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

Environmental Excellence
HANFORD

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

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

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

Author
J. M. Ayres

Date Published
August 1994

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# EXECUTIVE SUMMARY

This report provides the qualitative risk assessment (QRA) for the 100-FR-1 Source Operable Unit at the U. S. Department of Energy (DOE) Hanford Site in southeastern Washington State. The 100 F Area also includes the 100-FR-2 Source Operable Unit and the 100-FR-3 Groundwater Operable Unit.

The 100-FR-1 Operable Unit QRA is an evaluation of risk using a limited amount of data and a predefined set of human and environmental exposure scenarios and is not intended to replace or be a substitute for a baseline risk assessment.

This QRA was conducted according to specified methods using validated data from analysis of soil representative samples from the 100 F Area. Nothing in the following discussion indicates that the 100-FR-1 Operable Unit should be removed from the interim remedial measures (IRM) path.

## BACKGROUND

Signatories to the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1992) (the Washington State Department of Ecology, the U.S. Environmental Protection Agency, and the DOE) have developed a strategy for early initiation and completion of waste site cleanups, which is described in the *Hanford Past-Practice Strategy* (DOE-RL 1991). This strategy relies, in part, upon the use of QRA to assist in decision making. The results of the QRA will be used, along with other information, to make recommendations regarding IRM. The objective of conducting IRM is to achieve cleanup and reduce risk in a timely and cost-effective manner.

The data for this 100-FR-1 QRA are from historical information and recent limited field investigation (LFI) sampling. The data are evaluated using the *Hanford Site Risk Assessment Methodology* (HSRAM) (DOE-RL 1994) as guidance. The maximum detected representative constituent concentrations in the top 15 feet of the soil are compared to Hanford Site background concentrations established in *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes* (DOE-RL 1993). Constituent concentrations greater than background (inorganic only) are compared to risk-based benchmark concentrations. For both the human health and ecological evaluations, maximum constituent concentrations exceeding either of these criteria are retained for further evaluation.

The contaminants of potential concern are evaluated for human health effects using exposure scenarios, pathways, and parameters as defined in the HSRAM (DOE-RL 1994). The QRA is streamlined to consider only two human health exposure scenarios (frequent-use and occasional-use) with four pathways (soil ingestion, fugitive dust inhalation, inhalation of volatile organics from soil, and external radiation exposure), based on agreements by the 100 Area Tri-Party unit managers (December 21, 1992 and February 8, 1993). For humans, risks that might occur under frequent- and occasional-use were included to provide an upper

bound and reasonable maximum exposure estimates of risk. An evaluation of potential impact to groundwater associated with each high-priority waste site is addressed in the LFI.

## RESULTS

This QRA evaluates a total of 18 high priority and 4 nonprioritized waste sites as specified in the *Remedial Investigation/Feasibility Study Work Plan for the 100-FR-1 Operable Unit* (DOE-RL 1992). Historical and recent LFI sampling data were available for evaluation of 12 of the high priority and 2 of the nonprioritized waste sites. The remaining waste sites were evaluated using process knowledge from analogous sites in the 100 Area. Qualitative human health risks were categorized as high (lifetime incremental cancer risk [ICR]) $>10^{-2}$, medium ($10^{-4} <$ ICR $< 10^{-2}$), low ($10^{-6} <$ ICR $< 10^{-4}$), and very low (ICR $< 10^{-6}$). The 100-FR-1 Operable Unit waste sites with data are categorized in the frequent- and occasional-use scenarios in 1993 as follows:

- High frequent-use and medium occasional-use human health risk potential:
  - 116-F-1 Lewis Canal
  - 116-F-2 (107-F) Basin Overflow Trench
  - 116-F-3 (105-F) Fuel Storage Basin Trench
  - 116-F-4 (105-F) Pluto Crib
  - 116-F-6 (1608-F) Liquid Waste Disposal Trench
  - 116-F-10 (105-F) Dummy Decontamination French Drain
  - 116-F-14 (107-F) Retention Basin
  - Basin Leak Ditch
  - EM Bypass Ditch.

- Medium frequent-use and low occasional-use human health risk potential:
  - 108-F French Drain
  - 116-F-9 Pacific Northwest Laboratories Animal Waste Leach Trench
  - 116-F-11 (105-F) Cushion Corridor French Drain.

- Low frequent-use and very low occasional-use human health risk potential:
  - 116-F-5 Ball Washer Crib
  - Process/Discharge Pipelines.

The risk-driving pathway is external exposure to radionuclides. Specific radionuclides identified as key contributors to these overall risk estimates were cobalt-60, cesium-137, europium-152, and europium-154. Under current conditions, human intrusion into contaminated soils would be prevented such that the soil provides complete radiation shielding against gamma-emitting radionuclides more than 1.8 m (6 ft) below ground surface. Even when accounting for shielding, 4 of the 14 waste sites are still rated as having a medium human health risk (under the occasional-use scenario) because the maximum detected concentrations exist in the top 1.8 m (6 ft) of soil.

The ecological benchmark for radionuclides is a total internal dose rate of 1 rad/day. Organism doses that exceeded this dose rate are classified as a high risk. The following sites

exceeded this dose rate, with strontium-90 as the primary contributor, in the 100-FR-1 Operable Unit: The 116-F-4 Pluto Crib exceeds the 1 rad/day benchmark at the surface 0-1.8 m (0-6 ft) soil profile as well as the total the 0-4.6 m (15 ft) depth. This site was part of a soil treatability test completed in 1993. The results are reported in DOE-RL (1994).

For nonradiological constituents the following sites exceeded EHQ >1 and the no observable effect level (NOEL) for wildlife: Eight sites exceeded the wildlife NOEL (EHQ >1, 1 rad/day) for one or more nonradiological contaminants. These sites include: the 108 French Drain, the 116-F-1 Lewis Canal, the 116-F-2 Basin Overflow, the 116-F-3 Fuel Storage Basin Trench, the 116-F-4 Pluto Crib, the 116-F-6 Liquid Waste Disposal Trench, the 116-F-9 Animal Waste Leach Trench, and the 116-F-14 Retention Basin.

The primary nonradiological contaminants of potential concern include arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium, silver, and zinc.

## UNCERTAINTIES

Uncertainties exist in the human health evaluation for the following reasons:

- identification of contaminants and concentrations are based on historical and LFI data which are limited and not likely to fully characterize the sites
- a considerable amount of conservatism exists in the exposure assessment (i.e., the use of maximum concentrations, the assumptions of frequent-users being at the site daily as receptors)
- contaminants are assumed to be uniformly distributed across the waste-sites.

Uncertainty exists in the environmental evaluation for the following reasons:

- Data used as a source term were assumed to be available for uptake by site vegetation. All foodstuffs were assumed to be contaminated.
- The waste sites are primarily covered with cobble or gravel which limits the amount of vegetation available for ecological foodstuff.
- Modeling from soil to the ecological receptor (the pocket mouse) required a number of assumptions including soil-to-plant transfer factors or coefficients. To take the conservative approach, in all cases, the highest transfer factor was used.
- Ecological receptors are assumed to spend 100% of their time on the waste site.
- The highest dose was used to assess qualitative risk, although in reality the probable actual dose is lower than this extreme.

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# ACRONYMS

| | |
|---|---|
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CLP | contract laboratory program |
| COC | contaminants of concern |
| COPC | contaminants of potential concern |
| DOE | U.S. Department of Energy |
| Ecology | Washington State Department of Ecology |
| EHQ | environmental hazard quotient |
| EPA | U.S. Environmental Protection Agency |
| HEAST | Health Effect Assessment Summary Table |
| HI | hazard index |
| HPPS | Hanford Past-Practice Strategy |
| HQ | hazard quotient |
| HSRAM | Hanford Site Risk Assessment Methodology |
| ICR | incremental cancer risks |
| IRIS | Integrated Risk Information System |
| IRM | interim remedial measures |
| LFI | limited field investigation |
| LOEL | lowest observable effect level |
| NCRP | National Council on Radiation Protection and Measurements |
| NOEL | no observable effect level |
| NPL | National Priorities List |
| PCB | polychlorinated biphenyls |
| PEF | particulate emission fraction |
| PNL | Pacific Northwest Laboratories |
| QRA | qualitative risk assessment |
| RESRAD | residual radioactive material guidelines |
| RL | Richland Operations Office |
| TAL | target analyte list |
| TCL | target compound list |
| Tri-Party Agreement | Hanford Federal Facility Agreement and Consent Order |
| VOC | volatile organic compounds |
| WAC | Washington Administrative Code |

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# 1.0 INTRODUCTION

The 100 Area of the Hanford Site was included on the U.S. Environmental Protection Agency's (EPA) National Priorities List (NPL) under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). The 100-FR-1 Operable Unit is located within the 100 Area of the Hanford Site (Figure 1-1).

The Washington State Department of Ecology (Ecology), the EPA, and the U.S. Department of Energy (DOE) are signatories to the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1992). The signatories have developed a strategy for the initiation and completion of waste site cleanups at Hanford, which is described in the *Hanford Past-Practice Strategy* (HPPS) (DOE-RL 1991). The application of the HPPS at the 100-FR-1 Operable Unit is discussed in detail in the *Remedial Investigation/Feasibility Study Work Plan for the 100-FR-1 Operable Unit* (DOE-RL 1992).

This qualitative risk assessment (QRA) is intended to provide information to assist the Tri-Party Agreement signatories in making defensible decisions on the necessity of interim remedial measures (IRM) at the 100-FR-1 Operable Unit (DOE-RL 1992).

## 1.1 PURPOSE AND SCOPE OF REPORT

This report provides the QRA for the waste sites associated with the 100-FR-1 Operable Unit. The QRA is an evaluation of risk for a predefined set of human and ecological exposure scenarios. It is not intended to replace or be a substitute for a baseline risk assessment. The QRA is streamlined to consider only two human health scenarios (frequent- and occasional-use) with four exposure pathways (soil ingestion, fugitive dust inhalation, inhalation of volatile organics, and external radiation exposure) and a limited ecological evaluation. The use of these scenarios and pathways was agreed to by the 100 Area Tri-Party unit managers (December 21, 1992, and February 8, 1993).

## 1.2 OPERABLE UNIT BACKGROUND

The Hanford Site is a 1,434 $km^2$ (560 $mi^2$) tract of land located in Benton, Franklin, and Grant Counties in the south central portion of the state of Washington. The 100 F Area is located in Benton County along the south bank of the Columbia River, in the north central part of the Hanford Site (Figure 1-1). The 100-FR-1 Operable Unit is 32 km (20 mi) north-northwest of the City of Richland, Washington and covers approximately 1.3 $km^2$ (0.5 $m^2$). It lies predominantly within Section 33, the eastern portion of Section 32, and the southeastern portion of Section 29 of Township 14N, Range 27E. It is bounded by north/south Hanford Site plant coordinates N78500 and N82500 and east/west coordinates W27600 and W33000.

There are three operable units in the 100 F Area. The 100-FR-1 Operable Unit is one of two source operable units in the 100 F Area. Source operable units include facilities

and unplanned release sites that are potential sources of hazardous substance contamination. The groundwater potentially affected by the 100 F Area is the third operable unit, 100-FR-3, a groundwater operable unit. This QRA addresses the 100-FR-1 Source Operable Unit. The 100-FR-1 Operable Unit contains waste units associated with the original plant facilities constructed to support F Reactor operation, the cooling water retention basin systems for the F Reactor, and biological laboratories used to study the effects of radiation on plants and animals.

The F Reactor was one of nine water-cooled, graphite-moderated plutonium production reactors built along the Columbia River. It was constructed from 1943 to 1945 and operated from 1945 to 1965. The reactor and most of the facilities associated with it were retired in 1965.

Biological research was conducted at the 100-FR-1 Operable Unit from 1945 to 1976 to study the effects of radiation on plants and animals. Early biological studies were conducted to measure the effects of reactor effluent on fish. Later research included the use of swine, sheep, dogs and rats. Other animals were used to a lesser extent (Deford 1993).

Chapter 2.0 in the 100-FR-1 Work Plan (DOE-RL 1992) provides a detailed description of the operations conducted in the 100-FR-1 Operable Unit.

Figure 1-2 shows the approximate boundaries of the 100-FR-1 Operable Unit, its location relative to the other operable units, the high priority waste sites, and waste sites which were not prioritized.

## 1.3 OVERVIEW OF THE QRA APPROACH

The following sections provide an overview of the approach used in conducting the human health and ecological risk assessments in the 100-FR-1 Operable Unit QRA.

### 1.3.1 Data Evaluation

The purpose of this section is to provide an overview of the information used in the 100-FR-1 Operable Unit QRA. Detailed discussion of data sources is provided in the limited field investigation (LFI) report for this operable unit. Evaluation of data used in the QRA is presented in Chapter 2.0.

**1.3.1.1 Historical Data.** A majority of the historical data evaluated in Chapter 2.0 was reported earlier (Dorian and Richards 1978) and was obtained from the 100-FR-1 Operable Unit Work Plan (DOE-RL 1992). The Dorian and Richards (1978) study reported analytical results for radionuclides in soil samples. These historical radionuclide concentrations were corrected for radioactive decay through 1993. The maximum decay-corrected concentrations were considered further in the QRA. Although standard laboratory methods were used in sample analysis, the data were not validated.

were considered further in the QRA. Although standard laboratory methods were used in sample analysis, the data were not validated.

**1.3.1.2 LFI Data.** The LFI data include analytical results from samples collected in 1993. Sampling and field activities are summarized in the 100-FR-1 Operable Unit Work Plan (DOE-RL 1992). The LFI data collected for individual waste sites were analyzed using methods specified in the Quality Assurance Project Plan (DOE-RL 1992). Samples were typically analyzed for volatile and semivolatile organic compounds, pesticides, polychlorinated biphenyl (PCB), radionuclides, metals, and wet chemistry parameters. The LFI data used in this report were validated according to criteria discussed in the LFI (WHC 1994). The same data set is used in the QRA and the LFI.

In general, both historical and LFI data were used in the identification of contaminants of potential concern (COPC) and in the QRA, as discussed in detail in Chapter 2.0.

**1.3.1.3 General Hanford Site Background Summary.** The natural composition of soils at the Hanford Site has been characterized (DOE-RL 1993a). The characterization effort involved the determination of the concentrations of nonradioactive analytes in natural soils at the Hanford Site. This background information is used in the identification of COPC at 100-FR-1 Operable Unit as recommended in the *Hanford Site Risk Assessment Methodology* (HSRAM) (DOE-RL 1994). This approach has the advantage of providing a single set of background data for assessing risk. The application of this background data is described in Chapter 2.0. Background concentrations of radionuclides and organic compounds at the Hanford Site are not available, and detected levels are treated as being above background. Radionuclide or organic analytes are assumed to be COPC if their concentration exceeds risk-based selection criteria specified in HSRAM (DOE-RL 1994).

### 1.3.2 Human Health Evaluation

**1.3.2.1 Exposure Assessment.** The exposure assessment methodology is presented in Section 2.2 and Appendices A and C of the HSRAM (DOE-RL 1994). The exposure assessment is conducted according to a conceptual site model that includes the determination of exposure scenarios, exposure pathways, exposure parameters, exposure point concentrations, and the quantification of exposures. The components of the exposure assessment methodology are individually discussed in the following paragraphs.

**1.3.2.1.1 Conceptual Site Model.** The conceptual model for the 100-FR-1 Operable Unit (Figure 1-3) includes the hypothetical exposure pathways to human and ecological receptors at the 100 F Area. Figure 1-4 displays the site model used in evaluation of this QRA as specified in the HSRAM (DOE-RL 1994). The 100-FR-1 Operable Unit QRA conceptual model does not include potential receptor exposures from contaminant infiltration into groundwater (DOE-RL 1992).

**1.3.2.1.2 Exposure Scenarios.** Under current site conditions, there are no residents at the 100-FR-1 Operable Unit and institutional controls prevent inadvertent intrusion into waste sites. Thus, exposures and associated risks presented in the QRA are not actual risks but are estimates of potential risks under high-frequency use or low-frequency use. The frequent-use scenario estimates exposures to a hypothetical residential receptor living at each 100-FR-1 Operable Unit waste site. The occasional-use scenario was selected to approximate the infrequent exposures to hypothetical recreational users of the Columbia River and intruders on the 100-FR-1 Operable Unit waste sites.

In accordance with the Tri-Party Agreement, 2018 is the earliest year in which the federal government could release portions of the Hanford Site for nonindustrial uses. Radionuclide concentrations are corrected for decay to 2018 because this was the date when remedial actions were intended for completion in the Tri-Party Agreement. The HSRAM (DOE-RL 1994) (Section 2.2.5.2) identifies that future scenarios will be evaluated in 2018 and 2118. The reduction of human health risks estimated for 2018 reflect the delay of frequent-use scenario exposures for 25 years. Such reductions in human health risks are discussed for individual waste sites in Chapter 3.0.

**1.3.2.1.3 Exposure Pathways.** The pathways evaluated for each waste site and scenario in the 100-FR-1 Operable Unit QRA are:

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

No modeling of contaminant transport through the environment is used in this 100-FR-1 Operable Unit QRA as specified in the HSRAM (DOE-RL 1994).

**1.3.2.1.4 Exposure Parameters.** Exposure parameters for the scenarios evaluated in this QRA are defined in Appendix A of the HSRAM (DOE-RL 1994). Recreational exposure parameters are used to evaluate the occasional-use scenario and residential exposure parameters are used to evaluate the frequent-use scenario.

**1.3.2.1.5 Exposure Point Concentrations.** For purposes of the QRA, the maximum soil concentration of a COPC measured within the specified depth interval is used as the exposure point concentration. Historical radionuclide soil concentration data were corrected to the year 1993 to allow for radionuclide decay. Chapter 2.0 identifies and evaluates the concentrations used in the 100-FR-1 Operable Unit QRA.

The Washington Administrative Code (WAC) provides 4.6 m (15 ft) as a reasonable estimate of the depth of soil that could be excavated and distributed at the soil surface as a result of site development activities (WAC 173-340-740 [6][e]). Because the exposure scenarios evaluated in this QRA assume receptor contact with surface soil, only constituents present in the upper 15 ft of site soils are evaluated as COPC. The WAC does not currently address radionuclides which could result in exposures by other than direct contact (e. g.,

determined that radiation emitted by radionuclides located deeper than 1.8 m (6.0 ft) would be effectively shielded by the overlying soils (WHC 1993a). The occasional-use scenario is also evaluated using radionuclide exposure point concentrations derived from the maximum concentration detected in the upper 1.8 m (6.0 ft) of soil.

Air concentration data specific to individual waste sites were not available for use in this QRA. Therefore, COPC airborne concentrations are estimated from their respective maximum soil concentrations. Fugitive dust concentrations are estimated using a particulate emission fraction (PEF) of $2 \times 10^7$ $m^3/kg$. This PEF conservatively assumes that the fugitive dust concentrations at each waste site are constantly equivalent to the National Primary Ambient Air Quality Standard for particulate matter of 50 $\mu g/m^3$ (EPA 1993a). Concentrations of volatile organic compounds (VOC) are estimated using a volatilization factor derived from standard EPA equations (EPA 1988).

The data sources and exposure point concentrations used in the human health QRA are identified in and tabulated Chapter 2.0.

**1.3.2.1.6 Quantification of Exposures.** The methodology for the quantification of receptor exposures in the various scenarios is presented in the HSRAM (DOE-RL 1994). Standard EPA equations (EPA 1989, DOE-RL 1994) are used as the basis for all intake calculations. Exposures of human receptors to nonradioactive COPC are expressed as chronic daily intakes (i.e., milligrams of contaminant per kilogram of receptor body weight per day). Exposures to radionuclide COPC is expressed as total intake in picocuries.

**1.3.2.2 Toxicity Assessment.** The general procedures for toxicity assessment are presented in the HSRAM (DOE-RL 1994). The toxicity assessment for the QRA identifies contaminant-specific toxicity factors and briefly discusses the key toxicities associated with the detected contaminants. Tables 1-1 through 1-3 provide a brief summary of toxicologic data for the COPC identified in this 100-FR-1 Operable Unit QRA.

The following assumptions are made with respect to the toxicity parameters used in the 100-FR-1 Operable Unit QRA:

- All chromium in soil is assumed to be in the chromium (VI) state.
- In the case of VOC, ingestion toxicity parameters are assumed to be appropriate surrogates for their respective inhalation toxicity parameters when inhalation values are not available.
- Toxicity parameters were not available for polycyclic aromatic hydrocarbons. As a result, risks from these compounds are a source of uncertainty in the QRA, but the uncertainties are minor (see Section 3.1.1.2).
- When historical data do not specify which uranium isotope was detected, uranium-238 was assumed. It was assumed that the detected uranium originated from natural sources which consists of approximately 99 percent uranium-238 by mass.

**1.3.2.3 Risk Characterization.** The risk characterization for the QRA is conducted as presented in the HSRAM (DOE-RL 1994). The QRA approach evaluates sites with quantitative sampling data and sites with limited or no sampling data. Consequently, risk characterization is discussed separately for each situation.

**1.3.2.3.1 Risk Characterization When Quantitative Data Are Available.** The risk characterization methodology provides estimates of lifetime incremental cancer risks (ICR) for exposures to carcinogenic COPC and hazard quotients (HQ) for exposures to systemic toxicant COPC.

The total lifetime ICR and hazard index (HI) to human receptors at each site is determined by summing the individual COPC ICR and HQ contributions from all pathways, respectively. Because the risk characterization equation for carcinogens used in this QRA is only valid up to estimated risks of approximately $1 \times 10^{-2}$ (EPA 1989), lifetime ICR estimates which exceeded $1 \times 10^{-2}$ were reported as "$> 1 \times 10^{-2}$".

The total lifetime ICR for each waste site is qualitatively discussed with respect to the following levels (DOE-RL 1994):

- high (ICR $> 1 \times 10^{-2}$)
- medium ($1 \times 10^{-2} <$ ICR $< 1 \times 10^{-4}$)
- low ($1 \times 10^{-4} <$ ICR $< 1 \times 10^{-6}$)
- and very low (ICR $< 1 \times 10^{-6}$).

The major COPC and major exposure pathways contributing to total risk are discussed individually for sites at which total lifetime ICR exceed $1 \times 10^{-6}$ or HI exceed 1.0 (Chapter 3.0).

**1.3.2.3.2 Risk Characterization When Quantitative Data Are Not Available.** Waste sites without analytical data are evaluated qualitatively. The COPC releases are identified from available historical information or from process knowledge of the waste site's historical activities. Human health risks assessed at quantitatively characterized analogous waste sites are used to establish a range of risks which may exist at the investigated waste site. The resulting qualitative risk characterization includes a discussion of both the potential site risk and the appropriateness of the selected analogous site.

**1.3.2.4 Evaluation of Uncertainty.** The human health risks calculated in this QRA are estimates that reflect several assumptions and related uncertainties. Uncertainties inherent in these estimated risks reflect a combination of uncertainties in the data used, exposure and toxicity assessments, and risk characterization calculations. Uncertainties associated with the quality and the appropriateness of the data used are discussed in Chapter 2.0. Uncertainties unique to the individual waste sites are identified in Chapter 3.0.

**1.3.2.4.1 Exposure Assessment Uncertainties.** The impact of the exposure assessment uncertainties can be grouped into the following qualitative categories (EPA 1989):

- "Low" uncertainty might affect estimates by less than one order of magnitude

- "Moderate" uncertainty might affect estimates by one to two orders of magnitude

- "High" uncertainty might affect estimates by more than two orders of magnitude.

The major contributions to exposure assessment uncertainties result from assumptions concerning land use scenarios, exposure parameters, exposure pathways, and soil concentrations. Institutional controls that currently prevent frequent-use and limit occasional-use scenario exposures are assumed to be removed, although the future uses of the site are uncertain at this time. Therefore, the frequent-use and occasional-use scenario exposure pathways and parameters are used to evaluate the expected upper and lower bounds of exposures.

Contaminants of potential concern in subsurface soil were assumed to be accessible to the hypothetical receptor by all exposure pathways. Inhalation and ingestion exposures are generally limited to COPC concentrations located near the surface. This assumption results in over estimations of receptor exposures, especially in the occasional-use scenario, and at sites known to be covered with clean soil.

The use of maximum soil concentrations of all COPC from the surface to a depth of 4.6 m (15 ft) introduces "High" uncertainty into the exposure assessment. Spatial distributions of surface and subterranean COPC concentration are not considered. Because the maximum observed concentration is assumed everywhere in the surface and subsurface soil, the potential human exposure is over estimated, especially in the occasional-use scenario.

An assumption of "infinite source" geometry is used to evaluate individual external radiation exposures. This assumption is inherent in the EPA toxicity parameters used in this QRA (EPA 1993a). Exposures calculated using this assumed geometry estimate that a hypothetical receptor would be exposed to radiation from an infinitely wide and deep soil column uniformly distributed with the maximum concentrations of all radionuclide COPC. Because this assumption ignores differences in radiation intensity provided from any other distribution of COPC in soil, "High" uncertainty is introduced. At certain sites, this uncertainty causes exposures to be over estimated, and the associated "High" risks to be dominated by the external exposure pathway.

**1.3.2.4.2 Toxicity Assessment Uncertainties.** The effects of toxicity assessment uncertainties may reflect either under- or over-estimations of site risks. Uncertainties associated with the various toxicity parameters result from:

- using data from animal exposures to predict health effects in humans

- using dose-response information from a homogeneous animal or human population to predict potential health effects that may occur in the more heterogeneous general population

- using information on dose-response effects from high-dose exposures to predict effects at low-doses

- using short-term exposure data to estimate effects from chronic exposures, or vice versa.

The EPA addresses these uncertainties by assigning degrees of confidence to the published toxicology studies for the compounds in question. An assignment of "Low" confidence indicates that a change in the toxicity parameter is expected when additional chronic data become available (EPA 1989). Thus, an assignment of "Low" confidence implies "High" uncertainty in the toxicity assessment for this QRA. Similarly, a "Medium" confidence implies "Medium" uncertainty, and "High" confidence implies "Low" uncertainty. Tables 1-1 through 1-3 include the toxicologic uncertainties associated with the COPC in this QRA.

**1.3.2.4.3 Risk Characterization Uncertainties.** The risk characterization process combines the results of the exposure assessment with the toxicity assessment into a measure of risks to human health at the evaluated waste site. Therefore, uncertainties inherent in the component assessments are propagated into the risk characterization. Consequently, "High" exposure assessment uncertainty imparts "High" uncertainty into the risk characterization.

**1.3.2.4.4 Uncertainty Evaluation Summary.** Use of conservative assumptions usually results in over estimation of human health risk and increased uncertainty. This approach serves a useful purpose in this QRA by providing strict criteria for identifying the contaminants and exposure pathways of concern at the 100-FR-1 Operable Unit. Although these conservative assumptions serve to simplify the risk characterization process, the resulting numerical values do not represent the most realistic estimates of risks and hazards to human health. The use of the numerical risk and hazard estimates in the 100-FR-1 Operable Unit QRA should be limited to comparisons with QRA for other operable units evaluated using the same methodology (DOE-RL 1994).

### 1.3.3 Ecological Evaluation

The purpose of the qualitative ecological evaluation is to estimate the present potential ecological risks from existing contaminant concentrations at the 100-FR-1 Operable Unit for selected ecological receptors.

The 100-FR-1 Operable Unit is a terrestrial waste unit. The qualitative ecological evaluation approach relies mainly on professional judgement and experience regarding waste site stressors, appropriate ecological receptors and primary exposure pathways and uses existing or limited field data. The QRA is not an absolute measure of risk utilizing detailed conceptual models and pathway analyses. The operating assumption is that contaminants are present at the site and the QRA evaluates the estimated risk from these contaminants to an ecological receptor.

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

**1.3.3.1 Problem Formulation.** Issues relevant to evaluating the qualitative ecological risk for waste sites within the 100-FR-1 Operable Unit are the stressor characteristics, the ecosystems likely to be affected by these stressors, and the possible effects on the receptor (i.e., pocket mouse) from exposure to physical and chemical stressors.

**Stressor Characteristics.** The stressors of concern are identified as those contaminants detected above background. All contaminants exceeding background are included in the QRA. A discussion of the identification of stressors above background and their concentration are given in Chapter 2.0.

All contaminants evaluated have been detected in the soil within the operable unit or were identified through historical records. The operable unit does not contain surface water bodies and is not apparently subject to mass flows from surface water runoff. Data on vegetation sampling from the waste sites, collected under the facility monitoring program, are included as background information in HSRAM (DOE-RL 1994). Consequently, exposure to contaminants in 100-FR-1 was evaluated from a soil source term.

Components of the 100-FR-1 Operable Unit environment that may be affected by wastes at the site include all parts of the food web shown in Figure 1-4. The indicator receptor for risk screening is the Great Basin pocket mouse, a herbivore known to occur in waste sites. A list of site-specific plant and animal species, as well as threatened, endangered, and candidate species will be provided in DOE-Richland Operations Office (RL) (1994) for the Hanford Site.

Contaminants found in the soil at waste sites within the 100-FR-1 Operable Unit include radioactive and nonradioactive elements and organic compounds. For nonradioactive elements and organic compounds, ecological effects were evaluated by uptake of contaminants from the soil by plants, and by accumulation of these constituents through ingestion by the pocket mouse. Table 1-4 provides general soil-to-plant transfer coefficients used for the COPC at the 100-FR-1 Operable Unit.

Radionuclides can induce ecological effects as a result of their presence in the abiotic environment (external dose rate) and by their incorporation into the body (i.e., internal dose rate from consumption of contaminated food). The total daily radiation dose rate to an organism can be estimated as the sum of doses received from all radioactive elements ingested, residing in the body, and available in the organism's environment. The radiological dose rate an organism receives is usually expressed as rad/day.

**Receptor Selection.** Typically, in a quantitative risk assessment, several trophic levels and several ecological receptors within the foodweb are selected for study in order to encompass receptors of varying sensitivity, to assess different endpoints, and to evaluate

contaminant transport through different pathways. For the qualitative ecological evaluation, generally only one receptor is used for limited exposure scenarios and simple endpoints. The ecological receptor used in this QRA is the *Perognathus parvas* (Great Basin pocket mouse).

**Endpoint Selection.** Endpoints are classified as either assessment endpoints or measurement endpoints. As stated in *Framework for Ecological Risk Assessment* (EPA 1992), "Assessment endpoints are explicit expressions of the actual environmental value that is protected. Measurement endpoints are measurable responses to a stressor that are related to the valued characteristics chosen as the assessment endpoints." For the QRA, the measurement endpoint is the mortality of the Great Basin pocket mouse. No assessment endpoint has been identified. This is consistent with the objective of the qualitative ecological evaluation. The dose rate to the pocket mouse was used to screen the level of risk at an individual waste site. For radionuclides, dose to a mouse is compared to 1 rad/day (IAEA 1992). For nonradiological contaminants, exposure is compared to toxicity values and an ecological HQ is determined.

**The Conceptual Model.** Based on the descriptions of ecological resources present at or near the 100-FR-1 Operable Unit waste sites and assuming a contaminant source limited to the soil, a conceptual ecological model can be derived for the key ecological resources in Figure 1-4. In general, uptake of contaminants from soil by vegetation serves as the primary source of contaminant entry into the food chain. Only major routes of exposure to contaminants are considered for the QRA. For contributions to dose rate, radionuclides are screened for those which may add significant external ionizing radiation. Contributions to dose by inhalation and ingestion via preening or grooming contaminated fur are not documented and are assumed to be minimal for the QRA.

The approach taken in this QRA is to evaluate risk for the small herbivore component (Great Basin pocket mouse) based on a two-step accumulation model (i.e., soil-to-plant and plant-to-mouse). Equations relating to dose rate calculations for primary and secondary organisms are reported in DOE-RL (1994). The accumulation model is operated on a waste-site-by-waste-site basis. Because the home range of the mouse approximates the size of each of the waste sites, the mouse is assumed to be exposed to contaminants within the specific waste site during most or all of its lifetime.

Estimating ecological risks from contamination is problematic when considering animals whose habitat use extends beyond the operable unit boundaries. For example, the 116-F-4 Pluto Crib site is a relatively small area within the much larger 100-FR-1 Operable Unit, and the other waste sites are separated from each other by areas where contaminant concentrations are unknown, but are likely to be much lower than that found in the waste sites themselves. Consequently, the environment outside the 100-FR-1 Operable Unit as used by most of the wide-ranging animals in the conceptual model is likely to be a mix of contaminated and uncontaminated habitats.

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

**Characterization of Exposure.** This section focuses on the development of the exposure relationship between receptor and site contaminants. It is assumed chemicals and radionuclides are uniformly distributed over the site and are biologically available. Receptors are exposed to the maximum contaminant concentrations obtained from the LFI sampling efforts in 1993 and from historical studies (Dorian and Richards 1978). All radionuclide concentrations analyzed prior to 1993 were corrected for radioactive decay to 1993.

**Ecosystem Characterization.** The spatial distribution or the home range of the pocket mouse was evaluated from available site data to establish the point of contact (length of exposure to contaminants of concern) between the chemical and radionuclide stressors and the mouse. The overlap of receptor home range with the site was considered sufficient for evaluation as a potential receptor and it was assumed that all of its life is spent within the site.

**Exposure Analysis.** The purpose of the exposure analysis is to integrate the spatial and temporal distributions of the ecological components and contaminants to evaluate exposure. All nonradioactive and radioactive constituents identified as of potential concern (before the screening of constituents with the greatest human health risk, see Chapter 2.0) are considered to be of concern in the ecological evaluation. The analysis assumes that the receptor spends all of its life at the site, obtains all its food from the site, and all consumed food is contaminated. However, because there is no source of water within the site (nor is it a necessary requirement for the pocket mouse), drinking water is not considered a route of exposure.

For nonradiological constituents, concentrations estimated in mice are compared to the reported potentially toxic (benchmark) concentrations. For radiological constituents, mice concentrations were converted to dose. Total dose for all radionuclides are compared to published effect levels and regulatory standards where available. Contaminants of concern (COC) are those COPC which have exceeded any part of the hazard screening process. Contaminants of concern and COPC are defined in HSRAM (DOE-RL 1994).

**Exposure Profile.** The ecological evaluation focuses on potential noncarcinogenic effects on the Great Basin pocket mouse potentially exposed to constituents present in the 100-FR-1 Operable Unit waste sites. Terrestrial vegetation is represented as a generic plant species exposed to soil contaminants. The major route of exposure of plants to waste site COPC was assumed to be direct uptake from soil. The plant was assumed to be the sole source of food for the mouse.

For both radiological and nonradiological contaminants, the dose is based on receptor whole-body concentrations. Metal stressors are assumed to be bioavailable for uptake by vegetation, which is consistent with the objectives of the QRA.

In general, for organisms whose home range is smaller than the operable unit, it is assumed that 100 percent of their diet consisted of contaminated foodstuffs. An example calculation for radiological and hazardous chemical dose is also shown in DOE-RL (1994).

**Characterization of Ecological Effects.** Toxic responses can be induced in mice exposed to ionizing radiation and to hazardous chemicals. This characterization analyzes the relationship between the stressor and assessment and measurement endpoints. Because site-specific toxicity data are not available, potential adverse effects of these agents on the mouse were predicted based on toxicity data in the literature. The only regulatory standard for radionuclides in the environment is DOE Order 5400.5, which requires exposure to aquatic organisms to be < 1 rad/day. The dose of 1 rad/day was used as a default value for the mouse.

**Evaluation of Relevant Effects Data.** Ionizing radiation can impact wildlife depending upon the level of exposure. Exposure can be either acute or chronic. Depending on the exposure concentration, acute exposures can result in mortality, generally characterized by the $LD_{50}$ (concentration that will result in 50 percent mortality within the test group). Other possible effects from acute exposure are physiological and pathological changes, as well as developmental and reproductive effects. Effects from chronic exposure include physiological, reproductive, growth, and developmental effects.

To evaluate the chemical toxicity to the pocket mouse, intake values for a given contaminant were compared to the no observable effect level (NOEL) (Table 1-5). As indicated in DOE (1992), toxicity information for terrestrial organisms relied on animal studies that support the Integrated Risk Information System (IRIS) database (EPA 1993b) and the Health Effect Assessment Summary Table (HEAST) (EPA 1993a). As a screening tool, toxicity data presented in the IRIS (EPA 1993b) or in the HEAST (EPA 1993a) database (when absent in IRIS) were used for mammals. Uncertainty factors were applied to the animal toxicity data to correct for differences between species, to modify lowest observable effect levels (LOEL) to NOEL and to adjust data obtained through short-term studies to that which would be expected in long-term studies.

Intake of contaminants by the mouse was estimated using intake parameters obtained from either published literature or derived from EPA formulas. Intake of contaminants in vegetation was estimated using an equation adapted from EPA's Human Health Evaluation Manual (EPA 1989).

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

**1.3.3.3 Environmental Risk Characterization.** The risk characterization phase evaluates the likelihood of an adverse effect to the receptor organism. In addition, wildlife NOEL are compared to modeled dose for non-radiological contaminants. The environmental hazard quotient (EHQ) was based on a comparison between identified benchmark (adjusted wildlife NOEL for nonradioactive chemicals or 1 rad/day for radionuclides) and calculated animal dose or intake.

**Risk Estimation.** The toxicological benchmark for exposure of the pocket mouse to radiation was 1 rad/day. Estimated wildlife NOEL served as benchmarks for exposure to nonradiological chemicals. The relationship between the benchmark and estimated dose or intake was expressed as an EHQ.

$$EHQ = \frac{\text{Organism's Dose}}{\text{Benchmark Dose}}$$

The EHQ ratio is used to assess potential adverse effect to an individual animal. For example, an EHQ that approaches or exceeds unity would strongly indicate a potential adverse effect to an individual.

**Interpretation of Ecological Significance.** The approach presented for the QRA at the 100-FR-1 Operable Unit waste sites screened the potential radiation dose to the pocket mouse and the potential intake of hazardous chemicals by the mouse. The screening, or qualitative, approach models COPC uptake from soil to plant to the mouse. The ecological significance of the QRA is limited because limited biological field data exist to support or refute predicted impacts on individuals. In addition, without field data it is extremely difficult to ascertain impacts at the population or community level of organization.

**1.3.3.4 Uncertainty.** The uncertainty associated with the approach used in the qualitative ecological evaluation for the 100-FR-1 Operable Unit waste sites is significant because data used as a source term was assumed to be available for uptake by site vegetation. In addition, the waste sites are primarily covered with cobble or gravel which limits the amount of vegetation available for use as an ecological foodstuff. Modeling from soil to the pocket mouse required a number of assumptions including soil-to-plant transfer factors or coefficients. A review of the literature produces a range of values. In all cases the highest transfer factor was used. Other assumptions included estimating the time that a receptor spends feeding within the unit and that all foodstuff consumed is contaminated. The highest soil concentration is used to model qualitative risk. Uncertainties are also associated with the use of NOEL in the estimation of risk from exposure of wildlife to nonradioactive chemicals. With regard to radionuclides, radioactive decay was not considered after incorporation and it was assumed that all radionuclides are uniformly distributed throughout the body of the mouse. A major area of uncertainty in evaluating ecological effects from exposure to ionizing radiation is extrapolation from the individual to the population level of ecological organization. There is a minimal amount of information concerning dose/response relationships at the population level for the pocket mouse. Each of these uncertainties contribute to the overall degree of uncertainty associated with the ecological evaluation.

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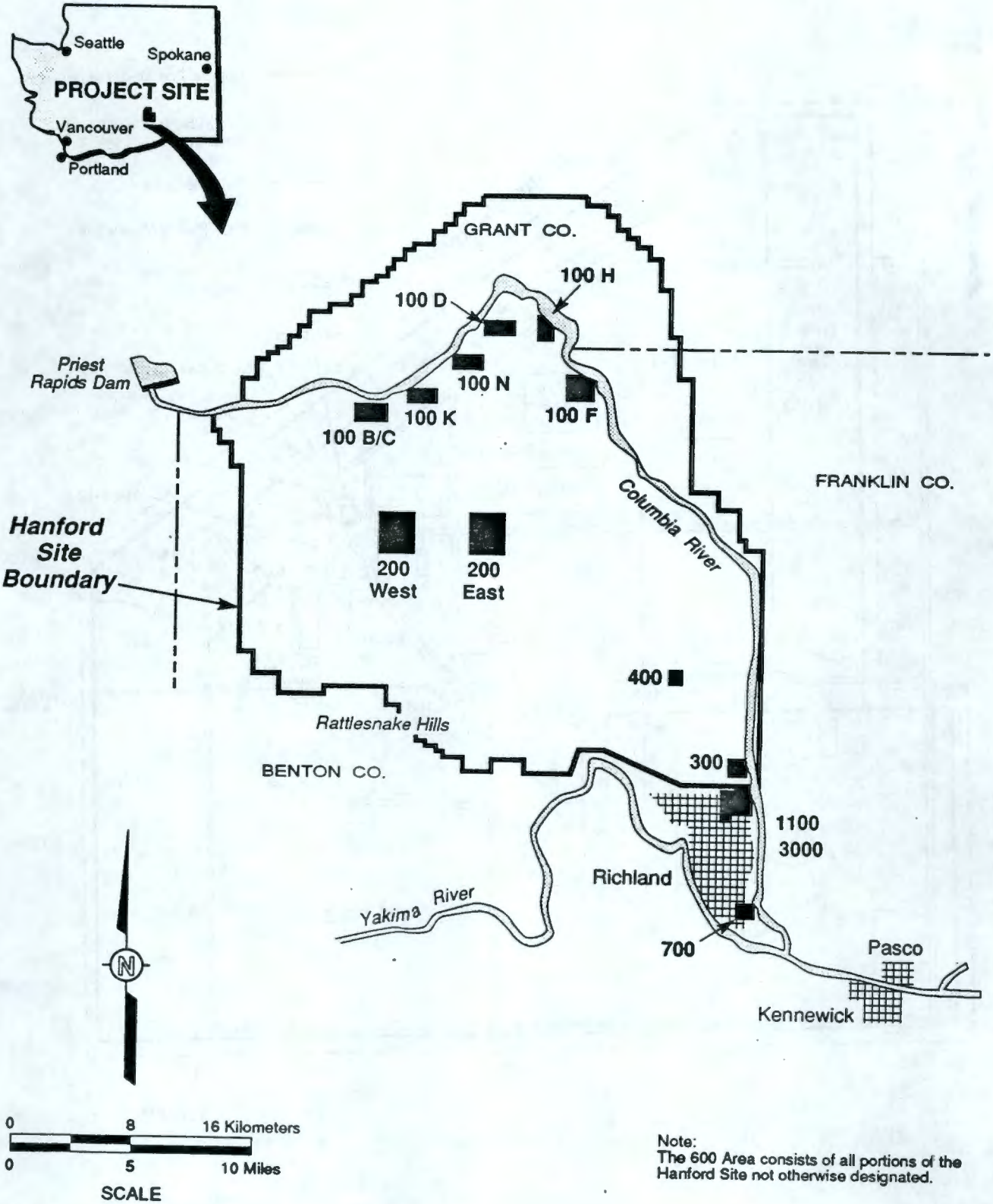
**Figure 1-1 Hanford Site and Area Designations**




Note:
The 600 Area consists of all portions of the Hanford Site not otherwise designated.

**Figure 1-2 High Priority and Non-Prioritized Waste Sites at the 100-FR-1 Operable Unit**

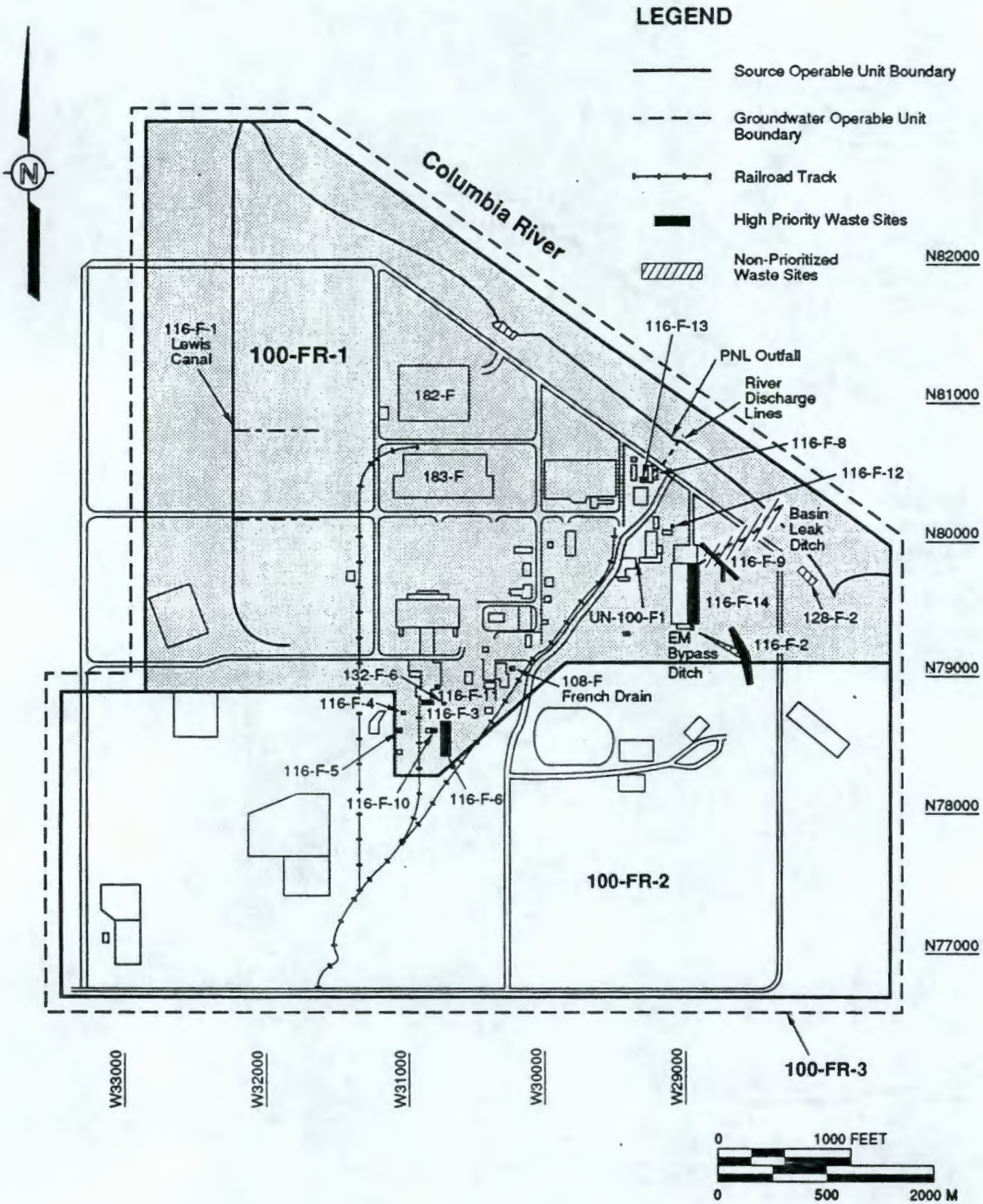


**Figure 1-3 Hypothetical Exposure Pathway Model Used in the 100-FR-1 Operable Unit QRA**

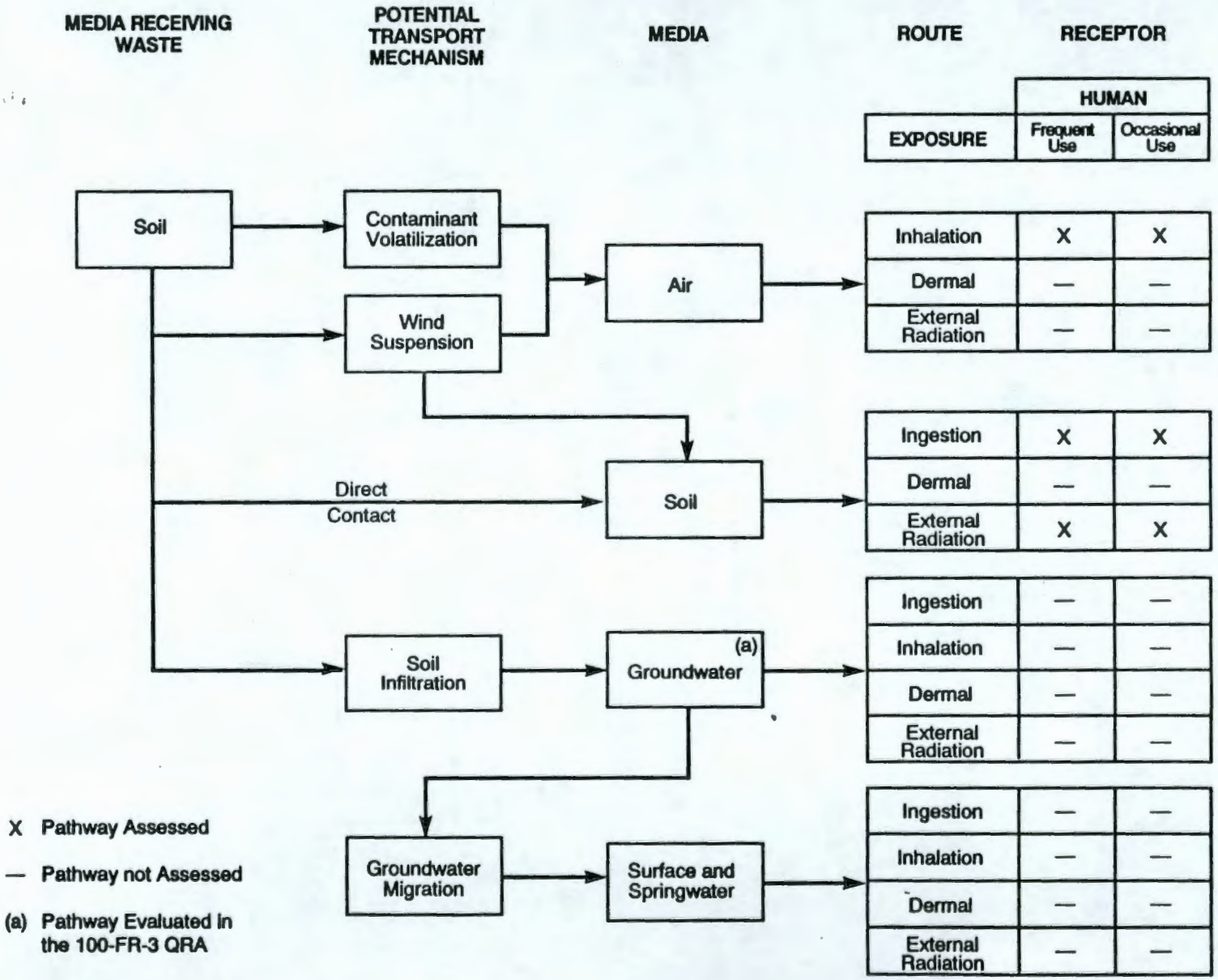


**Figure 1-4 Conceptual Model of Terrestrial Foodweb Relationships**

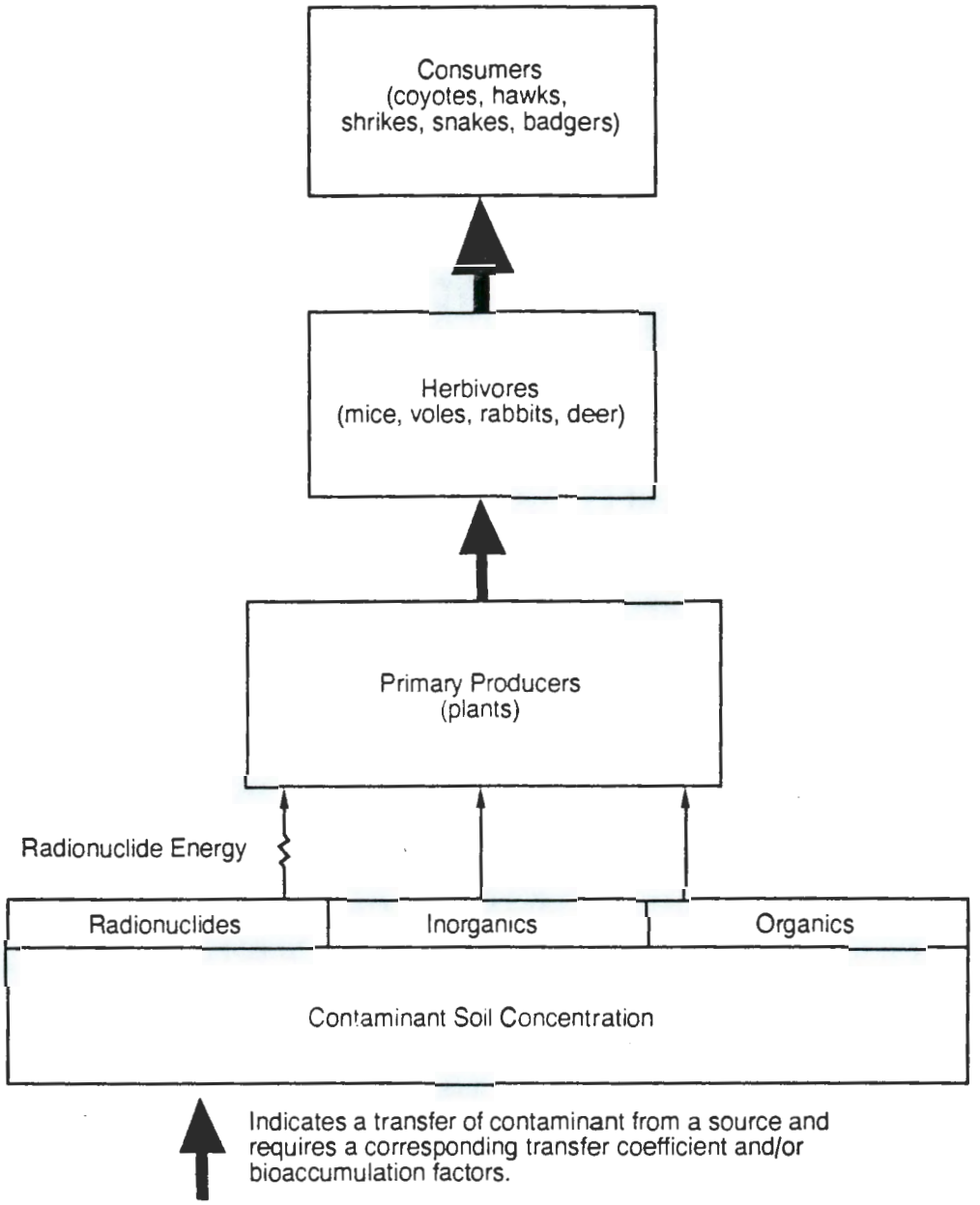


**Table 1-1 Summary of Carcinogenic Information for Radionuclide Analytes Detected at the 100-FR-1 Operable Unit**

| Radionuclide Analyte | Weight of Evidence Classification | Type of Cancer | Oral SF[a] $(pCi)^{-1}$ | Inhalation SF[a] $(pCi)^{-1}$ | External SF[a] $(pCi\text{-}yr/g)^{-1}$ | Toxicologic Uncertainty |
|---|---|---|---|---|---|---|
| Americium-241 | A[b] | - | 2.4E-10 | 3.2E-08 | 4.9E-09 | Low |
| Antimony-125 | A | - | 8.4E-13 | 1.1E-11 | 1.2E-06 | Low |
| Carbon-14 | A | - | 9.0E-13 | 6.4E-15 | -[c] | Low |
| Cesium-134 | A | - | 4.1E-11 | 2.8E-11 | 5.2E-06 | Low |
| Cesium-137 | A | - | 2.8E-11 | 1.9E-11 | 2.0E-06 | Low |
| Cobalt-60 | A | - | 1.5E-11 | 1.5E-10 | 8.6E-06 | Low |
| Europium-152 | A | - | 2.1E-12 | 1.1E-10 | 3.6E-06 | Low |
| Europium-154 | A | - | 3.0E-12 | 1.4E-10 | 4.1E-06 | Low |
| Europium-155 | A | - | 4.5E-13 | 1.8E-11 | 5.9E-08 | Low |
| Iodine-129 | A | - | 1.9E-10 | 1.2E-10 | 4.1E-09 | Low |
| Iridium-192 | A | - | 1.7E-12 | 2.7E-11 | 2.4E-06 | Low |
| Neptunium-237 | A | - | 2.2E-10 | 2.9E-08 | 4.3E-07 | Low |
| Nickel-63 | A | - | 2.4E-13 | 1.8E-12 | -[c] | Low |
| Plutonium-238 | A | - | 2.2E-10 | 3.9E-08 | 2.8E-11 | Low |
| Plutonium-239/240 | A | - | 2.3E-10 | 3.8E-08 | 2.7E-11 | Low |
| Potassium-40 | A | - | 1.1E-11 | 7.6E-12 | 5.4E-07 | Low |
| Radium-226 | A | bone | 1.2E-10 | 3.0E-09 | 6.0E-06 | Low |
| Ruthenium-106 | A | - | 9.5E-12 | 4.4E-10 | -[c] | Low |
| Strontium-90 | A | - | 3.6E-11 | 6.2E-11 | -[c] | Low |
| Technetium-99 | A | - | 1.3E-12 | 8.3E-12 | 6.0E-13 | Low |
| Thorium-228 | A | - | 5.5E-11 | 7.8E-08 | 5.6E-06 | Low |
| Thorium-232 | A | - | 1.2E-11 | 2.8E-08 | 2.6E-11 | Low |
| Tritium (H-3) | A | - | 5.4E-14 | 7.8E-14 | -[c] | Low |
| Uranium-233/234 | A | - | 1.6E-11 | 2.7E-08 | 4.2E-11 | Low |
| Uranium-235 | A | - | 1.6E-11 | 2.5E-08 | 2.4E-07 | Low |
| Uranium-238 | A | - | 2.8E-11 | 5.2E-08 | 3.6E-08 | Low |

[a]Health Effects Summary Tables (HEAST) (EPA 1993b).
[b]Group A Weight-of-Evidence; Human Carcinogen
[c]Not an External Exposure Hazard
SF = Slope factor
- Not determined. The carcinogenic potential of these contaminants is based on the fact that they emit ionizing radiation. EPA does not cite direct epidemiological evidence linking these radionuclides with a particular form of cancer (56 FR 33050).
Note: Radionuclide slope factors account for the contribution of radioactive daughter products, as indicated in HEAST (EPA 1993b).

