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WAG 9

APPENDIX C

SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

for OPERABLE UNIT 9-04: COMPREHENSIVE RI/FS FINAL WORK PLAN

Prepared By
Argonne National Laboratory-West

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WAG 9 Screening Level Ecological Risk Assessment

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EXECUTIVE SUMMARY

This screening level ecological risk assessment (SLERA) for Waste Area Group 9 (WAG 9) at the Idaho National Engineering Laboratory (INEL) was performed using the methodology developed in the Guidance Manual for Conducting Screening Level Ecological Risk Assessments at the INEL (VanHorn et al. 1995), subsequently referred to as the Guidance Manual. The purpose of this SLERA was to identify sites and contaminants of potential concern and identify data gaps that must be filled prior to conducting further assessments. Contaminants present at the WAG 9 sites identified in the Federal Facility Agreement and Consent Order (FFA/CO) (DOE-ID 1991) were evaluated for their potential to cause undesirable ecological effects. Sites for which there were inadequate sampling data were not evaluated as part of this assessment. The results of this assessment are intended to support more detailed and/or followup ecological risk assessments that may be required to incorporate additional data and to allow subsequent efforts to be focused on the most important ecological receptors, contaminants, and/or sites.

The SLERA assessment process applied for this analysis involves a three step approach that parallels the EPA *Framework for Ecological Risk Assessment* (EPA 1992a): problem formulation, screening analysis, and screening level evaluation. Each of these steps are described in the following sections.

E.1 Problem Formulation

In the problem formulation step of this analysis, all potential contaminant stressors were characterized, the facility and ecosystem at risk were described, and previous ecological investigations were reviewed and summarized. Descriptions for those sites identified in the FFA/CO, including all operable units (OUs) and individual contaminant sites within each OU, are presented. Those sites for which no contaminant source remains (e.g. remediated sites) and those for which no pathway to the terrestrial environment exists were eliminated in this step of the assessment. Only sites of potential concern were carried through the screening analysis and evaluation. As a result, ten WAG 9 sites of concern were identified and evaluated in this SLERA. The screening analysis is presented in Table 2-1, along with the rationale for eliminating sites.

The ecosystem characterization for WAG 9 is presented in Section 2.3. An area of potential contaminant influence, or assessment area, was defined using available contaminant sampling data and ecological rationale. Faunal species potentially occurring within this assessment area represent all 23 INEL avifauna functional groups, 10 mammalian functional groups, both reptilian groups and the single amphibian group found on the INEL.

Threatened and endangered (T/E) and species under consideration for T/E listing (C2) are addressed specifically for SLERA and are discussed in Section 2.3.1. The following T/E and C2 terrestrial species have the potential for inhabiting or frequenting the WAG 9 assessment area; the peregrine falcon (*Falco peregrinus*), ferruginous hawk (*Buteo regalis*), northern goshawk (*Accipiter gentilis*), burrowing owl (*Athene cunicularia*), loggerhead shrike (*Lanius ludovicianus*), bald eagle (*Haliaeetus leucocephalus*), pygmy rabbit (*Brachylagus idahoensis*), Townsend's western big-eared bat (*Plecotus townsendii*), the long-eared myotis (*myotis evotis*), and the small-footed myotis (*Myotis subulatus*). The following aquatic species also have the potential for occurring in the assessment areas where standing water occurs (i.e., facility ponds); the black tern (*Childonias niger*), white-faced ibis (*Plegadis chihi*), and trumpeter swan (*Cygnus buccinator*). No T/E or C2 plant species have been recorded inside the assessment area, however, tree-like

oxytheca (*Oxytheca dendroidea*), a state sensitive species, is found in the area. All the above species, with the exception of oxytheca, were specifically analyzed as part of this SLERA.

WAG 9 contaminated media includes subsurface and surface soil, surface water, and sediments. The contaminant data collected for human health risk assessment were summarized for the 10 WAG 9 sites of concern. Contaminant data for WAG 9 currently includes surface and subsurface soil, sediment, and surface water sampling (Section 2). Contaminants sampled for these media include organics, inorganics and radionuclides. These contaminated media have potential for posing risk to WAG 9 ecological components through various direct and indirect pathways. A pathway analysis, as presented in Section 2.5, was performed for the 10 sites of concern. An analysis for each medium was used to determine those functional groups, T/E species, and C_2 that were directly and indirectly exposed to potential contamination (receptors). Based on this information, assessment and measurement endpoints were developed. The endpoints were developed around the protection of the INEL biota represented by functional groups and individual T/E and sensitive species known to exist at WAG 9 and identified as having potential for exposure to contaminants. Assessment and measurement endpoints for this SLERA are summarized on Tables 2-22 and 2-23, respectively.

E.2 Screening Analysis

The screening analysis phase of the WAG 9 SLERA evaluated exposure of receptors to contaminants (see Section 3.1) and potential effects of that exposure (see Section 3.2). The evaluations were conducted interactively to ensure that the methods were compatible.

A hazard evaluation was performed that involved a comprehensive review of toxicity data for contaminants to identify the nature and severity of toxic properties, especially with respect to members of functional groups. Dose-response assessment was used to estimate the amount of chemical exposure that may result in adverse ecological effects. Because no dose-based toxicological criteria exist for ecological receptors, toxicity reference values (TRVs) were developed for the contaminants and functional groups at the INEL.

Each of the functional groups, T/E species, and C_2 were evaluated individually. Potential exposures were determined based on the life history and feeding habits. Quantification of exposures involved the use of numerical exposure factors including body weight, exposure duration, ingestion rate, fraction of diet and soil consumed, exposure duration, and fraction of time spent at the site.

Ecologically based screening levels (EBSLs) for contaminants in surface and subsurface soils at the INEL were developed as discussed in Section 3 using the TRVs and basic functional group exposure factors. EBSLs are defined as ecologically based target concentrations of contaminants in soil (or other media) derived from site-specific exposure scenarios for relevant ecological receptors. The EBSLs are then used in the screening process as discussed in the screening level evaluation.

E.3 Screening Level Evaluation

The screening level evaluation determines whether there is any indication of risk due to the contaminant concentrations. Exposure parameters and TRVs were used to calculate EBSLs for each functional group as described in Section 3. Screening Level Quotients (SLQs) were calculated by dividing the average concentration of contaminant in the contaminated media by the EBSL.

SLQs for WAG 9 contaminants are summarized in Section 4. If the average concentration of a contaminant in the medium of interest did not exceed its minimum EBSL (i.e., SLQs are less than 1 for nonradionuclides and 0.1 for radionuclides), adverse effects from receptor exposure to that chemical are not expected, and no further evaluation of that contaminant is required. Hence, the SLQ is an indicator of risk.

None of the four radionuclides that were assessed failed either the internal or external exposure screening. However, of the thirty-one nonradionuclide contaminants assessed, twenty-three were shown as having potential to cause adverse effects to the exposed populations. The results are presented in Section 4.

Three sites were also assessed separately for standing water and sediment contaminants. As discussed in Section 2.4.3 and 3.1.2.3, several of the radionuclides and nonradiological contaminants identified as present at the Industrial Waste Pond and Cooling Tower Blowdown Ditches, Industrial Waste Lift Station Discharge Ditch, and the ANL Sewage Lagoons were shown to have the potential to cause adverse effects to populations of ecological receptors. These sites will be assessed in the ERA.

E.4 SLERA Summary

SLERA endpoints were not attained (e.g., all SLQs are not less than target) and all WAG 9 sites were not evaluated. Consequently, no final management decisions regarding actual risk can be made using this SLERA. Additional site contaminant data for previously uncharacterized WAG 9 sites must be incorporated as data collection is finalized. For those ecological receptors determined to be at potential risk as a result of this screening, the first step is to determine whether site-specific data are available for the EBSL parameters. A more detailed evaluation of site contaminants that are driving the analysis will incorporate a limited spatial analysis. Use of site specific data, rather than conservative assumptions, will allow a more accurate interpretation of the potential risk.

E.5 Summary of Data Gaps

The major gaps identified in this SLERA include lack of analytical data to support (1) development of site-specific EBSLs, and (2) evaluation of aquatic, sediment and soil-associated pathways and receptors.

E.6 Transition from SLERA to ERA

The results of this SLERA will support performance of an ecological risk assessment (ERA) or additional screenings if required. Additional data identified through a more comprehensive literature search and forthcoming site characterization data (for new and uncharacterized sites) will be incorporated in the ERA.

Very conservative assumptions were applied in conducting this SLERA to identify all WAG 9 potential sites and contaminants of concern and those ecological receptors having highest potential for being adversely affected as a result of exposure to those sites/contaminants. Subsequent efforts will be focused on those WAG 9 contaminants and sites shown to be potential contributors to ecological risk. A more detailed analysis of risk using existing SLERA data, site-specific biological factors, and more complete analytical data will be conducted in the ERA or future screenings [i.e., bioaccumulation factors (BAFs), TRVs, and plant uptake factors (PUFs)]. Subsequently, less conservative, more realistic risk estimate values can be calculated and management decisions regarding ecological risk can be formulated.

The ERA will also incorporate methods to evaluate potential risk to receptors at the population level because effects to populations are more ecologically significant. Because food chain transfer of contamination affects populations at different trophic levels, the ERA will include evaluation of the accumulation or dilution of contaminants from lowest to highest trophic levels. In addition, external dose analysis techniques for radionuclides will be refined and applied during the performance of the ERA. Finally, during the RI/FS process, remedial actions and alternatives will be analyzed based on the results of the ERA.

CONTENTS

EXECUTIVE SUMMARY iii

ACRONYMS xiii

1. INTRODUCTION 1-1

1.1 Objectives 1-1

1.2 Scope and Organization 1-1

1.2.1 Problem Formulation 1-3
1.2.2 Screening Analysis 1-3
1.2.3 Screening Level Evaluation 1-4
1.2.4 Data Gap Identification and Strategy for Resolution 1-4
1.2.5 Transition From SLERA to ERA 1-4

1.3 Statutory/Regulatory Basis 1-4

2. PROBLEM FORMULATION 2-1

2.1 WAG 9 Description 2-1

2.1.1 Overview of WAG 9 2-1
2.1.2 Sites of Concern 2-5

2.2 Previous Investigations 2-5

2.3 Ecosystem Characterization 2-14

2.3.1 Biotic Components 2-14
2.3.2 Abiotic Components 2-33

2.4 Stressor Identification and Characterization 2-35

2.4.1 Conduct Initial Data Review 2-35
2.4.2 Conduct Phased Screening for Surface and Subsurface Soil Contamination 2-36
2.4.3 Initial Screening of Surface Water and Sediment Contaminants 2-41
2.4.4 Summary of Contaminants Assessed for WAG 9 2-52
2.4.5 Uncertainty Associated with Determining the Nature and Extent of Contamination Onsite and the Selection of Contaminants 2-52

2.5 Pathways of Contaminant Migration and Exposure 2-52

2.5.1 Surface Soil 2-55
2.5.2 Subsurface Soil 2-55
2.5.3 Surface Water and Sediments 2-59
2.5.4 Ecological Conceptual Site Model 2-59

2.6 Assessment Endpoints 2-64

2.7 Measurement Endpoint Selection 2-61

3. SCREENING ANALYSIS 3-1

3.1 Exposure Assessment 3-1

3.1.1 Discuss Contaminant Fate and Transport 3-1
3.1.2 Ecologically Based Screening Levels 3-8

3.2 Ecological Effects Assessment 3-43

3.2.1 Radionuclides 3-43
3.2.2 Nonradionuclides 3-44

4. Screening Level Evaluation 4-1

4.1 Risk Estimation 4-1

4.1.1 Risk Analysis of the ANL-W Windblown Area 4-16
4.1.2 Uncertainty Associated With Screening Level Quotients 4-16

4.2 Risk Evaluation 4-16

4.2.1 Uncertainty 4-17

4.3 Summary 4-17

5. SUMMARY OF DATA GAPS 5-1

5.1 Groundwater Issues 5-1

5.2 Additional WAG 9 Ecological Data Gaps 5-1

6. TRANSITION FROM SLERA TO ERA 6-1

7. REFERENCES 7-1

Appendix A—Site Descriptions A-1

Appendix B—Previous Ecological Investigations B-1

Appendix C—Species Excluded from the WAG 9 SLERA C-1

Appendix D—Toxicity Reference Values for Each Contaminant/Functional Group D-1

FIGURES

1-1. A step approach to ERA 1-2

2-1. Location of WAG 9 and the INEL 2-2

2-2. WAG 9 sites of potential concern (orange) 2-7

2-3. Vegetation map of the WAG 9 area, showing soil types and assessment area 2-15

2-4. Food web for fauna at WAG 9. 2-29

2-5. Ecological pathways/exposure model for WAG 9 surface contamination 2-56

2-6. Ecological pathways/exposure model for WAG 9 subsurface storage and disposal sites 2-58

2-7. Ecological pathways/exposure model for WAG 9 surface water contamination 2-60

2-8. WAG 9 ecological conceptual site model 2-61

TABLES

1-1. ARARs for the WAG 9 SLERA 1-5

2-1. WAG 9 operable unit and site descriptions 2-3

2-2. WAG 9 Operable units and sites of concern 2-6

2-3. Previous investigations applicable to the WAG 9 SLERA 2-9

2-4. Vegetation cover class summary for WAG 9 assessment area 2-18

2-5. WAG 9 vegetation cover classes and areas at the WAG 9 assessment area 2-18

2-6. Faunal functional groups potentially present within the WAG 9 assessment area 2-19

2-7. Threatened and endangered species, special species of concern, and sensitive species that may be found on the INEL 2-31

2-8. Summary of WAG 9 assessment area soil types 2-34

2-9. Vegetation/soil associations within the WAG 9 assessment area 2-34

2-10. Contaminants not detected in samples analyzed in subsurface soils 2-37

2-11. Contaminants not detected in samples analyzed in surface soils 2-39

2-12. Contaminants eliminated because FOD <5% (subsurface soils) 2-41

2-13. Contaminants eliminated because FOD <5% (surface soils) 2-41

2-14. Contaminants eliminated based on comparisons with background data 2-42

2-15. Initial surface water screening of ANL Industrial Waste Pond and Cooling Tower Blowdown Ditches (ANL-01) 2-44

2-16. Initial surface water screening of ANL Industrial Waste Lift Station Discharge Ditch (ANL-35) 2-46

2-17. Initial sediment screening of ANL Industrial Waste Pond and Cooling Tower Blowdown Ditches (ANL-01) 2-47

2-18. Initial sediment screening of ANL Sewage Lagoons (ANL-04) 2-50

2-19. WAG 9 subsurface soils contaminants 2-53

2-20. WAG 9 surface soils contaminants 2-54

2-21. Summary of WAG 9 direct exposure pathways and receptors 2-57

2-22. Summary of WAG 9 SLERA assessment endpoints. 2-63

2-23. Summary of WAG 9 SLERA measurement endpoints 2-65

3-1. WAG 9 EBSL functional group parameters 3-10

3-2. PUFs for WAG 9 nonradionuclide contaminants (unitless) 3-16

3-3. WAG 9 soil nonradiological TRVs (mg/kg-d) 3-17

3-4. WAG 9-specific soil nonradiological EBSLs (mg/kg). 3-25

3-5. WAG 9 CFs, Ēs and FAs 3-35

3-6. WAG 9 soil radiological TRVs 3-36

3-7. WAG 9-specific internal dose soil radiological EBSLs (pCi/g) 3-37

3-8. External dose soil radiological EBSLs (pCi/g) 3-39

3-9. Retained standing water contaminants 3-40

3-10. Retained sediment contaminants 3-41

3-11. AF values and criteria for their use in developing TRVs for INEL 3-46

4-1. Nonradiological screening level quotients (SLQs) for WAG 9 surface soil. 4-2

4-2. Nonradiological SLQs for WAG 9 subsurface soil 4-5

4-3. Radiological SLQs for WAG 9 surface soil (internal dose) 4-12

4-4. Radiological SLQs for WAG 9 subsurface soil (internal dose) 4-13

4-5. Radiological SLQs for external dose for WAG 9 surface soil 4-14

4-6. Radiological SLQs for external dose for WAG 9 subsurface soil 4-15

ACRONYMS

AFs	adjustment factors
ARARs	applicable or relevant and appropriate requirements
BAF	bioaccumulation factor
BLM	Bureau of Land Management
bw	body weight
C2	Category 2
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPCs	contaminants of potential concern
DOE	U.S. Department of Energy
DOE-ID	U.S. Department of Energy Idaho Operations Office
EBSL	ecologically based screening levels
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
FFA/CO	Federal Facility Agreement and Consent Order
FOD	frequency of detection
FOE	frequency of exceedance
FWS	Fish and Wildlife Service
GIS	geographic information system
IAEA	International Atomic Energy Agency
INEL	Idaho National Engineering Laboratory
INPS	Idaho Native Plant Society
LD_{50}	median lethal dose

LMIT	Lockheed Martin Idaho Technologies
LOAEL	lowest observed adverse effect level
MTR	Materials Test Reactor
NAWQC	National ambient water quality criteria
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAEL	no observed adverse effect level
NWI	National Wetlands Inventory
OUs	operable units
PCBs	polychlorinated biphenyls
PUF	plant uptake factor
QCE	Quantified critical exposure levels
RESL	Radiological and Environmental Sciences Laboratory
RI/FS	Remedial investigation/feasibility study
SARA	Superfund Amendments and Reauthorization Act
SLERA	screening level ecological risk assessment
SLQ	screening level quotient
T/E	threatened or endangered
TCC	Typic Camborthids-Typic Calciorthids
TEF	toxicity equivalency factor
TRVs	threshold reference values
TTF	Typic Torrifluvents
UCL	Upper confidence level
USFS	United States Forest Service
WAG 9	Waste area group 9

WAG 9
Screening Level
Ecological Risk Assessment

1. INTRODUCTION

This screening level ecological risk assessment (SLERA) for Waste Area Group 9 (WAG 9) at the Idaho National Engineering Laboratory (INEL), was performed using the methodology developed in the *Guidance Manual for Conducting Screening Level Ecological Risk Assessments at the INEL* (VanHorn et al. 1995), subsequently referred to as the Guidance Manual. Those contaminants present at WAG 9 that have the potential to cause undesirable ecological effects were identified and those sites identified in the Federal Facility Agreement and Consent Order (FFA/CO) (DOE-ID 1991) were evaluated. Any site for which there was inadequate sampling information to determine potential ecological effects was acknowledged. This SLERA is intended to support more detailed screenings and/or followup ecological risk assessments (ERAs) or additional screenings (if required) allowing subsequent efforts to be focused on the more important contaminants and sites.

This introductory section provides the objectives, scope and organization, and statutory/regulatory basis of WAG 9 SLERA.

1.1 Objectives

The objectives of the SLERA for WAG 9 were to:

- Identify those contaminants that may contribute to a potential ecological risk
- Identify those sites that contain levels of contamination contributing to this possible risk
- Indicate those sites for which additional data and/or monitoring is needed for performance of a more detailed ERA, if required, or finalization of the SLERA, if found to be a potential contributor to ecological risk through this initial screening process.

1.2 Scope and Organization

The U.S. Environmental Protection Agency (EPA) Framework (EPA 1992a) stresses the importance of a step approach to ERA at Superfund sites (Figure 1-1). The SLERA assessment process applied for this analysis involves a three step approach that parallels the EPA *Framework for Ecological Risk Assessment* (EPA 1992a): problem formulation, screening analysis and screening level evaluation. Each of these steps are described in the following sections. For a more detailed discussion of the approach, refer to the Guidance Manual (VanHorn et al. 1995).

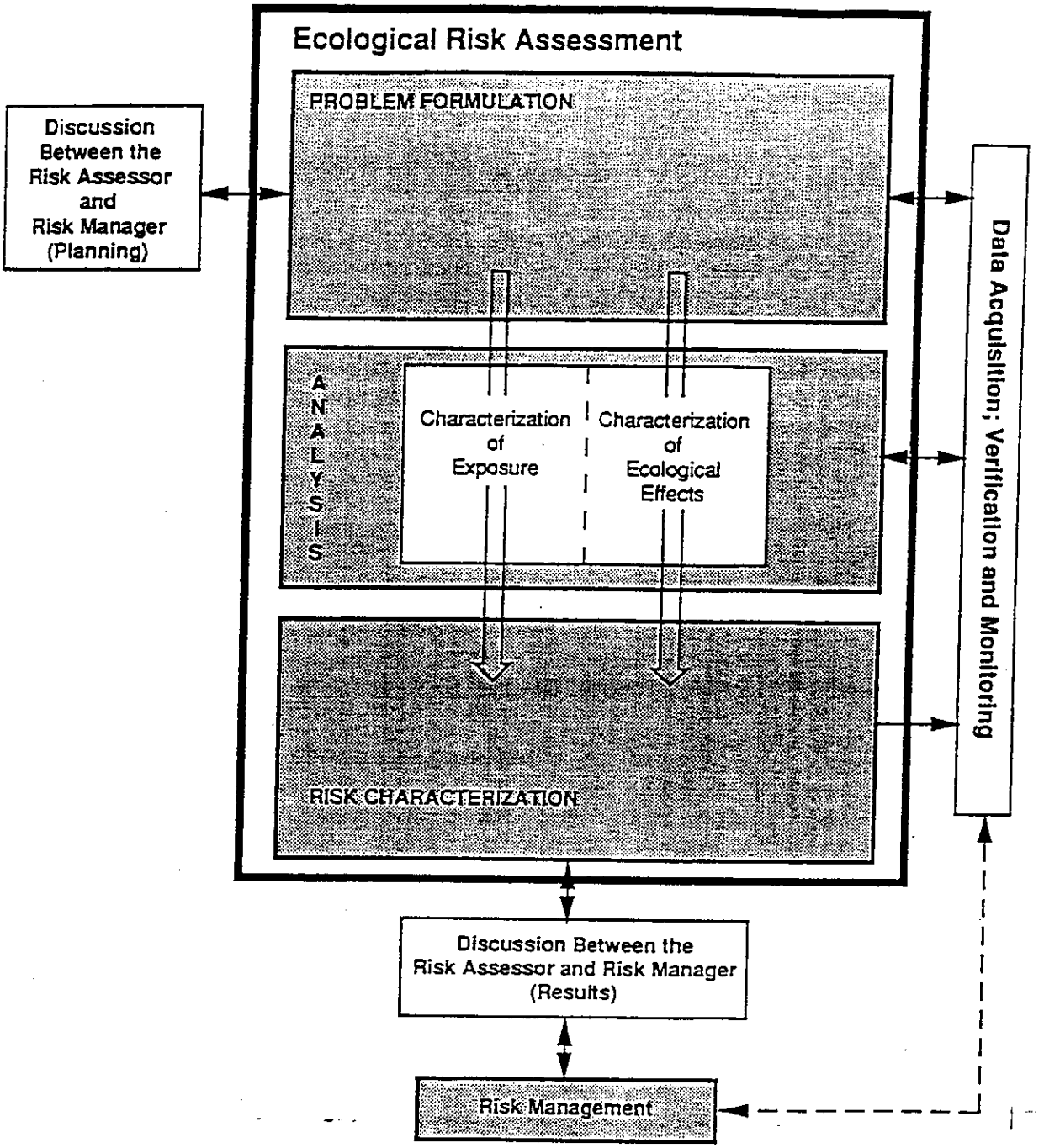

Figure 1-1. A step approach to SLERA.

1.2.1 Problem Formulation

The goal of the problem formulation of the ERA is to investigate the interactions between the stressor characteristics, the ecosystem potentially at risk, and the ecological effects (EPA 1992a). This process begins with a general description of the site and a characterization of the ecosystem at risk. Next, the potential stressors to the ecosystem are identified, the migration pathways of the identified stressors are modeled, and the potentially affected components of the ecosystem are identified. The ecosystem at risk and stressor characterization with exposure pathways are then assimilated into the conceptual site model. The problem formulation phase results in characterization of stressors (i.e., identification of contaminants), definition of the assessment endpoints, and ecological effects used to analyze risk using the ecological conceptual site model.

1.2.2 Screening Analysis

In the screening analysis step, the likelihood and significance of an adverse reaction from exposure to the stressor(s) was evaluated. A quantitative analysis was used, augmented by qualitative information and judgement as necessary.

Exposure to contaminants and potential effects of this exposure are evaluated as part of the screening analysis. These activities were conducted interactively to ensure that the methods used to evaluate exposure and effects were compatible.

Determining if exposure to site-related contaminants may increase the incidence of adverse effects in exposed populations is important in the SLERA process. The objective of this task is to estimate the magnitude, frequency, duration, and route of exposure to site-related contaminants by ecological receptors. Environmental fate properties are important because they provide information on the environmental behavior of contaminant compounds throughout various environmental media. The behavior and fate of the contaminants in the terrestrial environment was presented in a general manner as no formal transport and fate modeling was conducted for this SLERA.

Ecologically based screening levels (EBSLs) for contaminants in media identified at WAG 9 and other WAGs at the INEL were developed and used in the screening process. EBSLs are defined as ecologically based target concentrations of contaminants in soil derived from site-specific exposure scenarios for relevant ecological receptors.

The ecological effects assessment consisted of hazard evaluation, and dose-response assessment. The hazard evaluation involved a comprehensive review of toxicity data for contaminants to identify the nature and severity of toxic properties. Dose-response assessment allows prediction of the amount of chemical exposure that may result in adverse ecological effects. Because no dose-based toxicological criteria exist for ecological receptors, it was necessary to develop appropriate toxicity reference values (TRVs) for the contaminants and functional groups at the INEL. These TRVs were then used in the development of the EBSLs.

1.2.3 Screening Level Evaluation

The screening level evaluation step has two primary elements (EPA 1992a). The first is the development of an indicator of potential ecological risk [screening level quotient, (SLQ)]. The second is the presentation of the assessment results in a form that serves as input to the risk management process.

To determine whether there is any indication of risk due to the contaminant concentrations, exposure parameters were used to calculate EBSLs for the key functional groups as presented in Section 3. SLQs were calculated by dividing the average concentration of contaminant in the medium of interest by the EBSL.

SLQs were summarized for all WAG 9 contaminants. Where the average concentration of a contaminant in soil did not exceed its minimum EBSL (i.e., SLQs are less than target value), adverse effects from receptor exposure to that contaminant are not expected, and no further evaluation of that contaminant is required. Since EBSLs are based on levels at which an indication of effects to a species are apparent (i.e., TRVs), the SLQ is used as an indicator of effects, and indirectly risk.

1.2.4 Data Gap Identification and Strategy for Resolution

The identification of data gaps is a primary objective of the SLERA process. Data deficiencies identified in the screening assessment can be divided into two basic categories: (1) specific sites and/or contaminants that were not evaluated in previous characterization efforts (Track 1 and Track 2) and (2) insufficient ecological or toxicological data to support a screening assessment.

1.2.5 Transition From SLERA to ERA

The primary goals of a SLERA are to (1) identify potential sites and contaminants of concern and (2) identify those ecological receptors having highest potential for suffering adverse affects as a result of exposure to those sites/contaminants. Very conservative assumptions are applied in conducting SLERAs to ensure that no potential for ecological risks are over looked while still reducing the list of potential contaminants of concern by eliminating those that pose "no" or "low" likelihood for risk. Subsequent analyses will be focused on those contaminants and sites shown to be potential contributors to ecological risk. More detailed analyses using existing SLERA data, site-specific biological factors (BAFs, PUFs, TRVs), and more complete analytical data will be conducted for any further screenings and the ERA, resulting in less conservative, more realistic risk estimate values. Finally, during the RI/FS process, remedial actions and alternatives will be analyzed based on the results of the ERA or other screening. Management decisions regarding ecological risk can then be formulated.

1.3 Statutory/Regulatory Basis

The widespread application of ERAs to hazardous waste site investigations under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) began only recently. In December 1988, the EPA directed that "thorough and consistent" ecological assessments should be performed at all Superfund sites (EPA 1988). This directive was based on the language in CERCLA [as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and other statutes] mandating remediation of hazardous waste sites to protect the environment as well as human health. The National Contingency Plan

(NCP) requires that baseline risk assessments characterize the current and potential threats to human health and the environment [40 CFR Part 300.430 (d)(4)], and specifies that environmental risk evaluations "assess threats to the environment, especially sensitive habitats and critical habitats of species protected under the Endangered Species Act" [40 CFR Part 300.430(e)(2)(i)(G)].

Section 121(d)(A) of CERCLA requires that Superfund remedial actions meet Federal and State standards, requirements, criteria, or limitations that "are applicable or relevant and appropriate requirements (ARARs)." ARARs are those substantive environmental protection requirements promulgated under Federal or State laws that, while not legally applicable to the circumstances at the site or facility, address situations sufficiently similar so that their use is well suited to the particular site. ARARs applicable to the WAG 9 SLERA are listed in Table 1-1. A further discussion of ARARs is included in the Guidance Manual (VanHorn et al. 1995).

Compliance with ARARS is a threshold requirement that a remedial/restoration activity must meet to be eligible for selection as a remedy. ARARs are either contaminant-, action-, or location-specific, depending upon whether the requirement is triggered by the presence or emission of a chemical, by a particular action, or by a vulnerable or protected location. The following is a list of the definitions of these ARARs.

- Contaminant-specific – Risk-based numerical values or methodologies that establish an acceptable amount of concentration of a contaminant in the ambient environment
- Action-specific – Technology or activity-based requirements for remedial/restoration actions
- Location-specific – Restrictions placed upon the concentration of hazardous substances or the conduct of activity at a given location.

Only location-specific ARARs are applicable in the WAG 9 SLERA.

This SLERA addresses issues related to all ARARs listed for WAG 9 in Table 1-1 except the Wetlands Conservation Act. Threatened, endangered, or sensitive species as protected by ARARs are discussed in Section 2.3.1.3. Wetlands could be of concern at WAG 9 if any remedial action or development is proposed in the future and may need to be addressed at that time.

Table 1-1. ARARs for the WAG 9 SLERA.

Requirement	Authority	Trigger
Endangered Species Act	16 USC 1531–1543	Location specific
Threatened Fish and Wildlife	50 CFR 227.4	Location specific
Migratory Bird Conservation	16 USC 715	Location specific
Migratory Bird Treaty Act	16 USC 702	Location specific
Protection of Bald and Golden Eagles Act	16 USC 1531	Location specific
Idaho Fish and Wildlife Act	16 USC 756, 757	Location specific
Wetlands Conservation Act	16 USC 4404	Location specific

2. PROBLEM FORMULATION

The goal of the problem formulation of the ERA is to investigate the interactions between the stressor characteristics, the ecosystem potentially at risk, and the ecological effects (EPA 1992a). This process begins with a general description of the site and a characterization of the ecosystem at risk. Next, the potential stressors to the ecosystem are identified, the migration pathways of the identified stressors are modeled, and the potentially affected components of the ecosystem are identified. The ecosystem at risk and stressor characterization with exposure pathways are then assimilated into the ecological conceptual site model. The problem formulation phase results in characterization of stressors (i.e., identification of the COPCs), the assessment endpoints, and the ecological effects that will be used to analyze risk using the ecological conceptual site model.

2.1 WAG 9 Description

This section provides an overview of WAG 9 and presents the sites of concern.

2.1.1 Overview of WAG 9

WAG 9 includes hazardous waste release sites at the Argonne National Laboratory-West (ANL-W). The ANL-W facility is located in the extreme southeastern portion of the INEL as shown in Figure 2-1. The Argonne Research Area (ARA) consists of seven major complexes: Experimental Breeder Reactor II (EBR-II), the Transient Reactor Test Facility (TREAT), the Zero Power Physics Reactor (ZPPR), the Hot Fuel Examination Facility (HFEF), the Fuel Cycle Facility (FCF), the Fuel Manufacturing Facility (FMF), the Laboratory and Office Building, and support complexes such as the Radioactive Liquid Waste Treatment Facility (RLWTF), the Radioactive Scrap and Waste Facility (RSWF), and the Sodium Process Facility (SPF). The primary mission of ANL-W for the first 20 years of operation was the basic support of the research and development for liquid metal-cooled reactors. The current mission is to prove an electro-refining process, which would melt down waste and prepare it for burial.

