.000038 | 0.000036 |
| -2895.60 | 0.000036 | 0.000035 | 0.000034 |
| -3048.00 | 0.000033 | 0.000032 | 0.000031 |

```
*** ISCLT2 - VERSION 93109 ***    *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data    ***        08/10/93
                                  *** OU1,3,4 PM10        FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93    ***        07:27:34
                                                                                                                      PAGE  61

*** MODELING OPTIONS USED:  CONC   RURAL  FLAT   FLGPOL DFAULT

                            *** THE ANNUAL AVERAGE CONCENTRATION   VALUES FOR SOURCE GROUP: OU4CONPM ***
                                INCLUDING SOURCE(S):      STHSIL04, NTHSIL04,

                                      *** DISCRETE CARTESIAN RECEPTOR POINTS ***

                                  ** CONC OF OTHER    IN G/M3-OR-PCI/M3                          **

     X-COORD (M)  Y-COORD (M)        CONC                 X-COORD (M)  Y-COORD (M)        CONC
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
         5334.00       1676.00       0.000024                5944.00       2896.00       0.000019
         -122.00      -3048.00       0.000040                 335.00       -366.00       0.000238
          518.00       -671.00       0.005659                 732.00      -1463.00       0.000256
          183.00        366.00       0.000084                 732.00      -1951.00       0.000122

*** ISCLT2 - VERSION 93109 ***    *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data    ***        08/10/93
                                  *** OU1,3,4 PM10        FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93    ***        07:27:34
                                                                                                                      PAGE  62
*** MODELING OPTIONS USED:  CONC   RURAL  FLAT   FLGPOL DFAULT

                            *** THE ANNUAL AVERAGE CONCENTRATION   VALUES FOR SOURCE GROUP: OU4CONPM ***
                                INCLUDING SOURCE(S):      STHSIL04, NTHSIL04,

                                  ** CONC OF OTHER    IN G/M3-OR-PCI/M3                          **

BOUNDARY RECEPTOR NETWORK OF SOURCE ID: BRDRORIG
    OF SOURCE TYPE:   AREA  ; WITH ORIGIN AT (    608.00,    -695.00,       0.00)
(SEC.) X-COORD    Y-COORD       CONC       (SEC.) X-COORD    Y-COORD       CONC       (SEC.) X-COORD    Y-COORD       CONC
  1     795.0,     365.6,     0.000266      2     994.5,     366.9,     0.000337      3    1223.0,     370.2,     0.000296
  4    1543.9,     420.4,     0.000227      5    2127.8,     580.3,     0.000127      6    2115.8,     175.5,     0.000143
  7    2065.5,    -164.5,     0.000168      8    2071.4,    -437.0,     0.000180      9    2077.0,    -695.0,     0.000199
```

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 2083.2, | -955.1, | 0.000174 | 11 | 2085.2, | -1232.7, | 0.000157 | 12 | 2095.8, | -1554.0, | 0.000113 |
| 13 | 1950.9, | -1821.8, | 0.000097 | 14 | 1612.0, | -1891.6, | 0.000097 | 15 | 1343.0, | -1968.1, | 0.000098 |
| 16 | 1098.1, | -2041.6, | 0.000100 | 17 | 837.6, | -1996.9, | 0.000112 | 18 | 608.0, | -1655.0, | 0.000216 |
| 19 | 474.8, | -1450.3, | 0.000261 | 20 | 382.3, | -1315.2, | 0.000355 | 21 | 329.0, | -1178.2, | 0.000422 |
| 22 | 324.5, | -1032.8, | 0.000636 | 23 | 303.9, | -950.2, | 0.000854 | 24 | 247.7, | -903.0, | 0.000811 |
| 25 | 289.4, | -810.9, | 0.001069 | 26 | 274.2, | -753.9, | 0.000971 | 27 | 258.0, | -695.0, | 0.000727 |
| 28 | 233.8, | -629.0, | 0.000449 | 29 | 215.2, | -552.0, | 0.000257 | 30 | 185.4, | -451.0, | 0.000151 |
| 31 | 175.2, | -331.8, | 0.000115 | 32 | 95.7, | -84.5, | 0.000078 | 33 | 10.5, | 339.9, | 0.000047 |
| 34 | 220.5, | 369.7, | 0.000089 | 35 | 421.2, | 364.7, | 0.000124 | 36 | 608.0, | 365.0, | 0.000222 |

*** ISCLT2 - VERSION 93109 *** *** OU4 CRARE - Annual Conc.: 1 g/s (pCi/s) per m2, 1987-92 Met Data *** 08/10/93
*** OU1,3,4 PM10 FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93 *** 07:27:34
PAGE 63

*** MODELING OPTIONS USED: CONC RURAL FLAT FLGPOL DFAULT

*** THE MAXIMUM 10 ANNUAL AVERAGE CONCENTRATION VALUES FOR GROUP: OU1CONPM ***
INCLUDING SOURCE(S): WASTPIT1, WASTPIT2, WASTPIT3, WASTPIT4, WASTPIT5, WASTPIT6, WASTPIT7,
WASTPIT8,

** CONC OF OTHER IN G/M3-OR-PCI/M3 **

| RANK | CONC | AT | RECEPTOR (XR,YR) OF TYPE | | | RANK | CONC | AT | RECEPTOR (XR,YR) OF TYPE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 0.022478 | AT ( | 762.00, | -304.80) | GC | 6. | 0.010135 | AT ( | 762.00, | -457.20) | GC |
| 2. | 0.021072 | AT ( | 609.60, | -304.80) | GC | 7. | 0.008991 | AT ( | 609.60, | -152.40) | GC |
| 3. | 0.020126 | AT ( | 609.60, | -457.20) | GC | 8. | 0.008686 | AT ( | 914.40, | -304.80) | GC |
| 4. | 0.016157 | AT ( | 762.00, | -152.40) | GC | 9. | 0.008086 | AT ( | 914.40, | -152.40) | GC |
| 5. | 0.010518 | AT ( | 457.20, | -457.20) | GC | 10. | 0.007975 | AT ( | 762.00, | 0.00) | GC |

*** THE MAXIMUM 10 ANNUAL AVERAGE CONCENTRATION VALUES FOR GROUP: OU3CONPM ***
INCLUDING SOURCE(S): SWSWPROD, SWSEPROD, SWNWPROD, SWNEPROD, SESWPROD, SESEPROD, SENWPROD,
SENEPROD, NWSWPROD, NWSEPROD, NWNWPROD, NWNEPROD, NESWPROD, NESEPROD, NENWPROD, NENEPROD, CTRMPROD, SRGLPROD, WWPIPROD,

| RANK | CONC | AT | RECEPTOR (XR,YR) OF TYPE | | | RANK | CONC | AT | RECEPTOR (XR,YR) OF TYPE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 0.056757 | AT ( | 1524.00, | -609.60) | GC | 6. | 0.048839 | AT ( | 1371.60, | -762.00) | GC |
| 2. | 0.052615 | AT ( | 1524.00, | -457.20) | GC | 7. | 0.048526 | AT ( | 1524.00, | -304.80) | GC |
| 3. | 0.051422 | AT ( | 1371.60, | -457.20) | GC | 8. | 0.048360 | AT ( | 1676.40, | -609.60) | GC |
| 4. | 0.051415 | AT ( | 1371.60, | -609.60) | GC | 9. | 0.048050 | AT ( | 1676.40, | -304.80) | GC |
| 5. | 0.049916 | AT ( | 1524.00, | -762.00) | GC | 10. | 0.047823 | AT ( | 1219.20, | -609.60) | GC |

*** THE MAXIMUM 10 ANNUAL AVERAGE CONCENTRATION VALUES FOR GROUP: OU3HOTPM ***
INCLUDING SOURCE(S): PRODHOT1, PRODHOT2,

| RANK | CONC | AT | RECEPTOR (XR,YR) OF TYPE | | | RANK | CONC | AT | RECEPTOR (XR,YR) OF TYPE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | 0.011235 | AT ( | 1676.40, | -609.60) | GC | 6. | 0.006532 | AT ( | 1524.00, | -762.00) | GC |
| 2. | 0.008327 | AT ( | 1371.60, | -609.60) | GC | 7. | 0.006313 | AT ( | 1219.20, | -762.00) | GC |
| 3. | 0.007837 | AT ( | 1676.40, | -457.20) | GC | 8. | 0.006162 | AT ( | 1371.60, | -762.00) | GC |
| 4. | 0.007349 | AT ( | 1524.00, | -457.20) | GC | 9. | 0.006102 | AT ( | 1676.40, | -762.00) | GC |
| 5. | 0.007088 | AT ( | 1219.20, | -457.20) | GC | 10. | 0.005826 | AT ( | 1371.60, | -457.20) | GC |

*** RECEPTOR TYPES: GC = GRIDCART

```
                    GP = GRIDPOLR
                    DC = DISCCART
                    DP = DISCPOLR
                    BD = BOUNDARY

*** ISCLT2 - VERSION 93109 ***    *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data     ***         08/10/93
                                  *** OU1,3,4 PM10          FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93   ***         07:27:34
                                                                                                                        PAGE  64
*** MODELING OPTIONS USED:  CONC    RURAL   FLAT    FLGPOL DFAULT

                    *** THE MAXIMUM   10  ANNUAL  AVERAGE CONCENTRATION    VALUES FOR GROUP:  OU4CONPM ***
                        INCLUDING SOURCE(S):       STHSILO4, NTHSILO4,

                         ** CONC OF OTHER    IN G/M3-OR-PCI/M3                          **

RANK       CONC      AT        RECEPTOR (XR,YR) OF TYPE       RANK       CONC      AT       RECEPTOR (XR,YR) OF TYPE
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
  1.      0.006400 AT (      762.00,     -609.60)  GC          6.       0.003363 AT (     609.60,     -457.20)  GC
  2.      0.005659 AT (      518.00,     -671.00)  DC          7.       0.003190 AT (     457.20,     -762.00)  GC
  3.      0.004862 AT (      762.00,     -762.00)  GC          8.       0.002924 AT (     609.60,     -762.00)  GC
  4.      0.004631 AT (      609.60,     -609.60)  GC          9.       0.002383 AT (     914.40,     -609.60)  GC
  5.      0.003506 AT (      762.00,     -457.20)  GC         10.       0.002276 AT (     609.60,     -914.40)  GC

*** RECEPTOR TYPES:  GC = GRIDCART
                     GP = GRIDPOLR
                     DC = DISCCART
                     DP = DISCPOLR
                     BD = BOUNDARY

*** ISCLT2 - VERSION 93109 ***    *** OU4 CRARE - Annual Conc.:  1 g/s (pCi/s) per m2, 1987-92 Met Data     ***         08/10/93
                                  *** OU1,3,4 PM10          FD Contr No. 04/424331-RHCI J.PEHRSON 8/09/93   ***         07:27:34
                                                                                                                        PAGE  65
*** MODELING OPTIONS USED:  CONC    RURAL   FLAT    FLGPOL DFAULT

*** Message Summary For ISC2 Model Execution ***

 --------- Summary of Total Messages --------

A Total of            0 Fatal Error Message(s)
A Total of            2 Warning Message(s)
A Total of            0 Informational Message(s)

   ******** FATAL ERROR MESSAGES ********
              ***  NONE  ***

   ********  WARNING MESSAGES   ********
SO W320   55 APARM : Source Parameter May Be Out-of-Range for Parameter      QS
RE W216  144 RECART: FLAG Input Inconsistent With Option: Defaults Used COARSE1

   ************************************
   *** ISCLT2 Finishes Successfully ***
   ************************************
```

# ATTACHMENT K.IV

# INTAKE AND RISK CALCULATIONS

# Current Land Use Scenario

**Table K.IV-1**
**Summary of Intake Quantitation (chemicals)**
**Trespassing Child Current Land Use Scenario (age7-18)**
**Via Inhalation of Particulates**

**Intake Equation** = $\frac{CS \times EF \times ED \times IR \times ET}{BW \times AT}$

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 0.83 $m^3$/day |
| ET | Exposure time | 4 hours |
| EF | Exposure frequency | 52 days/year |
| EDn | Exposure duration for non-carcinogens | 12 Year |
| EDc | Exposure duration for carcinogens | 12 Year |
| BW | Body weight | 43 kg |
| ATc | Average time for carcinogens (lifetime) | 25550 days |
| ATn | Average time for non-carcinogens (EDn x 365) | 4380 days |
| CS | Concentration of chemicals in particulate as modeled | (see table below) |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 1.9E-06 | mg/m$^3$ |
| Aroclor-1016 | NA | mg/m$^3$ |
| Aroclor-1221 | 1.3E-09 | mg/m$^3$ |
| Aroclor-1242 | NA | mg/m$^3$ |
| Aroclor-1248 | 8.3E-10 | mg/m$^3$ |
| Aroclor-1254 | 4.3E-08 | mg/m$^3$ |
| Aroclor-1260 | 4.2E-08 | mg/m$^3$ |
| Arsenic | 8.8E-07 | mg/m$^3$ |
| Barium | 5.8E-05 | mg/m$^3$ |
| Beryllium | 7.8E-08 | mg/m$^3$ |
| Cadmium | 3.7E-07 | mg/m$^3$ |
| Chromium | 2.1E-07 | mg/m$^3$ |
| Cobalt | 8.9E-07 | mg/m$^3$ |
| Copper | 3.0E-06 | mg/m$^3$ |
| Cyanide | 2.2E-07 | mg/m$^3$ |
| Di-n-octyl phthalate | 3.5E-09 | mg/m$^3$ |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/m$^3$ |
| Heptachlorodibenzo-p-dioxin | NA | mg/m$^3$ |
| Lead | 8.2E-06 | mg/m$^3$ |
| Manganese | 4.0E-05 | mg/m$^3$ |
| Mercury | 2.0E-08 | mg/m$^3$ |
| Molybdenum | 3.0E-07 | mg/m$^3$ |
| Nickel | 2.4E-06 | mg/m$^3$ |
| Octachlorodibenzofuran | NA | mg/m$^3$ |
| Selenium | 5.6E-09 | mg/m$^3$ |
| Thallium | 2.5E-08 | mg/m$^3$ |
| Vanadium | 1.8E-06 | mg/m$^3$ |
| Zinc | 7.9E-06 | mg/m$^3$ |
| 2-Chlorophenol | NA | mg/m$^3$ |
| 2-Methylnaphthalene | 3.3E-09 | mg/m$^3$ |
| 4-Chlorophenyl-phenylether | NA | mg/m$^3$ |
| 4,4-DDT | NA | mg/m$^3$ |

**References**

**Table K.IV-1 (continued)**
**Summary of Risk Characterization (chemicals)**
**Trespassing Child Current Land Use Scenario (age7-18)**
**Via Inhalation of Particulates**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 2.1E-08 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.4E-11 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 9.1E-12 | NA | NA |
| Aroclor-1254 | 4.7E-10 | NA | NA |
| Aroclor-1260 | 4.6E-10 | NA | NA |
| Arsenic | 9.7E-09 | NA | NA |
| Barium | 6.4E-07 | 1.4E-04 | 4.6E-03 |
| Beryllium | 8.6E-10 | NA | NA |
| Cadmium | 4.1E-09 | NA | NA |
| Chromium | 2.3E-09 | NA | NA |
| Cobalt | 9.8E-09 | 3.0E-07 | 3.3E-02 |
| Copper | 3.3E-08 | NA | NA |
| Cyanide | 2.5E-09 | NA | NA |
| Di-n-octyl phthalate | 3.8E-11 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 9.0E-08 | NA | NA |
| Manganese | 4.3E-07 | 1.1E-04 | 3.9E-03 |
| Mercury | 2.2E-10 | 8.6E-05 | 2.5E-06 |
| Molybdenum | 3.3E-09 | NA | NA |
| Nickel | 2.7E-08 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 6.1E-11 | NA | NA |
| Thallium | 2.8E-10 | NA | NA |
| Vanadium | 2.0E-08 | NA | NA |
| Zinc | 8.6E-08 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.6E-11 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | NA | NA |
| | HQ Summation = | | 4.1E-02 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 3.6E-09 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 2.4E-12 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.6E-12 | NA | NA |
| Aroclor-1254 | 8.0E-11 | NA | NA |
| Aroclor-1260 | 8.0E-11 | NA | NA |
| Arsenic | 1.7E-09 | 1.5E+01 | 2.5E-08 |
| Barium | 1.1E-07 | NA | NA |
| Beryllium | 1.5E-10 | 8.4E+00 | 1.2E-09 |
| Cadmium | 7.1E-10 | 6.1E+00 | 4.3E-09 |
| Chromium | 3.9E-10 | 4.1E+01 | 1.6E-08 |
| Cobalt | 1.7E-09 | NA | NA |
| Copper | 5.7E-09 | NA | NA |
| Cyanide | 4.2E-10 | NA | NA |
| Di-n-octyl phthalate | 6.5E-12 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.5E-08 | NA | NA |
| Manganese | 7.4E-08 | NA | NA |
| Mercury | 3.7E-11 | NA | NA |
| Molybdenum | 5.6E-10 | NA | NA |
| Nickel | 4.6E-09 | 8.4E-01 | 3.8E-09 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 1.1E-11 | NA | NA |
| Thallium | 4.8E-11 | NA | NA |
| Vanadium | 3.5E-09 | NA | NA |
| Zinc | 1.5E-08 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 6.2E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 5.1E-08 |

5208

**Table K.IV-2**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Trespassing Child Current Land Use Scenario (age7-18)**
**Via Inhalation of Gases and Particulates**

**Intake Equation** = Ca X EF X EDn X ET X IR

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 0.83 $m^3$/day |
| EF | Exposure frequency | 52 days/year |
| EDn | Exposure duration | 12 Year |
| ET | Exposure time | 4 hours |
| Ca | Concentration of radionuclides in air | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/$m^3$ | Rn-222 | 4.0E+00 | pCi/$m^3$ |
| Am-241 | NA | pCi/$m^3$ | Ru-106 | NA | pCi/$m^3$ |
| Cs-137 | 4.7E-05 | pCi/$m^3$ | Sr-90 | 1.3E-04 | pCi/$m^3$ |
| Np-237 | 1.1E-05 | pCi/$m^3$ | Tc-99 | 6.4E-04 | pCi/$m^3$ |
| Pa-231 | 3.7E-05 | pCi/$m^3$ | Th-228 | 1.4E-04 | pCi/$m^3$ |
| Pb-210 | 1.1E-03 | pCi/$m^3$ | Th-230 | 1.5E-04 | pCi/$m^3$ |
| Pu-238 | 6.2E-05 | pCi/$m^3$ | Th-232 | 8.2E-05 | pCi/$m^3$ |
| Pu-239 | 3.5E-05 | pCi/$m^3$ | U-233 | NA | pCi/$m^3$ |
| Pu-240 | 3.5E-05 | pCi/$m^3$ | U-234 | 1.3E-03 | pCi/$m^3$ |
| Ra-226 | 8.1E-05 | pCi/$m^3$ | U-235 | 3.6E-05 | pCi/$m^3$ |
| Ra-228 | 8.8E-05 | pCi/$m^3$ | U-236 | 1.5E-05 | pCi/$m^3$ |
| | | | U-238 | 8.0E-04 | pCi/$m^3$ |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 8.8E-08 | NA |
| Am-241 | NA | 3.2E-08 | NA |
| Cs-137 | 9.8E-02 | 1.9E-11 | 1.9E-12 |
| Np-237 | 2.2E-02 | 2.9E-08 | 6.3E-10 |
| Pa-231 | 7.6E-02 | 3.6E-08 | 2.7E-09 |
| Pb-210 | 2.2E+00 | 4.0E-09 | 8.7E-09 |
| Pu-238 | 1.3E-01 | 3.9E-08 | 5.0E-09 |
| Pu-239 | 7.2E-02 | 3.8E-08 | 2.7E-09 |
| Pu-240 | 7.2E-02 | 3.8E-08 | 2.7E-09 |
| Ra-226 | 1.7E-01 | 3.0E-09 | 5.0E-10 |
| Ra-228 | 1.8E-01 | 6.9E-10 | 1.3E-10 |
| Rn-222 | 8.2E+03 | 7.7E-12 | 6.3E-08 |
| Ru-106 | NA | 4.4E-10 | NA |
| Sr-90 | 2.6E-01 | 5.6E-11 | 1.5E-11 |
| Tc-99 | 1.3E+00 | 8.3E-12 | 1.1E-11 |
| Th-228 | 2.9E-01 | 7.8E-08 | 2.3E-08 |
| Th-230 | 3.1E-01 | 2.9E-08 | 9.0E-09 |
| Th-232 | 1.7E-01 | 2.8E-08 | 4.7E-09 |
| U-233 | NA | 2.7E-08 | NA |
| U-234 | 2.8E+00 | 2.6E-08 | 7.2E-08 |
| U-235 | 7.4E-02 | 2.5E-08 | 1.8E-09 |
| U-236 | 3.0E-02 | 2.5E-08 | 7.6E-10 |
| U-238 | 1.7E+00 | 5.2E-08 | 8.6E-08 |
| | | ILCR Summation = | 2.8E-07 |

0600

Table K.IV-3
Summary of Intake Quantitation (chemicals)
Trespassing Child Current Land Use Scenario (age7-18)
Via Incidental Ingestion of Soil/Sediment

**Intake Equation** = $\frac{CS \times EF \times ED \times CF \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IRs | Ingestion rate of soil (RAGS, 1989) | 25 | mg/day |
| CF | Conversion factor | 1.00E-06 | kg/mg |
| EF | Exposure frequency | 52 | days/year |
| EDn | Exposure duration for non-carchogens | 12 | Year |
| EDc | Exposure duration for carcinogens | 12 | Year |
| BW | Body weight | 43 | kg |
| ATc | Average time for carchogens (lifetime) | 25550 | days |
| ATn | Average time for non-carchogens (EDn x 365) | 4380 | days |
| CS | Concentration of chemicals in soil | (see table below) | |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 3.2E+01 | mg/kg | Heptachlorodibenzofuran | NA | mg/kg |
| Aroclor-1016 | NA | mg/kg | Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Aroclor-1221 | 2.9E-02 | mg/kg | Lead | 1.8E+02 | mg/kg |
| Aroclor-1242 | NA | mg/kg | Manganese | 6.9E+02 | mg/kg |
| Aroclor-1248 | 2.2E-02 | mg/kg | Mercury | 4.7E-01 | mg/kg |
| Aroclor-1254 | 9.8E-01 | mg/kg | Molybdenum | 5.0E+00 | mg/kg |
| Aroclor-1260 | 1.0E+00 | mg/kg | Nickel | 4.4E+01 | mg/kg |
| Arsenic | 1.7E+01 | mg/kg | Octachlorodibenzofuran | NA | mg/kg |
| Barium | 1.4E+03 | mg/kg | Selenium | 1.3E-01 | mg/kg |
| Beryllium | 1.5E+00 | mg/kg | Thallium | 4.6E-01 | mg/kg |
| Cadmium | 6.4E+00 | mg/kg | Vanadium | 3.2E+01 | mg/kg |
| Chromium | 4.1E+01 | mg/kg | Zinc | 1.8E+02 | mg/kg |
| Cobalt | 1.6E+01 | mg/kg | 2-Chlorophenol | NA | mg/kg |
| Copper | 6.2E+01 | mg/kg | 2-Methylnaphthalene | 8.0E-02 | mg/kg |
| Cyanide | 5.3E+00 | mg/kg | 4-Chlorophenyl-phenylether | NA | mg/kg |
| Di-n-octyl phthalate | 8.3E-02 | mg/kg | 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-3 (continued)**
**Summary of Risk Characterization (chemicals)**
**Trespassing Child Current Land Use Scenario (age7-18)**
**Via Incidental Ingestion of Soil/Sediment**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 2.7E-06 | 4.0E-04 | 6.7E-03 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 2.4E-09 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.8E-09 | NA | NA |
| Aroclor-1254 | 8.1E-08 | NA | NA |
| Aroclor-1260 | 8.4E-08 | NA | NA |
| Arsenic | 1.4E-06 | 3.0E-04 | 4.6E-03 |
| Barium | 1.1E-04 | 7.0E-02 | 1.6E-03 |
| Beryllium | 1.2E-07 | 5.0E-03 | 2.5E-05 |
| Cadmium | 5.3E-07 | 5.0E-04 | 1.1E-03 |
| Chromium | 3.4E-06 | 5.0E-03 | 6.8E-04 |
| Cobalt | 1.3E-06 | 6.0E-02 | 2.2E-05 |
| Copper | 5.1E-06 | NA | NA |
| Cyanide | 4.4E-07 | 2.0E-02 | 2.2E-05 |
| Di-n-octyl phthalate | 6.9E-09 | 2.0E-02 | 3.4E-07 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.5E-05 | NA | NA |
| Manganese | 5.7E-05 | 1.4E-01 | 4.1E-04 |
| Mercury | 3.9E-08 | 3.0E-04 | 1.3E-04 |
| Molybdenum | 4.1E-07 | 5.0E-03 | 8.3E-05 |
| Nickel | 3.6E-06 | 2.0E-02 | 1.8E-04 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 1.1E-08 | 5.0E-03 | 2.2E-06 |
| Thallium | 3.8E-08 | 8.0E-05 | 4.8E-04 |
| Vanadium | 2.6E-06 | 7.0E-03 | 3.8E-04 |
| Zinc | 1.3E-05 | 3.0E-01 | 4.5E-05 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 6.6E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 1.6E-02 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 4.6E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 4.1E-10 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 3.1E-10 | 7.7E+00 | 2.4E-09 |
| Aroclor-1254 | 1.4E-08 | 7.7E+00 | 1.1E-07 |
| Aroclor-1260 | 1.4E-08 | 7.7E+00 | 1.1E-07 |
| Arsenic | 2.3E-07 | 1.8E+00 | 4.1E-07 |
| Barium | 1.9E-05 | NA | NA |
| Beryllium | 2.1E-08 | 4.3E+00 | 9.0E-08 |
| Cadmium | 9.1E-08 | NA | NA |
| Chromium | 5.8E-07 | NA | NA |
| Cobalt | 2.3E-07 | NA | NA |
| Copper | 8.8E-07 | NA | NA |
| Cyanide | 7.5E-08 | NA | NA |
| Di-n-octyl phthalate | 1.2E-09 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 2.6E-06 | NA | NA |
| Manganese | 9.9E-06 | NA | NA |
| Mercury | 6.7E-09 | NA | NA |
| Molybdenum | 7.1E-08 | NA | NA |
| Nickel | 6.2E-07 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 1.9E-09 | NA | NA |
| Thallium | 6.5E-09 | NA | NA |
| Vanadium | 4.5E-07 | NA | NA |
| Zinc | 2.3E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 1.1E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 7.2E-07 |

# Table K.IV-4
## Summary of Intake and Risk Quantitation (Radionuclides)
## Trespassing Child Current Land Use Scenario (age7-18)
## Via Incidental Ingestion of Soil/Sediment

**Intake Equation** = CS X EF X EDn X FI X IR

| | | | |
|---|---|---|---|
| IRs | Ingestion rate of soil (RAGS, 1989) | 25 | mg/day |
| EF | Exposure frequency | 52 | days/year |
| EDn | Exposure Duration | 12 | Year |
| FI | Fractional Intake | 1 | (unitless) |
| CS | Concentration of radionuclides in soil | | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/mg | Rn-222 | NA | pCi/mg |
| Am-241 | NA | pCi/mg | Ru-106 | NA | pCi/mg |
| Cs-137 | 8.4E-04 | pCi/mg | Sr-90 | 2.6E-03 | pCi/mg |
| Np-237 | 9.5E-04 | pCi/mg | Tc-99 | 1.5E-02 | pCi/mg |
| Pa-231 | 8.8E-04 | pCi/mg | Th-228 | 2.8E-03 | pCi/mg |
| Pb-210 | 2.5E-02 | pCi/mg | Th-230 | 2.9E-03 | pCi/mg |
| Pu-238 | 1.3E-03 | pCi/mg | Th-232 | 1.9E-03 | pCi/mg |
| Pu-239 | 6.7E-04 | pCi/mg | U-233 | NA | pCi/mg |
| Pu-240 | 6.7E-04 | pCi/mg | U-234 | 3.4E-02 | pCi/mg |
| Ra-226 | 1.9E-03 | pCi/mg | U-235 | 8.9E-04 | pCi/mg |
| Ra-228 | 2.0E-03 | pCi/mg | U-236 | 2.6E-04 | pCi/mg |
| | | | U-238 | 2.0E-02 | pCi/mg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 1.3E+01 | 2.8E-11 | 3.7E-10 |
| Np-237 | 1.5E+01 | 2.2E-10 | 3.3E-09 |
| Pa-231 | 1.4E+01 | 9.2E-11 | 1.3E-09 |
| Pb-210 | 3.9E+02 | 6.6E-10 | 2.6E-07 |
| Pu-238 | 2.1E+01 | 2.2E-10 | 4.5E-09 |
| Pu-239 | 1.0E+01 | 2.3E-10 | 2.4E-09 |
| Pu-240 | 1.0E+01 | 2.3E-10 | 2.4E-09 |
| Ra-226 | 2.9E+01 | 1.2E-10 | 3.5E-09 |
| Ra-228 | 3.1E+01 | 1.0E-10 | 3.1E-09 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 4.0E+01 | 3.3E-10 | 1.3E-08 |
| Tc-99 | 2.3E+02 | 1.3E-12 | 3.0E-10 |
| Th-228 | 4.3E+01 | 5.5E-11 | 2.4E-09 |
| Th-230 | 4.5E+01 | 1.3E-11 | 5.9E-10 |
| Th-232 | 2.9E+01 | 1.2E-11 | 3.5E-10 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 5.2E+02 | 1.6E-11 | 8.4E-09 |
| U-235 | 1.4E+01 | 1.6E-11 | 2.2E-10 |
| U-236 | 4.0E+00 | 1.5E-11 | 6.0E-11 |
| U-238 | 3.1E+02 | 2.8E-11 | 8.8E-09 |
| | | **ILCR Summation =** | 3.2E-07 |

5208

## Table K.IV-5
## Summary of Intake and Risk Quantitation (Radionuclides)
## Trespassing Child Current Land Use Scenario (age7-18)
## Via Incidental Ingestion while Wading

**Intake Equation** = Cs X EF X ED X FI X IR

| | | |
|---|---|---|
| IRsw | Ingestion rate of surface water | 0.025 l/day |
| EF | Exposure frequency | 13 days/year |
| EDn | Exposure duration for non-carcinogens | 12 Year |
| FI | Fractional intake for radionuclides | 1 (Unitless) |
| Cs | Concentration of radionuclides in surface water | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/l | Rn-222 | NA | pCi/l |
| Am-241 | NA | pCi/l | Ru-106 | NA | pCi/l |
| Cs-137 | NA | pCi/l | Sr-90 | NA | pCi/l |
| Np-237 | NA | pCi/l | Tc-99 | NA | pCi/l |
| Pa-231 | NA | pCi/l | Th-228 | NA | pCi/l |
| Pb-210 | NA | pCi/l | Th-230 | NA | pCi/l |
| Pu-238 | NA | pCi/l | Th-232 | NA | pCi/l |
| Pu-239 | NA | pCi/l | U-233 | NA | pCi/l |
| Pu-240 | NA | pCi/l | U-234 | 6.3E-03 | pCi/l |
| Ra-226 | NA | pCi/l | U-235 | 1.7E-04 | pCi/l |
| Ra-228 | NA | pCi/l | U-236 | 6.9E-05 | pCi/l |
| | | | U-238 | 3.8E-03 | pCi/l |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | NA | 2.8E-11 | NA |
| Np-237 | NA | 2.2E-10 | NA |
| Pa-231 | NA | 9.2E-11 | NA |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | NA | 2.2E-10 | NA |
| Pu-239 | NA | 2.3E-10 | NA |
| Pu-240 | NA | 2.3E-10 | NA |
| Ra-226 | NA | 1.2E-10 | NA |
| Ra-228 | NA | 1.0E-10 | NA |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | NA | 3.3E-10 | NA |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | NA | 5.5E-11 | NA |
| Th-230 | NA | 1.3E-11 | NA |
| Th-232 | NA | 1.2E-11 | NA |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 2.4E-02 | 1.6E-11 | 3.9E-13 |
| U-235 | 6.5E-04 | 1.6E-11 | 1.0E-14 |
| U-236 | 2.7E-04 | 1.5E-11 | 4.0E-15 |
| U-238 | 1.5E-02 | 2.8E-11 | 4.1E-13 |
| | | ILCR Summation = | 8.2E-13 |

0604

**Table K.IV-6**
**Summary of Intake Quantitation (chemicals)**
**Trespassing Child Current Land Use Scenario (age7-18)**
**Via Dermal Contact with Soil/Sediment**

**Intake Equation** = $\frac{CS \times EF \times ED \times CF \times ABS \times AF \times SA}{BW \times AT}$

| | | | |
|---|---|---|---|
| SA | Surface area of exposed skin (50th percentile, hands only) | 4200 | $cm^2$/day |
| AF | Soil to skin adhérence factor (RAGS, 1989) | 1 | $mg/cm^2$ |
| ABS | chemicals specific absorbtion factor (see table below) | csv | |
| CF | Conversion factor | 1E-06 | kg/mg |
| EF | Exposure frequency | 52 | days/year |
| EDn | Exposure duration for non-carcinogens | 12 | Year |
| EDc | Exposure duration for carcinogens | 12 | Year |
| BW | Body weight | 43 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 4380 | days |
| CS | Concentration of chemicals in soil | (see table below) | |

**Chemical Concentrations**

| Compound | ABS | Concentrati | Units |
|---|---|---|---|
| Antimony | 1.0E-02 | 3.2E+01 | mg/kg |
| Aroclor-1016 | 6.0E-02 | NA | mg/kg |
| Aroclor-1221 | 6.0E-02 | 2.9E-02 | mg/kg |
| Aroclor-1242 | 6.0E-02 | NA | mg/kg |
| Aroclor-1248 | 6.0E-02 | 2.2E-02 | mg/kg |
| Aroclor-1254 | 6.0E-02 | 9.8E-01 | mg/kg |
| Aroclor-1260 | 6.0E-02 | 1.0E+00 | mg/kg |
| Arsenic | 1.0E-03 | 1.7E+01 | mg/kg |
| Barium | 1.0E-02 | 1.4E+03 | mg/kg |
| Beryllium | 1.0E-02 | 1.5E+00 | mg/kg |
| Cadmium | 1.0E-02 | 6.4E+00 | mg/kg |
| Chromium | 1.0E-02 | 4.1E+01 | mg/kg |
| Cobalt | 1.0E-02 | 1.6E+01 | mg/kg |
| Copper | 1.0E-03 | 6.2E+01 | mg/kg |
| Cyanide | NA | 5.3E+00 | mg/kg |
| Di-n-octyl phthalate | 3.0E-01 | 8.3E-02 | mg/kg |

| Compound | | Concentrat | Units |
|---|---|---|---|
| Heptachlorodibenzofuran | 3.0E-02 | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | 3.0E-02 | NA | mg/kg |
| Lead | 1.0E-02 | 1.6E+02 | mg/kg |
| Manganese | 1.0E-02 | 6.9E+02 | mg/kg |
| Mercury | 5.0E-02 | 4.7E-01 | mg/kg |
| Molybdenum | 1.0E-02 | 5.0E+00 | mg/kg |
| Nickel | 5.0E-04 | 4.4E+01 | mg/kg |
| Octachlorodibenzofuran | 3.0E-02 | NA | mg/kg |
| Selenium | 1.0E-02 | 1.3E-01 | mg/kg |
| Thallium | 1.0E-02 | 4.6E-01 | mg/kg |
| Vanadium | 1.0E-03 | 3.2E+01 | mg/kg |
| Zinc | 1.0E-02 | 1.6E+02 | mg/kg |
| 2-Chlorophenol | NA | NA | mg/kg |
| 2-Methylnaphthalene | NA | 6.0E-02 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | NA | mg/kg |
| 4,4-DDT | 3.0E-01 | NA | mg/kg |

**References**

**Table K.IV-6 (continued)**
**Summary of Risk Characterization (chemicals)**
**Trespassing Child Current Land Use Scenario (age7-18)**
**Via Dermal Contact with Soil/Sediment**

| Compound | HQ Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
| Antimony | 4.5E-06 | 4.0E-04 | 1.1E-02 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 2.4E-08 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.8E-08 | NA | NA |
| Aroclor-1254 | 8.1E-07 | NA | NA |
| Aroclor-1260 | 8.4E-07 | NA | NA |
| Arsenic | 2.3E-07 | 3.0E-04 | 7.7E-04 |
| Barium | 1.9E-04 | 7.0E-02 | 2.7E-03 |
| Beryllium | 2.1E-07 | 5.0E-03 | 4.1E-05 |
| Cadmium | 8.9E-07 | 5.0E-04 | 1.8E-03 |
| Chromium | 5.7E-06 | 5.0E-03 | 1.1E-03 |
| Cobalt | 2.2E-06 | 6.0E-02 | 3.7E-05 |
| Copper | 8.6E-07 | NA | NA |
| Cyanide | 0.0E+00 | 2.0E-02 | NA |
| Di-n-octyl phthalate | 3.5E-07 | 2.0E-02 | 1.7E-05 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 2.5E-05 | NA | NA |
| Manganese | 9.7E-05 | 1.4E-01 | 6.9E-04 |
| Mercury | 3.3E-07 | 3.0E-04 | 1.1E-03 |
| Molybdenum | 6.9E-07 | 5.0E-03 | 1.4E-04 |
| Nickel | 3.0E-07 | 2.0E-02 | 1.5E-05 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 1.9E-08 | 5.0E-03 | 3.7E-06 |
| Thallium | 6.4E-08 | 8.0E-05 | 8.0E-04 |
| Vanadium | 4.4E-07 | 7.0E-03 | 6.3E-05 |
| Zinc | 2.3E-05 | 3.0E-01 | 7.5E-05 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 0.0E+00 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| HQ Summation = | | | 2.1E-02 |

| Compound | ILCR Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
| Antimony | 7.7E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 4.2E-09 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 3.1E-09 | 7.7E+00 | 2.4E-08 |
| Aroclor-1254 | 1.4E-07 | 7.7E+00 | 1.1E-06 |
| Aroclor-1260 | 1.4E-07 | 7.7E+00 | 1.1E-06 |
| Arsenic | 3.9E-08 | 1.8E+00 | 6.9E-08 |
| Barium | 3.3E-05 | NA | NA |
| Beryllium | 3.5E-08 | 4.3E+00 | 1.5E-07 |
| Cadmium | 1.5E-07 | NA | NA |
| Chromium | 9.6E-07 | NA | NA |
| Cobalt | 3.6E-07 | NA | NA |
| Copper | 1.5E-07 | NA | NA |
| Cyanide | 0.0E+00 | NA | NA |
| Di-n-octyl phthalate | 6.0E-08 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 4.3E-06 | NA | NA |
| Manganese | 1.7E-05 | NA | NA |
| Mercury | 5.6E-08 | NA | NA |
| Molybdenum | 1.2E-07 | NA | NA |
| Nickel | 5.2E-08 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 3.2E-09 | NA | NA |
| Thallium | 1.1E-08 | NA | NA |
| Vanadium | 7.6E-08 | NA | NA |
| Zinc | 3.9E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 0.0E+00 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| ILCR Summation = | | | 2.4E-06 |

5208

**Table K.IV-7**
**Summary of Risk Quantitation (Radionuclides)**
**Trespassing Child Current Land Use Scenario (age7-18)**
**Via External Radiation**

**Exposure Equation** = $[CR \times EF \times EDn \times ET_i \times (1-SH_i)] + [CR \times EF \times EDn \times ET_o \times (1-SH_o)]$

| | | |
|---|---|---|
| EF | Fraction of year spent exposured | 0.14 (unitless) |
| ED | Exposure duration | 12 Year |
| $ET_i$ | Fraction of day spent indoors | 0 (unitless) |
| $ET_o$ | Fraction of day spent outdoors | 0.17 (unitless) |
| $SH_i$ | Shield factor indoors | 0.5 (unitless) |
| $SH_o$ | Shield factor outdoors | 0 (unitless) |
| CR | Radionuclide specific concentrations | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/g | Rn-222 | NA | pCi/g |
| Am-241 | NA | pCi/g | Ru-106 | NA | pCi/g |
| Cs-137 | 7.1E-01 | pCi/g | Sr-90 | 1.9E+00 | pCi/g |
| Np-237 | 7.0E-01 | pCi/g | Tc-99 | 9.6E+00 | pCi/g |
| Pa-231 | 2.4E+00 | pCi/g | Th-228 | 2.7E+00 | pCi/g |
| Pb-210 | 7.0E+01 | pCi/g | Th-230 | 5.0E+00 | pCi/g |
| Pu-238 | 9.2E-01 | pCi/g | Th-232 | 2.1E+00 | pCi/g |
| Pu-239 | 5.2E-01 | pCi/g | U-233 | NA | pCi/g |
| Pu-240 | 5.2E-01 | pCi/g | U-234 | 5.6E+01 | pCi/g |
| Ra-226 | 5.0E+00 | pCi/g | U-235 | 1.7E+00 | pCi/g |
| Ra-228 | 2.8E+00 | pCi/g | U-236 | 1.4E+00 | pCi/g |
| | | | U-238 | 3.3E+01 | pCi/g |

| Radionuclides | CDI (year pCi/g) | CSF $(g/pCi-year)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | NA | NA |
| Am-241 | NA | 4.9E-09 | NA |
| Cs-137 | 2.0E-01 | 2.0E-06 | 4.0E-07 |
| Np-237 | 2.0E-01 | 4.3E-07 | 8.6E-08 |
| Pa-231 | 6.9E-01 | 2.6E-08 | 1.8E-08 |
| Pb-210 | 2.0E+01 | 1.6E-10 | 3.2E-09 |
| Pu-238 | 2.6E-01 | 2.8E-11 | 7.4E-12 |
| Pu-239 | 1.5E-01 | 1.7E-11 | 2.5E-12 |
| Pu-240 | 1.5E-01 | 2.7E-11 | 4.0E-12 |
| Ra-226 | 1.4E+00 | 6.0E-06 | 8.6E-06 |
| Ra-228 | 7.9E-01 | 2.9E-06 | 2.3E-06 |
| Rn-222 | NA | 5.9E-06 | NA |
| Ru-106 | NA | NA | NA |
| Sr-90 | 5.3E-01 | NA | NA |
| Tc-99 | 2.8E+00 | 6.0E-13 | 1.7E-12 |
| Th-228 | 7.7E-01 | 5.6E-06 | 4.3E-06 |
| Th-230 | 1.4E+00 | 5.4E-11 | 7.7E-11 |
| Th-232 | 6.1E-01 | 2.6E-11 | 1.6E-11 |
| U-233 | NA | 4.2E-11 | NA |
| U-234 | 1.6E+01 | 3.0E-11 | 4.8E-10 |
| U-235 | 5.0E-01 | 2.4E-07 | 1.2E-07 |
| U-236 | 4.0E-01 | 2.4E-11 | 9.5E-12 |
| U-238 | 9.3E+00 | 3.6E-08 | 3.3E-07 |
| | | ILCR Summation = | 1.6E-05 |



0607

**Table K.IV-8**
**Summary of Intake Quantitation (Chemicals)**
**Groundskeeper Current Land Use Scenario**
**Via Inhalation of Particulates**

**Intake Equation** = $\frac{CS \times EF \times ED \times IR \times ET}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 0.83 | $m^3$/day |
| ET | Exposure time | 8 | hours |
| EF | Exposure frequency | 250 | days/year |
| EDn | Exposure duration for non-carchogens | 25 | Year |
| EDc | Exposure duration for carcinogens | 25 | Year |
| BW | Body weight | 70 | kg |
| ATc | Average time for carchogens (lifetime) | 25550 | days |
| ATn | Average time for non-carchogens (EDn x 365) | 9125 | days |
| CS | Concentration of chemicals in particulate as modeled | | (see table below) |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 1.9E-06 | $mg/m^3$ | Heptachlorodibenzofuran | NA | $mg/m^3$ |
| Aroclor-1016 | NA | $mg/m^3$ | Heptachlorodibenzo-p-dioxin | NA | $mg/m^3$ |
| Aroclor-1221 | 1.3E-09 | $mg/m^3$ | Lead | 8.2E-06 | $mg/m^3$ |
| Aroclor-1242 | NA | $mg/m^3$ | Manganese | 4.0E-05 | $mg/m^3$ |
| Aroclor-1248 | 8.3E-10 | $mg/m^3$ | Mercury | 2.0E-08 | $mg/m^3$ |
| Aroclor-1254 | 4.3E-08 | $mg/m^3$ | Molybdenum | 3.0E-07 | $mg/m^3$ |
| Aroclor-1260 | 4.2E-08 | $mg/m^3$ | Nickel | 2.4E-06 | $mg/m^3$ |
| Arsenic | 8.8E-07 | $mg/m^3$ | Octachlorodibenzofuran | NA | $mg/m^3$ |
| Barium | 5.8E-05 | $mg/m^3$ | Selenium | 5.6E-09 | $mg/m^3$ |
| Beryllium | 7.8E-08 | $mg/m^3$ | Thallium | 2.5E-08 | $mg/m^3$ |
| Cadmium | 3.7E-07 | $mg/m^3$ | Vanadium | 1.8E-06 | $mg/m^3$ |
| Chromium | 2.1E-07 | $mg/m^3$ | Zinc | 7.9E-06 | $mg/m^3$ |
| Cobalt | 8.9E-07 | $mg/m^3$ | 2-Chlorophenol | NA | $mg/m^3$ |
| Copper | 3.0E-06 | $mg/m^3$ | 2-Methylnaphthalene | 3.3E-09 | $mg/m^3$ |
| Cyanide | 2.2E-07 | $mg/m^3$ | 4-Chlorophenyl-phenylether | NA | $mg/m^3$ |
| Di-n-octyl phthalate | 3.5E-09 | $mg/m^3$ | 4,4-DDT | NA | $mg/m^3$ |

**References**



00608

5208

**Table K.IV-8 (continued)**
**Summary of Risk Characterization (Chemicals)**
**Groundskeeper Current Land Use Scenario**
**Via Inhalation of Particulates**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 1.2E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 8.1E-11 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 5.4E-11 | NA | NA |
| Aroclor-1254 | 2.8E-09 | NA | NA |
| Aroclor-1260 | 2.7E-09 | NA | NA |
| Arsenic | 5.7E-08 | NA | NA |
| Barium | 3.8E-06 | 1.4E-04 | 2.7E-02 |
| Beryllium | 5.1E-09 | NA | NA |
| Cadmium | 2.4E-08 | NA | NA |
| Chromium | 1.4E-08 | NA | NA |
| Cobalt | 5.8E-08 | 3.0E-07 | 1.9E-01 |
| Copper | 1.9E-07 | NA | NA |
| Cyanide | 1.4E-08 | NA | NA |
| Di-n-octyl phthalate | 2.3E-10 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 5.3E-07 | NA | NA |
| Manganese | 2.6E-06 | 1.1E-04 | 2.3E-02 |
| Mercury | 1.3E-09 | 8.6E-05 | 1.5E-05 |
| Molybdenum | 1.9E-08 | NA | NA |
| Nickel | 1.6E-07 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 3.6E-10 | NA | NA |
| Thallium | 1.6E-09 | NA | NA |
| Vanadium | 1.2E-07 | NA | NA |
| Zinc | 5.1E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 2.1E-10 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | NA | NA |
| | HQ Summation = | | 2.4E-01 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 4.4E-08 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 2.9E-11 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.9E-11 | NA | NA |
| Aroclor-1254 | 9.9E-10 | NA | NA |
| Aroclor-1260 | 9.8E-10 | NA | NA |
| Arsenic | 2.1E-08 | 1.5E+01 | 3.1E-07 |
| Barium | 1.4E-06 | NA | NA |
| Beryllium | 1.8E-09 | 8.4E+00 | 1.5E-08 |
| Cadmium | 8.7E-09 | 6.1E+00 | 5.3E-08 |
| Chromium | 4.8E-09 | 4.1E+01 | 2.0E-07 |
| Cobalt | 2.1E-08 | NA | NA |
| Copper | 7.0E-08 | NA | NA |
| Cyanide | 5.2E-09 | NA | NA |
| Di-n-octyl phthalate | 8.1E-11 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.9E-07 | NA | NA |
| Manganese | 9.2E-07 | NA | NA |
| Mercury | 4.6E-10 | NA | NA |
| Molybdenum | 6.9E-09 | NA | NA |
| Nickel | 5.6E-08 | 8.4E-01 | 4.7E-08 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 1.3E-10 | NA | NA |
| Thallium | 5.8E-10 | NA | NA |
| Vanadium | 4.2E-08 | NA | NA |
| Zinc | 1.8E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 7.6E-11 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 6.2E-07 |

- 5208

# Table K.IV-9
## Summary of Intake and Risk Quantitation (Radionuclides)
## Groundskeeper Current Land Use Scenario
## Via Inhalation of Gases and Particulates

**Intake Equation** = Ca X EF X EDn X IR

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 0.83 $m^3$/day |
| EF | Exposure frequency | 250 days/year |
| EDn | Exposure duration | 25 Year |
| Ca | Concentration of radionuclides in air | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/$m^3$ | Rn-222 | 4.0E+00 | pCi/$m^3$ |
| Am-241 | NA | pCi/$m^3$ | Ru-106 | NA | pCi/$m^3$ |
| Cs-137 | 4.7E-05 | pCi/$m^3$ | Sr-90 | 1.3E-04 | pCi/$m^3$ |
| Np-237 | 1.1E-05 | pCi/$m^3$ | Tc-99 | 6.4E-04 | pCi/$m^3$ |
| Pa-231 | 3.7E-05 | pCi/$m^3$ | Th-228 | 1.4E-04 | pCi/$m^3$ |
| Pb-210 | 1.1E-03 | pCi/$m^3$ | Th-230 | 1.5E-04 | pCi/$m^3$ |
| Pu-238 | 6.2E-05 | pCi/$m^3$ | Th-232 | 8.2E-05 | pCi/$m^3$ |
| Pu-239 | 3.5E-05 | pCi/$m^3$ | U-233 | NA | pCi/$m^3$ |
| Pu-240 | 3.5E-05 | pCi/$m^3$ | U-234 | 1.3E-03 | pCi/$m^3$ |
| Ra-226 | 8.1E-05 | pCi/$m^3$ | U-235 | 3.6E-05 | pCi/$m^3$ |
| Ra-228 | 8.8E-05 | pCi/$m^3$ | U-236 | 1.5E-05 | pCi/$m^3$ |
| | | | U-238 | 8.0E-04 | pCi/$m^3$ |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 8.8E-08 | NA |
| Am-241 | NA | 3.2E-08 | NA |
| Cs-137 | 2.5E-01 | 1.9E-11 | 4.7E-12 |
| Np-237 | 5.4E-02 | 2.9E-08 | 1.6E-09 |
| Pa-231 | 1.9E-01 | 3.6E-08 | 6.8E-09 |
| Pb-210 | 5.4E+00 | 4.0E-09 | 2.2E-08 |
| Pu-238 | 3.2E-01 | 3.9E-08 | 1.3E-08 |
| Pu-239 | 1.8E-01 | 3.8E-08 | 6.9E-09 |
| Pu-240 | 1.8E-01 | 3.8E-08 | 6.9E-09 |
| Ra-226 | 4.2E-01 | 3.0E-09 | 1.3E-09 |
| Ra-228 | 4.6E-01 | 6.9E-10 | 3.2E-10 |
| Rn-222 | 2.1E+04 | 7.7E-12 | 1.6E-07 |
| Ru-106 | NA | 4.4E-10 | NA |
| Sr-90 | 6.5E-01 | 5.6E-11 | 3.6E-11 |
| Tc-99 | 3.3E+00 | 8.3E-12 | 2.8E-11 |
| Th-228 | 7.3E-01 | 7.8E-08 | 5.7E-08 |
| Th-230 | 7.8E-01 | 2.9E-08 | 2.3E-08 |
| Th-232 | 4.2E-01 | 2.8E-08 | 1.2E-08 |
| U-233 | NA | 2.7E-08 | NA |
| U-234 | 6.9E+00 | 2.6E-08 | 1.8E-07 |
| U-235 | 1.8E-01 | 2.5E-08 | 4.6E-09 |
| U-236 | 7.6E-02 | 2.5E-08 | 1.9E-09 |
| U-238 | 4.1E+00 | 5.2E-08 | 2.2E-07 |
| | | ILCR Summation = | 7.1E-07 |

**Table K.IV-10**
**Summary of Intake Quantitation (Chemicals)**
**Groundskeeper Current Land Use Scenario**
**Via Incidental Ingestion of Soil/Sediment**

**Intake Equation** = $\frac{CS \times EF \times ED \times CF \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IRs | Ingestion rate of soil (RAGS, 1989) | 50 | mg/day |
| CF | Conversion factor | 1.00E-06 | kg/mg |
| EF | Exposure frequency | 250 | days/year |
| EDn | Exposure duration for non-carchogens | 25 | Year |
| EDc | Exposure duration for carcinogens | 25 | Year |
| BW | Body weight | 70 | kg |
| ATc | Average time for carchogens (lifetime) | 25550 | days |
| ATn | Average time for non-carchogens (EDn x 365) | 9125 | days |
| CS | Concentration of chemicals in soil | (see table below) | |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 3.2E+01 | mg/kg |
| Aroclor-1016 | NA | mg/kg |
| Aroclor-1221 | 2.9E-02 | mg/kg |
| Aroclor-1242 | NA | mg/kg |
| Aroclor-1248 | 2.2E-02 | mg/kg |
| Aroclor-1254 | 9.6E-01 | mg/kg |
| Aroclor-1260 | 1.0E+00 | mg/kg |
| Arsenic | 1.7E+01 | mg/kg |
| Barium | 1.4E+03 | mg/kg |
| Beryllium | 1.5E+00 | mg/kg |
| Cadmium | 6.4E+00 | mg/kg |
| Chromium | 4.1E+01 | mg/kg |
| Cobalt | 1.6E+01 | mg/kg |
| Copper | 6.2E+01 | mg/kg |
| Cyanide | 5.3E+00 | mg/kg |
| DI-n-octyl phthalate | 8.3E-02 | mg/kg |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Lead | 1.6E+02 | mg/kg |
| Manganese | 6.9E+02 | mg/kg |
| Mercury | 4.7E-01 | mg/kg |
| Molybdenum | 5.0E+00 | mg/kg |
| Nickel | 4.4E+01 | mg/kg |
| Octachlorodibenzofuran | NA | mg/kg |
| Selenium | 1.3E-01 | mg/kg |
| Thallium | 4.6E-01 | mg/kg |
| Vanadium | 3.2E+01 | mg/kg |
| Zinc | 1.6E+02 | mg/kg |
| 2-Chlorophenol | NA | mg/kg |
| 2-Methylnaphthalene | 8.0E-02 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | mg/kg |
| 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-10 (continued)**
**Summary of Risk Characterization (Chemicals)**
**Groundskeeper Current Land Use Scenario**
**Via Incidental Ingestion of Soil/Sediment**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 1.6E-05 | 4.0E-04 | 3.9E-02 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.4E-08 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.1E-08 | NA | NA |
| Aroclor-1254 | 4.8E-07 | NA | NA |
| Aroclor-1260 | 4.9E-07 | NA | NA |
| Arsenic | 8.1E-06 | 3.0E-04 | 2.7E-02 |
| Barium | 6.7E-04 | 7.0E-02 | 9.6E-03 |
| Beryllium | 7.2E-07 | 5.0E-03 | 1.4E-04 |
| Cadmium | 3.1E-06 | 5.0E-04 | 6.3E-03 |
| Chromium | 2.0E-05 | 5.0E-03 | 4.0E-03 |
| Cobalt | 7.8E-06 | 6.0E-02 | 1.3E-04 |
| Copper | 3.0E-05 | NA | NA |
| Cyanide | 2.6E-06 | 2.0E-02 | 1.3E-04 |
| Di-n-octyl phthalate | 4.1E-08 | 2.0E-02 | 2.0E-06 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 8.9E-05 | NA | NA |
| Manganese | 3.4E-04 | 1.4E-01 | 2.4E-03 |
| Mercury | 2.3E-07 | 3.0E-04 | 7.7E-04 |
| Molybdenum | 2.4E-06 | 5.0E-03 | 4.9E-04 |
| Nickel | 2.1E-05 | 2.0E-02 | 1.1E-03 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 6.6E-08 | 5.0E-03 | 1.3E-05 |
| Thallium | 2.3E-07 | 8.0E-05 | 2.8E-03 |
| Vanadium | 1.6E-05 | 7.0E-03 | 2.2E-03 |
| Zinc | 7.9E-05 | 3.0E-01 | 2.6E-04 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 3.9E-08 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 9.7E-02 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 5.6E-06 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 5.1E-09 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 3.8E-09 | 7.7E+00 | 2.9E-08 |
| Aroclor-1254 | 1.7E-07 | 7.7E+00 | 1.3E-06 |
| Aroclor-1260 | 1.8E-07 | 7.7E+00 | 1.4E-06 |
| Arsenic | 2.9E-06 | 1.8E+00 | 5.0E-06 |
| Barium | 2.4E-04 | NA | NA |
| Beryllium | 2.6E-07 | 4.3E+00 | 1.1E-06 |
| Cadmium | 1.1E-06 | NA | NA |
| Chromium | 7.2E-06 | NA | NA |
| Cobalt | 2.8E-06 | NA | NA |
| Copper | 1.1E-05 | NA | NA |
| Cyanide | 9.2E-07 | NA | NA |
| Di-n-octyl phthalate | 1.5E-08 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.2E-05 | NA | NA |
| Manganese | 1.2E-04 | NA | NA |
| Mercury | 8.2E-08 | NA | NA |
| Molybdenum | 8.7E-07 | NA | NA |
| Nickel | 7.6E-06 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.3E-08 | NA | NA |
| Thallium | 8.1E-08 | NA | NA |
| Vanadium | 5.5E-06 | NA | NA |
| Zinc | 2.8E-05 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 1.4E-08 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 8.9E-06 |

- 5208

# Table K.IV-11
## Summary of Intake and Risk Quantitation (Radionuclides)
## Groundskeeper Current Land Use Scenario
## Via Incidental Ingestion of Soil/Sediment

**Intake Equation** = CS X EF X EDn X FI X IR

| | | | |
|---|---|---|---|
| IRs | Ingestion rate of soil (RAGS, 1989) | 50 | mg/day |
| EF | Exposure frequency | 250 | days/year |
| EDn | Exposure Duration | 25 | Year |
| FI | Fractional Intake | 1 | (unitless) |
| CS | Concentration of radionuclides in soil | | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/mg | Rn-222 | NA | pCi/mg |
| Am-241 | NA | pCi/mg | Ru-106 | NA | pCi/mg |
| Cs-137 | 8.4E-04 | pCi/mg | Sr-90 | 2.6E-03 | pCi/mg |
| Np-237 | 9.5E-04 | pCi/mg | Tc-99 | 1.5E-02 | pCi/mg |
| Pa-231 | 8.8E-04 | pCi/mg | Th-228 | 2.8E-03 | pCi/mg |
| Pb-210 | 2.5E-02 | pCi/mg | Th-230 | 2.9E-03 | pCi/mg |
| Pu-238 | 1.3E-03 | pCi/mg | Th-232 | 1.9E-03 | pCi/mg |
| Pu-239 | 6.7E-04 | pCi/mg | U-233 | NA | pCi/mg |
| Pu-240 | 6.7E-04 | pCi/mg | U-234 | 3.4E-02 | pCi/mg |
| Ra-226 | 1.9E-03 | pCi/mg | U-235 | 8.9E-04 | pCi/mg |
| Ra-228 | 2.0E-03 | pCi/mg | U-236 | 2.6E-04 | pCi/mg |
| | | | U-238 | 2.0E-02 | pCi/mg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 2.6E+02 | 2.8E-11 | 7.3E-09 |
| Np-237 | 3.0E+02 | 2.2E-10 | 6.6E-08 |
| Pa-231 | 2.8E+02 | 9.2E-11 | 2.5E-08 |
| Pb-210 | 7.9E+03 | 6.6E-10 | 5.2E-06 |
| Pu-238 | 4.1E+02 | 2.2E-10 | 9.1E-08 |
| Pu-239 | 2.1E+02 | 2.3E-10 | 4.8E-08 |
| Pu-240 | 2.1E+02 | 2.3E-10 | 4.8E-08 |
| Ra-226 | 5.8E+02 | 1.2E-10 | 7.0E-08 |
| Ra-228 | 6.2E+02 | 1.0E-10 | 6.2E-08 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 8.0E+02 | 3.3E-10 | 2.7E-07 |
| Tc-99 | 4.6E+03 | 1.3E-12 | 6.0E-09 |
| Th-228 | 8.6E+02 | 5.5E-11 | 4.7E-08 |
| Th-230 | 9.0E+02 | 1.3E-11 | 1.2E-08 |
| Th-232 | 5.9E+02 | 1.2E-11 | 7.1E-09 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 1.0E+04 | 1.6E-11 | 1.7E-07 |
| U-235 | 2.8E+02 | 1.6E-11 | 4.4E-09 |
| U-236 | 8.1E+01 | 1.5E-11 | 1.2E-09 |
| U-238 | 6.3E+03 | 2.8E-11 | 1.8E-07 |
| | | ILCR Summation = | 6.3E-06 |

**Table K.IV-12**
**Summary of Intake Quantitation (Chemicals)**
**Groundskeeper Current Land Use Scenario**
**Via Dermal Contact with Soil/Sediment**

**Intake Equation** = $\frac{CS \times EF \times ED \times CF \times ABS \times AF \times SA}{BW \times AT}$

| | | | |
|---|---|---|---|
| SA | Surface area of exposed skin (50th percentile, hands only) | 5800 | $cm^2$/day |
| AF | Soil to skin adherence factor (RAGS, 1989) | 1 | $mg/cm^2$ |
| ABS | Chemical specific absorbtion factor (see table below) | csv | |
| CF | Conversion factor | 1.00E-06 | kg/mg |
| EF | Exposure frequency | 250 | days/year |
| EDn | Exposure duration for non-carcinogens | 25 | Year |
| EDc | Exposure duration for carcinogens | 25 | Year |
| BW | Body weight | 70 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 9125 | days |
| CS | Concentration of chemicals in soil | (see table below) | |

**Chemical Concentrations**

| Compound | ABS | Concentrati | Units |
|---|---|---|---|
| Antimony | 1.0E-02 | 3.2E+01 | mg/kg |
| Aroclor-1016 | 6.0E-02 | NA | mg/kg |
| Aroclor-1221 | 6.0E-02 | 2.9E-02 | mg/kg |
| Aroclor-1242 | 6.0E-02 | NA | mg/kg |
| Aroclor-1248 | 6.0E-02 | 2.2E-02 | mg/kg |
| Aroclor-1254 | 6.0E-02 | 9.8E-01 | mg/kg |
| Aroclor-1260 | 6.0E-02 | 1.0E+00 | mg/kg |
| Arsenic | 1.0E-03 | 1.7E+01 | mg/kg |
| Barium | 1.0E-02 | 1.4E+03 | mg/kg |
| Beryllium | 1.0E-02 | 1.5E+00 | mg/kg |
| Cadmium | 1.0E-02 | 6.4E+00 | mg/kg |
| Chromium | 1.0E-02 | 4.1E+01 | mg/kg |
| Cobalt | 1.0E-02 | 1.6E+01 | mg/kg |
| Copper | 1.0E-03 | 6.2E+01 | mg/kg |
| Cyanide | NA | 5.3E+00 | mg/kg |
| Di-n-octyl phthalate | 3.0E-01 | 8.3E-02 | mg/kg |

| Compound | ABS | Concentrat | Units |
|---|---|---|---|
| Heptachlorodibenzofuran | 3.0E-02 | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | 3.0E-02 | NA | mg/kg |
| Lead | 1.0E-02 | 1.8E+02 | mg/kg |
| Manganese | 1.0E-02 | 6.9E+02 | mg/kg |
| Mercury | 5.0E-02 | 4.7E-01 | mg/kg |
| Molybdenum | 1.0E-02 | 5.0E+00 | mg/kg |
| Nickel | 5.0E-04 | 4.4E+01 | mg/kg |
| Octachlorodibenzofuran | 3.0E-02 | NA | mg/kg |
| Selenium | 1.0E-02 | 1.3E-01 | mg/kg |
| Thallium | 1.0E-02 | 4.6E-01 | mg/kg |
| Vanadium | 1.0E-03 | 3.2E+01 | mg/kg |
| Zinc | 1.0E-02 | 1.6E+02 | mg/kg |
| 2-Chlorophenol | NA | NA | mg/kg |
| 2-Methylnaphthalene | NA | 8.0E-02 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | NA | mg/kg |
| 4,4-DDT | 3.0E-01 | NA | mg/kg |

**References**



0614

5208

**Table K.IV-12 (continued)**
**Summary of Risk Characterization (Chemicals)**
**Groundskeeper Current Land Use Scenario**
**Via Dermal Contact with Soil/Sediment**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 1.8E-05 | 4.0E-04 | 4.6E-02 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 9.9E-08 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 7.4E-08 | NA | NA |
| Aroclor-1254 | 3.3E-06 | NA | NA |
| Aroclor-1260 | 3.4E-06 | NA | NA |
| Arsenic | 9.4E-07 | 3.0E-04 | 3.1E-03 |
| Barium | 7.6E-04 | 7.0E-02 | 1.1E-02 |
| Beryllium | 6.4E-07 | 5.0E-03 | 1.7E-04 |
| Cadmium | 3.6E-06 | 5.0E-04 | 7.3E-03 |
| Chromium | 2.3E-05 | 5.0E-03 | 4.7E-03 |
| Cobalt | 9.0E-06 | 6.0E-02 | 1.5E-04 |
| Copper | 3.5E-06 | NA | NA |
| Cyanide | 0.0E+00 | 2.0E-02 | NA |
| Di-n-octyl phthalate | 1.4E-06 | 2.0E-02 | 7.1E-05 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.0E-04 | NA | NA |
| Manganese | 3.9E-04 | 1.4E-01 | 2.8E-03 |
| Mercury | 1.3E-06 | 3.0E-04 | 4.5E-03 |
| Molybdenum | 2.8E-06 | 5.0E-03 | 5.7E-04 |
| Nickel | 1.2E-06 | 2.0E-02 | 6.2E-05 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 7.6E-08 | 5.0E-03 | 1.5E-05 |
| Thallium | 2.6E-07 | 8.0E-05 | 3.3E-03 |
| Vanadium | 1.8E-06 | 7.0E-03 | 2.6E-04 |
| Zinc | 9.2E-05 | 3.0E-01 | 3.1E-04 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 0.0E+00 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 8.4E-02 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 6.5E-08 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 3.5E-08 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 2.6E-08 | 7.7E+00 | 2.0E-07 |
| Aroclor-1254 | 1.2E-06 | 7.7E+00 | 9.1E-06 |
| Aroclor-1260 | 1.2E-06 | 7.7E+00 | 9.5E-06 |
| Arsenic | 3.3E-07 | 1.8E+00 | 5.9E-07 |
| Barium | 2.8E-04 | NA | NA |
| Beryllium | 3.0E-07 | 4.3E+00 | 1.3E-06 |
| Cadmium | 1.3E-06 | NA | NA |
| Chromium | 8.3E-06 | NA | NA |
| Cobalt | 3.2E-06 | NA | NA |
| Copper | 1.3E-06 | NA | NA |
| Cyanide | 0.0E+00 | NA | NA |
| Di-n-octyl phthalate | 5.1E-07 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.7E-05 | NA | NA |
| Manganese | 1.4E-04 | NA | NA |
| Mercury | 4.8E-07 | NA | NA |
| Molybdenum | 1.0E-06 | NA | NA |
| Nickel | 4.4E-07 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.7E-08 | NA | NA |
| Thallium | 9.3E-08 | NA | NA |
| Vanadium | 6.4E-07 | NA | NA |
| Zinc | 3.3E-05 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 0.0E+00 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 2.1E-05 |

- 5208

**Table K.IV-13**
**Summary of Risk Quantitation (Radionuclides)**
**Groundskeeper Current Land Use Scenario**
**Via External Radiation**

**Exposure Equation** = $[CR \times EF \times EDn \times ET_i \times (1-SH_i)] + [CR \times EF \times EDn \times ET_o \times (1-SH_o)]$

| | | | |
|---|---|---|---|
| EF | Fraction of year spent exposured | 0.68 | (unitless) |
| ED | Exposure duration | 25 | Year |
| $ET_i$ | Fraction of day spent indoors | 0 | (unitless) |
| $ET_o$ | Fraction of day spent outdoors (8hours/24hours) | 0.33 | (unitless) |
| $SH_i$ | Shield factor indoors | 0.5 | (unitless) |
| $SH_o$ | Shield factor outdoors | 0 | (unitless) |
| CR | Radionuclide specific concentrations | | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/g | Rn-222 | NA | pCi/g |
| Am-241 | NA | pCi/g | Ru-106 | NA | pCi/g |
| Cs-137 | 1.0E+00 | pCi/g | Sr-90 | 5.2E+00 | pCi/g |
| Np-237 | 7.0E-01 | pCi/g | Tc-99 | 3.8E+01 | pCi/g |
| Pa-231 | 2.4E+00 | pCi/g | Th-228 | 5.0E+00 | pCi/g |
| Pb-210 | 7.0E+01 | pCi/g | Th-230 | 5.0E+00 | pCi/g |
| Pu-238 | 3.0E+00 | pCi/g | Th-232 | 5.0E+00 | pCi/g |
| Pu-239 | 1.1E+00 | pCi/g | U-233 | NA | pCi/g |
| Pu-240 | 1.1E+00 | pCi/g | U-234 | 1.0E+02 | pCi/g |
| Ra-226 | 5.0E+00 | pCi/g | U-235 | 2.7E+00 | pCi/g |
| Ra-228 | 5.0E+00 | pCi/g | U-236 | 1.1E+00 | pCi/g |
| | | | U-238 | 6.0E+01 | pCi/g |

| Radionuclides | CDI (year pCi/g) | CSF $(g/pCi-year)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | NA | NA |
| Am-241 | NA | 4.9E-09 | NA |
| Cs-137 | 5.6E+00 | 2.0E-06 | 1.1E-05 |
| Np-237 | 3.9E+00 | 4.3E-07 | 1.7E-06 |
| Pa-231 | 1.4E+01 | 2.6E-08 | 3.5E-07 |
| Pb-210 | 3.9E+02 | 1.6E-10 | 6.3E-08 |
| Pu-238 | 1.7E+01 | 2.8E-11 | 4.6E-10 |
| Pu-239 | 6.3E+00 | 1.7E-11 | 1.1E-10 |
| Pu-240 | 6.3E+00 | 2.7E-11 | 1.7E-10 |
| Ra-226 | 2.8E+01 | 6.0E-06 | 1.7E-04 |
| Ra-228 | 2.8E+01 | 2.9E-06 | 8.1E-05 |
| Rn-222 | NA | 5.9E-06 | NA |
| Ru-106 | NA | NA | NA |
| Sr-90 | 2.9E+01 | NA | NA |
| Tc-99 | 2.1E+02 | 6.0E-13 | 1.3E-10 |
| Th-228 | 2.8E+01 | 5.6E-06 | 1.6E-04 |
| Th-230 | 2.8E+01 | 5.4E-11 | 1.5E-09 |
| Th-232 | 2.8E+01 | 2.6E-11 | 7.3E-10 |
| U-233 | NA | 4.2E-11 | NA |
| U-234 | 5.6E+02 | 3.0E-11 | 1.7E-08 |
| U-235 | 1.5E+01 | 2.4E-07 | 3.6E-06 |
| U-236 | 6.2E+00 | 2.4E-11 | 1.5E-10 |
| U-238 | 3.4E+02 | 3.6E-08 | 1.2E-05 |
| | | **ILCR Summation =** | 4.4E-04 |

0616

**Table K.IV-14**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RMB Resident Farm Adult Current Land Use Scenario**
**Via Inhalation of Particulates**

**Intake Equation** = $\frac{CS \times EF \times ED \times IR}{BW \times AT}$

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 20 $m^3$/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration for non-carcinogens | 70 Year |
| EDc | Exposure duration for carcinogens | 70 Year |
| BW | Body weight | 70 kg |
| ATc | Average time for carcinogens (lifetime) | 25550 days |
| ATn | Average time for non-carcinogens (EDn x 365) | 25550 days |
| CS | Concentration of chemicals in soil | (see table below) |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 1.6E-06 | mg/m$^3$ |
| Aroclor-1016 | NA | mg/m$^3$ |
| Aroclor-1221 | 1.9E-09 | mg/m$^3$ |
| Aroclor-1242 | NA | mg/m$^3$ |
| Aroclor-1248 | 1.3E-09 | mg/m$^3$ |
| Aroclor-1254 | 6.0E-08 | mg/m$^3$ |
| Aroclor-1260 | 6.3E-08 | mg/m$^3$ |
| Arsenic | 9.3E-07 | mg/m$^3$ |
| Barium | 8.5E-05 | mg/m$^3$ |
| Beryllium | 8.5E-08 | mg/m$^3$ |
| Cadmium | 3.7E-07 | mg/m$^3$ |
| Chromium | 2.5E-07 | mg/m$^3$ |
| Cobalt | 9.3E-07 | mg/m$^3$ |
| Copper | 3.7E-06 | mg/m$^3$ |
| Cyanide | 3.3E-07 | mg/m$^3$ |
| Di-n-octyl phthalate | 5.2E-09 | mg/m$^3$ |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/m$^3$ |
| Heptachlorodibenzo-p-dioxin | NA | mg/m$^3$ |
| Lead | 1.1E-05 | mg/m$^3$ |
| Manganese | 3.9E-05 | mg/m$^3$ |
| Mercury | 3.0E-08 | mg/m$^3$ |
| Molybdenum | 3.0E-07 | mg/m$^3$ |
| Nickel | 2.5E-06 | mg/m$^3$ |
| Octachlorodibenzofuran | NA | mg/m$^3$ |
| Selenium | 8.5E-09 | mg/m$^3$ |
| Thallium | 2.6E-08 | mg/m$^3$ |
| Vanadium | 1.8E-06 | mg/m$^3$ |
| Zinc | 9.6E-06 | mg/m$^3$ |
| 2-Chlorophenol | NA | mg/m$^3$ |
| 2-Methylnaphthalene | 5.0E-09 | mg/m$^3$ |
| 4-Chlorophenyl-phenylether | NA | mg/m$^3$ |
| 4,4-DDT | NA | mg/m$^3$ |