## Table 1-2 Summary of Carcinogenic Information for Chemical Analytes Detected at the 100-FR-1 Operable Unit

| Chemical Analyte | Weight of Evidence Classification | Type of Cancer | Oral SF $(mg/kg\text{-}d)^{-1}$ | Inhalation SF $(mg/kg\text{-}d)^{-1}$ | Toxicologic Uncertainty |
|---|---|---|---|---|---|
| **INORGANIC** | | | | | |
| Arsenic | A | lung, skin | 2E+00[a,b] | 1.5E+01[a,c] | Low |
| Beryllium | B2 | - | 4.3E+00[a] | 8.4E+00[a] | Moderate |
| Cadmium | B1 | lung | ND | 6.3E+00[a] | Moderate |
| Chromium (as VI)[d] | A | lung | -[e] | 4.2E+01[a] | Low |
| **ORGANIC** | | | | | |
| Benzene | A | leukemia | 2.9E-02[a] | 2.9E-02[a] | Low |
| Bis(2-ethylhexyl)phthalate | B2 | liver | 1.4E-02[a] | 1.4E-02[f] | Moderate |
| Chlordane | B2 | liver | 1.3E+00[a] | 1.3E+00[a] | Moderate |
| Methylene Chloride | B2 | - | 7.5E-03[a] | 1.6E-03[a] | Moderate |
| PCBs[g] | B2 | liver | 7.7E+00[a] | ND | Moderate |
| Trichloroethene | C-B2 | - | 1.1E-02[h] | 6.0E-03[h] | Moderate to High |
| Tetrachloroethene | C-B2 | - | 5.2E-02[h] | 2.0E-03[h] | Moderate to High |

[a]Integrated Risk Information System (IRIS) (EPA 1993a).
[b]Based on the proposed arsenic unit risk of 5E-05 ug/L (IRIS) (EPA 1993a).
[c]Slope factor to be used for administered (not absorbed) intake of inhaled arsenic. Based on inhalation unit risk of 4.3E-03 $(ug/m^3)^{-1}$.
[d]Chromium concentrations were assumed to be in the hexavalent (Cr+6) oxidation state. Other, less carcinogenic, oxidation states may be present.
[e]Not considered carcinogenic through this exposure pathway.
[f]Surrogate values equivalent to the oral SF were used for volatile organic compounds.
[g]The potency of PCB cogeners vary greatly, Aroclor 1260 is assumed to be representative of all PCB cogener mixtures.
[h]Superfund Technical Support Center (*Carcinogenicity Information for Tetrachloroethylene and Trichloroethylene,* U.S. Environmental Protection Agency, Superfund Health Risk Technical Support Center, Cincinnati, Ohio.)
- Cancer type not specified.
ND = Not Determined
SF = slope factor
PCB = polychlorinated biphenyl
A = Class A Weight-of-Evidence; Human Carcinogen.
B1 = Class B1 Weight-of-Evidence; Probable Human Carcinogen, limited human data are available.
B2 = Class B2 Weight-of-Evidence; Probable Human Carcinogen, sufficient evidence in animals and inadequate or no evidence in humans.
C = Class C Weight-of-Evidence; Possible Human Carcinogen.

**Table 1-3 Summary of Systemic Toxicity Information for Analytes Detected at the 100-FR-1 Operable Unit (page 1 of 3)**

| Analyte | Oral RfD (mg/kg/d) | Data Basis/ Source (a) | Critical Effect | Confidence Level (b) | Toxicological Uncertainty | Inhalation RfD (mg/kg/d) | Data Basis/ Source | Critical Effect | Confidence Level | Toxicological Uncertainty |
|---|---|---|---|---|---|---|---|---|---|---|
| **Inorganics** | | | | | | | | | | |
| Arsenic | 3.0E-04 | water/ IRIS | Hyper-pigmentation, keratosis | Medium | Moderate | ND | --- | --- | --- | --- |
| Antimony | 4.0E-04 | water/IRIS | longevity, altered blood chemistry | Low | High | ND | --- | --- | --- | --- |
| Beryllium | 5.0E-03 | water/IRIS | None Observed | Low | High | ND | --- | --- | --- | --- |
| Barium | 7.0E-02 | water/IRIS | Increased Blood Pressure | Medium | Moderate | 1.0E-04 | HEAST | Reproductive Effects | --- | --- |
| Cadmium | 1.0E-03 | food/IRIS | Proteinuria | High | Low | ND | --- | --- | --- | --- |
| Chromium (VI) (c) | 5.0E-03 | water/IRIS | None Observed | Low | High | ND | --- | --- | --- | --- |
| Cobalt | ND | --- | --- | --- | --- | ND | --- | --- | --- | --- |
| Copper | 4.0E-02 | oral/STSC | Gastrointestinal Irritation | --- | --- | ND | --- | --- | --- | --- |
| Fluoride | 6.0E-02 | water/IRIS | Cosmetic Effect of Dental Fluorosis | High | Low | ND | --- | --- | --- | --- |
| Lead | ND | --- | --- | --- | --- | ND | --- | --- | --- | --- |
| Manganese | 1.4E-01 | food/IRIS | Central Nervous System Effects | Medium | Moderate | 1.1E-04 | air/IRIS | Respiratory Symptoms, Psychomotor Disturbances | Medium | Moderate |
| Mercury | 3.0E-04 | oral/HEAST | Kidney Toxicity | --- | --- | 9.0E-05 | oral/HEAST | Neurotoxicity | --- | --- |
| Nickel | 2.0E-02 | food/IRIS | decreased body, organ weight | Medium | Moderate | ND | --- | --- | --- | --- |
| Nitrite (d) | 1.0E-01 | water/IRIS | Methemoglobinemia | High | Low | ND | --- | --- | --- | --- |
| Selenium | 5.0E-03 | food/IRIS | Selenosis | Medium | Moderate | ND | --- | --- | --- | --- |
| Silver | 5.0E-03 | Intravenous/IRIS | Argyria | Low | High | ND | --- | --- | --- | --- |
| Sulfate | ND | --- | --- | --- | --- | ND | --- | --- | --- | --- |
| Vanadium | 7.0E-03 | water/HEAST | None Observed | --- | --- | ND | --- | --- | --- | --- |
| Zinc | 3.0E-01 | oral/IRIS | Anemia | Medium | Moderate | ND | --- | --- | --- | --- |

**Table 1-3 Summary of Systemic Toxicity Information for Analytes Detected at the 100-FR-1 Operable Unit (page 2 of 3)**

| Analyte | Oral RfD (mg/kg/d) | Data Basis/ Source (a) | Critical Effect | Confidence Level (b) | Toxicological Uncertainty | Inhalation RfD (mg/kg/d) | Data Basis/ Source | Critical Effect | Confidence Level | Toxicological Uncertainty |
|---|---|---|---|---|---|---|---|---|---|---|
| **ORGANICS** | | | | | | | | | | |
| Acetone (e) | 1.0E-01 | gavage/IRIS | Nephrotoxicity | Medium | Moderate | 1.0E-01 | ---- | ---- | ---- | ---- |
| Benzo(a)anthracene | ND | ---- | ---- | ---- | ---- | ND | ---- | ---- | ---- | ---- |
| Benzo(b)fluoranthene | ND | ---- | ---- | ---- | ---- | ND | ---- | ---- | ---- | ---- |
| Benzo(k)fluoranthene | ND | ---- | ---- | ---- | ---- | ND | ---- | ---- | ---- | ---- |
| Bis-2(ethylhexyl) phthalate (e) | 2.0E-02 | oral/IRIS | Increased Liver Weight | Medium | Moderate | 2.0E-02 | ---- | ---- | ---- | ---- |
| 2-Butanone | 6.0E-01 | water/IRIS | Developmental Effects | Low | High | 2.9E-01 | air/IRIS | Developmental Effects | Low | High |
| Chlordane | 6.0E-05 | oral/IRIS | Liver Hypertrophy | Low | High | ND | ---- | ---- | ---- | ---- |
| Chrysene | ND | ---- | ---- | ---- | ---- | ND | ---- | ---- | ---- | ---- |
| Di-n-butylphthalate (e) | 1.0E-01 | oral/IRIS | Increased Liver Weight | Low | High | 1.0E-01 | ---- | ---- | ---- | ---- |
| Di-n-octylphthalate (e) | 2.0E-02 | oral/HEAST | Increased Liver and Kidney Weight | ---- | ---- | 2.0E-02 | ---- | ---- | ---- | ---- |
| Diethylphthalate (e) | 8.0E-01 | oral/IRIS | Decreased Growth Rate | Low | High | 8.0E-01 | ---- | ---- | ---- | ---- |
| Fluroanthene (e) | 4.0E-02 | oral/IRIS | Nephropathy, Increased Liver Weight | Low | High | 4.0E-02 | ---- | ---- | ---- | ---- |
| 2-Hexanone (f) | 6.0E-01 | water/IRIS | Developmental Effects | Low | High | 2.9E-01 | air/IRIS | Developmental Effects | Low | High |
| Methylene Chloride | 6.0E-02 | water/IRIS | Liver Toxicity | Medium | Moderate | 9.0E-01 | air/HEAST | Liver Toxicity | ---- | ---- |
| 4-mehtyl-2-pentanone | 5.0E-02 | oral/HEAST | Liver and Kidney Effects | ---- | ---- | 2.0E-02 | --/HEAST | Increased Liver Weight, Kidney Effects | ---- | ---- |
| Phenanthrene (e) | 3.0E-02 | oral/IRIS | Decreased Kidney Weight | Low | High | 3.0E-02 | ---- | ---- | ---- | ---- |
| Pyrene (e) | 3.0E-02 | oral/IRIS | Decreased Kidney Weight | Low | High | 3.0E-02 | ---- | ---- | ---- | ---- |
| Tetrachloroethene (e) | 1.0E-02 | gavage/IRIS | Weight Gain and Hepatoxicity | Medium | Moderate | 1.0E-02 | ---- | ---- | ---- | ---- |

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**Table 1-3 Summary of Systemic Toxicity Information for Analytes Detected at the 100-FR-1 Operable Unit (page 3 of 3)**

| Analyte | Oral RfD (mg/kg/d) | Data Basis/ Source (a) | Critical Effect | Confidence Level (b) | Toxicological Uncertainty | Inhalation RfD (mg/kg/d) | Data Basis/ Source | Critical Effect | Confidence Level | Toxicological Uncertainty |
|---|---|---|---|---|---|---|---|---|---|---|
| Toluene | 2.0E-01 | gavage/IRIS | Changes in Liver and Kidney Weight | Medium | Moderate | 1.0E-01 | air/IRIS | Neurological Effects | Medium | Moderate |
| Trichloroethene (e) | 6.0E-03 | ---/STSC | ---- | Low | High | 6.0E-03 | ---- | ---- | ---- | ---- |

(a) IRIS = Integrated Risk Information System (EPA 1993a); HEAST = Health Effects Summary Tables (EPA 1993b); STSC = Superfund Technical Support Center (Golder Associates 1994)
(b) EPA Confidence Classification. High Confidence implies that RfD is not expected to change upon review of additional data. Low Confidence implies that the RfD is expected to change upon review of additional data.
(c) Detected chromium concentrations were assumed to be in the hexavalent (chromium+6) oxidation state. Other, less toxic, oxidation states may be present.
(d) Detected nitrite/nitrate concentrations were assumed to consist of only nitrite. Nitrate, which is less toxic, may also be present.
(e) Unless specified otherwise, surrogate values equivalent to oral RfD were used for volatile organic compounds.
(f) 2-Butanone is used as a surrogate for 2-Hexanone
ND = Not Determined
RfD = Reference Dose
---- = Not applicable or data unavailable

## Table 1-4 General Soil-to-Plant Transfer Coefficients Used for Contaminants of Potential Concern (page 1 of 2)

| Contaminant | Plant-to-Soil Transfer Coefficient | Reference |
|---|---|---|
| **Radionuclides** | | |
| Americium-241 | 0.01 | Coughtrey et al. 1985 |
| Carbon-14 | 0.7 | Whicker and Schultz 1982 |
| Cesium-134 | 0.25 | Coughtrey et al. 1985 |
| Cesium | 0.080 | DOE 1992 |
| Cesium-137 | 0.6 | Miller et al. 1977 |
| Cobalt-60 | 0.5 | Coughtrey et al. 1985 |
| Europium-152 | 0.25 | Coughtrey et al. 1985 |
| Europium-154 | 0.001 | Coughtrey et al. 1985 |
| Europium-155 | 0.001 | Coughtrey et al. 1985 |
| Nickel-63 | 0.1 | Coughtrey et al. 1985 |
| Plutonium-238 | 0.07 | Coughtrey et al. 1985 |
| Plutonium (total) | 4.5E-4 | DOE 1992 |
| Plutonium-239/240 | 0.07 | Coughtrey et al. 1985 |
| Radium-226 | 0.1 | Coughtrey et al. 1983, and 1985 |
| Strontium-90 | 19 | Rouston and Cataldo 1978 |
| Strontium | 2.5 | DOE 1992 |
| Thorium-228 | 1E-04 | Whicker and Schultz 1982 |
| Thorium-232 | 1E-04 | Whicker and Schultz 1982 |
| Thorium | 0.00085 | DOE 1992 |
| Tritium | 4.8 | Whicker and Schultz 1982 |
| Uranium (total) | 1 | Whicker and Schultz 1982 |
| Uranium 233/234 | 0.0085 | DOE 1992 |
| Uranium 235 | 1 | Whicker and Schultz 1982 |
| Uranium 238 | 1 | Whicker and Schultz 1982 |
| | 1 | Whicker and Schultz 1982 |
| **Organics** | | |
| Acetone | 53.3 | DOE 1992 |
| Acenapththene | 0.16 | DOE 1992 |
| Arochlor-1254/1260 (PCB) | 0.011 | DOE 1992 |
| Benzene | 2.27 | DOE 1992 |
| Benzo(a)pyrene | 0.013 | DOE 1992 |
| Benzo(a)anthracene | 0.022 | DOE 1992 |
| Benzo(b)fluoranthene | 6.2E-3 | DOE 1992 |
| Chrysene | 0.022 | DOE 1992 |
| Chlordane (a and b) | 0.013 | DOE 1992 |
| Diethylphthalate (DEP) | NA* | DOE 1992 |
| Di-n-butylphthalate | 0.072 | DOE 1992 |
| Fluoranthene | 0.032 | DOE 1992 |
| Methylene chloride | 7.34 | DOE 1992 |
| Nitrate/nitrite | NA** | DOE 1992 |
| Phenanthrene | 0.102 | DOE 1992 |
| Pyrene | 0.033 | DOE 1992 |
| Tetrachlroethene | 0.42 | DOE 1992 |
| Toluene | 1.02 | DOE 1992 |
| Trichloroethane | 1.84 | DOE 1992 |

**Table 1-4 General Soil-to-Plant Transfer Coefficients Used for Contaminants of Potential Concern (page 2 of 2)**

| Contaminant | Plant-to-Soil Transfer Coefficient | Reference |
|---|---|---|
| **Metals** | | |
| Antimony | 0.013 | DOE 1992 |
| Arsenic | 0.04 | DOE 1992 |
| Barium | 0.15 | DOE 1992 |
| Cadmium | 0.55 | DOE 1992 |
| Chromium | 0.0075 | DOE 1992 |
| Cobalt | 0.020 | DOE 1992 |
| Copper | 0.40 | DOE 1992 |
| Lead | 0.045 | DOE 1992 |
| Mercury | 0.90 | DOE 1992 |
| Selenium | 0.025 | DOE 1992 |
| Silver | 0.40 | DOE 1992 |
| Zinc | 1.50 | DOE 1992 |

NA* = Not available; note DEP has a biological half-life of 2-14 days under aerobic conditions and bioaccumulation should not be significant in the upper soil levels where pocket mice would live.

NA** = Not available; nitrogen is considered a fertilizer.

## Table 1-5 Estimated Wildlife NOEL for 100-FR-1

| Chemical | Adjusted Wildlife NOEL (mg/kg/day) |
|---|---|
| **Organics** | |
| Arochlor-1254/1260 | 0.166 (b) |
| Acetone | 10.0 |
| Benzene | 6.4 (b) |
| Benzo(a)anthracene | 0.011 (b) |
| Benzo(b)fluoranthene | NA |
| Benzo(a)pyrene | NA |
| Bis(2-ethylhexyl)phthalate | 0.4 |
| 2-Butanone | NA |
| Chrysene | NA |
| Chlordane (a and b) | NA |
| Diethylphthalate | NA |
| Di-n-butylphthalate | 48.4 (b) |
| Di-n-octylphthalate | NA |
| Fluoranthene | 3.00 |
| 2-Hexone | NA |
| Methylene Chloride | 0.60 |
| 4-methyl-2-pentanone | 12.9 (b) |
| Nitrate/nitrite | 23.6 (b) |
| Phenanthrene | NA |
| Pyrene | 2.00 |
| Tetrachloroethene | 2.00 |
| Trichloroethene | 193 (b) |
| Toluene | 22 |
| Toxaphene | NA |
| **Inorganics** | |
| Antimony | 0.04 (b) |
| Arsenic | 0.00008 |
| Barium | 0.02 |
| Cadmium | 0.003 |
| Chromium | 0.2 |
| Copper | 1.86 |
| Lead | 0.000069 |
| Mercury | 0.03 |
| Selenium | 0.0015 |
| Silver | 0.0005 |
| zinc | 0.02 |

NOEL = no observable effect level
NA = Not available
Primary source for NOEL (DOE 1992)
(b) = Opresko et al. (1994)

# 2.0 DATA

This section provides brief descriptions of the high priority and non-prioritized 100-FR-1 Operable Unit waste sites and of the data used in the QRA. Detailed descriptions of the waste sites and sampling locations and activities may be found in the LFI report and in the 100-FR-1 Operable Unit Work Plan (DOE-RL 1992). The COPC identification process and tables of COPC at individual waste sites are included in this section.

Sources of data for this QRA include results of the LFI sampling of soils and historical data from earlier investigations. Limited field investigation data were extracted from the *Data Validation Report for the 100-FR-1 Operable Unit Vadose Soil* (Ayers 1993). Analyses included the full CERCLA Contract Laboratory Program (CLP) target compound list (TCL) and target analyte list (TAL) constituents as well as specified anions and radionuclides. The TCL and TAL constituent groups include volatile organics, semi-volatile organics, pesticides/PCB, and inorganics.

Historical site use information was obtained from the 100-FR-1 Operable Unit Work Plan (DOE-RL 1992). The historical sampling data include inventories and concentrations of radionuclides reported in the radiological characterization of the 100-FR-1 Operable Unit performed by Dorian and Richards (1978). All maximum concentrations of radionuclides measured in 1978 were corrected for radioactive decay to 1993. Only limited historical data are available for the characterization of nonradioactive inorganic and organic constituents that might be present in the waste sites.

Maximum concentrations of COPC in the soil within 4.6 m (15 ft) below the surface are used in the human health QRA. Maximum concentrations within 1.8 m (6 ft) and within 4.6 m (15 ft) are used in the ecological QRA. Analytical results for samples below 4.6 m (15 ft) are not evaluated in this QRA, but their potential contamination of groundwater is evaluated in the LFI report for the 100-FR-1 Operable Unit (DOE-RL 1992).

Although gross alpha and gross beta radioactivity measurements data are tabulated, these data are not used in the QRA because each radionuclide contributing to the gross alpha or beta measurement is addressed individually in Section 3.0.

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

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

Brief descriptions of individual waste sites are provided in Sections 2.1 through 2.4. More detailed descriptions are given in Section 3.1 of the 100-FR-1 Operable Unit Work Plan (DOE-RL 1992). Priorities of waste sites and their location are illustrated in Figure 1-2.

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

### 2.1.1 108-F French Drain

**2.1.1.1 Site Description.** The 108-F French Drain received condensate from laboratory hoods inside the 108-F Building that were possibly contaminated with plutonium-239 and beta-emitting isotopes (DOE-RL 1992).

**2.1.1.2 Available Data.** A soil sample was taken at the 108-F French Drain site during LFI. The maximum reported COPC concentrations at this site are summarized in Table 2-1.

### 2.1.2 116-F-1 Lewis Canal

**2.1.2.1 Site Description.** The Lewis Canal is a large unlined surface drainage feature approximately 914 m (3,000 ft) long and 12 m (40 ft) wide, with an average depth of 3 m (10 ft). The canal was used from 1953 to 1960 and routinely received liquid wastes from the F Reactor Building and the 190-F Building, and decontamination wastes from the 189-F Building. Liquid wastes sometimes contained sodium dichromate, sulfuric acid, potassium borate, and sulfamic acid. Other chemicals received are unknown. Effluent reactor cooling water drained to the river via this canal during the Ball 3X outage in 1953.

**2.1.2.2 Available Data.** Samples were obtained from two test pits and one borehole in support of the LFI. Historical data on radionuclides are also available for this waste site. Maximum concentrations of COPC at this site are summarized in Table 2-2.

### 2.1.3 116-F-2 (107-F) Basin Overflow Trench

**2.1.3.1 Site Description.** The 116-F-2 Basin Overflow Trench is an unlined, open trench used from 1950 to 1965 to dispose of cooling water contaminated as a result of fuel cladding failures. The trench was also used for disposal of decontamination fluids generated from decommissioning of the 116-F-14 Retention Basin (Section 2.1.11) and the F Reactor Fuel Storage Basin. The trench has dimensions of 90 m x 15 m (300 ft x 50 ft), and a depth of 5 m (15 ft). Sometime after the trench was deactivated, it was backfilled with 1.2 to 6 m (4 to 20 ft) of soil.

Until 1954, contaminated cooling water was diverted to the trench from the retention basin through a 30-cm (12-in) diameter steel pipe. It appears that the EM Bypass Ditch (Section 2.3.2), was excavated in 1954 to direct contaminated cooling water to the basin overflow trench.

**2.1.3.2 Available Data.** Limited field investigation samples were collected from a borehole at the north end of the basin overflow trench. Historical data are also available for this site. Maximum concentrations of COPC at this site are presented in Table 2-3.

### 2.1.4 116-F-3 (105-F) Fuel Storage Basin Trench

**2.1.4.1 Site Description.** The F Reactor 116-F-3 Fuel Storage Basin Trench was used from 1947 to 1951 to dispose of reactor effluent contaminated during fuel-cladding failures. The site also received sludge from the F Reactor Fuel Storage Basin. It is approximately 30 m (100 ft) long, with a variable width of 3 to 6 m (10 to 20 ft) and a depth of 2.4 m (8 ft). The trench was backfilled with approximately 2.4 m (8 ft) of soil after deactivation and appears today as a gravel-covered field.

**2.1.4.2 Available Data.** Two sample borings were drilled within the trench in 1975. Soil samples were collected at the bottom of each boring. Samples were analyzed from a test pit on the west end of the trench in support of the LFI. Maximum concentrations of COPC at this site are presented in Table 2-4.

### 2.1.5 116-F-4 (105-F) Pluto Crib

**2.1.5.1 Site Description.** The 116-F-4 Pluto Crib was used from 1950 to 1952 to dispose of water contaminated during fuel cladding failures. Water contaminated with an estimated 280 Ci of fission products was discharged to this crib during its operating period (Dorian and Richards 1978). It was a subgrade wood frame filled with gravel measuring approximately 3 m x 3 m x 3 m (10 ft x 10 ft x 10 ft).

**2.1.5.2 Available Data.** Soil sampling was performed in 1975 at two locations approximately 15 m (50 ft) southwest of the crib (Dorian and Richards 1978). A borehole was sampled at this site in support of the LFI. Maximum concentrations of COPC at this site are presented in Table 2-5. Although human health risks are evaluated for exposures to contaminated soil at the 116-F-4 Pluto Crib, the crib was excavated during a soil treatability study in 1993 and contaminated soil was removed. As a result of this excavation, risks assessed in Section 3.1.1.5 for potential exposures do not reflect current conditions at this site. Results of the soil treatability study will be reported in 1994.

### 2.1.6 116-F-5 Ball Washer Crib

**2.1.6.1 Site Description.** The 116-F-5 Ball Washer Crib measures 3 m x 3 m x 3 m (10 ft x 10 ft x 10 ft) and was used in 1953 for disposal of liquid wastes containing nitric acid used in the decontamination of boron steel balls.

**2.1.6.2 Available Data.** Historical data are available from one sample collected in the vicinity of the crib site at a depth of 3 m (10 ft) in 1975 (Dorian and Richards 1978). No LFI data are available for this site. Maximum concentrations of COPC at this site are presented in Table 2-6.

### 2.1.7 116-F-6 (1608-F) Liquid Waste Disposal Trench

**2.1.7.1 Site Description.** This site was an open excavation that was used intermittently to dispose of cooling water during maintenance on the retention basin system. Effluent water apparently overflowed from the trench and flooded a low area south of the trench in 1956. This area was later released from radiological control. The trench measures 90 m by 30 m (300 ft by 100 ft), with a depth of 3 m (10 ft). The trench was deactivated in 1965 and backfilled with approximately 1.8 m (6 ft) of soil.

**2.1.7.2 Available Data.** Samples were collected from a soil boring during the Dorian and Richards (1978) study in 1975-76. A borehole was drilled at the north end of the trench and sampled in support of the LFI. Maximum concentrations of COPC at this site are presented in Table 2-7.

### 2.1.8 116-F-9 Pacific Northwest Laboratories Animal Waste Leach Trench

**2.1.8.1 Site Description.** The 116-F-9 Pacific Northwest Laboratories (PNL) Animal Waste Leach Trench operated from 1963 to 1976 to receive waste water resulting from the cleaning of animal pens. It consists of two trenches joined together to form a Y shape near the 116-F-14 Retention Basin. The long section is 120 m by 5 m (400 ft x 15 ft) with a depth of 3 m (10 ft) and the shorter section is 30 m (100 ft) long and of similar width and depth.

**2.1.8.2 Available Data.** Radiological characterization of this unit was performed in 1979 in which sample borings were drilled (Miller and Wahlen 1987). A vadose zone borehole at the north end of the trench was sampled in support of the LFI. Maximum concentrations of COPC at this site are presented in Table 2-8.

### 2.1.9 116-F-10 (105-F) Dummy Decontamination French Drain

**2.1.9.1 Site Description.** The 116-F-10 Dummy Decontamination French Drain was used from 1948 to 1965 for disposal of fluids derived from dummy fuel-element spacer decontamination. The drain is a 1-m (3-ft) diameter, subsurface, vitreous tile pipe that extends vertically to a depth of 6.1 m (20 ft) and is filled with 3 m (10 ft) of sand and gravel. Available information (Stenner et al. 1988) indicates that the drain received liquid waste containing dilute nitric acid, sodium dichromate, sodium oxalate, and sodium sulfamate.

**2.1.9.2 Available Data.** Three soil borings were drilled and sampled in the vicinity of the drain in 1975 (Dorian and Richards 1978). There are no LFI data for this site. Maximum concentrations of COPC at this site are presented in Table 2-9.

### 2.1.10 116-F-11 (105-F) Cushion Corridor French Drain

**2.1.10.1 Site Description.** The 116-F-11 French Drain was used between 1953 and 1965 to dispose of cushion corridor liquid decontamination wastes. The unit has a diameter of 1 m (3 ft), and is 1 m (3 ft) deep.

**2.1.10.2 Available Data.** A single boring was sampled in this area in 1975 (Dorian and Richards 1978). However, because this boring is approximately 30 m (100 ft) away from 116-F-11 these results might not be representative of soils near this waste unit (DOE-RL 1992). There are no LFI data for this site. Maximum concentrations of COPC at this site are presented in Table 2-10.

### 2.1.11 116-F-14 (107-F) Retention Basin

**2.1.11.1 Site Description.** The 116-F-14 Retention Basin was a rectangular, concrete-lined, open-top reservoir with dimensions of 70 m x 137 m x 7.3 m (230 ft x 450 ft x 24 ft). Shortly after the reactor was shut down in 1965, water within the basin was pumped to the 116-F-2 overflow trench (Section 2.1.3) and several feet of fill material were placed over the sludge for stabilization. The retention basin and associated ancillary piping were decommissioned in 1987 and now the basin contains concrete, asphalt, and approximately 460 m (1,500 ft) of the 152-cm (60-in) diameter effluent pipe. The site was then partially backfilled and stabilized with a soil cap.

Known leakage from the 116-F-14 Retention Basin appears to have occurred primarily along the south and west sides (Dorian and Richards 1978). Estimates of leakage rates are not well documented, but the presence of a groundwater mound beneath the basin extending as high as 3 m (10 ft) above the pre-existing water table elevation (Brown 1963) suggests that significant leakage was occurring during 1962.

**2.1.11.2 Available Data.** Sampling of the retention basin soil and vicinity was performed in 1975 with test pits and borings in and around the retention basin and nearby structures (Dorian and Richards 1978). An additional borehole was drilled and sampled in support of the LFI. Maximum concentrations of COPC at this site are presented in Table 2-11.

### 2.1.12 Process/Discharge Pipelines

**2.1.12.1 Site Description.** During the F Reactor operating period, three separate pipelines were used to transfer water from the reactor building to the 116-F-14 Retention Basin (Section 2.1.11). The oldest pipeline was a 107-cm (42-in) diameter concrete below-ground pipe. This pipe was replaced with a 107-cm (42-in) diameter steel pipe with above and below-ground sections. Deterioration and increased flow requirements resulted in the installation of a third, 152-cm (60-in) diameter steel pipe, which also had above and below-ground sections. Portions of the steel pipes were removed and buried in the 116-F-14 Retention Basin.

**2.1.12.2 Available Data.** Historical data are available for the effluent pipelines. No LFI data were collected for this site. Maximum concentrations of COPC at this site are presented in Table 2-12.

## 2.2 HIGH PRIORITY WASTE SITES WITHOUT HISTORICAL OR LFI DATA

Use of analogous sites to assess risks at sites without data and the associated uncertainties are discussed in Section 2.6 and in Chapter 3.0.

### 2.2.1 116-F-8 (1904-F) Outfall Structure

**2.2.1.1 Site Description.** The 116-F-8 Outfall Structure and river discharge lines were designed to carry cooling water from the retention basin to the Columbia River. The outfall is an open, reinforced concrete structure that directed the water through either a spillway or river discharge lines. The river discharge lines consisted of two 107-cm (42-in) diameter steel pipes extending from the outfall structure approximately 137 m (450 ft) out to the center of the river. The outfall structure has been demolished and covered except for the lower portion of the flume. Contamination and or dose rate data are unavailable for the flume (Deford 1993).

**2.2.1.2 Discussion of Analogous Sites.** No historical (Dorian and Richard 1978) or LFI data are available for this site. Waste sites at other operable units have been identified in Table 4-3 of the 100-FR-1 Operable Unit Work Plan (DOE-RL 1992) as analogous to the 116-F-8 Outfall Structure for the purposes of QRA. These other sites include: the 116-B-6, 116-B-7, and 132-C-2 sites at the 100 B/C Area, the 116-D-5 and 116-DR-5 sites at the 100 D/DR Area, the 116-H-5 site at the 100 H Area and the 116-K-3 site at the 100 K Area. The 116-B-6, 116-B-7, and 132-C-2 waste sites at the 100 B/C Area are the subjects of QRA currently in preparation, and are not addressed here. Risks associated with the 116-DR-5 site were characterized by analogy to the 116-D-5 waste site (WHC 1993a) as were risks associated with the 116-H-5 site (WHC 1993b). The risks associated with the 116-D-5 waste site were evaluated using COPC data from soil samples obtained at >4.6 m (15 ft) below the surface. As such, the 116-D-5 waste site would not be characterized in this 100-FR-1 Operable Unit QRA, and is not an appropriate analogous waste site for the 116-F-8 (1904-F) Outfall Structure.

The 116-F-14 (107-F) Retention Basin (Section 2.1.11) is considered to be analogous to the 116-F-8 (1904-F) Outfall Structure. Both were concrete-lined facilities that handled cooling water. Because the residence time of cooling water in the retention basin was greater than in the outfall structure, the potential for cooling water leakage to the soil is expected to be greater at the 116-F-14 site. Thus, the risk associated with soil potentially contaminated by the outfall structure is expected to be no greater than that of the retention basin, and probably is much less. Both facilities have been demolished and now contain concrete, potentially contaminated soil, and clean soil cover.

The Process/Discharge Pipelines (Section 2.1.12) waste site is considered analogous to the steel pipes at the 116-F-8 Outfall Structure. Both facilities consist of steel pipe used to direct the flow of coolant water. The potential for leakage to soil is expected to approximate that of the Process/Discharge Pipelines. Thus, the risk associated with soil potentially contaminated by this outfall structure is expected to be analogous to that of the Process/Discharge Pipelines.

### 2.2.2 116-F-12 (148-F) French Drain

**2.2.2.1 Site Description.** The 116-F-12 French Drain was used from 1944 until 1964 to dispose of recovered effluent pump primewater from the 148-F pumphouse. This effluent was likely similar to the cooling water discharged from the retention basin. Soil sampling has not been performed in this area.

**2.2.2.2 Discussion of Analogous Sites.** There are no sites analogous to the 116-F-12 French Drain designated in Table 4-3 of the 100-FR-1 Operable Unit Work Plan (DOE-RL 1992). Soil contaminated by leakage from the coolant water retention basin (116-F-14) is considered to be analogous to soils potentially contaminated at the french drain.

### 2.2.3 116-F-13 (1705-F) Experimental Garden French Drain

**2.2.3.1 Site Description.** The 116-F-13 French Drain is 1 m (3 ft) in diameter by 1 m (3 ft) deep and was used from 1952 until 1976 to dispose of effluent water associated with studies at the experimental garden facility. Soil sampling has not been performed in the area of this site.

**2.2.3.2 Discussion of Analogous Sites.** There are no sites designated in Table 4-3 of the 100-FR-1 Operable Unit Work Plan (DOE-RL 1992) as analogous to 116-F-13. Soil contamination by leakage from the Coolant Water Retention Basin (116-F-14) is considered analogous to contamination at the Experimental Garden French Drain. Thus, these characterized sites are analogous to the 116-F-13.

### 2.2.4 132-F-6 (1608-F) Lift Station Demolition Site

**2.2.4.1 Site Description.** The 132-F-6 Lift Station was used to pump water from the reactor building drains into the reactor cooling water effluent line. In 1975-76, samples were collected from a soil boring (Dorian and Richards 1978). However, samples are from a depth >4.6 m (15 ft). There are no LFI data available for this site.

**2.2.4.2 Discussion of Analogous Sites.** There are no waste sites designated in Table 4-3 of the 100-FR-1 Operable Unit Work Plan (DOE-RL 1992) as analogous to the 132-F-6 Site. Because this facility was used to pump coolant water into the effluent discharge system, contaminated soil at this site is analogous to soil contaminated by leakage from Process/Discharge Pipelines (Section 2.1.12). Two characterized waste sites are located in

close proximity to the 132-F-6 site. These sites are the 116-F-3 Fuel Storage Basin Trench and the 116-F-11 Cushion Corridor French Drain. Because of their proximity, leakage from these latter two sites might have contaminated the 132-F-6 Lift Station Demolition Site at depths <4.6 m (15 ft). Because of the proximity of the 132-F-6 Lift Station Demolition Site to the 116-F-3 and 116-F-11 sites, it is likely that excavations and other activities postulated in the frequent-use scenario will also involve parts of the 116-F-3 or 116-F-11 site, or both. Thus, risks potentially incurred at the 116-F-6 site are considered analogous to risks estimated for the 116-F-3 and 116-F-11 sites.

### 2.2.5 PNL Outfall Structure

**2.2.5.1 Site Description.** The PNL Outfall Structure is located near the Columbia River upstream from the 116-F-8 Outfall Structure. It received wash wastewater from the animal pens contaminated with strontium-90 and smaller amounts of cesium-137 and plutonium-239. It also likely received cooling water effluent used in the 146-FR Aquatic Biology Laboratory. No sampling or radiological survey data are available for this site.

**2.2.5.2 Discussion of Analogous Sites.** There are no waste sites designated in Table 4-3 of the 100-FR-1 Operable Unit Work Plan (DOE-RL 1992) as analogous to the PNL Outfall Structure. Because this structure was contaminated with wash water from animal pens, the site selected as being analogous is the 116-F-9 PNL Animal Waste Leach Trench (Section 2.1.8).

### 2.2.6 UN-100-F1

**2.2.6.1 Site Description.** An unplanned release occurred in March, 1971 when an area of approximately 149 $m^2$ (1,600 $ft^2$) was contaminated with washwater from the animal pens that contained strontium-90 and plutonium-239. The area was covered with clean gravel after the incident. No sampling or radiological survey data are available for this site.

**2.2.6.2 Available Data.** There are no waste sites designated in Table 4-3 of the 100-FR-1 Operable Unit Work Plan (DOE-RL 1992) as analogous to the UN-100-F1 Site. Because this area was contaminated with wash water from animal pens, the site selected as being analogous is the 116-F-9 PNL Animal Waste Leach Trench (Section 2.1.8).

## 2.3 NONPRIORITIZED WASTE SITES WITH DATA

### 2.3.1 Basin Leak Ditch

**2.3.1.1 Site Description.** The Basin Leak Ditch is a narrow ditch approximately 152 m (500 ft) long that extends eastward from the retention basin toward the Columbia River. The ditch was first used when a major release flooded the area around the basin in May, 1955 and drained to the Columbia River via the basin leak ditch (DOE-RL 1992). This ditch later

received effluent that overflowed intermittently from a manhole located near the north end of the basin.

**2.3.1.2 Available Data.** In 1975, four soil borings were drilled near the basin leak ditch. Maximum concentrations of detected analytes from this site are presented in Table 2-13.

### 2.3.2 EM Bypass Ditch

**2.3.5.1 Site Description.** A ditch extended from the 107-cm (42-in) pipe valve of the retention basin to the center of the 116-F-2 Basin Overflow Trench (Section 2.1.3). The length of this ditch, estimated from aerial photographs, is 107 m (350 ft).

**2.3.5.2 Available Data.** Soil sampling of the ditch was performed in 1975 (Dorian and Richards 1978). Maximum concentrations of detected analytes from this site are presented in Table 2-14.

## 2.4 NONPRIORITIZED WASTE SITES WITHOUT DATA

### 2.4.1 128-F-2 Burning Pit

**2.4.1.1 Site Description.** The 128-F-2 Burning Pit was used between 1945 and 1965 for disposal of nonradioactive combustible materials including paint waste, chemical solvents and assorted office debris. The facility is located in the east end of the 100-FR-1 Operable Unit. No sampling or radiological survey data are available for this site.

**2.4.1.2 Discussion of Analogous Sites.** There are no waste sites designated in Table 4-3 of the 100-FR-1 Operable Unit Work Plan (DOE-RL 1992) as analogous to the 128-F-2 Burning Pit (DOE-RL 1992), nor are there other 100-FR-1 Operable Unit sites that are considered analogous to this site.

### 2.4.2 Pre-Reactor Coolant Water Facilities

**2.4.2.1 Site Description.** The 181-F River Pumphouse was a reinforced concrete building that housed electrically and steam turbine driven pumps that pumped river water to the 183-F Treatment Plant and the 182-F Reservoir. The pumphouse operated between 1945 and 1965 and was demolished.

The 182-F Reservoir received raw water from the Columbia River for input to the reactor cooling water system. An aerial radiological survey of the 100 F Area in 1973-74 indicated cobalt-60 surface contamination believed to reflect that contamination present in the incoming river water as a result of cooling water discharges from the reactors upstream (DOE-RL 1992). This contamination could have resulted in low levels of surface contamination of the concrete basin as well as contamination of the surrounding soils if the

basin leaked. There are no records of decommissioning activities for the 182-F Reservoir or of samples taken in the area.

The 183-F Treatment Plant contained facilities for treatment of raw water for solids removal and corrosion control. The clarified water was then stored in the 126-F-2 (183-F) clearwells for further use in the reactor cooling water system. Because of the radionuclide contamination associated with the incoming river water, it is likely that some surface contamination of the facilities and equipment occurred. No records of decommissioning activities or sampling for these facilities have been located.

**2.4.2.2 Discussion of Analogous Sites.** There are no waste sites designated in Table 4-3 of the 100-FR-1 Operable Unit Work Plan (DOE-RL 1992) as analogous to the Pre-Reactor Coolant Water Facilities Site (DOE-RL 1992). No other single waste site within the 100-FR-1 Operable Unit is considered analogous. However, clarified pre-reactor coolant water was used for decontamination purposes at the 116-F-5 Ball Washer Crib. Because historical soil analysis data are available for the 116-F-3 Site, the radionuclide concentrations at the 116-F-5 site are considered analogous to the Pre-Reactor Coolant Water Facilities. The chemical COPC measured in soil at the 116-F-14 Retention Basin are expected to be analogous to the chemical contamination at the Pre-Reactor Coolant Water Facilities because both facilities handled approximately the same volumes of water having similar chemical compositions.

## 2.5 SELECTION OF CONTAMINANTS OF POTENTIAL CONCERN

### 2.5.1 Human Health Evaluation

The information on each waste site is reviewed to identify chemicals or radionuclides that might impact the key media (i.e., soil, groundwater, surface water, air, or biota). This information includes process knowledge, disposal knowledge, records of inventory, historical studies data, information obtained during site reconnaissance, and data generated from LFI sampling activities.

Both the historical and LFI data are considered for identification of COPC. Contaminants detected in the upper 1.8 m (6 ft) of soil are also considered in the ecological QRA. The contaminants are considered for both human health or ecological QRA only if they are detected in the upper 4.6 m (15 ft) of soil. The maximum concentration of each detected contaminant from the historical or LFI data set is selected for evaluation.

The evaluation process discussed in Section C.2.1 of the HSRAM (DOE-RL 1994) is used to identify COPC for each waste site. This process includes comparison of maximum concentrations of contaminants to sitewide background concentrations (DOE-RL 1994) and to the preliminary risk-based benchmark concentrations (DOE-RL 1994). Risk-based benchmark concentrations are used to identify COPC for the human health QRA only. These benchmark concentrations correspond to a lifetime ICR of $1 \times 10^{-7}$ or an HQ of 0.1, assuming exposure according to the frequent-use scenario. Preliminary risk-based screening

is used to identify the major contributors to risk and hazards and to save time and resources in the review and implementation of the risk assessment.

Contaminants of potential concern for ecological QRA are also identified by comparison of maximum concentrations to Hanford Site background concentrations (DOE-RL 1993). If no Hanford Site background concentration is available, the contaminant is retained for further evaluation.

If no historical or LFI data are available for a waste site, the risks at the site are assumed to approximate risks at an analogous site (see Chapter 3.0).

Tables 2-1 through 2-14 illustrate the COPC identification process and provide the concentrations of COPC for each waste site evaluated in this 100-FR-1 Operable Unit QRA.

### 2.5.2 Ecological Data Evaluation

Selection of COPC for ecological QRA does not include comparison to a risk-based screening value. As a result, contaminants may be retained in the ecological risk evaluation which may not be included in the human health evaluation.

## 2.6 UNCERTAINTY ASSOCIATED WITH DATA EVALUATION

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

Data used in this QRA are generally of high, known quality (LFI data) or medium quality (Dorian and Richards 1978). Limited field investigation data were validated in accordance with WHC *Sample Management Administration Manual* (WHC 1990). The data used from the Dorian and Richards (1978) report were analyzed following routine laboratory protocols, but have not been validated, therefore the quality of the data is considered to be medium.

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

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

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

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

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

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

Uncertainty in data used to evaluate the inhalation pathway exposures was also considered "moderate", because the evaluation required extrapolation of airborne dust concentrations from soil concentrations. However, this "moderate" data uncertainty is not expected to significantly impact this QRA, because exposure via the inhalation pathway is not shown to be a major contributor to risk at most waste sites (see Chapter 3.0).

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

Contaminant identification uncertainty is considered to be "low" to "moderate" for waste sites evaluated using only historical data. The primary objectives of historical studies were to investigate radionuclides in exposure media added by Hanford

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

The impact of data uncertainty on the 100-FR-1 Operable Unit human health QRA, is described in Section 1.4 and summarized in Table 2-15. Briefly, uncertainty might result in either an over- or under-estimation of risk; and the magnitude of the error might be "low", "moderate", or "high". Uncertainties in risks estimated for 100-FR-1 Operable Unit QRA waste sites are dominated by the uncertainty of the exposure assessment, which is considered to be "moderate" to "high". This "moderate" to "high" exposure uncertainty reflects over- or under-estimations of risk resulting from the use of maximum COPC concentrations in the exposure assessment. Further sampling, or refinements in existing data, cannot reduce uncertainties associated with the exposure assessment unless effort changes the maximum concentration.

Table 2-16 contains a list of radionuclides known to have been released at the 100-FR-1 Operable Unit, but which were not detected in any of the analytical sampling efforts. The corresponding benchmark concentrations of these analytes are also compared to the detection limits specified in the work plan (DOE-RL 1992). Such undetected concentrations of these radionuclides represent "low" human health risks (i.e., ICR from $1x10^{-6}$ to $1x10^{-4}$). The potential risks of these undetected radionuclides are much lower than the primary contributors to risk at most 100-FR-1 Operable Unit sites (see Chapter 3.0). Therefore, the uncertainties attributed to the detection limits are not expected to have a significant impact on this QRA.

