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Risk Information in Support of Cost Estimates for the Baseline Environmental Management Report (BEMR)

June 1995

Prepared for the U.S. Department of Energy
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Pacific Northwest Laboratory
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Section I

Development and Application of Unit Risk Factor Methodology: Nevada Test Site

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June 1995

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(a) ICF Kaiser Engineers, Inc., Oakland, California.

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Executive Summary

The Pacific Northwest Laboratory (PNL)[a] effort on the overall Baseline Environmental Management Report (BEMR) project consists of four installation-specific work components performed in succession. These components include 1) development of source terms, 2) collection of data and preparation of environmental settings reports, 3) calculation of unit risk factors, and 4) utilization of the unit risk factors in Automated Remedial Action Methodology (ARAM) for computation of target concentrations and cost estimates. This report documents work completed for the Nevada Test Site, Nevada, for components 2 and 3.

This document is a three-volume set entitled *Risk Information in Support of Cost Estimates for the Baseline Environmental Management Report (BEMR)*. The three-volume set presents the Nevada Test Site data and includes a compilation of the reports which support the cost work for BEMR. Volume I, *Development and Application of Unit Risk Factors Methodology*, presents the work performed by PNL and ICF Kaiser Engineers, Inc. Volume II, *Environmental Settings Report*, includes an individual Nevada Test Site environmental settings-report. The Volume II text is also published separately as a chapter in a collection of environmental settings reports. Volume III, *Unit Exposure Factors Methodology*, describes the procedure used to calculate the unit exposure factors component of the unit risk factors methodology.

The product of this phase of the BEMR project is the development of unit factors (i.e., unit transport factors, unit exposure factors, and unit risk factors). Thousands of these unit factors are gene rated and fill approximately one megabyte of computer information per installation. The final unit risk factors (URF) are transmitted electronically to BEMR-Cost task personnel as input to a computer program (ARAM). Abstracted files and exhibits of the URF information are included in this report. These visual formats are intended to provide a sample of the final task deliverable (the URF files) which can be easily read without a computer.

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Abbreviations

ARAM	Automated Remedial Action Methodology
BEMR	Baseline Environmental Management Report
CERE	Consortium of Environmental Risk Evaluation
CoC	constituents of concern
DOE	U.S. Department of Energy
EM	Environmental Management
ER	Environmental Restoration
ESs	environmental settings
HI	Hazards Index
HRA-EIS	Hanford Remedial Action Environmental Impact Statement
MRA	Modular Risk Analysis
PEIS	Programmatic Environmental Impact Statement
PNL	Pacific Northwest Laboratory
SIF	summary intake factor
URF	unit risk factor

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1.0 Baseline Environmental Management Report (BEMR) Project Description

In fiscal year 1994 the National Defense Authorization Act required the annual development of a Baseline Environmental Management Report (BEMR), including 1) the total projected cost of the environmental management; 2) a description of each project/activity; 3) a description of the problem addressed by project/activity; 4) a proposed remediation of the problem, if known; and 5) the estimated cost and schedule of completion of each project/activity (in five-year increments).

The U.S. Department of Energy (DOE) has identified approximately 10,000 release sites across the DOE complex that need to be evaluated for potential remediation. BEMR will develop a "baseline case" using current release site information. The baseline case will reflect current contamination and land use assumptions for each installation. Only existing remedial technologies and low-level disposal waste sites (six) will be assumed to be available.

Sensitivity analyses of remediation costs will be used to define the range of cost for the baseline based on potential decision outcomes until agreements between DOE and stakeholders can be reached. A national scope and schedule (of DOE Environmental Management (EM) activities) will be developed to fit the funding assumptions. The sensitivity analyses will provide revised cost and schedule estimates based on each remediation alternative. A report that contains DOE Headquarters and DOE Field Staff draft results of the analysis has been produced (DOE 1995).

The DOE Environmental Restoration (ER) program's costs and schedules are important issues because of the enormous waste volumes that potentially could be generated. The current waste management inventory is approximately 790,000 m^3 with about 100,000 m^3 currently in "compliance." Added to these volumes are the projected ER volumes based on different land use assumptions, which vary from 2,000,000 (restricted land use) to 30,000,000 m^3 (unrestricted land use).

DOE EM-40 baseline cost, schedule, and waste volume estimates are developed from DOE field office data and Programmatic Environmental Impact Statement (PEIS)/BEMR modeling results. The modeling results for waste volumes were based on Automated Remedial Action Methodology (ARAM) runs that analyzes remediation of release sites based on different land use scenarios. ARAM is a remediation feasibility study computer model which was used to indicate the constituents of concern (CoC) and remedial action on release sites. The waste volumes resulting from the projected remediation are used to determine the cost of ER activities.

Risk information in support of BEMR consists of factors developed for distinct regions of installations (environmental settings) by constituent, waste type, release mechanism, exposure medium, and receptor type. The risk information is developed based on a modular risk approach which separates the source term, environmental transport, and exposure assessment into discrete units that can be computed independent of each other and combined once all factors are complete.

1.1 Pacific Northwest Laboratory (PNL) Scope of Work

The Pacific Northwest Laboratory (PNL) effort on the overall BEMR project consists of four installation-specific work components performed in succession. These components include 1) development of source terms, 2) collection of data and preparation of environmental settings reports, 3) calculation of unit risk factors, and 4) utilization of the unit risk factors in ARAM for computation of target concentrations and cost estimates. (Note: The four components were performed in a series. However it is also possible to perform components 1, 2, and 3 concurrently. This report [Section I] documents the work performed to complete component 3).

1.2 Collaboration With Consortium of Environmental Risk Evaluation (CERE)

In a program separate from BEMR, DOE Environmental Health (EH-6) is performing regional risk assessment work through the CERE. CERE is managed jointly by Xavier University and Tulane University. ICF Kaiser Engineers, Inc., a CERE contractor, has teamed with PNL in performing certain pieces of the risk triggers project. These pieces were identified as areas of potential overlap between the BEMR and CERE scopes of work. Therefore the work presented here represents a collaborative effort between CERE and BEMR.

1.3 Development of Source Term Information

An initial step in the BEMR project was the development of source term information, including waste volume estimates or inventory estimates. Source term information is collected for each individual release site for each installation from field office data and modeling results. Source term information is compiled and stored in a database called the DOE Programmatic Environmental Impact Statement (termed the PEIS database). The PEIS database is computer accessible. The title of the PEIS database report is *Description of Source Term Data Compiled for the Programmatic Environmental Impact Statement (PEIS)* (Short and Smith 1995).

1.4 Environmental Settings

Each installation is divided into appropriated environmental setting units which assume that the hydrology, climatology, and geology information for an environmental setting is homogenous. The number of different environmental settings depends on the complexity of the installation environment (may vary from 1 to 14 environmental settings).

The environmental settings information for twenty installations has been compiled and is reported in Holdren et al. 1994. Environmental settings information on five additional DOE installations is presented in Holdren et al. 1995.

Environmental setting information consists of the site-specific data required to model the atmospheric, groundwater, and surface water transport of contaminants within and near the boundaries of the installations. The environmental settings data describes the climate, atmospheric dispersion, hydrogeology, and surface water characteristics of the installations. The number of discrete environmental settings per installation varies. The approach is to minimize the number of settings per installation, while simplifying the representations of the different areas within an installation. The number chosen for each installation represents a compromise between the number of waste sites, the potential contaminant transport pathways found at each installation, and the ability of the risk model to deal with the complexity in a coherent and reasonable manner.

A companion to this document (Section II, *Environmental Settings Report*) includes the installation-specific environmental settings report. The work presented in Section II is a chapter abstracted from the reports by Holdren et al. (1994, 1995). The installation environmental settings report is presented as a companion document because it contains information pertinent to the development of the conceptual site model.

1.5 Modular Risk Analysis Methodology

The unit risk factor (URF) methodology originates in a compartment of the modular risk analysis methodology. The Modular Risk Analysis (MRA) methodology was first developed for the Hanford Remedial Action Environmental Impact Statement (HRA-EIS) by PNL and Advanced Sciences Inc. (Whelan et al. 1994). This methodology is described in several PNL documents (e.g., Strenge and Chamberlain 1994) and presentations (e.g., Whelan et al. 1994). This methodology was developed for regional- and site-wide type risk computations that involve a large number of release sites with different waste types for various environmental settings (ESs). The URF approach (described below) is the foundation of the MRA methodology. The URF approach is based on the assumptions of linearity between the release site source and the risk at the receptor. By determining the linearity of the system, the methodology can be divided into compartments that can be implemented independently and concurrently. The compartments of the MRA methodology are 1) source term determination (contaminant mass), 2) transport modeling of contaminant into the environment (environmental concentrations at the receptor location), 3) exposure assessment for dose to receptor (maximum exposed individual), and 4) derivation of risk triggers to determine action sites for remediation and CoC.

1.6 Unit Risk Factor Methodology

The BEMR transport and risk analyses were structured to take advantage of precalculated factors. This structuring required generation of URFs to allow a significant reduction in computer computational efforts. This section discusses the URF methodology as it applies to the BEMR project.

The URFs are not direct human health risk values. The URFs give human health impact from an exposure scenario per unit mass (or activity) of a pollutant in a defined waste form. The URFs are later multiplied by source inventories to obtain an estimate of human health risk. The URF methodology originates in a compartment of the MRA discussed above.

The MRA is implemented using the URF methodology, which divides the source to receptor risk into three parts: release site source term, unit transport factors (UTFs), and unit exposure factors (UEFs) to produce risk values. In BEMR, the URF is the product of multiplying the UTF by the UEF. The UTF, UEF, and URF are the three distinct pieces of the URF methodology.

The assumption of the URF methodology is that the environmental concentrations at the receptor location (UTFs) are linearly proportional to the magnitude of the release site source. It is also assumed that the exposure, dose, and risk values (UEFs) are linear with the environmental concentrations. Equation 1.1 shows these linear relationships.

$$\text{Risk} = S_a * \text{URF} = S_a * \text{UTF} * \text{UEF} \tag{1.1}$$

Where S_a (grams or Curies) is the actual magnitude of the source term for a release site. The URF approach will develop the matrix of UTFs and UEFs to be used by the ARAM code to compute risk estimates for each release site with enough information.

The focus of the URF approach is not to compute risk for each release site but to compute URFs based on UTFs and UEFs. These URFs are provided to the ARAM code where cost estimates are made for each release site using the actual magnitude of the source term (S_a) and the appropriate URF value for determining the appropriate remediation activity. The UTFs are based on unit sources (S_u) run through the risk program transport codes to compute unit environmental concentrations (C_s). The unit risk values (R_c) are based on the unit environmental concentration (C_u) run through the risk program exposure model, which establish the UEFs. The UTFs and UEFs in Equation 1.1 are defined in Equation 1.2 and Equation 1.3, respectively.

$$\text{UTF} = \left[\frac{C_s}{S_u}\right] \tag{1.2}$$

$$\text{UEF} = \left[\frac{R_c}{C_u}\right] \tag{1.3}$$

Equation 1.4 shows how the UTFs and UEFs are combined with the release site source term from the PEIS database to compute risk triggers in ARAM. The different compartments of the MRA methodology allow source term, transport, and exposure computations to be applied concurrently and linked together later.

$$\text{Risk} = S_a * \left[\frac{C_s}{S_u}\right] * \left[\frac{R_c}{C_u}\right] \tag{1.4}$$

The following sections further describe the UTF, UEF, and URF components of the process and their units. Section III, *Unit Exposure Factors Methodology*, provides detail specifically on the UEF component.

1.6.1 Unit Transport Factor

The UTF represents the environmental fate and transport component of the unit risk factor methodology or process. The UTF value in the BEMR work is the portion of the 1 Ci (1 g) assumed unit of a contaminant at the source which, after being transported through a specific environmental media (air, soil, groundwater, or surface water), ultimately arrives at the receptor exposure point. Both an onsite and an offsite receptor location is considered. The units of the UTF are media-dependent; for example, $(mg/m^3)/g$ or $(pCi/m^3)/Ci$ for air, $(mg/m^2)/g$ or $(pCi/m^2)/Ci$ for soil, and (g/ml)/g or (Ci/ml)/Ci for groundwater and surface water.

1.6.2 Unit Exposure Factor

The UEF accounts for the exposure assessment component of the URF methodology or process. The UEF is the amount of predicted risk per unit of environmental concentration to which a receptor is exposed. For purposes of the BEMR project, residential exposure is estimated. (Note: Other types of exposure [e.g., occupational] may easily be calculated with the MRA methodology.) The UEF units are a risk or hazard index (HI) per unit exposure or intake (presented as either weight per volume for air and water or weight per mass in soil). For example, the units for radionuclides in air are $risk/(pCi/m^3)$; for noncarcinogenic chemicals in air, $HI/(mg/m^3)$; and for carcinogenic chemicals in air, $risk/(mg/m^3)$. The units for radionuclides in soils are risk/(g/g); for noncarcinogenic chemicals in soil, HI/(g/g); and for carcinogens in soil, risk/(g/g).

A companion document to this document (Section III, *Unit Exposure Factors Methodology*) describes the procedure used to calculate the UEFs component of the URF methodology.

1.6.3 Unit Risk Factor

The URF numbers are not direct health risk values, because they are calculated independently of an actual source or source term. URF values are unitized expressions of risk. The URF analyses are intended to provide estimates of health impacts per unit mass in a waste form. The health impact measure for carcinogenic chemicals and radionuclides is the lifetime cancer incidence from intake received during a defined exposure duration. For noncarcinogens, the health impact measure is the HI, which is the ratio of the average daily intake versus the reference dose (evaluated for ingestion and inhalation intake routes). For each pollutant, the health impacts are added across all exposure pathways for a given exposure medium. All URF analyses are based on the exposure of an adult. The URF numbers are in the following units: for radionuclides, risk/Ci; for noncarcinogenic chemicals, HI/gram; and for carcinogenic chemicals, risk/gram. URFs are based on human exposure to a standardized (or unitized) amount of a contaminant in a generic source term (the standardized unit for radionuclides is 1 Curie [Ci], and the standardized unit for chemicals is 1 gram). In order to calculate risk for a given source, the URF number is multiplied by the source inventory.

1.7 Report Organization

This document is Section I of a three-volume set entitled *Risk Information in Support of Cost Estimates for the Baseline Environmental Management Report (BEMR)*. The three-volume set presents installation-specific data and includes a compilation of the reports which support the cost work for BEMR. Section I presents the work performed by PNL and ICF Kaiser Engineers, Inc. to develop and apply the URF methodology. This volume is organized as follows. Chapter 1.0, "Baseline Environmental Management Report (BEMR) Project Description," presents an overall description of the project. Chapter 2.0, "Installation Description," gives the facility purpose and history, a brief summary of the conceptual site models (CSMs), and the environmental settings data. Chapter 3.0, "Conceptual Site Model," provides the full CSM checklists developed for each environmental setting at a given installation, a list of the contaminants of interest, and associated records of assumption. Chapter 4.0, "Discussion of Unit Factors" provides visual pictures of UTF, UEF, and URF values. Chapter 5.0, "Anchoring Report," describes the anchoring methodology employed including a description of the anchoring process, the rationale for the site selected, a comparison of anchoring results to published values, and a summary of changes to the conceptual site model needed as a result of the anchoring, if applicable. Anchoring is a technique for approximating the accuracy of modeling results by comparing them to values reported elsewhere for the installation. Full citations of references are given at the conclusion of each chapter.

1.8 References

Holdren, G. R., C. S. Glantz, L. K. Berg, K. Delinger, S. M. Goodwin, J. R. Rustad, R. Schalla, and J. A. Schramke. 1994. *Environmental Settings for Selected U.S. Department of Energy Installations--Support Information for the Programmatic Environmental Impact Statement*. PNL-10180. Pacific Northwest Laboratory, Richland, Washington.

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U.S. Department of Energy (DOE). 1995. *Estimating the Cold War Mortgage, The 1995 Baseline Environmental Management Report, Volumes I and II.* U.S. Department of Energy Office of Environmental Management, Washington, D.C.

Whelan, G., J. W. Buck, and A. Nazarali. 1994. *Modular Risk Analysis for Assessing Multiple Waste Sites*. PNL-SA-24239. Pacific Northwest Laboratory, Richland, Washington.

2.0 Installation Description: The Nevada Test Site

This chapter provides a brief facility history of the Nevada Test Site (NTS), including the installation location and description, past operations, and contamination releases. In addition, the chapter contains descriptions of the CSMs, and the environmental settings material developed for the installation. Chapter 3.0 contains the complete CSM checklists and their attachments completed for this installation's environmental settings. Section II (of this set) includes the installation-specific environmental settings report. The information associated with these components comes from installation-specific reports and documents. Examples of such reports are annual reports, environmental impact statements, performance assessments, risk assessments (RAs), remedial investigations, and baseline risk reports. The chapter ends with a full citation to all chapter references.

2.1 Facility History

The NTS, located in southern Nevada, has been the primary location for testing of nuclear explosive devices in the continental United States since January 1951. The installation has been used for below and above ground nuclear testing. As many as 600 reported nuclear detonation tests were conducted between 1965 and 1991 (Daniels 1993; DOE 1992).

The NTS occupies an area of approximately 3510 square kilometers (1350 square miles) in a remote arid region (see Figure 2.1). (The average annual precipitation in the valleys ranges from 7.5 to 15 cm (3 to 6 inches) and on most of the ridges and mesas averages less than 25 cm [10 inches].) The southern two-thirds of the NTS is dominated by three large valleys or basins: Yucca, Frenchman, and Jackass Flats. Mountain ridges and hills enclose the basins. The northern and northwestern sections of NTS are dominated by Pahute Mesa and Rainer Mesa. The installation's complex terrain is not suited to simple air dispersion modeling.

The sole source of water for the NTS is groundwater. The groundwater is reported to be contaminated with radionuclides (Borg 1976). At this time, however, determining the cost of remediation of residues of underground detonations, including groundwater release, is outside of the scope of work of this BEMR task for the NTS. No surface water features are present at the NTS except during rare, heavy rainfall events (Winograd 1975).

2.2 Conceptual Site Models

The purpose of the CSM is to simplify and translate conditions in the real world into modeling terms which can serve as input to risk assessment calculations. The CSM is developed for each ES associated with an installation.

The CSM defines potential or suspected constituents, constituents of concern, waste chemistry, waste types, release mechanism, receiving media, routes of contaminant migration at the site,

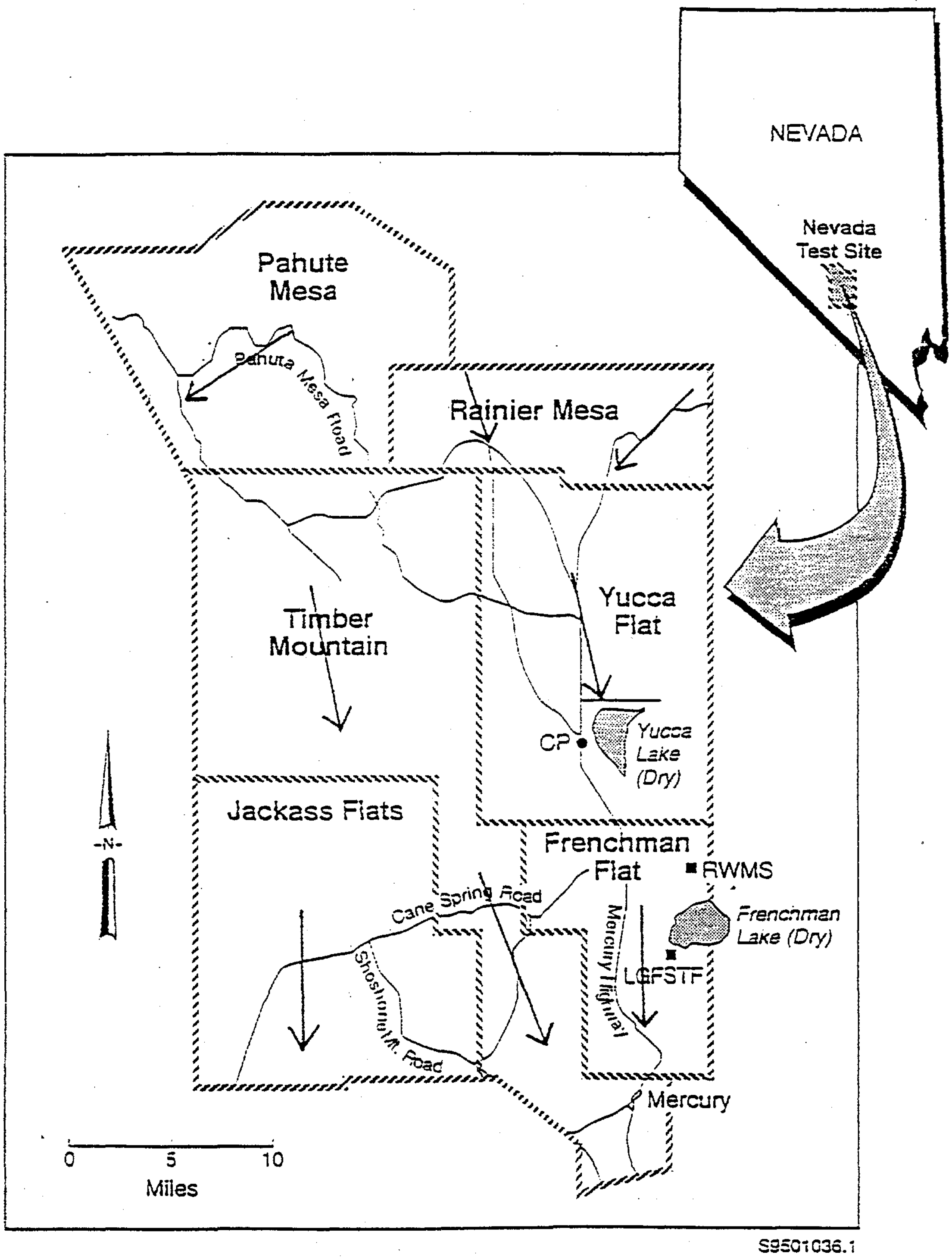

Figure 2.1. Nevada Test Site Location Map

potentially contaminated media, release source location, receptor locations, any assumptions about the release source, exposure pathways for each receptor, the approximate date of initial release, and any exceptions in the modeling. The CSMs are developed from a review of installation-specific literature, such as annual reports and investigations. In addition, the environmental settings material provides input to the CSM. The NTS has six environmental settings.

The CSM itself is in the form of a checklist with attachments. (See Chapter 3.0 for the complete CSM checklists and their attachments.) At the end of each checklist is a reference list. Typically the reference identifies the number of the record of assumption (ROA) used in developing the CSM.

Two maps are presented in the CSM. One map shows the general groundwater pathway flow, while the other shows the release source and boundary receptor locations for each of the six environmental settings at the NTS.

Also included in the CSM report is a list of the ROAs. An ROA is a memorandum that documents the assumption used in formulating the CSM or defining other input parameters. The assumption may be about the CSM such as the source and boundary receptor locations for each environmental setting. The assumption can also be about parameters used in the RA software runs, such as estimates of elevation for each ES, or which set of climatological data to use at each environmental location. Each ROA is numbered and has a specific title. A table of contents of the ROAs is provided in Chapter 3 of this section.

The CSM defines the relationships between the contaminated source at the release site and the health impacts at the receptors. The important components associated with these relationships are constituents of interest (CoC), the waste source types, the release mechanisms, the exposure media, receptor types and exposure pathways. The process for the development of the components of the CSM are described in the following sections.

2.2.1 Identification of Constituents of Concern

Four tables are typically included in the checklist that define the CoC. The first table is a preliminary list of all the constituents of concern. The second table is a list of the primary constituents. These are constituents that are found in the RA software library, and the PEIS database. The third table lists the constituents that are not found in the RA software chemical library. The fourth table lists the constituents that are not found in the PEIS database. For example, the existence of a contaminant that may have been identified in the document review.

An initial list of CoCs for each installation is determined by querying the PEIS source term database for all constituents that are identified for each release site. This list is augmented by including constituents identified in installation-specific documents. This combined set of constituents is the Preliminary List of CoCs.

The Preliminary List of CoCs includes the name of the contaminant, the CAS ID, whether it is in the PEIS source term database (Yes/No), whether it is in the RA software chemical library (Yes/No), and a reference (source of information). The CoC is divided into several categories defined as inorganic non-radionuclides, inorganic radionuclides, organic volatiles, and organic non-volatiles. An organic volatile is defined by a Henry's Law Constant $\geq 10^{-7}$ (atm•m^3/g-mole) while a contaminant with a Henry's Law constant $< 10^{-7}$ (atm•m^3/g-mole) is defined as an organic non-volatile.

The Preliminary List of CoC for an installation is used to develop a list of constituents that exist in both the PEIS source term and in the RA software chemical library, called the Primary List of CoCs. This primary list contains all the constituents that can currently be modelled by the RA software to produce URFs, and modelled by the ARAM code to provide cost estimates. Additional lists are developed that contain all the constituents not in the PEIS source term database and all the constituents not in the RA software chemical library. These two lists identify constituents that need to be researched more to identify if they should be added to the Primary List of CoCs (by adding to PEIS and/or the RA software).

2.2.2 Identification of Waste Types and Their Release Mechanisms

There are five different waste types defined for the URFs associated with the BEMR Project. These waste types are 1) soil contamination (surface and/or subsurface), 2) buried waste, 3) contaminated groundwater (groundwater plumes), 4) contaminated water from surface water impoundments, and 5) contaminated sediments from surface water impoundments. The CSM documents which waste types exist at each ES within an installation.

Initially the PEIS source term database is queried to determine the pertinent waste types for each ES. If a waste form is not identified for an ES, then that waste type is not run for URFs. However, if information independent of the PEIS database (installation-specific reports) indicates that the eliminated waste type does exist for the ES, the CSM lead and team leader may include the waste type in the URF matrix. This decision is coordinated with the installation cost leader.

Once the valid waste forms for each ES have been named, the valid release mechanisms are identified. Figures 2.2, 2.3, 2.4, and 2.5 show the full list of release mechanisms for each waste type. Release mechanisms are depicted as arrows, with the solid line arrows being valid and the dotted line arrows being invalid. For the CSM, a release mechanism is considered valid, based on Figures 2.2 to 2.5, unless installation-specific documents indicate otherwise. In some cases, engineering judgement is used in determining valid release mechanisms and is documented in an ROA memo.

The source location is typically picked as the center. Sometimes it is determined by means of a case study which varies the location and examines the results. The size of the source varies from 0.9 to 90,000 square meters (10 to 1,000,000 square feet), and increases by a factor of 10 each step. Exposure to two hypothetical receptors is examined. One is an onsite receptor, and the other is a boundary receptor. All ESs follow the same method for determining the location of the onsite receptor. The distance of the onsite receptor to the center of the source site is one and one-half times

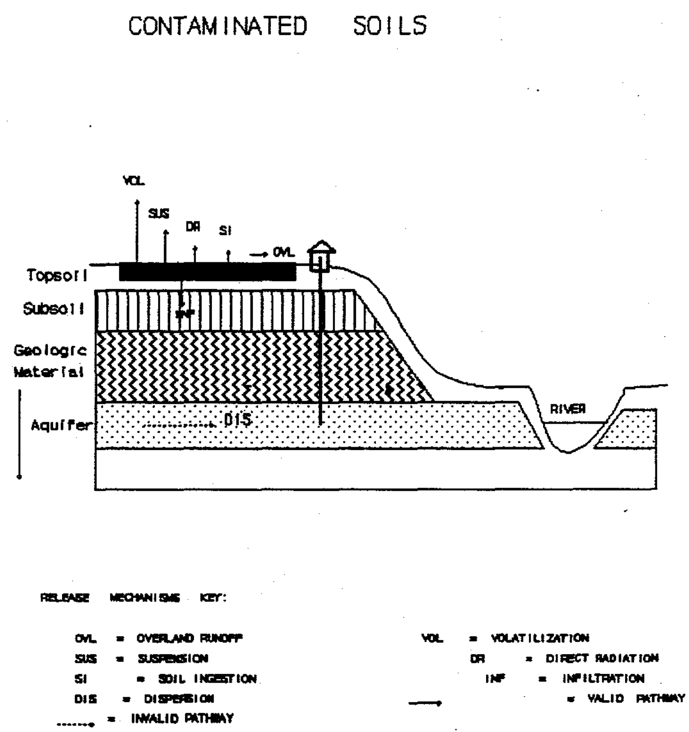

Figure 2.2. Valid Release Mechanisms Associated With Contaminated Soil Waste Type

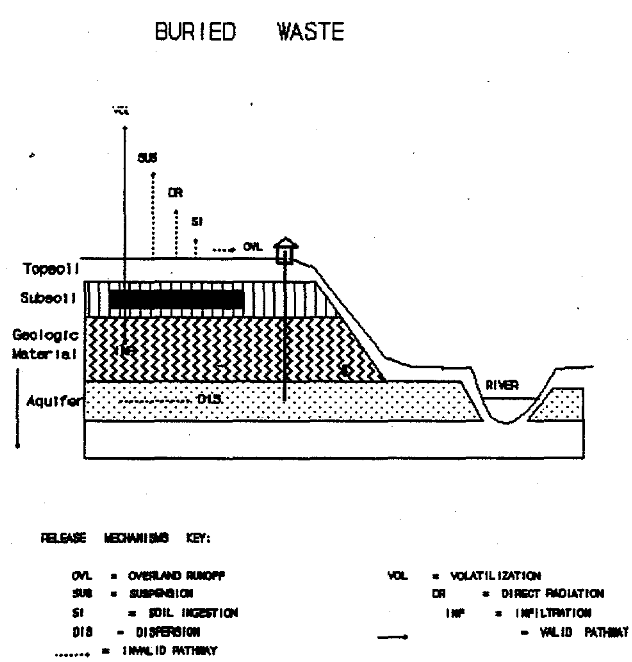

Figure 2.3. Valid Release Mechanisms Associated With Buried Waste Type

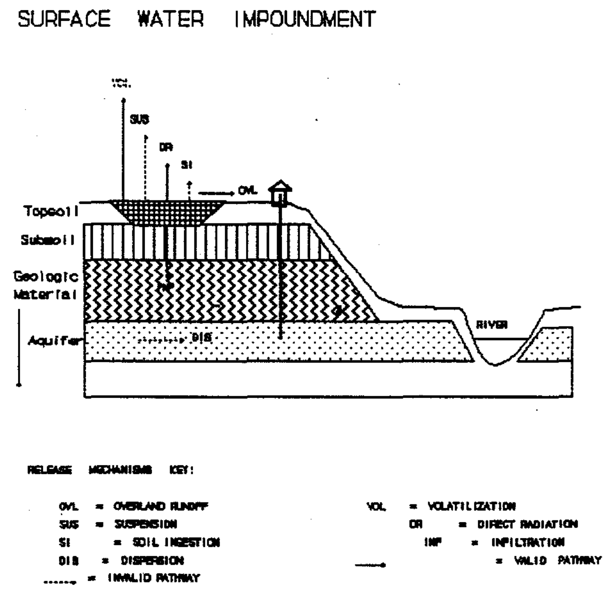

Figure 2.4. Valid Release Mechanisms Associated With Surface Water Impoundment (water and sediment) Waste Types

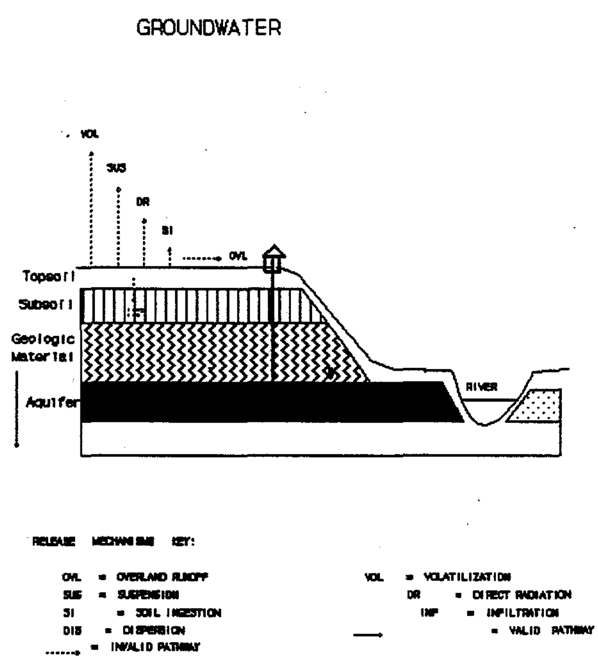

Figure 2.5. Valid Release Mechanisms Associated With Groundwater Waste Type

the length of the source site. The direction of the onsite receptor is in the direction of groundwaterflow or in the direction of highest concentration in the case of an atmospheric receptor. For both receptors, the exposure pathways considered where inhalation, ingestion, external radiation, and dermal contact.

2.2.3 Identification of Exposure Media

The waste types and their associated release mechanisms establish the full suite of exposure media that might be impacted by contamination. There are four possible exposure media that need to be considered: groundwater, surface water, air, and soil. Exposure media are eliminated based on installation-specific information (i.e., non-perennial surface water or insufficient precipitation for overland runoff) or based on the CSM developed for the ES. Any exposure medium that is eliminated from the CSM is justified and documented in an ROA memo.

The groundwater, air, and soil exposure media are generally easy to define but the surface water exposure medium can be more difficult. At some installations there may be several surface water bodies (i.e., rivers, reservoirs, lakes) that could supply drinking water and/or recreational activities. These surface water bodies' use needs to be individually evaluated. In some situations a surface water impoundment that is a source could also be an exposure medium.

In some cases perched and regional aquifers can be contaminated by the same release site. For these cases, two different sets of UTFs are developed using the characteristics from each aquifer. The different aquifers are characterized in the ES report to be used to develop URFs and cost estimates.

2.2.4 Identification of Receptor Types and Exposure Pathways

There are currently three types of receptors associated with the URF approach for the BEMR task. These are 1) hypothetical onsite receptors, 2) hypothetical restricted area boundary receptors, and 3) hypothetical installation boundary receptors. Actual (onsite and offsite) receptors are currently not being evaluated, but information associated with actual receptors is collected along with the other receptor. Figure 2.6 is a diagram illustrating the location of the different receptor types (X1 is the onsite location, X2 is the restricted area boundary location, and X3 is the installation boundary receptor location) at a hypothetical installation with respect to the release site (RS-1) and groundwater flow within the ES (ES-2).

In all cases there is an onsite and installation boundary receptor type for each ES. An exception to this case is when the ES is small and the onsite receptor is located at the edge of the installation (the onsite and installation boundary receptor are the same). The restricted area boundary receptor is modelled only if an installation-specific document has identified a land use restriction for a certain area within the installation (See Figure 2.6 for an example of a restricted area).

For NTS, the PEIS database lists 38 primary contaminants of interest (2 inorganics, 8 organics, and 28 radionuclides. Two waste forms--contaminated surface soil and buried waste--are modeled. As of this writing, only contaminants in surface soil are identified by the PEIS database as being present at

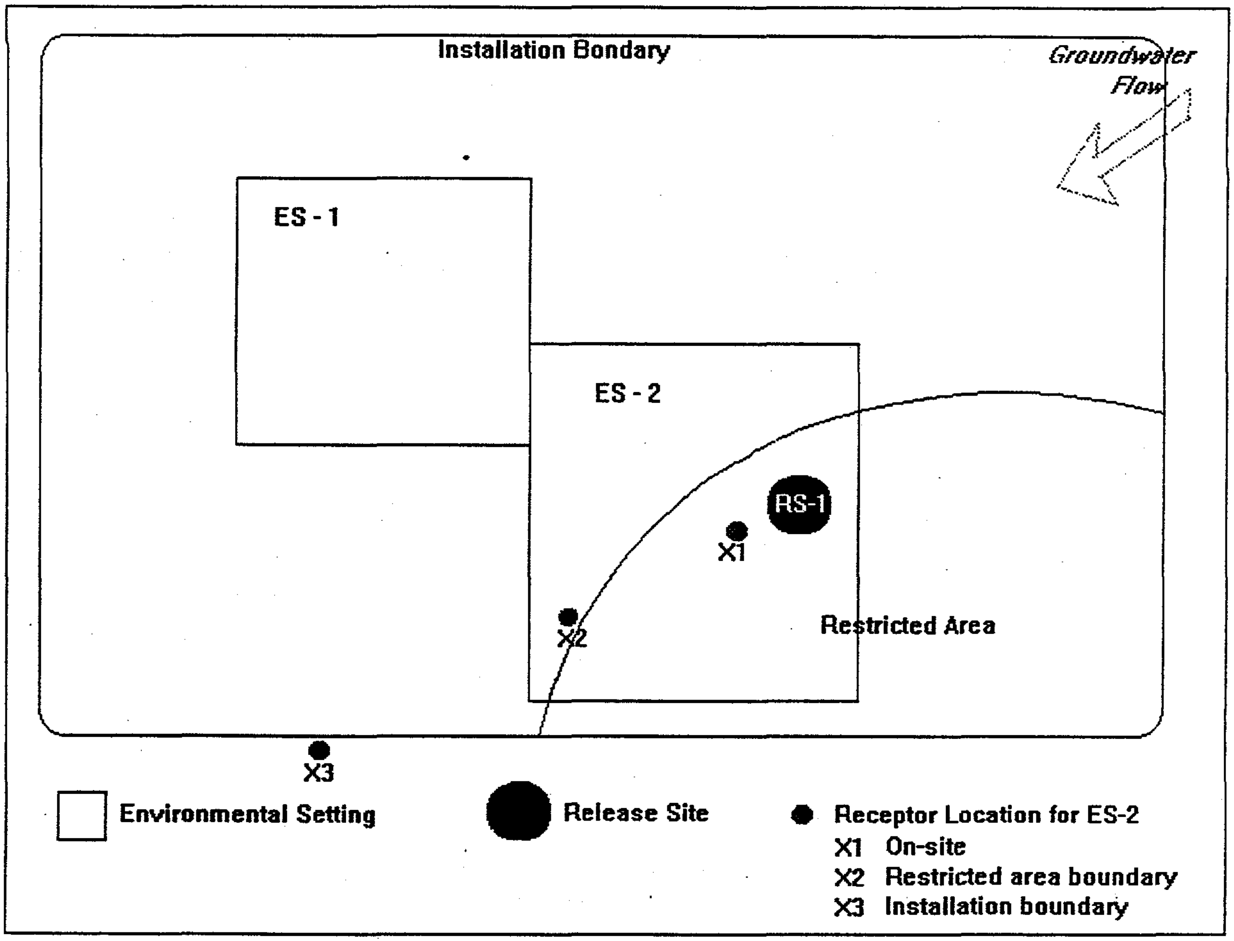

Figure 2.6. Diagram Illustrating the Location of the Different Receptor Types

NTS. However, buried waste is anticipated to be added soon to the PEIS database, therefore this waste form was examined. Groundwater was not modeled as a waste form as there are no data entries in the PEIS database. There is no true surface water located on or near the NTS site, so it was not considered as either a waste form or a receptor location. For the surface soil waste form, four release mechanisms were considered: infiltration to the groundwater, volatilization to air, suspension of dust to air, and direct radiation. For the buried waste case, only infiltration to the groundwater and volatilization to air are considered. See Chapter 3.0 for the complete CSM checklists and their attachments, by environmental settings.

2.3 Environmental Settings

Each installation is divided into appropriated ES units which assume that the hydrology, climatology, and geology information for an ES is homogenous. The number of different ESs depends on the complexity of the installation environment (may vary from 1 to 14).

Environmental setting information consists of the site-specific data required to model the atmospheric, groundwater, and surface water transport of contaminants within and near the boundaries of the installations. The ESs data describes the climate, atmospheric dispersion, hydrogeology, and surface water characteristics of the installations. The number of discrete ES per installation varies. The approach is to minimize the number of settings per installation, while simplifying the representations of the different areas within an installation. The number chosen for each installation represents a compromise between the number of waste sites, the potential contaminant transport pathways found at each installation, and the ability of the risk model to deal with the complexity in a coherent and reasonable manner.

A companion to this document--(Section II, *Environmental Settings Report*), includes the installation-specific ESs report. The work presented in Section II is a chapter abstracted from the reports by Holdren et al. (1994, 1995). The installation ESs report is presented as a companion document because it contains information pertinent to the development of the CSM.

The NTS is classified into six separate, contiguous ESs based on similarity of physiography and groundwater resources. These ESs are: Pahute Mesa, Rainier Mesa, Timber Mountain, Yucca Flat, Jackass Flat, and Frenchman Flat.

2.4 References

Borg, I. Y., R. Stone, H. B. Levy, and L. D. Ramspott. 1976. *Information Pertinent to the Migration of Radionuclides in Groundwater at the Nevada Test Site*. UCRL-52078. Lawerence Livermore National Laboratory, Livermore, California.

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Holdren, G. R., C. S. Glantz, L. K. Berg, K. Delinger, S. M. Goodwin, J. R. Rustad, R. Schalla, and J. A. Schramke. 1994. *Environmental Settings for Selected U.S. Department of Energy Installations--Support Information for the Programmatic Environmental Impact Statement*. PNL-10180. Pacific Northwest Laboratory, Richland, Washington.

Holdren, G. R., C. S. Glantz, L. K. Berg, K. Delinger, C. J. Fosmire, S. M. Goodwin, J. R. Rustad, R. Schalla, and J. A. Schramke. 1995. *Environmental Settings for Selected U.S. Department of Energy Installations--Support Information for the Programmatic Environmental Impact Statement and Baseline Environmental Management Report*. PNL-10180. Pacific Northwest Laboratory. Richland, Washington.

U.S. Department of Energy Nevada Field Office. 1992. *Annual Site Environmental Report - 1991. Volume 1*. DOE/NV/10630-33. Nevada Field Office, Las Vegas, Nevada.

Winograd, I., and W. Thordarson. 1975. *Hydrogeological and Hydrochemical Framework South-Central Great Basin, Nevada-California, with Special Reference to the Nevada Test Site*. Hydrology of Nuclear Test Sites. Geological Survey Professional Paper 712-C. U.S. Government Printing Office, Washington, D.C.

3.0 Conceptual Site Models

The purpose of the CSM is to simplify and translate conditions in the real world into modeling terms which can serve as input to RA calculations. The CSM is developed for each ES associated with an installation.

The CSM defines potential or suspected contaminants, contaminants of interest, waste chemistry, waste types, release mechanism, receiving media, routes of contaminant migration at the site, potentially contaminated media, release source location, receptor locations, any assumptions about the release source, exposure pathways for each receptor, the approximate date of initial release, and any exceptions in the modeling. The CSMs are developed from a review of installation-specific literature, such as annual reports and investigations. In addition, the ES material provides input to the CSM.

The CSM itself is in the form of a checklist with attachments. This chapter contains the complete CSM checklists, their attachments, and the ROAs used in developing the CSM.

CSM Data Acquisition Check-List: Pahute Mesa Environmental Setting

CONCEPTUAL SITE MODEL DATA ACQUISITION CHECK-LIST

Installation Name : Nevada Test Site

Environmental Setting considered : Pahute Mesa

Date: December 21, 1994

this form completed by: Gariann Gelston, PNL

Contaminant of Interest (COIs) List (attach list)

☒ List contaminants in PEIS database for all contaminated sites and exposure media. The primary list should include only those contaminants on the MEPAS modeling list and be separated by chemical class (e.g., VOCs, radionuclides, inorganics).

reference number(s) for primary list: 1

☒ COIs not listed in the database, but which are of potential concern (attach list).

reference number(s) for additional list: 2

Comments:

Waste Types and Release Mechanism List

(check all complete pathways)

		Reference Number
☒ Buried Waste		10
	☒ Infiltration to groundwater	11
	☐ Infiltration to surface water	3
	☒ Volatilization to air	11
☒ Surface Soil		10
	☒ Infiltration to groundwater	11
	☐ Infiltration to surface water	3
	☐ Overland runoff to surface water	3
	☒ Volatilization to air	11
	☒ Suspension of dust to air	11
	☒ Direct radiation	
☐ Surface Water (water)		3,4,10
	☐ Infiltration to groundwater	3
	☐ Infiltration to surface water	3
	☐ Overland runoff (i.e., overflow of containment) to surface water	3
	☐ Dispersion to other surface water	3
	☐ Volatilization to air	3

Waste Types and Release Mechanism List (continued)

		Reference Number
☐	Surface Water (sediment)	3,4,10
	☐ Infiltration to groundwater	3
	☐ Infiltration to surface water	3
	☐ Volatilization to air	3
☐	Groundwater	4 ,10
	☐ Dispersion to other groundwater	4
	☐ Dispersion to surface water	4

Comments:

Modeling Release Source Location Assumptions

☒ Centrally located in the environmental setting

☐ Other location within the environmental setting (please specify the location on the attached map and provide reasons(s) for why the alternative location was selected)

☒ Indicate approximate release source size: ~~Variable from 10ft^2 to 1,000,000ft^2~~

Source size areas range from 10ft^2 to 1,000,000ft^2 , with factor of 10 increments

(Follow generalize guidelines for positioning the release source for each environmental setting based on waste sites and release mechanisms. Place alternative release location on attached map from Receptor Location Section)

Modeling Assumptions (continued)

- ☒ Provide data on groundwater flow direction for this environmental setting. (Also indicate groundwater flow direction on the attached map).

  reference number: 5

- ☐ Provide data on surface water drainage direction for this environmental setting. (Also indicate drainage flow direction on the attached map).

  reference number: 3

Exposure Pathways List

(check all that apply) Reference Number

- ☒ On-site Receptors — 7
  - ☒ Inhalation — 12
    - ☒ Airborne contamination — 11
    - ☒ Groundwater contamination while showering — 11
    - ☐ Surface water contamination while showering — 3
    - ☒ Re-suspended soil particle inhalation — 11
  - ☒ Ingestion — 12
    - ☒ Airborne contamination — 11
      - ☒ leafy vegetables — 13
      - ☒ other vegetables — 13
      - ☒ meat products — 13
      - ☒ milk products — 13
    - ☒ Groundwater contamination — 11
      - ☒ drinking water — 13
      - ☒ showering — 13
      - ☒ leafy vegetables — 13
      - ☒ other vegetables — 13
      - ☒ meat products — 13
      - ☒ milk products — 13
    - ☐ Surface water contamination — 3
      - ☐ drinking water — 3
      - ☐ showering — 3
      - ☐ leafy vegetables — 3
      - ☐ other vegetables — 3
      - ☐ meat products — 3
      - ☐ milk products — 3
      - ☐ finfish — 3
      - ☐ shellfish — 3
      - ☐ swimming — 3
    - ☒ Soil contamination — 11
      - ☒ ingestion of soil — 13
  - ☒ External Radiation — 12
    - ☐ Surface water contamination — 3
      - ☐ swimming — 3
      - ☐ boating — 3
      - ☐ shore recreation — 3
    - ☒ Direct radiation — 13
  - ☒ Dermal Contact — 12
    - ☐ Surface water contamination — 3
      - ☐ swimming — 3
      - ☐ showering — 3
    - ☒ Groundwater contamination — 11
      - ☒ showering — 13
    - ☒ Contact with source contamination (all exposure media) — 13
    - ☒ Contact with deposited contamination — 13
      - ☒ soil (atmospheric dust) — 13
      - ☐ shoreline sediment (surface water) — 13

Exposure Pathways List (continued)

Reference Number

- ☒ Installation Boundary Receptors — 7
  - ☒ Inhalation — 12
    - ☒ Airborne contamination — 11
    - ☒ Groundwater contamination while showering — 11
    - ☐ Surface water contamination while showering — 3
    - ☒ Re-suspended soil particle inhalation — 11
  - ☒ Ingestion — 12
    - ☒ Airborne contamination — 11
      - ☒ leafy vegetables — 13
      - ☒ other vegetables — 13
      - ☒ meat products — 13
      - ☒ milk products — 13
    - ☒ Groundwater contamination — 11
      - ☒ drinking water — 13
      - ☒ showering — 13
      - ☒ leafy vegetables — 13
      - ☒ other vegetables — 13
      - ☒ meat products — 13
      - ☒ milk products — 13
    - ☐ Surface water contamination — 3
      - ☐ drinking water — 3
      - ☐ showering — 3
      - ☐ leafy vegetables — 3
      - ☐ other vegetables — 3
      - ☐ meat products — 3
      - ☐ milk products — 3
      - ☐ finfish — 3
      - ☐ shellfish — 3
      - ☐ swimming — 3
    - ☒ Soil contamination — 11
      - ☒ ingestion of soil — 13
  - ☒ External Radiation — 12
    - ☐ Surface water contamination — 3
      - ☐ swimming — 3
      - ☐ boating — 3
      - ☐ shore recreation — 3
    - ☐ Direct radiation — 13
  - ☒ Dermal Contact — 12
    - ☐ Surface water contamination — 3
      - ☐ swimming — 3
      - ☐ showering — 3
    - ☒ Groundwater contamination — 11
      - ☒ showering — 13
    - ☒ Contact with source contamination (all exposure media) — 13
    - ☒ Contact with deposited contamination — 13
      - ☒ soil (atmospheric dust) — 13
      - ☐ shoreline sediment (surface water) — 13

Exposure Pathways List (continued)

Reference Number

- ☐ Restricted Area Boundary Receptors — 8
  - ☐ Inhalation — 8
    - ☐ Airborne contamination — 8
    - ☐ Groundwater contamination while showering — 8
    - ☐ Surface water contamination while showering — 8
    - ☐ Re-suspended soil particle inhalation — 8
  - ☐ Ingestion — 8
    - ☐ Airborne contamination — 8
      - ☐ leafy vegetables — 8
      - ☐ other vegetables — 8
      - ☐ meat products — 8
      - ☐ milk products — 8
    - ☐ Groundwater contamination — 8
      - ☐ drinking water — 8
      - ☐ showering — 8
      - ☐ leafy vegetables — 8
      - ☐ other vegetables — 8
      - ☐ meat products — 8
      - ☐ milk products — 8
    - ☐ Surface water contamination — 8
      - ☐ drinking water — 8
      - ☐ showering — 8
      - ☐ leafy vegetables — 8
      - ☐ other vegetables — 8
      - ☐ meat products — 8
      - ☐ milk products — 8
      - ☐ finfish — 8
      - ☐ shellfish — 8
      - ☐ swimming — 8
    - ☐ Soil contamination — 8
      - ☐ ingestion of soil — 8
  - ☐ External Radiation — 8
    - ☐ Surface water contamination — 8
      - ☐ swimming — 8
      - ☐ boating — 8
      - ☐ shore recreation — 8
    - ☐ Direct radiation — 8
  - ☐ Dermal Contact — 8
    - ☐ Surface water contamination — 8
      - ☐ swimming — 8
      - ☐ showering — 8
    - ☐ Groundwater contamination — 8
      - ☐ showering — 8
    - ☐ Contact with source contamination (all exposure media) — 8
    - ☐ Contact with deposited contamination — 8
      - ☐ soil (atmospheric dust) — 8
      - ☐ shoreline sediment (surface water) — 8

Receptor Locations

Reference Number

Attached map detailing approximate location of:

			Reference Number
☒	On-site receptors		6
☒	Facility boundary receptors		7
	☒	groundwater receptor	7
	☐	surface water receptor	3
☐	Restricted Area boundary receptors		8
	☐	groundwater receptor	8
	☐	surface water receptor	8

Comments:

Approximate Date of Release in this Environmental Setting : January 1, 1962

reference number for release date: 9

Comments:

Exceptions (attach separate sheet and references for each)

☒ Contaminants of Interest
- those not on the MEPAS Modeling list which may be of concern at the site

☒ Waste Types and Release Mechanisms
- those listed above which are not of concern based on site information, or those which are not listed above which should be considered separately
- release mechanisms not included in list above which should be, or which were not listed but which should be considered due to site specific information

☐ Modeling Release Source Location
- suggestions for re-positioning of the release source in an environmental setting based on site specific info or other information

Reference List: (add sheets as necessary)

1. See attached Preliminary Contaminant List (Table 1), Primary Contaminant List (Table 2), and Listing of Contaminants Not found in MEPAS Database (Table 3).

2. Record of Assumption (ROA). NTS Installation. ROA NTS #032. *Additional Chemicals of Interest.* December 21, 1994. (Table 4).

3. Record of Assumption (ROA). NTS Installation. ROA NTS #021. *Surface Water.* November 15, 1994.

4. Record of Assumption (ROA). NTS Installation. ROA NTS #020. *PEIS Database.* November 15, 1994.

5. Holdren, G. R. , G. S. Glantz, L. K. Berg, K. Delinger, S. M. Goodwin, J. R. Rustad, R. Schalla, and J. A. Schramke. *Environmental Settings for Selected U.S. Department of Energy Installations--Support Information for the Programmatic Environmental Impact Statement.* Volume 2. July 1995. In Preparation. Pacific Northwest Laboratory. Richland, Washington. (See attached Figure 1.)

   Winograd, Isaac and Thodarson, William. *Hydrogeological and Hydrochemical Framework South-Central Great Basin, Nevada-California, with Special Reference to the Nevada Test Site.* Hydrology of Nuclear Test Sites. Geological Survey Professional Paper 712-C. U.S. Government Printing Office. Washington, D.C.

6. Record of Assumption (ROA). NTS Installation. ROA NTS #015. *Location of On-Site Receptors.* November 14, 1994.

7. Record of Assumption (ROA). NTS Installation. ROA NTS #013. *Source and Boundary Receptors for Pahute Mesa.* November 14, 1994. (See Figure 2)

8. Record of Assumption (ROA). NTS Installation. ROA NTS #019. *Restricted Area On-Site.* November 15, 1994.

9. Record of Assumption (ROA). NTS Installation. ROA NTS #008. *Initial Dates Contamination Introduced.* November 4, 1994.

10. Record of Assumption (ROA). NTS Installation. ROA NTS #017. *Rationale for Selection of Media.* November 28, 1994.

11. Record of Assumption (ROA). NTS Installation. ROA NTS #018. *Rationale for Selection of Pathways.* November 28, 1994.

12. Record of Assumption (ROA). NTS Installation. ROA NTS #022. *Rationale for Selection of Exposure Pathways.* November 28, 1994.

13. Record of Assumption (ROA). NTS Installation. ROA NTS #029. *Exposure Pathway Selection for UTF Analysis.* December 21, 1994.

Table 1. CoCs-Preliminary List

NTS CONSTITUENTS OF CONCERN - PRELIMINARY LIST				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Acids	NA	NO	NO	PEIS #61
Argon	7440371	NO	NO	PEIS #2301
Arsenic	7440382	YES	NO	PEIS #61
Asbestos	12001284	YES	NO	PEIS #2301
Berylium	7440417	YES	YES	
Caustics	NA	NO	NO	PEIS #61
Chromium	7440473	YES	YES	
Copper	7440508	YES	NO	PEIS #61
Lead	7439921	YES	YES	
Plutonium	7440075	NO	YES	
Uranium	7740611	YES	YES	
Zinc	7646857	YES	NO	PEIS #61
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Actinium 228	AC228	YES	NO	PEIS #6021
Americium 241	AM241	YES	YES	
Antimony 125	SB125	YES	YES	
Bismuth 214	BI214	NO	NO	PEIS #6021
Cadmium 109	CD109	YES	YES	
Carbon 14	C14	YES	YES	
Cesium 134	CS134	YES	YES	
Cesium 137	CS137	YES	YES	
Cobalt 57	CO57	YES	YES	
Cobalt 60	CO60	YES	YES	
Europium 152	EU152	YES	YES	
Europium 154	EU154	YES	YES	
Europium 155	EU155	YES	YES	
Krypton 85	KR85	YES	YES	
Lead 212	PB212	YES	NO	PEIS #6021
Lead 214	PB214	NO	NO	PEIS #6021

Table 1. (contd)

Plutonium 238	PU238	YES	YES	
Plutonium 239	PU239	YES	YES	
Plutonium 240	PU240	YES	YES	
Potassium 40	K40	YES	YES	
Radium 226	RA226	YES	YES	
Ruthenium 103	RU103	YES	YES	
Ruthenium 106	RU106	YES	YES	
Strontium 90	SR90	YES	YES	
Thallium 208	TH208	NO	NO	PEIS #6021
Thorium 228	TH228	YES	YES	
Thorium 232	TH232	YES	YES	
Tritium	H3/10028178	YES	YES	
Uranium 235	U235	YES	YES	
ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Cutting Fluids	NA	NO	NO	PEIS #61
Ethylene Glycol	10721	YES	YES	
Motor Oil	Motor oil	YES	YES	
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Chlorinated Solvents	NA	NO	NO	PEIS #2301
Diesel Fuel	Diesel F	YES	NO	PEIS #2301
Gasoline	8006619	YES	YES	
Hydraulic Flued	Hydr Flu	YES	YES	
Isopropyl Alcholhol	67630	YES	NO	PEIS #2301
Kerosene	8008206	YES	NO	PEIS #2301
Methanol	67561	YES	YES	
Methylene Chloride	75092	YES	YES	
Stoddard Solfent	NA	NO	NO	PEIS #2301
Pretroleum Solvents	NA	NO	NO	PEIS #2301
Petisol 202	NA	NO	NO	PEIS #2301
Polychlorinated Biphenyls	1336363	YES	YES	
Techloroethylene	79016	YES	YES	

Table 2. CoCs-Primary List

NTS CONSTITUENTS OF CONCERN - PRIMARY LIST				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Berylium	7440417	YES	YES	
Chromium	7440473	YES	YES	
Lead	7439921	YES	YES	
Uranium	7740611	YES	YES	
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Americium 241	AM241	YES	YES	
Antimony 125	SB125	YES	YES	
Cadmium 109	CD109	YES	YES	
Carbon 14	C14	YES	YES	
Cesium 134	CS134	YES	YES	
Cesium 137	CS137	YES	YES	
Cobalt 57	CO57	YES	YES	
Cobalt 60	CO60	YES	YES	
Europium 152	EU152	YES	YES	
Europium 154	EU154	YES	YES	
Europium 155	EU155	YES	YES	
Krypton 85	KR85	YES	YES	
Plutonium 238	PU238	YES	YES	
Plutonium 239	PU239	YES	YES	
Plutonium 240	PU240	YES	YES	
Potassium 40	K40	YES	YES	
Radium 226	RA226	YES	YES	
Ruthenium 103	RU103	YES	YES	
Ruthenium 106	RU106	YES	YES	
Strontium 90	SR90	YES	YES	
Throium 228	TH228	YES	YES	
Thorium 232	TH232	YES	YES	
Tritium	H3/10028178	YES	YES	
Uranium 235	U235	YES	YES	

Table 2. (contd)

ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Ethylene Glycol	10721	YES	YES	
Motor Oil	Motor oil	YES	YES	
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Gasoline	8006619	YES	YES	
Hydraulic Flued	Hydr Flu	YES	YES	
Methanol	67561	YES	YES	
Methylene Chloride	75092	YES	YES	
Polychlorinated Biphenyls	1336363	YES	YES	
Techloroethylene	79016	YES	YES	

Table 3. CoCs Not in MEPAS

NTS CONSTITUENTS OF CONCERN - NOT IN MEPAS DATABASE				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Acids	NA	NO	NO	PEIS #61
Argon	7440371	NO	NO	PEIS #2301
Caustics	NA	NO	NO	PEIS #61
Plutonium	7440075	NO	YES	
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Bismuth 214	BI214	NO	NO	PEIS #6021
Lead 214	PB214	NO	NO	PEIS #6021
Thallium 208	TH208	NO	NO	PEIS #6021
ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Cutting Fluids	NA	NO	NO	PEIS #61
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Chlorinated Solvents	NA	NO	NO	PEIS #2301
Stoddard Solfent	NA	NO	NO	PEIS #2301
Pretroleum Solvents	NA	NO	NO	PEIS #2301
Petisol 202	NA	NO	NO	PEIS #2301

Table 4. CoCs Not in PEIS

NTS CONSTITUENTS OF CONCERN - NOT IN PEIS DATABASE				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Acids	NA	NO	NO	PEIS #61
Argon	7440371	NO	NO	PEIS #2301
Arsenic	7440382	YES	NO	PEIS #61
Asbestos	12001284	YES	NO	PEIS #2301
Caustics	NA	NO	NO	PEIS #61
Copper	7440508	YES	NO	PEIS #61
Zinc	7646857	YES	NO	PEIS #61
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Actinium 228	AC228	YES	NO	PEIS #6021
Bismuth 214	BI214	NO	NO	PEIS #6021
Lead 212	PB212	YES	NO	PEIS #6021
Lead 214	PB214	NO	NO	PEIS #6021
Thallium 208	TH208	NO	NO	PEIS #6021
ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Cutting Fluids	NA	NO	NO	PEIS #61
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Chlorinated Solvents	NA	NO	NO	PEIS #2301
Diesel Fuel	Diesel F	YES	NO	PEIS #2301
Isopropyl Alcholhol	67630	YES	NO	PEIS #2301
Kerosene	8008206	YES	NO	PEIS #2301
Stoddard Solfent	NA	NO	NO	PEIS #2301
Pretroleum Solvents	NA	NO	NO	PEIS #2301
Petisol 202	NA	NO	NO	PEIS #2301

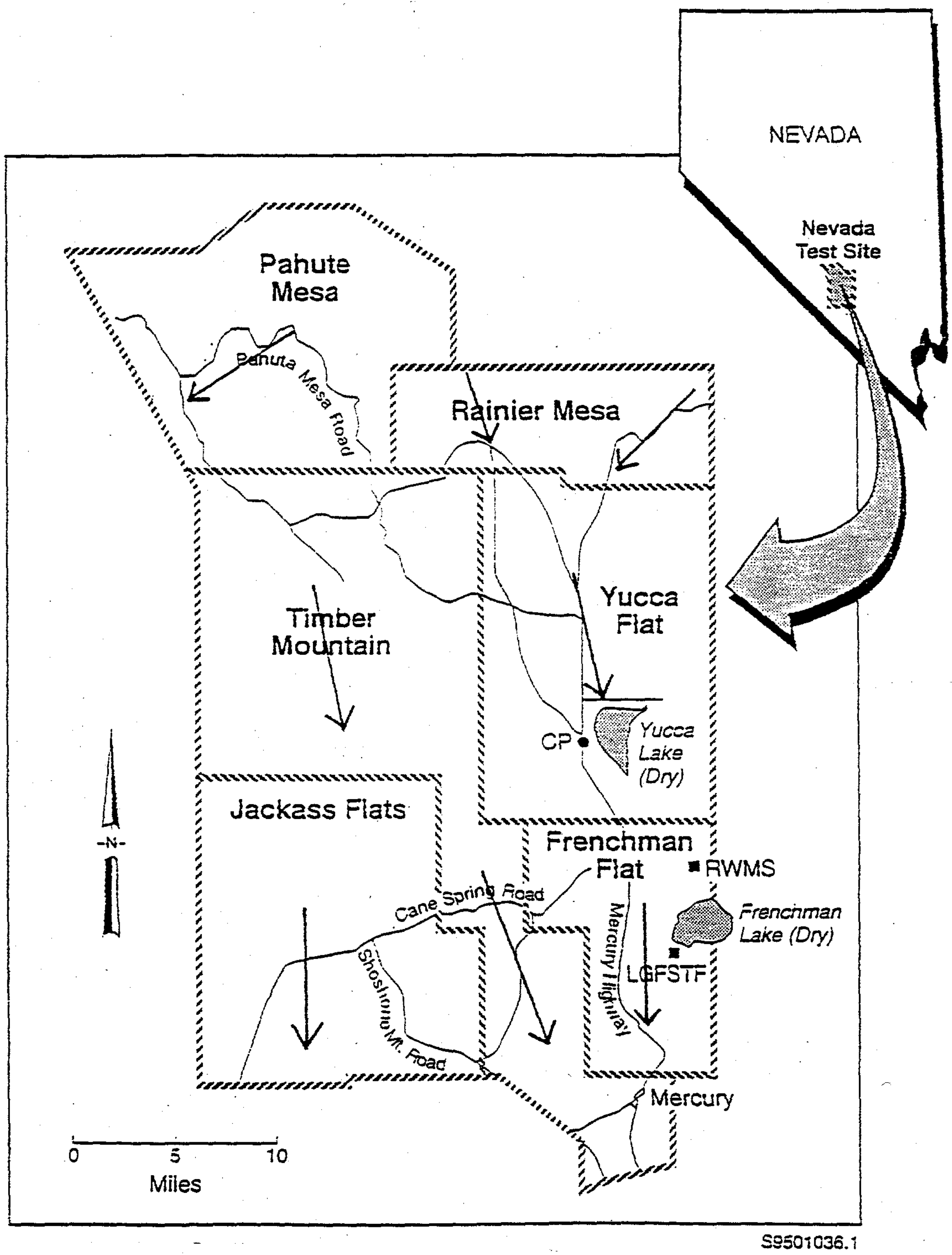

Figure 1. Nevada Test Site, Regional Groundwater Flow

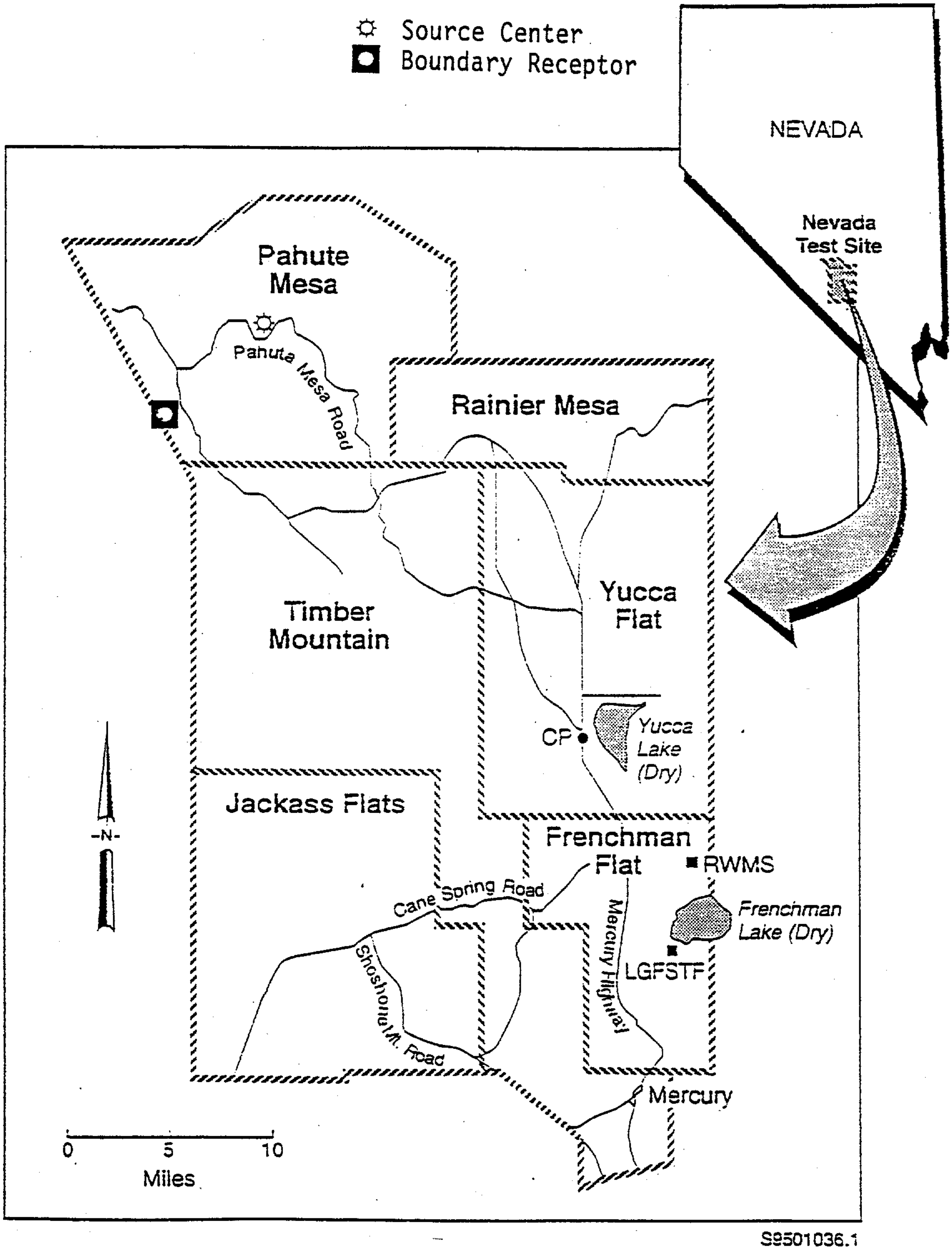

Figure 2. Nevada Test Site, Pahute Mesa

CSM Data Acquisition Check-List: Rainier Mesa Environmental Setting

CONCEPTUAL SITE MODEL DATA ACQUISITION CHECK-LIST

Installation Name : Nevada Test Site

Environmental Setting considered : Rainier Mesa

Date: December 21, 1994

this form completed by: Gariann Gelston, PNL

Contaminant of Interest (COIs) List (attach list)

- ☒ List contaminants in PEIS database for all contaminated sites and exposure media. The primary list should include only those contaminants on the MEPAS modeling list and be separated by chemical class (e.g., VOCs, radionuclides, inorganics).

  reference number(s) for primary list: 1

- ☒ COIs not listed in the database, but which are of potential concern (attach list).

  reference number(s) for additional list: 2

Comments:

Waste Types and Release Mechanism List

(check all complete pathways)

		Reference Number
☒ Buried Waste		10
	☒ Infiltration to groundwater	11
	☐ Infiltration to surface water	3
	☒ Volatilization to air	11
☒ Surface Soil		10
	☒ Infiltration to groundwater	11
	☐ Infiltration to surface water	3
	☐ Overland runoff to surface water	3
	☒ Volatilization to air	11
	☒ Suspension of dust to air	11
	☒ Direct radiation	
☐ Surface Water (water)		3,4,10
	☐ Infiltration to groundwater	3
	☐ Infiltration to surface water	3
	☐ Overland runoff (i.e., overflow of containment) to surface water	3
	☐ Dispersion to other surface water	3
	☐ Volatilization to air	3

Waste Types and Release Mechanism List (continued)

	Reference Number
☐ Surface Water (sediment)	3,4,10
☐ Infiltration to groundwater	3
☐ Infiltration to surface water	3
☐ Volatilization to air	3
☐ Groundwater	4 ,10
☐ Dispersion to other groundwater	4
☐ Dispersion to surface water	4

Comments:

Modeling Release Source Location Assumptions

- ☒ Centrally located in the environmental setting
- ☐ Other location within the environmental setting (please specify the location on the attached map and provide reasons(s) for why the alternative location was selected)

- ☒ Indicate approximate release source size: ~~Variable from 10ft^2 to 1,000,000ft^2~~

Source size areas range from 10ft^2 to 1,000,000ft^2 , with factor of 10 increments

(Follow generalize guidelines for positioning the release source for each environmental setting based on waste sites and release mechanisms. Place alternative release location on attached map from Receptor Location Section)

Modeling Assumptions (continued)

☒ Provide data on groundwater flow direction for this environmental setting. (Also indicate groundwater flow direction on the attached map).

reference number: 5

☐ Provide data on surface water drainage direction for this environmental setting. (Also indicate drainage flow direction on the attached map).

reference number: 3

Exposure Pathways List

(check all that apply)

Reference Number

- ☒ On-site Receptors — 7
  - ☒ Inhalation — 12
    - ☒ Airborne contamination — 11
    - ☒ Groundwater contamination while showering — 11
    - ☐ Surface water contamination while showering — 3
    - ☒ Re-suspended soil particle inhalation — 11
  - ☒ Ingestion — 12
    - ☒ Airborne contamination — 11
      - ☒ leafy vegetables — 13
      - ☒ other vegetables — 13
      - ☒ meat products — 13
      - ☒ milk products — 13
    - ☒ Groundwater contamination — 11
      - ☒ drinking water — 13
      - ☒ showering — 13
      - ☒ leafy vegetables — 13
      - ☒ other vegetables — 13
      - ☒ meat products — 13
      - ☒ milk products — 13
    - ☐ Surface water contamination — 3
      - ☐ drinking water — 3
      - ☐ showering — 3
      - ☐ leafy vegetables — 3
      - ☐ other vegetables — 3
      - ☐ meat products — 3
      - ☐ milk products — 3
      - ☐ finfish — 3
      - ☐ shellfish — 3
      - ☐ swimming — 3
    - ☒ Soil contamination — 11
      - ☒ ingestion of soil — 13
  - ☒ External Radiation — 12
    - ☐ Surface water contamination — 3
      - ☐ swimming — 3
      - ☐ boating — 3
      - ☐ shore recreation — 3
    - ☒ Direct radiation — 13
  - ☒ Dermal Contact — 12
    - ☐ Surface water contamination — 3
      - ☐ swimming — 3
      - ☐ showering — 3
    - ☒ Groundwater contamination — 11
      - ☒ showering — 13
    - ☒ Contact with source contamination (all exposure media) — 13
    - ☒ Contact with deposited contamination — 13
      - ☒ soil (atmospheric dust) — 13
      - ☐ shoreline sediment (surface water) — 13

Exposure Pathways List (continued)

Reference Number

- ☒ Installation Boundary Receptors — 7
  - ☒ Inhalation — 12
    - ☒ Airborne contamination — 11
    - ☒ Groundwater contamination while showering — 11
    - ☐ Surface water contamination while showering — 3
    - ☒ Re-suspended soil particle inhalation — 11
  - ☒ Ingestion — 12
    - ☒ Airborne contamination — 11
      - ☒ leafy vegetables — 13
      - ☒ other vegetables — 13
      - ☒ meat products — 13
      - ☒ milk products — 13
    - ☒ Groundwater contamination — 11
      - ☒ drinking water — 13
      - ☒ showering — 13
      - ☒ leafy vegetables — 13
      - ☒ other vegetables — 13
      - ☒ meat products — 13
      - ☒ milk products — 13
    - ☐ Surface water contamination — 3
      - ☐ drinking water — 3
      - ☐ showering — 3
      - ☐ leafy vegetables — 3
      - ☐ other vegetables — 3
      - ☐ meat products — 3
      - ☐ milk products — 3
      - ☐ finfish — 3
      - ☐ shellfish — 3
      - ☐ swimming — 3
    - ☒ Soil contamination — 11
      - ☒ ingestion of soil — 13
  - ☒ External Radiation — 12
    - ☐ Surface water contamination — 3
      - ☐ swimming — 3
      - ☐ boating — 3
      - ☐ shore recreation — 3
    - ☐ Direct radiation — 13
  - ☒ Dermal Contact — 12
    - ☐ Surface water contamination — 3
      - ☐ swimming — 3
      - ☐ showering — 3
    - ☒ Groundwater contamination — 11
      - ☒ showering — 13
    - ☒ Contact with source contamination (all exposure media) — 13
    - ☒ Contact with deposited contamination — 13
      - ☒ soil (atmospheric dust) — 13
      - ☐ shoreline sediment (surface water) — 13

Exposure Pathways List (continued)

Reference Number

- ☐ Restricted Area Boundary Receptors 8
  - ☐ Inhalation 8
    - ☐ Airborne contamination 8
    - ☐ Groundwater contamination while showering 8
    - ☐ Surface water contamination while showering 8
    - ☐ Re-suspended soil particle inhalation 8
  - ☐ Ingestion 8
    - ☐ Airborne contamination 8
      - ☐ leafy vegetables 8
      - ☐ other vegetables 8
      - ☐ meat products 8
      - ☐ milk products 8
    - ☐ Groundwater contamination 8
      - ☐ drinking water 8
      - ☐ showering 8
      - ☐ leafy vegetables 8
      - ☐ other vegetables 8
      - ☐ meat products 8
      - ☐ milk products 8
    - ☐ Surface water contamination 8
      - ☐ drinking water 8
      - ☐ showering 8
      - ☐ leafy vegetables 8
      - ☐ other vegetables 8
      - ☐ meat products 8
      - ☐ milk products 8
      - ☐ finfish 8
      - ☐ shellfish 8
      - ☐ swimming 8
    - ☐ Soil contamination 8
      - ☐ ingestion of soil 8
  - ☐ External Radiation 8
    - ☐ Surface water contamination 8
      - ☐ swimming 8
      - ☐ boating 8
      - ☐ shore recreation 8
    - ☐ Direct radiation 8
  - ☐ Dermal Contact 8
    - ☐ Surface water contamination 8
      - ☐ swimming 8
      - ☐ showering 8
    - ☐ Groundwater contamination 8
      - ☐ showering 8
    - ☐ Contact with source contamination (all exposure media) 8
    - ☐ Contact with deposited contamination 8
      - ☐ soil (atmospheric dust) 8
      - ☐ shoreline sediment (surface water) 8

Receptor Locations

Reference Number

Attached map detailing approximate location of:

			Reference Number
☒	On-site receptors	6	
☒	Facility boundary receptors	7	
	☒ groundwater receptor		7
	☐ surface water receptor		3
☐	Restricted Area boundary receptors	8	
	☐ groundwater receptor		8
	☐ surface water receptor		8

Comments:

Approximate Date of Release in this Environmental Setting : November 29, 1951

reference number for release date: 9

Comments:

Exceptions (attach separate sheet and references for each)

☒ Contaminants of Interest
- those not on the MEPAS Modeling list which may be of concern at the site

☒ Waste Types and Release Mechanisms
- those listed above which are not of concern based on site information, or those which are not listed above which should be considered separately
- release mechanisms not included in list above which should be, or which were not listed but which should be considered due to site specific information

☐ Modeling Release Source Location
- suggestions for re-positioning of the release source in an environmental setting based on site specific info or other information

Reference List: (add sheets as necessary)

1. See attached Preliminary Contaminant List (Table 1), Primary Contaminant List (Table 2), and Listing of Contaminants Not found in MEPAS Database (Table 3).