**References**



5208
0617

**Table K.IV-14 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Adult Current Land Use Scenario**
**Via Inhalation of Particulates**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 5.3E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 5.1E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 3.5E-10 | NA | NA |
| Aroclor-1254 | 1.6E-08 | NA | NA |
| Aroclor-1260 | 1.7E-08 | NA | NA |
| Arsenic | 2.5E-07 | NA | NA |
| Barium | 2.3E-05 | 1.4E-04 | 1.7E-01 |
| Beryllium | 2.3E-08 | NA | NA |
| Cadmium | 1.0E-07 | NA | NA |
| Chromium | 6.7E-08 | NA | NA |
| Cobalt | 2.5E-07 | 3.0E-07 | 8.5E-01 |
| Copper | 1.0E-06 | NA | NA |
| Cyanide | 9.0E-08 | NA | NA |
| Di-n-octyl phthalate | 1.4E-09 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.1E-06 | NA | NA |
| Manganese | 1.1E-05 | 1.1E-04 | 9.6E-02 |
| Mercury | 8.1E-09 | 8.6E-05 | 9.4E-05 |
| Molybdenum | 8.1E-08 | NA | NA |
| Nickel | 6.7E-07 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.3E-09 | NA | NA |
| Thallium | 7.2E-09 | NA | NA |
| Vanadium | 4.9E-07 | NA | NA |
| Zinc | 2.6E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 1.4E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | NA | NA |
| | Hazard Quotient Sum = | | 1.1E+00 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 5.3E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 5.1E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 3.5E-10 | NA | NA |
| Aroclor-1254 | 1.6E-08 | NA | NA |
| Aroclor-1260 | 1.7E-08 | NA | NA |
| Arsenic | 2.5E-07 | 1.5E+01 | 3.8E-06 |
| Barium | 2.3E-05 | NA | NA |
| Beryllium | 2.3E-08 | 8.4E+00 | 1.9E-07 |
| Cadmium | 1.0E-07 | 6.1E+00 | 6.2E-07 |
| Chromium | 6.7E-08 | 4.1E+01 | 2.8E-06 |
| Cobalt | 2.5E-07 | NA | NA |
| Copper | 1.0E-06 | NA | NA |
| Cyanide | 9.0E-08 | NA | NA |
| Di-n-octyl phthalate | 1.4E-09 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.1E-06 | NA | NA |
| Manganese | 1.1E-05 | NA | NA |
| Mercury | 8.1E-09 | NA | NA |
| Molybdenum | 8.1E-08 | NA | NA |
| Nickel | 6.7E-07 | 8.4E-01 | 5.6E-07 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.3E-09 | NA | NA |
| Thallium | 7.2E-09 | NA | NA |
| Vanadium | 4.9E-07 | NA | NA |
| Zinc | 2.6E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 1.4E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 8.0E-06 |

- 5208

**Table K.IV-15**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Adult Current Land Use Scenario**
**Via Inhalation of Gases and Particulates**

**Intake Equation** = Ca X EF X EDn X IR

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 20 $m^3$/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 70 Year |
| Ca | Concentration of radionuclides in air | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/$m^3$ | Rn-222 | 4.0E+00 | pCi/$m^3$ |
| Am-241 | NA | pCi/$m^3$ | Ru-106 | NA | pCi/$m^3$ |
| Cs-137 | 4.6E-05 | pCi/$m^3$ | Sr-90 | 1.5E-04 | pCi/$m^3$ |
| Np-237 | 1.6E-05 | pCi/$m^3$ | Tc-99 | 9.2E-04 | pCi/$m^3$ |
| Pa-231 | 5.5E-05 | pCi/$m^3$ | Th-228 | 1.4E-04 | pCi/$m^3$ |
| Pb-210 | 1.6E-03 | pCi/$m^3$ | Th-230 | 1.5E-04 | pCi/$m^3$ |
| Pu-238 | 8.0E-05 | pCi/$m^3$ | Th-232 | 8.0E-05 | pCi/$m^3$ |
| Pu-239 | 3.9E-05 | pCi/$m^3$ | U-233 | NA | pCi/$m^3$ |
| Pu-240 | 3.9E-05 | pCi/$m^3$ | U-234 | 1.7E-03 | pCi/$m^3$ |
| Ra-226 | 8.0E-05 | pCi/$m^3$ | U-235 | 4.4E-05 | pCi/$m^3$ |
| Ra-228 | 8.7E-05 | pCi/$m^3$ | U-236 | 1.8E-05 | pCi/$m^3$ |
| | | | U-238 | 9.9E-04 | pCi/$m^3$ |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 8.8E-08 | NA |
| Am-241 | NA | 3.2E-08 | NA |
| Cs-137 | 2.3E+01 | 1.9E-11 | 4.3E-10 |
| Np-237 | 7.8E+00 | 2.9E-08 | 2.3E-07 |
| Pa-231 | 2.7E+01 | 3.6E-08 | 9.7E-07 |
| Pb-210 | 7.8E+02 | 4.0E-09 | 3.1E-06 |
| Pu-238 | 3.9E+01 | 3.9E-08 | 1.5E-06 |
| Pu-239 | 1.9E+01 | 3.8E-08 | 7.3E-07 |
| Pu-240 | 1.9E+01 | 3.8E-08 | 7.3E-07 |
| Ra-226 | 3.9E+01 | 3.0E-09 | 1.2E-07 |
| Ra-228 | 4.3E+01 | 6.9E-10 | 2.9E-08 |
| Rn-222 | 2.0E+06 | 7.7E-12 | 1.5E-05 |
| Ru-106 | NA | 4.4E-10 | NA |
| Sr-90 | 7.4E+01 | 5.6E-11 | 4.2E-09 |
| Tc-99 | 4.5E+02 | 8.3E-12 | 3.7E-09 |
| Th-228 | 7.0E+01 | 7.8E-08 | 5.5E-06 |
| Th-230 | 7.3E+01 | 2.9E-08 | 2.1E-06 |
| Th-232 | 3.9E+01 | 2.8E-08 | 1.1E-06 |
| U-233 | NA | 2.7E-08 | NA |
| U-234 | 8.1E+02 | 2.6E-08 | 2.1E-05 |
| U-235 | 2.2E+01 | 2.5E-08 | 5.4E-07 |
| U-236 | 8.8E+00 | 2.5E-08 | 2.2E-07 |
| U-238 | 4.8E+02 | 5.2E-08 | 2.5E-05 |
| | | **ILCR Summation =** | 7.8E-05 |



0619

5208

**Table K.IV-16**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Adult Current Land Use Scenario**
**Via Ingestion of Drinking Water**

**Intake Equation** = Cw X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of groundwater (RAGS, 1989) | 2 l/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 70 Year |
| FI | Fractional intake for radionuclides | 1 (Unitless) |
| Cw | Concentration of radionuclides in groundwater | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/l | Rn-222 | NA | pCi/l |
| Am-241 | NA | pCi/l | Ru-106 | NA | pCi/l |
| Cs-137 | NA | pCi/l | Sr-90 | NA | pCi/l |
| Np-237 | NA | pCi/l | Tc-99 | NA | pCi/l |
| Pa-231 | NA | pCi/l | Th-228 | NA | pCi/l |
| Pb-210 | NA | pCi/l | Th-230 | NA | pCi/l |
| Pu-238 | NA | pCi/l | Th-232 | NA | pCi/l |
| Pu-239 | NA | pCi/l | U-233 | NA | pCi/l |
| Pu-240 | NA | pCi/l | U-234 | 6.1E+00 | pCi/l |
| Ra-226 | NA | pCi/l | U-235 | 1.6E-01 | pCi/l |
| Ra-228 | NA | pCi/l | U-236 | 6.7E-02 | pCi/l |
| | | | U-238 | 3.6E+00 | pCi/l |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | NA | 2.8E-11 | NA |
| Np-237 | NA | 2.2E-10 | NA |
| Pa-231 | NA | 9.2E-11 | NA |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | NA | 2.2E-10 | NA |
| Pu-239 | NA | 2.3E-10 | NA |
| Pu-240 | NA | 2.3E-10 | NA |
| Ra-226 | NA | 1.2E-10 | NA |
| Ra-228 | NA | 1.0E-10 | NA |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | NA | 3.3E-10 | NA |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | NA | 5.5E-11 | NA |
| Th-230 | NA | 1.3E-11 | NA |
| Th-232 | NA | 1.2E-11 | NA |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 3.0E+05 | 1.6E-11 | 4.8E-06 |
| U-235 | 7.9E+03 | 1.6E-11 | 1.3E-07 |
| U-236 | 3.3E+03 | 1.5E-11 | 4.9E-08 |
| U-238 | 1.8E+05 | 2.8E-11 | 5.0E-06 |
| | | ILCR Summation = | 9.9E-06 |



0620

**Table K.IV-17**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Adult Current Land Use Scenario**
**Via Ingestion of Meat Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of meat | 0.075 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 70 | Year |
| EDc | Exposure duration for carcinogens | 70 | Year |
| BW | Body weight | 70 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 25550 | days |
| CS | Concentration of chemicals in meat | | |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 6.7E-06 | mg/kg |
| Aroclor-1016 | NA | mg/kg |
| Aroclor-1221 | 5.6E-11 | mg/kg |
| Aroclor-1242 | NA | mg/kg |
| Aroclor-1248 | 1.9E-08 | mg/kg |
| Aroclor-1254 | 8.0E-06 | mg/kg |
| Aroclor-1260 | 3.1E-06 | mg/kg |
| Arsenic | 5.7E-06 | mg/kg |
| Barium | 2.2E-05 | mg/kg |
| Beryllium | 2.5E-07 | mg/kg |
| Cadmium | 8.1E-06 | mg/kg |
| Chromium | NA | mg/kg |
| Cobalt | 5.9E-05 | mg/kg |
| Copper | 9.5E-05 | mg/kg |
| Cyanide | 2.9E-11 | mg/kg |
| Di-n-octyl phthalate | 3.2E-04 | mg/kg |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Lead | 6.5E-06 | mg/kg |
| Manganese | 5.7E-05 | mg/kg |
| Mercury | 1.4E-05 | mg/kg |
| Molybdenum | 6.3E-06 | mg/kg |
| Nickel | 4.9E-05 | mg/kg |
| Octachlorodibenzofuran | NA | mg/kg |
| Selenium | 2.0E-07 | mg/kg |
| Thallium | 3.3E-06 | mg/kg |
| Vanadium | 1.6E-05 | mg/kg |
| Zinc | 3.1E-03 | mg/kg |
| 2-Chlorophenol | NA | mg/kg |
| 2-Methylnaphthalene | 1.4E-09 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | mg/kg |
| 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-17 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Adult Current Land Use Scenario**
**Via Ingestion of Meat Products**

| Compound | HQ Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
| Antimony | 6.9E-09 | 4.0E-04 | 1.7E-05 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 5.8E-14 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 2.0E-11 | NA | NA |
| Aroclor-1254 | 8.2E-09 | NA | NA |
| Aroclor-1260 | 3.2E-09 | NA | NA |
| Arsenic | 5.9E-09 | 3.0E-04 | 2.0E-05 |
| Barium | 2.3E-08 | 7.0E-02 | 3.2E-07 |
| Beryllium | 2.5E-10 | 5.0E-03 | 5.1E-08 |
| Cadmium | 8.3E-09 | 5.0E-04 | 1.7E-05 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 6.1E-08 | 6.0E-02 | 1.0E-06 |
| Copper | 9.7E-08 | NA | NA |
| Cyanide | 3.0E-14 | 2.0E-02 | 1.5E-12 |
| Di-n-octyl phthalate | 3.3E-07 | 2.0E-02 | 1.6E-05 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 6.7E-09 | NA | NA |
| Manganese | 5.8E-08 | 1.4E-01 | 4.2E-07 |
| Mercury | 1.4E-08 | 3.0E-04 | 4.7E-05 |
| Molybdenum | 6.5E-09 | 5.0E-03 | 1.3E-06 |
| Nickel | 5.0E-08 | 2.0E-02 | 2.5E-06 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.0E-10 | 5.0E-03 | 4.0E-08 |
| Thallium | 3.4E-09 | 8.0E-05 | 4.2E-05 |
| Vanadium | 1.6E-08 | 7.0E-03 | 2.3E-06 |
| Zinc | 3.2E-06 | 3.0E-01 | 1.1E-05 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 1.5E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 1.8E-04 |

| Compound | ILCR Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
| Antimony | 6.9E-09 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 5.8E-14 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 2.0E-11 | 7.7E+00 | 1.5E-10 |
| Aroclor-1254 | 8.2E-09 | 7.7E+00 | 6.3E-08 |
| Aroclor-1260 | 3.2E-09 | 7.7E+00 | 2.5E-08 |
| Arsenic | 5.9E-09 | 1.8E+00 | 1.0E-08 |
| Barium | 2.3E-08 | NA | NA |
| Beryllium | 2.5E-10 | 4.3E+00 | 1.1E-09 |
| Cadmium | 8.3E-09 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 6.1E-08 | NA | NA |
| Copper | 9.7E-08 | NA | NA |
| Cyanide | 3.0E-14 | NA | NA |
| Di-n-octyl phthalate | 3.3E-07 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 6.7E-09 | NA | NA |
| Manganese | 5.8E-08 | NA | NA |
| Mercury | 1.4E-08 | NA | NA |
| Molybdenum | 6.5E-09 | NA | NA |
| Nickel | 5.0E-08 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.0E-10 | NA | NA |
| Thallium | 3.4E-09 | NA | NA |
| Vanadium | 1.6E-08 | NA | NA |
| Zinc | 3.2E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 1.5E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 9.9E-08 |



0622

-5208

## Table K.IV-18
## Summary of Intake and Risk Quantitation (Radionuclides)
## Off-Property RME Resident Farm Adult Current Land Use Scenario
## Via Ingestion of Meat Products

**Intake Equation** = Cf X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of meat | 0.075 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 70 Year |
| Cf | Concentration of radionuclides in meat | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 3.3E-03 | pCi/kg | Sr-90 | NA | pCi/kg |
| Np-237 | 1.3E-06 | pCi/kg | Tc-99 | NA | pCi/kg |
| Pa-231 | 6.8E-03 | pCi/kg | Th-228 | 1.9E-06 | pCi/kg |
| Pb-210 | NA | pCi/kg | Th-230 | 3.1E-06 | pCi/kg |
| Pu-238 | 8.5E-08 | pCi/kg | Th-232 | 1.7E-08 | pCi/kg |
| Pu-239 | 5.5E-08 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 5.5E-08 | pCi/kg | U-234 | 5.3E-01 | pCi/kg |
| Ra-226 | 7.0E-05 | pCi/kg | U-235 | 1.4E-02 | pCi/kg |
| Ra-228 | 4.7E-05 | pCi/kg | U-236 | 5.7E-03 | pCi/kg |
| | | | U-238 | 3.1E-01 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 6.0E+00 | 2.8E-11 | 1.7E-10 |
| Np-237 | 2.5E-03 | 2.2E-10 | 5.4E-13 |
| Pa-231 | 1.2E+01 | 9.2E-11 | 1.1E-09 |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | 1.6E-04 | 2.2E-10 | 3.5E-14 |
| Pu-239 | 1.0E-04 | 2.3E-10 | 2.3E-14 |
| Pu-240 | 1.0E-04 | 2.3E-10 | 2.3E-14 |
| Ra-226 | 1.3E-01 | 1.2E-10 | 1.5E-11 |
| Ra-228 | 8.7E-02 | 1.0E-10 | 8.7E-12 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | NA | 3.3E-10 | NA |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | 3.5E-03 | 5.5E-11 | 1.9E-13 |
| Th-230 | 5.8E-03 | 1.3E-11 | 7.5E-14 |
| Th-232 | 3.1E-03 | 1.2E-11 | 3.7E-14 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 9.6E+02 | 1.6E-11 | 1.5E-08 |
| U-235 | 2.5E+01 | 1.6E-11 | 4.1E-10 |
| U-236 | 1.0E+01 | 1.5E-11 | 1.6E-10 |
| U-238 | 5.7E+02 | 2.8E-11 | 1.6E-08 |
| | | ILCR Summation = | 3.3E-08 |

**Table K.IV-19**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Adult Current Land Use Scenario**
**Via Ingestion of Dairy Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of dairy products | 0.3 | l/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 70 | Year |
| EDc | Exposure duration for carcinogens | 70 | Year |
| BW | Body weight | 70 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 25550 | days |
| CS | Concentration of chemicals in animal products | | |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 6.7E-07 | mg/kg | Heptachlorodibenzofuran | NA | mg/kg |
| Aroclor-1016 | NA | mg/kg | Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Aroclor-1221 | 1.6E-11 | mg/kg | Lead | 5.4E-06 | mg/kg |
| Aroclor-1242 | NA | mg/kg | Manganese | 5.0E-05 | mg/kg |
| Aroclor-1248 | 2.0E-08 | mg/kg | Mercury | 2.5E-08 | mg/kg |
| Aroclor-1254 | 1.7E-06 | mg/kg | Molybdenum | 1.6E-06 | mg/kg |
| Aroclor-1260 | 6.3E-06 | mg/kg | Nickel | 8.2E-06 | mg/kg |
| Arsenic | 1.7E-07 | mg/kg | Octachlorodibenzofuran | NA | mg/kg |
| Barium | 5.1E-05 | mg/kg | Selenium | 5.2E-08 | mg/kg |
| Beryllium | 2.2E-10 | mg/kg | Thallium | 1.6E-07 | mg/kg |
| Cadmium | 1.5E-06 | mg/kg | Vanadium | 1.3E-07 | mg/kg |
| Chromium | NA | mg/kg | Zinc | 3.1E-04 | mg/kg |
| Cobalt | 5.9E-06 | mg/kg | 2-Chlorophenol | NA | mg/kg |
| Copper | 1.4E-05 | mg/kg | 2-Methylnaphthalene | 8.0E-10 | mg/kg |
| Cyanide | NA | mg/kg | 4-Chlorophenyl-phenylether | NA | mg/kg |
| Di-n-octyl phthalate | 1.0E-04 | mg/kg | 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-19 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Adult Current Land Use Scenario**
**Via Ingestion of Dairy Products**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 2.8E-09 | 4.0E-04 | 6.9E-06 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 7.4E-14 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 8.0E-11 | NA | NA |
| Aroclor-1254 | 7.1E-09 | NA | NA |
| Aroclor-1260 | 2.6E-08 | NA | NA |
| Arsenic | 7.1E-10 | 3.0E-04 | 2.4E-06 |
| Barium | 2.1E-07 | 7.0E-02 | 3.0E-06 |
| Beryllium | 9.2E-13 | 5.0E-03 | 1.8E-10 |
| Cadmium | 6.0E-09 | 5.0E-04 | 1.2E-05 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 2.4E-08 | 6.0E-02 | 4.1E-07 |
| Copper | 5.8E-08 | NA | NA |
| Cyanide | NA | 2.0E-02 | NA |
| Di-n-octyl phthalate | 4.2E-07 | 2.0E-02 | 2.1E-05 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 2.2E-08 | NA | NA |
| Manganese | 2.0E-07 | 1.4E-01 | 1.5E-06 |
| Mercury | 1.0E-10 | 3.0E-04 | 3.4E-07 |
| Molybdenum | 6.5E-09 | 5.0E-03 | 1.3E-06 |
| Nickel | 3.4E-08 | 2.0E-02 | 1.7E-06 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.1E-10 | 5.0E-03 | 4.3E-08 |
| Thallium | 6.7E-10 | 8.0E-05 | 8.4E-06 |
| Vanadium | 5.2E-10 | 7.0E-03 | 7.4E-08 |
| Zinc | 1.3E-06 | 3.0E-01 | 4.2E-06 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 3.3E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 6.3E-05 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 2.8E-09 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 7.4E-14 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 8.0E-11 | 7.7E+00 | 6.2E-10 |
| Aroclor-1254 | 7.1E-09 | 7.7E+00 | 5.4E-08 |
| Aroclor-1260 | 2.6E-08 | 7.7E+00 | 2.0E-07 |
| Arsenic | 7.1E-10 | 1.8E+00 | 1.2E-09 |
| Barium | 2.1E-07 | NA | NA |
| Beryllium | 9.2E-13 | 4.3E+00 | 3.9E-12 |
| Cadmium | 6.0E-09 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 2.4E-08 | NA | NA |
| Copper | 5.8E-08 | NA | NA |
| Cyanide | NA | NA | NA |
| Di-n-octyl phthalate | 4.2E-07 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 2.2E-08 | NA | NA |
| Manganese | 2.0E-07 | NA | NA |
| Mercury | 1.0E-10 | NA | NA |
| Molybdenum | 6.5E-09 | NA | NA |
| Nickel | 3.4E-08 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.1E-10 | NA | NA |
| Thallium | 6.7E-10 | NA | NA |
| Vanadium | 5.2E-10 | NA | NA |
| Zinc | 1.3E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.3E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 2.6E-07 |

5208

**Table K.IV-20**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Adult Current Land Use Scenario**
**Via Ingestion of Dairy Products**

**Intake Equation** = Cp X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of dairy products | 0.3 l/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 70 Year |
| Cp | Concentration of radionuclides in animal products | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 1.2E-03 | pCi/kg | Sr-90 | 7.8E-25 | pCi/kg |
| Np-237 | 1.2E-07 | pCi/kg | Tc-99 | 2.3E-23 | pCi/kg |
| Pa-231 | 4.2E-05 | pCi/kg | Th-228 | 2.4E-06 | pCi/kg |
| Pb-210 | NA | pCi/kg | Th-230 | 2.6E-06 | pCi/kg |
| Pu-238 | 1.7E-08 | pCi/kg | Th-232 | 1.4E-06 | pCi/kg |
| Pu-239 | 1.1E-08 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 1.1E-08 | pCi/kg | U-234 | 1.6E+00 | pCi/kg |
| Ra-226 | 1.3E-04 | pCi/kg | U-235 | 4.2E-02 | pCi/kg |
| Ra-228 | 1.3E-04 | pCi/kg | U-236 | 1.8E-02 | pCi/kg |
| | | | U-238 | 9.6E-01 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 8.5E+00 | 2.8E-11 | 2.4E-10 |
| Np-237 | 9.0E-04 | 2.2E-10 | 2.0E-13 |
| Pa-231 | 3.1E-01 | 9.2E-11 | 2.9E-11 |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | 1.3E-04 | 2.2E-10 | 2.8E-14 |
| Pu-239 | 8.1E-05 | 2.3E-10 | 1.9E-14 |
| Pu-240 | 8.1E-05 | 2.3E-10 | 1.9E-14 |
| Ra-226 | 9.3E-01 | 1.2E-10 | 1.1E-10 |
| Ra-228 | 9.6E-01 | 1.0E-10 | 9.6E-11 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 5.8E-21 | 3.3E-10 | 1.9E-30 |
| Tc-99 | 1.7E-19 | 1.3E-12 | 2.2E-31 |
| Th-228 | 1.8E-02 | 5.5E-11 | 9.7E-13 |
| Th-230 | 1.9E-02 | 1.3E-11 | 2.5E-13 |
| Th-232 | 1.0E-02 | 1.2E-11 | 1.2E-13 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 1.2E+04 | 1.6E-11 | 1.9E-07 |
| U-235 | 3.1E+02 | 1.6E-11 | 5.0E-09 |
| U-236 | 1.3E+02 | 1.5E-11 | 1.9E-09 |
| U-238 | 7.0E+03 | 2.8E-11 | 2.0E-07 |
| | | ILCR Summation = | 3.9E-07 |

0626

**Table K.IV-21**
**Off-Property RME Resident Farm Adult Current Land Use Scenario**
**Via Ingestion of Vegetables and Fruits**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.122 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 70 | Year |
| EDc | Exposure duration for carcinogens | 70 | Year |
| BW | Body weight | 70 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 25550 | days |
| CS | Concentration of chemicals in vegetables | | |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 1.6E-04 | mg/kg | Heptachlorodibenzofuran | NA | mg/kg |
| Aroclor-1016 | NA | mg/kg | Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Aroclor-1221 | 8.4E-08 | mg/kg | Lead | 5.3E-04 | mg/kg |
| Aroclor-1242 | NA | mg/kg | Manganese | 3.4E-03 | mg/kg |
| Aroclor-1248 | 4.7E-08 | mg/kg | Mercury | 1.3E-06 | mg/kg |
| Aroclor-1254 | 2.6E-06 | mg/kg | Molybdenum | 2.6E-05 | mg/kg |
| Aroclor-1260 | 2.4E-06 | mg/kg | Nickel | 2.0E-04 | mg/kg |
| Arsenic | 7.0E-05 | mg/kg | Octachlorodibenzofuran | NA | mg/kg |
| Barium | 3.5E-03 | mg/kg | Selenium | 3.2E-07 | mg/kg |
| Beryllium | 6.1E-06 | mg/kg | Thallium | 2.0E-06 | mg/kg |
| Cadmium | 3.5E-05 | mg/kg | Vanadium | 1.5E-04 | mg/kg |
| Chromium | NA | mg/kg | Zinc | 7.2E-04 | mg/kg |
| Cobalt | 7.2E-05 | mg/kg | 2-Chlorophenol | NA | mg/kg |
| Copper | 2.3E-04 | mg/kg | 2-Methylnaphthalene | 1.9E-07 | mg/kg |
| Cyanide | 1.4E-05 | mg/kg | 4-Chlorophenyl-phenylether | NA | mg/kg |
| Di-n-octyl phthalate | 2.0E-07 | mg/kg | 4,4-DDT | NA | mg/kg |

**References**



0627

5208

**Table K.IV-21 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Adult Current Land Use Scenario**
**Via Ingestion of Vegetables and Fruits**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 2.7E-07 | 4.0E-04 | 6.9E-04 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.4E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 7.8E-11 | NA | NA |
| Aroclor-1254 | 4.4E-09 | NA | NA |
| Aroclor-1260 | 4.0E-09 | NA | NA |
| Arsenic | 1.2E-07 | 3.0E-04 | 3.9E-04 |
| Barium | 5.9E-06 | 7.0E-02 | 8.4E-05 |
| Beryllium | 1.0E-08 | 5.0E-03 | 2.0E-06 |
| Cadmium | 5.9E-08 | 5.0E-04 | 1.2E-04 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 1.2E-07 | 6.0E-02 | 2.0E-06 |
| Copper | 3.8E-07 | NA | NA |
| Cyanide | 2.3E-08 | 2.0E-02 | 1.1E-06 |
| Di-n-octyl phthalate | 3.3E-10 | 2.0E-02 | 1.6E-08 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 8.8E-07 | NA | NA |
| Manganese | 5.7E-06 | 1.4E-01 | 4.1E-05 |
| Mercury | 2.2E-09 | 3.0E-04 | 7.3E-06 |
| Molybdenum | 4.3E-08 | 5.0E-03 | 8.6E-06 |
| Nickel | 3.3E-07 | 2.0E-02 | 1.7E-05 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 5.3E-10 | 5.0E-03 | 1.1E-07 |
| Thallium | 3.3E-09 | 8.0E-05 | 4.2E-05 |
| Vanadium | 2.6E-07 | 7.0E-03 | 3.7E-05 |
| Zinc | 1.2E-06 | 3.0E-01 | 4.0E-06 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 3.2E-10 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 1.4E-03 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 2.7E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.4E-10 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 7.8E-11 | 7.7E+00 | 6.0E-10 |
| Aroclor-1254 | 4.4E-09 | 7.7E+00 | 3.4E-08 |
| Aroclor-1260 | 4.0E-09 | 7.7E+00 | 3.1E-08 |
| Arsenic | 1.2E-07 | 1.8E+00 | 2.0E-07 |
| Barium | 5.9E-06 | NA | NA |
| Beryllium | 1.0E-08 | 4.3E+00 | 4.4E-08 |
| Cadmium | 5.9E-08 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 1.2E-07 | NA | NA |
| Copper | 3.8E-07 | NA | NA |
| Cyanide | 2.3E-08 | NA | NA |
| Di-n-octyl phthalate | 3.3E-10 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 8.8E-07 | NA | NA |
| Manganese | 5.7E-06 | NA | NA |
| Mercury | 2.2E-09 | NA | NA |
| Molybdenum | 4.3E-08 | NA | NA |
| Nickel | 3.3E-07 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 5.3E-10 | NA | NA |
| Thallium | 3.3E-09 | NA | NA |
| Vanadium | 2.6E-07 | NA | NA |
| Zinc | 1.2E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.2E-10 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 3.1E-07 |

- 5208

**Table K.IV-22**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Adult Current Land Use Scenario**
**Via Ingestion of Vegetables and Fruits**

**Intake Equation** = Cv X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.122 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 70 Year |
| Cv | Concentration of radionuclides in vegetables | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 4.0E-03 | pCi/kg | Sr-90 | 3.4E-13 | pCi/kg |
| Np-237 | 5.8E-04 | pCi/kg | Tc-99 | 1.5E-12 | pCi/kg |
| Pa-231 | 2.1E-03 | pCi/kg | Th-228 | 1.2E-02 | pCi/kg |
| Pb-210 | 5.9E-02 | pCi/kg | Th-230 | 1.3E-02 | pCi/kg |
| Pu-238 | 4.2E-03 | pCi/kg | Th-232 | 6.8E-03 | pCi/kg |
| Pu-239 | 2.7E-03 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 2.7E-03 | pCi/kg | U-234 | 5.6E+01 | pCi/kg |
| Ra-226 | 6.8E-03 | pCi/kg | U-235 | 1.5E+00 | pCi/kg |
| Ra-228 | 7.2E-03 | pCi/kg | U-236 | 6.2E-01 | pCi/kg |
| | | | U-238 | 3.4E+01 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 1.2E+01 | 2.8E-11 | 3.4E-10 |
| Np-237 | 1.7E+00 | 2.2E-10 | 3.8E-10 |
| Pa-231 | 6.2E+00 | 9.2E-11 | 5.7E-10 |
| Pb-210 | 1.8E+02 | 6.6E-10 | 1.2E-07 |
| Pu-238 | 1.2E+01 | 2.2E-10 | 2.7E-09 |
| Pu-239 | 8.0E+00 | 2.3E-10 | 1.8E-09 |
| Pu-240 | 8.0E+00 | 2.3E-10 | 1.8E-09 |
| Ra-226 | 2.0E+01 | 1.2E-10 | 2.5E-09 |
| Ra-228 | 2.2E+01 | 1.0E-10 | 2.2E-09 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 1.0E-09 | 3.3E-10 | 3.3E-19 |
| Tc-99 | 4.4E-09 | 1.3E-12 | 5.7E-21 |
| Th-228 | 3.6E+01 | 5.5E-11 | 2.0E-09 |
| Th-230 | 3.8E+01 | 1.3E-11 | 5.0E-10 |
| Th-232 | 2.0E+01 | 1.2E-11 | 2.4E-10 |
| U-233 | NA | 1.8E-11 | NA |
| U-234 | 1.7E+05 | 1.6E-11 | 2.7E-06 |
| U-235 | 4.4E+03 | 1.6E-11 | 7.1E-08 |
| U-236 | 1.8E+03 | 1.5E-11 | 2.8E-08 |
| U-238 | 1.0E+05 | 2.8E-11 | 2.8E-06 |
| | | ILCR Summation = | 5.7E-06 |

**Table K.IV-23**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Youth Current Land Use Scenario**
**Via Inhalation of Particulates**

**Intake Equation** = $\frac{CS \times EF \times ED \times IR}{BW \times AT}$

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 20 $m^3$/day |
| EF | Exposure frequency[A] | 350 days/year |
| EDn | Exposure duration for non-carcinogens | 12 Year |
| EDc | Exposure duration for carcinogens | 12 Year |
| BW | Body weight | 43 kg |
| ATc | Average time for carcinogens (lifetime) | 25550 days |
| ATn | Average time for non-carcinogens (EDn x 365) | 4380 days |
| CS | Concentration of chemicals in soil | (see table below) |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 1.9E-06 | mg/m$^3$ |
| Aroclor-1016 | NA | mg/m$^3$ |
| Aroclor-1221 | 1.9E-09 | mg/m$^3$ |
| Aroclor-1242 | NA | mg/m$^3$ |
| Aroclor-1248 | 1.3E-09 | mg/m$^3$ |
| Aroclor-1254 | 6.0E-08 | mg/m$^3$ |
| Aroclor-1260 | 6.3E-08 | mg/m$^3$ |
| Arsenic | 9.3E-07 | mg/m$^3$ |
| Barium | 8.5E-05 | mg/m$^3$ |
| Beryllium | 8.5E-08 | mg/m$^3$ |
| Cadmium | 3.7E-07 | mg/m$^3$ |
| Chromium | 2.5E-07 | mg/m$^3$ |
| Cobalt | 9.3E-07 | mg/m$^3$ |
| Copper | 3.7E-06 | mg/m$^3$ |
| Cyanide | 3.3E-07 | mg/m$^3$ |
| Di-n-octyl phthalate | 5.2E-09 | mg/m$^3$ |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/m$^3$ |
| Heptachlorodibenzo-p-dioxin | NA | mg/m$^3$ |
| Lead | 1.1E-05 | mg/m$^3$ |
| Manganese | 3.9E-05 | mg/m$^3$ |
| Mercury | 3.0E-08 | mg/m$^3$ |
| Molybdenum | 3.0E-07 | mg/m$^3$ |
| Nickel | 2.5E-06 | mg/m$^3$ |
| Octachlorodibenzofuran | NA | mg/m$^3$ |
| Selenium | 8.5E-09 | mg/m$^3$ |
| Thallium | 2.6E-08 | mg/m$^3$ |
| Vanadium | 1.6E-06 | mg/m$^3$ |
| Zinc | 9.6E-06 | mg/m$^3$ |
| 2-Chlorophenol | NA | mg/m$^3$ |
| 2-Methylnaphthalene | 5.0E-09 | mg/m$^3$ |
| 4-Chlorophenyl-phenylether | NA | mg/m$^3$ |
| 4,4-DDT | NA | mg/m$^3$ |

**References**





0631

**Table K.IV-23 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RMB Resident Farm Youth Current Land Use Scenario**
**Via Inhalation of Particulates**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 8.7E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 8.3E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 5.7E-10 | NA | NA |
| Aroclor-1254 | 2.7E-08 | NA | NA |
| Aroclor-1260 | 2.6E-08 | NA | NA |
| Arsenic | 4.1E-07 | NA | NA |
| Barium | 3.8E-05 | 1.4E-04 | 2.7E-01 |
| Beryllium | 3.8E-08 | NA | NA |
| Cadmium | 1.7E-07 | NA | NA |
| Chromium | 1.1E-07 | NA | NA |
| Cobalt | 4.1E-07 | 3.0E-07 | 1.4E+00 |
| Copper | 1.7E-06 | NA | NA |
| Cyanide | 1.5E-07 | NA | NA |
| Di-n-octyl phthalate | 2.3E-09 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 5.0E-06 | NA | NA |
| Manganese | 1.7E-05 | 1.1E-04 | 1.6E-01 |
| Mercury | 1.3E-08 | 8.6E-05 | 1.5E-04 |
| Molybdenum | 1.3E-07 | NA | NA |
| Nickel | 1.1E-06 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 3.6E-09 | NA | NA |
| Thallium | 1.2E-08 | NA | NA |
| Vanadium | 7.9E-07 | NA | NA |
| Zinc | 4.3E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 2.2E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | NA | NA |
| | Hazard Quotient Sum = | | 1.8E+00 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 1.5E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.4E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 9.7E-11 | NA | NA |
| Aroclor-1254 | 4.6E-09 | NA | NA |
| Aroclor-1260 | 4.8E-09 | NA | NA |
| Arsenic | 7.1E-08 | 1.5E+01 | 1.1E-06 |
| Barium | 6.5E-06 | NA | NA |
| Beryllium | 6.5E-09 | 8.4E+00 | 5.4E-08 |
| Cadmium | 2.8E-08 | 6.1E+00 | 1.7E-07 |
| Chromium | 1.9E-08 | 4.1E+01 | 7.7E-07 |
| Cobalt | 7.1E-08 | NA | NA |
| Copper | 2.8E-07 | NA | NA |
| Cyanide | 2.5E-08 | NA | NA |
| Di-n-octyl phthalate | 4.0E-10 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 8.6E-07 | NA | NA |
| Manganese | 3.0E-06 | NA | NA |
| Mercury | 2.3E-09 | NA | NA |
| Molybdenum | 2.3E-08 | NA | NA |
| Nickel | 1.9E-07 | 8.4E-01 | 1.6E-07 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 6.5E-10 | NA | NA |
| Thallium | 2.0E-09 | NA | NA |
| Vanadium | 1.4E-07 | NA | NA |
| Zinc | 7.4E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.8E-10 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 2.2E-06 |







5208

5208

**Table K.IV-24**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Youth Current Land Use Scenario**
**Via Inhalation of Gases and Particulates**

**Intake Equation** = Ca X EF X EDn X IR

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 20 $m^3$/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 12 Year |
| Ca | Concentration of radionuclides in air | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/$m^3$ | Rn-222 | 4.0E+00 | pCi/$m^3$ |
| Am-241 | NA | pCi/$m^3$ | Ru-106 | NA | pCi/$m^3$ |
| Cs-137 | 4.6E-05 | pCi/$m^3$ | Sr-90 | 1.5E-04 | pCi/$m^3$ |
| Np-237 | 1.6E-05 | pCi/$m^3$ | Tc-99 | 9.2E-04 | pCi/$m^3$ |
| Pa-231 | 5.5E-05 | pCi/$m^3$ | Th-228 | 1.4E-04 | pCi/$m^3$ |
| Pb-210 | 1.6E-03 | pCi/$m^3$ | Th-230 | 1.5E-04 | pCi/$m^3$ |
| Pu-238 | 8.0E-05 | pCi/$m^3$ | Th-232 | 8.0E-05 | pCi/$m^3$ |
| Pu-239 | 3.9E-05 | pCi/$m^3$ | U-233 | NA | pCi/$m^3$ |
| Pu-240 | 3.9E-05 | pCi/$m^3$ | U-234 | 1.7E-03 | pCi/$m^3$ |
| Ra-226 | 8.0E-05 | pCi/$m^3$ | U-235 | 4.4E-05 | pCi/$m^3$ |
| Ra-228 | 8.7E-05 | pCi/$m^3$ | U-236 | 1.8E-05 | pCi/$m^3$ |
| | | | U-238 | 9.9E-04 | pCi/$m^3$ |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 8.8E-08 | NA |
| Am-241 | NA | 3.2E-08 | NA |
| Cs-137 | 3.9E+00 | 1.9E-11 | 7.3E-11 |
| Np-237 | 1.3E+00 | 2.9E-08 | 3.9E-08 |
| Pa-231 | 4.6E+00 | 3.6E-08 | 1.7E-07 |
| Pb-210 | 1.3E+02 | 4.0E-09 | 5.3E-07 |
| Pu-238 | 6.7E+00 | 3.9E-08 | 2.6E-07 |
| Pu-239 | 3.3E+00 | 3.8E-08 | 1.2E-07 |
| Pu-240 | 3.3E+00 | 3.8E-08 | 1.2E-07 |
| Ra-226 | 6.7E+00 | 3.0E-09 | 2.0E-08 |
| Ra-228 | 7.3E+00 | 6.9E-10 | 5.0E-09 |
| Rn-222 | 3.4E+05 | 7.7E-12 | 2.6E-06 |
| Ru-106 | NA | 4.4E-10 | NA |
| Sr-90 | 1.3E+01 | 5.6E-11 | 7.2E-10 |
| Tc-99 | 7.7E+01 | 8.3E-12 | 6.4E-10 |
| Th-228 | 1.2E+01 | 7.8E-08 | 9.4E-07 |
| Th-230 | 1.3E+01 | 2.9E-08 | 3.8E-07 |
| Th-232 | 6.7E+00 | 2.8E-08 | 1.9E-07 |
| U-233 | NA | 2.7E-08 | NA |
| U-234 | 1.4E+02 | 2.6E-08 | 3.6E-06 |
| U-235 | 3.7E+00 | 2.5E-08 | 9.2E-08 |
| U-236 | 1.5E+00 | 2.5E-08 | 3.8E-08 |
| U-238 | 8.3E+01 | 5.2E-08 | 4.3E-06 |
| | | ILCR Summation = | 1.3E-05 |

0632

208

**Table K.IV–25**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off–Property RME Resident Farm Youth Current Land Use Scenario**
**Via Ingestion of Drinking Water**

**Intake Equation** = Cw X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of groundwater (RAGS, 1989) | 2 l/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 12 Year |
| FI | Fractional intake for radionuclides | 1 (Unitless) |
| Cw | Concentration of radionuclides in groundwater | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac–227 | NA | pCi/l | Rn–222 | NA | pCi/l |
| Am–241 | NA | pCi/l | Ru–106 | NA | pCi/l |
| Cs–137 | NA | pCi/l | Sr–90 | NA | pCi/l |
| Np–237 | NA | pCi/l | Tc–99 | NA | pCi/l |
| Pa–231 | NA | pCi/l | Th–228 | NA | pCi/l |
| Pb–210 | NA | pCi/l | Th–230 | NA | pCi/l |
| Pu–238 | NA | pCi/l | Th–232 | NA | pCi/l |
| Pu–239 | NA | pCi/l | U–233 | NA | pCi/l |
| Pu–240 | NA | pCi/l | U–234 | 6.1E+00 | pCi/l |
| Ra–226 | NA | pCi/l | U–235 | 1.6E–01 | pCi/l |
| Ra–228 | NA | pCi/l | U–236 | 6.7E–02 | pCi/l |
| | | | U–238 | 3.6E+00 | pCi/l |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac–227 | NA | 3.5E–10 | NA |
| Am–241 | NA | 2.4E–10 | NA |
| Cs–137 | NA | 2.8E–11 | NA |
| Np–237 | NA | 2.2E–10 | NA |
| Pa–231 | NA | 9.2E–11 | NA |
| Pb–210 | NA | 6.6E–10 | NA |
| Pu–238 | NA | 2.2E–10 | NA |
| Pu–239 | NA | 2.3E–10 | NA |
| Pu–240 | NA | 2.3E–10 | NA |
| Ra–226 | NA | 1.2E–10 | NA |
| Ra–228 | NA | 1.0E–10 | NA |
| Rn–222 | NA | 1.7E–12 | NA |
| Ru–106 | NA | 9.5E–12 | NA |
| Sr–90 | NA | 3.3E–10 | NA |
| Tc–99 | NA | 1.3E–12 | NA |
| Th–228 | NA | 5.5E–11 | NA |
| Th–230 | NA | 1.3E–11 | NA |
| Th–232 | NA | 1.2E–11 | NA |
| U–233 | NA | 1.6E–11 | NA |
| U–234 | 5.1E+04 | 1.6E–11 | 8.1E–07 |
| U–235 | 1.4E+03 | 1.6E–11 | 2.2E–08 |
| U–236 | 5.6E+02 | 1.5E–11 | 8.4E–09 |
| U–238 | 3.0E+04 | 2.8E–11 | 8.5E–07 |
| | | ILCR Summation = | 1.7E–06 |



0633

**Table K.IV-26**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RMB Resident Farm Youth Current Land Use Scenario**
**Via Ingestion of Meat Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of meat | 0.075 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 12 | Year |
| EDc | Exposure duration for carcinogens | 12 | Year |
| BW | Body weight | 43 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 4380 | days |
| CS | Concentration of chemicals in Meat | | |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 6.7E-06 | mg/kg | Heptachlorodibenzofuran | NA | mg/kg |
| Aroclor-1016 | NA | mg/kg | Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Aroclor-1221 | 5.6E-11 | mg/kg | Lead | 6.5E-06 | mg/kg |
| Aroclor-1242 | NA | mg/kg | Manganese | 5.7E-05 | mg/kg |
| Aroclor-1248 | 1.9E-08 | mg/kg | Mercury | 1.4E-05 | mg/kg |
| Aroclor-1254 | 8.0E-06 | mg/kg | Molybdenum | 6.3E-06 | mg/kg |
| Aroclor-1260 | 3.1E-06 | mg/kg | Nickel | 4.9E-05 | mg/kg |
| Arsenic | 5.7E-06 | mg/kg | Octachlorodibenzofuran | NA | mg/kg |
| Barium | 2.2E-05 | mg/kg | Selenium | 2.0E-07 | mg/kg |
| Beryllium | 2.5E-07 | mg/kg | Thallium | 3.3E-06 | mg/kg |
| Cadmium | 8.1E-06 | mg/kg | Vanadium | 1.6E-05 | mg/kg |
| Chromium | NA | mg/kg | Zinc | 3.1E-03 | mg/kg |
| Cobalt | 5.9E-05 | mg/kg | 2-Chlorophenol | NA | mg/kg |
| Copper | 9.5E-05 | mg/kg | 2-Methylnaphthalene | 1.4E-09 | mg/kg |
| Cyanide | 2.9E-11 | mg/kg | 4-Chlorophenyl-phenylether | NA | mg/kg |
| Di-n-octyl phthalate | 3.2E-04 | mg/kg | 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-26 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RMB Resident Farm Youth Current Land Use Scenario**
**Via Ingestion of Meat Products**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 1.1E-08 | 4.0E-04 | 2.8E-05 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 9.4E-14 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 3.2E-11 | NA | NA |
| Aroclor-1254 | 1.3E-08 | NA | NA |
| Aroclor-1260 | 5.2E-09 | NA | NA |
| Arsenic | 9.6E-09 | 3.0E-04 | 3.2E-05 |
| Barium | 3.7E-08 | 7.0E-02 | 5.2E-07 |
| Beryllium | 4.1E-10 | 5.0E-03 | 8.3E-08 |
| Cadmium | 1.4E-08 | 5.0E-04 | 2.7E-05 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 9.9E-08 | 6.0E-02 | 1.7E-06 |
| Copper | 1.6E-07 | NA | NA |
| Cyanide | 4.9E-14 | 2.0E-02 | 2.5E-12 |
| Di-n-octyl phthalate | 5.3E-07 | 2.0E-02 | 2.7E-05 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.1E-08 | NA | NA |
| Manganese | 9.5E-08 | 1.4E-01 | 6.8E-07 |
| Mercury | 2.3E-08 | 3.0E-04 | 7.7E-05 |
| Molybdenum | 1.1E-08 | 5.0E-03 | 2.1E-06 |
| Nickel | 8.2E-08 | 2.0E-02 | 4.1E-06 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 3.3E-10 | 5.0E-03 | 6.5E-08 |
| Thallium | 5.5E-09 | 8.0E-05 | 6.8E-05 |
| Vanadium | 2.6E-08 | 7.0E-03 | 3.8E-06 |
| Zinc | 5.2E-06 | 3.0E-01 | 1.7E-05 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 2.4E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| HQ Summation = | | | 2.9E-04 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 1.9E-09 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.6E-14 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 5.5E-12 | 7.7E+00 | 4.2E-11 |
| Aroclor-1254 | 2.3E-09 | 7.7E+00 | 1.8E-08 |
| Aroclor-1260 | 8.9E-10 | 7.7E+00 | 6.9E-09 |
| Arsenic | 1.6E-09 | 1.8E+00 | 2.9E-09 |
| Barium | 6.3E-09 | NA | NA |
| Beryllium | 7.1E-11 | 4.3E+00 | 3.1E-10 |
| Cadmium | 2.3E-09 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 1.7E-08 | NA | NA |
| Copper | 2.7E-08 | NA | NA |
| Cyanide | 8.4E-15 | NA | NA |
| Di-n-octyl phthalate | 9.1E-08 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.9E-09 | NA | NA |
| Manganese | 1.6E-08 | NA | NA |
| Mercury | 4.0E-09 | NA | NA |
| Molybdenum | 1.8E-09 | NA | NA |
| Nickel | 1.4E-08 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 5.6E-11 | NA | NA |
| Thallium | 9.4E-10 | NA | NA |
| Vanadium | 4.5E-09 | NA | NA |
| Zinc | 8.9E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 4.1E-13 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| ILCR Summation = | | | 2.8E-08 |

**Table K.IV-27**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Youth Current Land Use Scenario**
**Via Ingestion of Meat Products**

**Intake Equation** = Cf X EF X EDn X Fi X IR

| | | |
|---|---|---|
| IR | Ingestion rate of meat | 0.075 kg/day |
| Fi | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 12 Year |
| Cf | Concentration of radionuclides in Meat | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 3.3E-03 | pCi/kg | Sr-90 | NA | pCi/kg |
| Np-237 | 1.3E-06 | pCi/kg | Tc-99 | NA | pCi/kg |
| Pa-231 | 6.6E-03 | pCi/kg | Th-228 | 1.9E-06 | pCi/kg |
| Pb-210 | NA | pCi/kg | Th-230 | 3.1E-06 | pCi/kg |
| Pu-238 | 8.5E-08 | pCi/kg | Th-232 | 1.7E-06 | pCi/kg |
| Pu-239 | 5.5E-08 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 5.5E-08 | pCi/kg | U-234 | 5.3E-01 | pCi/kg |
| Ra-226 | 7.0E-05 | pCi/kg | U-235 | 1.4E-02 | pCi/kg |
| Ra-228 | 4.7E-05 | pCi/kg | U-236 | 5.7E-03 | pCi/kg |
| | | | U-238 | 3.1E-01 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 1.0E+00 | 2.8E-11 | 2.9E-11 |
| Np-237 | 4.2E-04 | 2.2E-10 | 9.3E-14 |
| Pa-231 | 2.1E+00 | 9.2E-11 | 2.0E-10 |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | 2.7E-05 | 2.2E-10 | 5.9E-15 |
| Pu-239 | 1.7E-05 | 2.3E-10 | 4.0E-15 |
| Pu-240 | 1.7E-05 | 2.3E-10 | 4.0E-15 |
| Ra-226 | 2.2E-02 | 1.2E-10 | 2.6E-12 |
| Ra-228 | 1.5E-02 | 1.0E-10 | 1.5E-12 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | NA | 3.6E-10 | NA |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | 5.9E-04 | 5.5E-11 | 3.3E-14 |
| Th-230 | 9.9E-04 | 1.3E-11 | 1.3E-14 |
| Th-232 | 5.2E-04 | 1.2E-11 | 6.3E-15 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 1.7E+02 | 1.6E-11 | 2.6E-09 |
| U-235 | 4.3E+00 | 1.6E-11 | 7.0E-11 |
| U-236 | 1.6E+00 | 1.5E-11 | 2.7E-11 |
| U-238 | 9.6E+01 | 2.8E-11 | 2.7E-09 |
| | | ILCR Summation = | 5.7E-09 |

0636

**Table K-IV.28**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Youth Current Land Use Scenario**
**Via Ingestion of Dairy Products**

**Intake Equation:** $= \frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of dairy products | 0.3 | l/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 12 | Year |
| EDc | Exposure duration for carcinogens | 12 | Year |
| BW | Body weight | 43 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 4380 | days |
| CS | Concentration of chemicals in animal products | | |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 6.7E-07 | mg/kg | Heptachlorodibenzofuran | NA | mg/kg |
| Aroclor-1016 | NA | mg/kg | Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Aroclor-1221 | 1.6E-11 | mg/kg | Lead | 5.4E-06 | mg/kg |
| Aroclor-1242 | NA | mg/kg | Manganese | 5.0E-05 | mg/kg |
| Aroclor-1248 | 2.0E-08 | mg/kg | Mercury | 2.5E-08 | mg/kg |
| Aroclor-1254 | 1.7E-06 | mg/kg | Molybdenum | 1.6E-06 | mg/kg |
| Aroclor-1260 | 6.3E-08 | mg/kg | Nickel | 8.2E-06 | mg/kg |
| Arsenic | 1.7E-07 | mg/kg | Octachlorodibenzofuran | NA | mg/kg |
| Barium | 5.1E-05 | mg/kg | Selenium | 5.2E-08 | mg/kg |
| Beryllium | 2.2E-10 | mg/kg | Thallium | 1.6E-07 | mg/kg |
| Cadmium | 1.5E-08 | mg/kg | Vanadium | 1.3E-07 | mg/kg |
| Chromium | NA | mg/kg | Zinc | 3.1E-04 | mg/kg |
| Cobalt | 5.9E-06 | mg/kg | 2-Chlorophenol | NA | mg/kg |
| Copper | 1.4E-05 | mg/kg | 2-Methylnaphthalene | 8.0E-10 | mg/kg |
| Cyanide | NA | mg/kg | 4-Chlorophenyl-phenylether | NA | mg/kg |
| Di-n-octyl phthalate | 1.0E-04 | mg/kg | 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-28 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RMB Resident Farm Youth Current Land Use Scenario**
**Via Ingestion of Dairy Products**

| Compound | HQ Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
| Antimony | 4.5E-09 | 4.0E-04 | 1.1E-05 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.2E-13 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.3E-10 | NA | NA |
| Aroclor-1254 | 1.2E-08 | NA | NA |
| Aroclor-1260 | 4.2E-08 | NA | NA |
| Arsenic | 1.2E-09 | 3.0E-04 | 3.8E-06 |
| Barium | 3.4E-07 | 7.0E-02 | 4.9E-06 |
| Beryllium | 1.5E-12 | 5.0E-03 | 3.0E-10 |
| Cadmium | 9.8E-09 | 5.0E-04 | 2.0E-05 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 4.0E-08 | 6.0E-02 | 6.6E-07 |
| Copper | 9.5E-08 | NA | NA |
| Cyanide | NA | 2.0E-02 | NA |
| Di-n-octyl phthalate | 6.8E-07 | 2.0E-02 | 3.4E-05 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.6E-08 | NA | NA |
| Manganese | 3.3E-07 | 1.4E-01 | 2.4E-06 |
| Mercury | 1.7E-10 | 3.0E-04 | 5.6E-07 |
| Molybdenum | 1.1E-08 | 5.0E-03 | 2.1E-06 |
| Nickel | 5.5E-08 | 2.0E-02 | 2.7E-06 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 3.5E-10 | 5.0E-03 | 6.9E-08 |
| Thallium | 1.1E-09 | 8.0E-05 | 1.4E-05 |
| Vanadium | 8.4E-10 | 7.0E-03 | 1.2E-07 |
| Zinc | 2.1E-06 | 3.0E-01 | 6.9E-06 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 5.4E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 1.0E-04 |

| Compound | ILCR Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
| Antimony | 7.7E-10 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 2.1E-14 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 2.2E-11 | 7.7E+00 | 1.7E-10 |
| Aroclor-1254 | 2.0E-09 | 7.7E+00 | 1.5E-08 |
| Aroclor-1260 | 7.2E-09 | 7.7E+00 | 5.6E-08 |
| Arsenic | 2.0E-10 | 1.8E+00 | 3.5E-10 |
| Barium | 5.8E-08 | NA | NA |
| Beryllium | 2.6E-13 | 4.3E+00 | 1.1E-12 |
| Cadmium | 1.7E-09 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 6.8E-09 | NA | NA |
| Copper | 1.6E-08 | NA | NA |
| Cyanide | NA | NA | NA |
| Di-n-octyl phthalate | 1.2E-07 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 6.2E-09 | NA | NA |
| Manganese | 5.7E-08 | NA | NA |
| Mercury | 2.9E-11 | NA | NA |
| Molybdenum | 1.8E-09 | NA | NA |
| Nickel | 9.4E-09 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 6.0E-11 | NA | NA |
| Thallium | 1.9E-10 | NA | NA |
| Vanadium | 1.4E-10 | NA | NA |
| Zinc | 3.6E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 9.2E-13 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 7.1E-08 |

- 5208

**Table K.IV-29**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Youth Current Land Use Scenario**
**Via Ingestion of Dairy Products**

**Intake Equation** = Cp X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of dairy products | 0.3 l/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 12 Year |
| Cp | Concentration of radionuclides in animal products | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 1.2E-03 | pCi/kg | Sr-90 | 7.8E-25 | pCi/kg |
| Np-237 | 1.2E-07 | pCi/kg | Tc-99 | 2.3E-23 | pCi/kg |
| Pa-231 | 4.2E-05 | pCi/kg | Th-228 | 2.4E-06 | pCi/kg |
| Pb-210 | NA | pCi/kg | Th-230 | 2.6E-06 | pCi/kg |
| Pu-238 | 1.7E-08 | pCi/kg | Th-232 | 1.4E-06 | pCi/kg |
| Pu-239 | 1.1E-08 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 1.1E-08 | pCi/kg | U-234 | 1.6E+00 | pCi/kg |
| Ra-226 | 1.3E-04 | pCi/kg | U-235 | 4.2E-02 | pCi/kg |
| Ra-228 | 1.3E-04 | pCi/kg | U-236 | 1.8E-02 | pCi/kg |
| | | | U-238 | 9.6E-01 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 1.4E+00 | 2.8E-11 | 4.1E-11 |
| Np-237 | 1.5E-04 | 2.2E-10 | 3.4E-14 |
| Pa-231 | 5.3E-02 | 9.2E-11 | 4.9E-12 |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | 2.2E-05 | 2.2E-10 | 4.7E-15 |
| Pu-239 | 1.4E-05 | 2.3E-10 | 3.2E-15 |
| Pu-240 | 1.4E-05 | 2.3E-10 | 3.2E-15 |
| Ra-226 | 1.6E-01 | 1.2E-10 | 1.9E-11 |
| Ra-228 | 1.6E-01 | 1.0E-10 | 1.6E-11 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 9.9E-22 | 3.3E-10 | 3.3E-31 |
| Tc-99 | 2.9E-20 | 1.3E-12 | 3.7E-32 |
| Th-228 | 3.0E-03 | 5.5E-11 | 1.7E-13 |
| Th-230 | 3.3E-03 | 1.3E-11 | 4.3E-14 |
| Th-232 | 1.7E-03 | 1.2E-11 | 2.1E-14 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 2.0E+03 | 1.6E-11 | 3.2E-08 |
| U-235 | 5.3E+01 | 1.6E-11 | 8.5E-10 |
| U-236 | 2.2E+01 | 1.5E-11 | 3.3E-10 |
| U-238 | 1.2E+03 | 2.8E-11 | 3.4E-08 |
| | | **ILCR Summation =** | 6.7E-08 |

**Table K.IV-30**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Youth Current Land Use Scenario**
**Via Ingestion of Vegetables and Fruits**

**Intake Equation**

$$= \frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.122 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 12 | Year |
| EDc | Exposure duration for carcinogens | 12 | Year |
| BW | Body weight | 43 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 4380 | days |
| CS | Concentration of chemicals in vegetables | | |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 1.6E-04 | mg/kg |
| Aroclor-1016 | NA | mg/kg |
| Aroclor-1221 | 8.4E-08 | mg/kg |
| Aroclor-1242 | NA | mg/kg |
| Aroclor-1248 | 4.7E-08 | mg/kg |
| Aroclor-1254 | 2.6E-06 | mg/kg |
| Aroclor-1260 | 2.4E-06 | mg/kg |
| Arsenic | 7.0E-05 | mg/kg |
| Barium | 3.5E-03 | mg/kg |
| Beryllium | 6.1E-06 | mg/kg |
| Cadmium | 3.5E-05 | mg/kg |
| Chromium | NA | mg/kg |
| Cobalt | 7.2E-05 | mg/kg |
| Copper | 2.3E-04 | mg/kg |
| Cyanide | 1.4E-05 | mg/kg |
| Di-n-octyl phthalate | 2.0E-07 | mg/kg |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Lead | 5.3E-04 | mg/kg |
| Manganese | 3.4E-03 | mg/kg |
| Mercury | 1.3E-06 | mg/kg |
| Molybdenum | 2.6E-05 | mg/kg |
| Nickel | 2.0E-04 | mg/kg |
| Octachlorodibenzofuran | NA | mg/kg |
| Selenium | 3.2E-07 | mg/kg |
| Thallium | 2.0E-06 | mg/kg |
| Vanadium | 1.5E-04 | mg/kg |
| Zinc | 7.2E-04 | mg/kg |
| 2-Chlorophenol | NA | mg/kg |
| 2-Methylnaphthalene | 1.9E-07 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | mg/kg |
| 4,4-DDT | NA | mg/kg |

**References**



0640

5208

**Table K.IV-30 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RMB Resident Farm Youth Current Land Use Scenario**
**Via Ingestion of Vegetables and Fruits**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 4.5E-07 | 4.0E-04 | 1.1E-03 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 2.3E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.3E-10 | NA | NA |
| Aroclor-1254 | 7.1E-09 | NA | NA |
| Aroclor-1260 | 6.5E-09 | NA | NA |
| Arsenic | 1.9E-07 | 3.0E-04 | 6.3E-04 |
| Barium | 9.6E-06 | 7.0E-02 | 1.4E-04 |
| Beryllium | 1.6E-08 | 5.0E-03 | 3.3E-06 |
| Cadmium | 9.5E-08 | 5.0E-04 | 1.9E-04 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 2.0E-07 | 6.0E-02 | 3.3E-06 |
| Copper | 6.2E-07 | NA | NA |
| Cyanide | 3.7E-08 | 2.0E-02 | 1.9E-06 |
| Di-n-octyl phthalate | 5.3E-10 | 2.0E-02 | 2.7E-08 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.4E-08 | NA | NA |
| Manganese | 9.3E-06 | 1.4E-01 | 6.7E-05 |
| Mercury | 3.6E-09 | 3.0E-04 | 1.2E-05 |
| Molybdenum | 7.0E-08 | 5.0E-03 | 1.4E-05 |
| Nickel | 5.4E-07 | 2.0E-02 | 2.7E-05 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 8.6E-10 | 5.0E-03 | 1.7E-07 |
| Thallium | 5.4E-09 | 8.0E-05 | 6.8E-05 |
| Vanadium | 4.2E-07 | 7.0E-03 | 6.0E-05 |
| Zinc | 2.0E-06 | 3.0E-01 | 6.5E-06 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 5.3E-10 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 2.3E-03 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 7.6E-08 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 3.9E-11 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 2.2E-11 | 7.7E+00 | 1.7E-10 |
| Aroclor-1254 | 1.2E-09 | 7.7E+00 | 9.4E-09 |
| Aroclor-1260 | 1.1E-09 | 7.7E+00 | 8.5E-09 |
| Arsenic | 3.3E-08 | 1.8E+00 | 5.7E-08 |
| Barium | 1.6E-06 | NA | NA |
| Beryllium | 2.8E-09 | 4.3E+00 | 1.2E-08 |
| Cadmium | 1.6E-08 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 3.4E-08 | NA | NA |
| Copper | 1.1E-07 | NA | NA |
| Cyanide | 6.4E-09 | NA | NA |
| Di-n-octyl phthalate | 9.1E-11 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 2.5E-07 | NA | NA |
| Manganese | 1.6E-06 | NA | NA |
| Mercury | 6.1E-10 | NA | NA |
| Molybdenum | 1.2E-08 | NA | NA |
| Nickel | 9.3E-08 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 1.5E-10 | NA | NA |
| Thallium | 9.3E-10 | NA | NA |
| Vanadium | 7.2E-08 | NA | NA |
| Zinc | 3.4E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 9.0E-11 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 8.7E-08 |

5208

**Table K.IV-31**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Youth Current Land Use Scenario**
**Via Ingestion of Vegetables and Fruits**

**Intake Equation** = Cv X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.122 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 12 Year |
| Cv | Concentration of radionuclides in vegetables | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 4.0E-03 | pCi/kg | Sr-90 | 3.4E-13 | pCi/kg |
| Np-237 | 5.8E-04 | pCi/kg | Tc-99 | 1.5E-12 | pCi/kg |
| Pa-231 | 2.1E-03 | pCi/kg | Th-228 | 1.2E-02 | pCi/kg |
| Pb-210 | 5.9E-02 | pCi/kg | Th-230 | 1.3E-02 | pCi/kg |
| Pu-238 | 4.2E-03 | pCi/kg | Th-232 | 6.8E-03 | pCi/kg |
| Pu-239 | 2.7E-03 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 2.7E-03 | pCi/kg | U-234 | 5.6E+01 | pCi/kg |
| Ra-226 | 6.8E-03 | pCi/kg | U-235 | 1.5E+00 | pCi/kg |
| Ra-228 | 7.2E-03 | pCi/kg | U-236 | 6.2E-01 | pCi/kg |
| | | | U-238 | 3.4E+01 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 2.1E+00 | 2.8E-11 | 5.8E-11 |
| Np-237 | 3.0E-01 | 2.2E-10 | 6.6E-11 |
| Pa-231 | 1.1E+00 | 9.2E-11 | 9.8E-11 |
| Pb-210 | 3.0E+01 | 6.6E-10 | 2.0E-08 |
| Pu-238 | 2.1E+00 | 2.2E-10 | 4.7E-10 |
| Pu-239 | 1.4E+00 | 2.3E-10 | 3.2E-10 |
| Pu-240 | 1.4E+00 | 2.3E-10 | 3.2E-10 |
| Ra-226 | 3.5E+00 | 1.2E-10 | 4.2E-10 |
| Ra-228 | 3.7E+00 | 1.0E-10 | 3.7E-10 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 1.7E-10 | 3.3E-10 | 5.7E-20 |
| Tc-99 | 7.5E-10 | 1.3E-12 | 9.8E-22 |
| Th-228 | 6.2E+00 | 5.5E-11 | 3.4E-10 |
| Th-230 | 6.6E+00 | 1.3E-11 | 8.5E-11 |
| Th-232 | 3.5E+00 | 1.2E-11 | 4.2E-11 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 2.9E+04 | 1.6E-11 | 4.6E-07 |
| U-235 | 7.6E+02 | 1.6E-11 | 1.2E-08 |
| U-236 | 3.2E+02 | 1.5E-11 | 4.7E-09 |
| U-238 | 1.7E+04 | 2.8E-11 | 4.8E-07 |
| | | ILCR Summation = | 9.8E-07 |

0642

**Table K.IV-32**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Child Current Land Use Scenario**
**Via Inhalation of Particulates**

**Intake Equation** = $\frac{CS \times EF \times ED \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 12 | $m^3$/day |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 6 | Year |
| EDc | Exposure duration for carcinogens | 6 | Year |
| BW | Body weight | 15 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 2190 | days |
| CS | Concentration of chemicals in particulate as modeled | | (see table below) |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 1.9E-06 | mg/m$^3$ |
| Aroclor-1016 | NA | mg/m$^3$ |
| Aroclor-1221 | 1.9E-09 | mg/m$^3$ |
| Aroclor-1242 | NA | mg/m$^3$ |
| Aroclor-1248 | 1.3E-09 | mg/m$^3$ |
| Aroclor-1254 | 6.0E-08 | mg/m$^3$ |
| Aroclor-1260 | 6.3E-08 | mg/m$^3$ |
| Arsenic | 9.3E-07 | mg/m$^3$ |
| Barium | 8.5E-05 | mg/m$^3$ |
| Beryllium | 8.5E-08 | mg/m$^3$ |
| Cadmium | 3.7E-07 | mg/m$^3$ |
| Chromium | 2.5E-07 | mg/m$^3$ |
| Cobalt | 9.3E-07 | mg/m$^3$ |
| Copper | 3.7E-06 | mg/m$^3$ |
| Cyanide | 3.3E-07 | mg/m$^3$ |
| Di-n-octyl phthalate | 5.2E-09 | mg/m$^3$ |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/m$^3$ |
| Heptachlorodibenzo-p-dioxin | NA | mg/m$^3$ |
| Lead | 1.1E-05 | mg/m$^3$ |
| Manganese | 3.9E-05 | mg/m$^3$ |
| Mercury | 3.0E-08 | mg/m$^3$ |
| Molybdenum | 3.0E-07 | mg/m$^3$ |
| Nickel | 2.5E-06 | mg/m$^3$ |
| Octachlorodibenzofuran | NA | mg/m$^3$ |
| Selenium | 8.5E-09 | mg/m$^3$ |
| Thallium | 2.6E-08 | mg/m$^3$ |
| Vanadium | 1.6E-06 | mg/m$^3$ |
| Zinc | 9.6E-06 | mg/m$^3$ |
| 2-Chlorophenol | NA | mg/m$^3$ |
| 2-Methylnaphthalene | 5.0E-09 | mg/m$^3$ |
| 4-Chlorophenyl-phenylether | NA | mg/m$^3$ |
| 4,4-DDT | NA | mg/m$^3$ |

**References**

**Table K.IV-32 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RMB Resident Farm Child Current Land Use Scenario**
**Via Inhalation of Particulates**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 1.5E-06 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.4E-09 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 9.7E-10 | NA | NA |
| Aroclor-1254 | 4.6E-08 | NA | NA |
| Aroclor-1260 | 4.9E-08 | NA | NA |
| Arsenic | 7.1E-07 | NA | NA |
| Barium | 6.5E-05 | 1.4E-04 | 4.7E-01 |
| Beryllium | 6.5E-08 | NA | NA |
| Cadmium | 2.9E-07 | NA | NA |
| Chromium | 1.9E-07 | NA | NA |
| Cobalt | 7.1E-07 | 3.0E-07 | 2.4E+00 |
| Copper | 2.9E-06 | NA | NA |
| Cyanide | 2.5E-07 | NA | NA |
| Di-n-octyl phthalate | 4.0E-09 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 8.6E-06 | NA | NA |
| Manganese | 3.0E-05 | 1.1E-04 | 2.7E-01 |
| Mercury | 2.3E-08 | 8.6E-05 | 2.6E-04 |
| Molybdenum | 2.3E-07 | NA | NA |
| Nickel | 1.9E-06 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 6.5E-09 | NA | NA |
| Thallium | 2.0E-08 | NA | NA |
| Vanadium | 1.4E-06 | NA | NA |
| Zinc | 7.4E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.8E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | NA | NA |
| | HQ Summation = | | 3.1E+00 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 1.3E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.2E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 8.4E-11 | NA | NA |
| Aroclor-1254 | 3.9E-09 | NA | NA |
| Aroclor-1260 | 4.2E-09 | NA | NA |
| Arsenic | 6.1E-08 | 1.5E+01 | 9.2E-07 |
| Barium | 5.6E-06 | NA | NA |
| Beryllium | 5.6E-09 | 8.4E+00 | 4.7E-08 |
| Cadmium | 2.4E-08 | 6.1E+00 | 1.5E-07 |
| Chromium | 1.6E-08 | 4.1E+01 | 6.6E-07 |
| Cobalt | 6.1E-08 | NA | NA |
| Copper | 2.4E-07 | NA | NA |
| Cyanide | 2.2E-08 | NA | NA |
| Di-n-octyl phthalate | 3.4E-10 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 7.4E-07 | NA | NA |
| Manganese | 2.5E-06 | NA | NA |
| Mercury | 1.9E-09 | NA | NA |
| Molybdenum | 1.9E-08 | NA | NA |
| Nickel | 1.6E-07 | 8.4E-01 | 1.4E-07 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 5.6E-10 | NA | NA |
| Thallium | 1.7E-09 | NA | NA |
| Vanadium | 1.2E-07 | NA | NA |
| Zinc | 6.3E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.3E-10 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 1.9E-06 |

- 5208

**Table K.IV-33**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Child Current Land Use Scenario**
**Via Inhalation of Gases and Particulates**

**Intake Equation** = Ca X EF X EDn X IR

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 12 $m^3$/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 6 Year |
| Ca | Concentration of radionuclides in air | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/$m^3$ | Rn-222 | 4.0E+00 | pCi/$m^3$ |
| Am-241 | NA | pCi/$m^3$ | Ru-106 | NA | pCi/$m^3$ |
| Cs-137 | 4.6E-05 | pCi/$m^3$ | Sr-90 | 1.5E-04 | pCi/$m^3$ |
| Np-237 | 1.6E-05 | pCi/$m^3$ | Tc-99 | 9.2E-04 | pCi/$m^3$ |
| Pa-231 | 5.5E-05 | pCi/$m^3$ | Th-228 | 1.4E-04 | pCi/$m^3$ |
| Pb-210 | 1.6E-03 | pCi/$m^3$ | Th-230 | 1.5E-04 | pCi/$m^3$ |
| Pu-238 | 8.0E-05 | pCi/$m^3$ | Th-232 | 8.0E-05 | pCi/$m^3$ |
| Pu-239 | 3.9E-05 | pCi/$m^3$ | U-233 | NA | pCi/$m^3$ |
| Pu-240 | 3.9E-05 | pCi/$m^3$ | U-234 | 1.7E-03 | pCi/$m^3$ |
| Ra-226 | 8.0E-05 | pCi/$m^3$ | U-235 | 4.4E-05 | pCi/$m^3$ |
| Ra-228 | 8.7E-05 | pCi/$m^3$ | U-236 | 1.8E-05 | pCi/$m^3$ |
| | | | U-238 | 9.9E-04 | pCi/$m^3$ |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 8.8E-08 | NA |
| Am-241 | NA | 3.2E-08 | NA |
| Cs-137 | 1.2E+00 | 1.9E-11 | 2.2E-11 |
| Np-237 | 4.0E-01 | 2.9E-08 | 1.2E-08 |
| Pa-231 | 1.4E+00 | 3.6E-08 | 5.0E-08 |
| Pb-210 | 4.0E+01 | 4.0E-09 | 1.6E-07 |
| Pu-238 | 2.0E+00 | 3.9E-08 | 7.9E-08 |
| Pu-239 | 9.8E-01 | 3.8E-08 | 3.7E-08 |
| Pu-240 | 9.8E-01 | 3.8E-08 | 3.7E-08 |
| Ra-226 | 2.0E+00 | 3.0E-09 | 6.0E-09 |
| Ra-228 | 2.2E+00 | 6.9E-10 | 1.5E-09 |
| Rn-222 | 1.0E+05 | 7.7E-12 | 7.8E-07 |
| Ru-106 | NA | 4.4E-10 | NA |
| Sr-90 | 3.8E+00 | 5.6E-11 | 2.1E-10 |
| Tc-99 | 2.3E+01 | 8.3E-12 | 1.9E-10 |
| Th-228 | 3.6E+00 | 7.8E-08 | 2.8E-07 |
| Th-230 | 3.8E+00 | 2.9E-08 | 1.1E-07 |
| Th-232 | 2.0E+00 | 2.8E-08 | 5.6E-08 |
| U-233 | NA | 2.7E-08 | NA |
| U-234 | 4.2E+01 | 2.6E-08 | 1.1E-06 |
| U-235 | 1.1E+00 | 2.5E-08 | 2.8E-08 |
| U-236 | 4.5E-01 | 2.5E-08 | 1.1E-08 |
| U-238 | 2.5E+01 | 5.2E-08 | 1.3E-06 |
| | | ILCR Summation = | 4.0E-06 |



0645

208

**Table K.IV-34**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Child Current Land Use Scenario**
**Via Ingestion of Drinking Water**