WAG 9 is divided into 4 OUs consisting of 37 potential release sites. Summary assessments and Track 1 investigations have recommended no further action for several of these sites. Approximately 30 percent of these are currently being investigated and include numerous spills, an industrial waste pond, ditches, and drains. Possible COPCs include organic compounds, radionuclides, heavy metals (e.g. silver), and mixed wastes. Table 2-1 briefly describes the sites within each OU and summarizes the FFA/CO level of action. Table 2-1 also includes the justification for eliminating certain sites from consideration. Appendix A contains a more complete description of each site.

Radioactive wastes generated from ANL-W are primarily associated with irradiated experimental fuel subassemblies and capsules from EBR-II and, to a lesser degree, TREAT. After irradiation in ANL-W reactors, the subassemblies and capsules were conveyed to appropriate facilities for dismantling, sampling, and examination. If they were not contaminated with sodium (the coolant used in EBR-II), these reactor pieces and parts were shipped to the RWMC as remote-handled waste. Sodium-contaminated reactor parts were stored in the RSWF at ANL-W.

Idaho National Engineering Laboratory

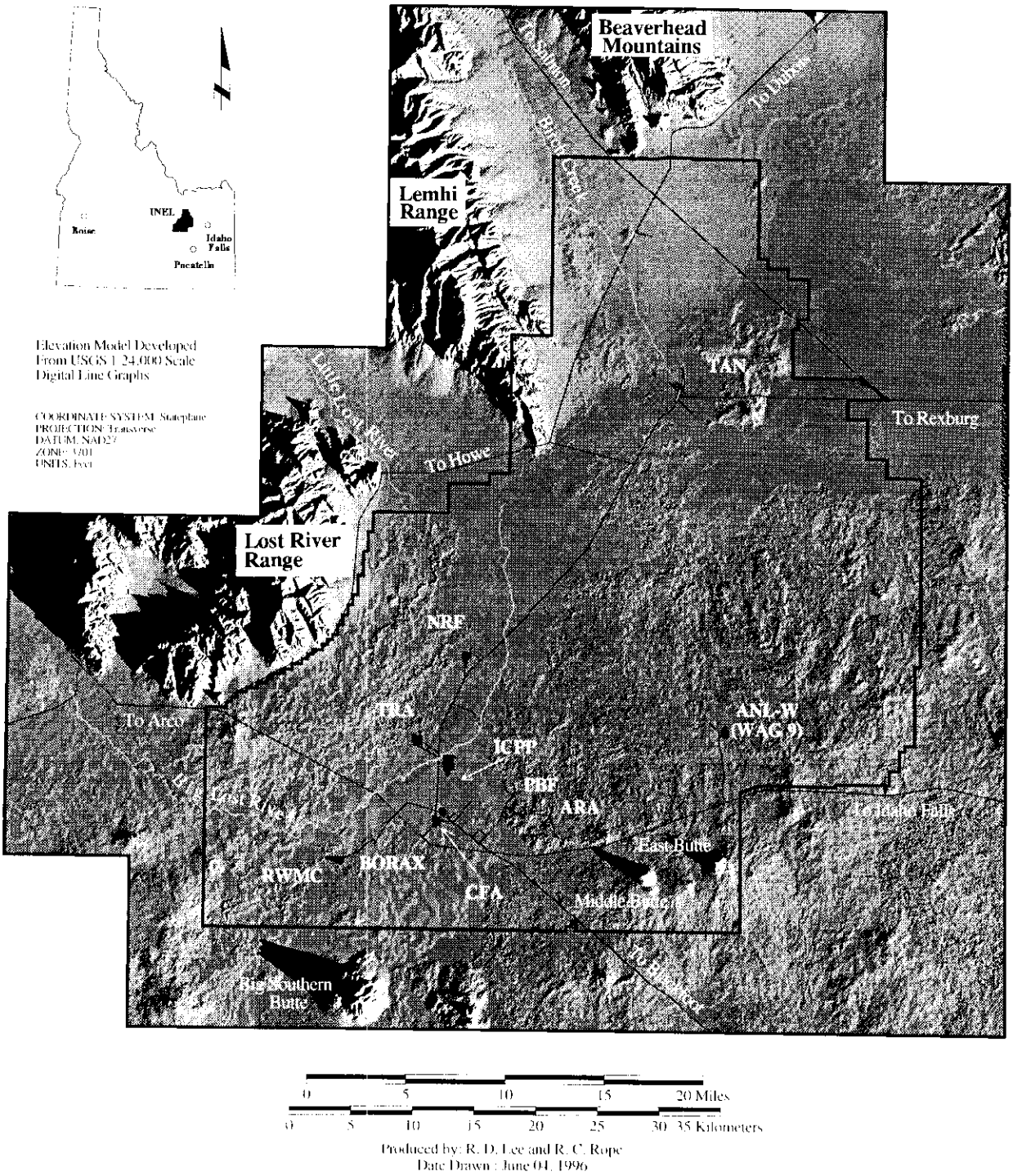

Figure 2-1. Location of WAG 9 and INEL

Table 2-1. WAG 9 operable unit and site descriptions.

OU	Site code	Sites description	Track	In	Justification
—	ANL-10	Dry Well between T-1 and ZPPR Mound	NFA		No hazardous constituents were disposed into this system. No source.
—	ANL-11	Waste Retention Tank 783	NFA		No hazardous constituents were disposed into the tank. No source.
—	ANL-12	Suspect Waste Retention Tank by 793	NFA		Site was decontaminated in 1979 and tank was removed. No source.
—	ANL-14	Septic Tank and Drain Fields (2) by 753	NFA		Site was decontaminated in 1979 and tank was removed. No source.
—	ANL-15	Dry Well by 768	NFA		Trace quantities of hydrazine disposed in drywell. Would have acted as an oxygen scavenger and been consumed. No source.
—	ANL-16	Dry Well by 759	NFA		Trace quantities of hydrazine disposed in drywell. Would have acted as an oxygen scavenger and been consumed. No source.
—	ANL-17	Dry Well by 720	NFA		No hazardous constituents were ever disposed into this system. No source.
—	ANL-18	Septic Tank and Drain Field by 789	NFA		This site contained sanitary wastes only. It was removed in 1979. No source.
—	ANL-20	Septic Tank and Leach Field by 793	NFA		This tank contained only sanitary wastes. No source.
—	ANL-21	TREAT Suspect Waste Tank and Leaching Field (Non-Rad)	NFA		This site was a non-radioactive collection tank, and no hazardous constituents were disposed into this system. No source.
—	ANL-22	TREAT Septic Tank and Leaching Field	NFA		No hazardous constituents were disposed into this system. No source.
—	ANL-23	TREAT Seepage Pit and Septic Tank W of 720	NFA		No hazardous constituents were disposed into this tank. It was filled with sand in 1980. No source.
—	ANL-24	Lab and Office Acid Neutralization Tank	NFA		No hazardous constituents were disposed into this tank. No source.
—	ANL-25	Interior Building Coffin Neutralization Tank	NFA		This above-ground tank was used to hold HNO_3 and NaOH for neutralization purposes. No source or pathway.
—	ANL-26	Critical Systems Maintenance Degreasing Unit	NFA		This active tank is self-contained within a building and serviced by a recycling company. There is no evidence of leakage. No pathway.
—	ANL-27	Plant Services Degreasing Unit	NFA		This active tank is self-contained within a building and serviced by a recycling company. There is no evidence of leakage. No source or pathway.
—	ANL-32	TREAT Control Building 721 Septic Tank and Leach Field	NFA		No hazardous constituents were ever disposed into this system. No source.
—	ANL-33	TREAT Control Building 721 Septic Tank and Seepage Pit (removed 1978)	NFA		No hazardous constituents were ever disposed into this system. No source.

Table 2-1. (continued).

OU	Site code	Sites description	Track	In	Justification
9-01	ANL-63	Septic Tank 789-A	T1		This system received sanitary effluent only. No source.
9-01	ANL-60	Knawa Butte Debris Pile	T1		Test excavations revealed only construction debris (concrete, dirt, rock, rebar). No source.
9-01	ANL-61	EBR-II Transformer Yard	T1		Site was cleaned. No source.
9-01	ANL-61A	PCB spill next to ANL-61		X	
9-01	ANL-62	Sodium Boiler Building (766) Hotwell	T1	X	
9-01	ANL-04	ANL Sewage Lagoons	T1	X	
9-01	ANL-19	Sludge Pit W of T-7 (Imhoff Tank)	T1		This site received sanitary wastes only. No known hazardous constituents were disposed in this tank. Tank was cut down 1 ft below grade in 1978 and filled with dirt. No source.
9-01	ANL-28	EBR-II Sump (regeneration)	T1		This sump was used to direct cooling tower blowdown regeneration effluent, ion exchange regeneration effluent, and small amounts of water laboratory chemicals. No source.
9-01	ANL-29	Industrial Waste Lift Station	T1	X	
9-01	ANL-30	Sanitary Waste Lift Station	T1		This concrete sump was 16 ft below grade. No pathway.
9-01	ANL-36	TREAT Photo Processing Discharge Ditch	T1	X	
9-02	ANL-08	EBR-II Leach Pit (radioactive)	T2		This site was excavated and concrete lid removed in 1993. Bottom was filled with bentonite and backfilled. No source. Sludges remain but below 10 feet. No pathway.
9-03	ANL-05	ANL Open Burn Pits #1, #2, #3	T2	X	
9-03	ANL-31	Industrial/Sanitary Waste Lift Station	T2		Chromium and radionuclides have been detected in one side of tank; however, site is a 6 ft × 6 ft × 14 ft deep reinforced concrete container. No pathway.
9-03	ANL-34	Fuel Oil Spill by Building 755	T2		Fifty gal of diesel fuel were spilled in early 1960s at this site. It is believed that PAHs have naturally degraded over the 30-year period since the spill. No source.
9-04	ANL-01	Industrial Waste Pond and Cooling Tower Blowdown Ditches (3)	RI/FS	X	
9-04	ANL-01A	Main Cooling Tower Blowdown Ditch Tank	RI/FS	X	
9-04	ANL-09	ANL Interceptor Canal	RI/FS	X	
9-04	ANL-35	Industrial Waste Lift Station Discharge Ditch	RI/FS	X	
9-04	ANL-53	Cooling Tower Riser Pits	RI/FS		Contamination below 10 feet. No pathway.

2.1.2 Sites of Concern

As discussed in the Guidance Manual (VanHorn et al. 1995) the sites identified in the FFA/CO (DOE 1991) are initially eliminated from consideration in the SLERA analysis based on whether the site is uncontaminated (no source to the environment) or because the site is unaccessible to the ecosystems of concern (no pathway to the environment). All sites at WAG 9 were reviewed for possible elimination from consideration in this SLERA. The final list of sites to be included in the analysis (sites of concern) are presented in Table 2-2. This list presents the COPCs identified at the site and the site area. Figure 2-2 illustrates the location of individual sites with relation to the ANL-W.

2.2 Previous Investigations

This section presents a review of relevant previous investigations performed at the INEL and locally which help identify receptors and the ecology of WAG 9 to be discussed in the WAG 9 SLERA.

Ecological research at the INEL has been conducted since the 1950s. The Radioecology and Ecology Program at the Radiological and Environmental Sciences Laboratory (RESL) [programs recently transferred to the Environmental Science and Research Foundation (the Foundation) in Idaho Falls, ID] performed extensive research in terrestrial ecology and radioecology on the INEL, resulting in over 300 publications (Morris 1994). The Foundation serves as the point of contact between DOE-Idaho Operations Office (ID) and the U.S. Fish and Wildlife Service (USWS) for issues regarding threatened or endangered species on the INEL. Other organizations participating in research include; the Lockheed Martin Idaho Technologies (LMIT) Environmental Assessment Technologies Group, and various universities such as Idaho State University, Colorado State University, and Washington State University. This research has resulted in data that can be used in all three steps of the SLERA process and later ERAs. Reviewing this research provides insight into existing data as well as identifies areas in which data are lacking. The INEL ecological investigations were reviewed and summarized for the INEL WAG-wide SLERAs (VanHorn et al. 1995). Table 2-3 lists the investigations that are most applicable to the INEL SLERA process. Table 2-3 identifies the applicability to the problem formulation, screening analysis, and/or screening level evaluation steps of the SLERA, the study area, topic species, and contaminants addressed (if the study was contaminant related). Appendix B provides summaries of the studies applicable to WAG 9.

Small mammals, avifauna, and vegetation comprise the majority of INEL ecological research subjects. Vegetation has been studied primarily across the INEL and few studies specifically relate to the WAG 9 area. Most of the investigations have focused on the facilities located in the south and southwestern portion of the INEL.

Surveys of INEL vertebrate fauna were conducted in 1984 (Arthur et al.1984) and in 1986 (Reynolds et al. 1986) and provide information on the abundance, occurrence, and distribution of INEL vertebrate fauna. It is noted that most of these surveys do not provide quantitative data on fauna populations. Some studies have been conducted regarding population of specific species, but are largely outdated and not useful in the WAG 9 SLERA.

Studies of large mammals that have been found applicable to the WAG 9 SLERA concern coyote (*Canis latrans*) and pronghorn (*Antilocapra americana*) (e.g., Johnson and Hansen 1979a, 1979b;

Table 2-2. WAG 9 Operable units and sites of concern.

OU	Site code	Sites description	Site (m^2)	COPCs	Contaminated media	Comments
9-01	ANL-61A	PCB spill next to ANL-61	19	PCBs	Subsurface soil	PCB spill.
9-01	ANL-62	Sodium Boiler Building (766) Hotwell	675	Tritium, hydrazine	Surface and subsurface soil	Tritium levels 10^5 µCi/mL. No evidence of migration.
*9-01	ANL-04	ANL Sewage Lagoons	7,200	Metals, radionuclides	Sediment	Received sanitary waste, photoprocessing solutions, silver. 1974 leak - 10^6 gallons. Now evaporative ponds.
9-01	ANL-29	Industrial Waste Lift Station	9	Silver	Surface and subsurface soil	EP Toxicity Test detected silver at < 1 ppm.
9-01	ANL-36	TREAT Photo Processing Discharge Ditch	243	Silver	Surface and subsurface soil	Currently houses active photo processing system
*9-03	ANL-05	ANL Open Burn Pits #1, #2, #3	10,890	Metals, radionuclides, VOCs, PAHs, and dioxin/furans	Surface and subsurface soil	Pits operated from 1960–1970
*9-04	ANL-01	Industrial Waste Pond and Cooling Tower Blowdown Ditches (3)	12,140	Metals, radionuclides, VOCs, and herbicides	Surface and subsurface soil, sediment, surface water	Only chromium and lead exceed the EP Toxicity levels. Two ditches still in operation
*9-04	ANL-01A	Main Cooling Tower Blowdown Ditch	288	Metals, radionuclides, and semivolatile organic compounds	Surface and subsurface soil	Only chromium and silver exceed TCLP limits
*9-04	ANL-09	ANL Interceptor Canal	3,848	Metals and radionuclides	Surface and subsurface soil	Received ion exchange column regeneration products, except for inadvertent rad waste discharges
*9-04	ANL-35	Industrial Waste Lift Station Discharge Ditch	900	Metals, radionuclides, VOCs, and dioxin/furans	Surface and subsurface soil, surface water	Only silver exceeds EP Toxicity levels. Soil was excavated in 1988

*These sites will be included in the WAG 9 Comprehensive Remedial Investigation/Feasibility Study.

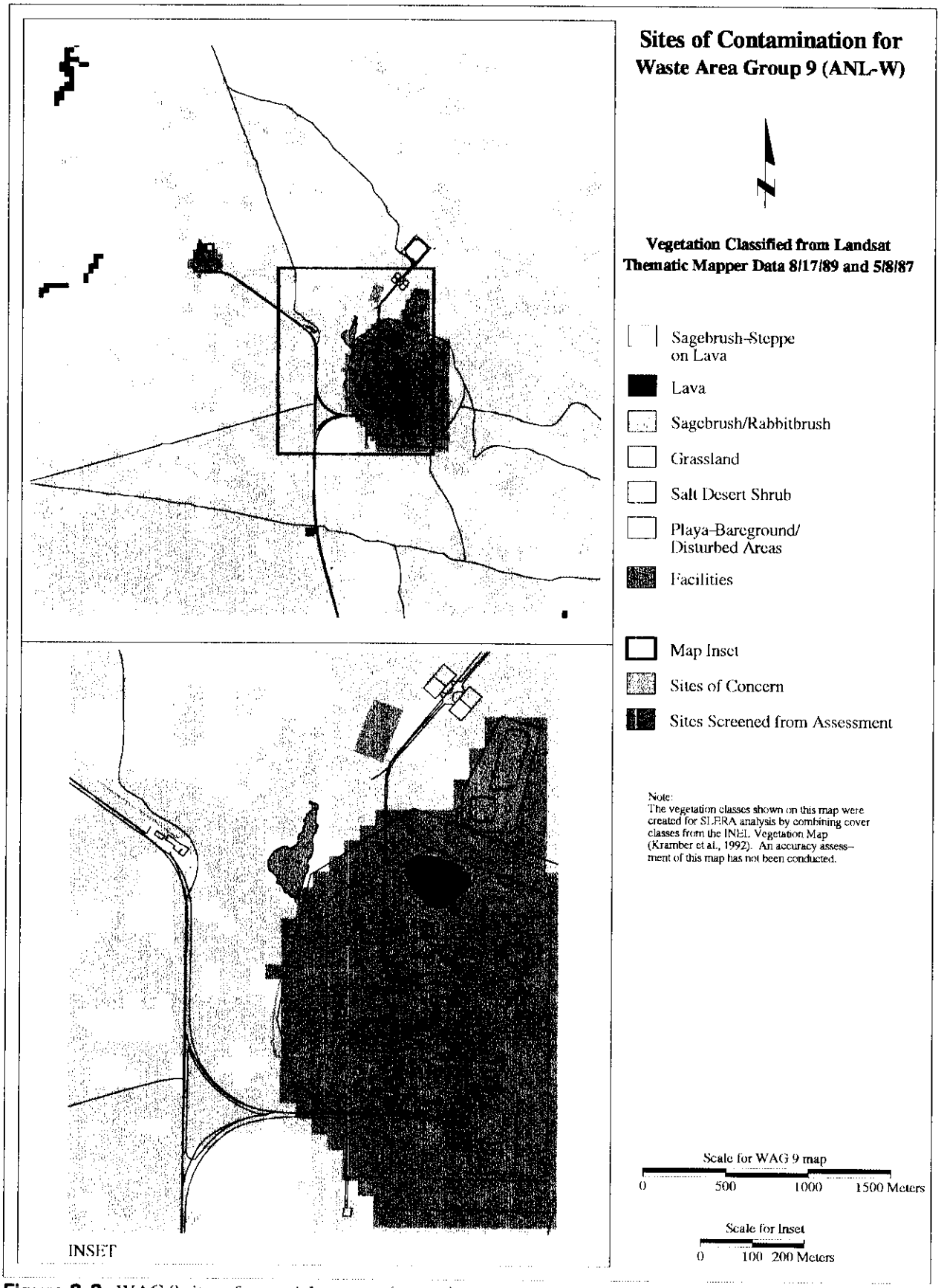

Figure 2-2. WAG 9 sites of potential concern (orange).

Table 2-3. Previous investigations applicable to the WAG 9 SLERA.

Reference	Applicability: Problem Formulation	Applicability: Analysis	Applicability: Risk Characterization	Study Area	Topic Species	Contaminants Addressed	Data Reported: Habitat	Data Reported: Diet	Data Reported: Susceptibility to Contaminant	Data Reported: Biological Response	Data Reported: Tissue Concentration
Anderson, 1991	X	X		INEL	Vegetation Wildlife Soil						
Arthur, Connelly, Halford, and Reynolds 1984	X			INEL	Vertebrate survey		X				
Connelly, 1982	X	X	X	INEL	Sage grouse	Radionuclides	Terrestrial/ Aquatic	X	X	X	X(?)
Connelly and Markham, 1983	X	X	X	TRA, ICPP, RWMC, CFA	Sage grouse	Radionuclides	Terrestrial/ Aquatic			X(?)	X(?)
Craig, Halford, and Markham, 1979	X	X	X	TRA, ICPP	Raptors	Radionuclides	Air/ Terrestrial				
Craig, Craig, and Powers, 1985		X		INEL	Long-eared owl		Air	X			
Energy Research and Development Administration, 1977	X			ANL	General		Terrestrial				
Evenson, 1981		X	X	INEL	Deer mouse	Radionuclides	Terrestrial		X(?)	X	X(?)
Filipovich, 1983	X			ARA	Deer mouse Great Basin pocket mouse Least chipmunk Montane vole Ord's kangaroo rat Western harvest mouse Northern grasshopper mouse Sagebrush vole		Terrestrial	X			
Halford, Millard, and Markham, 1981	X	X		TRA	Duck Geese Swan American coot	Radionuclides	Aquatic				X

Table 2-3. (continued).

Reference	Applicability: Problem Formulation	Applicability: Analysis	Applicability: Risk Characterization	Study Area	Topic Species	Contaminants Addressed	Data Reported: Habitat	Data Reported: Diet	Data Reported: Susceptibility to Contaminant	Data Reported: Biological Response	Data Reported: Tissue Concentration
Halford, Markham, and Dickson, 1982	X	X		TRA	Green-winged teal Mallard Northern pintail Lesser scaup Common goldeneye Bufflehead American coot		Aquatic/ Air	X		Dose	
Halford, Markham, and White 1983	X	X		TRA	Wing-clipped mallards	Cs-134 I-131 Cs-137 Ba-140 Se-75 Co-58 Zn-66 Co-67 Cr-51	Liquid radioactive waste pond			X	X
Halford and Millard, 1978	X			TRA	Vertebrate fauna		Leaching pond (Aquatic)				
Howe and Flake, 1989	X	X		INEL	Mourning dove		Aquatic/ Air				
Ibrahim and Culp, 1989	X	X		TRA	Net plankton Suspended particulates Sediment	Pu-239 Pu-240 Pu-238	Aquatic				
Johnson, 1979	X			INEL	Rabbits Black-tailed jackrabbit Pronghorn antelope Sheep Cattle		Terrestrial	X			
Johnson and Hansen, 1979a	X			INEL	Coyote		Terrestrial	X			
Johnson and Hansen, 1979b	X			INEL	Cottontail Woodrat		Terrestrial	X			

Table 2-3. (continued).

Reference	Applicability: Problem Formulation	Applicability: Analysis	Applicability: Risk Characterization	Study Area	Topic Species	Contaminants Addressed	Data Reported: Habitat	Data Reported: Diet	Data Reported: Susceptibility to Contaminant	Data Reported: Biological Response	Data Reported: Tissue Concentration
Johnson and Hansen, 1979c	X			INEL	Coyote		Terrestrial	X			
Kramber et al. 1992	X	X		INEL	Vegetation						
Koehler and Anderson, 1991	X			RWMC/ SDA	Deer mouse Montane vole Ord's kangaroo rat Townsend's ground squirrel		Terrestrial				
Kuzo, Fraley, Whicker, and Markham, 1987	X	X		TRA	Sediment Seston Periphyton	Pu-238 Pu-239,240 Am-241 Cm-242 Cm-244	Aquatic				
Markham, 1974	X	X		INEL		Radionuclides Environmental	Terrestrial				
Markham, Halford, Rope, and Kuzo, 1988		X		TRA	Mallard	Plutonium Americium Cm Strontium	Aquatic/ Air				
Markham and Halford, 1982	X	X	X	TRA, ARA, EBR-II, ICPP, LOFT, NRF, RWMC	Mourning dove	Radionuclides	Terrestrial/ Aquatic		X	X	X
Markham and Trost, 1986	X	X		INEL	Mourning dove		Terrestrial/ Air	X			
McBride, French, Dahl, and Detmer, 1978	X	X		INEL	Vegetation						
Millard, Whicker, and Markham, 1990	X	X	X	TRA	Barn swallow	Radionuclides	Elevated nesting (?)			Growth rate	
Olson, Jeppesen, and Lee 1995	X	X		INEL	Soils						
Parmenter, 1985	X	X		—	Coyotes	H-3 Water Na-22	Terrestrial	X		X	
Petersen and Best 1986	X			INEL	Sage sparrow Brewer's sparrow		Terrestrial/ Air	X			

Table 2-3. (continued).

Reference	Applicability			Study Area	Topic Species	Contaminants Addressed	Data Reported				
	Problem Formulation	Analysis	Risk Characterization				Habitat	Diet	Susceptibility to Contaminant	Biological Response	Tissue Concentration
Reynolds, Connelly, Halford, and Arthur, 1986	X			INEL	Vertebrate survey	None	Terrestrial Aquatic				
Rope, Arthur, Craig, and Craig, 1988	X			INEL, ICPP	Big sagebrush Bluegrass/ Muttongrass Bottlebrush grass Soil	Nutrients Trace Elements	Terrestrial				X

Markham et al. 1976, and 1980; Arthur and Gates 1988). Research on small mammals, as applicable to the WAG 9 SLERA, include small animal surveys (ERDA 1977) and studies of deer mice (*Peromyscus maniculatus*), black-tailed jackrabbit (*Lepus californicus)*, and Ord's kangaroo rat (*Dipodomys ordii*) (e.g., Arthur and Gates 1988; Johnson 1979) to determine doses and behavior as related to translocating contaminants.

Avifauna have been the topic of a large number of studies at the INEL. Few of these, only the ecological characterization conducted as part of the SAERF siting review, specifically relates to presence and abundance of avifauna at ANL-W. Additional studies have been conducted on sage grouse (*Centrocercus urophasianus*) and mourning doves (*Zenaida macroura*) (e.g., Markham and Trost 1986; Markham and Halford 1982; Connelly 1982). Potential doses to raptors nesting near nuclear facilities have also been studied (Craig et al. 1979), however this study was conducted near the Idaho Chemical Processing Plant (ICPP) and Test Reactor Area (TRA) and may not be applicable to the WAG 9 study area. In addition to these published studies, data from breeding bird and winter raptor surveys, which provide information on the occurrence, abundance, and habitat of avifauna across the INEL, are available from the Environmental Science and Research Foundation.

Invertebrate studies at the INEL are few and quite specific. Harvester ants (*Pogonomyrmex salinus*) have received recent attention because of their nest building behavior. As the ants excavate soil to build their nests, there is concern whether they translocate contaminants (Reynolds 1991). Information is reported about the occurrence or abundance of invertebrates in the WAG 9 assessment area.

Vegetation has been studied on the INEL and has resulted in classification and mapping of vegetation communities. McBride et al. (1978) is a frequently cited study regarding INEL vegetation, but more recent vegetation classification work has been conducted by Anderson et al. (1991) and Kramber et al. (1992). Anderson collected vegetation data specific to the New Production Reactor (NPR) area, west of the ANL-W, for the NPR Environmental Impact Statement (EIS). Vegetation surveys were also conducted for sagebrush associations within the WAG 9 assessment area as part of the SREF EIS (ERDA 1977). Vegetation across the INEL has been mapped using LANDSAT imagery data (Kramber et al. 1992). Additional vegetation studies focus on sagebrush species (*Artemisia* spp.), squirreltail bottlebrush grass (*Elymus elymoides*), Basin wildrye (*Leymus cinereus*), and wheatgrass (*Agropyron* spp.) and the relation to translocation or tissue concentrations of contaminants (e.g., Millard et al. 1983; Rope et al. 1988).

Studies specific to the TRA, approximately 20 miles west of WAG 9, are those on plankton uptake of radionuclides in radioactive liquid waste disposal ponds. Ibrahim and Culp (1989) and Kuzo et al. (1984) reported the concentrations and distribution of radionuclides in pond plankton and seston. Aside from these studies, little work has been published specifically on aquatic flora or microfauna at WAG 9.

Other studies of interest for the WAG 9 SLERA are those conducted on soils of the INEL. Olson et al. (1993 have coarsely mapped soils across the INEL, and other soil studies have been done as part of other vegetation or wildlife research (e.g., Rope et al. 1988). Studies have been conducted near ANL-W to characterize several soil types as part of the SREF EIS. A number of studies have been conducted at the Radioactive Waste Management Complex (RWMC).

In summary, considerable ecological research has been conducted at the INEL. This research has contributed to understanding flora and fauna interactions as related to INEL activities and operations; however, many areas exist where more research is needed. Little is known about the invertebrate populations at the INEL or about the relationships between INEL flora and fauna. And while much of INEL ecological research is represented here, it is not a comprehensive list. Efforts beyond the scope of the SLERA process are needed to compile an inventory of the data available regarding INEL flora and fauna.

2.3 Ecosystem Characterization

The INEL is located in a cool desert ecosystem characterized by shrub-steppe vegetation typical of the northern Great Basin and Columbia Plateau region. The surface of the INEL is relatively flat, with several prominent volcanic buttes and numerous basalt flows that provide important habitat for small and large mammals, reptiles, and raptors. The shrub-steppe communities are dominated by sagebrush and provide habitat for sagebrush community species, such as sage grouse, pronghorn, and sage sparrows (*Amphispiza belli*). Rabbitbrush (*Chrysothamnus* spp.), grasses and forbs, salt desert shrubs, and exotic weedy species comprise other communities. Juniper woodlands occur near the buttes and in the northwest portion of the INEL; these woodlands provide important habitat for raptors and large mammals. Limited riparian communities exist along intermittently flowing waters of the Big Lost River and Birch Creek drainages.

The area addressed by the WAG 9 ANL-W SLERA is shown on Figure 2-3 (in red). The assessment area is circular, centered between TREAT and the main facility complex, and encompasses approximately 688 hectares. The dimensions of the assessment area for WAG 9 were determined using soil contaminant sampling data and gamma detection data from aerial fly-overs (Jessmore et al. 1994). The maximum distance from WAG 9 contaminant sources for which above-background contaminant levels were detected was approximately 982 m (3,222 ft) (Jessmore et al. 1994). An ecological effects buffer of 491 m (1,611 ft) (or 1/2 the source to background distance) was added to ensure calculation of maximum exposures for species whose home ranges overlap areas of above and below background contaminant levels.

Figure 2-3 also illustrates vegetation communities and soil types associated with the assessment area. These components are discussed in detail in the following sections.