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**Table 2-1 Contaminants of Potential Concern Screening Process for the 108-F French Drain (page 1 of 5)**

| Detected Inorganic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Aluminum | 6110 | 6110 | 15600 | NA | Removed, below background | Removed, below background |
| Antimony | 3.9 | 3.9 | NE | 3.2 | Retained for further analysis | Retained |
| Arsenic | 6.2 | 6.2 | 8.92 | 0.032[b] | Removed, below background | Removed, below background |
| Barium | 64.7 | 64.7 | 171 | 450 | Removed, below background | Removed, below background |
| Beryllium | 0.18 | 0.18 | 1.77 | 0.015[b] | Removed, below background | Removed, below background |
| Calcium | 2160 | 2160 | 23920 | NA | Removed, below background | Removed, below background |
| Chromium | 164 | 164 | 27.9 | 0.39[b,c] | Retained for further analysis | Retained |
| Cobalt | 7.1 | 7.1 | 19.6 | ND | Removed, below background | Removed, below background |
| Copper | 73.8 | 73.8 | 28.2 | 320 | Removed, below screening concentration | Retained |
| Fluoride | 0.60 | 0.60 | 12 | 480 | Removed, below background | Removed, below background |

**Table 2-1 Contaminants of Potential Concern Screening Process for the 108-F French Drain (page 2 of 5)**

| Detected Inorganic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Iron | 20500 | 20500 | 39160 | NA | Removed, below background | Removed, below background |
| Lead | 73.2 | 73.2 | 14.75 | ND | Retained for further analysis | Retained |
| Magnesium | 3740 | 3740 | 8760 | NA | Removed, below background | Removed, below background |
| Manganese | 195 | 195 | 612 | 350 | Removed, below background | Removed, below background |
| Mercury | 0.48 | 0.48 | 1.25 | 2.4 | Removed, below background | Removed, below background |
| Nickel | 21.3 | 21.3 | 25.3 | 160 | Removed, below background | Removed, below background |
| Nitrite/Nitrate | 323 | 323 | 199[d] | 800[e] | Removed, below screening concentration | Retained |
| Potassium | 1160 | 1160 | 3120 | NA | Removed, below background | Removed, below background |
| Selenium | 0.78 | 0.78 | NE | 40 | Removed, below screening concentration | Retained |
| Sodium | 171 | 171 | 1290 | NA | Removed, below background | Removed, below background |

**Table 2-1 Contaminants of Potential Concern Screening Process for the 108-F French Drain (page 3 of 5)**

| Detected Inorganic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg)[a] | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Sulfate | 150 | 150 | 1320 | ND | Removed, below background | Removed, below background |
| Vanadium | 44.2 | 44.2 | 111 | 56 | Removed, below background | Removed, below background |
| Zinc | 129 | 129 | 79 | 2400 | Removed, below screening concentration | Retained |
| **Detected Organic Analyte** | **Maximum Concentration 0'-6' interval (mg/kg)** | **Maximum Concentration 0'-15' interval (mg/kg)** | **Hanford Soil Background Concentration (mg/kg)[a]** | **Human Health Risk-Based Screening Concentration (mg/kg)[a]** | **Analyte Status for Human Health QRA** | **Analyte Status for Ecological QRA** |
| PCB(Aroclors 1254,1260)[f] | 0.390 | 0.390 | NE | 0.0083 | Retained for further analysis | Retained |
| Benzo(a)anthracene | 0.062 | 0.062 | NE | ND | Retained for further analysis | Retained |
| Bis(2-ethylhexyl)phthalate | 4.1 | 4.1 | NE | 4.6[b] | Removed, below screening concentration | Retained |
| Fluoranthene | 0.045 | 0.045 | NE | 320 | Removed, below screening concentration | Retained |

Table 2-1 Contaminants of Potential Concern Screening Process for the 108-F French Drain (page 4 of 5)

| Detected Organic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Pyrene | 0.043 | 0.043 | NE | 240 | Removed, below screening concentration | Retained |
| Toluene | 0.480 | 0.480 | NE | 72 | Removed, below screening concentration | Retained |
| **Detected Radionuclide Analyte** | **Maximum Concentration 0'-6' interval (pCi/g)** | **Maximum Concentration 0'-15' interval (pCi/g)** | **Hanford Soil Background Concentration (pCi/g)** | **Human Health Risk-Based Screening Concentration (pCi/g)[a]** | **Analyte Status for Human Health QRA** | **Analyte Status for Ecological QRA** |
| Gross Alpha | 250 | 250 | NE | ND | Removed, confirmation data only | Removed, confirmation data only |
| Gross Beta | 13 | 13 | NE | ND | Removed, confirmation data only | Removed, confirmation data only |
| Americium-241 | 3.3 | 3.3 | NE | 0.28 | Retained for further analysis | Retained |
| Cesium-137 | 1.6 | 1.6 | NE | 0.0021 | Retained for further analysis | Retained |
| Europium-152 | 0.12 | 0.12 | NE | 0.0012 | Retained for further analysis | Retained |
| Plutonium-238 | 220 | 220 | NE | 0.23 | Retained for further analysis | Retained |

**Table 2-1 Contaminants of Potential Concern Screening Process for the 108-F French Drain (page 5 of 5)**

| Detected Radionuclide Analyte | Maximum Concentration 0'-6' interval (pCi/g) | Maximum Concentration 0'-15' interval (pCi/g) | Hanford Soil Background Concentration (pCi/g) | Human Health Risk-Based Screening Concentration (pCi/g)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Plutonium-239/240 | 34 | 34 | NE | 0.24[g] | Retained for further analysis | Retained |
| Potassium-40 | 13 | 13 | NE | 0.0077 | Retained for further analysis | Retained |
| Radium-226 | 0.42 | 0.42 | NE | 0.00069 | Retained for further analysis | Retained |
| Thorium-228 | 0.81 | 0.81 | NE | 0.00074 | Retained for further analysis | Retained |
| Thorium-232 | 0.75 | 0.75 | NE | 0.32 | Retained for further analysis | Retained |
| Uranium-233/234 | 0.46 | 0.46 | NE | 0.34[h] | Retained for further analysis | Retained |
| Uranium-238 | 0.47[i] | 0.47[i] | NE | 0.12 | Retained for further analysis | Retained |

NE = Background concentrations are not established.
ND = Screening concentration was not determined because toxicity factors were unavailable.
NA = Not applicable, contaminant is considered non-toxic to humans.
QRA = qualitative risk assessment
PCB = polychlorinated biphenyls
[a]Value calculated according to the frequent-use scenario, and represents the most protective screening value.
[b]Most restrictive screening concentration based on contaminant carcinogenic properties.
[c]Toxicity value for hexavalent chromium (Cr+6).
[d]Background is defined for nitrate.
[e]Based on higher toxicity value of nitrite.
[f]Sum of aroclor-1254 and aroclor-1260 concentrations.
[g]Based on higher toxicity values of plutonium-240.
[h]Based on higher toxicity values of uranium-233.
[i]Data reported as "uranium" was considered uranium-238.

Table 2-2 Contaminants of Potential Concern Screening Process for the 116-F-1 Lewis Canal (page 1 of 6)

| Detected Inorganic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Aluminum | 7500 | 7500 | 15600 | NA | Removed, below background | Removed, below background |
| Arsenic | 44 | 44 | 8.92 | 0.032[b] | Retained for further analysis | Retained |
| Barium | 77.9 | 77.9 | 171 | 450 | Removed, below background | Removed, below background |
| Beryllium | 0.29 | 0.29 | 1.77 | 0.015[b] | Removed, below background | Removed, below background |
| Cadmium | 0.65 | 0.65 | NE | 2.6 | Removed, below screening concentration | Retained |
| Calcium | 5150 | 5210 | 23920 | NA | Removed, below background | Removed, below background |
| Chromium | 23.3 | 23.3 | 27.9 | 0.39[c] | Removed, below background | Removed, below background |
| Cobalt | 8.6 | 8.6 | 19.6 | ND | Removed, below background | Removed, below background |
| Copper | 21.5 | 21.5 | 28.2 | 320 | Removed, below background | Removed, below background |
| Iron | 16300 | 16300 | 39160 | NA | Removed, below background | Removed, below background |
| Lead | 207 | 207 | 14.75 | ND | Retained for further analysis | Retained |

Table 2-2 Contaminants of Potential Concern Screening Process for the 116-F-1 Lewis Canal (page 2 of 6)

| Detected Inorganic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Manganese | 278 | 305 | 612 | 350 | Removed, below background | Removed, below background |
| Mercury | 0.69 | 0.69 | 1.25 | 2.4 | Removed, below background | Removed, below background |
| Nickel | 13 | 13 | 25.3 | 160 | Removed, below background | Removed, below background |
| Nitrite/Nitrate | 5.97 | 5.97 | 199[d] | 800[e] | Removed, below background | Removed, below background |
| Potassium | 1860 | 1860 | 3120 | NA | Removed, below background | Removed, below background |
| Silver | 1.3 | 1.3 | 2.7 | 40 | Removed, below background | Removed, below background |
| Sulfate | 71 | 95 | 1320 | ND | Removed, below background | Removed, below background |
| Vanadium | 39 | 40.8 | 111 | 56 | Removed, below background | Removed, below background |
| Zinc | 142 | 142 | 79 | 2400 | Removed, below screening concentration | Retained |

Table 2-2 Contaminants of Potential Concern Screening Process for the 116-F-1 Lewis Canal (page 3 of 6)

| Detected Organic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| 2-Butanone | 0.006 | 0.006 | NE | 500 | Removed, below screening concentration | Retained |
| 2-Hexanone | 0.003 | 0.003 | NE | 500 | Removed, below screening concentration | Retained |
| 4-Methyl-2-pentanone | 0.002 | 0.002 | NE | 47 | Removed, below screening concentration | Retained |
| Acetone | 0.015 | 0.015 | NE | 360 | Removed, below screening concentration | Retained |
| Bis(2-ethylhexyl) phthalate | 0.470 | 0.470 | NE | 4.6[b] | Removed, below screening concentration | Retained |
| Di-n-butylphthalate | 0.120 | 0.150 | NE | 800 | Removed, below screening concentration | Retained |
| Methylene Chloride | 0.012 | 0.012 | NE | 1.9[b] | Removed, below screening concentration | Retained |
| Tetrachloroethene | 0.001 | 0.001 | NE | 1.2 | Removed, below screening concentration | Retained |

Table 2-2 Contaminants of Potential Concern Screening Process for the 116-F-1 Lewis Canal (page 4 of 6)

| Detected Organic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Toluene | 0.057 | 0.057 | NE | 72 | Removed, below screening concentration | Retained |
| Trichloroethene | 0.002 | 0.002 | NE | 0.51[b] | Removed, below screening concentration | Retained |
| **Detected Radionuclide Analyte** | **Maximum Concentration 0'-6' interval (pCi/g)** | **Maximum Concentration 0'-15' interval (pCi/g)** | **Hanford Soil Background Concentration (pCi/g)** | **Human Health Risk-Based Screening Concentration (pCi/g)[a]** | **Analyte Status for Human Health QRA** | **Analyte Status for Ecological QRA** |
| Gross Alpha | 14 | 14 | NE | ND | Removed, confirmation data only | Removed, confirmation data only |
| Gross Beta | 35 | 35 | NE | ND | Removed, confirmation data only | Removed, confirmation data only |
| Carbon-14 | 190 | 220 | NE | 85 | Retained for further analysis | Retained |
| Cesium-134 | 0.0005 (H) | 0.0005 (H) | NE | 0.0008 | Removed, below screening concentration | Retained |
| Cesium-137 | 23(H) | 23(H) | NE | 0.0021 | Retained for further analysis | Retained |
| Cobalt-60 | 28(H) | 28(H) | NE | 0.00048 | Retained for further analysis | Retained |

Table 2-2 Contaminants of Potential Concern Screening Process for the 116-F-1 Lewis Canal (page 5 of 6)

| Detected Radionuclide Analyte | Maximum Concentration 0'-6' interval (pCi/g) | Maximum Concentration 0'-15' interval (pCi/g) | Hanford Soil Background Concentration (pCi/g) | Human Health Risk-Based Screening Concentration (pCi/g)[e] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Europium-152 | 124 (H) | 124 (H) | NE | 0.0012 | Retained for further analysis | Retained |
| Europium-154 | 37 (H) | 37 (H) | NE | 0.001 | Retained for further analysis | Retained |
| Europium-155 | 0.034 (H) | 0.034 (H) | NE | 0.071 | Removed, below screening concentration | Retained |
| Potassium-40 | 14 | 14 | NE | 0.0077 | Retained for further analysis | Retained |
| Plutonium-239/240 | 0.99 (H) | 0.99 (H) | NE | 0.24[f] | Retained for further analysis | Retained |
| Radium-226 | 0.65 | 0.65 | NE | 0.00069 | Retained for further analysis | Retained |
| Strontium-90 | 4.0 (H) | 4.0 (H) | NE | 2.1 | Retained for further analysis | Retained |
| Thorium-228 | 1 | 1.00 | NE | 0.00074 | Retained for further analysis | Retained |
| Thorium-232 | 0.94 | 0.94 | NE | 0.32 | Retained for further analysis | Retained |
| Tritium (H-3) | 8.4 (H) | 8.4 (H) | NE | 1400 | Removed, below screening concentration | Retained |
| Uranium-233/234 | 0.71 | 0.94 | NE | 0.34[g] | Retained for further analysis | Retained |

Table 2-2 Contaminants of Potential Concern Screening Process for the 116-F-1 Lewis Canal (page 6 of 6)

| Detected Radionuclide Analyte | Maximum Concentration 0'-6' interval (pCi/g) | Maximum Concentration 0'-15' interval (pCi/g) | Hanford Soil Background Concentration (pCi/g) | Human Health Risk-Based Screening Concentration (pCi/g)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Uranium-235 | 0.15 | 0.15 | NE | 0.017 | Retained for further analysis | Retained |
| Uranium-238[h] | 0.77 | 0.83 | NE | 0.12 | Retained for further analysis | Retained |

NA = Not applicable. Contaminant considered nontoxic to humans.
NE = Background concentrations are not established.
ND = Screening concentration was not determined because toxicity factors were unavailable.
H = Historical value decay-corrected to 1993.
QRA = qualitative risk assessment
[a]Value calculated according to the frequent-use scenario, and represents the most protective screening value.
[b]Screening concentration based on contaminant carcinogenic properties.
[c]Screening based on toxicity value for hexavalent chromium (Cr+6).
[d]Background is defined for nitrate.
[e]Screening based on toxicity value for nitrite.
[f]Screening based on higher toxicity values of plutonium-240.
[g]Screening based on higher toxicity values of uranium-233.
[h]Data reported as "uranium" was considered uranium-238.

Table 2-3 Contaminants of Potential Concern Screening Process of the 116-F-2 (107-F) Basin Overflow Trench (page 1 of 5)

| Detected Inorganic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Aluminum | 5630 | 5630 | 15600 | NA | Removed, below background | Removed, below background |
| Arsenic | 2.1 | 2.1 | 8.92 | 0.032[b] | Removed, below background | Removed, below background |
| Barium | 51.7 | 79.1 | 171 | 450 | Removed, below background | Removed, below background |
| Beryllium | 0.28 | 0.31 | 1.77 | 0.015[b] | Removed, below background | Removed, below background |
| Cadmium | NDA | 1.6 | NE | 2.6[b] | Removed, below screening concentration | Retained for 0-15 ft. |
| Calcium | 5000 | 5000 | 23920 | NA | Removed, below background | Removed, below background |
| Chromium | 11 | 98.1 | 27.9 | 0.39 [b,c] | Retained for further analysis | Retained |
| Cobalt | 7 | 9.3 | 19.6 | ND | Removed, below background | Removed, below background |
| Copper | 15 | 22 | 28.2 | 320 | Removed, below background | Removed, below background |
| Fluoride | 0.5 | 0.6 | 12 | 480 | Removed, below background | Removed, below background |
| Iron | 14700 | 17000 | 39160 | NA | Removed, below background | Removed, below background |

Table 2-3 Contaminants of Potential Concern Screening Process of the 116-F-2 (107-F) Basin Overflow Trench (page 2 of 5)

| Detected Inorganic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Lead | 3.80 | 12.9 | 14.75 | ND | Removed, below background | Removed, below background |
| Magnesium | 3830 | 3830 | 8760 | NA | Removed, below background | Removed, below background |
| Manganese | 253 | 253 | 612 | 350 | Removed, below background | Removed, below background |
| Mercury | NDA | 0.96 | 1.25 | 2.4 | Removed, below background | Removed, below background |
| Nickel | 9.6 | 11.1 | 25.3 | 160 | Removed, below background | Removed, below background |
| Nitrite/Nitrate | NDA | 6.16 | 199[d] | 800[e] | Removed, below background | Removed, below background |
| Potassium | 970 | 970 | 3120 | NA | Removed, below background | Removed, below background |
| Sodium | 157 | 248 | 1290 | NA | Removed, below background | Removed, below background |
| Sulfate | 9.0 | 17 | 1320 | ND | Removed, below background | Removed, below background |
| Vanadium | 34 | 40.4 | 111 | 56 | Removed, below background | Removed, below background |
| Zinc | 34.10 | 295 | 79 | 2400 | Removed, below screening concentration | Retained for 0-15 ft. |

Table 2-3 Contaminants of Potential Concern Screening Process of the 116-F-2 (107-F) Basin Overflow Trench (page 3 of 5)

| Detected Organic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Benzo(b)fluoranthene | NDA | 0.083 | NE | ND | Retained for further analysis | Retained for 0-15 ft. |
| Chrysene | NDA | 0.048 | NE | ND | Retained for further analysis | Retained for 0-15 ft. |
| **Detected Radionuclide Analyte** | **Maximum Concentration 0'-6' interval (pCi/g)** | **Maximum Concentration 0'-15' interval (pCi/g)** | **Hanford Soil Background Concentration (pCi/g)** | **Human Health Risk-Based Screening Concentration (pCi/g)[a]** | **Analyte Status for Human Health QRA** | **Analyte Status for Ecological QRA** |
| Gross Alpha | NDA | 11 | NE | ND | Removed, confirmation data only | Removed, confirmation data only |
| Gross Beta | 16 | 350 | NE | ND | Removed, confirmation data only | Removed, confirmation data only |
| Americium-241 | NDA | 0.57 | NE | 0.28 | Retained for further analysis | Retained for 0-15 ft. |
| Carbon-14 | 62 | 240 | NE | 85 | Retained for further analysis | Retained |
| Cesium-137 | 0.21 | 35 | NE | 0.0021 | Retained for further analysis | Retained |
| Cobalt-60 | 0.041 | 12 | NE | 0.00048 | Retained for further analysis | Retained |
| Europium-152 | 5.3 | 550 | NE | 0.0012 | Retained for further analysis | Retained |

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Table 2-3 Contaminants of Potential Concern Screening Process of the 116-F-2 (107-F) Basin Overflow Trench (page 4 of 5)

| Detected Radionuclide Analyte | Maximum Concentration 0'-6' interval (pCi/g) | Maximum Concentration 0'-15' interval (pCi/g) | Hanford Soil Background Concentration (pCi/g) | Human Health Risk-Based Screening Concentration (pCi/g)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Europium-154 | 0.27 | 360 | NE | 0.001 | Retained for further analysis | Retained |
| Europium-155 | NDA | 3.8 (H) | NE | 0.071 | Retained for further analysis | Retained for 0-15 ft. |
| Plutonium-238 | NDA | 0.068 | NE | 0.23 | Removed, below screening concentration | Retained for 0-15 ft. |
| Plutonium-239/240 | NDA | 3.7 | NE | 0.24[f] | Retained for further analysis | Retained for 0-15 ft. |
| Potassium-40 | 13 | 21 | NE | 0.0077 | Retained for further analysis | Not retained.[g] |
| Radium-226 | 0.52 | 0.52 | NE | 0.00069 | Retained for further analysis | Retained |
| Iridium-192 | NDA | 0.58 | NE | 0.0017 | Retained for further analysis | Not retained. (Short half-life)h[g] |
| Strontium-90 | NDA | 7.6 | NE | 2.1 | Retained for further analysis | Retained for 0-15 ft. |
| Thorium-228 | 0.99 | 0.99 | NE | 0.00074 | Retained for further analysis | Retained |
| Thorium-232 | 0.56 | 0.56 | NE | 0.32 | Retained for further analysis | Retained |
| Tritium (H-3) | NDA | 5.9 (H) | NE | 1400 | Removed, below screening | Retained for 0-15 ft. |

Table 2-3 Contaminants of Potential Concern Screening Process of the 116-F-2 (107-F) Basin Overflow Trench (page 5 of 5)

| Detected Radionuclide Analyte | Maximum Concentration 0'-6' interval (pCi/g) | Maximum Concentration 0'-15' interval (pCi/g) | Hanford Soil Background Concentration (pCi/g) | Human Health Risk-Based Screening Concentration (pCi/g)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Uranium-233/234 | 0.35 | 0.47 | NE | 0.34[i] | Retained for further analysis | Retained |
| Uranium-235 | NDA | 0.13 | NE | 0.017 | Retained for further analysis | Retained for 0-15 ft. |
| Uranium-238[j] | 0.43 | 0.59 | NE | 0.12 | Retained for further analysis | Retained |

NDA = No data available or analyte not detected.
NA = Not applicable, contaminant considered nontoxic to humans.
ND = Screening concentration was not determined because toxicity factors were unavailable.
NE = Background concentrations are not established.
H = Historical data: maximum concentration decay-corrected to 1993.
QRA = qualitative risk assessment
[a]Value calculated according to the frequent-use scenario, and represents the most protective screening value.
[b]Lower screening concentration based on contaminant carcinogenic properties.
[c]Toxicity value for hexavalent chromium (Cr +6).
[d]Background defined for nitrate.
[e]Based on toxicity value for nitrite.
[f]Based on higher toxicity values of plutonium-240.
[g]Potassium-40 is a naturally occurring radionuclide.
[h]Iridium-192 has a half life of less than one year. This is historical data (1978).
[i]Based on higher toxicity values of uranium-233.
[j]Data reported as "uranium" was considered uranium-238.

Table 2-4 Contaminants of Potential Concern Screening Process for the 116-F-3 (105-F) Fuel Storage Basin Trench (page 1 of 5)

| Detected Inorganic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Aluminum | 7740 | 7740 | 15600 | NA | Removed, below background | Removed, below background |
| Arsenic | 1 | 3.1 | 8.92 | 0.032 [b] | Removed, below background | Removed, below background |
| Barium | 378 | 378 | 171 | 450 | Removed, below screening concentration | Retained |
| Beryllium | 0.46 | 0.46 | 1.77 | 0.015[b] | Removed, below background | Removed, below background |
| Calcium | 11500 | 11500 | 23920 | NA | Removed, below background | Removed, below background |
| Chromium | 5.5 | 74.4 | 27.9 | 0.39[b,c] | Retained for further analysis | Retained for 0-15 ft. |
| Cobalt | 7.8 | 8.5 | 19.6 | ND | Removed, below background | Removed, below background |
| Copper | 22.2 | 23.8 | 28.2 | 320 | Removed, below background | Removed, below background |
| Fluoride | 0.5 | 0.7 | 12 | 480 | Removed, below background | Removed, below background |
| Iron | 12200 | 19500 | 39160 | NA | Removed, below background | Removed, below background |
| Lead | 18.2 | 49.9 | 14.75 | ND | Retained for further analysis | Retained |

Table 2-4 Contaminants of Potential Concern Screening Process for the 116-F-3 (105-F) Fuel Storage Basin Trench (page 2 of 5)

| Detected Inorganic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Magnesium | 4590 | 4590 | 8760 | NA | Removed, below background | Removed, below background |
| Manganese | 187 | 297 | 612 | 350 | Removed, below background | Removed, below background |
| Mercury | 0.12 | 1.5 | 1.25 | 2.4 | Removed, below screening concentration | Retained for 0-15 ft. |
| Nickel | 9.8 | 11.3 | 25.3 | 160 | Removed, below background | Removed, below background |
| Nitrite/Nitrate | 11.2 | 11.5 | 199[d] | 800[e] | Removed, below background | Removed, below background |
| Potassium | 979 | 1290 | 3120 | NA | Removed, below background | Removed, below background |
| Silver | NDA | 1.3 | 2.7 | 40 | Removed, below background | Removed, below background |
| Sodium | 648 | 648 | 1290 | NA | Removed, below background | Removed, below background |
| Sulfate | 11 | 26 | 1320 | ND | Removed, below background | Removed, below background |
| Vanadium | 30.2 | 36.3 | 111 | 56 | Removed, below background | Removed, below background |
| Zinc | 53.3 | 175 | 79 | 2400 | Removed, below screening concentration | Retained for 0-15 ft. |

Table 2-4 Contaminants of Potential Concern Screening Process for the 116-F-3 (105-F) Fuel Storage Basin Trench (page 3 of 5)

| Detected Organic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| 4-methyl-2-pentanone | NDA | 0.011 | NE | 47 | Removed, below screening concentration | Retained for 0-15 ft. |
| Acetone | NDA | 0.010 | NE | 360 | Removed, below screening concentration | Retained for 0-15 ft. |
| PCB(Aroclors-1254,1260) | NDA | 0.180[f] | NE | 0.0083 | Retained for further analysis | Retained for 0-15 ft. |
| Benzo(a)anthracene | 0.240 | 0.240 | NE | ND | Retained for further analysis | Retained |
| Benzo(b)fluoranthene | 0.220 | 0.220 | NE | ND | Retained for further analysis | Retained |
| Bis(2-ethylhexyl)phthalate | NDA | 0.043 | NE | 4.6[b] | Removed, below screening concentration | Retained for 0-15 ft. |
| Chrysene | 0.280 | 0.280 | NE | ND | Retained for further analysis | Retained |
| Di-n-butylphthalate | NDA | 0.077 | NE | 800 | Removed, below screening concentration | Retained for 0-15 ft. |
| Fluoranthene | 0.440 | 0.440 | NE | 320 | Removed, below screening concentration | Retained |
| Phenanthrene | 0.270 | 0.270 | NE | 240 | Removed, below screening concentration | Retained |

**Table 2-4 Contaminants of Potential Concern Screening Process for the 116-F-3 (105-F) Fuel Storage Basin Trench (page 4 of 5)**

| Detected Organic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Retained Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Pyrene | 0.440 | 0.440 | NE | 240 | Removed, below screening concentration | Retained |
| Toxaphene | NDA | 0.190 | NE | 0.058 | Retained for further analysis | Retained for 0-15 ft. |
| Toluene | 0.021 | 0.021 | NE | 72 | Removed, below screening concentration | Retained |
| **Detected Radionuclide Analyte** | **Maximum Concentration 0'-6' interval (pCi/g)** | **Maximum Concentration 0'-15' interval (pCi/g)** | **Hanford Soil Background Concentration (pCi/g)** | **Human Health Risk-Based Screening Concentration (pCi/g)[a]** | **Analyte Status for Human Health QRA** | **Analyte Status for Ecological QRA** |
| Gross Alpha | 6.7 | 7.9 | NE | ND | Removed, confirmation data only | Removed, confirmation data only |
| Gross Beta | 11 | 71 | NE | ND | Removed, confirmation data only | Removed, confirmation data only |
| Americium-241 | NDA | 0.033 | NE | 0.28 | Removed, below screening concentration | Retained for 0-15 ft. |
| Cesium-137 | 0.52 | 2.6 | NE | 0.0021 | Retained for further analysis | Retained |
| Cobalt-60 | 0.058 | 1.9 | NE | 0.00048 | Retained for further analysis | Retained |
| Europium-152 | 11 | 190 | NE | 0.0012 | Retained for further analysis | Retained |

Table 2-4 Contaminants of Potential Concern Screening Process for the 116-F-3 (105-F) Fuel Storage Basin Trench (page 5 of 5)

| Detected Radionuclide Analyte | Maximum Concentration 0'-6' interval (pCi/g) | Maximum Concentration 0'-15' interval (pCi/g) | Hanford Soil Background Concentration (pCi/g) | Human Health Risk-Based Screening Concentration (pCi/g)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Europium-154 | 0.075 | 9.8 | NE | 0.001 | Retained for further analysis | Retained |
| Plutonium-239/240 | NDA | 0.95 | NE | 0.24[g] | Retained for further analysis | Retained for 0-15 ft. |
| Potassium-40 | 7.9 | 23 | NE | 0.0077 | Retained for further analysis | Not retained[h] |
| Radium-226 | 0.50 | 0.55 | NE | 0.00069 | Retained for further analysis | Retained |
| Thorium-228 | 0.65 | 0.92 | NE | 0.00074 | Retained for further analysis | Retained |
| Thorium-232 | 0.69 | 0.69 | NE | 0.32 | Retained for further analysis | Retained |
| Uranium-233/234 | 0.51 | 0.68 | NE | 0.34[i] | Retained for further analysis | Retained |
| Uranium-235 | NDA | 0.55 | NE | 0.017 | Retained for further analysis | Retained |
| Uranium-238[j] | 0.36 | 0.58 | NE | 0.12 | Retained for further analysis | Retained |

NDA = No data available or analyte not detected.
NA = Not applicable; contaminant considered nontoxic to humans.
ND = Screening concentration was not determined because toxicity factors were unavailable.
NE = Background concentrations are not established.
QRA = qualitative risk assessment
PCB = polychlorinated biphenyl
[a]Value calculated according to the frequent-use scenario, and represents the most protective screening value.
[b]Screening concentration based on contaminant carcinogenic properties.
[c]Screening concentration based on toxicity value for hexavalent chromium (Cr+6).
[d]Background is defined for nitrate.
[e]Screening concentration based on toxicity value for nitrite.
[f]Maximum concentration is for total Aroclor.
[g]Screening concentration based on toxicity values for plutonium-240.
[h]Potassium-40 is a naturally occurring radionuclide.
[i]Screening concentration based on higher toxicity values of uranium-233.
[j]Data reported as "uranium" was considered uranium-238.

**Table 2-5 Contaminants of Potential Concern Screening Process for the 116-F-4 (105-F) Pluto Crib (page 1 of 5)**

| Detected Inorganic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Aluminum | 7390 | 7390 | 15600 | NA | Removed, below background | Removed, below background |
| Arsenic | 2.3 | 2.3 | 8.92 | 0.032[b] | Removed, below background | Removed, below background |
| Barium | 208 | 208 | 171 | 450 | Removed, below screening concentration | Retained |
| Beryllium | 0.32 | 0.32 | 1.77 | 0.015[b] | Removed, below background | Removed, below background |
| Calcium | 9260 | 9260 | 23920 | NA | Removed, below background | Removed, below background |
| Chromium | 10.5 | 10.5 | 27.9 | 0.39[b,c] | Removed, below background | Removed, below background |
| Cobalt | 8.5 | 8.6 | 19.6 | ND | Removed, below background | Removed, below background |
| Copper | 18.3 | 18.3 | 28.2 | 320 | Removed, below background | Removed, below background |
| Fluoride | 0.5 | 0.8 | 12 | 480 | Removed, below background | Removed, below background |
| Iron | 16400 | 16,400 | 39,160 | NA | Removed, below background | Removed, below background |
| Lead | 10.2 | 10.2 | 14.75 | ND | Removed, below background | Removed, below background |

Table 2-5 Contaminants of Potential Concern Screening Process for the 116-F-4 (105-F) Pluto Crib (page 2 of 5)

| Detected Inorganic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Magnesium | 4740 | 4740 | 8760 | NA | Removed, below background | Removed, below background |
| Manganese | 255 | 255 | 612 | 350 | Removed, below background | Removed, below background |
| Mercury | 0.06 | 0.06 | 1.25 | 2.4 | Removed, below background | Removed, below background |
| Nickel | 11.1 | 11.1 | 25.3 | 160 | Removed, below background | Removed, below background |
| Nitrite/Nitrate | 32.3 | 32.3 | 199[d] | 800[e] | Removed, below background | Removed, below background |
| Potassium | 1060 | 1060 | 3120 | NA | Removed, below background | Removed, below background |
| Silver | 0.94 | 0.94 | 2.7 | 40 | Removed, below background | Removed, below background |
| Sodium | 430 | 430 | 1290 | NA | Removed, below background | Removed, below background |
| Sulfate | 66 | 66 | 1320 | ND | Removed, below background | Removed, below background |
| Vanadium | 40.3 | 40.3 | 111 | 56 | Removed, below background | Removed, below background |
| Zinc | 39.3 | 39.3 | 79 | 2400 | Removed, below background | Removed, below background |

Table 2-5 Contaminants of Potential Concern Screening Process for the 116-F-4 (105-F) Pluto Crib (page 3 of 5)

| Detected Organic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| 2-Butanone | 0.022 | 0.022 | NE | 500 | Removed, below screening concentration | Retained |
| Acetone | 0.014 | 0.014 | NE | 360 | Removed, below screening concentration | Retained |
| Bis(2-ethylhexyl) phthalate | 0.800 | 0.800 | NE | 4.6[b] | Removed, below screening concentration | Retained |
| Di-n-butylphthalate | NDA | 0.130 | NE | 800 | Removed, below screening concentration | Retained for 0-15 ft. |
| Di-n-octylphthalate | NDA | 0.170 | NE | 160 | Removed, below screening concentration | Retained for 0-15 ft. |
| Methylene chloride | 0.005 | 0.005 | NE | 1.9 | Removed, below screening concentration | Retained |
| Toluene | 0.008 | 0.013 | NE | 72 | Removed, below screening concentration | Retained |

Table 2-5 Contaminants of Potential Concern Screening Process for the 116-F-4 (105-F) Pluto Crib (page 4 of 5)

| Detected Radionuclide Analyte | Maximum Concentration 0'-6' interval (pCi/g) | Maximum Concentration 0'-15' interval (pCi/g) | Hanford Soil Background Concentration (pCi/g) | Human Health Risk-Based Screening Concentration (pCi/g)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Gross Alpha | 14 | 96 | NE | ND | Removed, confirmation data only | Removed, confirmation data only |
| Gross Beta | 440 | 4900 | NE | ND | Removed, confirmation data only | Removed, confirmation data only |
| Americium-241 | 1.4 | 12 | NE | 0.28 | Retained for further analysis | Retained for 0-15 ft. |
| Cesium-134 | NDA | 0.3 | NE | 0.0008 | Retained for further analysis | Retained |
| Cesium-137 | 340 | 3819 (H) | NE | 0.0021 | Retained for further analysis | Retained |
| Cobalt-60 | 0.14 | 0.34 | NE | 0.00048 | Retained for further analysis | Retained |
| Europium-152 | 3.1 | 16 | NE | 0.0012 | Retained for further analysis | Retained |
| Europium-154 | 0.30 | 40 (H) | NE | 0.001 | Retained for further analysis | Retained |
| Europium-155 | 0.01 (H) | 44 (H) | NE | 0.071 | Retained for further analysis | Retained |
| Plutonium-238 | 0.15 | 1.3 (H) | NE | 0.23 | Retained for further analysis | Retained |
| Plutonium-239/240 | 12 | 130 | NE | 0.24[f] | Retained for further analysis | Retained |

**Table 2-5 Contaminants of Potential Concern Screening Process for the 116-F-4 (105-F) Pluto Crib (page 5 of 5)**

| Detected Radionuclide Analyte | Maximum Concentration 0'-6' interval (pCi/g) | Maximum Concentration 0'-15' interval (pCi/g) | Hanford Soil Background Concentration (pCi/g) | Human Health Risk-Based Screening Concentration (pCi/g)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Potassium-40 | 10 | 12 | NE | 0.0077 | Retained for further analysis | Not retained[g] |
| Radium-226 | 0.51 | 0.66 | NE | 0.00069 | Retained for further analysis | Retained |
| Strontium-90 | 160 | 2096 (H) | NE | 2.1 | Retained for further analysis | Retained |
| Thorium-228 | 0.49 | 0.49 | NE | 0.00074 | Retained for further analysis | Retained |
| Thorium-232 | 0.58 | 1.4 | NE | 0.32 | Retained for further analysis | Retained |
| Tritium (H-3) | NDA | 5.9 (H) | NE | 1400 | Removed, below screening concentration | Retained for 0-15 ft. |
| Uranium-233/234 | 0.77 | 0.86 | NE | 0.34[h] | Retained for further analysis | Retained |
| Uranium-238[i] | 0.49 | 1.3 | NE | 0.12 | Retained for further analysis | Retained |

H = Historical data; maximum concentration decay-corrected to 1993.
NDA = No data available or analyte not detected.
NA = Not applicable, contaminant previously screened.
ND = Screening concentration was not determined because toxicity factors were unavailable.
NE = Background concentrations are not established.
QRA = qualitative risk assessment
[a]Value calculated according to the frequent-use scenario, and represents the most protective screening value.
[b]Lower screening concentration based on contaminant carcinogenic properties.
[c]Toxicity value for hexavalent chromium (Cr +6).
[d]Background is defined for nitrate.
[e]Based on higher toxicity value of nitrite.
[f]Based on higher toxicity values of plutonium-240.
[g]Potassium-40 is a naturally occurring radionuclide.
[h]Based on higher toxicity values of uranium-233.
[i]Data reported as "uranium" was considered uranium-238.

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Table 2-6 Contaminants of Potential Concern Screening Process for the 116-F-5 Ball Washer Crib

| Detected Radionuclide Analyte | Maximum Concentration[a] 0'-6' interval (pCi/g) | Maximum Concentration[a] 0'-15' interval (pCi/g) | Hanford Soil Background Concentration (pCi/g) | Human Health Risk-Based Screening Concentration (pCi/g)[b] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Cesium-137 | NDA | 0.028 | NE | 0.0021 | Retained for further analysis | Retained |
| Europium-154 | NDA | 0.17 | NE | 0.001 | Retained for further analysis | Retained |
| Europium-155 | NDA | 0.02 | NE | 0.071 | Removed, below screening concentration | Retained |
| Strontium-90 | NDA | 0.02 | NE | 2.1 | Removed, below screening concentration | Retained |

NDA = No data available or analyte non-detected.
NE = Background concentrations are not established.
QRA = qualitative risk assessment
[a]Historical data; maximum concentrations decay-corrected to 1993.
[b]Value calculated according to the frequent-use scenario, and represents the most protective screening value.

**Table 2-7 Contaminants of Potential Concern Screening Process for the 116-F-6 (1608-F) Liquid Waste Disposal Trench (page 1 of 4)**

| Detected Inorganic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Aluminum | 6820 | 6820 | 15600 | NA | Removed, below background | Removed, below background |
| Arsenic | 1.4 | 1.5 | 8.92 | 0.032[b] | Removed, below background | Removed, below background |
| Barium | 66.3 | 66.3 | 171 | 450 | Removed, below background | Removed, below background |
| Beryllium | 0.32 | 0.32 | 1.77 | 0.015[b] | Removed, below background | Removed, below background |
| Calcium | 3950 | 3950 | 23920 | NA | Removed, below background | Removed, below background |
| Chromium | 9.4 | 30.2 | 27.9 | 0.39[b,c] | Retained for further analysis | Retained for 0-15 ft. |
| Cobalt | 10.3 | 10.3 | 19.6 | ND | Removed, below background | Removed, below background |
| Copper | 13.4 | 26.6 | 28.2 | 320 | Removed, below background | Removed, below background |
| Fluoride | 0.5 | 0.6 | 12 | 480 | Removed, below background | Removed, below background |
| Iron | 20800 | 20800 | 39160 | NA | Removed, below background | Removed, below background |
| Lead | 3.5 | 7 | 14.75 | ND | Removed, below background | Removed, below background |
| Magnesium | 4350 | 4350 | 8760 | NA | Removed, below background | Removed, below background |
| Manganese | 315 | 315 | 612 | 350 | Removed, below background | Removed, below background |

**Table 2-7 Contaminants of Potential Concern Screening Process for the 116-F-6 (1608-F) Liquid Waste Disposal Trench (page 2 of 4)**

| Detected Inorganic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Mercury | 0.23 | 0.23 | 1.25 | 2.4 | Removed, below background | Removed, below background |
| Nickel | 10.4 | 12.1 | 25.3 | 160 | Removed, below background | Removed, below background |
| Nitrite/Nitrate | NDA | 2.76 | 199[d] | 800[c] | Removed, below background | Removed, below background |
| Potassium | 1400 | 1400 | 3120 | NA | Removed, below background | Removed, below background |
| Sodium | 162 | 192 | 1290 | NA | Removed, below background | Removed, below background |
| Sulfate | 10 | 10 | 1320 | ND | Removed, below background | Removed, below background |
| Vanadium | 55.5 | 55.5 | 111 | 56 | Removed, below background | Removed, below background |
| Zinc | 41.2 | 106 | 79 | 2400 | Removed, below screening concentration | Retained for 0-15 ft. |
| **Detected Organic Analyte** | **Maximum Concentration 0'-6' interval (mg/kg)** | **Maximum Concentration 0'-15' interval (mg/kg)** | **Hanford Soil Background Concentration (mg/kg)** | **Human Health Risk-Based Screening Concentration (mg/kg)[a]** | **Analyte Status for Human Health QRA** | **Analyte Status for Ecological QRA** |
| Acetone | 0.014 | 0.014 | NE | 360 | Removed, below screening concentration | Retained |
| Benzene | NDA | 0.003 | NE | 0.074[b] | Removed, below screening concentration | Retained for 0-15 ft. |
| Di-n-butylphthalate | 0.110 | 0.14 | NE | 800 | Removed, below screening concentration | Retained |

**Table 2-7 Contaminants of Potential Concern Screening Process for the 116-F-6 (1608-F) Liquid Waste Disposal Trench (page 3 of 4)**

| Detected Organic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Methylene chloride | 0.002 | 0.002 | NE | 1.9[b] | Removed, below screening concentration | Retained |
| Toluene | 0.006 | 0.012 | NE | 72 | Removed, below screening concentration | Retained |
| **Detected Radionuclide Analyte** | **Maximum Concentration 0'-6' interval (pCi/g)** | **Maximum Concentration 0'-15' interval (pCi/g)** | **Hanford Soil Background Concentration (pCi/g)** | **Human Health Risk-Based Screening Concentration (pCi/g)[a]** | **Analyte Status for Human Health QRA** | **Analyte Status for Ecological QRA** |
| Gross Beta | 14 | 350 | NE | ND | Removed, confirmation data only | Removed, confirmation data only |
| Americium-241 | NDA | 0.72 | NE | 0.28 | Retained for further analysis | Retained |
| Cesium-134 | 0.0004 (H) | .0027 (H) | NE | 0.0008 | Retained for further analysis | Retained |
| Cesium-137 | 7.8 (H) | 230 | NE | 0.0021 | Retained for further analysis | Retained |
| Cobalt-60 | 0.46 (H) | 33 | NE | 0.00048 | Retained for further analysis | Retained |
| Europium-152 | 3.6 (H) | 190 | NE | 0.0012 | Retained for further analysis | Retained |
| Europium-154 | 0.37 (H) | 18 | NE | 0.001 | Retained for further analysis | Retained |
| Europium-155 | 0.01 (H) | 0.48 (H) | NE | 0.071 | Retained for further analysis | Retained |
| Plutonium-238 | NDA | 0.069 | NE | 0.23 | Removed, below screening concentration | Retained |
| Plutonium-239/240 | NDA | 2.5 | NE | 0.24[f] | Retained for further analysis | Retained |

Table 2-7 Contaminants of Potential Concern Screening Process for the 116-F-6 (1608-F) Liquid Waste Disposal Trench (page 4 of 4)

| Detected Radionuclide Analyte | Maximum Concentration 0'-6' interval (pCi/g) | Maximum Concentration 0'-15' interval (pCi/g) | Hanford Soil Background Concentration (pCi/g) | Human Health Risk-Based Screening Concentration (pCi/g)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Potassium-40 | 8.1 | 19 | NE | 0.0077 | Retained for further analysis | Not retained[g] |
| Radium-226 | 0.41 | 1 | NE | 0.00069 | Retained for further analysis | Retained |
| Strontium-90 | 1.6 (H) | 6.8 (H) | NE | 2.1 | Retained for further analysis | Retained |
| Thorium-228 | 0.39 | 0.63 | NE | 0.00074 | Retained for further analysis | Retained |
| Thorium-232 | 0.44 | 0.58 | NE | 0.32 | Retained for further analysis | Retained |
| Tritium | NDA | 29 (H) | NE | 1400 | Removed, below screening concentration | Retained |
| Uranium-233/234 | 0.43 | 0.83 | NE | 0.34[h] | Retained for further analysis | Retained |
| Uranium-238[i] | 0.51 | 0.69 | NE | 0.12 | Retained for further analysis | Retained |

H = Historical data; maximum concentration decay-corrected to 1993.
NA = Not applicable; contaminant is considered non-toxic to humans.
NE = Background concentrations are not established.
ND = Screening concentration was not determined because toxicity factors were unavailable.
NDA = No data available or analyte not detected.
QRA = qualitative risk assessment
[a]Value calculated according to the frequent-use scenario, and represents the most protective screening value.
[b]Most restrictive screening concentration based on contaminant carcinogenic properties.
[c]Screening concentration based on toxicity value for hexavalent chromium (Cr +6).
[d]Background is defined for nitrate.
[e]Screening concentration based on toxicity value for nitrite.
[f]Screening concentration based on higher toxicity values of plutonium-240.
[g]Potassium-40 is a naturally occurring radionuclide.
[h]Based on higher toxicity values of uranium-233.
[i]Data reported as "uranium" was considered uranium-238.

Table 2-8 Contaminants of Potential Concern Screening Process for the 116-F-9 Animal Waste Leach Trench (page 1 of 4)

| Detected Inorganic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Aluminum | 5550 | 7760 | 15600 | NA | Removed, below background | Removed, below background |
| Arsenic | 2 | 2.9 | 8.92 | 0.032[b] | Removed, below background | Removed, below background |
| Barium | 48.1 | 78.3 | 171 | 450 | Removed, below background | Removed, below background |
| Beryllium | 0.3 | 0.31 | 1.77 | 0.015[b] | Removed, below background | Removed, below background |
| Calcium | 3170 | 7190 | 23920 | NA | Removed, below background | Removed, below background |
| Chromium | 10.1 | 25.1 | 27.9 | 0.39[b,c] | Removed, below background | Removed, below background |
| Cobalt | 6.7 | 10.1 | 19.6 | ND | Removed, below background | Removed, below background |
| Copper | 15.4 | 32.5 | 28.2 | 320 | Removed, below screening concentration | Retained for 0-15 ft. |
| Fluoride | 1.0 | 1.2 | 12 | 480 | Removed, below background | Removed, below background |
| Iron | 13700 | 16100 | 39160 | NA | Removed, below background | Removed, below background |
| Lead | 3.4 | 14.6 | 14.75 | ND | Removed, below background | Removed, below background |
| Magnesium | 3920 | 4740 | 8760 | NA | Removed, below background | Removed, below background |
| Manganese | 233 | 265 | 612 | 350 | Removed, below background | Removed, below background |

**Table 2-8 Contaminants of Potential Concern Screening Process for the 116-F-9 Animal Waste Leach Trench (page 2 of 4)**

| Detected Inorganic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Mercury | 0.08 | 0.19 | 1.25 | 2.4 | Removed, below background | Removed, below background |
| Nickel | 10.7 | 11.1 | 25.3 | 160 | Removed, below background | Removed, below background |
| Nitrite/Nitrate | 2.86 | 17 | 199[d] | 800[e] | Removed, below background | Removed, below background |
| Potassium | 882 | 1400 | 3120 | NA | Removed, below background | Removed, below background |
| Silver | 1.2 | 7.9 | 2.7 | 40 | Removed, below screening concentration | Retained for 0-15 ft. |
| Sodium | 146 | 257 | 1290 | NA | Removed, below background | Removed, below background |
| Sulfate | 4.0 | 875 | 1320 | ND | Removed, below background | Removed, below background |
| Vanadium | 32.1 | 42.4 | 111 | 56 | Removed, below background | Removed, below background |
| Zinc | 32 | 246 | 79 | 2400 | Removed, below screening concentration | Retained for 0-15 ft. |
| **Detected Organic Analyte** | **Maximum Concentration 0'-6' interval (mg kg)** | **Maximum Concentration 0'-15' interval (mg kg)** | **Hanford Soil Background Concentration (mg/kg)** | **Human Health Risk-Based Screening Concentration (mg/kg)[a]** | **Analyte Status for Human Health QRA** | **Analyte Status for Ecological QRA** |
| 4-Methyl-2-pentanone | NDA | 0.013 | NE | 47 | Removed, below screening concentration | Retained for 0-15 ft. |
| Acetone | 0.006 | 0.066 | NE | 360 | Removed, below screening concentration | Retained |

Table 2-8 Contaminants of Potential Concern Screening Process for the 116-F-9 Animal Waste Leach Trench (page 3 of 4)

| Detected Organic Analyte | Maximum Concentration 0'-6' interval (mg kg) | Maximum Concentration 0'-15' interval (mg kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Bis(2-ethylhexyl) phthalate | 0.340 | 0.340 | NE | 4.6[b] | Removed, below screening concentration | Retained |
| Chlordane (alpha and gamma) | NDA | 0.53[f] | NE | 0.049[b] | Retained for further analysis | Retained for 0-15 ft. |
| Di-n-butylphthalate | 0.076 | 0.076 | NE | 800 | Removed, below screening concentration | Retained |
| Methylene chloride | NDA | 0.004 | NE | 1.9[b] | Removed, below screening concentration | Retained for 0-15 ft. |
| Toluene | 0.010 | 0.087 | NE | 72 | Removed, below screening concentration | Retained |
| **Detected Radionuclide Analyte** | **Maximum Concentration 0'-6' interval (pCi g)** | **Maximum Concentration 0'-15' interval (pCi g)** | **Hanford Soil Background Concentration (pCi/g)** | **Human Health Risk-Based Screening Concentration (pCi/g)[a]** | **Analyte Status for Human Health QRA** | **Analyte Status for Ecological QRA** |
| Gross Alpha | 8.6 | 8.6 | NE | ND | Removed, confirmation data only | Removed, confirmation data only |
| Gross Beta | 19 | 100 | NE | ND | Removed, confirmation data only | Removed, confirmation data only |
| Carbon-14 | 140 | 140 | NE | 85 | Retained for further analysis | Retained |
| Cesium-137 | NDA | 0.96 | NE | 0.0021 | Retained for further analysis | Retained for 0-15 ft. |
| Cobalt-60 | NDA | 0.074 | NE | 0.00048 | Retained for further analysis | Retained for 0-15 ft. |
| Europium-152 | NDA | 0.69 | NE | 0.0012 | Retained for further analysis | Retained for 0-15 ft. |

Table 2-8 Contaminants of Potential Concern Screening Process for the 116-F-9 Animal Waste Leach Trench (page 4 of 4)

| Detected Radionuclide Analyte | Maximum Concentration 0'-6' interval (pCi g) | Maximum Concentration 0'-15' interval (pCi g) | Hanford Soil Background Concentration (pCi/g) | Human Health Risk-Based Screening Concentration (pCi/g)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Plutonium-239/240 | NDA | 0.22 (H) | NE | 0.24[g] | Removed, below screening concentration | Retained for 0-15 ft. |
| Potassium-40 | 15 | 15 | NE | 0.0077 | Retained for further analysis | Not retained[h] |
| Radium-226 | 0.63 | 0.64 | NE | 0.00069 | Retained for further analysis | Retained |
| Strontium-90 | NDA | 95 (H) | NE | 2.1 | Retained for further analysis | Retained for 0-15 ft. |
| Thorium-228 | 1.1 | 1.1 | NE | 0.00074 | Retained for further analysis | Retained |
| Thorium-232 | 0.88 | 0.88 | NE | 0.32 | Retained for further analysis | Retained |
| Uranium-233/234 | 0.58 | 0.72 | NE | 0.34[i] | Retained for further analysis | Retained |
| Uranium-238[j] | 0.53 | 0.64 | NE | 0.12 | Retained for further analysis | Retained |

H = Historical Data; maximum concentration decay-corrected to 1993.
NA = Not applicable, contaminant considered nontoxic to humans.
ND = Screening concentration was not determined because toxicity factors were unavailable.
NDA = No data available or analyte not detected.
NE = Background concentrations are not established.
QRA = qualitative risk assessment
[a]Value calculated according to the frequent-use scenario, and represents the most protective screening value.
[b]Lower screening concentration based on contaminant carcinogenic properties.
[c]Screening based on toxicity value for hexavalent chromium (Cr +6).
[d]Background is defined for nitrate.
[e]Screening based on higher toxicity value for nitrite.
[f]Sum of chlordane concentrations.
[g]Screening based on higher toxicity values of plutonium-240.
[h]Potassium-40 is a naturally occurring radionuclide.
[i]Screening based on higher toxicity values of uranium-233.
[j]Data reported as "uranium" was considered uranium-238.

**Table 2-9 Contaminants of Potential Concern Screening Process for 116-F-10 (105-F) Dummy Decontamination French Drain**

| Detected Radionuclide Analyte | Maximum Concentration 0'-6' interval (pCi/g) | Maximum Concentration[a] 0'-15' interval (pCi/g) | Hanford Soil Background Concentration (pCi/g)[b] | Human Health Risk-Based Screening Concentration (pCi/g) | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Cesium-137 | NDA | 12 | NE | 0.0021 | Retained for further analysis | Retained for 0-15 ft. |
| Cesium-134 | NDA | 0.0028 | NE | 0.0008 | Retained for further analysis | Retained for 0-15 ft. |
| Cobalt-60 | NDA | 53 | NE | 0.00048 | Retained for further analysis | Retained for 0-15 ft. |
| Europium-152 | NDA | 119 | NE | 0.0012 | Retained for further analysis | Retained for 0-15 ft. |
| Europium-154 | NDA | 9.5 | NE | 0.001 | Retained for further analysis | Retained for 0-15 ft. |
| Europium-155 | NDA | 13 | NE | 0.071 | Retained for further analysis | Retained for 0-15 ft. |
| Strontium-90 | NDA | 0.21 | NE | 2.1 | Removed, below screening concentration | Retained for 0-15 ft. |
| Tritium (H-3) | NDA | 80 | NE | 1400 | Removed, below screening concentration | Retained for 0-15 ft. |
| Uranium-238[c] | NDA | 0.11 | NE | 0.12 | Retained for further analysis | Retained for 0-15 ft. |

NDA = No data available or analyte not detected.
NE = Background concentrations are not established.
QRA = qualitative risk assessment
[a]Historical data; maximum concentration is decay-corrected to 1993.
[b]Value calculated according to the frequent-use scenario, and represents the most protective screening value.
[c]Data reported as "uranium" was considered uranium-238.