2. Record of Assumption (ROA). NTS Installation. ROA NTS #032. *Additional Chemicals of Interest.* December 21, 1994 (Table 4).

3. Record of Assumption (ROA). NTS Installation. ROA NTS #021. *Surface Water.* November 15, 1994.

4. Record of Assumption (ROA). NTS Installation. ROA NTS #020. *PEIS Database.* November 15, 1994.

5. Holdren, G. R. , G. S. Glantz, L. K. Berg, K. Delinger, S. M. Goodwin, J. R. Rustad, R. Schalla, and J. A. Schramke. *Environmental Settings for Selected U.S. Department of Energy Installations--Support Information for the Programmatic Environmental Impact Statement. Volume* 2. July 1995. In Preparation. Pacific Northwest Laboratory. Richland, Washington (see attached Figure 1).

   Winograd, Isaac and Thodarson, William. *Hydrogeological and Hydrochemical Framework South-Central Great Basin, Nevada-California, with Special Reference to the Nevada Test Site.* Hydrology of Nuclear Test Sites. Geological Survey Professional Paper 712-C. U.S. Government Printing Office. Washington, D.C.

6. Record of Assumption (ROA). NTS Installation. ROA NTS #015. *Location of On-Site Receptors.* November 14, 1994.

7. Record of Assumption (ROA). NTS Installation. ROA NTS #014. *Source and Boundary Receptors for Rainier Mesa.* November 14, 1994 (see Figure 2).

8. Record of Assumption (ROA). NTS Installation. ROA NTS #019. *Restricted Area On-Site.* November 15, 1994.

9. Record of Assumption (ROA). NTS Installation. ROA NTS #008. *Initial Dates Contamination Introduced.* November 4, 1994.

10. Record of Assumption (ROA). NTS Installation. ROA NTS #017. *Rationale for Selection of Media.* November 28, 1994.

11. Record of Assumption (ROA). NTS Installation. ROA NTS #018. *Rationale for Selection of Pathways.* November 28, 1994.

12. Record of Assumption (ROA). NTS Installation. ROA NTS #022. *Rationale for Selection of Exposure Pathways.* November 28, 1994.

13. Record of Assumption (ROA). NTS Installation. ROA NTS #029. *Exposure Pathway Selection for UTF Analysis.* December 21, 1994.

Table 1. CoCs-Preliminary List

NTS CONSTITUENTS OF CONCERN - PRELIMINARY LIST				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Acids	NA	NO	NO	PEIS #61
Argon	7440371	NO	NO	PEIS #2301
Arsenic	7440382	YES	NO	PEIS #61
Asbestos	12001284	YES	NO	PEIS #2301
Berylium	7440417	YES	YES	
Caustics	NA	NO	NO	PEIS #61
Chromium	7440473	YES	YES	
Copper	7440508	YES	NO	PEIS #61
Lead	7439921	YES	YES	
Plutonium	7440075	NO	YES	
Uranium	7740611	YES	YES	
Zinc	7646857	YES	NO	PEIS #61
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Actinium 228	AC228	YES	NO	PEIS #6021
Americium 241	AM241	YES	YES	
Antimony 125	SB125	YES	YES	
Bismuth 214	BI214	NO	NO	PEIS #6021
Cadmium 109	CD109	YES	YES	
Carbon 14	C14	YES	YES	
Cesium 134	CS134	YES	YES	
Cesium 137	CS137	YES	YES	
Cobalt 57	CO57	YES	YES	
Cobalt 60	CO60	YES	YES	
Europium 152	EU152	YES	YES	
Europium 154	EU154	YES	YES	
Europium 155	EU155	YES	YES	
Krypton 85	KR85	YES	YES	
Lead 212	PB212	YES	NO	PEIS #6021
Lead 214	PB214	NO	NO	PEIS #6021

Table 1. (contd)

Plutonium 238	PU238	YES	YES	
Plutonium 239	PU239	YES	YES	
Plutonium 240	PU240	YES	YES	
Potassium 40	K40	YES	YES	
Radium 226	RA226	YES	YES	
Ruthenium 103	RU103	YES	YES	
Ruthenium 106	RU106	YES	YES	
Strontium 90	SR90	YES	YES	
Thallium 208	TH208	NO	NO	PEIS #6021
Thorium 228	TH228	YES	YES	
Thorium 232	TH232	YES	YES	
Tritium	H3/10028178	YES	YES	
Uranium 235	U235	YES	YES	
ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Cutting Fluids	NA	NO	NO	PEIS #61
Ethylene Glycol	10721	YES	YES	
Motor Oil	Motor oil	YES	YES	
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Chlorinated Solvents	NA	NO	NO	PEIS #2301
Diesel Fuel	Diesel F	YES	NO	PEIS #2301
Gasoline	8006619	YES	YES	
Hydraulic Flued	Hydr Flu	YES	YES	
Isopropyl Alcholhol	67630	YES	NO	PEIS #2301
Kerosene	8008206	YES	NO	PEIS #2301
Methanol	67561	YES	YES	
Methylene Chloride	75092	YES	YES	
Stoddard Solfent	NA	NO	NO	PEIS #2301
Pretroleum Solvents	NA	NO	NO	PEIS #2301
Petisol 202	NA	NO	NO	PEIS #2301
Polychlorinated Biphenyls	1336363	YES	YES	
Techloroethylene	79016	YES	YES	

Table 2. CoCs-Primary List

NTS CONSTITUENTS OF CONCERN - PRIMARY LIST				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Berylium	7440417	YES	YES	
Chromium	7440473	YES	YES	
Lead	7439921	YES	YES	
Uranium	7740611	YES	YES	
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Americium 241	AM241	YES	YES	
Antimony 125	SB125	YES	YES	
Cadmium 109	CD109	YES	YES	
Carbon 14	C14	YES	YES	
Cesium 134	CS134	YES	YES	
Cesium 137	CS137	YES	YES	
Cobalt 57	CO57	YES	YES	
Cobalt 60	CO60	YES	YES	
Europium 152	EU152	YES	YES	
Europium 154	EU154	YES	YES	
Europium 155	EU155	YES	YES	
Krypton 85	KR85	YES	YES	
Plutonium 238	PU238	YES	YES	
Plutonium 239	PU239	YES	YES	
Plutonium 240	PU240	YES	YES	
Potassium 40	K40	YES	YES	
Radium 226	RA226	YES	YES	
Ruthenium 103	RU103	YES	YES	
Ruthenium 106	RU106	YES	YES	
Strontium 90	SR90	YES	YES	
Throium 228	TH228	YES	YES	
Thorium 232	TH232	YES	YES	
Tritium	H3/10028178	YES	YES	
Uranium 235	U235	YES	YES	

Table 2. (contd)

ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Ethylene Glycol	10721	YES	YES	
Motor Oil	Motor oil	YES	YES	
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Gasoline	8006619	YES	YES	
Hydraulic Flued	Hydr Flu	YES	YES	
Methanol	67561	YES	YES	
Methylene Chloride	75092	YES	YES	
Polychlorinated Biphenyls	1336363	YES	YES	
Techloroethylene	79016	YES	YES	

Table 3. CoCs Not in MEPAS

NTS CONSTITUENTS OF CONCERN - NOT IN MEPAS DATABASE				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Acids	NA	NO	NO	PEIS #61
Argon	7440371	NO	NO	PEIS #2301
Caustics	NA	NO	NO	PEIS #61
Plutonium	7440075	NO	YES	
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Bismuth 214	BI214	NO	NO	PEIS #6021
Lead 214	PB214	NO	NO	PEIS #6021
Thallium 208	TH208	NO	NO	PEIS #6021
ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Cutting Fluids	NA	NO	NO	PEIS #61
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Chlorinated Solvents	NA	NO	NO	PEIS #2301
Stoddard Solfent	NA	NO	NO	PEIS #2301
Pretroleum Solvents	NA	NO	NO	PEIS #2301
Petisol 202	NA	NO	NO	PEIS #2301

Table 4. CoCs Not in PEIS

NTS CONSTITUENTS OF CONCERN - NOT IN PEIS DATABASE				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Acids	NA	NO	NO	PEIS #61
Argon	7440371	NO	NO	PEIS #2301
Arsenic	7440382	YES	NO	PEIS #61
Asbestos	12001284	YES	NO	PEIS #2301
Caustics	NA	NO	NO	PEIS #61
Copper	7440508	YES	NO	PEIS #61
Zinc	7646857	YES	NO	PEIS #61
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Actinium 228	AC228	YES	NO	PEIS #6021
Bismuth 214	BI214	NO	NO	PEIS #6021
Lead 212	PB212	YES	NO	PEIS #6021
Lead 214	PB214	NO	NO	PEIS #6021
Thallium 208	TH208	NO	NO	PEIS #6021
ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Cutting Fluids	NA	NO	NO	PEIS #61
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Chlorinated Solvents	NA	NO	NO	PEIS #2301
Diesel Fuel	Diesel F	YES	NO	PEIS #2301
Isopropyl Alcholhol	67630	YES	NO	PEIS #2301
Kerosene	8008206	YES	NO	PEIS #2301
Stoddard Solfent	NA	NO	NO	PEIS #2301
Pretroleum Solvents	NA	NO	NO	PEIS #2301
Petisol 202	NA	NO	NO	PEIS #2301

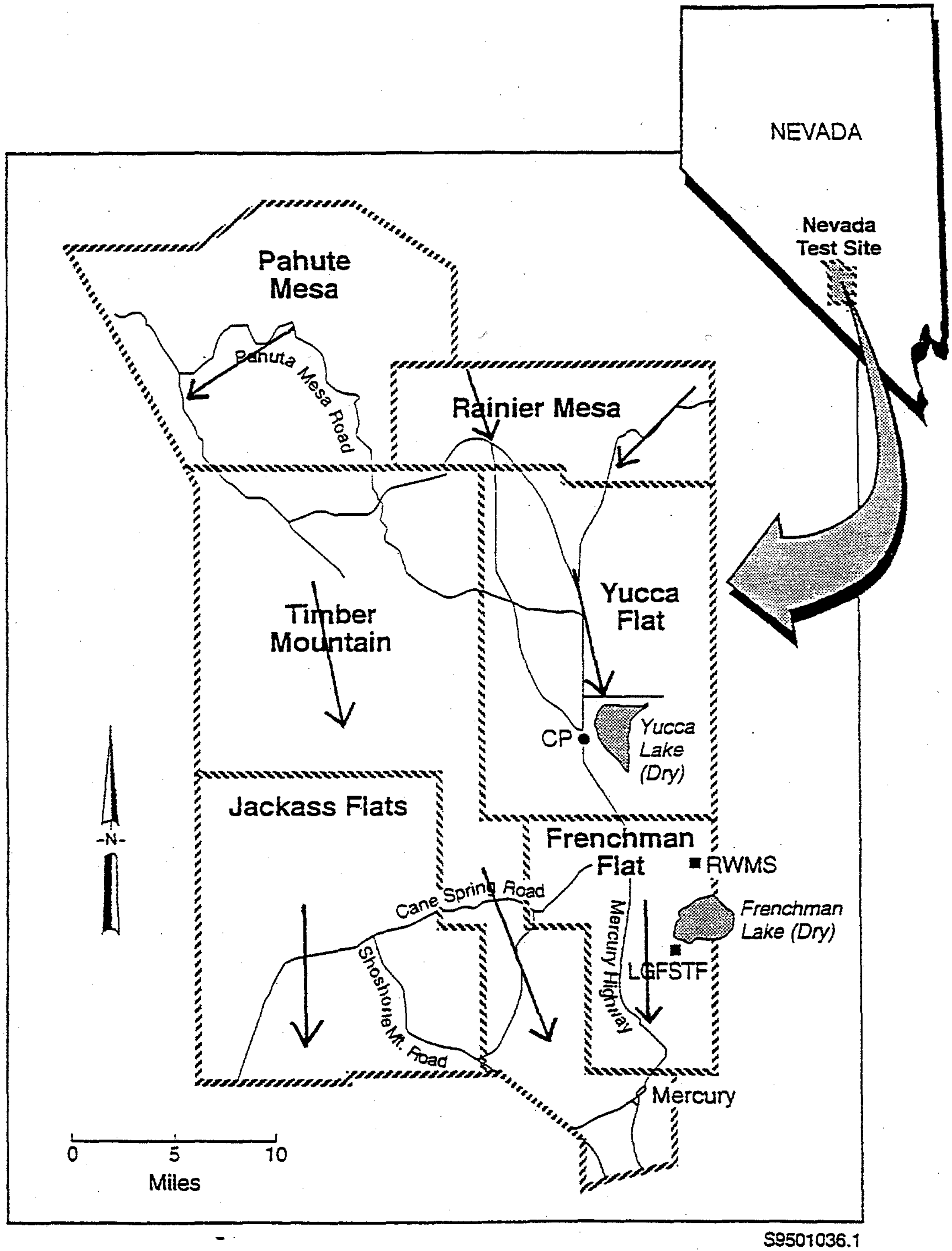

Figure 1. Nevada Test Site, Regional Groundwater Flow

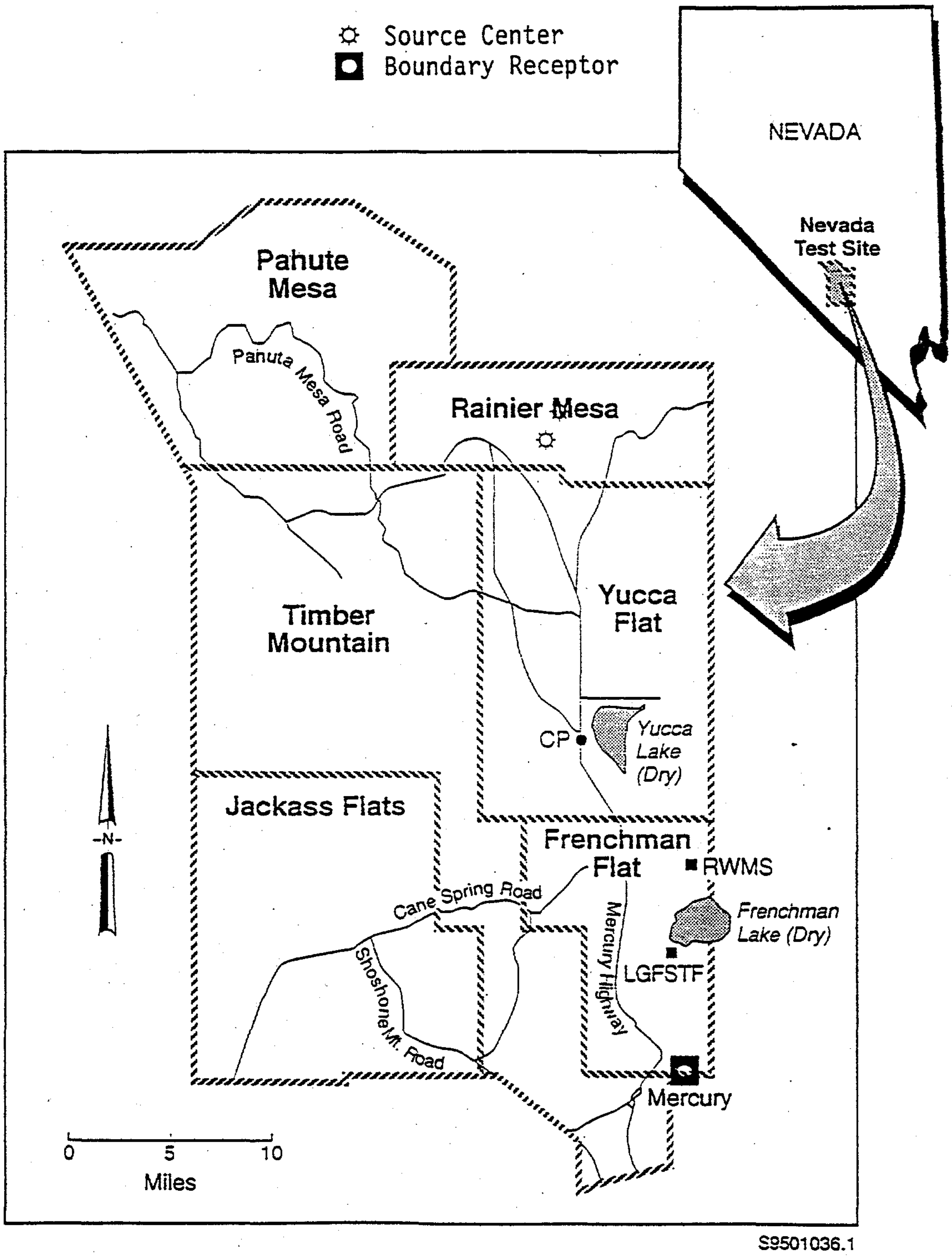

Figure 2. Nevada Test Site, Rainier Mesa

CSM Data Acquisition Check-List: Timber Mountain Environmental Setting

CONCEPTUAL SITE MODEL DATA ACQUISITION CHECK-LIST

Installation Name : Nevada Test Site

Environmental Setting considered : Timber Mountain

Date: December 21, 1994

this form completed by: Gariann Gelston, PNL

Contaminant of Interest (COIs) List (attach list)

☒ List contaminants in PEIS database for all contaminated sites and exposure media. The primary list should include only those contaminants on the MEPAS modeling list and be separated by chemical class (e.g., VOCs, radionuclides, inorganics).

reference number(s) for primary list: 1

☒ COIs not listed in the database, but which are of potential concern (attach list).

reference number(s) for additional list: 2

Comments:

Waste Types and Release Mechanism List

(check all complete pathways)

		Reference Number
☒	Buried Waste	10
☒	Infiltration to groundwater	11
☐	Infiltration to surface water	3
☒	Volatilization to air	11
☒	Surface Soil	10
☒	Infiltration to groundwater	11
☐	Infiltration to surface water	3
☐	Overland runoff to surface water	3
☒	Volatilization to air	11
☒	Suspension of dust to air	11
☒	Direct radiation	
☐	Surface Water (water)	3,4,10
☐	Infiltration to groundwater	3
☐	Infiltration to surface water	3
☐	Overland runoff (i.e., overflow of containment) to surface water	3
☐	Dispersion to other surface water	3
☐	Volatilization to air	3

Waste Types and Release Mechanism List (continued)

	Reference Number
☐ Surface Water (sediment)	3,4,10
☐ Infiltration to groundwater	3
☐ Infiltration to surface water	3
☐ Volatilization to air	3
☐ Groundwater	4 ,10
☐ Dispersion to other groundwater	4
☐ Dispersion to surface water	4

Comments:

Modeling Release Source Location Assumptions

☒ Centrally located in the environmental setting

☐ Other location within the environmental setting (please specify the location on the attached map and provide reasons(s) for why the alternative location was selected)

☒ Indicate approximate release source size: ~~Variable from $10ft^2$ to $1,000,000ft^2$~~

Source size areas range from $10ft^2$ to $1,000,000ft^2$, with factor of 10 increments

(Follow generalize guidelines for positioning the release source for each environmental setting based on waste sites and release mechanisms. Place alternative release location on attached map from Receptor Location Section)

Modeling Assumptions (continued)

☒ Provide data on groundwater flow direction for this environmental setting. (Also indicate groundwater flow direction on the attached map).

reference number: 5

☐ Provide data on surface water drainage direction for this environmental setting. (Also indicate drainage flow direction on the attached map).

reference number: 3

Exposure Pathways List

(check all that apply) — Reference Number

- ☒ On-site Receptors — 7
  - ☒ Inhalation — 12
    - ☒ Airborne contamination — 11
    - ☒ Groundwater contamination while showering — 11
    - ☐ Surface water contamination while showering — 3
    - ☒ Re-suspended soil particle inhalation — 11
  - ☒ Ingestion — 12
    - ☒ Airborne contamination — 11
      - ☒ leafy vegetables — 13
      - ☒ other vegetables — 13
      - ☒ meat products — 13
      - ☒ milk products — 13
    - ☒ Groundwater contamination — 11
      - ☒ drinking water — 13
      - ☒ showering — 13
      - ☒ leafy vegetables — 13
      - ☒ other vegetables — 13
      - ☒ meat products — 13
      - ☒ milk products — 13
    - ☐ Surface water contamination — 3
      - ☐ drinking water — 3
      - ☐ showering — 3
      - ☐ leafy vegetables — 3
      - ☐ other vegetables — 3
      - ☐ meat products — 3
      - ☐ milk products — 3
      - ☐ finfish — 3
      - ☐ shellfish — 3
      - ☐ swimming — 3
    - ☒ Soil contamination — 11
      - ☒ ingestion of soil — 13
  - ☒ External Radiation — 12
    - ☐ Surface water contamination — 3
      - ☐ swimming — 3
      - ☐ boating — 3
      - ☐ shore recreation — 3
    - ☒ Direct radiation — 13
  - ☒ Dermal Contact — 12
    - ☐ Surface water contamination — 3
      - ☐ swimming — 3
      - ☐ showering — 3
    - ☒ Groundwater contamination — 11
      - ☒ showering — 13
    - ☒ Contact with source contamination (all exposure media) — 13
    - ☒ Contact with deposited contamination — 13
      - ☒ soil (atmospheric dust) — 13
      - ☐ shoreline sediment (surface water) — 13

Exposure Pathways List (continued)

Reference Number

- ☒ Installation Boundary Receptors — 7
  - ☒ Inhalation — 12
    - ☒ Airborne contamination — 11
    - ☒ Groundwater contamination while showering — 11
    - ☐ Surface water contamination while showering — 3
    - ☒ Re-suspended soil particle inhalation — 11
  - ☒ Ingestion — 12
    - ☒ Airborne contamination — 11
      - ☒ leafy vegetables — 13
      - ☒ other vegetables — 13
      - ☒ meat products — 13
      - ☒ milk products — 13
    - ☒ Groundwater contamination — 11
      - ☒ drinking water — 13
      - ☒ showering — 13
      - ☒ leafy vegetables — 13
      - ☒ other vegetables — 13
      - ☒ meat products — 13
      - ☒ milk products — 13
    - ☐ Surface water contamination — 3
      - ☐ drinking water — 3
      - ☐ showering — 3
      - ☐ leafy vegetables — 3
      - ☐ other vegetables — 3
      - ☐ meat products — 3
      - ☐ milk products — 3
      - ☐ finfish — 3
      - ☐ shellfish — 3
      - ☐ swimming — 3
    - ☒ Soil contamination — 11
      - ☒ ingestion of soil — 13
  - ☒ External Radiation — 12
    - ☐ Surface water contamination — 3
      - ☐ swimming — 3
      - ☐ boating — 3
      - ☐ shore recreation — 3
    - ☐ Direct radiation — 13
  - ☒ Dermal Contact — 12
    - ☐ Surface water contamination — 3
      - ☐ swimming — 3
      - ☐ showering — 3
    - ☒ Groundwater contamination — 11
      - ☒ showering — 13
    - ☒ Contact with source contamination (all exposure media) — 13
    - ☒ Contact with deposited contamination — 13
      - ☒ soil (atmospheric dust) — 13
      - ☐ shoreline sediment (surface water) — 13

Exposure Pathways List (continued)

Reference Number

- ☐ Restricted Area Boundary Receptors — 8
  - ☐ Inhalation — 8
    - ☐ Airborne contamination — 8
    - ☐ Groundwater contamination while showering — 8
    - ☐ Surface water contamination while showering — 8
    - ☐ Re-suspended soil particle inhalation — 8
  - ☐ Ingestion — 8
    - ☐ Airborne contamination — 8
      - ☐ leafy vegetables — 8
      - ☐ other vegetables — 8
      - ☐ meat products — 8
      - ☐ milk products — 8
    - ☐ Groundwater contamination — 8
      - ☐ drinking water — 8
      - ☐ showering — 8
      - ☐ leafy vegetables — 8
      - ☐ other vegetables — 8
      - ☐ meat products — 8
      - ☐ milk products — 8
    - ☐ Surface water contamination — 8
      - ☐ drinking water — 8
      - ☐ showering — 8
      - ☐ leafy vegetables — 8
      - ☐ other vegetables — 8
      - ☐ meat products — 8
      - ☐ milk products — 8
      - ☐ finfish — 8
      - ☐ shellfish — 8
      - ☐ swimming — 8
    - ☐ Soil contamination — 8
      - ☐ ingestion of soil — 8
  - ☐ External Radiation — 8
    - ☐ Surface water contamination — 8
      - ☐ swimming — 8
      - ☐ boating — 8
      - ☐ shore recreation — 8
    - ☐ Direct radiation — 8
  - ☐ Dermal Contact — 8
    - ☐ Surface water contamination — 8
      - ☐ swimming — 8
      - ☐ showering — 8
    - ☐ Groundwater contamination — 8
      - ☐ showering — 8
    - ☐ Contact with source contamination (all exposure media) — 8
    - ☐ Contact with deposited contamination — 8
      - ☐ soil (atmospheric dust) — 8
      - ☐ shoreline sediment (surface water) — 8

Receptor Locations

Reference Number

Attached map detailing approximate location of:

		Reference Number
☒ On-site receptors		6
☒ Facility boundary receptors		7
☒ groundwater receptor		7
☐ surface water receptor		3
☐ Restricted Area boundary receptors		8
☐ groundwater receptor		8
☐ surface water receptor		8

Comments:

Approximate Date of Release in this Environmental Setting : January 27, 1951

reference number for release date: 9

Comments:

Exceptions (attach separate sheet and references for each)

☒ Contaminants of Interest
- those not on the MEPAS Modeling list which may be of concern at the site

☒ Waste Types and Release Mechanisms
- those listed above which are not of concern based on site information, or those which are not listed above which should be considered separately
- release mechanisms not included in list above which should be, or which were not listed but which should be considered due to site specific information

☐ Modeling Release Source Location
- suggestions for re-positioning of the release source in an environmental setting based on site specific info or other information

Reference List: (add sheets as necessary)

1. See attached Preliminary Contaminant List (Table 1), Primary Contaminant List (Table 2), and Listing of Contaminants Not found in MEPAS Database (Table 3).

2. Record of Assumption (ROA). NTS Installation. ROA NTS #032. *Additional Chemicals of Interest.* December 21, 1994. (Table 4).

3. Record of Assumption (ROA). NTS Installation. ROA NTS #021. *Surface Water.* November 15, 1994.

4. Record of Assumption (ROA). NTS Installation. ROA NTS #020. *PEIS Database.* November 15, 1994.

5. Holdren, G. R. , G. S. Glantz, L. K. Berg, K. Delinger, S. M. Goodwin, J. R. Rustad, R. Schalla, and J. A. Schramke. *Environmental Settings for Selected U.S. Department of Energy Installations--Support Information for the Programmatic Environmental Impact Statement. Volume 2.* July 1995. In Preparation. Pacific Northwest Laboratory. Richland, Washington (see attached Figure 1).

   Winograd, Isaac and Thodarson, William. *Hydrogeological and Hydrochemical Framework South-Central Great Basin, Nevada-California, with Special Reference to the Nevada Test Site.* Hydrology of Nuclear Test Sites. Geological Survey Professional Paper 712-C. U.S. Government Printing Office. Washington, D.C.

6. Record of Assumption (ROA). NTS Installation. ROA NTS #007. *Choice of Waste Site for Timber Mountain.* November 4, 1994.

7. Record of Assumption (ROA). NTS Installation. ROA NTS #033. *Boundary Receptor Location for Timber Mountain.* November 14, 1994 (see Figure 2).

8. Record of Assumption (ROA). NTS Installation. ROA NTS #019. *Restricted Area On-Site.* November 15, 1994.

9. Record of Assumption (ROA). NTS Installation. ROA NTS #008. *Initial Dates Contamination Introduced.* November 4, 1994.

10. Record of Assumption (ROA). NTS Installation. ROA NTS #017. *Rationale for Selection of Media.* November 28, 1994.

11. Record of Assumption (ROA). NTS Installation. ROA NTS #018. *Rationale for Selection of Pathways.* November 28, 1994.

12. Record of Assumption (ROA). NTS Installation. ROA NTS #022. *Rationale for Selection of Exposure Pathways.* November 28, 1994.

13. Record of Assumption (ROA). NTS Installation. ROA NTS #029. *Exposure Pathway Selection for UTF Analysis.* December 21, 1994.

Table 1. CoCs-Preliminary List

NTS CONSTITUENTS OF CONCERN - PRELIMINARY LIST				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Acids	NA	NO	NO	PEIS #61
Argon	7440371	NO	NO	PEIS #2301
Arsenic	7440382	YES	NO	PEIS #61
Asbestos	12001284	YES	NO	PEIS #2301
Berylium	7440417	YES	YES	
Caustics	NA	NO	NO	PEIS #61
Chromium	7440473	YES	YES	
Copper	7440508	YES	NO	PEIS #61
Lead	7439921	YES	YES	
Plutonium	7440075	NO	YES	
Uranium	7740611	YES	YES	
Zinc	7646857	YES	NO	PEIS #61
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Actinium 228	AC228	YES	NO	PEIS #6021
Americium 241	AM241	YES	YES	
Antimony 125	SB125	YES	YES	
Bismuth 214	BI214	NO	NO	PEIS #6021
Cadmium 109	CD109	YES	YES	
Carbon 14	C14	YES	YES	
Cesium 134	CS134	YES	YES	
Cesium 137	CS137	YES	YES	
Cobalt 57	CO57	YES	YES	
Cobalt 60	CO60	YES	YES	
Europium 152	EU152	YES	YES	
Europium 154	EU154	YES	YES	
Europium 155	EU155	YES	YES	
Krypton 85	KR85	YES	YES	
Lead 212	PB212	YES	NO	PEIS #6021
Lead 214	PB214	NO	NO	PEIS #6021

Table 1. (contd)

Plutonium 238	PU238	YES	YES	
Plutonium 239	PU239	YES	YES	
Plutonium 240	PU240	YES	YES	
Potassium 40	K40	YES	YES	
Radium 226	RA226	YES	YES	
Ruthenium 103	RU103	YES	YES	
Ruthenium 106	RU106	YES	YES	
Strontium 90	SR90	YES	YES	
Thallium 208	TH208	NO	NO	PEIS #6021
Thorium 228	TH228	YES	YES	
Thorium 232	TH232	YES	YES	
Tritium	H3/10028178	YES	YES	
Uranium 235	U235	YES	YES	
ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Cutting Fluids	NA	NO	NO	PEIS #61
Ethylene Glycol	10721	YES	YES	
Motor Oil	Motor oil	YES	YES	
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Chlorinated Solvents	NA	NO	NO	PEIS #2301
Diesel Fuel	Diesel F	YES	NO	PEIS #2301
Gasoline	8006619	YES	YES	
Hydraulic Flued	Hydr Flu	YES	YES	
Isopropyl Alcholhol	67630	YES	NO	PEIS #2301
Kerosene	8008206	YES	NO	PEIS #2301
Methanol	67561	YES	YES	
Methylene Chloride	75092	YES	YES	
Stoddard Solfent	NA	NO	NO	PEIS #2301
Pretroleum Solvents	NA	NO	NO	PEIS #2301
Petisol 202	NA	NO	NO	PEIS #2301
Polychlorinated Biphenyls	1336363	YES	YES	
Techloroethylene	79016	YES	YES	

Table 2. CoCs-Primary List

NTS CONSTITUENTS OF CONCERN - PRIMARY LIST				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Berylium	7440417	YES	YES	
Chromium	7440473	YES	YES	
Lead	7439921	YES	YES	
Uranium	7740611	YES	YES	
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Americium 241	AM241	YES	YES	
Antimony 125	SB125	YES	YES	
Cadmium 109	CD109	YES	YES	
Carbon 14	C14	YES	YES	
Cesium 134	CS134	YES	YES	
Cesium 137	CS137	YES	YES	
Cobalt 57	CO57	YES	YES	
Cobalt 60	CO60	YES	YES	
Europium 152	EU152	YES	YES	
Europium 154	EU154	YES	YES	
Europium 155	EU155	YES	YES	
Krypton 85	KR85	YES	YES	
Plutonium 238	PU238	YES	YES	
Plutonium 239	PU239	YES	YES	
Plutonium 240	PU240	YES	YES	
Potassium 40	K40	YES	YES	
Radium 226	RA226	YES	YES	
Ruthenium 103	RU103	YES	YES	
Ruthenium 106	RU106	YES	YES	
Strontium 90	SR90	YES	YES	
Throium 228	TH228	YES	YES	
Thorium 232	TH232	YES	YES	
Tritium	H3/10028178	YES	YES	
Uranium 235	U235	YES	YES	

Table 2. (contd)

ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Ethylene Glycol	10721	YES	YES	
Motor Oil	Motor oil	YES	YES	
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Gasoline	8006619	YES	YES	
Hydraulic Flued	Hydr Flu	YES	YES	
Methanol	67561	YES	YES	
Methylene Chloride	75092	YES	YES	
Polychlorinated Biphenyls	1336363	YES	YES	
Techloroethylene	79016	YES	YES	

Table 3. CoCs Not in MEPAS

NTS CONSTITUENTS OF CONCERN - NOT IN MEPAS DATABASE				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Acids	NA	NO	NO	PEIS #61
Argon	7440371	NO	NO	PEIS #2301
Caustics	NA	NO	NO	PEIS #61
Plutonium	7440075	NO	YES	
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Bismuth 214	BI214	NO	NO	PEIS #6021
Lead 214	PB214	NO	NO	PEIS #6021
Thallium 208	TH208	NO	NO	PEIS #6021
ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Cutting Fluids	NA	NO	NO	PEIS #61
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Chlorinated Solvents	NA	NO	NO	PEIS #2301
Stoddard Solfent	NA	NO	NO	PEIS #2301
Pretroleum Solvents	NA	NO	NO	PEIS #2301
Petisol 202	NA	NO	NO	PEIS #2301

Table 4. CoCs Not in PEIS

NTS CONSTITUENTS OF CONCERN - NOT IN PEIS DATABASE				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Acids	NA	NO	NO	PEIS #61
Argon	7440371	NO	NO	PEIS #2301
Arsenic	7440382	YES	NO	PEIS #61
Asbestos	12001284	YES	NO	PEIS #2301
Caustics	NA	NO	NO	PEIS #61
Copper	7440508	YES	NO	PEIS #61
Zinc	7646857	YES	NO	PEIS #61
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Actinium 228	AC228	YES	NO	PEIS #6021
Bismuth 214	BI214	NO	NO	PEIS #6021
Lead 212	PB212	YES	NO	PEIS #6021
Lead 214	PB214	NO	NO	PEIS #6021
Thallium 208	TH208	NO	NO	PEIS #6021
ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Cutting Fluids	NA	NO	NO	PEIS #61
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Chlorinated Solvents	NA	NO	NO	PEIS #2301
Diesel Fuel	Diesel F	YES	NO	PEIS #2301
Isopropyl Alcholhol	67630	YES	NO	PEIS #2301
Kerosene	8008206	YES	NO	PEIS #2301
Stoddard Solfent	NA	NO	NO	PEIS #2301
Pretroleum Solvents	NA	NO	NO	PEIS #2301
Petisol 202	NA	NO	NO	PEIS #2301

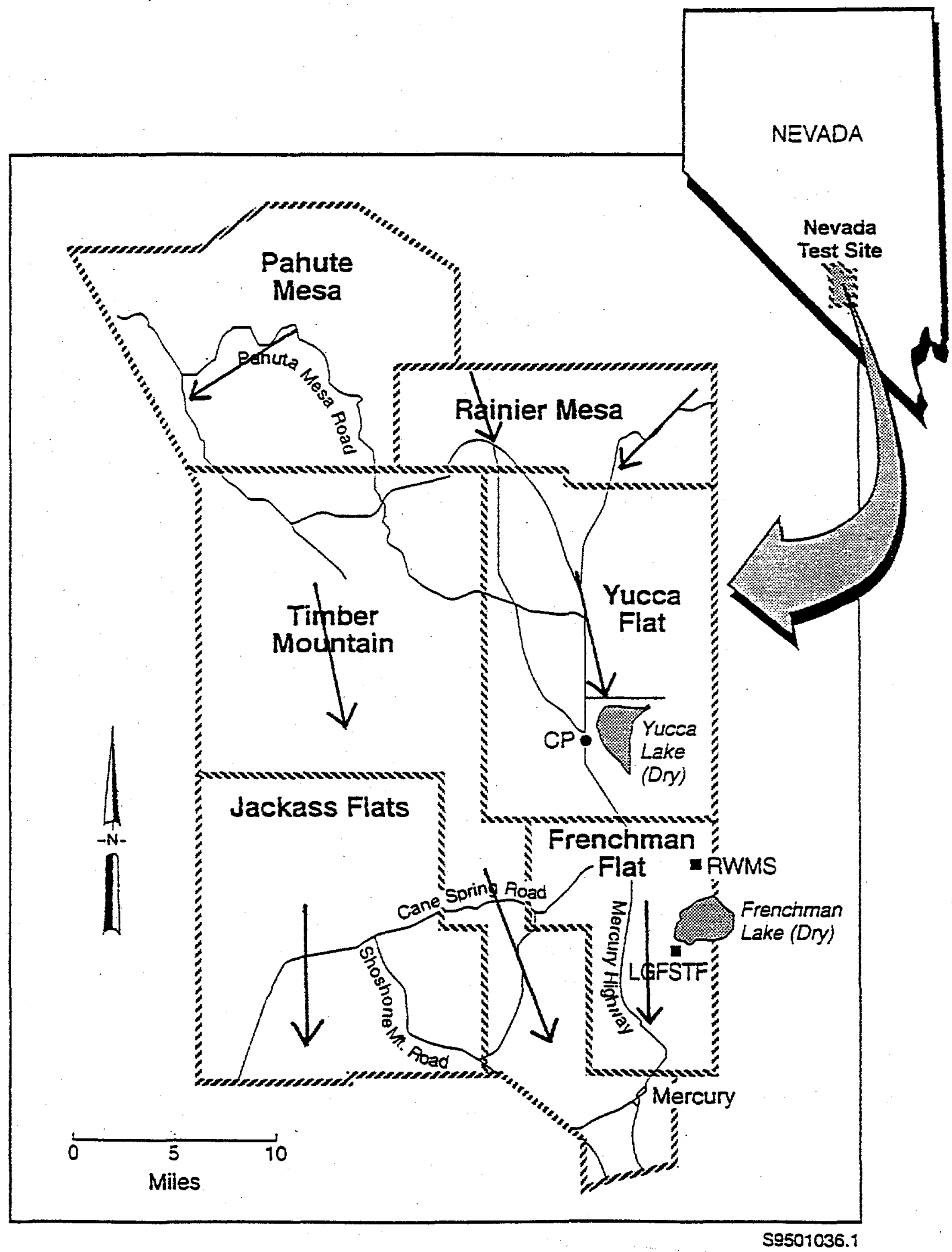

Figure 1. Nevada Test Site, Regional Groundwater Flow

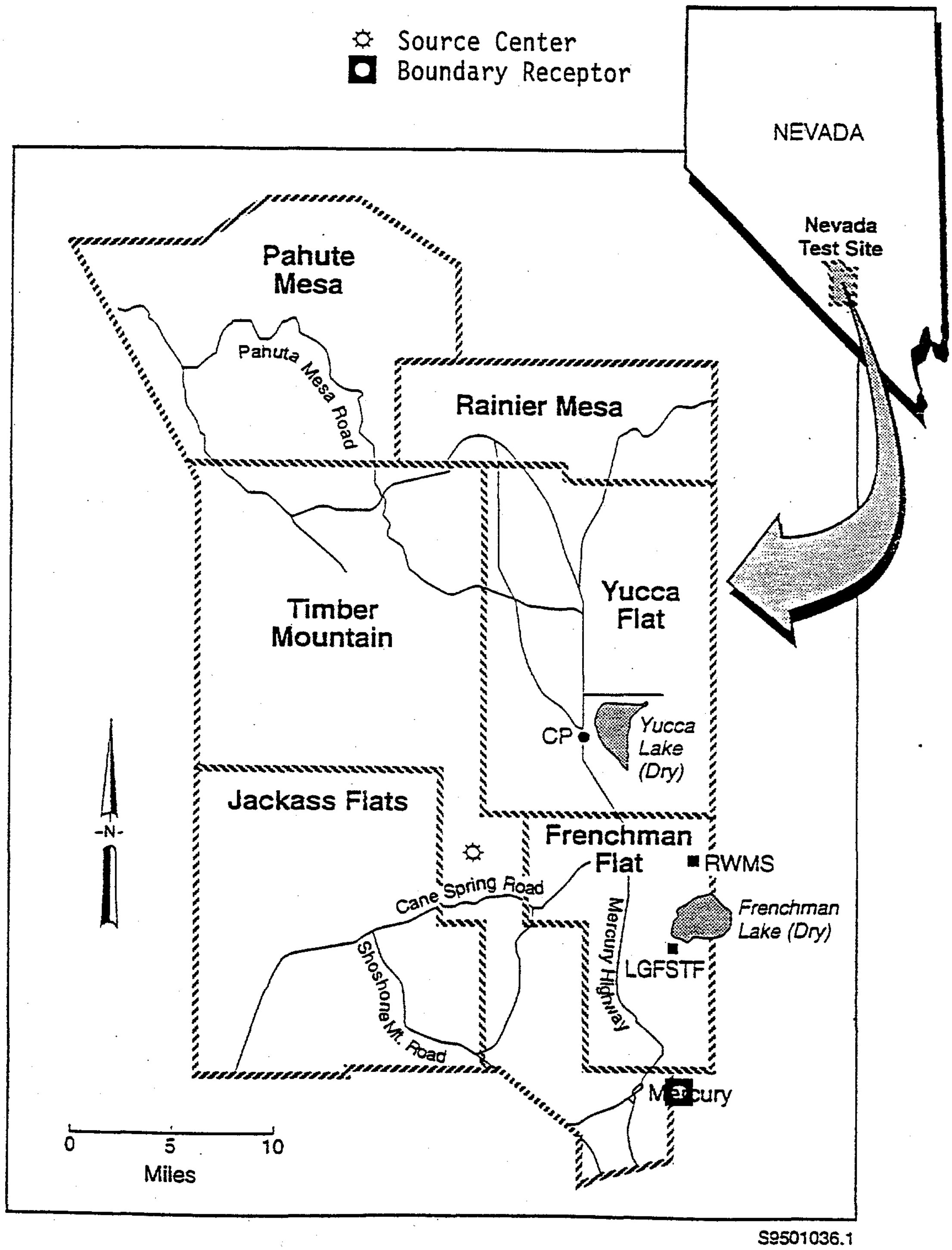

Figure 2. Nevada Test Site, Timber Mountain

CSM Data Acquisition Check-List: Yucca Flat Environmental Setting

CONCEPTUAL SITE MODEL DATA ACQUISITION CHECK-LIST

Installation Name : Nevada Test Site

Environmental Setting considered : Yucca Flat

Date: December 21, 1994

this form completed by: Gariann Gelston, PNL

Contaminant of Interest (COIs) List (attach list)

- ☒ List contaminants in PEIS database for all contaminated sites and exposure media. The primary list should include only those contaminants on the MEPAS modeling list and be separated by chemical class (e.g., VOCs, radionuclides, inorganics).

  reference number(s) for primary list: 1

- ☒ COIs not listed in the database, but which are of potential concern (attach list).

  reference number(s) for additional list: 2

Comments:

Waste Types and Release Mechanism List

(check all complete pathways)

		Reference Number
☒	Buried Waste	10
	☒ Infiltration to groundwater	11
	☐ Infiltration to surface water	3
	☒ Volatilization to air	11
☒	Surface Soil	10
	☒ Infiltration to groundwater	11
	☐ Infiltration to surface water	3
	☐ Overland runoff to surface water	3
	☒ Volatilization to air	11
	☒ Suspension of dust to air	11
	☒ Direct radiation	
☐	Surface Water (water)	3,4,10
	☐ Infiltration to groundwater	3
	☐ Infiltration to surface water	3
	☐ Overland runoff (i.e., overflow of containment) to surface water	3
	☐ Dispersion to other surface water	3
	☐ Volatilization to air	3

Waste Types and Release Mechanism List (continued)

	Reference Number
☐ Surface Water (sediment)	3,4,10
☐ Infiltration to groundwater	3
☐ Infiltration to surface water	3
☐ Volatilization to air	3
☐ Groundwater	4 ,10
☐ Dispersion to other groundwater	4
☐ Dispersion to surface water	4

Comments:

Modeling Release Source Location Assumptions

☒ Centrally located in the environmental setting

☐ Other location within the environmental setting (please specify the location on the attached map and provide reasons(s) for why the alternative location was selected)

☒ Indicate approximate release source size: ~~Variable from $10ft^2$ to $1,000,000ft^2$~~

Source size areas range from $10ft^2$ to $1,000,000ft^2$, with factor of 10 increments

(Follow generalize guidelines for positioning the release source for each environmental setting based on waste sites and release mechanisms. Place alternative release location on attached map from Receptor Location Section)

Modeling Assumptions (continued)

☒ Provide data on groundwater flow direction for this environmental setting. (Also indicate groundwater flow direction on the attached map).

reference number: 5

☐ Provide data on surface water drainage direction for this environmental setting. (Also indicate drainage flow direction on the attached map).

reference number: 3

Exposure Pathways List
(check all that apply)

Reference Number

- ☒ On-site Receptors — 7
  - ☒ Inhalation — 12
    - ☒ Airborne contamination — 11
    - ☒ Groundwater contamination while showering — 11
    - ☐ Surface water contamination while showering — 3
    - ☒ Re-suspended soil particle inhalation — 11
  - ☒ Ingestion — 12
    - ☒ Airborne contamination — 11
      - ☒ leafy vegetables — 13
      - ☒ other vegetables — 13
      - ☒ meat products — 13
      - ☒ milk products — 13
    - ☒ Groundwater contamination — 11
      - ☒ drinking water — 13
      - ☒ showering — 13
      - ☒ leafy vegetables — 13
      - ☒ other vegetables — 13
      - ☒ meat products — 13
      - ☒ milk products — 13
    - ☐ Surface water contamination — 3
      - ☐ drinking water — 3
      - ☐ showering — 3
      - ☐ leafy vegetables — 3
      - ☐ other vegetables — 3
      - ☐ meat products — 3
      - ☐ milk products — 3
      - ☐ finfish — 3
      - ☐ shellfish — 3
      - ☐ swimming — 3
    - ☒ Soil contamination — 11
      - ☒ ingestion of soil — 13
  - ☒ External Radiation — 12
    - ☐ Surface water contamination — 3
      - ☐ swimming — 3
      - ☐ boating — 3
      - ☐ shore recreation — 3
    - ☒ Direct radiation — 13
  - ☒ Dermal Contact — 12
    - ☐ Surface water contamination — 3
      - ☐ swimming — 3
      - ☐ showering — 3
    - ☒ Groundwater contamination — 11
      - ☒ showering — 13
    - ☒ Contact with source contamination (all exposure media) — 13
    - ☒ Contact with deposited contamination — 13
      - ☒ soil (atmospheric dust) — 13
      - ☐ shoreline sediment (surface water) — 13

Exposure Pathways List (continued)

Reference Number

- ☒ Installation Boundary Receptors — 7
  - ☒ Inhalation — 12
    - ☒ Airborne contamination — 11
    - ☒ Groundwater contamination while showering — 11
    - ☐ Surface water contamination while showering — 3
    - ☒ Re-suspended soil particle inhalation — 11
  - ☒ Ingestion — 12
    - ☒ Airborne contamination — 11
      - ☒ leafy vegetables — 13
      - ☒ other vegetables — 13
      - ☒ meat products — 13
      - ☒ milk products — 13
    - ☒ Groundwater contamination — 11
      - ☒ drinking water — 13
      - ☒ showering — 13
      - ☒ leafy vegetables — 13
      - ☒ other vegetables — 13
      - ☒ meat products — 13
      - ☒ milk products — 13
    - ☐ Surface water contamination — 3
      - ☐ drinking water — 3
      - ☐ showering — 3
      - ☐ leafy vegetables — 3
      - ☐ other vegetables — 3
      - ☐ meat products — 3
      - ☐ milk products — 3
      - ☐ finfish — 3
      - ☐ shellfish — 3
      - ☐ swimming — 3
    - ☒ Soil contamination — 11
      - ☒ ingestion of soil — 13
  - ☒ External Radiation — 12
    - ☐ Surface water contamination — 3
      - ☐ swimming — 3
      - ☐ boating — 3
      - ☐ shore recreation — 3
    - ☐ Direct radiation — 13
  - ☒ Dermal Contact — 12
    - ☐ Surface water contamination — 3
      - ☐ swimming — 3
      - ☐ showering — 3
    - ☒ Groundwater contamination — 11
      - ☒ showering — 13
    - ☒ Contact with source contamination (all exposure media) — 13
    - ☒ Contact with deposited contamination — 13
      - ☒ soil (atmospheric dust) — 13
      - ☐ shoreline sediment (surface water) — 13

Exposure Pathways List (continued)

Reference Number

- ☐ Restricted Area Boundary Receptors — 8
  - ☐ Inhalation — 8
    - ☐ Airborne contamination — 8
    - ☐ Groundwater contamination while showering — 8
    - ☐ Surface water contamination while showering — 8
    - ☐ Re-suspended soil particle inhalation — 8
  - ☐ Ingestion — 8
    - ☐ Airborne contamination — 8
      - ☐ leafy vegetables — 8
      - ☐ other vegetables — 8
      - ☐ meat products — 8
      - ☐ milk products — 8
    - ☐ Groundwater contamination — 8
      - ☐ drinking water — 8
      - ☐ showering — 8
      - ☐ leafy vegetables — 8
      - ☐ other vegetables — 8
      - ☐ meat products — 8
      - ☐ milk products — 8
    - ☐ Surface water contamination — 8
      - ☐ drinking water — 8
      - ☐ showering — 8
      - ☐ leafy vegetables — 8
      - ☐ other vegetables — 8
      - ☐ meat products — 8
      - ☐ milk products — 8
      - ☐ finfish — 8
      - ☐ shellfish — 8
      - ☐ swimming — 8
    - ☐ Soil contamination — 8
      - ☐ ingestion of soil — 8
  - ☐ External Radiation — 8
    - ☐ Surface water contamination — 8
      - ☐ swimming — 8
      - ☐ boating — 8
      - ☐ shore recreation — 8
    - ☐ Direct radiation — 8
  - ☐ Dermal Contact — 8
    - ☐ Surface water contamination — 8
      - ☐ swimming — 8
      - ☐ showering — 8
    - ☐ Groundwater contamination — 8
      - ☐ showering — 8
    - ☐ Contact with source contamination (all exposure media) — 8
    - ☐ Contact with deposited contamination — 8
      - ☐ soil (atmospheric dust) — 8
      - ☐ shoreline sediment (surface water) — 8

Receptor Locations

Reference Number

Attached map detailing approximate location of:

		Reference Number
☒	On-site receptors	6
☒	Facility boundary receptors	7
☒	groundwater receptor	7
☐	surface water receptor	3
☐	Restricted Area boundary receptors	8
☐	groundwater receptor	8
☐	surface water receptor	8

Comments:

Approximate Date of Release in this Environmental Setting : October 22, 1951

reference number for release date: 9

Comments:

Exceptions (attach separate sheet and references for each)

☒ Contaminants of Interest
- those not on the MEPAS Modeling list which may be of concern at the site

☒ Waste Types and Release Mechanisms
- those listed above which are not of concern based on site information, or those which are not listed above which should be considered separately
- release mechanisms not included in list above which should be, or which were not listed but which should be considered due to site specific information

☐ Modeling Release Source Location
- suggestions for re-positioning of the release source in an environmental setting based on site specific info or other information

Reference List: (add sheets as necessary)

1. See attached Preliminary Contaminant List (Table 1), Primary Contaminant List (Table 2), and Listing of Contaminants Not found in MEPAS Database (Table 3).

2. Record of Assumption (ROA). NTS Installation. ROA NTS #032. *Additional Chemicals of Interest.* December 21, 1994 (Table 4).

3. Record of Assumption (ROA). NTS Installation. ROA NTS #021. *Surface Water.* November 15, 1994.

4. Record of Assumption (ROA). NTS Installation. ROA NTS #020. *PEIS Database.* November 15, 1994.

5. Holdren, G. R. , G. S. Glantz, L. K. Berg, K. Delinger, S. M. Goodwin, J. R. Rustad, R. Schalla, and J. A. Schramke. *Environmental Settings for Selected U.S. Department of Energy Installations--Support Information for the Programmatic Environmental Impact Statement. Volume 2.* July 1995. In Preparation. Pacific Northwest Laboratory. Richland, Washington (see attached Figure 1).

   Winograd, Isaac and Thodarson, William. *Hydrogeological and Hydrochemical Framework South-Central Great Basin, Nevada-California, with Special Reference to the Nevada Test Site.* Hydrology of Nuclear Test Sites. Geological Survey Professional Paper 712-C. U.S. Government Printing Office. Washington, D.C.

6. Record of Assumption (ROA). NTS Installation. ROA NTS #015. *Location of On-Site Receptors.* November 14, 1994.

7. Record of Assumption (ROA). NTS Installation. ROA NTS #012. *Source and Boundary Receptors for Yucca Flat.* November 14, 1994 (see Figure 2).

8. Record of Assumption (ROA). NTS Installation. ROA NTS #019. *Restricted Area On-Site.* November 15, 1994.

9. Record of Assumption (ROA). NTS Installation. ROA NTS #008. *Initial Dates Contamination Introduced.* November 4, 1994.

10. Record of Assumption (ROA). NTS Installation. ROA NTS #017. *Rationale for Selection of Media.* November 28, 1994.

11. Record of Assumption (ROA). NTS Installation. ROA NTS #018. *Rationale for Selection of Pathways.* November 28, 1994.

12. Record of Assumption (ROA). NTS Installation. ROA NTS #022. *Rationale for Selection of Exposure Pathways.* November 28, 1994.

13. Record of Assumption (ROA). NTS Installation. ROA NTS #029. *Exposure Pathway Selection for UTF Analysis.* December 21, 1994.