2.3.1 Biotic Components

Characterizing the landscape within the WAG 9 assessment area is important for the SLERA since the vegetation types and constructed structures present support various members of the wildlife communities that may exist within the assessment area. For instance, sagebrush-steppe habitat supports a number of species including sage grouse, pronghorn, elk (*Cervus elaphus*), and waterfowl (all important game species); grasslands provide habitat for species such as the western meadowlark (*Sturnella neglecta*) and mule deer (also a game species); wetlands, such as disposal ponds, provide habitats for many avifauna species; and rock outcroppings support species such as bats, woodrats, and T/E species such as the pygmy rabbit (*Brachylagus idahoensis*). Facilities within the WAG 9 assessment area also provide important habitat. Buildings, lawns, ornamental vegetation, and ponds are utilized by a number of species such as waterfowl, raptors, rabbits, and bats. No areas of critical habitat are known to exist within the WAG 9 assessment area. However, the industrial waste pond located northwest of the facility supports wetland species including bulrush (*Scirpus*

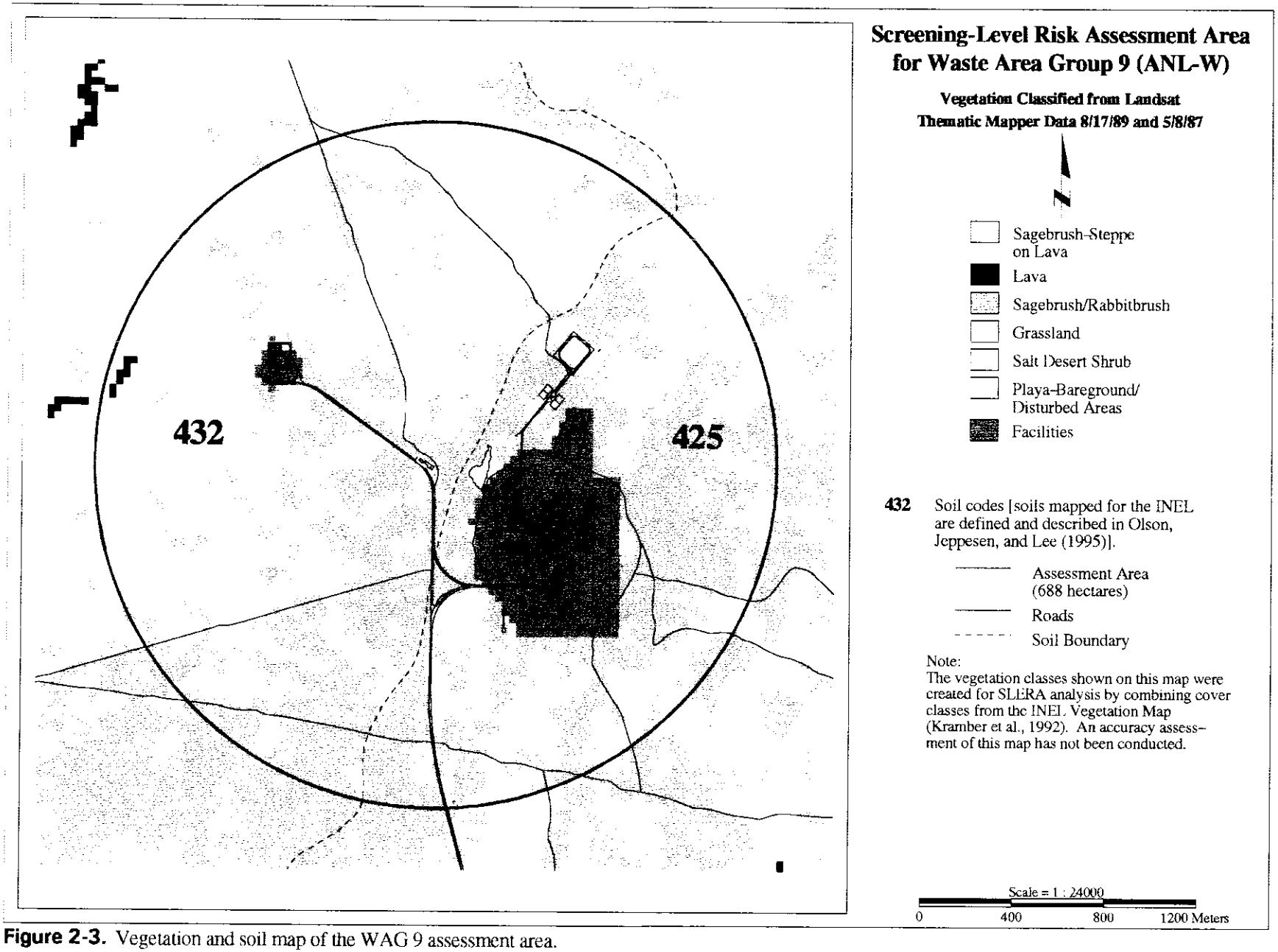

Figure 2-3. Vegetation and soil map of the WAG 9 assessment area.

acutus) and cattails (*Typha latifolia*) and has been mapped as part of the Fish and Wildlife Service (FWS) National Wetlands Inventory (NWI) (Hampton et al. 1995). A number of studies have been conducted citing waterfowl and other wildlife use of this area. A lava cave is located within one mile of the assessment boundary.

The flora and fauna existing in the WAG 9 assessment area are representative of those found across the INEL and are described in the following sections. Vegetation was quantitatively assessed for associations within the WAG 9 assessment area as part of the siting survey for the Safety Research Experiment Facilities (SREF) EIS (ERDA 1977). More recently flora in the assessment area was characterized using a vegetation map constructed for the INEL from a combination of LANDSAT imagery and field measurements from vegetation plots (Kramber et al. 1992). Fauna potentially existing within the assessment area was identified primarily from a 1986 vertebrate survey performed on the INEL (Reynolds et al. 1986) and from data collected as part of the 1977 EIS for the SREF (ERDA 1977). Information presented here is supported by previous field surveys and observations previously described in Section 2.2.

2.3.1.1 Flora. The 15 INEL vegetation cover classes defined using Landsat imagery data (Kramber et al. 1992) have been combined into eight cover classes for the WAG-wide SLERAs at the INEL (VanHorn et al. 1995). The vegetation mapped within the WAG 9 assessment area is shown in Figure 2-3. Five vegetation cover classes are represented at WAG 9, including sagebrush-steppe on lava, sagebrush/rabbitbrush, grassland, salt desert shrub, and playa-bareground/disturbed. The species composition for each of these classes is summarized on Table 2-4.

Sagebrush/rabbitbrush and sagebrush-steppe on lava are the predominant vegetation type comprising approximately 86% of the vegetation in the assessment area. The dominant vegetation species within this community are Wyoming big sagebrush (*Artemisia tridentata* spp. *wyomingensis*) and green rabbitbrush (*Chrysothamnus viscidiflorus*). Grasslands present in the assessment area are comprised primarily of wheat grasses (*Agropyron* spp.). Wetland species are supported by intermittent standing water from facility drainage and disposal ponds. Playa-bareground/disturbed areas cover classes represent approximately 3% of the WAG 9 assessment area vegetation cover. Table 2-5 summarizes the vegetative cover for the WAG 9 assessment area. Several of these vegetation associations have been quantitatively characterized through surveys conducted as part of the SREF site review (ERDA 1977).

Areas of facility ornamental vegetation are not represented on Figure 2-3; however, these ecologically important areas include lawns and deciduous trees and shrubs. Common bird species such as the American robin (*Turdus migratorus*) and house finch (*Carpodacus mexicanus*) and mammals including Nuttall's cottontail (*Sylvilagus nuttallii*) and the montane vole (*Microtus montanus*) utilize this vegetation. These areas also provide habitat for less common species such as the song sparrow (*Melospiza melodia*) and Bohemian waxwing (*Bombycilla garrulus*).

2.3.1.2 Fauna. A comprehensive list of fauna potentially present within the WAG 9 assessment area is presented on Table 2-6. The list incorporates the concept of functional grouping as described in the guidance manual (VanHorn et al. 1995) and was developed by updating 1986 data on the relative abundance, habitat use, and seasonal presence of fish, amphibians, reptiles, birds, and mammals recorded on the INEL (Reynolds et al. 1986) and communicating with INEL researchers and personnel conducting ecological studies since 1986. Fauna that are not supported by the existing habitat or that are rare or uncommon or

Table 2-4. Vegetation cover class summary for WAG 9 assessment area.

SLERA vegetation cover class	INEL vegetation cover classes	Dominant species
Grasslands	Steppe Basin Wildrye Grassland	*Leymus cinereus* *Descurainia sophia* *Sisymbrium altissimum* *Agropyron dasytachyum* *Artemisia tridentata* ssp. *wyomingensis* *Elymus elymoides* *Chrysothamnus viscidiflorus*
Sagebrush/rabbitbrush	Sagebrush-steppe off lava Sagebrush-winterfat Sagebrush-rabbitbrush	*Artemisia tridentata* ssp. *wyomingensis* *Chrysothamnus viscidiflorus* *Bromus tectorum* *Sisymbrium altissimum* *Oryzopsis hymenoides*
Salt desert shrubs	Salt Desert Shrub	*Atriplex nuttallii* *Atriplex canescens* *Atriplex confertifolia* *Ceratoides lanata*
Sagebrush-steppe on lava	Sagebrush-steppe on lava	*Artemisia tridentata* ssp. *wyomingensis* *Oryzopsis hymenoides* *Chrysothamnus viscidiflorus*
Playa-bareground/ disturbed areas	Playa-bareground/gravel borrow pits old fields, disturbed areas, seedings	*Kochia scoparia* *Salsola kali* *Artemisia tridentata* ssp. *wyomingensis* *Chrysothamnus viscidiflorus*

Table 2-5. WAG 9 vegetation cover classes and areas at the WAG 9 assessment area.

Vegetation cover class	Area (m^2)	Area (hectares)	Area (ft^2)	Percent cover (%)
Grassland	192,765	19	2,074,901	2.8
Sagebrush/Rabbitbrush	2,494,821	249	26,853,928	36.2
Salt Desert Shrub	56,700	6	610,311	<1
Sagebrush-Steppe on lava	3,443,523	344	37,065,636	50.0
Lava	8,924	1	96,060	<1
Playa-bareground/disturbed areas	179,087	18	1,927,670	2.6
Facilities	506,700	51	5,454,053	7.4
Totals	6,882,521	688	74,082,561	100.00

Table 2-6. Faunal functional groups potentially present within the WAG 9 assessment area.

Class	Functional group	Taxonomic name	Common name	Distribution/ status[a]	Abundance/ season/status[b]
Amphibia	A232	*Pseudacris triseriata*	Boreal chorus frog	w	R2
Aves	AV121	*Carduelis pinus*	Pine siskin	f, d	S5, M3
		Carduelis tristis	American goldfinch	d, ss	M5
		Coccothraustes vespertinus	Evening grosbeak	d	S5, M3
		Bombycilla cedrorum	Cedar waxwing	f, d	S5,M3,W5
Aves	AV122	*Passer domesticus*	House sparrow	f, d	B2, M1, W3
		Selasphorus rufus	Rufous hummingbird	d	S3, M3
		Zenaida macroura	Mourning dove	sw	B1, M3, W5
		Chondestes grammacus	Lark sparrow	sw	S3, M5
		Plectrophenax nivalis	Snow bunting	g, ss	W5
		Leucosticte arctoa	Rosy finch	ss	M5, W5
		Carpodacus mexicanus	House finch	f, d	S3, M3
		Perdix perdix	Gray partridge	g, ss, f	R3
		Alectoris chukar	Chukar	g, ss	R3
		Dendragapus obscurus	Blue grouse	f	S6
		Centrocercus urophasianus	Sage grouse	ss, g, f	R2
		Eremophila alpestris	Horned lark	g, ss	R2
		Junco hyemalis	Dark-eyed junco	sw	M3
		Columba livia	Rock dove	sw	R2
Aves	AV132	*Porzana carolina*	Sora	w, f	B5, M5
Aves	AV142	*Chen caerulescens*	Snow goose	w	M5
		Anas crecca	Green-winged teal	w	S5, M5
		Aythya americana	Redhead	w	S5, M5, W5
		Aythya collaris	Ring-necked duck	w	S5, M5
Aves	AV143	*Cygnus columbianus*	Tundra swan	w	M5
		Cygnus buccinator	Trumpeter swan	w	I6
		Branta canadensis	Canada goose	w	S3, M3
		Anas platyrhynchos	Mallard	w	B2, M2, W3
		Anas acuta	Northern pintail	w	S3, M3
		Anas discors	Blue-winged teal	w	B2, M3

Table 2-6. (continued).

Class	Functional group	Taxonomic name	Common name	Distribution/ status[a]	Abundance/ season/status[b]
		Anas cyanoptera	Cinnamon teal	w	S3, M3
		Anas clypeata	Northern shoveler	w	B3, M3
		Anas strepera	Gadwall	w	S3, M3
		Anas americana	American wigeon	w	S3, M3
		Aythya valisineria	Canvasback	w	B5, M5
Aves	AV210	*Childonias niger*	Black tern	w	S5, M5
		Contopus borealis	Olive-sided flycatcher	d	S5, M5
		Empidonax difficilis	Western flycatcher	d	S5
		Myiarchus cinerascens	Ash-throated flycatcher	d	S5
		Tyrannus verticalis	Western kingbird	f, d, j	B3, M3
		Tyrannus tyrannus	Eastern kingbird	f, d, j	B3, M3
		Tachycineta bicolor	Tree swallow	d, j	B3, M3
		Tachycineta thalassina	Violet-green swallow	d, j	B4, M4
		Myadestes townsendi	Townsend's solitaire	d	S5, M5
		Chordeiles minor	Common nighthawk	sw	B2, M3
		Aeronautes saxatalis	White-throated swift	d	S5
		Sayornis saya	Say's phoebe	ss, d, f, j	B3, M3
Aves	AV210A	*Stelgidopteryx serripennis*	Northern rough-winged swallow	d, j	B3, M3
		Riparia riparia	Bank swallow	d, j	B5, M3
		Hirundo pyrrhonota	Cliff swallow	d, j	B2, M2
		Hirundo rustica	Barn swallow	d, j	B2, M3
Aves	AV221	*Regulus calendula*	Ruby-crowned kinglet	d	M3, W6
		Sialia mexicana	Western bluebird	ss	S5, M5
		Bombycilla garrulus	Bohemian waxwing	f, d	S3, M2, W3
		Vireo gilvus	Warbling vireo	d	S5, M5
		Dendroica petechia	Yellow warbler	d	B5, M3
		Dendroica coronata	Yellow-rumped warbler	d	S3, M3
		Dendroica townsendi	Townsend's warbler	d	M5
		Geothlypis trichas	Common yellowthroat	d	S5
		Wilsonia pusilla	Wilson's warbler	d	S5, M5

Table 2-6. (continued).

Class	Functional group	Taxonomic name	Common name	Distribution/ status[a]	Abundance/ season/status[b]
		Icteria virens	Yellow-breasted chat	d	S5
		Piranga ludoviciana	Western tanager	d	S3, M3
		Pheucticus melanocephalus	Black-headed grosbeak	sw	S5, M5
		Icterus galbula	Northern oriole	d	S3, M3
		Picoides pubescens	Downy woodpecker	d	B5, M5
		Colaptes auratus	Northern flicker	d	B3, M3
Aves	AV222	*Larus pipixcan*	Franklin's gull	w, ss	S3, M3
		Larus californicus	California gull	w, ss	S5, M3
		Sturnus vulgaris	European starling	sw	R3
		Troglodytes aedon	House wren	d	R3
		Sialia currucoides	Mountain bluebird	ss	S3, M3
		Turdus migratorius	American robin	sw	B2, M2
		Oreoscoptes montanus	Sage thrasher	ss	B2, M2
		Passerina amoena	Lazuli bunting	d	S5, M5
		Spizella passerina	Chipping sparrow	f, d, ss	M5
		Spizella breweri	Brewer's sparrow	ss	B2, M2
		Amphispiza bilineata	Black-throated sparrow	ss	S5, M5
		Amphispiza belli	Sage sparrow	ss	B2, M2
		Passerculus sandwichensis	Savannah sparrow	d, g	S5, M3
		Zonotrichia leucophrys	White-crowned sparrow	ss	M4
		Sturnella neglecta	Western meadowlark	g, ss	B2, M2, W3
		Euphagus cyanocephalus	Brewer's blackbird	sw	B2, M2, W5
		Molothrus ater	Brown-headed cowbird	ss	B3, M3
		Charadrius vociferus	Killdeer	sw	B2, M2
		Anthus spinoletta	Water pipit	ss	M5
		Pipilo chlorurus	Green-tailed towhee	ss	S3, M3
		Pipilo erythrophthalmus	Rufous-sided towhee	sw	S3, M3
		Pooecetes gramineus	Vesper sparrow	g, ss	B3, M3

Table 2-6. (continued).

Class	Functional group	Taxonomic name	Common name	Distribution/ status[a]	Abundance/ season/status[b]
		Calamospiza melanocorys	Lark bunting	ss	S5, M5
		Melospiza melodia	Song sparrow	d	S5, M3
Aves	AV222A	*Salpinctes obsoletus*	Rock wren	ss	B3, M3
		Catherpes mexicanus	Canyon wren	ss	S5, M5
Aves	AV232	*Agelaius phoeniceus*	Red-winged blackbird	w, ss	B3, M3
		Xanthocephalus xanthocephalus	Yellow-headed blackbird	w, d	B4, M3
		Actitis macularia	Spotted sandpiper	w	S3, M3
		Calidris minutilla	Least sandpiper	w	S5, M5
Aves	AV233	*Tringa solitaria*	Solitary sandpiper	w	S5, M3
		Catoptrophorus semipalmatus	Willet	w, ss	S3, M3
		Numenius americanus	Long-billed curlew	w, ss	S3, M3
		Limosa fedoa	Marbled godwit	w	S3, M5
		Limnodromus scolopaceus	Long-billed dowitcher	w	M5
		Gallinago gallinago	Common snipe	w	S5, M5
		Plegadis chihi	White-faced ibis	w	S5, M5
Aves	AV241	*Aix sponsa*	Wood duck	w	S6, M5
		Phalaropus lobatus	Red-necked phalarope	w	M5
		Steganopus tricolor	Wilson's phalarope	w	S3, M3
Aves	AV242	*Aythya affinis*	Lesser scaup	w	S5, M3, W3
		Bucephala clangula	Common goldeneye	w	S5, M3, W3
		Bucephala islandica	Barrow's goldeneye	w	S6, M5
		Oxyura jamaicensis	Ruddy duck	w	B5, M3
		Tringa flavipes	Lesser yellowlegs	w	S5, M5
		Larus philadelphia	Bonaparte's gull	w	M5
		Bucephala albeola	Bufflehead	w	S5, M3
		Podilymbus podiceps	Pied-billed grebe	w	S5, M5
		Podiceps auritus	Horned grebe	w	M5
		Podiceps nigricollis	Eared grebe	w	B5, M3, W3

Table 2-6. (continued).

Class	Functional group	Taxonomic name	Common name	Distribution/ status[a]	Abundance/ season/status[b]
Aves	AV310	*Accipiter striatus*	Sharp-shinned hawk	sw	S5, M5, W5
		Accipiter cooperii	Cooper's hawk	sw	S3, M5, W5
		Accipiter gentilis	Northern goshawk	sw	S5, M5, W5
		Falco columbarius	Merlin	sw	R5
		Falco peregrinus	Peregrine falcon	sw	S5, M5, W5
		Falco mexicanus	Prairie falcon	sw	R3
Aves	AV322	*Nyctea scandiaca*	Snowy owl	sw	W5
		Haliaeetus leucocephalus	Bald eagle	sw	M5, W3
		Falco sparverius	American kestrel	sw	B2, M2, W3
		Circus cyaneus	Northern harrier	sw	R2
		Buteo swainsoni	Swainson's hawk	sw	B3, M3, W5
		Buteo jamaicensis	Red-tailed hawk	sw	B3, M3, W5
		Buteo regalis	Ferruginous hawk	sw	B3, M3, W5
		Lanius excubitor	Northern shrike	sw	M3, W5
		Lanius ludovicianus	Loggerhead shrike	ss	B3
		Bubo virginianus	Great horned owl	sw	R3
		Asio otus	Long-eared owl	d	B4, M4
		Asio flammeus	Short-eared owl	ss, g	B3, M3
		Aegolius acadicus	Northern saw-whet Owl	sw	S6, M6, W6
		Aquila chrysaetos	Golden eagle	sw	B3, M4, W2
		Cathartes aura	Turkey vulture	sw	S3, M3, W6
		Buteo lagopus	Rough-legged hawk	sw	S6, M2, W2
Aves	AV322A	*Athene cunicularia*	Burrowing owl	ss, g	B3, M3, W6
Aves	AV333	*Tringa melanoleuca*	Greater yellowlegs	w	M5
Aves	AV342	*Megac alcyon*	Belted kingfisher	w	S3, M3
		Pandion haliaetus	Osprey	w	M5
		Sterna caspia	Caspian tern	w	M5
		Sterna forsteri	Forster's tern	w	S5
		Botaurus lentiginosus	American bittern	w	S5, M5
		Ardea herodias	Great blue heron	w	S5, M5

Table 2-6. (continued).

Class	Functional group	Taxonomic name	Common name	Distribution/ status[a]	Abundance/ season/status[b]
		Mergus merganser	Common merganser	w	S3, M5
		Gavia immer	Common loon	w	M5
		Pelecanus erythrorhynchos	American white pelican	w	M5
		Aechmophorus occidentalis	Western grebe	w	S5,M5
Aves	AV422	*Aphelocoma coerulescens*	Scrub jay	U	U
		Pica pica	Black-billed magpie	sw	R2
		Corvus brachyrhynchos	American crow	sw	R3
		Phasianus colchicus	Ring-necked pleasant	g, ss	R3
		Corvus corax	Common raven	sw	R3
		Larus argentatus	Herring gull	w, ss, g	S3, M3
Aves	AV432	*Recurvirostra americana*	American avocet	w	S2, M3
		Larus delawarensis	Ring-billed gull	w, ss, g	S3, M3
Aves	AV433	*Casmerodius albus*	Great egret	w	S5, M5
Aves	AV442	*Fulica americana*	American coot	w	R3
Mammalia	M121	*Erethizon dorsatum*	Porcupine	r, f	I4
Mammalia	M122	*Lepus townsendii*	White-tailed jackrabbit	sw, ss	R4
		Lepus californicus	Black-tailed jackrabbit	sw, ss	R1,R4 (cyclic)
		Reithrodontomys megalotis	Western harvest mouse	sw, ss, g	R2
		Cervus elaphus	Elk	sw	R4
		Odocoileus hemionus	Mule deer	sw, ss, g	R3
		Antilocapra americana	Pronghorn	sw, ss, f	R1
Mammalia	M122A	*Sylvilagus nuttallii*	Nuttall's cottontail	sw, ss, f	R2
		Brachylagus idahoensis	Pygmy rabbit	ss, ro	R2
		Marmota flaviventris	Yellow-bellied marmot	sw, ro	R3
		Spermophilus townsendii	Townsend's ground squirrel	sw, ss, f	R2
		Perognathus parvus	Great basin pocket mouse	sw, ss	R3
		Dipodomys ordii	Ord's kangaroo rat	sw, ss, g	R2

Table 2-6. (continued).

Class	Functional group	Taxonomic name	Common name	Distribution/ status[a]	Abundance/ season/status[b]
		Neotoma cinerea	Bushy-tailed woodrat	sw, ro	R2
		Microtus montanus	Montane vole	sw, g, f	R1,R4 (cyclic)
		Lagurus curtatus	Sagebrush vole	ss	R3
Mammalia	M123	*Thomomys talpoides*	Northern pocket gopher	ss	R4
Mammalia	M210	*Lasiurus cinereus*	Hoary bat	d, j	U3
		Lasionycteris noctivagans	Silver-haired bat	sw	M4
Mammalia	M210A	*Myotis subulatus*	Small-footed myotis	sw, ro	R2
		Eptesicus fuscus	Big-brown bat	sw, f, c	R3
		Plecotus townsendii	Townsend's western big-eared bat	sw, c	R2
		Myotis evotis	Long-eared myotis	sw, c	U3
		Myotis lucifugus	Little brown myotis	sw, f	I2
		Myotis californicus	California myotis	sw	U2
Mammalia	M222	*Sorex merriami*	Merriam's shrew	sw, ss	R4
		Onychomys leucogaster	Northern grasshopper mouse	sw, ss	R4
Mammalia	M322	*Mustela frenata*	Long-tailed weasel	sw, ss	R2
		Taxidea taxus	Badger	sw	R3
		Felis rufus	Bobcat	sw, ss, j	R4
Mammalia	M422	*Tamias minimus*	Least chipmunk	sw, ss	R1
		Peromyscus maniculatus	Deer mouse	sw	R1
		Rattus norvegicus	Norway rat	NW/NE INEL; ag	R5
		Mus musculus	House mouse	f	R5
		Spilogale gracilis	Western spotted skunk	sw, ro	R5
Mammalia	M422A	*Canis latrans*	Coyote	sw	R2
Reptilia	R222	*Phrynosoma douglasii*	Short-horned lizard	sw, ss	R1
		Sceloporus graciosus	Sagebrush lizard	sw, ss	R1
		Eumeces skiltonianus	Western skink	South INEL	R5
Reptilia	R322	*Masticophis taeniatus*	Desert striped whipsnake	NE INEL, ss	R3
		Pituophis melanoleucus	Gopher snake	sw, ss	R2

Table 2-6. (continued).

Class	Functional group	Taxonomic name	Common name	Distribution/ status[a]	Abundance/ season/status[b]
		Thamnophis elegans	Western garter snake	sw	R3
		Coluber constrictor	Western racer	sw	I5
		Crotalus viridis	Western rattlesnake	sw, ss	R2

a.

w	On or near water	f	Facility complexes
ss	Shrub-steppe	c	Cave
d	Deciduous or riparian	ro	Rocky outcrop
j	Juniper woodland	ag	agricultural areas
g	Grassland	r	riparian
sw	Sitewide	U	Unknown

b.

1	Abundant - very numerous and certain to be seen or sampled.
2	Common - likely but not certain to be observed or sampled.
3	Uncommon - found in limited numbers, not likely to be sampled or observed.
4	Occasional or local - a species that is not always present or is restricted in distribution.
5	Rare - a species that has a range including all or part of the INEL, but has been documented ≤ seven times on the INEL.
6	Vagrant or accidental - a species that is not expected to occur on the INEL, but has been recorded there.
7	Possible occurrence - species for which sightings have been unverified or geographical range overlaps the INEL (and preferred habitat occurs on the INEL).

R	=	Breeder and year-round resident
B	=	Summer breeder
M	=	Migrant
I	=	Incidental species
W	=	Winter visitor
S	=	Summer visitor: no breeding records
U	=	Unknown.

otherwise unlikely to be found in the assessment area were eliminated from the list to simplify the SLERA analysis. Those species are listed in Appendix C.

Species potentially present in the WAG 9 assessment area represent all 22 INEL avian functional groups and 9 of 10 mammalian functional groups. Both reptilian functional groups are represented by species inhabiting the assessment area. Amphibians are likely to be present at the industrial waste pond but no formal surveys have been conducted to document their presence. No surface hydrology exists to support fish. Aquatic invertebrates however, are supported by habitat provided by facility treatment ponds.

Both aquatic and terrestrial invertebrates and microorganisms are present within the WAG 9 assessment area. Invertebrates are important links in dietary exposure for wildlife, and also may function as a good indicator for contaminant exposure in soil, aquatic systems, and vegetation uptake, and microorganisms

play an important role in ecosystem processes. However, insufficient ecological and toxicological data exist to adequately address these ecosystem components in this SLERA. A list of terrestrial invertebrates present in the WAG 9 assessment area can be found in ERDA 1977.

Although some population studies have been conducted for cyclic rabbit and rodent populations, several game species (e.g., pronghorn, sagegrouse) and raptors, no recent comprehensive studies have been conducted to assess either WAG specific or INEL-wide wildlife population status and/or trends. Discussion of potential needs for population level data in the interpretation of analysis results for this SLERA is included in Section 4.2.

Wildlife species present within the assessment area include birds, mammals and reptiles that are associated with facilities, sagebrush-steppe, rock outcroppings, deciduous trees and shrubs, grasslands, and water (e.g., facility ponds and drainage areas). The varying behaviors of these species include, but are not limited to, grazing and browsing on vegetation, burrowing and flying, and preying on insects and small mammals. Both aquatic and terrestrial species are potentially present. The complexity of these behaviors is significant when considering fate and transport of contaminants and the possibility of exposure to contaminants. Subsurface contamination can become surface contamination when translocated by burrowing animals, or can be introduced into the food web when plants uptake contamination and are then ingested by an herbivore. If prey, such as a small mammal, becomes contaminated by ingesting contaminated soil or vegetation, and is then captured by a predator, such as a ferruginous hawk, the contamination can be taken offsite when the hawk returns to its nest to feed nestlings. Scenarios for potential exposure of fauna to WAG 9 contaminants are discussed in Section 2.5.

The flora and fauna present within the WAG 9 assessment area are combined into a simplified food web model as presented on Figure 2-4. Variability in environmental conditions, such as population sizes or seasons, is not considered in this model, and a constant environment is assumed. Because both aquatic and terrestrial habitats are present in the assessment area, the model incorporates both terrestrial and aquatic species. Depicted are the decomposers, producers (vegetation), primary consumers or herbivores (e.g., rodents), secondary consumers or carnivores (e.g., snakes), and tertiary or top carnivores (e.g., raptors) and the dietary relationships between each level. These relationships were incorporated to identify direct and indirect exposure to contaminants for the conceptual site model as discussed in Section 2.5.4. This model depicts the possible transport of WAG 9 contaminants through the food web.

2.3.1.3 Threatened, Endangered or Sensitive Species. There are no threatened, endangered, or sensitive plant species known to exist within one mile of the WAG 9 assessment area boundary.

Threatened or endangered (T/E), or sensitive species that could exist at the assessment area are listed in Table 2-7. C2 species including the burrowing owl (*Athene cunicularia*), the loggerhead shrike (*Lanius ludovicanus*), the white-faced ibis (*Plegadis chihi*), pygmy rabbit (*Brachylagus idahoensis*) and sagebrush lizard (*Sceloporus graciosus*) have been recorded in the assessment area. The presence/status of Townsend's western big-eared bat (*Plecotus townsendii*), long-eared myotis (*Myotis evotus*) and the small-footed myotis (*Myotis subulatus*) is unknown; however, the proximity to suitable roosts (caves) and open water (industrial waste pond) provide reason to expect these species could inhabit the assessment area. Other sensitive bird species include the northern harrier (*Circus cyaneus*), the red-tailed hawk (*B. jamaicensis*), the

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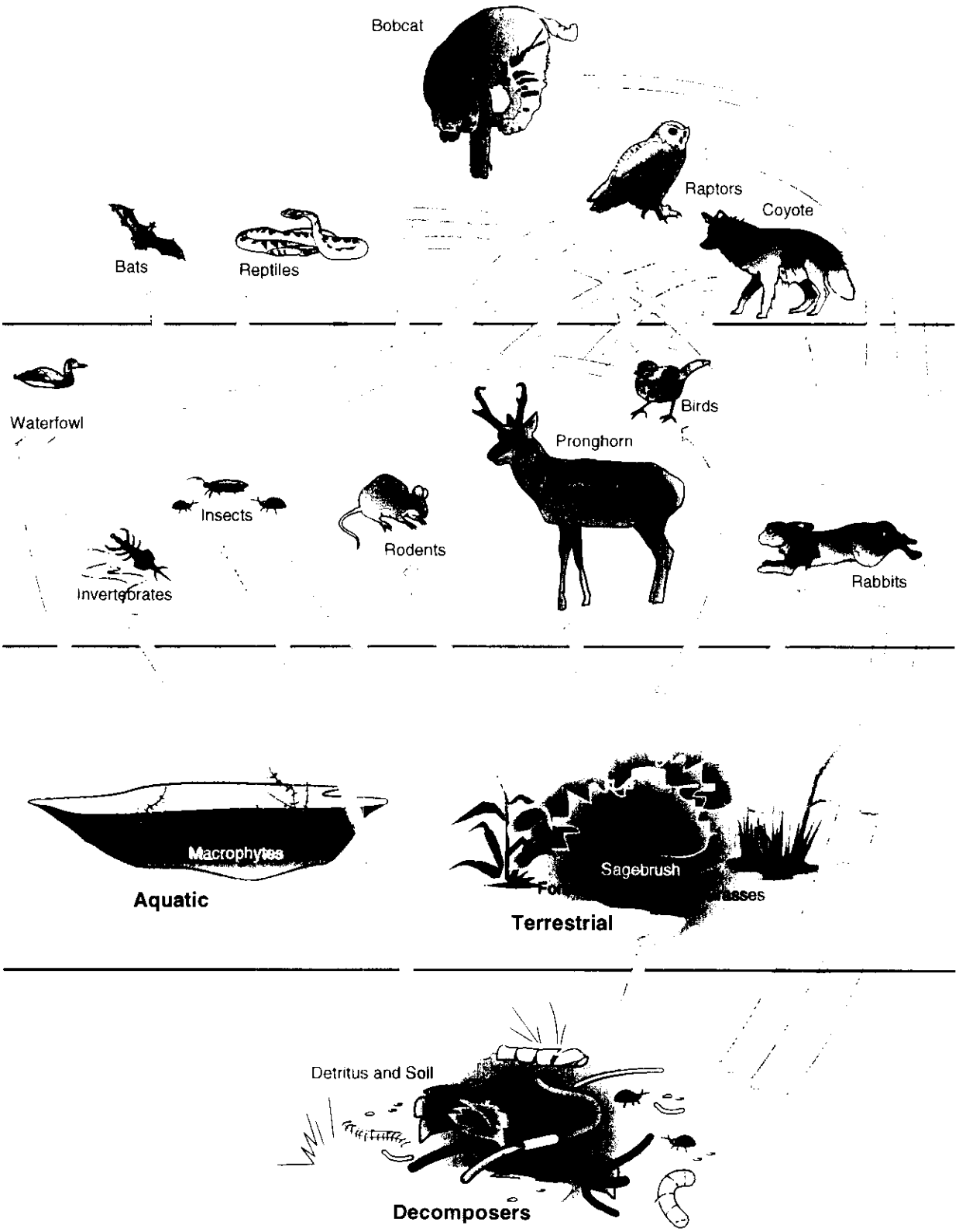

Figure 2-4. Food web for fauna at WAG 9.