Table 2-10 Contaminants of Potential Concern Screening Process for the 116-F-11 (105-F) Cushion Corridor French Drain

| Detected Radionuclide Analyte | Maximum Concentration[a] 0'-6' interval (pCi/g) | Maximum Concentration[a] 0'-15' interval (pCi/g) | Hanford Soil Background Concentration (pCi/g) | Human Health Risk-Based Screening Concentration (pCi/g)[b] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Cesium-137 | 1.1 | 1.1 | NE | 0.0021 | Retained for further analysis | Retained |
| Cobalt-60 | 0.12 | 0.12 | NE | 0.00048 | Retained for further analysis | Retained |
| Europium-152 | 2.7 | 2.7 | NE | 0.0012 | Retained for further analysis | Retained |
| Europium-154 | 0.37 | 0.37 | NE | 0.001 | Retained for further analysis | Retained |
| Europium-155 | 0.0014 | 0.0014 | NE | 0.071 | Removed, below screening concentration | Retained |
| Strontium-90 | 0.24 | 0.24 | NE | 2.1 | Removed, below screening concentration | Retained |
| Tritium (H-3) | 0.16 | 0.16 | NE | 1400 | Removed, below screening concentration | Retained |

NE = Background concentrations are not established.
QRA = qualitative risk assessment
[a]Historical data; maximum concentration is decay-corrected to 1993.
[b]Value calculated according to the frequent-use scenario, and represents the most protective screening value.

Table 2-11 Contaminants of Potential Concern Screening Process for the 116-F-14 (107-F) Retention Basin (page 1 of 4)

| Detected Inorganic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Aluminum | 13000 | 13000 | 15600 | NA | Removed, below background | Removed, below background |
| Arsenic | 2 | 2 | 8.92 | 0.032[b] | Removed, below background | Removed, below background |
| Barium | 170 | 170 | 171 | 450 | Removed, below background | Removed, below background |
| Beryllium | 0.59 | 0.59 | 1.77 | 0.015[b] | Removed, below background | Removed, below background |
| Cadmium | 1.5 | 1.5 | NE | 2.6 | Removed, below screening concentration | Retained |
| Calcium | 69700 | 69700 | 23920 | NA | Removed, NA | Removed, NA |
| Chromium | 124 | 124 | 27.9 | 0.39[b,c] | Retained for further analysis | Retained |
| Cobalt | 8.3 | 8.3 | 19.6 | ND | Removed, below background | Removed, below background |
| Copper | 29.3 | 29.3 | 28.2 | 320 | Removed, below screening concentration | Retained |
| Fluoride | 0.6 | 0.6 | 12 | 480 | Removed, below background | Removed, below background |
| Iron | 17400 | 17400 | 39160 | NA | Removed, below background | Removed, below background |
| Lead | 5 | 5 | 14.75 | ND | Removed, below background | Removed, below background |
| Magnesium | 6570 | 6570 | 8760 | NA | Removed, below background | Removed, below background |
| Manganese | 265 | 265 | 612 | 350 | Removed, below background | Removed, below background |

**Table 2-11 Contaminants of Potential Concern Screening Process for the 116-F-14 (107-F) Retention Basin (page 2 of 4)**

| Detected Inorganic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Mercury | 0.22 | 0.22 | 1.25 | 2.4 | Removed, below background | Removed, below background |
| Nickel | 13.6 | 13.6 | 25.3 | 160 | Removed, below background | Removed, below background |
| Nitrite/Nitrate | 3.17 | 3.17 | 199[d] | 800[e] | Removed, below background | Removed, below background |
| Potassium | 1200 | 1200 | 3120 | NA | Removed, below background | Removed, below background |
| Sodium | 703 | 703 | 1290 | NA | Removed, below background | Removed, below background |
| Sulfate | 57 | 57 | 1320 | ND | Removed, below background | Removed, below background |
| Vanadium | 50.5 | 50.5 | 111 | 56 | Removed, below background | Removed, below background |
| Zinc | 87.4 | 87.4 | 79 | 2400 | Removed, below screening concentration | Retained |
| **Detected Organic Analyte** | **Maximum Concentration 0'-6' interval (mg/kg)** | **Maximum Concentration 0'-15' interval (mg/kg)** | **Hanford Soil Background Concentration (mg/kg)** | **Human Health Risk-Based Screening Concentration (mg/kg)[a]** | **Analyte Status for Human Health QRA** | **Analyte Status for Ecological QRA** |
| Acetone | 0.023 | 0.023 | NE | 360 | Removed, below screening concentration | Retained |
| Bis(2-ethylhexyl) phthalate | 0.087 | 0.200 | NE | 4.6[b] | Removed, below screening concentration | Retained |
| Di-n-butylphthalate | 0.340 | 0.340 | NE | 800 | Removed, below screening concentration | Retained |
| Methylene chloride | 0.004 | 0.004 | NE | 1.9[b] | Removed, below screening concentration | Retained |

Table 2-11 Contaminants of Potential Concern Screening Process for the 116-F-14 (107-F) Retention Basin (page 3 of 4)

| Detected Organic Analyte | Maximum Concentration 0'-6' interval (mg/kg) | Maximum Concentration 0'-15' interval (mg/kg) | Hanford Soil Background Concentration (mg/kg) | Human Health Risk-Based Screening Concentration (mg/kg)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Toluene | 0.082 | 0.082 | NE | 72 | Removed, below screening concentration | Retained |
| **Detected Radionuclide Analyte** | **Maximum Concentration 0'-6' interval (pCi/g)** | **Maximum Concentration 0'-15' interval (pCi/g)** | **Hanford Soil Background Concentration (pCi/g)** | **Human Health Risk-Based Screening Concentration (pCi/g)[a]** | **Analyte Status for Human Health QRA** | **Analyte Status for Ecological QRA** |
| Gross Alpha | 14 | 14 | NE | ND | Removed, confirmation data only | Removed, confirmation data only |
| Gross Beta | 440 | 440 | NE | ND | Removed, confirmation data only | Removed, confirmation data only |
| Americium-241 | 0.98 | 0.98 | NE | 0.28 | Retained for further analysis | Retained |
| Carbon-14 | 28 | 28 | NE | 85 | Removed, below screening | Retained |
| Cesium-134 | 8.5 (H) | 8.5 (H) | NE | 0.0008 | Retained for further analysis | Retained |
| Cesium-137 | 4172 (H) | 4172 (H) | NE | 0.0021 | Retained for further analysis | Retained |
| Cobalt-60 | 844 (H) | 844 (H) | NE | 0.00048 | Retained for further analysis | Retained |
| Europium-152 | 6663 (H) | 6663 (H) | NE | 0.0012 | Retained for further analysis | Retained |
| Europium-154 | 3008 (H) | 3008 (H) | NE | 0.001 | Retained for further analysis | Retained |
| Europium-155 | 350 (H) | 350 (H) | NE | 0.071 | Retained for further analysis | Retained |
| Nickel-63 | 30643 (H) | 30643 (H) | NE | 320 | Retained for further analysis | Retained |

Table 2-11 Contaminants of Potential Concern Screening Process for the 116-F-14 (107-F) Retention Basin (page 4 of 4)

| Detected Radionuclide Analyte | Maximum Concentration 0'-6' interval (pCi/g) | Maximum Concentration 0'-15' interval (pCi/g) | Hanford Soil Background Concentration (pCi/g) | Human Health Risk-Based Screening Concentration (pCi/g)[a] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Plutonium-238 | 0.98 (H) | 0.98 (H) | NE | 0.23 | Retained for further analysis | Retained |
| Plutonium-239/240 | 45 (H) | 45 (H) | NE | 0.24[f] | Retained for further analysis | Retained |
| Potassium-40 | 11 | 12 | NE | 0.0077 | Retained for further analysis | Not retained[g] |
| Radium-226 | 0.50 | 0.51 | NE | 0.00069 | Retained for further analysis | Retained |
| Strontium-90 | 59 (H) | 59 (H) | NE | 2.1 | Retained for further analysis | Retained |
| Thorium-228 | 0.6 | 0.6 | NE | 0.00074 | Retained for further analysis | Retained |
| Thorium-232 | 0.60 | 0.74 | NE | 0.32 | Retained for further analysis | Retained |
| Tritium (H-3) | 6308 (H) | 6308 (H) | NE | 1400 | Retained for further analysis | Retained |
| Uranium-233/234 | 0.94 | 0.94 | NE | 0.34[h] | Retained for further analysis | Retained |
| Uranium-238[i] | 34 (H) | 34 (H) | NE | 0.12 | Retained for further analysis | Retained |

H = Historical data; maximum concentration decay-corrected to 1993.
NA = Not applicable, contaminant considered nontoxic to humans.
ND = Screening concentration was not determined because toxicity factors were unavailable.
NE = Background concentrations are not established.
QRA = qualitative risk assessment
[a]Value calculated according to the frequent-use scenario, and represents the most protective screening value.
[b]Lower screening concentration based on contaminant carcinogenic properties.
[c]Screening based on toxicity value for hexavalent chromium (Cr +6).
[d]Background is for nitrate.
[e]Based on toxicity value for nitrite.
[f]Screening based on toxicity values of plutonium-240.
[g]Potassium-40 is a naturally occurring radionuclide.
[h]Screening based on toxicity values of uranium-233.
[i]Data reported as "uranium" was considered uranium-238.

Table 2-12 Contaminants of Potential Concern Screening Process for Process/Discharge Pipelines

| Detected Radionuclide Analyte | Maximum Concentration[a] 0'-6' interval (pCi/g) | Maximum Concentration[a] 0'-15' interval (pCi/g) | Hanford Soil Background Concentration (pCi/g) | Human Health Risk-Based Screening Concentration (pCi/g)[b] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Cesium-137 | NDA | 0.025 | NE | 0.0021 | Retained for further analysis | Retained for 0-15 ft. |
| Cobalt-60 | 0.01 | 0.01 | NE | 0.00048 | Retained for further analysis | Retained |
| Europium-152 | 0.081 | 0.081 | NE | 0.0012 | Retained for further analysis | Retained |
| Europium-155 | 0.015 | 0.015 | NE | 0.071 | Removed, below screening concentration | Retained |
| Strontium-90 | 0.18 | 0.18 | NE | 2.1 | Removed, below screening concentration | Retained |
| Tritium (H-3) | NDA | 0.46 | NE | 1400 | Removed, below screening concentration | Retained for 0-15 ft. |
| Uranium-238 | 0.38[c] | 0.38[c] | NE | 0.12 | Retained for further analysis | Retained |

NDA = No data available or analyte not detected.
NE = Background concentrations are not established.
QRA = qualitative risk assessment
[a]Historical data; maximum concentration is decay-corrected to 1993.
[b]Value calculated according to the frequent-use scenario, and represents the most protective screening value.
[c]Data reported as "uranium" was considered uranium-238.

Table 2-13 Contaminants of Potential Concern Screening Process for the Basin Leak Ditch

| Detected Radionuclide Analyte | Maximum Concentration[a] 0'-6' interval (pCi/g) | Maximum Concentration[a] 0'-15' interval (pCi/g) | Hanford Soil Background Concentration (pCi/g) | Human Health Risk-Based Screening Concentration (pCi/g)[b] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Cesium-134 | 0.015 | 0.015 | NE | 0.0008 | Retained for further analysis | Retained |
| Cesium-137 | 30 | 30 | NE | 0.0021 | Retained for further analysis | Retained |
| Cobalt-60 | NDA | 34 | NE | 0.00048 | Retained for further analysis | Retained for 0-15 ft. |
| Europium-152 | 143 | 143 | NE | 0.0012 | Retained for further analysis | Retained |
| Europium-154 | 27 | 27 | NE | 0.001 | Retained for further analysis | Retained |
| Europium-155 | 2.4 | 2.4 | NE | 0.071 | Retained for further analysis | Retained |
| Plutonium-239/240 | 0.61 | 0.61 | NE | 0.24[c] | Retained for further analysis | Retained |
| Strontium-90 | 2.6 | 2.6 | NE | 2.1 | Retained for further analysis | Retained |
| Tritium (H-3) | 0.38 | 0.38 | NE | 1400 | Removed, below screening concentration | Retained |
| Uranium-238 | 0.19[d] | 0.19[d] | NE | 0.12 | Retained for further analysis | Retained |

NDA = No data available or analyte not detected.
NE = Background concentrations are not established.
QRA = qualitative risk assessment
[a]Historical data; maximum concentration decay-corrected to 1993.
[b]Value calculated according to the frequent-use scenario, and represents the most protective screening value.
[c]Based on higher toxicity values of plutonium-240.
[d]Data reported as "uranium" was considered uranium-238.

Table 2-14 Contaminants of Potential Concern Screening Process for the EM Bypass Ditch

| Detected Radionuclide Analyte | Maximum Concentration[a] 0'-6' interval (pCi/g) | Maximum Concentration[a] 0'-15' interval (pCi/g) | Hanford Soil Background Concentration (pCi/g) | Human Health Risk-Based Screening Concentration (pCi/g)[b] | Analyte Status for Human Health QRA | Analyte Status for Ecological QRA |
|---|---|---|---|---|---|---|
| Cesium-134 | 0.00042 | 0.014 | NE | 0.0008 | Retained for further analysis | Retained |
| Cesium-137 | 1.9 | 28 | NE | 0.0021 | Retained for further analysis | Retained |
| Cobalt-60 | 0.18 | 27 | NE | 0.00048 | Retained for further analysis | Retained |
| Europium-152 | 2.3 | 171 | NE | 0.0012 | Retained for further analysis | Retained |
| Europium-154 | 0.43 | 43 | NE | 0.001 | Retained for further analysis | Retained |
| Europium-155 | 0.05 | 3.4 | NE | 0.071 | Retained for further analysis | Retained |
| Plutonium-239/240 | NDA | 0.55 | NE | 0.24[c] | Retained for further analysis | Retained for 0-15 ft. |
| Strontium-90 | 0.17 | 3.8 | NE | 2.1 | Retained for further analysis | Retained |
| Tritium (H-3) | NDA | 2.2 | NE | 1400 | Removed, below screening concentration | Retained for 0-15 ft. |
| Uranium-238[d] | NDA | 0.17 | NE | 0.12 | Retained for further analysis | Retained for 0-15 ft. |

NDA = No data available or analyte not detected.
NE = Background concentrations are not established.
QRA = qualitative risk assessment
[a]Historical data; maximum concentration decay-corrected to 1993.
[b]Value calculated according to the frequent-use scenario, and represents the most protective screening value.
[c]Screening concentration based on higher toxicity values of plutonium-240.
[d]Data reported as "uranium" was considered uranium-238.

# Table 2-15 Contaminant Identification and Exposure Assessment Uncertainty Summary for 100-FR-1 Operable Unit Waste Sites

| Waste Site Designation | Contaminant Identification Uncertainty | Contaminant Concentration Uncertainty | Exposure Assessment Uncertainty | Potential Impact of Uncertainties on the Risk Characterization |
|---|---|---|---|---|
| 108-F French Drain | Low[a] | Low | Moderate[b] to High[c] | Over Estimation |
| 116-F-1 Lewis Canal | Low | Low | Moderate to High | Over Estimation |
| 116-F-2 (107-F) Basin Overflow Trench | Low | Low | Moderate to High | Over Estimation |
| 116-F-3 (105-F) Fuel Storage Basin Trench | Low | Low | Moderate to High | Over Estimation |
| 116-F-4 (105-F) Pluto Crib | Low | Low | Moderate to High | Over Estimation |
| 116-F-5 Ball Washer Crib[d] | Low to Moderate | Low to Moderate | Moderate to High | Over or Under Estimation |
| 116-F-6 (1608-F) Liquid Waste Disposal Trench | Low | Low | Moderate to High | Over Estimation |
| 116-F-8 (1904-F) Outfall Structure[e] | High | High | N/A[f] | Over or Under Estimation |
| 116-F-9 PNL Animal Waste Leach Trench | Low | Low | Moderate to High | Over Estimation |
| 116-F-10 (105-F) Dummy Decontamination French Drain[d] | Low to Moderate | Low to Moderate | Moderate to High | Over Estimation |
| 116-F-11 (105-F) Cushion Corridor French Drain[d] | Low to Moderate | Low to Moderate | Moderate to High | Over or Under Estimation |
| 116-F-12 (148-F) French Drain[e] | High | High | N/A | Over or Under Estimation |
| 116-F-13 (1705-F) Experimental Garden French Drain[e] | High | High | N/A | Over or Under Estimation |
| 116-F-14 (107-F) Retention Basin | Low | Low | Moderate to High | Over Estimation |
| 128-F-2 Burning Pit[e] | High | High | N/A | Over or Under Estimation |
| 132-F-6 (1608-F) Lift Station Demolition Site[e] | High | High | N/A | Over or Under Estimation |
| Basin Leak Ditch[d] | Low to Moderate | Low to Moderate | Moderate to High | Over Estimation |
| EM Bypass Ditch[d] | Low to Moderate | Low to Moderate | Moderate to High | Over Estimation |
| PNL Outfall Structure | High | High | N/A | Over or Under Estimation |
| Pre-Reactor Coolant Water Facilities[e] | High | High | N/A | Over Estimation |
| Process/Discharge Pipelines[d] | Low to Moderate | Low to Moderate | Moderate to High | Over or Under Estimation |
| UN-100-F1[e] | High | High | N/A | Over or Under Estimation |

PNL - Pacific Northwest Laboratories
N/A - not applicable
[a]Low Impact; may effect risk estimates by less than one order of magnitude.
[b]Moderate Impact; may effect risk estimates by between one and two orders of magnitude.
[c]High Impact; may effect risk estimates by more than two orders of magnitude.
[d]Historical data used, no analytical values for chemical and naturally occurring radionuclide (i.e., potassium-40) analytes reported.
[e]Sampling was not done at this waste site. Uncertainty dependent on the appropriateness of the selected analogous site.
[f]Not Applicable; exposure assessment was not performed on sites without data.

**Table 2-16 Undetected Analytes with Established Release Histories at the 100-FR-1 Operable Unit**

| Analyte | Detection Limit[a] (pCi/g) | Screening Concentration (pCi/g) |
|---|---|---|
| Niobium-94 | 0.5 | 0.00077 |
| Iodine-129 | 0.5 | 0.4 |
| Plutonium-241[b] | 4.0[c] | 21 |
| Technetium-99[b] | 4.0[c] | 59 |
| Zirconium-93[b] | 4.0[c] | 450 |
| Samarium-151 | 0.5 | 690 |
| Calcium-41 | 0.5 | NC[d] |
| Cadmium-113m | 4.0[c] | NC |

NC - not calculated
[a] Specified in the 100-FR-1 Operable Unit Work Plan (DOE-RL 1992)
[b] Radionuclide primarily decays by beta emission
[c] Detection limit for gross beta parameter
[d] Not Calculated; toxicity parameter not available for determining screening concentration

# 3.0 QUALITATIVE RISK ASSESSMENT

This chapter presents the human health and ecological qualitative risk evaluation for the high priority and non-prioritized waste sites on the 100-FR-1 Operable Unit. The individual site risk characterizations were performed using the maximum concentrations of the COPC identified in Chapter 2.0 and the methodology described in Section 1.3.

The risk characterizations in this QRA were based on a number of conservative assumptions. These conservative assumptions simplify the risk characterization process for the purpose of risk-based screening of site data. Therefore, the resulting numerical values do not represent the most realistic estimates of risk and hazards to human and ecological receptors, but do provide a means of identifying contaminants and exposure pathways of primary concern. The frequent-use scenario, which represents an upper bound of possible exposures, is useful in identifying exposure pathways and contaminants that can be eliminated from further consideration because risks are below levels protective of hypothetical residential exposures. The occasional-use scenario represents a lower bound of possible exposures (i.e., recreational exposure, which may not adequately address all possible current and future exposure pathways at Hanford). Although not useful in eliminating pathways or contaminants of concern, the occasional-use scenario is useful in identifying high priority pathways and contaminants that should be carefully considered for interim action and ultimate remediation. Pathways and COC that exceed risk-based goals for the frequent-use scenario but do not exceed risk-based goals for the occasional-use scenario are considered low priority COC because they will probably not be the contaminants comprising the largest percentage of the risk at a site.

## 3.1 HIGH PRIORITY WASTE SITES

### 3.1.1 Waste Sites with Data

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

#### 3.1.1.1 108-F French Drain.

**3.1.1.1.1 Human Health Risk Characterization.** Risks estimated for the frequent-use and occasional-use scenarios at the 108-F French Drain are summarized in Table 3-1 and Figure 3-1.

Several COPC represent estimated lifetime ICR $> 10^{-6}$ in the frequent-use scenario. Potassium-40, cesium-137, europium-152, radium-226, and thorium-228 soil concentrations represent ICR $> 10^{-6}$ from the external radiation exposure pathway. Lifetime ICR $> 10^{-6}$ are also estimated from ingestion exposures to PCB, plutonium-238, plutonium-239/240, and americium-241, and from inhalation exposures to chromium, plutonium-238,

plutonium-239/240, and americium-241 in this scenario. The HI estimated for this waste site does not exceed 1.0 in the frequent-use scenario.

External radiation exposure to potassium-40 and ingestion and inhalation exposures to plutonium-238 represent ICR $> 10^{-6}$ in the occasional-use scenario. None of the chemical COPC represent estimated ICR $> 10^{-6}$ or HI $> 1$ in the occasional-use scenario.

The total estimated lifetime ICR to humans was considered "medium" in the frequent-use scenario and "low" in the occasional-use scenario. Each exposure pathway evaluated (i.e., ingestion, inhalation, external radiation exposure) contributes to risk at this waste site. Primary risk-contributing COPC in the frequent-use scenario include potassium-40, cesium-137, thorium-228, and plutonium-238. Chromium, potassium-40, and plutonium-238 are the primary COPC contributors to risk in the occasional-use scenario.

A 28 percent reduction in ICR is anticipated if the onset of the frequent-use scenario exposures is delayed until 2018. The primary pathways contributing to risk would remain the external radiation, ingestion, and inhalation pathways, and the qualitative risk classification would remain "medium" for this site.

Shielding by clean-fill soils is not expected to reduce the external radiation exposure risks for the occasional-use scenario because the maximum soil concentrations at this site were all measured within 21.8 m (6.6 ft) of the ground surface.

**3.1.1.1.2 Human Health Risk Characterization Uncertainty Analysis.** Uncertainties attributed to the methodology used in this QRA are discussed in Section 1.4. Uncertainties inherent in the quality of the data used in the human health risk characterization were discussed in Section 2.6.

Toxicity factor information for benzo(a)anthracene and lead were not available for use in this QRA. Consequently, potential human health effects associated with exposures to these COPC were not estimated. The omission of potential ICR from benzo(a)anthracene is not expected to alter the qualitative risk characterization of the 108-F French Drain because the contributions to ICR from chemical COPC are much lower than from radionuclide COPC (Table 3-1).

**3.1.1.1.3 Ecological Evaluation for the 108-F French Drain.** The total calculated dose rates to the Great Basin pocket mouse from radionuclides, organics, and inorganics in the soil inside the 108-F French Drain are listed in Tables 3-2 and 3-3, and their EHQ are summarized in Tables 4-4 and 4-5. The total dose from radionuclides in soils $< 4.6$ m (15 ft) and 1.8 m (6 ft) does not exceed 1 rad/day. The wildlife NOEL (Table 1-5) for nonradiological contaminants were exceeded by copper, lead, selenium, and zinc in the 0-4.6 m (0-15 ft) soil profile. These contaminants also exceeded the wildlife NOEL in the upper 1.8-m (6-ft) soil profile, and are potentially available for biotransport to the pocket mouse.

**3.1.1.1.4 Uncertainties Associated with the Ecological Evaluation.** The uncertainty associated with the approach used in the qualitative ecological evaluation for this

waste site is described in Section 1.3.3. Because the exact location and size of the drain is not known, and part of the contaminated zone is thought to extend under the building, part of the site may not be accessible to the pocket mouse. Much of the area is not preferred habitat for the pocket mouse because the surface of the area is covered with gravel and maintained free of vegetation. The source term assumes that the contaminant is uniformly distributed in the soil profile. For the 108-F French Drain, this is not the case as the former use was a drain that received condensate from the biology laboratory hoods inside the 108-F building.

#### 3.1.1.2 116-F-1 Lewis Canal.

**3.1.1.2.1 Human Health Risk Characterization.** Risks estimated for the frequent-use and occasional-use scenarios at the 116-F-1 Lewis Canal are summarized in Table 3-4 and Figure 3-2.

Several COPC represent estimated ICR $> 10^{-6}$ in the frequent-use scenario. Potassium-40, cobalt-60, cesium-137, europium-152, europium-154, radium-226, and thorium-228 soil concentrations represent ICR $> 10^{-6}$ from the external radiation exposure pathway. Incremental cancer risks $> 10^{-6}$ is also estimated from ingestion and inhalation exposures to arsenic in the frequent-use scenario. Arsenic is also estimated to exceed the human systemic toxicant effect threshold (HI $> 1$) from ingestion exposures in the frequent-use scenario.

Potassium-40, cobalt-60, cesium-137, europium-152, and europium-154 external radiation exposures, and arsenic ingestion exposures represent ICR $> 10^{-6}$ in the occasional-use scenario. No COPC are estimated to represent ICR $> 10^{-6}$ from inhalation exposures in this scenario. Systemic toxicant COPC hazards did not exceed 1.0 in the occasional-use scenario.

The total estimated lifetime ICR to humans is considered "high" in the frequent-use scenario and "medium" in the occasional-use scenario. The external radiation exposure is considered to be the primary pathway contributing to ICR. Cobalt-60, europium-152, and europium-154 are considered the greatest contributors in both scenarios.

A 78 percent reduction in ICR is anticipated if the onset of frequent-use scenario exposures is delayed until 2018. The resulting ICR classification would be "medium". External radiation exposure would remain the primary pathway contributing to ICR.

An allowance for the shielding effects of clean-fill soils is not expected to significantly reduce the external radiation exposure risks in the occasional-use scenario. The maximum soil concentrations of the primary risk-contributing COPC were all measured within 1.8 m (6 ft) below the surface at this site.

**3.1.1.2.2 Human Health Risk Characterization Uncertainty Analysis.** Uncertainties attributed to the methodology and to quality of the data used in this QRA are discussed in Section 1.4 and Section 2.6, respectively.

Because toxicity factor information for cobalt and lead were not available for use in this QRA, potential human health effects attributed to exposures from these COPC were not estimated. Thus, human health risks associated with the 116-F-1 Lewis Canal are underestimated.

**3.1.1.2.3 Ecological Evaluation for the 116-F-1 Lewis Canal.** The total calculated dose rates to the Great Basin pocket mouse from radionuclides, organics, and inorganics in soil for the 116-F-1 Lewis Canal are listed in Tables 3-5 and 3-6, and their EHQ are summarized in Tables 4-4 and 4-5. The total doses from radionuclides in soils <4.6 m (15 ft) and 1.8 m (6 ft) do not exceed the EHQ (1 rad/day).

The wildlife NOEL (Table 1-5) for nonradiological contaminants were exceeded by arsenic, cadmium, lead, and zinc in the 0-4.6 m (0-15 ft) profile. These contaminants also exceeded the wildlife NOEL in the upper 2-m (6 ft) soil profile, and are potentially available for biotransport to the pocket mouse. There were organic compounds detected in soils inside the 116-F-1 Lewis Canal which have no published soil-to-plant transfer factor or wildlife NOEL value. These contaminants include 2-butanone and 2-hexanone. The presence of ketones may be from the use of organic solvents.

**3.1.1.2.4 Uncertainties Associated with the Ecological Evaluation.** The uncertainty associated with the approach used in the qualitative ecological evaluation for 116-F-1 Lewis Canal is described in Section 1.3.3. The source term also assumes that the contaminant is uniformly distributed in the soil and is available for uptake by site vegetation. The 116-F-1 Lewis Canal has been covered with clean soil, and subsequently maintained free of vegetation. Natural vegetation is present on both sides of the canal.

**3.1.1.3 116-F-2 (107-F) Basin Overflow Trench.**

**3.1.1.3.1 Human Health Risk Characterization.** Risks estimated for the frequent-use and occasional-use scenarios at the 116-F-2 site are summarized in Table 3-7 and Figure 3-3.

Several COPC represent estimated ICR $> 10^{-6}$ in the frequent-use scenario. Potassium-40, cobalt-60, cesium-137, europium-152, europium-154, europium-155, iridium-192, radium-226, and thorium-228 soil concentrations represent ICR $> 10^{-6}$ from the external radiation exposure pathway. Incremental cancer risks $> 10^{-6}$ are also estimated from ingestion exposures to cesium-137, europium-152, europium-154, and plutonium-239/240, and from inhalation exposures to chromium and plutonium-239/240. The HI estimated for this waste site does not exceed 1.0 in the frequent-use scenario.

Potassium-40, cobalt-60, cesium-137, europium-152, and europium-154 external radiation exposures represent ICR $> 10^{-6}$ in the occasional-use scenario. No COPC are estimated to represent ICR $> 10^{-6}$ from inhalation or ingestion exposures in this scenario. The total HI estimated for systemic toxicants does not exceed 1.0 in the occasional-use scenario.

The total estimated lifetime ICR to humans is considered "high" in the frequent-use scenario and "medium" in the occasional-use scenario. The external radiation exposure pathway is the major contributor to the total ICR in both scenarios. Europium-152 and europium-154 are the greatest ICR contributors in both scenarios.

A 77 percent reduction in ICR is anticipated if the onset of frequent-use scenario exposures is delayed until 2018. The resulting ICR classification would remain "high", however, the primary pathway contributing to risk would remain external radiation exposure.

An allowance for the shielding effects of clean-fill soils would reduce the estimated occasional-use scenario external radiation exposure ICR by 99 percent. The resulting qualitative risk classification would be reduced from "medium" to "low" for the occasional-use scenario.

**3.1.1.3.2 Human Health Risk Characterization Uncertainty Analysis.** Uncertainties attributed to the methodology and to quality of the data used in this QRA are discussed in Section 1.4 and Section 2.6, respectively.

Iridium-192, a fission product, was detected at this waste site. Because of its short radioactive half-life (approximately 74 days), its presence would not be possible unless an active nuclear reactor was in close proximity. The detection of this radionuclide might have resulted through a misinterpretation of the soil sample analysis.

Toxicity factor information for benzo(b)fluoranthene and chrysene were not available for use in this QRA. Consequently, potential human health effects attributed to exposures from these COPC were not estimated. The omission of potential ICR from benzo(a)anthracene and chrysene is not expected to alter the qualitative risk characterization of the 116-F-2 Basin Overflow Trench because the contributions to ICR from chemical COPC are much lower than from radionuclide COPC (Table 3-7).

**3.1.1.3.3 Ecological Evaluation for the 116-F-2 Basin Overflow Trench.** The total calculated dose rates to the Great Basin pocket mouse from radionuclides, organics, and inorganics in soil for the 116-F-2 Basin Overflow Trench are listed in Tables 3-8 and 3-9, and their EHQ are summarized in Tables 4-4 and 4-5. The total dose from radionuclides in soils <4.6 m (15 ft) and 1.8 m (0-6 ft) did not exceed the EHQ (1 rad/day).

The wildlife NOEL (Table 1-5) for non-radiological contaminants were exceeded by cadmium and zinc in the 0-4.6 m (0-15 ft) profile. However, these contaminants did not exceed the wildlife NOEL in the upper 1.8-m (6-ft) soil profile, and are less potentially available for biotransport. Several organic compounds, chrysene and benzo(a)pyrene, were detected in soils in the basin overflow trench. Benzo(a)pyrene and chrysene are designated along with respective suspected human carcinogens, but these compounds do not have established wildlife NOEL values.

**3.1.1.3.4 Uncertainties Associated with the Ecological Evaluation.** The uncertainty associated with the general approach used in the qualitative ecological evaluation for the 116-F-2 Basin Overflow Trench is described in Section 1.3.3. The trench now

contains clean fill which varies from 1 to 6 m (2.7 to 16.2 ft) in depth which would be expected to inhibit exposure.

#### 3.1.1.4 116-F-3 (105-F) Fuel Storage Basin Trench

**3.1.1.4.1 Human Health Risk Characterization.** Risks estimated for the frequent-use and occasional-use scenarios at the 116-F-3 Fuel Storage Basin Trench site are summarized in Table 3-10 and Figure 3-4.

Several COPC represent estimated ICR $> 10^{-6}$ in the frequent-use scenario. Potassium-40, cobalt-60, cesium-137, europium-152, europium-154, radium-226, thorium-228, and uranium-235 soil concentrations represent ICR $> 10^{-6}$ from the external radiation exposure pathway. Incremental cancer risks $> 10^{-6}$ are also estimated from inhalation exposures to hexavalent chromium and ingestion exposures to PCB. The total HI for systemic toxicants does not exceed 1.0 in the frequent-use scenario.

Potassium-40, cobalt-60, europium-152, and europium-154 external radiation exposures represent estimated ICR $> 10^{-6}$ in the occasional-use scenario. None of the COPC are estimated to contribute significant ICR from the inhalation and ingestion pathways in this scenario. The total HI does not exceed 1.0 in the occasional-use scenario.

The total estimated lifetime ICR to humans is considered "high" in the frequent-use scenario "medium" in the occasional-use scenario. The external radiation exposure pathway is the major contributor to the total ICR in the both scenarios. Europium-152 is the greatest ICR contributor in both scenarios evaluated.

A 70 percent reduction in ICR is anticipated if the onset of frequent-use scenario exposures is delayed until 2018. The resulting ICR would be re-classified from "high" to "medium". External radiation exposure would remain the primary pathway contributing to ICR.

An allowance for the shielding effects of clean-fill soils would reduce the estimated occasional-use scenario external radiation exposure ICR by 93 percent. The resulting qualitative risk characterization would be reduced from "medium" to "low" for the occasional-use scenario.

**3.1.1.4.2 Human Health Risk Characterization Uncertainty Analysis.** Uncertainties attributed to the methodology and to quality of the data used in this QRA are discussed in Section 1.4 and Section 2.6, respectively.

Toxicity information for benzo(a)anthracene, benzo(b)fluoranthene and chrysene were not available for use in this QRA. Consequently, potential human health effects attributed to exposures from these COPC were not estimated. The omission of potential ICR from benzo(a)anthracene, benzo(b)fluoranthene, and chrysene is not expected to alter the qualitative risk characterization of the 116-F-3 Fuel Storage Basin because the contributions to ICR from chemical COPC are much lower than from radionuclide COPC (Table 3-10).

**3.1.1.4.3 Ecological Evaluation for the 116-F-3 Fuel Storage Basin Trench.** The total calculated dose rates to the Great Basin pocket mouse from radionuclides, organics, and inorganics in soil in the 116-F-3 Fuel Storage Basin are listed in Tables 3-11 and 3-12, and their EHQ are summarized in Tables 4-4 and 4-5. The total dose from radionuclides in soils <4.6 m (0-15 ft) and 1.8 m (0-6 ft) does not exceed the EHQ (1 rad/day).

The wildlife NOEL (Table 1-5) for nonradiological contaminants were exceeded by barium, lead, mercury, and zinc in the 0-4.6 m (0-15 ft) profile. Of these contaminants only barium exceeded the wildlife NOEL in the upper 1.8-m soil profile. Several organic compounds benzo(a)pyrene, benzo(b)fluoranthene, chrysene, and phenanthrene) were detected in soils in the fuel storage basin trench. However, these organic compounds do not have published wildlife NOEL values and were not evaluated. Soil-to-plant transfer coefficients were not available for toxaphene and 4-methyl-2-pentanone; therefore, dose rates were not calculated for these constituents.

**3.1.1.4.4 Uncertainties Associated with the Ecological Evaluation.** The uncertainty associated with the general approach used in the qualitative ecological evaluation for the 116-F-3 Fuel Storage Basin Trench is described in Section 1.3.3. Because this trench is filled with approximately 2.4 m (8 ft) of clean soil, it is quite likely that much of the COPC are below this fill and not immediately accessible to pocket mouse burrows or uptake by vegetation.

### 3.1.1.5 116-F-4 (105-F) Pluto Crib.

**3.1.1.5.1 Human Health Risk Characterization.** Risks estimated for the frequent-use and occasional-use scenarios at the 116-F-4 (105-F) Pluto Crib site are summarized in Table 3-13 and Figure 3-5. The data used in this assessment are historical in nature. The 116-F-4 Pluto Crib was removed as part of a treatability study in 1993. No data were available from that study to assess current risks.

Several COPC represent estimated ICR $> 10^{-6}$ in the frequent-use scenario. Potassium-40, cobalt-60, cesium-134, cesium-137, europium-152, europium-154, europium-155, radium-226, thorium-228, uranium-238 and americium-241 soil concentrations represent ICR $> 10^{-6}$ from the external radiation exposure pathway. Incremental cancer risks $> 10^{-6}$ are also estimated from ingestion exposures to strontium-90, cesium-137, plutonium-239/240, and americium-241, and from inhalation exposures to strontium-90, plutonium-239/240, and americium-241 in this scenario. The total HI does not exceed 1.0 in the frequent-use scenario.

External radiation exposures to cesium-137, europium-152, and europium-154, ingestion exposures to strontium-90 and cesium-137 and inhalation exposures to plutonium-239/240 represent ICR $> 10^{-6}$ in the occasional-use scenario. None of the chemical COPC are estimated to represent significant ICR or HI in the occasional-use scenario.

The total estimated lifetime ICR to humans is considered "high" in the frequent-use scenario and "medium" in the occasional-use scenario. External radiation exposure is the

major pathway contributing to risk in both scenarios. Cesium-137 is identified as the major COPC contributing to risk in both scenarios.

A 47 percent reduction in ICR is anticipated if the onset of frequent-use scenario exposures is delayed until 2018. The resulting ICR classification would remain "high". External radiation exposure would remain the primary pathway contributing to ICR.

An allowance for the shielding effects of clean-fill soils would reduce the estimated occasional-use scenario external radiation exposure risks by 89 percent. However, this reduction is not expected to alter qualitative risk classification for the occasional-use scenario.

**3.1.1.5.2 Human Health Risk Characterization Uncertainty Analysis.** Uncertainties attributed to the methodology and to quality of the data used in this QRA are discussed in Section 1.4 and Section 2.6, respectively.

**3.1.1.5.3 Ecological Evaluation for the 116-F-4 Pluto Crib.** The total calculated dose rates to the Great Basin pocket mouse from radionuclides, organics, and inorganics in the soil in 116-F-4 Pluto Crib are listed in Tables 3-14 and 3-15, and their EHQ are summarized in Tables 4-4 and 4-5. The total dose from radionuclides in soils exceeds the EHQ (1 rad/day) for the 4.6 m (0-15 ft) profile. Radionuclides in the upper profile 0-1.8 m (0-6 ft) also exceed the EHQ and are potentially available for biotransport to the pocket mouse. The dose from radionuclides is primarily from strontium-90. The dose rate to the pocket mouse at the 0-1.8 m (0-6 ft) soil profile is 2.5 rad/day, while the dose rate calculated from the total 0-4.6 m (0-15 ft) soil profile is 32 rad/day.

The wildlife NOEL (Table 1-5) for nonradiological contaminants were exceeded by barium in the 0-4.6 m (0-15 ft) soil profile. These contaminants exceed the wildlife NOEL in the upper 1.8 m (6 ft) soil profile, and are potentially available for biotransport to the pocket mouse.

**3.1.1.5.4 Uncertainties Associated with the Ecological Evaluation.** The uncertainty associated with the approach used in the qualitative ecological evaluation for the 116-F-4 Pluto Crib is described in Section 1.3.3. The crib is relatively small (3 $m^2$ in diameter), and contained gravel for percolation. The crib was deactivated in 1952 and excavated in 1993.

**3.1.1.6 116-F-5 Ball Washer Crib.**

**3.1.1.6.1 Human Health Risk Characterization.** Risks estimated for the frequent-use and occasional-use scenarios at the 116-F-5 Ball Washer Crib site are summarized in Table 3-16 and Figure 3-6.

Cesium-137 and europium-154 soil concentrations represent estimated lifetime to ICR $> 10^{-6}$ from the external radiation exposure pathway in the frequent-use scenario. Exposures by the ingestion and inhalation pathways are not significant in this scenario.

None of the radionuclide COPC soil concentrations represent estimated ICR $> 10^{-6}$ in the occasional-use scenario. None of the exposure pathways evaluated represent estimated lifetime ICR $> 10^{-6}$ in the occasional-use scenario.

The total estimated lifetime ICR to humans is considered "low" in the frequent-use scenario and "very low" in the occasional-use scenario. External radiation exposure is the major pathway contributing to ICR risk in both scenarios. Europium-154 is the major contributor to ICR in both scenarios.

An 83 percent reduction in site ICR is anticipated if the onset of frequent-use scenario exposures is delayed until 2018. The resulting site ICR would remain "low". External radiation exposure would remain the primary pathway contributing to ICR.

Because there is no data for the soil from the surface to 1.8 m (6 ft) deep, it is not known if the soil provides a shielding effect leading to risk reduction.

**3.1.1.6.2 Human Health Risk Characterization Uncertainty Analysis.** Uncertainties attributed to the methodology and to quality of the data used in this QRA are discussed in Section 1.4 and Section 2.6, respectively.

Soils at this waste site were not analyzed for potential chemical contaminants. As a result, the potential human health ICR and HI associated with chemical COPC are probably under-estimated. However, the contributions of chemical COPC ICR is estimated to be much lower than risks from radionuclide COPC ICR at other 100-FR-1 Operable Unit waste sites.

**3.1.1.6.3 Ecological Evaluation for the 116-F-5 Ball Washer Crib.** The total calculated dose rates to the Great Basin pocket mouse from radionuclides in the soil inside the Ball Washer Crib are listed in Table 3-17, and their EHQ are summarized in Tables 4-4. The total dose from radionuclides in soils $< 4.6$ m (0-15 ft) in depth does not exceed the EHQ (1 rad/day). Data were not available for nonradiological contaminants at this depth. Data also were not available for radiological or nonradiological contaminants at the 0-1.8 m (0-6 ft) depth interval.

**3.1.1.6.4 Uncertainties Associated with the Ecological Evaluation.** The uncertainty associated with the general approach used in the qualitative ecological evaluation for the 116-F-5 Ball Washer Crib is described in Section 1.3.3. The crib is relatively small (3 m diameter) and is similar in description to the 116-F-4 Pluto Crib.

**3.1.1.7 116-F-6 (1608-F) Liquid Waste Disposal Trench.**

**3.1.1.7.1 Human Health Risk Characterization.** Risks estimated for the frequent-use and occasional-use scenarios at the 116-F-6 Liquid Waste Disposal Trench site are summarized in Table 3-18 and Figure 3-7.

Several COPC represent estimated ICR $> 10^{-6}$ in the frequent-use scenario. Potassium-40, cobalt-60, cesium-137, europium-152, europium-154, radium-226, and

thorium-228 soil concentrations represent estimated ICR $> 10^{-6}$ from the external radiation exposure pathway. Incremental cancer risks $> 10^{-6}$ are also estimated from ingestion exposures to cesium-137, and from inhalation exposures to chromium and plutonium-239/240 in this scenario. None of the chemical COPC are estimated to represent significant HI in the frequent-use scenario.

Potassium-40, cobalt-60, cesium-137, europium-152, and europium-154 external radiation exposures represent estimated ICR $> 10^{-6}$ in the occasional-use scenario. Incremental cancer risks $> 10^{-6}$ are not estimated for the inhalation and ingestion pathways in this scenario. None of the chemical COPC represent significant ICR or HI in the occasional-use scenario.

The total estimated lifetime ICR to humans is considered "high" in the frequent-use scenario and "medium" in the occasional-use scenarios. The external radiation exposure is the major exposure pathway contributing to ICR. Cobalt-60, cesium-137, and europium-152 were identified as the major COPC contributing to ICR in both scenarios.

A 68 percent reduction in total ICR is anticipated if the onset of frequent-use scenario exposures is delayed until 2018. The resulting ICR classification would remain "high". External radiation exposure would remain the primary pathway contributing to ICR.

An allowance for the shielding effects of clean-fill soils would reduce the estimated occasional-use scenario external radiation exposure ICR by 97 percent. The resulting ICR classification would be reduced from "medium" to "low" for the occasional-use scenario.

**3.1.1.7.2 Human Health Risk Characterization Uncertainty Analysis.** Uncertainties attributed to the methodology and to quality of the data used in this QRA are discussed in Section 1.4 and Section 2.6, respectively.

**3.1.1.7.3 Ecological Evaluation for the 116-F-6 Liquid Waste Disposal Trench.** The total calculated dose rates to the Great Basin pocket mouse from radionuclides, organics, and inorganics in the soil in the 116-F-6 Liquid Waste Disposal Trench are listed in Tables 3-19 and 3-20, and their EHQ are summarized in Tables 4-4 and 4-5. The total dose from radionuclides in soils $<4.6$ m (0-15 ft) does not exceed the EHQ (1 rad/day).

The wildlife NOEL (Table 1-5) for nonradiological contaminants were exceeded by zinc in the 0-4.6 m (0-15 ft) profile. Zinc was not present in the 1.8 m (0-6 ft) soil profile.

**3.1.1.7.4 Uncertainties Associated with the Ecological Evaluation.** The uncertainty associated with the approach used in the qualitative ecological evaluation for 116-F-6 Liquid Waste Disposal Trench is described in Section 1.3.3. Because the trench was buried with clean soil in 1965, at least part of the contaminant inventory may be beneath the rooting depth of most native plants.

Because the 116-F-6 Liquid Waste Disposal Trench apparently overflowed into a low area south of the trench, some contamination might be present near the surface. Much of the

trench area has been covered with clean soil and is maintained free of vegetation. Thus, uptake by the pocket mouse would be reduced due to the lack of vegetation.

### 3.1.1.8 116-F-9 PNL Animal Waste Leach Trench.

**3.1.1.8.1 Human Health Risk Characterization.** Risks estimated for the frequent-use and occasional-use scenarios at the 116-F-9 PNL Animal Waste Leach Trench site are summarized in Table 3-21 and Figure 3-8.

Several COPC represent estimated ICR $> 10^{-6}$ in the frequent-use scenario. Potassium-40, cobalt-60, cesium-137, europium-152, radium-226, thorium-228, and soil concentrations represent ICR $> 10^{-6}$ from the external radiation exposure pathway. Incremental cancer risks $> 10^{-6}$ are also estimated from ingestion exposures to chlordane and strontium-90. Exposures from the inhalation pathway do not represent ICR $> 10^{-6}$ in this scenario. The total HI do not exceed the human health effects threshold in the frequent-use scenario

Potassium-40 external radiation exposures represent estimated ICR $> 10^{-6}$ in the occasional-use scenario. The ingestion and inhalation pathways did not contribute ICR $> 10^{-6}$ in this scenario. The total HI do not exceed the human health effects threshold in the occasional-use scenario.

The total estimated lifetime ICR to humans is considered "medium" in the frequent-use scenario and "low" in the occasional-use scenario. The external radiation exposure pathway is the major contributor to ICR at this site. Primary risk-contributing COPC include potassium-40, europium-152, radium-226, and thorium-228.

A 41 percent reduction in total ICR is anticipated if the onset of frequent-use scenario exposures is delayed until 2018. The resulting ICR classification would remain "medium". External radiation exposure would remain the primary pathway contributing to ICR.

An allowance for the shielding effects of clean-fill soils would reduce the estimated occasional-use scenario external radiation exposure risks by 36 percent. However, this reduction is not expected to alter the qualitative risk classification for the occasional-use scenario.

**3.1.1.8.2 Human Health Risk Characterization Uncertainty Analysis.** Uncertainties attributed to the methodology and to quality of the data used in this QRA are discussed in Section 1.4 and Section 2.6, respectively.

**3.1.1.8.3 Ecological Evaluation for the 116-F-9 Animal Waste Trench.** The total calculated dose rates to the Great Basin pocket mouse from radionuclides, organics, and inorganics in the soil inside the 116-F-9 Animal Waste Trench are listed in Tables 3-22 and 3-23, and their EHQ are summarized in Tables 4-4 and 4-5. The total dose (0.8 rad/day) from radionuclides (primarily strontium-90) in soils $< 4.6$ m (0-15 ft) does not exceed the EHQ (1 rad/day). The EHQ for radionuclides is three orders of magnitude less using the

0-2 m (0-6.6 ft) soil contaminant profile. This suggests that the contaminants are deeper than 1.8 m (6 ft) and there is less potential of biotransport to the pocket mouse.

The wildlife NOEL (Table 1-5) for nonradiological contaminants were exceeded by lead, silver, and zinc in the 0-4.6 m (0-15 ft) profile. These contaminants do not exceed their wildlife NOEL in the upper 2-m (6-ft) soil profile and, like the radionuclides at this site, are buried deeper and are less available for biotransport to the pocket mouse. Chlordane was detected in soils inside the Animal Waste Trench, but does not have a published wildlife NOEL value. In addition, a transfer coefficient was not available for 2-pentanone thus the dose rate was not calculated.

**3.1.1.8.4 Uncertainties Associated with the Ecological Evaluation.** The uncertainty associated with the general approach used in the qualitative ecological evaluation for 116-F-9 Animal Waste Trench is described in Section 1.3.3. Because the trench was buried with clean soil in 1976, at least part of the contaminant inventory is below the rooting depth of most native plants. The site is maintained free of vegetation with herbicide.

**3.1.1.9 116-F-10 (105-F) Dummy Decontamination French Drain.**

**3.1.1.9.1 Human Health Risk Characterization.** Risks estimated for the frequent-use and occasional-use scenarios at the 116-F-10 (105-F) Dummy Decontamination French Drain site are summarized in Table 3-24 and Figure 3-9.

Several radionuclide COPC represent estimated ICR $> 10^{-6}$ in the frequent-use scenario. Cobalt-60, cesium-137, europium-152, europium-154, and europium-155 soil concentrations represent ICR $> 10^{-6}$ from the external radiation exposure pathway. Incremental cancer risks from cobalt-60 ingestion was also estimated to exceed $10^{-6}$. None of the COPC are estimated to contribute significant ICR from the inhalation pathway in the frequent-use scenario.

Cobalt-60, cesium-137, europium-152, and europium-154 soil concentrations represent ICR $> 10^{-6}$ from external radiation exposures in the occasional-use scenario. Neither the ingestion or inhalation exposure pathways contributed significant ICR in the occasional-use scenario.

The lifetime ICR to humans is considered "high" in the frequent-use scenario. The occasional-use scenarios represent a "medium" risk. The external radiation exposure pathway is the major contributor to risk. Cobalt-60 and europium-152 are the major contributors to risk in both scenarios.

An 83 percent reduction in site ICR is anticipated if the onset of frequent-use scenario exposures is delayed until 2018. The resulting ICR would be reduced from "high" to "medium". External radiation exposure would remain the primary pathway contributing to ICR.

Because there is no data for the soil from the surface to 1.8 m (6 ft) deep it is not known if the soil provides a shielding effect leading to risk reduction.

**3.1.1.9.2 Human Health Risk Characterization Uncertainty Analysis.** Uncertainties attributed to the methodology and to quality of the data used in this QRA are discussed in Section 1.4 and Section 2.6, respectively.

The soils at this waste site were not analyzed for chemical contaminants. As a result, the potential human health ICR and HI are probably under-estimated. However, the contributions of chemical COPC to ICR are estimated to be much lower than ICR from radionuclide COPC at other 100-FR-1 Operable Unit waste sites.

**3.1.1.9.3 Ecological Evaluation for the 116-F-10 Dummy Decontamination French Drain.** The total calculated dose rates to the Great Basin pocket mouse from radionuclides in the soil inside the 116-F-10 Dummy Decontamination French Drain are listed in Table 3-25, and their EHQ are summarized in Tables 4-4 and 4-5. The total dose from radionuclides in soils <4.6 m (0-15 ft) does not exceed the EHQ (1 rad/day). Data are not available for nonradiological contaminants, although historical records indicate that sodium dichromate may be present. Radiological data were not available for the 1.8 m (6 ft) soil profile. Data also were not available for radiological or nonradiological contaminants at the 0-1.8 m (0-6 ft) depth interval.