Table 1. CoCs-Preliminary List

NTS CONSTITUENTS OF CONCERN - PRELIMINARY LIST				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Acids	NA	NO	NO	PEIS #61
Argon	7440371	NO	NO	PEIS #2301
Arsenic	7440382	YES	NO	PEIS #61
Asbestos	12001284	YES	NO	PEIS #2301
Berylium	7440417	YES	YES	
Caustics	NA	NO	NO	PEIS #61
Chromium	7440473	YES	YES	
Copper	7440508	YES	NO	PEIS #61
Lead	7439921	YES	YES	
Plutonium	7440075	NO	YES	
Uranium	7740611	YES	YES	
Zinc	7646857	YES	NO	PEIS #61
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Actinium 228	AC228	YES	NO	PEIS #6021
Americium 241	AM241	YES	YES	
Antimony 125	SB125	YES	YES	
Bismuth 214	BI214	NO	NO	PEIS #6021
Cadmium 109	CD109	YES	YES	
Carbon 14	C14	YES	YES	
Cesium 134	CS134	YES	YES	
Cesium 137	CS137	YES	YES	
Cobalt 57	CO57	YES	YES	
Cobalt 60	CO60	YES	YES	
Europium 152	EU152	YES	YES	
Europium 154	EU154	YES	YES	
Europium 155	EU155	YES	YES	
Krypton 85	KR85	YES	YES	
Lead 212	PB212	YES	NO	PEIS #6021
Lead 214	PB214	NO	NO	PEIS #6021

Table 1. (contd)

Plutonium 238	PU238	YES	YES	
Plutonium 239	PU239	YES	YES	
Plutonium 240	PU240	YES	YES	
Potassium 40	K40	YES	YES	
Radium 226	RA226	YES	YES	
Ruthenium 103	RU103	YES	YES	
Ruthenium 106	RU106	YES	YES	
Strontium 90	SR90	YES	YES	
Thallium 208	TH208	NO	NO	PEIS #6021
Thorium 228	TH228	YES	YES	
Thorium 232	TH232	YES	YES	
Tritium	H3/10028178	YES	YES	
Uranium 235	U235	YES	YES	
ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Cutting Fluids	NA	NO	NO	PEIS #61
Ethylene Glycol	10721	YES	YES	
Motor Oil	Motor oil	YES	YES	
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Chlorinated Solvents	NA	NO	NO	PEIS #2301
Diesel Fuel	Diesel F	YES	NO	PEIS #2301
Gasoline	8006619	YES	YES	
Hydraulic Flued	Hydr Flu	YES	YES	
Isopropyl Alcholhol	67630	YES	NO	PEIS #2301
Kerosene	8008206	YES	NO	PEIS #2301
Methanol	67561	YES	YES	
Methylene Chloride	75092	YES	YES	
Stoddard Solfent	NA	NO	NO	PEIS #2301
Pretroleum Solvents	NA	NO	NO	PEIS #2301
Petisol 202	NA	NO	NO	PEIS #2301
Polychlorinated Biphenyls	1336363	YES	YES	
Techloroethylene	79016	YES	YES	

Table 2. CoCs-Primary List

NTS CONSTITUENTS OF CONCERN - PRIMARY LIST				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Berylium	7440417	YES	YES	
Chromium	7440473	YES	YES	
Lead	7439921	YES	YES	
Uranium	7740611	YES	YES	
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Americium 241	AM241	YES	YES	
Antimony 125	SB125	YES	YES	
Cadmium 109	CD109	YES	YES	
Carbon 14	C14	YES	YES	
Cesium 134	CS134	YES	YES	
Cesium 137	CS137	YES	YES	
Cobalt 57	CO57	YES	YES	
Cobalt 60	CO60	YES	YES	
Europium 152	EU152	YES	YES	
Europium 154	EU154	YES	YES	
Europium 155	EU155	YES	YES	
Krypton 85	KR85	YES	YES	
Plutonium 238	PU238	YES	YES	
Plutonium 239	PU239	YES	YES	
Plutonium 240	PU240	YES	YES	
Potassium 40	K40	YES	YES	
Radium 226	RA226	YES	YES	
Ruthenium 103	RU103	YES	YES	
Ruthenium 106	RU106	YES	YES	
Strontium 90	SR90	YES	YES	
Throium 228	TH228	YES	YES	
Thorium 232	TH232	YES	YES	
Tritium	H3/10028178	YES	YES	
Uranium 235	U235	YES	YES	

Table 2. (contd)

ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Ethylene Glycol	10721	YES	YES	
Motor Oil	Motor oil	YES	YES	
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Gasoline	8006619	YES	YES	
Hydraulic Flued	Hydr Flu	YES	YES	
Methanol	67561	YES	YES	
Methylene Chloride	75092	YES	YES	
Polychlorinated Biphenyls	1336363	YES	YES	
Techloroethylene	79016	YES	YES	

Table 3. CoCs Not in MEPAS

NTS CONSTITUENTS OF CONCERN - NOT IN MEPAS DATABASE				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Acids	NA	NO	NO	PEIS #61
Argon	7440371	NO	NO	PEIS #2301
Caustics	NA	NO	NO	PEIS #61
Plutonium	7440075	NO	YES	
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Bismuth 214	BI214	NO	NO	PEIS #6021
Lead 214	PB214	NO	NO	PEIS #6021
Thallium 208	TH208	NO	NO	PEIS #6021
ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Cutting Fluids	NA	NO	NO	PEIS #61
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Chlorinated Solvents	NA	NO	NO	PEIS #2301
Stoddard Solfent	NA	NO	NO	PEIS #2301
Pretroleum Solvents	NA	NO	NO	PEIS #2301
Petisol 202	NA	NO	NO	PEIS #2301

Table 4. CoCs Not in PEIS

NTS CONSTITUENTS OF CONCERN - NOT IN PEIS DATABASE				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Acids	NA	NO	NO	PEIS #61
Argon	7440371	NO	NO	PEIS #2301
Arsenic	7440382	YES	NO	PEIS #61
Asbestos	12001284	YES	NO	PEIS #2301
Caustics	NA	NO	NO	PEIS #61
Copper	7440508	YES	NO	PEIS #61
Zinc	7646857	YES	NO	PEIS #61
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Actinium 228	AC228	YES	NO	PEIS #6021
Bismuth 214	BI214	NO	NO	PEIS #6021
Lead 212	PB212	YES	NO	PEIS #6021
Lead 214	PB214	NO	NO	PEIS #6021
Thallium 208	TH208	NO	NO	PEIS #6021
ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Cutting Fluids	NA	NO	NO	PEIS #61
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Chlorinated Solvents	NA	NO	NO	PEIS #2301
Diesel Fuel	Diesel F	YES	NO	PEIS #2301
Isopropyl Alcholhol	67630	YES	NO	PEIS #2301
Kerosene	8008206	YES	NO	PEIS #2301
Stoddard Solfent	NA	NO	NO	PEIS #2301
Pretroleum Solvents	NA	NO	NO	PEIS #2301
Petisol 202	NA	NO	NO	PEIS #2301

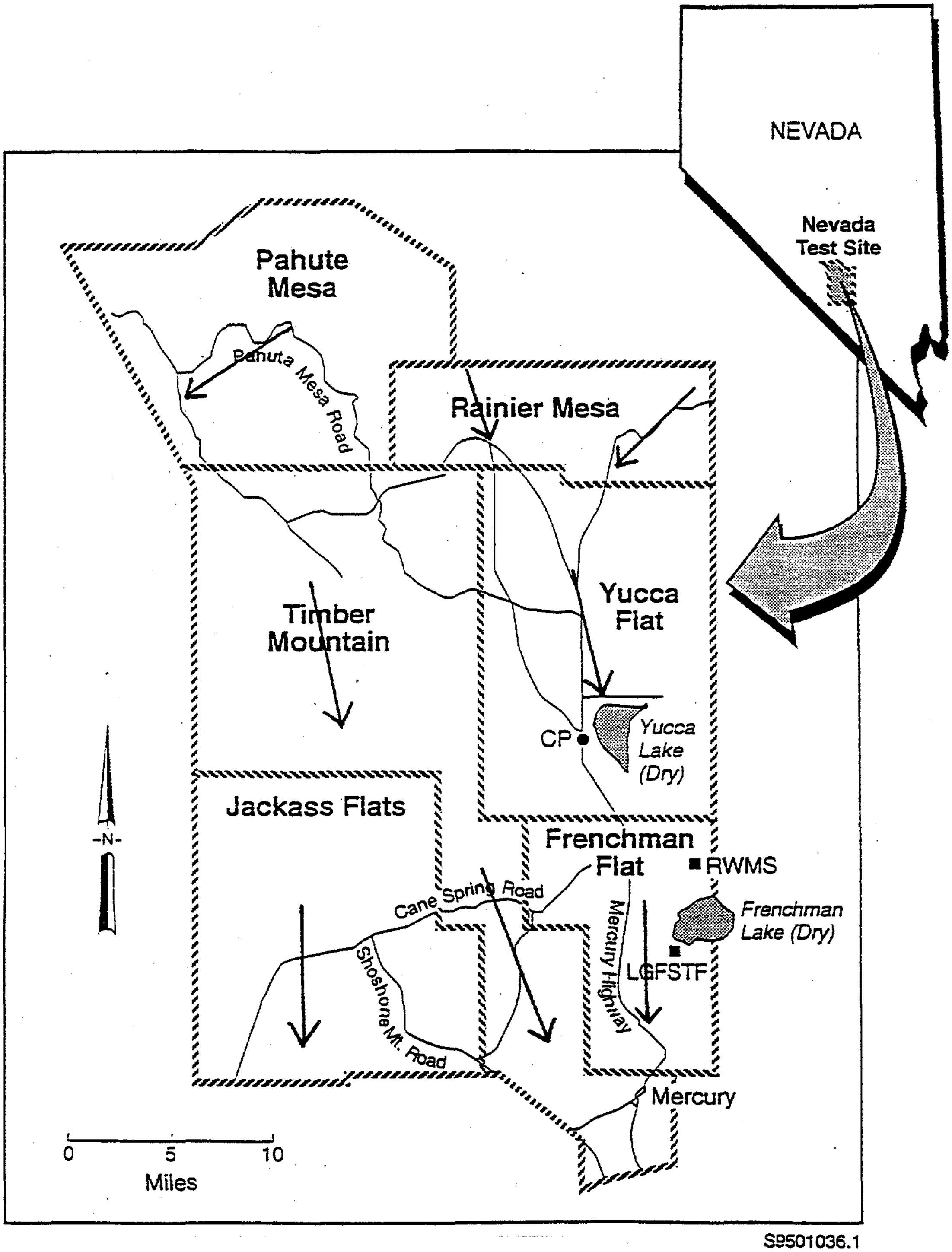

Figure 1. Nevada Test Site, Regional Groundwater Flow

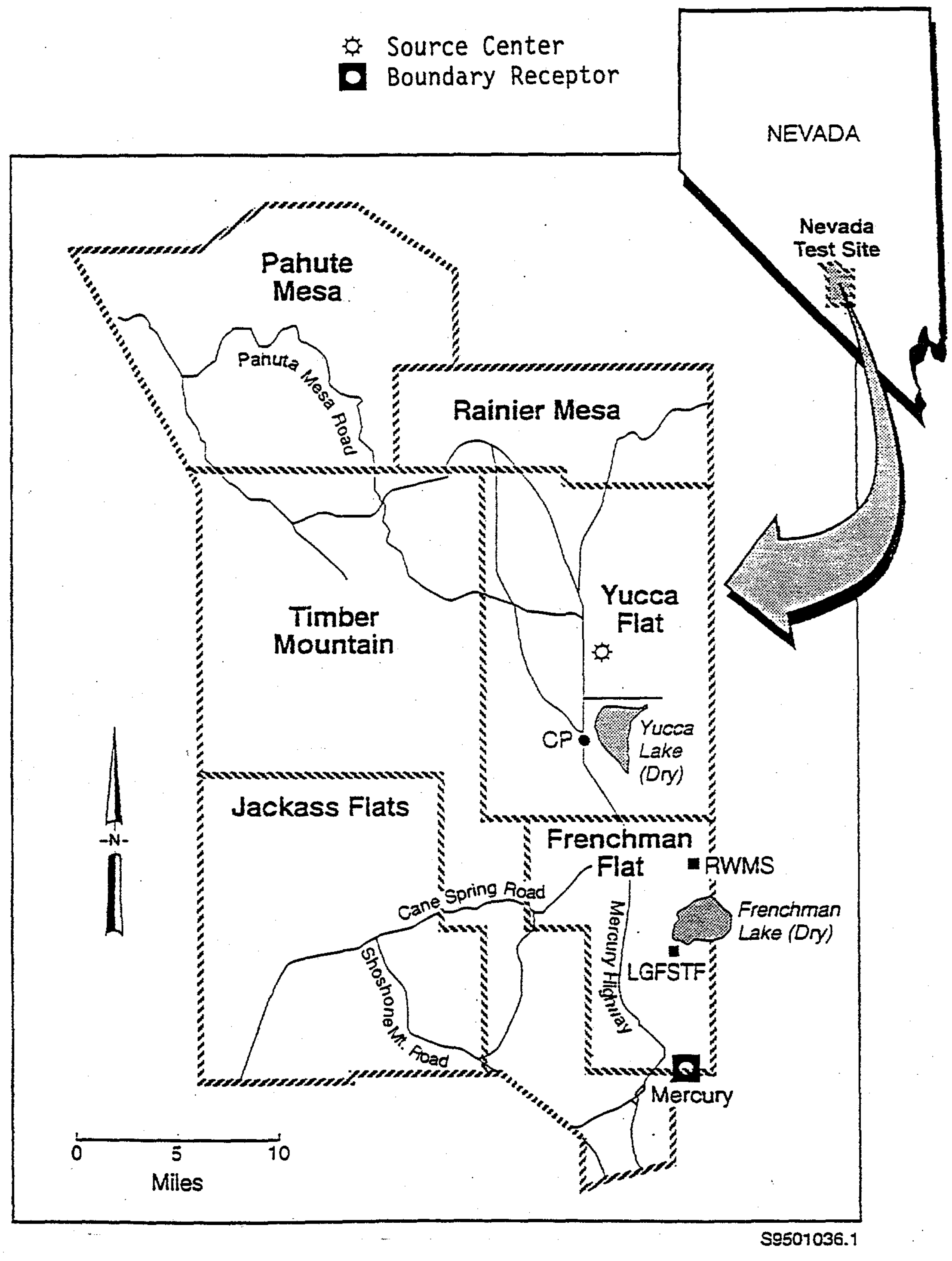

Figure 2. Nevada Test Site, Yucca Flat

CSM Data Acquisition Check-List: Jackass Flats Environmental Setting

CONCEPTUAL SITE MODEL DATA ACQUISITION CHECK-LIST

Installation Name : Nevada Test Site

Environmental Setting considered : Jackass Flat

Date: November 9, 1994

this form completed by: Gariann Gelston, PNL

Contaminant of Interest (COIs) List (attach list)

☒ List contaminants in PEIS database for all contaminated sites and exposure media. The primary list should include only those contaminants on the MEPAS modeling list and be separated by chemical class (e.g., VOCs, radionuclides, inorganics).

reference number(s) for primary list: 1

☒ COIs not listed in the database, but which are of potential concern (attach list).

reference number(s) for additional list: 2

Comments:

Waste Types and Release Mechanism List

(check all complete pathways)

		Reference Number
☒ Buried Waste		10
	☒ Infiltration to groundwater	11
	☐ Infiltration to surface water	3
	☒ Volatilization to air	11
☒ Surface Soil		10
	☒ Infiltration to groundwater	11
	☐ Infiltration to surface water	3
	☐ Overland runoff to surface water	3
	☒ Volatilization to air	11
	☒ Suspension of dust to air	11
	☒ Direct radiation	
☐ Surface Water (water)		3,4,10
	☐ Infiltration to groundwater	3
	☐ Infiltration to surface water	3
	☐ Overland runoff (i.e., overflow of containment) to surface water	3
	☐ Dispersion to other surface water	3
	☐ Volatilization to air	3

Waste Types and Release Mechanism List (continued)

Reference Number

- ☐ Surface Water (sediment) — 3,4,10
  - ☐ Infiltration to groundwater — 3
  - ☐ Infiltration to surface water — 3
  - ☐ Volatilization to air — 3

- ☐ Groundwater — 4 ,10
  - ☐ Dispersion to other groundwater — 4
  - ☐ Dispersion to surface water — 4

Comments:

Modeling Release Source Location Assumptions

- ☒ Centrally located in the environmental setting
- ☐ Other location within the environmental setting (please specify the location on the attached map and provide reasons(s) for why the alternative location was selected)

- ☒ Indicate approximate release source size: ~~Variable from 10ft^2 to 1,000,000ft^2~~

Source size areas range from 10ft^2 to 1,000,000ft^2 , with factor of 10 increments

(Follow generalize guidelines for positioning the release source for each environmental setting based on waste sites and release mechanisms. Place alternative release location on attached map from Receptor Location Section)

Modeling Assumptions (continued)

☒ Provide data on groundwater flow direction for this environmental setting. (Also indicate groundwater flow direction on the attached map).

reference number: 5

☐ Provide data on surface water drainage direction for this environmental setting. (Also indicate drainage flow direction on the attached map).

reference number: 3

Exposure Pathways List

(check all that apply)

Reference Number

Pathway				
☒ On-site Receptors	7			
☒ Inhalation		12		
☒ Airborne contamination			11	
☒ Groundwater contamination while showering			11	
☐ Surface water contamination while showering			3	
☒ Re-suspended soil particle inhalation			11	
☒ Ingestion		12		
☒ Airborne contamination			11	
☒ leafy vegetables				13
☒ other vegetables				13
☒ meat products				13
☒ milk products				13
☒ Groundwater contamination			11	
☒ drinking water				13
☒ showering				13
☒ leafy vegetables				13
☒ other vegetables				13
☒ meat products				13
☒ milk products				13
☐ Surface water contamination			3	
☐ drinking water				3
☐ showering				3
☐ leafy vegetables				3
☐ other vegetables				3
☐ meat products				3
☐ milk products				3
☐ finfish				3
☐ shellfish				3
☐ swimming				3
☒ Soil contamination			11	
☒ ingestion of soil				13
☒ External Radiation		12		
☐ Surface water contamination			3	
☐ swimming				3
☐ boating				3
☐ shore recreation				3
☒ Direct radiation			13	
☒ Dermal Contact		12		
☐ Surface water contamination			3	
☐ swimming				3
☐ showering				3
☒ Groundwater contamination			11	
☒ showering				13
☒ Contact with source contamination (all exposure media)			13	
☒ Contact with deposited contamination			13	
☒ soil (atmospheric dust)				13
☐ shoreline sediment (surface water)				13

Exposure Pathways List (continued)

Reference Number

- ☒ Installation Boundary Receptors — 7
  - ☒ Inhalation — 12
    - ☒ Airborne contamination — 11
    - ☒ Groundwater contamination while showering — 11
    - ☐ Surface water contamination while showering — 3
    - ☒ Re-suspended soil particle inhalation — 11
  - ☒ Ingestion — 12
    - ☒ Airborne contamination — 11
      - ☒ leafy vegetables — 13
      - ☒ other vegetables — 13
      - ☒ meat products — 13
      - ☒ milk products — 13
    - ☒ Groundwater contamination — 11
      - ☒ drinking water — 13
      - ☒ showering — 13
      - ☒ leafy vegetables — 13
      - ☒ other vegetables — 13
      - ☒ meat products — 13
      - ☒ milk products — 13
    - ☐ Surface water contamination — 3
      - ☐ drinking water — 3
      - ☐ showering — 3
      - ☐ leafy vegetables — 3
      - ☐ other vegetables — 3
      - ☐ meat products — 3
      - ☐ milk products — 3
      - ☐ finfish — 3
      - ☐ shellfish — 3
      - ☐ swimming — 3
    - ☒ Soil contamination — 11
      - ☒ ingestion of soil — 13
  - ☒ External Radiation — 12
    - ☐ Surface water contamination — 3
      - ☐ swimming — 3
      - ☐ boating — 3
      - ☐ shore recreation — 3
    - ☐ Direct radiation — 13
  - ☒ Dermal Contact — 12
    - ☐ Surface water contamination — 3
      - ☐ swimming — 3
      - ☐ showering — 3
    - ☒ Groundwater contamination — 11
      - ☒ showering — 13
    - ☒ Contact with source contamination (all exposure media) — 13
    - ☒ Contact with deposited contamination — 13
      - ☒ soil (atmospheric dust) — 13
      - ☐ shoreline sediment (surface water) — 13

Exposure Pathways List (continued) Reference Number

- ☐ Restricted Area Boundary Receptors 8
  - ☐ Inhalation 8
    - ☐ Airborne contamination 8
    - ☐ Groundwater contamination while showering 8
    - ☐ Surface water contamination while showering 8
    - ☐ Re-suspended soil particle inhalation 8
  - ☐ Ingestion 8
    - ☐ Airborne contamination 8
      - ☐ leafy vegetables 8
      - ☐ other vegetables 8
      - ☐ meat products 8
      - ☐ milk products 8
    - ☐ Groundwater contamination 8
      - ☐ drinking water 8
      - ☐ showering 8
      - ☐ leafy vegetables 8
      - ☐ other vegetables 8
      - ☐ meat products 8
      - ☐ milk products 8
    - ☐ Surface water contamination 8
      - ☐ drinking water 8
      - ☐ showering 8
      - ☐ leafy vegetables 8
      - ☐ other vegetables 8
      - ☐ meat products 8
      - ☐ milk products 8
      - ☐ finfish 8
      - ☐ shellfish 8
      - ☐ swimming 8
    - ☐ Soil contamination 8
      - ☐ ingestion of soil 8
  - ☐ External Radiation 8
    - ☐ Surface water contamination 8
      - ☐ swimming 8
      - ☐ boating 8
      - ☐ shore recreation 8
    - ☐ Direct radiation 8
  - ☐ Dermal Contact 8
    - ☐ Surface water contamination 8
      - ☐ swimming 8
      - ☐ showering 8
    - ☐ Groundwater contamination 8
      - ☐ showering 8
    - ☐ Contact with source contamination (all exposure media) 8
    - ☐ Contact with deposited contamination 8
      - ☐ soil (atmospheric dust) 8
      - ☐ shoreline sediment (surface water) 8

Receptor Locations

Reference Number

Attached map detailing approximate location of:

		Reference Number
☒ On-site receptors		6
☒ Facility boundary receptors		7
	☒ groundwater receptor	7
	☐ surface water receptor	3
☐ Restricted Area boundary receptors		8
	☐ groundwater receptor	8
	☐ surface water receptor	8

Comments:

Approximate Date of Release in this Environmental Setting : January 1, 1954

reference number for release date: 9

Comments:

Exceptions (attach separate sheet and references for each)

☒ Contaminants of Interest
- those not on the MEPAS Modeling list which may be of concern at the site

☒ Waste Types and Release Mechanisms
- those listed above which are not of concern based on site information, or those which are not listed above which should be considered separately
- release mechanisms not included in list above which should be, or which were not listed but which should be considered due to site specific information

☐ Modeling Release Source Location
- suggestions for re-positioning of the release source in an environmental setting based on site specific info or other information

Reference List: (add sheets as necessary)

1. See attached Preliminary Contaminant List (Table 1), Primary Contaminant List (Table 2), and Listing of Contaminants Not found in MEPAS Database (Table 3).

2. Record of Assumption (ROA). NTS Installation. ROA NTS #032. *Additional Chemicals of Interest.* December 21, 1994 (Table 4).

3. Record of Assumption (ROA). NTS Installation. ROA NTS #021. *Surface Water.* November 15, 1994.

4. Record of Assumption (ROA). NTS Installation. ROA NTS #020. *PEIS Database.* November 15, 1994.

5. Holdren, G. R. , G. S. Glantz, L. K. Berg, K. Delinger, S. M. Goodwin, J. R. Rustad, R. Schalla, and J. A. Schramke. *Environmental Settings for Selected U.S. Department of Energy Installations--Support Information for the Programmatic Environmental Impact Statement. Volume 2.* July 1995. In Preparation. Pacific Northwest Laboratory. Richland, Washington (see attached Figure 1).

   Winograd, Isaac and Thodarson, William. *Hydrogeological and Hydrochemical Framework South-Central Great Basin, Nevada-California, with Special Reference to the Nevada Test Site.* Hydrology of Nuclear Test Sites. Geological Survey Professional Paper 712-C. U.S. Government Printing Office. Washington, D.C.

6. Record of Assumption (ROA). NTS Installation. ROA NTS #015. *Location of On-Site Receptors* . November 14, 1994.

7. Record of Assumption (ROA). NTS Installation. ROA NTS #010. *Source and Boundary Receptors for Jackass Flat.* November 14, 1994 (see Figure 2).

8. Record of Assumption (ROA). NTS Installation. ROA NTS #019. *Restricted Area On-Site.* November 15, 1994.

9. Record of Assumption (ROA). NTS Installation. ROA NTS #008. *Initial Dates Contamination Introduced.* November 4, 1994.

10. Record of Assumption (ROA). NTS Installation. ROA NTS #017. *Rationale for Selection of Media.* November 28, 1994.

11. Record of Assumption (ROA). NTS Installation. ROA NTS #018. *Rationale for Selection of Pathways.* November 28, 1994.

12. Record of Assumption (ROA). NTS Installation. ROA NTS #022. *Rationale for Selection of Exposure Pathways.* November 28, 1994.

13. Record of Assumption (ROA). NTS Installation. ROA NTS #029. *Exposure Pathway Selection for UTF Analysis.* December 21, 1994.

Table 1. CoCs-Preliminary List

NTS CONSTITUENTS OF CONCERN - PRELIMINARY LIST				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Acids	NA	NO	NO	PEIS #61
Argon	7440371	NO	NO	PEIS #2301
Arsenic	7440382	YES	NO	PEIS #61
Asbestos	12001284	YES	NO	PEIS #2301
Berylium	7440417	YES	YES	
Caustics	NA	NO	NO	PEIS #61
Chromium	7440473	YES	YES	
Copper	7440508	YES	NO	PEIS #61
Lead	7439921	YES	YES	
Plutonium	7440075	NO	YES	
Uranium	7740611	YES	YES	
Zinc	7646857	YES	NO	PEIS #61
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Actinium 228	AC228	YES	NO	PEIS #6021
Americium 241	AM241	YES	YES	
Antimony 125	SB125	YES	YES	
Bismuth 214	BI214	NO	NO	PEIS #6021
Cadmium 109	CD109	YES	YES	
Carbon 14	C14	YES	YES	
Cesium 134	CS134	YES	YES	
Cesium 137	CS137	YES	YES	
Cobalt 57	CO57	YES	YES	
Cobalt 60	CO60	YES	YES	
Europium 152	EU152	YES	YES	
Europium 154	EU154	YES	YES	
Europium 155	EU155	YES	YES	
Krypton 85	KR85	YES	YES	
Lead 212	PB212	YES	NO	PEIS #6021
Lead 214	PB214	NO	NO	PEIS #6021

Table 1. (contd)

Plutonium 238	PU238	YES	YES	
Plutonium 239	PU239	YES	YES	
Plutonium 240	PU240	YES	YES	
Potassium 40	K40	YES	YES	
Radium 226	RA226	YES	YES	
Ruthenium 103	RU103	YES	YES	
Ruthenium 106	RU106	YES	YES	
Strontium 90	SR90	YES	YES	
Thallium 208	TH208	NO	NO	PEIS #6021
Thorium 228	TH228	YES	YES	
Thorium 232	TH232	YES	YES	
Tritium	H3/10028178	YES	YES	
Uranium 235	U235	YES	YES	
ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Cutting Fluids	NA	NO	NO	PEIS #61
Ethylene Glycol	10721	YES	YES	
Motor Oil	Motor oil	YES	YES	
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Chlorinated Solvents	NA	NO	NO	PEIS #2301
Diesel Fuel	Diesel F	YES	NO	PEIS #2301
Gasoline	8006619	YES	YES	
Hydraulic Flued	Hydr Flu	YES	YES	
Isopropyl Alcholhol	67630	YES	NO	PEIS #2301
Kerosene	8008206	YES	NO	PEIS #2301
Methanol	67561	YES	YES	
Methylene Chloride	75092	YES	YES	
Stoddard Solfent	NA	NO	NO	PEIS #2301
Pretroleum Solvents	NA	NO	NO	PEIS #2301
Petisol 202	NA	NO	NO	PEIS #2301
Polychlorinated Biphenyls	1336363	YES	YES	
Techloroethylene	79016	YES	YES	

Table 2. CoCs-Primary List

NTS CONSTITUENTS OF CONCERN - PRIMARY LIST				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Berylium	7440417	YES	YES	
Chromium	7440473	YES	YES	
Lead	7439921	YES	YES	
Uranium	7740611	YES	YES	
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Americium 241	AM241	YES	YES	
Antimony 125	SB125	YES	YES	
Cadmium 109	CD109	YES	YES	
Carbon 14	C14	YES	YES	
Cesium 134	CS134	YES	YES	
Cesium 137	CS137	YES	YES	
Cobalt 57	CO57	YES	YES	
Cobalt 60	CO60	YES	YES	
Europium 152	EU152	YES	YES	
Europium 154	EU154	YES	YES	
Europium 155	EU155	YES	YES	
Krypton 85	KR85	YES	YES	
Plutonium 238	PU238	YES	YES	
Plutonium 239	PU239	YES	YES	
Plutonium 240	PU240	YES	YES	
Potassium 40	K40	YES	YES	
Radium 226	RA226	YES	YES	
Ruthenium 103	RU103	YES	YES	
Ruthenium 106	RU106	YES	YES	
Strontium 90	SR90	YES	YES	
Throium 228	TH228	YES	YES	
Thorium 232	TH232	YES	YES	
Tritium	H3/10028178	YES	YES	
Uranium 235	U235	YES	YES	

Table 2. (contd)

ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Ethylene Glycol	10721	YES	YES	
Motor Oil	Motor oil	YES	YES	
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Gasoline	8006619	YES	YES	
Hydraulic Flued	Hydr Flu	YES	YES	
Methanol	67561	YES	YES	
Methylene Chloride	75092	YES	YES	
Polychlorinated Biphenyls	1336363	YES	YES	
Techloroethylene	79016	YES	YES	

Table 3. CoCs Not in MEPAS

NTS CONSTITUENTS OF CONCERN - NOT IN MEPAS DATABASE				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Acids	NA	NO	NO	PEIS #61
Argon	7440371	NO	NO	PEIS #2301
Caustics	NA	NO	NO	PEIS #61
Plutonium	7440075	NO	YES	
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Bismuth 214	BI214	NO	NO	PEIS #6021
Lead 214	PB214	NO	NO	PEIS #6021
Thallium 208	TH208	NO	NO	PEIS #6021
ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Cutting Fluids	NA	NO	NO	PEIS #61
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Chlorinated Solvents	NA	NO	NO	PEIS #2301
Stoddard Solfent	NA	NO	NO	PEIS #2301
Pretroleum Solvents	NA	NO	NO	PEIS #2301
Petisol 202	NA	NO	NO	PEIS #2301

Table 4. CoCs Not in PEIS

NTS CONSTITUENTS OF CONCERN - NOT IN PEIS DATABASE				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Acids	NA	NO	NO	PEIS #61
Argon	7440371	NO	NO	PEIS #2301
Arsenic	7440382	YES	NO	PEIS #61
Asbestos	12001284	YES	NO	PEIS #2301
Caustics	NA	NO	NO	PEIS #61
Copper	7440508	YES	NO	PEIS #61
Zinc	7646857	YES	NO	PEIS #61
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Actinium 228	AC228	YES	NO	PEIS #6021
Bismuth 214	BI214	NO	NO	PEIS #6021
Lead 212	PB212	YES	NO	PEIS #6021
Lead 214	PB214	NO	NO	PEIS #6021
Thallium 208	TH208	NO	NO	PEIS #6021
ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Cutting Fluids	NA	NO	NO	PEIS #61
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Chlorinated Solvents	NA	NO	NO	PEIS #2301
Diesel Fuel	Diesel F	YES	NO	PEIS #2301
Isopropyl Alcholhol	67630	YES	NO	PEIS #2301
Kerosene	8008206	YES	NO	PEIS #2301
Stoddard Solfent	NA	NO	NO	PEIS #2301
Pretroleum Solvents	NA	NO	NO	PEIS #2301
Petisol 202	NA	NO	NO	PEIS #2301

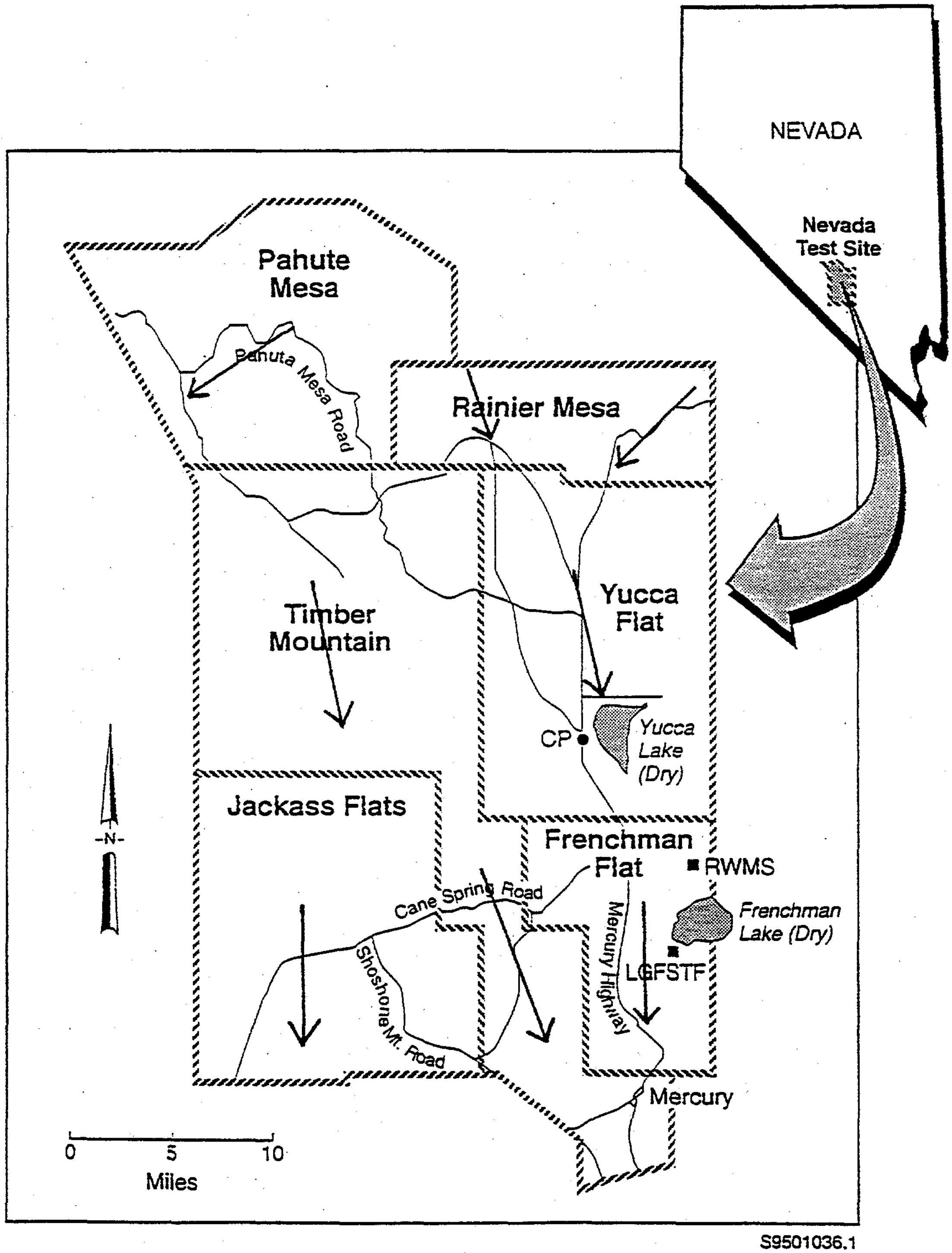

Figure 1. Nevada Test Site, Regional Groundwater Flow

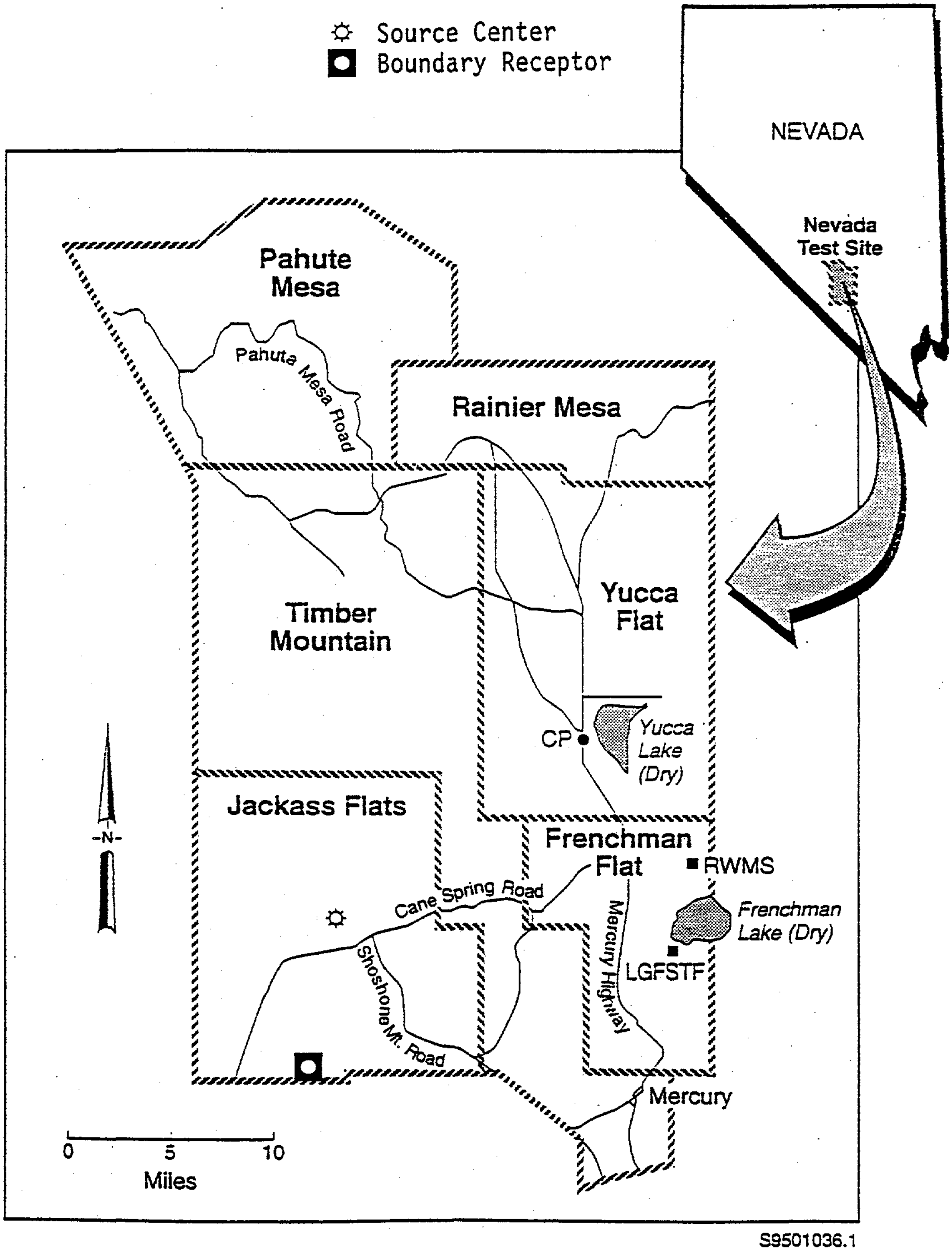

Figure 2. Nevada Test Site, Jackass Flats

CSM Data Acquisition Check-List:
Frenchman Flat Environmental Setting

CONCEPTUAL SITE MODEL DATA ACQUISITION CHECK-LIST

Installation Name : Nevada Test Site

Environmental Setting considered : Frenchman Flat

Date: December 21, 1994

this form completed by: Gariann Gelston, PNL

Contaminant of Interest (COIs) List (attach list)

- ☒ List contaminants in PEIS database for all contaminated sites and exposure media. The primary list should include only those contaminants on the MEPAS modeling list and be separated by chemical class (e.g., VOCs, radionuclides, inorganics).

  reference number(s) for primary list: 1

- ☒ COIs not listed in the database, but which are of potential concern (attach list).

  reference number(s) for additional list: 2

Comments:

Waste Types and Release Mechanism List

(check all complete pathways)

	Reference Number
☒ Buried Waste	10
☒ Infiltration to groundwater	11
☐ Infiltration to surface water	3
☒ Volatilization to air	11
☒ Surface Soil	10
☒ Infiltration to groundwater	11
☐ Infiltration to surface water	3
☐ Overland runoff to surface water	3
☒ Volatilization to air	11
☒ Suspension of dust to air	11
☒ Direct radiation	
☐ Surface Water (water)	3,4,10
☐ Infiltration to groundwater	3
☐ Infiltration to surface water	3
☐ Overland runoff (i.e., overflow of containment) to surface water	3
☐ Dispersion to other surface water	3
☐ Volatilization to air	3

Waste Types and Release Mechanism List (continued)

Reference Number

- ☐ Surface Water (sediment) — 3,4,10
  - ☐ Infiltration to groundwater — 3
  - ☐ Infiltration to surface water — 3
  - ☐ Volatilization to air — 3
- ☐ Groundwater — 4 ,10
  - ☐ Dispersion to other groundwater — 4
  - ☐ Dispersion to surface water — 4

Comments:

Modeling Release Source Location Assumptions

- ☒ Centrally located in the environmental setting
- ☐ Other location within the environmental setting (please specify the location on the attached map and provide reasons(s) for why the alternative location was selected)

- ☒ Indicate approximate release source size: ~~Variable from $10ft^2$ to $1,000,000ft^2$~~

Source size areas range from $10ft^2$ to $1,000,000ft^2$, with factor of 10 increments

(Follow generalize guidelines for positioning the release source for each environmental setting based on waste sites and release mechanisms. Place alternative release location on attached map from Receptor Location Section)

Modeling Assumptions (continued)

☒ Provide data on groundwater flow direction for this environmental setting. (Also indicate groundwater flow direction on the attached map).

reference number: 5

☐ Provide data on surface water drainage direction for this environmental setting. (Also indicate drainage flow direction on the attached map).

reference number: 3

Exposure Pathways List

(check all that apply) — Reference Number

- ☒ On-site Receptors — 7
  - ☒ Inhalation — 12
    - ☒ Airborne contamination — 11
    - ☒ Groundwater contamination while showering — 11
    - ☐ Surface water contamination while showering — 3
    - ☒ Re-suspended soil particle inhalation — 11
  - ☒ Ingestion — 12
    - ☒ Airborne contamination — 11
      - ☒ leafy vegetables — 13
      - ☒ other vegetables — 13
      - ☒ meat products — 13
      - ☒ milk products — 13
    - ☒ Groundwater contamination — 11
      - ☒ drinking water — 13
      - ☒ showering — 13
      - ☒ leafy vegetables — 13
      - ☒ other vegetables — 13
      - ☒ meat products — 13
      - ☒ milk products — 13
    - ☐ Surface water contamination — 3
      - ☐ drinking water — 3
      - ☐ showering — 3
      - ☐ leafy vegetables — 3
      - ☐ other vegetables — 3
      - ☐ meat products — 3
      - ☐ milk products — 3
      - ☐ finfish — 3
      - ☐ shellfish — 3
      - ☐ swimming — 3
    - ☒ Soil contamination — 11
      - ☒ ingestion of soil — 13
  - ☒ External Radiation — 12
    - ☐ Surface water contamination — 3
      - ☐ swimming — 3
      - ☐ boating — 3
      - ☐ shore recreation — 3
    - ☒ Direct radiation — 13
  - ☒ Dermal Contact — 12
    - ☐ Surface water contamination — 3
      - ☐ swimming — 3
      - ☐ showering — 3
    - ☒ Groundwater contamination — 11
      - ☒ showering — 13
    - ☒ Contact with source contamination (all exposure media) — 13
    - ☒ Contact with deposited contamination — 13
      - ☒ soil (atmospheric dust) — 13
      - ☐ shoreline sediment (surface water) — 13

Exposure Pathways List (continued)

Exposure Pathway	Reference Number			
☒ Installation Boundary Receptors	7			
☒ Inhalation		12		
☒ Airborne contamination			11	
☒ Groundwater contamination while showering			11	
☐ Surface water contamination while showering			3	
☒ Re-suspended soil particle inhalation			11	
☒ Ingestion		12		
☒ Airborne contamination			11	
☒ leafy vegetables				13
☒ other vegetables				13
☒ meat products				13
☒ milk products				13
☒ Groundwater contamination			11	
☒ drinking water				13
☒ showering				13
☒ leafy vegetables				13
☒ other vegetables				13
☒ meat products				13
☒ milk products				13
☐ Surface water contamination			3	
☐ drinking water				3
☐ showering				3
☐ leafy vegetables				3
☐ other vegetables				3
☐ meat products				3
☐ milk products				3
☐ finfish				3
☐ shellfish				3
☐ swimming				3
☒ Soil contamination			11	
☒ ingestion of soil				13
☒ External Radiation		12		
☐ Surface water contamination			3	
☐ swimming				3
☐ boating				3
☐ shore recreation				3
☐ Direct radiation			13	
☒ Dermal Contact		12		
☐ Surface water contamination			3	
☐ swimming				3
☐ showering				3
☒ Groundwater contamination			11	
☒ showering				13
☒ Contact with source contamination (all exposure media)			13	
☒ Contact with deposited contamination			13	
☒ soil (atmospheric dust)				13
☐ shoreline sediment (surface water)				13

Exposure Pathways List (continued)

Reference Number

- ☐ Restricted Area Boundary Receptors — 8
  - ☐ Inhalation — 8
    - ☐ Airborne contamination — 8
    - ☐ Groundwater contamination while showering — 8
    - ☐ Surface water contamination while showering — 8
    - ☐ Re-suspended soil particle inhalation — 8
  - ☐ Ingestion — 8
    - ☐ Airborne contamination — 8
      - ☐ leafy vegetables — 8
      - ☐ other vegetables — 8
      - ☐ meat products — 8
      - ☐ milk products — 8
    - ☐ Groundwater contamination — 8
      - ☐ drinking water — 8
      - ☐ showering — 8
      - ☐ leafy vegetables — 8
      - ☐ other vegetables — 8
      - ☐ meat products — 8
      - ☐ milk products — 8
    - ☐ Surface water contamination — 8
      - ☐ drinking water — 8
      - ☐ showering — 8
      - ☐ leafy vegetables — 8
      - ☐ other vegetables — 8
      - ☐ meat products — 8
      - ☐ milk products — 8
      - ☐ finfish — 8
      - ☐ shellfish — 8
      - ☐ swimming — 8
    - ☐ Soil contamination — 8
      - ☐ ingestion of soil — 8
  - ☐ External Radiation — 8
    - ☐ Surface water contamination — 8
      - ☐ swimming — 8
      - ☐ boating — 8
      - ☐ shore recreation — 8
    - ☐ Direct radiation — 8
  - ☐ Dermal Contact — 8
    - ☐ Surface water contamination — 8
      - ☐ swimming — 8
      - ☐ showering — 8
    - ☐ Groundwater contamination — 8
      - ☐ showering — 8
    - ☐ Contact with source contamination (all exposure media) — 8
    - ☐ Contact with deposited contamination — 8
      - ☐ soil (atmospheric dust) — 8
      - ☐ shoreline sediment (surface water) — 8

Receptor Locations

Reference Number

Attached map detailing approximate location of:

		Reference Number	
☒	On-site receptors	6	
☒	Facility boundary receptors	7	
☒	groundwater receptor		7
☐	surface water receptor		3
☐	Restricted Area boundary receptors	8	
☐	groundwater receptor		8
☐	surface water receptor		8

Comments:

Approximate Date of Release in this Environmental Setting : January 27, 1951

reference number for release date: 9

Comments:

Exceptions (attach separate sheet and references for each)

☒ Contaminants of Interest
- those not on the MEPAS Modeling list which may be of concern at the site

☒ Waste Types and Release Mechanisms
- those listed above which are not of concern based on site information, or those which are not listed above which should be considered separately
- release mechanisms not included in list above which should be, or which were not listed but which should be considered due to site specific information

☐ Modeling Release Source Location
- suggestions for re-positioning of the release source in an environmental setting based on site specific info or other information

Reference List: (add sheets as necessary)

1. See attached Preliminary Contaminant List (Table 1), Primary Contaminant List (Table 2), and Listing of Contaminants Not found in MEPAS Database (Table 3).

2. Record of Assumption (ROA). NTS Installation. ROA NTS #032. *Additional Chemicals of Interest.* December 21, 1994 (Table 4).

3. Record of Assumption (ROA). NTS Installation. ROA NTS #021. *Surface Water*. November 15, 1994.

4. Record of Assumption (ROA). NTS Installation. ROA NTS #020. *PEIS Database*. November 15, 1994.

5. Holdren, G. R. , G. S. Glantz, L. K. Berg, K. Delinger, S. M. Goodwin, J. R. Rustad, R. Schalla, and J. A. Schramke. *Environmental Settings for Selected U.S. Department of Energy Installations–Support Information for the Programmatic Environmental Impact Statement. Volume* 2. July 1995. In Preparation. Pacific Northwest Laboratory. Richland, Washington (see attached Figure 1).

   Winograd, Isaac and Thodarson, William. *Hydrogeological and Hydrochemical Framework South-Central Great Basin, Nevada-California, with Special Reference to the Nevada Test Site*. Hydrology of Nuclear Test Sites. Geological Survey Professional Paper 712-C. U.S. Government Printing Office. Washington, D.C.

6. Record of Assumption (ROA). NTS Installation. ROA NTS #015. *Location of On-Site Receptors*. November 14, 1994.

7. Record of Assumption (ROA). NTS Installation. ROA NTS #011. *Source and Boundary Receptors for Frenchman Flat* November 14, 1994 (see Figure 2).

8. Record of Assumption (ROA). NTS Installation. ROA NTS #019. *Restricted Area On-Site*. November 15, 1994.

9. Record of Assumption (ROA). NTS Installation. ROA NTS #008. *Initial Dates Contamination Introduced.* November 4, 1994.

10. Record of Assumption (ROA). NTS Installation. ROA NTS #017. *Rationale for Selection of Media*. November 28, 1994.

11. Record of Assumption (ROA). NTS Installation. ROA NTS #018. *Rationale for Selection of Pathways*. November 28, 1994.

12. Record of Assumption (ROA). NTS Installation. ROA NTS #022. *Rationale for Selection of Exposure Pathways*. November 28, 1994.

13. Record of Assumption (ROA). NTS Installation. ROA NTS #029. *Exposure Pathway Selection for UTF Analysis*. December 21, 1994.

Table 1. CoCs-Preliminary List

NTS CONSTITUENTS OF CONCERN - PRELIMINARY LIST				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Acids	NA	NO	NO	PEIS #61
Argon	7440371	NO	NO	PEIS #2301
Arsenic	7440382	YES	NO	PEIS #61
Asbestos	12001284	YES	NO	PEIS #2301
Berylium	7440417	YES	YES	
Caustics	NA	NO	NO	PEIS #61
Chromium	7440473	YES	YES	
Copper	7440508	YES	NO	PEIS #61
Lead	7439921	YES	YES	
Plutonium	7440075	NO	YES	
Uranium	7740611	YES	YES	
Zinc	7646857	YES	NO	PEIS #61
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Actinium 228	AC228	YES	NO	PEIS #6021
Americium 241	AM241	YES	YES	
Antimony 125	SB125	YES	YES	
Bismuth 214	BI214	NO	NO	PEIS #6021
Cadmium 109	CD109	YES	YES	
Carbon 14	C14	YES	YES	
Cesium 134	CS134	YES	YES	
Cesium 137	CS137	YES	YES	
Cobalt 57	CO57	YES	YES	
Cobalt 60	CO60	YES	YES	
Europium 152	EU152	YES	YES	
Europium 154	EU154	YES	YES	
Europium 155	EU155	YES	YES	
Krypton 85	KR85	YES	YES	
Lead 212	PB212	YES	NO	PEIS #6021
Lead 214	PB214	NO	NO	PEIS #6021

Table 1. (contd)

Plutonium 238	PU238	YES	YES	
Plutonium 239	PU239	YES	YES	
Plutonium 240	PU240	YES	YES	
Potassium 40	K40	YES	YES	
Radium 226	RA226	YES	YES	
Ruthenium 103	RU103	YES	YES	
Ruthenium 106	RU106	YES	YES	
Strontium 90	SR90	YES	YES	
Thallium 208	TH208	NO	NO	PEIS #6021
Thorium 228	TH228	YES	YES	
Thorium 232	TH232	YES	YES	
Tritium	H3/10028178	YES	YES	
Uranium 235	U235	YES	YES	
ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Cutting Fluids	NA	NO	NO	PEIS #61
Ethylene Glycol	10721	YES	YES	
Motor Oil	Motor oil	YES	YES	
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Chlorinated Solvents	NA	NO	NO	PEIS #2301
Diesel Fuel	Diesel F	YES	NO	PEIS #2301
Gasoline	8006619	YES	YES	
Hydraulic Flued	Hydr Flu	YES	YES	
Isopropyl Alcholhol	67630	YES	NO	PEIS #2301
Kerosene	8008206	YES	NO	PEIS #2301
Methanol	67561	YES	YES	
Methylene Chloride	75092	YES	YES	
Stoddard Solfent	NA	NO	NO	PEIS #2301
Pretroleum Solvents	NA	NO	NO	PEIS #2301
Petisol 202	NA	NO	NO	PEIS #2301
Polychlorinated Biphenyls	1336363	YES	YES	
Techloroethylene	79016	YES	YES	

Table 2. CoCs-Primary List

NTS CONSTITUENTS OF CONCERN - PRIMARY LIST				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Berylium	7440417	YES	YES	
Chromium	7440473	YES	YES	
Lead	7439921	YES	YES	
Uranium	7740611	YES	YES	
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Americium 241	AM241	YES	YES	
Antimony 125	SB125	YES	YES	
Cadmium 109	CD109	YES	YES	
Carbon 14	C14	YES	YES	
Cesium 134	CS134	YES	YES	
Cesium 137	CS137	YES	YES	
Cobalt 57	CO57	YES	YES	
Cobalt 60	CO60	YES	YES	
Europium 152	EU152	YES	YES	
Europium 154	EU154	YES	YES	
Europium 155	EU155	YES	YES	
Krypton 85	KR85	YES	YES	
Plutonium 238	PU238	YES	YES	
Plutonium 239	PU239	YES	YES	
Plutonium 240	PU240	YES	YES	
Potassium 40	K40	YES	YES	
Radium 226	RA226	YES	YES	
Ruthenium 103	RU103	YES	YES	
Ruthenium 106	RU106	YES	YES	
Strontium 90	SR90	YES	YES	
Throium 228	TH228	YES	YES	
Thorium 232	TH232	YES	YES	
Tritium	H3/10028178	YES	YES	
Uranium 235	U235	YES	YES	

Table 2. (contd)

ORANGICS				
Non-Volatiles (< 1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Ethylene Glycol	10721	YES	YES	
Motor Oil	Motor oil	YES	YES	
Volatiles (> 1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Gasoline	8006619	YES	YES	
Hydraulic Flued	Hydr Flu	YES	YES	
Methanol	67561	YES	YES	
Methylene Chloride	75092	YES	YES	
Polychlorinated Biphenyls	1336363	YES	YES	
Techloroethylene	79016	YES	YES	

Table 3. CoCs Not in MEPAS

NTS CONSTITUENTS OF CONCERN - NOT IN MEPAS DATABASE				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Acids	NA	NO	NO	PEIS #61
Argon	7440371	NO	NO	PEIS #2301
Caustics	NA	NO	NO	PEIS #61
Plutonium	7440075	NO	YES	
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Bismuth 214	BI214	NO	NO	PEIS #6021
Lead 214	PB214	NO	NO	PEIS #6021
Thallium 208	TH208	NO	NO	PEIS #6021
ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Cutting Fluids	NA	NO	NO	PEIS #61
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Chlorinated Solvents	NA	NO	NO	PEIS #2301
Stoddard Solfent	NA	NO	NO	PEIS #2301
Pretroleum Solvents	NA	NO	NO	PEIS #2301
Petisol 202	NA	NO	NO	PEIS #2301

Table 4. CoCs Not in PEIS

NTS CONSTITUENTS OF CONCERN - NOT IN PEIS DATABASE				
INORGANICS				
Non-Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Acids	NA	NO	NO	PEIS #61
Argon	7440371	NO	NO	PEIS #2301
Arsenic	7440382	YES	NO	PEIS #61
Asbestos	12001284	YES	NO	PEIS #2301
Caustics	NA	NO	NO	PEIS #61
Copper	7440508	YES	NO	PEIS #61
Zinc	7646857	YES	NO	PEIS #61
Radionuclides	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Actinium 228	AC228	YES	NO	PEIS #6021
Bismuth 214	BI214	NO	NO	PEIS #6021
Lead 212	PB212	YES	NO	PEIS #6021
Lead 214	PB214	NO	NO	PEIS #6021
Thallium 208	TH208	NO	NO	PEIS #6021
ORANGICS				
Non-Volatiles (<1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Cutting Fluids	NA	NO	NO	PEIS #61
Volatiles (>1.0E-7 atm/g-mol)	*CAS #*	*MEPAS*	*PEIS*	*Reference*
Chlorinated Solvents	NA	NO	NO	PEIS #2301
Diesel Fuel	Diesel F	YES	NO	PEIS #2301
Isopropyl Alcholhol	67630	YES	NO	PEIS #2301
Kerosene	8008206	YES	NO	PEIS #2301
Stoddard Solfent	NA	NO	NO	PEIS #2301
Pretroleum Solvents	NA	NO	NO	PEIS #2301
Petisol 202	NA	NO	NO	PEIS #2301

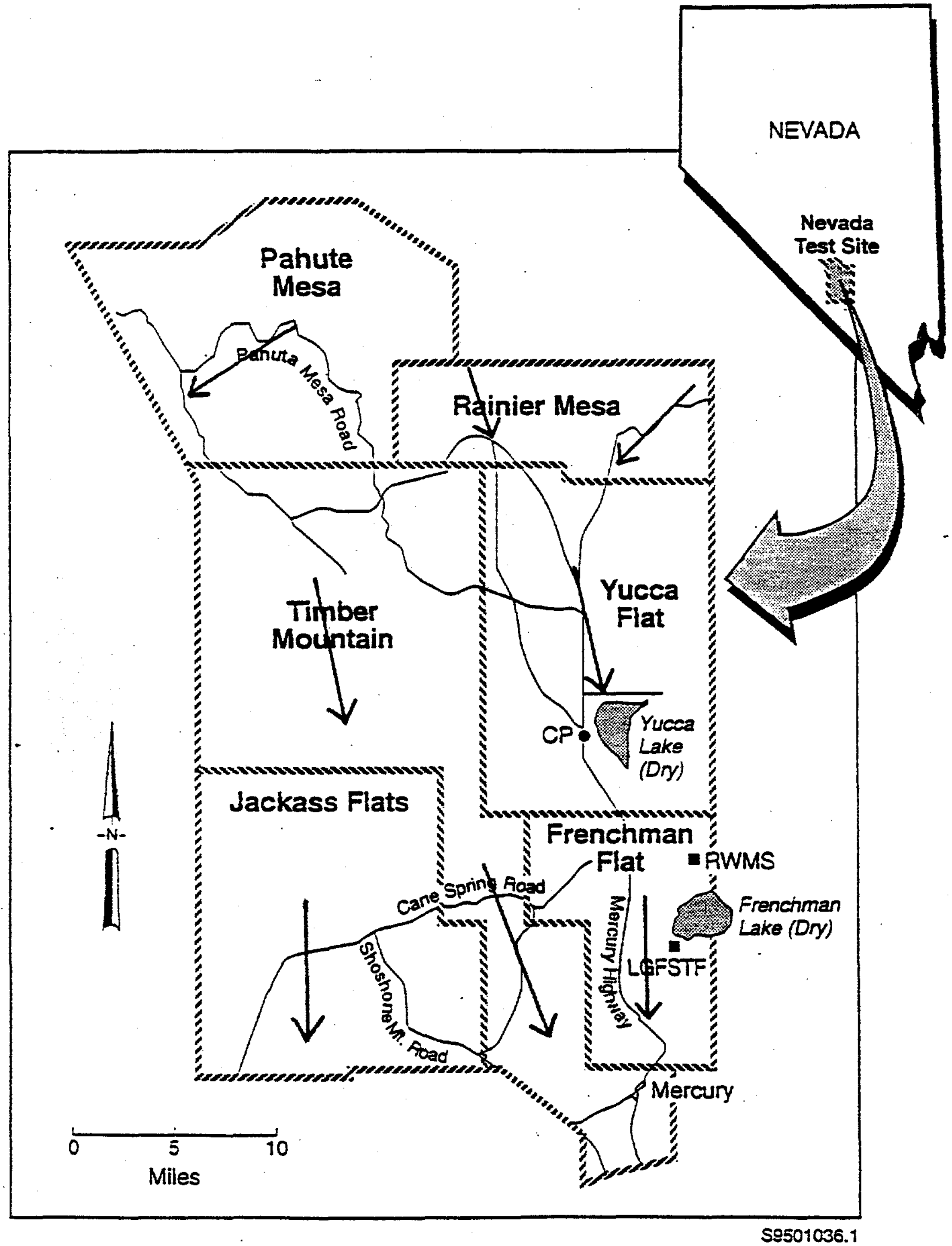

Figure 1. Nevada Test Site, Regional Groundwater Flow

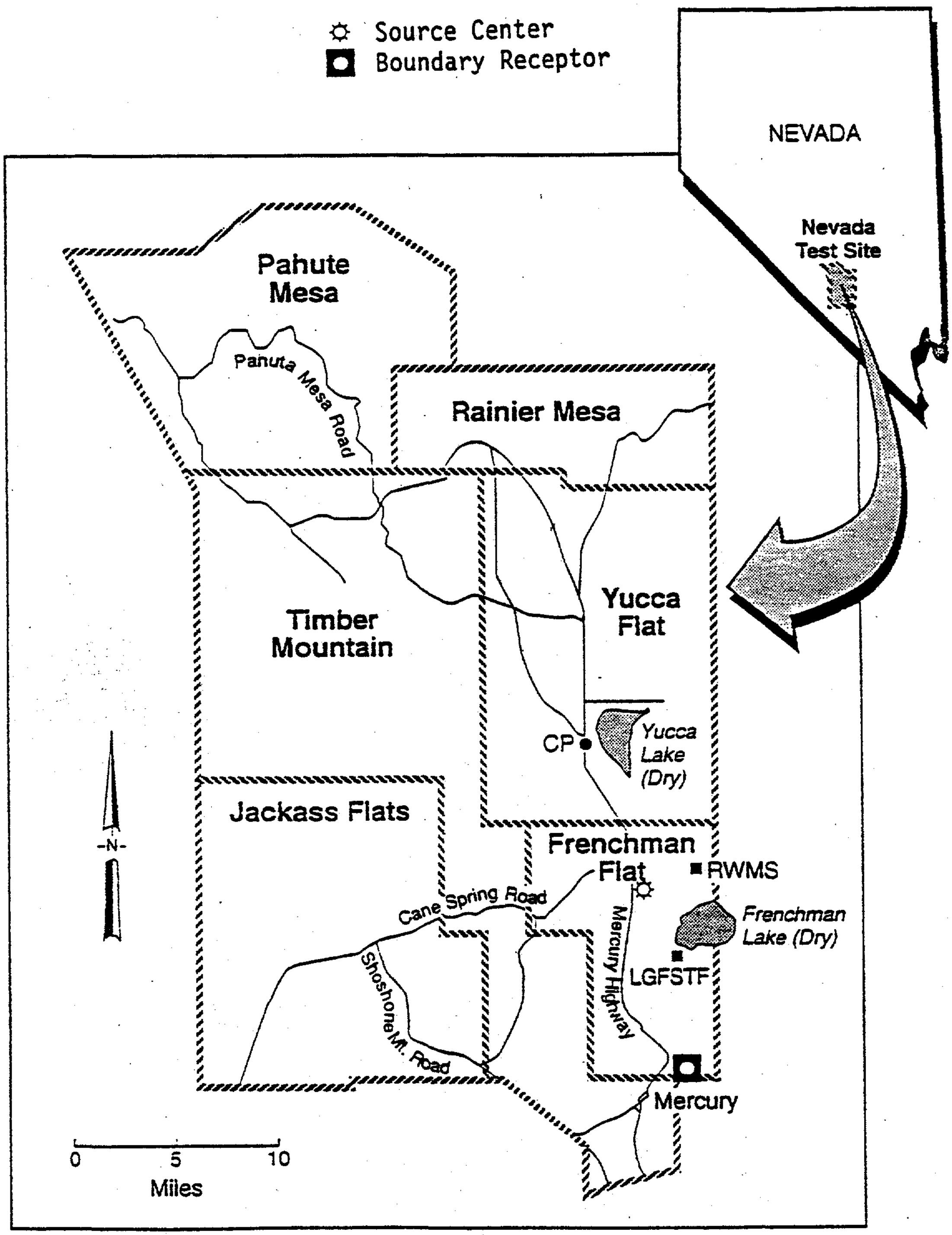

Figure 2. Nevada Test Site, Frenchman Flat

Records of Assumptions: Nevada Test Site

Records Of Assumptions: Nevada Test Site

ROA #	Title
001	Elevation Estimate for Rainier Mesa
002	Elevation Estimate for Yucca Flat
003	Elevation Estimate for Frenchman Flat
004	Elevation Estimate for Pahute Mesa
005	Elevation Estimate for Jackass Flats
006	Elevation Estimate for Timber Mountain
007	Choice of Waste Site for Timber Mountain
008	Initial Dates Contamination Introduced
009	Basis of Assumption of % Vegetative Cover
010	Source and Boundary Receptor Locations for Jackass Flats
011	Source and Boundary Receptor Locations for Frenchman Flat
012	Source and Boundary Receptor Locations for Yucca Flat
013	Source and Boundary Receptor Locations for Pahute Mesa
014	Source and Boundary Receptor Locations for Rainier Mesa
015	Location of On-site Receptors
016	Use of Unit Risk Factors (URF) Inappropriate for Deep Sites
017	Rationale for Selection of Media
018	Rationale for Selection of Pathways
019	Restricted Area On-site
020	PEIS Database
021	Surface Water
022	Rationale for Selection of Exposure Pathways
023	Multiple Aquifers for Rainier Mesa
024	Multiple Aquifers for Yucca Flat
025	Climatological Data Used at the Various Locations at NTS
026	MEI Location
027	Infiltration Rate for NTS Groundwater Flow
028	Clarification of JFD Issue
029	Exposure Pathway Selection for URF Analysis
030	Basis for BEMR URF Analysis
031	Assumptions Included in the Conceptual Site Model
032	Additional Chemicals of Interest
033	Boundary Receptor for Timber Mountain
034	Concurrence with Anchoring Methodology and Area Location

Record of Assumptions (ROA) Memorandum

TO: Mary Jarvis

FROM: Gariann Gelston

DATE: November 2, 1994

Installation ID: NTS

ROA No.: 001

SUBJECT: Elevation estimate for Rainier Mesa

This ROA memo is to describe the procedure used to estimate an elevation for the Rainier Mesa environmental setting.

Using topographical maps for the Nevada Test Site Gariann Gelston and Brad Warren chose a point in the center of the environmental setting. This point will continue to be used as a representative point for the source of this environmental setting. The elevation of this point was read from the topographical map and then compared with surrounding points to insure that it was not an extreme high or low.

This elevation was compared with reported elevations in a CSM report currently being prepared by Rudy Von Burg of the CERE team and was found to be consistent with that report.

Record of Assumptions (ROA) Memorandum

TO: Mary Jarvis

FROM: Gariann Gelston

DATE: November 2, 1994

Installation ID: NTS

ROA No.: 002

SUBJECT: Elevation estimate for Yucca Flat

This ROA memo is to describe the procedure used to estimate an elevation for the Yucca Flat environmental setting.

Using topographical maps for the Nevada Test Site Gariann Gelston and Brad Warren chose a point in the center of the environmental setting. This point will continue to be used as a representative point for the source of this environmental setting. The elevation of this point was read from the topographical map and then compared with surrounding points to insure that it was not an extreme high or low.

This elevation was compared with reported elevations in a CSM report currently being prepared by Rudy Von Burg of the CERE team and was found to be consistent with that report.

Record of Assumptions (ROA) Memorandum

TO: Mary Jarvis

FROM: Gariann Gelston

DATE: November 2, 1994

Installation ID: NTS

ROA No.: 003

SUBJECT: Elevation estimate for Frenchman Flat

This ROA memo is to describe the procedure used to estimate an elevation for the Frenchman Flat environmental setting.

Using topographical maps for the Nevada Test Site Gariann Gelston and Brad Warren chose a point in the center of the environmental setting. This point will continue to be used as a representative point for the source of this environmental setting. The elevation of this point was read from the topographical map and then compared with surrounding points to insure that it was not an extreme high or low.

This elevation was compared with reported elevations in a CSM report currently being prepared by Rudy Von Burg of the CERE team and was found to be consistent with that report.

Record of Assumptions (ROA) Memorandum

TO: Mary Jarvis

FROM: Gariann Gelston

DATE: November 2, 1994

Installation ID: NTS

ROA No.: 004

SUBJECT: Elevation estimate for Pahute Mesa

This ROA memo is to describe the procedure used to estimate an elevation for the Pahute Mesa environmental setting.

Using topographical maps for the Nevada Test Site Gariann Gelston and Brad Warren chose a point in the center of the environmental setting. This point will continue to be used as a representative point for the source of this environmental setting. The elevation of this point was read from the topographical map and then compared with surrounding points to insure that it was not an extreme high or low.

This elevation was compared with reported elevations in a CSM report currently being prepared by Rudy Von Burg of the CERE team and was found to be consistent with that report.

Record of Assumptions (ROA) Memorandum

TO: Mary Jarvis

FROM: Gariann Gelston

DATE: November 2, 1994

Installation ID: NTS

ROA No.: 005

SUBJECT: Elevation estimate for Jackass Flats

This ROA memo is to describe the procedure used to estimate an elevation for the Jackass Flats environmental setting.

Using topographical maps for the Nevada Test Site Gariann Gelston and Brad Warren chose a point in the center of the environmental setting. This point will continue to be used as a representative point for the source of this environmental setting. The elevation of this point was read from the topographical map and then compared with surrounding points to insure that it was not an extreme high or low.

This elevation was compared with reported elevations in a CSM report currently being prepared by Rudy Von Burg of the CERE team and was found to be consistent with that report.

Record of Assumptions (ROA) Memorandum

TO: Mary Jarvis

FROM: Gariann Gelston

DATE: November 2, 1994

Installation ID: NTS

ROA No.: 006

SUBJECT: Elevation estimate for Timber Mountain

This ROA memo is to describe the procedure used to estimate an elevation for the Timber Mountain environmental setting.

Using topographical maps for the Nevada Test Site Gariann Gelston and Brad Warren chose two (2) points, one point in the center of the portion of the environmental setting that touches the West edge of NTS, and the second in the center of Area 26. These points will continue to be used as a representative points for the source of this environmental setting. The reasoning for using two points is that Timber Mountain has contamination centralized in two main locations. Area 26 consists of dumps and leach fields, while the larger section of Timber Mountain was used for testing. The elevation of these points were read from the topographical map, averaged, and then compared with surrounding points to insure that they were not extreme highs or lows.

This average elevation was compared with reported elevations in a CSM report currently being prepared by Rudy Von Burg of the CERE team and was found to be consistent with that report.

Record of Assumptions (ROA) Memorandum

TO: Mary Jarvis

FROM: Brad Warren

DATE: November 4, 1994

Installation ID: NTS

ROA No.: 007

SUBJECT: Choice of Waste Site for Timber Mtn.

This ROA memo is to describe the method used for choosing the appropriate waste site for Timber Mountain.

There was some question as to where the contamination existed within the Timber Mountain Environmental Setting. As a result, we chose the two suggested to us by the team leadership. The first is located in the central area around 20 miles Northwest from the town of Mercury. The second is located in the mountainous area around 40 miles Northwest of Mercury in the vicinity of Timber Mountain itself.

After running the two waste sites it was determined that the first one was more conservative, giving concentrations around two orders of magnitude larger than the second. The first waste site was chosen for this reason.

Record of Assumptions (ROA) Memorandum

TO: File

FROM: Mary Jarvis

DATE: November 4, 1994

Installation ID: NTS

ROA No.: 008

SUBJECT: Initial Dates Contamination Introduced

This ROA describes how the assumptions for starting dates for contamination by environmental setting were decided. The initial start dates were arrived at by determining the initial date a bomb was exploded in each environmental setting. The PEIS database and installation references were consulted to find this information.

The dates used in the MEPAS runs are as follows:

Frenchman Flat---January 27, 1951. Date that first bomb was exploded at the Nevada Test Site (NTS).

Rainier Mesa---November 29, 1951. Earliest reported date in the PEIS database for any site area (area 10) falling within the Rainier Mesa boundary.

Jackass Flats---January 1, 1954. Reference states that the first bombing in this setting occurred in the mid-1950's. The exact date was not located. The date assumed is believed to be a conservative mid-1950's date. Reference is: PEIS 1141 (Information Pertinent to the Migration of Radionuclides in Ground Water at the Nevada Test Site, by I. Y. Borg, R. Stone, H. B. Levy, and L. D. Ramspott, May 25, 1976.

Timber Mountain---January 27, 1951. This is a conservative assumption which supposes that the earliest reported NTS bomb date also applies to the Timber Mountain environmental setting.

Pahute Mesa---January 1, 1962. The reference says that the first bomb was detonated in this area in 1962, therefore the first day of the year was chosen. Reference is PEIS 1141 (Information Pertinent to the Migration of Radionuclides in Ground Water at the Nevada Test Site, by I. Y. Borg, R. Stone, H. B. Levy, and L. D. Ramspott, May 25, 1976.

Yucca Flat---October 22, 1951. Earliest reported date in the PEIS database for any site area (area 7) falling within the Yucca Flat boundary.

Record of Assumptions (ROA) Memorandum

TO: File

FROM: Mary Jarvis

DATE: November 8, 1994

Installation ID: NTS

ROA No.: 009

SUBJECT: Basis for Assumptions of % Vegetative Cover

This ROA describes the basis for the BEMR assumption that zero (0%) of the NTS installation is covered with vegetation. After a detailed search of approximately one dozen installation-specific references, the team found no information which reported the probable average percent of vegetative cover at the NTS. Therefore the following logic was followed to arrive at a value.

The NTS installation is located in the most arid part of Nevada which has an annual average precipitation in the valleys of 3-6 inches and on the mesas an average of less than ten inches. The vegetation of the area is characteristic of the Great Basin deserts of the southwestern United States.

Desert shrubs (creosote bushes) cover most of the land area of the NTS. However at higher elevations there are areas of desert woodland (pinon, juniper, and sagebrush). (U.S. Department of Energy Nevada Field Office Annual Site Environmental Report-1991. Volume 1. September 1992.) A sparse vegetative cover or bare-soil surface is defined as <20% vegetation (Multimedia Environmental Pollutant Assessment System ([MEPAS] Application Guidance Volume 2- Guideline for Evaluating MEPAS Input Parameters for Version 3.0. August 1993. J. G. Droppo. Jr., D. L. Strenge, J. W. Buck, B. L. Hoopes, R. D. Brockhaus, M. B. Walter, G. Whelan. PNL-7216. Volume 2.

Based on NTS's location in a "true" desert biome, it is concluded that a vegetative cover of <20% is an appropriate assumption. The Hanford Installation is not located in a desert but rather in an arid steppe. The Hanford Installation has a slightly more dense average vegetative cover and a value of 10% was assumed for its Environmental Impact Assessment. Initial runs for the NTS presumed a vegetative cover assumption of 0% Later an assumption of 10% was tested to ascertain differences in the predicted concentrations. The values predicted were within the same order of magnitude and less than a factor of two different. The 10% assumption yielded slightly lower concentrations. It was concluded that the difference between using a vegetative cover assumption of 10% and 0% was negligible. Therefore the installation team opted to use the more conservative value of 0%.

Record of Assumptions (ROA) Memorandum

TO: Mary Jarvis

FROM: Gariann Gelston

DATE: November 14, 1994

Installation ID: NTS

ROA No.: 010

SUBJECT: Source and Boundary Receptor Locations for Jackass Flats

This ROA is a description of the process followed to decide the location of the source site and boundary receptor for Jackass Flats.

Due to southerly groundwater flow, the boundary receptor location of Jackass Flats is in the middle of the Southern border of Area 25.