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Table 2-7. Threatened and endangered species, special species of concern, and sensitive species that may be found on the INEL.[a] Species in **bold** are those T/E and Category 2 (C2) species included for WAG 9 screening.

Common names	Scientific name	Federal status[b]	State status[b]	BLM status[b]	USFS[c] status[b]	INPS status[b]
Plants						
Lemhi milkvetch	*Astragalus aquilonius*	—	—	S	S	S
Painted milkvetch	*Astragalus ceramicus var. apus*	3c	—	—	—	M
Plains milkvetch	*Astragalus gilviflorus*	NL	—	S	S	3
Winged-seed evening primrose	*Camissonia pterosperma*	NL	—	S	—	S
Nipple cactus	*Coryphantha missouriensis*	NL	—	—	—	M
Spreading gilia	*Ipomopsis (Gilia) polycladon*	NL	—	S	—	2
King's bladderpod	*Lesquerella kingii var. cobrensis*	—	—	—	—	M
Tree-like oxytheca	*Oxytheca dendroidea*	NL	—	S	—	S
Inconspicuous phacelia[c,d]	*Phacelia inconspicua*	C2	SSC	S	S	
Puzzling Halimolobos[d]	*Halimolobos perplexa var. perplexa*	—	—	—	—	M
Birds						
Peregrine falcon	***Falco peregrinus***	**LE**	**E**	—	—	
Merlin	*Falco columbarius*	NL	—	S	—	
Gyrfalcon	*Falco rusticolus*	NL	SSC	S	—	
Bald eagle	***Haliaeetus leucocphalus***	**LT**	**T**	—	—	
Ferruginous hawk	***Buteo regalis***	**C2**	**SSC**	**S**	—	
Black Tern	***Chlidonias niger***	**C2**	—	—	—	
Northern pygmy owl[c]	*Glaucidium gnoma*	—	SSC	—	—	
Burrowing owl	***Athene cunicularia***	**C2**	—	**S**	—	
Common loon	*Gavia immer*	—	SSC	—	—	
American white pelican	*Pelicanus erythrorhynchos*	—	SSC	—	—	
Great egret	*Casmerodius albus*	—	SSC	—	—	
White-faced Ibis	***Plegadis chihi***	**C2**	—	—	—	
Long-billed curlew	*Numenius americanus*	3c	—	S	—	
Loggerhead shrike	***Lanius ludovicianus***	**C2**	**NL**	**S**	—	
Northern goshawk	***Accipiter gentilis***	**C2**	**S**	—	**S**	
Swainson's hawk	*Buteo swainsoni*	—	—	S	—	
Trumpeter Swan	***Cygnus buccinator***	**C2**	**SSC**	**S**	**S**	
Sharptailed grouse	*Tympanuchus phasianellus*	C2	—	S	S	
Boreal owl	*Aegolius funereus*	—	SSC	S	S	
Flammulated owl	*Otus flammeolus*	—	SSC	—	S	
Mammals						
Pygmy rabbit	***Brachylagus (Sylvilagus) idahoensis***	**C2**	**SSC**	**S**	—	

Table 2-7. (continued).

Common names	Scientific name	Federal status[b]	State status[b]	BLM status[b]	USFS[e] status[b]	INPS status[b]
Townsend's western big-eared bat	***Plecotus townsendii***	**C2**	**SSC**	**S**	**S**	
Merriam's shrew	*Sorex merriami*	—	S	—	—	
Long-eared myotis	***Myotis evotis***	**C2**	—	—	—	
Small-footed myotis	***Myotis subulatus***	**C2**	—	—	—	
Western pipistrelle[c]	*Pipistrellus hesperus*	NL	SSC	—	—	
Fringed myotis[c]	*Myotis thysanodes*	—	SSC	—	—	
California Myotis[c]	*Myotis californicus*	—	SSC	—	—	
Reptiles and Amphibians						
Northern sagebrush lizard	***Sceloporus graciosus***	**C2**	—	—	—	
Ringneck snake[c]	*Diadophis punctatus*	C2	—	—	—	
Night snake[c]	*Hypsiglena torquata*	—	—	S	—	
Insects						
Idaho pointheaded grasshopper[c]	*Acrolophitus punchellus*	C2	SSC	—	—	
Fish						
Shorthead sculpin[c]	*Cottus confusus*	—	SSC	—	—	

a. This list was compiled from the U.S. Fish and Wildlife Service (USFWS) (letter dated September 22, 1995) the Idaho Department of Fish and Game Conservation Data Center threatened, endangered, and sensitive species for the State of Idaho (IDFG 1994) and RESL documentation for the INEL (Reynolds 1994; Reynolds et al. 1986).

b. Status Codes: S=sensitive; 2=State Priority 2; 3c=no longer considered for listing; M=State monitor species; NL=not listed; 1=State Priority 1; LE=listed endangered; E=endangered; SSC=species of special concern; and C2=Category 2 (defined in CDC 1994). BLM=Bureau of Land Management; INPS=Idaho Native Plant Society.

c. No documented sightings at the INEL, however, the ranges of these species overlap the INEL and are included as possibilities to be considered for field surveys.

d. Recent updates resulting from Idaho State Sensitive Species meeting (BLM, USFWS, INPS, USFS) - (INPS 1995)

e. United States Forest Service (USFS) Region 4

prairie falcon (*F. mexicanus*), the american kestrel (*Falco sparverius*), short-eared owl (*A. flammeus*), have also been observed inside the assessment area. Sage grouse breeding grounds (leks) are found both inside the assessment area and within one mile of the assessment boundary.

2.3.2 Abiotic Components

The ANL-W is located on the alluvial plain of the Big Lost River, in the southeastern section of the INEL. The topography of the assessment area is relatively flat. The area is comprised of approximately three-fifths of the Malm-Bondfarm-Matheson complex (432) soils and two-fifths of the Coffee/Nargon/Atom complex (425) soils. Table 2-8 lists these types as shown in Figure 2-3 and provides area in m^2, ft^2, and hectares.

The Malm-Bondfarm-Matheson complex (432) consists of moderately deep, well-drained, sandy-loam soils on basalt plains. A calcic horizon is present at approximately 30 cm (12 in.). Permeability of these soils is moderately rapid, and the erosion hazards for these soils are slight to moderate (Olson et al. 1995).

The Coffee/Nargon/Atom complex (425) varies from moderately deep to very deep, well drained, silty clay loam on lava plains. The permeability of these soils is moderate to moderately slow and the runoff varies from slow, for the Atom soil, to medium to rapid, for the Coffee and Nargon soils. The erosion hazard for these soils is slight to moderate (Olson et al. 1995). Several soils were also characterized as part of the SREF EIS.

Table 2-9 lists the vegetation/soil associations within the WAG 9 assessment area. Root uptake of contaminants is a complex process that depends on various soil properties such as pH, cation-exchange capacity, and organic matter content. In addition, the process is highly variable from one plant species to another. While soil-plant relationships are not specifically considered as part of the WAG 9 SLERA, this information is presented to support possible comprehensive analyses.

The climate at the WAG 9 assessment area cannot be differentiated from that of the entire INEL because meteorological data that are ultimately reported are collected in only two locations at the INEL. Data reported here are collected at the Central Facilities Area (CFA) National Oceanic and Atmospheric Administration meteorological station and are extrapolated to the ANL-W facility (WAG 9). The average annual temperature is 5.4°C (41.7°F) with a mean annual precipitation of 8.74 in. Annual snowfall ranges from a low of about 30 cm (12 in.) to a high of about 102 cm (40 in.) and an average of 66 cm (26 in.). Wind patterns at the assessment area are from the west-southwest or southwest approximately 40% of the time, and the average speed is 9.3 mph at 20 ft. Wind direction the remaining 60% of the time is a combination of directions, predominantly due west or northeast.

Besides the waste ponds and facility drainages at WAG 9, no other surface hydrology is present in the assessment area. Groundwater is present; however, for this assessment, it is assumed that no pathways to surface ecological receptors exist for these sites.

Table 2-8. Summary of WAG 9 assessment area soil types.

Soil-code[a]	Area (m^2)	Area (hectares)	Area (ft^2)	Percent cover
432	4,072,697	407	43,837,986	59.2%
425	2,811,604	281	30,263,737	40.8%
Totals	6,884,301	688	988,463,522	100.00%

a. Soil codes are defined in Section 2.3.3.

Table 2-9. Vegetation/soil associations within the WAG 9 assessment area.

Vegetation cover class	Soil code[a]	Area (m^2)	Area (hectares)	Area (ft^2)	Percent cover
Grassland	425	97,188	9.7	1,046,121	1.41%
Grassland	432	95,577	9.6	1,028,780	1.39%
Sagebrush/rabbitbrush	425	1,360,784	136.1	14,647,308	19.77%
Sagebrush/rabbitbrush	432	1,134,031	113.4	12,206,570	16.48%
Salt Desert Shrub	425	56,594	5.7	609,170	<1%
Salt Desert Shrub	432	106	<1	1,141	<1%
Sagebrush-steppe on lava	425	649,792	65	6,994,280	9.44%
Sagebrush-steppe on lava	432	2,793,733	279.3	30,071,379	40.59%
Lava[b]	432	8,924	0.9	96,060	<1%
Playa-bareground/gravel-borrow pits	425	169,331	16.9	1,822,657	2.46%
Playa-bareground/gravel-borrow pits	432	9,756	1	105,013	<1%
Facilities	425	476,100	47.6	5,124,678	6.92%
Facilities	432	30,600	3.1	329,374	1%
	Totals	6,882,516	688.3	74,082,532	100.00%

a. Soil codes are defined in Section 2.3.3

b. No areas of lava vegetation exist in the WAG 9 assessment area. The areas shown as lava represent features having the same spectral signature as lava.

2.4 Stressor Identification and Characterization

One of the first objectives of the risk assessment screening process is to identify contaminants. This section describes the data compilation methodologies and assumptions used to derive contaminants for assessment for WAG 9.

2.4.1 Conduct Initial Data Review

The initial data review was performed after sites of concern were identified as discussed in Section 2.1.2. The approach for utilizing the data available from the human health risk assessment activities at INEL is discussed in the Guidance Manual (VanHorn et al. 1995). WAG 9 sites have been investigated since 1986 at various levels of effort depending on the FFA/CO level of action (DOE-ID 1991). The data that were used to develop the preliminary list of contaminants for WAG 9 were compiled from results of investigations available from ANL-W. For two sites, values from the maximum concentration data base (MAX) were used to provide a limited, but validated data set. The data qualifiers and the MAX data bases are discussed in detail in Appendices of the Guidance Manual (VanHorn et al. 1995).

Sampling data were obtained as part of Track 1 and 2 investigations and from Pre-Remedial Action/Feasibility Study (RI/FS) to characterize the nature and extent of contamination present in various environmental media at WAG 9. Data needs were identified after review of existing literature and through the development of preliminary site characterization and risk assessment documents. Twenty-eight sites within WAG 9 were excluded from evaluation based on results of No Further Action (NFA) decisions and Track 1 and 2 investigations. Table 2-1 briefly describes these sites and the justification for eliminating them from consideration. Most of the sites eliminated have no known source of contamination (e.g., the site was decontaminated when the associated tank was removed, as was the case for ANL-14, Septic Tank and Drain Fields) or no exposure pathway for terrestrial receptors (e.g., the sump was 5 m (16 ft) below grade, as was the case with site ANL-30, Sanitary Waste Lift Station). In other cases, field sampling showed no contamination above risk-based levels present (e.g., ANL-36, TREAT Photo Processing Discharge Ditch) or there was no record of any spills or leaks at the site (e.g., ANL-11, Waste Retention Tank 783). Only the analytical data collected from the remaining 10 sites of concern were screened to determine contaminants for WAG 9.

Surface soil, subsurface soil, surface water, and sediment samples collected from WAG 9 sites of concern were used in the screening process. All data used in the SLERA meet useability criteria discussed in EPA's *Guidance for Data Useability in Risk Assessment* (EPA 1992b). Soil samples taken at a depth greater than 3 m (10 ft) were eliminated from the analysis, because there is no pathway to ecological receptors of concern to contaminants present at such depths. For this same reason, groundwater samples were eliminated. The soil data were then segregated into surface and subsurface groups based on sample depth. In general, any sample collected at a depth of 0 to 0.15 m (0 to 0.5 ft) was classified as surface, while samples taken at a depth of 0 m to 1.2 m (0 to 4 ft) were treated as subsurface samples. Soil samples collected at a depth greater than 3 m (10 ft) were eliminated, because there is no complete exposure pathway to ecological receptors for samples taken at depths greater than 3 m (10 ft). In some cases, samples were collected at depths that did not correspond directly to the definitions of surface and subsurface defined previously. For example, samples collected at a depth of 0 to 0.61 m (0 to 2 ft) were defined as subsurface, while samples collected at a depth of 0 to 0.3 m (0 to 1 ft) was classified as surface.

2.4.2 Conduct Phased Screening for Surface and Subsurface Soil Contamination

A phased screening process was used to identify contaminants in surface and subsurface soils. The phased screening process includes the following steps.

1. Eliminate contaminants with zero detects.

2. Eliminate contaminants with a frequency of detection (FOD) less than 5%.

3. Eliminate contaminants based on comparisons with background data.

As a result of this process, contaminants likely to be site-related and detected at levels greater than background concentrations were ultimately selected for assessment. To fully understand this process and its results, an explanation of each step follows.

Step 1: Eliminate Contaminants with Zero Detects. Detection limits vary depending on the contaminant analyzed, the analytical instrument used, and the characteristics of the media being tested. Before eliminating any contaminants, it is necessary to acknowledge that detection limits vary between sampling events. Therefore, some contaminant concentrations may not have been detected in samples from some sampling events due to varying detection limits. Contaminants not detected in any media were eliminated from further evaluation. Tables 2-10 and 2-11 list those contaminants eliminated due to non-detection in subsurface and surface soil samples, respectively, as well as the number of samples evaluated for each contaminant. Any sample with a "U" flag was considered a non-detect sample (despite the presence of additional flags), and the corresponding concentration reported was used as the detection limit. The "U" flag indicates that the contaminant is definitely not present above the numerical value (i.e., the detection limit) reported. If a sample had both "U" and "J" or "U" and "B" flags, it was still considered to be a non-detect. In subsurface soil samples, 178 nonradionuclides and 18 radionuclides were not detected above detection limits in any subsurface soil samples analyzed and were eliminated from further evaluation. For surface soils, 146 nonradiological and 11 radiological contaminants were not detected in any samples analyzed and were eliminated.

Step 2: Eliminate Contaminants with a FOD Less than Five Percent. The FOD was calculated for each remaining contaminant. FOD was determined as the number of positive samples [i.e., those without a "U" or "B" (organics only) flag] divided by the total number of samples analyzed for that contaminant. Any contaminant whose FOD was less than or equal to 5 percent was eliminated from further evaluation. In determining the FOD, for a given organic contaminant, however, samples flagged with a "B" qualifier were excluded. The "B" qualifier in organic analyses indicates possible/probable blank contamination, and EPA (1992b) recommends not using data with an organic "B" flag in risk assessments. Although some individual samples were eliminated for some contaminants, the FOD for all remaining contaminants (i.e., those not eliminated during Step 1) was calculated. All samples with a "U" flag were also excluded, since this flag indicates that the contaminant was not detected above the reported detection limit. For example, samples with both "U" and "J" flags or both "U" and "B" flags, were not included in the calculation of FODs.

Table 2-10. Contaminants not detected in samples analyzed in subsurface soils.

Contaminant	Sample size	Contaminant	Sample size	Contaminant	Sample size
1,1,1,2-Tetrachloroethane	2	2-Chlorophenol	10	Aroclor-1242	8
1,1,2,2-Tetrachloroethane	15	2-Hexanone	13	Aroclor -1248	8
1,1,2-Trichloroethane	15	2-Methylnaphthalene	10	Aroclor-1254	8
1,1-Dichloroethane	15	2-Methylphenol	10	Aroclor-1260	8
1,1-Dichloroethene	15	2-Nitroaniline	10	Benzene	15
1,2,3-Trichloropropane	4	2-Nitrophenol	10	Benzenethiol	4
1,2,3,4-Tetrachlorobenzene	1	2-Picoline	4	Benzidine	4
1,2,4,5-Tetrachlorobenzene	3	3,3-Dichlorobenzidine	10	Benzo Trichloride	4
1,2,4-Trichlorobenzene	10	3,3-Dimethylaminoazo-benzene	4	Benzo(a)anthracene	10
1,2-Dichlorobenzene	10	3-Methylcholanthrene	4	Benzo(a)pyrene	10
1,2-Dichloroethane	15	4 Bromophenyl-phenylether	6	Benzo(b)fluoranthene	10
1,2-Dichloroethene (total)	15	4 Methylphenol	6	Benzo(k)fluoranthene	10
1,2-Dichloropropane	15	4,4'-DDD	8	Benzioc Acid	4
1,2-Diphenylamine	4	4,4'-DDE	8	Benzyl Alcohol	4
1,3,4,6-Tetrachlorophenol	4	4,4'-DDT	8	Benzyl Dichloride	4
1,3-Dichlorobenzene	10	4,6-Dinitro-2-methylphenol	10	Beta-BHC	8
1,3-Dinitrobenzene	4	4-Aminobiphenyl	4	Bromodichloromethane	13
1,4-Dichlorobenzene	10	4-Bromophenyl-phenylether	4	Bromoform	15
1,4-Dinitrobenzene	4	4-Chloro-3-methylphenol	10	Bromomethane	15
1,4-Naphthoquinone	4	4-Chloroaniline	10	Carbazole	6
1-Naphthlyamine	4	4-Chlorophenyl-phenyl ether	6	Carbon Disulfide	15
1-Nitrosopiperidine	4	4-Dimethylaminoazobenzene	4	Carbon Tetrachloride	15
2,2-Oxibis(1-Chloropropane)	6	4-Methyl-2-Pentanone	15	Chlorobenzene	15
2,4,5-T	4	4-Methylphenol	4	Chlorobenzilate	4
2,4,5-TP (Silvex)	4	4-Nitroaniline	10	Chloroethane	15
2,4,5-Trichlorophenol	10	4-Nitrophenol	10	Chloromethane	15
2,4,6-Trichlorophenol	10	7,12-dimethylbenze(A)anthracene	4	Chrysene	10
2,4-D*	4	Acetonitrile	1	Delta-BHC	8
2,4-Diaminotoluene	4	Acetophenone	4	Di-n-butylphthalate	6
2,4-Dichlorophenol	10	Acrolein	2	Dibenzo(a,h)anthrancene	4
2,4-Dimethylphenol	10	Acrylonitrile	2	Dibenzofuran	6
2,4-Dinitrophenol	10	Aldrin	8	Dibromochloromethane	15
2,4-Dinitrotoluene	10	Allyl Chloride	2	Dibromomethane	2
2,5-Dinitrophenol	4	Alpha-BHC	8	Dieldrin	8
2,6-Dichlorophenol	4	Aniline	4	Diethylphthalate	10
2,6-Dinitrotoluene	10	Aroclor-1016	8	Dimethylphthalate	10
2-Acetylaminofluorene	4	Aroclor-1221	8	Diphenylamine	4
2-Chloroethylvinyl ether	2	Aroclor-1232	8	Disulfoten	

Table 2-10. (continued).

Contaminant	Sample size	Contaminant	Sample size	Contaminant	Sample size
Endosulfan I	8	N-Nitrosodiphenylamine (1)	6	bis(2-Chloroethoxy)methane	10
Endosulfan II	8	N-Nitrosoethylmethylamine	4	bis(2-Chloroethyl)ether	4
Endosulfan sulfate	8	N-Nitrosomorpholine	4	bis(2-Chloroisopropyl)ether	4
Endrin	8	Naphthalene	10	bis-1,3-Dichloropropene	15
Endrin ketone	8	Nitroanline	6	gamma-BHC (Lindane)	8
Ethyl Methacrylate	4	Nitrobenzene	10	gamma-Chlordane	8
Ethylbenzene	15	O-Phenylenediamine	4	trans-1,3-Dichloropropene	15
Fluoranthene	10	Parathion	4	trans-1,4-Dichloro-2-butene	2
Heptachlor	4	Pentachlorobenzene	4	Am-241	123
Heptachlor epoxide	4	Pentachloroethane	4	Ce-144	122
Hexachlorobenzene	10	Pentachloronitrobenzene	4	Cm-242	1
Hexachlorobutadiene	10	Pentachlorophenol	10	Cm-244	1
Hexachlorocyclopentadience	10	Phenol	10	Cs-134	122
Hexachloroethane	10	Phorate	4	Eu-152	122
Indeno(1,2,3-cd)pyrene	4	Pyridine	4	Eu-154	122
Iodomethane	2	Resorcinol	4	Mn-54	122
Isophorone	10	Safrole	4	Pu-238	1
Isosafrole	4	Styrene	13	Pu-239/240	1
Malononitrile	4	Tetrachloroethene	15	Ru-106	122
Methacrylonitrile	2	Toxaphene	4	Sb-125	122
Methoxychlor	4	Trichloroethene	15	Sr-90	4
Methyl methacrylate	2	Trichlorofluoromethane	2	Th-228	1
Methyl Methane Sulfonate	4	Vinyl Acetate	15	Th-230	1
Methyl parathion	4	Vinyl Chloride	15	Th-232	1
N-Nitroso-di-N-Butylamine	4	Xylene (total)	15	U-232	1
N-Nitroso-di-n-propylamine	10	alpha-Chlordane	8	U-235	122
N-Nitrosodiethylamine	4	2-Chloronaphthalene	10		
N-Nitrosodimethylamine	4	bis (2-Chloloroethyl) ether	6		

* Eliminated because detected in blanks.

Table 2-11. Contaminants not detected in samples analyzed in surface soils.

Contaminant	Sample size	Contaminant	Sample size	Contaminant	Sample size
1,2,3,4-Tetrachlorobenzene	1	2-Picoline	1	Benzo(a)anthracene	15
1,2,3-trichlorobenzene	1	3,3-Dichlorobenzidine	15	Benzo(a)pyrene	15
1,2,4,5-Tetrachlorobenzene	1	3-Methyl Cholanthrene	1	Benzo(b)fluoranthene	15
1,2,4-Trichlorobenzene	15	3-Nitroaniline	1	Benzo(k)fluoranthene	15
1,2,6,7-dibenzo(a, h)pyrene	1	3-Nitrotoluene	1	Benzioc Acid	1
1,2-Dichlorobenzene	15	4 Bromophenyl-phenylether	14	Benzyl Alcohol	1
1,2-Dinitrobenzene	1	4 Methylphenol	14	Benzyl Chloride	1
1,3-Dichlorobenzene	15	4,4'-DDD	1	Benzyl Dichloride	1
1,3-Dinitrobenzene	1	4,4'-DDE	1	Beta-BHC	1
1,4-Dichlorobenzene	15	4,4'-DDT	1	Bromobenzene	1
1,4-Dinitrobenezene	1	4,6-Dinitro-2-methylphenol	15	Bromodichloromethane	1
1,4-Naphthoquinone	1	4-Bromophenyl-phenylether	1	Butylbenzylphthalate	15
1-Chlorohexane	1	4-Chloro-3-methylphenol	15	Carbazole	14
2,2-Oxibis(1-Chloropropane)	14	4-Chloroaniline	15	Carbofuran	1
2,3,4,6-tetrachlorophenol	1	4-Chlorophenyl-phenyl ether	15	Cyclohexane, (DOT)	1
2,4,5-T	1	4-Methylphenol	1	Chrysene	15
2,4,5-TP (Silvex)	1	4-Nitroaniline	15	Delta-BHC	1
2,4,5-Trichlorophenol	15	4-Nitrophenol	15	Di-n-butylphthalate	14
2,4,6-Trichlorophenol	15	4-Nitrotoluene	1	Di-n-octylphthalate	15
2,4-D	1	Acenaphthene	15	Dibenzo(a,h)anthracene	1
2,4 -DB	1	Acenapthylene	15	Dibenzofuran	15
2,4-Diaminotoluene	1	Acrolein	1	Dibromochloromethane	1
2,4-Dichlorophenol	15	Acrylonitrile	1	Dicamba	1
2,4-Dimethylphenol	15	Aldrin	1	Dichloroprop	1
2,4-Dinitrophenol	15	Alpha-BHC	1	Dieldrin	1
2,4-Dinitrotoluene	15	Aniline	1	Diethlphthalate	14
2,5-Dinitrophenol	1	Anthracene	15	Dimethylphthalate	15
2,6-Dichlorophenol	1	Aroclor-1016	1	Disulfoten	1
2,6-Dinitrotoluene	15	Aroclor-1221	1	Endosulfan I	1
2-Chloronaphthalene	15	Aroclor-1232	1	Endosulfan II	1
2-Chlorophenol	15	Aroclor-1242	1	Endosulfan sulfate	1
2-Hexanone	1	Aroclor-1248	1	Endrin	1
2-Methylnaphthalene	15	Aroclor-1254	1	Endrin ketone	1
2-Methylphenol	15	Aroclor-1260	1	Ethylbenzene	1
2-Nitroaniline	15	Benzidine	1	Fluoranthene	15
2-Nitrophenol	15	Benzo(g,h,i)perylene	1	Fluorene	15
2-Nitrotoluene	1	Benzo Trichloride	1	Heptachlor	

Table 2-11. (continued).

Contaminant	Sample size	Contaminant	Sample size	Contaminant	Sample size
Heptachlor epoxide	1	Parathion	1	bis(2-Chloroisopropyl)ether	1
Hexachlorobenzene	15	Pentachlorophenol	15	bis (2-Ethylhexyl) phthalate	14
Hexachlorobutadiene	15	Phenanthrene	15	gamma-BHC (Lindane)	1
Hexachlorocyclopentadience	15	Phenol	15	gamma-Chlordane	1
Hexachloroethane	15	Phorate	1	Ce-144	133
Indeno(1,2,3-cd)pyrene	1	Pyrene	15	Cm-242	21
Isophorone	15	Pyridine	1	Eu-152	133
MCPP	1	Resorcinol	1	Eu-154	133
Methoxychlor	1	Styrene	1	Mn-54	133
Methyl parathion	1	Sulfate	1	Pu-238	21
N-Nitroso-di-n-propylamine	15	Toxaphene	1	Ru-106	133
N-Nitrosodimethylamine	1	alpha-Chlodane	1	Sb-124	133
N-Nitrosodiphenylamine (1)	15	bis(2-Chloloroethyl)ether	14	Th-228	21
Naphthalene	15	bis(2-Chloroethoxy)methane	15	Th-232	21
Nitroanline	14	bis(2-Chloroethyl)ether	1	U-235	21
Nitrobenzene	15				

Samples flagged with a "J" qualifier were included in the calculation of the FOD. "J" flags indicate that the reported value is an estimate. EPA (1992b) states that "data qualified as 'J' are useable for risk assessment purposes."

Contaminants that were eliminated because their frequency of detection was less than 5% of the total samples analyzed for that contaminant are listed in Table 2-12. Two nonradionuclides and one radionuclide were eliminated from further evaluation in subsurface soils. For surface soils, one nonradionuclide and four radionuclides were eliminated.

Step 3: Eliminate Contaminants Based on a Comparison with Background Data. Concentrations of each contaminant for each medium were compared to the site background data to obtain a FOE, the fraction of samples analyzed that exceeded local background levels. The FOE was calculated as the number of positive samples [i.e., those without a "U" or "B" (organics only) flag] that exceeded the 95 percent/95 percent UTL for the range of grab sample background values reported (Rood et al. 1995) divided by the total number of samples analyzed (all inorganic samples and organic samples that did not have a "B" flag). The contaminants that exceeded the INEL site-specific background levels (UTLs) at a frequency of 5 percent or less or have maximum concentrations less than the 95 percent UTL were eliminated. Table 2-13 contains a list of these contaminants. The table includes UTLs for the contaminants for which site-specific background data were available, the maximum concentration detected, and the FOD and FOE for contaminants detected in subsurface and surface soils.

Table 2-12. Contaminants eliminated because FOD <5% (subsurface soils).

Contaminant	Maximum detected value (mg/kg or pCi/g)	FOD
Selenium	4.7	1/113 (0.9%)
Thallium	2.35	1/52 (1.9%)
Co-60	0.31	3/125 (2.4%)

Table 2-13. Contaminants eliminated because FOD <5% (surface soils).

Contaminant	Maximum detected value (mg/kg or pCi/g)	FOD
Dioxins/furans	9.74×10^{-7}	3/72 (4.2 %)
Thallium	3.85	2/76 (2.6%)
Am-241	0.13	2/133 (1.5%)
Cm-244	0.06	1/21 (4.8%)
Cs-134	0.05	1/133 (0.8%)
Pu-239/240	0.11	1/21 (4.8%)

Because organic compounds are not normally present in the soil, background concentrations were assumed to be zero. Therefore, any detection of organic compounds was considered to be above background. In addition, background soil concentrations are not available for chloride, cyanide, fluoride, nitrate-N, o-phosphate-P, sulfate, Am-244, and Co-60. These contaminants were retained.

2.4.3 Initial Screening of Surface Water and Sediment Contaminants

Three locations of surface water and sediment contaminants at the WAG 9 assessment site were identified as possible sources of exposure to functional groups from ingestion of surface water and/or sediment. These locations are:

- Industrial Waste Pond and Cooling Tower Blowdown Ditches (ANL-01)—standing water and sediment
- Industrial Waste Lift Station Discharge Ditch (ANL-35)—standing water
- ANL Sewage Lagoons (ANL-04)—sediment.

Table 2-14. Contaminants eliminated based on comparisons with background data.