**3.1.1.9.4 Uncertainties Associated with the Ecological Evaluation.** The uncertainty associated with the approach used in the qualitative ecological evaluation for the 116-F-10 Dummy Decontamination French Drain is described in Section 1.3.3. The crib is relatively small (1 m diameter) and extends to a vertical depth of 6.1 m (16.5 ft). Because the drain was 6.1 m (16.5 ft) in depth, some of the contaminants may be deeper than rooting depth of native plants and, therefore, less likely to biotransport to the pocket mouse.

**3.1.1.10 116-F-11 (105-F) Cushion Corridor French Drain.**

**3.1.1.10.1 Human Health Risk Characterization.** Risks estimated for the frequent-use and occasional-use scenarios at the 116-F-11 (105-F) Cushion Corridor French Drain site are summarized in Table 3-26 and Figure 3-10.

Several radionuclide COPC represent estimated ICR $>10^{-6}$ in the frequent-use scenario. Cobalt-60, cesium-137, europium-152, and europium-154 soil concentrations represent ICR $>10^{-6}$ from the external radiation exposure pathway. None of the COPC are estimated to contribute significant ICR from the ingestion and inhalation pathways in the frequent-use scenario.

Europium-152 soil concentrations represent ICR $>10^{-6}$ from external radiation exposure in the occasional-use scenario. Neither the ingestion or inhalation exposure pathways contributed significant ICR in the occasional-use scenario.

The lifetime ICR to humans is considered "medium" in the frequent-use scenario and "low" in the occasional-use scenario. The external radiation exposure pathway is the major contributor to ICR. Europium-152 is the major contributor to risk in both scenarios, followed by cesium-137 and europium-154.

A 71 percent reduction in site ICR is anticipated if the onset of frequent-use scenario exposures is delayed until 2018. The resulting site ICR would remain classified as "medium". External radiation exposure would remain the primary pathway contributing to ICR.

An allowance for the shielding effects of clean-fill soils is not expected to reduce the external radiation exposure risks for the occasional-use scenario. The maximum soil concentrations of all COPC at this site were measured within 1.8 m (6 ft) below the surface.

**3.1.1.10.2 Human Health Risk Characterization Uncertainty Analysis.** Uncertainties attributed to the methodology and to quality of the data used in this QRA are discussed in Section 1.4 and Section 2.6, respectively.

The soils at this waste site were not analyzed for chemical contaminants. As a result, the potential human health ICR and HI are probably under-estimated. However, the contributions of chemical COPC to ICR are estimated to be much lower than ICR from radionuclide COPC at other 100-FR-1 Operable Unit waste sites.

**3.1.1.10.3 Ecological Evaluation for the 116-F-11 Cushion Corridor French Drain.** The total calculated dose rates to the Great Basin pocket mouse from radionuclides in the soil inside the Cushion Corridor French Drain are listed in Tables 3-27 and 3-28, and their EHQ are summarized in Tables 4-4 and 4-5. The total dose from radionuclides in soils <4.6 m (0-15 ft) does not exceed the EHQ (1 rad/day). Data are not available for nonradiological contaminants for this site.

**3.1.1.10.4 Uncertainties Associated with the Ecological Evaluation.** The uncertainty associated with the general approach used in the qualitative ecological evaluation for the 116-F-11 Cushion Corridor French Drain is described in Section 1.3.3. The nearest soil samples were taken from approximately 30 m (81 ft) away from the drain and are not necessarily representative of the contents of the drain.

**3.1.1.11 116-F-14 (107-F) Retention Basin.**

**3.1.1.11.1 Human Health Risk Characterization.** Risks estimated for the frequent-use and occasional-use scenarios at the 116-F-14 (107-F) Retention Basin site are summarized in Table 3-29 and Figure 3-11.

Several COPC represent estimated ICR $> 10^{-6}$ in the frequent-use scenario. Potassium-40, cobalt-60, cesium-134, cesium-137, europium-152, europium-154, europium-155, radium-226, thorium-228, and uranium-238 soil concentrations represent ICR $> 10^{-6}$ from the external radiation exposure pathway. Incremental cancer risks $> 10^{-6}$ are also estimated for ingestion exposures to cobalt-60, nickel-63, strontium-90, cesium-137, europium-152, europium-154, uranium-238, plutonium-239/240. Incremental cancer risks $> 10^{-6}$ are estimated for inhalation exposures to chromium, cobalt-60, europium-152, europium-154, uranium-238, and plutonium-239/240 in this scenario. The total HI do not exceed 1.0 in the frequent-use scenario

Cobalt-60, cesium-134, cesium-137, europium-152, europium-154 and europium-155 external radiation exposures represent ICR $> 10^{-6}$ in the occasional-use scenario. Incremental cancer risks $> 10^{-6}$ from cesium-137 are also estimated to result from ingestion exposures, however, no such ICR are estimated for the inhalation pathway in this scenario. The total HI do not exceed 1.0 in the occasional-use scenario.

The estimated lifetime ICR to humans is considered "high" in the frequent-use scenario and "medium" in the occasional-use scenario. The external radiation exposure pathway is the major contributor to ICR in both scenarios. Cobalt-60, cesium-137, europium-152, and europium-154 are identified as the major COPC contributing to risk.

A 74 percent reduction in total ICR is anticipated if the onset of frequent-use scenario exposures is delayed until 2018. The resulting ICR classification would remain "high". External radiation exposure would remain the primary pathway contributing to ICR.

An allowance for the shielding effects of clean-fill soils is not expected to significantly reduce the external radiation exposure risks for the occasional-use scenario. The maximum soil concentrations of the primary COPC contributing to risk were all measured within 1.8 m (6 ft) below the surface at this site.

**3.1.1.11.2 Human Health Risk Characterization Uncertainty Analysis.** Uncertainties attributed to the methodology and to quality of the data used in this QRA are discussed in Section 1.4 and Section 2.6, respectively.

**3.1.1.11.3 Ecological Evaluation for the 116-F-14 Retention Basin.** The total calculated dose rates to the Great Basin pocket mouse from radionuclides, organics, and inorganics in the soil inside the 116-F-14 Retention Basin are listed in Tables 3-30 and 3-31, and their EHQ are summarized in Tables 4-4 and 4-5. The total dose (0.55 rad/day) from radionuclides (primarily strontium-90) in soils < 4.6 m (15 ft) does not exceed the EHQ (1 rad/day). The EHQ for radionuclides is three orders of magnitude less using the 0 - 1.8 m (0 - 6 ft) soil contamination profile. The primary radionuclide contributing to the dose rate to the pocket mouse is strontium-90 with a dose rate of 0.50 rad/day.

The wildlife NOEL (Table 1-5) for nonradiological contaminants were exceeded by cadmium and zinc in the 0-4.6 m (0-15 ft) profile as well as the top 1.8 m (6.0 ft). Cadmium and zinc are potentially available for biotransport to the pocket mouse.

**3.1.1.11.4 Uncertainties Associated with the Ecological Evaluation.** The uncertainty associated with the general approach used in the qualitative ecological evaluation for this waste site is described in Section 1.3.3. Maintenance of gravel covers and vegetation-free areas (i.e., using herbicide) would be expected to reduce the desirability of the habitat for pocket mice.

### 3.1.1.12 Process/Discharge Pipelines.

**3.1.1.12.1 Human Health Risk Characterization.** Risks estimated for the frequent-use and occasional-use scenarios at the Process/Discharge Pipelines are summarized in Table 3-32 and Figure 3-12.

Three radionuclide COPC represent estimated ICR $> 10^{-6}$ in the frequent-use scenario. Cobalt-60, cesium-137, and europium-152 soil concentrations represent ICR $> 10^{-6}$ from the external radiation exposure pathway. None of the COPC are estimated to contribute significant ICR from the ingestion and inhalation pathways in the frequent-use scenario.

None of the radionuclide COPC represent an ICR $> 10^{-6}$ in the occasional-use scenario.

The estimated lifetime ICR to humans is considered "low" in the frequent-use scenario and "very low" in the occasional-use scenario. The external radiation exposure pathway is the major contributor to ICR at this site. Europium-152 is the major contributor to risk, followed by cobalt-60 and cesium-137.

A 69 percent reduction in total ICR is anticipated if the onset of frequent-use scenario exposures is delayed until 2018. However, the resulting site ICR classification would remain "low" in the frequent-use scenario. External radiation exposure would remain the primary pathway contributing to ICR.

An allowance for the shielding effects of clean-fill soils is not expected to significantly reduce the external radiation exposure ICR for the occasional-use scenario. The maximum soil concentrations of the primary COPC contributing to risk were found within 1.8 m (6 ft) below soil surface.

**3.1.1.12.2 Human Health Risk Characterization Uncertainty Analysis.** Uncertainties attributed to the methodology and to quality of the data used in this QRA are discussed in Section 1.4 and Section 2.6, respectively.

The soils at this waste site were not analyzed for potential chemical contaminants. As a result, the potential ICR and HI associated with chemical COPC are probably under-estimated. However, the contributions of chemical COPC to ICR is estimated to be much lower than ICR from radionuclide COPC at other 100-FR-1 Operable Unit waste sites.

**3.1.1.12.3 Ecological Evaluation for the Process Discharge/Pipelines.** The total calculated dose rates to the Great Basin pocket mouse from radionuclides in the soil inside the Process/Discharge Pipelines are listed in Tables 3-33 and 3-34, and their EHQ are summarized in Table 4-4. The total dose from radionuclides in soils $<4.6$ m (0-15 ft) does not exceed the EHQ (1 rad/day). No data are available concerning nonradiological contaminants.

**3.1.1.12.4 Uncertainties Associated with the Ecological Evaluation.** The uncertainty associated with the general approach used in the qualitative ecological evaluation for this waste site is described in Section 1.3.3.

### 3.1.2 Waste Sites Without Data

The characterization of risk associated with uncharacterized sites is based on process knowledge and characterization information from analogous sites. Specific uncertainties associated with the risk characterization are identified.

Because there is no sampling information for these sites, an ecological evaluation will not be provided. The identification of potential contaminants is limited to process information and ecologically these sites may not be comparable to any analogous site. See Chapter 2.0 for further information.

#### 3.1.2.1 116-F-8 (1904-F) Outfall Structure.

**3.1.2.1.1 Human Health Risk Characterization.** The 116-F-14 Retention Basin was selected as the waste site analogous to the 116-F-8 (1904-F) Outfall Structure (Section 2.2.1). Based on this analogy, the 116-F-8 Outfall Structure is expected to represent "high" risk in the frequent-use scenario and "medium" risks in the occasional-use scenario. Contaminants of potential concern at this site might include cobalt-60 and cesium-137. The external radiation exposure pathway is expected to be the primary risk-contributing pathway at this waste site.

**3.1.2.1.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain as a result of the absence of soil sample analysis data for this waste site. Although coolant water leakage into adjacent soils has not been documented from the 116-F-8 Outfall Structure, the coolant water handled at the 116-F-8 (1904-F) Outfall Structure is assumed to have similar composition and leakage rates into adjacent soils as at the 116-F-14 Retention Basin, which has been characterized. This uncertainty has an undetermined impact on the qualitative risk characterization of the 116-F-8 Outfall Structure, such that the risk might be either over- or under-estimated. If the 116-D-5 waste site was chosen as an analogous waste site (see Section 2.2.1), the analogous risks associated with the 116-F-8 Outfall Structure would also be estimated to be "high" for the frequent-use scenario and "medium" for the occasional-use scenario (WHC 1993a).

#### 3.1.2.2 116-F-12 (148-F) French Drain.

**3.1.2.2.1 Human Health Risk Characterization.** The 116-F-14 Retention Basin is selected as the waste site analogous to the 116-F-12 (148-F) French Drain. Based on this analogy, the 116-F-12 French Drain might represent "high" risks in the frequent-use scenario and "medium" risks in the occasional-use scenario. The HI for exposures to chemicals are not expected to exceed 1.0 in either the frequent-use or occasional-use scenario. Inhalation, ingestion, and external radiation are expected to be major pathways for exposure to the radionuclides described in Section 3.1.1.11.

**3.1.2.2.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain as a result of the absence of soil sample analysis data for this waste site. The coolant water handled at the 116-F-12 (148-F) French Drain is assumed to have similar composition and leakage rates into adjacent soils as at the characterized 116-F-14 Retention Basin. This uncertainty has an undetermined impact on the QRA for the 116-F-12 (148-F) French Drain, such that the ICR and HI might be over- or under-estimated.

### 3.1.2.3 116-F-13 (1705-F) Experimental Garden French Drain.

**3.1.2.3.1 Human Health Risk Characterization.** The 116-F-14 Retention Basin was selected as the analogous waste site to the 116-F-13 (1705-F) Experimental Garden French Drain. Based on this analogy, the 116-F-13 (1705-F) Experimental Garden French Drain may represent "high" risks in the frequent-use and "medium" risks" in the occasional-use scenario. Hazards from exposures to chemicals are not expected to exceed the human health effects threshold in either the frequent-use or occasional-use scenario. Inhalation, ingestion, and external radiation are expected to be major pathways for exposure to the radionuclides described in Section 3.1.1.11.

**3.1.2.3.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain as a result of the absence of soil sample analysis data from this waste site. The coolant water handled at the 116-F-13 (1705-F) Experimental Garden French Drain is assumed to have similar composition as coolant water stored in the 116-F-14 Retention Basin. However, leakage rates are assumed to exceed those at the retention basin because containment of effluent cooling water was not the purpose of this french drain. This uncertainty has an undetermined impact on the qualitative risk characterization of the 116-F-13 (1705-F) Experimental Garden French Drain, such that the ICR or HI might be over- or under-estimated.

### 3.1.2.4 132-F-6 (1608-F) Lift Station Demolition Site.

**3.1.2.4.1 Human Health Risk Characterization.** Soil analysis data could not be identified for this waste site within 4.6 m (15 ft) below the surface. The Process/Discharge Pipelines site was chosen as an analogous site for risk estimation at the 132-F-6 Lift Station Demolition Site. Based on this analogy, the 132-F-6 Lift Station Demolition Site is expected to represent "low" risks in the frequent-use scenario and "very low" risks in the occasional-use scenario. However, the 132-F-6 Site is located within approximately 76.2 to 137.2 m (250 to 450 ft) from both the 116-F-3 Fuel Storage Basin Trench and the 116-F-11 Cushion Corridor French Drain (Figure 1-2). As a result of their proximity, leakage from these sites might have contaminated the 132-F-6 Site at <4.6 m (15 ft) depth. Further, hypothetical activities included in the frequent- or occasional-use scenarios might include portions of the 116-F-3 or 116-F-11 Sites. Risks associated with the latter two sites are estimated at "medium" to "high" in the frequent-use scenario, and "low" to "medium" in the occasional-use scenario. Contaminants of potential concern at the 132-F-6 Site might include cobalt-60, cesium-137, europium-152, and europium-154. External radiation is anticipated to be the primary exposure pathway contributing to ICR.

**3.1.2.4.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain as a result of the absence of soil sample analysis data for this waste site within the soil interval of concern (i.e., surface to 4.6 m [15 ft] soil depth). This uncertainty has an undetermined impact on the qualitative risk characterization of the 132-F-6 Lift Station Demolition Site, such that the ICR and HI might be over- or under-estimated.

**3.1.2.5 PNL Outfall Structure.**

**3.1.2.5.1 Human Health Risk Characterization.** The 116-F-9 Animal Waste Leach Trench was selected as the waste site analogous to the PNL Outfall Structure. Based on this analogy, the PNL Outfall Structure might represent "medium" risks in the frequent-use and "low" risk in the occasional-use scenario. The primary risk-contributing pathway of concern would be the external exposure pathway. Radionuclide COPC might include potassium-40, europium-152, radium-226, and thorium-228.

Strontium-90 and plutonium-239 originating from animal research activities might contribute additional ICR from ingestion exposures. However, these COPC are not expected to be major contributors to ICR because ingestion is shown to be a minor exposure pathway at most other 100-FR-1 Operable Unit sites.

**3.1.2.5.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain as a result of the absence of soil sample analysis data for this waste site. This uncertainty has an undetermined impact on the qualitative risk characterization of the PNL Outfall Structure, such that the ICR and HI might be over- or under-estimated.

**3.1.2.6 UN-100-F1.**

**3.1.2.6.1 Human Health Risk Characterization.** The 116-F-9 Animal Waste Leach Trench was selected as the waste site analogous to the UN-100-F1 Site. Based on this analogy, the UN-100-F1 Site might represent "medium" risks for the frequent-use scenario and "low" risks for the occasional-use scenario. The primary risk contributing pathways might include inhalation, ingestion, and external radiation exposure. Radionuclide COPC might include potassium-40, cobalt-60, strontium-90, cesium-137, europium-152, radium-226, thorium-228, and plutonium-239. Chlordane might also contribute to ICR at this site.

**3.1.2.6.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain as a result of the absence of soil sample analysis data for this site. The selected analogous waste site has a history of repeated waste disposal compared to the single event release at the UN-100-F1 waste site. This difference in release history is a source of uncertainty that results in an over-estimation of the potential ICR or HI at the UN-100-F1 waste site.

## 3.2 NONPRIORITIZED WASTE SITES

### 3.2.1 Waste Sites with Data

The following sections present qualitative discussions of the risk at each nonprioritized waste site characterized by historical analytical data. Site-specific uncertainties associated with the risk characterization are identified.

#### 3.2.1.1 Basin Leak Ditch.

**3.2.1.1.1 Human Health Risk Characterization.** Risks estimated for the frequent-use and occasional-use scenarios at the Basin Leak Ditch site are summarized in Table 3-35 and Figure 3-13.

Several radionuclide COPC represent estimated ICR $> 10^{-6}$ in the frequent-use scenario. Cobalt-60, cesium-137, cesium-144, europium-152, europium-154, and europium-155, soil concentrations represent ICR $> 10^{-6}$ from the external radiation exposure pathway. Incremental cancer risks associated with cesium-137 ingestion is also estimated to exceed $10^{-6}$. Exposures by the inhalation pathway are not significant in the frequent-use scenario.

Incremental cancer risks $> 10^{-6}$ are estimated for external radiation exposures to cobalt-60, cesium-137, europium-152, and europium-154 in the occasional-use scenario. None of the other exposure pathways evaluated represent ICR $> 10^{-6}$ in the occasional-use scenario.

The total estimated lifetime ICR to humans is considered "high" in the frequent-use scenario and "medium" in the occasional-use scenario. External radiation exposure is the major exposure pathway contributing to ICR. Cobalt-60, europium-152, and europium-154 are the major risk contributors to ICR in both scenarios.

A 78 percent reduction in site ICR is anticipated if the onset of frequent-use scenario exposures is delayed until 2018. The resulting site ICR would be re-classified as "medium". External radiation exposure would remain the primary pathway contributing to ICR.

**3.2.1.1.2 Human Health Risk Characterization Uncertainty Analysis.** Uncertainties attributed to the methodology and to quality of the data used in this QRA are discussed in Section 1.4 and Section 2.6, respectively.

The soils at this waste site were not analyzed for potential chemical contaminants. As a result, the associated human health ICR and HI are probably under-estimated. However, the contributions of chemical COPC to ICR are estimated to be much lower than ICR from radionuclide COPC at other 100-FR-1 Operable Unit waste sites.

**3.2.1.1.3 Ecological Evaluation for the Basin Leak Ditch.** The total calculated dose rates to the Great Basin pocket mouse from radionuclides in the soil inside the Basin

Leak Ditch are listed in Tables 3-36 and 3-37, and their EHQ are summarized in Table 4-4. The total dose from radionuclides in soils <4.6 m (0-15 ft) and 1.8 m (0-6 ft) does not exceed the EHQ (1 rad/day). No data are available concerning nonradiological contaminants.

**3.2.1.1.4 Uncertainties Associated with the Ecological Evaluation.** The uncertainty associated with the general approach used in the qualitative ecological evaluation for this waste site is described in Section 1.3.3.

**3.2.1.2 EM Bypass Ditch.**

**3.2.1.2.1 Human Health Risk Characterization.** Risks estimated for the frequent-use and occasional-use scenarios at the EM Bypass Ditch site are summarized in Table 3-38 and Figure 3-14.

Several radionuclide COPC represent ICR $> 10^{-6}$ in the frequent-use scenario. Cobalt-60, cesium-137, cesium-144, europium-152, europium-154, and europium-155 soil concentrations represent ICR $> 10^{-6}$ from the external radiation exposure pathway. Incremental cancer risks associated with cesium-137 ingestion was also estimated to exceed $10^{-6}$. Exposures by the inhalation pathway were not significant in the frequent-use scenario.

Incremental cancer risks $> 10^{-6}$ are estimated for external radiation exposure to cobalt-60, cesium-137, europium-152, and europium-154, in the occasional-use scenario. None of the other exposure pathways evaluated represent ICR $> 10^{-6}$ in the occasional-use scenario.

The total estimated lifetime ICR to humans is considered "high" in the frequent-use scenario and "medium" in the occasional-use scenario. External radiation exposure is the major exposure pathway contributing to ICR. Cobalt-60, cesium-137, europium-152, and europium-154 are the major contributors in both scenarios.

A 77 percent reduction in site ICR is anticipated if the onset of frequent-use scenario exposures is delayed until 2018. The resulting ICR would remain "medium". External radiation exposure would remain the primary pathway contributing to ICR.

**3.2.1.2.2 Human Health Risk Characterization Uncertainty Analysis.** Uncertainties attributed to the methodology and to quality of the data used in this QRA are discussed in Section 1.4 and Section 2.6, respectively.

The soils at this waste site were not analyzed for potential chemical contaminants. As a result, the potential human health ICR and HI are probably under-estimated. However, the contributions of chemical COPC to ICR are estimated to be much lower than ICR from radionuclide COPC at other 100-FR-1 Operable Unit waste sites.

**3.2.1.2.3 Ecological Evaluation for the EM Bypass Ditch.** The total calculated dose rates to the Great Basin pocket mouse from radionuclides in the soil inside the EM Bypass Ditch are listed in Tables 3-39 and 3-40, and their EHQ are summarized in Table 4-4. The total dose from radionuclides in soils <4.6 m (0-15 ft) and 1.8 m (0-6 ft)

does not exceed the EHQ (1 rad/day). No data are available concerning nonradiological contaminants.

**3.2.1.2.4 Uncertainties Associated with the Ecological Evaluation.** The uncertainty associated with the general approach used in the qualitative ecological evaluation for this waste site is described in Section 1.3.3.

### 3.2.2 Waste Sites Without Data

The characterization of risks associated with uncharacterized sites are based on process knowledge and characterization information from analogous sites. Specific uncertainties associated with the risk characterization are identified.

#### 3.2.2.1 128-F-2 Burning Pit.

**3.2.2.1.1 Human Health Risk Characterization.** None of the characterized 100-FR-1 Operable Unit sites could be identified as analogous to the 128-F-2 Burning Pit. Because disposal of radionuclides or handling of effluent cooling water is not documented at the 128-F-2 Burning Pit, the risks associated with radionuclide exposure is surmised to be "very low". In general, the ICR associated with chemical COPC evaluated at other 100-FR-1 Operable Unit waste sites are below the ICR for radionuclide exposure; and, further, the HI estimated for systemic toxicity from exposure to chemicals has been found to be $< 1.0$ at all other 100-FR-1 Operable Unit waste sites.

**3.2.2.1.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative human health risk characterization is highly uncertain as a result of the absence of soil sample analysis data. This site might contain chemical COPC that have not been reported at other waste sites or might contain COPC at higher concentrations than reported at other characterized waste sites. These sources of uncertainty have an unknown impact on the 128-F-2 Burning Pit human health risk characterization, however, they might result in an under-estimation of risks at the 128-F-2 Burning Pit.

#### 3.2.2.2 Pre-Reactor Cooling Water Facilities.

**3.2.2.2.1 Human Health Risk Characterization.** No single 100-FR-1 Operable Unit site is selected as analogous to the Pre-Reactor Cooling Water Facilities. Based on knowledge of processes at the Pre-Reactor Coolant Water Facilities, the radionuclide COPC in soils are assumed to approximate the radionuclide content of soils measured at the 116-F-5 Ball Washer Crib. Thus ICR associated with the Pre-Reactor Coolant Water Facilities are estimated to be "low" in the frequent-use scenario and "very low" in the occasional-use scenario. Because the chemical COPC in the river water treated chemically to produce useful coolant is expected to be analogous to that of post-reactor cooling water, the risks associated with chemical COPC in soil at the Pre-Reactor Coolant Water Facilities and the 116-F-14 Retention Basin are assumed to be analogous. Based on this analogy, the total HI associated with COPC in soil at the Pre-Reactor Coolant Water Facilities are not expected to exceed 1.0.

**3.2.2.2.2 Human Health Risk Characterization Uncertainty Analysis.** The qualitative risk characterization is highly uncertain as a result of the absence of soil sample analysis data for this waste site. River water leakage into adjacent soils from the Pre-Reactor Coolant Water Facilities has not been documented. The selection of the 116-F-5 Ball Washer Crib soils as analogous to the radionuclide constituents and the 116-F-14 Retention Basin soils as analogous to the chemical constituents in soils at the Pre-Reactor Coolant Water Facilities are reasonable based on knowledge of process history. However, these assumptions introduce uncertainties that might result in an over-estimation of the potential risks at the Pre-Reactor Coolant Water Facilities.

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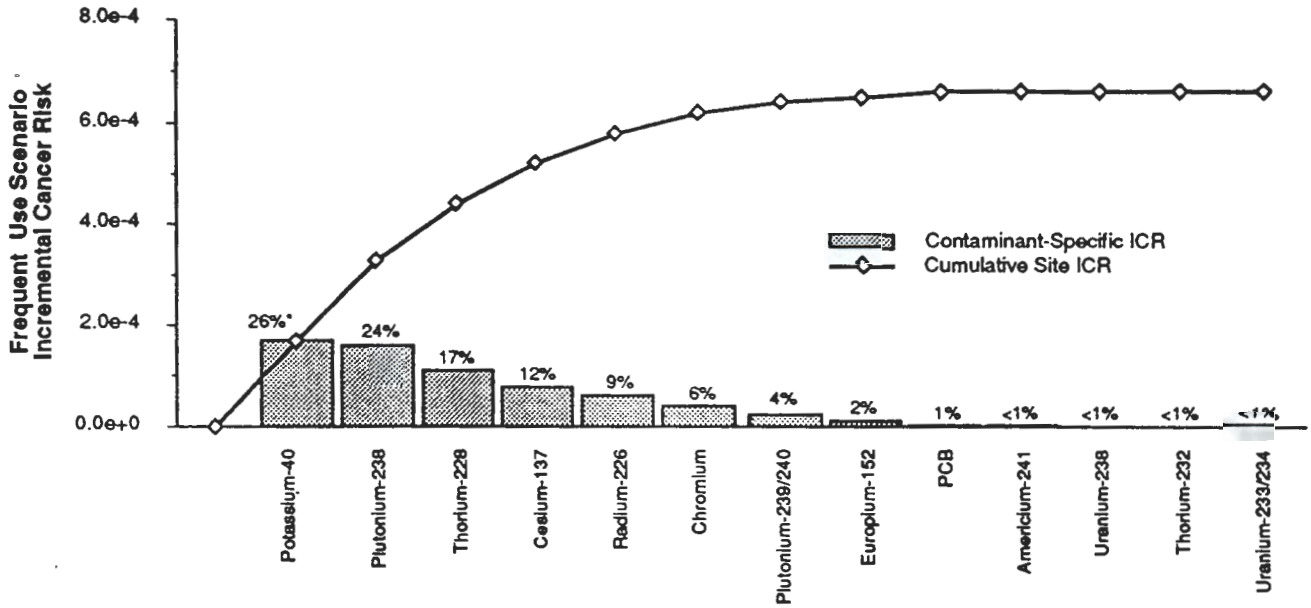
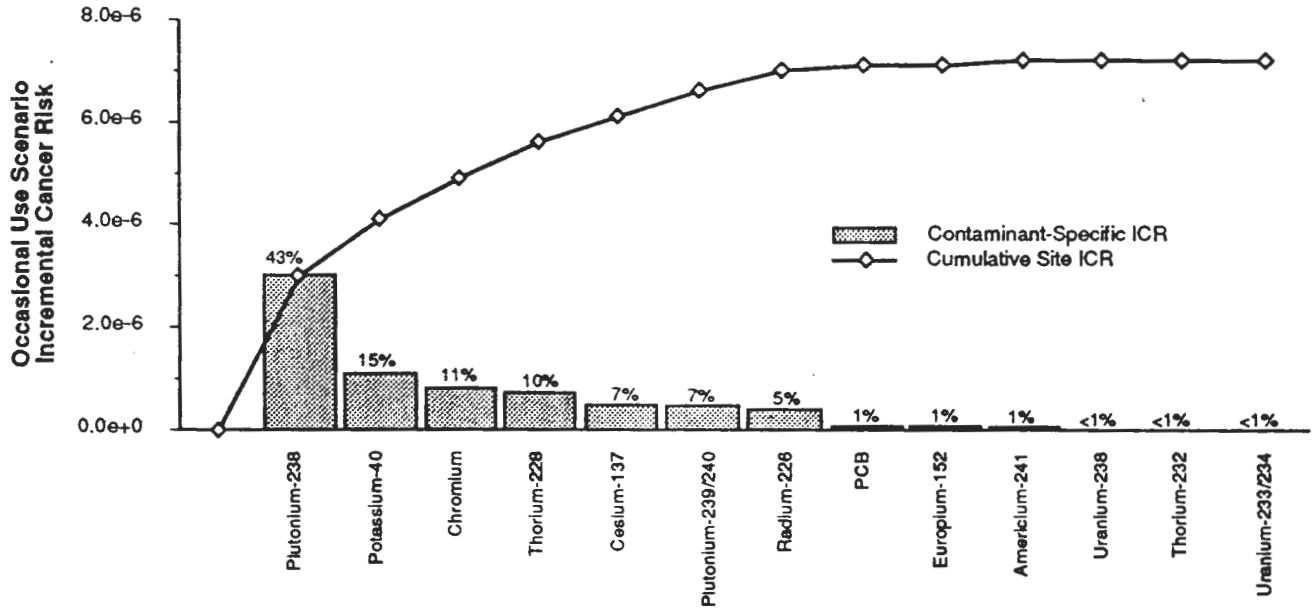
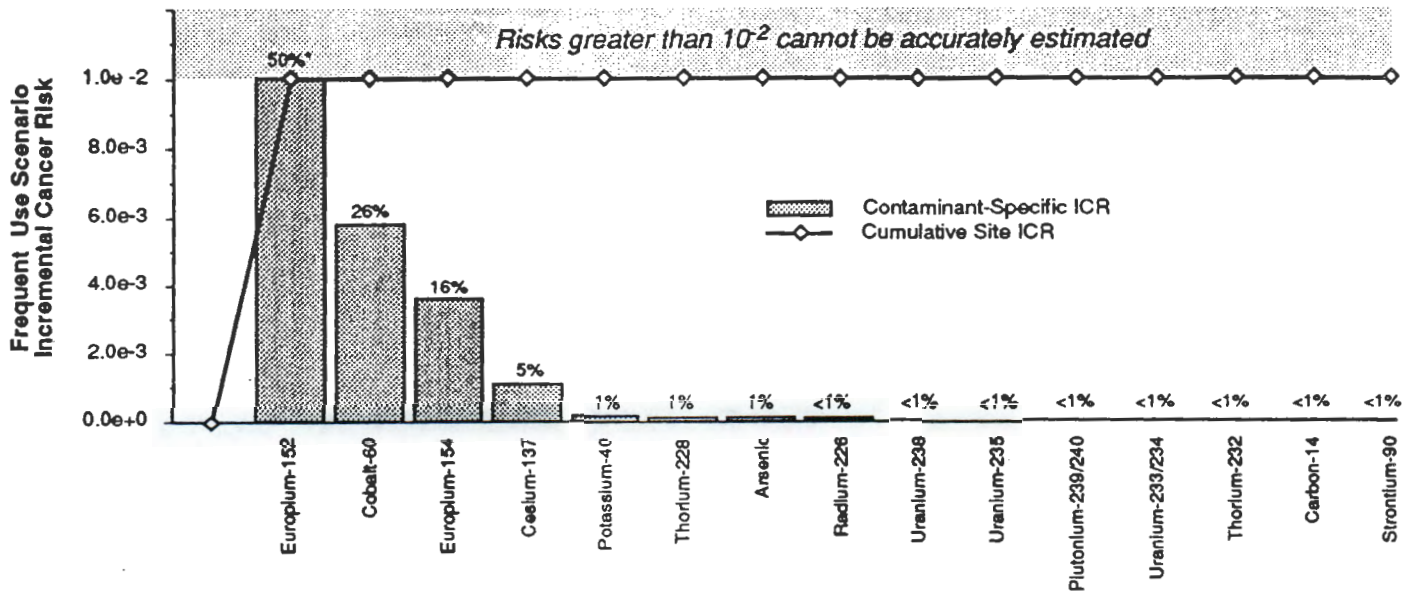
**Figure 3-1 108-F French Drain Human Health Risk Characterization**

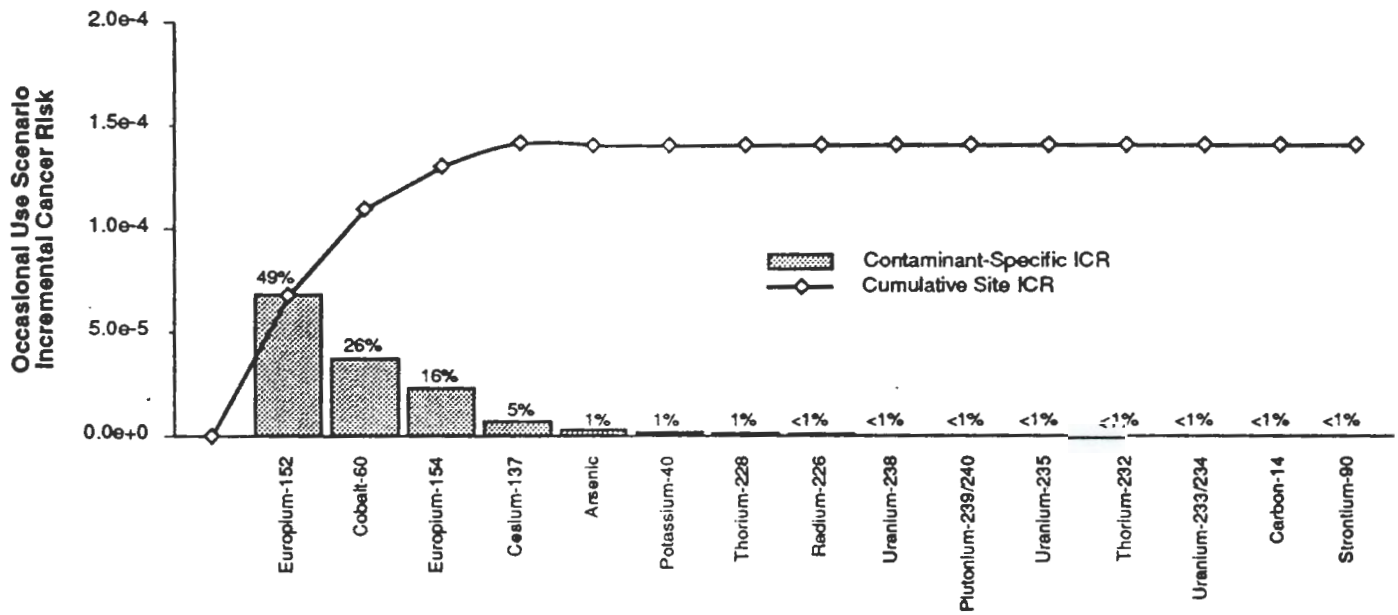



* = number at the top of each bar represents the percent of the total risk for each radionuclide.

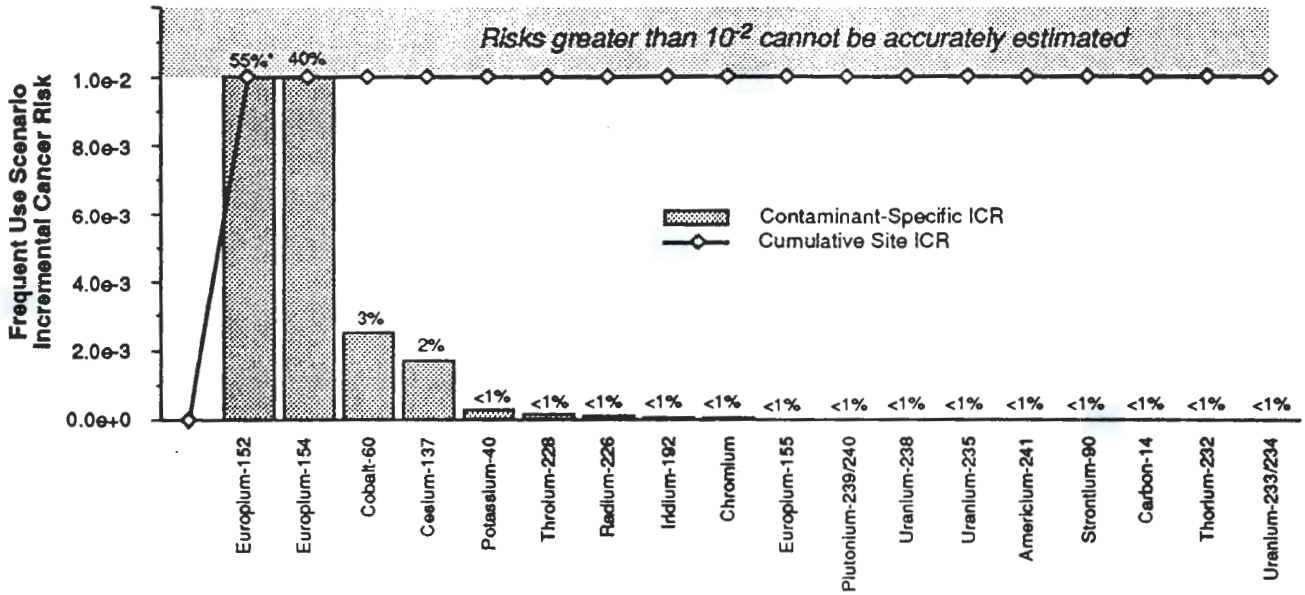
**Figure 3-2 116-F-1 Lewis Canal Human Health Risk Characterization**

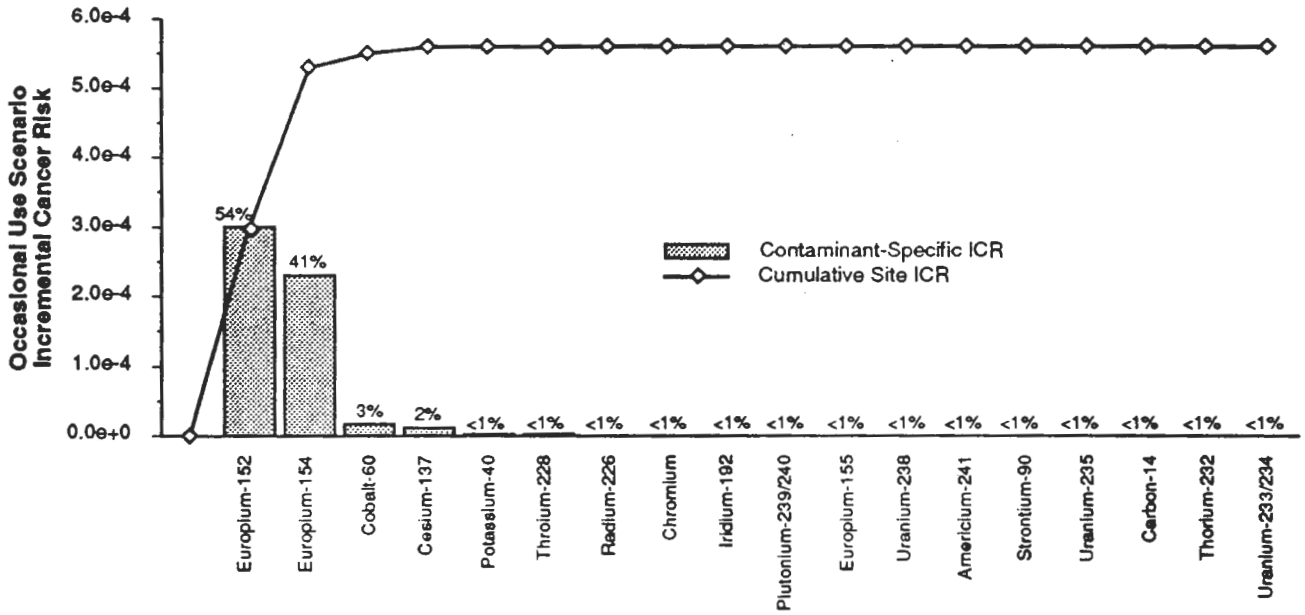



* = number at the top of each bar represents the percent of the total risk for each radionuclide.

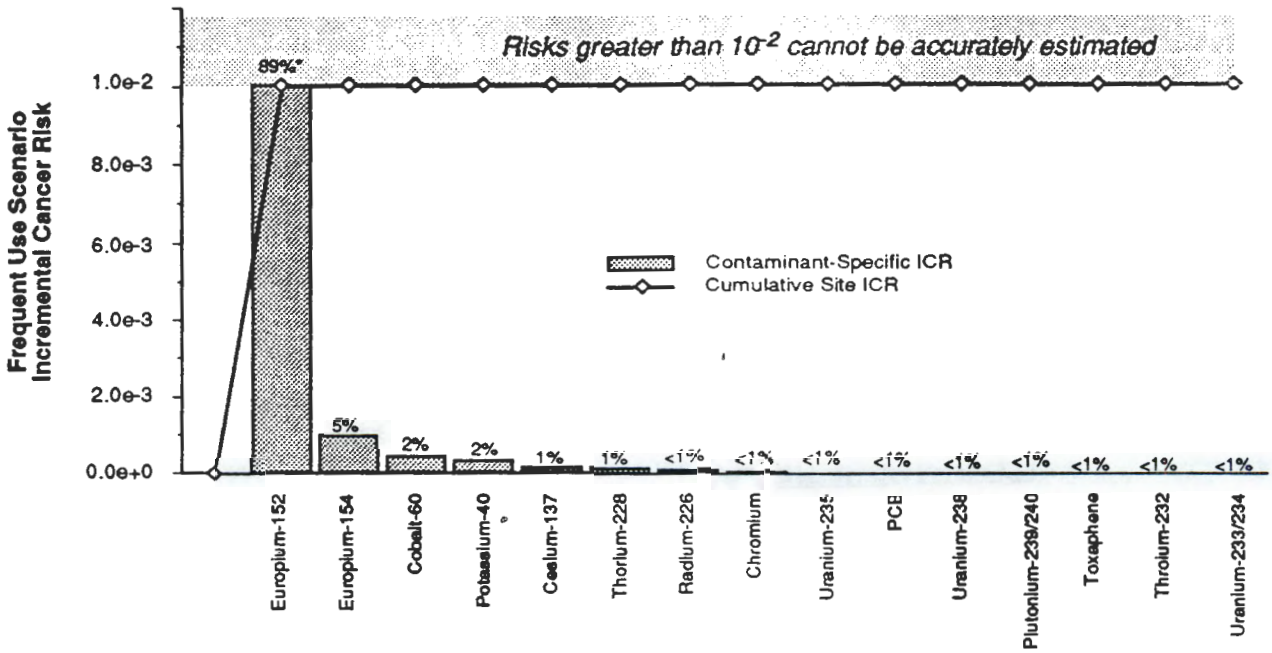
**Figure 3-3 116-F-2 (107-F) Basin Overflow Trench Human Health Risk Characterization**

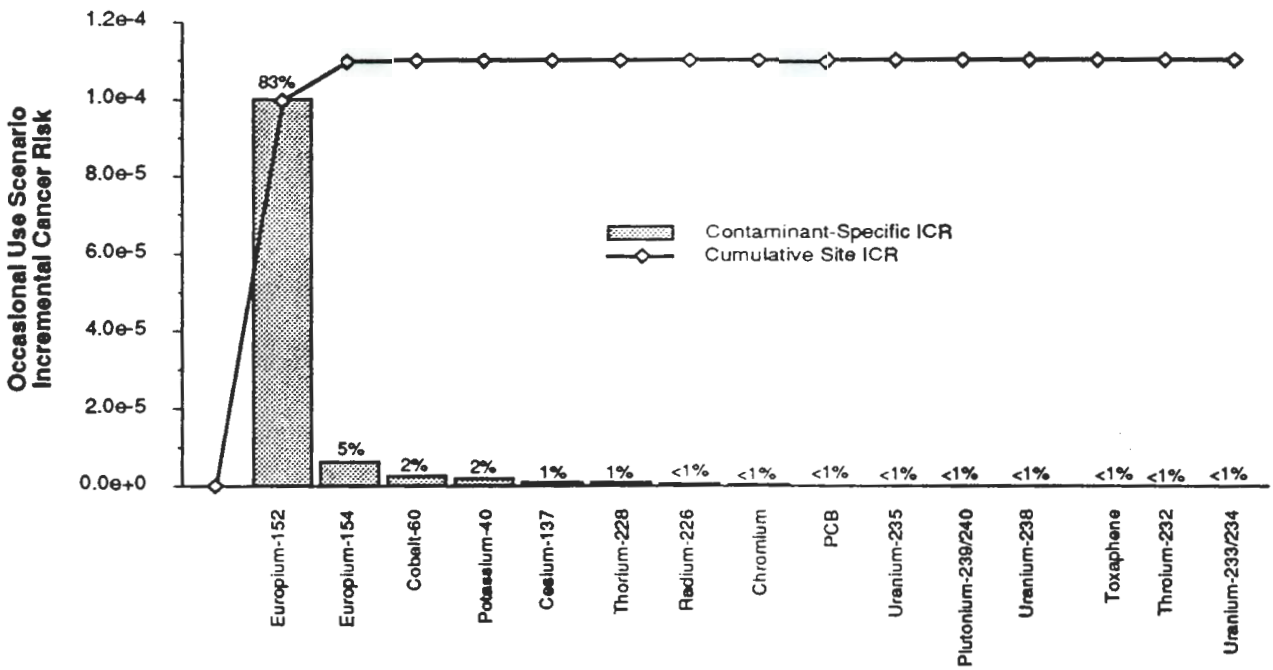



* = number at the top of each bar represents the percent of the total risk for each radionuclide.

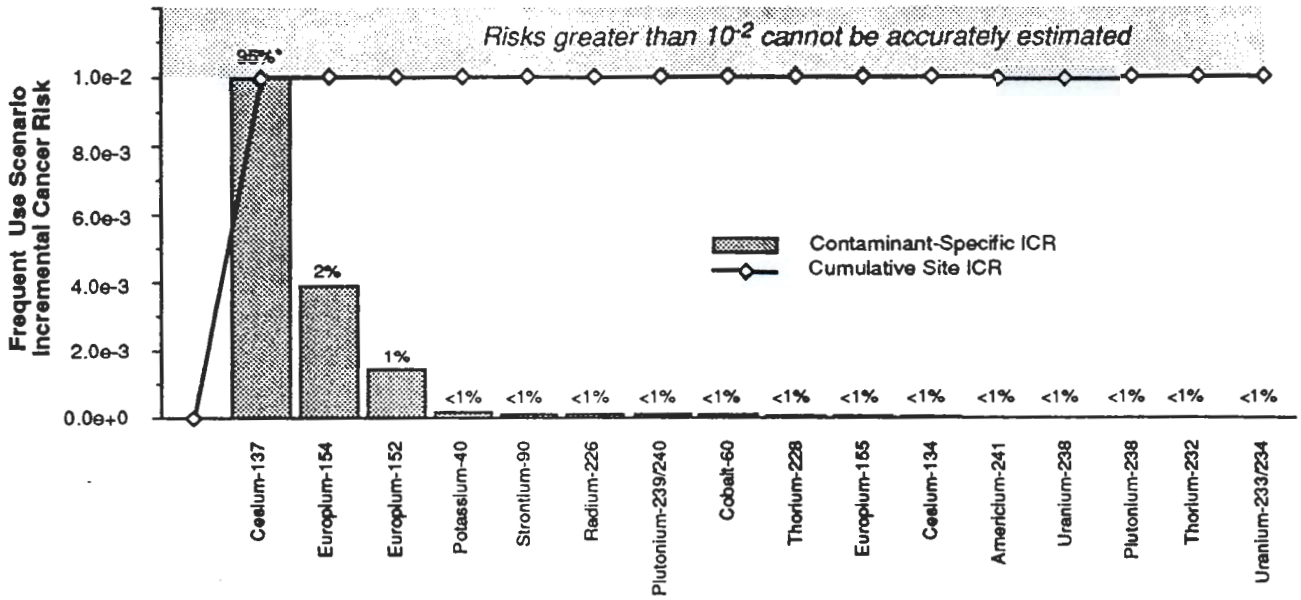
**Figure 3-4 116-F-3 (105-F) Fuel Storage Basin Trench Human Health Risk Characterization**

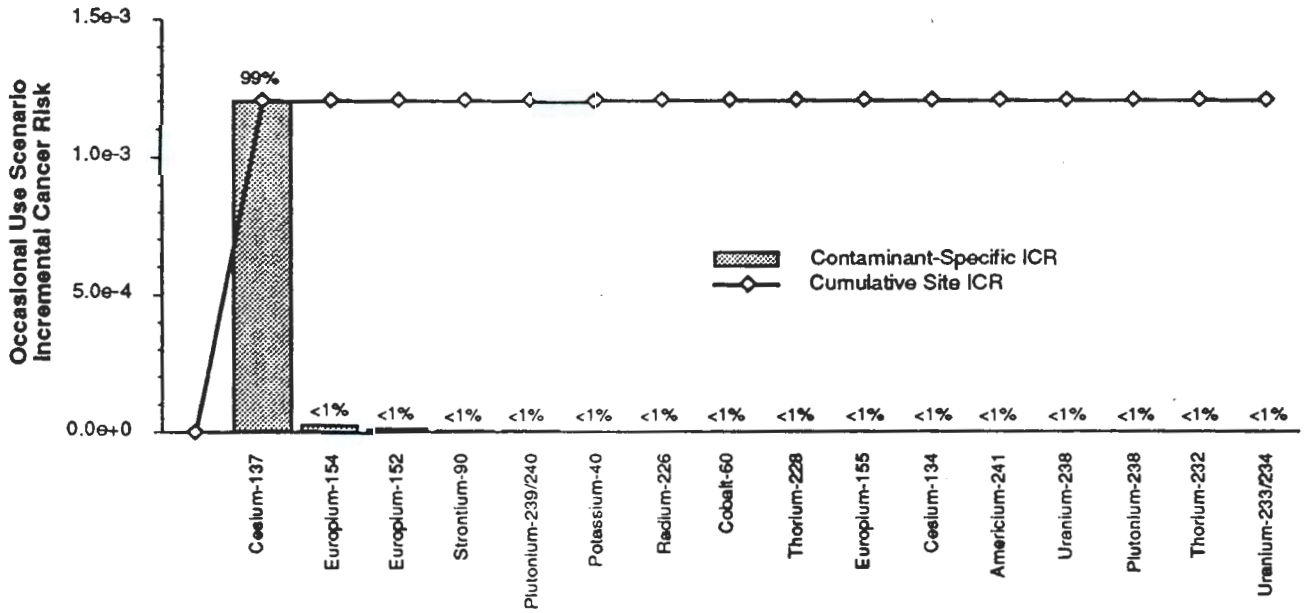



* = number at the top of each bar represents the percent of the total risk for each radionuclide.