**Intake Equation** = Cw X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of groundwater (RAGS, 1989) | 1.4 l/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 6 Year |
| FI | Fractional intake for radionuclides | 1 (Unitless) |
| Cw | Concentration of radionuclides in groundwater | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/l | Rn-222 | NA | pCi/l |
| Am-241 | NA | pCi/l | Ru-106 | NA | pCi/l |
| Cs-137 | NA | pCi/l | Sr-90 | NA | pCi/l |
| Np-237 | NA | pCi/l | Tc-99 | NA | pCi/l |
| Pa-231 | NA | pCi/l | Th-228 | NA | pCi/l |
| Pb-210 | NA | pCi/l | Th-230 | NA | pCi/l |
| Pu-238 | NA | pCi/l | Th-232 | NA | pCi/l |
| Pu-239 | NA | pCi/l | U-233 | NA | pCi/l |
| Pu-240 | NA | pCi/l | U-234 | 6.1E+00 | pCi/l |
| Ra-226 | NA | pCi/l | U-235 | 1.6E-01 | pCi/l |
| Ra-228 | NA | pCi/l | U-236 | 6.7E-02 | pCi/l |
| | | | U-238 | 3.6E+00 | pCi/l |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | NA | 2.8E-11 | NA |
| Np-237 | NA | 2.2E-10 | NA |
| Pa-231 | NA | 9.2E-11 | NA |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | NA | 2.2E-10 | NA |
| Pu-239 | NA | 2.3E-10 | NA |
| Pu-240 | NA | 2.3E-10 | NA |
| Ra-226 | NA | 1.2E-10 | NA |
| Ra-228 | NA | 1.0E-10 | NA |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | NA | 3.3E-10 | NA |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | NA | 5.5E-11 | NA |
| Th-230 | NA | 1.3E-11 | NA |
| Th-232 | NA | 1.2E-11 | NA |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 1.8E+04 | 1.6E-11 | 2.9E-07 |
| U-235 | 4.7E+02 | 1.6E-11 | 7.6E-09 |
| U-236 | 2.0E+02 | 1.5E-11 | 2.9E-09 |
| U-238 | 1.1E+04 | 2.8E-11 | 3.0E-07 |
| | | ILCR Summation = | 5.9E-07 |

0641

5208

**Table K.IV-35**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RMB Resident Farm Child Current Land Use Scenario**
**Via Ingestion of Meat Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of meat | 0.029 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 6 | Year |
| EDc | Exposure duration for carcinogens | 6 | Year |
| BW | Body weight | 15 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 2190 | days |
| CS | Concentration of chemicals in meat | | |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 6.7E-06 | mg/kg | Heptachlorodibenzofuran | NA | mg/kg |
| Aroclor-1016 | NA | mg/kg | Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Aroclor-1221 | 5.6E-11 | mg/kg | Lead | 6.5E-06 | mg/kg |
| Aroclor-1242 | NA | mg/kg | Manganese | 5.7E-05 | mg/kg |
| Aroclor-1248 | 1.9E-06 | mg/kg | Mercury | 1.4E-05 | mg/kg |
| Aroclor-1254 | 8.0E-06 | mg/kg | Molybdenum | 6.3E-06 | mg/kg |
| Aroclor-1260 | 3.1E-06 | mg/kg | Nickel | 4.9E-05 | mg/kg |
| Arsenic | 5.7E-06 | mg/kg | Octachlorodibenzofuran | NA | mg/kg |
| Barium | 2.2E-05 | mg/kg | Selenium | 2.0E-07 | mg/kg |
| Beryllium | 2.5E-07 | mg/kg | Thallium | 3.3E-06 | mg/kg |
| Cadmium | 8.1E-06 | mg/kg | Vanadium | 1.6E-05 | mg/kg |
| Chromium | NA | mg/kg | Zinc | 3.1E-03 | mg/kg |
| Cobalt | 5.9E-05 | mg/kg | 2-Chlorophenol | NA | mg/kg |
| Copper | 9.5E-05 | mg/kg | 2-Methylnaphthalene | 1.4E-09 | mg/kg |
| Cyanide | 2.9E-11 | mg/kg | 4-Chlorophenyl-phenylether | NA | mg/kg |
| Di-n-octyl phthalate | 3.2E-04 | mg/kg | 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-35 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Child Current Land Use Scenario**
**Via Ingestion of Meat Products**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 1.2E-08 | 4.0E-04 | 3.1E-05 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.0E-13 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 3.5E-11 | NA | NA |
| Aroclor-1254 | 1.5E-08 | NA | NA |
| Aroclor-1260 | 5.8E-09 | NA | NA |
| Arsenic | 1.1E-08 | 3.0E-04 | 3.5E-05 |
| Barium | 4.1E-08 | 7.0E-02 | 5.8E-07 |
| Beryllium | 4.6E-10 | 5.0E-03 | 9.2E-08 |
| Cadmium | 1.5E-08 | 5.0E-04 | 3.0E-05 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 1.1E-07 | 6.0E-02 | 1.8E-06 |
| Copper | 1.8E-07 | NA | NA |
| Cyanide | 5.5E-14 | 2.0E-02 | 2.7E-12 |
| Di-n-octyl phthalate | 5.9E-07 | 2.0E-02 | 3.0E-05 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.2E-08 | NA | NA |
| Manganese | 1.1E-07 | 1.4E-01 | 7.5E-07 |
| Mercury | 2.6E-08 | 3.0E-04 | 8.5E-05 |
| Molybdenum | 1.2E-08 | 5.0E-03 | 2.3E-06 |
| Nickel | 9.1E-08 | 2.0E-02 | 4.6E-06 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 3.6E-10 | 5.0E-03 | 7.2E-08 |
| Thallium | 6.1E-09 | 8.0E-05 | 7.6E-05 |
| Vanadium | 2.9E-08 | 7.0E-03 | 4.2E-06 |
| Zinc | 5.7E-06 | 3.0E-01 | 1.9E-05 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 2.7E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| HQ Summation = | | | 3.2E-04 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 1.1E-09 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 8.9E-15 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 3.0E-12 | 7.7E+00 | 2.3E-11 |
| Aroclor-1254 | 1.3E-09 | 7.7E+00 | 9.7E-09 |
| Aroclor-1260 | 4.9E-10 | 7.7E+00 | 3.8E-09 |
| Arsenic | 9.1E-10 | 1.8E+00 | 1.6E-09 |
| Barium | 3.5E-09 | NA | NA |
| Beryllium | 3.9E-11 | 4.3E+00 | 1.7E-10 |
| Cadmium | 1.3E-09 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 9.4E-09 | NA | NA |
| Copper | 1.5E-08 | NA | NA |
| Cyanide | 4.7E-15 | NA | NA |
| Di-n-octyl phthalate | 5.1E-08 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.0E-09 | NA | NA |
| Manganese | 9.0E-09 | NA | NA |
| Mercury | 2.2E-09 | NA | NA |
| Molybdenum | 1.0E-09 | NA | NA |
| Nickel | 7.8E-09 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 3.1E-11 | NA | NA |
| Thallium | 5.2E-10 | NA | NA |
| Vanadium | 2.5E-09 | NA | NA |
| Zinc | 4.9E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 2.3E-13 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| ILCR Summation = | | | 1.5E-08 |

52

**Table K.IV-36**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Child Current Land Use Scenario**
**Via Ingestion of Meat Products**

**Intake Equation** = Cf X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of meat | 0.029 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 6 Year |
| Cf | Concentration of radionuclides in meat | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 3.3E-03 | pCi/kg | Sr-90 | NA | pCi/kg |
| Np-237 | 1.3E-06 | pCi/kg | Tc-99 | NA | pCi/kg |
| Pa-231 | 6.8E-03 | pCi/kg | Th-228 | 1.9E-06 | pCi/kg |
| Pb-210 | NA | pCi/kg | Th-230 | 3.1E-06 | pCi/kg |
| Pu-238 | 8.5E-08 | pCi/kg | Th-232 | 1.7E-06 | pCi/kg |
| Pu-239 | 5.5E-08 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 5.5E-08 | pCi/kg | U-234 | 5.3E-01 | pCi/kg |
| Ra-226 | 7.0E-05 | pCi/kg | U-235 | 1.4E-02 | pCi/kg |
| Ra-228 | 4.7E-05 | pCi/kg | U-236 | 5.7E-03 | pCi/kg |
| | | | U-238 | 3.1E-01 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 2.0E-01 | 2.8E-11 | 5.6E-12 |
| Np-237 | 8.2E-05 | 2.2E-10 | 1.8E-14 |
| Pa-231 | 4.1E-01 | 9.2E-11 | 3.8E-11 |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | 5.2E-06 | 2.2E-10 | 1.1E-15 |
| Pu-239 | 3.3E-06 | 2.3E-10 | 7.7E-16 |
| Pu-240 | 3.3E-06 | 2.3E-10 | 7.7E-16 |
| Ra-226 | 4.3E-03 | 1.2E-10 | 5.1E-13 |
| Ra-228 | 2.9E-03 | 1.0E-10 | 2.9E-13 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | NA | 3.3E-10 | NA |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | 1.1E-04 | 5.5E-11 | 6.3E-15 |
| Th-230 | 1.9E-04 | 1.3E-11 | 2.5E-15 |
| Th-232 | 1.0E-04 | 1.2E-11 | 1.2E-15 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 3.2E+01 | 1.6E-11 | 5.1E-10 |
| U-235 | 8.4E-01 | 1.6E-11 | 1.3E-11 |
| U-236 | 3.5E-01 | 1.5E-11 | 5.2E-12 |
| U-238 | 1.9E+01 | 2.8E-11 | 5.3E-10 |
| | | ILCR Summation = | 1.1E-09 |



0649

**Table K.IV-37**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Child Current Land Use Scenario**
**Via Ingestion of Dairy Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | |
|---|---|---|
| IR | Ingestion rate of dairy products | 0.9 l/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration for non-carcinogens | 6 Year |
| EDc | Exposure duration for carcinogens | 6 Year |
| BW | Body weight | 15 kg |
| ATc | Average time for carcinogens (lifetime) | 25550 days |
| ATn | Average time for non-carcinogens (EDn x 365) | 2190 days |
| CS | Concentration of chemicals in animal products | |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 6.7E-07 | mg/kg |
| Aroclor-1016 | NA | mg/kg |
| Aroclor-1221 | 1.6E-11 | mg/kg |
| Aroclor-1242 | NA | mg/kg |
| Aroclor-1248 | 2.0E-08 | mg/kg |
| Aroclor-1254 | 1.7E-06 | mg/kg |
| Aroclor-1260 | 6.3E-06 | mg/kg |
| Arsenic | 1.7E-07 | mg/kg |
| Barium | 5.1E-05 | mg/kg |
| Beryllium | 2.2E-10 | mg/kg |
| Cadmium | 1.5E-06 | mg/kg |
| Chromium | NA | mg/kg |
| Cobalt | 5.9E-06 | mg/kg |
| Copper | 1.4E-05 | mg/kg |
| Cyanide | NA | mg/kg |
| Di-n-octyl phthalate | 1.0E-04 | mg/kg |
| Heptachlorodibenzofuran | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Lead | 5.4E-06 | mg/kg |
| Manganese | 5.0E-05 | mg/kg |
| Mercury | 2.5E-08 | mg/kg |
| Molybdenum | 1.6E-06 | mg/kg |
| Nickel | 8.2E-06 | mg/kg |
| Octachlorodibenzofuran | NA | mg/kg |
| Selenium | 5.2E-08 | mg/kg |
| Thallium | 1.6E-07 | mg/kg |
| Vanadium | 1.3E-07 | mg/kg |
| Zinc | 3.1E-04 | mg/kg |
| 2-Chlorophenol | NA | mg/kg |
| 2-Methylnaphthalene | 8.0E-10 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | mg/kg |
| 4,4-DDT | NA | mg/kg |

**References**



0650

- 5208

**Table K.IV-37 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Child Current Land Use Scenario**
**Via Ingestion of Dairy Products**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 3.9E-08 | 4.0E-04 | 9.7E-05 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.0E-12 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.1E-09 | NA | NA |
| Aroclor-1254 | 9.9E-08 | NA | NA |
| Aroclor-1260 | 3.6E-07 | NA | NA |
| Arsenic | 9.9E-09 | 3.0E-04 | 3.3E-05 |
| Barium | 2.9E-08 | 7.0E-02 | 4.2E-05 |
| Beryllium | 1.3E-11 | 5.0E-03 | 2.6E-09 |
| Cadmium | 8.5E-08 | 5.0E-04 | 1.7E-04 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 3.4E-07 | 6.0E-02 | 5.7E-06 |
| Copper | 8.2E-07 | NA | NA |
| Cyanide | NA | 2.0E-02 | NA |
| Di-n-octyl phthalate | 5.8E-06 | 2.0E-02 | 2.9E-04 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.1E-07 | NA | NA |
| Manganese | 2.9E-06 | 1.4E-01 | 2.0E-05 |
| Mercury | 1.4E-09 | 3.0E-04 | 4.6E-06 |
| Molybdenum | 9.1E-08 | 5.0E-03 | 1.8E-05 |
| Nickel | 4.7E-07 | 2.0E-02 | 2.4E-05 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 3.0E-09 | 5.0E-03 | 6.0E-07 |
| Thallium | 9.4E-09 | 8.0E-05 | 1.2E-04 |
| Vanadium | 7.2E-09 | 7.0E-03 | 1.0E-06 |
| Zinc | 1.8E-05 | 3.0E-01 | 5.9E-05 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 4.6E-11 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| HQ Summation = | | | 8.8E-04 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 3.3E-09 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 8.8E-14 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 9.6E-11 | 7.7E+00 | 7.4E-10 |
| Aroclor-1254 | 8.5E-09 | 7.7E+00 | 6.5E-08 |
| Aroclor-1260 | 3.1E-08 | 7.7E+00 | 2.4E-07 |
| Arsenic | 8.5E-10 | 1.8E+00 | 1.5E-09 |
| Barium | 2.5E-07 | NA | NA |
| Beryllium | 1.1E-12 | 4.3E+00 | 4.7E-12 |
| Cadmium | 7.2E-09 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 2.9E-08 | NA | NA |
| Copper | 7.0E-08 | NA | NA |
| Cyanide | NA | NA | NA |
| Di-n-octyl phthalate | 5.0E-07 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 2.7E-08 | NA | NA |
| Manganese | 2.5E-07 | NA | NA |
| Mercury | 1.2E-10 | NA | NA |
| Molybdenum | 7.8E-09 | NA | NA |
| Nickel | 4.0E-08 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.6E-10 | NA | NA |
| Thallium | 8.1E-10 | NA | NA |
| Vanadium | 6.2E-10 | NA | NA |
| Zinc | 1.5E-08 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 4.0E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| ILCR Summation = | | | 3.1E-07 |

5208

**Table K.IV–38**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off–Property RME Resident Farm Child Current Land Use Scenario**
**Via Ingestion of Dairy Products**

**Intake Equation** = Cp X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of dairy products | 0.9 l/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 6 Year |
| Cp | Concentration of radionuclides in animal products | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 1.2E-03 | pCi/kg | Sr-90 | 7.8E-25 | pCi/kg |
| Np-237 | 1.2E-07 | pCi/kg | Tc-99 | 2.3E-23 | pCi/kg |
| Pa-231 | 4.2E-05 | pCi/kg | Th-228 | 2.4E-06 | pCi/kg |
| Pb-210 | NA | pCi/kg | Th-230 | 2.6E-06 | pCi/kg |
| Pu-238 | 1.7E-08 | pCi/kg | Th-232 | 1.4E-06 | pCi/kg |
| Pu-239 | 1.1E-08 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 1.1E-08 | pCi/kg | U-234 | 1.6E+00 | pCi/kg |
| Ra-226 | 1.3E-04 | pCi/kg | U-235 | 4.2E-02 | pCi/kg |
| Ra-228 | 1.3E-04 | pCi/kg | U-236 | 1.8E-02 | pCi/kg |
| | | | U-238 | 9.6E-01 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 2.2E+00 | 2.8E-11 | 6.1E-11 |
| Np-237 | 2.3E-04 | 2.2E-10 | 5.1E-14 |
| Pa-231 | 8.0E-02 | 9.2E-11 | 7.4E-12 |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | 3.2E-05 | 2.2E-10 | 7.1E-15 |
| Pu-239 | 2.1E-05 | 2.3E-10 | 4.8E-15 |
| Pu-240 | 2.1E-05 | 2.3E-10 | 4.8E-15 |
| Ra-226 | 2.4E-01 | 1.2E-10 | 2.9E-11 |
| Ra-228 | 2.5E-01 | 1.0E-10 | 2.5E-11 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 1.5E-21 | 3.3E-10 | 4.9E-31 |
| Tc-99 | 4.3E-20 | 1.3E-12 | 5.6E-32 |
| Th-228 | 4.6E-03 | 5.5E-11 | 2.5E-13 |
| Th-230 | 5.0E-03 | 1.3E-11 | 6.4E-14 |
| Th-232 | 2.6E-03 | 1.2E-11 | 3.1E-14 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 3.0E+03 | 1.6E-11 | 4.8E-08 |
| U-235 | 8.0E+01 | 1.6E-11 | 1.3E-09 |
| U-236 | 3.3E+01 | 1.5E-11 | 5.0E-10 |
| U-238 | 1.8E+03 | 2.8E-11 | 5.1E-08 |
| | | **ILCR Summation** = | 1.0E-07 |

0652

**Table K.IV-39**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RMB Resident Farm Child Current Land Use Scenario**
**Via Ingestion of Vegetables and Fruits**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.102 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carchogens | 6 | Year |
| EDc | Exposure duration for carcinogens | 6 | Year |
| BW | Body weight | 15 | kg |
| ATc | Average time for carchogens (lifetime) | 25550 | days |
| ATn | Average time for non-carchogens (EDn x 365) | 2190 | days |
| CS | Concentration of chemicals in vegetables | | |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 1.6E-04 | mg/kg | Heptachlorodibenzofuran | NA | mg/kg |
| Aroclor-1016 | NA | mg/kg | Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Aroclor-1221 | 8.4E-08 | mg/kg | Lead | 5.3E-04 | mg/kg |
| Aroclor-1242 | NA | mg/kg | Manganese | 3.4E-03 | mg/kg |
| Aroclor-1248 | 4.7E-08 | mg/kg | Mercury | 1.3E-06 | mg/kg |
| Aroclor-1254 | 2.6E-06 | mg/kg | Molybdenum | 2.6E-05 | mg/kg |
| Aroclor-1260 | 2.4E-06 | mg/kg | Nickel | 2.0E-04 | mg/kg |
| Arsenic | 7.0E-05 | mg/kg | Octachlorodibenzofuran | NA | mg/kg |
| Barium | 3.5E-03 | mg/kg | Selenium | 3.2E-07 | mg/kg |
| Beryllium | 6.1E-06 | mg/kg | Thallium | 2.0E-06 | mg/kg |
| Cadmium | 3.5E-05 | mg/kg | Vanadium | 1.5E-04 | mg/kg |
| Chromium | NA | mg/kg | Zinc | 7.2E-04 | mg/kg |
| Cobalt | 7.2E-05 | mg/kg | 2-Chlorophenol | NA | mg/kg |
| Copper | 2.3E-04 | mg/kg | 2-Methylnaphthalene | 1.9E-07 | mg/kg |
| Cyanide | 1.4E-05 | mg/kg | 4-Chlorophenyl-phenylether | NA | mg/kg |
| Di-n-octyl phthalate | 2.0E-07 | mg/kg | 4,4-DDT | NA | mg/kg |

References



00653

- 5208

**Table K.IV-39 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Child Current Land Use Scenario**
**Via Ingestion of Vegetables and Fruits**

| Compound | HQ Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
| Antimony | 1.1E-06 | 4.0E-04 | 2.7E-03 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 5.5E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 3.1E-10 | NA | NA |
| Aroclor-1254 | 1.7E-08 | NA | NA |
| Aroclor-1260 | 1.6E-08 | NA | NA |
| Arsenic | 4.5E-07 | 3.0E-04 | 1.5E-03 |
| Barium | 2.3E-05 | 7.0E-02 | 3.3E-04 |
| Beryllium | 4.0E-08 | 5.0E-03 | 7.9E-06 |
| Cadmium | 2.3E-07 | 5.0E-04 | 4.6E-04 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 4.7E-07 | 6.0E-02 | 7.9E-06 |
| Copper | 1.5E-06 | NA | NA |
| Cyanide | 8.9E-08 | 2.0E-02 | 4.5E-06 |
| Di-n-octyl phthalate | 1.3E-09 | 2.0E-02 | 6.4E-08 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.4E-06 | NA | NA |
| Manganese | 2.2E-05 | 1.4E-01 | 1.6E-04 |
| Mercury | 8.5E-09 | 3.0E-04 | 2.8E-05 |
| Molybdenum | 1.7E-07 | 5.0E-03 | 3.4E-05 |
| Nickel | 1.3E-06 | 2.0E-02 | 6.5E-05 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.1E-09 | 5.0E-03 | 4.1E-07 |
| Thallium | 1.3E-08 | 8.0E-05 | 1.6E-04 |
| Vanadium | 1.0E-06 | 7.0E-03 | 1.4E-04 |
| Zinc | 4.7E-06 | 3.0E-01 | 1.6E-05 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 1.3E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 5.6E-03 |

| Compound | ILCR Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | CSF $(mg/kg\text{-}day)^{-1}$ | ILCR (unitless) |
| Antimony | 9.2E-08 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 4.7E-11 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 2.6E-11 | 7.7E+00 | 2.0E-10 |
| Aroclor-1254 | 1.5E-09 | 7.7E+00 | 1.1E-08 |
| Aroclor-1260 | 1.3E-09 | 7.7E+00 | 1.0E-08 |
| Arsenic | 3.9E-08 | 1.8E+00 | 6.8E-08 |
| Barium | 2.0E-06 | NA | NA |
| Beryllium | 3.4E-09 | 4.3E+00 | 1.5E-08 |
| Cadmium | 2.0E-08 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 4.0E-08 | NA | NA |
| Copper | 1.3E-07 | NA | NA |
| Cyanide | 7.7E-09 | NA | NA |
| Di-n-octyl phthalate | 1.1E-10 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.0E-07 | NA | NA |
| Manganese | 1.9E-06 | NA | NA |
| Mercury | 7.3E-10 | NA | NA |
| Molybdenum | 1.4E-08 | NA | NA |
| Nickel | 1.1E-07 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 1.8E-10 | NA | NA |
| Thallium | 1.1E-09 | NA | NA |
| Vanadium | 8.6E-08 | NA | NA |
| Zinc | 4.0E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 1.1E-10 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 1.0E-07 |

5208

**Table K.IV-40**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Child Current Land Use Scenario**
**Via Ingestion of Vegetables and Fruits**

**Intake Equation** = Cv X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.102 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 6 Year |
| Cv | Concentration of radionuclides in vegetables | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 4.0E-03 | pCi/kg | Sr-90 | 3.4E-13 | pCi/kg |
| Np-237 | 5.8E-04 | pCi/kg | Tc-99 | 1.5E-12 | pCi/kg |
| Pa-231 | 2.1E-03 | pCi/kg | Th-228 | 1.2E-02 | pCi/kg |
| Pb-210 | 5.9E-02 | pCi/kg | Th-230 | 1.3E-02 | pCi/kg |
| Pu-238 | 4.2E-03 | pCi/kg | Th-232 | 6.8E-03 | pCi/kg |
| Pu-239 | 2.7E-03 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 2.7E-03 | pCi/kg | U-234 | 5.6E+01 | pCi/kg |
| Ra-226 | 6.8E-03 | pCi/kg | U-235 | 1.5E+00 | pCi/kg |
| Ra-228 | 7.2E-03 | pCi/kg | U-236 | 6.2E-01 | pCi/kg |
| | | | U-238 | 3.4E+01 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 8.6E-01 | 2.8E-11 | 2.4E-11 |
| Np-237 | 1.2E-01 | 2.2E-10 | 2.7E-11 |
| Pa-231 | 4.4E-01 | 9.2E-11 | 4.1E-11 |
| Pb-210 | 1.3E+01 | 6.6E-10 | 8.4E-09 |
| Pu-238 | 8.9E-01 | 2.2E-10 | 2.0E-10 |
| Pu-239 | 5.7E-01 | 2.3E-10 | 1.3E-10 |
| Pu-240 | 5.7E-01 | 2.3E-10 | 1.3E-10 |
| Ra-226 | 1.5E+00 | 1.2E-10 | 1.8E-10 |
| Ra-228 | 1.5E+00 | 1.0E-10 | 1.5E-10 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 7.2E-11 | 3.3E-10 | 2.4E-20 |
| Tc-99 | 3.1E-10 | 1.3E-12 | 4.1E-22 |
| Th-228 | 2.6E+00 | 5.5E-11 | 1.4E-10 |
| Th-230 | 2.7E+00 | 1.3E-11 | 3.6E-11 |
| Th-232 | 1.4E+00 | 1.2E-11 | 1.7E-11 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 1.2E+04 | 1.6E-11 | 1.9E-07 |
| U-235 | 3.2E+02 | 1.6E-11 | 5.1E-09 |
| U-236 | 1.3E+02 | 1.5E-11 | 2.0E-09 |
| U-238 | 7.2E+03 | 2.8E-11 | 2.0E-07 |
| | | ILCR Summation = | 4.1E-07 |

0655

5208

# Future Land Use With Federal Ownership

0656

5208

{This page intentionally left blank}



0657

- 5208

**Table K.IV-41**
**Summary of Intake Quantitation (chemicals)**
**Expanded Trespasser: Future Land Use With Federal Ownership**
**Via Inhalation of Particulates**

**Intake Equation**

$$= \frac{CS \times EFa \times EDa \times IR \times ETa}{BWa \times ATa} + \frac{CS \times EFc \times EDc \times IR \times ETc}{BWc \times ATc}$$

| | | |
|---|---|---|
| IR | Inhalation rate of gases | 0.83 $m^3$/hour |
| ETa | Exposure time (adult) | 1 hour |
| ETc | Exposure time (child) | 2 hour |
| EFa | Exposure frequency (adult) | 40 days/year |
| EFc | Exposure frequency (child) | 120 days/year |
| EDa | Exposure duration (adult) | 32 Year |
| EDc | Exposure duration (child) | 12 Year |
| BWa | Body weight (adult) | 70 kg |
| BWc | Body weight (child) | 43 kg |
| AT | Average time for carcinogens | 25550 days |
| ATa | Average time for non-carcinogens (adult) | 11680 days |
| ATc | Average time for non-carcinogens (child) | 4380 days |
| CS | Concentration of chemicals in particulate as modeled | (see table below) |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 1.9E-06 | $mg/m^3$ | Heptachlorodibenzofuran | NA | $mg/m^3$ |
| Aroclor-1016 | NA | $mg/m^3$ | Heptachlorodibenzo-p-dioxin | NA | $mg/m^3$ |
| Aroclor-1221 | 1.3E-09 | $mg/m^3$ | Lead | 8.2E-06 | $mg/m^3$ |
| Aroclor-1242 | NA | $mg/m^3$ | Manganese | 4.0E-05 | $mg/m^3$ |
| Aroclor-1248 | 8.3E-10 | $mg/m^3$ | Mercury | 2.0E-08 | $mg/m^3$ |
| Aroclor-1254 | 4.3E-08 | $mg/m^3$ | Molybdenum | 3.1E-07 | $mg/m^3$ |
| Aroclor-1260 | 4.2E-08 | $mg/m^3$ | Nickel | 2.5E-06 | $mg/m^3$ |
| Arsenic | 8.9E-07 | $mg/m^3$ | Octachlorodibenzofuran | NA | $mg/m^3$ |
| Barium | 5.9E-05 | $mg/m^3$ | Selenium | 8.9E-09 | $mg/m^3$ |
| Beryllium | 7.9E-08 | $mg/m^3$ | Thallium | 2.6E-08 | $mg/m^3$ |
| Cadmium | 3.6E-07 | $mg/m^3$ | Vanadium | 1.8E-06 | $mg/m^3$ |
| Chromium | 2.1E-07 | $mg/m^3$ | Zinc | 7.9E-06 | $mg/m^3$ |
| Cobalt | 8.9E-07 | $mg/m^3$ | 2-Chlorophenol | NA | $mg/m^3$ |
| Copper | 3.0E-06 | $mg/m^3$ | 2-Methylnaphthalene | 3.3E-09 | $mg/m^3$ |
| Cyanide | 2.2E-07 | $mg/m^3$ | 4-Chlorophenyl-phenylether | NA | $mg/m^3$ |
| Di-n-octyl phthalate | 3.9E-09 | $mg/m^3$ | 4,4-DDT | NA | $mg/m^3$ |

**References**

0658

**Table K.IV-41 (continued)**
**Summary of Risk Characterization (chemicals)**
**Expanded Trespasser: Future Land Use With Federal Ownership**
**Via Inhalation of Particulates**

| Compound | HQ Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
| Antimony | 2.7E-08 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.7E-11 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.2E-11 | NA | NA |
| Aroclor-1254 | 6.0E-10 | NA | NA |
| Aroclor-1260 | 5.9E-10 | NA | NA |
| Arsenic | 1.2E-08 | NA | NA |
| Barium | 8.2E-07 | 1.4E-04 | 5.8E-03 |
| Beryllium | 1.1E-09 | NA | NA |
| Cadmium | 5.3E-09 | NA | NA |
| Chromium | 2.9E-09 | NA | NA |
| Cobalt | 1.2E-08 | 3.0E-07 | 4.2E-02 |
| Copper | 4.3E-08 | NA | NA |
| Cyanide | 3.1E-09 | NA | NA |
| Di-n-octyl phthalate | 5.4E-11 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.1E-07 | NA | NA |
| Manganese | 5.6E-07 | 1.1E-04 | 5.1E-03 |
| Mercury | 2.8E-10 | 8.6E-05 | 3.2E-06 |
| Molybdenum | 4.3E-09 | NA | NA |
| Nickel | 3.4E-08 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 1.2E-10 | NA | NA |
| Thallium | 3.6E-10 | NA | NA |
| Vanadium | 2.6E-08 | NA | NA |
| Zinc | 1.1E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 4.6E-11 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | NA | NA |
| | HQ Summation = | | 5.3E-02 |

| Compound | ILCR Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
| Antimony | 5.3E-09 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 3.5E-12 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 2.3E-12 | NA | NA |
| Aroclor-1254 | 1.2E-10 | NA | NA |
| Aroclor-1260 | 1.2E-10 | NA | NA |
| Arsenic | 2.5E-09 | 1.5E+01 | 3.7E-08 |
| Barium | 1.6E-07 | NA | NA |
| Beryllium | 2.2E-10 | 8.4E+00 | 1.8E-09 |
| Cadmium | 1.0E-09 | 6.1E+00 | 6.4E-09 |
| Chromium | 5.8E-10 | 4.1E+01 | 2.4E-08 |
| Cobalt | 2.5E-09 | NA | NA |
| Copper | 8.4E-09 | NA | NA |
| Cyanide | 6.2E-10 | NA | NA |
| Di-n-octyl phthalate | 1.1E-11 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 2.3E-08 | NA | NA |
| Manganese | 1.1E-07 | NA | NA |
| Mercury | 5.5E-11 | NA | NA |
| Molybdenum | 8.4E-10 | NA | NA |
| Nickel | 6.8E-09 | 8.4E-01 | 5.7E-09 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.5E-11 | NA | NA |
| Thallium | 7.1E-11 | NA | NA |
| Vanadium | 5.1E-09 | NA | NA |
| Zinc | 2.2E-08 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 9.1E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 7.5E-08 |

- 5208

## Table K.IV-42
## Summary of Intake and Risk Quantitation (Radionuclides)
## Expanded Trespasser: Future Land Use With Federal Ownership
## Via Inhalation of Gases and Particulates

**Intake Equation** = CA X EFa X EDa X IR X FDa + CA X EFc EDc X IR X FDc

| | | | |
|---|---|---|---|
| IR | Inhalation rate of gases | 0.83 | $m^3$/hour |
| EFa | Exposure frequency (adult) | 40 | days/year |
| EFc | Exposure frequency (child) | 120 | days/year |
| EDa | Exposure duration | 32 | Year |
| EDc | Exposure duration | 12 | Year |
| FDa | Fraction of Day (Adult) | 0.05 | (unitless) |
| FDc | Fraction of Day (Child) | 0.1 | (unitless) |
| CA | Concentration of radionuclides in air | | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Am-241 | NA | pCi/$m^3$ | Ru-106 | NA | pCi/$m^3$ |
| Cs-137 | 4.8E-05 | pCi/$m^3$ | Sr-90 | 1.3E-04 | pCi/$m^3$ |
| Np-237 | 1.1E-05 | pCi/$m^3$ | Tc-99 | 6.4E-04 | pCi/$m^3$ |
| Pa-231 | 5.1E-05 | pCi/$m^3$ | Th-228 | 1.4E-04 | pCi/$m^3$ |
| Pb-210 | 1.1E-03 | pCi/$m^3$ | Th-230 | 1.5E-04 | pCi/$m^3$ |
| Pu-238 | 6.2E-05 | pCi/$m^3$ | Th-232 | 6.4E-05 | pCi/$m^3$ |
| Pu-239 | 3.5E-05 | pCi/$m^3$ | U-233 | NA | pCi/$m^3$ |
| Pu-240 | 3.5E-05 | pCi/$m^3$ | U-234 | 1.3E-03 | pCi/$m^3$ |
| Ra-226 | 8.4E-05 | pCi/$m^3$ | U-235 | 3.7E-05 | pCi/$m^3$ |
| Ra-228 | 9.0E-05 | pCi/$m^3$ | U-236 | 1.6E-05 | pCi/$m^3$ |
| Rn-222 | 4.3E+00 | pCi/$m^3$ | U-238 | 8.1E-04 | pCi/$m^3$ |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Am-241 | NA | 3.2E-08 | NA |
| Cs-137 | 8.2E-03 | 1.9E-11 | 1.6E-13 |
| Np-237 | 1.8E-03 | 2.9E-08 | 5.3E-11 |
| Pa-231 | 8.8E-03 | 3.6E-08 | 3.2E-10 |
| Pb-210 | 1.9E-01 | 4.0E-09 | 7.5E-10 |
| Pu-238 | 1.1E-02 | 3.9E-08 | 4.2E-10 |
| Pu-239 | 6.0E-03 | 3.8E-08 | 2.3E-10 |
| Pu-240 | 6.0E-03 | 3.8E-08 | 2.3E-10 |
| Ra-226 | 1.4E-02 | 3.0E-09 | 4.3E-11 |
| Ra-228 | 1.5E-02 | 6.9E-10 | 1.1E-11 |
| Rn-222 | 7.4E+02 | 7.7E-12 | 5.7E-09 |
| Ru-106 | NA | 4.4E-10 | NA |
| Sr-90 | 2.2E-02 | 5.6E-11 | 1.2E-12 |
| Tc-99 | 1.1E-01 | 8.3E-12 | 9.2E-13 |
| Th-228 | 2.5E-02 | 7.6E-08 | 1.9E-09 |
| Th-230 | 2.6E-02 | 2.9E-08 | 7.7E-10 |
| Th-232 | 1.5E-02 | 2.8E-08 | 4.1E-10 |
| U-233 | NA | 2.7E-08 | NA |
| U-234 | 2.3E-01 | 2.6E-08 | 6.0E-09 |
| U-235 | 6.4E-03 | 2.5E-08 | 1.6E-10 |
| U-236 | 2.8E-03 | 2.5E-08 | 6.9E-11 |
| U-238 | 1.4E-01 | 5.2E-08 | 7.2E-09 |
| | | ILCR Summation = | 2.4E-08 |

0060

**Table K.IV-43**
**Summary of Intake Quantitation (chemicals)**
**Expanded Trespasser: Future Land Use With Federal Ownership**
**Via Incidental Ingestion of Soil/Sediment**

**Intake Equation**

$$= \frac{CS \times EFa \times EDa \times CF \times IRa}{BWa \times ATa} + \frac{CS \times EFc \times EDc \times CF \times IRc}{BWc \times ATc}$$

| | | |
|---|---|---|
| IRa | Ingestion rate of soil (adult) | 10 mg/day |
| IRc | Ingestion rate of soil (child) | 5 mg/day |
| CF | Conversion factor | 1.00E-06 kg/mg |
| EFa | Exposure frequency (adult) | 40 days/year |
| EFc | Exposure frequency (child) | 120 days/year |
| EDa | Exposure duration (adult) | 32 Year |
| EDc | Exposure duration (child) | 12 Year |
| BWa | Body weight (adult) | 70 kg |
| BWc | Body weight (child) | 43 kg |
| AT | Average time for carcinogens | 25550 days |
| ATa | Average time for non-carcinogens (adult) | 11680 days |
| ATc | Average time for non-carcinogens (child) | 4380 days |
| CS | Concentration of chemicals in soil | (see table below) |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 3.3E+01 | mg/kg |
| Aroclor-1016 | NA | mg/kg |
| Aroclor-1221 | 2.9E-02 | mg/kg |
| Aroclor-1242 | NA | mg/kg |
| Aroclor-1248 | 2.2E-02 | mg/kg |
| Aroclor-1254 | 9.8E-01 | mg/kg |
| Aroclor-1260 | 1.0E+00 | mg/kg |
| Arsenic | 1.7E+01 | mg/kg |
| Barium | 1.4E+03 | mg/kg |
| Beryllium | 1.5E+00 | mg/kg |
| Cadmium | 6.5E+00 | mg/kg |
| Chromium | 4.1E+01 | mg/kg |
| Cobalt | 1.6E+01 | mg/kg |
| Copper | 6.2E+01 | mg/kg |
| Cyanide | 5.3E+00 | mg/kg |
| Di-n-octyl phthalate | 8.8E-02 | mg/kg |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Lead | 1.8E+02 | mg/kg |
| Manganese | 7.0E+02 | mg/kg |
| Mercury | 4.7E-01 | mg/kg |
| Molybdenum | 5.1E+00 | mg/kg |
| Nickel | 4.4E+01 | mg/kg |
| Octachlorodibenzofuran | NA | mg/kg |
| Selenium | 1.8E-01 | mg/kg |
| Thallium | 4.7E-01 | mg/kg |
| Vanadium | 3.2E+01 | mg/kg |
| Zinc | 1.6E+02 | mg/kg |
| 2-Chlorophenol | NA | mg/kg |
| 2-Methylnaphthalene | 8.0E-02 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | mg/kg |
| 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-43 (continued)**
**Summary of Risk Characterization (chemicals)**
**Expanded Trespasser: Future Land Use With Federal Ownership**
**Via Incidental Ingestion of Soil/Sediment**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 1.8E-06 | 4.0E-04 | 4.4E-03 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.6E-09 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.2E-09 | NA | NA |
| Aroclor-1254 | 5.3E-08 | NA | NA |
| Aroclor-1260 | 5.4E-08 | NA | NA |
| Arsenic | 6.9E-07 | 3.0E-04 | 3.0E-03 |
| Barium | 7.4E-05 | 7.0E-02 | 1.1E-03 |
| Beryllium | 8.0E-08 | 5.0E-03 | 1.6E-05 |
| Cadmium | 3.5E-07 | 5.0E-04 | 7.0E-04 |
| Chromium | 2.2E-06 | 5.0E-03 | 4.5E-04 |
| Cobalt | 6.6E-07 | 6.0E-02 | 1.4E-05 |
| Copper | 3.3E-06 | NA | NA |
| Cyanide | 2.9E-07 | 2.0E-02 | 1.4E-05 |
| Di-n-octyl phthalate | 4.8E-09 | 2.0E-02 | 2.4E-07 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 9.8E-06 | NA | NA |
| Manganese | 3.8E-05 | 1.4E-01 | 2.7E-04 |
| Mercury | 2.5E-08 | 3.0E-04 | 8.5E-05 |
| Molybdenum | 2.7E-07 | 5.0E-03 | 5.5E-05 |
| Nickel | 2.4E-06 | 2.0E-02 | 1.2E-04 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 9.6E-09 | 5.0E-03 | 1.9E-06 |
| Thallium | 2.5E-08 | 8.0E-05 | 3.1E-04 |
| Vanadium | 1.7E-06 | 7.0E-03 | 2.5E-04 |
| Zinc | 8.7E-06 | 3.0E-01 | 2.9E-05 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 4.3E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 1.1E-02 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 4.5E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 4.0E-10 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 3.0E-10 | 7.7E+00 | 2.3E-09 |
| Aroclor-1254 | 1.3E-08 | 7.7E+00 | 1.0E-07 |
| Aroclor-1260 | 1.4E-08 | 7.7E+00 | 1.1E-07 |
| Arsenic | 2.3E-07 | 1.8E+00 | 4.0E-07 |
| Barium | 1.9E-05 | NA | NA |
| Beryllium | 2.0E-08 | 4.3E+00 | 8.8E-08 |
| Cadmium | 8.9E-08 | NA | NA |
| Chromium | 5.7E-07 | NA | NA |
| Cobalt | 2.2E-07 | NA | NA |
| Copper | 8.5E-07 | NA | NA |
| Cyanide | 7.3E-08 | NA | NA |
| Di-n-octyl phthalate | 1.2E-09 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 2.5E-06 | NA | NA |
| Manganese | 9.6E-06 | NA | NA |
| Mercury | 6.5E-09 | NA | NA |
| Molybdenum | 7.0E-08 | NA | NA |
| Nickel | 6.0E-07 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.4E-09 | NA | NA |
| Thallium | 6.4E-09 | NA | NA |
| Vanadium | 4.4E-07 | NA | NA |
| Zinc | 2.2E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 1.1E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 7.0E-07 |





0062

5208

# Table K.IV-44
## Summary of Intake and Risk Quantitation (Radionuclides)
## Expanded Trespasser: Future Land Use With Federal Ownership
## Via Incidental Ingestion of Soil/Sediment

**Intake Equation** = CS X EFa X EDa X FI X IRa + CS X EFc X EDc X FI X IRc

| | | |
|---|---|---|
| IRa | Ingestion rate of soil (adult) | 10 mg/day |
| IRc | Ingestion rate of soil (child) | 5 mg/day |
| EFa | Exposure frequency (adult) | 40 days/year |
| EFc | Exposure frequency (child) | 120 days/year |
| EDa | Exposure Duration | 32 Year |
| EDc | Exposure Duration | 12 Year |
| FI | Fractional Intake | 1 (unitless) |
| CS | Concentration of radionuclides in soil | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Am-241 | NA | pCi/mg | Ru-106 | NA | pCi/mg |
| Cs-137 | 8.4E-04 | pCi/mg | Sr-90 | 2.6E-03 | pCi/mg |
| Np-237 | 2.5E-04 | pCi/mg | Tc-99 | 1.5E-02 | pCi/mg |
| Pa-231 | 1.1E-03 | pCi/mg | Th-228 | 2.8E-03 | pCi/mg |
| Pb-210 | 2.6E-02 | pCi/mg | Th-230 | 2.9E-03 | pCi/mg |
| Pu-238 | 1.3E-03 | pCi/mg | Th-232 | 1.9E-03 | pCi/mg |
| Pu-239 | 6.7E-04 | pCi/mg | U-233 | NA | pCi/mg |
| Pu-240 | 6.7E-04 | pCi/mg | U-234 | 3.4E-02 | pCi/mg |
| Ra-226 | 1.9E-03 | pCi/mg | U-235 | 9.1E-04 | pCi/mg |
| Ra-228 | 2.0E-03 | pCi/mg | U-236 | 3.9E-04 | pCi/mg |
| Rn-222 | NA | pCi/mg | U-238 | 2.0E-02 | pCi/mg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 1.7E+01 | 2.8E-11 | 4.7E-10 |
| Np-237 | 5.1E+00 | 2.2E-10 | 1.1E-09 |
| Pa-231 | 2.1E+01 | 9.2E-11 | 2.0E-09 |
| Pb-210 | 5.2E+02 | 6.6E-10 | 3.4E-07 |
| Pu-238 | 2.6E+01 | 2.2E-10 | 5.8E-09 |
| Pu-239 | 1.3E+01 | 2.3E-10 | 3.1E-09 |
| Pu-240 | 1.3E+01 | 2.3E-10 | 3.1E-09 |
| Ra-226 | 3.8E+01 | 1.2E-10 | 4.6E-09 |
| Ra-228 | 4.0E+01 | 1.0E-10 | 4.0E-09 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 5.2E+01 | 3.3E-10 | 1.7E-08 |
| Tc-99 | 3.0E+02 | 1.3E-12 | 3.8E-10 |
| Th-228 | 5.6E+01 | 5.5E-11 | 3.1E-09 |
| Th-230 | 5.9E+01 | 1.3E-11 | 7.6E-10 |
| Th-232 | 3.8E+01 | 1.2E-11 | 4.6E-10 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 6.7E+02 | 1.6E-11 | 1.1E-08 |
| U-235 | 1.8E+01 | 1.6E-11 | 2.9E-10 |
| U-236 | 7.8E+00 | 1.5E-11 | 1.2E-10 |
| U-238 | 4.0E+02 | 2.8E-11 | 1.1E-08 |
| | | ILCR Summation = | 4.1E-07 |

- 5208

## Table K.IV-45
## Summary of Intake and Risk Quantitation (Radionuclides)
## Expanded Trespasser: Future Land Use With Federal Ownership
## Via Incidental Ingestion while Wading

**Intake Equation** = CS X EFa X EDa X FI X IR + CS X EFc X EDc X FI X IR

| | | |
|---|---|---|
| IRsw | Ingestion rate of surface water | 0.025 l/day |
| EFa | Exposure frequency (adult) | 10 days/year |
| EFc | Exposure frequency (child) | 30 days/year |
| EDa | Exposure duration (adult) | 32 Year |
| EDc | Exposure duration (child) | 12 Year |
| FI | Fractional intake for radionuclides | 1 (Unitless) |
| Cs | Concentration of radionuclides in surface water | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Am-241 | NA | pCi/l | Ru-106 | NA | pCi/l |
| Cs-137 | NA | pCi/l | Sr-90 | 7.1E-01 | pCi/l |
| Np-237 | NA | pCi/l | Tc-99 | NA | pCi/l |
| Pa-231 | NA | pCi/l | Th-228 | NA | pCi/l |
| Pb-210 | NA | pCi/l | Th-230 | NA | pCi/l |
| Pu-238 | NA | pCi/l | Th-232 | NA | pCi/l |
| Pu-239 | NA | pCi/l | U-233 | NA | pCi/l |
| Pu-240 | NA | pCi/l | U-234 | 2.2E+00 | pCi/l |
| Ra-226 | NA | pCi/l | U-235 | 5.8E-02 | pCi/l |
| Ra-228 | NA | pCi/l | U-236 | 2.4E-02 | pCi/l |
| Rn-222 | NA | pCi/l | U-238 | 1.3E+00 | pCi/l |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | NA | 2.8E-11 | NA |
| Np-237 | NA | 2.2E-10 | NA |
| Pa-231 | NA | 9.2E-11 | NA |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | NA | 2.2E-10 | NA |
| Pu-239 | NA | 2.3E-10 | NA |
| Pu-240 | NA | 2.3E-10 | NA |
| Ra-226 | NA | 1.2E-10 | NA |
| Ra-228 | NA | 1.0E-10 | NA |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 1.2E+01 | 3.3E-10 | 4.0E-09 |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | NA | 5.5E-11 | NA |
| Th-230 | NA | 1.3E-11 | NA |
| Th-232 | NA | 1.2E-11 | NA |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 3.7E+01 | 1.6E-11 | 5.9E-10 |
| U-235 | 9.8E-01 | 1.6E-11 | 1.6E-11 |
| U-236 | 4.0E-01 | 1.5E-11 | 6.1E-12 |
| U-238 | 2.2E+01 | 2.8E-11 | 6.2E-10 |
| | ILCR Summation | = | 5.2E-09 |

0664

**Table K.IV-46**
**Summary of Intake Quantitation (chemicals)**
**Expanded Trespasser: Future Land Use With Federal Ownership**
**Via Dermal Contact with Soil/Sediment**

**Intake Equation**

$$= \frac{CS \times EFa \times EDa \times CF \times ABS \times AF \times SA}{BWa \times ATa} + \frac{CS \times EFc \times EDc \times CF \times ABS \times AF \times SAc}{BWc \times ATc}$$

| | | | |
|---|---|---|---|
| SA | Surface area of exposed skin (adult) | 5800 | $cm^2$/day |
| SA | Surface area of exposed skin (child) | 4200 | $cm^2$/day |
| AF | Soil to skin adherence factor | 1 | $mg/cm^2$ |
| ABS | chemicals specific absorbtion factor (see table below) | csv | |
| CF | Conversion factor | 1E-06 | kg/mg |
| EFa | Exposure frequency (adult) | 40 | days/year |
| EFc | Exposure frequency (child) | 120 | days/year |
| EDa | Exposure duration (adult) | 32 | Year |
| EDc | Exposure duration (child) | 12 | Year |
| BWa | Body weight (adult) | 70 | kg |
| BWc | Body weight (child) | 43 | kg |
| AT | Average time for carcinogens | 25550 | days |
| ATa | Average time for non-carcinogens (adult) | 11680 | days |
| ATc | Average time for non-carcinogens (child) | 4380 | days |
| CS | Concentration of chemicals in soil | (see table below) | |

**Chemical Concentrations**

| Compound | ABS | Concentrati | Units |
|---|---|---|---|
| Antimony | 1.0E-02 | 3.3E+01 | mg/kg |
| Aroclor-1016 | 6.0E-02 | NA | mg/kg |
| Aroclor-1221 | 6.0E-02 | 2.9E-02 | mg/kg |
| Aroclor-1242 | 6.0E-02 | NA | mg/kg |
| Aroclor-1248 | 6.0E-02 | 2.2E-02 | mg/kg |
| Aroclor-1254 | 6.0E-02 | 9.8E-01 | mg/kg |
| Aroclor-1260 | 6.0E-02 | 1.0E+00 | mg/kg |
| Arsenic | 1.0E-03 | 1.7E+01 | mg/kg |
| Barium | 1.0E-02 | 1.4E+03 | mg/kg |
| Beryllium | 1.0E-02 | 1.5E+00 | mg/kg |
| Cadmium | 1.0E-02 | 6.5E+00 | mg/kg |
| Chromium | 1.0E-02 | 4.1E+01 | mg/kg |
| Cobalt | 1.0E-02 | 1.6E+01 | mg/kg |
| Copper | 1.0E-03 | 6.2E+01 | mg/kg |
| Cyanide | NA | 5.3E+00 | mg/kg |
| Di-n-octyl phthalate | 3.0E-01 | 8.8E-02 | mg/kg |

| Compound | ABS | Concentrat | Units |
|---|---|---|---|
| Heptachlorodibenzofuran | 3.0E-02 | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | 3.0E-02 | NA | mg/kg |
| Lead | 1.0E-02 | 1.8E+02 | mg/kg |
| Manganese | 1.0E-02 | 7.0E+02 | mg/kg |
| Mercury | 5.0E-02 | 4.7E-01 | mg/kg |
| Molybdenum | 1.0E-02 | 5.1E+00 | mg/kg |
| Nickel | 5.0E-04 | 4.4E+01 | mg/kg |
| Octachlorodibenzofuran | 3.0E-02 | NA | mg/kg |
| Selenium | 1.0E-02 | 1.8E-01 | mg/kg |
| Thallium | 1.0E-02 | 4.7E-01 | mg/kg |
| Vanadium | 1.0E-03 | 3.2E+01 | mg/kg |
| Zinc | 1.0E-02 | 1.6E+02 | mg/kg |
| 2-Chlorophenol | NA | NA | mg/kg |
| 2-Methylnaphthalene | NA | 8.0E-02 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | NA | mg/kg |
| 4,4-DDT | 3.0E-01 | NA | mg/kg |

**References**



0665

5208

**Table K.IV-46 (continued)**
**Summary of Risk Characterization (chemicals)**
**Expanded Trespasser: Future Land Use With Federal Ownership**
**Via Dermal Contact with Soil/Sediment**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 1.3E-05 | 4.0E-04 | 3.3E-02 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 7.2E-08 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 5.4E-08 | NA | NA |
| Aroclor-1254 | 2.4E-06 | NA | NA |
| Aroclor-1260 | 2.5E-06 | NA | NA |
| Arsenic | 6.6E-07 | 3.0E-04 | 2.3E-03 |
| Barium | 5.6E-04 | 7.0E-02 | 8.1E-03 |
| Beryllium | 6.1E-07 | 5.0E-03 | 1.2E-04 |
| Cadmium | 2.7E-06 | 5.0E-04 | 5.3E-03 |
| Chromium | 1.7E-05 | 5.0E-03 | 3.4E-03 |
| Cobalt | 6.6E-06 | 6.0E-02 | 1.1E-04 |
| Copper | 2.6E-06 | NA | NA |
| Cyanide | NA | 2.0E-02 | NA |
| Di-n-octyl phthalate | 1.1E-06 | 2.0E-02 | 5.5E-05 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 7.5E-05 | NA | NA |
| Manganese | 2.9E-04 | 1.4E-01 | 2.1E-03 |
| Mercury | 9.7E-07 | 3.0E-04 | 3.2E-03 |
| Molybdenum | 2.1E-06 | 5.0E-03 | 4.2E-04 |
| Nickel | 9.1E-07 | 2.0E-02 | 4.5E-05 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 7.3E-08 | 5.0E-03 | 1.5E-05 |
| Thallium | 1.9E-07 | 8.0E-05 | 2.4E-03 |
| Vanadium | 1.3E-06 | 7.0E-03 | 1.9E-04 |
| Zinc | 6.7E-05 | 3.0E-01 | 2.2E-04 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | NA | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| HQ Summation = | | | 6.1E-02 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 3.1E-06 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.7E-08 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 1.3E-08 | 7.7E+00 | 9.7E-08 |
| Aroclor-1254 | 5.6E-07 | 7.7E+00 | 4.3E-06 |
| Aroclor-1260 | 5.9E-07 | 7.7E+00 | 4.5E-06 |
| Arsenic | 1.6E-07 | 1.8E+00 | 2.8E-07 |
| Barium | 1.3E-04 | NA | NA |
| Beryllium | 1.4E-07 | 4.3E+00 | 6.2E-07 |
| Cadmium | 6.2E-07 | NA | NA |
| Chromium | 4.0E-06 | NA | NA |
| Cobalt | 1.5E-06 | NA | NA |
| Copper | 6.0E-07 | NA | NA |
| Cyanide | NA | NA | NA |
| Di-n-octyl phthalate | 2.6E-07 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.8E-05 | NA | NA |
| Manganese | 6.7E-05 | NA | NA |
| Mercury | 2.3E-07 | NA | NA |
| Molybdenum | 4.9E-07 | NA | NA |
| Nickel | 2.1E-07 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 1.7E-08 | NA | NA |
| Thallium | 4.5E-08 | NA | NA |
| Vanadium | 3.1E-07 | NA | NA |
| Zinc | 1.6E-05 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | NA | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| ILCR Summation = | | | 9.9E-06 |

200

**Table K.IV-47**
**Summary of Risk Quantitation (Radionuclides)**
**Expanded Trespasser: Future Land Use With Federal Ownership**
**Via External Radiation**

**Exposure Equation** = $[CR \times EF \times EDn \times ET_{oa} \times (1-SH_o)] + [CR \times EF \times EDn \times ET_{oc} \times (1-SH_o)]$

| | | | |
|---|---|---|---|
| EFa | Fraction of year spent exposured (adult) | 0.11 | (unitless) |
| EFc | Fraction of year spent exposured (child) | 0.33 | (unitless) |
| EDa | Exposure duration (adult) | 32 | Year |
| EDc | Exposure duration (child) | 12 | Year |
| $ET_{oa}$ | Fraction of day spent outdoors (adult) | 0.04 | (unitless) |
| $ET_{oc}$ | Fraction of day spent outdoors (child) | 0.08 | (unitless) |
| $SH_o$ | Shield factor outdoors | 0 | (unitless) |
| CR | Radionuclide specific concentrations | | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Am-241 | NA | pCi/g | Ru-106 | NA | pCi/g |
| Cs-137 | 8.4E-01 | pCi/g | Sr-90 | 2.6E+00 | pCi/g |
| Np-237 | 2.5E-01 | pCi/g | Tc-99 | 1.5E+01 | pCi/g |
| Pa-231 | 1.1E+00 | pCi/g | Th-228 | 2.8E+00 | pCi/g |
| Pb-210 | 2.6E+01 | pCi/g | Th-230 | 2.9E+00 | pCi/g |
| Pu-238 | 1.3E+00 | pCi/g | Th-232 | 1.9E+00 | pCi/g |
| Pu-239 | 6.7E-01 | pCi/g | U-233 | NA | pCi/g |
| Pu-240 | 6.7E-01 | pCi/g | U-234 | 3.4E+01 | pCi/g |
| Ra-226 | 1.9E+00 | pCi/g | U-235 | 9.1E-01 | pCi/g |
| Ra-228 | 2.0E+00 | pCi/g | U-236 | 3.9E-01 | pCi/g |
| Rn-222 | NA | pCi/g | U-238 | 2.0E+01 | pCi/g |

| Radionuclides | CDI (year pCi/g) | CSF $(g/pCi-year)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Am-241 | NA | 4.9E-09 | NA |
| Cs-137 | 3.8E-01 | 2.0E-06 | 7.7E-07 |
| Np-237 | 1.2E-01 | 4.3E-07 | 5.0E-08 |
| Pa-231 | 4.9E-01 | 2.6E-08 | 1.3E-08 |
| Pb-210 | 1.2E+01 | 1.6E-10 | 1.9E-09 |
| Pu-238 | 6.0E-01 | 2.8E-11 | 1.7E-11 |
| Pu-239 | 3.1E-01 | 1.7E-11 | 5.2E-12 |
| Pu-240 | 3.1E-01 | 2.7E-11 | 8.2E-12 |
| Ra-226 | 8.7E-01 | 6.0E-06 | 5.2E-06 |
| Ra-228 | 9.2E-01 | 2.9E-06 | 2.7E-06 |
| Rn-222 | NA | 5.9E-06 | NA |
| Ru-106 | NA | NA | NA |
| Sr-90 | 1.2E+00 | NA | NA |
| Tc-99 | 6.8E+00 | 6.0E-13 | 4.1E-12 |
| Th-228 | 1.3E+00 | 5.6E-06 | 7.2E-06 |
| Th-230 | 1.3E+00 | 5.4E-11 | 7.2E-11 |
| Th-232 | 8.8E-01 | 2.6E-11 | 2.3E-11 |
| U-233 | NA | 4.2E-11 | NA |
| U-234 | 1.5E+01 | 3.0E-11 | 4.6E-10 |
| U-235 | 4.1E-01 | 2.4E-07 | 1.0E-07 |
| U-236 | 1.8E-01 | 2.4E-11 | 4.3E-12 |
| U-238 | 9.2E+00 | 3.6E-08 | 3.3E-07 |
| | | **ILCR Summation =** | 1.6E-05 |

**Table K.IV-48**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Adult Future Land Use With Federal Ownership**
**Via Inhalation of Particulates**

**Intake Equation** = $\frac{CS \times EF \times ED \times IR}{BW \times AT}$

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 20 $m^3$/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration for non-carchogens | 70 Year |
| EDc | Exposure duration for carcinogens | 70 Year |
| BW | Body weight | 70 kg |
| ATc | Average time for carchogens (lifetime) | 25550 days |
| ATn | Average time for non-carchogens (EDn x 365) | 25550 days |
| CS | Concentration of chemicals in particulate as modeled | (see table below) |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 1.9E-06 | $mg/m^3$ | Heptachlorodibenzofuran | NA | $mg/m^3$ |
| Aroclor-1016 | NA | $mg/m^3$ | Heptachlorodibenzo-p-dioxin | NA | $mg/m^3$ |
| Aroclor-1221 | 1.9E-09 | $mg/m^3$ | Lead | 1.1E-05 | $mg/m^3$ |
| Aroclor-1242 | NA | $mg/m^3$ | Manganese | 3.9E-05 | $mg/m^3$ |
| Aroclor-1248 | 1.3E-09 | $mg/m^3$ | Mercury | 3.0E-08 | $mg/m^3$ |
| Aroclor-1254 | 6.0E-08 | $mg/m^3$ | Molybdenum | 3.0E-07 | $mg/m^3$ |
| Aroclor-1260 | 6.3E-08 | $mg/m^3$ | Nickel | 2.5E-06 | $mg/m^3$ |
| Arsenic | 9.3E-07 | $mg/m^3$ | Octachlorodibenzofuran | NA | $mg/m^3$ |
| Barium | 8.5E-05 | $mg/m^3$ | Selenium | 9.3E-09 | $mg/m^3$ |
| Beryllium | 8.5E-08 | $mg/m^3$ | Thallium | 2.6E-08 | $mg/m^3$ |
| Cadmium | 3.7E-07 | $mg/m^3$ | Vanadium | 1.8E-06 | $mg/m^3$ |
| Chromium | 2.5E-07 | $mg/m^3$ | Zinc | 9.7E-06 | $mg/m^3$ |
| Cobalt | 9.3E-07 | $mg/m^3$ | 2-Chlorophenol | NA | $mg/m^3$ |
| Copper | 3.7E-06 | $mg/m^3$ | 2-Methylnaphthalene | 5.0E-09 | $mg/m^3$ |
| Cyanide | 3.3E-07 | $mg/m^3$ | 4-Chlorophenyl-phenylether | NA | $mg/m^3$ |
| Di-n-octyl phthalate | 5.3E-09 | $mg/m^3$ | 4,4-DDT | NA | $mg/m^3$ |

**References**

**Table K.IV-48 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Adult Future Land Use With Federal Ownership**
**Via Inhalation of Particulates**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 5.3E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 5.1E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 3.5E-10 | NA | NA |
| Aroclor-1254 | 1.6E-08 | NA | NA |
| Aroclor-1260 | 1.7E-08 | NA | NA |
| Arsenic | 2.5E-07 | NA | NA |
| Barium | 2.3E-05 | 1.4E-04 | 1.7E-01 |
| Beryllium | 2.3E-08 | NA | NA |
| Cadmium | 1.0E-07 | NA | NA |
| Chromium | 6.7E-08 | NA | NA |
| Cobalt | 2.5E-07 | 3.0E-07 | 8.5E-01 |
| Copper | 1.0E-06 | NA | NA |
| Cyanide | 9.0E-08 | NA | NA |
| Di-n-octyl phthalate | 1.5E-09 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.1E-06 | NA | NA |
| Manganese | 1.1E-05 | 1.1E-04 | 9.7E-02 |
| Mercury | 8.1E-09 | 8.6E-05 | 9.4E-05 |
| Molybdenum | 8.3E-08 | NA | NA |
| Nickel | 6.7E-07 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.5E-09 | NA | NA |
| Thallium | 7.2E-09 | NA | NA |
| Vanadium | 4.9E-07 | NA | NA |
| Zinc | 2.7E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 1.4E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | NA | NA |
| | HQ Summation = | | 1.1E+00 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 5.3E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 5.1E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 3.5E-10 | NA | NA |
| Aroclor-1254 | 1.6E-08 | NA | NA |
| Aroclor-1260 | 1.7E-08 | NA | NA |
| Arsenic | 2.5E-07 | 1.5E+01 | 3.8E-06 |
| Barium | 2.3E-05 | NA | NA |
| Beryllium | 2.3E-08 | 8.4E+00 | 1.9E-07 |
| Cadmium | 1.0E-07 | 6.1E+00 | 6.2E-07 |
| Chromium | 6.7E-08 | 4.1E+01 | 2.8E-06 |
| Cobalt | 2.5E-07 | NA | NA |
| Copper | 1.0E-06 | NA | NA |
| Cyanide | 9.0E-08 | NA | NA |
| Di-n-octyl phthalate | 1.5E-09 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.1E-06 | NA | NA |
| Manganese | 1.1E-05 | NA | NA |
| Mercury | 8.1E-09 | NA | NA |
| Molybdenum | 8.3E-08 | NA | NA |
| Nickel | 6.7E-07 | 8.4E-01 | 5.6E-07 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.5E-09 | NA | NA |
| Thallium | 7.2E-09 | NA | NA |
| Vanadium | 4.9E-07 | NA | NA |
| Zinc | 2.7E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 1.4E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 8.0E-06 |

- 5208

**Table K.IV–49**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off–Property RME Resident Farm Adult Future Land Use With Federal Ownership**
**Via Inhalation of Gases and Particulates**

**Intake Equation** = Ca X EF X EDn X IR

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 20 $m^3$/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 70 Year |
| Ca | Concentration of radionuclides in air | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac–227 | NA | pCi/$m^3$ | Rn–222 | 4.1E+00 | pCi/$m^3$ |
| Am–241 | NA | pCi/$m^3$ | Ru–106 | NA | pCi/$m^3$ |
| Cs–137 | 4.6E–05 | pCi/$m^3$ | Sr–90 | 1.5E–04 | pCi/$m^3$ |
| Np–237 | 1.6E–05 | pCi/$m^3$ | Tc–99 | 9.2E–04 | pCi/$m^3$ |
| Pa–231 | 6.0E–05 | pCi/$m^3$ | Th–228 | 1.4E–04 | pCi/$m^3$ |
| Pb–210 | 1.6E–03 | pCi/$m^3$ | Th–230 | 1.5E–04 | pCi/$m^3$ |
| Pu–238 | 8.0E–05 | pCi/$m^3$ | Th–232 | 8.1E–05 | pCi/$m^3$ |
| Pu–239 | 3.9E–05 | pCi/$m^3$ | U–233 | NA | pCi/$m^3$ |
| Pu–240 | 3.9E–05 | pCi/$m^3$ | U–234 | 1.7E–03 | pCi/$m^3$ |
| Ra–226 | 8.1E–05 | pCi/$m^3$ | U–235 | 4.4E–05 | pCi/$m^3$ |
| Ra–228 | 8.8E–05 | pCi/$m^3$ | U–236 | 1.9E–05 | pCi/$m^3$ |
| | | | U–238 | 9.9E–04 | pCi/$m^3$ |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac–227 | NA | 8.8E–08 | NA |
| Am–241 | NA | 3.2E–08 | NA |
| Cs–137 | 2.3E+01 | 1.9E–11 | 4.3E–10 |
| Np–237 | 7.8E+00 | 2.9E–08 | 2.3E–07 |
| Pa–231 | 2.9E+01 | 3.6E–08 | 1.1E–06 |
| Pb–210 | 7.8E+02 | 4.0E–09 | 3.1E–06 |
| Pu–238 | 3.9E+01 | 3.9E–08 | 1.5E–06 |
| Pu–239 | 1.9E+01 | 3.8E–08 | 7.3E–07 |
| Pu–240 | 1.9E+01 | 3.8E–08 | 7.3E–07 |
| Ra–226 | 4.0E+01 | 3.0E–09 | 1.2E–07 |
| Ra–228 | 4.3E+01 | 6.9E–10 | 3.0E–08 |
| Rn–222 | 2.0E+06 | 7.7E–12 | 1.6E–05 |
| Ru–106 | NA | 4.4E–10 | NA |
| Sr–90 | 7.4E+01 | 5.6E–11 | 4.2E–09 |
| Tc–99 | 4.5E+02 | 8.3E–12 | 3.7E–09 |
| Th–228 | 7.1E+01 | 7.8E–08 | 5.5E–06 |
| Th–230 | 7.4E+01 | 2.9E–08 | 2.1E–06 |
| Th–232 | 4.0E+01 | 2.8E–08 | 1.1E–06 |
| U–233 | NA | 2.7E–08 | NA |
| U–234 | 8.1E+02 | 2.6E–08 | 2.1E–05 |
| U–235 | 2.2E+01 | 2.5E–08 | 5.4E–07 |
| U–236 | 9.3E+00 | 2.5E–08 | 2.3E–07 |
| U–238 | 4.8E+02 | 5.2E–08 | 2.5E–05 |
| | | ILCR Summation = | 7.9E–05 |

0670

- 5208

**Table K.IV-50**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Adult Future Land Use With Federal Ownership**
**Via Ingestion of Drinking Water**

**Intake Equation** = Cw X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of groundwater (RAGS, 1989) | 2 l/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 70 Year |
| FI | Fractional intake for radionuclides | 1 (Unitless) |
| Cw | Concentration of radionuclides in groundwater | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/l | Rn-222 | NA | pCi/l |
| Am-241 | NA | pCi/l | Ru-106 | NA | pCi/l |
| Cs-137 | NA | pCi/l | Sr-90 | 2.2E-06 | pCi/l |
| Np-237 | NA | pCi/l | Tc-99 | NA | pCi/l |
| Pa-231 | NA | pCi/l | Th-228 | NA | pCi/l |
| Pb-210 | NA | pCi/l | Th-230 | NA | pCi/l |
| Pu-238 | NA | pCi/l | Th-232 | NA | pCi/l |
| Pu-239 | NA | pCi/l | U-233 | NA | pCi/l |
| Pu-240 | NA | pCi/l | U-234 | 1.5E+00 | pCi/l |
| Ra-226 | NA | pCi/l | U-235 | 4.0E-02 | pCi/l |
| Ra-228 | NA | pCi/l | U-236 | 1.6E-02 | pCi/l |
| | | | U-238 | 9.2E-01 | pCi/l |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | NA | 2.8E-11 | NA |
| Np-237 | NA | 2.2E-10 | NA |
| Pa-231 | NA | 9.2E-11 | NA |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | NA | 2.2E-10 | NA |
| Pu-239 | NA | 2.3E-10 | NA |
| Pu-240 | NA | 2.3E-10 | NA |
| Ra-226 | NA | 1.2E-10 | NA |
| Ra-228 | NA | 1.0E-10 | NA |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 1.1E-01 | 3.3E-10 | 3.5E-11 |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | NA | 5.5E-11 | NA |
| Th-230 | NA | 1.3E-11 | NA |
| Th-232 | NA | 1.2E-11 | NA |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 7.5E+04 | 1.6E-11 | 1.2E-06 |
| U-235 | 2.0E+03 | 1.6E-11 | 3.1E-08 |
| U-236 | 7.8E+02 | 1.5E-11 | 1.2E-08 |
| U-238 | 4.5E+04 | 2.8E-11 | 1.3E-06 |
| | | ILCR Summation = | 2.5E-06 |

0671

**Table K.IV-51**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Adult Future Land Use With Federal Ownership**
**Via Ingestion of Meat Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of meat | 0.075 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 70 | Year |
| EDc | Exposure duration for carcinogens | 70 | Year |
| BW | Body weight | 70 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 25550 | days |
| CS | Concentration of chemicals in meat | | |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 6.6E-06 | mg/kg | Heptachlorodibenzofuran | NA | mg/kg |
| Aroclor-1016 | NA | mg/kg | Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Aroclor-1221 | 5.6E-11 | mg/kg | Lead | 6.5E-06 | mg/kg |
| Aroclor-1242 | NA | mg/kg | Manganese | 5.7E-05 | mg/kg |
| Aroclor-1248 | 1.9E-08 | mg/kg | Mercury | 1.4E-05 | mg/kg |
| Aroclor-1254 | 8.0E-06 | mg/kg | Molybdenum | 6.4E-06 | mg/kg |
| Aroclor-1260 | 3.1E-06 | mg/kg | Nickel | 4.9E-05 | mg/kg |
| Arsenic | 5.8E-06 | mg/kg | Octachlorodibenzofuran | NA | mg/kg |
| Barium | 2.2E-05 | mg/kg | Selenium | 3.1E-07 | mg/kg |
| Beryllium | 2.5E-07 | mg/kg | Thallium | 3.3E-06 | mg/kg |
| Cadmium | 8.1E-06 | mg/kg | Vanadium | 1.6E-05 | mg/kg |
| Chromium | NA | mg/kg | Zinc | 3.1E-03 | mg/kg |
| Cobalt | 6.0E-05 | mg/kg | 2-Chlorophenol | NA | mg/kg |
| Copper | 9.5E-05 | mg/kg | 2-Methylnaphthalene | 1.3E-09 | mg/kg |
| Cyanide | 3.0E-11 | mg/kg | 4-Chlorophenyl-phenylether | NA | mg/kg |
| Di-n-octyl phthalate | 3.5E-04 | mg/kg | 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-51 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Adult Future Land Use With Federal Ownership**
**Via Ingestion of Meat Products**

| Compound | HQ Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
| Antimony | 6.9E-09 | 4.0E-04 | 1.7E-05 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 5.8E-14 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 2.0E-11 | NA | NA |
| Aroclor-1254 | 8.2E-09 | NA | NA |
| Aroclor-1260 | 3.2E-09 | NA | NA |
| Arsenic | 5.9E-09 | 3.0E-04 | 2.0E-05 |
| Barium | 2.3E-08 | 7.0E-02 | 3.2E-07 |
| Beryllium | 2.6E-10 | 5.0E-03 | 5.1E-08 |
| Cadmium | 8.4E-09 | 5.0E-04 | 1.7E-05 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 6.2E-08 | 6.0E-02 | 1.0E-06 |
| Copper | 9.8E-08 | NA | NA |
| Cyanide | 3.0E-14 | 2.0E-02 | 1.5E-12 |
| Di-n-octyl phthalate | 3.6E-07 | 2.0E-02 | 1.8E-05 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 6.7E-09 | NA | NA |
| Manganese | 5.9E-08 | 1.4E-01 | 4.2E-07 |
| Mercury | 1.4E-08 | 3.0E-04 | 4.8E-05 |
| Molybdenum | 6.6E-09 | 5.0E-03 | 1.3E-06 |
| Nickel | 5.1E-08 | 2.0E-02 | 2.5E-06 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 3.2E-10 | 5.0E-03 | 6.4E-08 |
| Thallium | 3.4E-09 | 8.0E-05 | 4.3E-05 |
| Vanadium | 1.6E-08 | 7.0E-03 | 2.3E-06 |
| Zinc | 3.2E-06 | 3.0E-01 | 1.1E-05 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 1.3E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 1.8E-04 |

| Compound | ILCR Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
| Antimony | 6.9E-09 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 5.8E-14 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 2.0E-11 | 7.7E+00 | 1.5E-10 |
| Aroclor-1254 | 8.2E-09 | 7.7E+00 | 6.3E-08 |
| Aroclor-1260 | 3.2E-09 | 7.7E+00 | 2.5E-08 |
| Arsenic | 5.9E-09 | 1.8E+00 | 1.0E-08 |
| Barium | 2.3E-08 | NA | NA |
| Beryllium | 2.6E-10 | 4.3E+00 | 1.1E-09 |
| Cadmium | 8.4E-09 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 6.2E-08 | NA | NA |
| Copper | 9.8E-08 | NA | NA |
| Cyanide | 3.0E-14 | NA | NA |
| Di-n-octyl phthalate | 3.6E-07 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 6.7E-09 | NA | NA |
| Manganese | 5.9E-08 | NA | NA |
| Mercury | 1.4E-08 | NA | NA |
| Molybdenum | 6.6E-09 | NA | NA |
| Nickel | 5.1E-08 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 3.2E-10 | NA | NA |
| Thallium | 3.4E-09 | NA | NA |
| Vanadium | 1.6E-08 | NA | NA |
| Zinc | 3.2E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 1.3E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 9.9E-08 |