Source location within the Jackass Flats Environmental Setting was determined by the following method. The groundwater flow direction in Jackass Flats is generally North to South, therefore three points were considered as a source site. The first being located in the middle of the Northern border of Area 25, the second located in the center of Area 25, and the third located in the middle of the Southern border of Area 25. (Note: East-West movement was not a factor.) It was concluded that the third point was too conservative, it places the source site on top of the boundary receptor. The center point was chosen to be the source site location since it was more conservative than the first point and is also where the bulk of the waste is recorded for Area 25.

Record of Assumptions (ROA) Memorandum

TO: Mary Jarvis

FROM: Gariann Gelston

DATE: November 14, 1994

Installation ID: NTS

ROA No.: 011

SUBJECT: Source and Boundary Receptor Locations for Frenchman Flat

This ROA is a description of the process followed to decide the location of the source site and boundary receptor for Frenchman Flat.

Due to southerly groundwater flow, the boundary receptor location of Frenchman Flat is on the Southern border of Area 5 where it intersects with the Eastern border of Area 23.

Source location within the Frenchman Flat Environmental Setting was determined by the following method. The groundwater flow direction in Frenchman Flat is North to South, therefore three points were considered as a source site. The first being located in the middle of the Northern border of Area 5, the second located in the center of Area 5, and the third located where the Southern border of Area 5 intersects the Eastern border of Area 23. (Note: East West movement was not a factor.) It was concluded that the third point was too conservative, it places the source site on top of the boundary receptor. The center point was chosen to be the source site location since it was more conservative than the first point and is also where the bulk of the waste is recorded for Area 5.

Record of Assumptions (ROA) Memorandum

TO: Mary Jarvis

FROM: Gariann Gelston

DATE: November 14, 1994

Installation ID: NTS

ROA No.: 012

SUBJECT: Source and Boundary Receptor Locations for Yucca Flat

This ROA is a description of the process followed to decide the location of the source site and boundary receptor for Yucca Flat.

Do to Southerly groundwater flow, the boundary receptor location for Yucca Flat is on the Southern border of Area 5 where it intersects with the Eastern border of Area 23.

Source location within the Yucca Flat Environmental Setting was determined by the following method. The groundwater flow direction in Yucca Flat is North to South, therefore three points were considered as a source site. The first being located where Area 2, 8, 10, and 9 intersect, the second located in the middle of the border of Area 1 and 3, and the third located on the Southern border of Area 6 near the Area 11 border. (Note: East-West movement was not a factor.) It was concluded that the third point was too conservative. The second point was chosen to be the source site location since it was more conservative than the first point and is also where the bulk of the waste is recorded for Yucca Flat.

Record of Assumptions (ROA) Memorandum

TO: Mary Jarvis

FROM: Gariann Gelston

DATE: November 14, 1994

Installation ID: NTS

ROA No.: 013

SUBJECT: Source and Boundary Receptor Locations for Pahute Mesa

This ROA is a description of the process followed to decide the location of the source site and boundary receptor for Pahute Mesa.

Do to Southwestern groundwater flow, the boundary receptor location for Pahute Mesa is on the Southwest border of Area 20.

Source location within the Pahute Mesa Environmental Setting was determined by the following method. The groundwater flow direction in Pahute Mesa is to the Southwest, therefore three points were considered as a source site. The first being located on the Northeast border of Area 19, the second located to the east of the Area 20 and Area 19 intersection, and the third located on the Southeast border of Area 20. It was concluded that the third point was too conservative, with the boundary receptor and source point at the same location. The second point was chosen to be the source site location since it was more conservative than the first point and is also where the bulk of the waste is recorded for Pahute Mesa.

Record of Assumptions (ROA) Memorandum

TO: Mary Jarvis

FROM: Gariann Gelston

DATE: November 14, 1994

Installation ID: NTS

ROA No.: 014

SUBJECT: Source and Boundary Receptor Locations for Rainier Mesa

This ROA is a description of the process followed to decide the location of the source site and boundary receptor for Rainier Mesa.

Due to Southerly groundwater flow, the boundary receptor location for Rainier Mesa is on the Southern border of Area 5 where it intersects with the Eastern border of Area 23.

Source location within the Rainier Mesa Environmental Setting was determined by the following method. The groundwater flow direction in Rainier Mesa is to the South coming from the Northeast and Northwest, therefore three points were considered as a source site. The first being located on the Northern border of Area 15, the second located just above the center of Area 8, and the third located at the intersection of Area 8, 10, 2, and 9. It was concluded that the third point was too conservative. The second point was chosen to be the source site location since it was more conservative than the first point and is also the midpoint of numerous recorded waste sites located to the East and West.

Record of Assumptions (ROA) Memorandum

TO: Mary Jarvis

FROM: Gariann Gelston

DATE: November 15, 1994

Installation ID: NTS

ROA No.: 015

SUBJECT: Location of On-Site Receptors

The following ROA is to explain the method used for calculating the on-site receptors for all environmental settings.

All environmental settings followed the same method for determining the location of the on-site receptor. The distance of the on-site receptor from the center of the source is one and a half times the length of the source site (1.5 * L). Source site areas are square and range from 10 ft^2 to 1,000,000 ft^2, and increase by a factor of 10 each step. The direction of the on-site receptor is not specified since it is assumed to be in the direction of groundwater flow for the groundwater receptor, and in the direction of highest concentration for the air receptor.

Record of Assumptions (ROA) Memorandum

TO: File

FROM: Gariann Gelston and Mary Jarvis

DATE: November 10, 1994

Installation ID: NTS

ROA No.: 016

SUBJECT: Use of Unit Risk Factors (URF) Inappropriate for Deep Sites

The purpose of this ROA is to note that the use of the NTS URFs to calculate approximate site risk is not valid. The reason is that the exposure modeling (contained in the URF methodology) examines surficial soil contamination only (i.e., contamination to a depth of about 10 feet). As a result, the modeling is not representative of contamination significantly below 10 feet.

The PEIS database reports information on 6 NTS sites which are significantly below 10 feet.

location area #	depth (feet)
20	2,756.6
26	108.8
05	72.5
18	60.9
Unknown	52.2
12	43.5

These 6 sites are scattered across the NTS installation in various environmental settings. In order to prepare URFs appropriate exclusively to these 6 sites, it will be necessary to perform multiple depth runs for the entire installation. At this time, the team does not plan to make the additional depth runs.

Record of Assumption (ROA) Memorandum

TO: File

FROM: Mary Jarvis

DATE: November 28, 1994

Installation ID: NTS

ROA No.: 017

SUBJECT: Rationale for Selection of Media

For calculational purposes, it was assumed that only "surface soil" and "buried waste" are a source of contamination at the NTS installation.

A review of the PEIS database revealed that there is information for surface soil as a source at the NTS installation. There is no entry for buried waste, groundwater, or surface water. However, Dale King (BEMR-Cost Task) advised the NTS team on October 24, 1994 that he would need unit risk factors to calculate remediation costs for buried waste. Dale King said he recognized that buried waste is not currently contained in the PEIS database, however he said there are plans to add this information in the near future.

Record of Assumption (ROA) Memorandum

TO: File

FROM: Mary Jarvis

DATE: November 28, 1994

Installation ID: NTS

ROA No.: 018

SUBJECT: Rationale for Selection of Pathways

For calculational purposes, it was assumed that the only complete pathways (or "release mechanisms") of exposure from the source (or "waste types") to a receptor at NTS are those usually associated with "buried waste" and "surface soil." "Surface soil" and "buried waste" are the source of contamination (or waste types) at the NTS installation.

The pathways (or release mechanisms) assumed to be present include: for buried waste, infiltration to groundwater, and volatilization to air; and for surface soil, infiltration to groundwater, volatilization to air, suspension of dust to air, and direct radiation. All surface water release mechanisms associated with (buried waste and surface soil) are not included because these pathways are not viable at NTS except during rare and temporary flooding events (see ROA #21 for NTS).

Record of Assumption (ROA) Memorandum

TO: File

FROM: Mary Jarvis

DATE: November 15, 1994

Installation ID: NTS

ROA No.: 019

SUBJECT: Restricted Area On-site

One installation reference describes two on-site areas of plutonium-239,240 contamination adjacent to above ground nuclear test shots. (PEIS #6038. J. I. Daniels Editor. Pilot Study Risk Assessment for Selected Problems at the Nevada Test Site. June 1993. Lawrence Livermore Laboratory.)

The sites are described as Plutonium Valley (area 11) and GMX (area 5). The reference indicates that the sites are restricted access by virtue of the fact that they are located within the test ranges (all of which are restricted access). No information was located addressing whether these areas are planned to be restricted areas in the future. As a result, no restricted area was delineated in the conceptual site model.

ROA #020

Record of Assumption (ROA) Memorandum

TO: File

FROM: Mary Jarvis

DATE: November 15, 1994

Installation ID: NTS

ROA No.: 020

SUBJECT: PEIS Database

A review of the PEIS database revealed that there is information for surface soil as a source at the NTS installation. There is no entry for buried waste, groundwater, or surface water. However, Dale King (BEMR-Cost Task) advised the NTS team on October 24, 1994 that he would need unit risk factors for cleaning up buried waste. Dale King said he recognized that buried waste is not currently contained in the PEIS database, however he said there are plans to add this information soon. In addition, at this time, BEMR Costs' staff are not planning to calculate the cost of cleaning contamination due to past underground testing.

Record of Assumption (ROA) Memorandum

TO: File

FROM: Mary Jarvis

DATE: November 15, 1994

Installation ID: NTS

ROA No.: 021

SUBJECT: Surface Water

It is concluded that there is no on-site surface water pathway at NTS because "there are no continuously flowing streams on the NTS." (PEIS # 329. U.S. Department of Energy Nevada Field Office. Annual Site Environmental Report - 1991. Volume 1. DOE/NV/10630-33. It is further concluded that there is no surface water source to consider at the NTS site because there is no data for this medium entered in the PEIS database (at this time).

Surface drainage for Frenchman Flat and Yucca Flat are in closed-basins, which drain onto dry lakebeds in each valley. The remaining area of the NTS drains via arroyos an dry stream beds that carry water only during intense or persistent rainstorms. Pahute Mesa has an integrated channel system which carry runoff beyond NTS boundaries into the closed basins of Kawich Valley and Gold Flat on the Nellis AFB Range complex. The western and southernmost portions of the NTS have channel systems which carry runoff from intense storms toward the southern boundary of the NTS and off-site toward the Amargosa Desert. Jackass Flats and the Amargosa Desert are connected via the Amargosa River. (PEIS # 329. U.S. Department of Energy Nevada Field Office. Annual Site Environmental Report - 1991. Volume 1. DOE/NV/10630-33. Winograd, Isaac and Thordarson, William. Hydrogeological and Hydrochemical Framework South-Central Great Basin, Nevada-California, with Special Reference to the Nevada Test Site. Hydrology of Nuclear Test Sites. Geological Survey Professional Paper 712-C. U.S. Government Printing Office. Washington, D.C.

The closest major water body is Lake Mead at 72 miles distance from the NTS. During extreme conditions flashfloods may occur. Flashfloods have the potential to allow surface soil contamination to migrate off-site. However, since no large perennial or intermittent streams are found in the region, it was concluded not to do an overland runoff scenario off-site to a surface water body (at this time).

Record of Assumption (ROA) Memorandum

TO: File

FROM: Mary Jarvis

DATE: November 28, 1994

Installation ID: NTS

ROA No.: 022

SUBJECT: Rationale for Selection of Exposure Pathways

For calculational purposes, it was assumed that the receptors are both "on-site," and at the "installation boundary." No "restricted area boundary receptor" is hypothesized. The exposure pathways selected for assessment are those likely to result from the potential release of volatile organics, radionuclides, and/or particulate contamination from surface soil to the air. This material is in turn inhaled, ingested, and/or contacted dermally. Surface soil and buried waste sources are also assumed to leach to groundwater which is used for a variety of purposes, thereby creating the numerous potential exposure pathways identified below.

The exposure pathways chosen include the following:

* for all receptors via **inhalation exposure pathway**, airborne contamination, groundwater contamination while showering, and re-suspended soil particle;

* for **ingestion exposure pathway**, airborne contamination (leafy vegetables, other vegetables, meat products, milk products), groundwater contamination (drinking water, showering, leafy vegetables, other vegetables, meat products, milk products); soil contamination (ingestion of soil);

* for **external radiation**, direct radiation (on-site receptor only); and

* for **dermal contact**, groundwater contamination (showering), contact with source contamination (all media), contact with deposited contamination (all exposure media), and contact with deposited contamination (soil [atmospheric dust]).

Surface soil contaminated with radionuclides is assumed to impart direct radiation but only to the on-site receptor. The installation boundary receptor might in reality be exposed to direct external radiation, however this pathway is not supported by the modeling methodology employed herein, and as a result these calculations were not performed. This is recognized a limitation of the approach.

All surface water exposure pathways are excluded because these pathways are not viable at NTS except during rare and temporary flooding events (see ROA #21 for NTS).

Record of Assumptions (ROA) Memorandum

TO: Mary Jarvis

FROM: Brad Warren

DATE: November 17, 1994

Installation ID: NTS

ROA No.: 023

SUBJECT: Multiple Aquifers for Rainier Mesa

This ROA memo is to describe the method used for choosing the appropriate aquifer for Rainier Mesa.

The Groundwater flow from Rainier Mesa passes through Yucca Flat and Frenchman Flat on its way to the Boundary receptor. The Rainier Mesa consists of a 3500 ft vadose zone (600, 600, 1200, 1100 ft thickness for the PSZ's) and the contamination doesn't reach the aquifer within 10,000 years. For this reason, it was determined that the aquifer for Rainier Mesa would be appropriate to use for the runs.

Record of Assumptions (ROA) Memorandum

TO: Mary Jarvis

FROM: Brad Warren

DATE: November 17, 1994

Installation ID: NTS

ROA No.: 024

SUBJECT: Multiple Aquifers for Yucca Flat

This ROA memo is to describe the method used for choosing the appropriate aquifer for Yucca Flat.

The Groundwater flow from Yucca Flat passes through Frenchman Flat on its way to the Boundary receptor. Since Yucca Flat and Frenchman Flat both have identical aquifers, the Yucca Flat aquifer was used.

Record of Assumptions (ROA) Memorandum

TO: Mary Jarvis

FROM: Christian Fosmire

Installation ID: NTS

ROA No.: 025

SUBJECT: Climatological Data Used at the Various Locations at NTS

This ROA is a description of the process used to define which meteorological stations were used for each environmental setting at NTS.

For all the environmental settings, there are two possible meteorological stations, Desert Rock Airport and Yucca Flats, which have climatological data. The question posed was which meteorological station should be used for each of the six environmental settings: Jackass Flats, Timber Mountain, Yucca flat, Frenchman Flat, Rainier Mesa, and Pahute Mesa. In consultation with Cliff Glantz, it was decided to use his suggestions on how to pair up the meteorological station and the six environmental settings. Attached is a copy of the cc:mail message sent to Cliff and his response. In his response he states which meteorological station should be used with each environmental setting.

[13] From: Ronald N. Kickert at ~PNL83 10/18/94 4:38PM (1053 bytes: 23 ln)
To: Mary F. Jarvis at ~PNL41
cc: Brad R. Warren
Subject: BMER Met Data for 6 Env. Settings of NTS - Decision Needed
---------------------------------------Message Contents

According to the data tables from Clif Glantz, there are two met stations whose parameters data we have for the NTS:

Desert Rock Airport, in the southern tip around Mercury, NV
and
Yucca Flat, approx. in the middle of Yucca Flat

We will have to agree on how we assign each of these two stations among the six Environ. Setting areas.

I propose the following:

Desert Rock Airport: use for Jackass Flats
Timber Mtn.

Yucca Flat met sta.: use for Yucca Flat
Frenchman Flat
Rainier Mesa
Pahute Mesa

Please advise.

Ron

[10] From: Clifford S. Glantz at ~PNL83 10/19/94 4:09PM (948 bytes: 18 ln)
To: Ronald N. Kickert, Mary F. Jarvis at ~PNL41
cc: Brad R. Warren, Richard Holdren at ~PNL54
Subject: Assigning appropriate met data to NTS envi. settings
---------------------------------------Message Contents

Based on some brief discussions with Rich Holdren we suggest the following assignments:

Met station	Env. Setting
Desert Rock:	Jackass Flats Frenchman Flat
Yucca Flat:	Pahute Mesa Rainier Mesa Yucca Flat Timber Mtn.

(even though Desert Rock falls within this setting, most of Timber Mtn. is best described by Yucca Flat met. data!)

-- Cliff

Record of Assumption (ROA) Memorandum

TO: Mary Jarvis

FROM: Gariann Gelston

DATE: December 21, 1994

INSTALLATION ID: NTS

ROA NO.: 026

SUBJECT: MEI Location

The purpose of this ROA is to describe the process used for selection of the Maximum Exposed Individual for the atmospheric pathway for on-site and boundary receptors.

All on-site MEI receptors were chosen to be 100 m from the center of the waste site and in the Southwest direction. This distance was chosen because 100 m is the closest measured point to the center of the waste site. This direction was chosen because the Southwest direction has the highest concentrations given the joint frequency data used.

Boundary MEI receptors were based on the environmental setting being considered. All environmental settings used a direction of North. This was because at further distances the North wind direction yields slightly higher concentrations than the Southwest. Boundary distances from the center of the waste site vary due to location of the boundary. In all cases the distance to the nearest boundary from the waste site center was selected regardless of wind direction. By choosing the smallest distance the concentrations selected would be conservative and compensated for some concern on the use of the Nellis Air Force Base joint frequency data. The following MEI boundary distances were used: Frenchman Flat, 5 km; Jackass Flats, 10 km; Yucca Flat, 7.5 km; Timber Mountain, 15 km; Rainier Mesa, 5 km; Pahute Mesa, 9 km.

Record of Assumption (ROA) Memorandum

TO: Mary Jarvis

FROM: Brad Warren

DATE: December 21, 1994

INSTALLATION ID: NTS

ROA NO.: 027

SUBJECT: Infiltration Rate for NTS Groundwater flow

The infiltration rate for all Environmental Settings at NTS was discovered to be zero when calculated in MEPAS. To get the MEPAS User Interface to ask for infiltration rate, CWPOND was set to 1, meaning a designated pond site. When MEPAS asked for infiltration rate, the number used was the value given for Darcian Velocity in the Hydrogeological Environmental Settings data as directed by Rich Holdren.

Record of Assumption (ROA) Memorandum

TO: File

FROM: Mary Jarvis

DATE: December 20, 1994

Installation ID: NTS

ROA No.: 028

SUBJECT: Clarification of JFD Issue

The MEPAS runs which created the URF (unit risk factors) for the Nevada Test Site (NTS) used the joint frequency distribution (JFD) for Nellis Air Force Base. Later the JFD for Las Vegas was acquired. In addition, the existing runs use incorrect inputs for anemometer heights and thunderstorm days.

Christian Fosmire performed case studies and prepared the attached memos to help clarify the effect of these assumptions on the output modeling results. The memos are titled as follows: "Air Concentrations for Las Vegas Versus Nellis JFD," dated December 12, 1994. "NTS Air Concentrations for Nellis," dated December 2, 1994. "Using Incorrect Anemometer Height and Thunderstorm Days," December 2, 1994. "JFD for Nevada Test Site," December 2, 1994.

The conclusion drawn from the work documented in the memos is that the net effect on the output of utilizing the Las Vegas JFD data, the correct anemometer height (2.0 meters), and the correct number of thunderstorm days is minimal. For some contaminants the effect lowers the predicted concentrations, and in some cases it increases the predicted concentrations. On the whole, the increases and decreases appear to balance one another making the net effect relatively neutral. For example, using the Nellis AFB JFD for non-reactive gasses yields a higher (~40%) peak air concentration than using the Las Vegas JFD data. Particles modeled over distances of less than 2 kilometers yield higher (~10%) concentration values with Nellis data, whereas at 2-11 kilometers the Las Vegas data yields higher (~25%) results, and at greater than 11 kilometers the Nellis data yields higher (~200%) results. The corrected anemometer height (2.0 meters) results in slightly higher concentrations (~20%) at small distances and lower concentrations (~20%) at long distances. the difference in thunderstorm days had no affect on concentrations.

The air work also reveals that the terrain at NTS is very complex, containing mountains and valleys, which channel the winds. The use of a simple Gaussian plume air model (as is utilized in MEPAS) does not accurately model the expected air transport at NTS. Therefore, the results are anticipated to be inaccurate, but erring on the side of conservative- tending to overestimate the exposure point concentrations rather than underestimating them. The use of an air model which better approximates the environmental setting is recommended.

DON'T SAY IT -- *Write It!* Date: December 12, 1994

To: Mary Jarvis From: Christian Fosmire

Subject: Air Concentration for Las Vegas vs Nellis JFD

In an earlier DSI, I reported that the most appropriate Joint Frequency Distribution (JFD) of winds would be the Las Vegas JFD. However, the MEPAS runs were done using the Nellis Air Force Base JFD. In this DSI, I compare the peak air concentrations using the two JFDs. For non-reactive gases the peak air concentration calculated using the Nellis JFD is always larger than that calculated using the Las Vegas JFD. For particulates the difference depends upon particulate size and distance from the source.

To analyze how the two JFDs effect the air concentrations, I ran a test case from Yucca Flat using both the Nellis and the Las Vegas JFDs. To be consistent with the original MEPAS runs, I used an anemometer height of 9.1 meters, which is larger than the actual anemometer height, for the Nellis JFD. The peak concentration for the Nellis JFD occurs in either the southwest or north direction depending upon the distance. For the Las Vegas JFD, the peak concentration usually occurs in the northeast direction except for very large (>10 km) distances.

Figure 1 shows the ratio of air concentrations for large particles for the north and southwest direction using the Nellis JFD compared to the air concentration for the east-northeast direction using the Las Vegas JFD. For both the north and southwest directions at small distances (<150 m), the Nellis concentrations are only slightly larger than the Las Vegas concentrations. At intermediate distances, the Las Vegas concentrations are larger than the Nellis concentrations within a factor of two until you are a couple of kilometers for the source. The distance where the Nellis concentration once again becomes larger than the Las Vegas concentration is about 11 kilometers for the southwest direction and about 8 kilometers for the north direction. For very large distances, the Nellis concentrations become much larger than the Las Vegas concentration probably due to the fact that the peak concentration for Las Vegas at very large distances (>10 km) is not found in the northeast direction. For the case of smaller particles, the above results are expected except the distances at which the ratio crosses one would be different.

Figure 2 shows the ratio of air concentrations for Nellis and Las Vegas JFD for non-reactive gases again for the southwest directions for Nellis and the east-northeast direction for Las Vegas. For non-reactive gases, the Nellis JFD produces larger peak concentrations than Las Vegas for all distances.

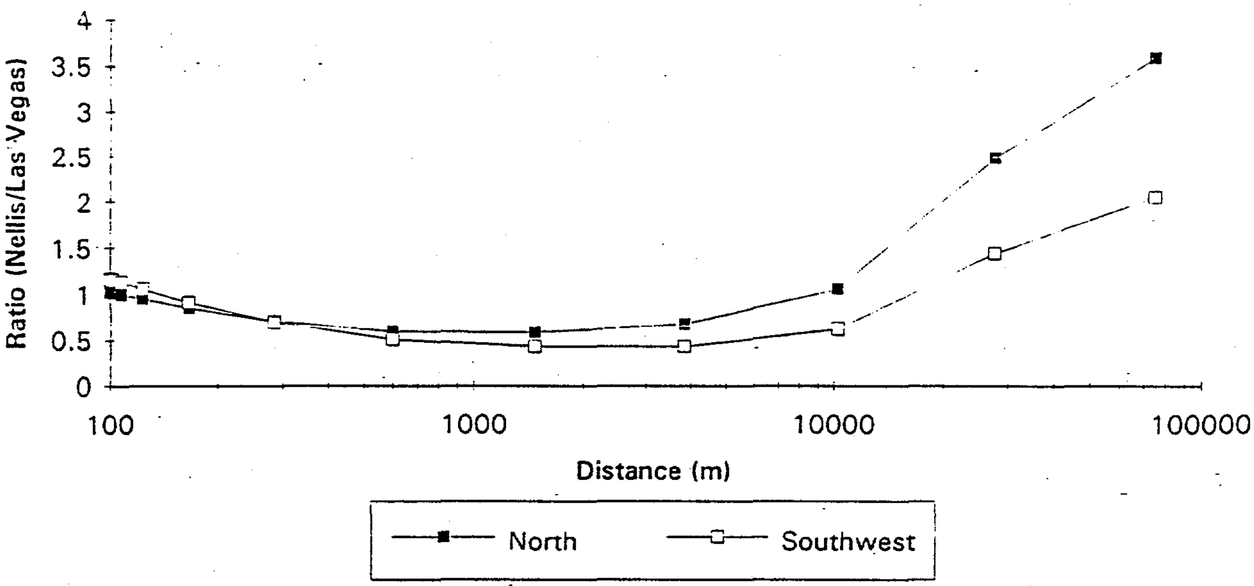

Figure 1. Ratio of Air Concentration for Large Particles (Nellis vs. Las Vegas)

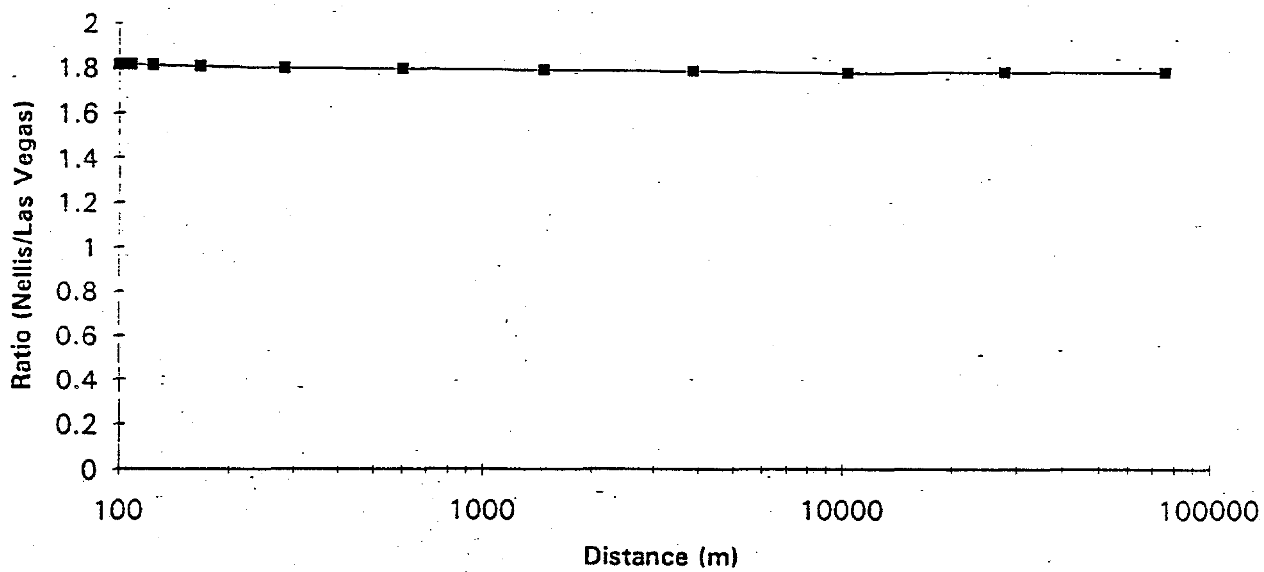

Figure 2. Ratio of Air Concentration for Non-Reactive Gases (Nellis vs. Las Vegas)

DON'T SAY IT -- *Write It!* Date: December 2, 1994

To: Mary Jarvis From: Christian Fosmire

Subject: NTS Air Concentration for Nellis Data

There has been a question about concentrations for two distances, north and southwest, as a function of distance for the Nevada Test Site MEPAS runs using the Nellis Joint Frequency Distribution (JFD). The Nellis JFD can have a peak concentration in either the north direction or the southwest direction depending upon the distance from the source location and the type of pollutant. The concentration difference between these two direction for a given distance and a given pollutant is within a factor of two for all distances.

To analyze the difference in the concentrations between the two directions, I looked at air concentrations from a MEPAS run using the meteorological data from Yucca Flats with a Nellis JFD. Figures 1, 2, and 3 show the ratio of the air concentration to the north to the air concentration to the southwest assuming a unit emission rate as a function of distance for large particles, small particles, and non-reactive gases, respectively. From Figure 1, the southwest concentration is larger than the northern concentration (the ratio is less than 1) for distances less than about 300 meters. The reason that the southwestern concentration is larger than the northern concentration is that a majority of the low wind speed, stable cases are for winds from the northeast (toward the southwest). The low wind speed, stable cases usually produce the highest concentrations. After 300 meters, the northern concentration becomes increasing larger than the southwestern concentration. The reason for the reversal is that with low wind speeds, the plume takes a longer time to travel a certain distance. During this time, particles are being deposited on the ground. Thus, more particles are being deposited at smaller distances so that concentration is less at larger distances. As shown in Figure 2, the distance at which the northern concentration becomes larger than the southwestern concentration is around 15,000 meters. The reason for the larger distance is due to the smaller particles depositing much slower than the larger particles. For the non-depositing gas, the southwestern concentration is always larger than the northern concentrations (Figure 3) as expected.

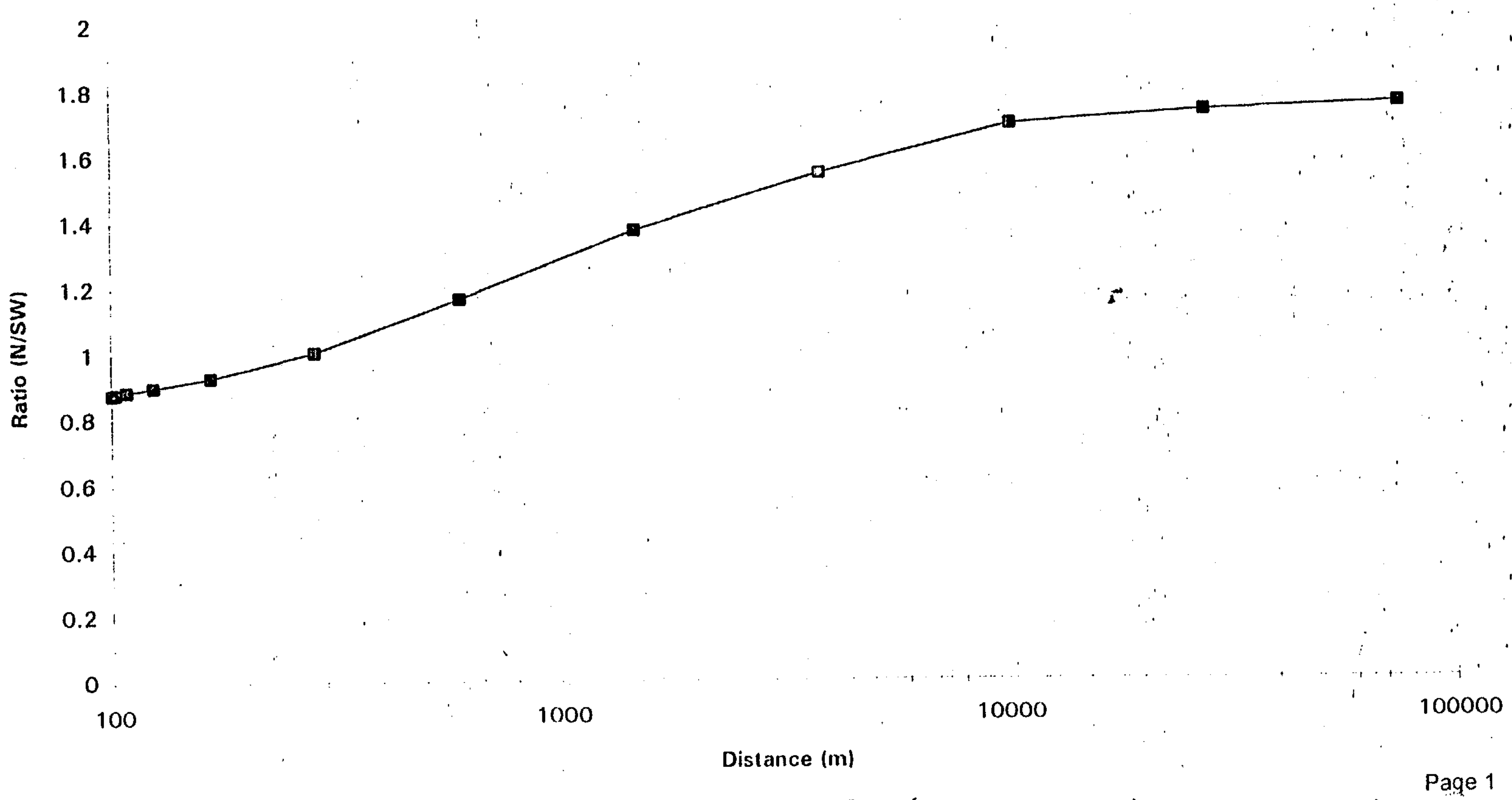

Figure 1. Ratio of Concentration for Large Particles (Yucca Nellis w/incorrect height)

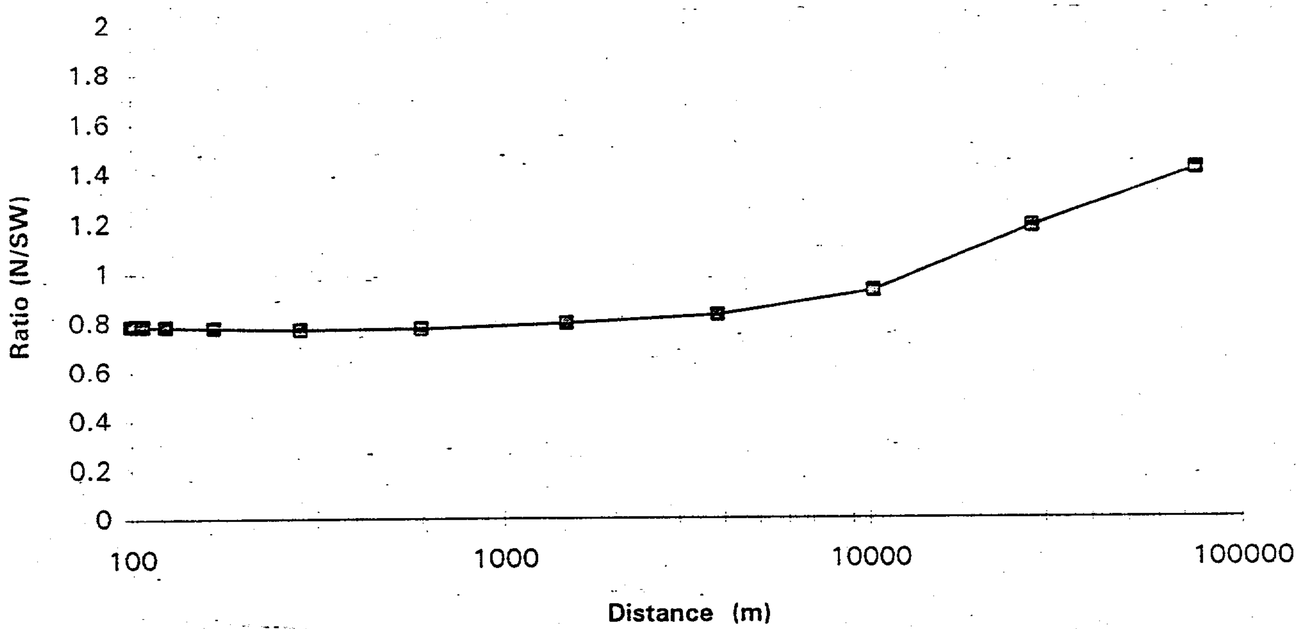

Figure 2. Ratio of Concentrtion for Small Particles (Yucca Nellis w/incorrect hieght)

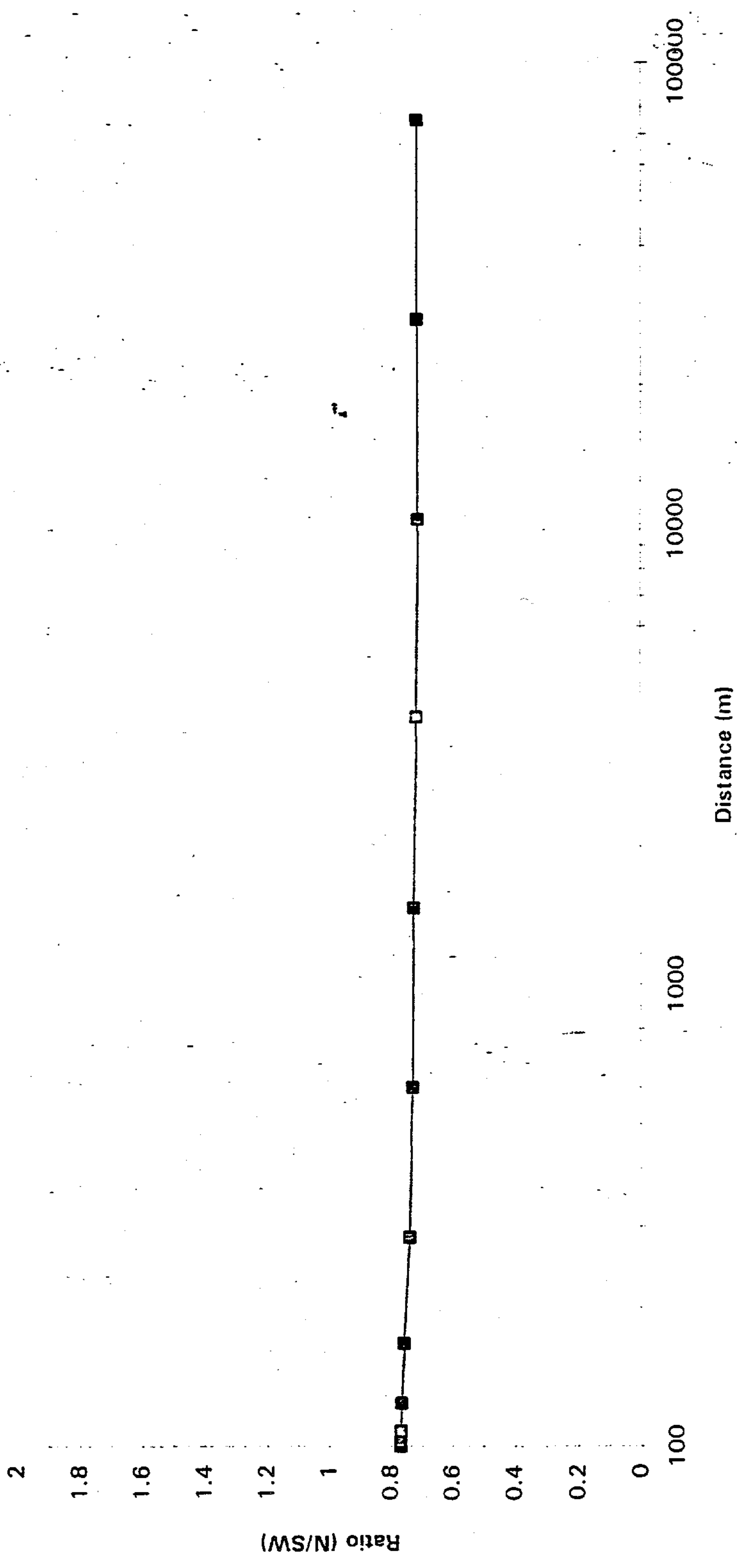

Figure 3. Ratio of Concentration for Non-Reactive Gases (Yucca Nellis w/incorrect height)

DON'T SAY IT -- *Write It!* **Date:** December 2, 1994

To: Mary Jarvis **From:** Christian Fosmire

Subject: Using incorrect anemometer height and Thunderstorm days

Two incorrect inputs in the MEPAS runs for NTS were using the incorrect anemometer height for the joint frequency data and using an incorrect number of thunderstorm days for the Desert Rock climatology data. In analyzing the difference in the concentrations when the correct and incorrect anemometer heights are used, the difference varies depending upon type of contaminant and distance. There appears to be no change in the concentration due to the incorrect input of the thunderstorm days.

The joint frequency distribution data requires an anemometer height associated with the data. In the MEPAS runs, anemometer height inputted were too high. To test what effect this has on the concentrations, I ran a case using a site at Yucca Flats with the Nellis Air Force Base joint frequency data at both the incorrect height (8.8m) and the correct height (2.0m). Figure 1 and 2 show the ratio of the concentrations for large particles as a function of direction for the north and southwest direction, respectively. The north and southwest directions are the direction were the maximum concentrations are found. At small distances the incorrect height gives slightly higher concentrations. At larger distances, the incorrect height give much smaller concentrations. There is little difference in the direction used. The reason for this behavior is that the winds are adjusted to be at the height of the plume which is assumed to be 2 meters. Because the incorrect height is larger then the correct height and the wind decrease with height when it is adjusted, the wind is actually traveling slower in the incorrect height case compared to the correct height case. The slower winds mean that at small distances the concentration is larger because the plume disperses slower. Because there is more deposition of material at small distances for the slower wind, at large distances the concentration will be less than for a faster wind. For small particles the same type of pattern is expected only the distance at which the ratio goes below one will differ. Figure 3 which show the ratio of concentration as a function of distance for a non-depositing gas show. Because there is no deposition, the concentration is always larger for the incorrect height case as expected.

Due to an error in the climatological worksheet, an incorrect number of thunderstorm days was inputted for the Desert Rock station. I found no difference in the concentrations when the correct number of thunderstorm days was inputted. The thunderstorm days effects the wet deposition rate which except for special stack cases is overwhelmed by the dry deposition.

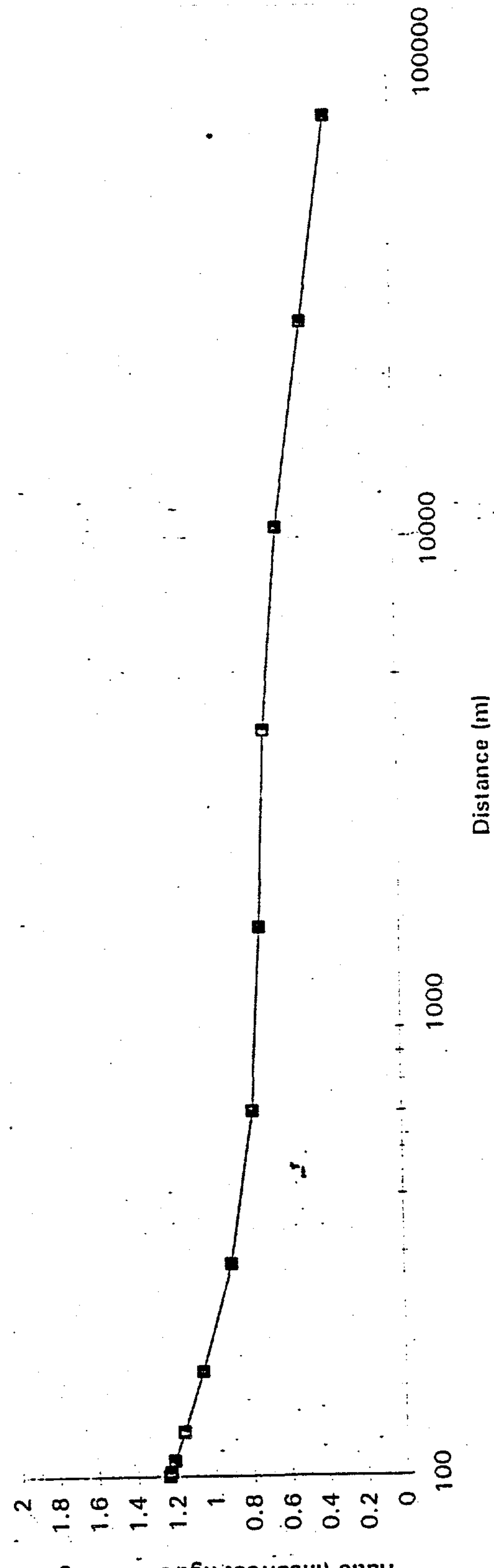

Figure 1. Ratio of Concentration for Large Particles (Yucca using Nellis for North direction)

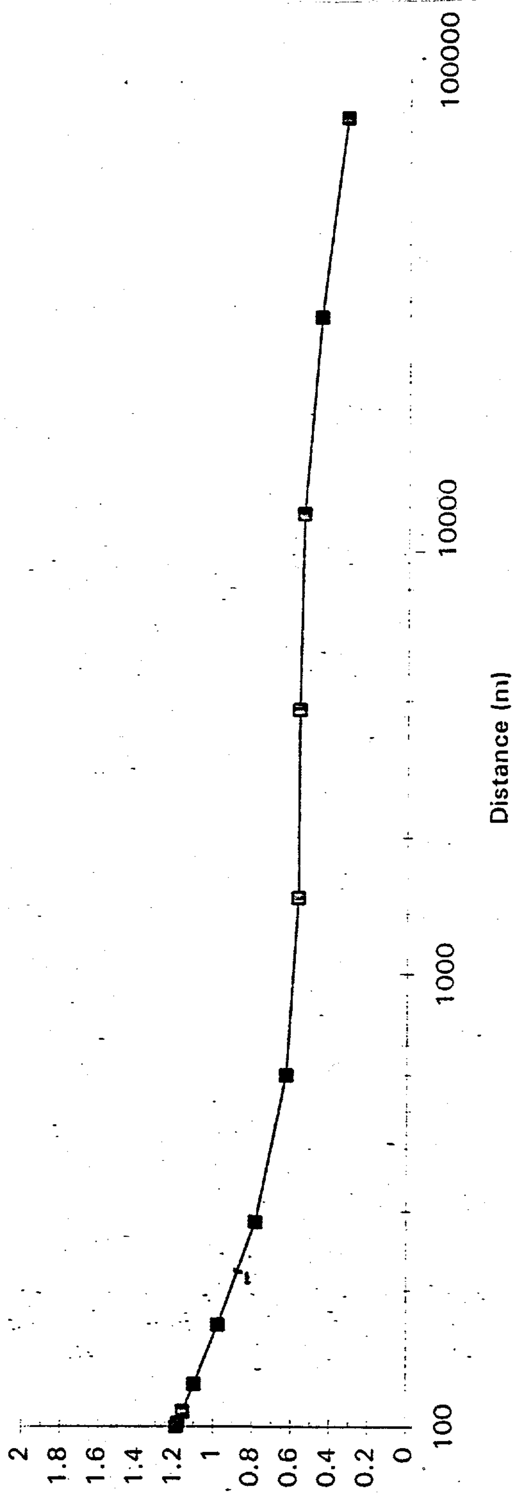

Figure 2. Ratio of Concentration for Large Particles (Yucca using Nellis for SW direction)

E54-3000-101 (10/89)

DON'T SAY IT··· *Write It!*

Date: December 2, 1994

To: Mary Jarvis

From: Christian Fosmire

Subject: JFD for the Nevada Test Site

In attempting to obtain a Joint Frequency Distribution (JFD) of winds as a function of atmospheric stability, wind speed, and wind direction for the Nevada Test Site, we have run into many problems. These problems are due to the complex terrain of the Nevada Test Site and the type of atmospheric model that is being used by MEPAS. For the JFD's that we have on hand, the Las Vegas JFD appears to be the only JFD that is not strongly influenced by the local topography and is the most appropriate JFD to use for representing the entire Nevada Test Site.

The atmospheric model being used in MEPAS is a straight line gaussian plume model. This type of model does not perform well for the Nevada Test Site because winds are strongly influenced by local topographic features. Thus, a straight line plume may only be valid over distances of a couple of kilometers or less at many locations at the Nevada Test Site. However, requirements to use the MEPAS model as a common tool for all PEIS and BEMR modeling and the scope of work for this project prevent us from using a more detailed supplementary model to better characterize the atmospheric transport at the Nevada Test Site.

At the Nevada Test Site, there are a number of station within the site that have records of wind speed and wind direction. Unfortunately, most of the sites have no associated record of atmospheric stability. While it is possible to estimate the stability at each station using data from other sources, this is beyond our scope of work. Only Desert Rock Airport and Yucca Flats have records of atmospheric stability, wind speed, and wind direction. As implied before, meteorological measurements at Desert Rock and Yucca Flats are strongly influenced by the local topography. Of these sites, a JFD of Desert Rock for the years 1981 - 1990 was obtained from Charles Steadman who works for the Meteorological Operations Branch of the Nevada Test Site. Figure 1 shows the frequency of occurrence of the winds as a function of wind direction at Desert Rock. As shown in Figure 1, there are two peaks in the frequency distribution. One peak is for winds from the northeast and the other is for winds from the southwest, with the peak for the winds from northeast being the larger of the two. The maximum is probably the result of nocturnal down-valley flow. Because the largest concentrations are often seen during stable conditions and drainage flow occurs in stable conditions, it is probable that peak pollutant concentrations calculated using the JFD would occur for winds from the northeast. This presents a problem if this data were applied to all locations at the Nevada Test Site because this result is strongly influenced by the orientation of the terrain around the Desert Rock station and is not consistent with other terrain orientations or the regional flow pattern. Thus, using a JFD from a site which is influenced strongly by the local topography may not be the preferred choice even if it is the site closest to the potential pollutant release point.

Besides Desert Rock, two other JFD's were obtained from the National Climatic Data Center : Nellis Air Force Base (for the years 1958 - 1967) and Las Vegas (for the years 1960 - 1964). The Las Vegas data comes from the McCarran International Airport. Both Nellis Air Force Base and McCarran Airport are located near Las Vegas which is located about 65 miles southeast of the Nevada Test Site. Nellis is about 20 miles northeast of McCarran. Figures 2 and 3 show the frequency of occurrences of the winds as a function of wind direction for Nellis and Las Vegas data, respectively. In comparing Figure 2 to Figure 3, the two distribution differ slightly in the direction and magnitude of peak frequency (winds from the south for Nellis and from the southwest for Las Vegas with Las Vegas having the larger peak). The major difference in the wind distributions is that for Nellis there is a secondary peak for winds from the northeast which suggests that there may be some local topography influence at that site. For the Las Vegas data, we don't see this secondary peak. As stated above, if the secondary peak for the Nellis data is due to drainage flow, it is possible that the peak concentrations may be due to winds from the northeast rather than for winds from the south for certain situations. We would expect that the concentration patterns would be different for Nellis than for Las Vegas. Because we are mostly interested in the regional effects and we would like a JFD with the minimal amount of topographic influence, this suggests that the Las Vegas JFD would be the most appropriate for the Nevada Test Site.

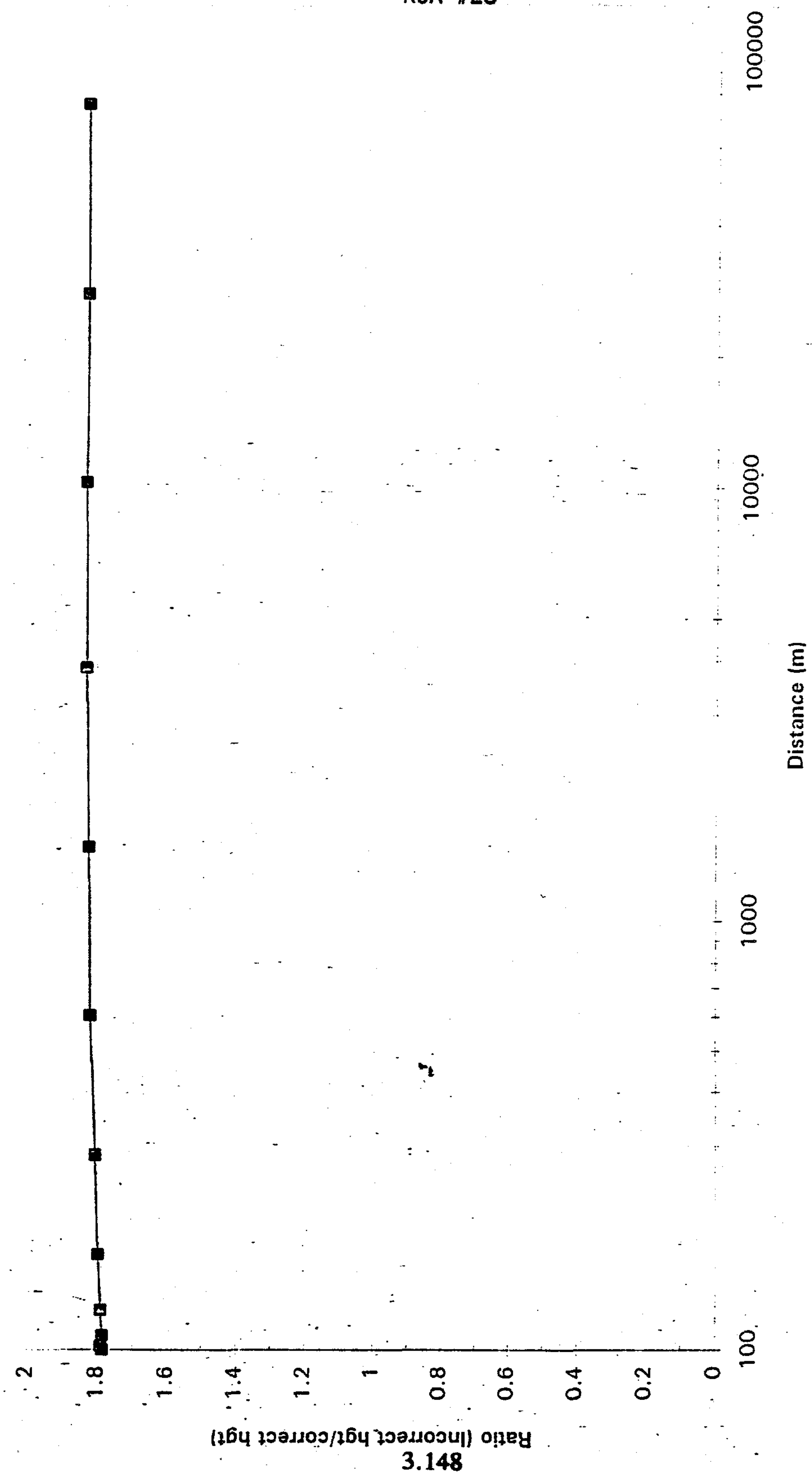

Figure 3. Ratio of Concentrations for Non-Reactive Gases (Yucca Nellis for N direction)

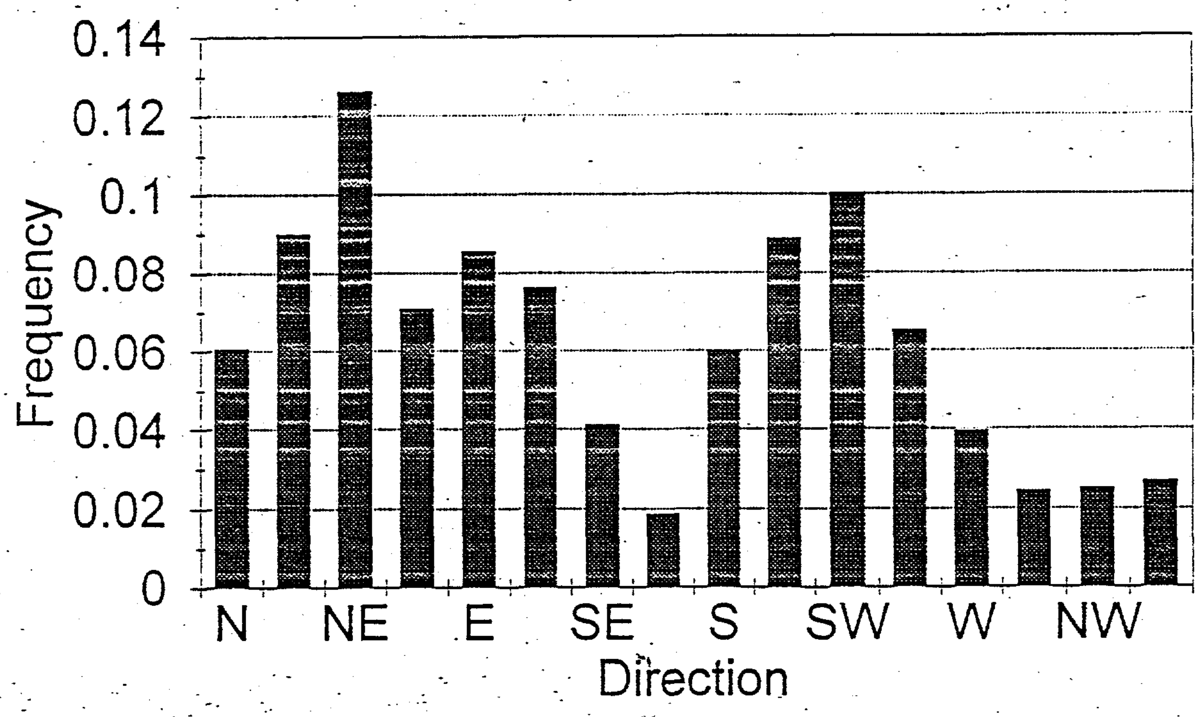

Figure 1. Frequency of Winds by Direction (for the Desert Rock Data)

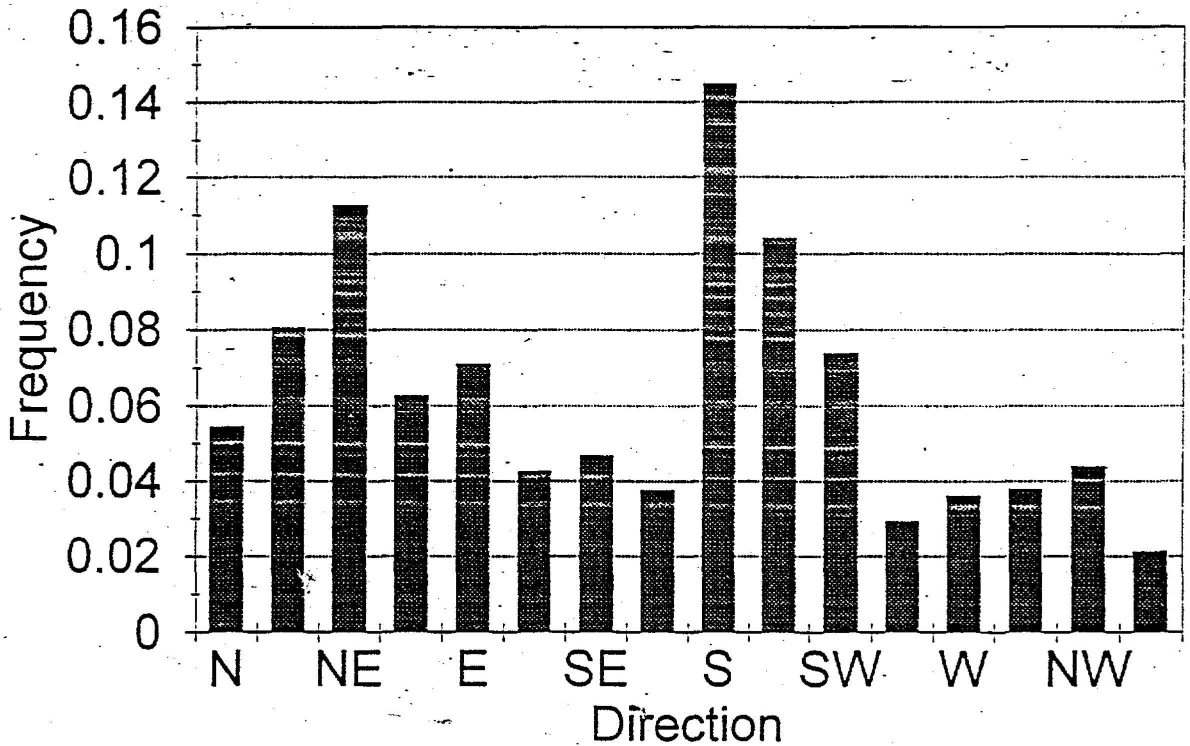

Figure 2. Frequency of Winds by Direction (for the Nellis AFB Data)

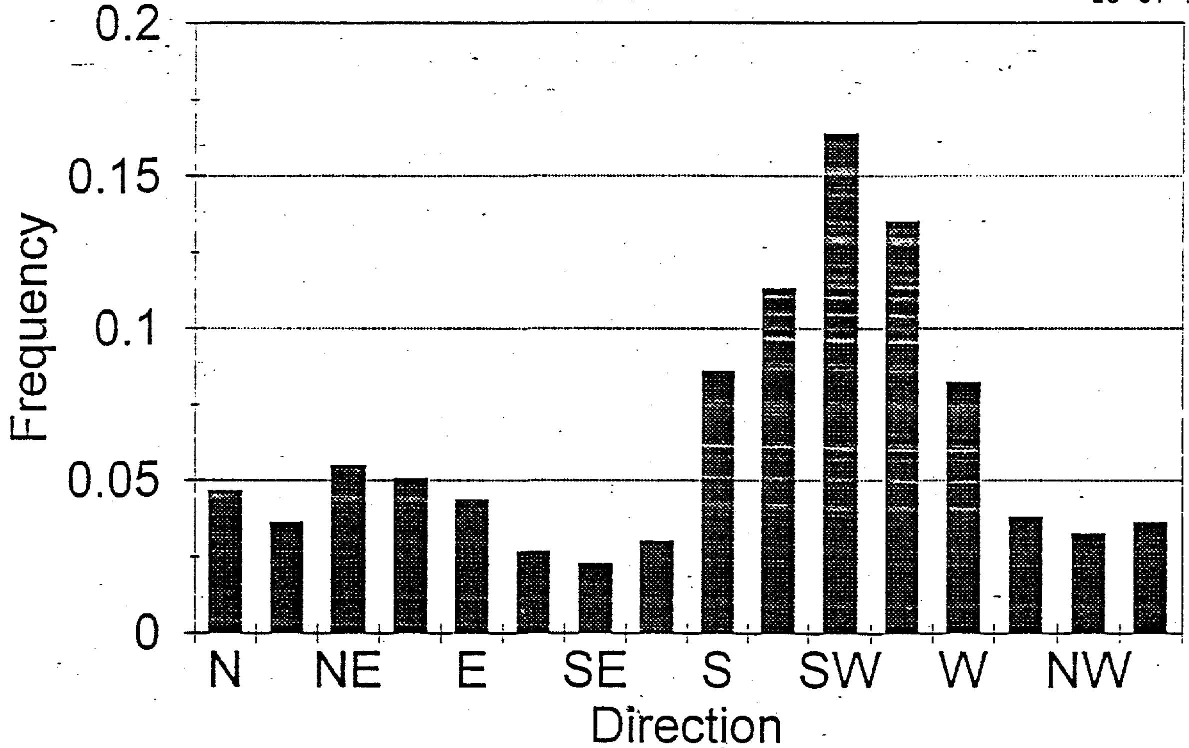

Figure 3. Frequency of Winds by Direction (for the Las Vegas Data)

Record of Assumptions (ROA) Memorandum

To: Gariann Gelston

From: Dennis Strenge

Date: December 21, 1994

Installation ID: General

ROA No.: 029

Subject: Exposure Pathways Selection for URF Analysis

The selection of exposure pathways for the unit risk factor (URF) analysis was driven by the goal of being consistent with Risk Assessment Guidance for Superfund (RAGS) published by EPA (1989), and as implemented by OSWER directives (1991). Sixteen exposure pathways are included among the five exposure media. Of these pathways, 14 were included because they were directly described in the RAGS or OSWER directives. These pathways are:

- soil ingestion
- soil dermal absorption
- fruit ingestion
- vegetable ingestion
- milk ingestion
- meat ingestion
- air inhalation
- volatile chemical inhalation for indoor water uses
- shower dermal absorption
- drinking water ingestion
- swimming water ingestion
- swimming dermal absorption, and
- fish ingestion.

The other three pathway were included to ensure that no potential exposures were underestimated or overlooked. These extra exposure pathways are:

- external dose from contaminated ground
- external dose from air, and
- swimming external dose.

In addition, radionuclide~~s~~ risks were for dermal absorption pathways, even though EPA does not provide guidance on such calculations.

Record of Assumptions (ROA) Memorandum

To:	Gariann Gelston
From:	Dennis Strenge
Date:	December 21, 1994
Installation ID:	General
ROA No.:	030
Subject:	Basis for BEMR URF Analysis

The attached summary report describes assumptions and methods used to evaluate the unit risk factors for the BEMR project.

1.0 INTRODUCTION

The work presented in this report was performed in support of the Department of Energy's Baseline Environmental Management Report (BEMR). PNL was asked to provide technical support by providing estimates of pollutant transport and risk assessments. This report describes the generation of unit risk factors (URFs) to be used as the basis for the BEMR risk assessment.

The BEMR transport and risk assessment analyses were structured to take advantage of precalculated factors, thus allowing timely computation of results. This structuring required generation of unit risk factors to allow a significant reduction in computer computation efforts. The URFs give the human health risk from an exposure scenario per unit concentration of a pollutant in a defined transport medium. The URFs are then multiplied by calculated medium concentrations to obtain an estimate of risk.

The unit risk factor analyses have been performed for the agricultural scenario defined in the Risk Assessment Guidance for Superfund (RAGS), published by EPA (USEPA 1989). The RAGS scenarios were developed as a guide to performing evaluations of risk related to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial investigations (RIs) and the Resource Conservation and Recovery Act (RCRA) facility investigations (FIs).

The RAGS document defines a number of scenarios. The agricultural scenario was chosen because it describes a conservative approach for baseline assessments and includes most exposure pathways. URFs are calculated for the agricultural scenario for an array of media, exposure pathways, and pollutants, as follows:

- Medium soil (per unit mass), soil (per unit area), air, groundwater, and surface water

- Exposure pathway 16 pathways defined

- Pollutant 156 chemicals and 83 radionuclides

The unit risk factors also depend on the pollutant type (i.e., radionuclide, chemical carcinogen, chemical non-carcinogen) and are evaluated appropriately for each pollutant. All chemicals are evaluated for both carcinogenic and non-carcinogenic effects.

Generation of unit risk factors for the BEMR was performed using the most current version of the MEPAS exposure assessment component. This component includes consideration of radioactive chain decay in all parts of the analysis and is referred to in this report as HAZDK (hazards evaluation, decay version, version date 15-Dec-1994).

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December, 1994

The scope of the URF analyses is described in Section 2 which indicates the media, exposure pathways and pollutants for which URFs have been evaluated for the agricultural scenario. Details of the exposure pathway analyses are presented in Section 3.

2.0 SCOPE OF URF ANALYSIS

This section describes the exposure scenarios, media, exposure pathways, and pollutants included in the URF analyses.

2.1 SCENARIO AND MEDIA

The RAGS agricultural scenario is used as the basis for the URF evaluations. This scenario is evaluated for five transport media determined to be necessary for the analysis: 1) soil defined per unit mass, 2) soil defined per unit area, 3) groundwater from wells, 4) surface water, and 5) air. These are the primary media for which pollutant concentrations are known or can be reasonably estimated. Other media are considered in the unit risk factor analyses as appropriate to the scenario and exposure pathways. For example, ingestion of agricultural products is included for use of contaminated water for irrigation of crops. In such cases the secondary medium concentration is evaluated using mathematical models in MEPAS, and the risk from the secondary medium is included in the units risk factors for the primary medium.

The agricultural scenario is intended to represent potential exposures to an individual who may take up residence on the land in the future and use the land for agricultural production. The agricultural scenario includes use of domestic water, production of and exposure to vegetable and animal products, and surface water recreational activities. The exposures are describe as occurring continuously throughout the year (except for surface water recreational activities). All of the media have potential for exposure of the farming individual. Exposure parameters are selected to represent continuous exposure by each pathway. Pathways included in the agricultural scenario are presented in Section 2.2.

2.2 EXPOSURE PATHWAYS

A total of sixteen exposure pathways are considered in the URF analyses. The pathways included in a specific analysis depend on the medium, scenario, and pollutant type (chemical or radionuclide). The exposure pathways appropriate to each analysis are indicated in Table 2.1, for the agricultural scenario. This table also indicates which pathways apply to chemicals and which apply to radionuclides.

TABLE 2.1. Exposure Pathways Included in Agricultural Scenario URF Analyses

Medium	Exposure Pathway	Chemicals	Radionuclides
Soil (mass)	Soil ingestion	yes	yes
	Soil dermal absorption	yes	yes
	External ground dose	no	yes
Soil (area)	Fruit ingestion	yes	yes
	Vegetable ingestion	yes	yes
	Meat ingestion	yes	yes
	Milk ingestion	yes	yes
	Soil dermal absorption	yes	yes
	Soil ingestion	yes	yes
	External ground dose	no	yes
Air	Fruit ingestion	yes	yes
	Vegetable ingestion	yes	yes
	Meat ingestion	yes	yes
	Milk ingestion	yes	yes
	Inhalation	yes	yes
	External air dose	no	yes
Groundwater	Drinking water ingestion	yes	yes
	Shower dermal absorption	yes	yes
	Fruit ingestion	yes	yes
	Vegetable ingestion	yes	yes
	Meat ingestion	yes	yes
	Milk ingestion	yes	yes
	Indoor inhalation of VOCs	yes	Rn222 only
Surface water	Drinking water ingestion	yes	yes
	Shower dermal absorption	yes	yes
	Fruit ingestion	yes	yes
	Vegetable ingestion	yes	yes
	Meat ingestion	yes	yes
	Milk ingestion	yes	yes
	Fish ingestion	yes	yes
	Swimming water ingestion	yes	yes
	Swimming dermal absorption	yes	yes
	Swimming external dose	no	yes
	Indoor inhalation of VOCs	yes	Rn222 only

2.3 POLLUTANTS

The pollutants included in the analysis were selected based on lists provided by project staff. The list of chemicals is given in Table 2.2 and the list of radionuclides is given in Table 2.3. In some cases, the initial list included chemical compounds, such as beryllium chloride. For the unit risk factor analysis, such pollutants are evaluated as the compound, as well as the individual constituents. For example, beryllium chloride is evaluated as the compound and as beryllium ion. The chemical list indicates such representations.