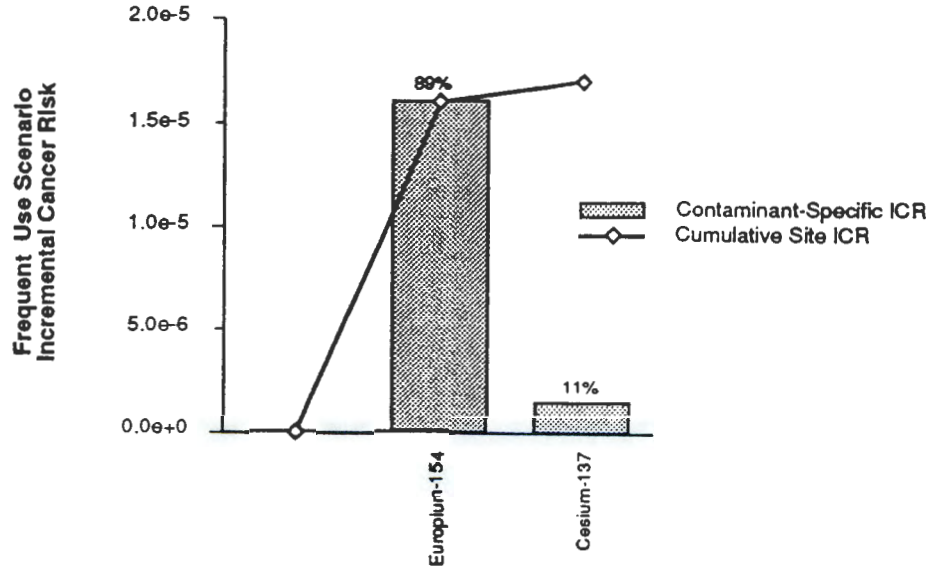
**Figure 3-5 116-F-4 (105-F) Pluto Crib Human Health Risk Characterization**

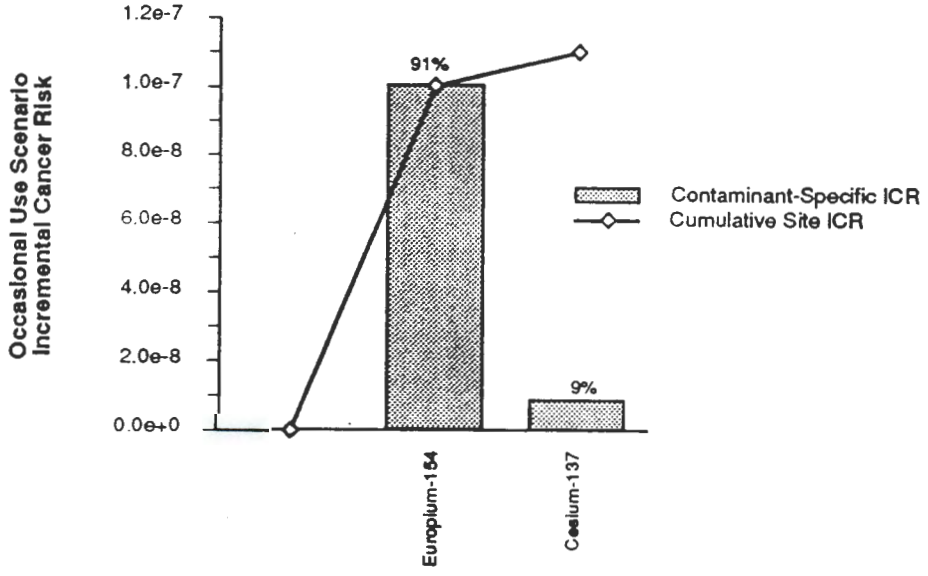



* = number at the top of each bar represents the percent of the total risk for each radionuclide.

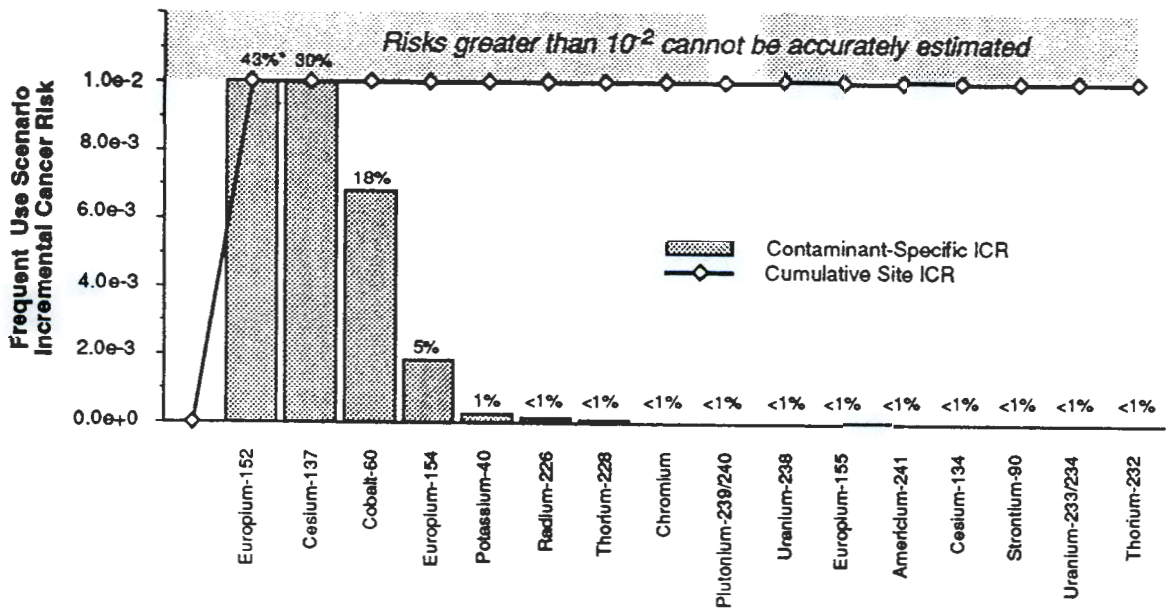
**Figure 3-6 116-F-5 Ball Washer Crib Human Health Risk Characterization**

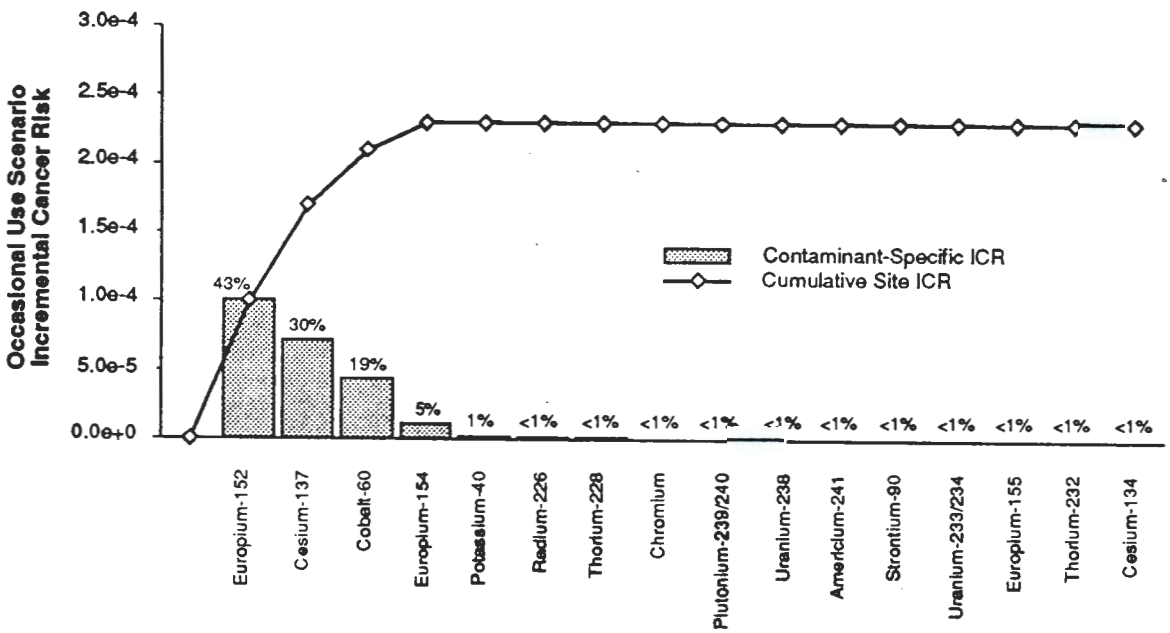



* = number at the top of each bar represents the percent of the total risk for each radionuclide.

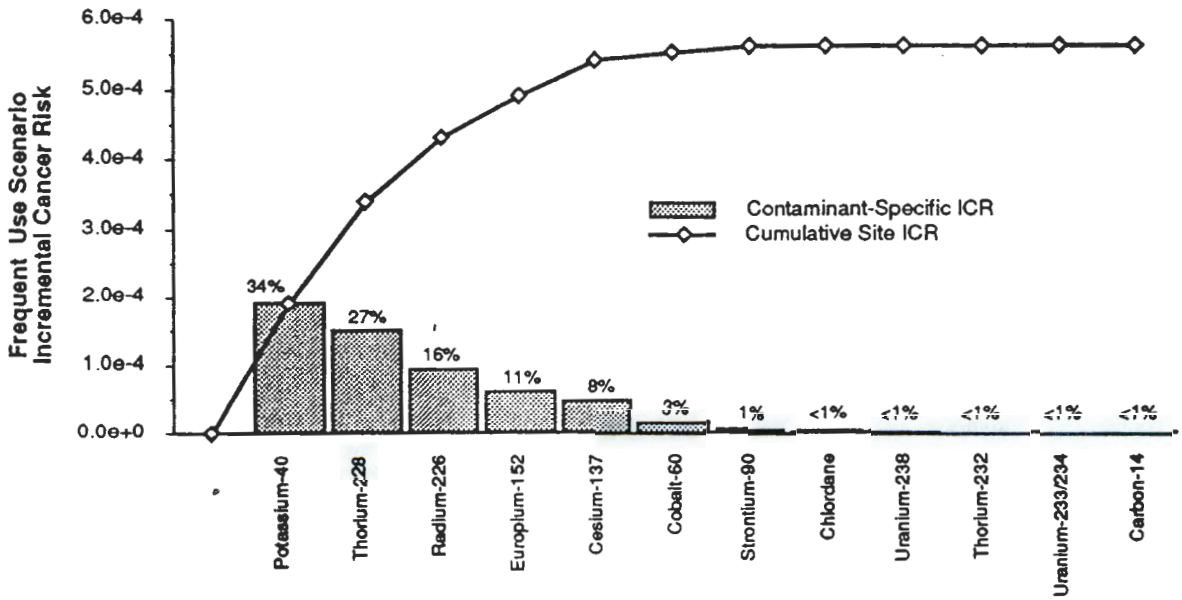
**Figure 3-7 116-F-6 (1608-F) Liquid Waste Disposal Trench Human Health Risk Characterization**

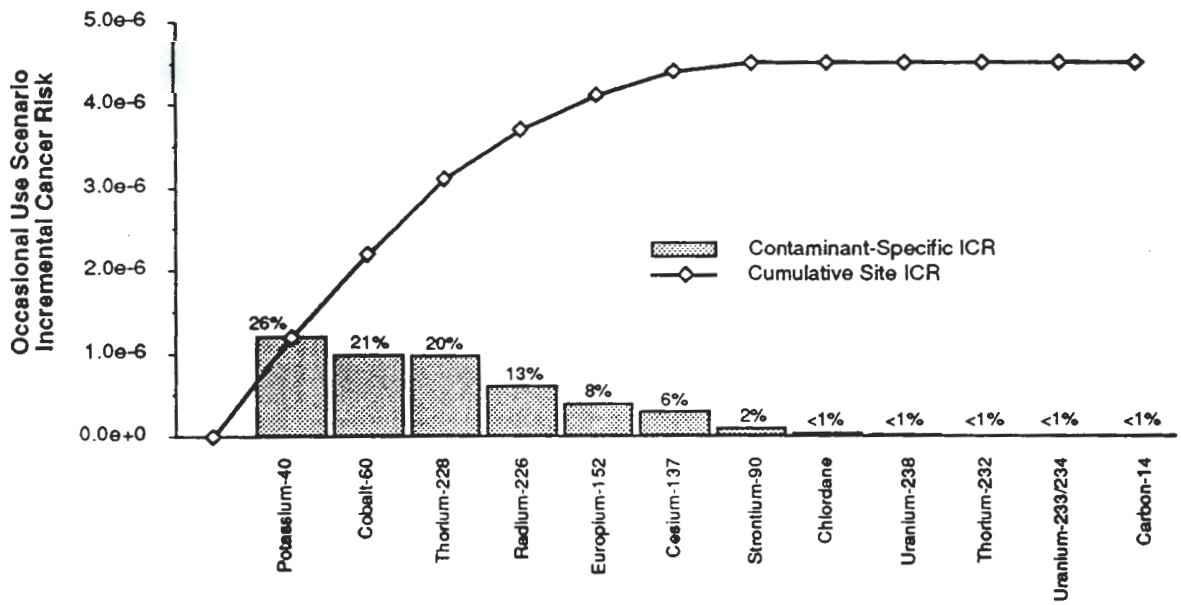



* = number at the top of each bar represents the percent of the total risk for each radionuclide.

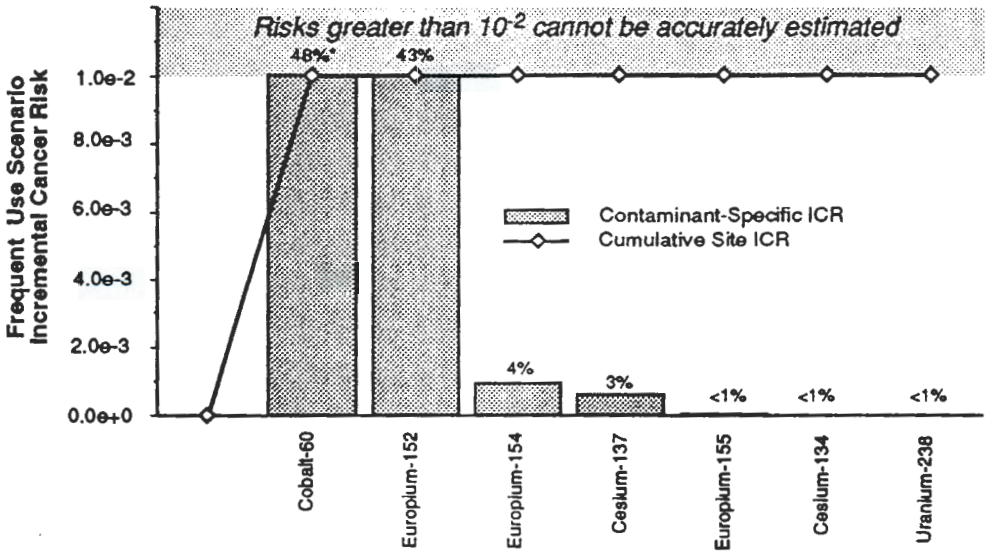
**Figure 3-8 116-F-9 PNL Animal Waste Leach Trench Human Health Risk Characterization**

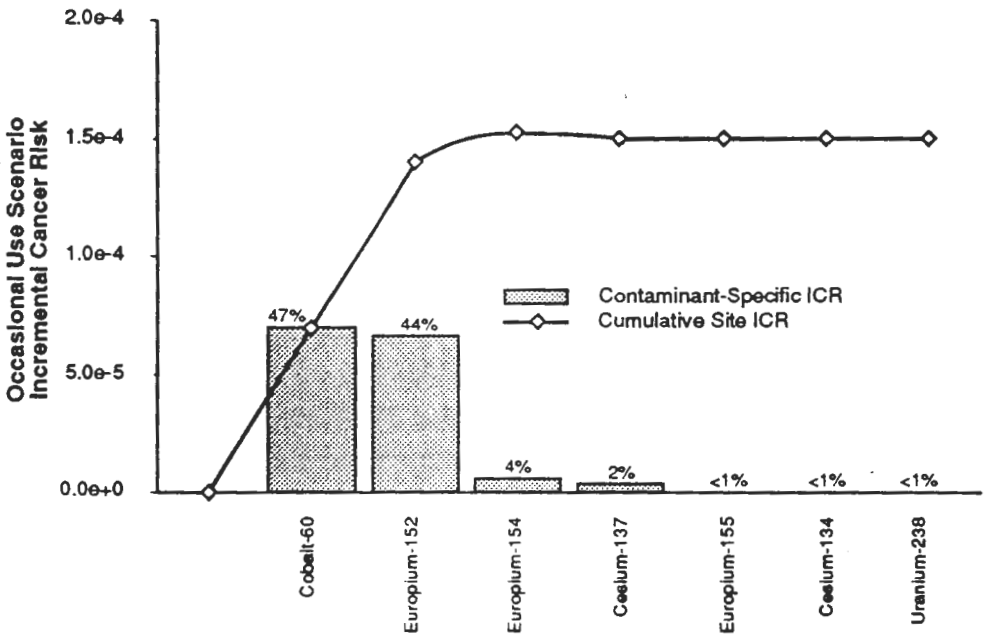



* = number at the top of each bar represents the percent of the total risk for each radionuclide.

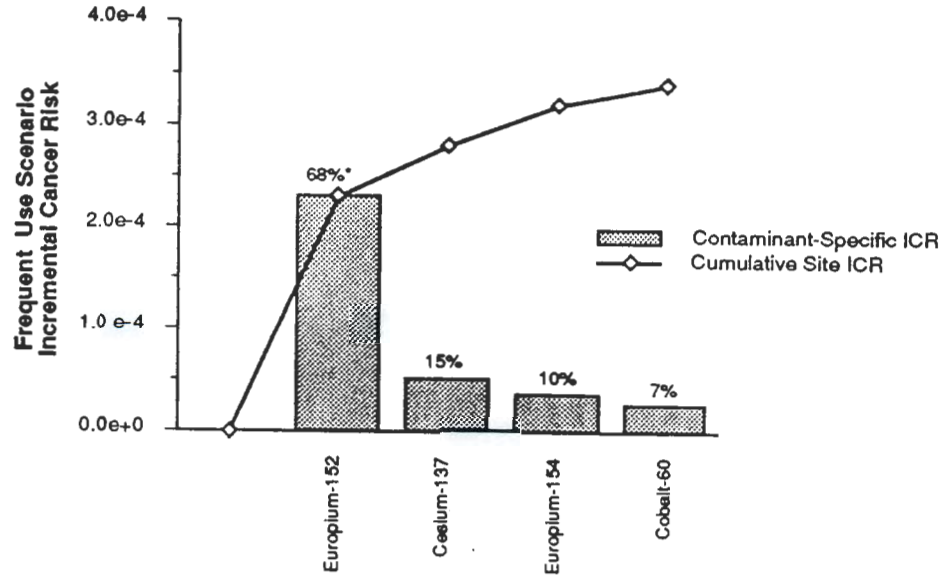
**Figure 3-9 116-F-10 (105-F) Dummy Decontamination French Drain Human Health Risk Characterization**

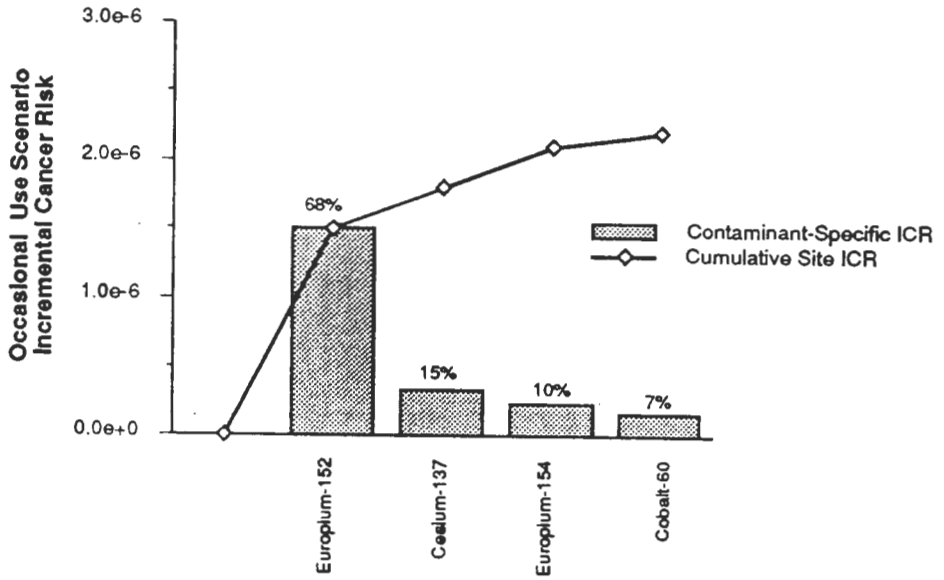



* = number at the top of each bar represents the percent of the total risk for each radionuclide.

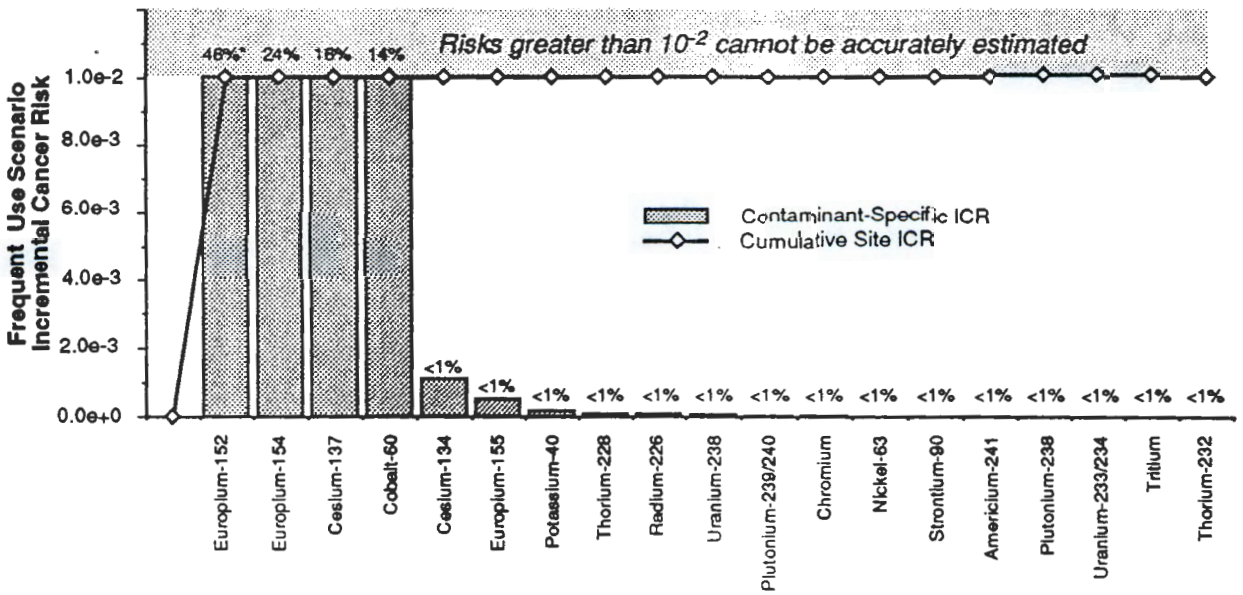
**Figure 3-10 116-F-11 (105-F) Cushion Corridor French Drain Human Health Risk Characterization**

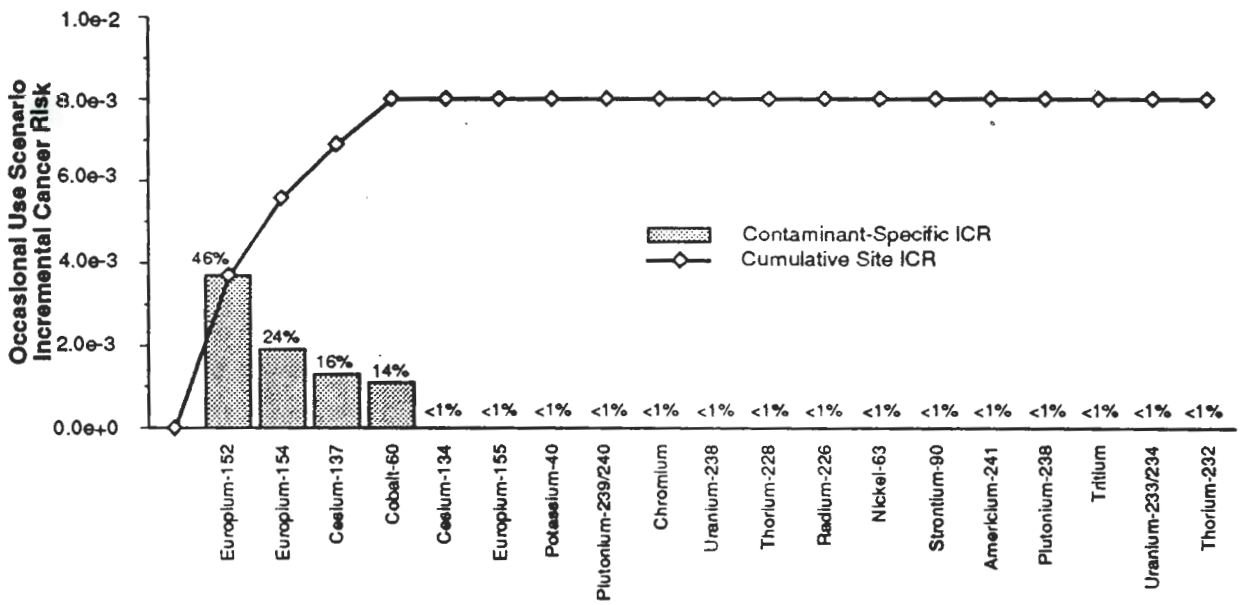



* = number at the top of each bar represents the percent of the total risk for each radionuclide.

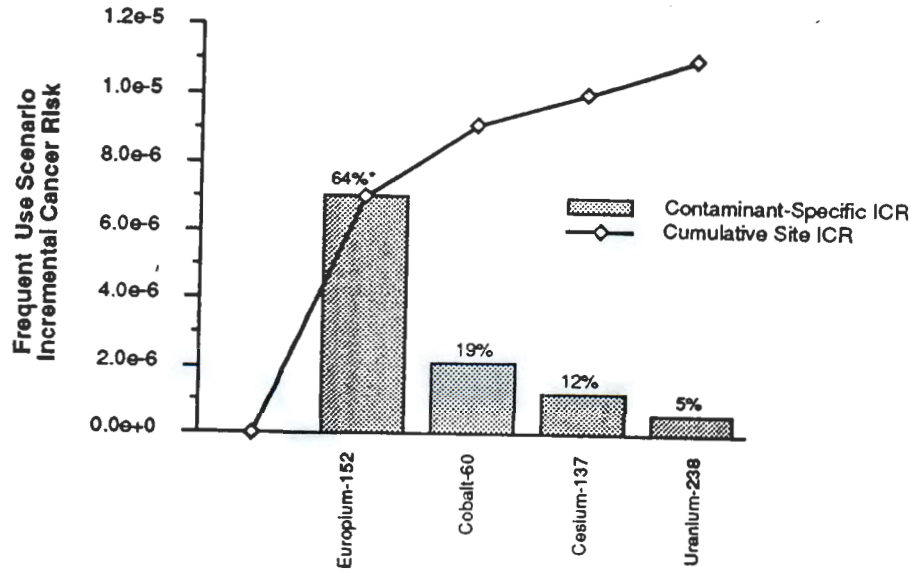
**Figure 3-11 116-F-14 (107-F) Retention Basin Human Health Risk Characterization**

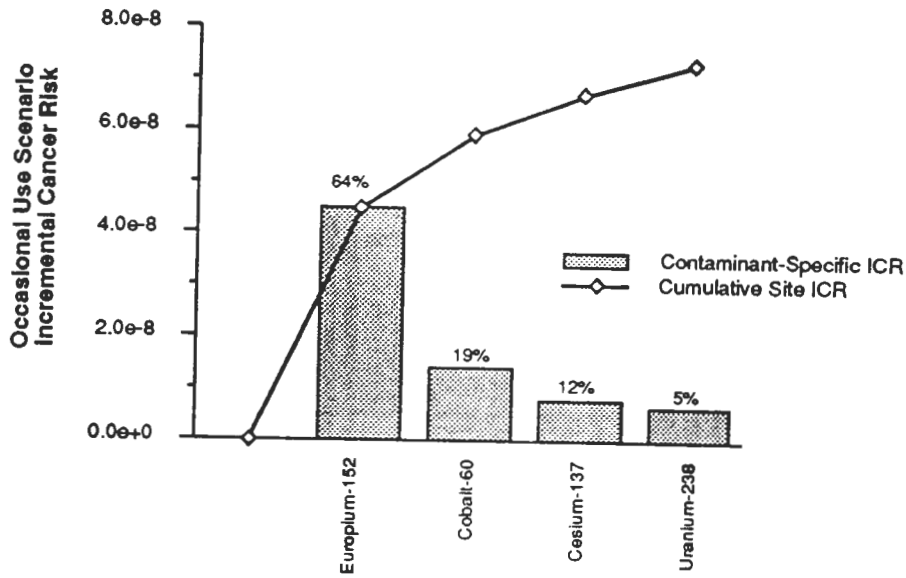



* = number at the top of each bar represents the percent of the total risk for each radionuclide.

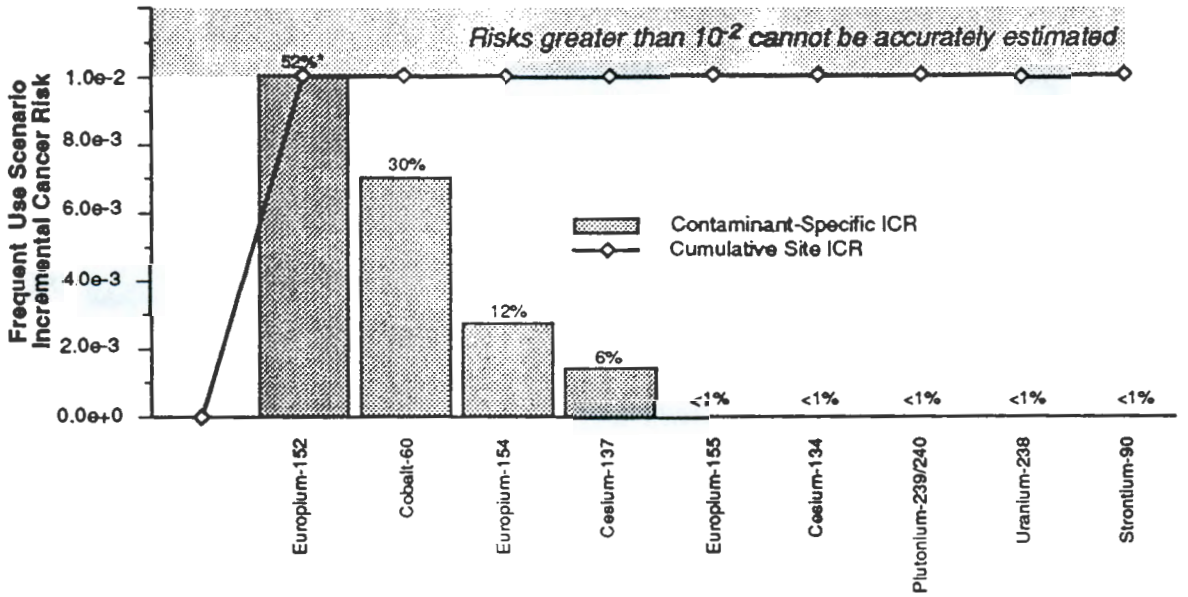
**Figure 3-12 Process/Discharge Pipelines Human Health Risk Characterization**

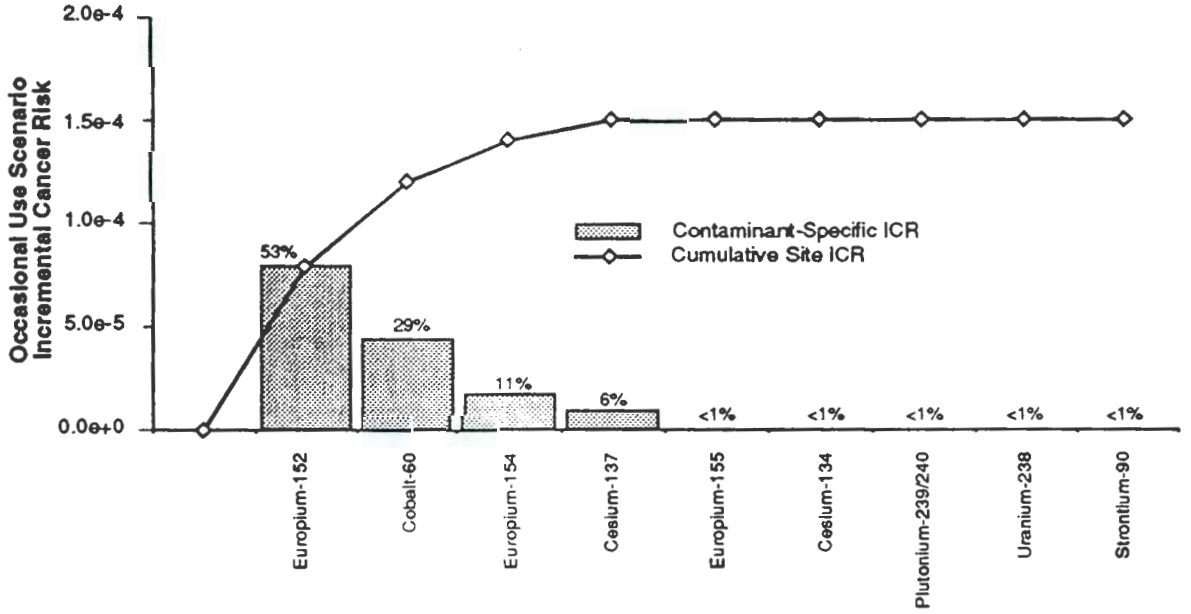



* = number at the top of each bar represents the percent of the total risk for each radionuclide.

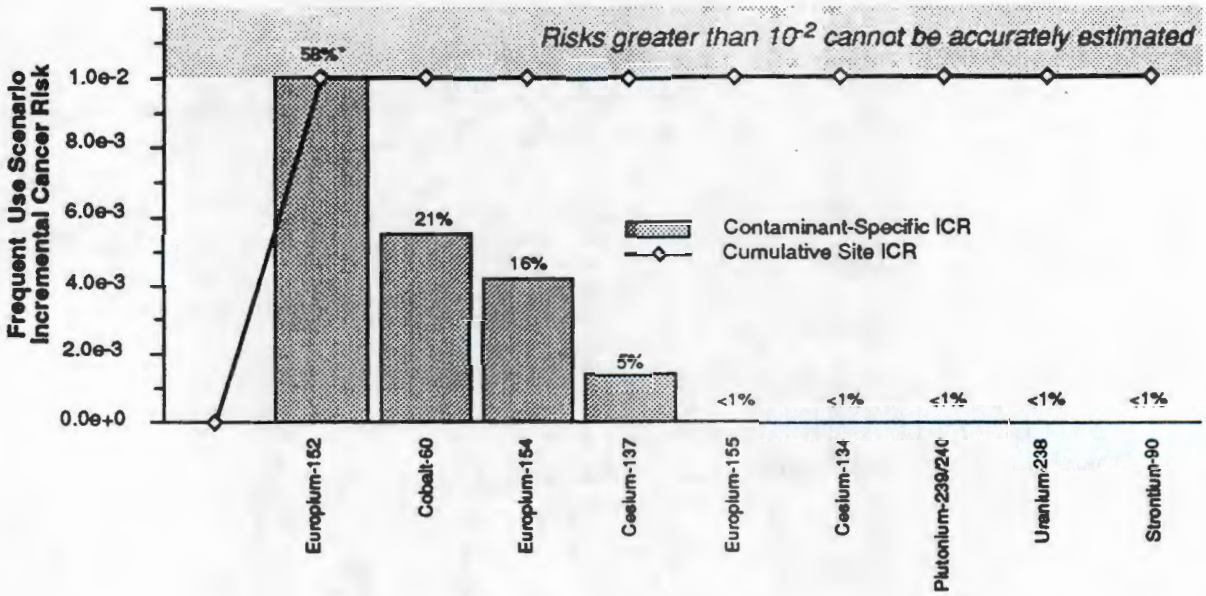
**Figure 3-13 Basin Leak Ditch Human Health Risk Characterization**

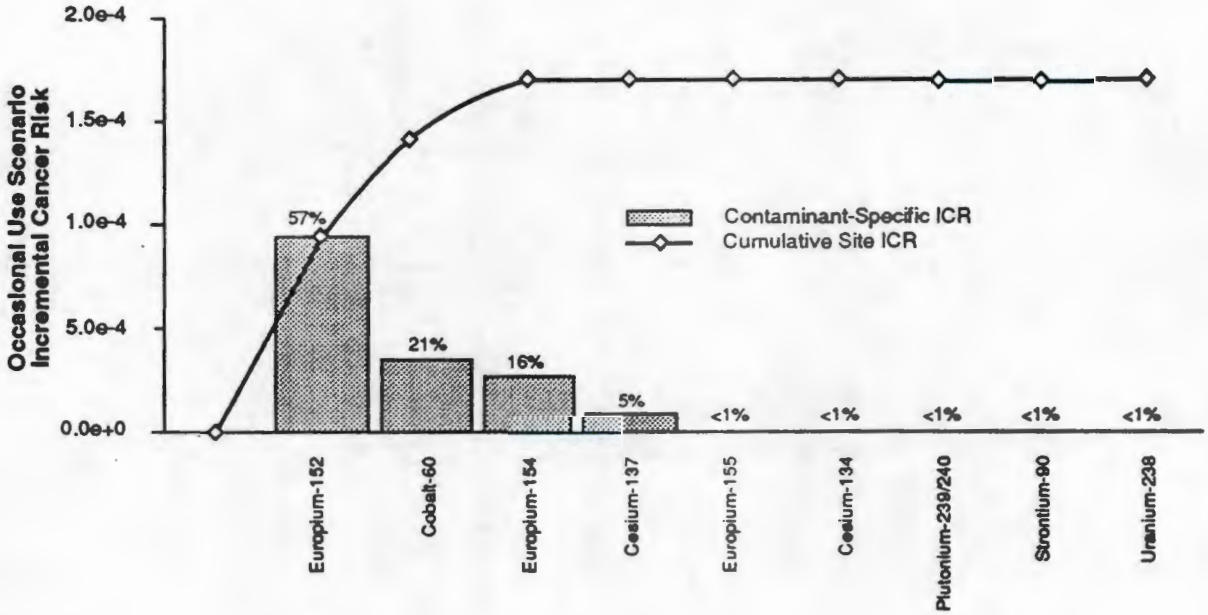



* = number at the top of each bar represents the percent of the total risk for each radionuclide.

**Figure 3-14 EM Bypass Ditch Human Health Risk Characterization**




* = number at the top of each bar represents the percent of the total risk for each radionuclide.

# Table 3-1 108-F French Drain Human Health Risk Characterization

| Radionuclide Contaminant of Potential Concern (COPC) | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|
| | Ingestion Incremental Cancer Risk (ICR) | Inhalation ICR | External Exposure ICR | Total ICR (a) | Ingestion ICR | Inhalation ICR | External Exposure ICR | Total ICR (a) |
| Potassium-40 | 1.9E-07 | 1.1E-09 | 1.7E-04 | 1.7E-04 | 3.6E-09 | 2.1E-11 | 1.1E-06 | 1.1E-06 |
| Plutonium-238 | 6.3E-05 | 9.4E-05 | 1.5E-07 | 1.6E-04 | 1.2E-06 | 1.6E-06 | 9.4E-10 | 3.0E-06 |
| Thorium-228 | 5.8E-08 | 6.9E-07 | 1.1E-04 | 1.1E-04 | 1.1E-09 | 1.3E-08 | 6.9E-07 | 7.1E-07 |
| Cesium-137 | 5.9E-08 | 3.3E-10 | 7.7E-05 | 7.7E-05 | 1.1E-09 | 6.4E-12 | 4.9E-07 | 4.9E-07 |
| Radium-226 | 6.6E-08 | 1.4E-08 | 6.0E-05 | 6.1E-05 | 1.3E-09 | 2.6E-10 | 3.9E-07 | 3.9E-07 |
| Plutonium-239/240 (b) | 1.0E-05 | 1.4E-05 | 2.2E-08 | 2.4E-05 | 2.0E-07 | 2.7E-07 | 1.4E-10 | 4.7E-07 |
| Europium-152 | 3.3E-10 | 1.5E-10 | 1.0E-05 | 1.0E-05 | 6.4E-12 | 2.8E-12 | 6.6E-08 | 6.6E-08 |
| Americium-241 | 1.0E-06 | 1.2E-06 | 3.9E-07 | 2.6E-06 | 2.0E-08 | 2.2E-08 | 2.5E-09 | 4.5E-08 |
| Uranium-238 | 1.7E-08 | 2.7E-07 | 4.1E-07 | 6.9E-07 | 3.3E-10 | 5.1E-09 | 2.6E-09 | 8.1E-09 |
| Thorium-232 | 1.2E-08 | 2.3E-07 | 4.7E-10 | 2.4E-07 | 2.3E-10 | 4.4E-09 | 3.0E-12 | 4.6E-09 |
| Uranium-233/234 (b) | 9.6E-09 | 1.4E-07 | 4.6E-10 | 1.5E-07 | 1.9E-10 | 2.6E-09 | 3.0E-12 | 2.8E-09 |
| Site Totals (c) | 8E-05 | 1E-04 | 4E-04 | 6E-04 | 1E-06 | 2E-06 | 3E-06 | 6E-06 |

| Chemical Carcinogen COPC | Frequent-Use Scenario | | | Occasional-Use Scenario | | |
|---|---|---|---|---|---|---|
| | Ingestion ICR | Inhalation ICR | Total ICR (a) | Ingestion ICR | Inhalation ICR | Total ICR (a) |
| Chromium | ---- | 4.2E-05 | 4.2E-05 | ---- | 8.1E-07 | 8.1E-07 |
| PCB | 4.7E-06 | ---- | 4.7E-06 | 9.0E-08 | ---- | 9.0E-08 |
| Site Totals (c) | 5E-06 | 4E-05 | 5E-05 | 9E-08 | 8E-07 | 9E-07 |

| Systemic Toxicant COPC | Frequent-Use Scenario | | | Occasional-Use Scenario | | |
|---|---|---|---|---|---|---|
| | Ingestion Hazard Index (HI) | Inhalation HI | Total HI (a) | Ingestion HI | Inhalation HI | Total HI (a) |
| Lead | ---- | ---- | ---- | ---- | ---- | ---- |
| Chromium | 0.41 | ---- | 0.41 | 0.0079 | ---- | 0.0079 |
| Antimony | 0.12 | ---- | 0.12 | 0.0023 | ---- | 0.0023 |
| Benzo(a)anthracene | ---- | ---- | ---- | ---- | ---- | ---- |
| Site Totals (c) | 0.5 | ---- | 0.5 | 0.01 | ---- | 0.01 |

COPC represents an ICR > 1E-6 or HI > 1.0

---- COPC does not present a risk or no toxicity data available for this pathway

(a) Total COPC Lifetime ICR or HI from all pathways

(b) Risk Characterization is based on most toxic COPC

(c) Total lifetime ICR or HI from all COPC over all pathways

PCB - polychlorinated biphenyl

**Table 3-2 Estimated Dose Rate for the Great Basin Pocket Mouse for the 108-F French Drain (0-6 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| Am-241 | 3.3 | 1.32E-11 | 3.8E-07 | No |
| Cs-137 | 1.6 | 3.97E-10 | 1.7E-05 | No |
| Eu-152 | 0.12 | 4.80E-14 | 2.5E-11 | No |
| Pu-238 | 220 | 6.16E-09 | 1.8E-04 | No |
| Pu-239/240 | 34 | 9.52E-10 | 2.6E-05 | No |
| Ra-226 | 0.42 | 1.68E-11 | 1.9E-04 | No |
| Th-228 | 0.81 | 3.24E-14 | 1.6E-10 | No |
| Th-232 | 0.75 | 3.00E-14 | 1.3E-10 | No |
| U-233/234 | 0.46 | 1.84E-10 | 8.7E-05 | No |
| U-238 | 0.47 | 1.88E-10 | 7.8E-05 | No |
| | | | TOTAL 0.00049 | |
| Organic/ Inorganic | Maximum soil conc. (mg/kg) | Veg. Conc. Wet (wet) (mg/kg) | Dose Rate mg/kg/day | Exceeds EHQ |
| PCB (arochlor-1254,1260) | 0.39 | 1.72E-03 | 4.9E-04 | No |
| benzo(a)anthracene | 0.062 | 5.46E-04 | 1.6E-04 | No |
| fluoranthene | 0.045 | 5.76E-04 | 1.6E-04 | No |
| pyrene | 0.043 | 5.16E-04 | 1.5E-04 | No |
| toluene | 0.48 | 1.96E-01 | 5.6E-02 | No |
| antimony | 3.9 | 2.03E-02 | 5.8E-03 | No |
| chromium | 164 | 4.92E-01 | 1.4E-01 | No |
| copper | 73.8 | 1.18E+01 | 3.4E+00 | Yes |
| lead | 73.2 | 1.32E+00 | 3.8E-01 | Yes |
| selenium | 0.78 | 1.40E-02 | 4.0E-03 | Yes |
| zinc | 129 | 2.32E+00 | 6.6E-01 | Yes |

Note: Transfer coefficients and no observable effect level were not available for nitrate/nitrite therefore; a dose rate was not calculated for this constituent.

**Table 3-3 Estimated Dose Rate for the Great Basin Pocket Mouse for the 108-F French Drain (0-15 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceed EHQ |
|---|---|---|---|---|
| Am-241 | 3.3 | 1.32E-11 | 3.8E-07 | No |
| Cs-137 | 1.6 | 3.97E-10 | 1.7E-05 | No |
| Eu-152 | 0.12 | 4.80E-14 | 2.5E-11 | No |
| Pu-238 | 220 | 6.16E-09 | 1.8E-04 | No |
| Pu-239/240 | 34 | 9.52E-10 | 2.6E-05 | No |
| Ra-226 | 0.42 | 1.68E-11 | 1.9E-04 | No |
| Th-228 | 0.81 | 3.24E-14 | 1.6E-10 | No |
| Th-232 | 0.75 | 3.00-E14 | 1.3E-10 | No |
| U-233/234 | 0.46 | 1.84E-10 | 8.7E-05 | No |
| U-238 | 0.47 | 1.88E-10 | 7.8E-05 | No |
| | | | TOTAL 0.00049 | |
| Organic/ Inorganic | Maximum soil conc. (mg/kg) | Veg. Conc. Wet (wet) (mg/kg) | Dose Rate mg/kg/day | Exceeds EHQ |
| PCB (arochlor-1254,1260) | 0.39 | 1.72E-03 | 4.9E-04 | No |
| benzo(a)anthracene | 0.062 | 5.46E-04 | 1.6E-04 | No |
| fluoranthene | 0.045 | 5.76E-04 | 1.6E-04 | No |
| pyrene | 0.043 | 5.16E-04 | 1.5E-04 | No |
| toluene | 0.48 | 1.96E-01 | 5.6E-02 | No |
| antimony | 3.9 | 2.03E-02 | 5.8E-03 | No |
| chromium | 164 | 4.92E-01 | 1.4E-01 | No |
| copper | 73.8 | 1.18E+00 | 3.4E+00 | Yes |
| lead | 73.2 | 1.32E+00 | 3.8E-01 | Yes |
| selenium | 0.78 | 1.40E-02 | 4.0E-03 | Yes |
| zinc | 129 | 2.32E+00 | 6.6E-01 | Yes |

Note: Transfer coefficients and no observable effect levels were not available for nitrate/nitrite therefore; a dose rate was not calculated for this constituent.

# Table 3-4 116-F-1 Lewis Canal Human Health Risk Characterization

| Radionuclide Contaminant of Potential Concern (COPC) | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|
| | Ingestion Incremental Cancer Risk (ICR) | Inhalation ICR | External Exposure ICR | Total ICR (a) | Ingestion ICR | Inhalation ICR | External Exposure ICR | Total ICR (a) |
| Europium-152 | 3.4E-07 | 1.5E-07 | >1E-02 (b) | >1E-02 | 6.5E-09 | 2.9E-09 | 6.8E-05 | 6.8E-05 |
| Cobalt-60 | 5.5E-07 | 4.6E-08 | 5.8E-03 | 5.8E-03 | 1.1E-08 | 8.9E-10 | 3.7E-05 | 3.7E-05 |
| Europium-154 | 1.4E-07 | 5.7E-08 | 3.6E-03 | 3.6E-03 | 2.8E-09 | 1.1E-09 | 2.3E-05 | 2.3E-05 |
| Cesium-137 | 8.3E-07 | 4.7E-09 | 1.1E-03 | 1.1E-03 | 1.6E-08 | 9.0E-11 | 6.9E-06 | 6.9E-06 |
| Potassium-40 | 2.0E-07 | 1.2E-09 | 1.8E-04 | 1.8E-04 | 3.9E-09 | 2.2E-11 | 1.2E-06 | 1.2E-06 |
| Thorium-228 | 7.2E-08 | 8.6E-07 | 1.3E-04 | 1.4E-04 | 1.4E-09 | 1.6E-08 | 8.6E-07 | 8.7E-07 |
| Radium-226 | 1.0E-07 | 2.1E-08 | 9.4E-05 | 9.4E-05 | 2.0E-09 | 4.1E-10 | 6.0E-07 | 6.0E-07 |
| Uranium-238 | 3.0E-08 | 4.7E-07 | 7.2E-07 | 1.2E-06 | 5.9E-10 | 9.1E-09 | 4.6E-09 | 1.4E-08 |
| Uranium-235 | 3.1E-09 | 4.1E-08 | 8.6E-07 | 9.1E-07 | 6.0E-11 | 7.9E-10 | 5.5E-09 | 6.4E-09 |
| Plutonium-239/240 (c) | 3.0E-07 | 4.1E-07 | 6.4E-10 | 7.1E-07 | 5.7E-09 | 7.9E-09 | 4.1E-12 | 1.4E-08 |
| Thorium-232 | 1.5E-08 | 2.9E-07 | 5.9E-10 | 3.0E-07 | 2.8E-10 | 5.5E-09 | 3.7E-12 | 5.8E-09 |
| Uranium-233/234 (c) | 2.0E-08 | 2.8E-07 | 9.5E-10 | 3.0E-07 | 3.8E-10 | 5.3E-09 | 6.0E-12 | 5.7E-09 |
| Carbon-14 | 2.6E-07 | 1.5E-11 | ---- | 2.6E-07 | 5.0E-09 | 3.0E-13 | ---- | 5.0E-09 |
| Strontium-90 | 1.9E-07 | 2.7E-09 | ---- | 1.9E-07 | 3.6E-09 | 5.2E-11 | ---- | 3.7E-09 |
| Site Totals (d) | 3E-06 | 3E-06 | >1E-02 | >1E-02 | 6E-08 | 5E-08 | 1E-04 | 1E-04 |

| Chemical Carcinogen COPC | Frequent-Use Scenario | | | Occasional-Use Scenario | | |
|---|---|---|---|---|---|---|
| | Ingestion ICR | Inhalation ICR | Total ICR (a) | Ingestion ICR | Inhalation ICR | Total ICR (a) |
| Arsenic | 1.4E-04 | 4.0E-06 | 1.0E-04 | 2.6E-06 | 7.7E-08 | 2.7E-06 |
| Site Totals (d) | 1E-04 | 4E-06 | 1E-04 | 3E-06 | 8E-08 | 3E-06 |

| Systemic Toxicant COPC | Frequent-Use Scenario | | | Occasional-Use Scenario | | |
|---|---|---|---|---|---|---|
| | Ingestion Hazard Index (HI) | Inhalation HI | Total HI (a) | Ingestion HI | Inhalation HI | Total HI (a) |
| Arsenic | 1.8 | ---- | 1.8 | 0.035 | ---- | 0.035 |
| Lead | ---- | ---- | ---- | ---- | ---- | ---- |
| Site Totals (d) | 1.8 | ---- | 1.8 | 0.035 | ---- | 0.035 |

COPC represents an ICR > 1E-6 or HI > 1.0

---- COPC does not present a risk or no toxicity data available for this pathway

(a) Total COPC Lifetime ICR or HI from all pathways

(b) Lifetime ICR >1E-02 cannot be accurately estimated using the methodology adopted in this qualitatiive risk assessment

(c) Risk Characterization is based on most toxic COPC

(d) Total lifetime ICR or HI from all COPC over all pathways

**Table 3-5 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-F-1 Lewis Canal (0-6 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| C-14 | 190 | 5.32E-08 | 4.4E-3 | No |
| Cs-134 | 0.0005 | 1.24E-13 | 5.0E-09 | No |
| Co-137 | 23 | 5.70E-09 | 2.4E-04 | No |
| Co-60 | 28 | 5.60E-09 | 7.9E-05 | No |
| Eu-152 | 124 | 4.96E-11 | 3.2E-07 | No |
| Eu-154 | 37 | 1.48E-11 | 1.9E-08 | No |
| Eu-155 | 0.034 | 1.36E-14 | 1.7E-11 | No |
| Pu-239/240 | 0.99 | 2.77E-11 | 7.6E-07 | No |
| Ra-226 | 0.65 | 2.60E-11 | 3.0E-04 | No |
| Sr-90 | 4 | 3.04E-08 | 3.4E-02 | No |
| Th-228 | 1 | 4.00E-14 | 2.0E-10 | No |
| Th-232 | 0.94 | 3.76E-14 | 1.6E-10 | No |
| Tritium (H-3) | 8.4 | 1.61E-08 | 2.0E-06 | No |
| U-233/234 | 0.71 | 2.84E-10 | 1.3E-04 | No |
| U-235 | 0.15 | 6.00E-11 | 2.7E-05 | No |
| U-238 | 0.77 | 3.08E-10 | 1.3E-04 | No |
| | | | TOTAL 0.039 | |
| Organic/ Inorganic | Maximum soil conc. (mg/kg) | Veg. Conc. Wet (wet) (mg/kg) | Dose Rate mg/kg/day | Exceeds EHQ |
| di-n-butylphthalate | 0.12 | 3.46E-03 | 9.9E-04 | No |
| methylene chloride | 0.012 | 2.52E-02 | 1.0E-02 | No |
| tetrachloroethene | 0.001 | 1.68E-04 | 4.8E-05 | No |
| trichloroethene | 0.002 | 1.47E-03 | 4.2E-04 | NA |
| acetone | 0.015 | 3.20E-01 | 9.1E-02 | No |
| toluene | 0.057 | 2.33E-02 | 6.6E-03 | No |
| arsenic | 44 | 7.04E-01 | 2.0E-01 | Yes |
| cadmium | 0.65 | 1.43E-01 | 4.1E-02 | Yes |
| lead | 207 | 3.73+00 | 1.1E+00 | Yes |
| zinc | 142 | 8.52E+01 | 2.4E+01 | Yes |

Note: Transfer coefficients and no observable effect levels were not available for 2-butanone, 2-hexanone, and 4-methyl-2-pentanone and, therefore; dose rates were not calculated for these constituents.
NA = No published wildlife NOEL value available.