# Table K.IV-52
## Summary of Intake and Risk Quantitation (Radionuclides)
## Off-Property RME Resident Farm Adult Future Land Use With Federal Ownership
## Via Ingestion of Meat Products

**Intake Equation** = Cf X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of meat | 0.075 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 70 Year |
| Cf | Concentration of radionuclides in meat | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 3.3E-03 | pCi/kg | Sr-90 | NA | pCi/kg |
| Np-237 | 1.3E-06 | pCi/kg | Tc-99 | NA | pCi/kg |
| Pa-231 | 9.5E-03 | pCi/kg | Th-228 | 1.9E-06 | pCi/kg |
| Pb-210 | NA | pCi/kg | Th-230 | 3.2E-06 | pCi/kg |
| Pu-238 | 8.5E-08 | pCi/kg | Th-232 | 1.7E-06 | pCi/kg |
| Pu-239 | 5.5E-08 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 5.5E-08 | pCi/kg | U-234 | 3.0E-03 | pCi/kg |
| Ra-226 | 7.2E-05 | pCi/kg | U-235 | 8.0E-05 | pCi/kg |
| Ra-228 | 4.8E-05 | pCi/kg | U-236 | 3.3E-05 | pCi/kg |
| | | | U-238 | 1.8E-03 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 6.0E+00 | 2.8E-11 | 1.7E-10 |
| Np-237 | 2.5E-03 | 2.2E-10 | 5.4E-13 |
| Pa-231 | 1.8E+01 | 9.2E-11 | 1.6E-09 |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | 1.8E-04 | 2.2E-10 | 3.5E-14 |
| Pu-239 | 1.0E-04 | 2.3E-10 | 2.3E-14 |
| Pu-240 | 1.0E-04 | 2.3E-10 | 2.3E-14 |
| Ra-226 | 1.3E-01 | 1.2E-10 | 1.6E-11 |
| Ra-228 | 8.7E-02 | 1.0E-10 | 8.7E-12 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | NA | 3.3E-10 | NA |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | 3.5E-03 | 5.5E-11 | 1.9E-13 |
| Th-230 | 5.8E-03 | 1.3E-11 | 7.6E-14 |
| Th-232 | 3.1E-03 | 1.2E-11 | 3.7E-14 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 5.5E+00 | 1.6E-11 | 8.8E-11 |
| U-235 | 1.5E-01 | 1.6E-11 | 2.3E-12 |
| U-236 | 6.1E-02 | 1.5E-11 | 9.2E-13 |
| U-238 | 3.3E+00 | 2.8E-11 | 9.2E-11 |
| | | **ILCR Summation =** | 2.0E-09 |

**Table K.IV-53**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Adult Future Land Use With Federal Ownership**
**Via Ingestion of Dairy Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of dairy products | 0.3 | l/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 70 | Year |
| EDc | Exposure duration for carcinogens | 70 | Year |
| BW | Body weight | 70 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 25550 | days |
| CS | Concentration of chemicals in animal products | | |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 6.8E-07 | mg/kg | Heptachlorodibenzofuran | NA | mg/kg |
| Aroclor-1016 | NA | mg/kg | Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Aroclor-1221 | 1.8E-11 | mg/kg | Lead | 5.4E-06 | mg/kg |
| Aroclor-1242 | NA | mg/kg | Manganese | 5.0E-05 | mg/kg |
| Aroclor-1248 | 2.0E-08 | mg/kg | Mercury | 2.5E-08 | mg/kg |
| Aroclor-1254 | 1.7E-06 | mg/kg | Molybdenum | 1.6E-06 | mg/kg |
| Aroclor-1260 | 6.3E-06 | mg/kg | Nickel | 8.2E-06 | mg/kg |
| Arsenic | 1.7E-07 | mg/kg | Octachlorodibenzofuran | NA | mg/kg |
| Barium | 5.2E-05 | mg/kg | Selenium | 8.3E-08 | mg/kg |
| Beryllium | 2.3E-10 | mg/kg | Thallium | 1.7E-07 | mg/kg |
| Cadmium | 1.5E-06 | mg/kg | Vanadium | 1.3E-07 | mg/kg |
| Chromium | NA | mg/kg | Zinc | 3.1E-04 | mg/kg |
| Cobalt | 6.0E-06 | mg/kg | 2-Chlorophenol | NA | mg/kg |
| Copper | 1.4E-05 | mg/kg | 2-Methylnaphthalene | 7.3E-10 | mg/kg |
| Cyanide | NA | mg/kg | 4-Chlorophenyl-phenylether | NA | mg/kg |
| Di-n-octyl phthalate | 1.1E-04 | mg/kg | 4,4-DDT | NA | mg/kg |

**References**



0075
5208

**Table K.IV-53 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Adult Future Land Use With Federal Ownership**
**Via Ingestion of Dairy Products**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 2.8E-09 | 4.0E-04 | 6.9E-06 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 7.4E-14 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 8.0E-11 | NA | NA |
| Aroclor-1254 | 7.1E-09 | NA | NA |
| Aroclor-1260 | 2.6E-08 | NA | NA |
| Arsenic | 7.1E-10 | 3.0E-04 | 2.4E-06 |
| Barium | 2.1E-07 | 7.0E-02 | 3.0E-06 |
| Beryllium | 9.2E-13 | 5.0E-03 | 1.8E-10 |
| Cadmium | 6.1E-09 | 5.0E-04 | 1.2E-05 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 2.5E-08 | 6.0E-02 | 4.1E-07 |
| Copper | 5.8E-08 | NA | NA |
| Cyanide | NA | 2.0E-02 | NA |
| Di-n-octyl phthalate | 4.6E-07 | 2.0E-02 | 2.3E-05 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 2.2E-08 | NA | NA |
| Manganese | 2.1E-07 | 1.4E-01 | 1.5E-06 |
| Mercury | 1.0E-10 | 3.0E-04 | 3.4E-07 |
| Molybdenum | 6.6E-09 | 5.0E-03 | 1.3E-06 |
| Nickel | 3.4E-08 | 2.0E-02 | 1.7E-06 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 3.4E-10 | 5.0E-03 | 6.8E-08 |
| Thallium | 6.8E-10 | 8.0E-05 | 8.5E-06 |
| Vanadium | 5.2E-10 | 7.0E-03 | 7.5E-08 |
| Zinc | 1.3E-06 | 3.0E-01 | 4.3E-06 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 3.0E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 6.6E-05 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 2.8E-09 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 7.4E-14 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 8.0E-11 | 7.7E+00 | 6.2E-10 |
| Aroclor-1254 | 7.1E-09 | 7.7E+00 | 5.4E-08 |
| Aroclor-1260 | 2.6E-08 | 7.7E+00 | 2.0E-07 |
| Arsenic | 7.1E-10 | 1.8E+00 | 1.2E-09 |
| Barium | 2.1E-07 | NA | NA |
| Beryllium | 9.2E-13 | 4.3E+00 | 4.0E-12 |
| Cadmium | 6.1E-09 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 2.5E-08 | NA | NA |
| Copper | 5.8E-08 | NA | NA |
| Cyanide | NA | NA | NA |
| Di-n-octyl phthalate | 4.6E-07 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 2.2E-08 | NA | NA |
| Manganese | 2.1E-07 | NA | NA |
| Mercury | 1.0E-10 | NA | NA |
| Molybdenum | 6.6E-09 | NA | NA |
| Nickel | 3.4E-08 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 3.4E-10 | NA | NA |
| Thallium | 6.8E-10 | NA | NA |
| Vanadium | 5.2E-10 | NA | NA |
| Zinc | 1.3E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.0E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 2.6E-07 |



5208
0076

208

**Table K.IV–54**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off–Property RME Resident Farm Adult Future Land Use With Federal Ownership**
**Via Ingestion of Dairy Products**

**Intake Equation** = Cp X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of dairy products | 0.3 l/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 70 Year |
| Cp | Concentration of radionuclides in animal products | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 1.2E-03 | pCi/kg | Sr-90 | 7.9E-25 | pCi/kg |
| Np-237 | 1.2E-07 | pCi/kg | Tc-99 | 2.3E-23 | pCi/kg |
| Pa-231 | 6.0E-05 | pCi/kg | Th-228 | 2.4E-06 | pCi/kg |
| Pb-210 | NA | pCi/kg | Th-230 | 2.7E-06 | pCi/kg |
| Pu-238 | 1.7E-08 | pCi/kg | Th-232 | 1.4E-06 | pCi/kg |
| Pu-239 | 1.1E-08 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 1.1E-08 | pCi/kg | U-234 | 9.1E-03 | pCi/kg |
| Ra-226 | 1.3E-04 | pCi/kg | U-235 | 2.4E-04 | pCi/kg |
| Ra-228 | 1.3E-04 | pCi/kg | U-236 | 1.0E-04 | pCi/kg |
| | | | U-238 | 5.5E-03 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 8.5E+00 | 2.8E-11 | 2.4E-10 |
| Np-237 | 9.0E-04 | 2.2E-10 | 2.0E-13 |
| Pa-231 | 4.4E-01 | 9.2E-11 | 4.0E-11 |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | 1.3E-04 | 2.2E-10 | 2.8E-14 |
| Pu-239 | 8.1E-05 | 2.3E-10 | 1.9E-14 |
| Pu-240 | 8.1E-05 | 2.3E-10 | 1.9E-14 |
| Ra-226 | 9.5E-01 | 1.2E-10 | 1.1E-10 |
| Ra-228 | 9.6E-01 | 1.0E-10 | 9.6E-11 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 5.8E-21 | 3.3E-10 | 1.9E-30 |
| Tc-99 | 1.7E-19 | 1.3E-12 | 2.2E-31 |
| Th-228 | 1.8E-02 | 5.5E-11 | 9.9E-13 |
| Th-230 | 1.9E-02 | 1.3E-11 | 2.5E-13 |
| Th-232 | 1.0E-02 | 1.2E-11 | 1.3E-13 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 6.7E+01 | 1.6E-11 | 1.1E-09 |
| U-235 | 1.8E+00 | 1.6E-11 | 2.9E-11 |
| U-236 | 7.5E-01 | 1.5E-11 | 1.1E-11 |
| U-238 | 4.0E+01 | 2.8E-11 | 1.1E-09 |
| | | ILCR Summation = | 2.7E-09 |



0677

**Table J.IV-55**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Adult Future Land Use With Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.122 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 70 | Year |
| EDc | Exposure duration for carcinogens | 70 | Year |
| BW | Body weight | 70 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 25550 | days |
| CS | Concentration of chemicals in vegetables | | |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 1.7E-04 | mg/kg | Heptachlorodibenzofuran | NA | mg/kg |
| Aroclor-1016 | NA | mg/kg | Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Aroclor-1221 | 8.4E-08 | mg/kg | Lead | 5.3E-04 | mg/kg |
| Aroclor-1242 | NA | mg/kg | Manganese | 3.5E-03 | mg/kg |
| Aroclor-1248 | 4.7E-08 | mg/kg | Mercury | 1.3E-06 | mg/kg |
| Aroclor-1254 | 2.6E-06 | mg/kg | Molybdenum | 2.6E-05 | mg/kg |
| Aroclor-1260 | 2.4E-06 | mg/kg | Nickel | 2.0E-04 | mg/kg |
| Arsenic | 7.0E-05 | mg/kg | Octachlorodibenzofuran | NA | mg/kg |
| Barium | 3.6E-03 | mg/kg | Selenium | 5.1E-07 | mg/kg |
| Beryllium | 6.1E-06 | mg/kg | Thallium | 2.0E-06 | mg/kg |
| Cadmium | 3.5E-05 | mg/kg | Vanadium | 1.6E-04 | mg/kg |
| Chromium | NA | mg/kg | Zinc | 7.2E-04 | mg/kg |
| Cobalt | 7.3E-05 | mg/kg | 2-Chlorophenol | NA | mg/kg |
| Copper | 2.3E-04 | mg/kg | 2-Methylnaphthalene | 1.6E-07 | mg/kg |
| Cyanide | 1.4E-05 | mg/kg | 4-Chlorophenyl-phenylether | NA | mg/kg |
| Di-n-octyl phthalate | 2.2E-07 | mg/kg | 4,4-DDT | NA | mg/kg |

**References**

**Table J.IV-55 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Adult Future Land Use With Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 2.8E-07 | 4.0E-04 | 6.9E-04 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.4E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 7.8E-11 | NA | NA |
| Aroclor-1254 | 4.4E-09 | NA | NA |
| Aroclor-1260 | 4.0E-09 | NA | NA |
| Arsenic | 1.2E-07 | 3.0E-04 | 3.9E-04 |
| Barium | 6.0E-08 | 7.0E-02 | 8.5E-05 |
| Beryllium | 1.0E-08 | 5.0E-03 | 2.0E-06 |
| Cadmium | 5.9E-08 | 5.0E-04 | 1.2E-04 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 1.2E-07 | 6.0E-02 | 2.0E-06 |
| Copper | 3.8E-07 | NA | NA |
| Cyanide | 2.3E-08 | 2.0E-02 | 1.1E-06 |
| Di-n-octyl phthalate | 3.6E-10 | 2.0E-02 | 1.8E-08 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 8.8E-07 | NA | NA |
| Manganese | 5.8E-06 | 1.4E-01 | 4.1E-05 |
| Mercury | 2.2E-09 | 3.0E-04 | 7.3E-06 |
| Molybdenum | 4.4E-08 | 5.0E-03 | 8.7E-06 |
| Nickel | 3.3E-07 | 2.0E-02 | 1.7E-05 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 8.5E-10 | 5.0E-03 | 1.7E-07 |
| Thallium | 3.4E-09 | 8.0E-05 | 4.2E-05 |
| Vanadium | 2.6E-07 | 7.0E-03 | 3.7E-05 |
| Zinc | 1.2E-06 | 3.0E-01 | 4.0E-06 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 2.9E-10 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 1.4E-03 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 2.8E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.4E-10 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 7.8E-11 | 7.7E+00 | 6.0E-10 |
| Aroclor-1254 | 4.4E-09 | 7.7E+00 | 3.4E-08 |
| Aroclor-1260 | 4.0E-09 | 7.7E+00 | 3.1E-08 |
| Arsenic | 1.2E-07 | 1.8E+00 | 2.1E-07 |
| Barium | 6.0E-08 | NA | NA |
| Beryllium | 1.0E-08 | 4.3E+00 | 4.4E-08 |
| Cadmium | 5.9E-08 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 1.2E-07 | NA | NA |
| Copper | 3.8E-07 | NA | NA |
| Cyanide | 2.3E-08 | NA | NA |
| Di-n-octyl phthalate | 3.6E-10 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 8.8E-07 | NA | NA |
| Manganese | 5.8E-06 | NA | NA |
| Mercury | 2.2E-09 | NA | NA |
| Molybdenum | 4.4E-08 | NA | NA |
| Nickel | 3.3E-07 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 8.5E-10 | NA | NA |
| Thallium | 3.4E-09 | NA | NA |
| Vanadium | 2.6E-07 | NA | NA |
| Zinc | 1.2E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 2.9E-10 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 3.1E-07 |

- 5208

## Table K.IV-56
## Summary of Intake and Risk Quantitation (Radionuclides)
## Off-Property RME Resident Farm Adult Future Land Use With Federal Ownership
## Via Ingestion of Vegetables and Fruits

**Intake Equation** = Cv X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.122 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 70 Year |
| Cv | Concentration of radionuclides in vegetables | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 4.0E-03 | pCi/kg | Sr-90 | 3.4E-13 | pCi/kg |
| Np-237 | 5.8E-04 | pCi/kg | Tc-99 | 1.5E-12 | pCi/kg |
| Pa-231 | 2.9E-03 | pCi/kg | Th-228 | 1.2E-02 | pCi/kg |
| Pb-210 | 6.2E-02 | pCi/kg | Th-230 | 1.3E-02 | pCi/kg |
| Pu-238 | 4.2E-03 | pCi/kg | Th-232 | 6.9E-03 | pCi/kg |
| Pu-239 | 2.7E-03 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 2.7E-03 | pCi/kg | U-234 | 3.3E-01 | pCi/kg |
| Ra-226 | 7.0E-03 | pCi/kg | U-235 | 8.9E-03 | pCi/kg |
| Ra-228 | 7.3E-03 | pCi/kg | U-236 | 3.7E-03 | pCi/kg |
| | | | U-238 | 2.0E-01 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 1.2E+01 | 2.8E-11 | 3.4E-10 |
| Np-237 | 1.7E+00 | 2.2E-10 | 3.8E-10 |
| Pa-231 | 8.7E+00 | 9.2E-11 | 8.0E-10 |
| Pb-210 | 1.8E+02 | 6.6E-10 | 1.2E-07 |
| Pu-238 | 1.2E+01 | 2.2E-10 | 2.7E-09 |
| Pu-239 | 8.0E+00 | 2.3E-10 | 1.8E-09 |
| Pu-240 | 8.0E+00 | 2.3E-10 | 1.8E-09 |
| Ra-226 | 2.1E+01 | 1.2E-10 | 2.5E-09 |
| Ra-228 | 2.2E+01 | 1.0E-10 | 2.2E-09 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 1.0E-09 | 3.3E-10 | 3.4E-19 |
| Tc-99 | 4.4E-09 | 1.3E-12 | 5.8E-21 |
| Th-228 | 3.6E+01 | 5.5E-11 | 2.0E-09 |
| Th-230 | 3.9E+01 | 1.3E-11 | 5.0E-10 |
| Th-232 | 2.1E+01 | 1.2E-11 | 2.5E-10 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 1.0E+03 | 1.6E-11 | 1.6E-08 |
| U-235 | 2.7E+01 | 1.6E-11 | 4.3E-10 |
| U-236 | 1.1E+01 | 1.5E-11 | 1.7E-10 |
| U-238 | 6.0E+02 | 2.8E-11 | 1.7E-08 |
| | | ILCR Summation = | 1.7E-07 |

0680

**Table K.IV-57**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Youth Future Land Use With Federal Ownership**
**Via Inhalation of Particulates**

**Intake Equation** = $\frac{CS \times EF \times ED \times IR}{BW \times AT}$

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 20 $m^3$/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration for non-carchogens | 12 Year |
| EDc | Exposure duration for carchogens | 12 Year |
| BW | Body weight | 43 kg |
| ATc | Average time for carchogens (lifetime) | 25550 days |
| ATn | Average time for non-carchogens (EDn x 365) | 4380 days |
| CS | Concentration of chemicals in particulate as modeled | (see table below) |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 1.9E-06 | mg/m$^3$ | Heptachlorodibenzofuran | NA | mg/m$^3$ |
| Aroclor-1016 | NA | mg/m$^3$ | Heptachlorodibenzo-p-dioxin | NA | mg/m$^3$ |
| Aroclor-1221 | 1.9E-09 | mg/m$^3$ | Lead | 1.1E-05 | mg/m$^3$ |
| Aroclor-1242 | NA | mg/m$^3$ | Manganese | 3.9E-05 | mg/m$^3$ |
| Aroclor-1248 | 1.3E-09 | mg/m$^3$ | Mercury | 3.0E-08 | mg/m$^3$ |
| Aroclor-1254 | 6.0E-08 | mg/m$^3$ | Molybdenum | 3.0E-07 | mg/m$^3$ |
| Aroclor-1260 | 6.3E-08 | mg/m$^3$ | Nickel | 2.5E-06 | mg/m$^3$ |
| Arsenic | 9.3E-07 | mg/m$^3$ | Octachlorodibenzofuran | NA | mg/m$^3$ |
| Barium | 8.5E-05 | mg/m$^3$ | Selenium | 9.3E-09 | mg/m$^3$ |
| Beryllium | 8.5E-08 | mg/m$^3$ | Thallium | 2.6E-08 | mg/m$^3$ |
| Cadmium | 3.7E-07 | mg/m$^3$ | Vanadium | 1.8E-06 | mg/m$^3$ |
| Chromium | 2.5E-07 | mg/m$^3$ | Zinc | 9.7E-06 | mg/m$^3$ |
| Cobalt | 9.3E-07 | mg/m$^3$ | 2-Chlorophenol | NA | mg/m$^3$ |
| Copper | 3.7E-06 | mg/m$^3$ | 2-Methylnaphthalene | 5.0E-09 | mg/m$^3$ |
| Cyanide | 3.3E-07 | mg/m$^3$ | 4-Chlorophenyl-phenylether | NA | mg/m$^3$ |
| Di-n-octyl phthalate | 5.3E-09 | mg/m$^3$ | 4,4-DDT | NA | mg/m$^3$ |

**References**

**Table K.IV-57 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Youth Future Land Use With Federal Ownership**
**Via Inhalation of Particulates**

| Compound | HQ Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
| Antimony | 8.7E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 8.3E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 5.7E-10 | NA | NA |
| Aroclor-1254 | 2.7E-08 | NA | NA |
| Aroclor-1260 | 2.8E-08 | NA | NA |
| Arsenic | 4.1E-07 | NA | NA |
| Barium | 3.8E-05 | 1.4E-04 | 2.7E-01 |
| Beryllium | 3.8E-08 | NA | NA |
| Cadmium | 1.7E-07 | NA | NA |
| Chromium | 1.1E-07 | NA | NA |
| Cobalt | 4.1E-07 | 3.0E-07 | 1.4E+00 |
| Copper | 1.7E-06 | NA | NA |
| Cyanide | 1.5E-07 | NA | NA |
| Di-n-octyl phthalate | 2.4E-09 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 5.0E-06 | NA | NA |
| Manganese | 1.7E-05 | 1.1E-04 | 1.6E-01 |
| Mercury | 1.3E-08 | 8.6E-05 | 1.5E-04 |
| Molybdenum | 1.4E-07 | NA | NA |
| Nickel | 1.1E-06 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 4.1E-09 | NA | NA |
| Thallium | 1.2E-08 | NA | NA |
| Vanadium | 7.9E-07 | NA | NA |
| Zinc | 4.3E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 2.2E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | NA | NA |
| | HQ Summation = | | 1.8E+00 |

| Compound | ILCR Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
| Antimony | 1.5E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.4E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 9.7E-11 | NA | NA |
| Aroclor-1254 | 4.6E-09 | NA | NA |
| Aroclor-1260 | 4.8E-09 | NA | NA |
| Arsenic | 7.1E-08 | 1.5E+01 | 1.1E-06 |
| Barium | 6.5E-06 | NA | NA |
| Beryllium | 6.5E-09 | 8.4E+00 | 5.4E-08 |
| Cadmium | 2.8E-08 | 6.1E+00 | 1.7E-07 |
| Chromium | 1.9E-08 | 4.1E+01 | 7.7E-07 |
| Cobalt | 7.1E-08 | NA | NA |
| Copper | 2.8E-07 | NA | NA |
| Cyanide | 2.5E-08 | NA | NA |
| Di-n-octyl phthalate | 4.1E-10 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 8.6E-07 | NA | NA |
| Manganese | 3.0E-06 | NA | NA |
| Mercury | 2.3E-09 | NA | NA |
| Molybdenum | 2.3E-08 | NA | NA |
| Nickel | 1.9E-07 | 8.4E-01 | 1.6E-07 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 7.1E-10 | NA | NA |
| Thallium | 2.0E-09 | NA | NA |
| Vanadium | 1.4E-07 | NA | NA |
| Zinc | 7.4E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.8E-10 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 2.2E-06 |

5208

**Table K.IV-58**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Youth Future Land Use With Federal Ownership**
**Via Inhalation of Gases and Particulates**

**Intake Equation** = Ca X EF X EDn X IR

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 20 $m^3$/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 12 Year |
| Ca | Concentration of radionuclides in air | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/$m^3$ | Rn-222 | 4.1E+00 | pCi/$m^3$ |
| Am-241 | NA | pCi/$m^3$ | Ru-106 | NA | pCi/$m^3$ |
| Cs-137 | 4.6E-05 | pCi/$m^3$ | Sr-90 | 1.5E-04 | pCi/$m^3$ |
| Np-237 | 1.6E-05 | pCi/$m^3$ | Tc-99 | 9.2E-04 | pCi/$m^3$ |
| Pa-231 | 6.0E-05 | pCi/$m^3$ | Th-228 | 1.4E-04 | pCi/$m^3$ |
| Pb-210 | 1.6E-03 | pCi/$m^3$ | Th-230 | 1.5E-04 | pCi/$m^3$ |
| Pu-238 | 8.0E-05 | pCi/$m^3$ | Th-232 | 8.1E-05 | pCi/$m^3$ |
| Pu-239 | 3.9E-05 | pCi/$m^3$ | U-233 | NA | pCi/$m^3$ |
| Pu-240 | 3.9E-05 | pCi/$m^3$ | U-234 | 1.7E-03 | pCi/$m^3$ |
| Ra-226 | 8.1E-05 | pCi/$m^3$ | U-235 | 4.4E-05 | pCi/$m^3$ |
| Ra-228 | 8.8E-05 | pCi/$m^3$ | U-236 | 1.9E-05 | pCi/$m^3$ |
| | | | U-238 | 9.9E-04 | pCi/$m^3$ |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 8.8E-08 | NA |
| Am-241 | NA | 3.2E-08 | NA |
| Cs-137 | 3.9E+00 | 1.9E-11 | 7.3E-11 |
| Np-237 | 1.3E+00 | 2.9E-08 | 3.9E-08 |
| Pa-231 | 5.0E+00 | 3.6E-08 | 1.8E-07 |
| Pb-210 | 1.3E+02 | 4.0E-09 | 5.4E-07 |
| Pu-238 | 6.7E+00 | 3.9E-08 | 2.6E-07 |
| Pu-239 | 3.3E+00 | 3.8E-08 | 1.2E-07 |
| Pu-240 | 3.3E+00 | 3.8E-08 | 1.2E-07 |
| Ra-226 | 6.8E+00 | 3.0E-09 | 2.0E-08 |
| Ra-228 | 7.4E+00 | 6.9E-10 | 5.1E-09 |
| Rn-222 | 3.5E+05 | 7.7E-12 | 2.7E-06 |
| Ru-106 | NA | 4.4E-10 | NA |
| Sr-90 | 1.3E+01 | 5.6E-11 | 7.2E-10 |
| Tc-99 | 7.7E+01 | 8.3E-12 | 6.4E-10 |
| Th-228 | 1.2E+01 | 7.8E-08 | 9.4E-07 |
| Th-230 | 1.3E+01 | 2.9E-08 | 3.7E-07 |
| Th-232 | 6.8E+00 | 2.8E-08 | 1.9E-07 |
| U-233 | NA | 2.7E-08 | NA |
| U-234 | 1.4E+02 | 2.6E-08 | 3.6E-06 |
| U-235 | 3.7E+00 | 2.5E-08 | 9.2E-08 |
| U-236 | 1.6E+00 | 2.5E-08 | 4.0E-08 |
| U-238 | 8.3E+01 | 5.2E-08 | 4.3E-06 |
| | | **ILCR Summation =** | 1.4E-05 |



0683

5208

**Table K.IV-59**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Youth Future Land Use With Federal Ownership**
**Via Ingestion of Drinking Water**

**Intake Equation** = Cw X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of groundwater (RAGS, 1989) | 2 l/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 12 Year |
| FI | Fractional intake for radionuclides | 1 (Unitless) |
| Cw | Concentration of radionuclides in groundwater | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/l | Rn-222 | NA | pCi/l |
| Am-241 | NA | pCi/l | Ru-106 | NA | pCi/l |
| Cs-137 | NA | pCi/l | Sr-90 | 2.2E-06 | pCi/l |
| Np-237 | NA | pCi/l | Tc-99 | NA | pCi/l |
| Pa-231 | NA | pCi/l | Th-228 | NA | pCi/l |
| Pb-210 | NA | pCi/l | Th-230 | NA | pCi/l |
| Pu-238 | NA | pCi/l | Th-232 | NA | pCi/l |
| Pu-239 | NA | pCi/l | U-233 | NA | pCi/l |
| Pu-240 | NA | pCi/l | U-234 | 1.5E+00 | pCi/l |
| Ra-226 | NA | pCi/l | U-235 | 4.0E-02 | pCi/l |
| Ra-228 | NA | pCi/l | U-236 | 1.6E-02 | pCi/l |
| | | | U-238 | 9.2E-01 | pCi/l |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | NA | 2.8E-11 | NA |
| Np-237 | NA | 2.2E-10 | NA |
| Pa-231 | NA | 9.2E-11 | NA |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | NA | 2.2E-10 | NA |
| Pu-239 | NA | 2.3E-10 | NA |
| Pu-240 | NA | 2.3E-10 | NA |
| Ra-226 | NA | 1.2E-10 | NA |
| Ra-228 | NA | 1.0E-10 | NA |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 1.8E-02 | 3.3E-10 | 6.0E-12 |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | NA | 5.5E-11 | NA |
| Th-230 | NA | 1.3E-11 | NA |
| Th-232 | NA | 1.2E-11 | NA |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 1.3E+04 | 1.6E-11 | 2.1E-07 |
| U-235 | 3.4E+02 | 1.6E-11 | 5.4E-09 |
| U-236 | 1.3E+02 | 1.5E-11 | 2.0E-09 |
| U-238 | 7.7E+03 | 2.8E-11 | 2.2E-07 |
| | | **ILCR Summation =** | 4.3E-07 |



0684

**Table K.IV-60**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RMB Resident Farm Youth Future Land Use With Federal Ownership**
**Via Ingestion of Meat Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of meat | 0.075 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 12 | Year |
| EDc | Exposure duration for carcinogens | 12 | Year |
| BW | Body weight | 43 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 4380 | days |
| CS | Concentration of chemicals in meat | | |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 6.8E-06 | mg/kg |
| Aroclor-1016 | NA | mg/kg |
| Aroclor-1221 | 5.6E-11 | mg/kg |
| Aroclor-1242 | NA | mg/kg |
| Aroclor-1248 | 1.9E-08 | mg/kg |
| Aroclor-1254 | 8.0E-06 | mg/kg |
| Aroclor-1260 | 3.1E-06 | mg/kg |
| Arsenic | 5.8E-06 | mg/kg |
| Barium | 2.2E-05 | mg/kg |
| Beryllium | 2.5E-07 | mg/kg |
| Cadmium | 8.1E-06 | mg/kg |
| Chromium | NA | mg/kg |
| Cobalt | 6.0E-05 | mg/kg |
| Copper | 9.5E-05 | mg/kg |
| Cyanide | 3.0E-11 | mg/kg |
| Di-n-octyl phthalate | 3.5E-04 | mg/kg |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Lead | 6.5E-06 | mg/kg |
| Manganese | 5.7E-05 | mg/kg |
| Mercury | 1.4E-05 | mg/kg |
| Molybdenum | 6.4E-06 | mg/kg |
| Nickel | 4.9E-05 | mg/kg |
| Octachlorodibenzofuran | NA | mg/kg |
| Selenium | 3.1E-07 | mg/kg |
| Thallium | 3.3E-06 | mg/kg |
| Vanadium | 1.6E-05 | mg/kg |
| Zinc | 3.1E-03 | mg/kg |
| 2-Chlorophenol | NA | mg/kg |
| 2-Methylnaphthalene | 1.3E-09 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | mg/kg |
| 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-60 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Youth Future Land Use With Federal Ownership**
**Via Ingestion of Meat Products**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 1.1E-08 | 4.0E-04 | 2.8E-05 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 9.4E-14 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 3.2E-11 | NA | NA |
| Aroclor-1254 | 1.3E-08 | NA | NA |
| Aroclor-1260 | 5.2E-09 | NA | NA |
| Arsenic | 9.6E-09 | 3.0E-04 | 3.2E-05 |
| Barium | 3.7E-08 | 7.0E-02 | 5.3E-07 |
| Beryllium | 4.2E-10 | 5.0E-03 | 8.4E-08 |
| Cadmium | 1.4E-08 | 5.0E-04 | 2.7E-05 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 1.0E-07 | 6.0E-02 | 1.7E-06 |
| Copper | 1.6E-07 | NA | NA |
| Cyanide | 4.9E-14 | 2.0E-02 | 2.5E-12 |
| Di-n-octyl phthalate | 5.9E-07 | 2.0E-02 | 3.0E-05 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.1E-08 | NA | NA |
| Manganese | 9.6E-08 | 1.4E-01 | 6.9E-07 |
| Mercury | 2.3E-08 | 3.0E-04 | 7.7E-05 |
| Molybdenum | 1.1E-08 | 5.0E-03 | 2.2E-06 |
| Nickel | 8.3E-08 | 2.0E-02 | 4.1E-06 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 5.2E-10 | 5.0E-03 | 1.0E-07 |
| Thallium | 5.5E-09 | 8.0E-05 | 6.9E-05 |
| Vanadium | 2.6E-08 | 7.0E-03 | 3.8E-06 |
| Zinc | 5.2E-06 | 3.0E-01 | 1.7E-05 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 2.2E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 2.9E-04 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 1.9E-09 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.6E-14 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 5.5E-12 | 7.7E+00 | 4.2E-11 |
| Aroclor-1254 | 2.3E-09 | 7.7E+00 | 1.8E-08 |
| Aroclor-1260 | 8.9E-10 | 7.7E+00 | 6.9E-09 |
| Arsenic | 1.6E-09 | 1.8E+00 | 2.9E-09 |
| Barium | 6.3E-09 | NA | NA |
| Beryllium | 7.2E-11 | 4.3E+00 | 3.1E-10 |
| Cadmium | 2.3E-09 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 1.7E-08 | NA | NA |
| Copper | 2.7E-08 | NA | NA |
| Cyanide | 8.5E-15 | NA | NA |
| Di-n-octyl phthalate | 1.0E-07 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.9E-09 | NA | NA |
| Manganese | 1.6E-08 | NA | NA |
| Mercury | 4.0E-09 | NA | NA |
| Molybdenum | 1.8E-09 | NA | NA |
| Nickel | 1.4E-08 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 8.9E-11 | NA | NA |
| Thallium | 9.5E-10 | NA | NA |
| Vanadium | 4.5E-09 | NA | NA |
| Zinc | 8.9E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.7E-13 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 2.8E-08 |

**Table K.IV-61**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Youth Future Land Use With Federal Ownership**
**Via Ingestion of Meat Products**

**Intake Equation** = Cf X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of meat | 0.075 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 12 Year |
| Cf | Concentration of radionuclides in meat | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 3.3E-03 | pCi/kg | Sr-90 | NA | pCi/kg |
| Np-237 | 1.3E-06 | pCi/kg | Tc-99 | NA | pCi/kg |
| Pa-231 | 9.5E-03 | pCi/kg | Th-228 | 1.9E-06 | pCi/kg |
| Pb-210 | NA | pCi/kg | Th-230 | 3.2E-06 | pCi/kg |
| Pu-238 | 8.5E-08 | pCi/kg | Th-232 | 1.7E-06 | pCi/kg |
| Pu-239 | 5.5E-08 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 5.5E-08 | pCi/kg | U-234 | 3.0E-03 | pCi/kg |
| Ra-226 | 7.2E-05 | pCi/kg | U-235 | 8.0E-05 | pCi/kg |
| Ra-228 | 4.8E-05 | pCi/kg | U-236 | 3.3E-05 | pCi/kg |
| | | | U-238 | 1.8E-03 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 1.0E+00 | 2.8E-11 | 2.9E-11 |
| Np-237 | 4.2E-04 | 2.2E-10 | 9.3E-14 |
| Pa-231 | 3.0E+00 | 9.2E-11 | 2.8E-10 |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | 2.7E-05 | 2.2E-10 | 5.9E-15 |
| Pu-239 | 1.7E-05 | 2.3E-10 | 4.0E-15 |
| Pu-240 | 1.7E-05 | 2.3E-10 | 4.0E-15 |
| Ra-226 | 2.3E-02 | 1.2E-10 | 2.7E-12 |
| Ra-228 | 1.5E-02 | 1.0E-10 | 1.5E-12 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | NA | 3.3E-10 | NA |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | 6.0E-04 | 5.5E-11 | 3.3E-14 |
| Th-230 | 1.0E-03 | 1.3E-11 | 1.3E-14 |
| Th-232 | 5.4E-04 | 1.2E-11 | 6.4E-15 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 9.4E-01 | 1.6E-11 | 1.5E-11 |
| U-235 | 2.5E-02 | 1.6E-11 | 4.0E-13 |
| U-236 | 1.1E-02 | 1.5E-11 | 1.6E-13 |
| U-238 | 5.6E-01 | 2.8E-11 | 1.6E-11 |
| | | ILCR Summation = | 3.4E-10 |

**Table K.IV-62**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RMB Resident Farm Youth Future Land Use With Federal Ownership**
**Via Ingestion of Dairy Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of dairy products | 0.3 | l/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 12 | Year |
| EDc | Exposure duration for carcinogens | 12 | Year |
| BW | Body weight | 43 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 4380 | days |
| CS | Concentration of chemicals in animal products | | |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 6.8E-07 | mg/kg | Heptachlorodibenzofuran | NA | mg/kg |
| Aroclor-1016 | NA | mg/kg | Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Aroclor-1221 | 1.8E-11 | mg/kg | Lead | 5.4E-06 | mg/kg |
| Aroclor-1242 | NA | mg/kg | Manganese | 5.0E-05 | mg/kg |
| Aroclor-1248 | 2.0E-08 | mg/kg | Mercury | 2.5E-08 | mg/kg |
| Aroclor-1254 | 1.7E-06 | mg/kg | Molybdenum | 1.6E-06 | mg/kg |
| Aroclor-1260 | 6.3E-06 | mg/kg | Nickel | 8.2E-06 | mg/kg |
| Arsenic | 1.7E-07 | mg/kg | Octachlorodibenzofuran | NA | mg/kg |
| Barium | 5.2E-05 | mg/kg | Selenium | 8.3E-08 | mg/kg |
| Beryllium | 2.3E-10 | mg/kg | Thallium | 1.7E-07 | mg/kg |
| Cadmium | 1.5E-06 | mg/kg | Vanadium | 1.3E-07 | mg/kg |
| Chromium | NA | mg/kg | Zinc | 3.1E-04 | mg/kg |
| Cobalt | 6.0E-06 | mg/kg | 2-Chlorophenol | NA | mg/kg |
| Copper | 1.4E-05 | mg/kg | 2-Methylnaphthalene | 7.3E-10 | mg/kg |
| Cyanide | NA | mg/kg | 4-Chlorophenyl-phenylether | NA | mg/kg |
| Di-n-octyl phthalate | 1.1E-04 | mg/kg | 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-62 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Youth Future Land Use With Federal Ownership**
**Via Ingestion of Dairy Products**

| Compound | HQ Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
| Antimony | 4.5E-09 | 4.0E-04 | 1.1E-05 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.2E-13 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.3E-10 | NA | NA |
| Aroclor-1254 | 1.2E-08 | NA | NA |
| Aroclor-1260 | 4.2E-08 | NA | NA |
| Arsenic | 1.2E-09 | 3.0E-04 | 3.9E-06 |
| Barium | 3.4E-07 | 7.0E-02 | 4.9E-06 |
| Beryllium | 1.5E-12 | 5.0E-03 | 3.0E-10 |
| Cadmium | 9.9E-09 | 5.0E-04 | 2.0E-05 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 4.0E-08 | 6.0E-02 | 6.7E-07 |
| Copper | 9.5E-08 | NA | NA |
| Cyanide | NA | 2.0E-02 | NA |
| Di-n-octyl phthalate | 7.5E-07 | 2.0E-02 | 3.7E-05 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.6E-08 | NA | NA |
| Manganese | 3.4E-07 | 1.4E-01 | 2.4E-06 |
| Mercury | 1.7E-10 | 3.0E-04 | 5.6E-07 |
| Molybdenum | 1.1E-08 | 5.0E-03 | 2.2E-06 |
| Nickel | 5.5E-08 | 2.0E-02 | 2.8E-06 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 5.6E-10 | 5.0E-03 | 1.1E-07 |
| Thallium | 1.1E-09 | 8.0E-05 | 1.4E-05 |
| Vanadium | 8.5E-10 | 7.0E-03 | 1.2E-07 |
| Zinc | 2.1E-06 | 3.0E-01 | 7.0E-06 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 4.9E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 1.1E-04 |

| Compound | ILCR Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
| Antimony | 7.7E-10 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 2.1E-14 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 2.2E-11 | 7.7E+00 | 1.7E-10 |
| Aroclor-1254 | 2.0E-09 | 7.7E+00 | 1.5E-08 |
| Aroclor-1260 | 7.2E-09 | 7.7E+00 | 5.6E-08 |
| Arsenic | 2.0E-10 | 1.8E+00 | 3.5E-10 |
| Barium | 5.9E-08 | NA | NA |
| Beryllium | 2.6E-13 | 4.3E+00 | 1.1E-12 |
| Cadmium | 1.7E-09 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 6.9E-09 | NA | NA |
| Copper | 1.6E-08 | NA | NA |
| Cyanide | NA | NA | NA |
| Di-n-octyl phthalate | 1.3E-07 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 6.2E-09 | NA | NA |
| Manganese | 5.8E-08 | NA | NA |
| Mercury | 2.9E-11 | NA | NA |
| Molybdenum | 1.8E-09 | NA | NA |
| Nickel | 9.4E-09 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 9.5E-11 | NA | NA |
| Thallium | 1.9E-10 | NA | NA |
| Vanadium | 1.5E-10 | NA | NA |
| Zinc | 3.6E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 8.3E-13 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 7.1E-08 |

5208

## Table K.IV–63
## Summary of Intake and Risk Quantitation (Radionuclides)
## Off–Property RME Resident Farm Youth Future Land Use With Federal Ownership
## Via Ingestion of Dairy Products

**Intake Equation** = Cp X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of dairy products | 0.3 l/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 12 Year |
| Cp | Concentration of radionuclides in animal products | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 1.2E-03 | pCi/kg | Sr-90 | 7.9E-25 | pCi/kg |
| Np-237 | 1.2E-07 | pCi/kg | Tc-99 | 2.3E-23 | pCi/kg |
| Pa-231 | 6.0E-05 | pCi/kg | Th-228 | 2.4E-06 | pCi/kg |
| Pb-210 | NA | pCi/kg | Th-230 | 2.7E-06 | pCi/kg |
| Pu-238 | 1.7E-08 | pCi/kg | Th-232 | 1.4E-06 | pCi/kg |
| Pu-239 | 1.1E-08 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 1.1E-08 | pCi/kg | U-234 | 9.1E-03 | pCi/kg |
| Ra-226 | 1.3E-04 | pCi/kg | U-235 | 2.4E-04 | pCi/kg |
| Ra-228 | 1.3E-04 | pCi/kg | U-236 | 1.0E-04 | pCi/kg |
| | | | U-238 | 5.5E-03 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 1.4E+00 | 2.8E-11 | 4.1E-11 |
| Np-237 | 1.5E-04 | 2.2E-10 | 3.4E-14 |
| Pa-231 | 7.5E-02 | 9.2E-11 | 6.9E-12 |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | 2.2E-05 | 2.2E-10 | 4.7E-15 |
| Pu-239 | 1.4E-05 | 2.3E-10 | 3.2E-15 |
| Pu-240 | 1.4E-05 | 2.3E-10 | 3.2E-15 |
| Ra-226 | 1.6E-01 | 1.2E-10 | 2.0E-11 |
| Ra-228 | 1.7E-01 | 1.0E-10 | 1.7E-11 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 9.9E-22 | 3.3E-10 | 3.3E-31 |
| Tc-99 | 2.9E-20 | 1.3E-12 | 3.8E-32 |
| Th-228 | 3.1E-03 | 5.5E-11 | 1.7E-13 |
| Th-230 | 3.3E-03 | 1.3E-11 | 4.3E-14 |
| Th-232 | 1.8E-03 | 1.2E-11 | 2.1E-14 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 1.1E+01 | 1.6E-11 | 1.8E-10 |
| U-235 | 3.1E-01 | 1.6E-11 | 4.9E-12 |
| U-236 | 1.3E-01 | 1.5E-11 | 1.9E-12 |
| U-238 | 6.9E+00 | 2.8E-11 | 1.9E-10 |
| | | ILCR Summation = | 4.7E-10 |

0690

- 5208

**Table K.IV-64**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Youth Future Land Use With Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.122 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 12 | Year |
| EDc | Exposure duration for carcinogens | 12 | Year |
| BW | Body weight | 43 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 4380 | days |
| CS | Concentration of chemicals in vegetables | | |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 1.7E-04 | mg/kg | Heptachlorodibenzofuran | NA | mg/kg |
| Aroclor-1016 | NA | mg/kg | Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Aroclor-1221 | 8.4E-08 | mg/kg | Lead | 5.3E-04 | mg/kg |
| Aroclor-1242 | NA | mg/kg | Manganese | 3.5E-03 | mg/kg |
| Aroclor-1248 | 4.7E-08 | mg/kg | Mercury | 1.3E-06 | mg/kg |
| Aroclor-1254 | 2.6E-06 | mg/kg | Molybdenum | 2.6E-05 | mg/kg |
| Aroclor-1260 | 2.4E-06 | mg/kg | Nickel | 2.0E-04 | mg/kg |
| Arsenic | 7.0E-05 | mg/kg | Octachlorodibenzofuran | NA | mg/kg |
| Barium | 3.6E-03 | mg/kg | Selenium | 5.1E-07 | mg/kg |
| Beryllium | 6.1E-06 | mg/kg | Thallium | 2.0E-06 | mg/kg |
| Cadmium | 3.5E-05 | mg/kg | Vanadium | 1.6E-04 | mg/kg |
| Chromium | NA | mg/kg | Zinc | 7.2E-04 | mg/kg |
| Cobalt | 7.3E-05 | mg/kg | 2-Chlorophenol | NA | mg/kg |
| Copper | 2.3E-04 | mg/kg | 2-Methylnaphthalene | 1.6E-07 | mg/kg |
| Cyanide | 1.4E-05 | mg/kg | 4-Chlorophenyl-phenylether | NA | mg/kg |
| Di-n-octyl phthalate | 2.2E-07 | mg/kg | 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-64 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Youth Future Land Use With Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 4.5E-07 | 4.0E-04 | 1.1E-03 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 2.3E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.3E-10 | NA | NA |
| Aroclor-1254 | 7.2E-09 | NA | NA |
| Aroclor-1260 | 6.5E-09 | NA | NA |
| Arsenic | 1.9E-07 | 3.0E-04 | 6.4E-04 |
| Barium | 9.7E-06 | 7.0E-02 | 1.4E-04 |
| Beryllium | 1.7E-08 | 5.0E-03 | 3.3E-06 |
| Cadmium | 9.6E-08 | 5.0E-04 | 1.9E-04 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 2.0E-07 | 6.0E-02 | 3.3E-06 |
| Copper | 6.2E-07 | NA | NA |
| Cyanide | 3.7E-08 | 2.0E-02 | 1.9E-06 |
| Di-n-octyl phthalate | 5.9E-10 | 2.0E-02 | 3.0E-08 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.4E-06 | NA | NA |
| Manganese | 9.4E-06 | 1.4E-01 | 6.7E-05 |
| Mercury | 3.6E-09 | 3.0E-04 | 1.2E-05 |
| Molybdenum | 7.1E-08 | 5.0E-03 | 1.4E-05 |
| Nickel | 5.4E-07 | 2.0E-02 | 2.7E-05 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 1.4E-09 | 5.0E-03 | 2.8E-07 |
| Thallium | 5.5E-09 | 8.0E-05 | 6.9E-05 |
| Vanadium | 4.2E-07 | 7.0E-03 | 6.0E-05 |
| Zinc | 2.0E-06 | 3.0E-01 | 6.6E-06 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 4.8E-10 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 2.4E-03 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 7.7E-08 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 3.9E-11 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 2.2E-11 | 7.7E+00 | 1.7E-10 |
| Aroclor-1254 | 1.2E-09 | 7.7E+00 | 9.4E-09 |
| Aroclor-1260 | 1.1E-09 | 7.7E+00 | 8.5E-09 |
| Arsenic | 3.3E-08 | 1.8E+00 | 5.7E-08 |
| Barium | 1.7E-06 | NA | NA |
| Beryllium | 2.8E-09 | 4.3E+00 | 1.2E-08 |
| Cadmium | 1.6E-08 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 3.4E-08 | NA | NA |
| Copper | 1.1E-07 | NA | NA |
| Cyanide | 6.4E-09 | NA | NA |
| Di-n-octyl phthalate | 1.0E-10 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 2.5E-07 | NA | NA |
| Manganese | 1.6E-06 | NA | NA |
| Mercury | 6.1E-10 | NA | NA |
| Molybdenum | 1.2E-08 | NA | NA |
| Nickel | 9.3E-08 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.4E-10 | NA | NA |
| Thallium | 9.4E-10 | NA | NA |
| Vanadium | 7.2E-08 | NA | NA |
| Zinc | 3.4E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 8.2E-11 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 8.8E-08 |

5208

**Table K.IV-65**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Youth Future Land Use With Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

**Intake Equation** = Cv X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.122 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 12 Year |
| Cv | Concentration of radionuclides in vegetables | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 4.0E-03 | pCi/kg | Sr-90 | 3.4E-13 | pCi/kg |
| Np-237 | 5.8E-04 | pCi/kg | Tc-99 | 1.5E-12 | pCi/kg |
| Pa-231 | 2.9E-03 | pCi/kg | Th-228 | 1.2E-02 | pCi/kg |
| Pb-210 | 6.2E-02 | pCi/kg | Th-230 | 1.3E-02 | pCi/kg |
| Pu-238 | 4.2E-03 | pCi/kg | Th-232 | 6.9E-03 | pCi/kg |
| Pu-239 | 2.7E-03 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 2.7E-03 | pCi/kg | U-234 | 3.3E-01 | pCi/kg |
| Ra-226 | 7.0E-03 | pCi/kg | U-235 | 8.9E-03 | pCi/kg |
| Ra-228 | 7.3E-03 | pCi/kg | U-236 | 3.7E-03 | pCi/kg |
| | | | U-238 | 2.0E-01 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 2.1E+00 | 2.8E-11 | 5.8E-11 |
| Np-237 | 3.0E-01 | 2.2E-10 | 6.6E-11 |
| Pa-231 | 1.5E+00 | 9.2E-11 | 1.4E-10 |
| Pb-210 | 3.2E+01 | 6.6E-10 | 2.1E-08 |
| Pu-238 | 2.1E+00 | 2.2E-10 | 4.7E-10 |
| Pu-239 | 1.4E+00 | 2.3E-10 | 3.2E-10 |
| Pu-240 | 1.4E+00 | 2.3E-10 | 3.2E-10 |
| Ra-226 | 3.6E+00 | 1.2E-10 | 4.3E-10 |
| Ra-228 | 3.7E+00 | 1.0E-10 | 3.7E-10 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 1.7E-10 | 3.3E-10 | 5.7E-20 |
| Tc-99 | 7.6E-10 | 1.3E-12 | 9.9E-22 |
| Th-228 | 6.3E+00 | 5.5E-11 | 3.4E-10 |
| Th-230 | 6.6E+00 | 1.3E-11 | 8.6E-11 |
| Th-232 | 3.5E+00 | 1.2E-11 | 4.3E-11 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 1.7E+02 | 1.6E-11 | 2.7E-09 |
| U-235 | 4.6E+00 | 1.6E-11 | 7.3E-11 |
| U-236 | 1.9E+00 | 1.5E-11 | 2.9E-11 |
| U-238 | 1.0E+02 | 2.8E-11 | 2.9E-09 |
| | | **ILCR Summation =** | 2.9E-08 |



0693

**Table K.IV-66**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RMB Resident Farm Child Future Land Use With Federal Ownership**
**Via Inhalation of particulates**

**Intake Equation** = $\frac{CS \times EF \times ED \times IR}{BW \times AT}$

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 12 $m^3$/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration for non-carcinogens | 6 Year |
| EDc | Exposure duration for carcinogens | 6 Year |
| BW | Body weight | 15 kg |
| ATc | Average time for carcinogens (lifetime) | 25550 days |
| ATn | Average time for non-carcinogens (EDn x 365) | 2190 days |
| CS | Concentration of chemicals in soil | (see table below) |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 1.9E-06 | $mg/m^3$ | Heptachlorodibenzofuran | NA | $mg/m^3$ |
| Aroclor-1016 | NA | $mg/m^3$ | Heptachlorodibenzo-p-dioxin | NA | $mg/m^3$ |
| Aroclor-1221 | 1.9E-09 | $mg/m^3$ | Lead | 1.1E-05 | $mg/m^3$ |
| Aroclor-1242 | NA | $mg/m^3$ | Manganese | 3.9E-05 | $mg/m^3$ |
| Aroclor-1248 | 1.3E-09 | $mg/m^3$ | Mercury | 3.0E-08 | $mg/m^3$ |
| Aroclor-1254 | 6.0E-08 | $mg/m^3$ | Molybdenum | 3.0E-07 | $mg/m^3$ |
| Aroclor-1260 | 6.3E-08 | $mg/m^3$ | Nickel | 2.5E-06 | $mg/m^3$ |
| Arsenic | 9.3E-07 | $mg/m^3$ | Octachlorodibenzofuran | NA | $mg/m^3$ |
| Barium | 8.5E-05 | $mg/m^3$ | Selenium | 9.3E-09 | $mg/m^3$ |
| Beryllium | 8.5E-08 | $mg/m^3$ | Thallium | 2.6E-08 | $mg/m^3$ |
| Cadmium | 3.7E-07 | $mg/m^3$ | Vanadium | 1.8E-06 | $mg/m^3$ |
| Chromium | 2.5E-07 | $mg/m^3$ | Zinc | 9.7E-06 | $mg/m^3$ |
| Cobalt | 9.3E-07 | $mg/m^3$ | 2-Chlorophenol | NA | $mg/m^3$ |
| Copper | 3.7E-06 | $mg/m^3$ | 2-Methylnaphthalene | 5.0E-09 | $mg/m^3$ |
| Cyanide | 3.3E-07 | $mg/m^3$ | 4-Chlorophenyl-phenylether | NA | $mg/m^3$ |
| Di-n-octyl phthalate | 5.3E-09 | $mg/m^3$ | 4,4-DDT | NA | $mg/m^3$ |

**References**

**Table K.IV-66 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RMB Resident Farm Child Future Land Use With Federal Ownership**
**Via Inhalation of Particulates**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 1.5E-06 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.4E-09 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 9.7E-10 | NA | NA |
| Aroclor-1254 | 4.6E-08 | NA | NA |
| Aroclor-1260 | 4.9E-08 | NA | NA |
| Arsenic | 7.1E-07 | NA | NA |
| Barium | 6.5E-05 | 1.4E-04 | 4.7E-01 |
| Beryllium | 6.5E-08 | NA | NA |
| Cadmium | 2.9E-07 | NA | NA |
| Chromium | 1.9E-07 | NA | NA |
| Cobalt | 7.1E-07 | 3.0E-07 | 2.4E+00 |
| Copper | 2.9E-06 | NA | NA |
| Cyanide | 2.5E-07 | NA | NA |
| Di-n-octyl phthalate | 4.1E-09 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 8.6E-06 | NA | NA |
| Manganese | 3.0E-05 | 1.1E-04 | 2.7E-01 |
| Mercury | 2.3E-08 | 8.6E-05 | 2.6E-04 |
| Molybdenum | 2.3E-07 | NA | NA |
| Nickel | 1.9E-06 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 7.1E-09 | NA | NA |
| Thallium | 2.0E-08 | NA | NA |
| Vanadium | 1.4E-06 | NA | NA |
| Zinc | 7.5E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.8E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | NA | NA |
| | Hazard Quotient Sum = | | 3.1E+00 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 1.3E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.2E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 8.4E-11 | NA | NA |
| Aroclor-1254 | 3.9E-09 | NA | NA |
| Aroclor-1260 | 4.2E-09 | NA | NA |
| Arsenic | 6.1E-08 | 1.5E+01 | 9.2E-07 |
| Barium | 5.6E-06 | NA | NA |
| Beryllium | 5.6E-09 | 8.4E+00 | 4.7E-08 |
| Cadmium | 2.4E-08 | 6.1E+00 | 1.5E-07 |
| Chromium | 1.6E-08 | 4.1E+01 | 6.6E-07 |
| Cobalt | 6.1E-08 | NA | NA |
| Copper | 2.4E-07 | NA | NA |
| Cyanide | 2.2E-08 | NA | NA |
| Di-n-octyl phthalate | 3.5E-10 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 7.4E-07 | NA | NA |
| Manganese | 2.6E-06 | NA | NA |
| Mercury | 1.9E-09 | NA | NA |
| Molybdenum | 2.0E-08 | NA | NA |
| Nickel | 1.6E-07 | 8.4E-01 | 1.4E-07 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 6.1E-10 | NA | NA |
| Thallium | 1.7E-09 | NA | NA |
| Vanadium | 1.2E-07 | NA | NA |
| Zinc | 6.4E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.3E-10 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 1.9E-06 |

- 5208

**Table K.IV-67**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Child Future Land Use With Federal Ownership**
**Via Inhalation of Gases and Particulates**

**Intake Equation** = Ca X EF X EDn X IR

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 12 $m^3$/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 6 Year |
| Ca | Concentration of radionuclides in air | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/$m^3$ | Rn-222 | 4.1E+00 | pCi/$m^3$ |
| Am-241 | NA | pCi/$m^3$ | Ru-106 | NA | pCi/$m^3$ |
| Cs-137 | 4.6E-05 | pCi/$m^3$ | Sr-90 | 1.5E-04 | pCi/$m^3$ |
| Np-237 | 1.6E-05 | pCi/$m^3$ | Tc-99 | 9.2E-04 | pCi/$m^3$ |
| Pa-231 | 6.0E-05 | pCi/$m^3$ | Th-228 | 1.4E-04 | pCi/$m^3$ |
| Pb-210 | 1.6E-03 | pCi/$m^3$ | Th-230 | 1.5E-04 | pCi/$m^3$ |
| Pu-238 | 8.0E-05 | pCi/$m^3$ | Th-232 | 8.1E-05 | pCi/$m^3$ |
| Pu-239 | 3.9E-05 | pCi/$m^3$ | U-233 | NA | pCi/$m^3$ |
| Pu-240 | 3.9E-05 | pCi/$m^3$ | U-234 | 1.7E-03 | pCi/$m^3$ |
| Ra-226 | 8.1E-05 | pCi/$m^3$ | U-235 | 4.4E-05 | pCi/$m^3$ |
| Ra-228 | 8.8E-05 | pCi/$m^3$ | U-236 | 1.9E-05 | pCi/$m^3$ |
| | | | U-238 | 9.9E-04 | pCi/$m^3$ |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 8.8E-08 | NA |
| Am-241 | NA | 3.2E-08 | NA |
| Cs-137 | 1.2E+00 | 1.9E-11 | 2.2E-11 |
| Np-237 | 4.0E-01 | 2.9E-08 | 1.2E-08 |
| Pa-231 | 1.5E+00 | 3.6E-08 | 5.4E-08 |
| Pb-210 | 4.0E+01 | 4.0E-09 | 1.6E-07 |
| Pu-238 | 2.0E+00 | 3.9E-08 | 7.9E-08 |
| Pu-239 | 9.8E-01 | 3.8E-08 | 3.7E-08 |
| Pu-240 | 9.8E-01 | 3.8E-08 | 3.7E-08 |
| Ra-226 | 2.0E+00 | 3.0E-09 | 6.1E-09 |
| Ra-228 | 2.2E+00 | 6.9E-10 | 1.5E-09 |
| Rn-222 | 1.0E+05 | 7.7E-12 | 8.0E-07 |
| Ru-106 | NA | 4.4E-10 | NA |
| Sr-90 | 3.8E+00 | 5.6E-11 | 2.1E-10 |
| Tc-99 | 2.3E+01 | 8.3E-12 | 1.9E-10 |
| Th-228 | 3.6E+00 | 7.8E-08 | 2.8E-07 |
| Th-230 | 3.8E+00 | 2.9E-08 | 1.1E-07 |
| Th-232 | 2.0E+00 | 2.8E-08 | 5.7E-08 |
| U-233 | NA | 2.7E-08 | NA |
| U-234 | 4.2E+01 | 2.6E-08 | 1.1E-06 |
| U-235 | 1.1E+00 | 2.5E-08 | 2.8E-08 |
| U-236 | 4.8E-01 | 2.5E-08 | 1.2E-08 |
| U-238 | 2.5E+01 | 5.2E-08 | 1.3E-06 |
| | | **ILCR Summation =** | 4.1E-06 |

0696

- 5208

**Table K.IV-68**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Child Future Land Use With Federal Ownership**
**Via Ingestion of Drinking Water**

**Intake Equation** = Cw X EF X EDn X FI X IR

| | | | |
|---|---|---|---|
| IR | Ingestion rate of groundwater (RAGS, 1989) | 1.4 | l/day |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration | 6 | Year |
| FI | Fractional intake for radionuclides | 1 | (Unitless) |
| Cw | Concentration of radionuclides in groundwater | | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/l | Rn-222 | NA | pCi/l |
| Am-241 | NA | pCi/l | Ru-106 | NA | pCi/l |
| Cs-137 | NA | pCi/l | Sr-90 | 2.2E-06 | pCi/l |
| Np-237 | NA | pCi/l | Tc-99 | NA | pCi/l |
| Pa-231 | NA | pCi/l | Th-228 | NA | pCi/l |
| Pb-210 | NA | pCi/l | Th-230 | NA | pCi/l |
| Pu-238 | NA | pCi/l | Th-232 | NA | pCi/l |
| Pu-239 | NA | pCi/l | U-233 | NA | pCi/l |
| Pu-240 | NA | pCi/l | U-234 | 1.5E+00 | pCi/l |
| Ra-226 | NA | pCi/l | U-235 | 4.0E-02 | pCi/l |
| Ra-228 | NA | pCi/l | U-236 | 1.6E-02 | pCi/l |
| | | | U-238 | 9.2E-01 | pCi/l |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | NA | 2.8E-11 | NA |
| Np-237 | NA | 2.2E-10 | NA |
| Pa-231 | NA | 9.2E-11 | NA |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | NA | 2.2E-10 | NA |
| Pu-239 | NA | 2.3E-10 | NA |
| Pu-240 | NA | 2.3E-10 | NA |
| Ra-226 | NA | 1.2E-10 | NA |
| Ra-228 | NA | 1.0E-10 | NA |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 6.4E-03 | 3.3E-10 | 2.1E-12 |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | NA | 5.5E-11 | NA |
| Th-230 | NA | 1.3E-11 | NA |
| Th-232 | NA | 1.2E-11 | NA |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 4.5E+03 | 1.6E-11 | 7.2E-08 |
| U-235 | 1.2E+02 | 1.6E-11 | 1.9E-09 |
| U-236 | 4.7E+01 | 1.5E-11 | 7.1E-10 |
| U-238 | 2.7E+03 | 2.8E-11 | 7.5E-08 |
| | | ILCR Summation = | 1.5E-07 |



0697

**Table K.IV-69**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Child Future Land Use With Federal Ownership**
**Via Ingestion of Meat Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of meat | 0.029 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 6 | Year |
| EDc | Exposure duration for carcinogens | 6 | Year |
| BW | Body weight | 15 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 2190 | days |
| CS | Concentration of chemicals in meat | | |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 6.8E-06 | mg/kg |
| Aroclor-1016 | NA | mg/kg |
| Aroclor-1221 | 5.6E-11 | mg/kg |
| Aroclor-1242 | NA | mg/kg |
| Aroclor-1248 | 1.9E-08 | mg/kg |
| Aroclor-1254 | 8.0E-08 | mg/kg |
| Aroclor-1260 | 3.1E-08 | mg/kg |
| Arsenic | 5.8E-08 | mg/kg |
| Barium | 2.2E-05 | mg/kg |
| Beryllium | 2.5E-07 | mg/kg |
| Cadmium | 8.1E-08 | mg/kg |
| Chromium | NA | mg/kg |
| Cobalt | 6.0E-05 | mg/kg |
| Copper | 9.5E-05 | mg/kg |
| Cyanide | 3.0E-11 | mg/kg |
| Di-n-octyl phthalate | 3.5E-04 | mg/kg |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Lead | 6.5E-06 | mg/kg |
| Manganese | 5.7E-05 | mg/kg |
| Mercury | 1.4E-05 | mg/kg |
| Molybdenum | 6.4E-06 | mg/kg |
| Nickel | 4.9E-05 | mg/kg |
| Octachlorodibenzofuran | NA | mg/kg |
| Selenium | 3.1E-07 | mg/kg |
| Thallium | 3.3E-06 | mg/kg |
| Vanadium | 1.6E-05 | mg/kg |
| Zinc | 3.1E-03 | mg/kg |
| 2-Chlorophenol | NA | mg/kg |
| 2-Methylnaphthalene | 1.3E-09 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | mg/kg |
| 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-69 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Child Future Land Use With Federal Ownership**
**Via Ingestion of Meat Products**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 1.3E-08 | 4.0E-04 | 3.1E-05 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.0E-13 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 3.5E-11 | NA | NA |
| Aroclor-1254 | 1.5E-08 | NA | NA |
| Aroclor-1260 | 5.8E-09 | NA | NA |
| Arsenic | 1.1E-08 | 3.0E-04 | 3.6E-05 |
| Barium | 4.1E-08 | 7.0E-02 | 5.9E-07 |
| Beryllium | 4.6E-10 | 5.0E-03 | 9.3E-08 |
| Cadmium | 1.5E-08 | 5.0E-04 | 3.0E-05 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 1.1E-07 | 6.0E-02 | 1.9E-06 |
| Copper | 1.8E-07 | NA | NA |
| Cyanide | 5.5E-14 | 2.0E-02 | 2.7E-12 |
| Di-n-octyl phthalate | 6.6E-07 | 2.0E-02 | 3.3E-05 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.2E-08 | NA | NA |
| Manganese | 1.1E-07 | 1.4E-01 | 7.6E-07 |
| Mercury | 2.6E-08 | 3.0E-04 | 8.6E-05 |
| Molybdenum | 1.2E-08 | 5.0E-03 | 2.4E-06 |
| Nickel | 9.2E-08 | 2.0E-02 | 4.6E-06 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 5.8E-10 | 5.0E-03 | 1.2E-07 |
| Thallium | 6.1E-09 | 8.0E-05 | 7.7E-05 |
| Vanadium | 2.9E-08 | 7.0E-03 | 4.2E-06 |
| Zinc | 5.8E-06 | 3.0E-01 | 1.9E-05 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 2.4E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 3.3E-04 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 1.1E-09 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 8.9E-15 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 3.0E-12 | 7.7E+00 | 2.3E-11 |
| Aroclor-1254 | 1.3E-09 | 7.7E+00 | 9.7E-09 |
| Aroclor-1260 | 4.9E-10 | 7.7E+00 | 3.8E-09 |
| Arsenic | 9.1E-10 | 1.8E+00 | 1.6E-09 |
| Barium | 3.5E-09 | NA | NA |
| Beryllium | 4.0E-11 | 4.3E+00 | 1.7E-10 |
| Cadmium | 1.3E-09 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 9.5E-09 | NA | NA |
| Copper | 1.5E-08 | NA | NA |
| Cyanide | 4.7E-15 | NA | NA |
| Di-n-octyl phthalate | 5.6E-08 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.0E-09 | NA | NA |
| Manganese | 9.1E-09 | NA | NA |
| Mercury | 2.2E-09 | NA | NA |
| Molybdenum | 1.0E-09 | NA | NA |
| Nickel | 7.8E-09 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 5.0E-11 | NA | NA |
| Thallium | 5.3E-10 | NA | NA |
| Vanadium | 2.5E-09 | NA | NA |
| Zinc | 5.0E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 2.1E-13 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 1.5E-08 |

5208

**Table K.IV-70**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Child Future Land Use With Federal Ownership**
**Via Ingestion of Meat Products**

**Intake Equation** = Cf X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of meat | 0.029 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 6 Year |
| Cf | Concentration of radionuclides in meat | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 3.3E-03 | pCi/kg | Sr-90 | NA | pCi/kg |
| Np-237 | 1.3E-06 | pCi/kg | Tc-99 | NA | pCi/kg |
| Pa-231 | 9.5E-03 | pCi/kg | Th-228 | 1.9E-06 | pCi/kg |
| Pb-210 | NA | pCi/kg | Th-230 | 3.2E-06 | pCi/kg |
| Pu-238 | 8.5E-08 | pCi/kg | Th-232 | 1.7E-06 | pCi/kg |
| Pu-239 | 5.5E-08 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 5.5E-08 | pCi/kg | U-234 | 3.0E-03 | pCi/kg |
| Ra-226 | 7.2E-05 | pCi/kg | U-235 | 8.0E-05 | pCi/kg |
| Ra-228 | 4.8E-05 | pCi/kg | U-236 | 3.3E-05 | pCi/kg |
| | | | U-238 | 1.8E-03 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 2.0E-01 | 2.8E-11 | 5.6E-12 |
| Np-237 | 8.2E-05 | 2.2E-10 | 1.8E-14 |
| Pa-231 | 5.8E-01 | 9.2E-11 | 5.3E-11 |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | 5.2E-06 | 2.2E-10 | 1.1E-15 |
| Pu-239 | 3.3E-06 | 2.3E-10 | 7.7E-16 |
| Pu-240 | 3.3E-06 | 2.3E-10 | 7.7E-16 |
| Ra-226 | 4.4E-03 | 1.2E-10 | 5.2E-13 |
| Ra-228 | 2.9E-03 | 1.0E-10 | 2.9E-13 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | NA | 3.3E-10 | NA |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | 1.2E-04 | 5.5E-11 | 6.4E-15 |
| Th-230 | 1.9E-04 | 1.3E-11 | 2.5E-15 |
| Th-232 | 1.0E-04 | 1.2E-11 | 1.2E-15 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 1.8E-01 | 1.6E-11 | 2.9E-12 |
| U-235 | 4.9E-03 | 1.6E-11 | 7.8E-14 |
| U-236 | 2.0E-03 | 1.5E-11 | 3.1E-14 |
| U-238 | 1.1E-01 | 2.8E-11 | 3.1E-12 |
| | | ILCR Summation = | 6.6E-11 |

0700

**Table K.IV-71**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Child Future Land Use With Federal Ownership**
**Via Ingestion of Dairy Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of dairy products | 0.9 | l/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 6 | Year |
| EDc | Exposure duration for carcinogens | 6 | Year |
| BW | Body weight | 15 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 2190 | days |
| CS | Concentration of chemicals in animal products | | |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 6.6E-07 | mg/kg |
| Aroclor-1016 | NA | mg/kg |
| Aroclor-1221 | 1.8E-11 | mg/kg |
| Aroclor-1242 | NA | mg/kg |
| Aroclor-1248 | 2.0E-08 | mg/kg |
| Aroclor-1254 | 1.7E-06 | mg/kg |
| Aroclor-1260 | 6.3E-06 | mg/kg |
| Arsenic | 1.7E-07 | mg/kg |
| Barium | 5.2E-05 | mg/kg |
| Beryllium | 2.3E-10 | mg/kg |
| Cadmium | 1.5E-06 | mg/kg |
| Chromium | NA | mg/kg |
| Cobalt | 6.0E-06 | mg/kg |
| Copper | 1.4E-05 | mg/kg |
| Cyanide | NA | mg/kg |
| Di-n-octyl phthalate | 1.1E-04 | mg/kg |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Lead | 5.4E-06 | mg/kg |
| Manganese | 5.0E-05 | mg/kg |
| Mercury | 2.5E-08 | mg/kg |
| Molybdenum | 1.6E-06 | mg/kg |
| Nickel | 8.2E-06 | mg/kg |
| Octachlorodibenzofuran | NA | mg/kg |
| Selenium | 8.3E-08 | mg/kg |
| Thallium | 1.7E-07 | mg/kg |
| Vanadium | 1.3E-07 | mg/kg |
| Zinc | 3.1E-04 | mg/kg |
| 2-Chlorophenol | NA | mg/kg |
| 2-Methylnaphthalene | 7.3E-10 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | mg/kg |
| 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-71 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Child Future Land Use With Federal Ownership**
**Via Ingestion of Dairy Products**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 3.9E-08 | 4.0E-04 | 9.7E-05 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.0E-12 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.1E-09 | NA | NA |
| Aroclor-1254 | 9.9E-08 | NA | NA |
| Aroclor-1260 | 3.6E-07 | NA | NA |
| Arsenic | 1.0E-08 | 3.0E-04 | 3.3E-05 |
| Barium | 3.0E-08 | 7.0E-02 | 4.2E-05 |
| Beryllium | 1.3E-11 | 5.0E-03 | 2.6E-09 |
| Cadmium | 8.5E-08 | 5.0E-04 | 1.7E-04 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 3.4E-07 | 6.0E-02 | 5.7E-06 |
| Copper | 8.2E-07 | NA | NA |
| Cyanide | NA | 2.0E-02 | NA |
| Di-n-octyl phthalate | 6.4E-06 | 2.0E-02 | 3.2E-04 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.1E-07 | NA | NA |
| Manganese | 2.9E-06 | 1.4E-01 | 2.1E-05 |
| Mercury | 1.4E-09 | 3.0E-04 | 4.8E-06 |
| Molybdenum | 9.3E-08 | 5.0E-03 | 1.9E-05 |
| Nickel | 4.7E-07 | 2.0E-02 | 2.4E-05 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 4.8E-09 | 5.0E-03 | 9.6E-07 |
| Thallium | 9.5E-09 | 8.0E-05 | 1.2E-04 |
| Vanadium | 7.3E-09 | 7.0E-03 | 1.0E-06 |
| Zinc | 1.8E-05 | 3.0E-01 | 6.0E-05 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 4.2E-11 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 9.2E-04 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 3.3E-09 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 8.8E-14 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 9.6E-11 | 7.7E+00 | 7.4E-10 |
| Aroclor-1254 | 8.5E-09 | 7.7E+00 | 6.5E-08 |
| Aroclor-1260 | 3.1E-08 | 7.7E+00 | 2.4E-07 |
| Arsenic | 8.5E-10 | 1.8E+00 | 1.5E-09 |
| Barium | 2.5E-07 | NA | NA |
| Beryllium | 1.1E-12 | 4.3E+00 | 4.8E-12 |
| Cadmium | 7.3E-09 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 3.0E-08 | NA | NA |
| Copper | 7.0E-08 | NA | NA |
| Cyanide | NA | NA | NA |
| Di-n-octyl phthalate | 5.5E-07 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 2.7E-08 | NA | NA |
| Manganese | 2.5E-07 | NA | NA |
| Mercury | 1.2E-10 | NA | NA |
| Molybdenum | 7.9E-09 | NA | NA |
| Nickel | 4.1E-08 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 4.1E-10 | NA | NA |
| Thallium | 8.1E-10 | NA | NA |
| Vanadium | 6.3E-10 | NA | NA |
| Zinc | 1.5E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.6E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 3.1E-07 |