Contaminant	FOD	Maximum value (mg/kg or pCi/g)	UTL (mg/kg or pCi/g)	FOE
		Subsurface		
Aluminum	66/68 (97.1%)	21,900	24,000	0/68 (0%)
Barium	116/116 (100%)	1,690	440	2/116 (1.7%)
Cadmium	55/116 (47.4%)	4.8	3.7	1/116 (0.9%)
Cobalt	54/64 (84.4%)	25.7	18	1/64 (1.6%)
Iron	68/68 (100%)	39,200	35,000	1/68 (1.5%)
Magnesium	64/64 (100%)	17,300	19,000	0/64 (0%)
Nickel	68/68 (100%)	84.3	55	1/68 (1.5%)
Potassium	68/68 (100%)	5,100	6,300	0/68 (0%)
Vanadium	68/68 (100%)	53.9	70	0/68 (0%)
U-238	1/1 (100%)	1.3	1.85	0/1 (0%)
		Surface		
Aluminum	76/76 (100%)	29,800	24,000	1/76 (1.3%)
Barium	76/82 (92.7%)	647	440	1/82 (1.2%)
Beryllium	66/76 (86.8%)	1.1	3.0	0/76 (0.0%)
Cadmium	39/82 (47.6%)	4.4	3.7	4/82 (4.9%)
Cobalt	65/76 (85.5%)	27	18	1/76 (1.3%)
Iron	76/76 (100%)	50,600	35,000	2/76 (2.6%)
Magnesium	76/76 (100%)	30,000	19,000	2/76 (2.6%)
Manganese	76/76 (100%)	1,200	700	1/76 (1.3%)
Potassium	75/76 (98.7%)	7,390	6,300	1/76 (1.3%)
Vanadium	76/76 (100%)	74.1	70	2/76 (2.6%)
Th-230	7/21 (33.3%)	1.8	1.88	0/21 (0%)

The concentration of each identified contaminant was evaluated to determine the potential risk associated with the ingestion of surface water or sediment by WAG 9 functional groups.

2.4.3.1 Screening of surface water contaminants. The surface water data from ANL-01 are presented in Table 2-15 and from ANL-35 in Table 2-16. The maximum detected concentration and the frequency of detection are presented for each contaminant sampled. The screening criteria and the frequency with which it was exceeded are also presented. The screening criteria for nonradionuclides were taken from the national ambient water quality criteria (NAWQC) available in Suter et al. (1992) and EPA (1986a). The screening criteria for radioactive contaminants were based on values determined by the IAEA (1992) to be protective of ecological receptors.

NAWQC are available for different forms of arsenic (arsenic V is more toxic than arsenic III) and chromium (chromium VI is more toxic than chromium III). However, detected concentrations of arsenic and chromium were not differentiated between forms. Table 2-15 presents comparisons of maximum detected concentrations with the NAWQC for each form. The NAWQC for methyl mercury was used, because inorganic mercury is converted to methyl mercury in the environment. There is no indication of methyl mercury being disposed at the site.

Several contaminants can be eliminated from further analysis. Although, all contaminants listed in the Tables 2-15 and 2-16 were detected in at least 5% of the samples, concentrations of chloride, mercury, nickel, and 2,4-D did not exceed the screening criteria at the ANL-01 site. At ANL-35, antimony, zinc, and 4-methyl-2-pentanone concentrations were less than the corresponding screening criteria. Acetone and methylene chloride were reported in samples at both sites and were also reported in blanks. They will be considered undetected and removed from analysis pursuant to EPA guidance (EPA,1992b) because the concentration in the samples was less than ten times that in the blanks.

Screening criteria were not located for fluoride, nitrate, phosphate, sulfate, bromoform, dicamba, OCDD, and thorium-228. These contaminants will be evaluated in the ecological risk assessment (ERA), if possible.

2.4.3.2 Screening of Sediment Contaminants. The sediment data from ANL-01 and ANL-04 are presented in Tables 2-17 and 2-18, respectively. The maximum concentration and frequency of detection are listed. Also listed are screening criteria for some of the contaminants identified in the sediment samples and the frequency that the sample concentration exceeded the screening criteria. All contaminants listed in the tables were detected in at least 5% of the samples.

Several screening criteria were located (Hull and Suter 1993) for some of the inorganic contaminants, as presented in Table 2-17 and 2-18. These were developed by the Wisconsin Department of Natural Resources, the National Oceanic and Atmospheric Administration, the US Environmental Protection Agency, Washington State, Beak Consultants of Canada, and the Ontario Ministry of the Environment. The sample concentrations were compared with the minimum of these screening criteria.

Table 2-15. Initial surface water screening of ANL Industrial Waste Pond and Cooling Tower Blowdown Ditches (ANL-01).

Contaminant	Maximum concentration (mg/L or pCi/L)	Frequency of Detection (FOD)	Chronic NAWQ criteria (mg/L)[a]	IAEA Radionuclide Value[b] (pCi/L)	Frequency of Exceedance (FOE)
INORGANICS					
Aluminum	3.99	6/10	0.087	NA	6/10
Antimony	0.05	3/12	0.018[c]	NA	1/12
Arsenic III/V	0.010	3/12	0.19/0.00077[c]	NA	3/12 / 3/12
Barium	0.148	8/12	0.109[c]	NA	1/12
Beryllium	0.004	6/12	0.00061[c]	NA	6/12
Cadmium	0.002	1/12	0.0011	NA	1/12
Calcium	121	8/10	d	NA	d
Chromium III/VI	0.187	6/12	0.210/0.011	NA	6/12 / 6/12
Chloride	61	6/6	230	NA	0/6[e]
Cobalt	0.003	1/12	0.00029[c]	NA	1/12
Copper	0.993	4/12	0.012	NA	4/12
Fluoride	2.1	6/6	d	NA	d
Iron	3.19	7/10	1	NA	1/10
Lead	0.358	3/12	0.0032	NA	2/12
Magnesium	41	8/10	0.00016[c]	NA	8/10
Manganese	0.21	7/10	0.011[c]	NA	7/10
Mercury	0.00004	6/12	3E-07[f]	NA	0/12[e]
Nickel	0.038	3/12	0.160	NA	0/12[e]
Nitrate	13	5/6	d	NA	d
O-Phosphate-P	7.2	6/6	d	NA	d
Potassium	21	7/10	0.00013[c]	NA	7/10
Silver	0.007	1/12	0.00039[c]	NA	1/12
Sodium	101	8/10	0.48[c]	NA	8/10
Sulfate	350	6/6	d	NA	d
Vanadium	0.029	7/12	0.003[c]	NA	7/12
Zinc	0.785	11/12	0.110	NA	

Table 2-15. (continued).

Contaminant	Maximum concentration (mg/L or pCi/L)	Frequency of Detection (FOD)	Chronic NAWQ criteria (mg/L)[a]	IAEA Radionuclide Value[b] (pCi/L)	Frequency of Exceedance (FOE)
ORGANICS					
2,4-D	0.0059	2/4	0.365	NA	0/4[e]
Dicamba	0.000272	2/2	d	NA	d
OCDD[g]	0.00000114	2/2	d	NA	d
RADIONUCLIDES					
H-3	4853	6/18	NA	1919	6/18
Pu-239	0.001	7/12	NA	0.0065	1/12
Th-228	2.55E-05	1/1	NA	d	d
Sr	34.6	3/4	NA	0.57	3/4
Co-60	1.59	3/6	NA	0.00065	3/6
Cs-137	5.28	3/9	NA	0.0027	3/9

a. Suter et al. (1992), EPA (1986).

b. Value protective of ecological receptors, International Atomic Energy Agency, IAEA (1992).

c. Estimated in Suter et al. (1992).

d. Screening criteria not located. Will be evaluated in ERA, if possible.

e. Eliminated.

f. Inorganic mercury.

g. Also detected in method blank.

NA = Not Applicable

Table 2-16. Initial surface water screening of ANL Industrial Waste Lift Station Discharge Ditch (ANL-35).

Contaminant	Maximum concentration (mg/L)	Frequency of Detection (FOD)	Chronic NAWQ criteria (mg/L)[a]	Frequency of Exceedance (FOE)
INORGANICS				
Antimony	0.0037	1/2	0.018[b]	0/2[c]
Copper	0.029	2/2	0.012	2/2
Zinc	0.082	1/2	0.110	0/2[c]
ORGANICS				
4-Methyl-2-pentanone	0.001	1/2	0.0023[b]	0/2[c]
Bromoform	0.001	1/2	NL[d]	NL[d]

a. Suter et al. (1992), EPA (1986).

b. Estimated in Suter et al. (1992).

c. Eliminated.

d. Screening criteria not located. Will be evaluated in ERA, if possible.

Sediment concentrations of organic contaminants were compared to calculated sediment quality benchmarks (SQB)s using the following equation:

$$SQB = f_{oc} \times K_{ow} \times NAWQC \tag{2-1}$$

where

SQB	=	Sediment quality benchmark for organics
f_{oc}	=	Fraction of organic carbon at INEL (0.003) (DOE 1994)
K_{ow}	=	Octanol-water partition coefficient (Hull and Suter 1993 and Montgomery and Welkom, 1989)
NAWQC	=	National ambient water quality criteria (Suter et al. 1992)

The screening criteria for radioactive contaminants were based on values determined by the IAEA (1992) to be protective of ecological receptors and the soil/water partition coefficient (K_d).

Table 2-17. Initial sediment screening of ANL Industrial Waste Pond and Cooling Tower Blowdown Ditches (ANL-01).

Contaminant	Maximum concentration (mg/kg or pCi/g)	FOD[a]	WDNR[b] Guideline[c]	NOAA ER-L[d] Concentration[c]	EPA[e] Polluted Sediment Classification[c]	WA[f] Value[c]	Beak[g] Guideline[c]	Ont. MOE[c,h]	Calculated SQB[i,j]	IAEA Value[k]	FOE[l]
INORGANICS											
Aluminum	31,800	19/19	--	--	--	--	--	--	NA	NA	m
Antimony	99.2	11/19	--	2	--	--	--	--	NA	NA	10/19
Arsenic III/V[m]	25	12/19	10	33	3	57	17	6	NA	NA	13/19
Barium	406	19/19	500	--	20	--	--	--	NA	NA	19/19
Beryllium	2.2	17/19	--	--	--	--	--	--	NA	NA	m
Cadmium	7	19/19	1	5	--	5.1	2.5	0.6	NA	NA	11/19
Calcium	139,000	14/19	--	--	--	--	--	--	NA	NA	m
Chloride	44	6/6	--	--	--	--	--	--	NA	NA	m
Chromium III/VI[n]	11,400	19/19	100	80	25	260	100	26	NA	NA	16/19
Cobalt	17.9	19/19	--	--	--	--	--	--	NA	NA	m
Copper	137	19/19	100	70	25	390	85	16	NA	NA	15/19
Cyanide	13.8	9/13	--	--	--	--	--	--	NA	NA	m
Fluoride	9.1	6/6	--	--	--	--	--	--	NA	NA	m
Iron	42,800	19/19	--	--	17000	--	--	--	NA	NA	12/19
Lead	32.6	19/19	50	35	40	450	55	31	NA	NA	1/19
Magnesium	37,700	19/19	--	--	--	--	--	--	NA	NA	m
Manganese	746	19/19	--	--	300	--	1200	460	NA	NA	10/19
Mercury	6.8	9/19	0.1	0.15	1	0.41	0.6	0.2	NA	NA	14/19
Nickel	65.2	19/19	100	30	20	--	92	16	NA	NA	18/19
Nitrate	3.1	4/4	--	--	--	--	--	--	NA	NA	m
Phosphate	1.3	4/4	--	--	--	--	--	--	NA	NA	m
Potassium	8110	19/19	--	--	--	--	--	--	NA	NA	

Table 2-17. (continued).

Contaminant	Maximum concentration (mg/kg or pCi/g)	FOD[a]	WDNR[b] Guideline[c]	NOAA ER-L[d] Concentration[c]	EPA[e] Polluted Sediment Classification [c]	WA[f] Value[c]	Beak[g] Guideline[c]	Ont. MOE[c,h]	Calculated SQB[i,j]	IAEA Value[k]	FOE[l]
Selenium	3.3	3/19	--	--	--	--	--	--	NA	NA	m
Silver	37.9	11/19	--	1	--	6.1	--	--	NA	NA	11/19
Sodium	1310	18/19	--	--	--	--	--	--	NA	NA	m
Sulfide	1266	4/4	--	--	--	--	--	--	NA	NA	m
Sulfate	3300	6/6	--	--	--	--	--	--	NA	NA	m
Vanadium	109	19/19	--	--	--	--	--	--	NA	NA	m
Zinc	5850	19/19	100	120	90	410	143	120	NA	NA	15/19
ORGANICS											
1,1,1-Trichloroethane	0.021	4/7	NA	NA	NA	NA	NA	NA	m	NA	m
2-Butanone	0.2	6/7	NA	NA	NA	NA	NA	NA	8.73	NA	0/7[m]
2,4,5-TP (silvex)	27.6	1/1	NA	NA	NA	NA	NA	NA	m	NA	m
Acetone	0.13	6/7	NA	NA	NA	NA	NA	NA	1.33	NA	0/7[m]
bis(2-Ethyl hexyl)phthalate	0.008	2/2	NA	NA	NA	NA	NA	NA	m	NA	m
Chloroform	.005	2/7	NA	NA	NA	NA	NA	NA	m	NA	m
Diethylphthalate	0.002	1/2	NA	NA	NA	NA	NA	NA	m	NA	m
Di-n-butylphthalate	0.009	1/2	NA	NA	NA	NA	NA	NA	m	NA	m
Methylene Chloride	0.3	7/7	NA	NA	NA	NA	NA	NA	11.7	NA	0/7[m]
Toluene	0.005	2/7	NA	NA	NA	NA	NA	NA	m	NA	m
RADIONUCLIDES											
Cesium-137	29.4	10/11	NA	NA	NA	NA	NA	NA	NA	2.6	7/11
Cobalt-60	0.23	6/11	NA	NA	NA	NA	NA	NA	NA	n	

Table 2-17. (continued).

Contaminant	Maximum concentration (mg/kg or pCi/g)	FOD[a]	WDNR[b] Guideline[c]	NOAA ER-L[d] Concentration[c]	EPA[e] Polluted Sediment Classification [c]	WA[f] Value[c]	Beak[g] Guideline[c]	Ont. MOE[c,h]	Calculated SQB[i,j]	IAEA Value[k]	FOE[l]
Thorium-230	1.7	3/4	NA	NA	NA	NA	NA	NA	NA	n	m
Uranium-238	2.9	4/4	NA	NA	NA	NA	NA	NA	NA	1.2	2/4

a. Frequency of Detection

b. Wisconsin Department of Natural Resources, cited in Hull and Suter (1993)

c. Hull and Suter (1993)

d. National Oceanic and Atmospheric Administration, Effects Range-Low, cited in Hull and Suter (1993)

e. US Environmental Protection Agency, cited in Hull and Suter (1993)

f. Washington State, cited in Hull and Suter (1993)

g. Beak Consultants, cited in Hull and Suter (1993)

h. Ontario Ministry of Environment, cited in Hull and Suter (1993)

i. Suter et al. (1992)

j. Sediment Quality Benchmark

k. International Atomic Energy Agency, IAEA (1992). Reported values were multiplied by soil/water partition coefficient.

l. Frequency of Exceedance. Comparisons were made against smallest screening value.

m. Screening criteria not located. Will be evaluated in ERA, if possible.

n. Different forms not differentiated in screening criteria or sample data.

o. Eliminated.

-- Not reported

NA = Not applicable

Table 2-18. Initial sediment screening of ANL Sewage Lagoons (ANL-04).

Contaminant	Maximum concentration (mg/kg or pCi/g)	FOD[a]	WDNR[b] Guideline[c]	NOAA ER-L[d] Concentration[c]	EPA[e] Polluted Sediment Classification[c]	WA[f] Value[c]	Beak[g] Guideline[c]	Ont. MOE[c,h]	IAEA Value[i]	FOE[j]
INORGANICS										
Aluminum	12,100	7/7	--	--	--	--	--	--	NA	k
Antimony	106	7/7	--	2	--	--	--	--	NA	7/7
Arsenic III/V[l]	10.4	6/7	10	33	3	57	17	6	NA	4/7
Barium	559	7/7	500	--	20	--	--	--	NA	7/7
Beryllium	1.8	7/7	--	--	--	--	--	--	NA	k
Calcium	77,100	7/7	--	--	--	--	--	--	NA	k
Chromium III/VI[l]	76.4	6/7	100	80	25	260	100	26	NA	2/7
Cobalt	8.6	6/7	--	--	--	--	--	--	NA	k
Copper	346	7/7	100	70	25	390	85	16	NA	3/7
Cyanide	16.3	7/7	--	--	--	--	--	--	NA	k
Iron	14,700	7/7	--	--	17000	--	--	--	NA	0/7[m]
Lead	121	7/7	50	35	40	450	55	31	NA	2/7
Magnesium	14,800	7/7	--	--	--	--	--	--	NA	k
Manganese	254	7/7	--	--	300	--	1200	460	NA	0/7[m]
Mercury	3.2	3/7	0.1	0.15	1	0.41	0.6	0.2	NA	7/7
Nickel	41.4	5/7	100	30	20	--	92	16	NA	5/7
Potassium	3150	7/7	--	--	--	--	--	--	NA	k
Selenium	3.5	3/7	--	--	--	--	--	--	NA	k
Silver	37.2	1/7	--	1	--	6.1	--	--	NA	1/7
Sodium	1530	7/7	--	--	--	--	--	--	NA	k
Vanadium	72.6	6/7	--	--	--	--	--	--	NA	k
Zinc	2390	7/7	100	120	90	410	143	120	NA	

Table 2-18. (continued).

Contaminant	Maximum concentration (mg/kg or pCi/g)	FOD[a]	WDNR[b] Guideline[c]	NOAA ER-L[d] Concentration[c]	EPA[e] Polluted Sediment Classification[c]	WA[f] Value[c]	Beak[g] Guideline[c]	Ont. MOE[c,h]	IAEA Value[i]	FOE[j]
RADIONUCLIDES										
Cesium-137	0.32	3/8	NA	NA	NA	NA	NA	NA	2.6	0/8[m]
Strontium-90	4.2	1/2	NA	NA	NA	NA	NA	NA	14	0/2[m]

a. Frequency of Detection

b. Wisconsin Department of Natural Resources, cited in Hull and Suter (1993)

c. Hull and Suter (1993)

d. National Oceanic and Atmospheric Administration, Effects Range-Low, cited in Hull and Suter (1993)

e. US Environmental Protection Agency, cited in Hull and Suter (1993)

f. Washington State, cited in Hull and Suter (1993)

g. Beak Consultants, cited in Hull and Suter (1993)

h. Ontario Ministry of Environment, cited in Hull and Suter (1993)

i. International Atomic Energy Agency, IAEA (1992). Reported values were multiplied by soil/water partition coefficient.

j. Frequency of Exceedance. Comparisons were made against smallest screening value.

k. Screening criteria not located. Will be evaluated in ERA, if possible.

l. Different forms not differentiated in screening criteria or sample data.

m. Eliminated.

-- Not reported

NA = Not applicable

Several contaminants can be eliminated from further analysis. The maximum concentrations of 2-butanone, acetone, and methylene chloride did not exceed the screening criteria at the ANL-01 site (Table 2-17). At ANL-04, screening criteria were not exceeded by manganese, cesium-137, and strontium-90 (Table 2-18).

Screening criteria were not located for beryllium, chloride, cobalt, cyanide, chloride, nitrate, phosphate, selenium, sulfide, sulfate, vanadium, 1,1,1-trichloroethane, 2,4,5-TP, bis(2 ethylhexyl)phthalate, chloroform, diethylphthalate, di-n-butylphthalate, toluene, cobalt-60, and thorium-230. These contaminants will be evaluated in the ERA, if possible.

2.4.4 Summary of Contaminants Assessed for WAG 9

Contaminants identified in WAG 9 surface water are listed in Tables 2-15 and 2-16. At ANL-01, 31 contaminants (25 nonradionuclides and 6 radionuclides) exceeded the corresponding screening criteria and are retained as surface water contaminants of concern. Only two nonradionuclides exceeded the NAWQC at ANL-35 and are considered contaminants of concern.

WAG 9 sediment contaminants are presented in Tables 2-17 and 2-18. Fourty contaminants (36 nonradionuclides and 4 radionuclides) at ANL-01 and 20 nonradionuclides at ANL-04 exceed the corresponding screening criteria and are retained as contaminants of concern.

Tables 2-19 and 2-20 summarize the contaminants identified in subsurface and surface soils, respectively. The tables provide the frequency of detection, the maximum detected concentrations, and the arithmetic mean concentration. For subsurface soils, 24 nonradioactive contaminants and one radionuclide remain in the assessment. For surface soils, 13 non-radionuclides and four radionuclides remain in the assessment. These contaminants will be quantitatively evaluated in the SLERA for WAG 9.

2.4.5 Uncertainty Associated with Determining the Nature and Extent of Contamination Onsite and the Selection of Contaminants

The uncertainties involved in measuring contaminant concentrations in environmental media can be substantial. Major sources of uncertainty in environmental sampling and analysis include handling procedures; sampling location, number, and density; selection of contaminants; analyte extraction; sample dilution; analytical detection limits and handling of nondetects; analyte interference; and instrument limitations. Even with strict quality assurance and control measures, there is no assurance that the environmental samples taken are fully representative of the site. Uncertainties associated with identifying contaminants include those connected with sampling environmental media and those related to the use of small data sets in the statistical evaluation of data. These uncertainties are expected to have a low to moderate potential to overestimate or underestimate risk.

2.5 Pathways of Contaminant Migration and Exposure

A total of 10 sites of concern have the potential for posing risk to WAG 9 ecological components through two primary media: contaminated surface soil, contaminated subsurface soil, and contaminated surface water as discussed in the following sections. There were 7 sites of the 10 which had available

Table 2-19. WAG 9 subsurface soil contaminants.

Contaminant	FOD	Maximum concentration	Arithmetic mean[a]
Nonradionuclides		(mg/kg)	(mg/kg)
1,1,1-Trichloroethane	6/15 (40%)	530.0	57.67
2-Butanone	7/15 (46.7%)	180.0	64.23
Acetone	7/13 (53.8%)	79.0	25.65
Antimony	8/57 (14.0%)	16.1	7.39
Arsenic	98/113 (86.7%)	24.8	6.44
Beryllium	61/68 (89.7%)	5.8	1.11
Butylbenzylphthalate	1/10 (10.0%)	245.0	179.75
Calcium	67/68 (98.5%)	88,200	56,577.5
Chloride	6/6 (100%)	37	18.32
Chloroform	2/15 (13.3%)	6.5	3.83
Chromium	116/116 (100%)	1110	47.42
Copper	68/68 (100%)	136	26.17
Cyanide	9/51 (17.6%)	12.2	1.01
Di(2-ethylhexyl)phthalate	2/8 (25.0%)	120.0	108.0
Di-n-octylphthalate	2/10 (20.0%)	245.0	132.25
Dioxins/furans	13/100 (13%)	1.1×10^{-4}	2.13×10^{-5}
Fluoride	6/6 (100%)	7	4.73
Lead	116/116 (100%)	57.4	13.94
Manganese	64/64 (100%)	1180	454.98
Mercury	53/116 (45.7%)	2.4	0.14
Methylene chloride	7/10 (70.0%)	310.0	143.90
Nitrate	6/6 (100%)	22	10.90
Phosphate	6/6 (100%)	17	5.48
Polychlorinated biphenyls	2/6 (33.3%)	55	47
Silver	44/115 (38.3%)	226	11.78
Sodium	64/68 (94.1%)	2780	501.65
Sulfate	6/8 (75%)	620	138.65
Toluene	4/15 (26.7%)	6.5	3.63
Zinc	62/68 (91.2%)	3020	

Table 2-19. (continued).

Contaminant	FOD	Maximum concentration	Arithmetic mean[a]
Radionuclides		(pCi/g)	(pCi/g)
Cs-137	39/125 (31.2%)	5.9	0.35

a. Non-detect values were assumed to be equal to one-half the detection limit. Samples with a "B" (organics only) flag were not included in calculation of mean values.

Table 2-20. WAG 9 surface soils contaminants.

Contaminant	FOD	Maximum concentration	Arithmetic mean[a]
Nonradionuclides		(mg/kg)	(mg/kg)
Antimony	7/68 (10.3%)	61.5	12.38
Arsenic	75/78 (96.2%)	74.6	12.07
Calcium	76/76 (100%)	190,000	40,817.11
Chromium	82/82 (100%)	9,990	497.21
Copper	76/76 (100%)	999	84.69
Cyanide	11/76 (14.5%)	32.4	1.37
Lead	78/82 (92.1%)	159	34.19
Mercury	47/78 (60.3%)	16.1	1.23
Nickel	76/76 (100%)	540	45.70
Selenium	10/78 (12.8%)	2.2	0.47
Silver	31/83 (37.3%)	352	33.20
Sodium	70/76 (92.1%)	3,060	485.76
Zinc	75/76 (98.7)	2,130	368.55
Radionuclides		(pCi/g)	(pCi/g)
Co-60	20/133 (15.0%)	0.37	0.18
Cs-137	111/133 (83.5%)	52	3.0
Sr-90	4/21 (19.0%)	5.8	0.89
U-238	12/21 (57.1%)	21	2.4

a. Non-detect values were assumed to be equal to one-half the detection limit. Samples with a "B" (organics only) flag were not included in calculation of mean values

sampling data for evaluation in the WAG 9 SLERA. These sites are listed by medium in Table 2-2. Surface water screening is addressed in Tables 2-15 and 2-16 for the contaminants detected in sites ANL-01 and ANL-35. Sediment screening data are presented for sites ANL-01 and ANL-04 on Table 2-17 and 2-18. Groundwater is considered inaccessible to ecological receptors because of the depth to the aquifer at the INEL [60–180 m (200–600 ft)] and large distance to surface springs [over 160 km (100 mi)] (EG&G Idaho 1993). Major contaminant classes for all media include metals, organic compounds, and radionuclides.

2.5.1 Surface Soil

Contaminated surface soil represents the major source of possible contaminant exposure for WAG 9 ecological components. Surface soil, as defined for use in the INEL SLERAs, includes the uppermost 15 cm (6 in.). Eight of the 10 WAG 9 sites of concern shown on Table 2-2 represent sources of surface soil contamination resulting from past contamination.

The ecological pathways/exposure model for WAG 9 contaminated surface soil is shown in Figure 2-5. This model depicts the various mechanisms for surface soil contamination transport. These include:

- Wind and water erosion
- Leaching and infiltration
- Plant uptake
- Burrowing animal translocation.

Transportation of contaminated soils through these mechanisms may result in contamination of various other media or secondary sources, including the following onsite and offsite sources:

- Surface water
- Surface soil
- Subsurface soil
- Vegetation.

Receptors having potential for direct exposure to WAG 9 surface soils are presented on Table 2-21. Ecological receptors can be exposed to contaminated media directly through ingestion of vegetation, water, or soil, or through physical contact or inhalation. Inhalation and physical contact, however, are considered to play minor roles in exposure to surface contamination for WAG 9. The functional groups identified as having direct exposure include most terrestrial bird, mammal, reptile, and insect species potentially present in the WAG 9 assessment area.

2.5.2 Subsurface Soil

The ecological pathways/exposure model for WAG 9 contaminated subsurface soils is presented in Figure 2-6. Nine of the 10 WAG 9 sites of concern (Table 2-2) involve contaminated subsurface soil sites resulting from buried contaminated soil or sediments, leach ponds and ditches and past surface spills followed by leaching. For the SLERA analysis, subsurface soils are defined at depths of 15 cm to 3 m (0.5 to 10 ft). Contaminants in subsurface soil can be transported to ecological receptors by plant uptake and translocation

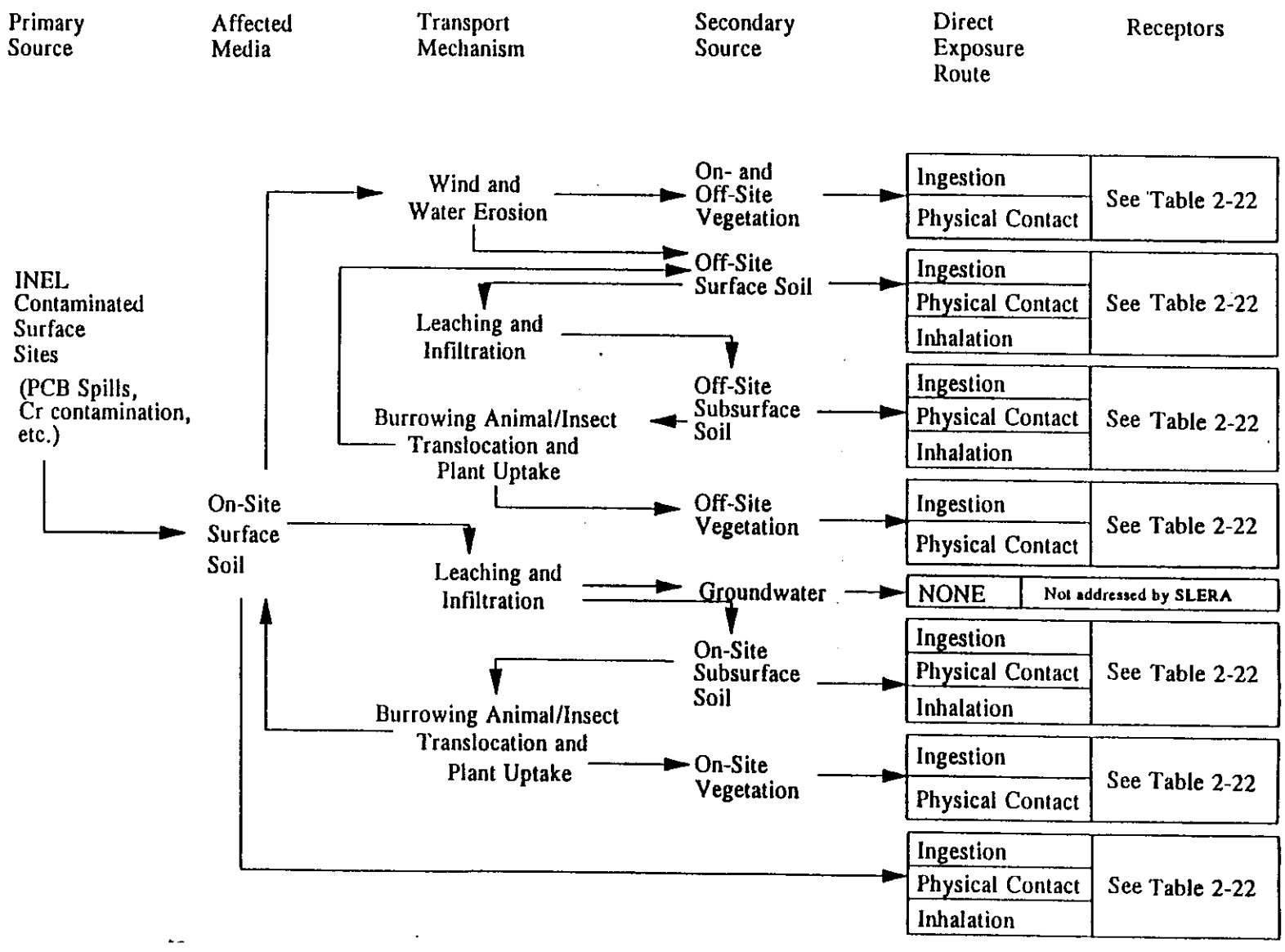

Figure 2-5. Ecological pathways/exposure model for WAG 9 surface contamination.

Table 2-21. Summary of WAG 9 direct exposure pathways and receptors.