**Table 3-6 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-F-1 Lewis Canal (0-15 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| C-14 | 220 | 6.16E-08 | 6.5E-04 | No |
| Cs-134 | 0.0005 | 1.24E-13 | 4.9E-09 | No |
| Cs-137 | 23 | 5.70E-09 | 2.4E-04 | No |
| Co-60 | 28 | 5.60E-09 | 7.9E-05 | No |
| Eu-152 | 124 | 4.96E-11 | 2.5E-08 | No |
| Eu-154 | 37 | 1.48E-11 | 1.9E-08 | No |
| Eu-155 | 0.034 | 1.36E-14 | 3.4E-12 | No |
| Pu-239/240 | 0.99 | 2.77E-11 | 7.6E-07 | No |
| Ra-226 | 0.65 | 2.60E-11 | 3.0E-04 | No |
| Sr-90 | 4 | 3.04E-08 | 3.4E-02 | No |
| Th-228 | 1 | 4.00E-14 | 2.0E-10 | No |
| Th-232 | 0.94 | 3.76E-14 | 1.6E-10 | No |
| Tritium (H-3) | 8.4 | 1.6.E-08 | 2.0E-06 | No |
| U-233/234 | 0.94 | 3.76E-10 | 1.8E-04 | No |
| U-235 | 0.15 | 6.00E-11 | 2.7E-05 | No |
| U-238 | 0.83 | 3.32E-10 | 1.4E-04 | No |
| | | | TOTAL 0.036 | |
| **Organic/ Inorganic** | **Maximum soil conc. (mg/kg)** | **Veg. Conc. Wet (wet) (mg/kg)** | **Dose Rate mg/kg/day** | **Exceeds EHQ** |
| di-n-butylphthalate | 0.15 | 4.32E-03 | 1.2E-03 | No |
| methylene chloride | 0.012 | 3.52E-02 | 1.0E-02 | No |
| tetrachloroethene | 0.001 | 1.68E-04 | 4.8E-05 | No |
| trichloroethene | 0.002 | 1.47E-03 | 4.2E-04 | NA |
| acetone | 0.015 | 3.20E-01 | 9.1E-02 | No |
| toluene | 0.057 | 2.33E-02 | 6.6E-03 | No |
| arsenic | 44 | 7.04E-01 | 2.0E-01 | Yes |
| cadmium | 0.65 | 1.43E-01 | 4.1E-02 | Yes |
| lead | 207 | 3.73E+00 | 1.1E+00 | Yes |
| zinc | 142 | 8.52E+01 | 2.4E+01 | Yes |

Note: Transfer coefficients and no observable effect levels were not available for 2 butanone, 2-hexanone, and 4-methyl-2-pentanone, therefore; dose rates were not calculated for these constituents.
NA = No published wildlife NOEL value available.

# Table 3-7 116-F-2 (107-F) Basin Overflow Trench Human Health Risk Characterization

| Radionuclide Contaminant of Potential Concern (COPC) | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|
| | Ingestion Incremental Cancer Risk (ICR) | Inhalation ICR | External Exposure ICR | Total ICR (a) | Ingestion ICR | Inhalation ICR | External Exposure ICR | Total ICR (a) |
| Europium-152 | 1.5E-06 | 6.7E-07 | >1E-02 (b) | >1E-02 | 2.9E-08 | 1.3E-08 | 3.0E-04 | 3.0E-04 |
| Europium-154 | 1.4E-06 | 5.5E-07 | >1E-02 | >1E-02 | 2.7E-08 | 1.1E-08 | 2.3E-04 | 2.3E-04 |
| Cobalt-60 | 2.4E-07 | 2.0E-08 | 2.5E-03 | 2.5E-03 | 4.5E-09 | 3.8E-10 | 1.6E-05 | 1.6E-05 |
| Cesium-137 | 1.3E-06 | 7.3E-09 | 1.7E-03 | 1.7E-03 | 2.5E-08 | 1.4E-10 | 1.1E-05 | 1.1E-05 |
| Potassium-40 | 3.0E-07 | 1.8E-09 | 2.7E-04 | 2.7E-04 | 5.8E-09 | 3.4E-11 | 1.7E-06 | 1.7E-06 |
| Thorium-228 | 7.1E-08 | 8.5E-07 | 1.3E-04 | 1.3E-04 | 1.4E-09 | 1.6E-08 | 8.5E-07 | 8.7E-07 |
| Radium-226 | 8.2E-08 | 1.7E-08 | 7.5E-05 | 7.5E-05 | 1.6E-09 | 3.3E-10 | 4.8E-07 | 4.8E-07 |
| Iridium-192 | 1.3E-09 | 1.7E-10 | 3.3E-05 | 3.3E-05 | 2.5E-11 | 3.3E-12 | 2.1E-07 | 2.1E-07 |
| Europium-155 | 2.2E-09 | 7.4E-10 | 5.3E-06 | 5.3E-06 | 4.3E-11 | 1.4E-11 | 3.4E-08 | 3.4E-08 |
| Plutonium-239/240 (c) | 1.1E-06 | 1.5E-06 | 2.4E-09 | 2.7E-06 | 2.1E-08 | 3.0E-08 | 1.5E-11 | 5.1E-08 |
| Uranium-238 | 2.2E-08 | 3.4E-07 | 5.1E-07 | 8.7E-07 | 4.2E-10 | 6.4E-09 | 3.2E-09 | 1.0E-08 |
| Uranium-235 | 2.7E-09 | 3.6E-08 | 7.5E-07 | 7.9E-07 | 5.2E-11 | 6.8E-10 | 4.8E-09 | 5.5E-09 |
| Americium-241 | 1.8E-07 | 2.0E-07 | 6.7E-08 | 4.5E-07 | 3.4E-09 | 3.8E-09 | 4.3E-10 | 7.7E-09 |
| Strontium-90 | 3.6E-07 | 5.2E-09 | ---- | 3.6E-07 | 6.9E-09 | 9.9E-11 | --- | 7.0E-09 |
| Carbon-14 | 2.8E-07 | 1.7E-11 | ---- | 2.8E-07 | 5.4E-09 | 3.2E-13 | --- | 5.4E-09 |
| Thorium-232 | 8.8E-09 | 1.7E-07 | 3.5E-10 | 1.8E-07 | 1.7E-10 | 3.3E-09 | 2.2E-12 | 3.5E-09 |
| Uranium-233/234 (c) | 9.9E-09 | 1.4E-07 | 4.7E-10 | 1.5E-07 | 1.9E-10 | 2.7E-09 | 3.0E-12 | 2.9E-09 |
| Site Totals (d) | 7E-06 | 5E-06 | >1E-02 | >1E-02 | 1E-07 | 9E-08 | 6E-04 | 6E-04 |

| Chemical Carcinogen COPC | Frequent-Use Scenario | | | Occasional-Use Scenario | | |
|---|---|---|---|---|---|---|
| | Ingestion ICR | Inhalation ICR | Total ICR (a) | Ingestion ICR | Inhalation ICR | Total ICR (a) |
| Chromium | ---- | 2.5E-05 | 2.5E-05 | ---- | 4.8E-07 | 4.8E-07 |
| Site Totals (d) | ---- | 3E-05 | 3E-05 | --- | 5E-07 | 5E-07 |

| Systemic Toxicant COPC | Frequent-Use Scenario | | | Occasional-Use Scenario | | |
|---|---|---|---|---|---|---|
| | Ingestion Hazard Index (HI) | Inhalation HI | Total HI (a) | Ingestion HI | Inhalation HI | Total HI (a) |
| Chromium | 0.25 | ---- | 0.25 | 0.047 | ---- | 0.047 |
| Benzo(b)fluoranthene | ---- | ---- | ---- | ---- | ---- | ---- |
| Chrysene | ---- | ---- | ---- | ---- | ---- | ---- |
| Site Totals (d) | 0.25 | ---- | 0.25 | 0.047 | ---- | 0.047 |

COPC represents an ICR > 1E-6 or HI > 1.0

--- COPC does not present a risk or no toxicity data available for this pathway

(a) Total COPC Lifetime ICR or HI from all pathways

(b) Lifetime ICR >1E-02 cannot be accurately estimated using the methodology adopted in this qualitative risk assessment

(c) Risk Characterization is based on most toxic COPC

(d) Total lifetime ICR or HI from all COPC over all pathways

**Table 3-8 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-F-2 Basin Overflow Trench (0-6 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg)) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| C-14 | 62 | 1.74E-08 | 1.44E-3 | No |
| Cs-137 | 0.21 | 5.21E-11 | 2.2E-06 | No |
| Co-60 | 0.041 | 8.20E-12 | 1.2E-07 | No |
| Eu-152 | 5.3 | 2.12E-12 | 1.1E-09 | No |
| Eu-154 | 0.27 | 1.08E-13 | 1.4E-10 | No |
| Ra-226 | 0.52 | 2.08E-11 | 2.4E-04 | No |
| Th-228 | 0.99 | 3.96E-14 | 2.0E-10 | No |
| Th-232 | 0.56 | 2.24E-14 | 9.5E-11 | No |
| U-233/234 | 0.35 | 1.40E-10 | 6.6E-05 | No |
| U-238 | 0.43 | 1.72E-10 | 7.2E-05 | No |
| | | | Total = 0.0018 | No |

**Table 3-9 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-F-2 Basin Overflow Trench (0-15 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| Am-241 | 0.57 | 2.28E-12 | 6.6E-08 | No |
| C-14 | 240 | 6.72E-08 | 7.1E-04 | No |
| Cs-137 | 35 | 8.68E-09 | 3.6E-04 | No |
| Co-60 | 12 | 2.40E-09 | 3.4E-05 | No |
| Eu-152 | 550 | 2.20E-10 | 1.1E-07 | No |
| Eu-154 | 360 | 1.44E-10 | 1.9E-07 | No |
| Eu-155 | 3.8 | 1.52E-12 | 3.8E-10 | No |
| Pu-238 | 0.068 | 1.90E-12 | 5.6E-08 | No |
| Pu-239/240 | 3.7 | 1.04E-10 | 2.8E-06 | No |
| Ra-226 | 0.52 | 2.08E-11 | 2.4E-04 | No |
| Ir-192(*) | 0.58 | | | |
| Sr-90 | 7.6 | 5.78E-08 | 6.5E-02 | No |
| Th-228 | 0.99 | 3.96E-14 | 2.0E-10 | No |
| Th-232 | 0.56 | 2.24E-14 | 9.5E-11 | No |
| H-3 | 5.9 | 1.13E-08 | 1.4E-06 | No |
| U-233/234 | 0.47 | 1.88E-10 | 8.9E-05 | No |
| U-235 | 0.13 | 5.20E-11 | 2.3E-05 | No |
| U-238 | 0.59 | 2.36E-10 | 9.8E-05 | No |
| | | | TOTAL 0.066 | No |
| Organic/ Inorganic | Maximum soil conc. (mg/kg) | Veg. Conc. Wet (wet) (mg/kg) | Dose Rate mg/kg/day | Exceeds EHQ |
| chrysene | 0.048 | 4.22E-04 | 1.2E-04 | NA |
| benzo(a)pyrene | 0.083 | 4.32E-04 | 1.2E-04 | NA |
| chromium | 98.1 | 2.94E-01 | 8.4E-02 | No |
| zinc | 295 | 1.77E+02 | 5.0E+01 | Yes |
| cadmium | 1.6 | 3.52E-01 | 1.0E-01 | Yes |

* Ir-192 is from historical data and was eliminated due to its short half-life, which is <1 year.
NA = No published wildlife NOEL value available.

# Table 3-10 116-F-3 (105-F) Fuel Storage Basin Trench Human Health Risk Characterization

| Radionuclide Contaminant of Potential Concern (COPC) | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|
| | Ingestion Incremental Cancer Risk (ICR) | Inhalation ICR | External Exposure ICR | Total ICR (a) | Ingestion ICR | Inhalation ICR | External Exposure ICR | Total ICR (a) |
| Europium-152 | 5.2E-07 | 2.3E-07 | >1E-02 (b) | >1E-02 | 1.0E-08 | 4.4E-09 | 1.0E-04 | 1.0E-04 |
| Europium-154 | 3.9E-08 | 1.5E-08 | 9.6E-04 | 9.6E-04 | 7.4E-10 | 2.9E-10 | 6.1E-06 | 6.1E-06 |
| Cobalt-60 | 3.7E-08 | 3.1E-09 | 3.9E-04 | 3.9E-04 | 7.2E-10 | 6.0E-11 | 2.5E-06 | 2.5E-06 |
| Potassium-40 | 3.3E-07 | 1.9E-09 | 3.0E-04 | 3.0E-04 | 6.4E-09 | 3.7E-11 | 1.9E-06 | 1.9E-06 |
| Cesium-137 | 9.5E-08 | 5.4E-10 | 1.2E-04 | 1.2E-04 | 1.8E-09 | 1.0E-11 | 8.0E-07 | 8.0E-07 |
| Thorium-228 | 6.6E-08 | 7.9E-07 | 1.2E-04 | 1.2E-04 | 1.3E-09 | 1.5E-08 | 7.9E-07 | 8.0E-07 |
| Radium-226 | 8.6E-08 | 1.8E-08 | 7.9E-05 | 7.9E-05 | 1.7E-09 | 3.5E-10 | 5.0E-07 | 5.1E-07 |
| Uranium-235 | 1.2E-08 | 1.5E-07 | 3.2E-06 | 3.3E-06 | 2.2E-10 | 2.9E-09 | 2.0E-08 | 2.3E-08 |
| Uranium-238 | 2.1E-08 | 3.3E-07 | 5.0E-07 | 8.5E-07 | 4.1E-10 | 6.3E-09 | 3.2E-09 | 9.9E-09 |
| Plutonium-239/240 (c) | 2.9E-07 | 4.0E-07 | 6.2E-10 | 6.8E-07 | 5.5E-09 | 7.6E-09 | 3.9E-12 | 1.3E-08 |
| Thorium-232 | 1.1E-08 | 2.1E-07 | 4.3E-10 | 2.2E-07 | 2.1E-10 | 4.1E-09 | 2.7E-12 | 4.3E-09 |
| Uranium-233/234 (c) | 1.4E-08 | 2.0E-07 | 6.9E-10 | 2.2E-07 | 2.7E-10 | 3.9E-09 | 4.4E-12 | 4.1E-09 |
| Site Totals (d) | 2E-06 | 2E-06 | >1E-02 | >1E-02 | 3E-08 | 4E-08 | 1E-04 | 1E-04 |

| Chemical Carcinogen COPC | Frequent-Use Scenario | | | Occasional-Use Scenario | | |
|---|---|---|---|---|---|---|
| | Ingestion ICR | Inhalation ICR | Total ICR (a) | Ingestion ICR | Inhalation ICR | Total ICR (a) |
| Chromium | ---- | 1.9E-05 | 1.9E-05 | ---- | 3.7E-07 | 3.7E-07 |
| PCB | 2.1E-06 | ---- | 2.1E-06 | 4.1E-08 | ---- | 4.1E-08 |
| Toxaphene | 3.3E-07 | 1.3E-09 | 3.3E-07 | 6.3E-09 | 2.5E-11 | 6.3E-09 |
| Site Totals (d) | 2E-06 | 2E-05 | 2E-05 | 5E-08 | 4E-07 | 4E-07 |

| Systemic Toxicant COPC | Frequent-Use Scenario | | | Occasional-Use Scenario | | |
|---|---|---|---|---|---|---|
| | Ingestion Hazard Index (HI) | Inhalation HI | Total HI (a) | Ingestion HI | Inhalation HI | Total HI (a) |
| Lead | ---- | ---- | ---- | ---- | ---- | ---- |
| Chromium | 0.19 | ---- | 0.19 | 0.0036 | ---- | 0.0036 |
| Benzo(a)anthracene | ---- | ---- | ---- | ---- | ---- | ---- |
| Toxaphene | ---- | ---- | ---- | ---- | ---- | ---- |
| Benzo(b)fluoranthene | ---- | ---- | ---- | ---- | ---- | ---- |
| Chrysene | ---- | ---- | ---- | ---- | ---- | ---- |
| Site Totals (d) | 0.19 | ---- | 0.19 | 0.0036 | ---- | 0.0036 |

COPC represents an ICR > 1E-6 or HI > 1.0

---- COPC does not present a risk or no toxicity data available for this pathway

(a) Total COPC Lifetime ICR or HI from all pathways

(b) Lifetime ICR >1E-02 cannot be accurately estimated using the methodology adopted in this qualitative risk assessment

(c) Risk Characterization is based on most toxic COPC

(d) Total lifetime ICR or HI from all COPC over all pathways

**Table 3-11 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-F-3 Fuel Storage Basin (0-6 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg)) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| Cs-137 | 0.52 | 1.29E-10 | 5.4E-06 | No |
| Co-60 | 0.058 | 1.16E-11 | 1.6E-07 | No |
| Eu-152 | 11 | 4.40E-12 | 2.3E-09 | No |
| Eu-154 | 0.075 | 3.00E-14 | 3.9E-11 | No |
| Ra-226 | 0.5 | 2.00E-11 | 2.3E-04 | No |
| Th-228 | 0.65 | 2.60E-14 | 1.3E-10 | No |
| Th-232 | 0.69 | 2.76E-14 | 1.2E-10 | No |
| U-233/234 | 0.51 | 2.04E-10 | 9.7E-05 | No |
| U-238 | 0.36 | 1.44E-10 | 6.0E-05 | No |
| | | | TOTAL 0.00039 | No |
| Organic/ Inorganic | Maximum soil conc. (mg/kg) | Veg. Conc. Wet (wet) (mg/kg) | Dose Rate mg/kg/day | Exceeds EHQ |
| pyrene | 0.44 | 5.28E-03 | 1.5E-03 | No |
| benzo(b)fluoranthene | 0.22 | 5.46E-04 | 1.6E-04 | NA |
| fluoranthene | 0.44 | 5.63E-03 | 1.6E-03 | No |
| chrysene | 0.28 | 2.46E-03 | 7.0E-04 | NA |
| benzo(a)anthracene | 0.24 | 2.11E-03 | 6.0E-04 | No |
| phenanthrene | 0.27 | 1.10E-02 | 3.1E-03 | No |
| barium | 378 | 2.27E+01 | 6.5E+00 | Yes |
| toluene | 0.021 | 8.57E-03 | 2.4E-03 | No |

NA = No published wildlife NOEL value available.

## Table 3-12 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-F-3 Fuel Storage Basin (0-15 feet)

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| Am-241 | 0.033 | 1.32E-13 | 3.8E-09 | No |
| Cs-137 | 2.6 | 6.45E-10 | 2.7E-05 | No |
| Co-60 | 1.9 | 3.80E-10 | 5.4E-06 | No |
| Eu-152 | 190 | 7.60E-11 | 3.9E-08 | No |
| Eu-154 | 9.8 | 3.92E-12 | 5.2E-09 | No |
| Pu-239/240 | 0.95 | 2.66E-11 | 7.3E-07 | No |
| Ra-226 | 0.55 | 2.20E-11 | 2.5E-04 | No |
| Th-228 | 0.92 | 3.68E-14 | 1.8E-10 | No |
| Th-232 | 0.69 | 2.76E-14 | 1.2E-10 | No |
| U-233/234 | 0.68 | 2.72E-10 | 1.3E-04 | No |
| U-235 | 0.55 | 2.20E-10 | 9.8E-05 | No |
| U-238 | 0.58 | 2.32E-10 | 9.7E-05 | No |
| | | | TOTAL 0.00061 | No |
| Organic/ Inorganic | Maximum soil conc. (mg/kg) | Veg. Conc. Wet (wet) (mg/kg) | Dose Rate mg/kg/day | Exceeds EHQ |
| di-n-butylphthalate | 0.077 | 2.22E-03 | 6.3E-04 | No |
| pyrene | 0.44 | 5.28E-03 | 1.5E-03 | No |
| benzo(b)fluoranthene | 0.22 | 5.46E-04 | 1.6E-04 | NA |
| fluoranthene | 0.44 | 5.63E-03 | 1.6E-03 | No |
| chrysene | 0.28 | 2.46E-03 | 7.0E-04 | NA |
| benzo(a)anthracene | 0.24 | 2.11E-03 | 6.0E-04 | No |
| phenanthrene | 0.27 | 1.10E-02 | 3.1E-03 | NA |
| chromium | 74.4 | 2.23E-01 | 6.4E-02 | No |
| lead | 49.9 | 8.98E-01 | 2.6E-01 | Yes |
| zinc | 175 | 1.05E+02 | 3.0E+01 | Yes |
| mercury | 1.5 | 5.40E-01 | 1.5E-01 | Yes |
| barium | 378 | 2.27E+01 | 6.5E+00 | Yes |
| PCB (Aroclors-1254,1260) | 0.18 | 7.92E-04 | 2.3E-04 | No |
| acetone | 0.01 | 2.13E-01 | 6.1E-02 | No |
| toluene | 0.021 | 8.57E-03 | 2.4E-03 | No |

Note: Transfer coefficients and no observable effect levels were not available for toxaphene and 4-methyl-2-pentanone, therefore; dose rates were not calculated for these constituents.

**Table 3-13 116-F-4 (105-F) Pluto Crib Human Health Risk Characterization**

| Radionuclide Contaminant of Potential Concern (COPC) | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|
| | Ingestion Incremental Cancer Risk (ICR) | Inhalation ICR | External Exposure ICR | Total ICR (a) | Ingestion ICR | Inhalation ICR | External Exposure ICR | Total ICR (a) |
| Cesium-137 | 1.4E-04 | 8.0E-07 | >1E-02 (b) | >1E-02 | 2.7E-06 | 1.5E-08 | 1.2E-03 | 1.2E-03 |
| Europium-154 | 1.6E-07 | 6.1E-08 | 3.9E-03 | 3.9E-03 | 3.0E-09 | 1.2E-09 | 2.5E-05 | 2.5E-05 |
| Europium-152 | 4.4E-08 | 1.9E-08 | 1.4E-03 | 1.4E-03 | 8.5E-10 | 3.7E-10 | 8.8E-06 | 8.8E-06 |
| Potassium-40 | 1.7E-07 | 1.0E-09 | 1.6E-04 | 1.6E-04 | 3.3E-09 | 1.9E-11 | 9.9E-07 | 9.9E-07 |
| Strontium-90 | 9.9E-05 | 1.4E-06 | --- | 1.0E-04 | 1.9E-06 | 2.7E-08 | --- | 1.9E-06 |
| Radium-226 | 1.0E-07 | 2.2E-08 | 9.5E-05 | 9.5E-05 | 2.0E-09 | 4.2E-10 | 6.1E-07 | 6.1E-07 |
| Plutonium-239/240 (c) | 3.9E-05 | 5.4E-05 | 8.4E-08 | 9.4E-05 | 7.5E-07 | 1.0E-06 | 5.4E-10 | 1.8E-06 |
| Cobalt-60 | 6.7E-09 | 5.6E-10 | 7.0E-05 | 7.0E-05 | 1.3E-10 | 1.1E-11 | 4.5E-07 | 4.5E-07 |
| Thorium-228 | 3.5E-08 | 4.2E-07 | 6.6E-05 | 6.6E-05 | 6.8E-10 | 8.0E-09 | 4.2E-07 | 4.3E-07 |
| Europium-155 | 2.6E-08 | 8.7E-09 | 6.2E-05 | 6.2E-05 | 5.0E-10 | 1.7E-10 | 4.0E-07 | 4.0E-07 |
| Cesium-134 | 1.6E-08 | 9.2E-11 | 3.7E-05 | 3.7E-05 | 3.1E-10 | 1.7E-12 | 2.4E-07 | 2.4E-07 |
| Americium-241 | 3.8E-06 | 4.2E-06 | 1.4E-06 | 9.4E-06 | 7.3E-08 | 8.1E-08 | 9.0E-09 | 1.6E-07 |
| Uranium-238 | 4.8E-08 | 7.4E-07 | 1.1E-06 | 1.9E-06 | 9.2E-10 | 1.4E-08 | 7.2E-09 | 2.2E-08 |
| Plutonium-238 | 3.8E-07 | 5.7E-07 | 9.0E-10 | 9.6E-07 | 7.4E-09 | 1.1E-08 | 5.7E-12 | 1.8E-08 |
| Thorium-232 | 2.2E-08 | 4.3E-07 | 8.7E-10 | 4.5E-07 | 4.2E-10 | 8.2E-09 | 5.6E-12 | 8.7E-09 |
| Uranium-233/234 (c) | 1.8E-08 | 2.6E-07 | 8.7E-10 | 2.7E-07 | 3.5E-10 | 4.9E-09 | 5.5E-12 | 5.2E-09 |
| Site Totals (d) | 3E-04 | 6E-05 | >1E-02 | >1E-02 | 5E-06 | 1E-06 | 1E-03 | 1E-03 |

COPC represents an ICR > 1E-6 or HI > 1.0

--- COPC does not present a risk or no toxicity data available for this pathway

(a) Total COPC Lifetime ICR or hazard index (HI) from all pathways

(b) Lifetime ICR > 1E-02 cannot be accurately estimated using the methodology adopted in this qualitative risk assessment

(c) Risk Characterization is based on most toxic COPC

(d) Total lifetime ICR or HI from all COPC over all pathways

**Table 3-14 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-F-4 Pluto Crib (0-6 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg)) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| Am-241 | 1.4 | 5.60E-12 | 1.6E-07 | No |
| Cs-137 | 340 | 8.43E-08 | 3.5E-03 | No |
| Co-60 | 0.14 | 2.80E-11 | 4.0E-07 | No |
| Eu-152 | 3.1 | 1.24E-12 | 6.4E-10 | No |
| Eu-154 | 0.3 | 1.20E-13 | 1.6E-10 | No |
| Eu-155 | 0.01 | 4.00E-15 | 1.0E-12 | No |
| Pu-238 | 0.15 | 4.20E-12 | 1.2E-07 | No |
| Pu-239/240 | 12 | 3.36E-10 | 9.2E-06 | No |
| Ra-226 | 0.51 | 2.04E-11 | 2.3E-04 | No |
| Sr-90 | 160 | 1.22E-06 | 1.4E+00 | Yes |
| Th-228 | 0.49 | 1.96E-14 | 9.8E-11 | No |
| Th-232 | 0.58 | 2.32E-14 | 9.9E-11 | No |
| U-233/234 | 0.77 | 3.08E-10 | 1.5E-04 | No |
| U-238 | 0.49 | 1.96E-10 | 8.2E-05 | No |
| | | | TOTAL 1.4 | Yes |
| Organic/ Inorganic | Maximum soil conc. (mg/kg) | Veg. Conc. Wet (wet) (mg/kg) | Dose Rate mg/kg/day | Exceeds EHQ |
| toluene | 0.008 | 3.26E-03 | 9.3E-04 | No |
| methylene chloride | 0.005 | 1.47E-02 | 4.2E-03 | No |
| acetone | 0.014 | 2.98E-01 | 8.5E-02 | No |
| barium | 208 | 1.25E+01 | 3.6E+00 | Yes |

Note: Transfer coefficients and no observable effect levels were not available for 2-butanone, therefore; dose rates were not calculated for this constituent.

**Table 3-15 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-F-4 Pluto Crib (0-15 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| Am-241 | 12 | 4.80E-11 | 1.4E-06 | No |
| Cs-134 | 0.3 | 7.44E-11 | 3.0E-06 | No |
| Cs-137 | 3819 | 9.47E-07 | 4.0E-02 | No |
| Co-60 | 0.34 | 6.80E-11 | 9.6E-07 | No |
| Eu-152 | 16 | 6.40E-12 | 3.3E-09 | No |
| Eu-154 | 40 | 1.60E-11 | 2.1E-08 | No |
| Eu-155 | 44 | 1.76E-11 | 4.4E-09 | No |
| Pu-238 | 1.3 | 3.64E-11 | 1.1E-06 | No |
| Pu-239/240 | 130 | 3.64E-09 | 1.0E-04 | No |
| Ra-226 | 0.66 | 2.64E-11 | 3.0E-04 | No |
| Sr-90 | 2096 | 1.59E-05 | 1.8E+01 | Yes |
| Th-228 | 0.49 | 1.96E-14 | 9.8E-11 | No |
| Th-232 | 1.4 | 5.60E-14 | 2.4E-10 | No |
| H-3 | 5.9 | 1.13E-08 | 1.4E-06 | No |
| U-233/234 | 0.86 | 3.44E-10 | 1.6E-04 | No |
| U-238 | 1.3 | 5.20E-10 | 2.2E-04 | No |
| | | | TOTAL 18 | Yes |
| Organic/ Inorganic | Maximum soil conc. (mg/kg) | Veg. Conc. Wet (wet) (mg/kg) | Dose Rate mg/kg/day | Exceed EHQ |
| di-n-butylphthalate | 0.13 | 3.74E-03 | 1.1E-03 | No |
| toluene | 0.013 | 5.30E-03 | 1.5E-03 | No |
| methylene chloride | 0.005 | 1.47E-02 | 4.2E-03 | No |
| acetone | 0.014 | 2.98E-01 | 8.5E-02 | No |
| barium | 208 | 1.25E+01 | 3.6E+00 | Yes |

Note: Transfer coefficients and no observable effect levels were not available for 2 butanone and di-n-octylphthalate, therefore; dose rates were not calculated for these constituents.

**Table 3-16 116-F-5 Ball Washer Crib Human Health Risk Characterization**

| Radionuclide Contaminant of Potential Concern (COPC) | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|
| | Ingestion Incremental Cancer Risk (ICR) | Inhalation ICR | External Exposure ICR | Total ICR (a) | Ingestion ICR | Inhalation ICR | External Exposure ICR | Total ICR (a) |
| Europium-154 | 6.5E-10 | 2.6E-10 | 1.6E-05 | 1.6E-05 | 1.3E-11 | 4.9E-12 | 1.0E-07 | 1.0E-07 |
| Cesium-137 | 1.0E-09 | 5.9E-12 | 1.4E-06 | 1.4E-06 | 2.0E-11 | 1.1E-13 | 8.7E-09 | 8.7E-09 |
| Site Totals (b) | 2E-09 | 3E-10 | 2E-05 | 2E-05 | 3E-11 | 5E-12 | 1E-07 | 1E-07 |

**COPC represents an ICR > 1E-6 or HI > 1.0**

(a) Total COPC Lifetime ICR or hazard index (HI) from all pathways

(b) Total lifetime ICR or HI from all COPC over all pathways

**Table 3-17 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-F-5 Ball Washer Crib (0-15 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| Cs-137 | 0.028 | 6.94E-12 | 2.9E-07 | No |
| Eu-154 | 0.17 | 6.80E-14 | 9.0E-11 | No |
| Eu-155 | 0.02 | 8.00E-15 | 2.0E-12 | No |
| Sr-90 | 0.02 | 1.53E-10 | 1.7E-04 | No |
| | | | TOTAL 0.00017 | No |

# Table 3-18 116-F-6 (1608-F) Liquid Waste Disposal Trench Human Health Risk Characterization

| Radionuclide Contaminant of Potential Concern (COPC) | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|
| | Ingestion Incremental Cancer Risk (ICR) | Inhalation ICR | External Exposure ICR | Total ICR (a) | Ingestion ICR | Inhalation ICR | External Exposure ICR | Total ICR (a) |
| Europium-152 | 5.2E-07 | 2.3E-07 | >1E-02 (b) | >1E-02 | 1.0E-08 | 4.4E-09 | 1.0E-04 | 1.0E-04 |
| Cesium-137 | 8.4E-06 | 4.8E-08 | >1E-02 | >1E-02 | 1.6E-07 | 9.2E-10 | 7.0E-05 | 7.1E-05 |
| Cobalt-60 | 6.5E-07 | 5.4E-08 | 6.8E-03 | 6.8E-03 | 1.2E-08 | 1.0E-09 | 4.3E-05 | 4.3E-05 |
| Europium-154 | 7.1E-08 | 2.8E-08 | 1.8E-03 | 1.8E-03 | 1.4E-09 | 5.3E-10 | 1.1E-05 | 1.1E-05 |
| Potassium-40 | 2.7E-07 | 1.6E-09 | 2.5E-04 | 2.5E-04 | 5.3E-09 | 3.0E-11 | 1.6E-06 | 1.6E-06 |
| Radium-226 | 1.6E-07 | 3.3E-08 | 1.4E-04 | 1.4E-04 | 3.0E-09 | 6.3E-10 | 9.2E-07 | 9.2E-07 |
| Thorium-228 | 4.5E-08 | 5.4E-07 | 8.5E-05 | 8.5E-05 | 8.7E-10 | 1.0E-08 | 5.4E-07 | 5.5E-07 |
| Plutonium-239/240 (c) | 7.5E-07 | 1.0E-06 | 1.6E-09 | 1.8E-06 | 1.4E-08 | 2.0E-08 | 1.0E-11 | 3.4E-08 |
| Uranium-238 | 2.5E-08 | 3.9E-07 | 6.0E-07 | 1.0E-06 | 4.9E-10 | 7.5E-09 | 3.8E-09 | 1.2E-08 |
| Europium-155 | 2.8E-10 | 9.4E-11 | 6.7E-07 | 6.7E-07 | 5.4E-12 | 1.8E-12 | 4.3E-09 | 4.3E-09 |
| Americium-241 | 2.3E-07 | 2.5E-07 | 8.5E-08 | 5.6E-07 | 4.4E-09 | 4.8E-09 | 5.4E-10 | 9.7E-09 |
| Cesium-134 | 1.4E-10 | 8.3E-13 | 3.4E-07 | 3.4E-07 | 2.8E-12 | 1.6E-14 | 2.1E-09 | 2.1E-09 |
| Strontium-90 | 3.2E-07 | 4.7E-09 | ---- | 3.3E-07 | 6.2E-09 | 8.9E-11 | ---- | 6.3E-09 |
| Uranium-233/234 (c) | 1.7E-08 | 2.5E-07 | 8.4E-10 | 2.6E-07 | 3.3E-10 | 4.7E-09 | 5.3E-12 | 5.0E-09 |
| Thorium-232 | 9.1E-09 | 1.8E-07 | 3.6E-10 | 1.9E-07 | 1.8E-10 | 3.4E-09 | 2.3E-12 | 3.6E-09 |
| Site Totals (d) | 1E-05 | 3E-06 | >1E-02 | >1E-02 | 2E-07 | 6E-08 | 2E-04 | 2E-04 |

| Chemical Carcinogen COPC | Frequent-Use Scenario | | | Occasional-Use Scenario | | |
|---|---|---|---|---|---|---|
| | Ingestion ICR | Inhalation ICR | Total ICR (a) | Ingestion ICR | Inhalation ICR | Total ICR (a) |
| Chromium | ---- | 7.8E-06 | 7.8E-06 | ---- | 1.5E-07 | 1.5E-07 |
| Site Totals (d) | ---- | 8E-06 | 8E-06 | ---- | 2E-07 | 2E-07 |

| Systemic Toxicant COPC | Frequent-Use Scenario | | | Occasional-Use Scenario | | |
|---|---|---|---|---|---|---|
| | Ingestion Hazard Index (HI) | Inhalation HI | Total HI (a) | Ingestion HI | Inhalation HI | Total HI (a) |
| Chromium | 0.076 | ---- | 0.076 | 0.0015 | ---- | 0.0015 |
| Site Totals (d) | 0.076 | ---- | 0.076 | 0.0015 | ---- | 0.0015 |

COPC represents an ICR > 1E-6 or HI > 1.0

---- COPC does not present a risk or no toxicity data available for this pathway

(a) Total COPC Lifetime ICR or HI from all pathways

(b) Lifetime ICR >1E-02 cannot be accurately estimated using the methodology adopted in this qualitative risk assessment

(c) Risk Characterization is based on most toxic COPC

(d) Total lifetime ICR or HI from all COPC over all pathways

**Table 3-19 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-F-6 Waste Disposal Trench (0-6 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| Cs-134 | 0.0004 | 9.92E-14 | 4.0E-09 | No |
| Cs-137 | 7.8 | 1.93E-09 | 8.1E-05 | No |
| Co-60 | 0.46 | 9.20E-11 | 1.3E-06 | No |
| Eu-152 | 3.6 | 1.44E-12 | 7.4E-10 | No |
| Eu-154 | 0.37 | 1.48E-13 | 1.9E-10 | No |
| Eu-155 | 0.01 | 4.00E-15 | 1.0E-12 | No |
| Ra-226 | 0.41 | 1.64E-11 | 1.9E-04 | No |
| Sr-90 | 1.6 | 1.22E-08 | 1.4E-02 | No |
| Th-228 | 0.39 | 1.56E-14 | 7.8E-11 | No |
| Th-232 | 0.44 | 1.76E-14 | 7.5E-11 | No |
| U-233/234 | 0.43 | 1.72E-10 | 8.2E-05 | No |
| U-238 | 0.51 | 2.04E-10 | 8.5E-05 | No |
| | | | TOTAL 0.014 | No |
| Organic/ Inorganic | Maximum soil conc. (mg/kg) | Veg. Conc. Wet (wet) (mg/kg) | Dose Rate mg/kg/day | Exceeds EHQ |
| di-n-butylphthalate | 0.11 | 3.17E-03 | 9.0E-04 | No |
| toluene | 0.006 | 2.45E-03 | 7.0E-04 | No |
| methylene chloride | 0.002 | 5.87E-03 | 1.7E-03 | No |
| acetone | 0.014 | 2.98E-01 | 8.5E-02 | No |

**Table 3-20 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-F-6 Liquid Waste Disposal Trench (0-15 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| Am-241 | 0.72 | 2.88E-12 | 8.4E-08 | No |
| Cs-134 | 0.0027 | 6.70E-13 | 2.7E-08 | No |
| Cs-137 | 230 | 5.70E-08 | 2.4E-03 | No |
| Co-60 | 33 | 6.60E-09 | 9.3E-05 | No |
| Eu-152 | 190 | 7.60E-11 | 3.9E-08 | No |
| Eu-154 | 18 | 7.20E-12 | 9.5E-09 | No |
| Eu-155 | 0.48 | 1.92E-13 | 4.8E-11 | No |
| Pu-238 | 0.069 | 1.93E-12 | 5.6E-08 | No |
| Pu-239/240 | 2.5 | 7.00E-11 | 1.9E-06 | No |
| Ra-226 | 1 | 4.00E-11 | 4.6E-04 | No |
| Sr-90 | 6.8 | 5.17E-08 | 4.4E-01 | No |
| Th-228 | 0.63 | 2.52E-14 | 1.3E-10 | No |
| Th-232 | 0.58 | 2.32E-14 | 9.9E-11 | No |
| H-3 | 29 | 5.57E-08 | 6.8E-06 | No |
| U-233/234 | 0.83 | 3.32E-10 | 1.6E-04 | No |
| U-238 | 0.69 | 2.76E-10 | 1.1E-04 | No |
| | | | TOTAL 0.44 | No |
| Organic/ Inorganic | Maximum soil conc. (mg/kg) | Veg. Conc. Wet (wet) (mg/kg) | Dose Rate mg/kg/day | Exceeds EHQ |
| di-n-butylphthalate | 0.14 | 4.03E-03 | 1.1E-03 | No |
| toluene | 0.012 | 4.90E-03 | 1.4E-03 | No |
| methylene chloride | 0.002 | 5.87E-03 | 1.7E-03 | No |
| acetone | 0.014 | 2.98E-01 | 8.5E-02 | No |
| chromium | 30.2 | 9.06E-02 | 2.6E-02 | No |
| zinc | 106 | 6.36E+01 | 1.8E+01 | Yes |
| benzene | 0.003 | 2.72E-03 | 7.8E-04 | No |

## Table 3-21 116-F-9 PNL Animal Waste Leach Trench Human Health Risk Characterization

| Radionuclide Contaminant of Potential Concern (COPC) | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|
| | Ingestion Incremental Cancer Risk (ICR) | Inhalation ICR | External Exposure ICR | Total ICR (a) | Ingestion ICR | Inhalation ICR | External Exposure ICR | Total ICR (a) |
| Potassium-40 | 2.2E-07 | 1.3E-09 | 1.9E-04 | 1.9E-04 | 4.2E-09 | 2.4E-11 | 1.2E-06 | 1.2E-06 |
| Thorium-228 | 7.9E-08 | 9.4E-07 | 1.5E-04 | 1.5E-04 | 1.5E-09 | 1.8E-08 | 9.4E-07 | 9.6E-07 |
| Radium-226 | 1.0E-07 | 2.1E-08 | 9.2E-05 | 9.2E-05 | 1.9E-09 | 4.0E-10 | 5.9E-07 | 5.9E-07 |
| Europium-152 | 1.9E-09 | 8.3E-10 | 6.0E-05 | 6.0E-05 | 3.7E-11 | 1.6E-11 | 3.8E-07 | 3.8E-07 |
| Cesium-137 | 3.5E-08 | 2.0E-10 | 4.6E-05 | 4.6E-05 | 6.8E-10 | 3.8E-12 | 2.9E-07 | 2.9E-07 |
| Cobalt-60 | 1.5E-09 | 1.2E-10 | 1.5E-05 | 1.5E-05 | 2.8E-10 | 2.3E-11 | 9.7E-07 | 9.7E-07 |
| Strontium-90 | 4.5E-06 | 6.5E-08 | --- | 4.6E-06 | 8.6E-08 | 1.2E-09 | --- | 8.8E-08 |
| Uranium-238 | 2.3E-08 | 3.7E-07 | 5.5E-07 | 9.4E-07 | 4.5E-10 | 7.0E-09 | 3.5E-09 | 1.1E-08 |
| Thorium-232 | 1.4E-08 | 2.7E-07 | 5.5E-10 | 2.9E-07 | 2.7E-10 | 5.2E-09 | 3.5E-12 | 5.4E-09 |
| Uranium-233/234 (b) | 1.5E-08 | 2.1E-07 | 7.3E-10 | 2.3E-07 | 2.9E-10 | 4.1E-09 | 4.6E-12 | 4.4E-09 |
| Carbon-14 | 1.7E-07 | 9.9E-12 | --- | 1.7E-07 | 3.2E-09 | 1.9E-13 | --- | 3.2E-09 |
| Site Totals (c) | 5E-06 | 2E-06 | 6E-04 | 6E-04 | 1E-07 | 4E-08 | 4E-06 | 5E-06 |

| Chemical Carcinogen COPC | Frequent-Use Scenario | | | Occasional-Use Scenario | | |
|---|---|---|---|---|---|---|
| | Ingestion ICR | Inhalation ICR | Total ICR (a) | Ingestion ICR | Inhalation ICR | Total ICR (a) |
| Chlordane | 1.1E-06 | 4.2E-09 | 1.1E-06 | 2.1E-08 | 8.1E-11 | 2.1E-08 |
| Site Totals (c) | 1E-06 | 4E-09 | 1E-06 | 2E-08 | 8E-11 | 2E-08 |

| Systemic Toxicant COPC | Frequent-Use Scenario | | | Occasional-Use Scenario | | |
|---|---|---|---|---|---|---|
| | Ingestion Hazard Index (HI) | Inhalation HI | Total HI (a) | Ingestion HI | Inhalation HI | Total HI (a) |
| Chlordane | 0.11 | --- | 0.11 | 0.0021 | --- | 0.0021 |
| Site Totals (c) | 0.11 | --- | 0.11 | 0.0021 | --- | 0.0021 |

COPC represents an ICR > 1E-6 or HI > 1.0

--- COPC does not present a risk or no toxicity data available for this pathway

(a) Total COPC Lifetime ICR or HI from all pathways

(b) Risk Characterization is based on most toxic COPC

(c) Total lifetime ICR or HI from all COPC over all pathways

**Table 3-22 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-F-9 Animal Waste Leach Trench (0-6 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| C-14 | 140 | 3.92E-08 | 3.2E-03 | No |
| Ra-226 | 0.63 | 2.52E-11 | 2.9E-04 | No |
| Th-228 | 1.1 | 4.40E-14 | 2.2E-10 | No |
| Th-232 | 0.88 | 3.52E-14 | 1.5E-10 | No |
| U-233/234 | 0.58 | 2.32E-10 | 1.1E-04 | No |
| U-238 | 0.53 | 2.12E-10 | 8.8E-05 | No |
| | | | TOTAL 0.0037 | No |
| Organic/ Inorganic | Maximum soil conc. (mg/kg) | Veg. Conc. Wet (wet) (mg/kg) | Dose Rate mg/kg/day | Exceeds EHQ |
| di-n-butylphthalate | 0.076 | 2.19E-03 | 6.2E-04 | No |
| acetone | 0.006 | 1.28E-01 | 3.6E-02 | No |

**Table 3-23 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-F-9 Animal Waste Leach Trench (0-15 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| C-14 | 140 | 3.92E-08 | 4.1E-04 | No |
| Cs-137 | 0.96 | 2.38E-10 | 1.0E-05 | No |
| Co-60 | 0.074 | 1.48E-11 | 2.1E-07 | No |
| Eu-152 | 0.69 | 2.76E-13 | 1.4E-10 | No |
| Pu-239/240 | 0.22 | 6.16E-12 | 1.7E-07 | No |
| Ra-226 | 0.64 | 2.56E-11 | 2.9E-04 | No |
| Sr-90 | 95 | 7.22E-07 | 8.1E-01 | No |
| Th-228 | 1.1 | 4.40E-14 | 2.2E-10 | No |
| Th-232 | 0.88 | 3.52E-14 | 1.5E-10 | No |
| U-233/234 | 0.72 | 2.88E-10 | 1.4E-04 | No |
| U-238 | 0.64 | 2.56E-10 | 1.1E-04 | No |
| | | | TOTAL 0.80 | No |
| Organic/ Inorganic | Maximum soil conc. (mg/kg) | Veg. Conc. Wet (wet) (mg/kg) | Dose Rate mg/kg/day | Exceeds EHQ |
| di-n-butylphthalate | 0.076 | 2.19E-03 | 6.2E-04 | No |
| methylene chloride | 0.004 | 1.17E-02 | 3.3E-03 | No |
| acetone | 0.066 | 1.41E+00 | 4.0E-01 | No |
| copper | 32.5 | 5.20E+00 | 1.48E+00 | No |
| silver | 7.9 | 1.26E+00 | 3.6E-01 | Yes |
| zinc | 246 | 1.48E+02 | 4.2E+01 | Yes |
| chlordane(alpha and beta) | 0.53 | 2.76E-03 | 7.9E-04 | NA |

Note: Transfer coefficients and no observable effect levels were not available for toxaphene and 4-methyl-2-pentanone, therefore; dose rates were not calculated for these constituents.
NA = A wildlife NOEL value was not available for chlordane.

**Table 3-24 116-F-10 (105-F) Dummy Decontamination French Drain Human Health Risk Characterization**

| Radionuclide Contaminant of Potential Concern (COPC) | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|
| | Ingestion Incremental Cancer Risk (ICR) | Inhalation ICR | External Exposure ICR | Total ICR (a) | Ingestion ICR | Inhalation ICR | External Exposure ICR | Total ICR (a) |
| Cobalt-60 | 1.1E-06 | 8.8E-08 | >1E-02 (b) | >1E-02 | 2.0E-08 | 1.7E-09 | 7.0E-05 | 7.0E-05 |
| Europium-152 | 3.3E-07 | 1.4E-07 | >1E-02 | >1E-02 | 6.3E-09 | 2.7E-09 | 6.6E-05 | 6.6E-05 |
| Europium-154 | 3.7E-08 | 1.5E-08 | 9.4E-04 | 9.4E-04 | 7.2E-10 | 2.8E-10 | 6.0E-06 | 6.0E-06 |
| Cesium-137 | 4.4E-07 | 2.5E-09 | 5.8E-04 | 5.8E-04 | 8.5E-09 | 4.8E-11 | 3.7E-06 | 3.7E-06 |
| Europium-155 | 7.4E-09 | 2.5E-09 | 1.8E-05 | 1.8E-05 | 1.4E-10 | 4.7E-11 | 1.1E-07 | 1.1E-07 |
| Cesium-134 | 1.5E-10 | 8.5E-13 | 3.4E-07 | 3.4E-07 | 2.9E-12 | 1.6E-14 | 2.2E-09 | 2.2E-09 |
| Uranium-238 | 4.0E-09 | 6.3E-08 | 9.5E-08 | 1.6E-07 | 7.8E-11 | 1.2E-09 | 6.1E-10 | 1.9E-09 |
| Site Totals (c) | 2E-06 | 3E-07 | >1E-02 | >1E-02 | 4E-08 | 5E-09 | 1E-04 | 1E-04 |

COPC represents an ICR > 1E-6 or HI > 1.0

(a) Total COPC Lifetime ICR or Hazard Index (HI) from all pathways

(b) Lifetime ICR > 1E-02 cannot be accurately estimated using the methodology adopted in this QRA

(c) Total lifetime ICR or HI from all COPC over all pathways

**Table 3-25 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-F-10 Dummy Decontamination French Drain (0-15 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| Cs-137 | 12 | 2.98E-09 | 1.2E-04 | No |
| Cs-134 | 0.0028 | 2.80E-13 | 2.8E-08 | No |
| Co-60 | 53 | 1.06E-08 | 1.5E-04 | No |
| Eu-152 | 119 | 4.76E-11 | 2.4E-08 | No |
| Eu-154 | 9.5 | 3.80E-12 | 5.0E-09 | No |
| Eu-155 | 13 | 5.20E-12 | 1.3E-09 | No |
| Sr-90 | 0.21 | 1.60E-09 | 1.8E-03 | No |
| Tritium (H-3) | 80 | 1.54E-07 | 1.9E-05 | No |
| U-238 | 0.11 | 4.40E-11 | 1.8E-05 | No |
| | | | TOTAL 0.0021 | No |

**Table 3-26 116-F-11 (105-F) Cushion Corridor French Drain Human Health Risk Characterization**

| Radionuclide Contaminant of Potential Concern (COPC) | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|
| | Ingestion Incremental Cancer Risk (ICR) | Inhalation ICR | External Exposure ICR | Total ICR (a) | Ingestion ICR | Inhalation ICR | External Exposure ICR | Total ICR (a) |
| Europium-152 | 7.3E-09 | 3.2E-09 | 2.3E-04 | 2.3E-04 | 1.4E-10 | 6.2E-11 | 1.5E-06 | 1.5E-06 |
| Cesium-137 | 3.9E-08 | 2.2E-10 | 5.1E-05 | 5.1E-05 | 7.5E-10 | 4.2E-12 | 3.2E-07 | 3.3E-07 |
| Europium-154 | 1.4E-09 | 5.7E-10 | 3.6E-05 | 3.6E-05 | 2.8E-11 | 1.1E-11 | 2.3E-07 | 2.3E-07 |
| Cobalt-60 | 2.4E-09 | 2.0E-10 | 2.6E-05 | 2.6E-05 | 4.7E-11 | 3.9E-12 | 1.6E-07 | 1.6E-07 |
| Site Totals (b) | 5E-08 | 4E-09 | 3E-04 | 3E-04 | 1E-09 | 8E-11 | 2E-06 | 2E-06 |

**COPC represents an ICR > 1E-6 or HI > 1.0**

(a) Total COPC Lifetime ICR or Hazard Index (HI) from all pathways
(b) Total lifetime ICR or HI from all COPC over all pathways

**Table 3-27 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-F-11 Cushion Corridor French Drain (0-6 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| Cs-137 | 1.1 | 2.73E-10 | 1.1E-05 | No |
| Co-60 | 0.12 | 2.40E-11 | 3.4E-07 | No |
| Eu-152 | 2.7 | 1.08E-12 | 5.6E-10 | No |
| Eu-154 | 0.37 | 1.48E-13 | 1.9E-10 | No |
| Eu-155 | 0.0014 | 5.60E-16 | 1.4E-13 | No |
| Sr-90 | 0.24 | 1.82E-09 | 2.0E-03 | No |
| Tritium (H-3) | 0.16 | 3.07E-10 | 3.7E-08 | No |
| | | | TOTAL 0.0021 | No |

NOTE: 116-F-11 does have data for inorganic or organic constituents for the 0-6 ft depth.