5208

**Table K.IV-72**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Child Future Land Use With Federal Ownership**
**Via Ingestion of Dairy Products**

**Intake Equation** = Cp X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of dairy products | 0.9 l/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 6 Year |
| Cp | Concentration of radionuclides in animal products | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 1.2E-03 | pCi/kg | Sr-90 | 7.9E-25 | pCi/kg |
| Np-237 | 1.2E-07 | pCi/kg | Tc-99 | 2.3E-23 | pCi/kg |
| Pa-231 | 6.0E-05 | pCi/kg | Th-228 | 2.4E-06 | pCi/kg |
| Pb-210 | NA | pCi/kg | Th-230 | 2.7E-06 | pCi/kg |
| Pu-238 | 1.7E-08 | pCi/kg | Th-232 | 1.4E-06 | pCi/kg |
| Pu-239 | 1.1E-08 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 1.1E-08 | pCi/kg | U-234 | 9.1E-03 | pCi/kg |
| Ra-226 | 1.3E-04 | pCi/kg | U-235 | 2.4E-04 | pCi/kg |
| Ra-228 | 1.3E-04 | pCi/kg | U-236 | 1.0E-04 | pCi/kg |
| | | | U-238 | 5.5E-03 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 2.2E+00 | 2.8E-11 | 6.1E-11 |
| Np-237 | 2.3E-04 | 2.2E-10 | 5.1E-14 |
| Pa-231 | 1.1E-01 | 9.2E-11 | 1.0E-11 |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | 3.2E-05 | 2.2E-10 | 7.1E-15 |
| Pu-239 | 2.1E-05 | 2.3E-10 | 4.8E-15 |
| Pu-240 | 2.1E-05 | 2.3E-10 | 4.8E-15 |
| Ra-226 | 2.4E-01 | 1.2E-10 | 2.9E-11 |
| Ra-228 | 2.5E-01 | 1.0E-10 | 2.5E-11 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 1.5E-21 | 3.3E-10 | 4.9E-31 |
| Tc-99 | 4.3E-20 | 1.3E-12 | 5.6E-32 |
| Th-228 | 4.6E-03 | 5.5E-11 | 2.5E-13 |
| Th-230 | 5.0E-03 | 1.3E-11 | 6.5E-14 |
| Th-232 | 2.7E-03 | 1.2E-11 | 3.2E-14 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 1.7E+01 | 1.6E-11 | 2.8E-10 |
| U-235 | 4.6E-01 | 1.6E-11 | 7.4E-12 |
| U-236 | 1.9E-01 | 1.5E-11 | 2.9E-12 |
| U-238 | 1.0E+01 | 2.8E-11 | 2.9E-10 |
| | | ILCR Summation = | 7.0E-10 |



0703

**Table K.IV-73**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Child Future Land Use With Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.102 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 6 | Year |
| EDc | Exposure duration for carcinogens | 6 | Year |
| BW | Body weight | 15 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 2190 | days |
| CS | Concentration of chemicals in vegetables | | |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 1.7E-04 | mg/kg |
| Aroclor-1016 | NA | mg/kg |
| Aroclor-1221 | 8.4E-08 | mg/kg |
| Aroclor-1242 | NA | mg/kg |
| Aroclor-1248 | 4.7E-08 | mg/kg |
| Aroclor-1254 | 2.6E-06 | mg/kg |
| Aroclor-1260 | 2.4E-06 | mg/kg |
| Arsenic | 7.0E-05 | mg/kg |
| Barium | 3.6E-03 | mg/kg |
| Beryllium | 6.1E-06 | mg/kg |
| Cadmium | 3.5E-05 | mg/kg |
| Chromium | NA | mg/kg |
| Cobalt | 7.3E-05 | mg/kg |
| Copper | 2.3E-04 | mg/kg |
| Cyanide | 1.4E-05 | mg/kg |
| Di-n-octyl phthalate | 2.2E-07 | mg/kg |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Lead | 5.3E-04 | mg/kg |
| Manganese | 3.5E-03 | mg/kg |
| Mercury | 1.3E-06 | mg/kg |
| Molybdenum | 2.6E-05 | mg/kg |
| Nickel | 2.0E-04 | mg/kg |
| Octachlorodibenzofuran | NA | mg/kg |
| Selenium | 5.1E-07 | mg/kg |
| Thallium | 2.0E-06 | mg/kg |
| Vanadium | 1.6E-04 | mg/kg |
| Zinc | 7.2E-04 | mg/kg |
| 2-Chlorophenol | NA | mg/kg |
| 2-Methylnaphthalene | 1.8E-07 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | mg/kg |
| 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-73 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Child Future Land Use With Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 1.1E-06 | 4.0E-04 | 2.7E-03 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 5.5E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 3.1E-10 | NA | NA |
| Aroclor-1254 | 1.7E-08 | NA | NA |
| Aroclor-1260 | 1.6E-08 | NA | NA |
| Arsenic | 4.6E-07 | 3.0E-04 | 1.5E-03 |
| Barium | 2.3E-05 | 7.0E-02 | 3.3E-04 |
| Beryllium | 4.0E-08 | 5.0E-03 | 7.9E-06 |
| Cadmium | 2.3E-07 | 5.0E-04 | 4.6E-04 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 4.8E-07 | 6.0E-02 | 7.9E-06 |
| Copper | 1.5E-06 | NA | NA |
| Cyanide | 8.9E-08 | 2.0E-02 | 4.5E-06 |
| Di-n-octyl phthalate | 1.4E-09 | 2.0E-02 | 7.1E-08 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.4E-06 | NA | NA |
| Manganese | 2.3E-05 | 1.4E-01 | 1.6E-04 |
| Mercury | 8.5E-09 | 3.0E-04 | 2.8E-05 |
| Molybdenum | 1.7E-07 | 5.0E-03 | 3.4E-05 |
| Nickel | 1.3E-06 | 2.0E-02 | 6.5E-05 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 3.3E-09 | 5.0E-03 | 6.6E-07 |
| Thallium | 1.3E-08 | 8.0E-05 | 1.6E-04 |
| Vanadium | 1.0E-06 | 7.0E-03 | 1.4E-04 |
| Zinc | 4.7E-06 | 3.0E-01 | 1.6E-05 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 1.1E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 5.6E-03 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 9.2E-08 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 4.7E-11 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 2.6E-11 | 7.7E+00 | 2.0E-10 |
| Aroclor-1254 | 1.5E-09 | 7.7E+00 | 1.1E-08 |
| Aroclor-1260 | 1.3E-09 | 7.7E+00 | 1.0E-08 |
| Arsenic | 3.9E-08 | 1.8E+00 | 3.9E-08 |
| Barium | 2.0E-06 | NA | NA |
| Beryllium | 3.4E-09 | 4.3E+00 | 1.5E-08 |
| Cadmium | 2.0E-08 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 4.1E-08 | NA | NA |
| Copper | 1.3E-07 | NA | NA |
| Cyanide | 7.7E-09 | NA | NA |
| Di-n-octyl phthalate | 1.2E-10 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.0E-07 | NA | NA |
| Manganese | 1.9E-06 | NA | NA |
| Mercury | 7.3E-10 | NA | NA |
| Molybdenum | 1.5E-08 | NA | NA |
| Nickel | 1.1E-07 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.8E-10 | NA | NA |
| Thallium | 1.1E-09 | NA | NA |
| Vanadium | 8.7E-08 | NA | NA |
| Zinc | 4.0E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 9.8E-11 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 1.0E-07 |

5208

**Table K.IV-74**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Child Future Land Use With Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

**Intake Equation** = Cv X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.102 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 6 Year |
| Cv | Concentration of radionuclides in vegetables | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 4.0E-03 | pCi/kg | Sr-90 | 3.4E-13 | pCi/kg |
| Np-237 | 5.8E-04 | pCi/kg | Tc-99 | 1.5E-12 | pCi/kg |
| Pa-231 | 2.9E-03 | pCi/kg | Th-228 | 1.2E-02 | pCi/kg |
| Pb-210 | 6.2E-02 | pCi/kg | Th-230 | 1.3E-02 | pCi/kg |
| Pu-238 | 4.2E-03 | pCi/kg | Th-232 | 6.9E-03 | pCi/kg |
| Pu-239 | 2.7E-03 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 2.7E-03 | pCi/kg | U-234 | 3.3E-01 | pCi/kg |
| Ra-226 | 7.0E-03 | pCi/kg | U-235 | 8.9E-03 | pCi/kg |
| Ra-228 | 7.3E-03 | pCi/kg | U-236 | 3.7E-03 | pCi/kg |
| | | | U-238 | 2.0E-01 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 8.6E-01 | 2.8E-11 | 2.4E-11 |
| Np-237 | 1.2E-01 | 2.2E-10 | 2.7E-11 |
| Pa-231 | 6.2E-01 | 9.2E-11 | 5.7E-11 |
| Pb-210 | 1.3E+01 | 6.6E-10 | 8.7E-09 |
| Pu-238 | 8.9E-01 | 2.2E-10 | 2.0E-10 |
| Pu-239 | 5.7E-01 | 2.3E-10 | 1.3E-10 |
| Pu-240 | 5.7E-01 | 2.3E-10 | 1.3E-10 |
| Ra-226 | 1.5E+00 | 1.2E-10 | 1.8E-10 |
| Ra-228 | 1.6E+00 | 1.0E-10 | 1.6E-10 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 7.3E-11 | 3.3E-10 | 2.4E-20 |
| Tc-99 | 3.2E-10 | 1.3E-12 | 4.1E-22 |
| Th-228 | 2.6E+00 | 5.5E-11 | 1.4E-10 |
| Th-230 | 2.8E+00 | 1.3E-11 | 3.6E-11 |
| Th-232 | 1.5E+00 | 1.2E-11 | 1.8E-11 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 7.1E+01 | 1.6E-11 | 1.1E-09 |
| U-235 | 1.9E+00 | 1.6E-11 | 3.1E-11 |
| U-236 | 8.0E-01 | 1.5E-11 | 1.2E-11 |
| U-238 | 4.3E+01 | 2.8E-11 | 1.2E-09 |
| | | ILCR Summation = | 1.2E-08 |

0706

- 5208

= 0208

# Future Land Use Without Federal Ownership

0708

{This page intentionally left blank}

**Table K.IV-75**
**Summary of Intake Quantitation (chemicals)**
**On-Property RMB Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Inhalation of Particulates**

**Intake Equation** = $\frac{CS \times EF \times ED \times IR}{BW \times AT}$

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 20 $m^3$/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration for non-carcinogens | 70 Year |
| EDc | Exposure duration for carcinogens | 70 Year |
| BW | Body weight | 70 kg |
| ATc | Average time for carcinogens (lifetime) | 25550 days |
| ATn | Average time for non-carcinogens (EDn x 365) | 25550 days |
| CS | Concentration of chemicals in particulate as modeled | (see table below) |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 2.8E-06 | mg/m$^3$ |
| Aroclor-1016 | NA | mg/m$^3$ |
| Aroclor-1221 | 4.2E-09 | mg/m$^3$ |
| Aroclor-1242 | NA | mg/m$^3$ |
| Aroclor-1248 | 2.8E-09 | mg/m$^3$ |
| Aroclor-1254 | 1.3E-07 | mg/m$^3$ |
| Aroclor-1260 | 1.4E-07 | mg/m$^3$ |
| Arsenic | 1.7E-06 | mg/m$^3$ |
| Barium | 1.9E-04 | mg/m$^3$ |
| Beryllium | 1.6E-07 | mg/m$^3$ |
| Cadmium | 5.8E-07 | mg/m$^3$ |
| Chromium | 4.7E-07 | mg/m$^3$ |
| Cobalt | 1.5E-06 | mg/m$^3$ |
| Copper | 7.4E-06 | mg/m$^3$ |
| Cyanide | 7.4E-07 | mg/m$^3$ |
| Di-n-octyl phthalate | 1.2E-08 | mg/m$^3$ |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/m$^3$ |
| Heptachlorodibenzo-p-dioxin | NA | mg/m$^3$ |
| Lead | 2.4E-05 | mg/m$^3$ |
| Manganese | 6.5E-05 | mg/m$^3$ |
| Mercury | 6.7E-08 | mg/m$^3$ |
| Molybdenum | 4.3E-07 | mg/m$^3$ |
| Nickel | 4.3E-06 | mg/m$^3$ |
| Octachlorodibenzofuran | NA | mg/m$^3$ |
| Selenium | 3.6E-08 | mg/m$^3$ |
| Thallium | 4.7E-08 | mg/m$^3$ |
| Vanadium | 2.9E-06 | mg/m$^3$ |
| Zinc | 2.0E-05 | mg/m$^3$ |
| 2-Chlorophenol | NA | mg/m$^3$ |
| 2-Methylnaphthalene | 1.1E-08 | mg/m$^3$ |
| 4-Chlorophenyl-phenylether | NA | mg/m$^3$ |
| 4,4-DDT | NA | mg/m$^3$ |

**References**

0710

**Table K.IV-75 (continued)**
**Summary of Risk Characterization (chemicals)**
**On-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Inhalation of Particulates**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 7.6E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.2E-09 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 7.6E-10 | NA | NA |
| Aroclor-1254 | 3.5E-08 | NA | NA |
| Aroclor-1260 | 3.9E-08 | NA | NA |
| Arsenic | 4.6E-07 | NA | NA |
| Barium | 5.2E-05 | 1.4E-04 | 3.7E-01 |
| Beryllium | 4.4E-08 | NA | NA |
| Cadmium | 1.6E-07 | NA | NA |
| Chromium | 1.3E-07 | NA | NA |
| Cobalt | 4.2E-07 | 3.0E-07 | 1.4E+00 |
| Copper | 2.0E-06 | NA | NA |
| Cyanide | 2.0E-07 | NA | NA |
| Di-n-octyl phthalate | 3.2E-09 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 6.5E-06 | NA | NA |
| Manganese | 1.8E-05 | 1.1E-04 | 1.6E-01 |
| Mercury | 1.8E-08 | 8.6E-05 | 2.1E-04 |
| Molybdenum | 1.2E-07 | NA | NA |
| Nickel | 1.2E-06 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 9.7E-09 | NA | NA |
| Thallium | 1.3E-08 | NA | NA |
| Vanadium | 7.9E-07 | NA | NA |
| Zinc | 5.3E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.0E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | NA | NA |
| | HQ Summation = | | 1.9E+00 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 7.6E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.2E-09 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 7.6E-10 | NA | NA |
| Aroclor-1254 | 3.5E-08 | NA | NA |
| Aroclor-1260 | 3.9E-08 | NA | NA |
| Arsenic | 4.6E-07 | 1.5E+01 | 6.9E-06 |
| Barium | 5.2E-05 | NA | NA |
| Beryllium | 4.4E-08 | 8.4E+00 | 3.7E-07 |
| Cadmium | 1.6E-07 | 6.1E+00 | 9.7E-07 |
| Chromium | 1.3E-07 | 4.1E+01 | 5.2E-06 |
| Cobalt | 4.2E-07 | NA | NA |
| Copper | 2.0E-06 | NA | NA |
| Cyanide | 2.0E-07 | NA | NA |
| Di-n-octyl phthalate | 3.2E-09 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 6.5E-06 | NA | NA |
| Manganese | 1.8E-05 | NA | NA |
| Mercury | 1.8E-08 | NA | NA |
| Molybdenum | 1.2E-07 | NA | NA |
| Nickel | 1.2E-06 | 8.4E-01 | 9.9E-07 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 9.7E-09 | NA | NA |
| Thallium | 1.3E-08 | NA | NA |
| Vanadium | 7.9E-07 | NA | NA |
| Zinc | 5.3E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.0E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 1.5E-05 |

**Table K.IV–76**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**On–Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Inhalation of Gases and Particulates**

**Intake Equation** = Ca X EF X EDn X IR

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 20 $m^3$/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 70 Year |
| Ca | Concentration of radionuclides in air | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac–227 | NA | pCi/$m^3$ | Rn–222 | 9.6E+00 | pCi/$m^3$ |
| Am–241 | NA | pCi/$m^3$ | Ru–106 | NA | pCi/$m^3$ |
| Cs–137 | 7.8E–05 | pCi/$m^3$ | Sr–90 | 3.0E–04 | pCi/$m^3$ |
| Np–237 | 3.6E–05 | pCi/$m^3$ | Tc–99 | 2.0E–03 | pCi/$m^3$ |
| Pa–231 | 1.7E–04 | pCi/$m^3$ | Th–228 | 2.1E–04 | pCi/$m^3$ |
| Pb–210 | 3.6E–03 | pCi/$m^3$ | Th–230 | 2.4E–04 | pCi/$m^3$ |
| Pu–238 | 1.7E–04 | pCi/$m^3$ | Th–232 | 1.5E–04 | pCi/$m^3$ |
| Pu–239 | 7.2E–05 | pCi/$m^3$ | U–233 | NA | pCi/$m^3$ |
| Pu–240 | 7.2E–05 | pCi/$m^3$ | U–234 | 3.6E–03 | pCi/$m^3$ |
| Ra–226 | 1.5E–04 | pCi/$m^3$ | U–235 | 9.6E–05 | pCi/$m^3$ |
| Ra–228 | 1.6E–04 | pCi/$m^3$ | U–236 | 4.0E–05 | pCi/$m^3$ |
| | | | U–238 | 2.2E–03 | pCi/$m^3$ |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac–227 | NA | 8.9E–08 | NA |
| Am–241 | NA | 3.2E–08 | NA |
| Cs–137 | 3.8E+01 | 1.9E–11 | 7.3E–10 |
| Np–237 | 1.8E+01 | 2.9E–08 | 5.1E–07 |
| Pa–231 | 8.1E+01 | 3.6E–08 | 2.9E–06 |
| Pb–210 | 1.8E+03 | 4.0E–09 | 7.1E–06 |
| Pu–238 | 8.1E+01 | 3.9E–08 | 3.2E–06 |
| Pu–239 | 3.5E+01 | 3.8E–08 | 1.3E–06 |
| Pu–240 | 3.5E+01 | 3.8E–08 | 1.3E–06 |
| Ra–226 | 7.1E+01 | 3.0E–09 | 2.1E–07 |
| Ra–228 | 7.8E+01 | 6.9E–10 | 5.4E–08 |
| Rn–222 | 4.7E+06 | 7.7E–12 | 3.6E–05 |
| Ru–106 | NA | 4.4E–10 | NA |
| Sr–90 | 1.5E+02 | 5.6E–11 | 8.3E–09 |
| Tc–99 | 9.8E+02 | 8.3E–12 | 8.1E–09 |
| Th–228 | 1.0E+02 | 7.8E–08 | 8.1E–06 |
| Th–230 | 1.2E+02 | 2.9E–08 | 3.4E–06 |
| Th–232 | 7.5E+01 | 2.8E–08 | 2.1E–06 |
| U–233 | NA | 2.7E–08 | NA |
| U–234 | 1.8E+03 | 2.6E–08 | 4.6E–05 |
| U–235 | 4.7E+01 | 2.5E–08 | 1.2E–06 |
| U–236 | 2.0E+01 | 2.5E–08 | 4.9E–07 |
| U–238 | 1.1E+03 | 5.2E–08 | 5.5E–05 |
| | | ILCR Summation = | 1.7E–04 |

- 5208

**Table K.IV-77**
**Summary of Intake Quantitation (Chemicals)**
**On-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Incidental Ingestion of Soil/Sediment**

**Intake Equation** = $\frac{CS \times EF \times ED \times CF \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IRs | Ingestion rate of soil (RAGS, 1989) | 180 | mg/day |
| CF | Conversion factor | 1.00E-06 | kg/mg |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carchogens | 70 | Year |
| EDc | Exposure duration for carcinogens | 70 | Year |
| BW | Body weight | 70 | kg |
| ATc | Average time for carchogens (lifetime) | 25550 | days |
| ATn | Average time for non-carchogens (EDn x 365) | 25550 | days |
| CS | Concentration of chemicals in soil | (see table below) | |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 3.1E+01 | mg/kg |
| Aroclor-1016 | NA | mg/kg |
| Aroclor-1221 | 8.0E-02 | mg/kg |
| Aroclor-1242 | NA | mg/kg |
| Aroclor-1248 | 6.0E-02 | mg/kg |
| Aroclor-1254 | 2.5E+00 | mg/kg |
| Aroclor-1260 | 2.8E+00 | mg/kg |
| Arsenic | 2.6E+01 | mg/kg |
| Barium | 3.6E+03 | mg/kg |
| Beryllium | 2.4E+00 | mg/kg |
| Cadmium | 6.9E+00 | mg/kg |
| Chromium | 7.6E+00 | mg/kg |
| Cobalt | 2.1E+01 | mg/kg |
| Copper | 1.3E+02 | mg/kg |
| Cyanide | 1.4E+01 | mg/kg |
| Di-n-octyl phthalate | 6.6E-01 | mg/kg |
| Heptachlorodibenzofuran | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Lead | 4.4E+02 | mg/kg |
| Manganese | 8.3E+02 | mg/kg |
| Mercury | 1.3E+00 | mg/kg |
| Molybdenum | 1.3E+01 | mg/kg |
| Nickel | 5.9E+01 | mg/kg |
| Octachlorodibenzofuran | NA | mg/kg |
| Selenium | 5.7E+00 | mg/kg |
| Thallium | 7.1E-01 | mg/kg |
| Vanadium | 3.6E+01 | mg/kg |
| Zinc | 3.4E+02 | mg/kg |
| 2-Chlorophenol | NA | mg/kg |
| 2-Methylnaphthalene | 2.2E-01 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | mg/kg |
| 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-77 (continued)**
**Summary of Risk Characterization (chemicals)**
**On-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Incidental Ingestion of Soil/Sediment**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 7.7E-05 | 4.0E-04 | 1.9E-01 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 2.0E-07 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.5E-07 | NA | NA |
| Aroclor-1254 | 6.1E-06 | NA | NA |
| Aroclor-1260 | 6.9E-06 | NA | NA |
| Arsenic | 6.3E-05 | 3.0E-04 | 2.1E-01 |
| Barium | 8.9E-03 | 7.0E-02 | 1.3E-01 |
| Beryllium | 5.9E-06 | 5.0E-03 | 1.2E-03 |
| Cadmium | 1.7E-05 | 5.0E-04 | 3.4E-02 |
| Chromium | 1.9E-05 | 5.0E-03 | 3.7E-03 |
| Cobalt | 5.1E-05 | 6.0E-02 | 8.6E 04 |
| Copper | 3.2E-04 | NA | NA |
| Cyanide | 3.5E-05 | 2.0E-02 | 1 8E-03 |
| Di-n-octyl phthalate | 1.6E-06 | 2.0E-02 | 8.1E-05 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.1E-03 | NA | NA |
| Manganese | 2.1E-03 | 1.4E-01 | 1 5E-02 |
| Mercury | 3.2E-06 | 3.0E-04 | 1.1E-02 |
| Molybdenum | 3.3E-05 | 5.0E-03 | 6.6E-03 |
| Nickel | 1.5E-04 | 2.0E-02 | 7.3E-03 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 1.4E-05 | 5.0E-03 | 2.8E-03 |
| Thallium | 1.8E-06 | 8.0E-05 | 2.2E-02 |
| Vanadium | 8.8E-05 | 7.0E-03 | 1.3E-02 |
| Zinc | 8.3E-04 | 3.0E-01 | 2.8E-03 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 5.4E-07 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 6.5E-01 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 7.7E-05 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 2.0E-07 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 1.5E-07 | 7.7E+00 | 1.1E-06 |
| Aroclor-1254 | 6.1E-06 | 7.7E+00 | 4.7E-05 |
| Aroclor-1260 | 6.9E-06 | 7.7E+00 | 5 3E-05 |
| Arsenic | 6.3E-05 | 1.8E+00 | 1.1E-04 |
| Barium | 8.9E-03 | NA | NA |
| Beryllium | 5.9E-06 | 4.3E+00 | 2.5E-05 |
| Cadmium | 1.7E-05 | NA | NA |
| Chromium | 1.9E-05 | NA | NA |
| Cobalt | 5.1E-05 | NA | NA |
| Copper | 3.2E-04 | NA | NA |
| Cyanide | 3 5E-05 | NA | NA |
| Di-n-octyl phthalate | 1.6E-06 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.1E-03 | NA | NA |
| Manganese | 2.1E-03 | NA | NA |
| Mercury | 3.2E-06 | NA | NA |
| Molybdenum | 3.3E-05 | NA | NA |
| Nickel | 1.5E-04 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 1.4E-05 | NA | NA |
| Thallium | 1.8E-06 | NA | NA |
| Vanadium | 8.8E-05 | NA | NA |
| Zinc | 8.3E-04 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 5.4E-07 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 2.4E-04 |

5208

# Table K.IV-78
## Summary of Intake and Risk Quantitation (Radionuclides)
## On-Property RME Resident Farm Adult Future Land Use Without Federal Ownership
## Via Incidental Ingestion of Soil/Sediment

**Intake Equation** = CS X EF X EDn X FI X IR

| | | | |
|---|---|---|---|
| IRs | Ingestion rate of soil (RAGS, 1989) | 180 | mg/day |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure Duration | 70 | Year |
| FI | Fractional Intake | 1 | (unitless) |
| CS | Concentration of radionuclides in soil | | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/mg | Rn-222 | NA | pCi/mg |
| Am-241 | NA | pCi/mg | Ru-106 | NA | pCi/mg |
| Cs-137 | 1.0E-03 | pCi/mg | Sr-90 | 5.2E-03 | pCi/mg |
| Np-237 | 7.0E-04 | pCi/mg | Tc-99 | 3.8E-02 | pCi/mg |
| Pa-231 | 2.5E-02 | pCi/mg | Th-228 | 5.0E-03 | pCi/mg |
| Pb-210 | 7.0E-02 | pCi/mg | Th-230 | 5.0E-03 | pCi/mg |
| Pu-238 | 3.0E-03 | pCi/mg | Th-232 | 5.0E-03 | pCi/mg |
| Pu-239 | 1.1E-03 | pCi/mg | U-233 | NA | pCi/mg |
| Pu-240 | 1.1E-03 | pCi/mg | U-234 | 1.0E-01 | pCi/mg |
| Ra-226 | 5.0E-03 | pCi/mg | U-235 | 2.7E-03 | pCi/mg |
| Ra-228 | 5.0E-03 | pCi/mg | U-236 | 2.5E-03 | pCi/mg |
| | | | U-238 | 6.0E-02 | pCi/mg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 4.4E+03 | 2.8E-11 | 1.2E-07 |
| Np-237 | 3.1E+03 | 2.2E-10 | 6.8E-07 |
| Pa-231 | 1.1E+05 | 9.2E-11 | 1.0E-05 |
| Pb-210 | 3.1E+05 | 6.6E-10 | 2.0E-04 |
| Pu-238 | 1.3E+04 | 2.2E-10 | 2.9E-06 |
| Pu-239 | 4.9E+03 | 2.3E-10 | 1.1E-06 |
| Pu-240 | 4.9E+03 | 2.3E-10 | 1.1E-06 |
| Ra-226 | 2.2E+04 | 1.2E-10 | 2.6E-06 |
| Ra-228 | 2.2E+04 | 1.0E-10 | 2.2E-06 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 2.3E+04 | 3.3E-10 | 7.5E-06 |
| Tc-99 | 1.7E+05 | 1.3E-12 | 2.2E-07 |
| Th-228 | 2.2E+04 | 5.5E-11 | 1.2E-06 |
| Th-230 | 2.2E+04 | 1.3E-11 | 2.9E-07 |
| Th-232 | 2.2E+04 | 1.2E-11 | 2.6E-07 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 4.4E+05 | 1.6E-11 | 7.1E-06 |
| U-235 | 1.2E+04 | 1.6E-11 | 1.9E-07 |
| U-236 | 1.1E+04 | 1.5E-11 | 1.6E-07 |
| U-238 | 2.6E+05 | 2.8E-11 | 7.4E-06 |
| | | **ILCR Summation** = | 2.5E-04 |

5208

**Table K.IV-79**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**On-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Ingestion of Drinking Water**

**Intake Equation** = Cw X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of groundwater (RAGS, 1989) | 2 l/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 70 Year |
| FI | Fractional intake for radionuclides | 1 (Unitless) |
| Cw | Concentration of radionuclides in groundwater | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/l | Rn-222 | NA | pCi/l |
| Am-241 | NA | pCi/l | Ru-106 | NA | pCi/l |
| Cs-137 | NA | pCi/l | Sr-90 | 5.9E-06 | pCi/l |
| Np-237 | NA | pCi/l | Tc-99 | NA | pCi/l |
| Pa-231 | NA | pCi/l | Th-228 | NA | pCi/l |
| Pb-210 | NA | pCi/l | Th-230 | NA | pCi/l |
| Pu-238 | NA | pCi/l | Th-232 | NA | pCi/l |
| Pu-239 | NA | pCi/l | U-233 | NA | pCi/l |
| Pu-240 | NA | pCi/l | U-234 | 6.7E-01 | pCi/l |
| Ra-226 | NA | pCi/l | U-235 | 1.8E-02 | pCi/l |
| Ra-228 | NA | pCi/l | U-236 | 7.4E-03 | pCi/l |
| | | | U-238 | 4.0E-01 | pCi/l |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | NA | 2.8E-11 | NA |
| Np-237 | NA | 2.2E-10 | NA |
| Pa-231 | NA | 9.2E-11 | NA |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | NA | 2.2E-10 | NA |
| Pu-239 | NA | 2.3E-10 | NA |
| Pu-240 | NA | 2.3E-10 | NA |
| Ra-226 | NA | 1.2E-10 | NA |
| Ra-228 | NA | 1.0E-10 | NA |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 2.9E-01 | 3.3E-10 | 9.5E-11 |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | NA | 5.5E-11 | NA |
| Th-230 | NA | 1.3E-11 | NA |
| Th-232 | NA | 1.2E-11 | NA |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 3.3E+04 | 1.6E-11 | 5.3E-07 |
| U-235 | 8.8E+02 | 1.6E-11 | 1.4E-08 |
| U-236 | 3.6E+02 | 1.5E-11 | 5.4E-09 |
| U-238 | 2.0E+04 | 2.8E-11 | 5.5E-07 |
| | | ILCR Summation = | 1.1E-06 |

0716

**Table K.IV-80**
**Summary of Intake Quantitation (chemicals)**
**On-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Dermal Contact with Soil/Sediment**

**Intake Equation** = $\frac{CS \times EF \times ED \times CF \times ABS \times AF \times SA}{BW \times AT}$

| | | |
|---|---|---|
| SA | Surface area of exposed skin (50th percentile, hands only) | 5800 $cm^2$/day |
| AF | Soil to skin adherence factor (RAGS, 1989) | 1 $mg/cm^2$ |
| ABS | Chemical specific absorbtion factor (see table below) | csv |
| CF | Conversion factor | 1E-06 kg/mg |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration for non-carcinogens | 70 Year |
| EDc | Exposure duration for carcinogens | 70 Year |
| BW | Body weight | 70 kg |
| ATc | Average time for carcinogens (lifetime) | 25550 days |
| ATn | Average time for non-carcinogens (EDn x 365) | 25550 days |
| CS | Concentration of chemicals in soil | (see table below) |

**Chemical Concentrations**

| Compound | ABS | Concentrati | Units |
|---|---|---|---|
| Antimony | 1.0E-02 | 3.1E+01 | mg/kg |
| Aroclor-1016 | 6.0E-02 | NA | mg/kg |
| Aroclor-1221 | 6.0E-02 | 8.0E-02 | mg/kg |
| Aroclor-1242 | 6.0E-02 | NA | mg/kg |
| Aroclor-1248 | 6.0E-02 | 6.0E-02 | mg/kg |
| Aroclor-1254 | 6.0E-02 | 2.5E+00 | mg/kg |
| Aroclor-1260 | 6.0E-02 | 2.8E+00 | mg/kg |
| Arsenic | 1.0E-03 | 2.6E+01 | mg/kg |
| Barium | 1.0E-02 | 3.6E+03 | mg/kg |
| Beryllium | 1.0E-02 | 2.4E+00 | mg/kg |
| Cadmium | 1.0E-02 | 6.9E+00 | mg/kg |
| Chromium | 1.0E-02 | 7.6E+00 | mg/kg |
| Cobalt | 1.0E-02 | 2.1E+01 | mg/kg |
| Copper | 1.0E-03 | 1.3E+02 | mg/kg |
| Cyanide | NA | 1.4E+01 | mg/kg |
| Di-n-octyl phthalate | 3.0E-01 | 6.6E-01 | mg/kg |

| Compound | ABS | Concentration | Units |
|---|---|---|---|
| Heptachlorodibenzofuran | 3.0E-02 | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | 3.0E-02 | NA | mg/kg |
| Lead | 1.0E-02 | 4.4E+02 | mg/kg |
| Manganese | 1.0E-02 | 8.3E+02 | mg/kg |
| Mercury | 5.0E-02 | 1.3E+00 | mg/kg |
| Molybdenum | 1.0E-02 | 1.3E+01 | mg/kg |
| Nickel | 5.0E-04 | 5.9E+01 | mg/kg |
| Octachlorodibenzofuran | 3.0E-02 | NA | mg/kg |
| Selenium | 1.0E-02 | 5.7E+00 | mg/kg |
| Thallium | 1.0E-02 | 7.1E-01 | mg/kg |
| Vanadium | 1.0E-03 | 3.6E+01 | mg/kg |
| Zinc | 1.0E-02 | 3.4E+02 | mg/kg |
| 2-Chlorophenol | NA | NA | mg/kg |
| 2-Methylnaphthalene | NA | 2.2E-01 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | NA | mg/kg |
| 4,4-DDT | 3.0E-01 | NA | mg/kg |

**References**

**Table K.IV-80 (continued)**
**Summary of Risk Characterization (chemicals)**
**On-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Dermal Contact with Soil/Sediment**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 2.5E-05 | 4.0E-04 | 6.2E-02 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 3.8E-07 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 2.9E-07 | NA | NA |
| Aroclor-1254 | 1.2E-05 | NA | NA |
| Aroclor-1260 | 1.3E-05 | NA | NA |
| Arsenic | 2.0E-06 | 3.0E-04 | 6.8E-03 |
| Barium | 2.9E-03 | 7.0E-02 | 4.1E-02 |
| Beryllium | 1.9E-06 | 5.0E-03 | 3.8E-04 |
| Cadmium | 5.5E-06 | 5.0E-04 | 1.1E-02 |
| Chromium | 6.0E-06 | 5.0E-03 | 1.2E-03 |
| Cobalt | 1.7E-05 | 6.0E-02 | 2.8E-04 |
| Copper | 1.0E-05 | NA | NA |
| Cyanide | NA | 2.0E-02 | NA |
| Di-n-octyl phthalate | 1.6E-05 | 2.0E-02 | 7.9E-04 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.5E-04 | NA | NA |
| Manganese | 6.6E-04 | 1.4E-01 | 4.7E-03 |
| Mercury | 5.2E-06 | 3.0E-04 | 1.7E-02 |
| Molybdenum | 1.1E-05 | 5.0E-03 | 2.1E-03 |
| Nickel | 2.3E-06 | 2.0E-02 | 1.2E-04 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 4.5E-06 | 5.0E-03 | 9.1E-04 |
| Thallium | 5.6E-07 | 8.0E-05 | 7.1E-03 |
| Vanadium | 2.8E-06 | 7.0E-03 | 4.0E-04 |
| Zinc | 2.7E-04 | 3.0E-01 | 8.9E-04 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | NA | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 1.6E-01 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 2.5E-05 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 3.8E-07 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 2.9E-07 | 7.7E+00 | 2.2E-06 |
| Aroclor-1254 | 1.2E-05 | 7.7E+00 | 9.0E-05 |
| Aroclor-1260 | 1.3E-05 | 7.7E+00 | 1.0E-04 |
| Arsenic | 2.0E-06 | 1.8E+00 | 3.6E-06 |
| Barium | 2.9E-03 | NA | NA |
| Beryllium | 1.9E-06 | 4.3E+00 | 8.2E-06 |
| Cadmium | 5.5E-06 | NA | NA |
| Chromium | 6.0E-06 | NA | NA |
| Cobalt | 1.7E-05 | NA | NA |
| Copper | 1.0E-05 | NA | NA |
| Cyanide | NA | NA | NA |
| Di-n-octyl phthalate | 1.6E-05 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.5E-04 | NA | NA |
| Manganese | 6.6E-04 | NA | NA |
| Mercury | 5.2E-06 | NA | NA |
| Molybdenum | 1.1E-05 | NA | NA |
| Nickel | 2.3E-06 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 4.5E-06 | NA | NA |
| Thallium | 5.6E-07 | NA | NA |
| Vanadium | 2.8E-06 | NA | NA |
| Zinc | 2.7E-04 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | NA | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 2.1E-04 |

5208

**Table K.IV–81**
**Summary of Risk Quantitation (Radionuclides)**
**On–Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via External Radiation**

**Exposure Equation** = $[CR \times EF \times EDn \times ET_i \times (1-SH_i)] + [CR \times EF \times EDn \times ET_o \times (1-SH_o)]$

| | | |
|---|---|---|
| EF | Fraction of year spent exposured | 0.95 (unitless) |
| ED | Exposure duration | 70 Year |
| $ET_i$ | Fraction of day spent indoors | 0.24 (unitless) |
| $ET_o$ | Fraction of day spent outdoors | 0.76 (unitless) |
| $SH_i$ | Shield factor indoors | 0.5 (unitless) |
| $SH_o$ | Shield factor outdoors | 0 (unitless) |
| CR | Radionuclide specific concentrations | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/g | Rn-222 | NA | pCi/g |
| Am-241 | NA | pCi/g | Ru-106 | NA | pCi/g |
| Cs-137 | 1.0E+00 | pCi/g | Sr-90 | 5.2E+00 | pCi/g |
| Np-237 | 7.0E-01 | pCi/g | Tc-99 | 3.8E+01 | pCi/g |
| Pa-231 | 2.5E+01 | pCi/g | Th-228 | 5.0E+00 | pCi/g |
| Pb-210 | 7.0E+01 | pCi/g | Th-230 | 5.0E+00 | pCi/g |
| Pu-238 | 3.0E+00 | pCi/g | Th-232 | 5.0E+00 | pCi/g |
| Pu-239 | 1.1E+00 | pCi/g | U-233 | NA | pCi/g |
| Pu-240 | 1.1E+00 | pCi/g | U-234 | 1.0E+02 | pCi/g |
| Ra-226 | 5.0E+00 | pCi/g | U-235 | 2.7E+00 | pCi/g |
| Ra-228 | 5.0E+00 | pCi/g | U-236 | 2.5E+00 | pCi/g |
| | | | U-238 | 6.0E+01 | pCi/g |

| Radionuclides | CDI (year pCi/g) | CSF $(g/pCi-year)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | NA | NA |
| Am-241 | NA | 4.9E-09 | NA |
| Cs-137 | 5.9E+01 | 2.0E-06 | 1.2E-04 |
| Np-237 | 4.1E+01 | 4.3E-07 | 1.8E-05 |
| Pa-231 | 1.5E+03 | 2.6E-08 | 3.8E-05 |
| Pb-210 | 4.1E+03 | 1.6E-10 | 6.6E-07 |
| Pu-238 | 1.7E+02 | 2.8E-11 | 4.8E-09 |
| Pu-239 | 6.6E+01 | 1.7E-11 | 1.1E-09 |
| Pu-240 | 6.6E+01 | 2.7E-11 | 1.8E-09 |
| Ra-226 | 2.9E+02 | 6.0E-06 | 1.8E-03 |
| Ra-228 | 2.9E+02 | 2.9E-06 | 8.5E-04 |
| Rn-222 | NA | 5.9E-06 | NA |
| Ru-106 | NA | NA | NA |
| Sr-90 | 3.0E+02 | NA | NA |
| Tc-99 | 2.2E+03 | 6.0E-13 | 1.3E-09 |
| Th-228 | 2.9E+02 | 5.6E-06 | 1.6E-03 |
| Th-230 | 2.9E+02 | 5.4E-11 | 1.6E-08 |
| Th-232 | 2.9E+02 | 2.6E-11 | 7.6E-09 |
| U-233 | NA | 4.2E-11 | NA |
| U-234 | 5.9E+03 | 3.0E-11 | 1.8E-07 |
| U-235 | 1.6E+02 | 2.4E-07 | 3.7E-05 |
| U-236 | 1.5E+02 | 2.4E-11 | 3.5E-09 |
| U-238 | 3.5E+03 | 3.6E-08 | 1.3E-04 |
| | | ILCR Summation = | 4.6E-03 |

5208

**Table K.IV-82**
**Summary of Intake Quantitation (chemicals)**
**On-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Ingestion of Meat Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of meat | 0.075 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 70 | Year |
| EDc | Exposure duration for carcinogens | 70 | Year |
| BW | Body weight | 70 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 25550 | days |
| CS | Concentration of chemicals in meat | | |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 3.4E-01 | mg/kg |
| Aroclor-1016 | NA | mg/kg |
| Aroclor-1221 | 2.2E-05 | mg/kg |
| Aroclor-1242 | NA | mg/kg |
| Aroclor-1248 | 3.3E-04 | mg/kg |
| Aroclor-1254 | 6.6E-02 | mg/kg |
| Aroclor-1260 | 2.3E-02 | mg/kg |
| Arsenic | 8.3E-02 | mg/kg |
| Barium | 1.6E+00 | mg/kg |
| Beryllium | 1.5E-03 | mg/kg |
| Cadmium | 1.0E+00 | mg/kg |
| Chromium | NA | mg/kg |
| Cobalt | 4.6E-01 | mg/kg |
| Copper | 1.5E-07 | mg/kg |
| Cyanide | 1.6E+00 | mg/kg |
| Di-n-octyl phthalate | NA | mg/kg |
| Heptachlorodibenzofuran | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Lead | 1.5E-01 | mg/kg |
| Manganese | 3.6E+00 | mg/kg |
| Mercury | 5.4E+00 | mg/kg |
| Molybdenum | 4.0E-01 | mg/kg |
| Nickel | 9.2E-01 | mg/kg |
| Octachlorodibenzofuran | NA | mg/kg |
| Selenium | 4.7E-03 | mg/kg |
| Thallium | 1.3E-02 | mg/kg |
| Vanadium | 6.2E-02 | mg/kg |
| Zinc | 1.2E+03 | mg/kg |
| 2-Chlorophenol | NA | mg/kg |
| 2-Methylnaphthalene | 1.3E-04 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | mg/kg |
| 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-82 (continued)**
**Summary of Risk Characterization (chemicals)**
**On-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Ingestion of Meat Products**

| Compound | HQ Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
| Antimony | 3.5E-04 | 4.0E-04 | 8.8E-01 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 2.2E-08 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 3.4E-07 | NA | NA |
| Aroclor-1254 | 7.0E-05 | NA | NA |
| Aroclor-1260 | 2.3E-05 | NA | NA |
| Arsenic | 8.5E-05 | 3.0E-04 | 2.8E-01 |
| Barium | 1.7E-03 | 7.0E-02 | 2.4E-02 |
| Beryllium | 1.5E-08 | 5.0E-03 | 3.1E-04 |
| Cadmium | 1.0E-03 | 5.0E-04 | 2.0E+00 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 4.9E-04 | 6.0E-02 | 8.2E-03 |
| Copper | 1.5E-10 | NA | NA |
| Cyanide | 1.8E-03 | 2.0E-02 | 9.2E-02 |
| Di-n-octyl phthalate | NA | 2.0E-02 | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.5E-04 | NA | NA |
| Manganese | 3.7E-03 | 1.4E-01 | 2.7E-02 |
| Mercury | 5.5E-03 | 3.0E-04 | 1.8E+01 |
| Molybdenum | 4.1E-04 | 5.0E-03 | 8.2E-02 |
| Nickel | 9.5E-04 | 2.0E-02 | 4.7E-02 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 4.8E-06 | 5.0E-03 | 9.6E-04 |
| Thallium | 1.3E-05 | 8.0E-05 | 1.7E-01 |
| Vanadium | 6.3E-05 | 7.0E-03 | 9.1E-03 |
| Zinc | 1.3E+00 | 3.0E-01 | 4.2E+00 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 1.3E-07 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 2.6E+01 |

| Compound | ILCR Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
| Antimony | 3.5E-04 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 2.2E-08 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 3.4E-07 | 7.7E+00 | 2.6E-06 |
| Aroclor-1254 | 7.0E-05 | 7.7E+00 | 5.4E-04 |
| Aroclor-1260 | 2.3E-05 | 7.7E+00 | 1.8E-04 |
| Arsenic | 8.5E-05 | 1.8E+00 | 1.5E-04 |
| Barium | 1.7E-03 | NA | NA |
| Beryllium | 1.5E-08 | 4.3E+00 | 6.6E-06 |
| Cadmium | 1.0E-03 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 4.9E-04 | NA | NA |
| Copper | 1.5E-10 | NA | NA |
| Cyanide | 1.8E-03 | NA | NA |
| Di-n-octyl phthalate | NA | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.5E-04 | NA | NA |
| Manganese | 3.7E-03 | NA | NA |
| Mercury | 5.5E-03 | NA | NA |
| Molybdenum | 4.1E-04 | NA | NA |
| Nickel | 9.5E-04 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 4.8E-06 | NA | NA |
| Thallium | 1.3E-05 | NA | NA |
| Vanadium | 6.3E-05 | NA | NA |
| Zinc | 1.3E+00 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 1.3E-07 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 8.7E-04 |

- 5208

**Table K.IV–83**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**On–Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Ingestion of Meat Products**

**Intake Equation** = Cf X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of meat | 0.075 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 70 Year |
| Cf | Concentration of radionuclides in meat | |

| | | | | | |
|---|---|---|---|---|---|
| Ac–227 | NA | pCi/kg | Rn–222 | NA | pCi/kg |
| Am–241 | NA | pCi/kg | Ru–106 | NA | pCi/kg |
| Cs–137 | 3.4E–03 | pCi/kg | Sr–90 | NA | pCi/kg |
| Np–237 | 1.4E–06 | pCi/kg | Tc–99 | NA | pCi/kg |
| Pa–231 | 9.6E–03 | pCi/kg | Th–228 | 1.9E–06 | pCi/kg |
| Pb–210 | NA | pCi/kg | Th–230 | 3.2E–06 | pCi/kg |
| Pu–238 | 8.6E–08 | pCi/kg | Th–232 | 1.7E–06 | pCi/kg |
| Pu–239 | 5.5E–08 | pCi/kg | U–233 | NA | pCi/kg |
| Pu–240 | 5.5E–08 | pCi/kg | U–234 | 4.2E–02 | pCi/kg |
| Ra–226 | 7.2E–05 | pCi/kg | U–235 | 1.1E–03 | pCi/kg |
| Ra–228 | 4.8E–05 | pCi/kg | U–236 | 4.6E–04 | pCi/kg |
| | | | U–238 | 2.5E–02 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac–227 | NA | 3.5E–10 | NA |
| Am–241 | NA | 2.4E–10 | NA |
| Cs–137 | 6.2E+00 | 2.8E–11 | 1.7E–10 |
| Np–237 | 2.6E–03 | 2.2E–10 | 5.7E–13 |
| Pa–231 | 1.8E+01 | 9.2E–11 | 1.6E–09 |
| Pb–210 | NA | 6.6E–10 | NA |
| Pu–238 | 1.6E–04 | 2.2E–10 | 3.5E–14 |
| Pu–239 | 1.0E–04 | 2.3E–10 | 2.3E–14 |
| Pu–240 | 1.0E–04 | 2.3E–10 | 2.3E–14 |
| Ra–226 | 1.3E–01 | 1.2E–10 | 1.6E–11 |
| Ra–228 | 8.8E–02 | 1.0E–10 | 8.8E–12 |
| Rn–222 | NA | 1.7E–12 | NA |
| Ru–106 | NA | 9.5E–12 | NA |
| Sr–90 | NA | 3.3E–10 | NA |
| Tc–99 | NA | 1.3E–12 | NA |
| Th–228 | 3.5E–03 | 5.5E–11 | 1.9E–13 |
| Th–230 | 5.9E–03 | 1.3E–11 | 7.6E–14 |
| Th–232 | 3.1E–03 | 1.2E–11 | 3.8E–14 |
| U–233 | NA | 1.6E–11 | NA |
| U–234 | 7.8E+01 | 1.6E–11 | 1.2E–09 |
| U–235 | 2.1E+00 | 1.6E–11 | 3.3E–11 |
| U–236 | 8.5E–01 | 1.5E–11 | 1.3E–11 |
| U–238 | 4.6E+01 | 2.8E–11 | 1.3E–09 |
| | | ILCR Summation = | 4.4E–09 |

0722

**Table K.IV-84**
**Summary of Intake Quantitation (chemicals)**
**On-Property RMB Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Ingestion of Dairy Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of dairy products | 0.3 | l/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 70 | Year |
| EDc | Exposure duration for carcinogens | 70 | Year |
| BW | Body weight | 70 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 25550 | days |
| CS | Concentration of chemicals in animal products | | |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 3.4E-02 | mg/kg | Heptachlorodibenzofuran | NA | mg/kg |
| Aroclor-1016 | NA | mg/kg | Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Aroclor-1221 | 6.8E-06 | mg/kg | Lead | 1.3E-01 | mg/kg |
| Aroclor-1242 | NA | mg/kg | Manganese | 3.2E+00 | mg/kg |
| Aroclor-1248 | 2.4E-04 | mg/kg | Mercury | 9.7E-03 | mg/kg |
| Aroclor-1254 | 1.5E-02 | mg/kg | Molybdenum | 9.6E-02 | mg/kg |
| Aroclor-1260 | 4.6E-02 | mg/kg | Nickel | 1.5E-01 | mg/kg |
| Arsenic | 2.5E-03 | mg/kg | Octachlorodibenzofuran | NA | mg/kg |
| Barium | 3.6E+00 | mg/kg | Selenium | 1.3E-03 | mg/kg |
| Beryllium | 1.3E-06 | mg/kg | Thallium | 6.5E-04 | mg/kg |
| Cadmium | 1.6E-01 | mg/kg | Vanadium | 5.0E-04 | mg/kg |
| Chromium | NA | mg/kg | Zinc | 1.2E+02 | mg/kg |
| Cobalt | 4.6E-02 | mg/kg | 2-Chlorophenol | NA | mg/kg |
| Copper | 1.9E+00 | mg/kg | 2-Methylnaphthalene | 7.0E-05 | mg/kg |
| Cyanide | NA | mg/kg | 4-Chlorophenyl-phenylether | NA | mg/kg |
| Di-n-octylphthalate | 5.7E-01 | mg/kg | 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-84 (continued)**
**Summary of Risk Characterization (chemicals)**
**On-Property RMB Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Ingestion of Dairy Products**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 1.4E-04 | 4.0E-04 | 3.5E-01 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 2.8E-08 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 9.7E-07 | NA | NA |
| Aroclor-1254 | 6.0E-05 | NA | NA |
| Aroclor-1260 | 1.9E-04 | NA | NA |
| Arsenic | 1.0E-05 | 3.0E-04 | 3.4E-02 |
| Barium | 1.6E-02 | 7.0E-02 | 2.3E-01 |
| Beryllium | 5.5E-09 | 5.0E-03 | 1.1E-06 |
| Cadmium | 7.4E-04 | 5.0E-04 | 1.5E+00 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 2.0E-04 | 6.0E-02 | 3.3E-03 |
| Copper | 7.8E-03 | NA | NA |
| Cyanide | NA | 2.0E-02 | NA |
| Di-n-octyl phthalate | 2.3E-03 | 2.0E-02 | 1.2E-01 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 5.1E-04 | NA | NA |
| Manganese | 1.3E-02 | 1.4E-01 | 9.3E-02 |
| Mercury | 4.0E-05 | 3.0E-04 | 1.3E-01 |
| Molybdenum | 4.1E-04 | 5.0E-03 | 8.2E-02 |
| Nickel | 6.3E-04 | 2.0E-02 | 3.2E-02 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 5.1E-06 | 5.0E-03 | 1.0E-03 |
| Thallium | 2.7E-06 | 8.0E-05 | 3.4E-02 |
| Vanadium | 2.0E-06 | 7.0E-03 | 2.9E-04 |
| Zinc | 5.0E-01 | 3.0E-01 | 1.7E+00 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 2.9E-07 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 4.3E+00 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 1.4E-04 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 2.8E-08 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 9.7E-07 | 7.7E+00 | 7.5E-06 |
| Aroclor-1254 | 6.0E-05 | 7.7E+00 | 4.7E-04 |
| Aroclor-1260 | 1.9E-04 | 7.7E+00 | 1.4E-03 |
| Arsenic | 1.0E-05 | 1.8E+00 | 1.8E-05 |
| Barium | 1.6E-02 | NA | NA |
| Beryllium | 5.5E-09 | 4.3E+00 | 2.4E-08 |
| Cadmium | 7.4E-04 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 2.0E-04 | NA | NA |
| Copper | 7.8E-03 | NA | NA |
| Cyanide | NA | NA | NA |
| Di-n-octyl phthalate | 2.3E-03 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 5.1E-04 | NA | NA |
| Manganese | 1.3E-02 | NA | NA |
| Mercury | 4.0E-05 | NA | NA |
| Molybdenum | 4.1E-04 | NA | NA |
| Nickel | 6.3E-04 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 5.1E-06 | NA | NA |
| Thallium | 2.7E-06 | NA | NA |
| Vanadium | 2.0E-06 | NA | NA |
| Zinc | 5.0E-01 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 2.9E-07 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 1.9E-03 |

- 5208

**Table K.IV-85**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**On-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Ingestion of Dairy Products**

**Intake Equation** = Cp X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of dairy products | 0.3 l/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 70 Year |
| Cp | Concentration of radionuclides in animal products | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 1.2E-03 | pCi/kg | Sr-90 | 1.5E-24 | pCi/kg |
| Np-237 | 1.3E-07 | pCi/kg | Tc-99 | 1.2E-22 | pCi/kg |
| Pa-231 | 6.0E-05 | pCi/kg | Th-228 | 2.5E-06 | pCi/kg |
| Pb-210 | NA | pCi/kg | Th-230 | 2.7E-06 | pCi/kg |
| Pu-238 | 1.7E-08 | pCi/kg | Th-232 | 1.4E-06 | pCi/kg |
| Pu-239 | 1.1E-08 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 1.1E-08 | pCi/kg | U-234 | 1.3E-01 | pCi/kg |
| Ra-226 | 1.3E-04 | pCi/kg | U-235 | 3.5E-03 | pCi/kg |
| Ra-228 | 1.3E-04 | pCi/kg | U-236 | 1.4E-03 | pCi/kg |
| | | | U-238 | 7.8E-02 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 8.7E+00 | 2.8E-11 | 2.4E-10 |
| Np-237 | 9.5E-04 | 2.2E-10 | 2.1E-13 |
| Pa-231 | 4.4E-01 | 9.2E-11 | 4.1E-11 |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | 1.3E-04 | 2.2E-10 | 2.8E-14 |
| Pu-239 | 8.1E-05 | 2.3E-10 | 1.9E-14 |
| Pu-240 | 8.1E-05 | 2.3E-10 | 1.9E-14 |
| Ra-226 | 9.6E-01 | 1.2E-10 | 1.1E-10 |
| Ra-228 | 9.7E-01 | 1.0E-10 | 9.7E-11 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 1.1E-20 | 3.3E-10 | 3.6E-30 |
| Tc-99 | 9.0E-19 | 1.3E-12 | 1.2E-30 |
| Th-228 | 1.8E-02 | 5.5E-11 | 9.9E-13 |
| Th-230 | 2.0E-02 | 1.3E-11 | 2.5E-13 |
| Th-232 | 1.0E-02 | 1.2E-11 | 1.3E-13 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 9.6E+02 | 1.6E-11 | 1.5E-08 |
| U-235 | 2.5E+01 | 1.6E-11 | 4.1E-10 |
| U-236 | 1.0E+01 | 1.5E-11 | 1.6E-10 |
| U-238 | 5.7E+02 | 2.8E-11 | 1.6E-08 |
| | | ILCR Summation = | 3.2E-08 |

**Table K.IV-86**
**Summary of Intake Quantitation (chemicals)**
**On-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.122 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 70 | Year |
| EDc | Exposure duration for carcinogens | 70 | Year |
| BW | Body weight | 70 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 25550 | days |
| CS | Concentration of chemicals in vegetables | | |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 9.8E-01 | mg/kg |
| Aroclor-1016 | NA | mg/kg |
| Aroclor-1221 | 2.7E-02 | mg/kg |
| Aroclor-1242 | NA | mg/kg |
| Aroclor-1248 | 4.8E-04 | mg/kg |
| Aroclor-1254 | 6.9E-03 | mg/kg |
| Aroclor-1260 | 1.1E-02 | mg/kg |
| Arsenic | 6.6E-01 | mg/kg |
| Barium | 2.1E+02 | mg/kg |
| Beryllium | 1.5E-02 | mg/kg |
| Cadmium | 3.6E+00 | mg/kg |
| Chromium | NA | mg/kg |
| Cobalt | 3.2E-01 | mg/kg |
| Copper | 2.5E+02 | mg/kg |
| Cyanide | 1.9E+00 | mg/kg |
| Di-n-octyl phthalate | 1.8E-05 | mg/kg |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Lead | 8.2E+00 | mg/kg |
| Manganese | 1.8E+02 | mg/kg |
| Mercury | 4.3E-01 | mg/kg |
| Molybdenum | 3.1E-01 | mg/kg |
| Nickel | 2.6E+00 | mg/kg |
| Octachlorodibenzofuran | NA | mg/kg |
| Selenium | 4.5E-03 | mg/kg |
| Thallium | 1.9E-03 | mg/kg |
| Vanadium | 1.8E-01 | mg/kg |
| Zinc | 2.4E+02 | mg/kg |
| 2-Chlorophenol | NA | mg/kg |
| 2-Methylnaphthalene | 1.8E-02 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | mg/kg |
| 4,4-DDT | NA | mg/kg |

**References**



0726
5208

**Table K.IV-86 (continued)**
**Summary of Risk Characterization (chemicals)**
**On-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 1.6E-03 | 4.0E-04 | 4.1E+00 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 4.5E-05 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 8.0E-07 | NA | NA |
| Aroclor-1254 | 1.2E-05 | NA | NA |
| Aroclor-1260 | 1.8E-05 | NA | NA |
| Arsenic | 1.1E-03 | 3.0E-04 | 3.7E+00 |
| Barium | 3.4E-01 | 7.0E-02 | 4.9E+00 |
| Beryllium | 2.5E-05 | 5.0E-03 | 5.0E-03 |
| Cadmium | 5.9E-03 | 5.0E-04 | 1.2E+01 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 5.3E-04 | 6.0E-02 | 8.9E-03 |
| Copper | 4.1E-01 | NA | NA |
| Cyanide | 3.1E-03 | 2.0E-02 | 1.6E-01 |
| Di-n-octyl phthalate | 3.0E-08 | 2.0E-02 | 1.5E-06 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.4E-02 | NA | NA |
| Manganese | 2.9E-01 | 1.4E-01 | 2.1E+00 |
| Mercury | 7.1E-04 | 3.0E-04 | 2.4E+00 |
| Molybdenum | 5.1E-04 | 5.0E-03 | 1.0E-01 |
| Nickel | 4.4E-03 | 2.0E-02 | 2.2E-01 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 7.4E-06 | 5.0E-03 | 1.5E-03 |
| Thallium | 3.1E-06 | 8.0E-05 | 3.9E-02 |
| Vanadium | 2.9E-04 | 7.0E-03 | 4.2E-02 |
| Zinc | 4.1E-01 | 3.0E-01 | 1.4E+00 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 3.0E-05 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 3.1E+01 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 1.6E-03 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 4.5E-05 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 8.0E-07 | 7.7E+00 | 6.1E-06 |
| Aroclor-1254 | 1.2E-05 | 7.7E+00 | 8.9E-05 |
| Aroclor-1260 | 1.8E-05 | 7.7E+00 | 1.4E-04 |
| Arsenic | 1.1E-03 | 1.8E+00 | 1.9E-03 |
| Barium | 3.4E-01 | NA | NA |
| Beryllium | 2.5E-05 | 4.3E+00 | 1.1E-04 |
| Cadmium | 5.9E-03 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 5.3E-04 | NA | NA |
| Copper | 4.1E-01 | NA | NA |
| Cyanide | 3.1E-03 | NA | NA |
| Di-n-octyl phthalate | 3.0E-08 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.4E-02 | NA | NA |
| Manganese | 2.9E-01 | NA | NA |
| Mercury | 7.1E-04 | NA | NA |
| Molybdenum | 5.1E-04 | NA | NA |
| Nickel | 4.4E-03 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 7.4E-06 | NA | NA |
| Thallium | 3.1E-06 | NA | NA |
| Vanadium | 2.9E-04 | NA | NA |
| Zinc | 4.1E-01 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.0E-05 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 2.3E-03 |

5208

**Table K.IV-87**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**On-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

**Intake Equation** = Cv X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.122 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 70 Year |
| Cv | Concentration of radionuclides in vegetables | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 4.1E-03 | pCi/kg | Sr-90 | 5.9E-13 | pCi/kg |
| Np-237 | 5.9E-04 | pCi/kg | Tc-99 | 6.8E-12 | pCi/kg |
| Pa-231 | 2.9E-03 | pCi/kg | Th-228 | 1.2E-02 | pCi/kg |
| Pb-210 | 6.2E-02 | pCi/kg | Th-230 | 1.3E-02 | pCi/kg |
| Pu-238 | 4.2E-03 | pCi/kg | Th-232 | 6.9E-03 | pCi/kg |
| Pu-239 | 2.7E-03 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 2.7E-03 | pCi/kg | U-234 | 4.6E+00 | pCi/kg |
| Ra-226 | 7.0E-03 | pCi/kg | U-235 | 1.2E-01 | pCi/kg |
| Ra-228 | 7.3E-03 | pCi/kg | U-236 | 5.0E-02 | pCi/kg |
| | | | U-238 | 2.7E+00 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 1.2E+01 | 2.8E-11 | 3.4E-10 |
| Np-237 | 1.8E+00 | 2.2E-10 | 3.9E-10 |
| Pa-231 | 8.7E+00 | 9.2E-11 | 8.0E-10 |
| Pb-210 | 1.8E+02 | 6.6E-10 | 1.2E-07 |
| Pu-238 | 1.2E+01 | 2.2E-10 | 2.7E-09 |
| Pu-239 | 8.0E+00 | 2.3E-10 | 1.8E-09 |
| Pu-240 | 8.0E+00 | 2.3E-10 | 1.8E-09 |
| Ra-226 | 2.1E+01 | 1.2E-10 | 2.5E-09 |
| Ra-228 | 2.2E+01 | 1.0E-10 | 2.2E-09 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 1.7E-09 | 3.3E-10 | 5.8E-19 |
| Tc-99 | 2.0E-08 | 1.3E-12 | 2.6E-20 |
| Th-228 | 3.6E+01 | 5.5E-11 | 2.0E-09 |
| Th-230 | 3.9E+01 | 1.3E-11 | 5.0E-10 |
| Th-232 | 2.1E+01 | 1.2E-11 | 2.5E-10 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 1.4E+04 | 1.6E-11 | 2.2E-07 |
| U-235 | 3.6E+02 | 1.6E-11 | 5.8E-09 |
| U-236 | 1.5E+02 | 1.5E-11 | 2.2E-09 |
| U-238 | 8.2E+03 | 2.8E-11 | 2.3E-07 |
| | | ILCR Summation = | 5.9E-07 |

0728

**Table K.IV-88**
**Summary of Intake Quantitation (chemicals)**
**On-Property RMB Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Inhalation of Particulates**

**Intake Equation** = $\frac{CS \times EF \times ED \times IR}{BW \times AT}$

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 20 $m^3$/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration for non-carchogens | 12 Year |
| EDc | Exposure duration for carcinogens | 12 Year |
| BW | Body weight | 43 kg |
| ATc | Average time for carchogens (lifetime) | 25550 days |
| ATn | Average time for non-carchogens (EDn x 365) | 4380 days |
| CS | Concentration of chemicals in particulate as modeled | (see table below) |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 2.6E-06 | mg/$m^3$ |
| Aroclor-1016 | NA | mg/$m^3$ |
| Aroclor-1221 | 4.2E-09 | mg/$m^3$ |
| Aroclor-1242 | NA | mg/$m^3$ |
| Aroclor-1248 | 2.6E-09 | mg/$m^3$ |
| Aroclor-1254 | 1.3E-07 | mg/$m^3$ |
| Aroclor-1260 | 1.4E-07 | mg/$m^3$ |
| Arsenic | 1.7E-06 | mg/$m^3$ |
| Barium | 1.9E-04 | mg/$m^3$ |
| Beryllium | 1.6E-07 | mg/$m^3$ |
| Cadmium | 5.6E-07 | mg/$m^3$ |
| Chromium | 4.7E-07 | mg/$m^3$ |
| Cobalt | 1.5E-06 | mg/$m^3$ |
| Copper | 7.4E-06 | mg/$m^3$ |
| Cyanide | 7.4E-07 | mg/$m^3$ |
| Di-n-octyl phthalate | 1.2E-08 | mg/$m^3$ |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/$m^3$ |
| Heptachlorodibenzo-p-dioxin | NA | mg/$m^3$ |
| Lead | 2.4E-05 | mg/$m^3$ |
| Manganese | 6.5E-05 | mg/$m^3$ |
| Mercury | 6.7E-08 | mg/$m^3$ |
| Molybdenum | 4.3E-07 | mg/$m^3$ |
| Nickel | 4.3E-06 | mg/$m^3$ |
| Octachlorodibenzofuran | NA | mg/$m^3$ |
| Selenium | 3.6E-08 | mg/$m^3$ |
| Thallium | 4.7E-08 | mg/$m^3$ |
| Vanadium | 2.9E-06 | mg/$m^3$ |
| Zinc | 2.0E-05 | mg/$m^3$ |
| 2-Chlorophenol | NA | mg/$m^3$ |
| 2-Methylnaphthalene | 1.1E-08 | mg/$m^3$ |
| 4-Chlorophenyl-phenylether | NA | mg/$m^3$ |
| 4,4-DDT | NA | mg/$m^3$ |

**References**

**Table K.IV-88 (continued)**
**Summary of Risk Characterization (chemicals)**
**On-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Inhalation of Particulates**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 1.2E-08 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.9E-09 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.2E-09 | NA | NA |
| Aroclor-1254 | 5.7E-08 | NA | NA |
| Aroclor-1260 | 6.4E-08 | NA | NA |
| Arsenic | 7.5E-07 | NA | NA |
| Barium | 6.4E-05 | 1.4E-04 | 6.0E-01 |
| Beryllium | 7.2E-08 | NA | NA |
| Cadmium | 2.6E-07 | NA | NA |
| Chromium | 2.1E-07 | NA | NA |
| Cobalt | 6.8E-07 | 3.0E-07 | 2.3E+00 |
| Copper | 3.3E-06 | NA | NA |
| Cyanide | 3.3E-07 | NA | NA |
| Di-n-octyl phthalate | 5.3E-09 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.1E-05 | NA | NA |
| Manganese | 2.9E-05 | 1.1E-04 | 2.7E-01 |
| Mercury | 3.0E-08 | 8.6E-05 | 3.5E-04 |
| Molybdenum | 1.9E-07 | NA | NA |
| Nickel | 1.9E-06 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 1.6E-08 | NA | NA |
| Thallium | 2.1E-08 | NA | NA |
| Vanadium | 1.3E-06 | NA | NA |
| Zinc | 8.7E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 4.9E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | NA | NA |
| | HQ Summation = | | 3.1E+00 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 2.1E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 3.2E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 2.1E-10 | NA | NA |
| Aroclor-1254 | 9.7E-09 | NA | NA |
| Aroclor-1260 | 1.1E-08 | NA | NA |
| Arsenic | 1.3E-07 | 1.5E+01 | 1.9E-06 |
| Barium | 1.4E-05 | NA | NA |
| Beryllium | 1.2E-08 | 8.4E+00 | 1.0E-07 |
| Cadmium | 4.5E-08 | 6.1E+00 | 2.7E-07 |
| Chromium | 3.6E-08 | 4.1E+01 | 1.5E-06 |
| Cobalt | 1.2E-07 | NA | NA |
| Copper | 5.7E-07 | NA | NA |
| Cyanide | 5.7E-08 | NA | NA |
| Di-n-octyl phthalate | 9.0E-10 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.8E-08 | NA | NA |
| Manganese | 5.0E-06 | NA | NA |
| Mercury | 5.1E-09 | NA | NA |
| Molybdenum | 3.3E-08 | NA | NA |
| Nickel | 3.3E-07 | 8.4E-01 | 2.8E-07 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.7E-09 | NA | NA |
| Thallium | 3.6E-09 | NA | NA |
| Vanadium | 2.2E-07 | NA | NA |
| Zinc | 1.5E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 8.4E-10 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 4.0E-06 |

208

**Table K.IV-89**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**On-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Inhalation of Gases and Particulates**

**Intake Equation** = Ca X EF X EDn X IR

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 20 $m^3$/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 12 Year |
| Ca | Concentration of radionuclides in air | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/$m^3$ | Rn-222 | 9.6E+00 | pCi/$m^3$ |
| Am-241 | NA | pCi/$m^3$ | Ru-106 | NA | pCi/$m^3$ |
| Cs-137 | 7.8E-05 | pCi/$m^3$ | Sr-90 | 3.0E-04 | pCi/$m^3$ |
| Np-237 | 3.6E-05 | pCi/$m^3$ | Tc-99 | 2.0E-03 | pCi/$m^3$ |
| Pa-231 | 1.7E-04 | pCi/$m^3$ | Th-228 | 2.1E-04 | pCi/$m^3$ |
| Pb-210 | 3.6E-03 | pCi/$m^3$ | Th-230 | 2.4E-04 | pCi/$m^3$ |
| Pu-238 | 1.7E-04 | pCi/$m^3$ | Th-232 | 1.5E-04 | pCi/$m^3$ |
| Pu-239 | 7.2E-05 | pCi/$m^3$ | U-233 | NA | pCi/$m^3$ |
| Pu-240 | 7.2E-05 | pCi/$m^3$ | U-234 | 3.6E-03 | pCi/$m^3$ |
| Ra-226 | 1.5E-04 | pCi/$m^3$ | U-235 | 9.6E-05 | pCi/$m^3$ |
| Ra-228 | 1.6E-04 | pCi/$m^3$ | U-236 | 4.0E-05 | pCi/$m^3$ |
| | | | U-238 | 2.2E-03 | pCi/$m^3$ |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 6.8E-08 | NA |
| Am-241 | NA | 3.2E-08 | NA |
| Cs-137 | 6.6E+00 | 1.9E-11 | 1.2E-10 |
| Np-237 | 3.0E+00 | 2.9E-08 | 8.8E-08 |
| Pa-231 | 1.4E+01 | 3.6E-08 | 5.0E-07 |
| Pb-210 | 3.0E+02 | 4.0E-09 | 1.2E-06 |
| Pu-238 | 1.4E+01 | 3.9E-08 | 5.4E-07 |
| Pu-239 | 6.0E+00 | 3.8E-08 | 2.3E-07 |
| Pu-240 | 6.0E+00 | 3.8E-08 | 2.3E-07 |
| Ra-226 | 1.2E+01 | 3.0E-09 | 3.7E-08 |
| Ra-228 | 1.3E+01 | 6.9E-10 | 9.2E-09 |
| Rn-222 | 8.1E+05 | 7.7E-12 | 6.2E-06 |
| Ru-106 | NA | 4.4E-10 | NA |
| Sr-90 | 2.5E+01 | 5.6E-11 | 1.4E-09 |
| Tc-99 | 1.7E+02 | 8.3E-12 | 1.4E-09 |
| Th-228 | 1.8E+01 | 7.8E-08 | 1.4E-06 |
| Th-230 | 2.0E+01 | 2.9E-08 | 5.9E-07 |
| Th-232 | 1.3E+01 | 2.8E-08 | 3.6E-07 |
| U-233 | NA | 2.7E-08 | NA |
| U-234 | 3.0E+02 | 2.6E-08 | 7.9E-06 |
| U-235 | 8.1E+00 | 2.5E-08 | 2.0E-07 |
| U-236 | 3.4E+00 | 2.5E-08 | 8.4E-08 |
| U-238 | 1.8E+02 | 5.2E-08 | 9.4E-06 |
| | | ILCR Summation = | 2.9E-05 |



0731

**Table K.IV-90**
**Summary of Intake Quantitation (Chemicals)**
**On-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Incidental Ingestion of Soil/Sediment**

**Intake Equation** = $\frac{CS \times EF \times ED \times CF \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IRs | Ingestion rate of soil (RAGS, 1989) | 100 | mg/day |
| CF | Conversion factor | 1.00E-06 | kg/mg |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 12 | Year |
| EDc | Exposure duration for carcinogens | 12 | Year |
| BW | Body weight | 43 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 4380 | days |
| CS | Concentration of chemicals in soil | (see table below) | |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 3.1E+01 | mg/kg |
| Aroclor-1016 | 0.0E+00 | mg/kg |
| Aroclor-1221 | 8.0E-02 | mg/kg |
| Aroclor-1242 | 0.0E+00 | mg/kg |
| Aroclor-1248 | 6.0E-02 | mg/kg |
| Aroclor-1254 | 2.5E+00 | mg/kg |
| Aroclor-1260 | 2.6E+00 | mg/kg |
| Arsenic | 2.6E+01 | mg/kg |
| Barium | 3.6E+03 | mg/kg |
| Beryllium | 2.4E+00 | mg/kg |
| Cadmium | 6.9E+00 | mg/kg |
| Chromium | 7.6E+00 | mg/kg |
| Cobalt | 2.1E+01 | mg/kg |
| Copper | 1.3E+02 | mg/kg |
| Cyanide | 1.4E+01 | mg/kg |
| Di-n-octyl phthalate | 6.6E-01 | mg/kg |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Lead | 4.4E+02 | mg/kg |
| Manganese | 6.3E+02 | mg/kg |
| Mercury | 1.3E+00 | mg/kg |
| Molybdenum | 1.3E+01 | mg/kg |
| Nickel | 5.9E+01 | mg/kg |
| Octachlorodibenzofuran | 0.0E+00 | mg/kg |
| Selenium | 5.7E+00 | mg/kg |
| Thallium | 7.1E-01 | mg/kg |
| Vanadium | 3.6E+01 | mg/kg |
| Zinc | 3.4E+02 | mg/kg |
| 2-Chlorophenol | 0.0E+00 | mg/kg |
| 2-Methylnaphthalene | 2.2E-01 | mg/kg |
| 4-Chlorophenyl-phenylether | 0.0E+00 | mg/kg |
| 4,4-DDT | 0.0E+00 | mg/kg |