Exposure medium	Direct exposure route	Potential receptors (functional groups)[a]
Subsurface soil	Ingestion (dietary)	AV222A, AV322A, M121, M122A, M123, M222, M322, M422, M422A, R222, R322, terrestrial invertebrates, microorganisms, individual plant species
	Physical contact	AV222A, AV322A, M121, M122A, M123, M222, M322, M422, M422A, R222, R322
	Inhalation	Not addressed
Surface soil	Ingestion (dietary)	AV121, AV122, AV222, AV322, AV322A, AV422, M122, M122A, M322, M422, M422A, R222, R322, terrestrial invertebrates, microorganisms
	Physical contact	AV121, AV122, AV210, AV210A, AV310, AV322, AV322A, AV422, M122, M122A, M322, M422, M422A, R222, R322, terrestrial invertebrates, microorganisms, individual plant species
	Inhalation	Not addressed
Vegetation	Ingestion (dietary)	AV121, AV122, AV143, AV422, M122, M122A, M422, phytophagous insects
	Physical contact	AV121, AV122, AV210, AV210A, AV221, AV222, AV233, AV310, AV322, AV322A, M121, M122, M122A, terrestrial invertebrates
Surface water	Ingestion (dietary)	AV121, AV122, AV143, AV210, AV210A, AV221, AV222, AV233, AV310, AV322, AV322A, AV422, AV442, M122, M122A, M210A, M322, M422, M422A, R222, R322, aquatic microfauna
	Physical Contact	AV143,AV233,AV442, aquatic microflora/fauna
Sediments	Ingestion (dietary)	AV442, benthic invertebrates
	Physical contact	AV143, AV233, AV442, benthic invertebrates
	Inhalation	Not addressed

a. Individual species associated with these groups are listed on Table 2-6.

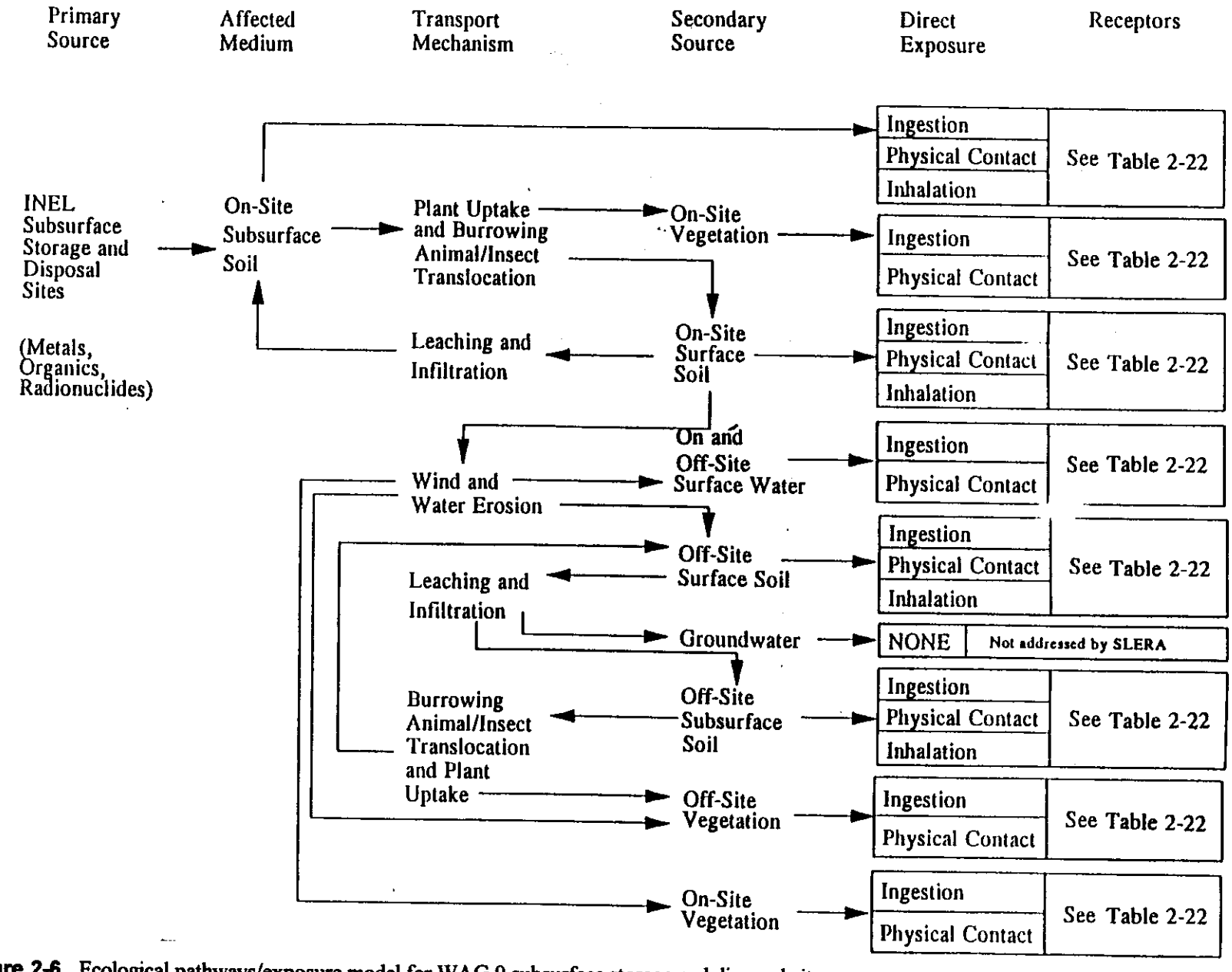

Figure 2-6. Ecological pathways/exposure model for WAG 9 subsurface storage and disposal sites.

by burrowing animals and macroinvertebrates. Contamination depths greater than 3 m (10 ft) below surface are considered inaccessible to ecological receptors, since this is generally below the root zone of plants and burrowing depth of ground-dwelling animals.

Once contaminated soil is brought close to the surface, transport and exposure scenarios for ecological receptors are the same as for surface soil. For subsurface contamination, inhalation and direct contact (by burrowing animals) are likely more important exposure routes than for surface contamination.

Receptors having potential for direct exposure to WAG 9 subsurface soil contamination are presented on Table 2-21. These receptors include animals dwelling below ground and deep rooting plants. Because subsurface soil contamination may be translocated to the surface by burrowing and plant uptake, other terrestrial species also have some potential for exposure through this pathway.

2.5.3 Surface Water and Sediments

Surface water sites exist at the ANL facility include the Industrial Waste Pond and cooling tower blowdown ditches (ANL-01), the Sewage Lagoons (ANL--04) and the Industrial Waste Lift Station discharge ditch (ANL-35). Contaminated sediments are associated with the Industrial Waste Pond and Sewage Lagoons.

The pathways/exposure model for contaminated surface water sites at the INEL is shown in Figure 2-7. Ecological receptors having potential for direct exposure to surface water and sediment pathways are identified on Table 2-21. Receptors having potential for exposure through this pathway were analyzed using Ambient Water Quality Criteria and/or sediment quality criteria.

2.5.4 Ecological Conceptual Site Model

The pathways/exposure models for surface soil, subsurface soil, and surface water were integrated to produce the WAG 9 conceptual site model shown in Figure 2-8. This model reflects both direct (previous sections) and indirect (i.e., predation) receptor exposure pathways for WAG 9 contaminants.

2.6 Assessment Endpoints

Assessment endpoints are "formal expressions of the actual environmental values that are to be protected" (Suter 1989). Assessment endpoints developed for this SLERA are presented on Table 2-22. The endpoints were developed around the protection of INEL biota represented by functional groups and individual T/E and sensitive species know to exist at WAG 9 and identified as having potential for exposure to contaminants (see Section 2.5). Each T/E species is addressed individually in the risk analysis, whereas potential effects to other receptors are dealt with at the functional group level. Assessment endpoints defined for the WAG 9 SLERA reflect INEL-wide hazard/policy goals discussed in the guidance manual (VanHorn et al. 1995) and incorporate the suggested criteria for developing assessment endpoints, including ecological relevance, susceptibility to the stressors, policy goals and societal values, and accessibility to prediction and measurement (EPA 1993a; Suter 1993).

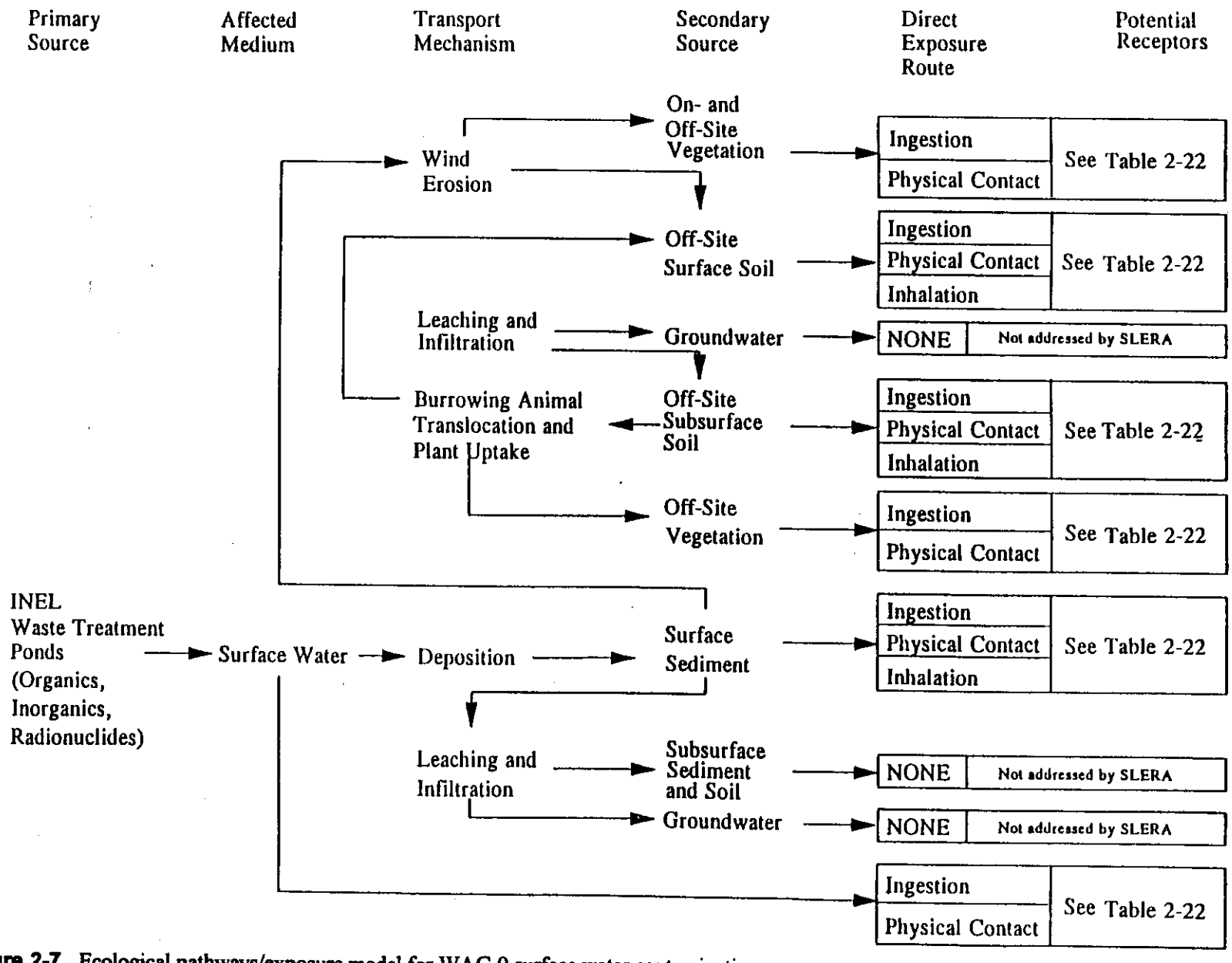

Figure 2-7. Ecological pathways/exposure model for WAG 9 surface water contamination.

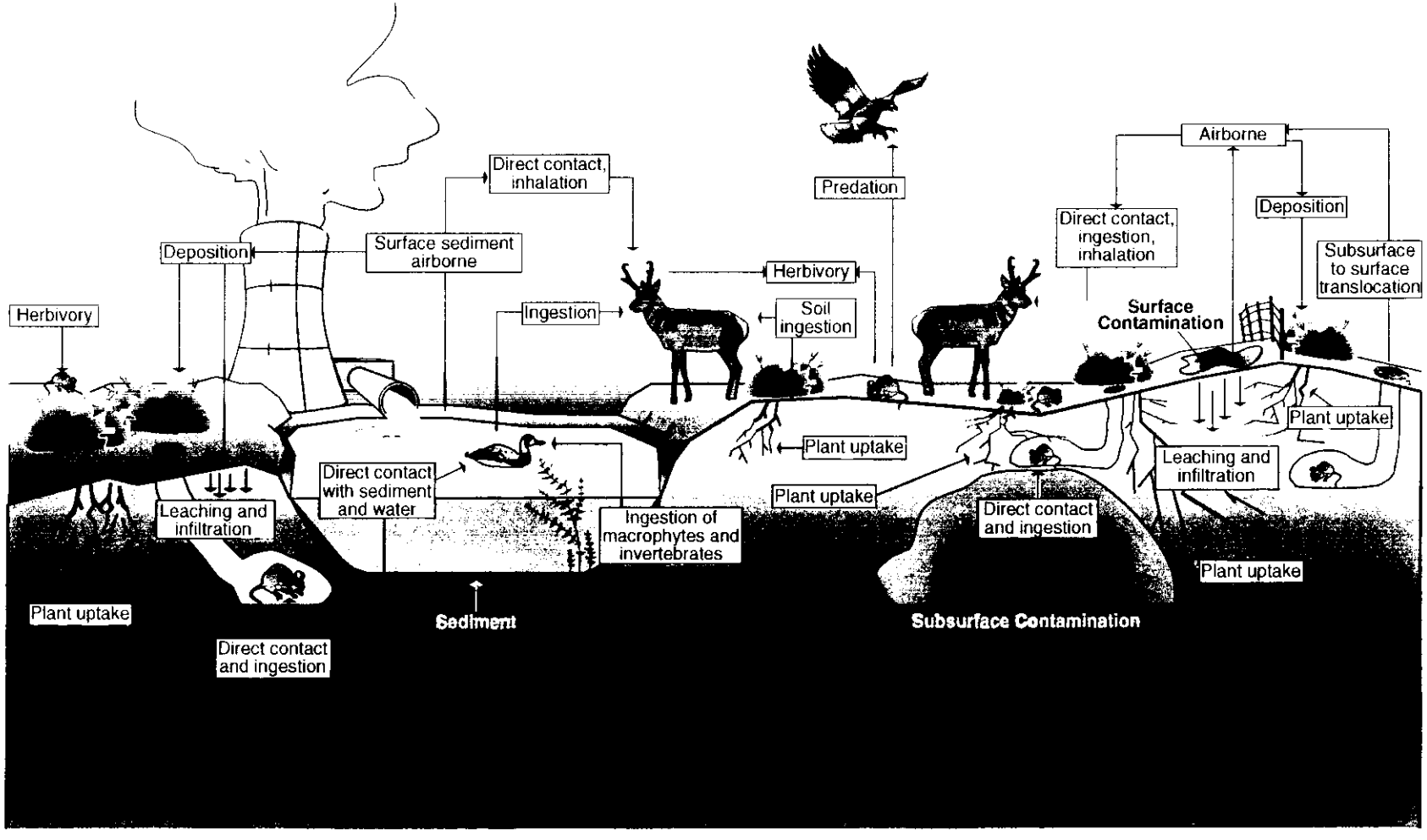

Figure 2-8. WAG 9 ecological conceptual site model.

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Table 2-22. Summary of WAG 9 SLERA assessment endpoints.

Management goal	WAG SLERA endpoint	Indicator of effects
No unacceptable reductions to INEL T/E individuals and populations as a result of exposure to organic, inorganic, and radionuclide contamination.	No indication of possible effects to T/E individuals and populations as a result of contaminant exposure: peregrine falcon, northern goshawk, bald eagle, ferruginous hawk, loggerhead shrike, burrowing owl, trumpeter swan, white-faced ibis, black tern, pygmy rabbit, Townsend's western big-eared bat, long-eared myotis, small-footed myotis, and sagebrush lizard individuals and populations (Functional Groups AV310, AV322, AV322A, AV143, AV233, AV210, M123, M210A, and R222).	SLQ ≥ 1 for nonradiological contaminants SLQ ≥ .1 for radiological contaminants
No unacceptable reductions to INEL T/E individuals and populations as a result of physical stressors.	Not addressed by SLERA	N/A
No unacceptable reductions to abundance and diversity of INEL native biota as a result of exposure to organic, inorganic, and radionuclide contamination	No indication of possible effects to WAG 9 native vegetation communities as a result of contaminant exposure.	SLQ ≥ 1 for nonradiological contaminants SLQ ≥ .1 for radiological contaminants
	No indication of possible effects to WAG 9 wildlife populations as a result of contaminant exposure (represented by functional groups identified in the site conceptual model: waterfowl, small mammals, large mammals, song birds, raptors, top predators, invertebrates).	SLQ ≥ 1 for nonradiological contaminants SLQ ≥ .1 for radiological contaminants
No unacceptable reductions to abundance and diversity of INEL native biota as a result of physical stressors.	Not addressed by SLERA	N/A

Source: Suter 1993

These assessment endpoints are the focus for SLERA risk characterization and link the measurement endpoints to the SLERA goals. The primary objective of this SLERA is to identify contaminants and levels of those contaminants that represent potential risk to WAG 9 ecological components. Consequently, toxic effects to ecological components as a result of exposure to contaminants were considered a primary concern for WAG 9 biota. Although adverse effects due to physical stressors are also of concern in evaluating potential risks to INEL ecological components, these effects are not addressed by SLERA endpoints. It is beyond the scope of a SLERA to quantify risk, so an ecologically based approach is used to establish the potential for contaminants to contribute to ecological risk to WAG 9 individuals and populations. A SLQ is used to indicate whether or not a potential for adverse effects exists. The use of SLQs as an indicator of effects is discussed in detail in Section 4.

2.7 Measurement Endpoint Selection

Measurement endpoints are measurable responses to ecological receptors to contaminants that can be related to SLERA assessment endpoints (Section 2.6). For this SLERA, WAG 9 ecological components (flora and fauna) were not surveyed directly. Rather, published references were used as the primary sources of ecological and toxicological data from which measurement endpoints were derived. Values extracted from these references were used to calculate EBSLs for all ecological receptors and to develop TRVs for contaminants.

Table 2-23 summarizes the measurement endpoints developed to address WAG 9 screening-level assessment endpoints (Section 2.6). Quantified critical exposure (QCE) levels and adjustment factors were constructed from the literature to develop appropriate TRVs for receptors associated with WAG 9 contaminant pathways (Section 3.2.2). Criteria for development of these TRVs are discussed in Section 3.2. In general, the criteria incorporate the requirements for appropriate measurement endpoints, including relevance to an assessment endpoint, applicability to the route of exposure, use of existing data, and consideration of scale (VanHorn et al. 1995).

Published values for species dietary habits, home ranges, site use, exposure duration, soil ingestion, food digestion, and body weights (BWs) for the representative species listed on Table 3-1 and discussed in Section 3.1.2 were used in conjunction with these TRVs to develop EBSLs for each affected receptor.

Average contaminant soil concentrations were then divided by the EBSL to produce an SLQ for each contaminant and receptor of concern. The SLQ is ultimately used to measure whether the assessment endpoint has been attained, that is, no indication of possible effects is determined (SLQs are less than target value for all receptors for each contaminant).

The use of EBSLs and contaminant concentrations to derive SLQs for WAG 9 ecological receptors is discussed in detailed in Section 4.1.

Table 2-23. Summary of WAG 9 SLERA measurement endpoints.

WAG 9 assessment endpoint	Ecological component	Functional group (other groups represented)	Toxicity test species[b] (TRV/EBSL)
No indication of possible effects to T/E individuals and populations as a result of contaminant exposure: peregrine falcon, burrowing owl, ferruginous hawk, bald eagle, loggerhead shrike, northern goshawk, white-faced ibis, black tern, trumpeter swan, pygmy rabbit, and Townsend's western big-eared bat, small-footed myotis (SLQ <1 for nonradiological controls and 0.1 for radiological controls)	Pygmy rabbit	M122A(M123)	Rat, mouse/meadow vole (M122A), deer mouse
	Peregrine falcon, Northern goshawk	AV310	Chicken, goshawk, American kestrel/red-tailed hawk (AV322)
	Burrowing owl	AV322A	Chicken, goshawk, American kestrel/red-tailed hawk (AV322)
	Ferruginous hawk, Loggerhead shrike, Bald eagle	AV322	
	Townsend's western big-eared bat	M210A (M210)	
	Small- footed myotis, Long-eared myotis		
	White-faced ibis	AV233	
	Black tern	AV210	
	Trumpeter swan	AV143	
	Sagebrush lizard	R222	
No indication of possible effects to WAG 9 native vegetation communities as a result of contaminant exposure (SLQ <1 for nonradiological controls and 0.1 for radiological controls)	Vegetation	Sagebrush, bunchgrass	Bush beans, crop plants
No indication of possible effects to WAG 9 wildlife populations as a result of contaminant exposure (represented by functional groups identified in the site conceptual model: waterfowl, small mammals, large mammals, song birds, raptors, top predators, invertebrates) (SLQ <1 for nonradiological controls and 0.1 for radiological controls)	Mammalian	M422, M122A (M222, M123)	Rat,mouse/meadow vole (M122A), deer mouse
	Mammalian carnivore/ omnivore	M422A, M322	Rat, mouse, dog, cat, mink/fox
	Mammalian herbivores	M121 (M122)	Rat, mouse, mule deer/pronghorn
	Avian carnivores	AV322	Goshawk, American kestrel/red-tailed hawk (AV322)
			Chicken, pheasant, quail, passerines/sharp-tailed and ruffed grouse
	Avian herbivore	AV122 (AV122)	Chicken, pheasant, quail, passerines/American robin, cliff swallow
	Avian insectivore	AV210, AV222 (AV210A, AV221, AV222A)	Chicken, pheasant, quail passerines
			None located
			None located/Western racer
	Avian carnivore/ omnivore	AV422	Unidentified
	Mammalian insectivore	M210A (M210)	
	Reptiles	R222, R322	
	Invertebrates	Unidentified	

a. Measurement endpoints are discussed in Section 3.

b. Data for measurement species are discussed in detail in Section 3 and summarized in the Appendices.

3. SCREENING ANALYSIS

The risk analysis step of the WAG 9 SLERA involves assessing exposure to contaminants and potential effects of exposure. These activities are conducted interactively to ensure that the methods used to assess exposure and effects are compatible. Assessing exposure and effects is based on the ecological endpoints and conceptual models derived during the problem formulation presentation.

3.1 Exposure Assessment

Determining if exposure to site-related contaminants may increase the incidence of adverse effects in exposed populations is an important activity in the risk analysis step. The objective of this activity is to estimate the magnitude, frequency, duration, and route of exposure to site-related contaminants by ecological receptors. Accomplishing this task involves completing the following steps:

1. Discuss contaminant fate and transport properties of the contaminants.

2. Estimate Ecologically Based Screening Levels (EBSL)s for all functional groups and contaminants.

3.1.1 Discuss Contaminant Fate and Transport

This section discusses the behavior and fate of the contaminant in the terrestrial environment. No formal transport and fate modeling was conducted for this SLERA. Environmental fate properties are important because they provide information on the environmental behavior of contaminant compounds throughout various environmental media. WAG 9 surface and subsurface soil contaminants that were identified in Section 2.4 are:

- 1,1,1-trichloroethane
- 2-butanone
- acetone
- antimony
- arsenic
- beryllium
- butylbenzylphthalate
- calcium
- chloride
- chloroform
- chromium
- copper
- cyanide
- di(2-ethylhexyl)phthalate
- di-n-octylphthalate
- dioxins/furans
- fluoride
- lead
- manganese
- mercury
- methylene chloride
- nickel
- nitrate
- phosphate
- polychlorinated biphenyls
- selenium
- silver
- sodium
- sulfate
- toluene
- zinc
- Co-60
- Cs-137
- Sr-90
- U-238

The following subsections contain discussions of the fate and transport of selected nonradiological metals, nonradiological organic, and radiological contaminants.

3.1.1.1 Nonradiological Metals. This subsection discusses the fate and transport of nonradiological metals. Metals readily sorb to particulate matter and may complex with various anions such

as carbonates and sulfides, modifying their water solubility. Such sorption and complexation (typically diminishes) the bioavailability of metals in soils/sediments or aqueous systems (Adams et al. 1992).

Antimony—Antimony is a multivalent element and can exist in the +5, +3, or -3 oxidation states. Antimony may accumulate with heavy elements in carbonaceous shales or become sorbed on clays and hydrous oxides. Antimony may be volatilized when stibine (SbH_3) or its methylated derivatives are formed during the reduction of antimony in soils. Antimony has an affinity for clay and other mineral surfaces. Less than 10% of the antimony in sediments from both contaminated and uncontaminated sediments was bound to easily oxidizable organic matter (Callahan et al. 1979). Since antimony has an anionic character in aqueous solution, it probably has little affinity for complexation with humic and fulvic acids.

Arsenic—Arsenic is commonly present in living organisms and is constantly being oxidized, reduced, or metabolized. Many arsenic compounds are readily solubilized in soil, making them available for plant uptake or for reduction by organisms or chemical interactions. Biological uptake of arsenic results in measurable quantities of reduced or methylated arsenic forms. Arsenic occurs naturally in all environmental media. Arsenic has four valence states: -3, 0, +3, and +5. Arsines and methylarsines, which are characteristic of compounds in the -3 state, are unstable in air. Most arsenical degrade to yield arsenate, although arsenite may form under anaerobic conditions. Biotransformation of these compounds may occur and yield volatile arsenicals. The dominant form of arsenic present in aerobic soils is As^{+5}, while As^{+3} is the primary species in anaerobic soils. Inorganic arsenic is more mobile than organic arsenicals and thus is more likely to leach into surface waters or groundwater. Trivalent species are generally more toxic, more soluble, and more mobile than pentavalent forms. Soil microbes can metabolize arsenic to volatile arsine forms. The half-life of arsenic in soil is estimated to be 6.5 years for arsenic trioxide to 16 years for lead arsenate. Arsenates sorb most readily to soils with high organic matter content, low pH, low phosphate, and low mineral content. In air, most arsenic particulates contain inorganic arsenic compounds, particularly As^{+3} compounds (Eisler 1988a).

At relatively low levels, arsenic stimulates growth and development in several plant species (Eisler 1988a). The bioavailability of arsenic depends on several factors including pH, soil texture and fertility level, and plant species. Inorganic arsenate is readily taken up by plants via the phosphate carrier mechanism. As a result, plants tend to have a poor ability to distinguish arsenate from phosphate. In general, arsenic is most available to plants grown in coarse soils having little colloidal material and a low ion-exchange capacity. Conversely, fine soils high in clay, organic matter, iron, calcium, and phosphate tend to retard the bioavailability of arsenic to plants (NRCC 1978). The accumulation of arsenic in plants tends to be directly correlated with the amount of arsenic in the dissolved fraction versus total arsenic concentrations (NRCC 1978).

Beryllium—Beryllium is a metal with a complicated coordination chemistry, and it can form complexes, oxycarboxylates, and chelates with a variety of materials. Although little information concerning adsorption of beryllium is available, based on its geochemical similarity to aluminum, it is expected to be adsorbed onto clay mineral surfaces at low pH and to be complexed into some insoluble compounds at high pH. In most natural environments, beryllium is likely to be present in sorbed or precipitated, rather than dissolved, form (EPA 1985).

Chromium—Chromium is a multivalent element and can exist in the +2, +3, and +6 oxidation states. The latter two, chromium (III) and chromium (VI),are the most stable in the environment. In soils and sediments, chromium is influenced by oxidation/reduction reactions and can be adsorbed on the mineral and organic exchange complex or exist as a coating in iron and manganese hydrons oxides particles. Moreover, chromium can remain in solution in the pore water phase, become chelated by an organic ligand, or precipitated (Adriano 1986; Callahan et al. 1979). The sorption of chromium (VI) by hydrous metals oxides and other soil mineral components decreases as pH increases. The presence of other anions (e.g. sulfate and phosphate) significantly affects the extent of adsorption by competing for adsorption sites. Formation of ion pairs, such as dissolved calcium chromate, can also reduce the extent of adsorption. In contrast to chromium (VI), the sorption of chromium (III) increases with pH. In general, it appears from laboratory studies that chromium (III) is adsorbed more strongly than chromium (VI). Organic material may also be an important adsorbent in sediments and soils. Slight enrichment of chromium occurs in the humic fraction. Typically, in normal, well-drained arid soils, the great majority of chromium is in the form of chromium (III).

Copper—Copper is one of the least mobile of the trace elements and tends to be uniformly distributed in the soil horizon. Persistence in soils is due to binding to organic matter, its formation of oxides with iron and manganese, the presence of clay minerals, and soil pH. A pH of 6 or less increases the mobility and availability of copper in soil. Copper is one of the trace elements most extensively complexed by humic materials. Most copper is readily available to plants when soil pH is below 6, especially in soils with low organic matter and humic material content. Sulfides, which are abundant in soils under reducing conditions, effectively precipitate copper. Biogenic ligands bind with copper, resulting in the precipitation and sorption of copper. Copper is one of seven essential plant micronutrients. Copper in soil tends to strongly bind with organic matter, which limits its availability for uptake by plants. Soil parameters that appear to influence copper availability include pH, CEC, an organic matter content.

Cyanide—No data are available at this time for the fate and transport of cyanide (CN).

Lead—Lead is a ubiquitous trace constituent in rocks, soils, plants, water, and air. Lead is neither essential nor beneficial to living organisms. Lead is a bluish-gray, soft metal. Metallic lead is relatively insoluble in hard waters. Lead occurs in four valence states: elemental (Pb^{O}), monovalent (Pb^{+}), divalent (Pb^{+2}), and tetravalent (Pb^{+4}). In nature, lead occurs mainly as Pb^{+2} and is oxidized to Pb^{+4}. Some lead salts are somewhat soluble in water. Of the organoleads, tetraethyllead and tetramethyllead are most stable and highly soluble in many organic solvents but fairly insoluble in water. Both undergo photochemical degradation in the atmosphere to elemental lead and free organic radicals. Organolead compounds are primarily anthropogenically-produced (Eisler 1988b).

Manganese—The transport and partitioning of manganese is influenced by solubility of the particular form present, which, in turn, is determined primarily by pH oxidation/reduction potential. Manganese may exist in one of four oxidation states: 2+, 3+, 4+, and 7+. Divalent manganese (Mn+2) exists mostly in waters with a pH of 4-7. The likelihood that soluble manganese compounds will sorb to soils is affected primarily by the cation exchange capacity and organic matter content of the soil. Soil sorption can vary by as much as five orders of magnitude depending on soil conditions. The oxidation state of manganese in soil may be altered by microbial populations (ATSDR 1990).

Mercury—Mercury exists in the environment in three oxidation states: the element itself, +1 (mercurous) state, and +2 (mercuric) state. The factors that affect which species will dominate in the environment are the redox potential and the pH of the system. Particle-bound mercury can be converted to insoluble mercury sulfide, which can be bioconverted into more soluble or volatile forms that may re-enter the atmosphere or be taken up by biota and bioaccumulated in the terrestrial food chain. Mercury forms many stable organic complexes that generally are more soluble in organic matter than in water. Mercury strongly adsorbs to inorganic and organic particles. Mercury can be transformed in the environment by biotic and abiotic oxidation and reduction, bioconversion of organic and inorganic forms, and photolysis. Mercury can be strongly concentrated by living organisms (Callahan et al. 1979).