Table 2.2. Chemicals Included in URF Analyses

Chemical Name	MEPAS CAS
Aluminum (ionic)	7429905
Amonia	7664417
Antimony (ionic)	7440360
Arsenic (ionic)	7440382
Asbestos (croc)	12001284
Barium (ionic)	7440393
Beryllium (ionic)	7440417
Boron (ionic)	7440428
Cadmium (ionic)	7440439
Calcium (ionic)	7440702
Chlorine gas	7782505
Chromic acid	7738945
Chromium VI (ionic)	7440473
Cobalt (ionic)	7440484
Copper (ionic)	7440508
Cyanide ion	57125
Fluoride ion	7782414
Lead (ionic)	7439921
Lithium ion	7447418
Magnesium (ionic)	7786303
Manganese (ionic)	7439965
Mercury (ionic)	7439976
Nickel (ionic)	7440020
Nitrate ion	14797558
Nitric acid	7697372
Phosphate ion	7601549
Potassium hydroxide	1310583
Selenium (ionic)	7782492
Silver (ionic)	7440224
Sodium bichromate	10588019
Sodium hydroxide	1310732
Sodium (ionic)	7647145
Sulfate ion	12808798
Thallium (ionic)	7440280
Tin (ionic)	7440315
Tributyl phosphate	126738
Uranium (ionic)	7440611
Vanadium (ionic)	7440622
Zinc compounds	7646857
bis(2et-hexyl)phthlt	117817
Chrysene	218019
Ethylene glycol	107211
gamma-HCCH (Lindane)	58899
Hydraulic Fluid	HYDR FLU
Indeno(1,2,3-cd)pyre	193395
Motor Oil	MOTOR OL
Phenol	108952
1,1-Dichloroethylene	75354
1,1,1-Trichloroethan	71556
1,1,2-Trichloroethan	79005
1,1-Dichloroethane	75343
1,2-Dichlorobenzene	95501
1,2-Dichloroethane	107062

Chemical Name	MEPAS CAS
1,2-Dichloroethylene	156605
1,3-Dichlorobenzene	541731
1,4-Dichlorobenzene	106467
1,4-Dioxane	123911
2-Methylnaphthalene	91576
Acenaphthylene	208968
Acetone	67641
Alpha-hexachlorocycl	319846
Anthracene	120127
Aroclor 1254 (pcb)	11091691
Aroclor 1260 (pcb)	11096825
Benzene	71432
Benzo(a)anthracene	56553
Benzo(a)pyrene	50328
Benzo(b)fluoranthene	205992
Benzo(k)fluoranthene	207089
beta - HCCH	319857
Carbon disulfide	75150
Carbon tetrachloride	56235
Chlordane	57749
Chlorobenzene	108907
Chlorodibromomethane	124481
Chloroethane	75003
Chloroform	67663
Chloromethane(methy)	74873
DDD	72548
DDE	72559
Di-n-butyl phthalate	84742
Diesel Fuel	DIESEL F
EDTA	60004
Endrin	72208
Ethane	74840
Ethyl acetate	141786
Ethylbenzene	100414
Fluoranthene	206440
Fluorene	86737
Freon 113	76131
Fuel Oil #2	FUEL OIL
Gasoline	8006619
Hexanes	110543
HMX (h-no2 tetzocine	2691410
Isobutane	75285
Isopropyl alcohol	67630
Kerosene	8008206
Methanol	67561
Methyl ethyl ketone	78933
Methylene chloride	75092
N-Dodecane	112403
N-nitrosodiphnylamne	86306
N-nitrosodipropylami	621647
Naphthalene	91203
Octane	111659
PCBs (general)	1336363

Chemical Name	MEPAS CAS
Pentachlorophenol	87865
PETN	78115
Phenanthrene	85018
Propane	74986
Pyrene	129000
RDX 6h-3no2-triazine	121824
Tetrachloroethylene	127184
TNT 3no2-toluene	118967
Toluene	108883
Tribromomethane	75252
Trichloroethylene	79016
Trichloromonofluorom	75694
Trimethylbenzene	25551137
Vinyl chloride	75014
Xylene (mixed)	1330207
n-Butane	106978
n-Pentane	109660
o-Xylene	95476
4-Methyl-2-pentanone	108101
Benzoic acid	65850
Beryllium chloride	7787475
Chromium III	CR-III
Dibenzo(a,h)antrac	53703
Stryene-butadiene	9003558
Strontium ion	10476854
Iron	15438310
Potassium ion	7447407
Sulfuric Acid	7664939
1,2,4-Trichlorobnzne	120821
2,4-Dinitrotoluene	121142
2-Chlorophenol	95578
2-Hexanone	591786
2-Methylphenol	95487
DDT	50293
4-Methylphenol	106445
Acenaphthene	83329
Bromodichloromethane	75274
Isophorone	78591
Aldrin	309002
Delta-BHC	319868
Endosulfan I	115297A
Endosulfan II	115297B
Heptachlor	76448
Diethyl Phthalate	84662
Molybdenum	7439987
Phosphoric Acid	7664382
allyl alchohol	107186
Trichloromonofluoro	75694
Mineral Oil	8012951
Tetrahydro furan	109999

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Table 2.3. Radionuclides Included in URF Analyses

Subject to changes, Bill

Radionuclide	Radionuclide	Radionuclide
Ac225	I131	Rn222
Ac227	K40	Ru103
Am241	Kr85	Ru106
Am243	Mn54	S35
Be7	Na22	Sb124
Bi210	Nb95	Sb125
C14	Ni63	Sr89
Cd109	Np237	Sr90
Ce144	Np239	Ta182
Ce144	P32	Tc99
Cf252	Pa231	Te125M
Cm242	Pa233	Th227
Cm244	Pb210	Th228
Cm248	Pb212	Th229
Co56	Pm147	Th230
Co57	Po210	Th231
Co58	Pu238	Th232
Co60	Pu239	Th234
Cs134	Pu240	U232
Cs137	Pu241	U233
Eu152	Pu242	U234
Eu154	Ra223	U235
Eu155	Ra224	U236
Fe55	Ra225	U238
H3	Ra226	Y90
H3-EL	Ra228	
I129		

2.4 RISK AND EXPOSED INDIVIDUAL REPRESENTATION

The URF analyses are intended to provide estimates of health impacts per unit concentration in a medium. The health impact measure for carcinogenic chemicals and radionuclides is the lifetime cancer incidence from intake received during a defined exposure duration. For non-carcinogenic chemicals the health impact measure is the hazard index, which is the ratio of the average daily intake to the reference dose (evaluated for ingestion and inhalation intake routes).

For each pollutant, the health impacts are added across all exposure pathways for a given medium (see the exposure pathway list in Section 2.2). This addition is performed by adding URFs. Because it is desired to add health impacts, it is necessary to ensure that all exposure pathways (for a given medium) are evaluated in a consistent manner with respect to representation of the individual and exposure duration. To ensure this consistency, some of the exposure conditions recommended in RAGS have been modified slightly. All URF analyses are based on exposure of an adult. The use of a "composite adult" is included for those exposure pathways for which such an approach is recommends. The composite adult is evaluated using child parameter values for 6 years followed by adult parameter values for 24 years, giving a total exposure duration of 30 years. This approach is used for all pollutant types.

The unit risk factors involve normalization to unit concentration of a pollutant in each of the five media. The units of normalization are indicated in Table 2.4.

TABLE 2.4. Media Normalization Units

Medium	Chemicals	Radionuclides
Soil (mass)	mg/kg	pCi/kg
Soil (area)	mg/m^2	pCi/m^2
Air	mg/m^3	pCi/m^3
Groundwater	mg/L	pCi/L
Surface water	mg/L	pCi/L

3.0 UNIT RISK FACTOR GENERATION

This section presents the methods used in the URF generation. The general equation is presented in the next section which describes the method used to perform the analyses using MEPAS. Details of the analyses for each scenario are provided in the following sections.

3.1 METHODS FOR URF EVALUATION

Generation of unit risk factors for the BEMR was performed using the most current version of the MEPAS exposure assessment component, HAZDK. The general method for implementation of HAZDK is described in this section.

The unit risk factors are evaluated using equations and parameters for each exposure pathway. The equations are structured to take advantage of the summary intake factor (SIF) concept presented in the HSBRAM report (DOE 1993). The concept of SIFs involves structuring the intake equations for each exposure pathway in such a way that pollutant independent parameters are separated from the pollutant specific parameters and the initial media concentration. Each exposure pathway model can then be described as the product of three factors: a media concentration, an SIF independent of pollutant, and a factor composed of all pollutant specific parameters. As an example, the drinking water exposure pathway can be described as follows:

$$\text{Intake or Exposure} = C_{mi}\, PF_{mix}\, SIF_{smyx} \qquad (1)$$

where Intake = average daily intake of chemical pollutants (mg/kg•d) or = total intake or exposure received over the exposure duration (pCi or hr)

C_{mi} = concentration of pollutant i, of type y, in medium m (mg or pCi per unit quantity of medium L, kg, m^3, or m^2)

PF_{mix} = pollutant specific factor for medium m, pollutant i, and exposure pathway x (units specific to analysis),

SIF_{smyx} = Summary Intake Factor for scenario s, medium m, polutant type y, and exposure pathway x (units specific to analysis). Only the agricultural scenario was evaluated in the BEMR analysis.

The SIF values are evaluated for each toxicity type: nc - non-carcinogenic chemicals, cc - carcinogenic chemicals, and ra - radionuclides. The appropriate SIF is used for each pollutant for the exposure pathway of concern.

The program HAZDK allows the user to define SIF values for each exposure pathway. The pollutant specific parameters are taken from the MEPAS database and combined with the SIF values and unit media concentrations to provide the unit risk factors.

The following sections define details of methods for evaluation of UDFs. Section 3.1.1 identifies the methods used to estimate the health impacts from radionuclide the intake or exposure evaluated by Equation (1). Section 3.1.2 provides similar information for chemicals. Section 3.2 defines the SIFs for the agricultural scenario. Section 3.3 identifies pollutant specific parameters and analyses applied to each exposure pathway.

3.1.1 Radionuclide URF Health Impact Analysis

The average daily intake and lifetime radiation doses are used to estimate the URFs for the health impact measure appropriate to the pollutant. The cancer incidence risk for radionuclides is evaluated as follows for inhalation exposure pathways,

$$URF_{ih} = Intake_{ih} \, SF_{ih} \quad (2)$$

and for ingestion exposure pathways,

$$URF_{ig} = Intake_{ig} \, SF_{ig} \quad (3)$$

where URF_{ih} = unit risk factor for an inhalation pathway for radionuclide i (risk per unit medium concentration)

URF_{ig} = unit risk factor for an ingestion pathway for radionuclide i (risk per unit medium concentration)

$Intake_{ih}$ = inhalation intake for radionuclide i for the inhalation pathway of interest (pCi)

$Intake_{ig}$ = ingestion intake for radionuclide i for the ingestion pathway of interest (pCi)

SF_{ih} = inhalation slope factor for radionuclide i (risk/pCi)

SF_{ig} = ingestion slope factor for radionuclide i (risk/pCi).

For exposure pathways involving external radiation exposure the URFs are evaluated as follows:

$$URF_{ix} = Exposure_{ix}\, SF_{ix} \tag{4}$$

where URF_{ix} = unit risk factor for an external radiation exposure pathway for radionuclide i (risk per unit medium concentration)

$Exposure_{ix}$ = exposure time for radionuclide i for the external radiation exposure pathway of interest (hr)

SF_{ix} = external exposure slope factor for radionuclide i (risk/hr per pCi/unit medium quantity).

The external slope factors provided in HEAST (EPA 1993) are for use with contaminated soil (pCi/kg soil). For external exposure to air and water, slope factors are generated from radiation dose factors and the default health effects conversion factor of 6.2×10^{-4} risk per rem. For example, the air immersion effective slope factor is evaluated as follows:

$$SF_{ia} = 6.2 \times 10^{-4}\, DF_{ia} \tag{5}$$

where SF_{ia} = air immersion slope factor for radionuclide i (risk/hr per pCi/m^3)

DF_{ia} = air immersion dose rate factor for radionuclide i (rem/hr per pCi/m^3)

6.2×10^{-4} = cancer incidence conversion factor (risk/rem).

3.1.1 Chemical URF Health Impact Analysis

The intake parameter for chemical exposures is the average daily intake for a chemical by either ingestion or inhalation. For carcinogenic chemicals the intake is the average over the lifetime of the individual (70 years), and for non-carcinogenic chemicals this is the average over the 30 years exposure duration for the agricultural scenario).

The lifetime cancer incidence risk for chemical ingestion exposures is evaluated as follows:

$$URF_{ig} = Intake_{ig}\, SF_{ig} \tag{6}$$

where URF_{ig} = unit risk factor for chemical carcinogen i from an ingestion exposure pathway g (risk/unit medium concentration)

$Intake_{ig}$ = average daily intake of chemical i from ingestion pathway g (mg/kg/d)

SF_{ig} = ingestion slope factor for chemical i (risk per mg/kg/d).

The lifetime cancer incidence risk for inhalation is evaluated in a similar manner as follows:

$$URF_{ih} = Intake_{ih}\, SF_{ih} \tag{7}$$

where URF_{ih} = unit risk factor for chemical carcinogen i from an inhalation exposure pathway h (risk/unit medium concentration)

$Intake_{ih}$ = average daily intake of chemical i from inhalation pathway h (mg/kg/d)

SF_{ih} = inhalation slope factor for chemical i (risk per mg/kg/d).

The health impact parameter for non-carcinogenic chemicals is the hazard index, evaluated as follows for ingestion pathways:

$$URF_{ig} = Intake_{ig} / RfD_{ig} \tag{8}$$

where URF_{ig} = unit risk factor for chemical non-carcinogen i from an ingestion exposure pathway g (hazard index/unit medium concentration)

$Intake_{ig}$ = average daily intake of chemical i from ingestion pathway g (mg/kg/d)

RfD_{ig} = ingestion reference dose for chemical i (mg/kg/d).

The hazard index for inhalation is evaluated in a similar manner as follows:

$$URF_{ih} = Intake_{ih} / RfD_{ih} \tag{9}$$

where URF_{ih} = unit risk factor for chemical non-carcinogen i from an inhalation exposure pathway h (hazard index/unit medium concentration)

$Intake_{ih}$ = average daily intake of chemical i from inhalation pathway h (mg/kg/d)

RfD_{ih} = inhalation reference dose for chemical i (mg/kg/d)

Dermal exposures are evaluated as equivalent to ingestion exposures with correction for the fractional absorption of the chemical in the gastrointestinal tract. This correction is indicated in Section 3.6 in definition of the pollutant specific parameters (PFs).

3.2 AGRICULTURAL SCENARIO SIF EVALUATION

The agricultural exposure scenario is based on exposures over a 30-year exposure duration. Evaluation of unit risk factors for the agricultural scenario is described in the following sections for each exposure pathway for each medium.

3.2.1 Medium: Soil (mass)

The agricultural scenario exposure pathways for soil (per unit mass) are: ingestion of agricultural products (vegetables, fruit, meat, and milk), soil ingestion, soil dermal absorption, and external exposure to ground contamination.

The soil ingestion pathway is evaluated for a daily effective soil ingestion rate of 255 mg/d. The soil dermal contact pathway is evaluated for one contact event per day, a skin contact area of 2,500 cm^2 for a child (6 years) and 5,000 cm^2 for an adult (24 years), a soil adherence factor of 0.2 mg/cm^2. External exposure is assumed to occur 24 hours a day. A shielding factor of 0.8 is applied. The vegetable ingestion pathway is modelled in the HAZDK analyses as "leafy vegetables" with a daily ingestion rate of 80 g/d (accounting for the fraction of the year when food is produced elswhere). The fruit ingestion pathway is modelled as "other vegetables" with a daily ingestion rate of 42 g/d. The daily ingestion rate for meat is 75 g/d and the ingestion rate for milk is 300 g/d. All pathways occur 365 days per year. All pathways occur 365 days per year.

The SIF values for this medium are given in Table 3.1 for each pollutant type and exposure pathway.

TABLE 3.1. Agricultural Scenario Summary Intake Factors: Soil (mass)

Exposure Pathway	Type[a]	SIF Value	Units
Soil ingestion	NC	3.81E-6	kg/(kg d)
	CC	1.63E-6	kg/(kg d)
	RA	1.32E+0	kg
Soil dermal absorption	NC	1.81E-5	kg/(kg d)
	CC	7.75E-6	kg/(kg d)
	RA	9.86E+0	kg
Vegetable Ingestion	NC	1.14E-3	kg/(kg d)
	CC	4.90E-4	kg/(kg d)
	RA	8.77E+2	kg
Fruit Ingestion	NC	6.00E-4	kg/(kg d)
	CC	2.57E-4	kg/(kg d)
	RA	4.60E+2	kg
Meat Ingestion	NC	1.07E-3	kg/(kg d)
	CC	4.59E-4	kg/(kg d)
	RA	8.22E+2	kg/(kg d)
Milk Ingestion	NC	4.29E-3	kg/(kg d)
	CC	1.84E-3	kg/(kg d)
	RA	3.29E+3	L
Soil external	RA	2.10E+5	h

(a) NC - non-carcinogenic chemicals, CC - carcinogenic chemicals, RA - radionuclides

3.2.2 Medium: Soil (area)

Contamination deposited onto soil from atmospheric transport and deposition is modeled as a concentration per unit area of soil. The agricultural scenario URFs for this medium are evaluated for the same pathways as the soil per unit mass medium analyses plus ingestion of fruit, vegetables, meat, and milk.

The exposure parameters are the same as those defined for the soil (mass) medium. The vegetable ingestion pathway is modelled in the HAZDK analyses as "leafy vegetables" with a daily ingestion rate of 80 g/d (accounting for the fraction of the year when food is 80 g/d (accounting fproduced elswhere) . The fruit ingestion pathway is modelled as "other vegetables" with a daily ingestion rate of 42 g/d. The daily ingestion rate for meat is 75 g/d and the ingestion rate for milk is 300 g/d. All pathways occur 365 days per year. The SIF values for each pathway for this medium are given in Table 3.2 for each pollutant type.

TABLE 3.2. Agricultural Scenario Summary Intake Factors: Soil (area)

Exposure Pathway	Type[a]	SIF Value	Units
Soil Ingestion	NC	6.35E-8	m^2/(kg d)
	CC	2.72E-8	m^2/(kg d)
	RA	2.19E-2	m^2
Soil Dermal	NC	3.01E-7	m^2 ev/(kg d)
	CC	1.29E-7	m^2 ev/(kg d)
	RA	1.65E-1	m^2 ev
Vegetable ingestion	NC	1.14E-3	kg/(kg d)
	CC	4.90E-4	kg/(kg d)
	RA	8.77E+2	kg
Fruit ingestion	NC	6.00E-4	kg/(kg d)
	CC	2.57E-4	kg/(kg d)
	RA	4.60E+2	kg
Meat ingestion	NC	1.07E-3	kg/(kg d)
	CC	4.59E-4	kg/(kg d)
	RA	8.22E+2	kg
Milk ingestion	NC	4.29E-3	L/(kg d)
	CC	1.84E-3	L/(kg d)
	RA	3.29E+3	L
Soil External		RA	2.10E+5 h

(a) NC - non-carcinogenic chemicals, CC - carcinogenic chemicals, RA - radionuclides

3.2.3 Medium: Air

Agricultural scenario URFs for air are evaluated for inhalation, external exposure from submersion in the cloud, and consumption of fruits, vegetables, meat, and milk. The air inhalation rate is set to 20 m^3 for the adult and external exposure occurs for 24 hours per day. Inhalation and external exposure occurs for 365 days per year. The vegetable ingestion pathway is modelled in the HAZDK analyses as "leafy vegetables" with a daily ingestion rate of 80 g/d (accounting for the fraction of the year when food is 80 g/d (accounting fproduced elswhere) . The fruit ingestion pathway is modelled as "other vegetables" with a daily ingestion rate of 42 g/d. The daily ingestion rate for meat is 75 g/d and the ingestion rate for milk is 300 g/d. All pathways occur 365 days per year. The SIF values for each pathway for this medium are given in Table 3.3 for each pollutant type.

TABLE 3.3. Agricultural Scenario Summary Intake Factors: Air

Exposure Pathway	Type[a]	SIF Value	Units
Inhalation	NC	2.86E-1	$m^3/(kg\ d)$
	CC	1.22E-1	$m^3/(kg\ d)$
	RA	2.19E+5	m^3
Air external dose	RA	2.63E+5	hr
Vegetable ingestion	NC	1.14E-3	kg/(kg d)
	CC	4.90E-4	kg/(kg d)
	RA	8.77E+2	kg
Fruit ingestion	NC	6.00E-4	kg/(kg d)
	CC	2.57E-4	kg/(kg d)
	RA	4.60E+2	kg
Meat ingestion	NC	1.07E-3	kg/(kg d)
	CC	4.59E-4	kg/(kg d)
	RA	8.22E+2	kg
Milk ingestion	NC	4.29E-3	L/(kg d)
	CC	1.84E-3	L/(kg d)
	RA	3.29E+3	L

(a) NC - non-carcinogenic chemicals, CC - carcinogenic chemicals, RA - radionuclides

3.2.4 Medium: Groundwater

Use of contaminated groundwater in the agricultural scenario includes drinking water, showering, and ingestion of fruits, vegetables, meat, and milk 365 days per year. The exposure pathways involved in these uses are: drinking water, shower water dermal absorption, and indoor inhalation of volatile compounds, and ingestion of homegrown fruit, vegetables, meat, and milk. Individuals are assumed to drink 2 L of contaminated water and take 1 shower of 12 minutes duration per day. The inhalation rate is 15 m^3/d and the indoor air volatilization factor is 0.5 for volatile chemicals and 0.1 for Rn222. Dermal exposure in the shower is evaluated for a skin area of 20,000 cm^2. The vegetable ingestion pathway is modelled in the HAZDK analyses as "leafy vegetables" with a daily ingestion rate of 80 g/d (accounting for the fraction of the year when food is produced elsewhere). The fruit ingestion pathway is modelled as "other vegetables" with a daily ingestion rate of 42 g/d. The daily ingestion rate for meat is 75 g/d and the ingestion rate for milk is 300 g/d. All pathways occur 365 days per year. The SIF values for each pathway for this medium are given in Table 3.4 for each pollutant type.

TABLE 3.4. Agricultural Scenario Summary Intake Factors: Groundwater

Exposure Pathway	Type[a]	SIF Value	Units
Water ingestion	NC	2.86E-2	L/(kg d)
	CC	1.22E-2	L/(kg d)
	RA	2.19E+4	L
Indoor inhalation	NC	1.07E-1	L/(kg d)
	CC	4.59E-2	L/(kg d)
	RA	1.64E+4	L
Vegetable ingestion	NC	1.14E-3	kg/(kg d)
	CC	4.90E-4	kg/(kg d)
	RA	8.77E+2	kg
Fruit ingestion	NC	6.00E-4	kg/(kg d)
	CC	2.57E-4	kg/(kg d)
	RA	4.60E+2	kg
Meat ingestion	NC	1.07E-3	kg/(kg d)
	CC	4.59E-4	kg/(kg d)
	RA	8.22E+2	kg
Milk ingestion	NC	4.29E-3	L/(kg d)
	CC	1.84E-3	L/(kg d)
	RA	3.29E+3	L

(a) NC - non-carcinogenic chemicals, CC - carcinogenic chemicals, RA - radionuclides

3.2.5 Medium: Surface Water

Unit risk factors for surface water are evaluated in the agricultural scenario for ingestion of drinking water, showering, ingestion of fish, exposure related to swimming, and ingestion of fruit, vegetables, meat, and milk. All exposure pathways are assumed to occur 365 days per year except swimming which occurs 7 days per year.

The exposed individual is assumed to drink 2 L of contaminated water per day. The inhalation rate is 15 m^3/d and the indoor air volatilization factor is 0.5 for volatile chemicals and 0.1 for Rn222. Dermal exposure while showering is evaluated for a skin area of 20,000 cm^2. The exposure time for swimming is 2.6 hr/d. Dermal exposure while swimming is evaluated for a skin area of 20,000 cm^2. Inadvertant ingestion of water while swimming is 50 ml/hr. The vegetable ingestion pathway is modelled in the HAZDK analyses as "leafy vegetables" with a daily ingestion rate of 80 g/d (accounting for the fraction of the year when food is produced elsewhere). The fruit ingestion pathway is modelled as "other vegetables" with a daily ingestion rate of 42 g/d. The daily ingestion rate for meat is 75 g/d and the ingestion rate for milk is 300 g/d. The exposed individual catches enough fish from the contaminated surface water body to ingest 54 g/d edible fish each day of the year. The SIF values for each pathway for this medium are given in Table 3.5 for each pollutant type.

TABLE 3.5. Agricultural Scenario Summary Intake Factors: Surface Water

Exposure Pathway	Type[a]	SIF Value	Units
Water ingestion	NC	2.86E-2	L/(kg d)
	CC	1.22E-2	L/(kg d)
	RA	2.19E+4	L
Water dermal absorption	NC	5.71E-2	L h/(kg d cm)
	CC	2.45E-2	L h/(kg d cm)
	RA	4.38E+4	L h/cm
Indoor inhalation	NC	1.07E-1	L/(kg d)
	CC	4.59E-2	L/(kg d)
	RA	1.64E+4	L
Fish ingestion	NC	7.71E-4	L/(kg d)
	CC	3.31E-4	L/(kg d)
	RA	5.92E+2	L
Swimming dermal absorption	NC	1.43E-2	L h/(kg d cm)
	CC	6.11E-3	L h/(kg d cm)
	RA	1.09E+4	L h/cm
Swimming water Ingestion	NC	3.56E-5	L/(kg d)
	CC	1.53E-5	L/(kg d)
	RA	2.73E+1	L
Swimming external dose	RA	5.47E+2	h
Vegetable ingestion	NC	1.14E-3	kg/(kg d)
	CC	4.90E-4	kg/(kg d)
	RA	8.77E+2	kg
Fruit ingestion	NC	6.00E-4	kg/(kg d)
	CC	2.57E-4	kg/(kg d)
	RA	4.60E+2	kg

Meat ingestion	NC	1.07E-3	kg/(kg d)
	CC	4.59E-4	kg/(kg d)
	RA	8.22E+2	kg
Milk ingestion	NC	4.29E-3	L/(kg d)
	CC	1.84E-3	L/(kg d)
	RA	3.29E+3	L

(a) NC - non-carcinogenic chemicals, CC - carcinogenic chemicals, RA - radionuclides

Record of Assumptions (ROA) Memorandum

To: File

From: R. Von Burg

Date: 12-21-94

Installation ID: Nevada Test Site

ROA Number: 031

Subject: Assumptions included in the conceptual site model description.

Memorandum

1. The primary concern at this test site is the presence of radioactive materials due to the detonnation of nuclear bombs. There is little industrial waste associated with this site other than was was found in the Site Inventory List.

2. The PEIS data base was the primary source for determining the COIs

3. The current population on the site is adequately maintained by the available supply of groundwater.

4. There is nonperennial surface water available for agricultural purposes and obtaining groundwater for live stock and feed is too expensive. Endemic plants are insufficient to maintain live stock.

5. there is insufficient surface water available to maintain a sufficient supply of "game" as a primary source of nutrition for the hypothetical receptors.

6. Groundwater is sufficient to maintain homegrown produce, bathing and drinking for the hypothetical receptors.

7. Contaminated groundwater is capable of migration off-site.

Record of Assumptions (ROA) Memorandum

To: File

From: R. Von Burg

Date: 12-21-94

Installation ID: Nevada Test Site

ROA Number: 032

Subject: additional chemicals of interest

Memorandum

A review of the ER SITES INVENTORY LIST (PEIS # 2301) indicates that there are a number of chemicals or substances that have not been entered on the PEIS database. For example:

5 gal can labelled Stoddard Solvent
Bucker w/ PETISOL 202
55 gal drum, full, isopropyl alcohol.
are just three items that have not been listed on the ICF database.

For a complete listing of potential chemicals not on the PEIS database but listed in the site inventory list please consult the table captioned "NTS Contaminants of Interest- not in PEIS" included in the Conceptual Site Model document.

Table 10. COIs-not in PEIS

NTS CONTAMINANTS OF INTEREST - not in PEIS				
INORGANICS				
Non-Radionuclides	***CAS #***	***MEPAS***	***PEIS***	***Other***
Acids	NA	NO	NO	PEIS # 61
Argon	7440371	NO	NO	SIL
Arsenic	7440382	YES	NO	PEIS # 61
Asbestos	12001284	YES	NO	SIL
Caustics	NA	NO	NO	PEIS # 61
Copper	7440508	YES	NO	PEIS # 61
Zinc	7646857	YES	NO	PEIS # 61
Radionuclides/Radiation	***CAS #***	***MEPAS***	***PEIS***	***Other***
Actinium 228	AC228	YES	NO	PEIS 6021
Bismuth 214	BI214	NO	NO	PEIS 6021
Lead 212	PB212	YES	NO	PEIS 6021
Lead 214	PB214	NO	NO	PEIS 6021
Thallium 208	TH208	NO	NO	PEIS 6021
ORGANICS				
Non-Volatiles (< 1.0 E-7 atm/g-mole)	***CAS #***	***MEPAS***	***PEIS***	***Other***
Cutting fluids	NA	NO	NO	PEIS # 61
Volatiles (> 1.0 E-7 atm/g-mole)	***CAS #***	***MEPAS***	***PEIS***	***Other***
Chlorinated Solvents	NA	NO	NO	SIL
Diesel Fuel	Diesel F	YES	NO	SIL
Isopropyl alcohol	67630	YES	NO	SIL
kerosene	8008206	YES	NO	SIL
Stoddard Solvent	NA	NO	NO	SIL
petroleulm solvent	NA	NO	NO	SIL
Petisol 202	NA	NO	NO	SIL

SIL = Site Inventory List

Record of Assumption (ROA) Memorandum

TO:	Mary Jarvis
FROM:	Gariann Gelston
DATE:	December 27, 1994
INSTALLATION ID:	NTS
ROA NO.:	033
SUBJECT:	Boundary Receptor for Timber Mountain

This ROA is a description of the process followed to decide the location of the boundary receptor for Timber Mountain.

Due to Southerly groundwater flow, the boundary receptor location of Timber Mountain is on the Southern border of Area 5 where it intersects with the Eastern border of Area 23.

Record of Assumption (ROA) Memorandum

TO: File

FROM: Mary Jarvis

DATE: December 28, 1994

Installation ID: NTS

ROA No.: 034

SUBJECT: Concurrence with Anchoring Methodology and Site Location

Attached is the documentation of a phone call from Christian Fosmire (PNL) to Rudy Von Berg (CERE) discussing the choice of Site 5 for anchoring of the NTS Installation. In summary, Rudy Von Berg agreed with the choice of Site 5 (although it was his second choice).

A meeting to discuss the proposed anchoring methodology was held with Terri Miley (Anchoring Lead), Gariann Gelston and Mary Jarvis on December 1, 1994. Terri Miley agreed that the proposed methodology was appropriate and authorized the NTS team to proceed with the results. A follow up meeting to discuss the anchoring results was held on December 20, 1994 with Terri Miley, Gariann Gelston, Mary Jarvis, Rudy Von Berg and Mike Easter (CERE).

Terri Miley is currently reviewing the anchoring report and final comments are expected in January 1995.

Battelle
Pacific Northwest Laboratories

Project Number K25180

Internal Distribution

File/LB

Date December 15, 1994

To Mary Jarvis

From Christian Fosmire

Subject Telephone conference with Rudy Von Berg on NTS Anchoring

As instructed, I talked with Rudy Von Berg about using Area 5 to do the anchoring for NTS. After reviewing the site, Rudy said that using Area 5 would be fine. While he would have preferred to use Area 23 which is just south of Area 5 and includes the town of Mercury, he understood that we were limited by the data contained in the PEIS database and stated that Area 5 would be a good second choice.

4.0 Discussion of Unit Factors

This chapter provides a visual picture of the unit transport factor (UTF), unit exposure factor (UEF), and unit risk factor (URF) values for atmospheric and soil exposure routes from contaminated soil. The low precipitation and infiltration rates contribute to zero or very near zero concentrations for the overland and groundwater exposure routes and therefore will not be addressed in this chapter. The volatilization release mechanism will not be discussed because all of the contaminants are inorganic in solid state and do not volatilize under normal conditions. Decay products of the eight selected contaminants will not be discussed but were included in the final risk estimation.

Because unit factors from one component are assumed to be independent of other components, analysis of a factor within a component should not be related to risk estimates. Unit transport factors do not include source-term or exposure and therefore cannot be directly related to risk estimates. The discussion presented in this chapter provides insight into the characteristics and properties of these unit factors by contaminant, environmental, setting, release mechanism, and exposure medium for the NTS.

Based on risk estimates derived from unit factors and source-term information, driver release sites and contaminants were identified for the NTS installation. For this study the driver release sites were located in the Jackass Flats and Timber Mountain environmental settings and the contaminants of concern are ^{241}Am, ^{137}Cs, ^{60}Co, ^{152}Eu, ^{154}Eu, ^{155}Eu, ^{238}Pu, and ^{90}Sr. These two environmental settings and eight contaminants were selected to illustrate the characteristics and properties of the unit factors for the NTS installation.

The purpose for developing unit factors is to estimate public health impacts on an installation or regional basis. The unit factors are created using a modular risk analysis approach (Whelan et al. 1994) that allows the source-term component, environmental fate and transport component, and exposure component of the risk estimate to be conducted concurrently. This approach also permits modifications to one component after the analysis is completed without changing the other factors.

4.1 Unit Transport Factors

The unit transport factors represent the environmental fate and transport component of the modular risk analysis approach. The UTF is the product of unit mass (1g or 1Ci) of a contaminant transported through the appropriate media to the exposure medium (groundwater, surface water, air, or soil). The resulting output is time-varying environmental (air and soil deposition) concentrations at each selected receptor. The units of UTFs are environmental concentration per unit mass of contaminant ([pCi/g]/g or [g/g]/g). For this analysis a hypothetical onsite and boundary (installation fenceline) receptor are evaluated.

Jackass Flats and Timber Mountain represent two very different environmental settings within the NTS. Jackass Flats has higher average temperature, faster average wind speed, and lower annual precipitation then Timber Mountain. This combination of parameters leads to more suspension of contaminated soil and therefore higher air and soil deposition concentrations at the receptors.

In all cases the differences between constituent unit concentrations are because of the varying decay rates of the radionuclides (i.e., ^{241}Am and ^{238}Pu have relatively long halflives compared to ^{60}Co and ^{155}Eu). Table 4.1 shows the halflives of the different radionuclides.

Figure 4.1 displays the onsite receptor air and soil deposition concentrations from the soil suspension transport pathway for the Jackass Flats and Timber Mountain environmental settings. Unit soil deposition concentrations are approximately six orders of magnitude higher than air concentrations because the contaminants are all classified as large particles and deposit quickly making the air concentrations comparatively low.

Figure 4.2 displays the related boundary receptor concentrations for the air and deposited soil pathways. The relative trends of these figures are the same as Figure 4.1 because the same processes are in effect (i.e., halflife and deposition). As seen in Figures 4.3 and 4.4, the relative distance from the release site results in higher onsite concentrations (air and soil deposition) than those calculated for the boundary.

4.2 Unit Exposure Factors

Unit exposure factors represent the exposure medium and pathway factors associated with a unit contaminant environmental concentration (Strenge and Chamberlain 1994). The UEF is the product of

Table 4.1. Constituent Halflives

Constituent	Halflife (years)
^{241}Am	4.33E+02
^{137}Cs	3.12E+01
^{60}Co	5.28E+00
^{152}Eu	1.36E+01
^{154}Eu	8.79E+00
^{155}Eu	4.96E+00
^{238}Pu	8.79E+01
^{90}Sr	2.87E+01

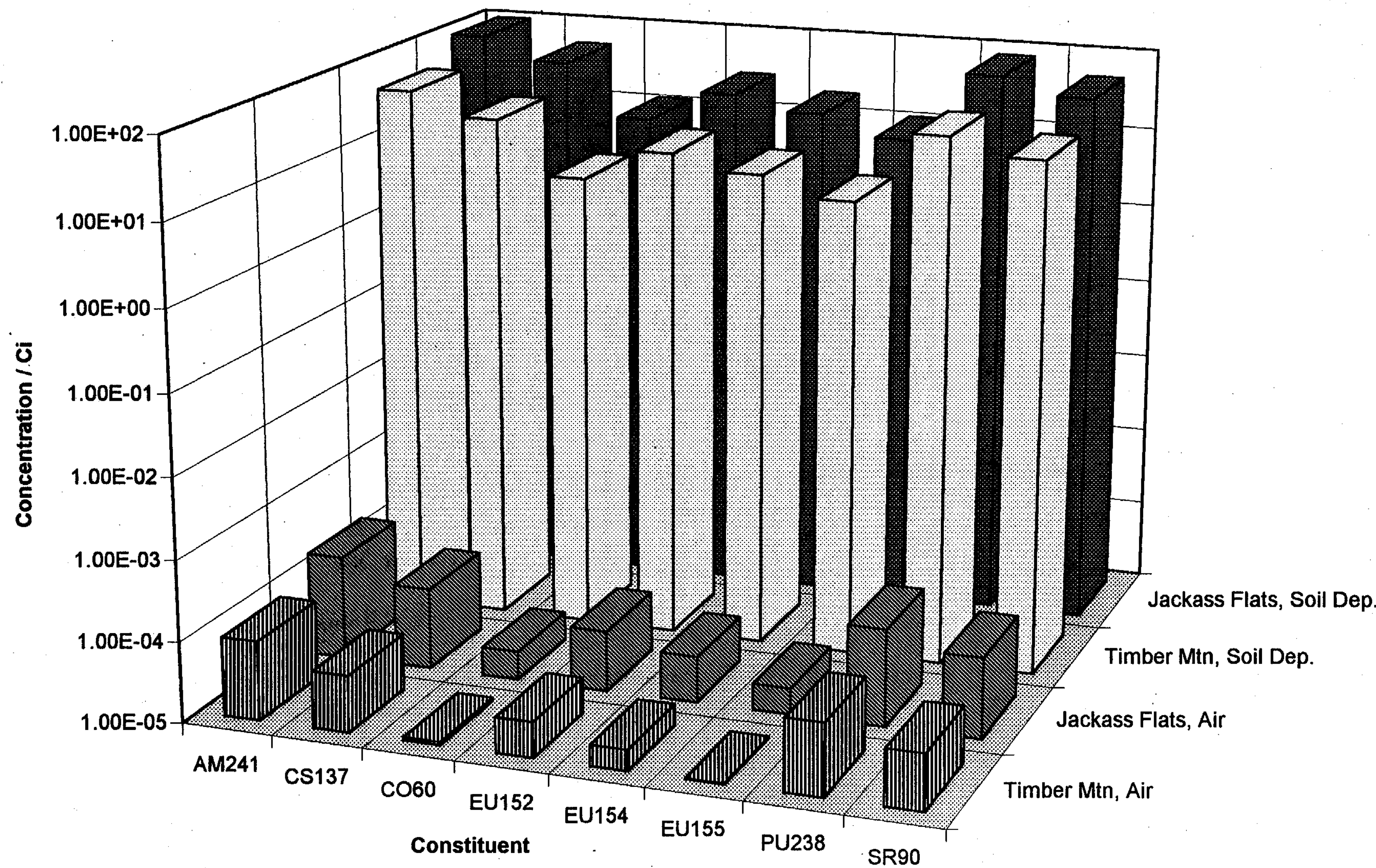

Figure 4.1. Onsite Unit Transport Factors

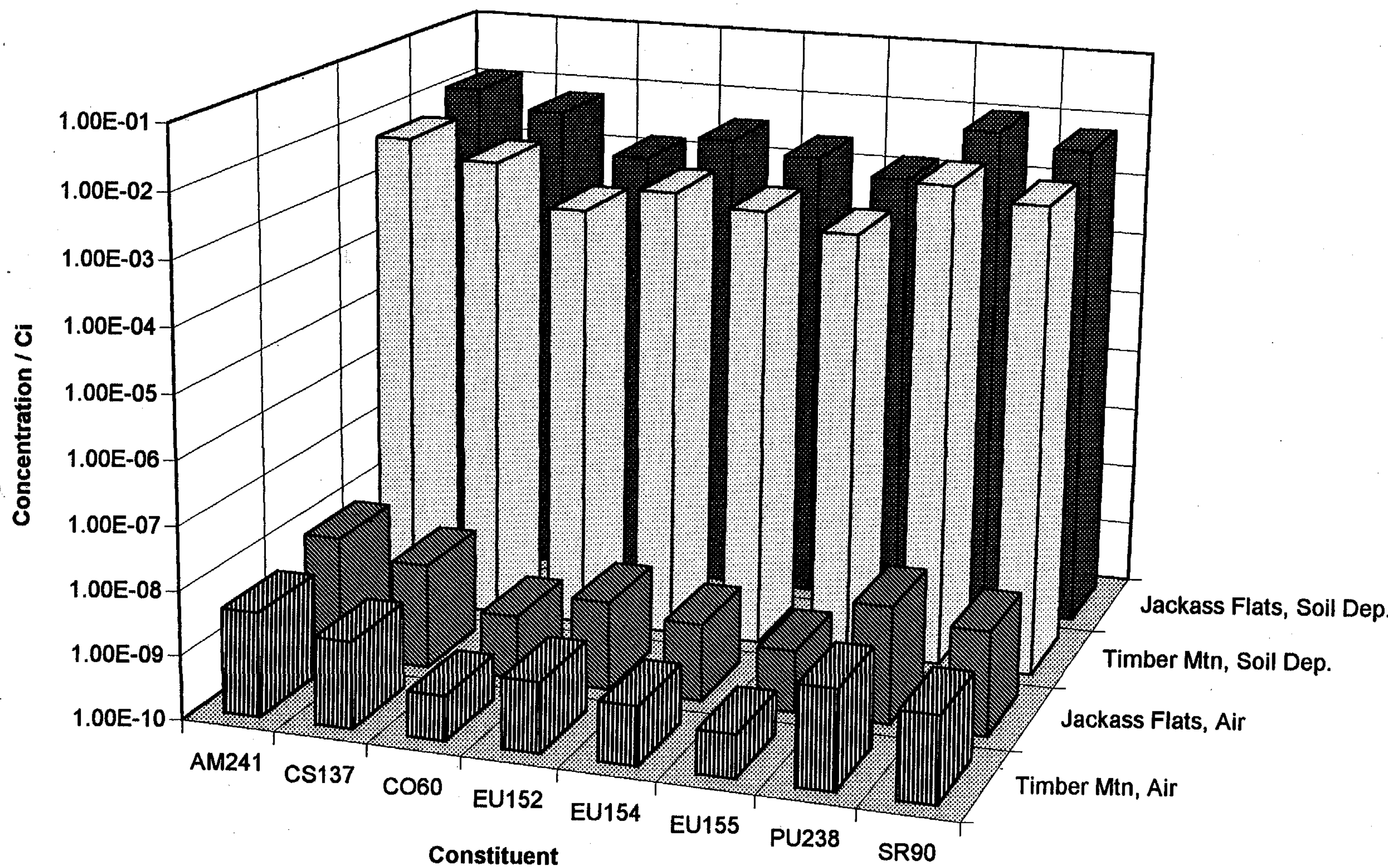

Figure 4.2. Boundary Unit Transport Factors

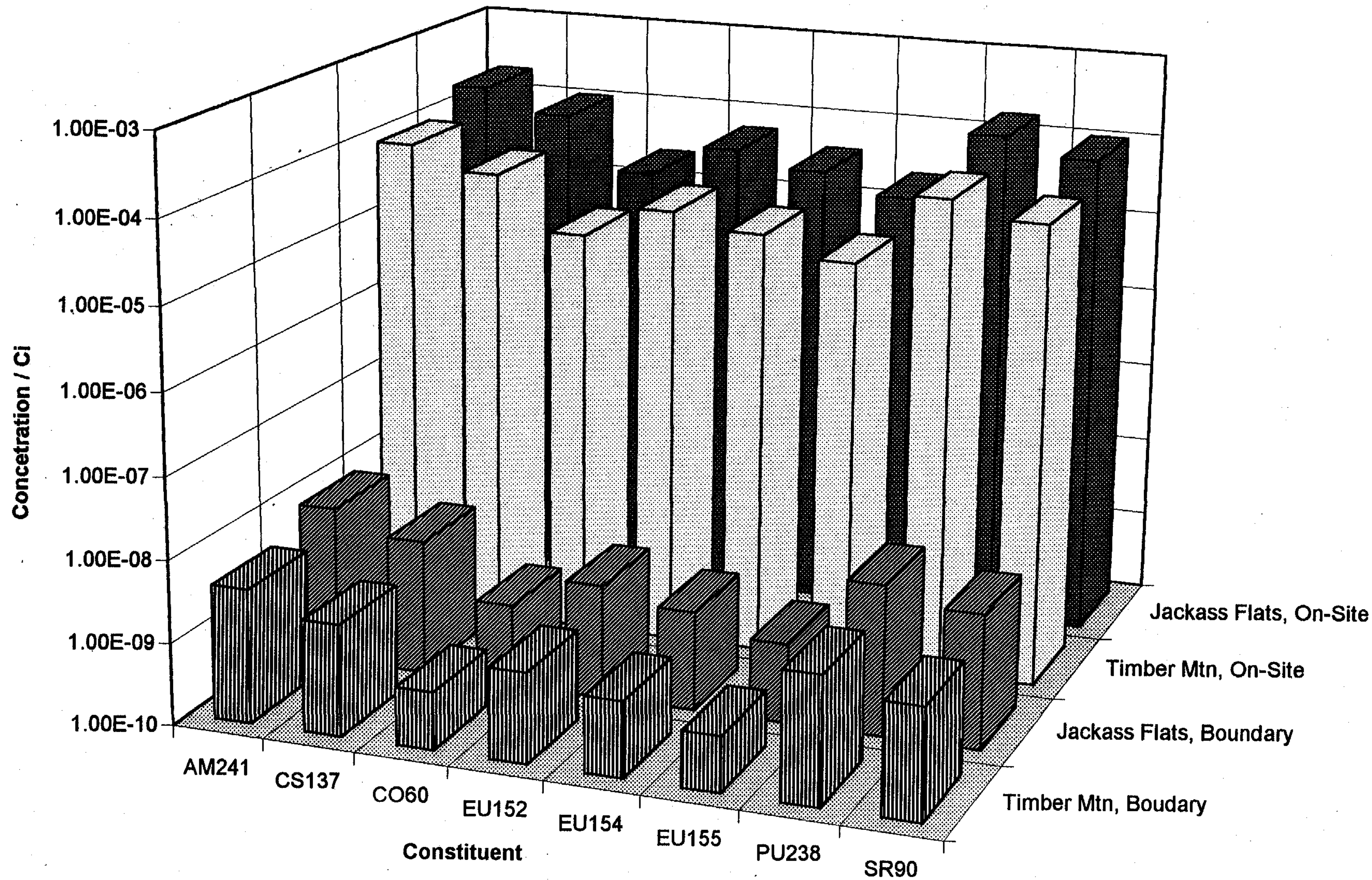

Figure 4.3. Air Unit Transport Factors

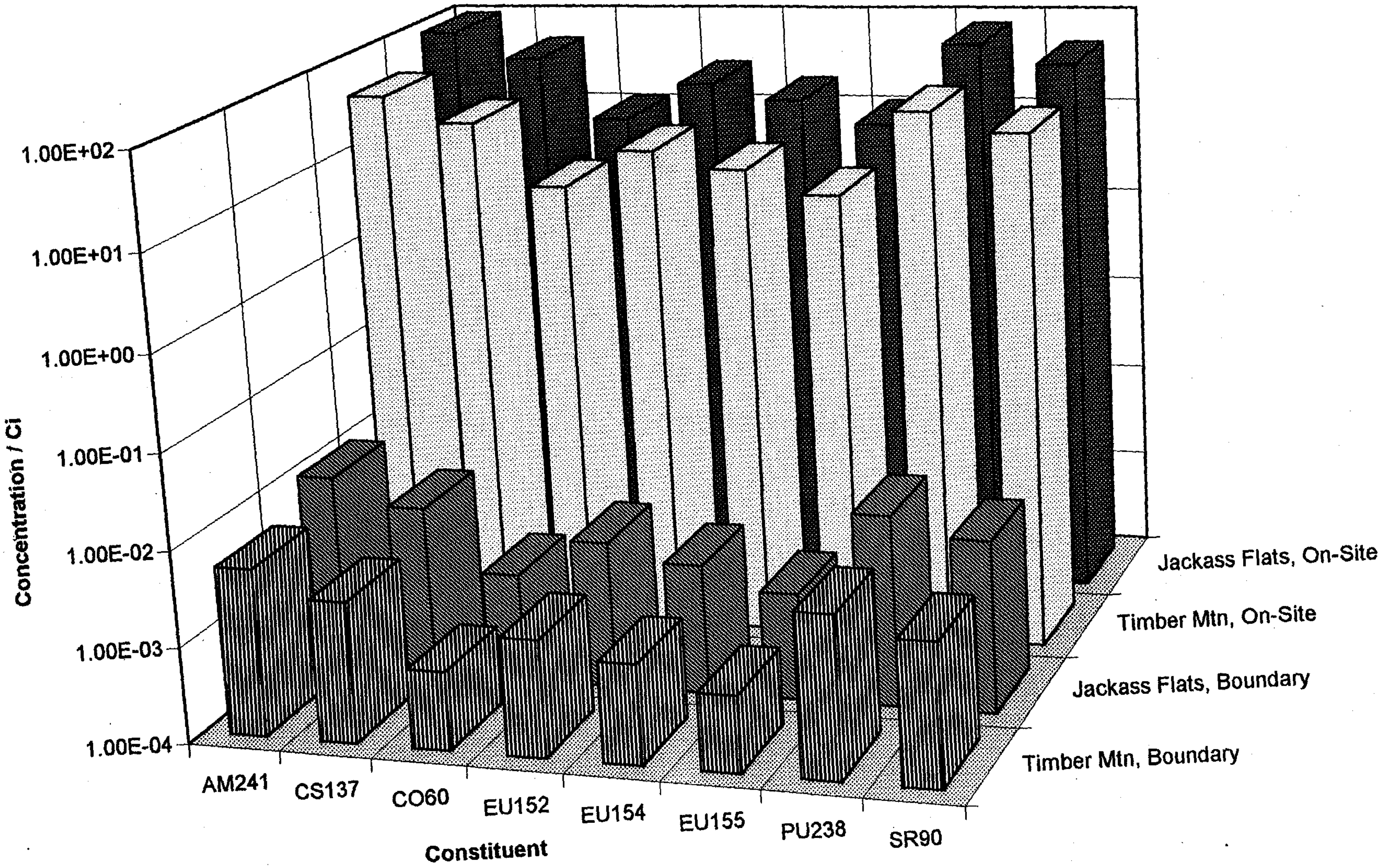

Figure 4.4. Soil Deposition Unit Transport Factors

a unit environmental concentration [unit mass (1g or 1Ci) per unit quantity of medium (L, kg, m^3, or, m^2)], exposure pathway parameters (inhalation rate, ingestion rate, and exposure duration), and health impact factors (slope factor, reference dose factor, and radiation dose conversion factor). The units of the UEF are risk or hazard index (HI) per unit medium concentration (risk/[pCi/g], risk/[g/g], HI/[pCi/g], or HI/[g/g]). The exposure pathways considered in the UEF analyses are presented in Table 2.1 of Section II of this report. A more detailed explanation of the UEF Methodology can be found in Section II of this report.

The UEF types associated with surface soil contamination are direct soil, air, and soil deposition. Figure 4.5 displays the dose factors for the four exposure pathways: ground exposure, ingestion, inhalation, and dermal contact. The exposure pathways associated with direct soil UEFs are direct dermal contact, external radiation dose, and soil ingestion. The exposure pathways associated with air UEFs are soil suspension and inhalation, and agricultural ingestion. The exposure pathways associated with soil deposition UEFs are direct dermal contact, external radiation dose, soil suspension and inhalation, agricultural ingestion, and soil ingestion. Figure 4.6 displays the direct soil, air, and deposited soil exposure factors. Because infiltration is not a driving transport pathway at the NTS, the air exposure scenario generally produced higher UEFs than the direct contact and the deposited soil scenarios.

4.3 Unit Risk Factors

A unit risk factor (URF) is the product of the appropriate UTF and UEF. The URF from a surface soil release site has units of health impact per unit mass (risk/Ci, risk/g, or HI/g). To estimate the risk from a contaminant, the appropriate URF is multiplied by the source inventory. In this report only the unit factors will be discussed (actual source strength not used) and the reader should be cautioned not to infer risk estimates from the results presented.

Because of the bombing activity at the NTS the majority of contaminants at the NTS are radionuclides. Figures 4.7 and 4.8 display the onsite exposure concerns, direct soil, direct radiation, and air/soil deposition unit risk of each radionuclide and both environmental settings considered in this chapter. Because direct soil and direct radiation are exposures from the unit concentrations at the release site (i.e., no transportation takes place before exposure to the individual), Jackass Flats and Timber Mountain yield the same unit risk for each contaminant. The air and soil deposition exposure consists of the combination of air and soil deposition concentrations to produce a URF that accounts for risk exposure from both airborne pathways.

In Figure 4.9 onsite and boundary unit concentrations are displayed for air and soil deposition combined. The higher UEFs from the air media for ^{241}Am and ^{238}Pu (Figure 4.6) magnify the UTFs to produce higher URFs for ^{241}Am and ^{238}Pu. As with the UTFs, onsite URFs are higher than boundary URFs for the respective constituents. The dryer climate at Jackass Flats results in higher URFs than Timber Mountain, as would be anticipated. Because UEFs for direct soil and direct radiation are not considered for a boundary receptor, URFs can not be calculated.

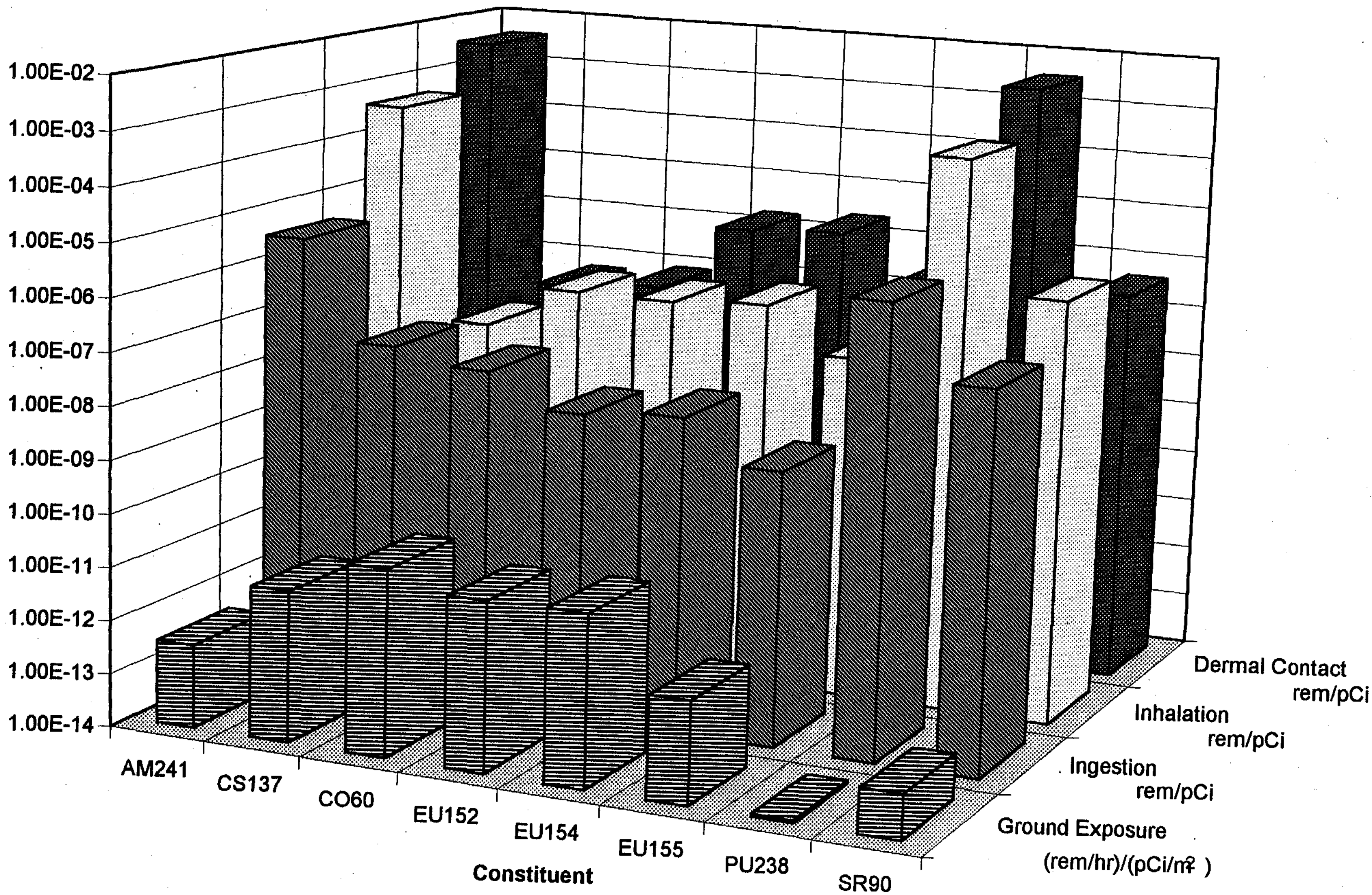

Figure 4.5. Dose Factors

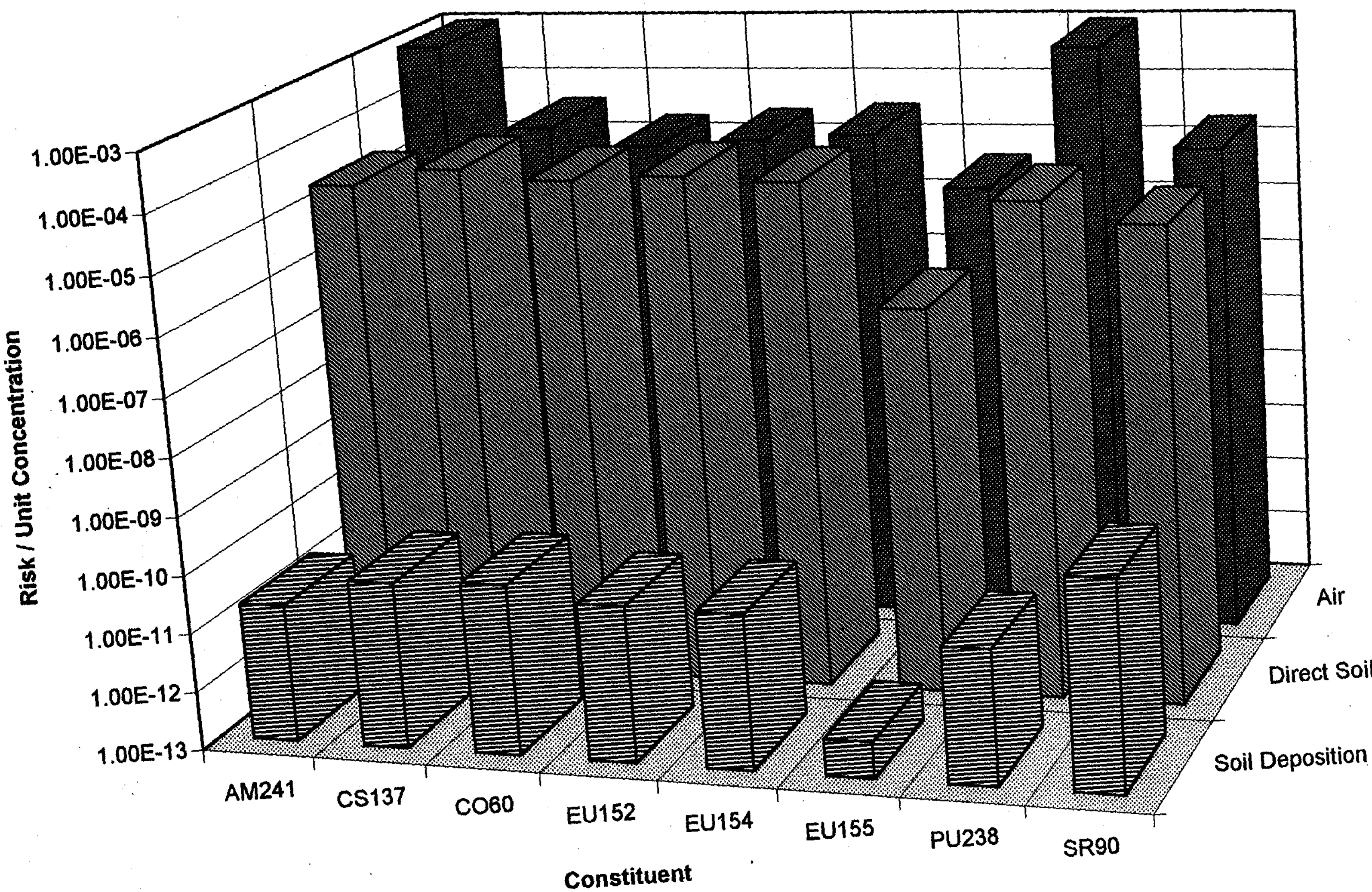

Figure 4.6. Unit Exposure Factors

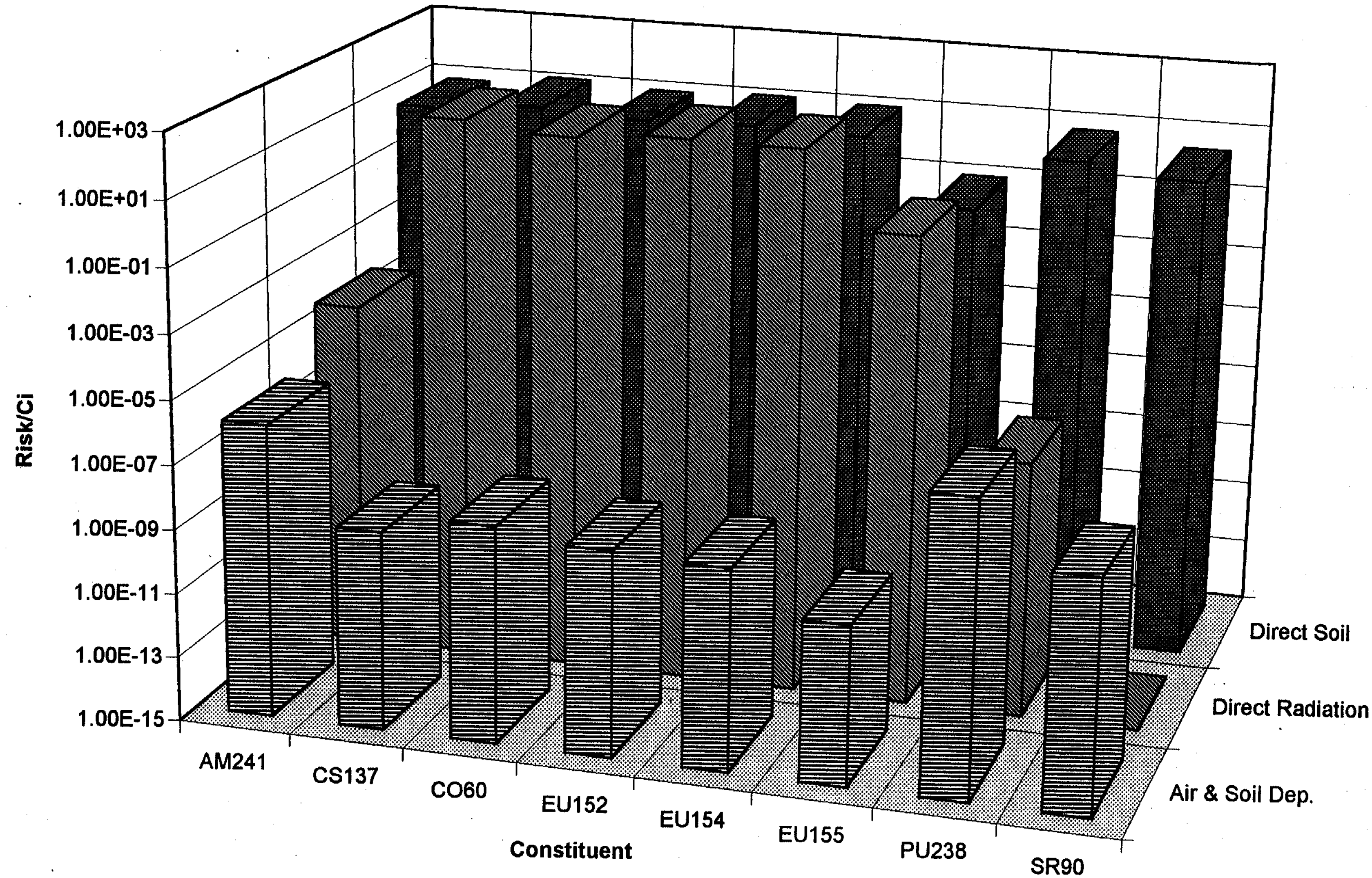

Figure 4.7. Onsite Unit Risk Factors for Jackass Flats

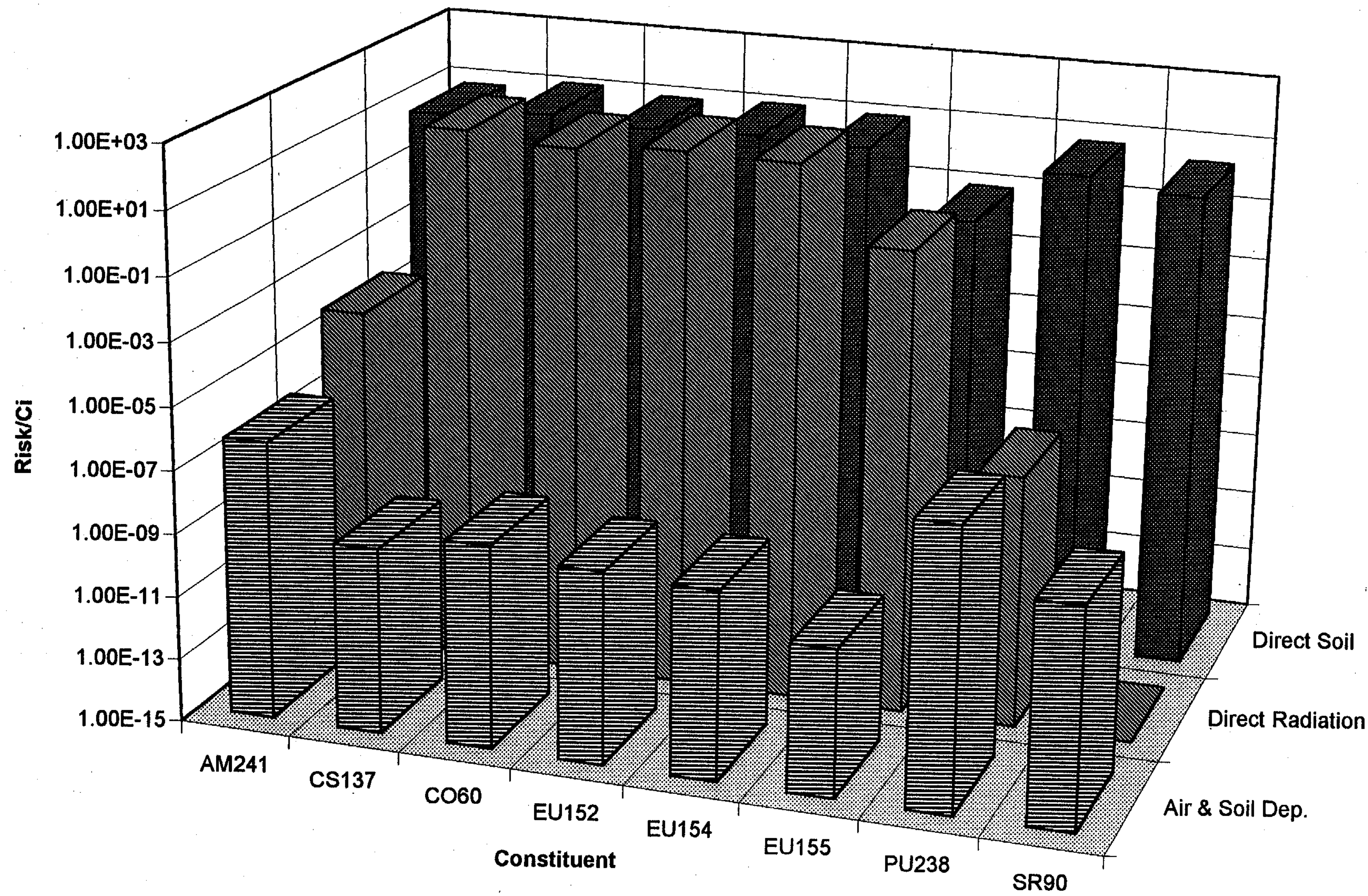

Figure 4.8. Onsite Unit Risk Factors for Timber Mountain

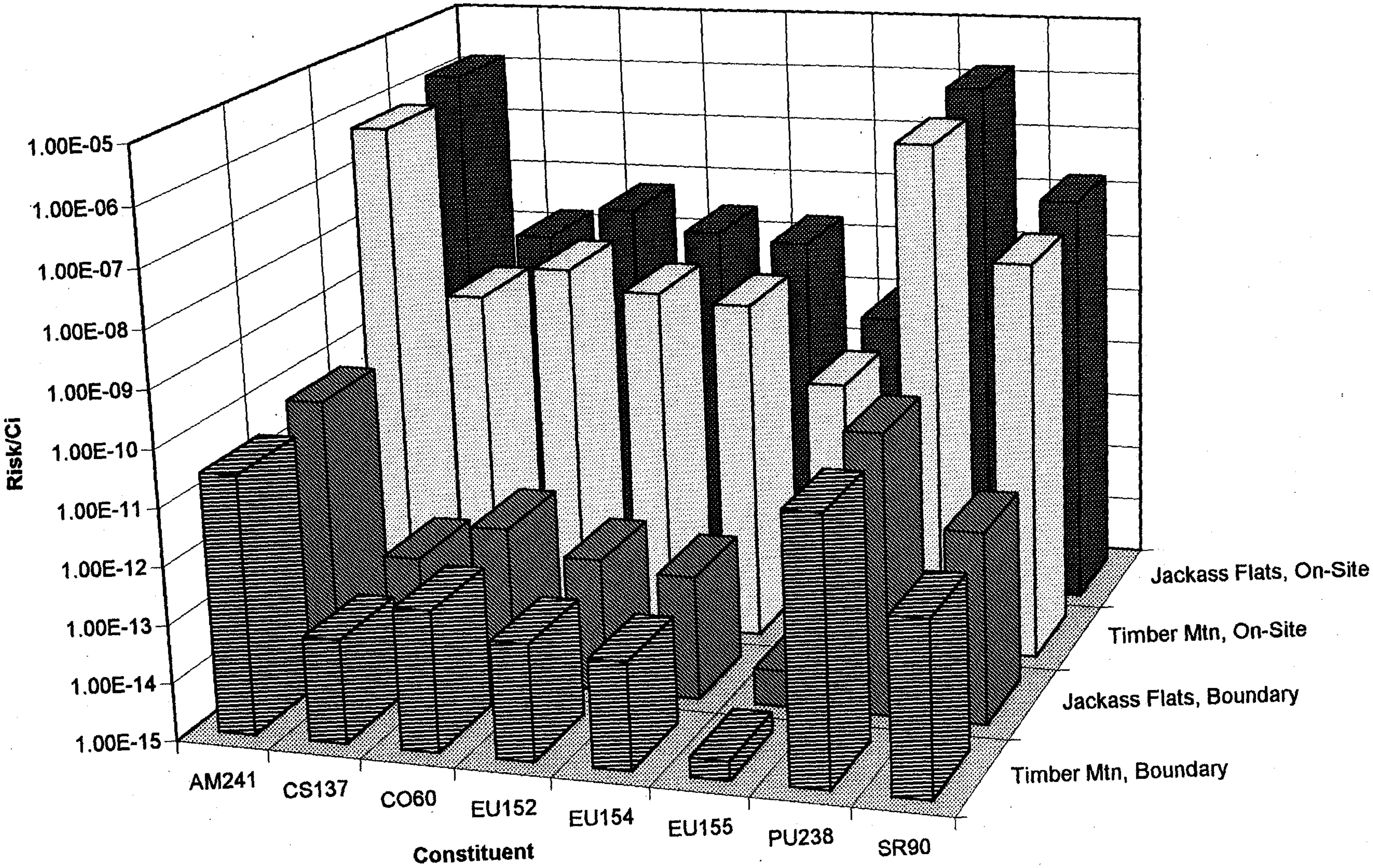

Figure 4.9. Air and Soil Deposition Unit Risk Factors

4.4 Conclusion

The results of the unit factor methodology task of the BEMR project are the development of unit factors (i.e., UTFs, UEFs, and URFs). Note that UTFs, UEFs or URFs by themselves cannot be used to imply resultant risk estimates. This is because unit factors use unit mass to estimate transport and exposure pathways that can be combined with an estimate of the actual mass for a contaminant at a release site. Thousands of these unit factors are generated for the NTS installation. Viewing the UTF, URF, and UEF data in graphical form serves to identify and correct computational errors or inconsistencies. The final URFs are transmitted electronically to BEMR cost task personnel for cost analysis with consideration of the estimated release site inventories.