**Table 3-28 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-F-11 Cushion Corridor French Drain (0-15 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| Cs-137 | 1.1 | 2.73E-10 | 1.1E-05 | No |
| Co-60 | 0.12 | 2.40E-11 | 3.4E-07 | No |
| Eu-152 | 2.7 | 1.08E-12 | 6.9E-10 | No |
| Eu-154 | 0.37 | 1.48E-13 | 1.9E-10 | No |
| Eu-155 | 0.0014 | 5.60E-16 | 6.9E-13 | No |
| Sr-90 | 0.24 | 1.82E-09 | 2.02E-03 | No |
| Tritium (H-3) | 0.16 | 3.07E-10 | 3.7E-08 | No |
| | | | TOTAL 0.0021 | No |

**Table 3-29 116-F-14 (107-F) Retention Basin Human Health Risk Characterization**

| Radionuclide Contaminant of Potential Concern (COPC) | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|
| | Ingestion Incremental Cancer Risk (ICR) | Inhalation ICR | External Exposure ICR | Total ICR (a) | Ingestion ICR | Inhalation ICR | External Exposure ICR | Total ICR (a) |
| Europium-152 | 1.8E-05 | 8.1E-06 | >1E-02 (b) | >1E-02 | 3.5E-07 | 1.5E-07 | 3.7E-03 | 3.7E-03 |
| Europium-154 | 1.2E-05 | 4.6E-06 | >1E-02 | >1E-02 | 2.3E-07 | 8.8E-08 | 1.9E-03 | 1.9E-03 |
| Cesium-137 | 1.5E-04 | 8.7E-07 | >1E-02 | >1E-02 | 2.9E-06 | 1.7E-08 | 1.3E-03 | 1.3E-03 |
| Cobalt-60 | 1.7E-05 | 1.4E-06 | >1E-02 | >1E-02 | 3.2E-07 | 2.7E-08 | 1.1E-03 | 1.1E-03 |
| Cesium-134 | 4.6E-07 | 2.6E-09 | 1.1E-03 | 1.1E-03 | 8.8E-09 | 5.0E-11 | 6.8E-06 | 6.8E-06 |
| Europium-155 | 2.1E-07 | 6.9E-08 | 5.0E-04 | 5.0E-04 | 4.0E-09 | 1.3E-09 | 3.2E-06 | 3.2E-06 |
| Potassium-40 | 1.7E-07 | 1.0E-09 | 1.6E-04 | 1.6E-04 | 3.3E-09 | 1.9E-11 | 9.9E-07 | 9.9E-07 |
| Thorium-228 | 4.3E-08 | 5.1E-07 | 8.1E-05 | 8.1E-05 | 8.3E-10 | 9.8E-09 | 5.1E-07 | 5.2E-07 |
| Radium-226 | 8.0E-08 | 1.7E-08 | 7.3E-05 | 7.4E-05 | 1.5E-09 | 3.2E-10 | 4.7E-07 | 4.7E-07 |
| Uranium-238 | 1.2E-06 | 1.9E-05 | 2.9E-05 | 5.0E-05 | 2.4E-08 | 3.7E-07 | 1.9E-07 | 5.8E-07 |
| Plutonium-239/240 (c) | 1.4E-05 | 1.9E-05 | 2.9E-08 | 3.2E-05 | 2.6E-07 | 3.6E-07 | 1.9E-10 | 6.2E-07 |
| Nickel-63 | 9.6E-06 | 6.1E-07 | ---- | 1.0E-05 | 1.9E-07 | 1.2E-08 | ---- | 2.0E-07 |
| Strontium-90 | 2.8E-06 | 4.1E-08 | ---- | 2.8E-06 | 5.4E-08 | 7.7E-10 | ---- | 5.5E-08 |
| Americium-241 | 3.1E-07 | 3.4E-07 | 1.2E-07 | 7.7E-07 | 5.9E-09 | 6.6E-09 | 7.3E-10 | 1.3E-08 |
| Plutonium-238 | 2.8E-07 | 4.2E-07 | 6.6E-10 | 7.0E-07 | 5.4E-09 | 8.0E-09 | 4.2E-12 | 1.3E-08 |
| Tritium (H-3) | 4.5E-07 | 5.4E-09 | ---- | 4.5E-07 | 8.6E-09 | 1.0E-10 | ---- | 8.7E-09 |
| Uranium-233/234 (c) | 2.0E-08 | 2.8E-07 | 9.5E-10 | 3.0E-07 | 3.8E-10 | 5.3E-09 | 6.0E-12 | 5.7E-09 |
| Thorium-232 | 1.2E-08 | 2.3E-07 | 4.6E-10 | 2.4E-07 | 2.2E-10 | 4.4E-09 | 2.9E-12 | 4.6E-09 |
| Site Totals (d) | 2E-04 | 6E-05 | >1E-02 | >1E-02 | 4E-06 | 1E-06 | 8E-03 | 8E-03 |

| Chemical Carcinogen COPC | Frequent-Use Scenario | | | Occasional-Use Scenario | | |
|---|---|---|---|---|---|---|
| | Ingestion ICR | Inhalation ICR | Total ICR (a) | Ingestion ICR | Inhalation ICR | Total ICR (a) |
| Chromium | ---- | 3.2E-05 | 3.2E-05 | ---- | 6.1E-07 | 6.1E-07 |
| Site Totals (d) | ---- | 3E-05 | 3E-05 | ---- | 6E-07 | 6E-07 |

| Systemic Toxicant COPC | Frequent-Use Scenario | | | Occasional-Use Scenario | | |
|---|---|---|---|---|---|---|
| | Ingestion Hazard Index (HI) | Inhalation HI | Total HI (a) | Ingestion HI | Inhalation HI | Total HI (a) |
| Chromium | 0.31 | ---- | 0.31 | 0.006 | ---- | 0.006 |
| Site Totals (d) | 0.31 | ---- | 0.31 | 0.006 | ---- | 0.006 |

COPC represents an ICR > 1E-6 or HI > 1.0

---- COPC does not present a risk or no toxicity data available for this pathway

(a) Total COPC Lifetime ICR or HI from all pathways

(b) Lifetime ICR >1E-02 cannot be accurately estimated using the methodology adopted in this qualitative risk assessment

(c) Risk Characterization is based on most toxic COPC

(d) Total lifetime ICR or HI from all COPC over all pathways

**Table 3-30 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-F-14 Retention Basin (0-6 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| Am-241 | 0.98 | 3.92E-12 | 1.1E-07 | No |
| C-14 | 28 | 7.84E-09 | 6.5E-04 | No |
| Cs-134 | 8.50 | 2.11E-09 | 8.5E-05 | No |
| Cs-137 | 4172 | 1.03E-06 | 4.3E-02 | No |
| Co-60 | 844 | 1.69E-07 | 2.4E-03 | No |
| Eu-152 | 6663 | 2.67E-09 | 1.4E-06 | No |
| Eu-154 | 3008 | 1.20E-09 | 1.6E-06 | No |
| Eu-155 | 350 | 1.40E-10 | 3.5E-08 | No |
| Ni-63 | 30643 | 1.23E-06 | 4.8E-03 | No |
| Pu-238 | 0.98 | 2.74E-11 | 8.0E-07 | No |
| Pu-239/240 | 45 | 1.26E-09 | 3.4E-05 | No |
| Ra-226 | 0.5 | 2.00E-11 | 2.3E-04 | No |
| Sr-90 | 59 | 4.48E-07 | 5.0E-01 | No |
| Th-228 | 0.6 | 2.40E-14 | 1.2E-10 | No |
| Th-232 | 0.6 | 2.40E-14 | 1.0E-10 | No |
| H-3 | 6308 | 1.21E-05 | 1.5E-03 | No |
| U-233/234 | 0.94 | 3.76E-10 | 1.8E-04 | No |
| U-238 | 34 | 1.36E-08 | 5.7E-03 | No |
| | | | TOTAL 0.55 | No |
| Organic/ Inorganic | Maximum soil conc. (mg/kg) | Veg. Conc. Wet (wet) (mg/kg) | Dose Rate mg/kg/day | Exceeds EHQ |
| di-n-butylphthalate | 0.34 | 9.79E-03 | 2.8E-03 | No |
| toluene | 0.082 | 3.35E-02 | 9.5E-03 | No |
| methylene chloride | 0.004 | 1.17E-02 | 3.3E-03 | No |
| acetone | 0.023 | 4.90E-01 | 1.4E-01 | No |
| chromium | 124 | 3.72E-01 | 1.1E-01 | No |
| copper | 29.3 | 4.69E+00 | 1.3E+00 | No |
| zinc | 87.4 | 5.24E+01 | 1.5E+01 | Yes |
| cadmium | 1.5 | 3.30E-01 | 9.4E-02 | Yes |

**Table 3-31 Estimated Dose Rate for the Great Basin Pocket Mouse for the 116-F-14 Retention Basin (0-15 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceed EHQ |
|---|---|---|---|---|
| Am-241 | 0.98 | 3.92E-12 | 1.1E-07 | No |
| C-14 | 28 | 7.84E-09 | 8.3E-05 | No |
| Cs-134 | 8.50 | 2.11E-09 | 8.5E-05 | No |
| Cs-137 | 4172 | 1.03E-06 | 4.4E-02 | No |
| Co-60 | 844 | 1.69E-07 | 2.4E-03 | No |
| Eu-152 | 6663 | 2.67E-09 | 1.4E-06 | No |
| Eu-154 | 3008 | 1.20E-09 | 1.6E-06 | No |
| Eu-155 | 350 | 1.40E-10 | 3.5E-08 | No |
| Ni-63 | 30643 | 1.23E-06 | 4.8E-03 | No |
| Pu-238 | 0.98 | 2.74E-11 | 8.0E-07 | No |
| Pu-239/240 | 45 | 1.26E-09 | 3.4E-05 | No |
| Ra-226 | 0.51 | 2.04E-11 | 2.3E-04 | No |
| Sr-90 | 59 | 4.48E-07 | 5.0E-01 | No |
| Th-228 | 0.6 | 2.40E-14 | 1.2E-10 | No |
| Th-232 | 0.74 | 2.96E-14 | 1.3E-10 | No |
| H-3 | 6308 | 1.21E-05 | 1.5E-03 | No |
| U-233/234 | 0.94 | 3.76E-10 | 1.8E-04 | No |
| U-238 | 34 | 1.36E-08 | 5.7E-03 | No |
| | | | TOTAL 0.55 | No |
| **Organic/ Inorganic** | **Maximum soil conc. (mg/kg)** | **Veg. Conc. Wet (wet) (mg/kg)** | **Dose Rate mg/kg/day** | **Exceeds EHQ** |
| di-n-butylphthalate | 0.023 | 6.62E-04 | 1.9E-04 | No |
| toluene | 0.082 | 3.35E-02 | 9.5E-03 | No |
| methylene chloride | 0.004 | 1.17E-02 | 3.3E-03 | No |
| acetone | 0.023 | 4.90E-01 | 1.4E-01 | No |
| chromium | 124 | 3.72E-01 | 1.1E-01 | No |
| copper | 29.3 | 4.69E+00 | 1.3E+00 | No |
| zinc | 87.4 | 5.24E+01 | 1.5E+01 | Yes |
| cadmium | 1.5 | 3.30E-01 | 9.4E-02 | Yes |

## Table 3-32 Process/Discharge Pipelines Human Health Risk Characterization

| Radionuclide Contaminant of Potential Concern (COPC) | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|
| | Ingestion Incremental Cancer Risk (ICR) | Inhalation ICR | External Exposure ICR | Total ICR (a) | Ingestion ICR | Inhalation ICR | External Exposure ICR | Total ICR (a) |
| Europium-152 | 2.2E-10 | 9.8E-11 | **7.0E-06** | **7.0E-06** | 4.3E-12 | 1.9E-12 | 4.5E-08 | 4.5E-08 |
| Cobalt-60 | 2.0E-10 | 1.7E-11 | **2.1E-06** | **2.1E-06** | 3.9E-12 | 3.2E-13 | 1.4E-08 | 1.4E-08 |
| Cesium-137 | 9.3E-10 | 5.3E-12 | **1.2E-06** | **1.2E-06** | 1.8E-11 | 1.0E-13 | 7.8E-09 | 7.8E-09 |
| Uranium-238 | 1.4E-08 | 2.2E-07 | 3.3E-07 | 5.6E-07 | 2.7E-10 | 4.1E-09 | 2.1E-09 | 6.5E-09 |
| Site Totals (b) | 2E-08 | 2E-07 | **1E-05** | **1E-05** | 3E-10 | 4E-09 | 7E-08 | 7E-08 |

COPC represents an ICR > 1E-6 or HI > 1.0

(a) Total COPC Lifetime ICR or Hazard Index (HI) from all pathways

(b) Total lifetime ICR or HI from all COPC over all pathways

**Table 3-33 Estimated Dose Rate for the Great Basin Pocket Mouse for the Process/Discharge Pipelines (0-6 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| Co-60 | 0.01 | 2.00E-12 | 2.8E-08 | No |
| Eu-152 | 0.081 | 3.24E-14 | 1.7E-11 | No |
| Eu-155 | 0.015 | 6.00E-15 | 1.5E-12 | No |
| Sr-90 | 0.18 | 1.37E-09 | 1.5E-03 | No |
| U-238 | 0.38 | 1.52E-10 | 6.8E-05 | No |
| | | | TOTAL 0.0016 | No |

**Table 3-34 Estimated Dose Rate for the Great Basin Pocket Mouse for the Process/Discharge Pipelines (0-15 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| Cs-137 | 0.025 | 6.20E-12 | 2.6E-07 | No |
| Co-60 | 0.01 | 2.00E-12 | 2.8E-08 | No |
| Eu-152 | 0.081 | 3.24E-14 | 1.7E-11 | No |
| Eu-155 | 0.015 | 6.00E-15 | 1.5E-12 | No |
| Sr-90 | 0.18 | 1.37E-09 | 1.5E-03 | No |
| Tritium (H-3) | 0.46 | 8.83E-10 | 1.1E-07 | No |
| U-238 | 0.38 | 1.52E-10 | 6.8E-05 | No |
| | | | TOTAL 0.0016 | No |

95133-0215

**Table 3-35 Basin Leak Ditch Human Health Risk Characterization**

| Radionuclide Contaminant of Potential Concern (COPC) | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|
| | Ingestion Incremental Cancer Risk (ICR) | Inhalation ICR | External Exposure ICR | Total ICR (a) | Ingestion ICR | Inhalation ICR | External Exposure ICR | Total ICR (a) |
| Europium-152 | 3.9E-07 | 1.7E-07 | **> 10-2 (b)** | **> 10-2** | 7.6E-09 | 3.3E-09 | **7.9E-05** | **7.9E-05** |
| Cobalt-60 | 6.6E-07 | 5.6E-08 | **7.0E-03** | **7.0E-03** | 1.3E-08 | 1.1E-09 | **4.4E-05** | **4.4E-05** |
| Europium-154 | 1.1E-07 | 4.2E-08 | **2.7E-03** | **2.7E-03** | 2.1E-09 | 8.0E-10 | **1.7E-05** | **1.7E-05** |
| Cesium-137 | **1.1E-06** | 6.2E-09 | **1.4E-03** | **1.4E-03** | 2.1E-08 | 1.2E-10 | **9.1E-06** | **9.1E-06** |
| Europium-155 | 1.4E-09 | 4.7E-10 | **3.4E-06** | **3.4E-06** | 2.7E-11 | 9.0E-12 | 2.1E-08 | 2.1E-08 |
| Cesium-134 | 8.0E-10 | 4.6E-12 | **1.9E-06** | **1.9E-06** | 1.5E-11 | 8.7E-14 | 1.2E-08 | 1.2E-08 |
| Plutonium-239/240 (c) | 1.8E-07 | 2.5E-07 | 3.9E-10 | 4.4E-07 | 3.5E-09 | 4.9E-09 | 2.5E-12 | 8.4E-09 |
| Uranium-238 | 7.0E-09 | 1.1E-07 | 1.6E-07 | 2.8E-07 | 1.3E-10 | 2.1E-09 | 1.0E-09 | 3.3E-09 |
| Strontium-90 | 1.2E-07 | 1.8E-09 | ---- | 1.2E-07 | 2.3E-09 | 3.4E-11 | ---- | 2.4E-09 |
| Site Totals (d) | **3E-06** | 6E-07 | **> 10-2** | **> 10-2** | 5E-08 | 1E-08 | **1E-04** | **1E-04** |

COPC represents an ICR > 1E-6 or HI > 1.0

---- COPC does not present a risk from this pathway

(a) Total COPC Lifetime ICR or Hazard Index (HI) from all pathways

(b) Lifetime ICR >10-2 cannot be accurately estimated using the methodology adopted in this qualitative risk assessment

(c) Risk Characterization is based on most toxic COPC

(d) Total lifetime ICR or HI from all COPC over all pathways

**Table 3-36 Estimated Dose Rate for the Great Basin Pocket Mouse for Basin Leak Ditch (0-6 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| Cs-134 | 0.015 | 3.72E-12 | 1.5E-07 | No |
| Cs-137 | 30 | 7.44E-09 | 3.1E-04 | No |
| Eu-152 | 143 | 5.72E-11 | 2.9E-08 | No |
| Eu-154 | 27 | 1.08E-11 | 1.4E-08 | No |
| Eu-155 | 2.4 | 9.60E-13 | 2.4E-10 | No |
| Pu-239/240 | 0.61 | 1.71E-11 | 4.7E-07 | No |
| Sr-90 | 2.6 | 1.98E-08 | 2.2E-02 | No |
| Tritium (H-3) | 0.38 | 7.30E-10 | 8.9E-08 | No |
| U-238 | 0.19 | 7.60E-11 | 3.4E-05 | No |
| | | | TOTAL 0.022 | No |

NOTE: The Basin Leak Ditch does not have data for inorganic or organic constituents for the 0-6 ft depth.

**Table 3-37 Estimated Dose Rate for the Great Basin Pocket Mouse for the Basin Leak Ditch (0-15 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| Cs-134 | 0.015 | 3.72E-12 | 1.5E-07 | No |
| Cs-137 | 30 | 7.44E-09 | 3.1E-04 | No |
| Co-60 | 34 | 6.80E-09 | 9.6E-05 | No |
| Eu-152 | 143 | 5.72E-11 | 2.9E-08 | No |
| Eu-154 | 27 | 1.08E-11 | 1.4E-08 | No |
| Eu-155 | 2.4 | 9.60E-13 | 2.4E-10 | No |
| Pu-239/240 | 0.61 | 1.71E-11 | 4.7E-07 | No |
| Sr-90 | 2.6 | 1.98E-08 | 2.2E-02 | No |
| Tritium (H-3) | 0.38 | 7.30E-10 | 8.9E-08 | No |
| U-238 | 0.19 | 7.60E-11 | 3.4E-05 | No |
| | | | TOTAL 0.023 | No |

# Table 3-38 EM Bypass Ditch Human Health Risk Characterization

| Radionuclide Contaminant of Potential Concern (COPC) | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|
| | Ingestion Incremental Cancer Risk (ICR) | Inhalation ICR | External Exposure ICR | Total ICR (a) | Ingestion ICR | Inhalation ICR | External Exposure ICR | Total ICR (a) |
| Europium-152 | 4.7E-07 | 2.1E-07 | **> 10-2 (b)** | **> 10-2** | 9.1E-09 | 4.0E-09 | **9.4E-05** | **9.4E-05** |
| Cobalt-60 | 5.3E-07 | 4.4E-08 | **5.5E-03** | **5.5E-03** | 1.0E-08 | 8.4E-10 | **3.5E-05** | **3.5E-05** |
| Europium-154 | 1.7E-07 | 6.6E-08 | **4.2E-03** | **4.2E-03** | 3.2E-09 | 1.3E-09 | **2.7E-05** | **2.7E-05** |
| Cesium-137 | **1.0E-06** | 5.9E-09 | **1.4E-03** | **1.4E-03** | 2.0E-08 | 1.1E-10 | **8.7E-06** | **8.7E-06** |
| Europium-155 | 2.0E-09 | 6.7E-10 | **4.8E-06** | **4.8E-06** | 3.8E-11 | 1.3E-11 | 3.0E-08 | 3.1E-08 |
| Cesium-134 | 7.6E-10 | 4.4E-12 | **1.8E-06** | **1.8E-06** | 1.5E-11 | 8.3E-14 | 1.1E-08 | 1.1E-08 |
| Plutonium-239/240 (c) | 1.7E-07 | 2.3E-07 | 3.6E-10 | 4.0E-07 | 3.2E-09 | 4.4E-09 | 2.3E-12 | 7.6E-09 |
| Uranium-238 | 6.2E-09 | 9.7E-08 | 1.5E-07 | 2.5E-07 | 1.2E-10 | 1.9E-09 | 9.4E-10 | 2.9E-09 |
| Strontium-90 | 1.8E-07 | 2.6E-09 | ---- | 1.8E-07 | 3.4E-09 | 4.9E-11 | ---- | 3.5E-09 |
| Site Totals (d) | **3E-06** | 7E-07 | **3E-02** | **3E-02** | 5E-08 | 1E-08 | **2E-04** | **2E-04** |

COPC represents an ICR > 1E-6 or HI > 1.0

---- COPC does not present a risk from this pathway

(a) Total COPC Lifetime ICR or Hazard Index (HI) from all pathways

(b) Lifetime ICR >10-2 cannot be accurately estimated using the methodology adopted in this qualitative risk assessment

(c) Risk Characterization is based on most toxic COPC

(d) Total lifetime ICR or HI from all COPC over all pathways

**Table 3-39 Estimated Dose Rate for the Great Basin Pocket Mouse for the EM Bypass Ditch (0-6 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| Cs-134 | 0.00042 | 1.04E-13 | 4.2E-09 | No |
| Cs-137 | 1.9 | 4.71E-10 | 2.0E-05 | No |
| Co-60 | 0.18 | 3.60E-11 | 5.1E-07 | No |
| Eu-152 | 2.3 | 9.20E-13 | 4.7E-10 | No |
| Eu-154 | 0.43 | 1.72E-13 | 2.3E-10 | No |
| Eu-155 | 0.05 | 2.00E-14 | 5.0E-12 | No |
| Sr-90 | 0.17 | 1.29E-09 | 1.4E-03 | No |
| | | | TOTAL 0.0015 | No |

NOTE: The EM Bypass Ditch does not have data for inorganic or organic constituents for the 0-6 ft depth.

**Table 3-40 Estimated Dose Rate for the Great Basin Pocket Mouse for the EM Bypass Ditch (0-15 feet)**

| Isotope | Activity/g Soil (pCi/g) | Activity/kg Vegetation (wet) (Ci/kg) | Dose Rate (rad/day) | Exceeds EHQ |
|---|---|---|---|---|
| Cs-134 | 0.014 | 3.47E-12 | 1.4E-07 | No |
| Cs-137 | 28 | 6.94E-09 | 2.9E-04 | No |
| Co-60 | 27 | 5.40E-09 | 7.6E-05 | No |
| Eu-152 | 171 | 6.84E-11 | 3.5E-08 | No |
| Eu-154 | 43 | 1.72E-11 | 2.3E-08 | No |
| Eu-155 | 3.4 | 1.36E-12 | 3.4E-10 | No |
| Pu-239/240 | 0.55 | 1.54E-11 | 4.2E-07 | No |
| Sr-90 | 3.8 | 2.89E-08 | 3.2E-02 | No |
| Tritium (H-3) | 2.2 | 4.22E-09 | 5.1E-07 | No |
| U-238 | 0.17 | 6.80E-11 | 3.0E-05 | No |
| | | | TOTAL 0.032 | No |

# 4.0 SUMMARY AND CONCLUSIONS

The 100-FR-1 Operable Unit QRA presents a qualitative evaluation of human health and ecologic risks associated with the high priority and nonprioritized waste sites included in the 100-FR-1 Operable Unit. The human health QRA evaluates two exposure scenarios (i.e., frequent- and occasional-use) over four exposure pathways (i.e., soil ingestion, fugitive dust inhalation, inhalation of volatile organics, and external radiation exposure). The ecologic QRA estimates risks to a selected ecological receptor, the Great Basin pocket mouse. The use of these scenarios and pathways was agreed to by the 100 Area Tri-Party unit managers (December 21, 1992 and February 8, 1993). The reductions in human health risks from delaying the onset of human exposures to the year 2018 (i.e., decreasing radionuclide COPC soil concentrations through radioactive decay) and from external radiation shielding effects provided by clean-fill soil cover are also estimated. This QRA is not intended to replace or be a substitute for a baseline risk assessment.

This QRA includes conservative assumptions which simplify the risk characterization process, resulting in qualified estimates of risks and hazards to human health. The use of the numerical risk and hazard estimates in the 100-FR-1 Operable Unit QRA should be limited to comparisons with QRA for other operable units evaluated using the same methodology (DOE-RL 1994a).

## 4.1 HUMAN HEALTH QUALITATIVE RISK ASSESSMENT

The 100-FR-1 Operable Unit human health QRA provides estimates of risks that occur under frequent-use or occasional-use scenarios based on the best available knowledge of current waste site conditions. Because neither of these exposure scenarios currently occur, risks that might occur for humans under frequent- and occasional-use were included to provide an upper and lower bound estimate of risk to a reasonable maximum exposure individual.

### 4.1.1 Results of the Human Health QRA

Table 4-1 and Figure 4-1 summarize the results of the 100-FR-1 Operable Unit human health risk characterization of waste sites. Nine of the fourteen waste sites for which there are soil analysis data are considered to have "high" human health risks in the frequent-use scenario.

The external radiation exposure pathway is shown to be the primary risk-contributing pathway at all of the evaluated waste sites. No separate figure is produced for the external radiation pathway as it so overwhelms the other two pathways. The total human health risk is the external exposure risk. Consequently, radionuclide COPC that are external radiation exposure hazards (cobalt-60, cesium-137, europium-152, and europium-154) are considered the primary risk-contributing COPC. Chemicals (arsenic, chromium, PCB) and radionuclide COPC that represent internal radiation hazards (tritium, carbon-14, strontium-90, etc.)

represent insignificant human health risks in comparison to the primary risk-contributing COPC. Figure 4-1 also demonstrates that the inhalation, and ingestion exposure pathways represent much lower human health risks than does the external radiation pathway at the 100-FR-1 Operable Unit waste sites.

The potential decreases in human health risks from delaying the onset of human frequent-use scenario exposures to the year 2018 are shown in Figure 4-2. A reduction of one qualitative risk category (i.e., "high" risk reduced to the "medium" risk category) is anticipated at five of the fourteen evaluated waste sites under the frequent-use scenario. This reduction in risk can be primarily attributed to the radioactive decay of cobalt-60, cesium-137, europium-152, and europium-154.

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

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

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

Exposure estimates for hypothetical human receptors include an extrapolation of external radiation field properties and air COPC particulate concentrations from soil COPC concentrations. Direct measurements, such as those provided by external radiation dosimeters, are expected to significantly reduce this source of uncertainty in the 100-FR-1 Operable Unit QRA.

The assumption of a homogenous distribution of the maximum soil concentration of each radionuclide COPC ("infinite source" geometry) is used to evaluate individual external radiation exposure risks. Uncertainty is introduced into the QRA because this assumption ignores the differences in radiation intensity provided for any other distribution of radionuclide COPC in soil, and results in an over estimation of the external radiation exposure risks. Because the external radiation exposure pathway was found to be the primary risk-contributing pathway at all evaluated waste sites, this source of uncertainty is expected to significantly impact the 100-FR-1 Operable Unit QRA.

Table 4-2 summarizes the qualitative risk evaluation of waste sites that have no soil analysis data. Historical information and risk estimates from analogous sites were used to estimate the qualitative risk category for such sites. The accuracy of the estimated qualitative risk category is highly dependent on the appropriateness of the selected analogous waste site.

This major source of uncertainty can be reduced as site-specific data become available for these waste sites.

## 4.2 ECOLOGICAL QUALITATIVE RISK ASSESSMENT

### 4.2.1 Results of the Ecological Evaluation

A qualitative ecological evaluation was completed for radiological constituents for the 100-FR-1 Operable Unit. The findings are:

- Historical data indicate that 116-F-4 Pluto Crib exceeds the EHQ (Table 4-3) at the surface 0-1.8 m (0-6 ft) soil profile as well as the total the 0-4.6 m (0-15 ft) depth, although it is recognized that the Pluto Crib was excavated in 1993.

- Eight sites (Table 4-4) exceed the wildlife NOEL (EHQ > 1) for one or more nonradiological contaminants. These sites include: the 108 French Drain, the 116-F-1 Lewis Canal, the 116-F-2 Basin Overflow, the 116-F-3 Fuel Storage Basin Trench, the 116-F-4 Pluto Crib (historical data), the 116-F-6 Liquid Waste Disposal Trench, the 116-F-9 Animal Waste Leach Trench, and the 116-F-14 Retention Basin.

The estimation of significant EHQ for radionuclides within 1.8 m (6 ft) of the soil surface, indicates that radionuclides at 116-F-4 Pluto Crib are available for uptake by plants and can be biologically transported to the pocket mouse. Radionuclides at the 116-F-9 Animal Leach Trench, however, did not exceed the EHQ of 1 rad/day (0.8 rad/day) within the 4.6 m (15 ft) of soil. The top 1.8 m (6 ft) of soil was three orders of magnitude less than the total 4.6 m (15 ft) soil profile. This result indicates that there is less of a hazard for biotransport of contaminants to the pocket mouse. For sites where the total radiological EHQ dose is > 1, strontium-90 is the primary dose contributor. Table 4-5 provides a comparison of the contaminants, which exceed an EHQ of one, for the individual waste sites.

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

The uncertainty in contaminant concentrations for the ecological evaluation is related to the accuracy of the data. Uncertainty exists in both the contaminants identified and the exposure concentrations. As for the human health assessment, the maximum observed contaminant concentration is used for the evaluation, and this provides a measure of conservativism to the pocket mouse dose model. However, if this number is not realistic, no amount of modeling will overcome this deficiency.

The QRA models the potential exposure of pocket mice suspected to be present in or near the waste site. The issues of concern with regard to ecological risk assessment (particularly qualitative) are uncertainties in using an assortment of environmental variables in risk modeling. Site-specific organisms (e.g., pocket mouse), are identified as being associated with the site, but little, if any, data may exist concerning transfer of contaminants from site-specific organisms. Often, it is necessary to use biological trophic transfer information for related species. The pocket mouse dose model includes a number of factors which are represented in the literature by a range of values, and each contribute to the overall uncertainty. These include factors such as the soil-to-plant contaminant transfer coefficients, the mouse feeding rate, the average pocket mouse body weight, radionuclide biological decay, and radionuclide assimilation factors.

Because uncertainty exists within the dose modeling, the pocket mouse dose model for this QRA builds certain conservatism into the dose estimates. For example, the maximum observed contaminant concentration is used. The exposure scenario assumes uniform soil contamination of the maximum concentration within waste sites and total contamination of mouse foodstuffs. No provision is made for dilution of contaminated foodstuff by noncontaminated foodstuff. The model assumes that the plant roots contact the contaminant and that seed concentration is the same as the plant. Seasonal behavior (hibernation) that can reduce internal exposure and body burden is not considered.

**Figure 4-1 100-FR-1 Operable Unit Waste Site Total Human Health Risks**
**100-FR-1 Operable Unit Waste Site Human Health Ingestion Risks**
**100-FR-1 Operable Unit Waste Site Human Health Inhalation Risks**

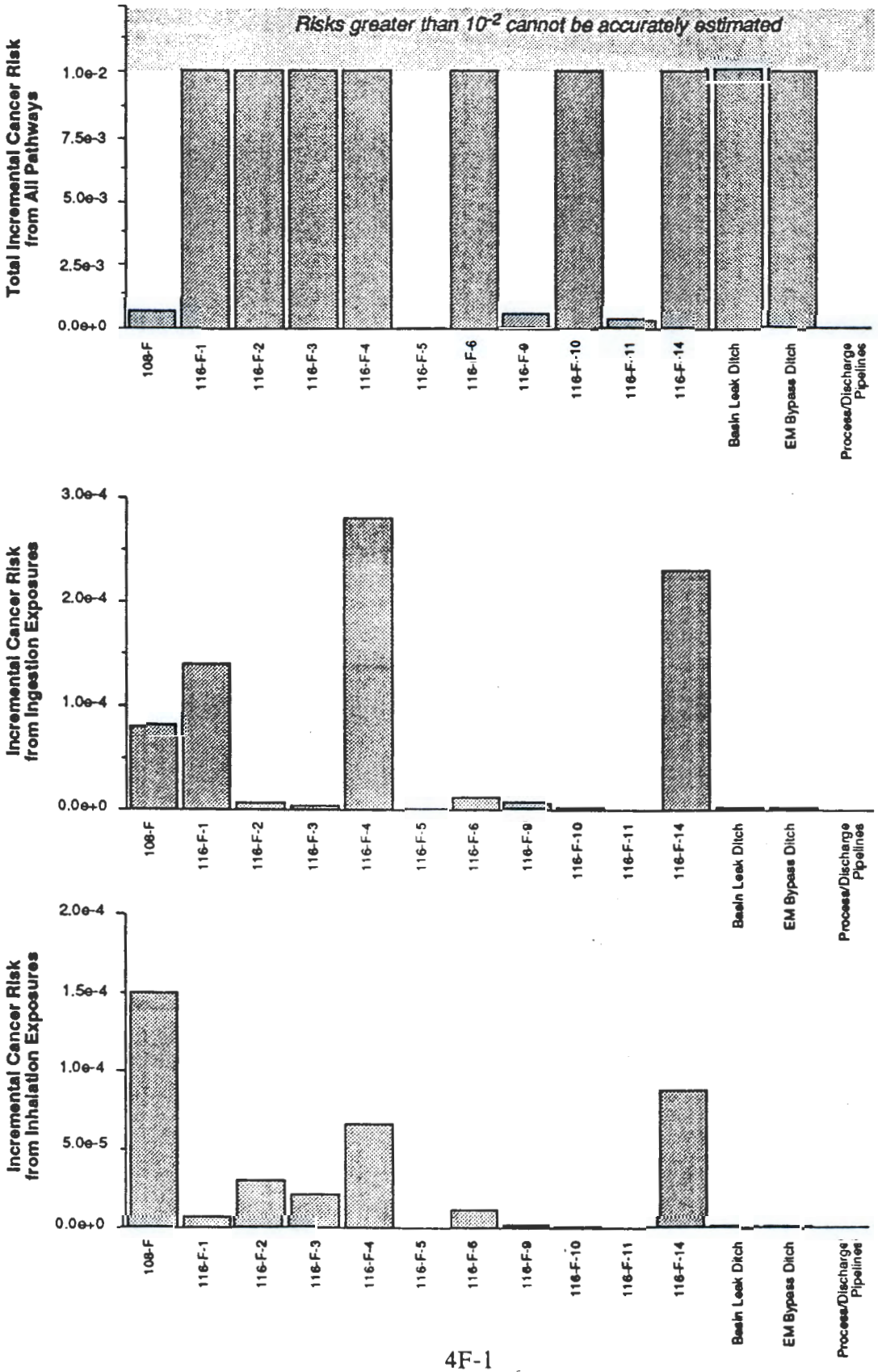


**Figure 4-2 Effect of Radionuclide Decay on Frequent-Use Scenario Site Risks**

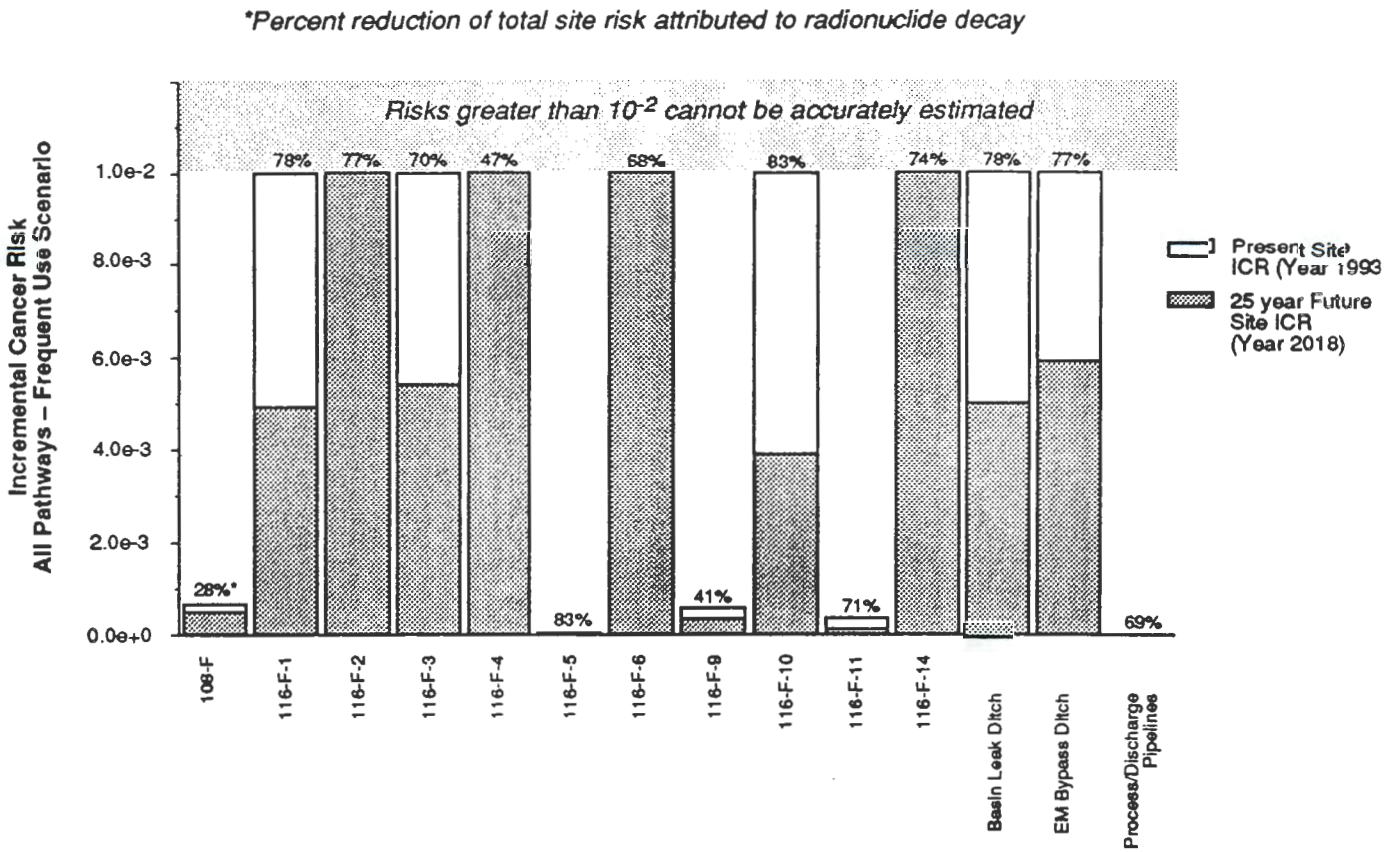


**Table 4-1 Summary of the Human Health Qualitative Risk Assessment for the 100-FR-1 Operable Unit High Priority and Nonprioritized Waste Sites with Data (page 1 of 2)**

| Waste Site Designation | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|
| | Qualitative Risk Classification (a) | Major Contaminant | Major Pathway | 2018 Qualitative Risk Classification (a,b) | Qualitative Risk Classification (a) | Major Contaminant | Major Pathway | Modified Qualitative Risk Classification (a,c) |
| 108-F French Drain | Medium | Potassium-40<br>Plutonium-238<br>Thorium-228<br>Cesium-137 | External Radiation<br>Inhalation<br>Ingestion | Medium | Low | Plutonium-238<br>Potassium-40<br>Chromium<br>Thorium-228 | External Radiation<br>Inhalation<br>Ingestion | Low |
| 116-F-1 Lewis Canal | High | Europium-152<br>Cobalt-60<br>Europium-154 | External Radiation | Medium | Medium | Europium-152<br>Cobalt-60<br>Europium-154 | External Radiation | Medium |
| 116-F-2 (107-F) Basin Overflow Trench | High | Europium-152<br>Europium-154 | External Radiation | High | Medium | Europium-152<br>Europium-154 | External Radiation | Low |
| 116-F-3 (105-F) Fuel Storage Basin Trench | High | Europium-152 | External Radiation | Medium | Medium | Europium-152 | External Radiation | Low |
| 116-F-4 (105-F) Pluto Crib | High | Cesium-137 | External Radiation | High | Medium | Cesium-137 | External Radiation | Medium |
| 116-F-5 Ball Washer Crib | Low | Europium-154<br>Cesium-137 | External Radiation | Low | Very Low | Europium-154<br>Cesium-137 | External Radiation | ND |
| 116-F-6 (1608-F) Liquid Waste Disposal Trench | High | Europium-152<br>Cesium-137<br>Cobalt-60 | External Radiation | High | Medium | Europium-152<br>Cesium-137<br>Cobalt-60 | External Radiation | Low |
| 116-F-9 PNL Animal Waste Leach Trench | Medium | Potassium-40<br>Thorium-228<br>Radium-226<br>Europium-152 | External Radiation | Medium | Low | Potassium-40<br>Cobalt-60<br>Thorium-228<br>Radium-226 | External Radiation | Low |
| 116-F-10 (105-F) Dummy Decontamination French Drain | High | Cobalt-60<br>Europium-152 | External Radiation | Medium | Medium | Cobalt-60<br>Europium-152 | External Radiation | ND |
| 116-F-11 (105-F) Cushion Corridor French Drain | Medium | Europium-152<br>Cesium-137<br>Europium-154 | External Radiation | Medium | Low | Europium-152<br>Cesium-137<br>Europium-154 | External Radiation | Low |

Table 4-1 Summary of the Human Health Qualitative Risk Assessment for the 100-FR-1 Operable Unit High Priority and Nonprioritized Waste Sites with Data (page 2 of 2)

| Waste Site Designation | Frequent-Use Scenario | | | | Occasional-Use Scenario | | | |
|---|---|---|---|---|---|---|---|---|
| | Qualitative Risk Classification (a) | Major Contaminant | Major Pathway | 2018 Qualitative Risk Classification (a,b) | Qualitative Risk Classification (a) | Major Contaminant | Major Pathway | Modified Qualitative Risk Classification (a,c) |
| 116-F-14 (107-F) Retention Basin | High | Europium-152<br>Europium-154<br>Cesium-137<br>Cobalt-60 | External Radiation | High | Medium | Europium-152<br>Europium-154<br>Cesium-137<br>Cobalt-60 | External Radiation | Medium |
| Process/Discharge Pipelines | Low | Europium-152<br>Cobalt-60<br>Cesium-137 | External Radiation | Low | Very Low | Europium-152<br>Cobalt-60<br>Cesium-137 | External Radiation | Very Low |
| Basin Leak Ditch | High | Europium-152<br>Cobalt-60<br>Europium-154 | External Radiation | Medium | Medium | Europium-152<br>Cobalt-60<br>Europium-154 | External Radiation | Medium |
| EM Bypass Ditch | High | Europium-152<br>Cobalt-60<br>Europium-154 | External Radiation | Medium | Medium | Europium-152<br>Cobalt-60<br>Europium-154 | External Radiation | Low |

(a) Very Low = Very Low Qualitative Risk; Incremental Cancer Risk (ICR) < 10-6
Low = Low Qualitative Risk; 10-6 < ICR < 10-4
Medium = Medium Qualitative Risk; 10-4 < ICR < 10-2
High = High Qualitative Risk; ICR > 10-2
ND = Not Determined, data unavailable to determine qualitative risk
(b) Qualitative risk when the onset of frequent-use scenario exposures is delayed to the year 2018
(c) Qualitative risk when shielding effects of clean-fill soils are considered when estimating occasional-use scenario external radiation exposures.

**Table 4-2** Summary of the Human Health Qualitative Risk Assessment for 100-FR-1 Operable Unit High Priority and Nonprioritized Waste Sites without Data

| Waste Site Designation | Analogous Waste Site (a) | Frequent-Use Scenario | | | Occasional-Use Scenario | | |
|---|---|---|---|---|---|---|---|
| | | Qualitative Risk Classification (b) | Potential Major Contaminant | Potential Major Pathway | Qualitative Risk Classification (b) | Potential Major Contaminant | Potential Major Pathway |
| 116-F-8 (1904-F) Outfall Structure | 116-F-14 Retention Basin | High (c) | Europium-154<br>Europium-152<br>Cobalt-60<br>Cesium-137 | External Radiation | Medium (c) | Europium-154<br>Europium-152<br>Cobalt-60<br>Cesium-137 | External Radiation |
| 116-F-12 (148-F) French Drain | 116-F-14 Retention Basin | High (c) | Europium-154<br>Europium-152<br>Cobalt-60<br>Cesium-137 | External Radiation | Medium (c) | Europium-154<br>Europium-152<br>Cobalt-60<br>Cesium-137 | External Radiation |
| 116-F-13 (1705-F) Experimental Garden French Drain | 116-F-14 Retention Basin | High (c) | Europium-154<br>Europium-152<br>Cobalt-60<br>Cesium-137 | External Radiation | Medium (c) | Europium-154<br>Europium-152<br>Cobalt-60<br>Cesium-137 | External Radiation |
| 128-F-2 Burning Pit | None | Medium (c,d) | Unknown | Ingestion<br>Inhalation | Low (c,d) | Unknown | Ingestion<br>Inhalation |
| 132-F-6 (1608-F) Lift Station Demolition Site | 116-F-3 Fuel Storage Basin Trench<br>116-F-11 Cushion Corridor French Drain | Medium to High | Europium-152<br>Europium-154<br>Cesium-137 | External Radiation | Low to Medium | Europium-152<br>Europium-154<br>Cesium-137 | External Radiation |
| PNL Outfall Structure | 116-F-9 PNL Animal Waste Trench | Medium (c) | Potassium-40<br>Radium-226<br>Thorium-232<br>Europium-152 | External Radiation | Low (c) | Europium-152<br>Potassium-40<br>Radium-226<br>Thorium-232 | External Radiation |
| Pre-Reactor Coolant Water Facilities | 116-F-14 Retention Basin (Chemical) 116-F-5 Ball Washer Crib (Radionuclide) | Low (c) | Europium-154<br>Cesium-137<br>Chromium | External Radiation | Very Low (c) | Europium-154<br>Cesium-137<br>Chromium | External Radiation |
| UN-100-F1 | 116-F-9 PNL Animal Waste Trench | Medium (c) | Potassium-40<br>Thorium-228<br>Radium-226<br>Europium-152 | External Radiation | Low (c) | Potassium-40<br>Thorium-228<br>Radium-226<br>Cobalt-60 | External Radiation |

(a) Selection of Analogous Waste Sites Described in Chapter 2.0 of this Report.
(b) Very Low = Very Low Qualitative Risk; Incremental Cancer Risk (ICR) < 10-6
Low = Low Qualitative Risk; 10-6 < ICR < 10-4
Medium = Medium Qualitative Risk; 10-4 < ICR < 10-2
High = High Qualitative Risk; ICR > 10-2
(c) Risk Category may reflect an upper bound of potential risks at this waste site.
(d) Qualitative risk classification is based on the highest risk category for chemical contaminants of potential concern from waste sites characterized by analytical data.

## Table 4-3 Environmental Hazard Quotients Summary for Radionuclides by Waste Site

| Waste Site | Dose Rate Exceeds 1 rad/day (EHQ of 1) 0-6 feet | Dose Rate Exceeds 1 rad/day (EHQ of 1) 0-15 feet |
|---|---|---|
| 108-F French Drain | No | No |
| 116-F-1 Lewis Canal | No | No |
| 116-F-2 Basin Overflow Trench | No | No |
| 116-F-3 Fuel Storage Basin Trench | No | No |
| 116-F-4 Pluto Crib | Yes | Yes |
| 116-F-5 Ball Washer Crib | NDA | No |
| 116-F-6 Liquid Waste Disposal Trench | No | No |
| 116-F-9 Animal Waste Leach Trench | No | No |
| 116-F-10 Dummy Decontamination French Drain | NDA | No |
| 116-F-11 Cushion Corridor French Drain | No | No |
| 116-F-14 Retention Basin | No | No |
| Process Discharge Pipeline | No | No |
| Basin Leak Ditch | No | No |
| EM Bypass Ditch | No | No |

NDA = No data available
EHQ = environmental hazard quotient

**Table 4-4 Environmental Hazard Quotients Summary for Nonradiological Contaminants Which Exceed Hanford Background by Waste Site**

| Waste Site | Dose Rate Exceeds NOEL (EHQ of 1) 0-6 feet | Dose Rate Exceeds NOEL (EHQ of 1) 0-15 feet |
|---|---|---|
| 108-F French Drain (lead, selenium, zinc) | Yes | Yes |
| 116-F-1 Lewis Canal (arsenic, lead, cadmium, zinc) | Yes | Yes |
| 116-F-2 Basin Overflow Trench (zinc, cadmium) | No | Yes |
| 116-F-3 Fuel Storage Basin Trench (lead, zinc, mercury [0-15 ft only], barium) | Yes | Yes |
| 116-F-4 Pluto Crib (barium) | Yes | Yes |
| 116-F-5 Ball Washer Crib | NDA | NDA |
| 116-F-6 Liquid Waste Disposal Trench (zinc) | No | Yes |
| 116-F-9 Animal Waste Leach Trench (lead, silver, zinc) | No | Yes |
| 116-F-10 Dummy Decontamination French Drain | NDA | NDA |
| 116-F-11 Cushion Corridor French Drain | NDA | NDA |
| 116-F-14 Retention Basin (zinc, cadmium) | Yes | Yes |
| Process Discharge Pipelines | NDA | NDA |
| Basin Leak Ditch | NDA | NDA |
| EM Bypass Ditch | NDA | NDA |

NDA = No data available
EHQ = environmental hazard quotient
NOEL = no observable effect level
LOEL = lowest observable effect level

## Table 4-5 Comparison of Contaminants (Exceeding the EHQ) Between Sites

| WASTE SITE | Ag | As | Cd | Cu | Ba | Hg | Se | Pb | Zn | Radionuclide |
|---|---|---|---|---|---|---|---|---|---|---|
| 108 French Drain | | | | X | | | X | X | X | |
| 116-F-1 Lewis Canal | | X | X | | | | | X | X | |
| 116-F-2 Basin Overflow | | | X | | | | | | X | |
| 116-F-3 Fuel Storage Basin Trench | | | | | X | X | | X | X | |
| 116-F-4 Pluto Crib | | | | | X | | | | | X |
| 116-F-6 Liquid Waste Disposal Trench | | | | | | | | | X | |
| 116-F-9 Animal Waste Leach Trench | X | | | | | | | | X | |
| 116-F-14 Retention Basin | | | X | | | | | | X | |

EHQ = environmental hazard quotient

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