Nickel—Nickel is continuously transferred between, air, water, and soil via various natural processes including weathering, runoff, erosion, and leaching. Nickel is very persistent in both soil and water. In the atmosphere, nickel exists primarily in the aerosol form. Nickel can exist in water in various soluble and insoluble forms depending upon the physicochemical properties of the water. The mobility of nickel in aqueous media is affected by complexation, precipitation/dissolution, oxidation/reduction, and adsorption/desorption. The average residence time of nickel in soil is estimated to be 2,400 to 3,500 years. Although nickel is very persistent in soil, it can leach into groundwater. The sorption of nickel to soils correlates with pH, total iron, and organic matter content. Organic complexing agents in soil tend to restrict the movement of nickel by forming organo-nickel compounds. Nickel is fairly mobile in soils in a low pH and cation exchange capacity (ATSDR 1988a).

Selenium—Selenium is stable in four valence states: -2, 0, +4, and +6. The positive anions are present in oxyanions and organo-selenium compounds. The inorganic forms dominate the physical chemistry of selenium in solution. Inorganic selenium is extremely insoluble and will sorb strongly to soil. Selenium can be adsorbed by iron and manganese hydroxides, organic matter, and iron sulfides. Selenium can become mobile in soil/water systems under alkaline conditions. Chemical speciation controls solubility. Under low pH conditions, more insoluble elemental selenium tends to be present (Callhan et al. 1979).

Silver—Silver is a transitional metal with one stable cationic state, Ag^+. Chemical speciation, sorption, and bioaccumulation are important factors affecting the fate and transport of silver. Oxidation-reduction potential and soil pH primarily determine the fate of silver in soils. In the absence of organic matter, silver tends to be removed from soils.

Zinc—Zinc is an essential nutrient that is found in nature primarily as the mineral spalerite (ZnS). Acidic conditions affect the release of zinc from soil to cationic exchange sites. Liming soil to increase pH or the addition of high amounts of inorganic matter reduces the bioavailability of zinc in soil. Zinc, which is considered an essential plant nutrient (i.e., it is necessary for plant metabolism), occurs naturally in plants at levels higher than nonessential nutrient, cadmium. Plant uptake of zinc is influenced by soil pH, soil fertility, organic matter content, phosphorous levels, and the presence of chelating compounds in soil. Zinc oxides, carbonates, phosphates, and sulfides are less soluble and therefore less available to plants than zinc salts. Availability of zinc is enhanced by acidic soils in which the solubility of most metals is increased. High levels of cadmium and phosphorus in soil reduces zinc availability to plants (Kabata-Pendias and Pendias 1992).

3.1.1.2 Nonradiological Organic Contaminants. This subsection discusses the fate and transport of nonradiological organic contaminants

2-Butanone—2-Butanone (methyl ethyl ketone) is fairly mobile in soil/groundwater systems. 2-Butanone is highly soluble in water as evidenced by its very low K_{oc} and K_{ow} values.. 2-Butanone is slightly less mobile in soil/groundwater systems than acetone. Since acetone is not strongly sorbed to soils, some volatilization may also occur. Acetone is fairly susceptible to microbial degradation.

Acetone—Acetone is mobile in soil/groundwater systems. Only a small amount of acetone released into the environment is expected to sorb to soil. The majority is expected to migrate freely through the soil-water phase and migrate freely via diffusion and infiltration with little or no retardation. Acetone is infinitely soluble in water as evidenced by its very low K_{oc} and K_{ow} values. Since acetone is not strongly sorbed to soils, some volatilization may also occur. Acetone is highly susceptible to microbial degradation.

Chloroform—Photolysis and hydrolysis are not significant environmental fate processes for chloroform. There are some evidences of bio-accumulation from moderate to weak levels in marine organisms. Chloroform tends to specifically accumulate in the adipose tissue, which may have important consequences of bio-magnification in aquatic food chains. Most of the chloroform released to the environment eventually enters the atmosphere, while much smaller amounts enter groundwater as a result of filtration through the soil (ATSDR 1993a). Chloroform is highly mobile in soil with transport to groundwater likely. Volatilization of chloroform in near-surface soils is likely to an important removal mechanism. Transformation processes are significant in natural soils. Diffusion through soil-air pores up to the ground surface and subsequent removal by wind may be an important transport pathway. The mobility of chloroform in soil\groundwater systems is strongly influenced by the fraction expected to sorb to soil. Its low K_{ow} value (93) indicates weak adsorption to soils or organic matter. It is highly volatile and little potential for substantial bioaccumulation in living organisms. Although it is likely to volatilize from soil surfaces, the fraction not subject to volatilization is expected to be mobile in groundwater.

Di-n-octylphthalate—Although relatively little specific information concerning di-n-octylphthalate is available, the environmental transport and fate of this contaminant can be largely inferred from data for phthalate esters as a group. Di-n-octylphthate probably hydrolyzes in surface waters, but at such a slow rate that this process would not be significant under most conditions. Photolysis and oxidation do not appear to be important environmental fate processes (EPA 1985).

Dioxins/Furans—Polychlorinated dibenzodioxins (CDD)s and polychlorinated dibenzofurans (CDF)s are chemically classified as halogenated aromatic hydrocarbons. They can be formed as unintentional by-products through a variety of chemical reactions and combustion processes. In general, these compounds have very low water solubility, high octanol-water partition coefficients, and low vapor pressure and tend to bioaccumulate.

The environmental fate and environmental distribution of these compounds are not yet well understood. CDDs/CDFs entering the atmosphere are removed either by photodegradation or by deposition. In soil, sediment, and the water column, CDDs/CDFs are primarily associated with particulate and organic matter because of their high lipophilicity and low water solubility. Because of their very low water solubilities and vapor pressures, CDDs/CDFs below the soil surface are strongly adsorbed and show little

upward or downward vertical migration. Burial in-place, resuspension back into the air, or erosion of soil to water bodies appears to be the predominant fate of CDDs/CDFs sorbed to soil. When entering the aquatic environment, most are associated with particulate matter and are likely to remain sorbed to the particulate matter once in the aquatic environment. They primarily undergo sedimentation and burial. The ultimate environmental sink of CDDs/CDFs is believed to be aquatic sediments.

These compounds exhibit little potential for significant leaching or volatilization once sorbed to particulate matter and are extremely stable under most environmental conditions. The only environmentally significant transformation process is believed to be photodegradation of nonsorbed species in the gaseous phase, at the soil-air or water-air interface, or in association with organic cosolvents.

Methylene chloride (dichloromethane)—Methylene chloride is expected to be highly mobile in soil/groundwater systems, with little or no retardation affecting transport. Volatilization is an important removal process for methylene chloride in surface soils. Methylene chloride is expected to undergo rapid biotransformation and degradation due to hydrolysis. In deeper soil, most methylene chloride is expected to be in the soil-water phase, moving freely with flowing groundwater. The persistence of methylene chloride in soil/groundwater systems can be as much as months or years.

Polychlorinated biphenyls (PCBs)—PCBs are a family of compounds that vary widely in physical, chemical, and biological properties. The fate of PCBs in the environment is affected by biodegradation and photolysis. Non-destructive processes that affect the distribution and transport of PCBs are adsorption, volatilization, and bioaccumulation. PCBs tend to have high octanol-water partitioning coefficients, low water solubilities, and sorb strongly to soil organic matter. The tendency of PCBs to adsorb to soil and hence their environmental persistence increases with the degree of chlorination as well as with the organic content of the soil. PCBs with a high degree of chlorination degrade very slowly in the environment. Significant leaching of PCBs from soil is not likely. The biota are another environmental compartment into which these compounds may be partitioned. Volatilization and transport as an aerosol followed by fallout with dust or rain is the probable cause of the widespread distribution of PCBs (Callahan et al. 1979).

Toluene—Toluene is relatively mobile in soil-water systems, and volatilization through air-filled pores is also possible. While toluene is resistant to hydrolysis, they are probably biodegradable. Toluene sorbs primarily to soil in near-surface soils. In saturated, deeper soils, about half is likely to exist in the soil water phase. Its relatively low log K_{ow} value of 2.73 indicates weak adsorption to soils or organic matter. Toluene is highly volatile from aqueous solutions, weakly adsorbed by soil, and has a small potential to bioaccumulate in living organisms. Although it may volatilize from soil surfaces, the fraction not subject to volatilization may eventually migrate into groundwater.

3.1.1.3 Radionuclides. This subsection discusses the fate and transport of radionuclides.

Cesium (Cs-137)—This cesium isotope is a fission product produced in nuclear reactors. Cesium is an alkali metal with properties similar to potassium and rubidium. The distribution of Cs-137 in the stratosphere and the pattern of its terrestrial deposition are similar to those for Sr-90. Cs-137 has a 30.2-year half-life. Cesium is tightly bound to soil with a strong retention to clay soils. As late as 18 years after the cessation of nuclear weapons testing in 1963, Cs-137 was still confined to the upper 24 cm of silty clay and exhibited a half-value depth (that depth at which the concentration is 50% of the surface

contamination) of about 6 cm in undisturbed soil (Eisenbud 1987). Thus, the main portal of entry of cesium to the food chain during periods of active fallout was foliar absorption. There has been evidence of a high bioconcentration in some plant and animal species. An example is the Cheronobyl fallout in Sweden, which reached sixfold higher concentrations in certain animals. (IAEA 1992). Cesium is a congener of potassium. However, the Cs/K ratio is not as constant in biological systems as is the Sr/Ca ratio. Cesium metabolism resembles that of potassium. It too is distributed uniformly throughout the body. The uptake of cesium from soil has been shown to be inversely proportional to the potassium content of soils in which there is a potassium deficiency.

Cobalt (Co-60)—Cobalt-60 is produced in nuclear explosions and in reactors. Co-60 has a 5.27 year half-life. Cobalt has a tendency to form soluble complexes with dissolved organic matter.

Strontium (Sr-90)—Strontium (Sr) is an alkaline earth element and is, therefore, chemically similar to calcium and barium. Strontium follows calcium through food chains from environment to organism, but some degree of discrimination exists against strontium (Kirchman et al. 1993). Both strontium and calcium are retained in vertebrate organisms primarily in bone. Sr-90 is a radionuclide formed during nuclear fission. It has a radioactive half-life of 29.1 years and decays by beta emission. Its daughter radionuclide, yttrium-90 (Y-90) also is radioactive. Y-90 has a half-life of 64 hours and decays by beta emission to the stable isotope zirconium-90 (Zr-90) (Shleien 1992). Since Sr-90 is produced in the fuel of nuclear reactors, some Sr-90 in the environment at the INEL may be from the reactors operated there or from waste transported onto the site. WHO (1983) reports that small amounts of Sr-90 produced in reactor fuel may reach the coolant through defects in the fuel cladding. In coolant purification or following coolant leakage, Sr-90 may reach the gaseous and/or liquid effluent streams and, in controlled amounts, be released to the environment. In terrestrial ecosystems, 60 to 80% of Sr-90 from fallout is retained in the upper 5 cm of undisturbed soil (Horne 1978). The rate of movement of Sr-90 in soil typically is slow and depends on soil type; low cation exchange capacity, rapid water movement, and high electrolyte concentrations increase migration rates (WHO 1983). Plants acquire Sr-90 by root uptake and direct deposition onto foliage. Adsorption into the leaves is relatively slow and superficial material is readily lost. Uptake from soil normally is the primary mode of Sr-90 entry into plants. The amount of exchangeable calcium in soil is a key factor in determining the extent of Sr-90 uptake by plants; uptake is greatest from soils of low calcium content. Sr-90 in plants can be transferred to herbivorous animals and subsequently to higher trophic levels (WHO 1983; Kirchman et al. 1993). Sr-90 in the environment at the INEL most likely is from both atmospheric fallout and release from on-site activities. Sr-90 in the environment is transferred to animal and human diets primarily through terrestrial pathways, and is retained in vertebrate organisms primarily in bone, but also is retained in muscle tissue and various internal organs (Kirchman et al. 1993).

Uranium (U-238)—Uranium (U) is found in all rocks and soils. Acid igneous rocks (high silica content) contain a concentration of the order of 3 ppm, about 100 times greater than ultra-basic igneous rocks but considerably less than the phosphate rocks of Florida and southeastern Idaho and neighboring areas. The phosphate rocks in these areas contain as much as 120 ppm. The high U content of phosphate rocks is reflected in high U concentrations in commercial phosphate fertilizers. The uranium normally found in nature consists of four isotopes: U-230, U-234, U-235, and U-238. U-238 is present in the amount of 99.28%, has a half-life of 4.5×10^9 years and a specific activity of 3.3×10^5 pCi/g, and is usually in equilibrium with U-234 (0.0058%). U-235, the parent isotope of the actinium series, is present in the amount of 0.71%, and has a half-life of 7.04×10^8 years and a specific activity of 1.54×10^4 pCi/g. Although not

typically occurring naturally in soil U-236 has a half-life of 2.34×10^7. Uranium exists in nature in two oxidation states, U(IV) and U(VI) (Hem 1985). The Eh-pH diagram of the U-C-O-H system shows that tetravalent uranium is relatively insoluble in soil-water systems, existing primarily as the solid species $UO_{2(c)}$ across the entire spectrum of pH values, and reducing Eh values. When oxidized to the hexavalent form, uranium is highly mobile under all pH conditions, except for a limited area around pH 5 to pH 6.5 where the uranium carbonate is stable, precipitating as $UO_2CO_{3(c)}$. At values greater than 6, the uranyl carbonate complex $UO_2(CO_3)_2^{-2}{}_{(aq)}$ becomes stable thereby increasing the solubility of uranium. At highly alkaline values, the highly soluble complex $UO_2(CO_2)_2^{-4}{}_{(aq)}$ is stable. Because uranium occurs in soils and fertilizers, the element is present in food and human tissues.

3.1.2 Ecologically Based Screening Levels

Estimating EBSLs for contaminants at WAG 9 provides a rational, consistent approach for screening of sites that may require further investigation or remedial action, and prioritization of sites based on comparison of concentrations of contaminants with EBSLs. EBSLs are ecologically based target concentrations of contaminants in soil derived from site-specific exposure scenarios for relevant ecological receptors.

The approach includes the following elements:

- Compiling ecologically based toxicity criteria for each functional group/contaminant combination to generate appropriate toxicity reference values (TRV)s
- Rearranging exposure equations to calculate EBSLs from target intakes and default exposure assumptions
- Calculating SLQs; the ratio of contaminant to EBSL for each contaminant
- Summarizing risks for multiple contaminants
- Discussing the uncertainties inherent in each step of the methodology
- Justifying a conclusion regarding further consideration of ecological risk within the WAG 9 (or subunit, depending on the conditions).

Site-wide EBSLs were developed for each contaminant/functional group combination using best available estimates for species-specific exposure parameters and TRVs. These site-wide EBSLs were modified for application at WAG 9 by dividing by the site use factor (SUF). The WAG 9 EBSLs for each contaminant were compared with actual average soil concentrations of the contaminant to perform an evaluation of conditions. Exceedance of the EBSLs at WAG 9 may indicate that further investigation of potential risks to ecological receptors is warranted, depending on the magnitude of the exceedance, the uncertainty involved in TRV and EBSL development, and other considerations. Because of the multiple conservative assumptions inherent in the process of EBSL development, if no exceedances occur and the sum of all SLQs is not greater than the set value, then the contaminant is eliminated from further consideration as a potential source of risk to the receptors.

Each of the receptors was evaluated individually. Potential exposures for these species was determined based on the species' life history and feeding habits. Quantification of exposures used species-specific numerical exposure factors including body weight, ingestion rate, and fraction of diet composed of vegetation or prey, and soil consumed from the affected area. Species parameters used to model intakes by the functional groups are presented in Table 3-1. These values are derived from the various key species in the functional groups. The parameters in Table 3-1 are the maximum percent prey, percent vegetation, percent soil, exposure duration, and ingestion rate, and the minimum home range and body weight for each functional group because these values were the most conservative.

Each receptor's diet was assumed to be composed of percentages of two food types (i.e., percentages of either prey or vegetation) to simplify exposure calculations. For example, herbivorous animals are assumed to consume solely vegetation taken from the WAG 9 assessment area. While this is a simplistic and conservative assumption, breaking down the diet of individual species within a functional group in more detail, while warranted, is beyond the scope of a SLERA and should be addressed in the WAG 9 ERA. Most terrestrial receptors incidentally or directly ingest soil and the percent of soil ingested from that affected area was also estimated. Insectivore diets were not determined for the SLERA because of the complexity of contaminant intake from insects to insectivores. The methods for estimating contaminant concentrations in insect prey pose large uncertainty and there are currently inadequate data to support the insect prey methodology. This is a data gap and uncertainty in the SLERA and will be addressed in the ERA.

Exposure estimates were corrected for the WAG 9 assessment area by the use of site use factors (SUFs). The SUF is the WAG 9 assessment area (ha) divided by the species' home range (ha) to a maximum of 1. The total assessment area of WAG 9 is 688 ha. Home ranges for the functional groups at WAG 9 are summarized in Table 3-1. Two functional groups [avian carnivores (AV310) and mammalian omnivores (M422A)] have a SUF less than 1. A SUF of less than 1 indicates that the home range is larger than the area affected. Therefore, it is likely that avian carnivores in the functional group AV310 and mammalian omnivores in M422A consume prey, vegetation, and soil from unaffected areas.

Exposure duration (ED) is based on the migratory pattern of the receptors. This is determined using the status and abundance data compiled for site species (Reynolds 1986). Five status/abundance categories are represented - resident, breeding, summer visitor, migratory, and winter visitor. For year-round residents, ED is assumed to be 1 (i.e., receptors potentially spend up to 100% of the year on the assessment area). For species breeding on site the ED is assumed to be 0.65 (i.e., receptors potentially spend up to 65% of the year on the assessment area). For migratory, summer and winter visitors the ED is assumed to be 0.25 (i.e., receptors potentially spend up to 25% of the year on the assessment area). The most conservative ED duration is chosen from the functional group members to represent the functional group ED.

Food intake rates (g dry weight/day) for passerine birds, non-passerine birds, rodents, herbivores, all other mammals, and insectivorous reptiles can be estimated for the assessment using the following allometric equations (Nagy 1987). The equation for insectivorous reptiles was conservatively assumed to be applicable to the carnivorous reptiles (R322). Due to the fact that different allometric equations may apply to different species within a group, the equations representative of all mammals and avians were used to calculate the IR for the functional groups.

Table 3-1. WAG 9 EBSL functional group parameters.

Functional Groups	PP[a]	PV[b]	PS[c]	SUF[d]	ED[e]	IR (kg/day)[f]	BW (kg)[g]	Home range (ha)[h]
Amphibian insectivores (A232)	-	-	-	-	-	-	-	-
Avian herbivores (AV121)	0	0.99	0.01	1	0.25	0.00348	0.0132	unknown
Avian herbivores (AV122)	0	0.907	0.093	1	1	0.00146	0.0035	5.18
Avian herbivores (AV132)	0	0.99	0.01	1	0.65	0.00951	0.0619	0.001
Avian herbivores (AV142)	0	0.98	0.02	1	0.25	0.0301	0.364	unknown
Avian herbivores (AV143)	0	0.917	0.083	1	0.65	0.0324	0.408	620
Avian insectivores (AV210)	0.99	0	0.01	1	0.65	0.0029	0.01	0.304
Avian insectivores (AV210A)	0.97	0	0.03	1	0.65	0.00371	0.0146	unknown
Avian insectivores (AV221)	0.99	0	0.01	1	0.65	0.00228	0.0069	0.202
Avian insectivores (AV222)	0.97	0	0.03	1	1	0.00307	0.0109	0.42
Avian insectivores (AV222A)	0.97	0	0.03	1	0.65	0.00337	0.0126	unknown
Avian insectivores (AV232)	0.89	0	0.11	1	0.65	0.00127	0.00281	0.0232
Avian insectivores (AV233)	0.89	0	0.11	1	0.25	0.00478	0.0215	unknown
Avian insectivores (AV241)	0.89	0	0.11	1	0.25	0.00655	0.0349	unknown
Avian insectivores (AV242)	0.89	0	0.11	1	0.65	0.0113	0.081	89
Avian carnivores (AV310)	0.98	0	0.02	0.681	1	0.0167	0.147	1010
Avian carnivores (AV322)	0.98	0	0.02	1	1	0.00799	0.0474	60
Avian carnivores (AV322A)	0.97	0	0.03	1	0.25	0.0106	0.151	6
Avian carnivores (AV333)	0.98	0	0.02	1	0.25	0.0184	0.171	unknown
Avian carnivores (AV342)	0.98	0	0.02	1	0.25	0.0783	1.58	8.4
Avian omnivores (AV422)	0.454	0.454	0.093	1	1	0.0113	0.0802	unknown
Avian omnivores (AV432)	0.495	0.495	0.01	1	0.25	0.0275	0.316	unknown
Avian omnivores (AV433)	0.495	0.495	0.01	1	0.25	0.065	0.935	unknown
Avian omnivores (AV442)	0.495	0.495	0.01	1	1	0.0527	0.724	unknown
Mammalian herbivores (M121)	0	0.98	0.02	1	0.25	0.555	12.7	unknown
Mammalian herbivores (M122)	0	0.937	0.063	1	1	0.00241	0.017	6.07
Mammalian herbivores (M122A)	0	0.972	0.028	1	1	0.00364	0.028	0.00251
Mammalian herbivores (M123)	0	0.98	0.02	1	1	0.0128	0.13	unknown
Mammalian insectivores (M210)	0.99	0	0.01	1	0.25	0.00169	0.011	unknown
Mammalian insectivores (M210A)	0.99	0	0.01	1	1	0.0015	0.0095	unknown
Mammalian insectivores (M222)	0.976	0	0.024	1	1	0.00102	0.006	0.2
Mammalian carnivore (M322)	0.972	0	0.028	1	1	0.155	2.7	14.2
Mammalian omnivores (M422)	0.486	0.486	0.028	1	1	0.000256	0.022	0.0[illegible]

Table 3-1. (continued).

Functional Groups	PP[a]	PV[b]	PS[c]	SUF[d]	ED[e]	IR (kg/day)[f]	BW (kg)[g]	Home range (ha)[h]
Mammalian omnivores (M422A)	0.972	0	0.028	.106	1	0.0754	19	6480
Reptilian insectivores (R222)	0.976	0	0.024	1	1	0.07	0.06	unknown
Reptilian carnivores (R322)	0.98	0	0.02	1	1	0.251	3	unknown

a. PP = percentage of diet represented by prey ingested (unitless). Herbivores = 0% prey, total PV = PV - PS; carnivores = 0% vegetation, total PP = PP - PS; and omnivores = (1.00 - PS)/2 for PP and PV.

b. PV = percentage of diet represented by vegetation ingested (unitless).

c. PS = percentage of diet represented by soil ingested (unitless). Soil ingestion from Beyer et al. (1994) and Arthur and Gates (1988) - (pronghorn, jackrabbit).

d. SUF = site use factor [total WAG 9 assessment area divided by home range (in ha)] (unitless).

e. ED = exposure duration (fraction of year spent in the affected area) (unitless). Conventions: Residents - 0.05–1.00 (birds and migratory and transient mammals) 1.00 (small mammals); breeding - 0.05–0.65 (birds and migratory and transient mammals); summer visitors - 0.05–0.25; winter visitors - 0.05–0.25.

f. IR = ingestion rate [derived using allometric equations based on body weight (Nagy 1987)].

g. BW = body weight. Mammalian body weights primarily from Burt and Grossenheider (1976) and EPA Exposure Factors Handbook (1993) for some species. Avian body weights from Dunning.

h. Home ranges from Hoover and Wills (1987).

$$Food\ intake\ rate = 0.398\ BW^{0.850} \quad (passerines) \tag{3-1}$$

$$Food\ intake\ rate = 1.11\ BW^{0.445} \quad (desert\ birds) \tag{3-2}$$

$$Food\ intake\ rate = 0.301\ BW^{0.710} \quad (all\ birds) \tag{3-3}$$

$$Food\ intake\ rate = 0.583\ BW^{0.585} \quad (rodents) \tag{3-4}$$

$$Food\ intake\ rate = 0.577\ BW^{0.727} \quad (herbivores) \tag{3-5}$$

$$Food\ intake\ rate = 0.235\ BW^{0.822} \quad (all\ mammals) \tag{3-6}$$

$$Food\ intake\ rate = 0.013\ BW^{0.773} \quad (insectivorous\ reptiles) \tag{3-7}$$

where

BW = body weight in grams.

The following subsections describe the estimation of the EBSLs for nonradiological and radiological contaminants, respectively.

3.1.2.1 Soil EBSLs for Nonradiological Contaminants. The exposure equation used to calculate average daily soil intake is rearranged to estimate soil EBSLs for the functional groups/contaminant combinations. For example, dose (intake) in mg/kg body weight-day can be estimated using the following equation:

$$EE_{tot} = \frac{[(PP \times CP) + (PV \times CV) + (PS \times CS)] \times IR \times ED}{BW} \tag{3-8}$$

where

EE_{tot} = estimated exposure from all complete exposure pathways (mg/kg body weight-day)

PP = percentage of diet represented by prey ingested (unitless)

CP = concentration of contaminant in prey item ingested (mg/kg)

PV = percentage of diet represented by vegetation ingested (unitless)

CV = concentration of contaminant in vegetation ingested (mg/kg)

PS = percentage of diet represented by soil ingested (unitless)

CS = concentration of contaminant in soil ingested (mg/kg)

IR = ingestion rate (kg/day), food intake rate (g/day) divided by 1,000 g/kg

ED = exposure duration (fraction of year spent in the affected area) (unitless)

BW = receptor-specific body weight (kg).

The concentration of contaminant in prey can be estimated using the equation:

$$CP = CS \times BAF \tag{3-9}$$

where

CP = concentration in prey item ingested (mg/kg)

CS = concentration of contaminant in soil (mg/kg)

BAF = contaminant-specific bioaccumulation factor (unitless).

The concentration of contaminant in vegetation (CV) can be estimated using the equation:

$$CV = CS \times PUF \tag{3-10}$$

where

CV = concentration in vegetation (mg/kg)

CS = concentration of contaminant in soil (mg/kg)

PUF = contaminant-specific plant uptake factor (unitless).

Using Equations 3-9 and 3-10, Equation 3-11 can be rewritten as:

$$EE_{tot} = \frac{[(PP \times CS \times BAF) + (PV \times CS \times PUF) + (PS \times CS)] \times IR \times ED}{BW} \tag{3-11}$$

where

PP = percentage of diet represented by prey ingested (unitless)

CS = concentration of contaminant in soil (mg/kg)

BAF = contaminant-specific bioaccumulation factor (unitless)

PV = percentage of diet represented by vegetation ingested (unitless)

PUF = contaminant-specific plant uptake factor (unitless)

PS = percentage of diet represented by soil ingested (unitless)

IR	=	ingestion rate (kg/day), food intake rate (g/day) divided by 1,000 g/kg
ED	=	exposure duration (fraction of year spent in the affected area) (unitless)
BW	=	receptor-specific body weight (kg).

Toxicity quotients (TQs), which represent a quantitative method for evaluating potential adverse impacts to exposed populations, are defined as:

$$TQ = \frac{EE_{tot}}{TRV} \tag{3-12}$$

where

TQ	=	toxicity quotient (unitless)
EE_{tot}	=	estimated exposure from all complete exposure pathways (mg/kg body weight-day)
TRV	=	contaminant-specific toxicity reference value (mg/kg-day).

Thus, solving for the CS from the equations and redefining this value as the EBSL, the EBSL for a nonradiological contaminant in soil is estimated using the equation:

$$EBSL = \frac{TRV \times BW}{[(PP \times BAF) + (PV \times PUF) + PS] \times IR \times ED} \tag{3-13}$$

where

EBSL	=	INEL-specific EBSL for nonradiological contaminant in soil (mg/kg)
TRV	=	toxicity reference value (mg/kg-day)
PP	=	percentage of diet represented by prey ingested (unitless)
PV	=	percentage of diet represented by vegetation ingested (unitless)
PS	=	percentage of diet represented by soil ingested (unitless)
IR	=	ingestion rate (kg/day), food intake rate (g/day) divided by 1,000 g/kg
ED	=	exposure duration (fraction of year spent in the affected area) (unitless)
BW	=	receptor-specific body weight (kg).

Contaminant-specific PUFs for nonradionuclides contaminants are presented in Table 3-2. PUFs for all metals are taken from Baes et al. (1984). The PUF for organics is estimated using the Travis and Arms (1988) equation of $1.588-0.578\log K_{ow}$. Log partitioning coefficients (K_{ow}s) were taken from Montgomery and Welkom (1990).

BAFs developed for the INEL site are not generally available. BAFs were assumed to be 1 for most of the WAG 9 contaminants unless there is evidence of bioaccumulation from literature evaluation, then, the more conservative value (>1) will be used. BAFs need to be developed for the INEL and this data gap is addressed in the summary.

Preliminary TRVs for nonradionuclide contaminants are presented in Table 3-3. Derivation of these TRVs is discussed in Section 3.2.

TRVs of the following contaminants were not developed for mammalian receptors.

- calcium
- chloride
- fluoride
- phosphate

TRVs of the following contaminants were not developed for avian receptors.

- 1,1,1-trichloroethane
- 2-butanone
- acetone
- antimony
- beryllium
- butylbenzylphthalate
- calcium
- chloride
- chloroform
- di(2-ethylhexyl)phthalate
- di-n-octylphthalate
- fluoride
- methylene chloride
- nitrate
- phosphate
- silver
- sodium
- sulfate
- toluene

Therefore, these contaminants could not be evaluated for potential risk and this data gap should be reassessed in the WAG 9 ERA. The resulting EBSLs are then divided by the SUF to result in WAG 9-specific EBSLs. WAG 9-specific EBSLs for nonradiological contaminants and functional groups are presented in Table 3-4.

3.1.2.2 Soil EBSLs for Radiological Contaminants. The following subsections describe the estimation of EBSLs for radiological contaminants. Both internal and external radiation dose development are described separately.

3.1.2.2.1 Internal Radiation Dose—Internal radiation dose estimates are calculated by assuming that the steady-state whole body concentration is equivalent to the steady-state concentration of radionuclides in reproductive organs using the equation:

$$Dose = \frac{TC \times ED \times \overline{E} \times FA \times 3{,}200\ dis/day\text{-}pCi}{6.24 \times 10^{9}\ MeV/g\text{-}Gy} \qquad (3\text{-}14)$$

Table 3-2. PUFs for WAG 9 nonradionuclide contaminants (unitless).

Contaminant	PUF
1,1,1-Trichloroethane	1.39
2-Butanone	27.4
2,3,7,8-TCDD	0.00509
Acetone	53.3
Antimony	0.2
Arsenic	0.04
Beryllium	0.01
Butylbenzylphthalate	0.0651
Calcium	3.5
Chloroform	2.81
Chromium	0.0075
Copper	0.4
Cyanide	1
Di-(2-ethylhexyl)phthalate	0.194
Di-n-octylphthalate	0.000187
Lead	0.045
Manganese	0.25
Mercury	0.9
Methylene chloride	6.86
Nickel	0.06
Nitrates	1
PCBs	0.0125
Selenium	0.025
Silver	0.4
Sodium	0.075
Sulfates	1
Toluene	1.02
Zinc	1.5

Table 3-3. WAG 9 soil nonradiological TRVs (mg/kg-d).