The majority of the contaminants at the NTS are radionuclides; the eight radionuclides selected for this chapter are believed to be a representation of the radionuclides found at the NTS. It should be noted that some fuels, inorganics, and organics have been detected at the NTS and were considered in the complete analysis of the NTS URFs.

Groundwater and surface water pathways are not considered in this analysis because of low precipitation and very small infiltration rates. Therefore, only surface soil releases into the air have been considered for this illustrative analysis. Buried waste UTFs were calculated but were not considered in the final analysis because actual inventories had not been verified. The soil deposition and atmospheric suspension are the airborne pathways considered along with direct exposure routes of direct soil contact and direct radiation. Volatilization release mechanism were not discussed because all of the contaminants are inorganic in solid state and do not volatilize under normal conditions.

Of the six environmental settings at the NTS, Jackass Flats and Timber Mountain were selected for this analysis because they have the highest risk estimates and they represent the two types of environmental settings at the NTS. Jackass Flats represents a dry flat surface with higher winds than Timber Mountain. Frenchman Flat and Yucca Flat also fall into this type of environmental setting. Timber Mountain represents a mountainous or plateau setting with more precipitation and lower wind speeds. Rainier Mesa and Pahute Mesa fall into this type of environmental setting. Of the driver release sites and contaminants identified for the NTS installation, Jackass Flats yields the highest overall URFs, with the onsite exposure potential being higher than at the boundary receptor. However, when source inventories are considered along with the URF it is interesting to note that ^{241}Am and ^{238}Pu at Timber Mountain yielded higher risk estimates than at Jackass Flats. This is because estimated release site inventories at Timber Mountain were higher that those at Jackass Flats for ^{241}Am and ^{238}Pu. Cesium-137, ^{152}Eu, and ^{90}Sr were found to have high risk estimates in both the Timber Mountain and Jackass Flats environmental settings. However for these constituents, Jackass Flats had higher risk estimates than Timber Mountain. Exposure pathways considered from these surface soil release sites were direct dermal contact, external radiation dose, soil suspension and inhalation, agricultural ingestion, and soil ingestion.

5.0 Anchoring Report

As part of the BEMR project, each installation team "anchored" data. Anchoring is a technique for approximating the accuracy of modeling results by comparing them to values reported elsewhere for the installation.

For anchoring purposes, if two sets of results match within an order of magnitude, they are concluded to be virtually the same value. Ideally, the anchoring is done for each ES for an onsite receptor using several pathways and two to three contaminants. These comparisons can be done with reported results of cancer risk values, measured environmental concentrations, or reported inventories. Ideally, a published baseline RA utilizing analytical results will be available for use. The site chosen for anchoring will ideally be one known by the installation to be a potential problem.

For the NTS, anchoring was performed for the groundwater pathway and the air pathway. It was not possible to anchor the groundwater results because of a lack of groundwater source data in the PEIS database. Instead, measured air concentrations of plutonium were compared with model results. Good agreement--within an order of magnitude in most cases--was found between the model and measured values.

5.1 Introduction

For anchoring purposes, if two sets of results match within an order of magnitude, they are concluded to be virtually the same value. Ideally one anchoring should be performed for each environmental setting at an installation. One onsite receptor, several pathways, and 2 to 3 contaminants should be addressed. Anchoring can be performed on comparable analyses which report results in cancer risk values, or measured environmental concentrations. Ideally, a published baseline risk assessment, utilizing analytical results will be available for use. The site chosen for anchoring would ideally be one known by the installation to be a potential problem.

The anchoring for NTS began by collecting installation documents. A risk assessment has been published for the NTS site (Daniels 1993) and it was hoped to use this as the basis of the anchoring. Unfortunately no risks were presented for any area comparable to an area listed in the PEIS database. The number one ranking (cancer) risk drivers site is reported to be Area 5, near Cambric, (ER Risk Drivers for Nevada Test Site in an enclosure to a letter from Terry L. Ross, PNL, to Mike Lakin, ICF Kaiser Engineers, dated October 3, 1994). In addition, there exists published empirical environmental concentration data for ambient air and groundwater in Area 5. Therefore Area 5 was chosen as the test case for anchoring purposes. The conceptual site model used (from the Unit Transport Factor results) was a surface soil case for the Frenchman Flat environmental setting. The locations (Area 5 and Frenchman Flat) differs by the area of the source, the depth of the source, and the location where the joint frequency distribution (JFD) data was collected.

5.2 Methodology

The following Area 5 surface soil contaminants were considered; americium-241, cesium-137, plutonium-239/240, and strontium-90. For all four anchoring runs, the waste (source) inventory used were that found in the PEIS database (see Table 5.1). The anchoring runs vary by which area, and depth. The area used was either the area given in the PEIS database (7,507,810.0 meters squared or 80,813,394.26 feet squared), or the area from the Unit Transport Factor (UTF) runs of NTS (92,903.04 meters squared or 1,000,000 feet squared). The distance to the groundwater receptor changed with the area size, 1.5*the length of the area. The depth used was either the depth from the PEIS database (0.15 meters or 0.49 feet), or the depth used in the UTF runs (3.05 meters or 10 feet). For each volume (combinations of area and depth), the soil concentration (inventory/volume) varied for each run, thus changing the concentration (soil concentration/top soil density) used in the particulate source worksheet.

Table 5.1. PEIS Database Inventory, Depth, Width Values

Contaminant Name	Inventory (Ci)	Depth of Source (ft)	Area of Source ft^2
Americium-241	6.00E-01	10	80,813,394,26
Cesium-137	4.00E-01	10	80,813,394,26
Plutonium-239/240	4.80E+00	10	80,813,394,26
Strontium-90	9.00E-01	10	80,813,394,26

5.3 Groundwater Anchoring

The first step was to anchor groundwater concentrations to an onsite groundwater receptor (Daniels 1993). The report provides the maximum observed concentrations at a groundwater well near Cambric, located in Area 5. MEPAS model runs used an onsite receptors at a distance of 1.5 times the length of the site, from the center of the source in the direction of flow, which is generally to the south.

Two model runs were made to anchor the groundwater concentrations for NTS Unfortunately, no modeled concentration values where obtained for groundwater receptors. The reason is that for the NTS installation, The model is asked to calculate the concentration in the groundwater due to infiltration, only. At NTS the precipitation rate is very small, and these specific contaminants do not move to and flow in groundwater very well. Therefore, the amount of contamination due to infiltration is negligible. Elevated installation groundwater concentrations were measured and reported (Daniels 1993). However these measurements are probably due to groundwater as a contamination source, rather than groundwater as a transport pathway receiving soil contamination via infiltration.

Groundwater as a source was not quantified in the Unit Transport runs for NTS, because there is currently no reported groundwater source available in the PEIS database. Thus, for NTS it was not possible to anchor to reported groundwater concentrations.

5.4 Airborne Anchoring

Reported atmospheric concentrations were anchored to concentrations predicted by modeling for an onsite receptor at a distance of 9 kilometers from the center of the source in the southern direction. PEIS #R693 (DOE Nevada Field Office 1992) reports annual airborne concentrations for a monitoring station located south of the source. The contaminant used in the anchoring was plutonium-239. There was no data reported in the annual report for any other contaminants listed in the PEIS database.

5.5 Results of Airborne Anchoring

Two model runs were done for the anchoring of the NTS area. The results are presented in Table 5.2, "Calculated and Monitored Concentration Comparison." The runs vary by area of the source, and depth of the source. The air concentration of Plutonium-239 calculated by each run is compared to the monitored air concentration for Area 5 (found in PEIS R693).

Figure 5.5 of PEIS R693 and Figure 3 of section 4 in PEIS 6038, indicate that one of the monitoring stations that monitored air concentration of Plutonium- 239 was comparable to a location 9 kilometers south of the source for the Unit Transport Factor runs. Table 5.2 shows the calculated air concentrations in Frenchman Flat (Area 5) for the two cases, along with the monitored air concentration (7.00E-06 pCi/m^3). The concentrations show that there is good agreement in the values i.e., the values are within one order of magnitude. Given the uncertainty associated with the air emission value, and the uncertainty concerning the location of the monitoring station as compared to the model source, the concentration results are amazingly close for both of the cases. Table 5,2 has been calculated beyond concentration to show a Projected Risk value. Again the results are remarkably close. The slightly lower calculated value is likely due to a combination of monitoring data being effected by several sources and the unit limitations to the UTF methodology.

Table 5.2. Calculated and Monitored Concentration Comparison for PU-239

	MONITORED DATA	UNIT METHOD	UTF & PEIS DATABASE
PEIS Source Inventory (Ci)	--	4.80E+00	4.80E+00
UTF (pCi/m^3)	--	1.10E-09	--
Concentration (pCi/m^3)	7.00E-06	--	**4.22E-07**
UEF Risk/(pCi/m^3)	8.36E-03	8.36E-03	8.36E-03
URF (UTF * UEF)	--	9.19E-12	--
Projected Risk (Risk/Ci)	**5.85E-08**	**4.41E-11**	**3.61E-9**

5.6 References

Daniels, J.I., ed. 1993. *Pilot Study Risk Assessment for Selected Problems at the Nevada Test Site.* UCRL-52078, Lawrence Livermore National Laboratory, Livermore, California.

U.S. Department of Energy (DOE) Nevada Field Office. 1992. *Annual Site Environmental Report - 1991. Volume I.* DOE/NV/10630-33. U.S. Department of Energy Nevada Field Office, Las Vegas, Nevada.

Section II

Unit Exposure Factors Methodology

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Abbreviations

BEMR	Baseline Environmental Management Report
CAS	Chemical Abstract Services
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
HAZDK	hazards evaluation, decay version
MEPAS	Multimedia Environmental Pollutant Assessment System
OSWER	Office of Waste and Energy Response
RAGS	Risk Assessment Guidance for Superfund
RfCs	reference concentrations
RfDs	reference doses
SIF	summary intake factor
UEFs	unit exposure factors

Contents

Tables

1.0 Introduction

The work presented in this report was performed in support of the Department of Energy's Baseline Environmental Management Report (BEMR). Pacific Northwest Laboratory[a] (PNL) was asked to provide technical support by providing estimates of pollutant transport and risk assessments. This report describes the generation of unit exposure factors (UEFs) to be used as the basis for the BEMR risk assessment.

The BEMR transport and risk assessment analyses were structured to take advantage of precalculated factors, thus allowing timely computation of results. This structuring required generation of UEFs to allow a significant reduction in computer computation efforts. The UEFs give the human health risk from an exposure scenario per unit concentration of a pollutant in a defined transport medium. The UEFs are then multiplied by calculated medium concentrations to obtain an estimate of risk.

The UEFs relate pollutant concentration in a medium to human health impact. The use of the UEFs can be represented by the following equation which includes transport from the source to the point of exposure in the environment.

$$\text{Risk} = \text{Source Term} \times \text{Unit Transport Factor} \times \text{Unit Exposure Factor}$$

where

Risk = measure of human health impact appropriate for a given pollutant at a specific location,

Source Term = quantity of the pollutant in the source configuration,

Unit Transport Factor = pre-calculated factor that relates the source term to the medium concentration for a particular transport pathway (e.g., groundwater) and pollutant for a specific location,

Unit Exposure Factor = pre-calculated factor that relates medium concentration to human health impact measure for a pollutant and transport pathway.

The UEF analyses have been performed using models and exposure pathway for an "agricultural scenario" based on the residential scenario defined in the Risk Assessment Guidance for Superfund (RAGS), published by the U.S. Environmental Protection Agency (EPA) (EPA 1989a), and on the agricultural scenario defined in Office of Waste and Emergency Response directive (OSWER) (EPA 1991). Specific parameter values were taken from these documents and the Exposure Factors Handbook (EPA 1989b) when necessary. The RAGS scenarios were developed as a guide to performing

(a) Pacific Northwest Laboratory is operated for the U.S. Department of Energy by Battelle Memorial Institute under Contract DE-AC06-76RLO 1830.

evaluations of risk related to the Comprehensive Environmental Response, Compensation, and Liability Act remedial investigations and the Resource Conservation and Recovery Act facility investigations.

The RAGS document and OSWER directive define a number of scenarios. The agricultural scenario was chosen because it describes a conservative approach for baseline assessments and includes most exposure pathways. UEFs are calculated for the agricultural scenario for an array of media, exposure pathways, and pollutants, as follows:

Medium: soil (per unit mass), soil (per unit area), air, groundwater, and surface water

Exposure pathway: 16 pathways defined

Pollutant: 156 chemicals and 83 radionuclides as defined as being of interest to the BEMR study.

The UEFs also depend on the pollutant type (i.e., radionuclide, chemical carcinogen, chemical non-carcinogen) and are evaluated appropriately for each pollutant. Analyses are performed for all chemicals for both carcinogenic and non-carcinogenic effects, as appropriate to the toxicity parameters defined for specific chemicals. For example, if a chemical is not considered to be carcinogenic by the ingestion route, then UEF values are not defined for ingestion (or dermal) exposure pathways for that chemical.

Generation of UEFs for the BEMR was performed using the most current version of the Multimedia Environmental Pollutant Assessment System (MEPAS) exposure assessment component. This component includes consideration of radioactive chain decay in all parts of the analysis.

The scope of the UEF analyses is described in Section 2.0 which indicates the media, exposure pathways and pollutants for which UEFs have been evaluated for the agricultural scenario. Details of the exposure pathway analyses are presented in Section 3.0.

2.0 Scope of UEF Analysis

This section describes the exposure scenarios, media, exposure pathways, and pollutants included in the UEF analyses.

2.1 Scenario and Media

The RAGS residential and OSWER directive agricultural scenarios are used as the basis for the UEF agricultural scenario evaluations. This scenario is evaluated for five transport media determined to be necessary for the analysis: 1) soil defined per unit mass, 2) soil defined per unit area, 3) groundwater from wells, 4) surface water, and 5) air. These are the primary media for which pollutant concentrations are known or can be reasonably estimated. Two types of soil media are needed to accommodate use of measured soil concentration data and analyses based on estimated atmospheric deposition to soil. Measured pollutant concentrations are reported as amount of pollutant per mass of soil. The soil (mass) unit exposure factors are used with measured pollutant concentrations. Atmospheric transport and deposition analyses provide estimates of soil concentration per unit area. The soil (area) unit exposure factors are used with the atmospheric transport pathways. Other media are considered in the UEF analyses as appropriate to the scenario and exposure pathways. For example, ingestion of agricultural products is included for use of contaminated water for irrigation of crops. In such cases the secondary medium concentration is evaluated using mathematical models in MEPAS, and the risk from the secondary medium is included in the UEF for the primary medium.

The agricultural scenario is intended to represent potential exposures to an individual who may take up residence on the land in the future and use the land for agricultural production. The agricultural scenario includes use of domestic water, production of and exposure to vegetable and animal products, and surface water recreational activities. The exposures are described as occurring continuously throughout the year (except for surface water recreational activities). All of the media have potential for exposure of the farming individual. Exposure parameters are selected to represent continuous exposure by each pathway. Pathways included in the agricultural scenario are presented in Section 2.2.

2.2 Exposure Pathways

A total of sixteen exposure pathways are considered in the UEF analyses. The pathways included in a specific analysis depend on the medium, scenario, and pollutant type (chemical or radionuclide). The exposure pathways appropriate to each analysis are indicated in Table 2.1 for the agricultural scenario. This table also indicates which pathways apply to chemicals and which apply to radionuclides.

Table 2.1. Exposure Pathways Included in Agricultural Scenario UEF Analyses

Medium	Exposure Pathway	Chemicals	Radionuclides
Soil (mass)	Soil Ingestion	Yes	Yes
	Soil Dermal Absorption	Yes	Yes
	External Ground Dose	No	Yes
	Fruit Ingestion	Yes	Yes
	Vegetable Ingestion	Yes	Yes
	Meat Ingestion	Yes	Yes
	Milk Ingestion	Yes	Yes
Soil (area)	Fruit Ingestion	Yes	Yes
	Vegetable Ingestion	Yes	Yes
	Meat Ingestion	Yes	Yes
	Milk Ingestion	Yes	Yes
	Soil Dermal Absorption	Yes	Yes
	Soil Ingestion	Yes	Yes
	External Ground Dose	No	Yes
Air	Fruit Ingestion	Yes	Yes
	Vegetable Ingestion	Yes	Yes
	Meat Ingestion	Yes	Yes
	Milk Ingestion	Yes	Yes
	Inhalation	Yes	Yes
	External Air Dose	No	Yes
Groundwater	Drinking Water Ingestion	Yes	Yes
	Shower Dermal Absorption	Yes	Yes
	Fruit Ingestion	Yes	Yes
	Vegetable Ingestion	Yes	Yes
	Meat Ingestion	Yes	Yes
	Milk Ingestion	Yes	Yes
	Indoor Inhalation of VOCs	Yes	Rn-222 only
Surface water	Drinking Water Ingestion	Yes	Yes
	Shower Dermal Absorption	Yes	Yes
	Fruit Ingestion	Yes	Yes
	Vegetable Ingestion	Yes	Yes
	Meat Ingestion	Yes	Yes
	Milk Ingestion	Yes	Yes
	Fish Ingestion	Yes	Yes
	Swimming Water Ingestion	Yes	Yes
	Swimming Dermal Absorption	Yes	Yes
	Swimming External Dose	No	Yes
	Indoor Inhalation of VOCs	Yes	Rn-222 only

Table 2.2. Chemicals Included in UEF Analyses

Chemical Name	MEPAS CAS	Chemical Name	MEPAS CAS	Chemical Name	MEPAS CAS
Aluminum (ionic)	7429905	Acenaphthylene	208968	Acenaphthene	83329
Ammonia	7664417	Acetone	67641	Aldrin	309002
Antimony (ionic)	7440360	Alpha-hexachlorocycl	319846	Aroclor 1248 (PCB)	12672296
Arsenic (ionic)	7440382	Anthracene	120127	Asphalt	8052424
Asbestos (croc)	12001284	Aroclor 1254 (pcb)	11091691	Benzoic acid	65850
Barium (ionic)	7440393	Aroclor 1260 (pcb)	11096825	Beryllium chloride	7787475
Beryllium (ionic)	7440417	Benzene	71432	Bromodichloromethane	75274
Boron (ionic)	7440428	Benzo(a)anthracene	56553	Chromium III	CR-III
Cadmium (ionic)	7440439	Benzo(a)pyrene	50328	DDT	50293
Calcium (ionic)	7440702	Benzo(b)fluoranthene	205992	Delta-BHC	319868
Chlorine gas	7782505	Benzo(k)fluoranthene	207089	Dibenzo(a,h)antrac	53703
Chromic acid	7738945	beta - HCCH	319857	Dieldrin	60571
Chromium VI (ionic)	7440473	Carbon disulfide	75150	Diethyl Phthalate	84662
Cobalt (ionic)	7440484	Carbon tetrachloride	56235	Di-n-octylphthalate	117840
Copper (ionic)	7440508	Chlordane	57749	Endosulfan I	115297A
Cyanide ion	57125	Chlorobenzene	108907	Endosulfan II	115297B
Fluoride ion	7782414	Chlorodibromomethane	124481	Ethyl ether	60297
Lead (ionic)	7439921	Chloroethane	75003	Heptachlor	76448
Lithium ion	7447418	Chloroform	67663	Heptanes	142825
Magnesium (ionic)	7786303	Chloromethane(methy)	74873	Iron	15438310
Manganese (ionic)	7439965	DDD	72548	Isophorone	78591
Mercury (ionic)	7439976	DDE	72559	Methylcyclopentane	96377
Nickel (ionic)	7440020	Di-n-butyl phthalate	84742	Methylcyclohexane	108872
Nitrate ion	14797558	Diesel Fuel	DIESEL F	Mineral Oil	8012951
Nitric acid	7697372	EDTA	60004	Molybdenum	7439987
Phosphate ion	7601549	Endrin	72208	Nitrite	NITRITE
Potassium hydroxide	1310583	Ethane	74840	Nonane	111842
Selenium (ionic)	7782492	Ethyl acetate	141786	Phosphoric Acid	7664382
Silver (ionic)	7440224	Ethylbenzene	100414	Potassium ion	7447407
Sodium bichromate	10588019	Fluoranthene	206440	Sodium ion	7647145
Sodium hydroxide	1310732	Fluorene	86737	Strontium ion	10476854
Sodium (ionic)	7647145	Freon 113	76131	Styrene	100425
Sulfate ion	12808798	Fuel Oil #2	FUEL OIL	Stryene-butadiene	9003558
Thallium (ionic)	7440280	Gasoline	8006619	Sulfuric Acid	7664939
Tin (ionic)	7440315	Hexanes	110543	Tetrahydro furan	109999
Tributyl phosphate	126738	HMX (h-no2 tetzocine	2691410	Trichloroethylene	79016
Uranium (ionic)	7440611	Isobutane	75285	Trichloromonofluoro	75694
Vanadium (ionic)	7440622	Isopropyl alcohol	67630	Trichloromonofluorom	75694
Zinc compounds	7646857	Kerosene	8008206	Trimethylbenzene	25551137
bis(2et-hexyl)phthl	117817	Methanol	67561	Vinyl chloride	75014
Chrysene	218019	Methyl ethyl ketone	78933	Xylene (mixed)	1330207
Ethylene glycol	107211	Methylene chloride	75092	allyl alchohol	107186
gamma-HCCH (Lindane)	58899	N-Dodecane	112403	m-xylene	108383
Hydraulic Fluid	HYDR FLU	N-nitrosodiphnylamne	86306	n-Butane	106978
Indeno(1,2,3-cd)pyre	193395	N-nitrosodipropylami	621647	n-Pentane	109660
Motor Oil	MOTOR OL	Naphthalene	91203	o-Xylene	95476
Phenol	108952	Octane	111659	trans-1,3-dichloropr	10061026
1,1-Dichloroethylene	75354	PCBs (general)	1336363	1122-tetrachlorethan	79345
1,1,1-Trichloroethan	71556	Pentachlorophenol	87865	123-trichloroprpane	96184
1,1,2-Trichloroethan	79005	PETN	78115	1245-tetrachlorobenz	95943
1,1-Dichloroethane	75343	Phenanthrene	85018	1,2,4-Trichlorobnzne	120821
1,2-Dichlorobenzene	95501	Propane	74986	2-Chlorophenol	95578
1,2-Dichloroethane	107062	Pyrene	129000	2-Hexanone	591786
1,2-Dichloroethylene	156605	RDX 6h-3no2-triazine	121824	2-Methylphenol	95487
1,3-Dichlorobenzene	541731	Tetrachloroethylene	127184	2,4-Dinitrotoluene	121142
1,4-Dichlorobenzene	106467	TNT 3no2-toluene	118967	4-Methylphenol	106445
1,4-Dioxane	123911	Toluene	108883	4-Methyl-2-pentanone	108101
2-Methylnaphthalene	91576	Tribromomethane	75252		

Table 2.3. Radionuclides Included in UEF Analyses

Radionuclide	Radionuclide	Radionuclide
Ac225	I129	Rn222
Ac227	I131	Ru103
Am241	K40	Ru106
Am243	Kr85	S35
Be7	Mn54	Sb124
Bi210	Na22	Sb125
C14	Nb95	Se75
Cd109	Ni63	Sr85
Ce144	Np237	Sr89
Ce144	Np239	Sr90
Cf252	P32	Ta182
Cm242	Pa231	Tc99
Cm244	Pa233	Te125M
Cm248	Pb210	Th227
Co56	Pb212	Th228
Co57	Pm147	Th229
Co58	Po210	Th230
Co60	Pu238	Th231
Cs132	Pu239	Th232
Cs134	Pu240	Th234
Cs137	Pu241	U232
Eu152	Pu242	U233
Eu154	Ra223	U234
Eu155	Ra224	U235
Fe55	Ra225	U236
H3	Ra226	U238
H3-EL	Ra228	Y90
		Zn65

2.3 Pollutants

The pollutants included in the analysis were selected based on lists provided by project staff. The list of chemicals is given in Table 2.2 and the list of radionuclides is given in Table 2.3. In some cases, the initial list included chemical compounds, such as beryllium chloride. For the UEF analysis, such pollutants are evaluated as the compound, as well as the individual constituents. For example, beryllium chloride is evaluated as the compound and as beryllium ion. The chemical list indicates such representations.

2.4 Risk and Exposed Individual Representation

The UEF analyses are intended to provide estimates of health impacts per unit concentration in a medium. The health impact measure for carcinogenic chemicals and radionuclides is the lifetime cancer incidence from intake received during a defined exposure duration. For non-carcinogenic chemicals the health impact measure is the hazard index, which is the ratio of the average daily intake to the reference dose (evaluated for ingestion and inhalation intake routes).

For each pollutant, the health impacts are added across all exposure pathways for a given medium (see the exposure pathway list in Section 2.2). This addition is performed by adding UEFs. Because it is desired to add health impacts, it is necessary to ensure that all exposure pathways (for a given medium) are evaluated in a consistent manner with respect to representation of the individual and exposure duration. To ensure this consistency, some of the exposure conditions recommended in RAGS have been modified slightly. All UEF analyses are based on exposure of an adult. The use of a "composite adult" is included for those exposure pathways for which such an approach is recommended. The composite adult is evaluated using child parameter values for 6 years followed by adult parameter values for 24 years, giving a total exposure duration of 30 years. This approach is used for all pollutant types.

The unit exposure factors involve normalization to unit concentration of a pollutant in each of the five media. The units of normalization are indicated in Table 2.4.

Table 2.4. Media Normalization Units

Medium	Chemicals	Radionuclides
Soil (mass)	mg/kg	pCi/kg
Soil (area)	mg/m^2	pCi/m^2
Air	mg/m^3	pCi/m^3
Groundwater	mg/L	pCi/L
Surface water	mg/L	pCi/L

3.0 Unit Exposure Factor Generation

This section presents the methods used in the UEF generation. The general equation is presented in the next section which describes the method used to perform the analyses using MEPAS. Details of the analyses for each scenario are provided in the following sections.

3.1 Methods for UEF Evaluation

Generation of unit risk factors for the BEMR was performed using the most current version of the MEPAS exposure assessment component. The general method is described in this section.

The unit exposure factors are evaluated using equations and parameters for each exposure pathway. The equations are structured to take advantage of the summary intake factor (SIF) concept presented in the Hanford Site Baseline Risk Assessment Methodology report (DOE 1993). The concept of SIFs involves structuring the intake equations for each exposure pathway in such a way that pollutant independent parameters are separated from the pollutant specific parameters and the initial media concentration. Each exposure pathway model can then be described as the product of three factors: a media concentration, an SIF independent of pollutant, and a factor composed of all pollutant specific parameters. As an example, the drinking water exposure pathway can be described as follows:

$$\text{Intake or Exposure} = C_{mi}\, PF_{mix}\, SIF_{smyx} \tag{3.1}$$

where Intake = average daily intake of chemical pollutants (mg/kg · d)

or = total intake of radionuclides or radiation exposure received over the exposure duration (pCi or hr)

C_{mi} = concentration of pollutant i, of type y, in medium m (mg or pCi per unit quantity of medium L, kg, m^3, or m^2)

PF_{mix} = pollutant specific factor for medium m, pollutant i, and exposure pathway x (units specific to analysis)

SIF_{smyx} = Summary Intake Factor for scenario s, medium m, pollutant type y, and exposure pathway x (units specific to analysis). Only the agricultural scenario was evaluated in the BEMR analysis.

The SIF values are evaluated for each toxicity type: nc (non-carcinogenic chemicals), cc (carcinogenic chemicals), and ra (radionuclides). The appropriate SIF is used for each pollutant for the exposure pathway of concern. The intake or exposure as defined by Equation 3.1 is used to estimate the risk or hazard index, which is the final endpoint in the UEF analysis.

The program allows the user to define SIF values for each exposure pathway. The pollutant specific parameters are taken from the MEPAS database and combined with the SIF values, unit media concentrations, and risk factors to provide the unit exposure factors.

The following sections define details of methods for evaluation of UEFs. Section 3.1.1 identifies the methods used to estimate the health impacts from the radionuclide intake or exposure evaluated by Equation 3.1 for which the medium concentration has been set to unity (units as per Table 2.4). Section 3.1.2 provides similar information for chemicals. Section 3.2 defines the SIFs for the agricultural scenario. Section 3.3 identifies pollutant specific parameters and analyses applied to each exposure pathway.

3.1.1 Radionuclide UEF Health Impact Analysis

The average daily intake and lifetime radiation doses are used to estimate the UEFs for the health impact measure appropriate to the pollutant. The cancer incidence risk for radionuclides is evaluated as follows for inhalation exposure pathways

$$UEF_{ih} = Intake_{ih}\ SF_{ih} \tag{3.2}$$

and for ingestion exposure pathways

$$UEF_{ig} = Intake_{ig}\ SF_{ig} \tag{3.3}$$

where UEF_{ih} = unit exposure factor for an inhalation pathway for radionuclide i (risk per unit exposure medium concentration)

UEF_{ig} = unit exposure factor for an ingestion pathway for radionuclide i (risk per unit exposure medium concentration)

$Intake_{ih}$ = inhalation intake for radionuclide i for the inhalation pathway of interest (pCi per pCi/medium)

$Intake_{ig}$ = ingestion intake for radionuclide i for the ingestion pathway of interest (pCi per pCi/medium)

SF_{ih} = inhalation slope factor for radionuclide i (risk/pCi)

SF_{ig} = ingestion slope factor for radionuclide i (risk/pCi).

For pathways involving external radiation exposure the UEFs are evaluated as follows:

$$UEF_{ix} = Exposure_{ix}\ SF_{ix} \tag{3.4}$$

where UEF_{ix} = unit exposure factor for an external radiation exposure pathway for radionuclide i (risk per unit medium concentration)

$Exposure_{ix}$ = exposure time for radionuclide i for the external radiation exposure pathway of interest (hr)

SF_{ix} = external exposure slope factor for radionuclide i (risk/hr per pCi/unit medium concentration).

The external slope factors provided in Health Effects Assessment Summary tables (EPA 1993) are for use with contaminated soil (pCi/kg soil). For external exposure to air and water, slope factors are generated from radiation dose factors and the default health effects conversion factor of 6.2×10^{-4} risk per rem. For example, the air immersion effective slope factor is evaluated as follows:

$$SF_{ia} = 6.2 \times 10^{-4} \, DF_{ia} \tag{3.5}$$

where SF_{ia} = air immersion slope factor for radionuclide i (risk/hr per pCi/m^3)

DF_{ia} = air immersion dose rate factor for radionuclide i (rem/hr per pCi/m^3)

6.2×10^{-4} = cancer incidence conversion factor (risk/rem).

3.1.2 Chemical UEF Health Impact Analysis

The intake parameter for chemical exposures is the average daily intake for a chemical by either ingestion or inhalation. For carcinogenic chemicals the intake is the average over the lifetime of the individual (70 years), and for non-carcinogenic chemicals this is the average over the 30-year exposure duration for the agricultural scenario.

The lifetime cancer incidence risk for chemical ingestion exposures is evaluated as follows:

$$UEF_{ig} = Intake_{ig} \, SF_{ig} \tag{3.6}$$

where UEF_{ig} = unit exposure factor for chemical carcinogen i from an ingestion exposure pathway g (risk/unit medium concentration)

$Intake_{ig}$ = average daily intake of chemical i from ingestion pathway g per unit medium concentration (mg/kg/d per unit medium concentration)

SF_{ig} = ingestion slope factor for chemical i (risk per mg/kg/d).

The lifetime cancer incidence risk for inhalation is evaluated in a similar manner as follows:

$$UEF_{ih} = Intake_{ih}\ SF_{ih} \tag{3.7}$$

where UEF_{ih} = unit exposure factor for chemical carcinogen i from an inhalation exposure pathway h (risk/unit medium concentration)

$Intake_{ih}$ = average daily intake of chemical i from inhalation pathway h per unit medium concentration (mg/kg/d per unit medium concentration)

SF_{ih} = inhalation slope factor for chemical i (risk per mg/kg/d).

The health impact parameter for non-carcinogenic chemicals is the hazard index, evaluated as follows for ingestion pathways:

$$UEF_{ig} = Intake_{ig}/RfD_{ig} \tag{3.8}$$

where UEF_{ig} = unit exposure factor for chemical non-carcinogen i from an ingestion exposure pathway g (hazard index/unit medium concentration)

$Intake_{ig}$ = average daily intake of chemical i from ingestion pathway g per unit medium concentration (mg/kg/d per unit medium concentration)

RfD_{ig} = ingestion reference dose for chemical i (mg/kg/d).

The hazard index for inhalation is evaluated in a similar manner as follows:

$$UEF_{ih} = Intake_{ih}/RfD_{ih} \tag{3.9}$$

where UEF_{ih} = unit exposure factor for chemical non-carcinogen i from an inhalation exposure pathway h (hazard index/unit medium concentration)

$Intake_{ih}$ = average daily intake of chemical i from inhalation pathway h per unit medium concentration (mg/kg/d per unit medium concentration)

RfD_{ih} = inhalation reference dose for chemical i (mg/kg/d).

Dermal exposures are evaluated as equivalent to ingestion exposures with correction for the fractional absorption of the chemical in the gastrointestinal tract.

The UEF equations for inhalation of chemicals are based on slope factors and reference doses (RfDs). This method was originally proposed by EPA, but since about 1992 the EPA has switched to use of unit risk concentrations (instead of inhalation slope factors) and reference concentrations (RfCs instead of RfDs). The concentration values can be converted to slope factors and RfDs by assuming a standard inhalation rate (20 m^3/d) and body weight (70 kg). This method is appropriate for most contaminants. However, for chemicals having inhalation effects based on respiratory system response, it may not be appropriate to add risks or hazard indices from inhalation and ingestion pathways. To add results for such chemicals could overestimate the health impacts. For the BEMR analyses, this possible overestimation is ignored.

3.2 Agricultural Scenario SIF Evaluation

The agricultural exposure scenario is based on exposures over a 30-year exposure duration. The evaluation of unit risk factors for the agricultural scenario is described in the following sections for each exposure pathway for each medium.

3.2.1 Medium: Soil (mass)

The agricultural scenario exposure pathways for soil (per unit mass) are ingestion of agricultural products (vegetables, fruit, meat, and milk), soil ingestion, soil dermal absorption, and external exposure to ground contamination.

The soil dermal contact pathway is evaluated for one contact event per day, a skin contact area of 2500 cm^2 for a child (6 years old and 15-kg body weight) and 5000 cm^2 for an adult (24 years old and 70-kg body weight), and a soil adherence factor of 0.2 mg/cm^2. The soil ingestion pathway is evaluated for a daily effective soil ingestion rate of 255 mg/d. The effective ingestion rate is based on intake at 200 mg/d for 6 years as a 15-kg child and at 100 mg/d for 24 years as a 70-kg adult. The effective ingestion rate represents the intake rate for a 70-kg adult over a 30-year period (to give the same average daily intake for the composite individual). External exposure is assumed to occur 24 hours a day. A shielding factor of 0.8 is applied. The vegetable ingestion pathway is modelled in the HAZDK analyses as "leafy vegetables" with a daily ingestion rate of 80 g/d (accounting for the fraction of the year when food is produced elsewhere). The fruit ingestion pathway is modelled as "other vegetables" with a daily ingestion rate of 42 g/d. The daily ingestion rate for meat is 75 g/d and the ingestion rate for milk is 300 g/d. All pathways occur 365 days per year.

The SIF values for this medium are given in Table 3.1 for each pollutant type and exposure pathway.

3.2.2 Medium: Soil (area)

Contamination deposited onto soil from atmospheric transport and deposition is modeled as a concentration per unit area of soil. The agricultural scenario UEFs for this medium are evaluated for the same pathways as the soil per unit mass medium analyses plus ingestion of fruit, vegetables, meat, and milk.

The exposure parameters are the same as those defined for the soil (mass) medium. The vegetable ingestion pathway is modelled in the HAZDK analyses as "leafy vegetables" with a daily ingestion rate of 80 g/d (accounting for the fraction of the year when food is produced elsewhere). The fruit

Table 3.1. Agricultural Scenario Summary Intake Factors: Soil (mass)

Exposure Pathway	Type[a]	SIF Value	Units
Soil Ingestion	NC	3.81E-6	kg/(kg d)
	CC	1.63E-6	kg/(kg d)
	RA	1.32E+0	kg
Soil Dermal Absorption	NC	1.81E-5	kg/(kg d)
	CC	7.75E-6	kg/(kg d)
	RA	9.86E+0	kg
Vegetable Ingestion	NC	1.14E-3	kg/(kg d)
	CC	4.90E-4	kg/(kg d)
	RA	8.77E+2	kg
Fruit Ingestion	NC	6.00E-4	kg/(kg d)
	CC	2.57E-4	kg/(kg d)
	RA	4.60E+2	kg
Meat Ingestion	NC	1.07E-3	kg/(kg d)
	CC	4.59E-4	kg/(kg d)
	RA	8.22E+2	kg/(kg d)
Milk Ingestion	NC	4.29E-3	kg/(kg d)
	CC	1.84E-3	kg/(kg d)
	RA	3.29E+3	L
Soil External	RA	2.10E+5	h

(a) NC - non-carcinogenic chemicals, CC - carcinogenic chemicals, RA - radionuclides

Table 3.2. Agricultural Scenario Summary Intake Factors: Soil (area)

Exposure Pathway	Type[a]	SIF Value	Units
Soil Ingestion	NC	6.35E-8	$m^2/(kg\ d)$
	CC	2.72E-8	$m^2/(kg\ d)$
	RA	2.19E-2	m^2
Soil Dermal	NC	3.01E-7	m^2 ev/(kg d)
	CC	1.29E-7	m^2 ev/(kg d)
	RA	1.65E-1	m^2 ev
Vegetable Ingestion	NC	1.14E-3	kg/(kg d)
	CC	4.90E-4	kg/(kg d)
	RA	8.77E+2	kg
Fruit Ingestion	NC	6.00E-4	kg/(kg d)
	CC	2.57E-4	kg/(kg d)
	RA	4.60E+2	kg
Meat Ingestion	NC	1.07E-3	kg/(kg d)
	CC	4.59E-4	kg/(kg d)
	RA	8.22E+2	kg
Milk Ingestion	NC	4.29E-3	L/(kg d)
	CC	1.84E-3	L/(kg d)
	RA	3.29E+3	L
Soil External	RA	2.10E+5	h

(a) NC - non-carcinogenic chemicals, CC - carcinogenic chemicals, RA - radionuclides

ingestion pathway is modelled as "other vegetables" with a daily ingestion rate of 42 g/d. The daily ingestion rate for meat is 75 g/d and the ingestion rate for milk is 300 g/d. All pathways occur 365 days per year. The SIF values for each pathway for this medium are given in Table 3.2 for each pollutant type.

3.2.3 Medium: Air

Agricultural scenario UEFs for air are evaluated for inhalation, external exposure from submersion in a cloud, and consumption of fruits, vegetables, meat, and milk. The air inhalation rate is set to 20 m^3 for the adult and external exposure occurs for 24 hours per day. Inhalation and external exposure occurs for 365 days per year. The vegetable ingestion pathway is modelled in the HAZDK analyses as "leafy vegetables" with a daily ingestion rate of 80 g/d (accounting for the fraction of the year when food is produced elsewhere). The fruit ingestion pathway is modelled as "other vegetables" with a daily ingestion rate of 42 g/d. The daily ingestion rate for meat is 75 g/d and the ingestion rate for milk is 300 g/d. All pathways occur 365 days per year. The SIF values for each pathway for this medium are given in Table 3.3 for each pollutant type.

Table 3.3. Agricultural Scenario Summary Intake Factors: Air

Exposure Pathway	Type[a]	SIF Value	Units
Inhalation	NC	2.86E-1	m^3/(kg d)
	CC	1.22E-1	m^3/(kg d)
	RA	2.19E+5	m^3
Air External Dose	RA	2.63E+5	hr
Vegetable Ingestion	NC	1.14E-3	kg/(kg d)
	CC	4.90E-4	kg/(kg d)
	RA	8.77E+2	kg
Fruit Ingestion	NC	6.00E-4	kg/(kg d)
	CC	2.57E-4	kg/(kg d)
	RA	4.60E+2	kg
Eat Ingestion	NC	1.07E-3	kg/(kg d)
	CC	4.59E-4	kg/(kg d)
	RA	8.22E+2	kg
Milk Ingestion	NC	4.29E-3	L/(kg d)
	CC	1.84E-3	L/(kg d)
	RA	3.29E+3	L

(a) NC - non-carcinogenic chemicals, CC - carcinogenic chemicals, RA - radionuclides

3.2.4 Medium: Groundwater

Use of contaminated groundwater in the agricultural scenario includes drinking water, showering, and ingestion of fruits, vegetables, meat, and milk 365 days per year. The exposure pathways involved in these uses are drinking water, shower water dermal absorption, indoor inhalation of volatile compounds, and ingestion of homegrown fruit, vegetables, meat, and milk. Individuals are assumed to drink 2 L of contaminated water and take 1 shower of 12 minutes duration per day. The inhalation rate is 15 m^3/d and the indoor air volatilization factor is 0.5 for volatile chemicals and 0.1 for Rn222. The concentrations in agricultural products were estimated using pollutant-specific concentration ratio and transfer factor values described in Appendix B. Dermal exposure in the shower is evaluated for a skin area of 20,000 cm^2. The vegetable ingestion pathway is modelled in the analyses as "leafy vegetables" with a daily ingestion rate of 80 g/d (accounting for the fraction of the year when food is produced elsewhere). The fruit ingestion pathway is modelled as "other vegetables" with a daily ingestion rate of 42 g/d. The daily ingestion rate for meat is 75 g/d and the ingestion rate for milk is 300 g/d. All pathways occur 365 days per year. The SIF values for each pathway for this medium are given in Table 3.4 for each pollutant type.

3.2.5 Medium: Surface Water

Unit exposure factors for surface water are evaluated in the agricultural scenario for ingestion of drinking water, showering, ingestion of fish, exposure related to swimming, and ingestion of fruit, vegetables, meat, and milk. All exposure pathways are assumed to occur 365 days per year except swimming which occurs 7 days per year.

The exposed individual is assumed to drink 2 L of contaminated water per day. The inhalation rate is 15 m^3/d and the indoor air volatilization factor is 0.5 for volatile chemicals and 0.1 for Rn222. The air volatilization factor relates average daily indoor air concentration to the pollutant concentration in the domestic supply water. Transfer to air occurs from showering, food preparation, and other indoor use of water. The volatilization pathway is included for all chemical pollutants with a Henry's Law constant (dimensional) greater than 10^{-5} atm m^3/g-mole. Dermal exposure while showering is evaluated for a skin area of 20,000 cm^2. The exposure time for swimming is 2.6 hr/d. Dermal exposure while swimming is evaluated for a skin area of 20,000 cm^2. Inadvertent ingestion of water while swimming is 50 ml/hr. The vegetable ingestion pathway is modelled in the HAZDK analyses as "leafy vegetables" with a daily ingestion rate of 80 g/d (accounting for the fraction of the year when food is produced elsewhere). The fruit ingestion pathway is modelled as "other vegetables" with a daily ingestion rate of 42 g/d. The daily ingestion rate for meat is 75 g/d and the ingestion rate for milk is 300 g/d. The exposed individual catches enough fish from the contaminated surface water body to ingest 54 g/d edible fish each day of the year. The SIF values for each pathway for this medium are given in Table 3.5 for each pollutant type.

Table 3.4. Agricultural Scenario Summary Intake Factors: Groundwater

Exposure Pathway	Type[a]	SIF Value	Units
Water Ingestion	NC	2.86E-2	L/(kg d)
	CC	1.22E-2	L/(kg d)
	RA	2.19E+4	L
Indoor Inhalation	NC	1.07E-1	L/(kg d)
	CC	4.59E-2	L/(kg d)
	RA	1.64E+4	L
Vegetable Ingestion	NC	1.14E-3	kg/(kg d)
	CC	4.90E-4	kg/(kg d)
	RA	8.77E+2	kg
Fruit Ingestion	NC	6.00E-4	kg/(kg d)
	CC	2.57E-4	kg/(kg d)
	RA	4.60E+2	kg
Meat Ingestion	NC	1.07E-3	kg/(kg d)
	CC	4.59E-4	kg/(kg d)
	RA	8.22E+2	kg
Milk Ingestion	NC	4.29E-3	L/(kg d)
	CC	1.84E-3	L/(kg d)
	RA	3.29E+3	L

(a) NC - non-carcinogenic chemicals, CC - carcinogenic chemicals, RA - radionuclides

Table 3.5. Agricultural Scenario Summary Intake Factors: Surface Water

Exposure Pathway	Type[a]	SIF Value	Units
Water Ingestion	NC	2.86E-2	L/(kg d)
	CC	1.22E-2	L/(kg d)
	RA	2.19E+4	L
Water Dermal Absorption	NC	5.71E-2	L h/(kg d cm)
	CC	2.45E-2	L h/(kg d cm)
	RA	4.38E+4	L h/cm
Indoor Inhalation	NC	1.07E-1	L/(kg d)
	CC	4.59E-2	L/(kg d)
	RA	1.64E+4	L
Fish Ingestion	NC	7.71E-4	L/(kg d)
	CC	3.31E-4	L/(kg d)
	RA	5.92E+2	L
Swimming Dermal Absorption	NC	1.43E-2	L h/(kg d cm)
	CC	6.11E-3	L h/(kg d cm)
	RA	1.09E+4	L h/cm
Swimming Water Ingestion	NC	3.56E-5	L/(kg d)
	CC	1.53E-5	L/(kg d)
	RA	2.73E+1	L
Swimming External Dose	RA	5.47E+2	h
Vegetable Ingestion	NC	1.14E-3	kg/(kg d)
	CC	4.90E-4	kg/(kg d)
	RA	8.77E+2	kg
Fruit Ingestion	NC	6.00E-4	kg/(kg d)
	CC	2.57E-4	kg/(kg d)
	RA	4.60E+2	kg
Meat Ingestion	NC	1.07E-3	kg/(kg d)
	CC	4.59E-4	kg/(kg d)
	RA	8.22E+2	kg
Milk Ingestion	NC	4.29E-3	L/(kg d)
	CC	1.84E-3	L/(kg d)
	RA	3.29E+3	L

(a) NC - non-carcinogenic chemicals, CC - carcinogenic chemicals, RA - radionuclides

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Appendix A

Unit Exposure Factor Tables

Appendix A

Unit Exposure Factor Tables

This appendix presents summary tables of unit exposure factor values for each medium, and detailed tables giving all unit exposure factor values for all exposure pathways. The summary tables give unit exposure factor values summed over all exposure pathways relevant to a medium. Each table provides results for one pollutant type: non-carcinogenic chemicals, carcinogenic chemicals, or radionuclides. Each of the chemical result tables contain the same list of chemicals. A zero value for a UEF in one of these tables indicates that there was no toxicity value for the pollutant for that particular type of exposure. For example, if there were no inhalation reference doses for a pollutant, there would be zero values for inhalation pathways for the pollutant in the non-carcinogenic impact table. The content of the tables in the order of presentation is as follows:

Table Number	Medium	Impact/Pollutant Type
A.1	All	Non-carcinogens
A.2	All	Carcinogens
A.3	All	Radionuclides

Table A.1. Unit Exposure Factors for Non-carcinogenic Chemical Impacts

Chemical Name	Soil (mass)	Soil (area)	Air	Groundwater	Surface Water
11-Dichloroethylene	4.24E-05	0.00E+00	3.17E+01	1.62E+01	1.69E+01
11-Dichloroethane	1.34E-05	0.00E+00	2.86E+00	1.46E+00	1.51E+00
111-Trichloroethan	1.88E-04	0.00E+00	7.15E+01	3.66E+01	4.67E+01
112-Trichloroethan	7.99E-04	0.00E+00	7.18E+01	3.66E+01	4.41E+01
1122-tetrachlorethan	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
12-Dichloroethylene	1.97E-04	0.00E+00	1.43E+01	7.33E+00	7.45E+00
12-Dichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
12-Dichlorobenzene	2.62E-04	0.00E+00	7.23E+00	3.17E+00	3.95E+00
123-trichloroprpane	2.69E-04	0.00E+00	1.18E+04	2.86E+01	3.01E+02
124-Trichlorobenzene	3.37E-03	0.00E+00	4.09E+03	1.54E+01	1.13E+02
1245-tetrachlorobenz	1.69E-01	0.00E+00	1.57E+05	1.79E+02	4.82E+03
13-Dichlorobenzene	1.15E-04	0.00E+00	3.24E+00	1.69E+00	2.27E+00
14-Dioxane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
14-Dichlorobenzene	3.51E-06	0.00E+00	1.43E+00	5.43E-01	5.51E-01
2-Methylphenol	1.26E-02	5.10E-04	5.83E+00	1.96E+00	2.12E+00
2-Hexanone	3.00E-03	1.52E-04	2.12E+00	1.42E+00	1.44E+00
2-Chlorophenol	1.59E-02	8.56E-04	8.70E+01	3.16E+01	3.27E+01
2-Methylnaphthalene	1.76E-03	8.84E-05	7.31E+00	2.68E+00	9.42E+00
24-Dinitrotoluene	5.89E-01	1.95E-02	2.17E+02	6.35E+01	6.77E+01
4-Methyl-2-pentanone	3.33E-03	1.39E-04	5.75E+00	3.40E+00	3.41E+00
4-Methylphenol	2.31E-02	7.90E-04	5.83E+00	2.59E+00	2.74E+00
Acenaphthene	1.76E-03	8.92E-05	7.34E+00	2.68E+00	1.16E+01
Acenaphthylene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Acetone	1.45E-04	0.00E+00	2.89E+00	1.47E+00	1.48E+00
Aldrin	7.75E+00	3.10E-01	7.47E+04	6.05E+03	8.68E+04
Allyl alchohol	3.11E-02	6.35E-04	5.89E+01	1.23E+01	1.24E+01
Alpha-hexachlorocycl	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aluminum (ionic)	1.51E-02	1.37E-03	4.85E+02	1.02E+02	1.22E+02
Amonia	1.32E-04	1.65E-05	1.84E+01	1.32E+00	1.32E+00
Anthracene	2.35E-04	0.00E+00	1.79E+00	5.43E-01	4.88E+00
Antimony (ionic)	1.66E-02	1.83E-03	1.11E+03	1.11E+02	5.01E+02
Aroclor 1248 (PCB)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aroclor 1254 (pcb)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aroclor 1260 (pcb)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic (ionic)	2.63E-02	2.03E-03	5.23E+02	1.31E+02	3.88E+02
Asbestos (croc)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Asphalt	4.02E-03	1.84E-04	6.59E+01	7.76E+00	2.45E+01
Barium (ionic)	1.67E-04	1.06E-05	2.86E+03	5.85E-01	2.79E+00
Benzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(a)anthracene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzoic acid	3.53E-04	1.16E-05	1.09E-01	3.62E-02	3.78E-02
Beryllium chloride	1.74E-03	1.93E-04	3.00E+01	9.97E+00	1.35E+01
Beryllium (ionic)	1.74E-03	1.93E-04	3.00E+01	9.97E+00	1.35E+01
beta - HCCH	3.93E-01	1.91E-02	1.46E+03	1.56E+02	1.61E+03
bis(2et-hexyl)phthlt	3.75E-01	2.36E-02	4.34E+01	3.04E+01	3.05E+01

Table A.1. (contd)

Chemical Name	Soil (mass)	Soil (area)	Air	Groundwater	Surface Water
Boron (ionic)	3.36E-03	1.09E-04	6.88E+00	8.18E-01	8.20E-01
Bromodichloromethane	1.05E-04	0.00E+00	1.73E+03	7.30E+00	8.00E+00
Cadmium (ionic)	1.71E-01	6.74E-03	1.01E+03	1.00E+02	4.10E+02
Calcium (ionic)	2.28E-07	2.84E-08	2.55E-02	2.26E-03	2.26E-03
Carbon disulfide	5.39E-06	0.00E+00	1.02E+02	3.90E+01	3.91E+01
Carbon tetrachloride	1.20E-03	0.00E+00	4.08E+02	2.10E+02	3.75E+02
Chlordane	1.10E+00	0.00E+00	4.69E+03	7.94E+02	4.95E+03
Chlorine gas	2.31E-05	2.49E-09	2.67E+01	1.92E+00	5.43E+00
Chlorobenzene	2.63E-04	0.00E+00	5.02E+01	2.09E+01	4.58E+01
Chlorodibromomethane	4.87E-04	0.00E+00	1.43E+01	1.99E+00	2.50E+00
Chloroethane	3.51E-08	0.00E+00	2.86E-02	1.46E-02	1.48E-02
Chloroform	1.24E-04	0.00E+00	2.86E+01	1.53E+01	1.63E+01
Chloromethane(methy)	3.56E-05	0.00E+00	2.40E-05	7.65E-02	7.84E-02
Chromic acid	2.92E-03	1.96E-04	5.01E+05	1.17E+01	4.31E+01
Chromium VI (ionic)	2.92E-03	1.96E-04	5.01E+05	1.17E+01	4.31E+01
Chromium III	1.46E-05	9.83E-07	5.48E-01	5.83E-02	2.15E-01
Chrysene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt (ionic)	2.92E-03	1.36E-04	8.39E+02	5.22E+00	9.99E+00
Copper (ionic)	6.30E-01	2.09E-02	9.33E+02	2.04E+02	3.33E+02
Cyanide ion	1.18E+00	3.70E-02	2.17E+01	9.70E+01	9.70E+01
DDD	8.72E-04	6.82E-05	1.33E+01	1.44E+00	4.33E+01
DDE	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DDT	8.26E-02	5.78E-03	2.44E+03	2.41E+02	4.36E+03
Delta-BHC	9.13E-02	3.88E-03	3.20E+02	3.34E+01	3.61E+02
Di-n-butyl phthalate	5.22E-04	3.68E-05	6.72E+00	5.91E-01	5.36E+01
Di-n-octylphthalate	1.13E+01	3.53E-01	2.20E+05	1.65E+04	1.65E+04
Dibenzo(a,h)antrac	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dieldrin	9.88E+00	3.50E-01	2.35E+04	2.52E+03	7.76E+04
Diesel Fuel	2.93E-04	0.00E+00	9.27E-01	4.46E-01	1.57E+00
Diethyl Phthalate	8.16E-04	2.81E-05	5.44E-01	1.08E-01	1.36E-01
EDTA	1.19E+01	3.73E-01	2.64E+02	9.32E+02	9.32E+02
Endosulfan I	2.90E-02	1.25E-03	7.28E+01	8.34E+00	4.37E+01
Endosulfan II	2.67E-02	1.18E-03	7.29E+01	8.18E+00	4.91E+01
Endrin	1.63E-01	1.19E-02	1.93E+03	1.72E+02	3.98E+03
Ethane	0.00E+00	0.00E+00	5.29E-06	1.98E-06	1.98E-06
Ethyl ether	9.52E-06	0.00E+00	6.90E+01	4.11E-01	4.17E-01
Ethyl acetate	1.01E-05	0.00E+00	3.18E-01	1.63E-01	1.64E-01
Ethylbenzene	6.08E-05	0.00E+00	1.00E+00	1.33E+00	2.40E+00
Ethylene glycol	9.15E-02	3.03E-03	2.49E-01	7.42E+00	7.42E+00
Fluoranthene	1.33E-03	9.28E-05	1.20E+01	1.61E+00	7.32E+01
Fluorene	2.18E-03	1.20E-04	1.11E+01	4.03E+00	1.79E+01
Fluoride ion	2.11E-03	7.19E-05	1.59E+01	1.40E+00	1.53E+00
Freon 113	8.88E-09	0.00E+00	3.32E-02	1.37E-02	1.80E-02
Fuel Oil #2	2.93E-04	1.47E-05	1.22E+00	4.46E-01	1.57E+00
gamma-HCCH (Lindane)	7.57E-01	3.05E-02	2.13E+03	2.31E+02	6.95E+02
Gasoline	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Heptachlor	2.76E-01	0.00E+00	1.02E+05	1.31E+02	2.49E+03
Heptanes	1.97E-08	0.00E+00	3.07E+00	1.62E-02	1.22E-01

Table A.1. (contd)

Chemical Name	Soil (mass)	Soil (area)	Air	Groundwater	Surface Water
Hexanes	1.87E-06	0.00E+00	4.76E+00	2.72E+00	9.16E+00
HMX (h-no2 tetzocine	1.53E-01	4.84E-03	8.68E+00	1.24E+01	1.25E+01
Hydraulic Fluid	7.85E-05	4.73E-06	5.01E-01	1.81E-01	1.62E+00
Indeno(1,2,3-cd)pyre	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron	1.23E-05	6.73E-07	3.35E+01	3.43E-02	1.22E+00
Isobutane	1.72E-09	0.00E+00	2.15E-02	1.13E-02	1.44E-02
Isophorone	1.52E-03	6.90E-05	2.17E+00	3.49E-01	4.21E-01
Isopropyl alcohol	8.00E-06	0.00E+00	4.17E-02	2.23E-02	2.23E-02
Kerosene	1.51E-04	7.58E-06	6.27E-01	2.29E-01	8.06E-01
Lead (ionic)	4.32E-03	3.96E-04	7.83E+02	2.83E+01	8.34E+01
Lithium ion	2.14E-05	7.27E-07	6.41E-01	4.70E-02	4.70E-02
m-xylene	1.85E-06	0.00E+00	1.72E+02	5.57E-01	6.15E-01
Magnesium (ionic)	8.72E-06	2.80E-07	4.09E+00	1.81E-03	2.59E-03
Manganese (ionic)	1.06E-03	3.85E-05	2.02E+02	6.54E-01	5.07E+00
Mercury (ionic)	3.81E+00	1.21E-01	5.67E+03	5.89E+02	3.16E+03
Methanol	1.32E-04	0.00E+00	5.72E-01	2.94E-01	2.94E-01
Methyl ethyl ketone	4.95E-04	0.00E+00	1.03E+00	1.21E+00	1.22E+00
Methylcyclohexane	6.47E-04	0.00E+00	1.59E+02	7.71E+01	6.69E+02
Methylcyclopentane	3.50E-06	0.00E+00	7.94E-01	5.10E-01	1.98E+00
Methylene chloride	2.20E-05	0.00E+00	4.76E+00	2.43E+00	2.47E+00
Mineral Oil	7.85E-05	4.73E-06	5.02E-01	1.81E-01	1.62E+00
Molybdenum	9.71E-03	3.82E-04	1.10E+02	1.02E+01	1.18E+01
Motor Oil	7.85E-05	4.73E-06	5.01E-01	1.81E-01	1.62E+00
n-Butane	2.51E-09	0.00E+00	2.58E+00	1.13E-02	1.55E-02
n-Pentane	5.31E-09	0.00E+00	2.72E+00	1.23E-02	2.46E-02
N-Dodecane	3.02E-06	2.74E-07	9.49E-02	3.64E-02	7.59E-01
N-nitrosodipropylami	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
N-nitrosodiphnylamne	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Naphthalene	4.88E-03	2.08E-04	1.12E+01	4.13E+00	6.88E+00
Nickel (ionic)	2.29E-03	9.11E-05	1.14E+01	2.36E+00	6.23E+00
Nitrate ion	6.15E-02	1.92E-03	1.43E+00	4.78E+00	7.71E+01
Nitric acid	2.80E+00	8.78E-02	6.54E+01	2.19E+02	3.53E+03
Nitrite	1.13E-04	1.41E-05	1.28E+01	1.12E+00	1.13E+00
Nonane	1.54E-08	1.41E-09	8.21E-03	3.96E-03	7.50E-02
o-Xylene	2.72E-06	0.00E+00	1.72E+02	5.56E-01	5.87E-01
Octane	4.26E-08	0.00E+00	6.71E-02	2.51E-02	4.38E-01
PCBs (general)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pentachlorophenol	1.71E-03	1.22E-04	1.65E+01	2.72E+00	1.14E+02
PETN	2.57E+00	8.09E-02	9.91E+01	2.08E+02	2.08E+02
Phenanthrene	1.75E-03	0.00E+00	1.33E+01	4.09E+00	3.72E+01
Phenol	1.65E-03	6.92E-05	5.11E-01	2.22E-01	2.27E-01
Phosphate ion	1.78E-02	5.57E-04	4.36E+01	1.61E+00	1.19E+02
Phosphoric Acid	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Potassium ion	1.37E-06	4.36E-08	1.87E-03	2.50E-04	1.76E-03
Potassium hydroxide	2.73E-05	3.42E-06	3.10E+00	2.73E-01	2.73E-01
Propane	0.00E+00	0.00E+00	3.62E-06	1.36E-06	1.36E-06
Pyrene	1.63E-03	1.19E-04	1.86E+01	2.90E+00	7.52E+01
RDX 6h-3no2-triazine	7.89E-02	3.15E-03	1.45E+02	1.85E+01	5.91E+01

Table A.1. (contd)

Chemical Name	Soil (mass)	Soil (area)	Air	Groundwater	Surface Water
Selenium (ionic)	8.87E-03	3.56E-04	3.76E+02	1.27E+01	3.90E+01
Silver (ionic)	1.02E-02	3.95E-04	3.59E+02	2.71E+01	2.75E+01
Sodium ion	1.00E-06	3.26E-08	9.75E-03	7.79E-04	1.04E-03
Sodium bichromate	2.92E-03	1.96E-04	5.01E+05	1.17E+01	4.31E+01
Sodium (ionic)	1.00E-06	3.26E-08	9.75E-03	7.79E-04	1.04E-03
Sodium hydroxide	2.73E-04	3.42E-05	3.10E+01	2.73E+00	2.73E+00
Strontium ion	7.29E-04	2.34E-05	2.10E+00	1.30E-01	1.95E-01
Stryene-butadiene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Styrene	2.72E-06	0.00E+00	1.20E+02	7.52E-01	1.10E+00
Sulfate ion	6.76E-05	2.12E-06	4.10E+00	6.93E-03	1.51E-02
Sulfuric Acid	5.47E-04	6.83E-05	6.22E+01	5.46E+00	5.46E+00
Tetrachloroethylene	4.40E-04	0.00E+00	2.86E+01	1.67E+01	2.49E+01
Tetrahydro furan	9.96E-07	1.65E-09	6.97E-02	3.35E-02	3.36E-02
Thallium (ionic)	3.75E-01	1.62E-02	8.18E+03	7.13E+02	9.71E+04
Tin (ionic)	1.02E-04	3.94E-06	1.12E+00	1.08E-01	3.97E+00
TNT 3no2-toluene	2.77E+00	9.08E-02	8.68E+02	2.84E+02	2.97E+02
Toluene	1.31E-05	0.00E+00	2.60E+00	1.45E+00	1.72E+00
trans-1,3-dichloropr	1.94E-02	0.00E+00	6.67E+03	1.51E+02	1.79E+02
Tribromomethane	9.46E-04	0.00E+00	1.44E+01	2.05E+00	3.02E+00
Tributyl phosphate	5.38E-05	2.09E-06	2.51E+01	2.31E+00	3.22E+01
Trichloroethylene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Trichloromonofluorom	4.43E-07	0.00E+00	9.52E-01	4.88E-01	5.73E-01
Trichloromonofluoro	4.43E-07	0.00E+00	1.14E+02	4.88E-01	5.73E-01
Trimethylbenzene	4.43E-01	0.00E+00	2.58E+00	9.27E+02	4.19E+03
Uranium (ionic)	4.07E-03	2.58E-04	2.67E+02	1.42E+01	2.73E+01
Vanadium (ionic)	1.31E-03	9.94E-05	5.63E+01	5.49E+00	6.51E+00
Vinyl chloride	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xylene (mixed)	1.85E-06	0.00E+00	3.99E+02	1.27E+00	1.33E+00
Zinc compounds	5.87E-03	1.85E-04	4.41E+00	7.92E-01	7.22E+00