**References**

**Table K.IV-90 (continued)**
**Summary of Risk Characterization (chemicals)**
**On-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Incidental Ingestion of Soil/Sediment**

| Compound | HQ Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
| Antimony | 6.9E-05 | 4.0E-04 | 1.7E-01 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.6E-07 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.3E-07 | NA | NA |
| Aroclor-1254 | 5.5E-06 | NA | NA |
| Aroclor-1260 | 6.2E-06 | NA | NA |
| Arsenic | 5.7E-05 | 3.0E-04 | 1.9E-01 |
| Barium | 6.1E-03 | 7.0E-02 | 1.2E-01 |
| Beryllium | 5.4E-06 | 5.0E-03 | 1.1E-03 |
| Cadmium | 1.5E-05 | 5.0E-04 | 3.1E-02 |
| Chromium | 1.7E-05 | 5.0E-03 | 3.4E-03 |
| Cobalt | 4.7E-05 | 6.0E-02 | 7.8E-04 |
| Copper | 2.9E-04 | NA | NA |
| Cyanide | 3.2E-05 | 2.0E-02 | 1.6E-03 |
| Di-n-octyl phthalate | 1.5E-06 | 2.0E-02 | 7.4E-05 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 9.8E-04 | NA | NA |
| Manganese | 1.9E-03 | 1.4E-01 | 1.3E-02 |
| Mercury | 2.9E-06 | 3.0E-04 | 9.7E-03 |
| Molybdenum | 3.0E-05 | 5.0E-03 | 5.9E-03 |
| Nickel | 1.3E-04 | 2.0E-02 | 6.6E-03 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 1.3E-05 | 5.0E-03 | 2.5E-03 |
| Thallium | 1.6E-06 | 8.0E-05 | 2.0E-02 |
| Vanadium | 7.9E-05 | 7.0E-03 | 1.1E-02 |
| Zinc | 7.5E-04 | 3.0E-01 | 2.5E-03 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 4.9E-07 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 5.9E-01 |

| Compound | ILCR Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
| Antimony | 1.2E-05 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 3.1E-08 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 2.3E-08 | 7.7E+00 | 1.8E-07 |
| Aroclor-1254 | 9.4E-07 | 7.7E+00 | 7.2E-06 |
| Aroclor-1260 | 1.1E-06 | 7.7E+00 | 8.2E-06 |
| Arsenic | 9.8E-06 | 1.8E+00 | 1.7E-05 |
| Barium | 1.4E-03 | NA | NA |
| Beryllium | 9.2E-07 | 4.3E+00 | 3.9E-06 |
| Cadmium | 2.6E-06 | NA | NA |
| Chromium | 2.9E-06 | NA | NA |
| Cobalt | 8.0E-06 | NA | NA |
| Copper | 4.9E-05 | NA | NA |
| Cyanide | 5.5E-06 | NA | NA |
| Di-n-octyl phthalate | 2.5E-07 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.7E-04 | NA | NA |
| Manganese | 3.2E-04 | NA | NA |
| Mercury | 5.0E-07 | NA | NA |
| Molybdenum | 5.1E-06 | NA | NA |
| Nickel | 2.3E-05 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.2E-06 | NA | NA |
| Thallium | 2.7E-07 | NA | NA |
| Vanadium | 1.4E-05 | NA | NA |
| Zinc | 1.3E-04 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 8.4E-08 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 3.7E-05 |



0733

5208

# Table K.IV-91
## Summary of Intake and Risk Quantitation (Radionuclides)
## On-Property RME Resident Farm Youth Future Land Use Without Federal Ownership
## Via Incidental Ingestion of Soil/Sediment

**Intake Equation** = CS X EF X EDn X FI X IR

| | | | |
|---|---|---|---|
| IRs | Ingestion rate of soil (RAGS, 1989) | 100 | mg/day |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure Duration | 12 | Year |
| FI | Fractional Intake | 1 | (unitless) |
| CS | Concentration of radionuclides in soil | | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/mg | Rn-222 | NA | pCi/mg |
| Am-241 | NA | pCi/mg | Ru-106 | NA | pCi/mg |
| Cs-137 | 1.0E-03 | pCi/mg | Sr-90 | 5.2E-03 | pCi/mg |
| Np-237 | 7.0E-04 | pCi/mg | Tc-99 | 3.8E-02 | pCi/mg |
| Pa-231 | 2.5E-02 | pCi/mg | Th-228 | 5.0E-03 | pCi/mg |
| Pb-210 | 7.0E-02 | pCi/mg | Th-230 | 5.0E-03 | pCi/mg |
| Pu-238 | 3.0E-03 | pCi/mg | Th-232 | 5.0E-03 | pCi/mg |
| Pu-239 | 1.1E-03 | pCi/mg | U-233 | NA | pCi/mg |
| Pu-240 | 1.1E-03 | pCi/mg | U-234 | 1.0E-01 | pCi/mg |
| Ra-226 | 5.0E-03 | pCi/mg | U-235 | 2.7E-03 | pCi/mg |
| Ra-228 | 5.0E-03 | pCi/mg | U-236 | 2.5E-03 | pCi/mg |
| | | | U-238 | 6.0E-02 | pCi/mg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 4.2E+02 | 2.8E-11 | 1.2E-08 |
| Np-237 | 2.9E+02 | 2.2E-10 | 6.5E-08 |
| Pa-231 | 1.1E+04 | 9.2E-11 | 9.8E-07 |
| Pb-210 | 2.9E+04 | 6.6E-10 | 1.9E-05 |
| Pu-238 | 1.2E+03 | 2.2E-10 | 2.7E-07 |
| Pu-239 | 4.7E+02 | 2.3E-10 | 1.1E-07 |
| Pu-240 | 4.7E+02 | 2.3E-10 | 1.1E-07 |
| Ra-226 | 2.1E+03 | 1.2E-10 | 2.5E-07 |
| Ra-228 | 2.1E+03 | 1.0E-10 | 2.1E-07 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 2.2E+03 | 3.3E-10 | 7.2E-07 |
| Tc-99 | 1.6E+04 | 1.3E-12 | 2.1E-08 |
| Th-228 | 2.1E+03 | 5.5E-11 | 1.2E-07 |
| Th-230 | 2.1E+03 | 1.3E-11 | 2.7E-08 |
| Th-232 | 2.1E+03 | 1.2E-11 | 2.5E-08 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 4.2E+04 | 1.6E-11 | 6.7E-07 |
| U-235 | 1.1E+03 | 1.6E-11 | 1.8E-08 |
| U-236 | 1.0E+03 | 1.5E-11 | 1.6E-08 |
| U-238 | 2.5E+04 | 2.8E-11 | 7.1E-07 |
| | | ILCR Summation = | 2.4E-05 |

0734

5208

**Table K.IV-92**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**On-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Ingestion of Drinking Water**

**Intake Equation** = Cw X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of groundwater (RAGS, 1989) | 2 l/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 12 Year |
| FI | Fractional intake for radionuclides | 1 (Unitless) |
| Cw | Concentration of radionuclides in groundwater | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/l | Rn-222 | NA | pCi/l |
| Am-241 | NA | pCi/l | Ru-106 | NA | pCi/l |
| Cs-137 | NA | pCi/l | Sr-90 | 5.9E-06 | pCi/l |
| Np-237 | NA | pCi/l | Tc-99 | NA | pCi/l |
| Pa-231 | NA | pCi/l | Th-228 | NA | pCi/l |
| Pb-210 | NA | pCi/l | Th-230 | NA | pCi/l |
| Pu-238 | NA | pCi/l | Th-232 | NA | pCi/l |
| Pu-239 | NA | pCi/l | U-233 | NA | pCi/l |
| Pu-240 | NA | pCi/l | U-234 | 6.7E-01 | pCi/l |
| Ra-226 | NA | pCi/l | U-235 | 1.8E-02 | pCi/l |
| Ra-228 | NA | pCi/l | U-236 | 7.4E-03 | pCi/l |
| | | | U-238 | 4.0E-01 | pCi/l |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | NA | 2.8E-11 | NA |
| Np-237 | NA | 2.2E-10 | NA |
| Pa-231 | NA | 9.2E-11 | NA |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | NA | 2.2E-10 | NA |
| Pu-239 | NA | 2.3E-10 | NA |
| Pu-240 | NA | 2.3E-10 | NA |
| Ra-226 | NA | 1.2E-10 | NA |
| Ra-228 | NA | 1.0E-10 | NA |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 4.9E-02 | 3.3E-10 | 1.6E-11 |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | NA | 5.5E-11 | NA |
| Th-230 | NA | 1.3E-11 | NA |
| Th-232 | NA | 1.2E-11 | NA |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 5.6E+03 | 1.6E-11 | 9.0E-08 |
| U-235 | 1.5E+02 | 1.6E-11 | 2.4E-09 |
| U-236 | 6.2E+01 | 1.5E-11 | 9.3E-10 |
| U-238 | 3.4E+03 | 2.8E-11 | 9.4E-08 |
| | | ILCR Summation = | 1.9E-07 |

**Table K.IV-93**
**Summary of Intake Quantitation (chemicals)**
**On-Property RMB Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Dermal Contact with Soil/Sediment**

**Intake Equation** = $\frac{CS \times EF \times ED \times CF \times ABS \times AF \times SA}{BW \times AT}$

| | | |
|---|---|---|
| SA | Surface area of exposed skin (50th percentile, hands only) | 4200 $cm^2$/day |
| AF | Soil to skin adherence factor (RAGS, 1989) | 1 $mg/cm^2$ |
| ABS | Chemical specific absorbtion factor (see table below) | csv |
| CF | Conversion factor | 1E-06 kg/mg |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration for non-carcinogens | 12 Year |
| EDc | Exposure duration for carcinogens | 12 Year |
| BW | Body weight | 43 kg |
| ATc | Average time for carcinogens (lifetime) | 25550 days |
| ATn | Average time for non-carcinogens (EDn x 365) | 4380 days |
| CS | Concentration of chemicals in soil | (see table below) |

**Chemical Concentrations**

| Compound | ABS | Concentrati | Units |
|---|---|---|---|
| Antimony | 1.0E-02 | 3.1E+01 | mg/kg |
| Aroclor-1016 | 6.0E-02 | 0.0E+00 | mg/kg |
| Aroclor-1221 | 6.0E-02 | 8.0E-02 | mg/kg |
| Aroclor-1242 | 6.0E-02 | 0.0E+00 | mg/kg |
| Aroclor-1248 | 6.0E-02 | 6.0E-02 | mg/kg |
| Aroclor-1254 | 6.0E-02 | 2.5E+00 | mg/kg |
| Aroclor-1260 | 6.0E-02 | 2.8E+00 | mg/kg |
| Arsenic | 1.0E-03 | 2.6E+01 | mg/kg |
| Barium | 1.0E-02 | 3.6E+03 | mg/kg |
| Beryllium | 1.0E-02 | 2.4E+00 | mg/kg |
| Cadmium | 1.0E-02 | 6.9E+00 | mg/kg |
| Chromium | 1.0E-02 | 7.6E+00 | mg/kg |
| Cobalt | 1.0E-02 | 2.1E+01 | mg/kg |
| Copper | 1.0E-03 | 1.3E+02 | mg/kg |
| Cyanide | NA | 1.4E+01 | mg/kg |
| Di-n-octyl phthalate | 3.0E-01 | 6.6E-01 | mg/kg |

| Compound | ABS | Concentration | Units |
|---|---|---|---|
| Heptachlorodibenzofuran | 3.0E-02 | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | 3.0E-02 | NA | mg/kg |
| Lead | 1.0E-02 | 4.4E+02 | mg/kg |
| Manganese | 1.0E-02 | 8.3E+02 | mg/kg |
| Mercury | 5.0E-02 | 1.3E+00 | mg/kg |
| Molybdenum | 1.0E-02 | 1.3E+01 | mg/kg |
| Nickel | 5.0E-04 | 5.9E+01 | mg/kg |
| Octachlorodibenzofuran | 3.0E-02 | 0.0E+00 | mg/kg |
| Selenium | 1.0E-02 | 5.7E+00 | mg/kg |
| Thallium | 1.0E-02 | 7.1E-01 | mg/kg |
| Vanadium | 1.0E-03 | 3.6E+01 | mg/kg |
| Zinc | 1.0E-02 | 3.4E+02 | mg/kg |
| 2-Chlorophenol | NA | 0.0E+00 | mg/kg |
| 2-Methylnaphthalene | NA | 2.2E-01 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | 0.0E+00 | mg/kg |
| 4,4-DDT | 3.0E-01 | 0.0E+00 | mg/kg |

**References**



0736

5908

**Table K.IV-93 (continued)**
**Summary of Risk Characterization (chemicals)**
**On-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Dermal Contact with Soil/Sediment**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 2.9E-05 | 4.0E-04 | 7.3E-02 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 4.5E-07 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 3.4E-07 | NA | NA |
| Aroclor-1254 | 1.4E-05 | NA | NA |
| Aroclor-1260 | 1.6E-05 | NA | NA |
| Arsenic | 2.4E-06 | 3.0E-04 | 8.0E-03 |
| Barium | 3.4E-03 | 7.0E-02 | 4.8E-02 |
| Beryllium | 2.2E-06 | 5.0E-03 | 4.5E-04 |
| Cadmium | 6.5E-06 | 5.0E-04 | 1.3E-02 |
| Chromium | 7.1E-06 | 5.0E-03 | 1.4E-03 |
| Cobalt | 2.0E-05 | 6.0E-02 | 3.3E-04 |
| Copper | 1.2E-05 | NA | NA |
| Cyanide | NA | 2.0E-02 | NA |
| Di-n-octyl phthalate | 1.9E-05 | 2.0E-02 | 9.3E-04 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 4.1E-04 | NA | NA |
| Manganese | 7.8E-04 | 1.4E-01 | 5.6E-03 |
| Mercury | 6.1E-06 | 3.0E-04 | 2.0E-02 |
| Molybdenum | 1.2E-05 | 5.0E-03 | 2.5E-03 |
| Nickel | 2.8E-06 | 2.0E-02 | 1.4E-04 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 5.3E-06 | 5.0E-03 | 1.1E-03 |
| Thallium | 6.6E-07 | 8.0E-05 | 8.3E-03 |
| Vanadium | 3.3E-06 | 7.0E-03 | 4.8E-04 |
| Zinc | 3.1E-04 | 3.0E-01 | 1.0E-03 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | NA | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| HQ Summation = | | | 1.8E-01 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 5.0E-06 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 7.7E-08 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 5.8E-08 | 7.7E+00 | 4.5E-07 |
| Aroclor-1254 | 2.4E-06 | 7.7E+00 | 1.8E-05 |
| Aroclor-1260 | 2.7E-06 | 7.7E+00 | 2.1E-05 |
| Arsenic | 4.1E-07 | 1.8E+00 | 7.2E-07 |
| Barium | 5.8E-04 | NA | NA |
| Beryllium | 3.9E-07 | 4.3E+00 | 1.7E-06 |
| Cadmium | 1.1E-06 | NA | NA |
| Chromium | 1.2E-06 | NA | NA |
| Cobalt | 3.4E-06 | NA | NA |
| Copper | 2.1E-06 | NA | NA |
| Cyanide | NA | NA | NA |
| Di-n-octyl phthalate | 3.2E-06 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 7.1E-05 | NA | NA |
| Manganese | 1.3E-04 | NA | NA |
| Mercury | 1.0E-06 | NA | NA |
| Molybdenum | 2.1E-06 | NA | NA |
| Nickel | 4.7E-07 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 9.2E-07 | NA | NA |
| Thallium | 1.1E-07 | NA | NA |
| Vanadium | 5.7E-07 | NA | NA |
| Zinc | 5.4E-05 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | NA | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| ILCR Summation = | | | 4.2E-05 |

**Table K.IV-94**
**Summary of Intake and Risk Quantitation (Radionuclides)** - 5208
**On-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Incidental Ingestion while Wading**

**Intake Equation** = Cs X EF X ED X FI X IR

| | | |
|---|---|---|
| IRsw | Ingestion rate of surface water | 0.025 l/day |
| EF | Exposure frequency | 68 days/year |
| EDn | Exposure duration for non-carcinogens | 12 Year |
| FI | Fractional intake for radionuclides | 1 (Unitless) |
| Cs | Concentration of radionuclides in surface water | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/l | Rn-222 | NA | pCi/l |
| Am-241 | NA | pCi/l | Ru-106 | NA | pCi/l |
| Cs-137 | NA | pCi/l | Sr-90 | 7.1E-01 | pCi/l |
| Np-237 | NA | pCi/l | Tc-99 | NA | pCi/l |
| Pa-231 | NA | pCi/l | Th-228 | NA | pCi/l |
| Pb-210 | NA | pCi/l | Th-230 | NA | pCi/l |
| Pu-238 | NA | pCi/l | Th-232 | NA | pCi/l |
| Pu-239 | NA | pCi/l | U-233 | NA | pCi/l |
| Pu-240 | NA | pCi/l | U-234 | 2.2E+00 | pCi/l |
| Ra-226 | NA | pCi/l | U-235 | 5.8E-02 | pCi/l |
| Ra-228 | NA | pCi/l | U-236 | 2.4E-02 | pCi/l |
| | | | U-238 | 1.3E+00 | pCi/l |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | NA | 2.8E-11 | NA |
| Np-237 | NA | 2.2E-10 | NA |
| Pa-231 | NA | 9.2E-11 | NA |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | NA | 2.2E-10 | NA |
| Pu-239 | NA | 2.3E-10 | NA |
| Pu-240 | NA | 2.3E-10 | NA |
| Ra-226 | NA | 1.2E-10 | NA |
| Ra-228 | NA | 1.0E-10 | NA |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 1.9E+01 | 3.3E-10 | 6.2E-09 |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | NA | 5.5E-11 | NA |
| Th-230 | NA | 1.3E-11 | NA |
| Th-232 | NA | 1.2E-11 | NA |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 5.7E+01 | 1.6E-11 | 9.2E-10 |
| U-235 | 1.5E+00 | 1.6E-11 | 2.4E-11 |
| U-236 | 6.3E-01 | 1.5E-11 | 9.4E-12 |
| U-238 | 3.4E+01 | 2.8E-11 | 9.6E-10 |
| | | ILCR Summation = | 8.1E-09 |



0739

**Table K.IV-95**
**Summary of Intake Quantitation (chemicals)**
**On-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Ingestion of Meat Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of meat | 0.075 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 12 | Year |
| EDc | Exposure duration for carcinogens | 12 | Year |
| BW | Body weight | 43 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 4380 | days |
| CS | Concentration of chemicals in meat | | |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 3.4E-01 | mg/kg | Heptachlorodibenzofuran | NA | mg/kg |
| Aroclor-1016 | NA | mg/kg | Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Aroclor-1221 | 2.2E-05 | mg/kg | Lead | 1.5E-01 | mg/kg |
| Aroclor-1242 | NA | mg/kg | Manganese | 3.6E+00 | mg/kg |
| Aroclor-1248 | 3.3E-04 | mg/kg | Mercury | 5.4E+00 | mg/kg |
| Aroclor-1254 | 6.8E-02 | mg/kg | Molybdenum | 4.0E-01 | mg/kg |
| Aroclor-1260 | 2.3E-02 | mg/kg | Nickel | 9.2E-01 | mg/kg |
| Arsenic | 8.3E-02 | mg/kg | Octachlorodibenzofuran | NA | mg/kg |
| Barium | 1.6E+00 | mg/kg | Selenium | 4.7E-03 | mg/kg |
| Beryllium | 1.5E-03 | mg/kg | Thallium | 1.3E-02 | mg/kg |
| Cadmium | 1.0E+00 | mg/kg | Vanadium | 6.2E-02 | mg/kg |
| Chromium | NA | mg/kg | Zinc | 1.2E+03 | mg/kg |
| Cobalt | 4.8E-01 | mg/kg | 2-Chlorophenol | NA | mg/kg |
| Copper | 1.5E-07 | mg/kg | 2-Methylnaphthalene | 1.3E-04 | mg/kg |
| Cyanide | 1.8E+00 | mg/kg | 4-Chlorophenyl-phenylether | NA | mg/kg |
| Di-n-octyl phthalate | NA | mg/kg | 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-95 (continued)**
**Summary of Risk Characterization (chemicals)**
**On-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Ingestion of Meat Products**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 5.7E-04 | 4.0E-04 | 1.4E+00 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 3.6E-08 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 5.6E-07 | NA | NA |
| Aroclor-1254 | 1.1E-04 | NA | NA |
| Aroclor-1260 | 3.8E-05 | NA | NA |
| Arsenic | 1.4E-04 | 3.0E-04 | 4.6E-01 |
| Barium | 2.7E-03 | 7.0E-02 | 3.9E-02 |
| Beryllium | 2.5E-06 | 5.0E-03 | 5.0E-04 |
| Cadmium | 1.7E-03 | 5.0E-04 | 3.3E+00 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 8.0E-04 | 6.0E-02 | 1.3E-02 |
| Copper | 2.5E-10 | NA | NA |
| Cyanide | 3.0E-03 | 2.0E-02 | 1.5E-01 |
| Di-n-octyl phthalate | NA | 2.0E-02 | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 2.5E-04 | NA | NA |
| Manganese | 6.1E-03 | 1.4E-01 | 4.3E-02 |
| Mercury | 9.0E-03 | 3.0E-04 | 3.0E+01 |
| Molybdenum | 6.6E-04 | 5.0E-03 | 1.3E-01 |
| Nickel | 1.5E-03 | 2.0E-02 | 7.7E-02 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 7.8E-06 | 5.0E-03 | 1.6E-03 |
| Thallium | 2.2E-05 | 8.0E-05 | 2.7E-01 |
| Vanadium | 1.0E-04 | 7.0E-03 | 1.5E-02 |
| Zinc | 2.0E+00 | 3.0E-01 | 6.8E+00 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 2.1E-07 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 4.3E+01 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 9.8E-05 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 6.2E-09 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 9.5E-08 | 7.7E+00 | 7.3E-07 |
| Aroclor-1254 | 1.9E-05 | 7.7E+00 | 1.5E-04 |
| Aroclor-1260 | 6.5E-06 | 7.7E+00 | 5.0E-05 |
| Arsenic | 2.4E-05 | 1.8E+00 | 4.2E-05 |
| Barium | 4.7E-04 | NA | NA |
| Beryllium | 4.3E-07 | 4.3E+00 | 1.8E-06 |
| Cadmium | 2.9E-04 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 1.4E-04 | NA | NA |
| Copper | 4.3E-11 | NA | NA |
| Cyanide | 5.1E-04 | NA | NA |
| Di-n-octyl phthalate | NA | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 4.3E-05 | NA | NA |
| Manganese | 1.0E-03 | NA | NA |
| Mercury | 1.5E-03 | NA | NA |
| Molybdenum | 1.1E-04 | NA | NA |
| Nickel | 2.6E-04 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 1.3E-06 | NA | NA |
| Thallium | 3.8E-06 | NA | NA |
| Vanadium | 1.8E-05 | NA | NA |
| Zinc | 3.5E-01 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.6E-08 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 2.4E-04 |

**Table K.IV–96**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**On–Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Ingestion of Meat Products**

**Intake Equation** = Cf X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of meat | 0.075 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 12 Year |
| Cf | Concentration of radionuclides in meat | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 3.4E-03 | pCi/kg | Sr-90 | NA | pCi/kg |
| Np-237 | 1.4E-06 | pCi/kg | Tc-99 | NA | pCi/kg |
| Pa-231 | 9.6E-03 | pCi/kg | Th-228 | 1.9E-06 | pCi/kg |
| Pb-210 | NA | pCi/kg | Th-230 | 3.2E-06 | pCi/kg |
| Pu-238 | 8.6E-08 | pCi/kg | Th-232 | 1.7E-06 | pCi/kg |
| Pu-239 | 5.5E-08 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 5.5E-08 | pCi/kg | U-234 | 4.2E-02 | pCi/kg |
| Ra-226 | 7.2E-05 | pCi/kg | U-235 | 1.1E-03 | pCi/kg |
| Ra-228 | 4.8E-05 | pCi/kg | U-236 | 4.6E-04 | pCi/kg |
| | | | U-238 | 2.5E-02 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 1.1E+00 | 2.8E-11 | 3.0E-11 |
| Np-237 | 4.5E-04 | 2.2E-10 | 9.8E-14 |
| Pa-231 | 3.0E+00 | 9.2E-11 | 2.8E-10 |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | 2.7E-05 | 2.2E-10 | 5.9E-15 |
| Pu-239 | 1.7E-05 | 2.3E-10 | 4.0E-15 |
| Pu-240 | 1.7E-05 | 2.3E-10 | 4.0E-15 |
| Ra-226 | 2.3E-02 | 1.2E-10 | 2.7E-12 |
| Ra-228 | 1.5E-02 | 1.0E-10 | 1.5E-12 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | NA | 3.3E-10 | NA |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | 6.0E-04 | 5.5E-11 | 3.3E-14 |
| Th-230 | 1.0E-03 | 1.3E-11 | 1.3E-14 |
| Th-232 | 5.4E-04 | 1.2E-11 | 6.5E-15 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 1.3E+01 | 1.6E-11 | 2.1E-10 |
| U-235 | 3.6E-01 | 1.6E-11 | 5.7E-12 |
| U-236 | 1.5E-01 | 1.5E-11 | 2.2E-12 |
| U-238 | 8.0E+00 | 2.8E-11 | 2.2E-10 |
| | | ILCR Summation = | 7.6E-10 |

**Table K.IV-97**
**Summary of Intake Quantitation (chemicals)**
**On-Property RMB Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Ingestion of Dairy Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of dairy products | 0.3 | l/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 12 | Year |
| EDc | Exposure duration for carcinogens | 12 | Year |
| BW | Body weight | 43 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 4380 | days |
| CS | Concentration of chemicals in animal products | | |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 3.4E-02 | mg/kg |
| Aroclor-1016 | NA | mg/kg |
| Aroclor-1221 | 6.6E-06 | mg/kg |
| Aroclor-1242 | NA | mg/kg |
| Aroclor-1248 | 2.4E-04 | mg/kg |
| Aroclor-1254 | 1.5E-02 | mg/kg |
| Aroclor-1260 | 4.6E-02 | mg/kg |
| Arsenic | 2.5E-03 | mg/kg |
| Barium | 3.6E+00 | mg/kg |
| Beryllium | 1.3E-06 | mg/kg |
| Cadmium | 1.6E-01 | mg/kg |
| Chromium | NA | mg/kg |
| Cobalt | 4.6E-02 | mg/kg |
| Copper | 1.9E+00 | mg/kg |
| Cyanide | NA | mg/kg |
| Di-n-octylphthalate | 5.7E-01 | mg/kg |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Lead | 1.3E-01 | mg/kg |
| Manganese | 3.2E+00 | mg/kg |
| Mercury | 9.7E-03 | mg/kg |
| Molybdenum | 9.9E-02 | mg/kg |
| Nickel | 1.5E-01 | mg/kg |
| Octachlorodibenzofuran | NA | mg/kg |
| Selenium | 1.3E-03 | mg/kg |
| Thallium | 6.5E-04 | mg/kg |
| Vanadium | 5.0E-04 | mg/kg |
| Zinc | 1.2E+02 | mg/kg |
| 2-Chlorophenol | NA | mg/kg |
| 2-Methylnaphthalene | 7.0E-05 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | mg/kg |
| 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-97 (continued)**
**Summary of Risk Characterization (chemicals)**
**On-Property RMB Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Ingestion of Dairy Products**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 2.3E-04 | 4.0E-04 | 5.7E-01 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 4.6E-08 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.6E-06 | NA | NA |
| Aroclor-1254 | 9.8E-05 | NA | NA |
| Aroclor-1260 | 3.0E-04 | NA | NA |
| Arsenic | 1.7E-05 | 3.0E-04 | 5.6E-02 |
| Barium | 2.6E-02 | 7.0E-02 | 3.7E-01 |
| Beryllium | 9.0E-09 | 5.0E-03 | 1.8E-06 |
| Cadmium | 1.2E-03 | 5.0E-04 | 2.4E+00 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 3.2E-04 | 6.0E-02 | 5.4E-03 |
| Copper | 1.3E-02 | NA | NA |
| Cyanide | NA | 2.0E-02 | NA |
| Di-n-octyl phthalate | 3.8E-03 | 2.0E-02 | 1.9E-01 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 6.4E-04 | NA | NA |
| Manganese | 2.1E-02 | 1.4E-01 | 1.5E-01 |
| Mercury | 6.5E-05 | 3.0E-04 | 2.2E-01 |
| Molybdenum | 6.6E-04 | 5.0E-03 | 1.3E-01 |
| Nickel | 1.0E-03 | 2.0E-02 | 5.2E-02 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 8.4E-06 | 5.0E-03 | 1.7E-03 |
| Thallium | 4.4E-06 | 8.0E-05 | 5.5E-02 |
| Vanadium | 3.3E-06 | 7.0E-03 | 4.7E-04 |
| Zinc | 8.2E-01 | 3.0E-01 | 2.7E+00 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 4.7E-07 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 6.9E+00 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 3.9E-05 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 7.8E-09 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 2.7E-07 | 7.7E+00 | 2.1E-06 |
| Aroclor-1254 | 1.7E-05 | 7.7E+00 | 1.3E-04 |
| Aroclor-1260 | 5.2E-05 | 7.7E+00 | 4.0E-04 |
| Arsenic | 2.9E-06 | 1.8E+00 | 5.0E-06 |
| Barium | 4.4E-03 | NA | NA |
| Beryllium | 1.5E-09 | 4.3E+00 | 6.6E-09 |
| Cadmium | 2.1E-04 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 5.5E-05 | NA | NA |
| Copper | 2.2E-03 | NA | NA |
| Cyanide | NA | NA | NA |
| Di-n-octyl phthalate | 6.5E-04 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.4E-04 | NA | NA |
| Manganese | 3.6E-03 | NA | NA |
| Mercury | 1.1E-05 | NA | NA |
| Molybdenum | 1.1E-04 | NA | NA |
| Nickel | 1.8E-04 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 1.4E-06 | NA | NA |
| Thallium | 7.5E-07 | NA | NA |
| Vanadium | 5.7E-07 | NA | NA |
| Zinc | 1.4E-01 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 8.1E-08 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 5.4E-04 |

- 5208

**Table K.IV-98**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**On-Property RMB Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Ingestion of Dairy Products**

**Intake Equation** = Cp X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of dairy products | 0.3 l/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 12 Year |
| Cp | Concentration of radionuclides in animal products | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 1.2E-03 | pCi/kg | Sr-90 | 1.5E-24 | pCi/kg |
| Np-237 | 1.3E-07 | pCi/kg | Tc-99 | 1.2E-22 | pCi/kg |
| Pa-231 | 6.0E-05 | pCi/kg | Th-228 | 2.5E-06 | pCi/kg |
| Pb-210 | NA | pCi/kg | Th-230 | 2.7E-06 | pCi/kg |
| Pu-238 | 1.7E-08 | pCi/kg | Th-232 | 1.4E-06 | pCi/kg |
| Pu-239 | 1.1E-08 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 1.1E-08 | pCi/kg | U-234 | 1.3E-01 | pCi/kg |
| Ra-226 | 1.3E-04 | pCi/kg | U-235 | 3.5E-03 | pCi/kg |
| Ra-228 | 1.3E-04 | pCi/kg | U-236 | 1.4E-03 | pCi/kg |
| | | | U-238 | 7.8E-02 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 1.5E+00 | 2.8E-11 | 4.2E-11 |
| Np-237 | 1.6E-04 | 2.2E-10 | 3.6E-14 |
| Pa-231 | 7.6E-02 | 9.2E-11 | 7.0E-12 |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | 2.2E-05 | 2.2E-10 | 4.8E-15 |
| Pu-239 | 1.4E-05 | 2.3E-10 | 3.2E-15 |
| Pu-240 | 1.4E-05 | 2.3E-10 | 3.2E-15 |
| Ra-226 | 1.6E-01 | 1.2E-10 | 2.0E-11 |
| Ra-228 | 1.7E-01 | 1.0E-10 | 1.7E-11 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 1.9E-21 | 3.3E-10 | 6.2E-31 |
| Tc-99 | 1.5E-19 | 1.3E-12 | 2.0E-31 |
| Th-228 | 3.1E-03 | 5.5E-11 | 1.7E-13 |
| Th-230 | 3.4E-03 | 1.3E-11 | 4.4E-14 |
| Th-232 | 1.6E-03 | 1.2E-11 | 2.1E-14 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 1.6E+02 | 1.6E-11 | 2.6E-09 |
| U-235 | 4.3E+00 | 1.6E-11 | 7.0E-11 |
| U-236 | 1.8E+00 | 1.5E-11 | 2.7E-11 |
| U-238 | 9.8E+01 | 2.8E-11 | 2.7E-09 |
| | | ILCR Summation = | 5.5E-09 |

0744

**Table K.IV-99**
**Summary of Intake Quantitation (chemicals)**
**On-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.122 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 12 | Year |
| EDc | Exposure duration for carcinogens | 12 | Year |
| BW | Body weight | 43 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 4380 | days |
| CS | Concentration of chemicals in vegetables | | |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 9.8E-01 | mg/kg |
| Aroclor-1016 | NA | mg/kg |
| Aroclor-1221 | 2.7E-02 | mg/kg |
| Aroclor-1242 | NA | mg/kg |
| Aroclor-1248 | 4.8E-04 | mg/kg |
| Aroclor-1254 | 6.9E-03 | mg/kg |
| Aroclor-1260 | 1.1E-02 | mg/kg |
| Arsenic | 6.6E-01 | mg/kg |
| Barium | 2.1E+02 | mg/kg |
| Beryllium | 1.5E-02 | mg/kg |
| Cadmium | 3.6E+00 | mg/kg |
| Chromium | NA | mg/kg |
| Cobalt | 3.2E-01 | mg/kg |
| Copper | 2.5E+02 | mg/kg |
| Cyanide | 1.9E+00 | mg/kg |
| Di-n-octyl phthalate | 1.8E-05 | mg/kg |
| Heptachlorodibenzofuran | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Lead | 8.2E+00 | mg/kg |
| Manganese | 1.8E+02 | mg/kg |
| Mercury | 4.3E-01 | mg/kg |
| Molybdenum | 3.1E-01 | mg/kg |
| Nickel | 2.6E+00 | mg/kg |
| Octachlorodibenzofuran | NA | mg/kg |
| Selenium | 4.5E-03 | mg/kg |
| Thallium | 1.9E-03 | mg/kg |
| Vanadium | 1.8E-01 | mg/kg |
| Zinc | 2.4E+02 | mg/kg |
| 2-Chlorophenol | NA | mg/kg |
| 2-Methylnaphthalene | 1.8E-02 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | mg/kg |
| 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-99 (continued)**
**Summary of Risk Characterization (chemicals)**
**On-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

| Compound | HQ Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
| Antimony | 2.7E-03 | 4.0E-04 | 6.6E+00 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 7.3E-05 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.3E-06 | NA | NA |
| Aroclor-1254 | 1.9E-05 | NA | NA |
| Aroclor-1260 | 3.0E-05 | NA | NA |
| Arsenic | 1.8E-03 | 3.0E-04 | 6.0E+00 |
| Barium | 5.6E-01 | 7.0E-02 | 8.0E+00 |
| Beryllium | 4.1E-05 | 5.0E-03 | 8.1E-03 |
| Cadmium | 9.7E-03 | 5.0E-04 | 1.9E+01 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 8.7E-04 | 6.0E-02 | 1.5E-02 |
| Copper | 6.7E-01 | NA | NA |
| Cyanide | 5.1E-03 | 2.0E-02 | 2.5E-01 |
| Di-n-octyl phthalate | 4.9E-08 | 2.0E-02 | 2.4E-06 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 2.2E-02 | NA | NA |
| Manganese | 4.8E-01 | 1.4E-01 | 3.4E+00 |
| Mercury | 1.2E-03 | 3.0E-04 | 3.9E+00 |
| Molybdenum | 8.3E-04 | 5.0E-03 | 1.7E-01 |
| Nickel | 7.2E-03 | 2.0E-02 | 3.6E-01 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 1.2E-05 | 5.0E-03 | 2.4E-03 |
| Thallium | 5.1E-06 | 8.0E-05 | 6.4E-02 |
| Vanadium | 4.8E-04 | 7.0E-03 | 6.8E-02 |
| Zinc | 6.6E-01 | 3.0E-01 | 2.2E+00 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 4.9E-05 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| HQ Summation = | | | 5.0E+01 |

| Compound | ILCR Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | CSF $(mg/kg-day)^{-1}$ | ILCR (unitless) |
| Antimony | 4.5E-04 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.3E-05 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 2.2E-07 | 7.7E+00 | 1.7E-06 |
| Aroclor-1254 | 3.2E-06 | 7.7E+00 | 2.5E-05 |
| Aroclor-1260 | 5.1E-06 | 7.7E+00 | 4.0E-05 |
| Arsenic | 3.1E-04 | 1.8E+00 | 5.4E-04 |
| Barium | 9.6E-02 | NA | NA |
| Beryllium | 6.9E-06 | 4.3E+00 | 3.0E-05 |
| Cadmium | 1.7E-03 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 1.5E-04 | NA | NA |
| Copper | 1.2E-01 | NA | NA |
| Cyanide | 8.7E-04 | NA | NA |
| Di-n-octyl phthalate | 8.3E-09 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.8E-03 | NA | NA |
| Manganese | 8.2E-02 | NA | NA |
| Mercury | 2.0E-04 | NA | NA |
| Molybdenum | 1.4E-04 | NA | NA |
| Nickel | 1.2E-03 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.1E-06 | NA | NA |
| Thallium | 8.7E-07 | NA | NA |
| Vanadium | 8.2E-05 | NA | NA |
| Zinc | 1.1E-01 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 8.4E-06 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| ILCR Summation = | | | 6.4E-04 |



0746

- 5208

-. 5208

**Table K.IV-100**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**On-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

**Intake Equation** = Cv X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.122 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 12 Year |
| Cv | Concentration of radionuclides in vegetables | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 4.1E-03 | pCi/kg | Sr-90 | 5.9E-13 | pCi/kg |
| Np-237 | 5.9E-04 | pCi/kg | Tc-99 | 6.8E-12 | pCi/kg |
| Pa-231 | 2.9E-03 | pCi/kg | Th-228 | 1.2E-02 | pCi/kg |
| Pb-210 | 6.2E-02 | pCi/kg | Th-230 | 1.3E-02 | pCi/kg |
| Pu-238 | 4.2E-03 | pCi/kg | Th-232 | 6.9E-03 | pCi/kg |
| Pu-239 | 2.7E-03 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 2.7E-03 | pCi/kg | U-234 | 4.6E+00 | pCi/kg |
| Ra-226 | 7.0E-03 | pCi/kg | U-235 | 1.2E-01 | pCi/kg |
| Ra-228 | 7.3E-03 | pCi/kg | U-236 | 5.0E-02 | pCi/kg |
| | | | U-238 | 2.7E+00 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 2.1E+00 | 2.8E-11 | 5.8E-11 |
| Np-237 | 3.0E-01 | 2.2E-10 | 6.6E-11 |
| Pa-231 | 1.5E+00 | 9.2E-11 | 1.4E-10 |
| Pb-210 | 3.2E+01 | 6.6E-10 | 2.1E-08 |
| Pu-238 | 2.1E+00 | 2.2E-10 | 4.7E-10 |
| Pu-239 | 1.4E+00 | 2.3E-10 | 3.2E-10 |
| Pu-240 | 1.4E+00 | 2.3E-10 | 3.2E-10 |
| Ra-226 | 3.6E+00 | 1.2E-10 | 4.3E-10 |
| Ra-228 | 3.8E+00 | 1.0E-10 | 3.8E-10 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 3.0E-10 | 3.3E-10 | 9.9E-20 |
| Tc-99 | 3.5E-09 | 1.3E-12 | 4.5E-21 |
| Th-228 | 6.3E+00 | 5.5E-11 | 3.4E-10 |
| Th-230 | 6.6E+00 | 1.3E-11 | 8.6E-11 |
| Th-232 | 3.5E+00 | 1.2E-11 | 4.3E-11 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 2.3E+03 | 1.6E-11 | 3.7E-08 |
| U-235 | 6.2E+01 | 1.6E-11 | 9.9E-10 |
| U-236 | 2.6E+01 | 1.5E-11 | 3.8E-10 |
| U-238 | 1.4E+03 | 2.8E-11 | 3.9E-08 |
| | | ILCR Summation = | 1.0E-07 |

- 5208

**Table K.IV-101**
**Summary of Risk Quantitation (Radionuclides)**
**On-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via External Radiation**

**Exposure Equation** = $[CR \times EF \times EDn \times ET_i \times (1-SH_i)] + [CR \times EF \times EDn \times ET_o \times (1-SH_o)]$

| | | |
|---|---|---|
| EF | Fraction of year spent exposured | 0.95 (unitless) |
| ED | Exposure duration | 12 Year |
| $ET_i$ | Fraction of day spent indoors | 0.24 (unitless) |
| $ET_o$ | Fraction of day spent outdoors | 0.76 (unitless) |
| $SH_i$ | Shield factor indoors | 0.5 (unitless) |
| $SH_o$ | Shield factor outdoors | 0 (unitless) |
| CR | Radionuclide specific concentrations | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/g | Rn-222 | NA | pCi/g |
| Am-241 | NA | pCi/g | Ru-106 | NA | pCi/g |
| Cs-137 | 1.0E+00 | pCi/g | Sr-90 | 5.2E+00 | pCi/g |
| Np-237 | 7.0E-01 | pCi/g | Tc-99 | 3.8E+01 | pCi/g |
| Pa-231 | 2.5E+01 | pCi/g | Th-228 | 5.0E+00 | pCi/g |
| Pb-210 | 7.0E+01 | pCi/g | Th-230 | 5.0E+00 | pCi/g |
| Pu-238 | 3.0E+00 | pCi/g | Th-232 | 5.0E+00 | pCi/g |
| Pu-239 | 1.1E+00 | pCi/g | U-233 | NA | pCi/g |
| Pu-240 | 1.1E+00 | pCi/g | U-234 | 1.0E+02 | pCi/g |
| Ra-226 | 5.0E+00 | pCi/g | U-235 | 2.7E+00 | pCi/g |
| Ra-228 | 5.0E+00 | pCi/g | U-236 | 2.5E+00 | pCi/g |
| | | | U-238 | 6.0E+01 | pCi/g |

| Radionuclides | CDI (year pCi/g) | CSF $(g/pCi-year)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | NA | NA |
| Am-241 | NA | 4.9E-09 | NA |
| Cs-137 | 1.0E+01 | 2.0E-06 | 2.0E-05 |
| Np-237 | 7.0E+00 | 4.3E-07 | 3.0E-06 |
| Pa-231 | 2.5E+02 | 2.6E-08 | 6.6E-06 |
| Pb-210 | 7.0E+02 | 1.6E-10 | 1.1E-07 |
| Pu-238 | 3.0E+01 | 2.8E-11 | 8.3E-10 |
| Pu-239 | 1.1E+01 | 1.7E-11 | 1.9E-10 |
| Pu-240 | 1.1E+01 | 2.7E-11 | 3.0E-10 |
| Ra-226 | 5.0E+01 | 6.0E-06 | 3.0E-04 |
| Ra-228 | 5.0E+01 | 2.9E-06 | 1.5E-04 |
| Rn-222 | NA | 5.9E-06 | NA |
| Ru-106 | NA | NA | NA |
| Sr-90 | 5.2E+01 | NA | NA |
| Tc-99 | 3.8E+02 | 6.0E-13 | 2.3E-10 |
| Th-228 | 5.0E+01 | 5.6E-06 | 2.8E-04 |
| Th-230 | 5.0E+01 | 5.4E-11 | 2.7E-09 |
| Th-232 | 5.0E+01 | 2.6E-11 | 1.3E-09 |
| U-233 | NA | 4.2E-11 | NA |
| U-234 | 1.0E+03 | 3.0E-11 | 3.0E-08 |
| U-235 | 2.7E+01 | 2.4E-07 | 6.4E-06 |
| U-236 | 2.5E+01 | 2.4E-11 | 6.0E-10 |
| U-238 | 6.0E+02 | 3.6E-08 | 2.2E-05 |
| | | ILCR Summation = | 7.9E-04 |

0748

**Table K.IV-102**
**Summary of Intake Quantitation (chemicals)**
**On-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Inhalation of Particulates**

**Intake Equation** = $\frac{CS \times EF \times ED \times IR}{BW \times AT}$

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 12 $m^3$/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration for non-carchogens | 6 Year |
| EDc | Exposure duration for carchogens | 6 Year |
| BW | Body weight | 15 kg |
| ATc | Average time for carchogens (lifetime) | 25550 days |
| ATn | Average time for non-carchogens (EDn x 365) | 2190 days |
| CS | Concentration of chemicals in particulate as modeled | (see table below) |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 2.8E-06 | mg/m$^3$ | Heptachlorodibenzofuran | NA | mg/m$^3$ |
| Aroclor-1016 | NA | mg/m$^3$ | Heptachlorodibenzo-p-dioxin | NA | mg/m$^3$ |
| Aroclor-1221 | 4.2E-09 | mg/m$^3$ | Lead | 2.4E-05 | mg/m$^3$ |
| Aroclor-1242 | NA | mg/m$^3$ | Manganese | 6.5E-05 | mg/m$^3$ |
| Aroclor-1248 | 2.6E-09 | mg/m$^3$ | Mercury | 6.7E-08 | mg/m$^3$ |
| Aroclor-1254 | 1.3E-07 | mg/m$^3$ | Molybdenum | 4.3E-07 | mg/m$^3$ |
| Aroclor-1260 | 1.4E-07 | mg/m$^3$ | Nickel | 4.3E-06 | mg/m$^3$ |
| Arsenic | 1.7E-06 | mg/m$^3$ | Octachlorodibenzofuran | NA | mg/m$^3$ |
| Barium | 1.9E-04 | mg/m$^3$ | Selenium | 3.6E-08 | mg/m$^3$ |
| Beryllium | 1.6E-07 | mg/m$^3$ | Thallium | 4.7E-08 | mg/m$^3$ |
| Cadmium | 5.8E-07 | mg/m$^3$ | Vanadium | 2.9E-06 | mg/m$^3$ |
| Chromium | 4.7E-07 | mg/m$^3$ | Zinc | 2.0E-05 | mg/m$^3$ |
| Cobalt | 1.5E-06 | mg/m$^3$ | 2-Chlorophenol | NA | mg/m$^3$ |
| Copper | 7.4E-06 | mg/m$^3$ | 2-Methylnaphthalene | 1.1E-08 | mg/m$^3$ |
| Cyanide | 7.4E-07 | mg/m$^3$ | 4-Chlorophenyl-phenylether | NA | mg/m$^3$ |
| Di-n-octylphthalate | 1.2E-08 | mg/m$^3$ | 4,4-DDT | NA | mg/m$^3$ |

**References**

**Table K.IV-102 (continued)**
**Summary of Risk Characterization (chemicals)**
**On-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Inhalation of Particulates**

| Compound | HQ Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
| Antimony | 2.1E-06 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 3.2E-09 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 2.1E-09 | NA | NA |
| Aroclor-1254 | 9.7E-08 | NA | NA |
| Aroclor-1260 | 1.1E-07 | NA | NA |
| Arsenic | 1.3E-06 | NA | NA |
| Barium | 1.4E-04 | 1.4E-04 | 1.0E+00 |
| Beryllium | 1.2E-07 | NA | NA |
| Cadmium | 4.5E-07 | NA | NA |
| Chromium | 3.6E-07 | NA | NA |
| Cobalt | 1.2E-08 | 3.0E-07 | 3.9E+00 |
| Copper | 5.7E-06 | NA | NA |
| Cyanide | 5.7E-07 | NA | NA |
| Di-n-octyl phthalate | 9.1E-09 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.8E-05 | NA | NA |
| Manganese | 5.0E-05 | 1.1E-04 | 4.6E-01 |
| Mercury | 5.1E-06 | 8.6E-05 | 6.0E-04 |
| Molybdenum | 3.3E-07 | NA | NA |
| Nickel | 3.3E-06 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.7E-08 | NA | NA |
| Thallium | 3.6E-08 | NA | NA |
| Vanadium | 2.2E-06 | NA | NA |
| Zinc | 1.5E-05 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 8.4E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | NA | NA |
| | HQ Summation = | | 5.4E+00 |

| Compound | ILCR Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
| Antimony | 1.8E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 2.8E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.8E-10 | NA | NA |
| Aroclor-1254 | 8.4E-09 | NA | NA |
| Aroclor-1260 | 9.5E-09 | NA | NA |
| Arsenic | 1.1E-07 | 1.5E+01 | 1.7E-06 |
| Barium | 1.2E-05 | NA | NA |
| Beryllium | 1.1E-08 | 8.4E+00 | 8.9E-08 |
| Cadmium | 3.8E-08 | 6.1E+00 | 2.3E-07 |
| Chromium | 3.1E-08 | 4.1E+01 | 1.3E-06 |
| Cobalt | 1.0E-07 | NA | NA |
| Copper | 4.9E-07 | NA | NA |
| Cyanide | 4.9E-08 | NA | NA |
| Di-n-octyl phthalate | 7.8E-10 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.6E-06 | NA | NA |
| Manganese | 4.3E-06 | NA | NA |
| Mercury | 4.4E-09 | NA | NA |
| Molybdenum | 2.6E-08 | NA | NA |
| Nickel | 2.8E-07 | 8.4E-01 | 2.4E-07 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.3E-09 | NA | NA |
| Thallium | 3.1E-09 | NA | NA |
| Vanadium | 1.9E-07 | NA | NA |
| Zinc | 1.3E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 7.2E-10 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 3.5E-06 |

5208



0750

5208

**Table K.IV-103**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**On-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Inhalation of Gases and Particulates**

**Intake Equation** = Ca X EF X EDn X IR

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 12 $m^3$/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 6 Year |
| Ca | Concentration of radionuclides in air | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/$m^3$ | Rn-222 | 9.6E+00 | pCi/$m^3$ |
| Am-241 | NA | pCi/$m^3$ | Ru-106 | NA | pCi/$m^3$ |
| Cs-137 | 7.8E-05 | pCi/$m^3$ | Sr-90 | 3.0E-04 | pCi/$m^3$ |
| Np-237 | 3.6E-05 | pCi/$m^3$ | Tc-99 | 2.0E-03 | pCi/$m^3$ |
| Pa-231 | 1.7E-04 | pCi/$m^3$ | Th-228 | 2.1E-04 | pCi/$m^3$ |
| Pb-210 | 3.6E-03 | pCi/$m^3$ | Th-230 | 2.4E-04 | pCi/$m^3$ |
| Pu-238 | 1.7E-04 | pCi/$m^3$ | Th-232 | 1.5E-04 | pCi/$m^3$ |
| Pu-239 | 7.2E-05 | pCi/$m^3$ | U-233 | NA | pCi/$m^3$ |
| Pu-240 | 7.2E-05 | pCi/$m^3$ | U-234 | 3.6E-03 | pCi/$m^3$ |
| Ra-226 | 1.5E-04 | pCi/$m^3$ | U-235 | 9.6E-05 | pCi/$m^3$ |
| Ra-228 | 1.6E-04 | pCi/$m^3$ | U-236 | 4.0E-05 | pCi/$m^3$ |
| | | | U-238 | 2.2E-03 | pCi/$m^3$ |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 8.8E-08 | NA |
| Am-241 | NA | 3.2E-08 | NA |
| Cs-137 | 2.0E+00 | 1.9E-11 | 3.7E-11 |
| Np-237 | 9.1E-01 | 2.9E-08 | 2.6E-08 |
| Pa-231 | 4.2E+00 | 3.6E-08 | 1.5E-07 |
| Pb-210 | 9.1E+01 | 4.0E-09 | 3.6E-07 |
| Pu-238 | 4.2E+00 | 3.9E-08 | 1.6E-07 |
| Pu-239 | 1.8E+00 | 3.8E-08 | 6.9E-08 |
| Pu-240 | 1.8E+00 | 3.8E-08 | 6.9E-08 |
| Ra-226 | 3.7E+00 | 3.0E-09 | 1.1E-08 |
| Ra-228 | 4.0E+00 | 6.9E-10 | 2.8E-09 |
| Rn-222 | 2.4E+05 | 7.7E-12 | 1.9E-06 |
| Ru-106 | NA | 4.4E-10 | NA |
| Sr-90 | 7.6E+00 | 5.6E-11 | 4.3E-10 |
| Tc-99 | 5.0E+01 | 8.3E-12 | 4.2E-10 |
| Th-228 | 5.3E+00 | 7.8E-08 | 4.1E-07 |
| Th-230 | 6.1E+00 | 2.9E-08 | 1.8E-07 |
| Th-232 | 3.9E+00 | 2.8E-08 | 1.1E-07 |
| U-233 | NA | 2.7E-08 | NA |
| U-234 | 9.1E+01 | 2.6E-08 | 2.4E-06 |
| U-235 | 2.4E+00 | 2.5E-08 | 6.0E-08 |
| U-236 | 1.0E+00 | 2.5E-08 | 2.5E-08 |
| U-238 | 5.4E+01 | 5.2E-08 | 2.8E-06 |
| | | ILCR Summation = | 8.7E-06 |

0751

**Table K.IV-104**
**Summary of Intake Quantitation (chemicals)**
**On-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Incidental Ingestion of Soil/Sediment**

**Intake Equation** = $\frac{CS \times EF \times ED \times CF \times IR}{BW \times AT}$

| | | |
|---|---|---|
| IRs | Ingestion rate of soil (RAGS, 1989) | 200 mg/day |
| CF | Conversion factor | 1.00E-06 kg/mg |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration for non-carchogens | 6 Year |
| EDc | Exposure duration for carcinogens | 6 Year |
| BW | Body weight | 15 kg |
| ATc | Average time for carchogens (lifetime) | 25550 days |
| ATn | Average time for non-carchogens (EDn x 365) | 2190 days |
| CS | Concentration of chemicals in soil | (see table below) |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 3.1E+01 | mg/kg | Heptachlorodibenzofuran | NA | mg/kg |
| Aroclor-1016 | 0.0E+00 | mg/kg | Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Aroclor-1221 | 8.0E-02 | mg/kg | Lead | 4.4E+02 | mg/kg |
| Aroclor-1242 | 0.0E+00 | mg/kg | Manganese | 8.3E+02 | mg/kg |
| Aroclor-1248 | 6.0E-02 | mg/kg | Mercury | 1.3E+00 | mg/kg |
| Aroclor-1254 | 2.5E+00 | mg/kg | Molybdenum | 1.3E+01 | mg/kg |
| Aroclor-1260 | 2.6E+00 | mg/kg | Nickel | 5.9E+01 | mg/kg |
| Arsenic | 2.6E+01 | mg/kg | Octachlorodibenzofuran | 0.0E+00 | mg/kg |
| Barium | 3.6E+03 | mg/kg | Selenium | 5.7E+00 | mg/kg |
| Beryllium | 2.4E+00 | mg/kg | Thallium | 7.1E-01 | mg/kg |
| Cadmium | 6.9E+00 | mg/kg | Vanadium | 3.6E+01 | mg/kg |
| Chromium | 7.5E+00 | mg/kg | Zinc | 3.4E+02 | mg/kg |
| Cobalt | 2.1E+01 | mg/kg | 2-Chlorophenol | 0.0E+00 | mg/kg |
| Copper | 1.3E+02 | mg/kg | 2-Methylnaphthalene | 2.2E-01 | mg/kg |
| Cyanide | 1.4E+01 | mg/kg | 4-Chlorophenyl-phenylether | 0.0E+00 | mg/kg |
| Di-n-octyl phthalate | 6.6E-01 | mg/kg | 4,4-DDT | 0.0E+00 | mg/kg |

**References**



0752

- 5208

**Table K.IV-104 (continued)**
**Summary of Risk Characterization (chemicals)**
**On-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Incidental Ingestion of Soil/Sediment**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 4.0E-04 | 4.0E-04 | 9.9E-01 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.0E-06 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 7.7E-07 | NA | NA |
| Aroclor-1254 | 3.1E-05 | NA | NA |
| Aroclor-1260 | 3.6E-05 | NA | NA |
| Arsenic | 3.3E-04 | 3.0E-04 | 1.1E+00 |
| Barium | 4.6E-02 | 7.0E-02 | 6.6E-01 |
| Beryllium | 3.1E-05 | 5.0E-03 | 6.1E-03 |
| Cadmium | 8.8E-05 | 5.0E-04 | 1.8E-01 |
| Chromium | 9.6E-05 | 5.0E-03 | 1.9E-02 |
| Cobalt | 2.7E-04 | 6.0E-02 | 4.4E-03 |
| Copper | 1.8E-03 | NA | NA |
| Cyanide | 1.8E-04 | 2.0E-02 | 9.2E-03 |
| Di-n-octyl phthalate | 8.4E-06 | 2.0E-02 | 4.2E-04 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 5.6E-03 | NA | NA |
| Manganese | 1.1E-02 | 1.4E-01 | 7.6E-02 |
| Mercury | 1.7E-05 | 3.0E-04 | 5.5E-02 |
| Molybdenum | 1.7E-04 | 5.0E-03 | 3.4E-02 |
| Nickel | 7.5E-04 | 2.0E-02 | 3.8E-02 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 7.3E-05 | 5.0E-03 | 1.5E-02 |
| Thallium | 9.1E-06 | 8.0E-05 | 1.1E-01 |
| Vanadium | 4.6E-04 | 7.0E-03 | 6.5E-02 |
| Zinc | 4.3E-03 | 3.0E-01 | 1.4E-02 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 2.8E-06 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 3.4E+00 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 3.4E-05 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 8.8E-08 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 6.6E-08 | 7.7E+00 | 5.1E-07 |
| Aroclor-1254 | 2.7E-06 | 7.7E+00 | 2.1E-05 |
| Aroclor-1260 | 3.1E-06 | 7.7E+00 | 2.4E-05 |
| Arsenic | 2.8E-05 | 1.8E+00 | 4.9E-05 |
| Barium | 4.0E-03 | NA | NA |
| Beryllium | 2.6E-06 | 4.3E+00 | 1.1E-05 |
| Cadmium | 7.6E-06 | NA | NA |
| Chromium | 8.2E-06 | NA | NA |
| Cobalt | 2.3E-05 | NA | NA |
| Copper | 1.4E-04 | NA | NA |
| Cyanide | 1.6E-05 | NA | NA |
| Di-n-octyl phthalate | 7.2E-07 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 4.8E-04 | NA | NA |
| Manganese | 9.1E-04 | NA | NA |
| Mercury | 1.4E-06 | NA | NA |
| Molybdenum | 1.5E-05 | NA | NA |
| Nickel | 6.5E-05 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 6.2E-06 | NA | NA |
| Thallium | 7.8E-07 | NA | NA |
| Vanadium | 3.9E-05 | NA | NA |
| Zinc | 3.7E-04 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 2.4E-07 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 1.1E-04 |

5208

# Table K.IV-105
## Summary of Intake and Risk Quantitation (Radionuclides)
## On-Property RME Resident Farm Child Future Land Use Without Federal Ownership
## Via Incidental Ingestion of Soil/Sediment

**Intake Equation** = CS X EF X EDn X FI X IR

| | | | |
|---|---|---|---|
| IRs | Ingestion rate of soil (RAGS, 1989) | 200 | mg/day |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure Duration | 6 | Year |
| FI | Fractional Intake | 1 | (unitless) |
| CS | Concentration of radionuclides in soil | | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/mg | Rn-222 | NA | pCi/mg |
| Am-241 | NA | pCi/mg | Ru-106 | NA | pCi/mg |
| Cs-137 | 1.0E-03 | pCi/mg | Sr-90 | 5.2E-03 | pCi/mg |
| Np-237 | 7.0E-04 | pCi/mg | Tc-99 | 3.8E-02 | pCi/mg |
| Pa-231 | 2.5E-02 | pCi/mg | Th-228 | 5.0E-03 | pCi/mg |
| Pb-210 | 7.0E-02 | pCi/mg | Th-230 | 5.0E-03 | pCi/mg |
| Pu-238 | 3.0E-03 | pCi/mg | Th-232 | 5.0E-03 | pCi/mg |
| Pu-239 | 1.1E-03 | pCi/mg | U-233 | NA | pCi/mg |
| Pu-240 | 1.1E-03 | pCi/mg | U-234 | 1.0E-01 | pCi/mg |
| Ra-226 | 5.0E-03 | pCi/mg | U-235 | 2.7E-03 | pCi/mg |
| Ra-228 | 5.0E-03 | pCi/mg | U-236 | 2.5E-03 | pCi/mg |
| | | | U-238 | 6.0E-02 | pCi/mg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 4.2E+02 | 2.8E-11 | 1.2E-08 |
| Np-237 | 2.9E+02 | 2.2E-10 | 6.5E-08 |
| Pa-231 | 1.1E+04 | 9.2E-11 | 9.8E-07 |
| Pb-210 | 2.9E+04 | 6.6E-10 | 1.9E-05 |
| Pu-238 | 1.2E+03 | 2.2E-10 | 2.7E-07 |
| Pu-239 | 4.7E+02 | 2.3E-10 | 1.1E-07 |
| Pu-240 | 4.7E+02 | 2.3E-10 | 1.1E-07 |
| Ra-226 | 2.1E+03 | 1.2E-10 | 2.5E-07 |
| Ra-228 | 2.1E+03 | 1.0E-10 | 2.1E-07 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 2.2E+03 | 3.3E-10 | 7.2E-07 |
| Tc-99 | 1.6E+04 | 1.3E-12 | 2.1E-08 |
| Th-228 | 2.1E+03 | 5.5E-11 | 1.2E-07 |
| Th-230 | 2.1E+03 | 1.3E-11 | 2.7E-08 |
| Th-232 | 2.1E+03 | 1.2E-11 | 2.5E-08 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 4.2E+04 | 1.6E-11 | 6.7E-07 |
| U-235 | 1.1E+03 | 1.6E-11 | 1.8E-08 |
| U-236 | 1.0E+03 | 1.5E-11 | 1.6E-08 |
| U-238 | 2.5E+04 | 2.8E-11 | 7.1E-07 |
| | | **ILCR Summation** = | 2.4E-05 |

0754

- 5208

**Table K.IV-106**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**On-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Ingestion of Drinking Water**

**Intake Equation** = Cw X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of groundwater (RAGS, 1989) | 1.4 l/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 6 Year |
| FI | Fractional intake for radionuclides | 1 (Unitless) |
| Cw | Concentration of radionuclides in groundwater | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/l | Rn-222 | NA | pCi/l |
| Am-241 | NA | pCi/l | Ru-106 | NA | pCi/l |
| Cs-137 | NA | pCi/l | Sr-90 | 5.9E-06 | pCi/l |
| Np-237 | NA | pCi/l | Tc-99 | NA | pCi/l |
| Pa-231 | NA | pCi/l | Th-228 | NA | pCi/l |
| Pb-210 | NA | pCi/l | Th-230 | NA | pCi/l |
| Pu-238 | NA | pCi/l | Th-232 | NA | pCi/l |
| Pu-239 | NA | pCi/l | U-233 | NA | pCi/l |
| Pu-240 | NA | pCi/l | U-234 | 6.7E-01 | pCi/l |
| Ra-226 | NA | pCi/l | U-235 | 1.8E-02 | pCi/l |
| Ra-228 | NA | pCi/l | U-236 | 7.4E-03 | pCi/l |
| | | | U-238 | 4.0E-01 | pCi/l |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | NA | 2.8E-11 | NA |
| Np-237 | NA | 2.2E-10 | NA |
| Pa-231 | NA | 9.2E-11 | NA |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | NA | 2.2E-10 | NA |
| Pu-239 | NA | 2.3E-10 | NA |
| Pu-240 | NA | 2.3E-10 | NA |
| Ra-226 | NA | 1.2E-10 | NA |
| Ra-228 | NA | 1.0E-10 | NA |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 1.7E-02 | 3.3E-10 | 5.7E-12 |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | NA | 5.5E-11 | NA |
| Th-230 | NA | 1.3E-11 | NA |
| Th-232 | NA | 1.2E-11 | NA |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 2.0E+03 | 1.6E-11 | 3.2E-08 |
| U-235 | 5.3E+01 | 1.6E-11 | 8.5E-10 |
| U-236 | 2.2E+01 | 1.5E-11 | 3.3E-10 |
| U-238 | 1.2E+03 | 2.8E-11 | 3.3E-08 |
| | | ILCR Summation = | 6.6E-08 |

**Table K.IV-107**
**Summary of Intake Quantitation (chemicals)**
**On-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Dermal Contact with Soil/Sediment**

**Intake Equation** = $\frac{CS \times EF \times ED \times CF \times ABS \times AF \times SA}{BW \times AT}$

| | | | |
|---|---|---|---|
| SA | Surface area of exposed skin (50th percentile; hands only) | 2000 | $cm^2$/day |
| AF | Soil to skin adherence factor (RAGS, 1989) | 1 | $mg/cm^2$ |
| ABS | Chemical specific absorbtion factor (see table below) | csv | |
| CF | Conversion factor | 1E-06 | kg/mg |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 6 | Year |
| EDc | Exposure duration for carcinogens | 6 | Year |
| BW | Body weight | 15 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 2190 | days |
| CS | Concentration of chemicals in soil | (see table below) | |

**Chemical Concentrations**

| Compound | ABS | Concentrati | Units |
|---|---|---|---|
| Antimony | 1.0E-02 | 3.1E+01 | mg/kg |
| Aroclor-1016 | 6.0E-02 | 0.0E+00 | mg/kg |
| Aroclor-1221 | 6.0E-02 | 6.0E-02 | mg/kg |
| Aroclor-1242 | 6.0E-02 | 0.0E+00 | mg/kg |
| Aroclor-1248 | 6.0E-02 | 6.0E-02 | mg/kg |
| Aroclor-1254 | 6.0E-02 | 2.5E+00 | mg/kg |
| Aroclor-1260 | 6.0E-02 | 2.6E+00 | mg/kg |
| Arsenic | 1.0E-03 | 2.6E+01 | mg/kg |
| Barium | 1.0E-02 | 3.6E+03 | mg/kg |
| Beryllium | 1.0E-02 | 2.4E+00 | mg/kg |
| Cadmium | 1.0E-02 | 6.9E+00 | mg/kg |
| Chromium | 1.0E-02 | 7.5E+00 | mg/kg |
| Cobalt | 1.0E-02 | 2.1E+01 | mg/kg |
| Copper | 1.0E-03 | 1.3E+02 | mg/kg |
| Cyanide | NA | 1.4E+01 | mg/kg |
| Di-n-octyl phthalate | 3.0E-01 | 6.6E-01 | mg/kg |

| Compound | | Concentrat | Units |
|---|---|---|---|
| Heptachlorodibenzofuran | 3.0E-02 | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | 3.0E-02 | NA | mg/kg |
| Lead | 1.0E-02 | 4.4E+02 | mg/kg |
| Manganese | 1.0E-02 | 8.3E+02 | mg/kg |
| Mercury | 5.0E-02 | 1.3E+00 | mg/kg |
| Molybdenum | 1.0E-02 | 1.3E+01 | mg/kg |
| Nickel | 5.0E-04 | 5.9E+01 | mg/kg |
| Octachlorodibenzofuran | 3.0E-02 | 0.0E+00 | mg/kg |
| Selenium | 1.0E-02 | 5.7E+00 | mg/kg |
| Thallium | 1.0E-02 | 7.1E-01 | mg/kg |
| Vanadium | 1.0E-03 | 3.6E+01 | mg/kg |
| Zinc | 1.0E-02 | 3.4E+02 | mg/kg |
| 2-Chlorophenol | NA | 0.0E+00 | mg/kg |
| 2-Methylnaphthalene | NA | 2.2E-01 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | 0.0E+00 | mg/kg |
| 4,4-DDT | 3.0E-01 | 0.0E+00 | mg/kg |

**References**



0756

- 5208

**Table K.IV-107 (continued)**
**Summary of Risk Characterization (chemicals)**
**On-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Dermal Contact with Soil/Sediment**

| Compound | HQ Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
| Antimony | 4.0E-05 | 4.0E-04 | 9.9E-02 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 6.1E-07 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 4.6E-07 | NA | NA |
| Aroclor-1254 | 1.9E-05 | NA | NA |
| Aroclor-1260 | 2.1E-05 | NA | NA |
| Arsenic | 3.3E-06 | 3.0E-04 | 1.1E-02 |
| Barium | 4.6E-03 | 7.0E-02 | 6.6E-02 |
| Beryllium | 3.1E-06 | 5.0E-03 | 6.1E-04 |
| Cadmium | 8.8E-06 | 5.0E-04 | 1.8E-02 |
| Chromium | 9.6E-06 | 5.0E-03 | 1.9E-03 |
| Cobalt | 2.7E-05 | 6.0E-02 | 4.4E-04 |
| Copper | 1.6E-05 | NA | NA |
| Cyanide | NA | 2.0E-02 | NA |
| Di-n-octyl phthalate | 2.5E-05 | 2.0E-02 | 1.3E-03 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 5.6E-04 | NA | NA |
| Manganese | 1.1E-03 | 1.4E-01 | 7.6E-03 |
| Mercury | 8.3E-06 | 3.0E-04 | 2.8E-02 |
| Molybdenum | 1.7E-05 | 5.0E-03 | 3.4E-03 |
| Nickel | 3.8E-06 | 2.0E-02 | 1.9E-04 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 7.3E-06 | 5.0E-03 | 1.5E-03 |
| Thallium | 9.1E-07 | 8.0E-05 | 1.1E-02 |
| Vanadium | 4.6E-06 | 7.0E-03 | 6.5E-04 |
| Zinc | 4.3E-04 | 3.0E-01 | 1.4E-03 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | NA | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 2.5E-01 |

| Compound | ILCR Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
| Antimony | 3.4E-08 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 5.3E-08 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 3.9E-08 | 7.7E+00 | 3.0E-07 |
| Aroclor-1254 | 1.6E-06 | 7.7E+00 | 1.2E-05 |
| Aroclor-1260 | 1.8E-06 | 7.7E+00 | 1.4E-05 |
| Arsenic | 2.8E-07 | 1.8E+00 | 4.9E-07 |
| Barium | 4.0E-04 | NA | NA |
| Beryllium | 2.6E-07 | 4.3E+00 | 1.1E-06 |
| Cadmium | 7.6E-07 | NA | NA |
| Chromium | 8.2E-07 | NA | NA |
| Cobalt | 2.3E-06 | NA | NA |
| Copper | 1.4E-06 | NA | NA |
| Cyanide | NA | NA | NA |
| Di-n-octyl phthalate | 2.2E-06 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 4.8E-05 | NA | NA |
| Manganese | 9.1E-05 | NA | NA |
| Mercury | 7.1E-07 | NA | NA |
| Molybdenum | 1.5E-06 | NA | NA |
| Nickel | 3.2E-07 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 6.2E-07 | NA | NA |
| Thallium | 7.6E-08 | NA | NA |
| Vanadium | 3.9E-07 | NA | NA |
| Zinc | 3.7E-05 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | NA | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 2.9E-05 |

5208

**Table K.IV-108**
**Summary of Risk Quantitation (Radionuclides)**
**On-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via External Radiation**

**Exposure Equation** = $[CR \times EF \times EDn \times ET_i \times (1-SH_i)] + [CR \times EF \times EDn \times ET_o \times (1-SH_o)]$

| | | |
|---|---|---|
| EF | Fraction of year spent exposured | 0.95 (unitless) |
| ED | Exposure duration | 6 Year |
| $ET_i$ | Fraction of day spent indoors | 0.92 (unitless) |
| $ET_o$ | Fraction of day spent outdoors | 0.08 (unitless) |
| $SH_i$ | Shield factor indoors | 0.5 (unitless) |
| $SH_o$ | Shield factor outdoors | 0 (unitless) |
| CR | Radionuclide specific concentrations | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/g | Rn-222 | NA | pCi/g |
| Am-241 | NA | pCi/g | Ru-106 | NA | pCi/g |
| Cs-137 | 1.0E+00 | pCi/g | Sr-90 | 5.2E+00 | pCi/g |
| Np-237 | 7.0E-01 | pCi/g | Tc-99 | 3.8E+01 | pCi/g |
| Pa-231 | 2.5E+01 | pCi/g | Th-228 | 5.0E+00 | pCi/g |
| Pb-210 | 7.0E+01 | pCi/g | Th-230 | 5.0E+00 | pCi/g |
| Pu-238 | 3.0E+00 | pCi/g | Th-232 | 5.0E+00 | pCi/g |
| Pu-239 | 1.1E+00 | pCi/g | U-233 | NA | pCi/g |
| Pu-240 | 1.1E+00 | pCi/g | U-234 | 1.0E+02 | pCi/g |
| Ra-226 | 5.0E+00 | pCi/g | U-235 | 2.7E+00 | pCi/g |
| Ra-228 | 5.0E+00 | pCi/g | U-236 | 2.5E+00 | pCi/g |
| | | | U-238 | 6.0E+01 | pCi/g |

| Radionuclides | CDI (year pCi/g) | CSF $(g/pCi-year)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | NA | NA |
| Am-241 | NA | 4.9E-09 | NA |
| Cs-137 | 3.1E+00 | 2.0E-06 | 6.2E-06 |
| Np-237 | 2.2E+00 | 4.3E-07 | 9.3E-07 |
| Pa-231 | 7.8E+01 | 2.6E-08 | 2.0E-06 |
| Pb-210 | 2.2E+02 | 1.6E-10 | 3.4E-08 |
| Pu-238 | 9.1E+00 | 2.8E-11 | 2.5E-10 |
| Pu-239 | 3.4E+00 | 1.7E-11 | 5.9E-11 |
| Pu-240 | 3.4E+00 | 2.7E-11 | 9.3E-11 |
| Ra-226 | 1.5E+01 | 6.0E-06 | 9.2E-05 |
| Ra-228 | 1.5E+01 | 2.9E-06 | 4.5E-05 |
| Rn-222 | NA | 5.9E-06 | NA |
| Ru-106 | NA | NA | NA |
| Sr-90 | 1.6E+01 | NA | NA |
| Tc-99 | 1.2E+02 | 6.0E-13 | 7.0E-11 |
| Th-228 | 1.5E+01 | 5.6E-06 | 8.6E-05 |
| Th-230 | 1.5E+01 | 5.4E-11 | 8.3E-10 |
| Th-232 | 1.5E+01 | 2.6E-11 | 4.0E-10 |
| U-233 | NA | 4.2E-11 | NA |
| U-234 | 3.1E+02 | 3.0E-11 | 9.2E-09 |
| U-235 | 8.2E+00 | 2.4E-07 | 2.0E-06 |
| U-236 | 7.7E+00 | 2.4E-11 | 1.8E-10 |
| U-238 | 1.8E+02 | 3.6E-08 | 6.6E-06 |
| | | ILCR Summation = | 2.4E-04 |