Table A.2. Unit Exposure Factors for Carcinogenic Chemical Impacts

Chemical Name	Soil (mass)	Soil (area)	Air	Groundwater	Surface Water
11-Dichloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
11-Dichloroethylene	9.82E-08	0.00E+00	2.20E-02	1.83E-02	1.99E-02
111-Trichloroethan	1.85E-08	0.00E+00	6.99E-03	3.58E-03	4.57E-03
112-Trichloroethan	7.82E-08	0.00E+00	7.02E-03	3.58E-03	4.31E-03
1122-tetrachlorethan	1.76E-06	8.15E-08	3.72E-02	1.28E-02	1.44E-02
12-Dichlorobenzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
12-Dichloroethane	2.25E-07	0.00E+00	1.11E-02	5.68E-03	5.74E-03
12-Dichloroethylene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
123-trichloroprpane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
124-Trichlorobenzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1245-tetrachlorobenz	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
13-Dichlorobenzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
14-Dichlorobenzene	2.06E-07	0.00E+00	3.00E-03	1.55E-03	2.04E-03
14-Dioxane	3.11E-07	4.06E-09	1.37E-03	7.32E-04	7.33E-04
2-Methylnaphthalene	6.48E-07	3.25E-08	2.69E-03	9.85E-04	3.46E-03
2-Hexanone	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2-Chlorophenol	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2-Methylphenol	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
24-Dinitrotoluene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4-Methylphenol	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4-Methyl-2-pentanone	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Acenaphthene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Acenaphthylene	0.00E+00	0.00E+00	7.47E-01	2.80E-01	2.80E-01
Acetone	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aldrin	1.69E-03	6.79E-05	1.64E+01	1.32E+00	1.89E+01
Allyl alchohol	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Alpha-hexachlorocycl	6.14E-04	2.47E-05	1.73E+00	1.88E-01	1.23E+00
Aluminum (ionic)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Amonia	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Anthracene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony (ionic)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aroclor 1254 (pcb)	3.28E-04	1.70E-05	4.31E+00	4.19E-01	1.07E+01
Aroclor 1260 (pcb)	1.62E-03	5.73E-05	2.90E+01	2.40E+00	2.48E+00
Aroclor 1248 (PCB)	1.88E-04	1.26E-05	2.56E+00	2.79E-01	1.65E+01
Arsenic (ionic)	5.93E-06	4.55E-07	1.96E+00	2.94E-02	8.74E-02
Asbestos (croc)	3.94E-05	4.92E-06	4.47E+00	3.93E-01	4.02E-01
Asphalt	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium (ionic)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzene	2.15E-08	0.00E+00	3.55E-03	1.89E-03	2.04E-03
Benzo(a)anthracene	1.88E-05	1.32E-06	2.46E-01	3.72E-02	3.29E+00
Benzo(a)pyrene	1.87E-04	1.09E-05	2.81E+00	3.93E-01	7.86E+00
Benzo(b)fluoranthene	2.61E-05	1.53E-06	3.93E-01	5.51E-02	1.10E+00
Benzo(k)fluoranthene	1.23E-05	7.21E-07	1.85E-01	2.52E-02	5.17E-01
Benzoic acid	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium (ionic)	1.60E-05	1.78E-06	1.31E+00	9.19E-02	1.24E-01
Beryllium chloride	1.60E-05	1.78E-06	1.31E+00	9.19E-02	1.24E-01
beta - HCCH	9.09E-05	4.42E-06	3.38E-01	3.62E-02	3.72E-01
bis(2et-hexyl)phthlt	4.49E-05	2.84E-06	5.21E-03	3.65E-03	3.66E-03

Table A.2. (contd)

Chemical Name	Soil (mass)	Soil (area)	Air	Groundwater	Surface Water
Boron (ionic)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bromodichloromethane	1.17E-07	0.00E+00	1.92E+00	8.13E-03	8.91E-03
Cadmium (ionic)	2.31E-04	9.11E-06	1.36E+00	1.35E-01	5.53E-01
Calcium (ionic)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbon disulfide	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbon tetrachloride	4.67E-08	0.00E+00	6.50E-03	4.63E-03	1.11E-02
Chlordane	3.69E-05	0.00E+00	3.16E-01	2.65E-02	1.65E-01
Chlorine gas	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chlorobenzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chlorodibromomethane	3.50E-07	0.00E+00	1.03E-02	1.44E-03	1.80E-03
Chloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chloroform	3.25E-09	0.00E+00	9.91E-03	3.84E-03	3.87E-03
Chloromethane(methy)	1.07E-07	0.00E+00	7.71E-04	5.19E-04	5.25E-04
Chromic acid	2.57E-04	1.73E-05	9.62E+00	1.02E+00	3.78E+00
Chromium VI (ionic)	0.00E+00	0.00E+00	5.02E+00	0.00E+00	0.00E+00
Chromium III	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chrysene	5.72E-07	4.03E-08	7.54E-03	1.13E-03	5.91E-02
Cobalt (ionic)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper (ionic)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cyanide ion	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DDD	4.49E-06	3.51E-07	6.97E-02	7.44E-03	2.23E-01
DDE	1.10E-05	6.41E-07	1.73E-01	1.60E-02	9.66E-01
DDT	6.01E-06	4.22E-07	1.78E-01	1.75E-02	3.18E-01
Delta-BHC	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Di-n-butyl phthalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Di-n-octylphthalate	1.36E-03	4.24E-05	2.63E+01	1.98E+00	1.99E+00
Dibenzo(a,h)antrac	1.44E-04	1.01E-05	1.90E+00	5.83E-01	2.41E+02
Dieldrin	3.39E-03	1.20E-04	8.07E+00	8.64E-01	2.67E+01
Diesel Fuel	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Diethyl Phthalate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EDTA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Endosulfan II	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Endosulfan I	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Endrin	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ethyl acetate	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ethyl ether	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ethylbenzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ethylene glycol	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fluoranthene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fluorene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fluoride ion	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Freon 113	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fuel Oil #2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
gamma-HCCH (Lindane)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gasoline	2.15E-10	3.57E-08	3.55E-05	1.82E-05	1.96E-05
Heptachlor	2.66E-04	0.00E+00	9.80E+01	1.26E-01	2.40E+00
Heptanes	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table A.2. (contd)

Chemical Name	Soil (mass)	Soil (area)	Air	Groundwater	Surface Water
Hexanes	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HMX (h-no2 tetzocine	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hydraulic Fluid	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Indeno(1,2,3-cd)pyre	8.11E-05	3.72E-06	1.33E+00	1.65E-01	5.04E-01
Iron	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Isobutane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Isophorone	1.23E-07	5.62E-09	1.78E-04	2.84E-05	3.43E-05
Isopropyl alcohol	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kerosene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead (ionic)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lithium ion	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
m-xylene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Magnesium (ionic)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese (ionic)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury (ionic)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Methanol	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Methyl ethyl ketone	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Methylcyclohexane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Methylcyclopentane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Methylene chloride	4.24E-09	6.03E-07	1.97E-04	1.98E-04	2.04E-04
Mineral Oil	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Molybdenum	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Motor Oil	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
n-Pentane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
n-Butane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
N-Dodecane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
N-nitrosodiphnylamne	4.26E-07	0.00E+00	6.16E-04	3.41E-04	5.28E-04
N-nitrosodipropylami	2.43E-03	1.06E-04	9.10E-01	3.72E-01	3.81E-01
Naphthalene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel (ionic)	0.00E+00	0.00E+00	1.03E-01	0.00E+00	0.00E+00
Nitrate ion	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nitric acid	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nitrite	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nonane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
o-Xylene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Octane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PCBs (general)	1.87E-04	7.34E-06	3.58E+00	3.60E-01	4.58E+02
Pentachlorophenol	2.64E-06	1.88E-07	2.54E-02	4.20E-03	1.76E-01
PETN	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Phenanthrene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Phenol	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Phosphate ion	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Phosphoric Acid	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Potassium hydroxide	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Potassium ion	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Propane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pyrene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RDX 6h-3no2-triazine	1.12E-05	4.46E-07	2.06E-02	2.63E-03	8.37E-03

Table A.2. (contd)

Chemical Name	Soil (mass)	Soil (area)	Air	Groundwater	Surface Water
Selenium (ionic)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Silver (ionic)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sodium bichromate	2.57E-04	1.73E-05	9.62E+00	1.02E+00	3.78E+00
Sodium ion	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sodium (ionic)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sodium hydroxide	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Strontium ion	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Stryene-butadiene	1.38E-07	7.26E-09	6.44E-04	2.34E-04	1.14E-03
Styrene	6.98E-09	0.00E+00	3.40E-02	1.08E-03	1.98E-03
Sulfate ion	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sulfuric Acid	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tetrachloroethylene	9.62E-08	0.00E+00	2.24E-04	1.39E-03	3.20E-03
Tetrahydro furan	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium (ionic)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tin (ionic)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TNT 3no2-toluene	1.78E-05	5.83E-07	5.59E-03	1.83E-03	1.91E-03
Toluene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
trans-1,3-dichloropr	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tribromomethane	6.40E-08	0.00E+00	4.86E-04	1.39E-04	2.04E-04
Tributyl phosphate	3.18E-09	1.24E-10	5.23E-04	1.37E-04	1.91E-03
Trichloroethylene	8.82E-09	0.00E+00	1.59E-03	8.41E-04	8.96E-04
Trichloromonofluoro	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Trichloromonofluorom	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Trimethylbenzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium (ionic)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium (ionic)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vinyl chloride	1.38E-07	0.00E+00	3.55E-02	4.48E-02	4.67E-02
Xylene (mixed)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc compounds	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table A.3. Unit Exposure Factors for Radionuclide Impacts

Chemical Name	Soil (mass)	Soil (area)	Air	Groundwater	Surface Water
AC225	3.17E-11	4.36E-13	5.27E-04	9.84E-07	1.18E-06
AC227	7.49E-08	1.07E-08	1.93E-02	3.90E-04	3.95E-04
AC228	1.17E-11	5.42E-15	5.81E-06	1.16E-08	1.78E-08
AM241	2.26E-08	2.84E-09	7.04E-03	1.08E-04	1.44E-04
AM243	3.45E-08	4.32E-09	7.04E-03	1.08E-04	1.44E-04
BE7	2.52E-11	2.09E-12	6.70E-08	8.39E-10	8.99E-10
BI210	5.63E-13	2.83E-15	1.78E-05	6.31E-08	6.25E-08
C14	2.86E-12	0.00E+00	3.08E-06	1.20E-07	2.57E-06
CD109	3.07E-11	1.90E-12	1.55E-05	2.68E-07	1.20E-06
CE144	1.27E-10	2.30E-11	7.52E-05	2.10E-07	2.04E-06
CF252	1.41E-09	2.06E-10	2.14E-02	4.73E-05	5.72E-05
CM242	1.01E-10	9.19E-12	8.56E-04	3.00E-06	4.92E-06
CM243	1.38E-08	1.91E-09	5.72E-03	7.35E-05	1.02E-04
CM244	7.43E-09	1.09E-09	4.84E-03	5.90E-05	8.27E-05
CM245	2.52E-08	3.14E-09	7.04E-03	1.10E-04	1.46E-04
CM248	8.69E-08	1.09E-08	2.64E-02	4.07E-04	5.42E-04
CO56	3.56E-09	3.84E-10	7.43E-06	2.86E-07	1.82E-06
CO57	1.63E-10	2.93E-11	1.95E-06	2.24E-08	1.36E-07
CO58	7.39E-10	7.44E-11	2.58E-06	5.82E-08	3.71E-07
CO60	5.16E-08	9.43E-09	3.69E-05	6.06E-07	3.54E-06
CS132	6.16E-11	7.67E-13	3.88E-07	3.51E-08	1.43E-06
CS134	1.27E-08	2.51E-09	2.69E-05	2.35E-06	5.09E-05
CS137	3.59E-08	4.84E-09	1.85E-05	1.71E-06	3.48E-05
EU152	4.42E-08	6.77E-09	2.45E-05	1.07E-07	1.39E-07
EU154	3.77E-08	6.25E-09	3.12E-05	1.48E-07	1.93E-07
EU155	3.33E-10	6.17E-11	4.01E-06	2.17E-08	2.84E-08
FE55	3.71E-13	2.61E-14	2.26E-07	9.08E-09	3.29E-07
H3	5.86E-16	5.43E-17	3.74E-08	1.46E-09	1.50E-09
H3-EL	9.55E-14	0.00E+00	8.68E-13	1.16E-09	1.17E-09
I129	1.24E-08	4.21E-10	1.49E-04	1.34E-05	6.97E-05
I131	3.96E-11	5.91E-13	1.27E-05	1.29E-06	1.20E-05
K40	1.89E-08	1.81E-09	7.30E-06	1.07E-06	7.59E-06
KR85	7.42E-11	1.18E-11	2.69E-10	0.00E+00	1.15E-12
MN52	2.12E-10	2.29E-12	1.25E-06	4.96E-08	5.72E-07
MN54	2.87E-09	5.34E-10	1.39E-06	3.38E-08	2.94E-07
MN56	2.06E-12	4.35E-16	2.49E-07	3.44E-10	9.59E-08
NA22	2.18E-08	4.34E-09	1.48E-05	1.12E-06	1.52E-06
NB95	2.89E-10	1.72E-11	1.90E-06	6.66E-08	1.44E-07
NI63	7.21E-12	2.64E-13	4.37E-07	8.65E-09	2.29E-08
NP237	4.89E-08	6.05E-09	6.39E-03	1.29E-04	1.61E-04
NP239	1.71E-12	7.91E-15	3.78E-07	1.86E-08	1.58E-07
P32	2.51E-11	1.78E-13	2.30E-06	1.96E-07	1.45E-04
PA231	1.09E-07	1.23E-08	7.90E-03	3.02E-04	3.02E-04
PA233	3.58E-11	1.70E-12	1.98E-06	3.34E-08	4.01E-08
PB210	1.98E-09	1.65E-10	9.62E-04	2.01E-05	5.92E-05
PB212	7.69E-12	6.72E-15	1.10E-05	5.82E-08	4.01E-07
PM147	3.50E-13	4.90E-14	6.62E-06	1.42E-08	1.88E-08
PO210	1.54E-11	1.18E-12	5.88E-04	4.97E-06	4.94E-05

Table A.3. (contd)

Chemical Name	Soil (mass)	Soil (area)	Air	Groundwater	Surface Water
PU238	1.77E-08	2.30E-09	8.58E-03	9.34E-05	1.26E-04
PU239	2.23E-08	2.80E-09	8.36E-03	1.05E-04	1.39E-04
PU240	2.23E-08	2.80E-09	8.36E-03	1.05E-04	1.39E-04
PU241	5.82E-10	6.69E-11	5.08E-05	1.98E-06	2.51E-06
PU242	2.11E-08	2.65E-09	7.92E-03	9.88E-05	1.31E-04
RA223	8.54E-12	1.82E-13	6.84E-04	1.62E-06	4.27E-06
RA224	6.38E-11	4.55E-13	2.64E-04	8.16E-07	2.39E-06
RA225	4.85E-11	9.50E-13	3.32E-04	1.35E-06	3.45E-06
RA226	1.44E-07	1.80E-08	6.75E-04	3.97E-06	8.94E-06
RA228	1.00E-07	1.66E-08	8.12E-04	2.78E-05	6.48E-05
RN222	9.42E-13	0.00E+00	3.68E-07	9.46E-08	9.45E-08
RU103	1.86E-10	1.21E-11	1.96E-06	2.49E-08	7.90E-08
RU106	7.83E-10	1.49E-10	9.75E-05	2.81E-07	8.44E-07
S35	8.28E-12	2.40E-13	2.42E-07	2.05E-08	1.18E-07
SB124	1.24E-09	1.12E-10	5.30E-06	8.15E-08	4.26E-07
SB125	3.83E-09	7.65E-10	2.56E-06	2.58E-08	1.25E-07
SE75	3.10E-10	4.19E-11	3.17E-06	2.52E-07	8.37E-07
SR85	2.88E-10	2.72E-11	3.94E-07	2.53E-08	4.83E-08
SR89	5.51E-12	1.16E-13	1.09E-06	9.64E-08	1.85E-07
SR90	9.32E-09	4.07E-10	2.06E-05	1.99E-06	3.05E-06
TA182	1.49E-09	1.99E-10	9.74E-06	4.93E-08	3.02E-05
TC99	1.32E-09	4.15E-11	2.66E-06	1.86E-07	1.98E-07
TE125M	5.91E-13	4.50E-14	1.28E-06	2.56E-08	2.27E-07
TH227	2.43E-11	8.24E-13	1.07E-03	1.68E-06	1.91E-06
TH228	2.55E-08	5.15E-09	1.71E-02	5.05E-05	5.38E-05
TH229	1.51E-07	1.74E-08	1.69E-02	4.66E-04	4.71E-04
TH230	1.63E-08	2.00E-09	6.36E-03	6.83E-05	6.91E-05
TH231	1.74E-14	2.52E-17	1.09E-07	1.46E-08	3.83E-08
TH232	3.36E-07	3.45E-08	6.14E-03	3.81E-04	3.81E-04
TH234	3.90E-12	1.68E-13	7.28E-06	1.07E-07	3.44E-07
U232	2.21E-07	2.64E-08	1.32E-02	2.01E-06	3.10E-06
U233	3.72E-10	2.71E-11	5.92E-03	6.85E-07	1.16E-06
U234	1.58E-10	1.05E-11	5.70E-03	6.77E-07	1.15E-06
U235	5.99E-09	7.39E-10	5.48E-03	6.72E-07	1.15E-06
U236	1.48E-10	9.88E-12	5.48E-03	6.37E-07	1.08E-06
U238	2.33E-09	2.75E-10	1.14E-02	1.11E-06	1.94E-06
Y90	1.99E-13	1.05E-15	1.25E-06	6.41E-08	1.12E-07
ZN65	1.89E-09	2.87E-10	9.96E-06	7.02E-07	1.33E-05

Appendix B

Pollutant Specific Parameter Values

Appendix B

Pollutant Specific Parameter Values

This appendix presents the pollutant-specific parameters used in the development of the unit exposure factors. The parameter values are presented in tables for chemicals and radionuclides. References are given for all values based on the reference index system developed for the MEPAS chemical database. The reference citations are given at the end of this appendix, keyed to the MEPAS reference numbers given in the tables.

The chemical toxicity parameters are given in Table B.1, with parameters described as follows.

- Oral Slope Factor: slope factor for estimation of cancer incidence for ingestion and dermal exposure pathways (risk per mg/kg/d)
- Inhalation Slope Factor: slope factor for estimation of cancer incidence for inhalation exposure pathways (risk per mg/kg/d)
- Oral Reference Dose: reference dose for calculation of hazard indices for ingestion and dermal exposure pathways (mg/kg/d)
- Inhalation Reference Dose: reference dose for calculation of hazard indices for inhalation exposure pathways (mg/kg/d).

The radionuclide slope factors are given in Table B.2, with parameters described as follows.

- Oral Slope Factor: slope factor for estimation of cancer incidence for ingestion of radionuclides (risk/pCi ingested)
- Inhalation Slope Factor: slope factor for estimation of cancer incidence for inhalation of radionuclides (risk/pCi inhaled)
- External Slope Factor: slope factor for estimation of cancer incidence for exposure to external radiation normalized to activity in an infinite slab of uniformly contaminated soil (risk/yr per pCi/g)
- Dermal Dose Factor: dose factor for estimation of radiation dose (effective dose equivalent) from dermal absorption of radionuclides (rem/pCi absorbed).

The food chain transfer factors for chemicals are given in Table B.3 and for radionuclides in Table B.4. The parameters in these tables are described as follows.

- Plant Concentration Ratio: ratio of pollutant concentration in plants relative to the concentration in soil (for chemicals, mg/kg wet-weight plant per mg/kg dry soil, and for radionuclides pCi/kg wet-weight plant per pCi/kg dry soil)

- Meat Transfer Factor: factor to estimate meat concentration from constant intake of a pollutant in animal feed or water (for chemicals, mg/kg wet-weight meat per mg/d intake, and for radionuclides, pCi/kg wet-weight meat per pCi/d intake)

- Milk Transfer Factor: factor to estimate milk concentration from constant intake of a pollutant in animal feed or water (for chemicals, mg/L milk per mg/d intake, and for radionuclides, pCi/L milk per pCi/d intake)

- Fish Bioaccumulation Factor: ratio of pollutant concentration in edible parts of fish relative to the concentration in surface water (for chemicals, mg/kg wet-weight fish per mg/L water, and for radionuclides, pCi/kg wet-weight fish per pCi/L water).

Table B.1. Chemical Toxicity Parameters

Chemical Name	Cas No.	Oral Slope Factor Kg/d/mg	Ref. No.	Inhalation Slope Factor KG/dmg	Ref. No.	Oral Reference Dose Mg/kg/d	Ref. No.	Inhalation Reference Dose mg/kg/d	Ref. No.
ALUMINUM	7429905	0.00E+00	NV	0.00E+00	NV	4.00E-04	400	1.40E-03	342
AMMONIA	7664417	0.00E+00	NV	0.00E+00	NV	2.90E-02	338	2.90E-02	404
ANTIMONY	7440360	0.00E+00	NV	0.00E+00	NV	4.00E-04	404	4.00E-04	334
ARSENIC	7440382	1.75E+00	404	1.50E+01	404	3.00E-04	404	0.00E+00	NV
ASBESTOS (CROC)	12001284	2.40E+01	338	2.40E+01	404	0.00E+00	NV	0.00E+00	NV
BARIUM	7440393	0.00E+00	NV	0.00E+00	NV	7.00E-02	404	1.00E-04	400
BERYLLIUM	7440417	4.30E+00	404	8.40E+00	404	5.00E-03	404	0.00E+00	NV
BORON	7440428	0.00E+00	NV	0.00E+00	NV	9.00E-02	404	9.00E-02	334
CADMIUM	7440439	6.30E+00	338	6.30E+00	404	5.00E-04	404	5.00E-04	334
CALCIUM ION	7440702	0.00E+00	NV	0.00E+00	NV	1.70E+01	429	1.70E+01	334
CHLORINE	7782505	0.00E+00	NV	0.00E+00	NV	1.10E-02	338	1.10E-02	339
CHROMIC ACID	7738945	4.10E+01	338	4.10E+01	404	5.00E-03	404	5.70E-07	400
CHROMIUM VI	7440473	4.10E+01	338	4.10E+01	404	5.00E-03	404	5.70E-07	400
COBALT	7440484	0.00E+00	NV	0.00E+00	NV	8.10E-03	340	3.50E-04	339
COPPER	7440508	0.00E+00	NV	0.00E+00	NV	3.00E-04	404	1.00E-02	276
CYANIDE ION	57125	0.00E+00	NV	0.00E+00	NV	2.00E-02	404	2.00E-02	334
FLUORIDE	7782414	0.00E+00	NV	0.00E+00	NV	6.00E-02	404	6.00E-02	334
LEAD	7439921	0.00E+00	NV	0.00E+00	NV	1.40E-03	321	4.30E-04	291
LITHIUM ION	7447418	0.00E+00	NV	0.00E+00	NV	6.00E+00	361	6.00E+00	334
MAGNESIUM	7786303	0.00E+00	NV	0.00E+00	NV	5.00E+01	339	7.00E-02	339
MANGANESE	7439965	0.00E+00	NV	0.00E+00	NV	7.00E-02	400	1.43E-03	404
MERCURY	7439976	0.00E+00	NV	0.00E+00	NV	3.00E-04	314	8.60E-05	314
NICKEL	7440020	0.00E+00	NV	8.40E-01	404	2.00E-02	404	0.00E+00	NV
NITRATE	14797558	0.00E+00	NV	0.00E+00	NV	1.60E+00	404	1.60E+00	334
NITRIC ACID	7697372	0.00E+00	NV	0.00E+00	NV	3.50E-02	338	3.50E-02	339
PHOSPHATE ION	7601549	0.00E+00	NV	0.00E+00	NV	4.60E-01	340	7.00E-03	340
POTASSIUM HYDROXIDE	1310583	0.00E+00	NV	0.00E+00	NV	1.40E-01	360	1.40E-01	360
SELENIUM	7782492	0.00E+00	NV	0.00E+00	NV	5.00E-03	404	1.00E-03	302
SILVER	7440224	0.00E+00	NV	0.00E+00	NV	5.00E-03	404	5.00E-03	334
SODIUM BICHROMATE	10588019	4.10E+01	338	4.10E+01	404	5.00E-03	404	5.70E-07	400
SODIUM HYDROXIDE	1310732	0.00E+00	NV	0.00E+00	NV	1.40E-02	338	1.40E-02	339
SODIUM ION	7647145	0.00E+00	NV	0.00E+00	NV	3.00E+02	377	3.00E+02	334
SULFATE	12808798	0.00E+00	NV	0.00E+00	NV	7.10E+01	379	7.00E-02	339
THALLIUM	7440280	0.00E+00	NV	0.00E+00	NV	8.00E-05	404	8.00E-05	334
TIN	7440315	0.00E+00	NV	0.00E+00	NV	6.00E-01	314	6.00E-01	338
TRIBUTYL PHOSPHATE	126738	7.90E-03	404	0.00E+00	NV	1.75E-02	338	1.75E-02	339
URANIUM	7440611	0.00E+00	NV	0.00E+00	NV	3.00E-03	420	1.40E-03	339
VANADIUM	7440622	0.00E+00	NV	0.00E+00	NV	9.00E-03	404	9.00E-03	334
ZINC COMPOUNDS	7646857	0.00E+00	NV	0.00E+00	NV	3.00E-01	404	3.00E-01	334

Table B.1. (contd)

Chemical Name	Cas No.	Oral Slope Factor Kg/d/mg	Ref. No.	Inhalation Slope Factor KG/dmg	Ref. No.	Oral Reference Dose Mg/kg/d	Ref. No.	Inhalation Reference Dose mg/kg/d	Ref. No.
BIS(2ET-HEXYL)PHTHLT	117817	1.40E-02	404	1.40E-02	334	2.00E-02	404	2.00E-02	334
CHRYSENE	218019	2.55E-02	418	2.68E-02	418	0.00E+00	NV	0.00E+00	NV
ETHYLENE GLYCOL	107211	0.00E+00	NV	0.00E+00	NV	2.00E+00	404	2.00E+00	334
GAMMA-HCCH (LINDANE)	58899	0.00E+00	NV	0.00E+00	NV	3.00E-04	404	3.00E-04	334
HYDRAULIC FLUID	HYDR FLU	0.00E+00	NV	0.00E+00	NV	9.00E-01	357	9.00E-01	357
INDENO(1,2,3-CD)PYRE	193395	1.34E+00	418	1.42E+00	418	0.00E+00	NV	0.00E+00	NV
MOTOR OIL	MOTOR OL	0.00E+00	NV	0.00E+00	NV	9.00E-01	357	9.00E-01	357
PHENOL	108952	0.00E+00	NV	0.00E+00	NV	6.00E-01	404	6.00E-01	334
1,1 DICHLOROETHYLENE	75354	6.00E-01	404	1.80E-01	404	9.00E-03	404	9.00E-03	334
1,1,1-TRICHLOROETHAN	71556	5.73E-02	307	5.70E-02	334	4.00E-03	404	4.00E-03	334
1,1,2-TRICHLOROETHAN	79005	5.70E-02	404	5.70E-02	404	4.00E-03	404	4.00E-03	334
1,1-DICHLOROETHANE	75343	0.00E+00	NV	0.00E+00	NV	1.00E-01	314	1.00E-01	314
1,2 DICHLOROBENZENE	95501	0.00E+00	NV	0.00E+00	NV	9.00E-02	404	4.00E-02	400
1,2 DICHLOROETHANE	107062	9.10E-02	404	9.10E-02	404	0.00E+00	NV	0.00E+00	NV
1,2 DICHLOROETHYLENE	156605	0.00E+00	NV	0.00E+00	NV	2.00E-02	404	2.00E-02	334
1,3-DICHLOROBENZENE	541731	0.00E+00	NV	0.00E+00	NV	9.00E-02	315	9.00E-02	334
1,4-DICHLOROBENZENE	106467	2.40E-02	400	2.40E-02	314	5.70E+00	319	2.00E-01	400
1,4-DIOXANE	123911	1.10E-02	404	1.10E-02	334	0.00E+00	NV	0.00E+00	NV
2-METHYLNAPHTHALENE	91576	1.43E-02	338	1.43E-02	295	6.00E-02	321	6.00E-02	334
ACENAPHTHYLENE	208968	0.00E+00	NV	6.10E+00	335	0.00E+00	NV	0.00E+00	NV
ACETONE	67641	0.00E+00	NV	0.00E+00	NV	1.00E-01	404	1.00E-01	334
ALPHA-HEXACHLOROCYCL	319846	6.30E+00	404	6.30E+00	404	0.00E+00	NV	0.00E+00	NV
ANTHRACENE	120127	0.00E+00	NV	0.00E+00	NV	3.00E-01	404	3.00E-01	334
AROCLOR 1254 (PCB)	11091691	7.70E+00	406	7.70E+00	406	0.00E+00	NV	0.00E+00	NV
AROCLOR 1260 (PCB)	11096825	7.70E+00	406	7.70E+00	406	0.00E+00	NV	0.00E+00	NV
BENZENE	71432	2.90E-02	404	2.90E-02	404	0.00E+00	NV	0.00E+00	NV
BENZO(A)ANTHRACENE	56553	8.40E-01	418	8.85E-01	418	0.00E+00	NV	0.00E+00	NV
BENZO(A)PYRENE	50328	5.79E+00	404	6.10E+00	400	0.00E+00	NV	0.00E+00	NV
BENZO(B)FLUORANTHENE	205992	8.11E-01	418	8.54E-01	418	0.00E+00	NV	0.00E+00	NV
BENZO(K)FLUORANTHENE	207089	3.82E-01	418	4.03E-01	418	0.00E+00	NV	0.00E+00	NV
BETA - HCCH	319857	1.80E+00	404	1.80E+00	404	3.00E-04	400	3.00E-04	334
CARBON DISULFIDE	75150	0.00E+00	NV	0.00E+00	NV	1.00E-01	404	2.80E-03	400
CARBON TETRACHLORIDE	56235	1.30E-01	404	5.30E-02	404	7.00E-04	404	7.00E-04	334
CHLORDANE	57749	1.30E+00	404	1.30E+00	404	6.00E-05	404	0.00E+00	NV
CHLOROBENZENE	108907	0.00E+00	NV	0.00E+00	NV	2.00E-02	404	5.70E-03	400
CHLORODIBROMOMETHANE	124481	8.40E-02	404	8.40E-02	334	2.00E-02	404	2.00E-02	334
CHLOROETHANE	75003	0.00E+00	NV	0.00E+00	NV	1.00E+01	334	1.00E+01	404
CHLOROFORM	67663	6.10E-03	404	8.10E-02	404	1.00E-02	404	1.00E-02	334
CHLOROMETHANE(METHY)	74873	1.30E-02	400	6.30E-03	400	5.40E-01	315	0.00E+00	NV

Table B.1. (contd)

Chemical Name	Cas No.	Oral Slope Factor Kg/d/mg	Ref. No.	Inhalation Slope Factor KG/dmg	Ref. No.	Oral Reference Dose Mg/kg/d	Ref. No.	Inhalation Reference Dose mg/kg/d	Ref. No.
DDD	72548	2.40E-01	318	2.50E-01	334	5.00E-02	321	5.00E-02	339
DDE	72559	3.40E-01	404	3.40E-01	334	0.00E+00	NV	0.00E+00	NV
DI-N-BUTYL PHTHALATE	84742	0.00E+00	NV	0.00E+00	NV	1.00E-01	404	1.00E-01	334
DIESEL FUEL	DIESEL F	0.00E+00	NV	0.00E+00	NV	3.60E-01	340	3.60E-01	334
EDTA	60004	0.00E+00	NV	0.00E+00	NV	1.30E-03	340	1.30E-03	334
ENDRIN	72208	0.00E+00	NV	0.00E+00	NV	3.00E-04	404	3.00E-04	334
ETHANE	74840	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV	5.40E+04	339
ETHYL ACETATE	141786	0.00E+00	NV	0.00E+00	NV	9.00E-01	404	9.00E-01	334
ETHYLBENZENE	100414	0.00E+00	NV	0.00E+00	NV	1.00E-01	404	2.90E-01	404
FLUORANTHENE	206440	0.00E+00	NV	0.00E+00	NV	4.00E-02	404	4.00E-02	334
FLUORENE	86737	0.00E+00	NV	0.00E+00	NV	4.00E-02	404	4.00E-02	334
FREON 113	76131	0.00E+00	NV	0.00E+00	NV	3.00E+01	404	8.61E+00	404
FUEL OIL #2	FUEL OIL	0.00E+00	NV	0.00E+00	NV	3.60E-01	340	3.60E-01	334
GASOLINE	8006619	2.90E-04	388	2.90E-04	388	0.00E+00	NV	0.00E+00	NV
HEXANES	110543	0.00E+00	NV	0.00E+00	NV	6.00E-02	388	6.00E-02	404
HMX (H-NO2 TETZOCINE	2691410	0.00E+00	NV	0.00E+00	NV	5.00E-02	404	5.00E-02	334
ISOBUTANE	75285	0.00E+00	NV	0.00E+00	NV	1.33E+01	338	1.33E+01	339
ISOPROPYL ALCOHOL	67630	0.00E+00	NV	0.00E+00	NV	6.90E+00	338	6.90E+00	339
KEROSENE	8008206	0.00E+00	NV	0.00E+00	NV	7.00E-01	338	7.00E-01	339
METHANOL	67561	0.00E+00	NV	0.00E+00	NV	5.00E-01	404	5.00E-01	334
METHYL ETHYL KETONE	78933	0.00E+00	NV	0.00E+00	NV	5.00E-02	314	2.90E-01	404
METHYLENE CHLORIDE	75092	7.50E-03	404	1.60E-03	404	6.00E-02	404	6.00E-02	334
N-DODECANE	112403	0.00E+00	NV	0.00E+00	NV	7.30E+00	338	7.30E+00	339
N-NITROSODIPHNYLAMNE	86306	4.90E-03	404	4.90E-03	334	0.00E+00	NV	0.00E+00	NV
N-NITROSODIPROPYLAMI	621647	7.00E+00	404	7.00E+00	334	0.00E+00	NV	0.00E+00	NV
NAPHTHALENE	91203	0.00E+00	NV	0.00E+00	NV	4.00E-02	314	4.00E-02	314
OCTANE	111659	0.00E+00	NV	0.00E+00	NV	1.02E+01	338	1.02E+01	339
PCBs (GENERAL)	1336363	7.70E+00	404	7.70E+00	334	0.00E+00	NV	0.00E+00	NV
PENTACHLOROPHENOL	87865	1.20E-01	404	1.20E-01	334	3.00E-02	404	3.00E-02	334
PETN 5ERYTHRITOL-4NO	78115	0.00E+00	NV	0.00E+00	NV	3.00E-03	366	3.00E-03	366
PHENANTHRENE	85018	0.00E+00	NV	0.00E+00	NV	4.00E-02	407	4.00E-02	407
PROPANE	74986	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV	7.90E+04	339
PYRENE	129000	0.00E+00	NV	0.00E+00	NV	3.00E-02	404	3.00E-02	334
RDX 6H-3NO2-TRIAZINE	121824	1.10E-01	404	1.10E-01	334	3.00E-03	404	3.00E-03	334
TETRACHLOROETHYLENE	127184	5.10E-02	305	1.80E-03	400	1.00E-02	404	1.00E-02	334
TNT 3NO2-TOLUENE	118967	3.00E-02	404	3.00E-02	334	5.00E-04	404	5.00E-04	334
TOLUENE	108883	0.00E+00	NV	0.00E+00	NV	2.00E-01	404	1.10E-01	404
TRIBROMOMETHANE	75252	7.90E-03	404	3.90E-03	404	2.00E-02	404	2.00E-02	334
TRICHLOROETHYLENE	79016	1.10E-02	404	1.30E-02	407	0.00E+00	NV	0.00E+00	NV

Table B.1. (contd)

Chemical Name	Cas No.	Oral Slope Factor Kg/d/mg	Ref. No.	Inhalation Slope Factor KG/dmg	Ref. No.	Oral Reference Dose Mg/kg/d	Ref. No.	Inhalation Reference Dose mg/kg/d	Ref. No.
TRICHLOROMONOFLUOROM	75694	0.00E+00	NV	0.00E+00	NV	3.00E-01	404	3.00E-01	334
TRIMETHYLBENZENE	25551137	0.00E+00	NV	0.00E+00	NV	5.00E-05	400	8.80E-01	339
VINYL CHLORIDE	75014	1.90E+00	314	2.90E-01	400	0.00E+00	NV	0.00E+00	NV
XYLENE (MIXED)	1330207	0.00E+00	NV	0.00E+00	NV	2.00E+00	404	8.60E-02	400
n-BUTANE	106978	0.00E+00	NV	0.00E+00	NV	1.33E+01	333	1.33E+01	339
n-PENTANE	109660	0.00E+00	NV	0.00E+00	NV	1.26E+01	338	1.26E+01	339
o-XYLENE	95476	0.00E+00	NV	0.00E+00	NV	2.00E+00	314	2.00E-01	400
4-METHYL-2-PENTANONE	108101	0.00E+00	NV	0.00E+00	NV	5.00E-02	400	5.00E-02	334
BENZOIC ACID	65850	0.00E+00	NV	0.00E+00	NV	4.00E+00	404	4.00E+00	334
BERYLLIUM CHLORIDE	7787475	4.30E+00	404	8.40E+00	404	5.00E-03	404	0.00E+00	NV
CHROMIUM III	CR-III	0.00E+00	NV	0.00E+00	NV	1.00E+00	404	1.00E+00	334
DIBENZO(A,H)ANTRAC	53703	6.43E+00	418	6.77E+00	418	0.00E+00	NV	0.00E+00	NV
STRYENE-BUTADIENE	9003558	3.40E-03	338	3.40E-03	378	0.00E+00	NV	0.00E+00	NV
STRONTIUM ION	10476854	0.00E+00	NV	0.00E+00	NV	6.00E-01	404	1.70E-01	334
IRON	15438310	0.00E+00	NV	0.00E+00	NV	1.30E+00	386	8.60E-03	289
POTASSIUM ION	7447407	0.00E+00	NV	0.00E+00	NV	5.10E+02	375	5.10E+02	375
SULFURIC ACID	7664939	0.00E+00	NV	0.00E+00	NV	7.00E-03	338	7.00E-03	339
1,2,4TRICHLOROBENZNE	120821	0.00E+00	NV	0.00E+00	NV	1.00E-02	404	1.00E-02	334
2,4-DINITROTOLUENE	121142	0.00E+00	NV	0.00E+00	NV	2.00E-03	404	2.00E-03	334
2-CHLOROPHENOL	95578	0.00E+00	NV	0.00E+00	NV	5.00E-03	404	5.00E-03	334
2-HEXANONE ME-BU-KET	591786	0.00E+00	NV	0.00E+00	NV	1.40E-01	338	1.40E-01	339
2-METHYLPHENOL(0-CRE	95487	0.00E+00	NV	0.00E+00	NV	5.00E-02	404	1.00E-01	277
DDT	50293	3.40E-01	404	3.40E-01	404	5.00E-04	404	5.00E-04	334
4-METHYLPHENOL(P-CRE	106445	0.00E+00	NV	0.00E+00	NV	5.00E-02	314	1.00E-01	277
ACENAPHTHENE	83329	0.00E+00	NV	0.00E+00	NV	6.00E-02	404	6.00E-02	334
BROMODICHLOROMETHAN	75274	1.30E-01	404	1.30E-01	334	2.00E-02	404	2.00E-02	334
ISOPHORONE	78591	9.50E-04	404	9.50E-04	334	2.00E-01	404	2.00E-01	334
ALDRIN	309002	1.70E+01	404	1.70E+01	404	3.00E-05	404	3.00E-05	334
DELTA-HCCH	319868	0.00E+00	NV	0.00E+00	NV	2.00E-03	321	2.00E-03	334
ENDOSULFAN I (ALPHA)	115297A	0.00E+00	NV	0.00E+00	NV	5.00E-05	404	5.00E-05	334
ENDOSULFAN II (BETA)	115297B	0.00E+00	NV	0.00E+00	NV	5.00E-05	401	5.00E-05	334
HEPTACHLOR	76448	4.50E+00	404	4.50E+00	404	5.00E-04	404	5.00E-04	334
DIETHYL PHTHALATE	84662	0.00E+00	NV	0.00E+00	NV	8.00E-01	404	8.00E-01	334
MOLYBDENUM	7439987	0.00E+00	NV	0.00E+00	NV	5.00E-03	404	5.00E-03	334
PHOSPHORIC ACID	7664382	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV
ALLYL ALCOHOL	107186	0.00E+00	NV	0.00E+00	NV	5.00E-03	404	5.00E-03	334
TRICHLOROMONOFLUOROM	75694	0.00E+00	NV	0.00E+00	NV	3.00E-01	404	3.00E-01	334
MINERAL OIL	8012951	0.00E+00	NV	0.00E+00	NV	9.00E-01	340	9.00E-01	334
TETRAHYDRO FURAN	109999	0.00E+00	NV	0.00E+00	NV	4.10E+00	338	4.10E+00	339

Table B.1. (contd)

Chemical Name	Cas No.	Oral Slope Factor Kg/d/mg	Ref. No.	Inhalation Slope Factor KG/dmg	Ref. No.	Oral Reference Dose Mg/kg/d	Ref. No.	Inhalation Reference Dose mg/kg/d	Ref. No.
DIELDRIN	60571	1.60E+01	404	1.60E+01	404	5.00E-05	404	5.00E-05	334
SODIUM ION	7647145	0.00E+00	NV	0.00E+00	NV	3.00E+02	377	3.00E+02	334
STYRENE	100425	3.00E-02	400	2.00E-03	400	2.00E-01	404	2.90E-01	404
NITRITE	NITRITE	0.00E+00	NV	0.00E+00	NV	3.40E-02	338	3.40E-02	339
AROCLOR 1248 (PBC)	12672296	7.70E+00	406	7.70E+00	406	0.00E+00	NV	0.00E+00	NV
DI-N-OCTYLPHTHALATE	117840	1.40E-02	404	1.40E-02	334	2.00E-02	404	2.00E-02	334
ETHYL ETHER	60297	0.00E+00	NV	0.00E+00	NV	2.00E-01	404	5.00E-01	339
HEPTANES	142825	0.00E+00	NV	0.00E+00	NV	1.12E+01	338	1.12E+01	339
m-XYLENE	108383	0.00E+00	NV	0.00E+00	NV	2.00E+00	314	2.00E-01	400
METHYLCYCLOHEXANE	108872	0.00E+00	NV	0.00E+00	NV	7.00E-04	340	7.10E-01	339
METHYLCYCLOPENTANE	96377	0.00E+00	NV	0.00E+00	NV	9.00E-02	340	1.12E+02	339
NONANE	111842	0.00E+00	NV	0.00E+00	NV	7.35E+01	338	7.35E+01	339
ASPHALT	8052424	0.00E+00	NV	0.00E+00	NV	3.50E-02	338	3.50E-02	347
1,2,4,5-TETRACHLOROB	95943	0.00E+00	NV	0.00E+00	NV	3.00E-04	404	3.00E-04	314
1,2,3TRICHLOROPRPANE	96184	0.00E+00	NV	0.00E+00	NV	6.00E-03	404	6.00E-03	334
1,1,2,2-TETRACLOROET	79345	2.00E-01	404	2.00E-01	404	0.00E+00	NV	0.00E+00	NV
TRANS-1,3-DICHLOROPR	10061026	0.00E+00	NV	0.00E+00	NV	3.00E-04	321	5.70E-03	334

Table B.2. Radionuclide Slope Factors and Dermal Dose Factors

Radionuclide	Oral Slope Factor Risk/pCi	Ref. No.	Inhalation Slope Factor Risk/pCi	Ref. No.	External Slope Factor Risk/yr per pCi/gq	Ref. No.	Dermal Dose Factor Rem/pCi	Ref. No.
AC227	3.50E-10	419	8.80E-08	419	8.50E-07	419	1.40E-02	398
TH227	4.50E-12	419	4.90E-09	419	1.60E-07	419	5.70E-05	398
RA223	6.40E-11	419	3.10E-09	419	2.30E-07	419	1.00E-06	398
AM241	2.40E-10	419	3.20E-08	419	4.90E-09	419	3.70E-03	398
AM243	2.40E-10	419	3.20E-08	419	2.50E-07	419	3.70E-03	398
NP239	9.40E-13	419	1.60E-12	419	2.30E-07	419	4.30E-09	425
PU239	2.30E-10	419	3.80E-08	419	1.70E-11	419	3.60E-03	398
CM243	1.90E-10	419	2.60E-08	419	1.60E-07	419	2.50E-03	398
SB124	2.90E-12	419	2.20E-11	419	6.50E-06	419	7.00E-09	398
SB125	8.40E-13	419	1.10E-11	419	1.20E-06	419	3.40E-09	398
TE125M	8.50E-13	419	5.40E-12	419	2.60E-09	419	1.10E-08	398
TH231	4.00E-13	419	4.90E-13	419	2.30E-09	419	6.80E-10	398
PA231	9.20E-11	419	3.60E-08	419	2.60E-08	419	1.10E-02	398
CM245	2.40E-10	419	3.20E-08	419	5.30E-08	419	3.80E-03	398
CF252	6.70E-10	500	9.73E-08	500	3.13E-09	500	1.00E-03	425
CM248	9.10E-10	419	1.20E-07	419	2.20E-11	419	1.40E-02	425
CM244	1.60E-10	419	2.20E-08	419	3.00E-11	419	2.00E-03	398
PU240	2.30E-10	419	3.80E-08	419	2.70E-11	419	3.60E-03	398
U235	1.60E-11	419	2.50E-08	419	2.40E-07	419	5.60E-06	398
PU241	3.60E-12	419	2.30E-10	419	8.38E-12	500	6.90E-05	398
CM242	1.30E-11	419	3.90E-09	419	3.40E-11	419	9.70E-05	398
PU238	2.20E-10	419	3.90E-08	419	2.80E-11	419	3.20E-03	398
RA226	1.20E-10	419	3.00E-09	419	6.00E-06	419	5.50E-06	398
RN222	1.40E-12	419	7.30E-13	419	1.20E-09	419	0.00E+00	NDF
PB210	6.60E-10	419	4.00E-09	419	1.60E-10	419	3.00E-05	398
BI210	1.60E-12	419	8.00E-11	419	4.56E-09	500	2.70E-08	425
PO210	1.50E-10	419	2.60E-09	419	2.90E-11	419	1.90E-05	398
TH230	1.30E-11	419	2.90E-08	419	2.50E-03	419	5.40E-11	425
U234	1.60E-11	419	2.60E-08	419	3.00E-11	419	6.10E-06	398
RA224	3.80E-11	419	1.20E-09	419	2.30E-08	419	3.80E-07	398
PB212	5.80E-12	419	5.00E-11	419	5.50E-06	419	2.10E-07	398
RA228	8.93E-10	500	3.15E-09	500	4.01E-06	500	4.80E-06	398
TH228	5.50E-11	419	7.80E-08	419	5.56E-06	419	1.80E-03	398
TH232	1.20E-11	419	2.80E-08	419	1.40E-02	419	2.60E-11	425
U232	3.70E-11	419	6.00E-08	419	4.60E-11	419	3.00E-05	398
U238	2.80E-11	419	5.20E-08	419	3.60E-08	419	5.50E-06	398
TH234	4.00E-12	419	3.20E-11	419	5.10E-08	419	3.90E-08	398
AC228	5.00E-13	419	2.60E-11	419	2.90E-06	419	6.50E-07	398
EU152	2.10E-12	419	1.10E-10	419	3.60E-06	419	1.60E-06	398
EU154	3.00E-12	419	1.40E-10	419	4.10E-06	419	2.10E-06	398
SR90	3.60E-11	419	6.20E-11	419	2.18E-08	500	4.10E-07	398
Y90	3.20E-12	419	5.50E-12	419	2.31E-08	500	4.40E-09	398
CD109	7.90E-12	419	6.50E-11	419	7.30E-10	419	2.40E-07	425
C14	9.00E-13	419	6.40E-15	419	6.98E-11	500	2.09E-09	398
CE144	6.20E-12	419	3.40E-10	419	1.40E-07	419	1.10E-06	398
CS134	4.10E-11	419	2.80E-11	419	5.20E-06	419	7.20E-08	398
CS137	2.80E-11	419	1.90E-11	419	2.00E-06	419	5.00E-08	398

Table B.2. (contd)

Radionuclide	Oral Slope Factor Risk/pCi	Ref. No.	Inhalation Slope Factor Risk/pCi	Ref. No.	External Slope Factor Risk/yr per pCi/gq	Ref. No.	Dermal Dose Factor Rem/pCi	Ref. No.
CO56	7.81E-12	500	2.46E-11	500	1.43E-05	500	3.00E-08	424
CO57	5.80E-13	419	8.20E-12	419	1.90E-07	419	2.50E-09	398
CO58	1.60E-12	419	9.80E-12	419	3.30E-06	419	5.50E-09	398
CO60	1.50E-11	419	1.50E-10	419	8.60E-06	419	7.30E-08	398
I129	1.90E-10	419	1.20E-10	419	4.10E-09	419	2.50E-07	398
I131	3.60E-11	419	2.40E-11	419	1.50E-06	419	4.90E-08	398
FE55	2.70E-13	419	8.40E-13	419	0.00E+00	NDF	5.60E-09	425
KR85	0.00E+00	NDF	4.70E-17	419	7.00E-09	419	0.00E+00	NDF
NI63	2.40E-13	419	1.80E-12	419	0.00E+00	NDF	6.60E-09	398
NB95	6.50E-13	419	5.10E-12	419	2.60E-06	419	9.30E-09	398
P32	3.50E-12	419	3.00E-12	419	1.26E-08	500	9.30E-09	398
PU242	2.20E-10	419	3.60E-08	419	2.30E-11	419	3.40E-03	398
K40	1.10E-11	419	7.60E-12	419	5.40E-07	419	2.00E-08	398
NP237	2.20E-10	419	2.90E-08	419	4.30E-07	419	4.50E-03	398
PA233	1.00E-12	419	8.60E-12	419	4.20E-07	419	0.00E+00	NDF
TH229	8.90E-11	419	7.70E-08	419	6.80E-07	419	1.70E-02	398
RA225	5.10E-11	419	1.50E-09	419	1.90E-09	419	1.10E-06	398
AC225	1.70E-11	419	2.40E-09	419	6.30E-07	419	2.20E-05	398
PM147	3.10E-13	419	3.00E-11	419	6.00E-12	419	1.80E-07	425
RU103	9.10E-13	419	8.40E-12	419	1.50E-06	419	5.30E-09	398
RU106	9.50E-12	419	4.40E-10	419	6.70E-07	419	0.00E+00	NDF
NA22	6.80E-12	419	4.80E-12	419	7.20E-06	419	1.20E-08	398
SR89	3.00E-12	419	2.90E-12	419	4.70E-10	419	8.40E-09	398
S35	2.20E-13	419	1.90E-13	419	7.30E-11	500	4.10E-10	398
TA182	1.70E-12	419	4.30E-11	419	4.10E-06	419	3.20E-08	425
TC99	1.30E-12	419	8.30E-12	419	6.00E-13	419	2.50E-09	398
H3	5.40E-14	419	7.80E-14	419	5.40E-14	NDF	0.00E+00	398
U233	1.60E-11	419	2.70E-08	419	4.20E-11	419	6.20E-06	398
U236	1.50E-11	419	2.50E-08	419	2.40E-11	419	5.80E-06	398
H3-EL	3.91E-14	500	3.29E-18	500	0.00E+00	NDF	0.00E+00	NDF
MN52	2.20E-12	419	3.70E-12	419	1.20E-05	419	4.00E-10	425
MN54	1.10E-12	419	5.30E-12	419	2.90E-06	419	9.60E-09	398
MN56	4.00E-13	419	2.80E-13	419	6.10E-06	419	1.90E-10	398
BE7	3.00E-14	419	2.70E-13	419	1.50E-07	419	4.30E-10	398
CS132	1.17E-12	500	7.63E-13	500	3.01E-06	500	2.00E-09	425
SE75	5.80E-12	419	6.00E-12	419	8.10E-07	419	1.10E-08	398
SR85	7.70E-13	419	1.00E-12	419	1.40E-06	419	2.40E-09	398
EU155	4.50E-13	419	1.80E-11	419	5.90E-08	419	3.00E-07	398
ZN65	8.50E-12	419	1.60E-11	419	2.00E-06	419	2.70E-08	398

Table B.3. Food Chain Transfer Factors for Chemicals

Chemical Name	CAS No.	Plant CR	Ref.	Meat TF	Ref.	Milk TF	Ref.	Fish BCF	Ref.
ALUMINUM	7429905	1.80E-04	152	1.50E-03	152	5.00E-04	152	1.00E+01	152
AMMONIA	7664417	8.25E+00	501	3.32E-08	502	1.05E-08	503	1.29E+00	504
ANTIMONY	7440360	1.40E-04	402	1.00E-03	402	1.00E-04	402	2.00E+02	402
ARSENIC	7440382	1.50E-03	402	2.00E-03	402	6.00E-05	402	1.00E+02	402
ASBESTOS (CROC)	12001284	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV	1.00E+00	329
BARIUM	7440393	3.75E-03	402	1.50E-04	402	3.50E-04	402	2.00E+02	402
BERYLLIUM	7440417	4.70E-04	95	8.00E-04	95	2.00E-06	95	1.90E+01	245
BORON	7440428	1.20E-01	152	8.00E-04	152	2.70E-03	152	2.20E-01	152
CADMIUM	7440439	3.75E-02	402	5.50E-04	402	1.00E-03	402	2.00E+02	402
CALCIUM ION	7440702	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV
CHLORINE	7782505	1.75E+01	402	8.00E-02	402	1.50E-02	402	5.00E+01	402
CHROMIC ACID	7738945	1.13E-03	402	5.50E-03	402	1.50E-03	402	2.00E+02	402
CHROMIUM VI	7440473	1.13E-03	402	5.50E-03	402	1.50E-03	402	2.00E+02	402
COBALT	7440484	9.40E-03	95	1.00E-03	95	5.00E-04	95	5.00E+01	95
COPPER	7440508	6.25E-02	402	1.00E-02	402	1.50E-03	402	5.00E+01	402
CYANIDE ION	57125	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV
FLUORIDE	7782414	2.00E-02	95	2.00E-02	95	7.00E-03	95	1.00E+01	95
LEAD	7439921	8.00E-04	402	3.00E-04	402	2.50E-04	402	1.00E+02	402
LITHIUM ION	7447418	8.30E-04	402	1.00E-02	402	5.00E-02	402	5.00E-01	402
MAGNESIUM	7786303	1.38E-01	402	5.00E-03	402	4.00E-03	402	5.00E+01	402
MANGANESE	7439965	3.75E-02	402	4.00E-04	402	3.50E-04	402	4.00E+02	402
MERCURY	7439976	5.00E-02	402	2.50E-01	402	4.50E-04	402	1.00E+03	402
NICKEL	7440020	1.50E-02	402	6.00E-03	402	1.00E-03	402	1.00E+02	402
NITRATE	14797558	7.50E+00	402	7.50E-02	402	2.50E-02	402	1.50E+05	402
NITRIC ACID	7697372	7.50E+00	402	7.50E-02	402	2.50E-02	402	1.50E+05	402
PHOSPHATE ION	7601549	8.75E-01	402	5.50E-02	402	1.50E-02	402	7.00E+04	402
POTASSIUM HYDROXIDE	1310583	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV
SELENIUM	7782492	6.25E-03	402	1.50E-02	402	4.00E-03	402	1.70E+02	402
SILVER	7440224	3.25E-04	402	3.00E-03	402	2.00E-02	402	2.30E+00	402
SODIUM BICHROMATE	10588019	1.13E-03	402	5.50E-03	402	1.50E-03	402	2.00E+02	402
SODIUM HYDROXIDE	1310732	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV
SODIUM ION	7647145	1.38E-02	402	5.50E-02	402	3.50E-02	402	1.00E+02	402
SULFATE	12808798	3.75E-01	402	1.00E-01	402	1.50E-02	402	7.50E+02	402
THALLIUM	7440280	1.00E-04	152	4.00E-02	152	2.00E-03	152	1.00E+04	152
TIN	7440315	1.50E-03	402	8.00E-02	402	1.00E-03	402	3.00E+03	402
TRIBUTYL PHOSPHATE	126738	3.43E+00	501	1.51E-07	502	4.79E-08	503	5.13E+00	504
URANIUM	7440611	3.50E-03	402	2.00E-04	402	6.00E-04	402	5.00E+01	402
VANADIUM	7440622	1.30E-03	152	2.30E-03	152	1.00E-03	152	1.00E+01	152
ZINC COMPOUNDS	7646857	1.48E-01	402	1.00E-01	402	1.00E-02	402	2.50E+03	402
BIS(2ET-HEXYL)PHTHLT	117817	2.77E+00	501	2.19E-07	502	6.92E-08	503	7.17E+00	504

Table B.3. (contd)

Chemical Name	CAS No.	Plant CR	Ref.	Meat TF	Ref.	Milk TF	Ref.	Fish BCF	Ref.
CHRYSENE	218019	6.49E+00	501	5.02E-08	502	1.59E-08	503	1.88E+00	504
ETHYLENE GLYCOL	107211	5.47E+00	501	6.76E-08	502	2.14E-08	503	2.46E+00	504
GAMMA-HCCH (LINDANE)	58899	9.26E+00	501	1.66E-02	238	2.51E-03	238	1.80E+02	209
HYDRAULIC FLUID	HYDR FLU	7.97E+00	501	3.52E-08	502	1.11E-08	503	1.36E+00	504
INDENO(1,2,3-CD)PYRE	193395	7.38E+00	501	4.02E-08	502	1.27E-08	503	1.53E+00	504
MOTOR OIL	MOTOR OL	7.97E+00	501	3.52E-08	502	1.11E-08	503	1.36E+00	504
PHENOL	108952	7.91E+00	501	3.57E-08	502	1.13E-08	503	1.38E+00	504
1,1 DICHLOROETHYLENE	75354	3.28E+00	501	1.63E-07	502	5.16E-08	503	5.49E+00	504
1,1,1-TRICHLOROETHAN	71556	7.60E+00	501	3.82E-08	502	1.21E-08	503	5.20E+01	248
1,1,2-TRICHLOROETHAN	79005	3.58E+00	501	1.41E-07	502	4.45E-08	503	3.90E+01	85
1,1-DICHLOROETHANE	75343	5.13E+00	501	7.54E-08	502	2.38E-08	503	2.72E+00	504
1,2 DICHLOROBENZENE	95501	7.13E+00	501	4.27E-08	502	1.35E-08	503	8.90E+01	252
1,2 DICHLOROETHANE	107062	7.97E+00	501	3.52E-08	502	1.11E-08	503	2.00E+00	248
1,2 DICHLOROETHYLENE	156605	2.62E+00	501	2.41E-07	502	7.63E-08	503	2.90E+00	161
1,3-DICHLOROBENZENE	541731	7.13E+00	501	4.27E-08	502	1.35E-08	503	6.60E+01	252
1,4-DICHLOROBENZENE	106467	7.13E+00	501	4.27E-08	502	1.35E-08	503	6.00E+01	252
1,4-DIOXANE	123911	4.69E+00	501	8.79E-08	502	2.78E-08	503	3.13E+00	504
2-METHYLNAPHTHALENE	91576	4.07E+00	501	1.12E-07	502	3.55E-08	503	3.91E+00	504
ACENAPHTHYLENE	208968	5.70E+00	501	6.28E-08	502	1.99E-08	503	3.01E+02	161
ACETONE	67641	6.14E+00	501	5.53E-08	502	1.75E-08	503	2.05E+00	504
ALPHA-HEXACHLOROCYCL	319846	4.48E+00	501	1.66E-02	238	2.51E-03	238	5.00E+02	161
ANTHRACENE	120127	7.97E+00	501	3.52E-08	502	1.11E-08	503	1.36E+00	504
AROCLOR 1254 (PCB)	11091691	3.69E+00	501	5.25E-02	238	1.12E-02	238	4.56E+00	504
AROCLOR 1260 (PCB)	11096825	3.22E+00	501	1.68E-07	502	5.32E-08	503	5.65E+00	504
BENZENE	71432	2.85E+00	501	2.08E-07	502	6.59E-08	503	6.86E+00	504
BENZO(A)ANTHRACENE	56553	8.04E+00	501	3.47E-08	502	1.10E-08	503	1.17E+04	260
BENZO(A)PYRENE	50328	3.61E+00	501	1.38E-07	502	4.37E-08	503	4.72E+00	504
BENZO(B)FLUORANTHENE	205992	3.61E+00	501	1.38E-07	502	4.37E-08	503	4.72E+00	504
BENZO(K)FLUORANTHENE	207089	3.61E+00	501	1.38E-07	502	4.37E-08	503	4.72E+00	504
BETA - HCCH	319857	4.48E+00	501	9.55E-08	502	3.02E-08	503	3.37E+00	504
CARBON DISULFIDE	75150	3.65E+00	501	1.36E-07	502	4.29E-08	503	4.64E+00	504
CARBON TETRACHLORIDE	56235	3.81E+00	501	1.26E-07	502	3.99E-08	503	1.50E+02	246
CHLORDANE	57749	2.64E+00	501	7.41E-03	238	3.72E-04	238	3.22E+02	247
CHLOROBENZENE	108907	4.86E+00	501	8.29E-08	502	2.62E-08	503	6.45E+02	208
CHLORODIBROMOMETHANE	124481	3.00E+00	501	1.91E-07	502	6.03E-08	503	6.32E+00	504
CHLOROETHANE	75003	7.22E+00	501	4.17E-08	502	1.32E-08	503	1.59E+00	504
CHLOROFORM	67663	3.82E+00	501	1.26E-07	502	3.97E-08	503	4.33E+00	504
CHLOROMETHANE(METHY)	74873	4.69E+00	501	8.79E-08	502	2.78E-08	503	3.13E+00	504
DDD	72548	2.98E+00	501	1.26E-02	238	3.02E-03	238	2.71E+03	251
DDE	72559	4.11E+00	501	4.90E-02	238	9.55E-03	238	8.45E+03	251
DI-N-BUTYL PHTHALATE	84742	7.13E+00	501	4.27E-08	502	1.35E-08	503	1.62E+00	504

Table B.3. (contd)

Chemical Name	CAS No.	Plant CR	Ref.	Meat TF	Ref.	Milk TF	Ref.	Fish BCF	Ref.
DIESEL FUEL	DIESEL F	4.07E+00	501	1.12E-07	502	3.55E-08	503	3.91E+00	504
EDTA	60004	3.06E+00	501	1.84E-07	502	5.82E-08	503	6.13E+00	504
ENDRIN	72208	9.36E+00	501	1.20E-02	238	1.74E-03	238	1.48E+03	85
ETHANE	74840	4.36E+00	501	1.00E-07	502	3.16E-08	503	3.51E+00	504
ETHYL ACETATE	141786	4.85E+00	501	8.31E-08	502	2.63E-08	503	2.97E+00	504
ETHYLBENZENE	100414	9.16E+00	501	2.76E-08	502	8.74E-09	503	1.09E+00	504
FLUORANTHENE	206440	4.48E+00	501	9.55E-08	502	3.02E-08	503	3.37E+00	504
FLUORENE	86737	3.07E+00	501	1.83E-07	502	5.80E-08	503	7.13E+02	161
FREON 113	76131	8.71E+00	501	3.01E-08	502	9.53E-09	503	1.18E+00	504
FUEL OIL #2	FUEL OIL	4.07E+00	501	1.12E-07	502	3.55E-08	503	3.91E+00	504
GASOLINE	8006619	2.85E+00	501	2.08E-07	502	6.59E-08	503	6.86E+00	504
HEXANES	110543	4.03E+00	501	1.14E-07	502	3.61E-08	503	3.97E+00	504
HMX (H-NO2 TETZOCINE	2691410	5.84E+00	501	6.03E-08	502	1.91E-08	503	2.22E+00	504
ISOBUTANE	75285	4.66E+00	501	8.92E-08	502	2.82E-08	503	3.17E+00	504
ISOPROPYL ALCOHOL	67630	3.17E+00	501	1.74E-07	502	5.50E-08	503	5.81E+00	504
KEROSENE	8008206	4.07E+00	501	1.12E-07	502	3.55E-08	503	3.91E+00	504
METHANOL	67561	4.11E+00	501	1.11E-07	502	3.50E-08	503	3.85E+00	504
METHYL ETHYL KETONE	78933	4.06E+00	501	1.13E-07	502	3.57E-08	503	3.93E+00	504
METHYLENE CHLORIDE	75092	2.75E+00	501	2.21E-07	502	6.99E-08	503	7.24E+00	504
N-DODECANE	112403	5.47E+00	501	6.76E-08	502	2.14E-08	503	2.46E+00	504
N-NITROSODIPHNYLAMNE	86306	3.29E+00	501	1.63E-07	502	5.15E-08	503	5.48E+00	504
N-NITROSODIPROPYLAMI	621647	7.66E+00	501	3.77E-08	502	1.19E-08	503	1.45E+00	504
NAPHTHALENE	91203	2.65E+00	501	2.36E-07	502	2.00E-04	238	7.68E+00	504
OCTANE	111659	2.66E+00	501	2.34E-07	502	7.41E-08	503	7.63E+00	504
PCBs (GENERAL)	1336363	3.40E+00	501	1.53E-07	502	4.85E-08	503	1.80E+05	161
PENTACHLOROPHENOL	87865	3.69E+00	501	1.33E-07	502	4.21E-08	503	4.56E+00	504
PETN 5ERYTHRITOL-4NO	78115	5.84E+00	501	6.03E-08	502	1.91E-08	503	2.22E+00	504
PHENANTHRENE	85018	7.97E+00	501	3.52E-08	502	1.11E-08	503	1.36E+00	504
PROPANE	74986	7.94E+00	501	3.54E-08	502	1.12E-08	503	1.37E+00	504
PYRENE	129000	4.48E+00	501	9.55E-08	502	3.02E-08	503	2.80E+03	260
RDX 6H-3NO2-TRIAZINE	121824	9.63E+00	501	2.54E-08	502	8.02E-09	503	1.01E+00	504
TETRACHLOROETHYLENE	127184	4.59E+00	501	9.14E-08	502	2.89E-08	503	1.00E+02	161
TNT 3NO2-TOLUENE	118967	6.94E+00	501	4.47E-08	502	1.41E-08	503	1.69E+00	504
TOLUENE	108883	5.13E+00	501	7.54E-08	502	2.38E-08	503	2.72E+00	504
TRIBROMOMETHANE	75252	8.89E+00	501	2.91E-08	502	9.21E-09	503	1.14E+00	504
TRICHLOROETHYLENE	79016	8.47E+00	501	3.16E-08	502	1.00E-08	503	1.10E+01	161
TRICHLOROMONOFLUOROM	75694	7.41E+00	501	3.99E-08	502	1.26E-08	503	1.52E+00	504
TRIMETHYLBENZENE	25551137	7.33E+00	501	4.07E-08	502	1.29E-08	503	1.55E+00	504
VINYL CHLORIDE	75014	3.54E+00	501	1.43E-07	502	4.53E-08	503	4.87E+00	504
XYLENE (MIXED)	1330207	5.84E+00	501	6.03E-08	502	1.91E-08	503	2.22E+00	504
n-BUTANE	106978	3.92E+00	501	1.20E-07	502	3.80E-08	503	4.16E+00	504

Table B.3. (contd)

Chemical Name	CAS No.	Plant CR	Ref.	Meat TF	Ref.	Milk TF	Ref.	Fish BCF	Ref.
n-PENTANE	109660	7.63E+00	501	3.79E-08	502	1.20E-08	503	1.46E+00	504
o-XYLENE	95476	5.64E+00	501	6.41E-08	502	2.03E-08	503	2.34E+00	504
4-METHYL-2-PENTANONE	108101	6.60E+00	501	4.87E-08	502	1.54E-08	503	1.83E+00	504
BENZOIC ACID	65850	7.66E+00	501	3.77E-08	502	1.19E-08	503	1.45E+00	504
BERYLLIUM CHLORIDE	7787475	4.70E-04	95	8.00E-04	95	2.00E-06	95	1.90E+01	245
CHROMIUM III	CR-III	1.13E-03	402	5.50E-03	402	1.50E-03	402	2.00E+02	402
DIBENZO(A,H)ANTRAC	53703	4.86E+00	501	8.29E-08	502	2.62E-08	503	1.13E+05	161
STRYENE-BUTADIENE	9003558	3.07E+00	501	1.84E-07	502	5.81E-08	503	6.11E+00	504
STRONTIUM ION	10476854	2.03E-01	402	3.00E-04	402	1.50E-03	402	5.00E+01	402
IRON	15438310	2.50E-04	402	2.00E-02	402	2.50E-04	402	2.00E+03	402
POTASSIUM ION	7447407	1.38E-01	402	2.00E-02	402	7.00E-03	402	1.00E+03	402
SULFURIC ACID	7664939	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV
1,2,4TRICHLOROBENZNE	120821	2.68E+00	501	2.31E-07	502	7.31E-08	503	7.53E+00	504
2,4-DINITROTOLUENE	121142	4.06E+00	501	1.13E-07	502	3.57E-08	503	3.93E+00	504
2-CHLOROPHENOL	95578	3.07E+00	501	1.83E-07	502	5.80E-08	503	6.40E+00	250
2-HEXANONE ME-BU-KET	591786	7.72E+00	501	3.72E-08	502	1.18E-08	503	1.43E+00	504
2-METHYLPHENOL(0-CRE	95487	7.72E+00	501	3.72E-08	502	1.18E-08	503	1.43E+00	504
DDT	50293	5.80E+00	501	2.82E-02	238	1.07E-02	238	2.24E+00	504
4-METHYLPHENOL(P-CRE	106445	7.13E+00	501	4.27E-08	502	1.35E-08	503	1.62E+00	504
ACENAPHTHENE	83329	4.01E+00	501	1.16E-07	502	3.65E-08	503	4.01E+00	504
BROMODICHLOROMETHAN	75274	9.31E+00	501	2.69E-08	502	8.50E-09	503	1.06E+00	504
ISOPHORONE	78591	2.77E+00	501	2.19E-07	502	6.91E-08	503	7.16E+00	504
ALDRIN	309002	2.62E+00	501	8.51E-02	238	2.40E-02	238	3.14E+03	215
DELTA-HCCH	319868	3.25E+00	501	1.66E-02	238	2.51E-03	238	5.57E+00	504
ENDOSULFAN I (ALPHA)	115297A	2.62E+00	501	2.19E-04	238	7.63E-08	503	7.83E+00	504
ENDOSULFAN II (BETA)	115297B	2.62E+00	501	2.19E-04	238	7.63E-08	503	7.83E+00	504
HEPTACHLOR	76448	3.44E+00	501	1.55E-02	238	3.24E-03	238	5.11E+00	504
DIETHYL PHTHALATE	84662	3.17E+00	501	1.73E-07	502	5.48E-08	503	5.80E+00	504
MOLYBDENUM	7439987	1.50E-02	402	6.00E-03	402	1.50E-03	402	1.00E+01	402
PHOSPHORIC ACID	7664382	8.75E-01	402	5.50E-02	402	1.50E-02	402	7.00E+04	402
ALLYL ALCOHOL	107186	4.94E+00	501	8.04E-08	502	2.54E-08	503	2.88E+00	504
TRICHLOROMONOFLUOROM	75694	7.41E+00	501	3.99E-08	502	1.26E-08	503	1.52E+00	504
MINERAL OIL	8012951	7.97E+00	501	3.52E-08	502	1.11E-08	503	1.36E+00	504
TETRAHYDRO FURAN	109999	6.94E+00	501	4.47E-08	502	1.41E-08	503	1.69E+00	504
DIELDRIN	60571	4.28E+00	501	7.94E-03	238	1.07E-02	238	4.87E+03	243
SODIUM ION	7647145	1.38E-02	402	5.50E-02	402	3.50E-02	402	1.00E+02	402
STYRENE	100425	3.62E+00	501	1.38E-07	502	4.36E-08	503	4.71E+00	504
NITRITE	NITRITE	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV
AROCLOR 1248 (PBC)	12672296	5.37E+00	501	6.96E-08	502	2.20E-08	503	2.53E+00	504
DI-N-OCTYLPHTHALATE	117840	4.62E+00	501	9.04E-08	502	2.86E-08	503	3.21E+00	504
ETHYL ETHER	60297	3.92E+00	501	1.20E-07	502	3.80E-08	503	4.16E+00	504

Table B.3. (contd)

Chemical Name	CAS No.	Plant CR	Ref.	Meat TF	Ref.	Milk TF	Ref.	Fish BCF	Ref.
HEPTANES	142825	7.54E+00	501	3.87E-08	502	1.22E-08	503	1.48E+00	504
m-XYLENE	108383	5.13E+00	501	7.54E-08	502	2.38E-08	503	2.72E+00	504
METHYLCYCLOHEXANE	108872	4.01E+00	501	1.16E-07	502	3.65E-08	503	4.01E+00	504
METHYLCYCLOPENTANE	96377	8.43E+00	501	3.19E-08	502	1.01E-08	503	1.24E+00	504
NONANE	111842	6.98E+00	501	4.42E-08	502	1.40E-08	503	1.67E+00	504
ASPHALT	8052424	7.38E+00	501	4.02E-08	502	1.27E-08	503	1.53E+00	504
1,2,4,5-TETRACHLOROB	95943	7.38E+00	501	4.02E-08	502	1.27E-08	503	1.80E+03	85
1,2,3TRICHLOROPRPANE	96184	3.34E+00	501	1.59E-07	502	5.01E-08	503	5.35E+00	504
1,1,2,2-TETRACLOROET	79345	8.80E+00	501	2.96E-08	502	9.37E-09	503	1.16E+00	504
TRANS-1,3-DICHLOROPR	10061026	5.74E+00	501	6.20E-08	502	1.96E-08	503	2.28E+00	504

Table B.4. Food Chain Transfer Factors for Radionuclides

Radionuclide	Oral Slope Factor Risk/pCi	Ref. No.	Inhalation Slope Factor Risk/pci	Ref. No.	External Slope Factor Risk/yr per pCi/g	Ref. No.	Dermal Dose Factor rem/pCi	Ref. No.
AC227	8.75E-05	402	2.50E-05	402	2.00E-05	402	2.50E+01	402
TH227	3.00E-05	402	6.00E-06	402	5.00E-06	402	1.00E+02	402
RA223	8.00E-04	402	2.50E-04	402	4.50E-04	402	7.00E+01	402
AM241	1.03E-04	402	3.50E-06	402	4.00E-07	402	2.50E+02	402
AM243	1.03E-04	402	3.50E-06	402	4.00E-07	402	2.50E+02	402
NP239	2.35E-03	402	2.00E-04	402	6.00E-04	402	2.50E+02	402
PU239	5.00E-05	402	5.00E-07	402	1.00E-07	402	2.50E+02	402
CM243	6.00E-05	402	3.50E-06	402	2.00E-05	402	2.50E+02	402
SB124	1.40E-04	402	1.00E-03	402	1.00E-04	402	2.00E+02	402
SB125	1.40E-04	402	1.00E-03	402	1.00E-04	402	2.00E+02	402
TE125M	6.25E-03	402	1.50E-02	402	2.00E-04	402	4.00E+02	402
TH231	3.00E-05	402	6.00E-06	402	5.00E-06	402	1.00E+02	402
PA231	6.25E-05	402	1.00E-05	402	5.00E-06	402	1.10E+01	402
CM245	6.00E-05	402	3.50E-06	402	2.00E-05	402	2.50E+02	402
CF252	2.50E-03	402	5.00E-03	402	7.50E-07	402	2.50E+01	402
CM248	6.00E-05	402	3.50E-06	402	2.00E-05	402	2.50E+02	402
CM244	6.00E-05	402	3.50E-06	402	2.00E-05	402	2.50E+02	402
PU240	5.00E-05	402	5.00E-07	402	1.00E-07	402	2.50E+02	402
U235	3.50E-03	402	2.00E-04	402	6.00E-04	402	5.00E+01	402
PU241	5.00E-05	402	5.00E-07	402	1.00E-07	402	2.50E+02	402
CM242	6.00E-05	402	3.50E-06	402	2.00E-05	402	2.50E+02	402
PU238	5.00E-05	402	5.00E-07	402	1.00E-07	402	2.50E+02	402
RA226	8.00E-04	402	2.50E-04	402	4.50E-04	402	7.00E+01	402
RN222	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV
PB210	8.00E-04	402	3.00E-04	402	2.50E-04	402	1.00E+02	402
BI210	8.00E-04	402	4.00E-04	402	5.00E-04	402	1.50E+01	402
PO210	2.25E-03	402	3.00E-04	402	3.50E-04	402	5.00E+02	402
TH230	3.00E-05	402	6.00E-06	402	5.00E-06	402	1.00E+02	402
U234	3.50E-03	402	2.00E-04	402	6.00E-04	402	5.00E+01	402
RA224	8.00E-04	402	2.50E-04	402	4.50E-04	402	7.00E+01	402
PB212	8.00E-04	402	3.00E-04	402	2.50E-04	402	1.00E+02	402
RA228	8.00E-04	402	2.50E-04	402	4.50E-04	402	7.00E+01	402
TH228	3.00E-05	402	6.00E-06	402	5.00E-06	402	1.00E+02	402
TH232	3.00E-05	402	6.00E-06	402	5.00E-06	402	1.00E+02	402
U232	3.50E-03	402	2.00E-04	402	6.00E-04	402	5.00E+01	402
U238	3.50E-03	402	2.00E-04	402	6.00E-04	402	5.00E+01	402
TH234	3.00E-05	402	6.00E-06	402	5.00E-06	402	1.00E+02	402
AC228	6.76E-01	402	2.51E-06	402	7.94E-07	402	1.95E+01	402
EU152	1.00E-03	402	5.00E-03	402	2.00E-05	402	2.50E+01	402
EU154	1.00E-03	402	5.00E-03	402	2.00E-05	402	2.50E+01	402
SR90	2.03E-01	402	3.00E-04	402	1.50E-03	402	5.00E+01	402
Y90	1.50E-03	402	3.00E-04	402	2.00E-05	402	2.50E+01	402
CD109	3.75E-02	402	5.50E-04	402	1.00E-03	402	2.00E+02	402
C14	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV	4.60E+03	95
CE144	1.00E-03	402	7.50E-04	402	2.00E-05	402	5.00E+02	402
CS134	1.23E-02	402	2.00E-02	402	7.00E-03	402	2.00E+03	402
CS137	1.23E-02	402	2.00E-02	402	7.00E-03	402	2.00E+03	402

Table B.4. (contd)

Radionuclide	Oral Slope Factor Risk/pCi	Ref. No.	Inhalation Slope Factor Risk/pci	Ref. No.	External Slope Factor Risk/yr per pCi/g	Ref. No.	Dermal Dose Factor rem/pCi	Ref. No.
CO56	1.00E-02	402	2.00E-02	402	2.00E-03	402	3.30E+02	402
CO57	1.00E-02	402	2.00E-02	402	2.00E-03	402	3.30E+02	402
CO58	1.00E-02	402	2.00E-02	402	2.00E-03	402	3.30E+02	402
CO60	1.00E-02	402	2.00E-02	402	2.00E-03	402	3.30E+02	402
I129	1.25E-02	402	7.00E-03	402	1.00E-02	402	5.00E+02	402
I131	1.25E-02	402	7.00E-03	402	1.00E-02	402	5.00E+02	402
FE55	2.50E-04	402	2.00E-02	402	2.50E-04	402	2.00E+03	402
KR85	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV
NI63	1.50E-02	402	6.00E-03	402	1.00E-03	402	1.00E+02	402
NB95	1.25E-03	402	2.50E-01	402	2.00E-02	402	2.00E+02	402
P32	8.75E-01	402	5.50E-02	402	1.50E-02	402	7.00E+04	402
PU242	5.00E-05	402	5.00E-07	402	1.00E-07	402	2.50E+02	402
K40	1.38E-01	402	2.00E-02	402	7.00E-03	402	1.00E+03	402
NP237	2.35E-03	402	5.50E-05	402	5.00E-06	402	2.50E+02	402
PA233	6.25E-05	402	1.00E-05	402	5.00E-06	402	1.10E+01	402
TH229	3.00E-05	402	6.00E-06	402	5.00E-06	402	1.00E+02	402
RA225	8.00E-04	402	2.50E-04	402	4.50E-04	402	7.00E+01	402
AC225	6.76E-01	402	2.51E-06	402	7.94E-07	402	1.95E+01	402
PM147	1.00E-03	402	5.00E-03	402	2.00E-05	402	2.50E+01	402
RU103	5.00E-03	402	2.00E-03	402	6.00E-07	402	1.00E+02	402
RU106	5.00E-03	402	2.00E-03	402	6.00E-07	402	1.00E+02	402
NA22	1.38E-02	402	5.50E-02	402	3.50E-02	402	1.00E+02	402
SR89	2.03E-01	402	3.00E-04	402	1.50E-03	402	5.00E+01	402
S35	3.75E-01	402	1.00E-01	402	1.50E-02	402	7.50E+02	402
TA182	6.25E-04	402	6.00E-04	402	3.00E-06	402	3.00E+04	402
TC99	2.75E-01	402	8.50E-03	402	1.00E-02	402	1.50E+01	402
H3	0.00E+00	NV	0.00E+00	NV	0.00E+00	NV	1.00E+00	95
U233	3.50E-03	402	2.00E-04	402	6.00E-04	402	5.00E+01	402
U236	3.50E-03	402	2.00E-04	402	6.00E-04	402	5.00E+01	402
H3-EL	7.03E+00	501	4.37E-08	502	1.38E-08	503	1.66E+00	504
MN52	3.75E-02	402	4.00E-04	402	3.50E-04	402	4.00E+02	402
MN54	3.75E-02	402	4.00E-04	402	3.50E-04	402	4.00E+02	402
MN56	3.75E-02	402	4.00E-04	402	3.50E-04	402	4.00E+02	402
BE7	3.75E-04	402	1.00E-03	402	9.00E-07	402	2.00E+00	402
CS132	1.23E-02	402	2.00E-02	402	7.00E-03	402	2.00E+03	402
SE75	6.25E-03	402	1.50E-02	402	4.00E-03	402	1.70E+02	402
SR85	2.03E-01	402	3.00E-04	402	1.50E-03	402	5.00E+01	402
EU155	1.00E-03	402	5.00E-03	402	2.00E-05	402	2.50E+01	402
ZN65	1.48E-01	402	1.00E-01	402	1.00E-02	402	2.50E+03	402

B.1 References Cited in Pollutant Parameter Tables

This section contains footnotes and reference citations for parameter values given in this Appendix.

NDF - No dose factors are defined for this radionuclide and exposure route.

NV - No parameter value is defined

1 No value defined in the chemical database

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321 U.S. Environmental Protection Agency (EPA). 1986b. *Verified Reference Doses (RFDs) of the USEPA*. ECAO-CIN-475. Office of Health and Environmental Assessment, Washington, D.C.

329 A value of 1 is conservatively assigned for bioaccumulation of asbestos representing equal concentration in water and fish (or shellfish).

334 Toxicity value set equal to value for ingestion

335 Value is set to value for benzo(a)pyrene.

338 Toxicity value set equal to value for inhalation

339 Inhalation toxicity value is based on the American Council of Gov. Industr. Hygienists (ACGIH) value for TLV. The reference dose is: RfD = TLV (mg/m^3) x 0.007.

340 The ingestion toxicity values are based on the rat oral LD50 value from RTECS (NIOSH. 1987 and later versions, Registry of Toxic Effects of Chemical Substances).

342 The TLV used to estimate the inhalation reference value is based on the value reported for soluble salts of aluminum.

347 Inhalation RFD is based on the TLV (Threshold Limit Value) for asphalt (petroleum) fumes.

357 Chemical toxicity values are based on mineral oil.

360 Chemical toxicity values for potassium are set equal to value for sodium hydroxide.

361 The toxicity of lithium is based on the sodium reference dose and the relative toxicity of lithium for human low dose. RfD sodium = 300 mg/kg/d. LDL sodium = 12400 mg/kg. LDL lithium = 243 mg/kg. RfD lithium = 243/12400 x 300 = 6 mg/kg/d.

366 Values set to values for RDX.

375 RFD set to value for sodium ion, corrected for atomic weight.

377 The average intake of sodium is 1600 to 9600 mg/day. Reference dose (RfD) is set to twice the higher value: RfD = 9600 mg/day x 2 / 70 kg = 300 mg/kg/d.

378 Value based on butadiene inhalation SF (1.8 kg d/mg) with stoichiometric correction (0.342) and reduction for binding of butadiene in polymer form (0.01). 1.8 x 0.342 x 0.01 = 0.0062.

379 The ingestion reference dose for sulfate ion is based on the secondary drinking water standard: RfD = 250 mg/L x 2 L/d / 70 kg = 7.14 mg/kg/d.

386 The ingestion RfD is based on the recommended daily allowance of 18 mg for iron, increased by a factor of 5. RfD = 18 mg/d/70 kg x 5 = 1.3 mg/kg/d.

393 Calculated by the EPA Office of Radiation Programs (ORP). EPA classifies all radionuclides as Group A carcinogens. For guidance, refer to the User's Guide for radionuclides.

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402 Kennedy, W. E., and D. L. Strenge. 1992. *Residual Radioactive Contamination From Decommissioning: Technical Basis for Translating Contamination Levels to Annual Total Effective Dose Equivalent*. NUREG/CR-5512 (PNL-7994) Vol. 1, U.S. Nuclear Regulatory Commission, Washington, D.C.

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406 Toxicity values set equal to values for PCBs general classification.

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419 U.S. EPA Health Effects Assessment Summary Tables, Office of Solid Waste and Emergency Response. EPA 540-R-93-058. Annual Updates.

420 IRIS Online Monthly Updates (EPA Integrated Risk Information System).

423 Set to value for mercury from Kennedy and Strenge (1992), reference 402.

425 Calculated using Code for Internal DosimetrY (CINDY) with modified data libraries. Strenge, Kennedy, Sula, Johnson. 1992. Code for Internal DosimetrY. PNL-7493 Pt 1, Rev 1. PNL, Richland, Washington.

427 Based on TLV-TWA for Aluminum of 2 mg/m3, ACGIH, 1986.

429 Based on recommended daily allowance (RDA) for calcium of 1200 mg/d (10-18 yrs). Oral RfD = 1200 mg/d x 1/70 kg = 17 mg/kg/d.

430 Based on rat oral LD50 for calcium of 9285 mg/kg. RfD = 9285 x 4E-5 = 0.37 mg/kg/d.

431 Based on rat oral LD50 for copper sulfate of 300 mg/kg. RfD = 300 x 4E-5 = 0.012 mg/kg/d.

432 Based on ACGIH TLV-TWA of 1 mg/m^3 for copper. RfD inhalation = 1 mg/m^3 Cu x 159.6/63.55 = 2.51 mg/m^3 CuSO4 x 0.007 = 0.018 mg/kg/d.

434 Based on ACGIH TLV-TWA of 1 mg/m3 for iron. RfD inhalation = 1 x 241.88/55.85 = 4.33 mg/m3 Fe(NO3)2 x 0.007 = 0.03 mg/kg/d.

435 Based on Registry of Toxic Effects of Chemical Substances (RTECS) rat oral LD50 of 6400 mk/kg for potassium ferrocyanide. RfD ingestion = 6400 x 211.97/368.37 = 3683 mg/kg x 4E-5 = 0.15 mg/kg/d.

437 Based on ACGIH TLV-TWA of 1 mg/m3 for iron. RfD inhalation = 1 x 180/55.85 = 3.22 mg/m3 Fe(NO3)2 x 0.007 = 0.023 mg/kg/d.

438 Based on RTECS mouse oral LD50 of 1640 mg/kg for butyl phosphate. RfD ingestion = 1640 x 4E-5 = 0.066 mg/kg/d.

440 Based on ACGIH TLV-TWA of 2 mg/m3 for aluminum. RfD inhalation = 2 mg/m3 Al x 81.97/26.98 x 0.007 = 0.043 mg/kg/d.

442 Based on RTECS mouse oral LD50 of 103 mg/kg for aluminum fluoride. RfD ingestion = 103 x 4E-5 = 0.0041 mg/kg/d.

443 Based on ACGIH TLV-TWA of 2 mg/m3 for aluminum soluble salts. 2 x 83.98/27 = 6.22 mg/m3 AlF3. RfD inhalation = 6.22 x 0.007 = 0.044.

444 Based on mouse intravenous LD50 of 96 mg/kg. RfD = 96 mg/kg x 4E-5 x 10 oral/intravenous = 0.04 mg/kg/d.

445 Based on rat oral LD50 of 2217 mg/kg. RfD ingestion = 2217 x 4E-5 = 0.09 mg/kg/d.

446 Based on ACGIH TLV-TWA of 1 mg/m^3 for oxalic acid. RfD inhalation = 1 mg/m^3 x 0.007 = 0.007 mg/kg/d.

447 Based on mouse intravenous LD50 of 155 mg/kg. RfD = 155 x 4E-5 x 10 oral/intravenous = 0.06 mg/kg/d.

448 Based on RTECS oral LD50 of 7500 mg/kg for oxalic acid. RfD ingestion = 7500 x 4E-3 = 0.3 mg/kg/d.

449 Based on nitrate RfD of 1.6 mg/kg/d. MW 2NO_3 = 2 x 62 = 124. RfD Mg(NO3)2 = 148/124 x 1.6 = 1.9 mg/kg/d.

451 Based on rat oral LD50 of 3200 mg/kg for dibutyl phosphonate. RfD = 3200 x 4E-5 = 0.13 mg/kg/d.

453 Based on rat oral LD50 of 3000 mg/kg tributyl phosphonate. RfD = 3000 x 4E-5 = 0.12 mg/kg/d.

456 Bintein, S., J. DeVillers, and Carcher. 1993. *Nonlinear Dependance of Fish Biconcentration on n-octanol/water Partition Coefficient SAR and QSAR in Environmental Research.* Vol. 1, pp. 29-39.

500 Slope factor calculated from dose factor and health effects conversion factor of 6.2 x 10^{-4} effects per rem.

501 Plant concentration ratio calculated using correlation with octanol-water partition coefficient of Travis and Arms (1988), reference number 238.

502 Meat transfer factor calculated using correlation with octanol-water partition coefficient of Travis and Arms (1988), reference number 238.

503 Milk transfer factor calculated using correlation with octanol-water partition coefficient of Travis and Arms (1988), reference number 238.

504 Fish bioaccumulation factor calculated using correlation with octanol-water partition coefficient of Bintein et al. (1993), reference number 456.

Section III

Environmental Settings Report: Nevada Test Site

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June 1995

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Abbreviations

DOC	U.S. Department of Commerce
DOE	U.S. Department of Energy
NTS	Nevada Test Site

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1.0 Nevada Test Site

The Nevada Test Site (NTS) was established in 1950 for the purpose of conducting nuclear weapons tests. It is currently used to conduct all United States nuclear weapons tests. These tests are conducted underground for containment of detonation products. Other energy-related projects, such as development of a nuclear-powered rocket and ramjets, have also been carried out on the NTS.

The NTS is approximately 105 km (65 mi) northwest of Las Vegas, Nevada (Figure 1.1). The facility is located on a 3,497-km^2 (1,350-mi^2) portion of restricted-access, federally owned land. NTS is bordered on its west, north, and east sides by the Nellis Air Force Base Range Complex. The southern portion of NTS is bounded by public access land. The topography of NTS is typical of much of the Basin and Range physiographic province of Nevada, Arizona, and Utah. It consists basically of three large valleys (Yucca Flat, Frenchman Flat, and Jackass Flats) surrounded by hills and mountains. The northern and northwestern portions are dominated by two large mesas, Rainier Mesa and Pahute Mesa. Elevations range from 914 m (3,000 ft) on Frenchman Flat to 2,316 m (7,600 ft) on Rainier Mesa. The slopes on the upland surface are steep and dissected, whereas the slopes on the lower surfaces are gentle and alluviated with rock debris from the adjacent highlands (DOE 1992). The principal effect upon the terrain from nuclear testing has been the creation of numerous dish-shaped surface subsidence craters, particularly in Yucca Flat (DOE 1992).

Throughout the year, there is not enough water in the area surrounding NTS to support the growth of food crops without irrigation. Variations in precipitation and temperature cause marked differences in plant life. Creosote bush, burro bush, and a variety of yuccas dominate in the bajadas below 1,220 m (4,000 ft), giving way to blackbrush and joshua trees at slightly higher elevations. Juniper, pinon pine, and sagebrush dominate between 1,830 and 2,290 m (6,000 and 7,500 ft), being replaced by white fir and yellow pine above 2290 (7,500 ft) (Winograd and Thordarson 1975).

1.1 Climate

The NTS area is on the boundary of the "mid-latitude arid" and "tropical arid" climate (Critchfield 1974). Meteorological data are available from onsite measurements at Desert Rock Airport and Yucca Flats and from measurement taken in the city of Las Vegas, Nevada. On average the maximum daily temperature in Las Vegas exceeds 32°C (90°F) on 131 days per year and is below 0°C (32°F) once every five years; the minimum daily temperature is below 0°C (32°F) on 33 days per year and a temperature below -18°C (0°F) has not been recorded (DOC 1987a). July is the warmest month, with daily maximum and minimum temperatures averaging 40°C (104°F) and 24°C (76°F), respectively. January is the coolest month, with daily maximum and minimum temperatures averaging 13°C (56°F) and 1°C (33°F), respectively (DOC 1987a). At higher elevations on the NTS, near-surface air temperatures may be significantly cooler than at Las Vegas.

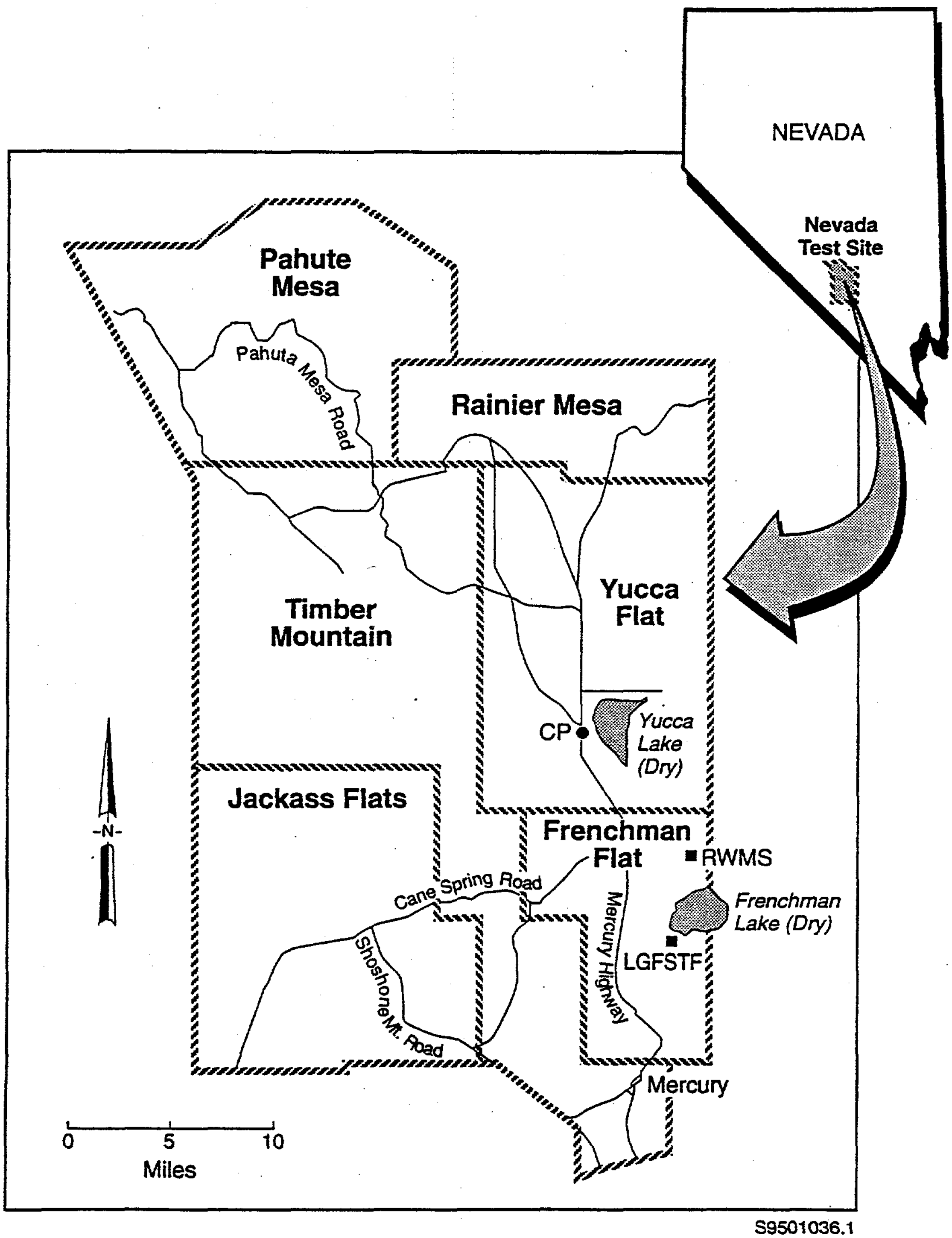

Figure 1.1. Location of Nevada Test Site

Annual precipitation at Las Vegas is on the order of 11 cm (4 in.). Measurable precipitation (defined as 0.025 cm [0.01 in.] or greater) is recorded on an average of 26 days per year and the area experiences an average of 14 thunderstorm days per year. The average annual snowfall is 2.5 cm (1 in.) (DOC 1992) and daily snowfall accumulations of 2.5 cm (1 in.) or greater occur an average of twice every 5 years (DOC 1987a). Data from Desert Rock and Yucca Flats indicate annual precipitation levels between 15 cm (6 in.) and 17 cm (7 in.) with measurable precipitation being recorded on an average of 35 days per year. Even greater levels of precipitation and snowfall occur at higher elevations on the installation.

The winds at the NTS site are strongly influenced by the local and regional complex terrain. At Las Vegas, the prevailing wind direction is from the southwest. Wind speeds average about 4 m/s (9 mph) at about 6 m (20 ft). Average wind speeds are highest in April (5 m/s [11 mph]) and lowest in December (3 m/s [7 mph]) (DOC 1987b).

1.2 Geology

In general, the geology of the NTS consists of three major rock units. These include 1) complexly folded and faulted sedimentary rocks of Precambrian and Paleozoic age which are overlain in many places by 2) volcanic tuffs and lava of Tertiary age, which (in the valleys) are covered by 3) alluvium of late Tertiary and Quaternary age (DOE 1992). The following is a brief description of the various rock units.

During Precambrian and Paleozoic time, the region was part of the Cordilleran geosyncline, in which 11,300 m (37,000 ft) of marine sediments accumulated (Winograd and Thordarson 1975). Precambrian and Paleozoic sedimentation was marked by two major sequences of clastic and carbonate sedimentation with clastic sediments composed primarily of shale and quartzite, and carbonate sediments dominated by limestone and dolomite (DOE 1992). Minor clastic rocks occur within the lower carbonate sequence. No major unconformities occur within the Precambrian and Paleozoic sediments (Winograd and Thordarson 1975). No Mesozoic rocks are known to underlie the NTS or its immediate surrounding area.

Cenozoic volcanic and sedimentary rocks are widely distributed in the region. Tertiary volcanic and associated sedimentary rocks locally reach thicknesses as much as 1,830 m (6,000 ft) in Yucca Flat, 2,590 m (8,500 ft) in western Frenchman Flat and eastern Jackass Flats, 1,525 m (5,000 ft) in western Jackass Flats, and greater than 4,115 (13,500 ft) beneath Pahute Mesa (Winograd and Thordarson 1975). The volcanic rocks are of both pyroclastic and lava-flow origin and include several rock types. Common rock types consist of ash-flow and ash-fall tuffs, and lava flows ranging in composition from rhyolite to basalt. Associated sedimentary rocks include conglomerates, tuffaceous sandstones and siltstones, calcareous lacustrine tuffs, claystone, and fresh-water limestone (Winograd and Thordarson 1975). Quaternary strata consist primarily of valley fill with minor basalt flows (Winograd and Thordarson 1975). These sediments attain thicknesses of 600 to 900 m (2,000 to 3,000 ft) in the central portions of the valleys (DOE 1992).

Two major periods of deformation affected the region (Winograd and Thordarson 1975). The first period of deformation occurred in late Mesozoic and possibly early Tertiary time and resulted in folding and thrust faulting of the Precambrian and Paleozoic rocks. During middle to late Cenozoic time the region underwent normal block faulting, producing the Basin and Range topography. Displacements along major strike-slip faults, measured in kilometers, occurred during both periods of deformation. Alluvium is rarely faulted. Compared to the Paleozoic rocks, the Tertiary rocks are relatively undeformed and dips are generally gentle (DOE 1992).

1.3 Hydrology

Depths to groundwater beneath the NTS vary from about 157 m (515 ft) beneath the Frenchman Flat playa (Winograd and Thordarson 1975) in the southern portion of the NTS to greater than 610 m (2,000 ft) beneath the Pahute Mesa (DOE 1992). In the eastern portions of the NTS, the water table generally occurs in the alluvium and volcanic rocks above the regional carbonate aquifer. Shallower groundwater flow is generally toward major valleys (Yucca and Frenchman Flats) where it is then deflected downward and joins the regional drainage to the southwest (DOE 1992).

Two major hydrologic systems exist on the NTS. Groundwater in the northwestern part of the NTS (Pahute Mesa area) flows to the south and southwest toward the Ash Meadows Discharge Area, Oasis Valley near Beatty, Nevada, and Death Valley. Groundwater to the east of the NTS moves from north to south. In the extreme southern portion of the NTS at Mercury Valley, the eastern groundwater flow shifts southwest toward the Ash Meadows Discharge Area. Recharge for the hydrologic systems most likely occurs by precipitation at higher elevations and infiltration along intermittent stream channels and in playas (DOE 1992). Perched groundwater at the NTS occurs principally within widespread tuff and lava-flow aquitards underlying ridges (Winograd and Thordarson 1975). Perched water is not known to occur within the aquifers or aquitards beneath Yucca Flat, Frenchman Flat, or Jackass Flats.

No natural surface-water bodies are present on the NTS. Water used at the NTS comes from local wells. The Amargosa River which lies to the southwest along the Nevada-California border is an ephemeral stream. Lake Mead is the closest major body of surface water, located approximately 160 km (100 mi) southeast of the NTS.

1.4 Environmental Settings

One meteorological exhibit and two joint frequency distribution exhibit are sufficient to address the climate and atmospheric dispersion characteristics of NTS for BEMR modeling purposes. Meteorological data for the installation are presented in Exhibit 1.1. Atmospheric dispersion data in the form of a joint frequency distribution of wind direction, wind speed, and atmospheric stability are presented in Exhibits 1.2 and 1.3.

Hydrogeologic settings for the NTS are based on both physiographic and groundwater considerations, with the boundaries for the individual settings being drawn along current operational unit boundaries. This was done for the convenience of assigning waste units to specific hydrogeologic settings. Six different settings were developed for the site and are shown in Figure 1.2. Three of the hydrogeologic settings consist of intermontane basins including Yucca Flat, Frenchman Flat, and Jackass Flats. The higher elevation areas at the Site are collapsed into the Rainier Meas, Pahute Meas, and Timber Mountain settings. A brief description of the hydrogeology of each setting follows. Hydrogeologic data for the NTS environmental settings are presented in Tables 1.1 through 1.6.

Yucca and Frenchman Flats are hydrologically closed basins that lie along the eastern edge of the NTS. Water captured by the higher elevation areas surrounding these basins is transported to and percolates into the alluvium. Water flow in the shallow subsurface is generally downward until it intersects the tuffaceous material, at which point it migrates laterally toward the vicinity of the playas within each basin. In the areas underlying the playas, water migrates downward through the volcanics and is eventually captured by the regional carbonate aquifer.

Jackass Flats has many similarities with the other two basins. Thick alluvium overlying tertiary volcanics and pre-Mesozoic sediments determine the migration of both water and contaminants in the subsurface. Unlike Yucca or Frenchman Flats, Jackass Flats has surface drainage capable of transporting materials off site. Forty Mile Creek bisects the setting along its western third.

The three higher elevation hydrogeologic settings, Pahute Mesa, Rainier Mesa, and Timber Mountain all lack the highly permeable surface alluvium that is a major characteristic of the other three settings. Dominated by uplifted Tertiary volcanics and Paleozoic sediments, these settings offer distinctly different contaminant transport pathways than occur in the basins. The primary feature distinguishing the three higher elevation settings is the flow path of the regional aquifers underlying each. In the vicinity of Pahute Mesa, the regional groundwater flow is toward the southwest, entering Nellis Air Force Base directly. Water from this aquifer eventually emerges in springs and seeps in the Oasis Valley. Regional groundwater flow associated with Rainier Mesa is complex. Components of flow from the central and western portions of the setting converge and migrate into the Yucca Flat area. In the more eastern portions of this setting, regional groundwater flow is toward the southeast. For the purposes of the BEMR project, this setting is modeled as having a dominant groundwater flow component toward the south, into Yucca Flat. As with Rainier Mesa, groundwater underlying the Timber Mountain setting is controlled to a large degree by topography and is complex. In general, it is assumed that the dominant component of the flow is toward the south and into the Jackass Flats area.

1.5 Installation Participation in the Development of Environmental Settings

The climatic and hydrogeologic descriptions for the NTS are based on publicly available documents written for DOE environmental programs. Site experts were contacted and participated in the development and review of environmental settings for this installation. Charles Steadman supplied input into the development of the meteorologic environmental settings. Individuals supplying input into the development of the hydrogeologic environmental settings included Frank Maxwell, Environmental

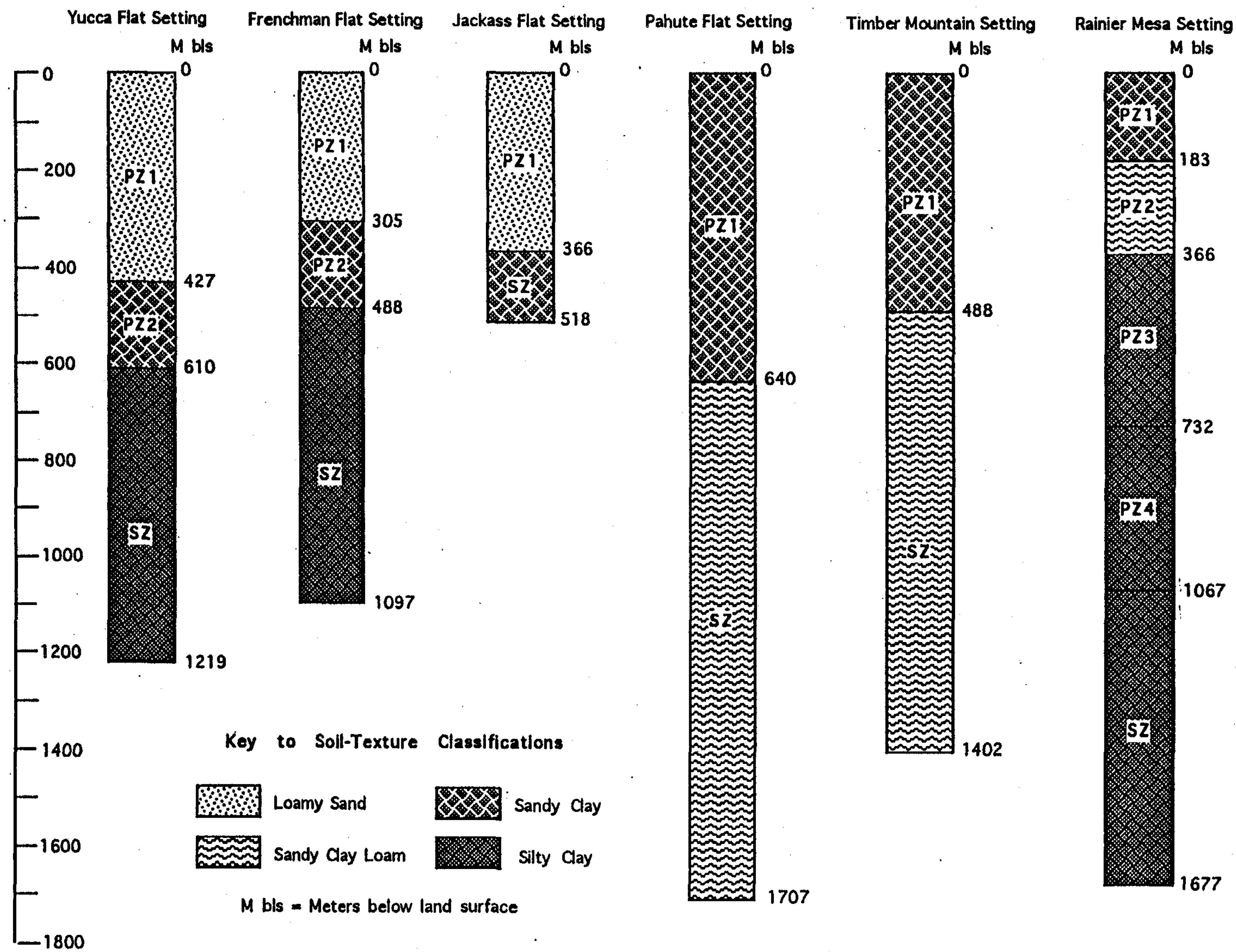

Figure 1.2. Nevada Test Site Environmental Settings

Restoration Division, DOE, Nevada Field Office, and Doug Trudeau and James Cole of the U.S.G.S. It should be noted that because of the size of NTS, the hydrogeologic settings described above necessarily contain a great deal of composited data. Use of the data should be strictly limited to broad scale assessments and generalized descriptions. Users are cautioned that more accurate and detailed characterizations are available for more computationally intensive studies.

Exhibit 1.1

Nevada Test Site Average Local Climatology. Meteorological parameters are presented using the units with which they are routinely measured (e.g., temperature: °F, wind speed: mph). Data are from measurements made at Desert Rock Airport and at Yucca Flat.

Station Name: Desert Rock Airport, Desert Rock, Nevada	Elevation: 1007 m	Latitude: 36.63°N
Yucca Flat, Yucca Flat, Nevada	Elevation: 1196 m	Latitude: 36.95°N

Annual Mean Air Temp:	62.4°F	(DRA)	Reference (a) Based on observations made from 1978-1991
	54.9°F	(UCC)	Reference (b) Based on observations made from 1962-1978
Anemometer Height:	9.1 m	(DRA)	Reference (a) Based on observations made from 1978-1991
	8.8 m	(UCC)	Reference (b) Based on observations made from 1962-1978
Mean Annual Wind Speed:	9.2 mph	(DRA)	Reference (a) Based on observations made from 1978-1991
	7.2 mph	(UCC)	Reference (b) Based on observations made from 1962-1978
Fastest 1-Min Wind Speed:	67.0 mph	(DRA)	Reference (a) Based on observations made from 1978-1991
	60.0 mph	(UCC)	Reference (b) Based on observations made from 1962-1978. Actual fastest wind speed is 60+ mph.
Annual Precipitation:	5.9 in.	(DRA)	Reference (a) Based on observations made from 1978-1991
	6.7 in.	(UCC)	Reference (b) Based on observations made from 1962-1978
Precipitation Days:	35 yr^{-1}	(DRA)	Reference (a) Based on observations made from 1978-1991
	34 yr^{-1}	(UCC)	Reference (b) Based on observations made from 1962-1978
Thunderstorms Freq:	14 yr^{-1}	(DRA)	Reference (a) Based on observations made from 1978-1991
	15 yr^{-1}	(UCC)	Reference (b) Based on observations made from 1962-1978
Avg Morning Mixing Ht:	380 m		Reference (a) Based on observations made from 1978-1991
	200 m		Reference (b) Based on observations made from 1962-1978
Avg Afternoon Mixing Ht:	2200 m		Reference (a) Based on observations made from 1978-1991
	2100 m		Reference (b) Based on observations made from 1962-1978
Top Soil Moisture Capacity:	1.37 cm		Reference (c)
MEPAS Parameters: Climatic Region Index:	2		Reference (c)
Precipitation-Evaporation Index:	13		Reference (c)
Soil Cons. Serv. Curve Number:	21		Reference (c)

Monthly Averages

Month	Temperature (°F)	Precipitation (In.)	Wind Speed (MPH)	Cloud Cover (10ths)	Precipitation Days (#)	Daily RH Max (%)	Daily RH Min (%)
Jan	43.5	0.64	8.9	4.9	4	58	35
Feb	47.5	0.68	9.4	5.4	3	55	28
Mar	51.8	0.72	9.5	5.1	5	57	30
Apr	60.3	0.32	10.2	4.5	2	43	20
May	68.3	0.36	10.3	3.8	3	39	17
Jun	79.0	0.10	10.3	2.4	1	26	12
Jul	84.2	0.57	9.8	2.3	3	33	16
Aug	81.9	0.79	8.9	2.4	4	40	19
Sep	74.5	0.34	9.0	2.6	2	39	19
Oct	63.7	0.32	8.1	3.0	2	45	22
Nov	50.8	0.56	8.5	4.2	3	54	29
Dec	43.4	0.54	8.0	4.6	3	61	36
	↓	↓	↓	↓	↓	↓	↓
Reference: ...	(a)	(a)	(a)	(a)	(a)	(a)	(a)

(a) Unpublished technical data provided by correspondence with Charles Steadman (National Weather Service Western Region, Weather Service Nuclear Support Office), April 1993.

(b) Unpublished technical data provided by correspondence with Charles Steadman (National Weather Service Western Region, Weather Service Nuclear Support Office), April 1993.

(c) Droppo, J. G., Jr., D. L. Strenge, J. W. Buck, B. L. Hoopes, R. D. Brockhaus, M. B. Walter, and G. Whelan. *Multimedia Environmental Pollutant Assessment System (MEPAS) Application Guidance. Volume 2 - Guidelines for Evaluating MEPAS Input Parameters*. PNL-7216, Pacific Northwest Laboratory, Richland, Washington.

Exhibit 1.2

Joint Frequency Distribution of Atmospheric Stability, Wind Direction, and Wind Speed for Las Vegas. Atmospheric stability is determined using the Pasquill-Gifford method. Wind measurements were made on-site at 6.1 m (20 ft) above ground level. Data are based on measurements made from 1960 through 1964.

Wind Stab Class	Direction from Which the Wind is Blowing	Wind Speed Class (Knots)					
		0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	>21
A	North	0.00144	0.00064	0.00000	0.00000	0.00000	0.00000
A	North-Northeast	0.00118	0.00068	0.00000	0.00000	0.00000	0.00000
A	Northeast	0.00193	0.00132	0.00000	0.00000	0.00000	0.00000
A	East-Northeast	0.00179	0.00114	0.00000	0.00000	0.00000	0.00000
A	East	0.00205	0.00114	0.00000	0.00000	0.00000	0.00000
A	East-Southeast	0.00119	0.00073	0.00000	0.00000	0.00000	0.00000
A	Southeast	0.00145	0.00084	0.00000	0.00000	0.00000	0.00000
A	South-Southeast	0.00089	0.00055	0.00000	0.00000	0.00000	0.00000
A	South	0.00087	0.00057	0.00000	0.00000	0.00000	0.00000
A	South-Southwest	0.00042	0.00027	0.00000	0.00000	0.00000	0.00000
A	Southwest	0.00058	0.00027	0.00000	0.00000	0.00000	0.00000
A	West-Southwest	0.00033	0.00021	0.00000	0.00000	0.00000	0.00000
A	West	0.00036	0.00023	0.00000	0.00000	0.00000	0.00000
A	West-Northwest	0.00053	0.00016	0.00000	0.00000	0.00000	0.00000
A	Northwest	0.00059	0.00032	0.00000	0.00000	0.00000	0.00000
A	North-Northwest	0.00056	0.00034	0.00000	0.00000	0.00000	0.00000
B	North	0.00349	0.00349	0.00103	0.00000	0.00000	0.00000
B	North-Northeast	0.00394	0.00402	0.00110	0.00000	0.00000	0.00000
B	Northeast	0.00726	0.00735	0.00203	0.00000	0.00000	0.00000
B	East-Northeast	0.00676	0.00831	0.00324	0.00000	0.00000	0.00000
B	East	0.00574	0.00680	0.00265	0.00000	0.00000	0.00000
B	East-Southeast	0.00349	0.00395	0.00160	0.00000	0.00000	0.00000
B	Southeast	0.00233	0.00233	0.00094	0.00000	0.00000	0.00000
B	South-Southeast	0.00180	0.00137	0.00094	0.00000	0.00000	0.00000
B	South	0.00170	0.00167	0.00087	0.00000	0.00000	0.00000
B	South-Southwest	0.00113	0.00084	0.00071	0.00000	0.00000	0.00000
B	Southwest	0.00199	0.00114	0.00064	0.00000	0.00000	0.00000
B	West-Southwest	0.00139	0.00078	0.00043	0.00000	0.00000	0.00000
B	West	0.00109	0.00059	0.00023	0.00000	0.00000	0.00000
B	West-Northwest	0.00134	0.00089	0.00030	0.00000	0.00000	0.00000
B	Northwest	0.00185	0.00142	0.00041	0.00000	0.00000	0.00000
B	North-Northwest	0.00150	0.00128	0.00034	0.00000	0.00000	0.00000
C	North	0.00087	0.00356	0.00231	0.00034	0.00011	0.00005
C	North-Northeast	0.00084	0.00349	0.00322	0.00034	0.00000	0.00000
C	Northeast	0.00151	0.00637	0.00514	0.00053	0.00002	0.00000
C	East-Northeast	0.00142	0.00580	0.00573	0.00053	0.00005	0.00000
C	East	0.00142	0.00564	0.00450	0.00037	0.00002	0.00000
C	East-Southeast	0.00074	0.00308	0.00290	0.00048	0.00000	0.00000
C	Southeast	0.00056	0.00235	0.00167	0.00064	0.00005	0.00005
C	South-Southeast	0.00039	0.00167	0.00210	0.00105	0.00039	0.00011
C	South	0.00071	0.00276	0.00340	0.00247	0.00091	0.00025
C	South-Southwest	0.00072	0.00217	0.00315	0.00274	0.00244	0.00087
C	Southwest	0.00095	0.00320	0.00288	0.00164	0.00190	0.00098
C	West-Southwest	0.00076	0.00304	0.00187	0.00053	0.00025	0.00009
C	West	0.00086	0.00253	0.00121	0.00016	0.00009	0.00007
C	West-Northwest	0.00080	0.00279	0.00078	0.00005	0.00002	0.00000
C	Northwest	0.00059	0.00205	0.00112	0.00016	0.00005	0.00005
C	North-Northwest	0.00046	0.00192	0.00139	0.00037	0.00011	0.00002

Exhibit 1.2 (contd)

Wind Stab Class	Direction from Which the Wind is Blowing	Wind Speed Class (Knots) 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	>21
D	North	0.00005	0.00096	0.00116	0.00354	0.00288	0.00126
D	North-Northeast	0.00005	0.00098	0.00066	0.00253	0.00114	0.00025
D	Northeast	0.00005	0.00162	0.00203	0.00322	0.00091	0.00014
D	East-Northeast	0.00007	0.00158	0.00180	0.00224	0.00048	0.00005
D	East	0.00007	0.00162	0.00167	0.00142	0.00014	0.00000
D	East-Southeast	0.00002	0.00082	0.00094	0.00089	0.00014	0.00000
D	Southeast	0.00002	0.00075	0.00057	0.00142	0.00041	0.00016
D	South-Southeast	0.00002	0.00064	0.00094	0.00256	0.00167	0.00039
D	South	0.00006	0.00107	0.00217	0.01007	0.00484	0.00105
D	South-Southwest	0.00003	0.00105	0.00217	0.00922	0.00874	0.00390
D	Southwest	0.00007	0.00240	0.00210	0.00929	0.01100	0.00543
D	West-Southwest	0.00012	0.00244	0.00100	0.00473	0.00315	0.00094
D	West	0.00012	0.00311	0.00114	0.00087	0.00071	0.00023
D	West-Northwest	0.00006	0.00187	0.00048	0.00050	0.00011	0.00011
D	Northwest	0.00004	0.00132	0.00082	0.00119	0.00107	0.00114
D	North-Northwest	0.00005	0.00089	0.00073	0.00233	0.00386	0.00212
E	North	0.00017	0.00032	0.00142	0.00498	0.00233	0.00073
E	North-Northeast	0.00010	0.00021	0.00100	0.00242	0.00046	0.00016
E	Northeast	0.00019	0.00021	0.00096	0.00251	0.00071	0.00011
E	East-Northeast	0.00006	0.00018	0.00128	0.00114	0.00027	0.00002
E	East	0.00016	0.00021	0.00078	0.00043	0.00000	0.00000
E	East-Southeast	0.00004	0.00011	0.00050	0.00021	0.00002	0.00002
E	Southeast	0.00015	0.00018	0.00046	0.00050	0.00023	0.00007
E	South-Southeast	0.00005	0.00014	0.00135	0.00292	0.00116	0.00032
E	South	0.00016	0.00039	0.00580	0.01580	0.00384	0.00068
E	South-Southwest	0.00009	0.00027	0.00637	0.02105	0.00692	0.00226
E	Southwest	0.00014	0.00032	0.00886	0.02128	0.00881	0.00290
E	West-Southwest	0.00016	0.00039	0.00884	0.00742	0.00171	0.00055
E	West	0.00019	0.00030	0.00548	0.00171	0.00027	0.00000
E	West-Northwest	0.00017	0.00041	0.00226	0.00112	0.00032	0.00007
E	Northwest	0.00018	0.00027	0.00137	0.00292	0.00139	0.00073
E	North-Northwest	0.00015	0.00016	0.00105	0.00452	0.00317	0.00142
F	North	0.00161	0.00452	0.00342	0.00000	0.00000	0.00000
F	North-Northeast	0.00107	0.00306	0.00336	0.00000	0.00000	0.00000
F	Northeast	0.00129	0.00397	0.00336	0.00000	0.00000	0.00000
F	East-Northeast	0.00134	0.00336	0.00194	0.00000	0.00000	0.00000
F	East	0.00130	0.00372	0.00185	0.00000	0.00000	0.00000
F	East-Southeast	0.00121	0.00279	0.00082	0.00000	0.00000	0.00000
F	Southeast	0.00118	0.00276	0.00082	0.00000	0.00000	0.00000
F	South-Southeast	0.00100	0.00354	0.00208	0.00000	0.00000	0.00000
F	South	0.00216	0.00797	0.01400	0.00000	0.00000	0.00000
F	South-Southwest	0.00282	0.00982	0.02317	0.00000	0.00000	0.00000
F	Southwest	0.00637	0.02557	0.04315	0.00000	0.00000	0.00000
F	West-Southwest	0.00883	0.03664	0.04856	0.00000	0.00000	0.00000
F	West	0.00797	0.03226	0.02082	0.00000	0.00000	0.00000
F	West-Northwest	0.00358	0.01411	0.00537	0.00000	0.00000	0.00000
F	Northwest	0.00189	0.00621	0.00345	0.00000	0.00000	0.00000
F	North-Northwest	0.00134	0.00393	0.00247	0.00000	0.00000	0.00000

Exhibit 1.3

Joint Frequency Distribution of Atmospheric Stability, Wind Direction, and Wind Speed for Las Vegas-Nellis Air Base. Atmospheric stability is determined using the Pasquill-Gifford method. Wind measurements were made on-site at 2.0 m (7 ft) above ground level. Data are based on measurements made from 1958 through 1967.

Wind Stab Class	Direction from Which the Wind is Blowing	Wind Speed Class (Knots)					
		0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	>21
A	North	0.00158	0.00035	0.00000	0.00000	0.00000	0.00000
A	North-Northeast	0.00143	0.00025	0.00000	0.00000	0.00000	0.00000
A	Northeast	0.00276	0.00063	0.00000	0.00000	0.00000	0.00000
A	East-Northeast	0.00187	0.00035	0.00000	0.00000	0.00000	0.00000
A	East	0.00411	0.00103	0.00000	0.00000	0.00000	0.00000
A	East-Southeast	0.00354	0.00087	0.00000	0.00000	0.00000	0.00000
A	Southeast	0.00438	0.00098	0.00000	0.00000	0.00000	0.00000
A	South-Southeast	0.00227	0.00054	0.00000	0.00000	0.00000	0.00000
A	South	0.00583	0.00146	0.00000	0.00000	0.00000	0.00000
A	South-Southwest	0.00388	0.00082	0.00000	0.00000	0.00000	0.00000
A	Southwest	0.00283	0.00067	0.00000	0.00000	0.00000	0.00000
A	West-Southwest	0.00133	0.00024	0.00000	0.00000	0.00000	0.00000
A	West	0.00178	0.00026	0.00000	0.00000	0.00000	0.00000
A	West-Northwest	0.00142	0.00022	0.00000	0.00000	0.00000	0.00000
A	Northwest	0.00112	0.00019	0.00000	0.00000	0.00000	0.00000
A	North-Northwest	0.00076	0.00008	0.00000	0.00000	0.00000	0.00000
B	North	0.00325	0.00081	0.00034	0.00000	0.00000	0.00000
B	North-Northeast	0.00441	0.00126	0.00047	0.00000	0.00000	0.00000
B	Northeast	0.00654	0.00268	0.00102	0.00000	0.00000	0.00000
B	East-Northeast	0.00447	0.00171	0.00078	0.00000	0.00000	0.00000
B	East	0.00921	0.00370	0.00153	0.00000	0.00000	0.00000
B	East-Southeast	0.00604	0.00250	0.00093	0.00000	0.00000	0.00000
B	Southeast	0.00651	0.00300	0.00135	0.00000	0.00000	0.00000
B	South-Southeast	0.00330	0.00142	0.00085	0.00000	0.00000	0.00000
B	South	0.01067	0.00420	0.00215	0.00000	0.00000	0.00000
B	South-Southwest	0.01215	0.00375	0.00111	0.00000	0.00000	0.00000
B	Southwest	0.00826	0.00227	0.00090	0.00000	0.00000	0.00000
B	West-Southwest	0.00368	0.00091	0.00031	0.00000	0.00000	0.00000
B	West	0.00498	0.00128	0.00027	0.00000	0.00000	0.00000
B	West-Northwest	0.00386	0.00070	0.00011	0.00000	0.00000	0.00000
B	Northwest	0.00293	0.00065	0.00015	0.00000	0.00000	0.00000
B	North-Northwest	0.00189	0.00039	0.00005	0.00000	0.00000	0.00000
C	North	0.00105	0.00082	0.00126	0.00026	0.00003	0.00001
C	North-Northeast	0.00169	0.00097	0.00175	0.00039	0.00011	0.00000
C	Northeast	0.00324	0.00252	0.00464	0.00072	0.00008	0.00000
C	East-Northeast	0.00215	0.00185	0.00337	0.00059	0.00001	0.00001
C	East	0.00354	0.00312	0.00450	0.00066	0.00003	0.00000
C	East-Southeast	0.00213	0.00191	0.00257	0.00050	0.00000	0.00000
C	Southeast	0.00219	0.00200	0.00326	0.00080	0.00008	0.00001
C	South-Southeast	0.00117	0.00109	0.00203	0.00099	0.00016	0.00006
C	South	0.00363	0.00322	0.00543	0.00242	0.00090	0.00016
C	South-Southwest	0.00374	0.00296	0.00334	0.00185	0.00109	0.00057
C	Southwest	0.00313	0.00222	0.00218	0.00085	0.00030	0.00007
C	West-Southwest	0.00145	0.00093	0.00059	0.00017	0.00008	0.00000
C	West	0.00179	0.00126	0.00087	0.00016	0.00001	0.00002
C	West-Northwest	0.00121	0.00072	0.00057	0.00021	0.00005	0.00003
C	Northwest	0.00141	0.00089	0.00046	0.00008	0.00003	0.00001
C	North-Northwest	0.00065	0.00042	0.00029	0.00000	0.00000	0.00000

Exhibit 1.3 (contd)

Wind Stab Class	Direction from Which the Wind is Blowing	Wind Speed Class (Knots)					
		0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	>21
D	North	0.00029	0.00077	0.00167	0.00483	0.00135	0.00039
D	North-Northeast	0.00035	0.00091	0.00326	0.00965	0.00380	0.00142
D	Northeast	0.00056	0.00200	0.00669	0.01290	0.00268	0.00072
D	East-Northeast	0.00050	0.00182	0.00527	0.00497	0.00038	0.00005
D	East	0.00060	0.00222	0.00468	0.00310	0.00035	0.00005
D	East-Southeast	0.00029	0.00121	0.00240	0.00272	0.00029	0.00011
D	Southeast	0.00017	0.00065	0.00265	0.00500	0.00069	0.00017
D	South-Southeast	0.00018	0.00041	0.00215	0.00798	0.00233	0.00054
D	South	0.00060	0.00163	0.00962	0.02850	0.00843	0.00236
D	South-Southwest	0.00036	0.00123	0.00419	0.01545	0.00734	0.00332
D	Southwest	0.00027	0.00089	0.00263	0.00949	0.00387	0.00188
D	West-Southwest	0.00010	0.00040	0.00077	0.00244	0.00072	0.00034
D	West	0.00026	0.00073	0.00120	0.00227	0.00059	0.00015
D	West-Northwest	0.00018	0.00048	0.00131	0.00411	0.00178	0.00077
D	Northwest	0.00028	0.00077	0.00117	0.00417	0.00188	0.00069
D	North-Northwest	0.00006	0.00027	0.00058	0.00109	0.00026	0.00013
E	North	0.00000	0.00206	0.00320	0.00000	0.00000	0.00000
E	North-Northeast	0.00000	0.00368	0.00370	0.00000	0.00000	0.00000
E	Northeast	0.00000	0.00477	0.00659	0.00000	0.00000	0.00000
E	East-Northeast	0.00000	0.00279	0.00459	0.00000	0.00000	0.00000
E	East	0.00000	0.00238	0.00247	0.00000	0.00000	0.00000
E	East-Southeast	0.00000	0.00122	0.00129	0.00000	0.00000	0.00000
E	Southeast	0.00000	0.00125	0.00147	0.00000	0.00000	0.00000
E	South-Southeast	0.00000	0.00113	0.00187	0.00000	0.00000	0.00000
E	South	0.00000	0.00379	0.01446	0.00000	0.00000	0.00000
E	South-Southwest	0.00000	0.00234	0.00602	0.00000	0.00000	0.00000
E	Southwest	0.00000	0.00183	0.00283	0.00000	0.00000	0.00000
E	West-Southwest	0.00000	0.00082	0.00081	0.00000	0.00000	0.00000
E	West	0.00000	0.00112	0.00088	0.00000	0.00000	0.00000
E	West-Northwest	0.00000	0.00110	0.00107	0.00000	0.00000	0.00000
E	Northwest	0.00000	0.00163	0.00152	0.00000	0.00000	0.00000
E	North-Northwest	0.00000	0.00077	0.00093	0.00000	0.00000	0.00000
F	North	0.02298	0.00707	0.00000	0.00000	0.00000	0.00000
F	North-Northeast	0.03131	0.00986	0.00000	0.00000	0.00000	0.00000
F	Northeast	0.03872	0.01223	0.00000	0.00000	0.00000	0.00000
F	East-Northeast	0.01919	0.00587	0.00000	0.00000	0.00000	0.00000
F	East	0.01901	0.00489	0.00000	0.00000	0.00000	0.00000
F	East-Southeast	0.00986	0.00227	0.00000	0.00000	0.00000	0.00000
F	Southeast	0.00802	0.00227	0.00000	0.00000	0.00000	0.00000
F	South-Southeast	0.00552	0.00170	0.00000	0.00000	0.00000	0.00000
F	South	0.02452	0.01086	0.00000	0.00000	0.00000	0.00000
F	South-Southwest	0.02112	0.00748	0.00000	0.00000	0.00000	0.00000
F	Southwest	0.02032	0.00632	0.00000	0.00000	0.00000	0.00000
F	West-Southwest	0.01047	0.00278	0.00000	0.00000	0.00000	0.00000
F	West	0.01324	0.00311	0.00000	0.00000	0.00000	0.00000
F	West-Northwest	0.01465	0.00327	0.00000	0.00000	0.00000	0.00000
F	Northwest	0.01898	0.00471	0.00000	0.00000	0.00000	0.00000
F	North-Northwest	0.00998	0.00259	0.00000	0.00000	0.00000	0.00000

Table 1.1. Hydrogeologic Setting Data Summary of the Yucca Flat Setting, Nevada Test Site. MEPAS parameters are listed for both the partially saturated (PZ) and saturated zones (SZ).

Parameter	Units	PZ1	PZ2	SZ1
Darcian_Velocity	cm/yr	2.41	2.41	--
SoilC	n/a	4.38	10.4	10.4
Thickness	m	427	183	610
Bulk_Density	gm/cm^3	1.49	2.3	2.4
Total_Porosity	%	43.7	10	5.4
Field_Capacity	%	12	9.9	--
Conductivity	m/d	320	100.E-05	--
Longitudinal_Disp.	m	4.3	0.2	305[a]
Transverse_Disp.	m	--	--	61[a]
Vertical_Disp.	m	--	--	30[a]
Effective_Porosity	%	--	--	2.3
Velocity	m/d	--	--	0.03
Distance	m	--	--	3050
Textural_Class	--	Loamy	Sandy	Silty
	Sand	Clay	Clay	
%_sand	%	84	50	8
%_silt	%	12	8	47
%_clay	%	4	42	45
%_OMC	%	0	0	0
%_Fe	%	2.1	1.43	0.13
pH	n/a	7.2	7.5	7.3

Notes: The Welded Tuff unit is an aquifer, but is treated as a PZ here because the receptor for the aquifer is the Lower Carbonate Aquifer.

(a) It is recommended that default values be substituted for the values listed once the distances to the receptors have been determined.

Table 1.2. Hydrogeologic Setting Data Summary of the Frenchman Flat Setting, Nevada Test Site. MEPAS parameters are listed for both the partially saturated (PZ) and saturated zones (SZ).

Parameter	Units	PZ1	PZ2	SZ1
Darcian_Velocity	cm/yr	2.41	2.41	--
SoilC	n/a	4.38	10.4	10.4
Thickness	m	305	183	610
Bulk_Density	gm/cm^3	1.49	2.3	2.4
Total_Porosity	%	43.7	10	5.4
Field_Capacity	%	12	9.96	--
Conductivity	m/d	320	1.00E-05	--
Longitudinal_Disp.	m	3	0.2	305[a]
Transverse_Disp.	m	--	--	61[a]
Vertical_Disp.	m	--	--	30[a]
Effective_Porosity	%	--	--	2.3
Velocity	m/d	--	--	0.03
Distance	m	--	--	3050
Textural_Class	-- Sand	Loamy Clay	Sandy Clay	Silty
%_sand	%	84	50	8
%_silt	%	12	8	47
%_clay	%	4	42	45
%_OMC	%	0	0	0
%_Fe	%	2.1	1.43	0.13
pH	n/a	7.2	7.5	7.3

Notes: The Welded Tuff unit is an aquifer, but is treated as a PZ here because the receptor for the aquifer is the Lower Carbonate Aquifer.

(a) It is recommended that default values be substituted for the values listed once the distances to the receptors have been determined.

Table 1.3. Hydrogeologic Setting Data Summary of the Jackass Flats Setting, Nevada Test Site. MEPAS parameters are listed for both the partially saturated (PZ) and saturated zones (SZ).

Parameter	Units	PZ1	SZ1
Darcian_velocity	cm/yr	1.65	--
SoilC	n/a	4.38	10.4
Thickness	m	366	152
Bulk_Density	gm/cm^3	1.49	2.3
Total_Porosity	%	43.7	10
Field_Capacity	%	12	--
Conductivity	m/d	320	--
Longitudinal_Disp.	m	4	305[a]
Transverse_Disp.	m	--	61[a]
Vertical_Disp.	m	--	30[a]
Effective_Porosity	%	--	2
Velocity	m/d	--	0.03
Distance	m	--	3050
Textural_Class	--	Loamy	Sandy
	Sand	Clay	
%_sand	%	84	50
%_silt	%	12	8
%_clay	%	4	42
%_OMC	%	0	0
%_Fe	%	2.1	1.43
pH	n/a	7.2	7.5

Notes:
(a) It is recommended that default values be substituted for the values listed once the distances to the receptors have been determined.

Table 1.4. Hydrogeologic Setting Data Summary of the Pahute Mesa Setting, Nevada Test Site. MEPAS parameters are listed for both the partially saturated (PZ) and saturated zones (SZ).

Parameter	Units	PZ1	SZ1
Darcian_Velocity	cm/yr	4.6	--
SoilC	n/a	10.4	7.12
Thickness	m	640	1067
Bulk_Density	gm/cm^3	1.62	1.6
Total_Porosity	%	37.7	40
Field_Capacity	%	9	--
Conductivity	m/d	2.00E-03	--
Longitudinal_Disp.	m	6	305[a]
Transverse_Disp.	m	--	61[a]
Vertical_Disp.	m	--	61[a]
Effective_Porosity	%	--	3
Velocity	m/d	--	8
Distance	m	--	3050
Textural_Class	-- Clay	Sandy Clay Loam	Sandy
%_sand	%	50	60
%_silt	%	8	14
%_clay	%	42	26
%_OMC	%	0	0
%_Fe	%	1.43	1.5
pH	n/a	7.5	7.5

Notes:
(a) It is recommended that default values be substituted for the values listed once the distances to the receptors have been determined.

Table 1.5. Hydrogeologic Setting Data Summary of the Timber Mountain Setting, Nevada Test Site. MEPAS parameters are listed for both the partially saturated (PZ) and saturated zones (SZ).

Parameter	Units	PZ1	SZ1
Darcian_Velocity	cm/yr	3.1	--
SoilC	n/a	7.12	7.12
Thickness	m	488	914
Bulk_Density	gm/cm^3	1.6	1.6
Total_Porosity	%	40	40
Field_Capacity	%	24	--
Conductivity	m/d	8.00E-04	--
Longitudinal_Disp.	m	5	305[(a)]
Transverse_Disp.	m	--	61[(a)]
Vertical_Disp.	m	--	61[(a)]
Effective_Porosity	%	--	11
Velocity	m/d	--	0.03
Distance	m	--	8
Textural_Class	--	Sandy	Sandy
	Clay Loam	Clay Loam	
%_sand	%	60	60
%_silt	%	14	14
%_clay	%	26	26
%_OMC	%	0	0
%_Fe	%	1.5	1.5
pH	n/a	7.5	7.5

Notes:
(a) It is recommended that default values be substituted for the values listed once the distances to the receptors have been determined.

Table 1.6. Hydrogeologic Setting Data Summary of the Rainier Mesa Setting, Nevada Test Site. MEPAS parameters are listed for both the partially saturated zones (PZ) and the saturated zone (SZ).

Parameter	Units	PZ1	PZ2	PZ3	PZ4	SZ1
Darcian_Velocity	cm/yr	5.6	5.6	5.6	5.6	--
SoilC		10.4	7.12	10.4	10.4	10.4
Thickness	m	183	183	366	335	610
Bulk_Density	gm/cm^3	2.3	1.6	2.4	2.5	2.5
Total_Porosity	%	10	40	3.8	5.4	5.4
Field_Capacity	%	6	24	2	2	--
Conductivity	m/d	1.00E-05	8.00E-04	4.00E-07	4.00E-04	--
Longitudinal_Disp.	m	1.8	1.8	3.7	3.4	305[a]
Transverse_Disp.	m	--	--	--	--	61[a]
Vertical_Disp.	m	--	--	--	--	61[a]
Effective_Porosity	%	--	--	--	--	2.3
Velocity	m/d	--	--	--	--	0.03
Distance	m	--	--	--	--	
Textural_Class	-- Clay	Sandy Clay Loam	Sandy Clay	Silty Clay	Silty Clay	Silty Clay
%_sand	%	50	60	8	8	8
%_silt	%	8	14	47	47	47
%_clay	%	42	26	45	45	45
%_OMC	%	0	0	0	0	0
%_Fe	%	1.43	1.5	1.5	0	0
pH	n/a	7.5	7.5	7.5	7.6	7.6

Notes:
(a) It is recommended that default values be substituted for the values listed once the distances to the receptors have been determined.

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