**Table K.IV-109**
**Summary of Intake Quantitation (chemicals)**
**On-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Ingestion of Meat Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of meat | 0.029 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 6 | Year |
| EDc | Exposure duration for carcinogens | 6 | Year |
| BW | Body weight | 15 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 2190 | days |
| CS | Concentration of chemicals in meat | | |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 3.4E-01 | mg/kg | Heptachlorodibenzofuran | NA | mg/kg |
| Aroclor-1016 | NA | mg/kg | Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Aroclor-1221 | 2.2E-05 | mg/kg | Lead | 1.5E-01 | mg/kg |
| Aroclor-1242 | NA | mg/kg | Manganese | 3.6E+00 | mg/kg |
| Aroclor-1248 | 3.3E-04 | mg/kg | Mercury | 5.4E+00 | mg/kg |
| Aroclor-1254 | 6.6E-02 | mg/kg | Molybdenum | 4.0E-01 | mg/kg |
| Aroclor-1260 | 2.3E-02 | mg/kg | Nickel | 9.2E-01 | mg/kg |
| Arsenic | 8.3E-02 | mg/kg | Octachlorodibenzofuran | NA | mg/kg |
| Barium | 1.6E+00 | mg/kg | Selenium | 4.7E-03 | mg/kg |
| Beryllium | 1.5E-03 | mg/kg | Thallium | 1.3E-02 | mg/kg |
| Cadmium | 1.0E+00 | mg/kg | Vanadium | 6.2E-02 | mg/kg |
| Chromium | NA | mg/kg | Zinc | 1.2E+03 | mg/kg |
| Cobalt | 4.8E-01 | mg/kg | 2-Chlorophenol | NA | mg/kg |
| Copper | 1.5E-07 | mg/kg | 2-Methylnaphthalene | 1.3E-04 | mg/kg |
| Cyanide | 1.8E+00 | mg/kg | 4-Chlorophenyl-phenylether | NA | mg/kg |
| Di-n-octyl phthalate | NA | mg/kg | 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-109 (continued)**
**Summary of Risk Characterization (chemicals)**
**On-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Ingestion of Meat Products**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 6.3E-04 | 4.0E-04 | 1.6E+00 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 4.0E-08 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 6.2E-07 | NA | NA |
| Aroclor-1254 | 1.3E-04 | NA | NA |
| Aroclor-1260 | 4.2E-05 | NA | NA |
| Arsenic | 1.5E-04 | 3.0E-04 | 5.1E-01 |
| Barium | 3.0E-03 | 7.0E-02 | 4.3E-02 |
| Beryllium | 2.8E-06 | 5.0E-03 | 5.5E-04 |
| Cadmium | 1.8E-03 | 5.0E-04 | 3.7E+00 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 8.9E-04 | 6.0E-02 | 1.5E-02 |
| Copper | 2.6E-10 | NA | NA |
| Cyanide | 3.3E-03 | 2.0E-02 | 1.7E-01 |
| Di-n-octyl phthalate | NA | 2.0E-02 | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 2.6E-04 | NA | NA |
| Manganese | 6.7E-03 | 1.4E-01 | 4.8E-02 |
| Mercury | 1.0E-02 | 3.0E-04 | 3.3E+01 |
| Molybdenum | 7.4E-04 | 5.0E-03 | 1.5E-01 |
| Nickel | 1.7E-03 | 2.0E-02 | 8.6E-02 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 8.7E-06 | 5.0E-03 | 1.7E-03 |
| Thallium | 2.4E-05 | 8.0E-05 | 3.0E-01 |
| Vanadium | 1.1E-04 | 7.0E-03 | 1.6E-02 |
| Zinc | 2.3E+00 | 3.0E-01 | 7.5E+00 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 2.3E-07 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 4.7E+01 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 5.4E-05 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 3.4E-09 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 5.3E-08 | 7.7E+00 | 4.1E-07 |
| Aroclor-1254 | 1.1E-05 | 7.7E+00 | 8.3E-05 |
| Aroclor-1260 | 3.6E-06 | 7.7E+00 | 2.8E-05 |
| Arsenic | 1.3E-05 | 1.8E+00 | 2.3E-05 |
| Barium | 2.6E-04 | NA | NA |
| Beryllium | 2.4E-07 | 4.3E+00 | 1.0E-06 |
| Cadmium | 1.6E-04 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 7.6E-05 | NA | NA |
| Copper | 2.4E-11 | NA | NA |
| Cyanide | 2.8E-04 | NA | NA |
| Di-n-octyl phthalate | NA | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 2.4E-05 | NA | NA |
| Manganese | 5.8E-04 | NA | NA |
| Mercury | 8.5E-04 | NA | NA |
| Molybdenum | 6.3E-05 | NA | NA |
| Nickel | 1.5E-04 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 7.4E-07 | NA | NA |
| Thallium | 2.1E-06 | NA | NA |
| Vanadium | 9.8E-06 | NA | NA |
| Zinc | 1.9E-01 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 2.0E-08 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 1.3E-04 |

- 5208

**Table K.IV-110**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**On-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Ingestion of Meat Products**

**Intake Equation** = Cf X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of meat | 0.029 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 6 Year |
| Cf | Concentration of radionuclides in meat | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 3.4E-03 | pCi/kg | Sr-90 | NA | pCi/kg |
| Np-237 | 1.4E-06 | pCi/kg | Tc-99 | NA | pCi/kg |
| Pa-231 | 9.6E-03 | pCi/kg | Th-228 | 1.9E-06 | pCi/kg |
| Pb-210 | NA | pCi/kg | Th-230 | 3.2E-06 | pCi/kg |
| Pu-238 | 8.6E-08 | pCi/kg | Th-232 | 1.7E-06 | pCi/kg |
| Pu-239 | 5.5E-08 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 5.5E-08 | pCi/kg | U-234 | 4.2E-02 | pCi/kg |
| Ra-226 | 7.2E-05 | pCi/kg | U-235 | 1.1E-03 | pCi/kg |
| Ra-228 | 4.8E-05 | pCi/kg | U-236 | 4.6E-04 | pCi/kg |
| | | | U-238 | 2.5E-02 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 2.1E-01 | 2.6E-11 | 5.7E-12 |
| Np-237 | 8.6E-05 | 2.2E-10 | 1.9E-14 |
| Pa-231 | 5.8E-01 | 9.2E-11 | 5.4E-11 |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | 5.2E-06 | 2.2E-10 | 1.1E-15 |
| Pu-239 | 3.4E-06 | 2.3E-10 | 7.7E-16 |
| Pu-240 | 3.4E-06 | 2.3E-10 | 7.7E-16 |
| Ra-226 | 4.4E-03 | 1.2E-10 | 5.3E-13 |
| Ra-228 | 2.9E-03 | 1.0E-10 | 2.9E-13 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | NA | 3.3E-10 | NA |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | 1.2E-04 | 5.5E-11 | 6.4E-15 |
| Th-230 | 1.9E-04 | 1.3E-11 | 2.5E-15 |
| Th-232 | 1.0E-04 | 1.2E-11 | 1.2E-15 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 2.6E+00 | 1.6E-11 | 4.1E-11 |
| U-235 | 6.9E-02 | 1.6E-11 | 1.1E-12 |
| U-236 | 2.8E-02 | 1.5E-11 | 4.2E-13 |
| U-238 | 1.5E+00 | 2.8E-11 | 4.3E-11 |
| | | ILCR Summation = | 1.5E-10 |

**Table K.IV-111**
**Summary of Intake Quantitation (chemicals)**
**On-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Ingestion of Dairy Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of dairy products | 0.9 | l/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 6 | Year |
| EDc | Exposure duration for carcinogens | 6 | Year |
| BW | Body weight | 15 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 2190 | days |
| CS | Concentration of chemicals in animal products | | |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 3.4E-02 | mg/kg | Heptachlorodibenzofuran | NA | mg/kg |
| Aroclor-1016 | NA | mg/kg | Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Aroclor-1221 | 6.6E-06 | mg/kg | Lead | 1.3E-01 | mg/kg |
| Aroclor-1242 | NA | mg/kg | Manganese | 3.2E+00 | mg/kg |
| Aroclor-1248 | 2.4E-04 | mg/kg | Mercury | 9.7E-03 | mg/kg |
| Aroclor-1254 | 1.5E-02 | mg/kg | Molybdenum | 9.9E-02 | mg/kg |
| Aroclor-1260 | 4.6E-02 | mg/kg | Nickel | 1.5E-01 | mg/kg |
| Arsenic | 2.5E-03 | mg/kg | Octachlorodibenzofuran | NA | mg/kg |
| Barium | 3.6E+00 | mg/kg | Selenium | 1.3E-03 | mg/kg |
| Beryllium | 1.3E-06 | mg/kg | Thallium | 6.5E-04 | mg/kg |
| Cadmium | 1.6E-01 | mg/kg | Vanadium | 5.0E-04 | mg/kg |
| Chromium | NA | mg/kg | Zinc | 1.2E+02 | mg/kg |
| Cobalt | 4.6E-02 | mg/kg | 2-Chlorophenol | NA | mg/kg |
| Copper | 1.9E+00 | mg/kg | 2-Methylnaphthalene | 7.0E-05 | mg/kg |
| Cyanide | NA | mg/kg | 4-Chlorophenyl-phenylether | NA | mg/kg |
| Di-n-octylphthalate | 5.7E-01 | mg/kg | 4,4-DDT | NA | mg/kg |

**References**

0762

**Table K.IV-111 (continued)**
**Summary of Risk Characterization (chemicals)**
**On-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Ingestion of Dairy Products**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 2.0E-03 | 4.0E-04 | 4.9E+00 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 3.9E-07 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.4E-05 | NA | NA |
| Aroclor-1254 | 8.5E-04 | NA | NA |
| Aroclor-1260 | 2.6E-03 | NA | NA |
| Arsenic | 1.4E-04 | 3.0E-04 | 4.8E-01 |
| Barium | 2.2E-01 | 7.0E-02 | 3.2E+00 |
| Beryllium | 7.7E-08 | 5.0E-03 | 1.5E-05 |
| Cadmium | 1.0E-02 | 5.0E-04 | 2.1E+01 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 2.8E-03 | 6.0E-02 | 4.6E-02 |
| Copper | 1.1E-01 | NA | NA |
| Cyanide | NA | 2.0E-02 | NA |
| Di-n-octyl phthalate | 3.3E-02 | 2.0E-02 | 1.6E+00 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 7.2E-03 | NA | NA |
| Manganese | 1.8E-01 | 1.4E-01 | 1.3E+00 |
| Mercury | 5.6E-04 | 3.0E-04 | 1.9E+00 |
| Molybdenum | 5.7E-03 | 5.0E-03 | 1.1E+00 |
| Nickel | 8.9E-03 | 2.0E-02 | 4.4E-01 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 7.2E-05 | 5.0E-03 | 1.4E-02 |
| Thallium | 3.8E-05 | 8.0E-05 | 4.7E-01 |
| Vanadium | 2.8E-05 | 7.0E-03 | 4.1E-03 |
| Zinc | 7.0E+00 | 3.0E-01 | 2.3E+01 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 4.0E-06 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 6.0E+01 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 1.7E-04 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 3.4E-08 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 1.2E-06 | 7.7E+00 | 9.0E-06 |
| Aroclor-1254 | 7.2E-05 | 7.7E+00 | 5.6E-04 |
| Aroclor-1260 | 2.2E-04 | 7.7E+00 | 1.7E-03 |
| Arsenic | 1.2E-05 | 1.8E+00 | 2.1E-05 |
| Barium | 1.9E-02 | NA | NA |
| Beryllium | 6.6E-09 | 4.3E+00 | 2.8E-08 |
| Cadmium | 8.9E-04 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 2.4E-04 | NA | NA |
| Copper | 9.4E-03 | NA | NA |
| Cyanide | NA | NA | NA |
| Di-n-octyl phthalate | 2.8E-03 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 6.2E-04 | NA | NA |
| Manganese | 1.6E-02 | NA | NA |
| Mercury | 4.8E-05 | NA | NA |
| Molybdenum | 4.9E-04 | NA | NA |
| Nickel | 7.6E-04 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 6.2E-06 | NA | NA |
| Thallium | 3.2E-06 | NA | NA |
| Vanadium | 2.4E-06 | NA | NA |
| Zinc | 6.0E-01 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.5E-07 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 2.3E-03 |

208

**Table K.IV-112**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**On-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Ingestion of Dairy Products**

**Intake Equation** = Cp X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of dairy products | 0.9 l/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 6 Year |
| Cp | Concentration of radionuclides in animal products | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 1.2E-03 | pCi/kg | Sr-90 | 1.5E-24 | pCi/kg |
| Np-237 | 1.3E-07 | pCi/kg | Tc-99 | 1.2E-22 | pCi/kg |
| Pa-231 | 6.0E-05 | pCi/kg | Th-228 | 2.5E-06 | pCi/kg |
| Pb-210 | NA | pCi/kg | Th-230 | 2.7E-06 | pCi/kg |
| Pu-238 | 1.7E-08 | pCi/kg | Th-232 | 1.4E-06 | pCi/kg |
| Pu-239 | 1.1E-08 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 1.1E-08 | pCi/kg | U-234 | 1.3E-01 | pCi/kg |
| Ra-226 | 1.3E-04 | pCi/kg | U-235 | 3.5E-03 | pCi/kg |
| Ra-228 | 1.3E-04 | pCi/kg | U-236 | 1.4E-03 | pCi/kg |
| | | | U-238 | 7.8E-02 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 2.2E+00 | 2.8E-11 | 6.2E-11 |
| Np-237 | 2.4E-04 | 2.2E-10 | 5.4E-14 |
| Pa-231 | 1.1E-01 | 9.2E-11 | 1.0E-11 |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | 3.3E-05 | 2.2E-10 | 7.2E-15 |
| Pu-239 | 2.1E-05 | 2.3E-10 | 4.8E-15 |
| Pu-240 | 2.1E-05 | 2.3E-10 | 4.8E-15 |
| Ra-226 | 2.5E-01 | 1.2E-10 | 2.9E-11 |
| Ra-228 | 2.5E-01 | 1.0E-10 | 2.5E-11 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 2.8E-21 | 3.3E-10 | 9.2E-31 |
| Tc-99 | 2.3E-19 | 1.3E-12 | 3.0E-31 |
| Th-228 | 4.6E-03 | 5.5E-11 | 2.5E-13 |
| Th-230 | 5.0E-08 | 1.3E-11 | 6.5E-14 |
| Th-232 | 2.7E-03 | 1.2E-11 | 3.2E-14 |
| U-233 | NA | 1.8E-11 | NA |
| U-234 | 2.5E+02 | 1.6E-11 | 3.9E-09 |
| U-235 | 6.5E+00 | 1.6E-11 | 1.0E-10 |
| U-236 | 2.7E+00 | 1.5E-11 | 4.0E-11 |
| U-238 | 1.5E+02 | 2.8E-11 | 4.1E-09 |
| | | **ILCR Summation =** | 8.3E-09 |



0764

**Table K.IV-113**
**Summary of Intake Quantitation (chemicals)**
**On-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.102 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 6 | Year |
| EDc | Exposure duration for carcinogens | 6 | Year |
| BW | Body weight | 15 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 2190 | days |
| CS | Concentration of chemicals in vegetables | | |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 9.8E-01 | mg/kg | Heptachlorodibenzofuran | NA | mg/kg |
| Aroclor-1016 | NA | mg/kg | Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Aroclor-1221 | 2.7E-02 | mg/kg | Lead | 8.2E+00 | mg/kg |
| Aroclor-1242 | NA | mg/kg | Manganese | 1.8E+02 | mg/kg |
| Aroclor-1248 | 4.8E-04 | mg/kg | Mercury | 4.3E-01 | mg/kg |
| Aroclor-1254 | 6.9E-03 | mg/kg | Molybdenum | 3.1E-01 | mg/kg |
| Aroclor-1260 | 1.1E-02 | mg/kg | Nickel | 2.6E+00 | mg/kg |
| Arsenic | 6.6E-01 | mg/kg | Octachlorodibenzofuran | NA | mg/kg |
| Barium | 2.1E+02 | mg/kg | Selenium | 4.5E-03 | mg/kg |
| Beryllium | 1.5E-02 | mg/kg | Thallium | 1.9E-03 | mg/kg |
| Cadmium | 3.6E+00 | mg/kg | Vanadium | 1.8E-01 | mg/kg |
| Chromium | NA | mg/kg | Zinc | 2.4E+02 | mg/kg |
| Cobalt | 3.2E-01 | mg/kg | 2-Chlorophenol | NA | mg/kg |
| Copper | 2.5E+02 | mg/kg | 2-Methylnaphthalene | 1.8E-02 | mg/kg |
| Cyanide | 1.9E+00 | mg/kg | 4-Chlorophenyl-phenylether | NA | mg/kg |
| Di-n-octyl phthalate | 1.8E-05 | mg/kg | 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-113 (continued)**
**Summary of Risk Characterization (chemicals)**
**On-Property RMB Resident Farm Child Future Land Use Without Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

| Compound | HQ Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
| Antimony | 6.4E-03 | 4.0E-04 | 1.6E+01 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.8E-04 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 3.1E-06 | NA | NA |
| Aroclor-1254 | 4.5E-05 | NA | NA |
| Aroclor-1260 | 7.2E-05 | NA | NA |
| Arsenic | 4.3E-03 | 3.0E-04 | 1.4E+01 |
| Barium | 1.3E+00 | 7.0E-02 | 1.9E+01 |
| Beryllium | 9.7E-05 | 5.0E-03 | 1.9E-02 |
| Cadmium | 2.3E-02 | 5.0E-04 | 4.6E+01 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 2.1E-03 | 6.0E-02 | 3.5E-02 |
| Copper | 1.6E+00 | NA | NA |
| Cyanide | 1.2E-02 | 2.0E-02 | 6.1E-01 |
| Di-n-octyl phthalate | 1.2E-07 | 2.0E-02 | 5.8E-06 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 5.3E-02 | NA | NA |
| Manganese | 1.1E+00 | 1.4E-01 | 8.2E+00 |
| Mercury | 2.8E-03 | 3.0E-04 | 9.2E+00 |
| Molybdenum | 2.0E-03 | 5.0E-03 | 4.0E-01 |
| Nickel | 1.7E-02 | 2.0E-02 | 8.6E-01 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.9E-05 | 5.0E-03 | 5.8E-03 |
| Thallium | 1.2E-05 | 8.0E-05 | 1.5E-01 |
| Vanadium | 1.1E-03 | 7.0E-03 | 1.6E-01 |
| Zinc | 1.6E+00 | 3.0E-01 | 5.3E+00 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 1.2E-04 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| HQ Summation = | | | 1.2E+02 |

| Compound | ILCR Calculation | | |
|---|---|---|---|
| | CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
| Antimony | 5.4E-04 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.5E-05 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 2.7E-07 | 7.7E+00 | 2.1E-06 |
| Aroclor-1254 | 3.9E-06 | 7.7E+00 | 3.0E-05 |
| Aroclor-1260 | 6.1E-06 | 7.7E+00 | 4.7E-05 |
| Arsenic | 3.7E-04 | 1.8E+00 | 6.5E-04 |
| Barium | 1.2E-01 | NA | NA |
| Beryllium | 8.3E-06 | 4.3E+00 | 3.6E-05 |
| Cadmium | 2.0E-03 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 1.8E-04 | NA | NA |
| Copper | 1.4E-01 | NA | NA |
| Cyanide | 1.0E-03 | NA | NA |
| Di-n-octyl phthalate | 1.0E-08 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 4.6E-03 | NA | NA |
| Manganese | 9.8E-02 | NA | NA |
| Mercury | 2.4E-04 | NA | NA |
| Molybdenum | 1.7E-04 | NA | NA |
| Nickel | 1.5E-03 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.5E-06 | NA | NA |
| Thallium | 1.0E-06 | NA | NA |
| Vanadium | 9.8E-05 | NA | NA |
| Zinc | 1.4E-01 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 1.0E-05 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| ILCR Summation = | | | 7.6E-04 |

- 5208

**Table K.IV-114**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**On-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

**Intake Equation** = Cv X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.102 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 6 Year |
| Cv | Concentration of radionuclides in vegetables | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 4.1E-03 | pCi/kg | Sr-90 | 5.9E-13 | pCi/kg |
| Np-237 | 5.9E-04 | pCi/kg | Tc-99 | 6.8E-12 | pCi/kg |
| Pa-231 | 2.9E-03 | pCi/kg | Th-228 | 1.2E-02 | pCi/kg |
| Pb-210 | 6.2E-02 | pCi/kg | Th-230 | 1.3E-02 | pCi/kg |
| Pu-238 | 4.2E-03 | pCi/kg | Th-232 | 6.9E-03 | pCi/kg |
| Pu-239 | 2.7E-03 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 2.7E-03 | pCi/kg | U-234 | 4.6E+00 | pCi/kg |
| Ra-226 | 7.0E-03 | pCi/kg | U-235 | 1.2E-01 | pCi/kg |
| Ra-228 | 7.3E-03 | pCi/kg | U-236 | 5.0E-02 | pCi/kg |
| | | | U-238 | 2.7E+00 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 8.7E-01 | 2.8E-11 | 2.4E-11 |
| Np-237 | 1.3E-01 | 2.2E-10 | 2.8E-11 |
| Pa-231 | 6.2E-01 | 9.2E-11 | 5.7E-11 |
| Pb-210 | 1.3E+01 | 6.6E-10 | 8.7E-09 |
| Pu-238 | 8.9E-01 | 2.2E-10 | 2.0E-10 |
| Pu-239 | 5.7E-01 | 2.3E-10 | 1.3E-10 |
| Pu-240 | 5.7E-01 | 2.3E-10 | 1.3E-10 |
| Ra-226 | 1.5E+00 | 1.2E-10 | 1.8E-10 |
| Ra-228 | 1.6E+00 | 1.0E-10 | 1.6E-10 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 1.3E-10 | 3.3E-10 | 4.1E-20 |
| Tc-99 | 1.5E-09 | 1.3E-12 | 1.9E-21 |
| Th-228 | 2.6E+00 | 5.5E-11 | 1.4E-10 |
| Th-230 | 2.8E+00 | 1.3E-11 | 3.6E-11 |
| Th-232 | 1.5E+00 | 1.2E-11 | 1.8E-11 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 9.8E+02 | 1.6E-11 | 1.6E-08 |
| U-235 | 2.6E+01 | 1.6E-11 | 4.1E-10 |
| U-236 | 1.1E+01 | 1.5E-11 | 1.6E-10 |
| U-238 | 5.8E+02 | 2.8E-11 | 1.6E-08 |
| | | ILCR Summation = | 4.2E-08 |

**Table K.IV-115**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Inhalation of Particulates**

**Intake Equation** = $\frac{CS \times EF \times ED \times IR}{BW \times AT}$

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 20 $m^3$/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration for non-carcinogens | 70 Year |
| EDc | Exposure duration for carcinogens | 70 Year |
| BW | Body weight | 70 kg |
| ATc | Average time for carcinogens (lifetime) | 25550 days |
| ATn | Average time for non-carcinogens (EDn x 365) | 25550 days |
| CS | Concentration of chemicals in particulate as modeled | (see table below) |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 1.9E-06 | $mg/m^3$ | Heptachlorodibenzofuran | NA | $mg/m^3$ |
| Aroclor-1016 | NA | $mg/m^3$ | Heptachlorodibenzo-p-dioxin | NA | $mg/m^3$ |
| Aroclor-1221 | 1.9E-09 | $mg/m^3$ | Lead | 1.1E-05 | $mg/m^3$ |
| Aroclor-1242 | NA | $mg/m^3$ | Manganese | 3.9E-05 | $mg/m^3$ |
| Aroclor-1248 | 1.3E-09 | $mg/m^3$ | Mercury | 3.0E-08 | $mg/m^3$ |
| Aroclor-1254 | 6.0E-08 | $mg/m^3$ | Molybdenum | 3.0E-07 | $mg/m^3$ |
| Aroclor-1260 | 6.3E-08 | $mg/m^3$ | Nickel | 2.5E-06 | $mg/m^3$ |
| Arsenic | 9.3E-07 | $mg/m^3$ | Octachlorodibenzofuran | NA | $mg/m^3$ |
| Barium | 6.5E-05 | $mg/m^3$ | Selenium | 9.3E-09 | $mg/m^3$ |
| Beryllium | 8.5E-08 | $mg/m^3$ | Thallium | 2.6E-08 | $mg/m^3$ |
| Cadmium | 3.7E-07 | $mg/m^3$ | Vanadium | 1.8E-06 | $mg/m^3$ |
| Chromium | 2.5E-07 | $mg/m^3$ | Zinc | 9.7E-06 | $mg/m^3$ |
| Cobalt | 9.3E-07 | $mg/m^3$ | 2-Chlorophenol | NA | $mg/m^3$ |
| Copper | 3.7E-06 | $mg/m^3$ | 2-Methylnaphthalene | 5.0E-09 | $mg/m^3$ |
| Cyanide | 3.3E-07 | $mg/m^3$ | 4-Chlorophenyl-phenylether | NA | $mg/m^3$ |
| Di-n-octyl phthalate | 5.3E-09 | $mg/m^3$ | 4,4-DDT | NA | $mg/m^3$ |

**References**



0768

5208

**Table K.IV-115 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RMB Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Inhalation of Particulates**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 5.3E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 5.1E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 3.5E-10 | NA | NA |
| Aroclor-1254 | 1.6E-08 | NA | NA |
| Aroclor-1260 | 1.7E-08 | NA | NA |
| Arsenic | 2.5E-07 | NA | NA |
| Barium | 2.3E-05 | 1.4E-04 | 1.7E-01 |
| Beryllium | 2.3E-08 | NA | NA |
| Cadmium | 1.0E-07 | NA | NA |
| Chromium | 6.7E-08 | NA | NA |
| Cobalt | 2.5E-07 | 3.0E-07 | 8.5E-01 |
| Copper | 1.0E-06 | NA | NA |
| Cyanide | 9.0E-08 | NA | NA |
| Di-n-octyl phthalate | 1.5E-09 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.1E-06 | NA | NA |
| Manganese | 1.1E-05 | 1.1E-04 | 9.7E-02 |
| Mercury | 8.1E-09 | 8.6E-05 | 9.4E-05 |
| Molybdenum | 8.3E-08 | NA | NA |
| Nickel | 6.7E-07 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.5E-09 | NA | NA |
| Thallium | 7.2E-09 | NA | NA |
| Vanadium | 4.9E-07 | NA | NA |
| Zinc | 2.7E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 1.4E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | NA | NA |
| | HQ Summation = | | 1.1E+00 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 5.3E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 5.1E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 3.5E-10 | NA | NA |
| Aroclor-1254 | 1.6E-08 | NA | NA |
| Aroclor-1260 | 1.7E-08 | NA | NA |
| Arsenic | 2.5E-07 | 1.5E+01 | 3.8E-06 |
| Barium | 2.3E-05 | NA | NA |
| Beryllium | 2.3E-08 | 8.4E+00 | 1.9E-07 |
| Cadmium | 1.0E-07 | 6.1E+00 | 6.2E-07 |
| Chromium | 6.7E-08 | 4.1E+01 | 2.8E-06 |
| Cobalt | 2.5E-07 | NA | NA |
| Copper | 1.0E-06 | NA | NA |
| Cyanide | 9.0E-08 | NA | NA |
| Di-n-octyl phthalate | 1.5E-09 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.1E-06 | NA | NA |
| Manganese | 1.1E-05 | NA | NA |
| Mercury | 8.1E-09 | NA | NA |
| Molybdenum | 8.3E-08 | NA | NA |
| Nickel | 6.7E-07 | 8.4E-01 | 5.6E-07 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.5E-09 | NA | NA |
| Thallium | 7.2E-09 | NA | NA |
| Vanadium | 4.9E-07 | NA | NA |
| Zinc | 2.7E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 1.4E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 8.0E-06 |

- 5208

**Table K.IV-116**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Inhalation of Gases and Particulates**

**Intake Equation** = Ca X EF X EDn X IR

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 20 $m^3$/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 70 Year |
| Ca | Concentration of radionuclides in air | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/$m^3$ | Rn-222 | 4.1E+00 | pCi/$m^3$ |
| Am-241 | NA | pCi/$m^3$ | Ru-106 | NA | pCi/$m^3$ |
| Cs-137 | 4.6E-05 | pCi/$m^3$ | Sr-90 | 1.5E-04 | pCi/$m^3$ |
| Np-237 | 1.6E-05 | pCi/$m^3$ | Tc-99 | 9.2E-04 | pCi/$m^3$ |
| Pa-231 | 6.0E-05 | pCi/$m^3$ | Th-228 | 1.4E-04 | pCi/$m^3$ |
| Pb-210 | 1.6E-03 | pCi/$m^3$ | Th-230 | 1.5E-04 | pCi/$m^3$ |
| Pu-238 | 8.0E-05 | pCi/$m^3$ | Th-232 | 8.1E-05 | pCi/$m^3$ |
| Pu-239 | 3.9E-05 | pCi/$m^3$ | U-233 | NA | pCi/$m^3$ |
| Pu-240 | 3.9E-05 | pCi/$m^3$ | U-234 | 1.7E-03 | pCi/$m^3$ |
| Ra-226 | 8.1E-05 | pCi/$m^3$ | U-235 | 4.4E-05 | pCi/$m^3$ |
| Ra-228 | 8.8E-05 | pCi/$m^3$ | U-236 | 1.9E-05 | pCi/$m^3$ |
| | | | U-238 | 9.9E-04 | pCi/$m^3$ |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 8.8E-08 | NA |
| Am-241 | NA | 3.2E-08 | NA |
| Cs-137 | 2.3E+01 | 1.9E-11 | 4.3E-10 |
| Np-237 | 7.8E+00 | 2.9E-08 | 2.3E-07 |
| Pa-231 | 2.9E+01 | 3.6E-08 | 1.1E-06 |
| Pb-210 | 7.8E+02 | 4.0E-09 | 3.1E-06 |
| Pu-238 | 3.9E+01 | 3.9E-08 | 1.5E-06 |
| Pu-239 | 1.9E+01 | 3.8E-08 | 7.3E-07 |
| Pu-240 | 1.9E+01 | 3.8E-08 | 7.3E-07 |
| Ra-226 | 4.0E+01 | 3.0E-09 | 1.2E-07 |
| Ra-228 | 4.3E+01 | 6.9E-10 | 3.0E-08 |
| Rn-222 | 2.0E+06 | 7.7E-12 | 1.6E-05 |
| Ru-106 | NA | 4.4E-10 | NA |
| Sr-90 | 7.4E+01 | 5.6E-11 | 4.2E-09 |
| Tc-99 | 4.5E+02 | 8.3E-12 | 3.7E-09 |
| Th-228 | 7.1E+01 | 7.8E-08 | 5.5E-06 |
| Th-230 | 7.4E+01 | 2.9E-08 | 2.1E-06 |
| Th-232 | 4.0E+01 | 2.8E-08 | 1.1E-06 |
| U-233 | NA | 2.7E-08 | NA |
| U-234 | 8.1E+02 | 2.6E-08 | 2.1E-05 |
| U-235 | 2.2E+01 | 2.5E-08 | 5.4E-07 |
| U-236 | 9.3E+00 | 2.5E-08 | 2.3E-07 |
| U-238 | 4.8E+02 | 5.2E-08 | 2.5E-05 |
| | | **ILCR Summation =** | 7.9E-05 |

208

**Table K.IV-117**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Ingestion of Drinking Water**

**Intake Equation** = Cw X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of groundwater (RAGS, 1989) | 2 l/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 70 Year |
| FI | Fractional intake for radionuclides | 1 (Unitless) |
| Cw | Concentration of radionuclides in groundwater | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/l | Rn-222 | NA | pCi/l |
| Am-241 | NA | pCi/l | Ru-106 | NA | pCi/l |
| Cs-137 | NA | pCi/l | Sr-90 | 2.2E-06 | pCi/l |
| Np-237 | NA | pCi/l | Tc-99 | NA | pCi/l |
| Pa-231 | NA | pCi/l | Th-228 | NA | pCi/l |
| Pb-210 | NA | pCi/l | Th-230 | NA | pCi/l |
| Pu-238 | NA | pCi/l | Th-232 | NA | pCi/l |
| Pu-239 | NA | pCi/l | U-233 | NA | pCi/l |
| Pu-240 | NA | pCi/l | U-234 | 1.5E+00 | pCi/l |
| Ra-226 | NA | pCi/l | U-235 | 4.0E-02 | pCi/l |
| Ra-228 | NA | pCi/l | U-236 | 1.6E-02 | pCi/l |
| | | | U-238 | 9.2E-01 | pCi/l |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | NA | 2.8E-11 | NA |
| Np-237 | NA | 2.2E-10 | NA |
| Pa-231 | NA | 9.2E-11 | NA |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | NA | 2.2E-10 | NA |
| Pu-239 | NA | 2.3E-10 | NA |
| Pu-240 | NA | 2.3E-10 | NA |
| Ra-226 | NA | 1.2E-10 | NA |
| Ra-228 | NA | 1.0E-10 | NA |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 1.1E-01 | 3.3E-10 | 3.5E-11 |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | NA | 5.5E-11 | NA |
| Th-230 | NA | 1.3E-11 | NA |
| Th-232 | NA | 1.2E-11 | NA |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 7.5E+04 | 1.6E-11 | 1.2E-06 |
| U-235 | 2.0E+03 | 1.6E-11 | 3.1E-08 |
| U-236 | 7.8E+02 | 1.5E-11 | 1.2E-08 |
| U-238 | 4.5E+04 | 2.8E-11 | 1.3E-06 |
| | | ILCR Summation = | 2.5E-06 |

- 5208

**Table K.IV-118**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Ingestion of Meat Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of meat | 0.075 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 70 | Year |
| EDc | Exposure duration for carcinogens | 70 | Year |
| BW | Body weight | 70 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 25550 | days |
| CS | Concentration of chemicals in fish | | |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 6.6E-06 | mg/kg |
| Aroclor-1016 | NA | mg/kg |
| Aroclor-1221 | 5.6E-11 | mg/kg |
| Aroclor-1242 | NA | mg/kg |
| Aroclor-1248 | 1.9E-08 | mg/kg |
| Aroclor-1254 | 8.0E-08 | mg/kg |
| Aroclor-1260 | 3.1E-08 | mg/kg |
| Arsenic | 5.6E-06 | mg/kg |
| Barium | 2.2E-05 | mg/kg |
| Beryllium | 2.5E-07 | mg/kg |
| Cadmium | 8.1E-06 | mg/kg |
| Chromium | NA | mg/kg |
| Cobalt | 6.0E-05 | mg/kg |
| Copper | 9.5E-05 | mg/kg |
| Cyanide | 3.0E-11 | mg/kg |
| Di-n-octyl phthalate | 3.5E-04 | mg/kg |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Lead | 6.5E-06 | mg/kg |
| Manganese | 5.7E-05 | mg/kg |
| Mercury | 1.4E-05 | mg/kg |
| Molybdenum | 6.4E-06 | mg/kg |
| Nickel | 4.9E-05 | mg/kg |
| Octachlorodibenzofuran | NA | mg/kg |
| Selenium | 3.1E-07 | mg/kg |
| Thallium | 3.3E-06 | mg/kg |
| Vanadium | 1.6E-05 | mg/kg |
| Zinc | 3.1E-03 | mg/kg |
| 2-Chlorophenol | NA | mg/kg |
| 2-Methylnaphthalene | 1.3E-09 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | mg/kg |
| 4,4-DDT | NA | mg/kg |

References



0172

**Table K.IV-118 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Ingestion of Meat Products**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 6.9E-09 | 4.0E-04 | 1.7E-05 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 5.8E-14 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 2.0E-11 | NA | NA |
| Aroclor-1254 | 8.2E-09 | NA | NA |
| Aroclor-1260 | 3.2E-09 | NA | NA |
| Arsenic | 5.9E-09 | 3.0E-04 | 2.0E-05 |
| Barium | 2.3E-08 | 7.0E-02 | 3.2E-07 |
| Beryllium | 2.6E-10 | 5.0E-03 | 5.1E-08 |
| Cadmium | 8.4E-09 | 5.0E-04 | 1.7E-05 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 6.2E-08 | 6.0E-02 | 1.0E-06 |
| Copper | 9.8E-08 | NA | NA |
| Cyanide | 3.0E-14 | 2.0E-02 | 1.5E-12 |
| Di-n-octyl phthalate | 3.6E-07 | 2.0E-02 | 1.8E-05 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 6.7E-09 | NA | NA |
| Manganese | 5.9E-08 | 1.4E-01 | 4.2E-07 |
| Mercury | 1.4E-08 | 3.0E-04 | 4.8E-05 |
| Molybdenum | 6.6E-09 | 5.0E-03 | 1.3E-06 |
| Nickel | 5.1E-08 | 2.0E-02 | 2.5E-06 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 3.2E-10 | 5.0E-03 | 6.4E-08 |
| Thallium | 3.4E-09 | 8.0E-05 | 4.3E-05 |
| Vanadium | 1.6E-08 | 7.0E-03 | 2.3E-06 |
| Zinc | 3.2E-06 | 3.0E-01 | 1.1E-05 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 1.3E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 1.8E-04 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 6.9E-09 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 5.8E-14 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 2.0E-11 | 7.7E+00 | 1.5E-10 |
| Aroclor-1254 | 8.2E-09 | 7.7E+00 | 6.3E-08 |
| Aroclor-1260 | 3.2E-09 | 7.7E+00 | 2.5E-08 |
| Arsenic | 5.9E-09 | 1.8E+00 | 1.0E-08 |
| Barium | 2.3E-08 | NA | NA |
| Beryllium | 2.6E-10 | 4.3E+00 | 1.1E-09 |
| Cadmium | 8.4E-09 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 6.2E-08 | NA | NA |
| Copper | 9.8E-08 | NA | NA |
| Cyanide | 3.0E-14 | NA | NA |
| Di-n-octyl phthalate | 3.6E-07 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 6.7E-09 | NA | NA |
| Manganese | 5.9E-08 | NA | NA |
| Mercury | 1.4E-08 | NA | NA |
| Molybdenum | 6.6E-09 | NA | NA |
| Nickel | 5.1E-08 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 3.2E-10 | NA | NA |
| Thallium | 3.4E-09 | NA | NA |
| Vanadium | 1.6E-08 | NA | NA |
| Zinc | 3.2E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 1.3E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 9.9E-08 |

- 5208

**Table K.IV-119**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Ingestion of Meat Products**

**Intake Equation** = Cf X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of meat | 0.075 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 70 Year |
| Cf | Concentration of radionuclides in fish | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 3.3E-03 | pCi/kg | Sr-90 | NA | pCi/kg |
| Np-237 | 1.3E-06 | pCi/kg | Tc-99 | NA | pCi/kg |
| Pa-231 | 9.5E-03 | pCi/kg | Th-228 | 1.9E-06 | pCi/kg |
| Pb-210 | NA | pCi/kg | Th-230 | 3.2E-06 | pCi/kg |
| Pu-238 | 8.5E-08 | pCi/kg | Th-232 | 1.7E-06 | pCi/kg |
| Pu-239 | 5.5E-08 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 5.5E-08 | pCi/kg | U-234 | 3.0E-03 | pCi/kg |
| Ra-226 | 7.2E-05 | pCi/kg | U-235 | 6.0E-05 | pCi/kg |
| Ra-228 | 4.8E-05 | pCi/kg | U-236 | 3.3E-05 | pCi/kg |
| | | | U-238 | 1.8E-03 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 6.0E+00 | 2.8E-11 | 1.7E-10 |
| Np-237 | 2.5E-03 | 2.2E-10 | 5.4E-13 |
| Pa-231 | 1.8E+01 | 9.2E-11 | 1.6E-09 |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | 1.6E-04 | 2.2E-10 | 3.5E-14 |
| Pu-239 | 1.0E-04 | 2.3E-10 | 2.3E-14 |
| Pu-240 | 1.0E-04 | 2.3E-10 | 2.3E-14 |
| Ra-226 | 1.3E-01 | 1.2E-10 | 1.6E-11 |
| Ra-228 | 8.7E-02 | 1.0E-10 | 8.7E-12 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | NA | 3.3E-10 | NA |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | 3.5E-03 | 5.5E-11 | 1.9E-13 |
| Th-230 | 5.8E-03 | 1.3E-11 | 7.6E-14 |
| Th-232 | 3.1E-03 | 1.2E-11 | 3.7E-14 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 5.5E+00 | 1.6E-11 | 8.8E-11 |
| U-235 | 1.5E-01 | 1.6E-11 | 2.3E-12 |
| U-236 | 6.1E-02 | 1.5E-11 | 9.2E-13 |
| U-238 | 3.3E+00 | 2.8E-11 | 9.2E-11 |
| | | **ILCR Summation =** | 2.0E-09 |



0774

**Table K.IV-120**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Ingestion of Milk Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | |
|---|---|---|
| IR | Ingestion rate of dairy products | 0.3 l/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration for non-carcinogens | 70 Year |
| EDc | Exposure duration for carcinogens | 70 Year |
| BW | Body weight | 70 kg |
| ATc | Average time for carcinogens (lifetime) | 25550 days |
| ATn | Average time for non-carcinogens (EDn x 365) | 25550 days |
| CS | Concentration of chemicals in animal products | |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 6.8E-07 | mg/kg | Heptachlorodibenzofuran | NA | mg/kg |
| Aroclor-1016 | NA | mg/kg | Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Aroclor-1221 | 1.8E-11 | mg/kg | Lead | 5.4E-06 | mg/kg |
| Aroclor-1242 | NA | mg/kg | Manganese | 5.0E-05 | mg/kg |
| Aroclor-1248 | 2.0E-08 | mg/kg | Mercury | 2.5E-08 | mg/kg |
| Aroclor-1254 | 1.7E-06 | mg/kg | Molybdenum | 1.6E-06 | mg/kg |
| Aroclor-1260 | 6.3E-06 | mg/kg | Nickel | 8.2E-06 | mg/kg |
| Arsenic | 1.7E-07 | mg/kg | Octachlorodibenzofuran | NA | mg/kg |
| Barium | 5.2E-05 | mg/kg | Selenium | 8.3E-08 | mg/kg |
| Beryllium | 2.3E-10 | mg/kg | Thallium | 1.7E-07 | mg/kg |
| Cadmium | 1.5E-06 | mg/kg | Vanadium | 1.3E-07 | mg/kg |
| Chromium | NA | mg/kg | Zinc | 3.1E-04 | mg/kg |
| Cobalt | 6.0E-06 | mg/kg | 2-Chlorophenol | NA | mg/kg |
| Copper | 1.4E-05 | mg/kg | 2-Methylnaphthalene | 7.3E-10 | mg/kg |
| Cyanide | NA | mg/kg | 4-Chlorophenyl-phenylether | NA | mg/kg |
| Di-n-octyl phthalate | 1.1E-04 | mg/kg | 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-120 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Ingestion of Milk Products**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 2.8E-09 | 4.0E-04 | 6.9E-06 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 7.4E-14 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 8.0E-11 | NA | NA |
| Aroclor-1254 | 7.1E-09 | NA | NA |
| Aroclor-1260 | 2.6E-08 | NA | NA |
| Arsenic | 7.1E-10 | 3.0E-04 | 2.4E-06 |
| Barium | 2.1E-07 | 7.0E-02 | 3.0E-06 |
| Beryllium | 9.2E-13 | 5.0E-03 | 1.8E-10 |
| Cadmium | 6.1E-09 | 5.0E-04 | 1.2E-05 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 2.5E-08 | 6.0E-02 | 4.1E-07 |
| Copper | 5.8E-08 | NA | NA |
| Cyanide | NA | 2.0E-02 | NA |
| Di-n-octyl phthalate | 4.6E-07 | 2.0E-02 | 2.3E-05 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 2.2E-08 | NA | NA |
| Manganese | 2.1E-07 | 1.4E-01 | 1.5E-06 |
| Mercury | 1.0E-10 | 3.0E-04 | 3.4E-07 |
| Molybdenum | 6.6E-09 | 5.0E-03 | 1.3E-06 |
| Nickel | 3.4E-08 | 2.0E-02 | 1.7E-06 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 3.4E-10 | 5.0E-03 | 6.8E-08 |
| Thallium | 6.8E-10 | 8.0E-05 | 8.5E-06 |
| Vanadium | 5.2E-10 | 7.0E-03 | 7.5E-08 |
| Zinc | 1.3E-06 | 3.0E-01 | 4.3E-06 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 3.0E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 6.6E-05 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 2.8E-09 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 7.4E-14 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 8.0E-11 | 7.7E+00 | 6.2E-10 |
| Aroclor-1254 | 7.1E-09 | 7.7E+00 | 5.4E-08 |
| Aroclor-1260 | 2.6E-08 | 7.7E+00 | 2.0E-07 |
| Arsenic | 7.1E-10 | 1.8E+00 | 1.2E-09 |
| Barium | 2.1E-07 | NA | NA |
| Beryllium | 9.2E-13 | 4.3E+00 | 4.0E-12 |
| Cadmium | 6.1E-09 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 2.5E-08 | NA | NA |
| Copper | 5.8E-08 | NA | NA |
| Cyanide | NA | NA | NA |
| Di-n-octyl phthalate | 4.6E-07 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 2.2E-08 | NA | NA |
| Manganese | 2.1E-07 | NA | NA |
| Mercury | 1.0E-10 | NA | NA |
| Molybdenum | 6.6E-09 | NA | NA |
| Nickel | 3.4E-08 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 3.4E-10 | NA | NA |
| Thallium | 6.8E-10 | NA | NA |
| Vanadium | 5.2E-10 | NA | NA |
| Zinc | 1.3E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.0E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 2.6E-07 |



0775

5208

- 5208

**Table K.IV–121**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off–Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Ingestion of Milk Products**

**Intake Equation** = Cp X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of dairy products | 0.3 l/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 70 Year |
| Cp | Concentration of radionuclides in animal products | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 1.2E-03 | pCi/kg | Sr-90 | 7.9E-25 | pCi/kg |
| Np-237 | 1.2E-07 | pCi/kg | Tc-99 | 2.3E-23 | pCi/kg |
| Pa-231 | 6.0E-05 | pCi/kg | Th-228 | 2.4E-06 | pCi/kg |
| Pb-210 | NA | pCi/kg | Th-230 | 2.7E-06 | pCi/kg |
| Pu-238 | 1.7E-08 | pCi/kg | Th-232 | 1.4E-06 | pCi/kg |
| Pu-239 | 1.1E-08 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 1.1E-08 | pCi/kg | U-234 | 9.1E-03 | pCi/kg |
| Ra-226 | 1.3E-04 | pCi/kg | U-235 | 2.4E-04 | pCi/kg |
| Ra-228 | 1.3E-04 | pCi/kg | U-236 | 1.0E-04 | pCi/kg |
| | | | U-238 | 5.5E-03 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 8.5E+00 | 2.8E-11 | 2.4E-10 |
| Np-237 | 9.0E-04 | 2.2E-10 | 2.0E-13 |
| Pa-231 | 4.4E-01 | 9.2E-11 | 4.0E-11 |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | 1.3E-04 | 2.2E-10 | 2.8E-14 |
| Pu-239 | 8.1E-05 | 2.3E-10 | 1.9E-14 |
| Pu-240 | 8.1E-05 | 2.3E-10 | 1.9E-14 |
| Ra-226 | 9.5E-01 | 1.2E-10 | 1.1E-10 |
| Ra-228 | 9.6E-01 | 1.0E-10 | 9.6E-11 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 5.8E-21 | 3.3E-10 | 1.9E-30 |
| Tc-99 | 1.7E-19 | 1.3E-12 | 2.2E-31 |
| Th-228 | 1.8E-02 | 5.5E-11 | 9.9E-13 |
| Th-230 | 1.9E-02 | 1.3E-11 | 2.5E-13 |
| Th-232 | 1.0E-02 | 1.2E-11 | 1.3E-13 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 6.7E+01 | 1.6E-11 | 1.1E-09 |
| U-235 | 1.8E+00 | 1.6E-11 | 2.9E-11 |
| U-236 | 7.5E-01 | 1.5E-11 | 1.1E-11 |
| U-238 | 4.0E+01 | 2.8E-11 | 1.1E-09 |
| | | ILCR Summation = | 2.7E-09 |

0777

**Table K.IV-122**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Ingestion of Vegetables and Fruits.**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.122 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 70 | Year |
| EDc | Exposure duration for carcinogens | 70 | Year |
| BW | Body weight | 70 | kg. |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 25550 | days |
| CS | Concentration of chemicals in vegetables | | |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 1.7E-04 | mg/kg |
| Aroclor-1016 | NA | mg/kg |
| Aroclor-1221 | 8.4E-08 | mg/kg |
| Aroclor-1242 | NA | mg/kg |
| Aroclor-1248 | 4.7E-08 | mg/kg |
| Aroclor-1254 | 2.6E-06 | mg/kg |
| Aroclor-1260 | 2.4E-06 | mg/kg |
| Arsenic | 7.0E-05 | mg/kg |
| Barium | 3.6E-03 | mg/kg |
| Beryllium | 6.1E-06 | mg/kg |
| Cadmium | 3.5E-05 | mg/kg |
| Chromium | NA | mg/kg |
| Cobalt | 7.3E-05 | mg/kg |
| Copper | 2.3E-04 | mg/kg |
| Cyanide | 1.4E-05 | mg/kg |
| Di-n-octyl phthalate | 2.2E-07 | mg/kg |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Lead | 5.3E-04 | mg/kg |
| Manganese | 3.5E-03 | mg/kg |
| Mercury | 1.3E-06 | mg/kg |
| Molybdenum | 2.6E-05 | mg/kg |
| Nickel | 2.0E-04 | mg/kg |
| Octachlorodibenzofuran | NA | mg/kg |
| Selenium | 5.1E-07 | mg/kg |
| Thallium | 2.0E-06 | mg/kg |
| Vanadium | 1.6E-04 | mg/kg |
| Zinc | 7.2E-04 | mg/kg |
| 2-Chlorophenol | NA | mg/kg |
| 2-Methylnaphthalene | 1.8E-07 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | mg/kg |
| 4,4-DDT | NA | mg/kg |

**References**



0778

FEMP-OU4CRARE-6 FINAL
5208
NOV 1994

**Table K.IV-122 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 2.8E-07 | 4.0E-04 | 6.9E-04 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.4E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 7.8E-11 | NA | NA |
| Aroclor-1254 | 4.4E-09 | NA | NA |
| Aroclor-1260 | 4.0E-09 | NA | NA |
| Arsenic | 1.2E-07 | 3.0E-04 | 3.9E-04 |
| Barium | 6.0E-06 | 7.0E-02 | 8.5E-05 |
| Beryllium | 1.0E-08 | 5.0E-03 | 2.0E-06 |
| Cadmium | 5.9E-08 | 5.0E-04 | 1.2E-04 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 1.2E-07 | 6.0E-02 | 2.0E-06 |
| Copper | 3.6E-07 | NA | NA |
| Cyanide | 2.3E-08 | 2.0E-02 | 1.1E-06 |
| Di-n-octyl phthalate | 3.6E-10 | 2.0E-02 | 1.8E-08 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 8.8E-07 | NA | NA |
| Manganese | 5.8E-06 | 1.4E-01 | 4.1E-05 |
| Mercury | 2.2E-09 | 3.0E-04 | 7.3E-06 |
| Molybdenum | 4.4E-08 | 5.0E-03 | 8.7E-06 |
| Nickel | 3.3E-07 | 2.0E-02 | 1.7E-05 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 8.5E-10 | 5.0E-03 | 1.7E-07 |
| Thallium | 3.4E-09 | 8.0E-05 | 4.2E-05 |
| Vanadium | 2.6E-07 | 7.0E-03 | 3.7E-05 |
| Zinc | 1.2E-06 | 3.0E-01 | 4.0E-06 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 2.9E-10 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 1.4E-03 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 2.8E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.4E-10 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 7.8E-11 | 7.7E+00 | 6.0E-10 |
| Aroclor-1254 | 4.4E-09 | 7.7E+00 | 3.4E-08 |
| Aroclor-1260 | 4.0E-09 | 7.7E+00 | 3.1E-08 |
| Arsenic | 1.2E-07 | 1.8E+00 | 2.1E-07 |
| Barium | 6.0E-06 | NA | NA |
| Beryllium | 1.0E-08 | 4.3E+00 | 4.4E-08 |
| Cadmium | 5.9E-08 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 1.2E-07 | NA | NA |
| Copper | 3.6E-07 | NA | NA |
| Cyanide | 2.3E-08 | NA | NA |
| Di-n-octyl phthalate | 3.6E-10 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 8.8E-07 | NA | NA |
| Manganese | 5.8E-06 | NA | NA |
| Mercury | 2.2E-09 | NA | NA |
| Molybdenum | 4.4E-08 | NA | NA |
| Nickel | 3.3E-07 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 8.5E-10 | NA | NA |
| Thallium | 3.4E-09 | NA | NA |
| Vanadium | 2.6E-07 | NA | NA |
| Zinc | 1.2E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 2.9E-10 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 3.1E-07 |



0779

- 5208

5208

**Table K.IV-123**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Adult Future Land Use Without Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

**Intake Equation** = Cv X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.122 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 70 Year |
| Cv | Concentration of radionuclides in vegetables | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 4.0E-03 | pCi/kg | Sr-90 | 3.4E-13 | pCi/kg |
| Np-237 | 5.8E-04 | pCi/kg | Tc-99 | 1.5E-12 | pCi/kg |
| Pa-231 | 2.9E-03 | pCi/kg | Th-228 | 1.2E-02 | pCi/kg |
| Pb-210 | 6.2E-02 | pCi/kg | Th-230 | 1.3E-02 | pCi/kg |
| Pu-238 | 4.2E-03 | pCi/kg | Th-232 | 6.9E-03 | pCi/kg |
| Pu-239 | 2.7E-03 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 2.7E-03 | pCi/kg | U-234 | 3.3E-01 | pCi/kg |
| Ra-226 | 7.0E-03 | pCi/kg | U-235 | 8.9E-03 | pCi/kg |
| Ra-228 | 7.3E-03 | pCi/kg | U-236 | 3.7E-03 | pCi/kg |
| | | | U-238 | 2.0E-01 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 1.2E+01 | 2.8E-11 | 3.4E-10 |
| Np-237 | 1.7E+00 | 2.2E-10 | 3.8E-10 |
| Pa-231 | 8.7E+00 | 9.2E-11 | 8.0E-10 |
| Pb-210 | 1.8E+02 | 6.6E-10 | 1.2E-07 |
| Pu-238 | 1.2E+01 | 2.2E-10 | 2.7E-09 |
| Pu-239 | 8.0E+00 | 2.3E-10 | 1.8E-09 |
| Pu-240 | 8.0E+00 | 2.3E-10 | 1.8E-09 |
| Ra-226 | 2.1E+01 | 1.2E-10 | 2.5E-09 |
| Ra-228 | 2.2E+01 | 1.0E-10 | 2.2E-09 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 1.0E-09 | 3.3E-10 | 3.4E-19 |
| Tc-99 | 4.4E-09 | 1.3E-12 | 5.8E-21 |
| Th-228 | 3.8E+01 | 5.5E-11 | 2.0E-09 |
| Th-230 | 3.9E+01 | 1.3E-11 | 5.0E-10 |
| Th-232 | 2.1E+01 | 1.2E-11 | 2.5E-10 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 1.0E+03 | 1.6E-11 | 1.6E-08 |
| U-235 | 2.7E+01 | 1.6E-11 | 4.3E-10 |
| U-236 | 1.1E+01 | 1.5E-11 | 1.7E-10 |
| U-238 | 6.0E+02 | 2.8E-11 | 1.7E-08 |
| | | **ILCR Summation =** | 1.7E-07 |

**Table K.IV-124**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Inhalation of Particulates**

**Intake Equation** = $\frac{CS \times EF \times ED \times IR}{BW \times AT}$

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 20 $m^3$/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration for non-carcinogens | 12 Year |
| EDc | Exposure duration for carcinogens | 12 Year |
| BW | Body weight | 43 kg |
| ATc | Average time for carcinogens (lifetime) | 25550 days |
| ATn | Average time for non-carcinogens (EDn x 365) | 4380 days |
| CS | Concentration of chemicals in particulate as modeled | (see table below) |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 1.9E-06 | $mg/m^3$ | Heptachlorodibenzofuran | NA | $mg/m^3$ |
| Aroclor-1016 | NA | $mg/m^3$ | Heptachlorodibenzo-p-dioxin | NA | $mg/m^3$ |
| Aroclor-1221 | 1.9E-09 | $mg/m^3$ | Lead | 1.1E-05 | $mg/m^3$ |
| Aroclor-1242 | NA | $mg/m^3$ | Manganese | 3.9E-05 | $mg/m^3$ |
| Aroclor-1248 | 1.3E-09 | $mg/m^3$ | Mercury | 3.0E-08 | $mg/m^3$ |
| Aroclor-1254 | 6.0E-08 | $mg/m^3$ | Molybdenum | 3.0E-07 | $mg/m^3$ |
| Aroclor-1260 | 6.3E-08 | $mg/m^3$ | Nickel | 2.5E-06 | $mg/m^3$ |
| Arsenic | 9.3E-07 | $mg/m^3$ | Octachlorodibenzofuran | NA | $mg/m^3$ |
| Barium | 8.5E-05 | $mg/m^3$ | Selenium | 9.3E-09 | $mg/m^3$ |
| Beryllium | 8.5E-08 | $mg/m^3$ | Thallium | 2.6E-08 | $mg/m^3$ |
| Cadmium | 3.7E-07 | $mg/m^3$ | Vanadium | 1.8E-06 | $mg/m^3$ |
| Chromium | 2.5E-07 | $mg/m^3$ | Zinc | 9.7E-06 | $mg/m^3$ |
| Cobalt | 9.3E-07 | $mg/m^3$ | 2-Chlorophenol | NA | $mg/m^3$ |
| Copper | 3.7E-06 | $mg/m^3$ | 2-Methylnaphthalene | 5.0E-09 | $mg/m^3$ |
| Cyanide | 3.3E-07 | $mg/m^3$ | 4-Chlorophenyl-phenylether | NA | $mg/m^3$ |
| Di-n-octyl phthalate | 5.3E-09 | $mg/m^3$ | 4,4-DDT | NA | $mg/m^3$ |

**References**

**Table K.IV-124 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Inhalation of Particulates**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 8.7E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 8.3E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 5.7E-10 | NA | NA |
| Aroclor-1254 | 2.7E-08 | NA | NA |
| Aroclor-1260 | 2.8E-08 | NA | NA |
| Arsenic | 4.1E-07 | NA | NA |
| Barium | 3.8E-05 | 1.4E-04 | 2.7E-01 |
| Beryllium | 3.8E-08 | NA | NA |
| Cadmium | 1.7E-07 | NA | NA |
| Chromium | 1.1E-07 | NA | NA |
| Cobalt | 4.1E-07 | 3.0E-07 | 1.4E+00 |
| Copper | 1.7E-06 | NA | NA |
| Cyanide | 1.5E-07 | NA | NA |
| Di-n-octyl phthalate | 2.4E-09 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 5.0E-06 | NA | NA |
| Manganese | 1.7E-05 | 1.1E-04 | 1.6E-01 |
| Mercury | 1.3E-08 | 8.6E-05 | 1.5E-04 |
| Molybdenum | 1.4E-07 | NA | NA |
| Nickel | 1.1E-06 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 4.1E-09 | NA | NA |
| Thallium | 1.2E-08 | NA | NA |
| Vanadium | 7.9E-07 | NA | NA |
| Zinc | 4.3E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 2.2E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | NA | NA |
| | HQ Summation = | | 1.8E+00 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 1.5E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.4E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 9.7E-11 | NA | NA |
| Aroclor-1254 | 4.6E-09 | NA | NA |
| Aroclor-1260 | 4.8E-09 | NA | NA |
| Arsenic | 7.1E-08 | 1.5E+01 | 1.1E-06 |
| Barium | 6.5E-06 | NA | NA |
| Beryllium | 6.5E-09 | 8.4E+00 | 5.4E-08 |
| Cadmium | 2.8E-08 | 6.1E+00 | 1.7E-07 |
| Chromium | 1.9E-08 | 4.1E+01 | 7.7E-07 |
| Cobalt | 7.1E-08 | NA | NA |
| Copper | 2.8E-07 | NA | NA |
| Cyanide | 2.5E-08 | NA | NA |
| Di-n-octyl phthalate | 4.1E-10 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 8.6E-07 | NA | NA |
| Manganese | 3.0E-06 | NA | NA |
| Mercury | 2.3E-09 | NA | NA |
| Molybdenum | 2.3E-08 | NA | NA |
| Nickel | 1.9E-07 | 8.4E-01 | 1.6E-07 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 7.1E-10 | NA | NA |
| Thallium | 2.0E-09 | NA | NA |
| Vanadium | 1.4E-07 | NA | NA |
| Zinc | 7.4E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.8E-10 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 2.2E-06 |



0782

5208

- 5208

**Table K.IV-125**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Inhalation of Gases and Particulates**

**Intake Equation** = Ca X EF X EDn X IR

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 20 $m^3$/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 12 Year |
| Ca | Concentration of radionuclides in air | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/$m^3$ | Rn-222 | 4.1E+00 | pCi/$m^3$ |
| Am-241 | NA | pCi/$m^3$ | Ru-106 | NA | pCi/$m^3$ |
| Cs-137 | 4.6E-05 | pCi/$m^3$ | Sr-90 | 1.5E-04 | pCi/$m^3$ |
| Np-237 | 1.6E-05 | pCi/$m^3$ | Tc-99 | 9.2E-04 | pCi/$m^3$ |
| Pa-231 | 6.0E-05 | pCi/$m^3$ | Th-228 | 1.4E-04 | pCi/$m^3$ |
| Pb-210 | 1.6E-03 | pCi/$m^3$ | Th-230 | 1.5E-04 | pCi/$m^3$ |
| Pu-238 | 8.0E-05 | pCi/$m^3$ | Th-232 | 8.1E-05 | pCi/$m^3$ |
| Pu-239 | 3.9E-05 | pCi/$m^3$ | U-233 | NA | pCi/$m^3$ |
| Pu-240 | 3.9E-05 | pCi/$m^3$ | U-234 | 1.7E-03 | pCi/$m^3$ |
| Ra-226 | 8.1E-05 | pCi/$m^3$ | U-235 | 4.4E-05 | pCi/$m^3$ |
| Ra-228 | 8.8E-05 | pCi/$m^3$ | U-236 | 1.9E-05 | pCi/$m^3$ |
| | | | U-238 | 9.9E-04 | pCi/$m^3$ |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 8.8E-08 | NA |
| Am-241 | NA | 3.2E-08 | NA |
| Cs-137 | 3.9E+00 | 1.9E-11 | 7.3E-11 |
| Np-237 | 1.3E+00 | 2.9E-08 | 3.9E-08 |
| Pa-231 | 5.0E+00 | 3.6E-08 | 1.8E-07 |
| Pb-210 | 1.3E+02 | 4.0E-09 | 5.4E-07 |
| Pu-238 | 6.7E+00 | 3.9E-08 | 2.6E-07 |
| Pu-239 | 3.3E+00 | 3.8E-08 | 1.2E-07 |
| Pu-240 | 3.3E+00 | 3.8E-08 | 1.2E-07 |
| Ra-226 | 6.8E+00 | 3.0E-09 | 2.0E-08 |
| Ra-228 | 7.4E+00 | 6.9E-10 | 5.1E-09 |
| Rn-222 | 3.5E+05 | 7.7E-12 | 2.7E-06 |
| Ru-106 | NA | 4.4E-10 | NA |
| Sr-90 | 1.3E+01 | 5.6E-11 | 7.2E-10 |
| Tc-99 | 7.7E+01 | 8.3E-12 | 6.4E-10 |
| Th-228 | 1.2E+01 | 7.8E-08 | 9.4E-07 |
| Th-230 | 1.3E+01 | 2.9E-08 | 3.7E-07 |
| Th-232 | 6.8E+00 | 2.8E-08 | 1.9E-07 |
| U-233 | NA | 2.7E-08 | NA |
| U-234 | 1.4E+02 | 2.6E-08 | 3.6E-06 |
| U-235 | 3.7E+00 | 2.5E-08 | 9.2E-08 |
| U-236 | 1.6E+00 | 2.5E-08 | 4.0E-08 |
| U-238 | 8.3E+01 | 5.2E-08 | 4.3E-06 |
| | | ILCR Summation = | 1.4E-05 |

208

**Table K.IV–126**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off–Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Ingestion of Drinking Water**

**Intake Equation** = Cw X EF X EDn X FI X IR

| | | | |
|---|---|---|---|
| IR | Ingestion rate of groundwater (RAGS, 1989) | 2 | l/day |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration | 12 | Year |
| FI | Fractional intake for radionuclides | 1 | (Unitless) |
| Cw | Concentration of radionuclides in groundwater | | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac–227 | NA | pCi/l | Rn–222 | NA | pCi/l |
| Am–241 | NA | pCi/l | Ru–106 | NA | pCi/l |
| Cs–137 | NA | pCi/l | Sr–90 | 2.2E–06 | pCi/l |
| Np–237 | NA | pCi/l | Tc–99 | NA | pCi/l |
| Pa–231 | NA | pCi/l | Th–228 | NA | pCi/l |
| Pb–210 | NA | pCi/l | Th–230 | NA | pCi/l |
| Pu–238 | NA | pCi/l | Th–232 | NA | pCi/l |
| Pu–239 | NA | pCi/l | U–233 | NA | pCi/l |
| Pu–240 | NA | pCi/l | U–234 | 1.5E+00 | pCi/l |
| Ra–226 | NA | pCi/l | U–235 | 4.0E–02 | pCi/l |
| Ra–228 | NA | pCi/l | U–236 | 1.6E–02 | pCi/l |
| | | | U–238 | 9.2E–01 | pCi/l |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac–227 | NA | 3.5E–10 | NA |
| Am–241 | NA | 2.4E–10 | NA |
| Cs–137 | NA | 2.8E–11 | NA |
| Np–237 | NA | 2.2E–10 | NA |
| Pa–231 | NA | 9.2E–11 | NA |
| Pb–210 | NA | 6.6E–10 | NA |
| Pu–238 | NA | 2.2E–10 | NA |
| Pu–239 | NA | 2.3E–10 | NA |
| Pu–240 | NA | 2.3E–10 | NA |
| Ra–226 | NA | 1.2E–10 | NA |
| Ra–228 | NA | 1.0E–10 | NA |
| Rn–222 | NA | 1.7E–12 | NA |
| Ru–106 | NA | 9.5E–12 | NA |
| Sr–90 | 1.8E–02 | 3.3E–10 | 6.0E–12 |
| Tc–99 | NA | 1.3E–12 | NA |
| Th–228 | NA | 5.5E–11 | NA |
| Th–230 | NA | 1.3E–11 | NA |
| Th–232 | NA | 1.2E–11 | NA |
| U–233 | NA | 1.6E–11 | NA |
| U–234 | 1.3E+04 | 1.6E–11 | 2.1E–07 |
| U–235 | 3.4E+02 | 1.6E–11 | 5.4E–09 |
| U–236 | 1.3E+02 | 1.5E–11 | 2.0E–09 |
| U–238 | 7.7E+03 | 2.8E–11 | 2.2E–07 |
| | | **ILCR Summation =** | 4.3E–07 |

0784

**Table K.IV-127**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Ingestion of Meat Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of meat | 0.075 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 12 | Year |
| EDc | Exposure duration for carcinogens | 12 | Year |
| BW | Body weight | 43 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 4380 | days |
| CS | Concentration of chemicals in meat | | |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 6.8E-06 | mg/kg |
| Aroclor-1016 | NA | mg/kg |
| Aroclor-1221 | 5.6E-11 | mg/kg |
| Aroclor-1242 | NA | mg/kg |
| Aroclor-1248 | 1.9E-08 | mg/kg |
| Aroclor-1254 | 8.0E-08 | mg/kg |
| Aroclor-1260 | 3.1E-08 | mg/kg |
| Arsenic | 5.6E-08 | mg/kg |
| Barium | 2.2E-05 | mg/kg |
| Beryllium | 2.5E-07 | mg/kg |
| Cadmium | 8.1E-06 | mg/kg |
| Chromium | NA | mg/kg |
| Cobalt | 6.0E-05 | mg/kg |
| Copper | 9.5E-05 | mg/kg |
| Cyanide | 3.0E-11 | mg/kg |
| Di-n-octyl phthalate | 3.5E-04 | mg/kg |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Lead | 6.5E-06 | mg/kg |
| Manganese | 5.7E-05 | mg/kg |
| Mercury | 1.4E-05 | mg/kg |
| Molybdenum | 6.4E-06 | mg/kg |
| Nickel | 4.9E-05 | mg/kg |
| Octachlorodibenzofuran | NA | mg/kg |
| Selenium | 3.1E-07 | mg/kg |
| Thallium | 3.3E-06 | mg/kg |
| Vanadium | 1.6E-05 | mg/kg |
| Zinc | 3.1E-03 | mg/kg |
| 2-Chlorophenol | NA | mg/kg |
| 2-Methylnaphthalene | 1.3E-09 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | mg/kg |
| 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-127 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Ingestion of Meat Products**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 1.1E-08 | 4.0E-04 | 2.8E-05 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 9.4E-14 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 3.2E-11 | NA | NA |
| Aroclor-1254 | 1.3E-08 | NA | NA |
| Aroclor-1260 | 5.2E-09 | NA | NA |
| Arsenic | 9.6E-09 | 3.0E-04 | 3.2E-05 |
| Barium | 3.7E-08 | 7.0E-02 | 5.3E-07 |
| Beryllium | 4.2E-10 | 5.0E-03 | 8.4E-08 |
| Cadmium | 1.4E-08 | 5.0E-04 | 2.7E-05 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 1.0E-07 | 6.0E-02 | 1.7E-06 |
| Copper | 1.6E-07 | NA | NA |
| Cyanide | 4.9E-14 | 2.0E-02 | 2.5E-12 |
| Di-n-octyl phthalate | 5.9E-07 | 2.0E-02 | 3.0E-05 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.1E-08 | NA | NA |
| Manganese | 9.6E-08 | 1.4E-01 | 6.9E-07 |
| Mercury | 2.3E-08 | 3.0E-04 | 7.7E-05 |
| Molybdenum | 1.1E-08 | 5.0E-03 | 2.2E-06 |
| Nickel | 8.3E-08 | 2.0E-02 | 4.1E-06 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 5.2E-10 | 5.0E-03 | 1.0E-07 |
| Thallium | 5.5E-09 | 8.0E-05 | 6.9E-05 |
| Vanadium | 2.6E-08 | 7.0E-03 | 3.8E-06 |
| Zinc | 5.2E-06 | 3.0E-01 | 1.7E-05 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 2.2E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 2.9E-04 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 1.9E-09 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.6E-14 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 5.5E-12 | 7.7E+00 | 4.2E-11 |
| Aroclor-1254 | 2.3E-09 | 7.7E+00 | 1.8E-08 |
| Aroclor-1260 | 8.9E-10 | 7.7E+00 | 6.9E-09 |
| Arsenic | 1.6E-09 | 1.8E+00 | 2.9E-09 |
| Barium | 6.3E-09 | NA | NA |
| Beryllium | 7.2E-11 | 4.3E+00 | 3.1E-10 |
| Cadmium | 2.3E-09 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 1.7E-08 | NA | NA |
| Copper | 2.7E-08 | NA | NA |
| Cyanide | 8.5E-15 | NA | NA |
| Di-n-octyl phthalate | 1.0E-07 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.9E-09 | NA | NA |
| Manganese | 1.6E-08 | NA | NA |
| Mercury | 4.0E-09 | NA | NA |
| Molybdenum | 1.8E-09 | NA | NA |
| Nickel | 1.4E-08 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 8.9E-11 | NA | NA |
| Thallium | 9.5E-10 | NA | NA |
| Vanadium | 4.5E-09 | NA | NA |
| Zinc | 8.9E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.7E-13 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 2.8E-08 |





- 5208

0786

- 5208

**Table K.IV-128**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Ingestion of Meat Products**

**Intake Equation** = Cf X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of meat | 0.075 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 12 Year |
| Cf | Concentration of radionuclides in meat | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 3.3E-03 | pCi/kg | Sr-90 | NA | pCi/kg |
| Np-237 | 1.3E-06 | pCi/kg | Tc-99 | NA | pCi/kg |
| Pa-231 | 9.5E-03 | pCi/kg | Th-228 | 1.9E-06 | pCi/kg |
| Pb-210 | NA | pCi/kg | Th-230 | 3.2E-06 | pCi/kg |
| Pu-238 | 8.5E-08 | pCi/kg | Th-232 | 1.7E-06 | pCi/kg |
| Pu-239 | 5.5E-08 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 5.5E-08 | pCi/kg | U-234 | 3.0E-03 | pCi/kg |
| Ra-226 | 7.2E-05 | pCi/kg | U-235 | 8.0E-05 | pCi/kg |
| Ra-228 | 4.8E-05 | pCi/kg | U-236 | 3.3E-05 | pCi/kg |
| | | | U-238 | 1.8E-03 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 1.0E+00 | 2.8E-11 | 2.9E-11 |
| Np-237 | 4.2E-04 | 2.2E-10 | 9.3E-14 |
| Pa-231 | 3.0E+00 | 9.2E-11 | 2.8E-10 |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | 2.7E-05 | 2.2E-10 | 5.9E-15 |
| Pu-239 | 1.7E-05 | 2.3E-10 | 4.0E-15 |
| Pu-240 | 1.7E-05 | 2.3E-10 | 4.0E-15 |
| Ra-226 | 2.3E-02 | 1.2E-10 | 2.7E-12 |
| Ra-228 | 1.5E-02 | 1.0E-10 | 1.5E-12 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | NA | 3.3E-10 | NA |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | 6.0E-04 | 5.5E-11 | 3.3E-14 |
| Th-230 | 1.0E-03 | 1.3E-11 | 1.3E-14 |
| Th-232 | 5.4E-04 | 1.2E-11 | 6.4E-15 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 9.4E-01 | 1.6E-11 | 1.5E-11 |
| U-235 | 2.5E-02 | 1.6E-11 | 4.0E-13 |
| U-236 | 1.1E-02 | 1.5E-11 | 1.6E-13 |
| U-238 | 5.6E-01 | 2.8E-11 | 1.6E-11 |
| | | ILCR Summation = | 3.4E-10 |

**Table K.IV-129**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Ingestion of Dairy Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of dairy products | 0.3 | l/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 12 | Year |
| EDc | Exposure duration for carcinogens | 12 | Year |
| BW | Body weight | 43 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 4380 | days |
| CS | Concentration of chemicals in animal products | | |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 6.8E-07 | mg/kg | Heptachlorodibenzofuran | NA | mg/kg |
| Aroclor-1016 | NA | mg/kg | Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Aroclor-1221 | 1.8E-11 | mg/kg | Lead | 5.4E-06 | mg/kg |
| Aroclor-1242 | NA | mg/kg | Manganese | 5.0E-05 | mg/kg |
| Aroclor-1248 | 2.0E-08 | mg/kg | Mercury | 2.5E-08 | mg/kg |
| Aroclor-1254 | 1.7E-06 | mg/kg | Molybdenum | 1.6E-06 | mg/kg |
| Aroclor-1260 | 6.3E-06 | mg/kg | Nickel | 8.2E-06 | mg/kg |
| Arsenic | 1.7E-07 | mg/kg | Octachlorodibenzofuran | NA | mg/kg |
| Barium | 5.2E-05 | mg/kg | Selenium | 8.3E-08 | mg/kg |
| Beryllium | 2.3E-10 | mg/kg | Thallium | 1.7E-07 | mg/kg |
| Cadmium | 1.5E-06 | mg/kg | Vanadium | 1.3E-07 | mg/kg |
| Chromium | NA | mg/kg | Zinc | 3.1E-04 | mg/kg |
| Cobalt | 6.0E-06 | mg/kg | 2-Chlorophenol | NA | mg/kg |
| Copper | 1.4E-05 | mg/kg | 2-Methylnaphthalene | 7.3E-10 | mg/kg |
| Cyanide | NA | mg/kg | 4-Chlorophenyl-phenylether | NA | mg/kg |
| Di-n-octyl phthalate | 1.1E-04 | mg/kg | 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-129 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Ingestion of Dairy Products**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 4.5E-09 | 4.0E-04 | 1.1E-05 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.2E-13 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.3E-10 | NA | NA |
| Aroclor-1254 | 1.2E-08 | NA | NA |
| Aroclor-1260 | 4.2E-08 | NA | NA |
| Arsenic | 1.2E-09 | 3.0E-04 | 3.9E-06 |
| Barium | 3.4E-07 | 7.0E-02 | 4.9E-06 |
| Beryllium | 1.5E-12 | 5.0E-03 | 3.0E-10 |
| Cadmium | 9.9E-09 | 5.0E-04 | 2.0E-05 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 4.0E-08 | 6.0E-02 | 6.7E-07 |
| Copper | 9.5E-08 | NA | NA |
| Cyanide | NA | 2.0E-02 | NA |
| Di-n-octyl phthalate | 7.5E-07 | 2.0E-02 | 3.7E-05 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.6E-08 | NA | NA |
| Manganese | 3.4E-07 | 1.4E-01 | 2.4E-06 |
| Mercury | 1.7E-10 | 3.0E-04 | 5.6E-07 |
| Molybdenum | 1.1E-08 | 5.0E-03 | 2.2E-06 |
| Nickel | 5.5E-08 | 2.0E-02 | 2.8E-06 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 5.6E-10 | 5.0E-03 | 1.1E-07 |
| Thallium | 1.1E-09 | 8.0E-05 | 1.4E-05 |
| Vanadium | 8.5E-10 | 7.0E-03 | 1.2E-07 |
| Zinc | 2.1E-06 | 3.0E-01 | 7.0E-06 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 4.9E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 1.1E-04 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 7.7E-10 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 2.1E-14 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 2.2E-11 | 7.7E+00 | 1.7E-10 |
| Aroclor-1254 | 2.0E-09 | 7.7E+00 | 1.5E-08 |
| Aroclor-1260 | 7.2E-09 | 7.7E+00 | 5.6E-08 |
| Arsenic | 2.0E-10 | 1.8E+00 | 3.5E-10 |
| Barium | 5.9E-08 | NA | NA |
| Beryllium | 2.6E-13 | 4.3E+00 | 1.1E-12 |
| Cadmium | 1.7E-09 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 6.9E-09 | NA | NA |
| Copper | 1.6E-08 | NA | NA |
| Cyanide | NA | NA | NA |
| Di-n-octyl phthalate | 1.3E-07 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 6.2E-09 | NA | NA |
| Manganese | 5.8E-08 | NA | NA |
| Mercury | 2.9E-11 | NA | NA |
| Molybdenum | 1.8E-09 | NA | NA |
| Nickel | 9.4E-09 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 9.5E-11 | NA | NA |
| Thallium | 1.9E-10 | NA | NA |
| Vanadium | 1.5E-10 | NA | NA |
| Zinc | 3.6E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 8.3E-13 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 7.1E-08 |

**Table K.IV–130**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off–Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Ingestion of Dairy Products**

**Intake Equation** = Cp X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of dairy products | 0.3 l/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 12 Year |
| Cp | Concentration of radionuclides in animal products | |

| | | | | | |
|---|---|---|---|---|---|
| Ac–227 | NA | pCi/kg | Rn–222 | NA | pCi/kg |
| Am–241 | NA | pCi/kg | Ru–106 | NA | pCi/kg |
| Cs–137 | 1.2E–03 | pCi/kg | Sr–90 | 7.9E–25 | pCi/kg |
| Np–237 | 1.2E–07 | pCi/kg | Tc–99 | 2.3E–23 | pCi/kg |
| Pa–231 | 6.0E–05 | pCi/kg | Th–228 | 2.4E–06 | pCi/kg |
| Pb–210 | NA | pCi/kg | Th–230 | 2.7E–06 | pCi/kg |
| Pu–238 | 1.7E–08 | pCi/kg | Th–232 | 1.4E–06 | pCi/kg |
| Pu–239 | 1.1E–08 | pCi/kg | U–233 | NA | pCi/kg |
| Pu–240 | 1.1E–08 | pCi/kg | U–234 | 9.1E–03 | pCi/kg |
| Ra–226 | 1.3E–04 | pCi/kg | U–235 | 2.4E–04 | pCi/kg |
| Ra–228 | 1.3E–04 | pCi/kg | U–236 | 1.0E–04 | pCi/kg |
| | | | U–238 | 5.5E–03 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac–227 | NA | 3.5E–10 | NA |
| Am–241 | NA | 2.4E–10 | NA |
| Cs–137 | 1.4E+00 | 2.8E–11 | 4.1E–11 |
| Np–237 | 1.5E–04 | 2.2E–10 | 3.4E–14 |
| Pa–231 | 7.5E–02 | 9.2E–11 | 6.9E–12 |
| Pb–210 | NA | 6.6E–10 | NA |
| Pu–238 | 2.2E–05 | 2.2E–10 | 4.7E–15 |
| Pu–239 | 1.4E–05 | 2.3E–10 | 3.2E–15 |
| Pu–240 | 1.4E–05 | 2.3E–10 | 3.2E–15 |
| Ra–226 | 1.6E–01 | 1.2E–10 | 2.0E–11 |
| Ra–228 | 1.7E–01 | 1.0E–10 | 1.7E–11 |
| Rn–222 | NA | 1.7E–12 | NA |
| Ru–106 | NA | 9.5E–12 | NA |
| Sr–90 | 9.9E–22 | 3.3E–10 | 3.3E–31 |
| Tc–99 | 2.9E–20 | 1.3E–12 | 3.8E–32 |
| Th–228 | 3.1E–03 | 5.5E–11 | 1.7E–13 |
| Th–230 | 3.3E–03 | 1.3E–11 | 4.3E–14 |
| Th–232 | 1.8E–03 | 1.2E–11 | 2.1E–14 |
| U–233 | NA | 1.6E–11 | NA |
| U–234 | 1.1E+01 | 1.6E–11 | 1.8E–10 |
| U–235 | 3.1E–01 | 1.6E–11 | 4.9E–12 |
| U–236 | 1.3E–01 | 1.5E–11 | 1.9E–12 |
| U–238 | 6.9E+00 | 2.8E–11 | 1.9E–10 |
| | | **ILCR Summation =** | 4.7E–10 |

0790

**Table K.IV-131**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.122 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 12 | Year |
| EDc | Exposure duration for carcinogens | 12 | Year |
| BW | Body weight | 43 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 4380 | days |
| CS | Concentration of chemicals in vegetables | | |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 1.7E-04 | mg/kg |
| Aroclor-1016 | NA | mg/kg |
| Aroclor-1221 | 8.4E-08 | mg/kg |
| Aroclor-1242 | NA | mg/kg |
| Aroclor-1248 | 4.7E-08 | mg/kg |
| Aroclor-1254 | 2.6E-08 | mg/kg |
| Aroclor-1260 | 2.4E-06 | mg/kg |
| Arsenic | 7.0E-05 | mg/kg |
| Barium | 3.6E-03 | mg/kg |
| Beryllium | 6.1E-06 | mg/kg |
| Cadmium | 3.5E-05 | mg/kg |
| Chromium | NA | mg/kg |
| Cobalt | 7.3E-05 | mg/kg |
| Copper | 2.3E-04 | mg/kg |
| Cyanide | 1.4E-05 | mg/kg |
| Di-n-octyl phthalate | 2.2E-07 | mg/kg |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Lead | 5.3E-04 | mg/kg |
| Manganese | 3.5E-03 | mg/kg |
| Mercury | 1.3E-08 | mg/kg |
| Molybdenum | 2.6E-05 | mg/kg |
| Nickel | 2.0E-04 | mg/kg |
| Octachlorodibenzofuran | NA | mg/kg |
| Selenium | 5.1E-07 | mg/kg |
| Thallium | 2.0E-06 | mg/kg |
| Vanadium | 1.6E-04 | mg/kg |
| Zinc | 7.2E-04 | mg/kg |
| 2-Chlorophenol | NA | mg/kg |
| 2-Methylnaphthalene | 1.8E-07 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | mg/kg |
| 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-131 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 4.5E-07 | 4.0E-04 | 1.1E-03 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 2.3E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.3E-10 | NA | NA |
| Aroclor-1254 | 7.2E-09 | NA | NA |
| Aroclor-1260 | 6.5E-09 | NA | NA |
| Arsenic | 1.9E-07 | 3.0E-04 | 6.4E-04 |
| Barium | 9.7E-06 | 7.0E-02 | 1.4E-04 |
| Beryllium | 1.7E-08 | 5.0E-03 | 3.3E-06 |
| Cadmium | 9.6E-08 | 5.0E-04 | 1.9E-04 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 2.0E-07 | 6.0E-02 | 3.3E-06 |
| Copper | 6.2E-07 | NA | NA |
| Cyanide | 3.7E-08 | 2.0E-02 | 1.9E-06 |
| Di-n-octyl phthalate | 5.9E-10 | 2.0E-02 | 3.0E-08 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.4E-06 | NA | NA |
| Manganese | 9.4E-06 | 1.4E-01 | 6.7E-05 |
| Mercury | 3.6E-09 | 3.0E-04 | 1.2E-05 |
| Molybdenum | 7.1E-08 | 5.0E-03 | 1.4E-05 |
| Nickel | 5.4E-07 | 2.0E-02 | 2.7E-05 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 1.4E-09 | 5.0E-03 | 2.8E-07 |
| Thallium | 5.5E-09 | 8.0E-05 | 6.9E-05 |
| Vanadium | 4.2E-07 | 7.0E-03 | 6.0E-05 |
| Zinc | 2.0E-06 | 3.0E-01 | 6.6E-06 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 4.8E-10 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 2.4E-03 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 7.7E-08 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 3.9E-11 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 2.2E-11 | 7.7E+00 | 1.7E-10 |
| Aroclor-1254 | 1.2E-09 | 7.7E+00 | 9.4E-09 |
| Aroclor-1260 | 1.1E-09 | 7.7E+00 | 8.5E-09 |
| Arsenic | 3.3E-08 | 1.8E+00 | 5.7E-08 |
| Barium | 1.7E-06 | NA | NA |
| Beryllium | 2.8E-09 | 4.3E+00 | 1.2E-08 |
| Cadmium | 1.6E-08 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 3.4E-08 | NA | NA |
| Copper | 1.1E-07 | NA | NA |
| Cyanide | 6.4E-09 | NA | NA |
| Di-n-octyl phthalate | 1.0E-10 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 2.5E-07 | NA | NA |
| Manganese | 1.6E-06 | NA | NA |
| Mercury | 6.1E-10 | NA | NA |
| Molybdenum | 1.2E-08 | NA | NA |
| Nickel | 9.3E-08 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.4E-10 | NA | NA |
| Thallium | 9.4E-10 | NA | NA |
| Vanadium | 7.2E-08 | NA | NA |
| Zinc | 3.4E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 8.2E-11 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 8.8E-08 |



0792

5208

208

**Table K.IV-132**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Youth Future Land Use Without Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

**Intake Equation** = Cv X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.122 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 12 Year |
| Cv | Concentration of radionuclides in vegetables | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 4.0E-03 | pCi/kg | Sr-90 | 3.4E-13 | pCi/kg |
| Np-237 | 5.8E-04 | pCi/kg | Tc-99 | 1.5E-12 | pCi/kg |
| Pa-231 | 2.9E-03 | pCi/kg | Th-228 | 1.2E-02 | pCi/kg |
| Pb-210 | 6.2E-02 | pCi/kg | Th-230 | 1.3E-02 | pCi/kg |
| Pu-238 | 4.2E-03 | pCi/kg | Th-232 | 6.9E-03 | pCi/kg |
| Pu-239 | 2.7E-03 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 2.7E-03 | pCi/kg | U-234 | 3.3E-01 | pCi/kg |
| Ra-226 | 7.0E-03 | pCi/kg | U-235 | 8.9E-03 | pCi/kg |
| Ra-228 | 7.3E-03 | pCi/kg | U-236 | 3.7E-03 | pCi/kg |
| | | | U-238 | 2.0E-01 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 2.1E+00 | 2.8E-11 | 5.8E-11 |
| Np-237 | 3.0E-01 | 2.2E-10 | 6.6E-11 |
| Pa-231 | 1.5E+00 | 9.2E-11 | 1.4E-10 |
| Pb-210 | 3.2E+01 | 6.6E-10 | 2.1E-08 |
| Pu-238 | 2.1E+00 | 2.2E-10 | 4.7E-10 |
| Pu-239 | 1.4E+00 | 2.3E-10 | 3.2E-10 |
| Pu-240 | 1.4E+00 | 2.3E-10 | 3.2E-10 |
| Ra-226 | 3.6E+00 | 1.2E-10 | 4.3E-10 |
| Ra-228 | 3.7E+00 | 1.0E-10 | 3.7E-10 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 1.7E-10 | 3.3E-10 | 5.7E-20 |
| Tc-99 | 7.6E-10 | 1.3E-12 | 9.9E-22 |
| Th-228 | 6.3E+00 | 5.5E-11 | 3.4E-10 |
| Th-230 | 6.6E+00 | 1.3E-11 | 8.6E-11 |
| Th-232 | 3.5E+00 | 1.2E-11 | 4.3E-11 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 1.7E+02 | 1.6E-11 | 2.7E-09 |
| U-235 | 4.6E+00 | 1.6E-11 | 7.3E-11 |
| U-236 | 1.9E+00 | 1.5E-11 | 2.9E-11 |
| U-238 | 1.0E+02 | 2.8E-11 | 2.9E-09 |
| | | ILCR Summation = | 2.9E-08 |

**Table K.7-133**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RMB Resident Farm Child Future Land Use Without Federal Ownership**
**Via Inhalation of Particulates**

**Intake Equation** = $\frac{CS \times EF \times ED \times IR}{BW \times AT}$

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 12 $m^3$/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration for non-carchogens | 6 Year |
| EDc | Exposure duration for carcinogens | 6 Year |
| BW | Body weight | 15 kg |
| ATc | Average time for carchogens (lifetime) | 25550 days |
| ATn | Average time for non-carchogens (EDn x 365) | 2190 days |
| CS | Concentration of chemicals in soil | (see table below) |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 1.9E-06 | mg/m$^3$ |
| Aroclor-1016 | NA | mg/m$^3$ |
| Aroclor-1221 | 1.9E-09 | mg/m$^3$ |
| Aroclor-1242 | NA | mg/m$^3$ |
| Aroclor-1248 | 1.3E-09 | mg/m$^3$ |
| Aroclor-1254 | 6.0E-08 | mg/m$^3$ |
| Aroclor-1260 | 6.3E-08 | mg/m$^3$ |
| Arsenic | 9.3E-07 | mg/m$^3$ |
| Barium | 8.5E-05 | mg/m$^3$ |
| Beryllium | 8.5E-08 | mg/m$^3$ |
| Cadmium | 3.7E-07 | mg/m$^3$ |
| Chromium | 2.5E-07 | mg/m$^3$ |
| Cobalt | 9.3E-07 | mg/m$^3$ |
| Copper | 3.7E-06 | mg/m$^3$ |
| Cyanide | 3.3E-07 | mg/m$^3$ |
| Di-n-octyl phthalate | 5.3E-09 | mg/m$^3$ |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/m$^3$ |
| Heptachlorodibenzo-p-dioxin | NA | mg/m$^3$ |
| Lead | 1.1E-05 | mg/m$^3$ |
| Manganese | 3.9E-05 | mg/m$^3$ |
| Mercury | 3.0E-08 | mg/m$^3$ |
| Molybdenum | 3.0E-07 | mg/m$^3$ |
| Nickel | 2.5E-06 | mg/m$^3$ |
| Octachlorodibenzofuran | NA | mg/m$^3$ |
| Selenium | 9.3E-09 | mg/m$^3$ |
| Thallium | 2.6E-08 | mg/m$^3$ |
| Vanadium | 1.8E-06 | mg/m$^3$ |
| Zinc | 9.7E-06 | mg/m$^3$ |
| 2-Chlorophenol | NA | mg/m$^3$ |
| 2-Methylnaphthalene | 5.0E-09 | mg/m$^3$ |
| 4-Chlorophenyl-phenylether | NA | mg/m$^3$ |
| 4,4-DDT | NA | mg/m$^3$ |

**References**



0194
5208

**Table K.7-133 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Inhalation of Particulates**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 1.5E-06 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.4E-09 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 9.7E-10 | NA | NA |
| Aroclor-1254 | 4.6E-08 | NA | NA |
| Aroclor-1260 | 4.9E-08 | NA | NA |
| Arsenic | 7.1E-07 | NA | NA |
| Barium | 6.5E-05 | 1.4E-04 | 4.7E-01 |
| Beryllium | 6.5E-08 | NA | NA |
| Cadmium | 2.9E-07 | NA | NA |
| Chromium | 1.9E-07 | NA | NA |
| Cobalt | 7.1E-07 | 3.0E-07 | 2.4E+00 |
| Copper | 2.9E-06 | NA | NA |
| Cyanide | 2.5E-07 | NA | NA |
| Di-n-octyl phthalate | 4.1E-09 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 8.6E-06 | NA | NA |
| Manganese | 3.0E-05 | 1.1E-04 | 2.7E-01 |
| Mercury | 2.3E-08 | 8.6E-05 | 2.6E-04 |
| Molybdenum | 2.3E-07 | NA | NA |
| Nickel | 1.9E-06 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 7.1E-09 | NA | NA |
| Thallium | 2.0E-08 | NA | NA |
| Vanadium | 1.4E-06 | NA | NA |
| Zinc | 7.5E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.6E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | NA | NA |
| | Hazard Quotient Sum = | | 3.1E+00 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 1.3E-07 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.2E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 8.4E-11 | NA | NA |
| Aroclor-1254 | 3.9E-09 | NA | NA |
| Aroclor-1260 | 4.2E-09 | NA | NA |
| Arsenic | 6.1E-08 | 1.5E+01 | 9.2E-07 |
| Barium | 5.6E-06 | NA | NA |
| Beryllium | 5.6E-09 | 8.4E+00 | 4.7E-08 |
| Cadmium | 2.4E-08 | 6.1E+00 | 1.5E-07 |
| Chromium | 1.6E-08 | 4.1E+01 | 6.6E-07 |
| Cobalt | 6.1E-08 | NA | NA |
| Copper | 2.4E-07 | NA | NA |
| Cyanide | 2.2E-08 | NA | NA |
| Di-n-octyl phthalate | 3.5E-10 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 7.4E-07 | NA | NA |
| Manganese | 2.6E-06 | NA | NA |
| Mercury | 1.9E-09 | NA | NA |
| Molybdenum | 2.0E-08 | NA | NA |
| Nickel | 1.6E-07 | 8.4E-01 | 1.4E-07 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 6.1E-10 | NA | NA |
| Thallium | 1.7E-09 | NA | NA |
| Vanadium | 1.2E-07 | NA | NA |
| Zinc | 6.4E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.3E-10 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 1.9E-06 |

- 5208

**Table K.7–134**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off–Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Inhalation of Gases and Particulates**

**Intake Equation** = Ca X EF X EDn X IR

| | | |
|---|---|---|
| IR | Inhalation rate of gases (RAGS, 1989) | 12 $m^3$/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 6 Year |
| Ca | Concentration of radionuclides in air | (see table below) |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/$m^3$ | Rn-222 | 4.1E+00 | pCi/$m^3$ |
| Am-241 | NA | pCi/$m^3$ | Ru-106 | NA | pCi/$m^3$ |
| Cs-137 | 4.6E-05 | pCi/$m^3$ | Sr-90 | 1.5E-04 | pCi/$m^3$ |
| Np-237 | 1.6E-05 | pCi/$m^3$ | Tc-99 | 9.2E-04 | pCi/$m^3$ |
| Pa-231 | 6.0E-05 | pCi/$m^3$ | Th-228 | 1.4E-04 | pCi/$m^3$ |
| Pb-210 | 1.6E-03 | pCi/$m^3$ | Th-230 | 1.5E-04 | pCi/$m^3$ |
| Pu-238 | 8.0E-05 | pCi/$m^3$ | Th-232 | 8.1E-05 | pCi/$m^3$ |
| Pu-239 | 3.9E-05 | pCi/$m^3$ | U-233 | NA | pCi/$m^3$ |
| Pu-240 | 3.9E-05 | pCi/$m^3$ | U-234 | 1.7E-03 | pCi/$m^3$ |
| Ra-226 | 8.1E-05 | pCi/$m^3$ | U-235 | 4.4E-05 | pCi/$m^3$ |
| Ra-228 | 8.8E-05 | pCi/$m^3$ | U-236 | 1.9E-05 | pCi/$m^3$ |
| | | | U-238 | 9.9E-04 | pCi/$m^3$ |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 8.8E-08 | NA |
| Am-241 | NA | 3.2E-08 | NA |
| Cs-137 | 1.2E+00 | 1.9E-11 | 2.2E-11 |
| Np-237 | 4.0E-01 | 2.9E-08 | 1.2E-08 |
| Pa-231 | 1.5E+00 | 3.6E-08 | 5.4E-08 |
| Pb-210 | 4.0E+01 | 4.0E-09 | 1.6E-07 |
| Pu-238 | 2.0E+00 | 3.9E-08 | 7.9E-08 |
| Pu-239 | 9.8E-01 | 3.8E-08 | 3.7E-08 |
| Pu-240 | 9.8E-01 | 3.8E-08 | 3.7E-08 |
| Ra-226 | 2.0E+00 | 3.0E-09 | 6.1E-09 |
| Ra-228 | 2.2E+00 | 6.9E-10 | 1.5E-09 |
| Rn-222 | 1.0E+05 | 7.7E-12 | 8.0E-07 |
| Ru-106 | NA | 4.4E-10 | NA |
| Sr-90 | 3.8E+00 | 5.6E-11 | 2.1E-10 |
| Tc-99 | 2.3E+01 | 8.3E-12 | 1.9E-10 |
| Th-228 | 3.6E+00 | 7.8E-08 | 2.8E-07 |
| Th-230 | 3.8E+00 | 2.9E-08 | 1.1E-07 |
| Th-232 | 2.0E+00 | 2.8E-08 | 5.7E-08 |
| U-233 | NA | 2.7E-08 | NA |
| U-234 | 4.2E+01 | 2.6E-08 | 1.1E-06 |
| U-235 | 1.1E+00 | 2.5E-08 | 2.8E-08 |
| U-236 | 4.8E-01 | 2.5E-08 | 1.2E-08 |
| U-238 | 2.5E+01 | 5.2E-08 | 1.3E-06 |
| | | ILCR Summation = | 4.1E-06 |

0796

5208

**Table K.7-135**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Ingestion of Drinking Water**

**Intake Equation** = Cw X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of groundwater (RAGS, 1989) | 1.4 l/day |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 6 Year |
| FI | Fractional intake for radionuclides | 1 (Unitless) |
| Cw | Concentration of radionuclides in groundwater | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/l | Rn-222 | NA | pCi/l |
| Am-241 | NA | pCi/l | Ru-106 | NA | pCi/l |
| Cs-137 | NA | pCi/l | Sr-90 | 2.2E-06 | pCi/l |
| Np-237 | NA | pCi/l | Tc-99 | NA | pCi/l |
| Pa-231 | NA | pCi/l | Th-228 | NA | pCi/l |
| Pb-210 | NA | pCi/l | Th-230 | NA | pCi/l |
| Pu-238 | NA | pCi/l | Th-232 | NA | pCi/l |
| Pu-239 | NA | pCi/l | U-233 | NA | pCi/l |
| Pu-240 | NA | pCi/l | U-234 | 1.5E+00 | pCi/l |
| Ra-226 | NA | pCi/l | U-235 | 4.0E-02 | pCi/l |
| Ra-228 | NA | pCi/l | U-236 | 1.6E-02 | pCi/l |
| | | | U-238 | 9.2E-01 | pCi/l |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | NA | 2.8E-11 | NA |
| Np-237 | NA | 2.2E-10 | NA |
| Pa-231 | NA | 9.2E-11 | NA |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | NA | 2.2E-10 | NA |
| Pu-239 | NA | 2.3E-10 | NA |
| Pu-240 | NA | 2.3E-10 | NA |
| Ra-226 | NA | 1.2E-10 | NA |
| Ra-228 | NA | 1.0E-10 | NA |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 6.4E-03 | 3.3E-10 | 2.1E-12 |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | NA | 5.5E-11 | NA |
| Th-230 | NA | 1.3E-11 | NA |
| Th-232 | NA | 1.2E-11 | NA |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 4.5E+03 | 1.6E-11 | 7.2E-08 |
| U-235 | 1.2E+02 | 1.6E-11 | 1.9E-09 |
| U-236 | 4.7E+01 | 1.5E-11 | 7.1E-10 |
| U-238 | 2.7E+03 | 2.8E-11 | 7.5E-08 |
| | | **ILCR Summation =** | 1.5E-07 |

0797

**Table K.IV-136**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Ingestion of Meat Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of meat | 0.029 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 6 | Year |
| EDc | Exposure duration for carcinogens | 6 | Year |
| BW | Body weight | 15 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 2190 | days |
| CS | Concentration of chemicals in meat | | |

**Chemical Concentrations**

| Compound | Concentration | Units | Compound | Concentration | Units |
|---|---|---|---|---|---|
| Antimony | 6.8E-06 | mg/kg | Heptachlorodibenzofuran | NA | mg/kg |
| Aroclor-1016 | NA | mg/kg | Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Aroclor-1221 | 5.6E-11 | mg/kg | Lead | 6.5E-06 | mg/kg |
| Aroclor-1242 | NA | mg/kg | Manganese | 5.7E-05 | mg/kg |
| Aroclor-1248 | 1.9E-08 | mg/kg | Mercury | 1.4E-05 | mg/kg |
| Aroclor-1254 | 8.0E-06 | mg/kg | Molybdenum | 6.4E-06 | mg/kg |
| Aroclor-1260 | 3.1E-06 | mg/kg | Nickel | 4.9E-05 | mg/kg |
| Arsenic | 5.8E-06 | mg/kg | Octachlorodibenzofuran | NA | mg/kg |
| Barium | 2.2E-05 | mg/kg | Selenium | 3.1E-07 | mg/kg |
| Beryllium | 2.5E-07 | mg/kg | Thallium | 3.3E-06 | mg/kg |
| Cadmium | 8.1E-06 | mg/kg | Vanadium | 1.6E-05 | mg/kg |
| Chromium | NA | mg/kg | Zinc | 3.1E-03 | mg/kg |
| Cobalt | 6.0E-05 | mg/kg | 2-Chlorophenol | NA | mg/kg |
| Copper | 9.5E-05 | mg/kg | 2-Methylnaphthalene | 1.3E-09 | mg/kg |
| Cyanide | 3.0E-11 | mg/kg | 4-Chlorophenyl-phenylether | NA | mg/kg |
| Di-n-octyl phthalate | 3.5E-04 | mg/kg | 4,4-DDT | NA | mg/kg |

**References**

0798





5808

**Table K.IV-136 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RMB Resident Farm Child Future Land Use Without Federal Ownership**
**Via Ingestion of Meat Products**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 1.3E-08 | 4.0E-04 | 3.1E-05 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.0E-13 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 3.5E-11 | NA | NA |
| Aroclor-1254 | 1.5E-08 | NA | NA |
| Aroclor-1260 | 5.8E-09 | NA | NA |
| Arsenic | 1.1E-08 | 3.0E-04 | 3.6E-05 |
| Barium | 4.1E-08 | 7.0E-02 | 5.9E-07 |
| Beryllium | 4.6E-10 | 5.0E-03 | 9.3E-08 |
| Cadmium | 1.5E-08 | 5.0E-04 | 3.0E-05 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 1.1E-07 | 6.0E-02 | 1.9E-06 |
| Copper | 1.8E-07 | NA | NA |
| Cyanide | 5.5E-14 | 2.0E-02 | 2.7E-12 |
| Di-n-octyl phthalate | 6.6E-07 | 2.0E-02 | 3.3E-05 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.2E-08 | NA | NA |
| Manganese | 1.1E-07 | 1.4E-01 | 7.6E-07 |
| Mercury | 2.6E-08 | 3.0E-04 | 8.6E-05 |
| Molybdenum | 1.2E-08 | 5.0E-03 | 2.4E-06 |
| Nickel | 9.2E-08 | 2.0E-02 | 4.6E-06 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 5.6E-10 | 5.0E-03 | 1.2E-07 |
| Thallium | 6.1E-09 | 8.0E-05 | 7.7E-05 |
| Vanadium | 2.9E-08 | 7.0E-03 | 4.2E-06 |
| Zinc | 5.8E-06 | 3.0E-01 | 1.9E-05 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 2.4E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 3.3E-04 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 1.1E-09 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 8.9E-15 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 3.0E-12 | 7.7E+00 | 2.3E-11 |
| Aroclor-1254 | 1.3E-09 | 7.7E+00 | 9.7E-09 |
| Aroclor-1260 | 4.9E-10 | 7.7E+00 | 3.8E-09 |
| Arsenic | 9.1E-10 | 1.6E+00 | 1.6E-09 |
| Barium | 3.5E-09 | NA | NA |
| Beryllium | 4.0E-11 | 4.3E+00 | 1.7E-10 |
| Cadmium | 1.3E-09 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 9.5E-09 | NA | NA |
| Copper | 1.5E-08 | NA | NA |
| Cyanide | 4.7E-15 | NA | NA |
| Di-n-octyl phthalate | 5.6E-08 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 1.0E-09 | NA | NA |
| Manganese | 9.1E-09 | NA | NA |
| Mercury | 2.2E-09 | NA | NA |
| Molybdenum | 1.0E-09 | NA | NA |
| Nickel | 7.8E-09 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 5.0E-11 | NA | NA |
| Thallium | 5.3E-10 | NA | NA |
| Vanadium | 2.5E-09 | NA | NA |
| Zinc | 5.0E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 2.1E-13 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 1.5E-08 |







5208

- 5208

**Table K.IV–137**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off–Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Ingestion of Meat Products**

**Intake Equation** = Cf X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of meat | 0.029 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 6 Year |
| Cf | Concentration of radionuclides in meat | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 3.3E-03 | pCi/kg | Sr-90 | NA | pCi/kg |
| Np-237 | 1.3E-06 | pCi/kg | Tc-99 | NA | pCi/kg |
| Pa-231 | 9.5E-03 | pCi/kg | Th-228 | 1.9E-06 | pCi/kg |
| Pb-210 | NA | pCi/kg | Th-230 | 3.2E-06 | pCi/kg |
| Pu-238 | 8.5E-08 | pCi/kg | Th-232 | 1.7E-06 | pCi/kg |
| Pu-239 | 5.5E-08 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 5.5E-08 | pCi/kg | U-234 | 3.0E-03 | pCi/kg |
| Ra-226 | 7.2E-05 | pCi/kg | U-235 | 8.0E-05 | pCi/kg |
| Ra-228 | 4.8E-05 | pCi/kg | U-236 | 3.3E-05 | pCi/kg |
| | | | U-238 | 1.8E-03 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 2.0E-01 | 2.8E-11 | 5.6E-12 |
| Np-237 | 8.2E-05 | 2.2E-10 | 1.8E-14 |
| Pa-231 | 5.8E-01 | 9.2E-11 | 5.3E-11 |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | 5.2E-06 | 2.2E-10 | 1.1E-15 |
| Pu-239 | 3.3E-06 | 2.3E-10 | 7.7E-16 |
| Pu-240 | 3.3E-06 | 2.3E-10 | 7.7E-16 |
| Ra-226 | 4.4E-03 | 1.2E-10 | 5.2E-13 |
| Ra-228 | 2.9E-03 | 1.0E-10 | 2.9E-13 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | NA | 3.3E-10 | NA |
| Tc-99 | NA | 1.3E-12 | NA |
| Th-228 | 1.2E-04 | 5.5E-11 | 6.4E-15 |
| Th-230 | 1.9E-04 | 1.3E-11 | 2.5E-15 |
| Th-232 | 1.0E-04 | 1.2E-11 | 1.2E-15 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 1.8E-01 | 1.6E-11 | 2.9E-12 |
| U-235 | 4.9E-03 | 1.6E-11 | 7.8E-14 |
| U-236 | 2.0E-03 | 1.5E-11 | 3.1E-14 |
| U-238 | 1.1E-01 | 2.8E-11 | 3.1E-12 |
| | | ILCR Summation = | 6.6E-11 |

0800

**Table K.IV-138**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Ingestion of Dairy Products**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of dairy products | 0.9 | l/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 6 | Year |
| EDc | Exposure duration for carcinogens | 6 | Year |
| BW | Body weight | 15 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 2190 | days |
| CS | Concentration of chemicals in animal products | | |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 6.8E-07 | mg/kg |
| Aroclor-1016 | NA | mg/kg |
| Aroclor-1221 | 1.8E-11 | mg/kg |
| Aroclor-1242 | NA | mg/kg |
| Aroclor-1248 | 2.0E-08 | mg/kg |
| Aroclor-1254 | 1.7E-06 | mg/kg |
| Aroclor-1260 | 6.3E-06 | mg/kg |
| Arsenic | 1.7E-07 | mg/kg |
| Barium | 5.2E-05 | mg/kg |
| Beryllium | 2.3E-10 | mg/kg |
| Cadmium | 1.5E-06 | mg/kg |
| Chromium | NA | mg/kg |
| Cobalt | 6.0E-06 | mg/kg |
| Copper | 1.4E-05 | mg/kg |
| Cyanide | NA | mg/kg |
| Di-n-octyl phthalate | 1.1E-04 | mg/kg |
| Heptachlorodibenzofuran | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Lead | 5.4E-06 | mg/kg |
| Manganese | 5.0E-05 | mg/kg |
| Mercury | 2.5E-08 | mg/kg |
| Molybdenum | 1.6E-06 | mg/kg |
| Nickel | 8.2E-06 | mg/kg |
| Octachlorodibenzofuran | NA | mg/kg |
| Selenium | 8.3E-08 | mg/kg |
| Thallium | 1.7E-07 | mg/kg |
| Vanadium | 1.3E-07 | mg/kg |
| Zinc | 3.1E-04 | mg/kg |
| 2-Chlorophenol | NA | mg/kg |
| 2-Methylnaphthalene | 7.3E-10 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | mg/kg |
| 4,4-DDT | NA | mg/kg |

**References**

**Table K.IV-138 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RMB Resident Farm Child Future Land Use Without Federal Ownership**
**Via Ingestion of Dairy Products**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 3.9E-08 | 4.0E-04 | 9.7E-05 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 1.0E-12 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 1.1E-09 | NA | NA |
| Aroclor-1254 | 9.9E-08 | NA | NA |
| Aroclor-1260 | 3.6E-07 | NA | NA |
| Arsenic | 1.0E-08 | 3.0E-04 | 3.3E-05 |
| Barium | 3.0E-06 | 7.0E-02 | 4.2E-05 |
| Beryllium | 1.3E-11 | 5.0E-03 | 2.6E-09 |
| Cadmium | 8.5E-08 | 5.0E-04 | 1.7E-04 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 3.4E-07 | 6.0E-02 | 5.7E-06 |
| Copper | 8.2E-07 | NA | NA |
| Cyanide | NA | 2.0E-02 | NA |
| Di-n-octyl phthalate | 6.4E-06 | 2.0E-02 | 3.2E-04 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.1E-07 | NA | NA |
| Manganese | 2.9E-06 | 1.4E-01 | 2.1E-05 |
| Mercury | 1.4E-09 | 3.0E-04 | 4.8E-06 |
| Molybdenum | 9.3E-08 | 5.0E-03 | 1.9E-05 |
| Nickel | 4.7E-07 | 2.0E-02 | 2.4E-05 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 4.8E-09 | 5.0E-03 | 9.6E-07 |
| Thallium | 9.5E-09 | 8.0E-05 | 1.2E-04 |
| Vanadium | 7.3E-09 | 7.0E-03 | 1.0E-06 |
| Zinc | 1.8E-05 | 3.0E-01 | 6.0E-05 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 4.2E-11 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 9.2E-04 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 3.3E-09 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 8.8E-14 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 9.6E-11 | 7.7E+00 | 7.4E-10 |
| Aroclor-1254 | 8.5E-09 | 7.7E+00 | 6.5E-08 |
| Aroclor-1260 | 3.1E-08 | 7.7E+00 | 2.4E-07 |
| Arsenic | 8.5E-10 | 1.8E+00 | 1.5E-09 |
| Barium | 2.5E-07 | NA | NA |
| Beryllium | 1.1E-12 | 4.3E+00 | 4.8E-12 |
| Cadmium | 7.3E-09 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 3.0E-08 | NA | NA |
| Copper | 7.0E-08 | NA | NA |
| Cyanide | NA | NA | NA |
| Di-n-octyl phthalate | 5.5E-07 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 2.7E-08 | NA | NA |
| Manganese | 2.5E-07 | NA | NA |
| Mercury | 1.2E-10 | NA | NA |
| Molybdenum | 7.9E-09 | NA | NA |
| Nickel | 4.1E-08 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 4.1E-10 | NA | NA |
| Thallium | 8.1E-10 | NA | NA |
| Vanadium | 6.3E-10 | NA | NA |
| Zinc | 1.5E-06 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 3.6E-12 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 3.1E-07 |



0802

- 5208

# Table K.IV-139
## Summary of Intake and Risk Quantitation (Radionuclides)
## Off-Property RME Resident Farm Child Future Land Use Without Federal Ownership
## Via Ingestion of Dairy Products

**Intake Equation** = Cp X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of dairy products | 0.9 l/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 6 Year |
| Cp | Concentration of radionuclides in animal products | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 1.2E-03 | pCi/kg | Sr-90 | 7.9E-25 | pCi/kg |
| Np-237 | 1.2E-07 | pCi/kg | Tc-99 | 2.3E-23 | pCi/kg |
| Pa-231 | 6.0E-05 | pCi/kg | Th-228 | 2.4E-06 | pCi/kg |
| Pb-210 | NA | pCi/kg | Th-230 | 2.7E-06 | pCi/kg |
| Pu-238 | 1.7E-08 | pCi/kg | Th-232 | 1.4E-06 | pCi/kg |
| Pu-239 | 1.1E-08 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 1.1E-08 | pCi/kg | U-234 | 9.1E-03 | pCi/kg |
| Ra-226 | 1.3E-04 | pCi/kg | U-235 | 2.4E-04 | pCi/kg |
| Ra-228 | 1.3E-04 | pCi/kg | U-236 | 1.0E-04 | pCi/kg |
| | | | U-238 | 5.5E-03 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 2.2E+00 | 2.8E-11 | 6.1E-11 |
| Np-237 | 2.3E-04 | 2.2E-10 | 5.1E-14 |
| Pa-231 | 1.1E-01 | 9.2E-11 | 1.0E-11 |
| Pb-210 | NA | 6.6E-10 | NA |
| Pu-238 | 3.2E-05 | 2.2E-10 | 7.1E-15 |
| Pu-239 | 2.1E-05 | 2.3E-10 | 4.8E-15 |
| Pu-240 | 2.1E-05 | 2.3E-10 | 4.8E-15 |
| Ra-226 | 2.4E-01 | 1.2E-10 | 2.9E-11 |
| Ra-228 | 2.5E-01 | 1.0E-10 | 2.5E-11 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 1.5E-21 | 3.3E-10 | 4.9E-31 |
| Tc-99 | 4.3E-20 | 1.3E-12 | 5.6E-32 |
| Th-228 | 4.6E-03 | 5.5E-11 | 2.5E-13 |
| Th-230 | 5.0E-03 | 1.3E-11 | 6.5E-14 |
| Th-232 | 2.7E-03 | 1.2E-11 | 3.2E-14 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 1.7E+01 | 1.6E-11 | 2.8E-10 |
| U-235 | 4.6E-01 | 1.6E-11 | 7.4E-12 |
| U-236 | 1.9E-01 | 1.5E-11 | 2.9E-12 |
| U-238 | 1.0E+01 | 2.8E-11 | 2.9E-10 |
| | | ILCR Summation = | 7.0E-10 |

**Table K.IV-140**
**Summary of Intake Quantitation (chemicals)**
**Off-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

**Intake Equation** = $\frac{CS \times EF \times ED \times FI \times IR}{BW \times AT}$

| | | | |
|---|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.102 | kg/day |
| FI | Fraction ingested from contaminated source | 1 | (Unitless) |
| EF | Exposure frequency | 350 | days/year |
| EDn | Exposure duration for non-carcinogens | 6 | Year |
| EDc | Exposure duration for carcinogens | 6 | Year |
| BW | Body weight | 15 | kg |
| ATc | Average time for carcinogens (lifetime) | 25550 | days |
| ATn | Average time for non-carcinogens (EDn x 365) | 2190 | days |
| CS | Concentration of chemicals in vegetables | | |

**Chemical Concentrations**

| Compound | Concentration | Units |
|---|---|---|
| Antimony | 1.7E-04 | mg/kg |
| Aroclor-1016 | NA | mg/kg |
| Aroclor-1221 | 8.4E-08 | mg/kg |
| Aroclor-1242 | NA | mg/kg |
| Aroclor-1248 | 4.7E-08 | mg/kg |
| Aroclor-1254 | 2.6E-06 | mg/kg |
| Aroclor-1260 | 2.4E-06 | mg/kg |
| Arsenic | 7.0E-05 | mg/kg |
| Barium | 3.6E-03 | mg/kg |
| Beryllium | 6.1E-06 | mg/kg |
| Cadmium | 3.5E-05 | mg/kg |
| Chromium | NA | mg/kg |
| Cobalt | 7.3E-05 | mg/kg |
| Copper | 2.3E-04 | mg/kg |
| Cyanide | 1.4E-05 | mg/kg |
| Di-n-octyl phthalate | 2.2E-07 | mg/kg |

| Compound | Concentration | Units |
|---|---|---|
| Heptachlorodibenzofuran | NA | mg/kg |
| Heptachlorodibenzo-p-dioxin | NA | mg/kg |
| Lead | 5.3E-04 | mg/kg |
| Manganese | 3.5E-03 | mg/kg |
| Mercury | 1.3E-06 | mg/kg |
| Molybdenum | 2.6E-05 | mg/kg |
| Nickel | 2.0E-04 | mg/kg |
| Octachlorodibenzofuran | NA | mg/kg |
| Selenium | 5.1E-07 | mg/kg |
| Thallium | 2.0E-06 | mg/kg |
| Vanadium | 1.6E-04 | mg/kg |
| Zinc | 7.2E-04 | mg/kg |
| 2-Chlorophenol | NA | mg/kg |
| 2-Methylnaphthalene | 1.6E-07 | mg/kg |
| 4-Chlorophenyl-phenylether | NA | mg/kg |
| 4,4-DDT | NA | mg/kg |

**References**

0804

**Table K.IV-140 (continued)**
**Summary of Risk Characterization (chemicals)**
**Off-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

| Compound | HQ Calculation CDI (mg/kg-day) | RfD (mg/kg-day) | HQ (unitless) |
|---|---|---|---|
| Antimony | 1.1E-06 | 4.0E-04 | 2.7E-03 |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 5.5E-10 | NA | NA |
| Aroclor-1242 | NA | NA | NA |
| Aroclor-1248 | 3.1E-10 | NA | NA |
| Aroclor-1254 | 1.7E-08 | NA | NA |
| Aroclor-1260 | 1.6E-08 | NA | NA |
| Arsenic | 4.6E-07 | 3.0E-04 | 1.5E-03 |
| Barium | 2.3E-05 | 7.0E-02 | 3.3E-04 |
| Beryllium | 4.0E-08 | 5.0E-03 | 7.9E-06 |
| Cadmium | 2.3E-07 | 5.0E-04 | 4.6E-04 |
| Chromium | NA | 5.0E-03 | NA |
| Cobalt | 4.8E-07 | 6.0E-02 | 7.9E-06 |
| Copper | 1.5E-06 | NA | NA |
| Cyanide | 8.9E-08 | 2.0E-02 | 4.5E-06 |
| Di-n-octyl phthalate | 1.4E-09 | 2.0E-02 | 7.1E-08 |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.4E-06 | NA | NA |
| Manganese | 2.3E-05 | 1.4E-01 | 1.6E-04 |
| Mercury | 8.5E-09 | 3.0E-04 | 2.8E-05 |
| Molybdenum | 1.7E-07 | 5.0E-03 | 3.4E-05 |
| Nickel | 1.3E-06 | 2.0E-02 | 6.5E-05 |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 3.3E-09 | 5.0E-03 | 6.6E-07 |
| Thallium | 1.3E-08 | 8.0E-05 | 1.6E-04 |
| Vanadium | 1.0E-06 | 7.0E-03 | 1.4E-04 |
| Zinc | 4.7E-06 | 3.0E-01 | 1.6E-05 |
| 2-Chlorophenol | NA | 5.0E-02 | NA |
| 2-Methylnaphthalene | 1.1E-09 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 5.0E-04 | NA |
| | HQ Summation = | | 5.6E-03 |

| Compound | ILCR Calculation CDI (mg/kg-day) | CSF (mg/kg-day)$^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Antimony | 9.2E-08 | NA | NA |
| Aroclor-1016 | NA | NA | NA |
| Aroclor-1221 | 4.7E-11 | NA | NA |
| Aroclor-1242 | NA | 7.7E+00 | NA |
| Aroclor-1248 | 2.6E-11 | 7.7E+00 | 2.0E-10 |
| Aroclor-1254 | 1.5E-09 | 7.7E+00 | 1.1E-08 |
| Aroclor-1260 | 1.3E-09 | 7.7E+00 | 1.0E-08 |
| Arsenic | 3.9E-08 | 1.8E+00 | 6.9E-08 |
| Barium | 2.0E-06 | NA | NA |
| Beryllium | 3.4E-09 | 4.3E+00 | 1.5E-08 |
| Cadmium | 2.0E-08 | NA | NA |
| Chromium | NA | NA | NA |
| Cobalt | 4.1E-08 | NA | NA |
| Copper | 1.3E-07 | NA | NA |
| Cyanide | 7.7E-09 | NA | NA |
| Di-n-octyl phthalate | 1.2E-10 | NA | NA |
| Heptachlorodibenzofuran | NA | NA | NA |
| Heptachlorodibenzo-p-dioxin | NA | NA | NA |
| Lead | 3.0E-07 | NA | NA |
| Manganese | 1.9E-06 | NA | NA |
| Mercury | 7.3E-10 | NA | NA |
| Molybdenum | 1.5E-08 | NA | NA |
| Nickel | 1.1E-07 | NA | NA |
| Octachlorodibenzofuran | NA | NA | NA |
| Selenium | 2.8E-10 | NA | NA |
| Thallium | 1.1E-09 | NA | NA |
| Vanadium | 8.7E-08 | NA | NA |
| Zinc | 4.0E-07 | NA | NA |
| 2-Chlorophenol | NA | NA | NA |
| 2-Methylnaphthalene | 9.8E-11 | NA | NA |
| 4-Chlorophenyl-phenylether | NA | NA | NA |
| 4,4-DDT | NA | 3.4E-01 | NA |
| | ILCR Summation = | | 1.0E-07 |

5208

**Table K.IV-141**
**Summary of Intake and Risk Quantitation (Radionuclides)**
**Off-Property RME Resident Farm Child Future Land Use Without Federal Ownership**
**Via Ingestion of Vegetables and Fruits**

**Intake Equation** = Cv X EF X EDn X FI X IR

| | | |
|---|---|---|
| IR | Ingestion rate of fruits or vegetables | 0.102 kg/day |
| FI | Fraction ingested from contaminated source | 1 (Unitless) |
| EF | Exposure frequency | 350 days/year |
| EDn | Exposure duration | 6 Year |
| Cv | Concentration of radionuclides in vegetables | |

| | | | | | |
|---|---|---|---|---|---|
| Ac-227 | NA | pCi/kg | Rn-222 | NA | pCi/kg |
| Am-241 | NA | pCi/kg | Ru-106 | NA | pCi/kg |
| Cs-137 | 4.0E-03 | pCi/kg | Sr-90 | 3.4E-13 | pCi/kg |
| Np-237 | 5.8E-04 | pCi/kg | Tc-99 | 1.5E-12 | pCi/kg |
| Pa-231 | 2.9E-03 | pCi/kg | Th-228 | 1.2E-02 | pCi/kg |
| Pb-210 | 6.2E-02 | pCi/kg | Th-230 | 1.3E-02 | pCi/kg |
| Pu-238 | 4.2E-03 | pCi/kg | Th-232 | 6.9E-03 | pCi/kg |
| Pu-239 | 2.7E-03 | pCi/kg | U-233 | NA | pCi/kg |
| Pu-240 | 2.7E-03 | pCi/kg | U-234 | 3.3E-01 | pCi/kg |
| Ra-226 | 7.0E-03 | pCi/kg | U-235 | 8.9E-03 | pCi/kg |
| Ra-228 | 7.3E-03 | pCi/kg | U-236 | 3.7E-03 | pCi/kg |
| | | | U-238 | 2.0E-01 | pCi/kg |

| Radionuclides | CDI (pCi) | CSF $(pCi)^{-1}$ | ILCR (unitless) |
|---|---|---|---|
| Ac-227 | NA | 3.5E-10 | NA |
| Am-241 | NA | 2.4E-10 | NA |
| Cs-137 | 8.6E-01 | 2.8E-11 | 2.4E-11 |
| Np-237 | 1.2E-01 | 2.2E-10 | 2.7E-11 |
| Pa-231 | 6.2E-01 | 9.2E-11 | 5.7E-11 |
| Pb-210 | 1.3E+01 | 6.6E-10 | 8.7E-09 |
| Pu-238 | 8.9E-01 | 2.2E-10 | 2.0E-10 |
| Pu-239 | 5.7E-01 | 2.3E-10 | 1.3E-10 |
| Pu-240 | 5.7E-01 | 2.3E-10 | 1.3E-10 |
| Ra-226 | 1.5E+00 | 1.2E-10 | 1.8E-10 |
| Ra-228 | 1.6E+00 | 1.0E-10 | 1.6E-10 |
| Rn-222 | NA | 1.7E-12 | NA |
| Ru-106 | NA | 9.5E-12 | NA |
| Sr-90 | 7.3E-11 | 3.3E-10 | 2.4E-20 |
| Tc-99 | 3.2E-10 | 1.3E-12 | 4.1E-22 |
| Th-228 | 2.6E+00 | 5.5E-11 | 1.4E-10 |
| Th-230 | 2.8E+00 | 1.3E-11 | 3.6E-11 |
| Th-232 | 1.5E+00 | 1.2E-11 | 1.8E-11 |
| U-233 | NA | 1.6E-11 | NA |
| U-234 | 7.1E+01 | 1.6E-11 | 1.1E-09 |
| U-235 | 1.9E+00 | 1.6E-11 | 3.1E-11 |
| U-236 | 8.0E-01 | 1.5E-11 | 1.2E-11 |
| U-238 | 4.3E+01 | 2.8E-11 | 1.2E-09 |
| | | ILCR Summation = | 1.2E-08 |

0806

# ATTACHMENT K.V

## SUMMARY OF THE TECHNICAL JUSTIFICATIONS FOR SOLID-LIQUID PARTITION COEFFICIENT AND PERCENT EXTRACTABLE OF URANIUM IN CONTAMINATED SOIL

ATTACHMENT K.V

5208

# SUMMARY OF THE TECHNICAL JUSTIFICATIONS FOR SOLID-LIQUID PARTITION COEFFICIENT AND PERCENT EXTRACTABLE OF URANIUM IN CONTAMINATED SOIL

## 1.0 INTRODUCTION

During the contaminant fate and transport modeling for the OU4 CRARE to support residual risk assessment, model parameters were estimated for Uranium. Two important geochemical parameters required in the modeling process are the solid-liquid partition coefficient ($K_d$) and the percentage of extractable Uranium in the waste material. Because Uranium is the predominant contaminant at the FEMP, site-specific values of these parameters are preferred for the CRARE modeling. This document summarizes the information and procedures used to estimate the site-specific $K_d$ values and percent of extractable Uranium in residual contaminated soil for the OU4 CRARE modeling. A screening-level model confirmation process has been conducted and is described in this document. The objective of this process was to verify that the estimated parameter values are reasonable by comparing modeling results, using these parameter values, with measured groundwater and soil conditions at the FEMP. The possible range of future surface water infiltration rates in the Production Area after remedial actions is also discussed.

It is important to note that additional information for determining the model parameters will become available from the on-going RI/FS processes of other Operable Units at the FEMP. Therefore, the parameter values used in the OU4 CRARE and presented in this document are based on the currently available data and will be refined before the next CRARE.

## 2.0 SOLID-LIQUID PARTITION COEFFICIENT

Distribution coefficients are used in the fate and transport modeling to simulate the reversible adsorption/desorption process of contaminants. The actual adsorption/desorption process is affected by many physical and chemical conditions (e.g., chemical forms, pH, clay content etc.). Chemicals with higher $K_d$ values are more likely to be adsorbed onto soil materials and thus have less potential of migration in the subsurface environment. $K_d$ is commonly defined as the constant equilibrium ratio between solid phase and dissolved phase concentrations of a chemical in contaminant fate and transport models such as ODAST and SWIFT.

### 2.1 Literature Values

A literature search was performed to determine the possible range of $K_d$ values for Uranium. Table 2-1 presents a summary of the literature search. As can be seen in the table, the range of $K_d$ values is quite large and the values vary significantly between soil types. The exp(u) values in Table 2-1 are the geometric means of all the available measurements.

### 2.2 Site-Specific Values

Available site-specific information that can be utilized to determine $K_d$ values of Uranium include on-going batch tests with site soils, previous geochemical studies, and existing

analytical data of soil and perched groundwater concentrations measured in the glacial overburden. The following subsections summarize this information and present the estimated site-specific $K_d$ values for Uranium.

### 2.2.1 Analytical Data From Monitoring Wells

When both the soil and groundwater concentrations of Uranium at the same location are measured, the $K_d$ can be determined by simply calculating the ratio of these two concentrations. There are more than one hundred sets of soil and perched water concentrations available from the 1000-series wells installed in the Production Area. These soil and perched water Uranium concentrations were utilized to estimate of the site-specific $K_d$ for Uranium in the Production Area. The pairs of soil and perched water concentrations used in the calculation were measured at the same elevation in the same boring. Because perched water flow velocities are so low in the glacial overburden, it is reasonable to assume that the measured soil and liquid phase concentrations are under equilibrium conditions. Before dividing a soil concentration by the corresponding perched water concentration to determine a $K_d$ value, the soil concentration was corrected by subtracting the mass of Uranium contained in the soil moisture (assuming the moisture content is 25 percent).

Table 2-2 summarizes the calculated $K_d$ values. Because of the different forms of Uranium and geochemical conditions which exist in the Plant 2/3, Plant 6 and Plant 9 areas (Lee and Marsh, 1992), a separate $K_d$ value was estimated for these areas. Overall, two $K_d$ values were developed in the Production Area. The geometric mean of all $K_d$ values calculated for wells in the Plant 2/3, Plant 6, and Plant 9 areas was 16 L/Kg. The geometric mean of calculated $K_d$ in the remaining part of the Production Area was 235 L/Kg. The geometric means were used because they are lower than the arithmetic means. Both of these two $K_d$ values are within the reported literature ranges summarized in Table 2-1. Because these soil and perched water samples were taken from locations away but very close to the source of contaminations, the estimated $K_d$ values of Uranium can be representative of both the glacial overburden and the extractable portion of waste materials.

There are less than 3 pairs of location-specific soil and groundwater Uranium concentrations identified in the GMA. Therefore, the above described calculation was not performed for the GMA at this time.

### 2.2.2 Results from Laboratory Tests

Geochemical Programs: Issue 3 and Issue 5 Report (DOE 1990) presented a range of Uranium $K_d$ values for the sand and gravel materials. Although soil and groundwater concentrations from various locations at the FEMP were evaluated in the study, the report only estimated a range of Uranium $K_d$ values for the sand and gravel materials in the South Plume area. A retardation factor of 12 was selected in subsequent solute transport model calibrations conducted for the South Plume using this range of $K_d$ values. The $K_d$ value which gives the retardation factor of 12 is about 1.4 L/Kg. In general, the $K_d$ value determined during the South Plume modeling is only appropriate for the GMA and is not intended to be used for the glacial overburden and the waste materials. A $K_d$ value of 1.8 L/Kg, which can result in unrealistically high estimates of groundwater concentrations, was used for the glacial overburden in some of the previous RI reports. This $K_d$ value is actually in the range of values for sand and gravel materials.

Experimental results reported in an ORNL study on the Uranium contaminated surface soils from the Production Area at the FEMP (Lee, et al., 1993) indicate that the range of $K_d$ is very large. Among the two contaminated soil samples tested in the equilibration study, only insignificant amounts of Uranium leached out from one soil sample (i.e., sample A-14) which has a significantly higher solid phase concentration. In fact, this soil sample never reached an equilibrium condition in the duration of the test (i.e., 70 days). More soluble Uranium did leach out from the other soil sample (i.e., sample B-16). At the end of the test, this soil sample was close to an equilibrium condition. Using the results of the B-16 soil sample, a $K_d$ value of 31.45 L/Kg can be calculated.

Batch tests are being conducted to measure the $K_d$ of Uranium in the waste, glacial overburden, and aquifer materials collected from OU2 waste units using deionized water as extracting agent. Preliminary results show that $K_d$ values of the waste materials, contaminated surface soils and glacial till are in the range of 50 L/Kg and higher. Preliminary $K_d$ results in the aquifer materials are usually lower than 10 L/Kg. The final results of these tests will be available by the end of August 1993. Similar tests on waste materials from the OU4 area are scheduled to start in late August 1993.

## 3.0 PERCENT EXTRACTABLE

Together with the $K_d$ values, an estimation of percent of extractable Uranium in the waste materials and contaminated soils are required to determine the concentrations of Uranium in the leachate formed by the interaction of precipitation with the soils. Based on the currently available partial results from OU5 soil washing studies, Uranium mass in contaminated soil at the FEMP is not completely extractable. Under natural conditions, only a portion of the Uranium currently absorbed to the soil will leach out and become mobile. The percent of extractable Uranium in untreated and treated soils are estimated to be 30% and 5%, respectively. A discussion of the rationale and justification for these numbers follows.

### 3.1 Untreated Soil

The percent of extractable Uranium used in the OU4 CRARE modeling is based on the results of the ORNL soil characterization and washing study (Lee and Marsh, 1992). According to operational history and observed soil and perched water contaminations, the most soluble form of Uranium in the FEMP exists in the Plant 2/3 area. Summarizing the data Table 17 in Lee and Marsh report for the Plant 2/3 soils (i.e., samples SP2-2-ABC and SP2-3-ABC), the percent of extractable Uranium varied from 2 percent when nitric acid was used to 32 percent when citric acid was used. Uranium was not extracted with water in this study. Based on the range of extractable Uranium identified from this study a value of 30 percent extractable Uranium was chosen to estimate the percent of Uranium that may be mobilized from contaminated soils. It is noted that this number is very conservative, in that the Uranium present in contaminated soils will be mobilized by precipitation, rather than citric acid. Precipitation will probably mobilize no more than 2 percent of the Uranium in the soils.

Because OU4 soils were not part of the ORNL study, contaminated soils from the Plant 2/3 area were selected to represent uranium contamination in OU4 soils. The decision to use the Plant 2/3 soils as an analog for OU4 soils is based on process information that indicates much of the waste in the OU4 soils originated from activities carried out at Plant 2/3 (DOE,

1993d). Therefore, aqueous spills that occurred around the Plant 2/3 area may have been slurried material that leaked from Plant 2/3 to K-65 Silos piping. Laboratory tests are being conducted to measure the percent of extractable Uranium in waste materials collected from other waste units using deionized water as the extracting agent. Before the results of these tests are available, the estimated percent extractable Uranium for the Plant 2/3 soil will be used as a conservative assumption for all contaminated soils in the OU4 CRARE fate and transport modeling.

### 3.2 Treated Soil

Soils that are washed with treatment extractants and replaced on the ground will be leached by precipitation. It is assumed that the washing process removes 85 percent of the extractable Uranium (i.e., 0.85 x 30% = 25.5%), leaving about 5 percent extractable Uranium in the soil. Therefore, 5 percent extractable Uranium will be assumed for washed soils, and this fraction is available for reactions with precipitation. This assumption is based on engineering judgement and will be verified during the actual soil washing process. At this time, 5 percent extractable from the treated soil is considered very conservative and will be used in the OU4 CRARE modeling to estimate the residual risk.

## 4.0 INFILTRATION RATE

The surface water infiltration rate in the Production Area can be as high as 7.5 in/yr (DOE, 1993b). This infiltration rate was determined during the groundwater flow model calibration done in 1990. According to the current leading remedial alternatives, the Production Area is the only area where significant residual soil contamination may be exposed to precipitation after remedial actions are completed in the FEMP. Therefore, the impacts of residual leachate from the Production Area on the GMA need to be defined. The impact of future remedial actions on the infiltration rate can be very significant. Unfortunately, OU3 and OU5 have not initiated the evaluation process for the future infiltration rates yet. Therefore, assumptions need to be made regarding the future infiltration rates in the Production Area for the OU4 CRARE modeling. Given the broad scope in the current definitions of the leading remedial alternative, it was assumed that the infiltration rate through the washed and back-filled soil in localized areas (i.e., Plant 2/3, Plant 6, and Plant 9) can be reduced by up to one order of magnitude (i.e., 0.75 in/yr), if determined necessary. This reduction of infiltration can be achieved by vegetation, compacting the back-filled soil, and mixing the back-filled soil with low permeability materials (e.g., clay and bentonite).

## 5.0 MODEL CONFIRMATION

A screening-level fate and transport model (DOE, 1993a) was used to confirm that the estimated $K_d$ and percent extractable Uranium can result in the current Uranium concentrations in the perched water and the GMA. The confirmation procedure involved: 1) defining the existing hydrogeological conditions and the extent of the source area; 2) inputing a source leachate concentration; 3) obtaining the model's results for concentration in the GMA after 30 years; 4) comparing the results with measured results from the 2000-series wells; and 5) confirming the total solid phase concentrations with the measured soil concentrations.

Two contaminated sites in the Production Area were investigated in the vicinity of Plant 2/3, Plant 6, and Plant 9. The model input values used for the confirmation were: source area = 300 feet by 300 feet, source/Layer 1 (i.e., glacial till) $K_d$ = 16 L/Kg, Layer 2/down gradient (i.e., GMA) $K_d$ = 1.4 L/Kg, percent extractable = 30%, and infiltration rate = 7.5 in/yr. Representative source leachate concentrations were estimated using 1000-series well total Uranium measurements. All the other model hydrogeological parameters used have the same values as specified in the ODAST and SWIFT models for these areas. The modeled and measured results are summarized in Table 5-1. From the table it can be seen that the model results compared well with the average measured concentrations and the results were always within the measured concentration range. For example, the modeled Plant 2/3 area concentration was 6.26 ug/L as compared to the average measured concentration of 6.02 ug/L and a measured concentration range of 3.34 to 7.45 ug/L. When the source leachate concentrations were converted into the total solid phase concentrations, using the $K_d$ = 16 L/Kg and percent extractable Uranium in unwashed soil= 30% , the results are about 500 and 2500 mg/Kg for the Plant 2/3 and Plant 6/9 areas, respectively. These solid phase concentrations are consistent with the measured surface soil conditions.

There is no significant Uranium contamination in perched water or the GMA in the remaining Production Area not studied in the model confirmation process. Also no significant soil contamination was found below 5 feet from the ground surface in the remaining area. This supports the higher $K_d$ values (i.e., 235 L/Kg) estimated for the remaining port of the Production Area.

## 6.0 SUMMARY

In summary, contaminated soils will be modeled in the OU4 CRARE assuming that 30 percent of the total Uranium is extractable, and the leachate concentration will be calculated using the source and glacial till solid-liquid partition coefficients of 16 and 235 L/Kg depending on the location in the Production Area. Soils that are washed and replaced on the ground will be assumed to contain 5 percent extractable Uranium, and the leachate concentration will also be calculated with distribution coefficients of 16 or 235 L/Kg. For the OU4 CRARE modeling, $K_d$ of 16 L/Kg and percent extractable Uranium of 30 percent (or 5 percent if the soil is washed) are also assumed for residual contaminated soils and glacial overburden in all other on-property areas. Distribution coefficient in the sand and gravel materials is conservatively assumed to be 1.4 L/Kg. These estimations were based on limited information. Whenever necessary, conservative assumptions were made. As the first CRARE in the FEMP, it was not possible to have all the required area-specific geochemical parameters defined. The laboratory tests that are being conducted for measuring the $K_d$ and percent extractable Uranium in water will be available to reassess the Uranium mobility in the next CRARE.

**TABLE 2-1**
**SUMMARY OF LITERATURE URANIUM Kd (L/kg) VALUES**
**FEMP, FERNALD, OHIO**

| COC | CLAY (Thibault et al., 1990) | | SILT (Thibault et al., 1990) | | SAND (Thibault et al., 1990) | | AGRICULTURAL SOILS AND CLAYS (Baes et al., 1984) | | AGRICULTURAL SOILS (Baes and Sharp, 1983) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | exp (μ) | Range | exp (μ) | Range | exp (μ) | Range | exp (μ) | Range | exp (μ) | Range |
| Uranium | 1600 | 46-395100 | 15 | 0.2-4500 | 35 | 0.03-2200 | 450 | -- | 45 | 10.5-4400 |

-- Not Available

References:


Baes, C. F., III, and R. D. Sharp, 1983, A Proposal for Estimation of Soil Leaching and Leaching Constant for Use in Assessment Models, J. Environ Qual., Vol. 12, No. 1, pp. 17-28.

Baes, C. F., III, R. D. Sharp, A. L. Sjoreen, and R. W. Shor, September 1984, A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture, Oak Ridge National Laboratory, Health and Safety Research Division, Oak Ridge, Tennessee, ORNL-5786.

Thibault, D. H., M. I. Sheppard, and P. A. Smith, March 1990, A Critical Compilation and Review of Default Soil Solid/Liquid Partition Coefficients, Kd, for Use in Environmental Assessments, Atomic Energy of Canada Limited, Whiteshell Nuclear Research Establishment, Pinawa, Maitoba, Canada, AECL-10125.





- 5208
0813

# TABLE 2-2
## SUMMARY OF SITE SPECIFIC Kd (L/kg) VALUES
## FEMP, FERNALD, OHIO

### OUTSIDE YELLOW REGION

| Well No. | Corrected KD value | | LN (KD value) |
|---|---|---|---|
| 1131 | 131.430 | avg(97.19, 165.66) | 4.878 |
| 1167 | 1124.800 | | 7.025 |
| 1181 | 186.470 | | 5.228 |
| 1187 | 81.680 | | 4.403 |
| 1198 | 130.230 | | 4.869 |
| 1244 | 1086.760 | | 6.991 |
| 1245 | 451.630 | avg(630.23, 273.02) | 6.113 |
| 1246 | 3581.360 | | 8.183 |
| 1250 | 40.080 | | 3.691 |
| 1267 | 185.850 | | 5.225 |
| 1277 | 93.550 | | 4.538 |
| 1280 | 501.190 | | 6.217 |
| 1281 | 129.050 | | 4.860 |
| 1287 | 188.480 | | 5.239 |
| 1338 | 696.780 | avg(1224.8, 168.78) | 6.546 |
| 1345 | 6849.800 | | 8.832 |
| 1347 | 144.540 | | 4.974 |
| 1348 | 433.910 | | 6.073 |
| 1354 | 106.660 | | 4.670 |
| 1356 | 309.660 | avg(495.63, 123.69) | 5.735 |
| 1360 | 1066.470 | | 6.972 |
| 1443 | 1215.400 | | 7.103 |
| 1448 | 591.220 | avg(510.75, 671.68) | 6.382 |
| 1509 | 203.520 | avg(77.94, 329.1) | 5.316 |
| 1510 | 88.160 | | 4.479 |
| 1513 | 200.770 | | 5.302 |
| 1515 | 608.890 | | 6.412 |
| 1151 | 34.380 | | 3.537 |
| 1266 | 2727.070 | | 7.911 |
| 1317 | 350.450 | | 5.859 |
| 1339 | 14.770 | | 2.693 |
| 1341 | 186.790 | | 5.230 |
| 1441 | 3.030 | | 1.109 |
| 1447 | 20.940 | | 3.042 |
| **Arithmetic Mean:** | 698.993 | | 5.460 |
| **Geometric Mean:** | | | 235.086 |

### INSIDE YELLOW REGION

| Well No. | Corrected KD value | | LN (KD value) |
|---|---|---|---|
| 1154 | 40.340 | | 3.697 |
| 1179 | 20.930 | | 3.041 |
| 1180 | 28.690 | avg(13.13, 44.24) | 3.357 |
| 1182 | 11.500 | | 2.442 |
| 1183 | 26.740 | avg(25.75, 27.72) | 3.286 |
| 1185 | 25.490 | avg(16.17, 34.8) | 3.238 |
| 1186 | 1.950 | | 0.668 |
| 1194 | 30.340 | | 3.412 |
| 1195 | 6.280 | avg(6.68, 5.88) | 1.837 |
| 1196 | 10.340 | | 2.336 |
| 1199 | 27.950 | avg(19.89, 36.01) | 3.330 |
| 1200 | 14.180 | avg(16.54, 11.81) | 2.652 |
| 1201 | 78.090 | | 4.358 |
| 1202 | 36.620 | avg(44.99, 28.24) | 3.601 |
| 1203 | 879.920 | avg(1315.59, 444.24) | 6.780 |
| 1204 | 14.090 | | 2.645 |
| 1205 | 22.650 | | 3.120 |
| 1206 | 8.470 | | 2.137 |
| 1207 | 29.690 | | 3.391 |
| 1209 | 2.450 | avg(1.48, 3.41) | 0.896 |
| 1212 | 10.090 | avg(6.57, 13.6) | 2.312 |
| 1213 | 3.830 | avg(0.37, 7.29) | 1.343 |
| 1214 | 216.400 | | 5.377 |
| 1215 | 24.330 | | 3.192 |
| 1216 | 30.370 | avg(26.78, 33.96) | 3.413 |
| 1217 | 13.500 | | 2.603 |
| 1219 | 31.370 | avg(46.58, 16.16) | 3.446 |
| 1220 | 121.880 | avg(25.43, 2.98, 337.22) | 4.803 |
| 1221 | 20.330 | avg(39.65, 1.0) | 3.012 |
| 1224 | 3.250 | avg(2.77, 3.72) | 1.179 |
| 1225 | 51.570 | | 3.943 |
| 1230 | 13.230 | | 2.582 |
| 1231 | 2.200 | avg(0.97, 3.43) | 0.788 |
| 1232 | 3.330 | avg(6.42, 0.24) | 1.203 |
| 1233 | 1.680 | avg(1.92, 1.44) | 0.519 |
| 1236 | 31.640 | avg(38.59, 24.69) | 3.454 |
| 1240 | 17.940 | | 2.887 |
| 1271 | 21.130 | | 3.051 |
| 1357 | 28.220 | avg(38.57, 17.87) | 3.340 |
| 1145 | 25.870 | avg(2.16, 49.58) | 3.253 |
| 1148 | 10.950 | avg(14.4, 7.49) | 2.393 |
| 1149 | 10.710 | | 2.371 |
| 1324 | 0.370 | avg(0.14, 0.6) | −0.994 |
| **Arithmetic Mean:** | 46.765 | | 2.784 |
| **Geometric Mean:** | | | 16.177 |

**TABLE 5-1**
**SUMMARY OF MODEL VERIFICATION RESULTS**
**FEMP, FERNALD, OHIO**

| LOCATION | MODEL LEACHATE[1] CONCENTRATION (ug/L) | MODELED[2] GROUNDWATER CONCENTRATION (ug/L) | AVERAGE OF 2000 SERIES WELL TOTAL URANIUM MEASUREMENTS (ug/L) | RANGE OF 2000 SERIES WELL TOTAL URANIUM MEASUREMENTS (ug/L) |
|---|---|---|---|---|
| Plant 2/3 | 10000 | 6.26 | 6.02 | 3.34 - 7.45 |
| Plant 6 and 9 | 50000 | 31.32 | 27.8 | 0.8 - 120 |

(1) Representative values based on 1000 Series Well Total Uranium measurements.
(2) Model concentration in the Great Miami Aquifer after 30 years of simulation.



0815
5208
☆ U.S. GOVERNMENT PRINTING OFFICE: 1994-550-232/80187