Functional groups	1,1,1-trichloroethane	2-Butanone	2,3,7,8-TCDD[a]	Acetone
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	-	-	5.20E-06	-
Avian herbivores (AV122)	-	-	5.20E-06	-
Avian herbivores (AV132)	-	-	5.20E-06	-
Avian herbivores (AV142)	-	-	5.20E-06	-
Avian herbivores (AV143)	-	-	5.20E-06	-
Trumpeter swan	-	-	2.60E-06	-
Avian insectivores (AV210)	-	-	5.20E-06	-
Black tern	-	-	2.60E-06	-
Avian insectivores (AV210A)	-	-	5.20E-06	-
Avian insectivores (AV221)	-	-	5.20E-06	-
Avian insectivores (AV222)	-	-	5.20E-06	-
Avian insectivores (AV222A)	-	-	5.20E-06	-
Avian insectivores (AV232)	-	-	5.20E-06	-
Avian insectivores (AV233)	-	-	5.20E-06	-
White-faced ibis	-	-	2.60E-06	-
Avian insectivores (AV241)	-	-	5.20E-06	-
Avian insectivores (AV242)	-	-	5.20E-06	-
Avian carnivores (AV310)	-	-	5.20E-06	-
Northern goshawk & peregrine falcon	-	-	2.60E-06	-
Avian carnivores (AV322)	-	-	5.20E-06	-
Bald eagle, ferrugnious hawk, & loggerhead shrike	-	-	2.60E-06	-
Avian carnivores (AV322A)	-	-	5.20E-06	-
Avian carnivores (AV333)	-	-	5.20E-06	-
Avian carnivores (AV342)	-	-	5.20E-06	-
Avian omnivores (AV422)	-	-	7.80E-06	-
Avian omnivores (AV432)	-	-	7.80E-06	-
Avian omnivores (AV433)	-	-	7.80E-06	-
Avian omnivores (AV442)	-	-	7.80E-06	-
Mammalian herbivores (M121)	1.25E+02	2.21E+02	5.60E-08	6.30E+00
Mammalian herbivores (M122)	8.30E+01	1.48E+02	3.70E-08	4.20E+00
Mammalian herbivores (M122A)	8.30E+01	1.48E+02	3.70E-08	4.20E+00
Pygmy rabbit	4.15E+01	7.38E+01	1.85E-08	2.10E+00
Mammalian herbivores (M123)	1.25E+02	2.21E+02	5.60E-08	6.30E+00
Mammalian insectivores (M210)	8.30E+01	1.48E+02	3.70E-08	4.20E+00
Mammalian insectivores (M210A)	8.30E+01	1.48E+02	3.70E-08	4.20E+00
Townsend's western big-eared bat & small-footed myotis	4.15E+01	7.38E+01	1.85E-08	2.10E+00
Mammalian insectivores (M222)	8.30E+01	1.48E+02	3.70E-08	4.20E+00
Mammalian carnivore (M322)	8.30E+01	1.48E+02	3.70E-08	4.20E+00
Mammalian omnivores (M422)	1.25E+02	2.21E+02	5.60E-08	6.30E+00
Mammalian omnivores (M422A)	1.25E+02	2.21E+02	5.60E-08	6.30E+00
Reptilian insectivores (R222)	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-
plants	-	-	-	-

a. Dioxins/furans.

Table 3-3. (continued).

Functional groups	Antimony	Arsenic	Beryllium	Butylbenzylphthalate
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	-	2.40E-01	-	-
Avian herbivores (AV122)	-	2.40E-01	-	-
Avian herbivores (AV132)	-	2.40E-01	-	-
Avian herbivores (AV142)	-	4.80E-01	-	-
Avian herbivores (AV143)	-	4.80E-01	-	-
Trumpeter swan	-	2.40E-01	-	-
Avian insectivores (AV210)	-	1.60E-01	-	-
Black tern	-	8.00E-02	-	-
Avian insectivores (AV210A)	-	1.60E-01	-	-
Avian insectivores (AV221)	-	1.60E-01	-	-
Avian insectivores (AV222)	-	1.60E-01	-	-
Avian insectivores (AV222A)	-	1.60E-01	-	-
Avian insectivores (AV232)	-	1.60E-01	-	-
Avian insectivores (AV233)	-	1.60E-01	-	-
White-faced ibis	-	8.00E-02	-	-
Avian insectivores (AV241)	-	1.60E-01	-	-
Avian insectivores (AV242)	-	1.60E-01	-	-
Avian carnivores (AV310)	-	1.60E-01	-	-
Northern goshawk & peregrine falcon	-	8.00E-02	-	-
Avian carnivores (AV322)	-	1.60E-01	-	-
Bald eagle, ferrugnious hawk, & loggerhead shrike	-	8.00E-02	-	-
Avian carnivores (AV322A)	-	1.60E-01	-	-
Avian carnivores (AV333)	-	1.60E-01	-	-
Avian carnivores (AV342)	-	1.60E-01	-	-
Avian omnivores (AV422)	-	1.60E-01	-	-
Avian omnivores (AV432)	-	1.60E-01	-	-
Avian omnivores (AV433)	-	1.60E-01	-	-
Avian omnivores (AV442)	-	1.60E-01	-	-
Mammalian herbivores (M121)	6.30E-01	6.40E-02	1.80E-01	6.63E+00
Mammalian he rbivores (M122)	4.20E-01	2.40E-03	1.20E-01	4.42E+00
Mammalian herbivores (M122A)	4.20E-01	2.40E-03	1.20E-01	4.42E+00
Pygmy rabbit	2.10E-01	1.20E-03	6.00E-02	2.21E+00
Mammalian herbivores (M123)	6.30E-01	6.40E-02	1.80E-01	6.63E+00
Mammalian insectivores (M210)	4.20E-01	2.40E-03	1.20E-01	4.42E+00
Mammalian insectivores (M210A)	4.20E-01	2.40E-03	1.20E-01	4.42E+00
Townsend's western big-eared bat & small-footed myotis	2.10E-01	1.20E-03	6.00E-02	2.21E+00
Mammalian insectivores (M222)	4.20E-01	2.40E-03	1.20E-01	4.42E+00
Mammalian carnivore (M322)	4.20E-01	2.40E-03	1.20E-01	4.42E+00
Mammalian omnivores (M422)	6.30E-01	6.40E-02	1.80E-01	6.63E+00
Mammalian omnivores (M422A)	6.30E-01	6.40E-02	1.80E-01	6.63E+00
Reptilian insectivores (R222)	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-
Plants	5.00E+00	1.00E+01	1.00E+01	-

Table 3-3. (continued).

Functional groups	Calcium	Chloride	Chloroform	Chromium VI
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	-	-	-	9.10E-01
Avian herbivores (AV122)	-	-	-	9.10E-01
Avian herbivores (AV132)	-	-	-	9.10E-01
Avian herbivores (AV142)	-	-	-	9.10E-01
Avian herbivores (AV143)	-	-	-	9.10E-01
Trumpeter swan	-	-	-	4.55E-01
Avian insectivores (AV210)	-	-	-	9.10E-01
Black tern	-	-	-	4.55E-01
Avian insectivores (AV210A)	-	-	-	9.10E-01
Avian insectivores (AV221)	-	-	-	9.10E-01
Avian insectivores (AV222)	-	-	-	9.10E-01
Avian insectivores (AV222A)	-	-	-	9.10E-01
Avian insectivores (AV232)	-	-	-	9.10E-01
Avian insectivores (AV233)	-	-	-	9.10E-01
White-faced ibis	-	-	-	4.55E-01
Avian insectivores (AV241)	-	-	-	9.10E-01
Avian insectivores (AV242)	-	-	-	9.10E-01
Avian carnivores (AV310)	-	-	-	9.10E-01
Northern goshawk & peregrine falcon	-	-	-	4.55E-01
Avian carnivores (AV322)	-	-	-	9.10E-01
Bald eagle, ferrugnious hawk, & loggerhead shrike	-	-	-	4.55E-01
Avian carnivores (AV322A)	-	-	-	9.10E-01
Avian carnivores (AV333)	-	-	-	9.10E-01
Avian carnivores (AV342)	-	-	-	9.10E-01
Avian omnivores (AV422)	-	-	-	1.40E+00
Avian omnivores (AV432)	-	-	-	1.40E+00
Avian omnivores (AV433)	-	-	-	1.40E+00
Avian omnivores (AV442)	-	-	-	1.40E+00
Mammalian herbivores (M121)	-	-	5.40E-01	2.00E-02
Mammalian herbivores (M122)	-	-	3.70E-01	2.00E-02
Mammalian herbivores (M122A)	-	-	3.70E-01	2.00E-02
Pygmy rabbit	-	-	1.85E-01	1.00E-02
Mammalian herbivores (M123)	-	-	5.40E-01	2.00E-02
Mammalian insectivores (M210)	-	-	3.70E-01	2.00E-02
Mammalian insectivores (M210A)	-	-	3.70E-01	2.00E-02
Townsend's western big-eared bat & small-footed myotis	-	-	1.85E-01	1.00E-02
Mammalian insectivores (M222)	-	-	3.70E-01	2.00E-02
Mammalian carnivore (M322)	-	-	3.70E-01	3.00E-02
Mammalian omnivores (M422)	-	-	3.70E-01	3.00E-02
Mammalian omnivores (M422A)	-	-	1.60E+00	7.00E-02
Reptilian insectivores (R222)	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-
Plants	-	-	-	2.00E+00

Table 3-3. (continued).

Functional groups	Copper	Cyanide	Di-2-ethylhexyl phthalate	Di-n-octylphthalate
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	6.70E-01	9.00E-03	-	-
Avian herbivores (AV122)	6.70E-01	9.00E-03	-	-
Avian herbivores (AV132)	6.70E-01	9.00E-03	-	-
Avian herbivores (AV142)	6.70E-01	1.80E-02	-	-
Avian herbivores (AV143)	6.70E-01	1.80E-02	-	-
Trumpeter swan	3.35E-01	9.00E-03	-	-
Avian insectivores (AV210)	6.70E-01	6.00E-03	-	-
Black tern	3.35E-01	3.00E-03	-	-
Avian insectivores (AV210A)	6.70E-01	6.00E-03	-	-
Avian insectivores (AV221)	6.70E-01	6.00E-03	-	-
Avian insectivores (AV222)	6.70E-01	6.00E-03	-	-
Avian insectivores (AV222A)	6.70E-01	6.00E-03	-	-
Avian insectivores (AV232)	6.70E-01	6.00E-03	-	-
Avian insectivores (AV233)	6.70E-01	6.00E-03	-	-
White-faced ibis	3.35E-01	3.00E-03	-	-
Avian insectivores (AV241)	6.70E-01	6.00E-03	-	-
Avian insectivores (AV242)	6.70E-01	6.00E-03	-	-
Avian carnivores (AV310)	6.70E-01	2.60E-02	-	-
Northern goshawk & peregrine falcon	3.35E-01	1.30E-02	-	-
Avian carnivores (AV322)	6.70E-01	6.00E-03	-	-
Bald eagle, ferrugnious hawk, & loggerhead shrike	3.35E-01	3.00E-03	-	-
Avian carnivores (AV322A)	6.70E-01	6.00E-03	-	-
Avian carnivores (AV333)	6.70E-01	6.00E-03	-	-
Avian carnivores (AV342)	6.70E-01	6.00E-03	-	-
Avian omnivores (AV422)	1.00E+00	6.00E-03	-	-
Avian omnivores (AV432)	1.00E+00	6.00E-03	-	-
Avian omnivores (AV433)	1.00E+00	6.00E-03	-	-
Avian omnivores (AV442)	1.00E+00	6.00E-03	-	-
Mammalian herbivores (M121)	1.30E+00	2.00E-02	1.49E+01	9.72E+00
Mammalian herbivores (M122)	1.30E+00	2.00E-02	9.92E+00	6.48E+00
Mammalian herbivores (M122A)	1.30E+00	2.00E-02	9.92E+00	6.48E+00
Pygmy rabbit	6.50E-01	1.00E-02	4.96E+00	3.24E+00
Mammalian herbivores (M123)	1.30E+00	2.00E-02	1.49E+01	9.72E+00
Mammalian insectivores (M210)	1.30E+00	2.00E-02	9.92E+00	6.48E+00
Mammalian insectivores (M210A)	1.30E+00	2.00E-02	9.92E+00	6.48E+00
Townsend's western big-eared bat & small-footed myotis	6.50E-01	1.00E-02	4.96E+00	3.24E+00
Mammalian insectivores (M222)	1.30E+00	2.00E-02	9.92E+00	6.48E+00
Mammalian carnivore (M322)	4.00E+00	3.00E-02	9.92E+00	6.48E+00
Mammalian omnivores (M422)	1.30E+00	3.00E-02	1.49E+01	9.72E+00
Mammalian omnivores (M422A)	2.00E+00	5.00E-02	1.49E+01	9.72E+00
Reptilian insectivores (R222)	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-
Plants	4.00E+01	-	-	-

Table 3-3. (continued).

Functional groups	Fluoride	Lead	Manganese	Mercury
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	-	4.00E-02	9.70E-01	1.00E-02
Avian herbivores (AV122)	-	3.00E-02	9.70E-01	1.00E-02
Avian herbivores (AV132)	-	3.00E-02	9.70E-01	1.00E-02
Avian herbivores (AV142)	-	1.90E+00	9.70E-01	1.00E-02
Avian herbivores (AV143)	-	1.90E+00	9.70E-01	1.00E-02
Trumpeter swan	-	9.50E-01	4.85E-01	5.00E-03
Avian insectivores (AV210)	-	4.00E-02	9.70E-01	1.00E-02
Black tern	-	2.00E-02	4.85E-01	5.00E-03
Avian insectivores (AV210A)	-	8.00E-02	9.70E-01	1.00E-02
Avian insectivores (AV221)	-	4.00E-02	9.70E-01	1.00E-02
Avian insectivores (AV222)	-	4.00E-02	9.70E-01	1.00E-02
Avian insectivores (AV222A)	-	4.00E-02	9.70E-01	1.00E-02
Avian insectivores (AV232)	-	4.00E-02	9.70E-01	1.00E-02
Avian insectivores (AV233)	-	4.00E-02	9.70E-01	1.00E-02
White-faced ibis	-	2.00E-02	4.85E-01	5.00E-03
Avian insectivores (AV241)	-	4.00E-02	9.70E-01	1.00E-02
Avian insectivores (AV242)	-	4.00E-02	9.70E-01	1.00E-02
Avian carnivores (AV310)	-	3.00E-02	9.70E-01	1.00E-02
Northern goshawk & peregrine falcon	-	1.50E-02	4.85E-01	5.00E-03
Avian carnivores (AV322)	-	3.00E-02	9.70E-01	1.00E-02
Bald eagle, ferrugnious hawk, & loggerhead shrike	-	1.50E-02	4.85E-01	5.00E-03
Avian carnivores (AV322A)	-	3.00E-02	9.70E-01	1.00E-02
Avian carnivores (AV333)	-	3.00E-02	9.70E-01	1.00E-02
Avian carnivores (AV342)	-	3.00E-02	9.70E-01	1.00E-02
Avian omnivores (AV422)	-	3.00E-02	1.50E+00	2.00E-02
Avian omnivores (AV432)	-	3.00E-02	1.50E+00	2.00E-02
Avian omnivores (AV433)	-	3.00E-02	1.50E+00	2.00E-02
Avian omnivores (AV442)	-	3.00E-02	1.50E+00	2.00E-02
Mammalian herbivores (M121)	-	8.90E-03	5.40E-01	2.00E-03
Mammalian herbivores (M122)	-	8.90E-03	3.60E-01	2.00E-03
Mammalian herbivores (M122A)	-	8.90E-03	3.60E-01	2.00E-03
Pygmy rabbit		4.45E-03	1.80E-01	1.00E-03
Mammalian herbivores (M123)	-	8.90E-03	5.40E-01	2.00E-03
Mammalian insectivores (M210)	-	8.90E-03	3.60E-01	2.00E-03
Mammalian insectivores (M210A)	-	8.90E-03	3.60E-01	2.00E-03
Townsend's western big-eared bat & small-footed myotis		4.45E-03	1.80E-01	1.00E-03
Mammalian insectivores (M222)	-	8.90E-03	3.60E-01	2.00E-03
Mammalian carnivore (M322)	-	1.30E-02	3.60E-01	5.00E-03
Mammalian omnivores (M422)	-	1.30E-02	5.40E-01	2.00E-03
Mammalian omnivores (M422A)	-	2.70E-02	5.40E-01	3.00E-03
Reptilian insectivores (R222)	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-
Plants	-	5.00E+01	5.00E+02	3.00E-01

Table 3-3. (continued).

Functional groups	Methylene chloride	Nickel	Nitrates	PCBs
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	-	4.83E+00	1.83E+01	4.00E-02
Avian herbivores (AV122)	-	4.83E+00	1.83E+01	4.00E-02
Avian herbivores (AV132)	-	4.83E+00	1.83E+01	4.00E-02
Avian herbivores (AV142)	-	1.03E+01	1.83E+01	4.00E-02
Avian herbivores (AV143)	-	1.03E+01	1.83E+01	4.00E-02
Trumpeter swan	-	5.15E+00	9.15E+00	2.00E-02
Avian insectivores (AV210)	-	3.40E+00	1.83E+01	4.00E-02
Black tern	-	1.70E+00	9.15E+00	2.00E-02
Avian insectivores (AV210A)	-	3.40E+00	1.83E+01	4.00E-02
Avian insectivores (AV221)	-	3.40E+00	1.83E+01	4.00E-02
Avian insectivores (AV222)	-	3.40E+00	1.83E+01	4.00E-02
Avian insectivores (AV222A)	-	3.40E+00	1.83E+01	4.00E-02
Avian insectivores (AV232)	-	3.40E+00	1.83E+01	4.00E-02
Avian insectivores (AV233)	-	3.40E+00	1.83E+01	4.00E-02
White-faced ibis	-	1.70E+00	9.15E+00	2.00E-02
Avian insectivores (AV241)	-	3.40E+00	1.83E+01	4.00E-02
Avian insectivores (AV242)	-	3.40E+00	1.83E+01	4.00E-02
Avian carnivores (AV310)	-	3.40E+00	1.83E+01	7.90E-01
Northern goshawk & peregrine falcon	-	1.70E+00	9.15E+00	3.95E-01
Avian carnivores (AV322)	-	3.40E+00	1.83E+01	4.00E-02
Bald eagle, ferrugnious hawk, & loggerhead shrike	-	1.70E+00	9.15E+00	2.00E-02
Avian carnivores (AV322A)	-	3.40E+00	1.83E+01	4.00E-02
Avian carnivores (AV333)	-	3.40E+00	1.83E+01	4.00E-02
Avian carnivores (AV342)	-	3.40E+00	1.83E+01	4.00E-02
Avian omnivores (AV422)	-	3.40E+00	2.75E+01	6.00E-02
Avian omnivores (AV432)	-	3.40E+00	2.75E+01	6.00E-02
Avian omnivores (AV433)	-	3.40E+00	2.75E+01	6.00E-02
Avian omnivores (AV442)	-	3.40E+00	2.75E+01	6.00E-02
Mammalian herbivores (M121)	1.30E+00	1.25E+00	1.20E+00	1.00E-03
Mammalian herbivores (M122)	8.30E-01	8.30E-01	8.00E-01	1.00E-03
Mammalian herbivores (M122A)	8.30E-01	8.30E-01	8.00E-01	1.00E-03
Pygmy rabbit	4.15E-01	4.15E-01	4.00E-01	5.00E-04
Mammalian herbivores (M123)	1.30E+00	1.25E+00	1.20E+00	1.00E-03
Mammalian insectivores (M210)	8.30E-01	8.30E-01	8.00E-01	1.00E-03
Mammalian insectivores (M210A)	8.30E-01	8.30E-01	8.00E-01	1.00E-03
Townsend's western big-eared bat & small-footed myotis	4.15E-01	4.15E-01	4.00E-01	5.00E-04
Mammalian insectivores (M222)	8.30E-01	8.30E-01	8.00E-01	1.00E-03
Mammalian carnivore (M322)	8.30E-01	8.30E-01	8.00E-01	4.00E-03
Mammalian omnivores (M422)	1.30E+00	1.25E+00	1.20E+00	1.00E-03
Mammalian omnivores (M422A)	1.30E+00	1.30E+01	1.20E+00	2.00E-03
Reptilian insectivores (R222)	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-
Plants	-	2.50E+01	-	4.00E+01

Table 3-3. (continued).

Functional groups	Phosphate	Selenium	Silver	Sodium
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	-	1.00E-02	-	-
Avian herbivores (AV122)	-	1.00E-02	-	-
Avian herbivores (AV132)	-	1.00E-02	-	-
Avian herbivores (AV142)	-	1.00E-01	-	-
Avian herbivores (AV143)	-	1.00E-01	-	-
Trumpeter swan	-	5.00E-02	-	-
Avian insectivores (AV210)	-	1.00E-02	-	-
Black tern	-	5.00E-03	-	-
Avian insectivores (AV210A)	-	1.00E-02	-	-
Avian insectivores (AV221)	-	1.00E-02	-	-
Avian insectivores (AV222)	-	1.00E-02	-	-
Avian insectivores (AV222A)	-	1.00E-02	-	-
Avian insectivores (AV232)	-	1.00E-02	-	-
Avian insectivores (AV233)	-	1.00E-02	-	-
White-faced ibis	-	5.00E-03	-	-
Avian insectivores (AV241)	-	1.00E-02	-	-
Avian insectivores (AV242)	-	1.00E-02	-	-
Avian carnivores (AV310)	-	1.00E-02	-	-
Northern goshawk & peregrine falcon	-	5.00E-03	-	-
Avian carnivores (AV322)	-	1.00E-02	-	-
Bald eagle, ferrugnious hawk, & loggerhead shrike	-	5.00E-03	-	-
Avian carnivores (AV322A)	-	1.00E-02	-	-
Avian carnivores (AV333)	-	1.00E-02	-	-
Avian carnivores (AV342)	-	1.00E-02	-	-
Avian omnivores (AV422)	-	1.00E-02	-	-
Avian omnivores (AV432)	-	1.00E-02	-	-
Avian omnivores (AV433)	-	1.00E-02	-	-
Avian omnivores (AV442)	-	1.00E-02	-	-
Mammalian herbivores (M121)	-	2.00E-02	7.50E-01	4.94E+01
Mammalian herbivores (M122)	-	1.30E-02	5.00E-01	3.29E+01
Mammalian herbivores (M122A)	-	1.30E-02	5.00E-01	3.29E+01
Pygmy rabbit		6.50E-03	2.50E-01	1.65E+01
Mammalian herbivores (M123)	-	2.00E-02	7.50E-01	4.94E+01
Mammalian insectivores (M210)	-	1.30E-02	5.00E-01	3.29E+01
Mammalian insectivores (M210A)	-	1.30E-02	5.00E-01	3.29E+01
Townsend's western big-eared bat & small-footed myotis		6.50E-03	2.50E-01	1.65E+01
Mammalian insectivores (M222)	-	1.30E-02	5.00E-01	3.29E+01
Mammalian carnivore (M322)	-	1.30E-02	5.00E-01	3.29E+01
Mammalian omnivores (M422)	-	2.00E-02	7.50E-01	4.94E+01
Mammalian omnivores (M422A)	-	2.00E-02	7.50E-01	4.94E+01
Reptilian insectivores (R222)	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-
Plants	-	1.00E+00	2.00E+00	-

Table 3-3. (continued).

Functional groups	Sulfates	Toluene	Zinc
Amphibian insectivores (A232)	-	-	-
Avian herbivores (AV121)	-	-	2.00E+00
Avian herbivores (AV122)	-	-	2.00E+00
Avian herbivores (AV132)	-	-	2.00E+00
Avian herbivores (AV142)	-	-	2.00E+00
Avian herbivores (AV143)	-	-	2.00E+00
Trumpeter swan	-	-	1.00E+00
Avian insectivores (AV210)	-	-	2.00E+00
Black tern	-	-	1.00E+00
Avian insectivores (AV210A)	-	-	2.00E+00
Avian insectivores (AV221)	-	-	2.00E+00
Avian insectivores (AV222)	-	-	2.00E+00
Avian insectivores (AV222A)	-	-	2.00E+00
Avian insectivores (AV232)	-	-	2.00E+00
Avian insectivores (AV233)	-	-	2.00E+00
White-faced ibis	-	-	1.00E+00
Avian insectivores (AV241)	-	-	2.00E+00
Avian insectivores (AV242)	-	-	2.00E+00
Avian carnivores (AV310)	-	-	2.00E+00
Northern goshawk & peregrine falcon	-	-	1.00E+00
Avian carnivores (AV322)	-	-	2.00E+00
Bald eagle, ferrugnious hawk, & loggerhead shrike	-	-	1.00E+00
Avian carnivores (AV322A)	-	-	2.00E+00
Avian carnivores (AV333)	-	-	2.00E+00
Avian carnivores (AV342)	-	-	2.00E+00
Avian omnivores (AV422)	-	-	3.00E+00
Avian omnivores (AV432)	-	-	3.00E+00
Avian omnivores (AV433)	-	-	3.00E+00
Avian omnivores (AV442)	-	-	3.00E+00
Mammalian herbivores (M121)	8.00E-01	1.39E+01	5.20E-01
Mammalian herbivores (M122)	8.00E-01	9.29E+00	3.40E-01
Mammalian herbivores (M122A)	8.00E-01	9.29E+00	3.40E-01
Pygmy rabbit	4.00E-01	4.65E+00	1.70E-01
Mammalian herbivores (M123)	8.00E-01	1.39E+01	5.20E-01
Mammalian insectivores (M210)	5.40E-01	9.29E+00	3.40E-01
Mammalian insectivores (M210A)	5.40E-01	9.29E+00	3.40E-01
Townsend's western big-eared bat & small-footed myotis	2.70E-01	4.65E+00	1.70E-01
Mammalian insectivores (M222)	5.40E-01	9.29E+00	5.20E-01
Mammalian carnivore (M322)	5.40E-01	9.29E+00	1.58E+01
Mammalian omnivores (M422)	5.40E-01	1.39E+01	5.20E-01
Mammalian omnivores (M422A)	5.40E-01	1.39E+01	7.00E+00
Reptilian insectivores (R222)	-	-	-
Reptilian carnivores (R322)	-	-	-
Plants	-	2.00E+00	2.00E+01

Table 3-4. WAG 9-specific soil nonradiological EBSLs (mg/kg).

Functional groups	1,1,1-trichloroethane	2-Butanone	2,3,7,8TCDD[a]	Acetone
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	-	-	5.25E-03	-
Avian herbivores (AV122)	-	-	1.27E-04	-
Avian herbivores (AV132)	-	-	2.83E-04	-
Avian herbivores (AV142)	-	-	2.90E-03	-
Avian herbivores (AV143)	-	-	1.16E-03	-
Trumpeter swan	-	-	2.08E-03	-
Avian insectivores (AV210)	-	-	2.76E-05	-
Black tern	-	-	6.90E-05	-
Avian insectivores (AV210A)	-	-	3.15E-05	-
Avian insectivores (AV221)	-	-	2.42E-05	-
Avian insectivores (AV222)	-	-	1.85E-05	-
Avian insectivores (AV222A)	-	-	2.99E-05	-
Avian insectivores (AV232)	-	-	1.77E-05	-
Avian insectivores (AV233)	-	-	9.37E-05	-
White-faced ibis	-	-	1.58E-04	-
Avian insectivores (AV241)	-	-	1.11E-04	-
Avian insectivores (AV242)	-	-	5.72E-05	-
Avian carnivores (AV310)	-	-	6.72E-05	-
Northern goshawk & peregrine falcon	-	-	6.07E-04	-
Avian carnivores (AV322)	-	-	3.09E-05	-
Bald eagle, ferruginous hawk, & loggerhead shrike	-	-	1.60E-03	-
Avian carnivores (AV322A)	-	-	1.88E-04	-
Avian carnivores (AV333)	-	-	1.93E-04	-
Avian carnivores (AV342)	-	-	4.20E-04	-
Avian omnivores (AV422)	-	-	9.50E-05	-
Avian omnivores (AV432)	-	-	5.34E-04	-
Avian omnivores (AV433)	-	-	7.80E-04	-
Avian omnivores (AV442)	-	-	1.99E-04	-
Mammalian herbivores (M121)	8.28E+03	7.54E+02	2.05E-04	1.10E+01
Mammalian herbivores (M122)	4.28E+02	4.04E+01	3.85E-06	5.92E-01
Mammalian herbivores (M122A)	4.70E+02	4.48E+01	3.49E-06	6.56E-01
Pygmy rabbit	3.72E+02	3.40E+01	9.17E-06	4.98E-01
Mammalian herbivores (M123)	9.30E+02	8.83E+01	6.94E-06	1.29E+00
Mammalian insectivores (M210)	1.08E+03	1.92E+03	4.83E-07	5.48E+01
Mammalian insectivores (M210A)	2.11E+03	3.75E+03	9.40E-07	1.07E+02
Townsend's western big-eared bat & small-footed myotis	2.71E+02	4.81E+02	1.21E-07	1.37E+01
Mammalian insectivores (M222)	4.86E+02	8.64E+02	2.17E-07	2.46E+01
Mammalian carnivore (M322)	1.44E+03	2.56E+03	6.43E-07	7.29E+01
Mammalian omnivores (M422)	8.28E+02	1.33E+02	7.95E-07	1.99E+00
Mammalian omnivores (M422A)	2.46E+04	3.95E+03	2.36E-05	5.90E+01
Reptilian insectivores (R222)	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-
Plants	-	-	-	-

a. All dioxin/furans.

Table 3-4. (continued).

Functional groups	Antimony	Arsenic	Beryllium	Butylbenzylphthalate
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	-	7.35E+01	-	-
Avian herbivores (AV122)	-	4.44E+00	-	-
Avian herbivores (AV132)	-	1.13E+01	-	-
Avian herbivores (AV142)	-	1.95E+02	-	-
Avian herbivores (AV143)	-	7.82E+01	-	-
Trumpeter swan	-	1.40E+02	-	-
Avian insectivores (AV210)	-	8.48E-01	-	-
Black tern	-	2.12E+00	-	-
Avian insectivores (AV210A)	-	9.68E-01	-	-
Avian insectivores (AV221)	-	7.45E-01	-	-
Avian insectivores (AV222)	-	5.68E-01	-	-
Avian insectivores (AV222A)	-	9.20E-01	-	-
Avian insectivores (AV232)	-	5.45E-01	-	-
Avian insectivores (AV233)	-	2.88E+00	-	-
White-faced ibis	-	4.85E+00	-	-
Avian insectivores (AV241)	-	3.41E+00	-	-
Avian insectivores (AV242)	-	1.76E+00	-	-
Avian carnivores (AV310)	-	2.07E+00	-	-
Northern goshawk & peregrine falcon	-	1.87E+01	-	-
Avian carnivores (AV322)	-	9.49E-01	-	-
Bald eagle, ferruginous hawk, & loggerhead shrike	-	4.93E+01	-	-
Avian carnivores (AV322A)	-	5.79E+00	-	-
Avian carnivores (AV333)	-	5.94E+00	-	-
Avian carnivores (AV342)	-	1.29E+01	-	-
Avian omnivores (AV422)	-	1.90E+00	-	-
Avian omnivores (AV432)	-	1.08E+01	-	-
Avian omnivores (AV433)	-	1.57E+01	-	-
Avian omnivores (AV442)	-	3.99E+00	-	-
Mammalian herbivores (M121)	2.67E+02	9.89E+01	5.53E+02	7.24E+03
Mammalian herbivores (M122)	1.18E+01	1.68E-01	1.17E+01	2.51E+02
Mammalian herbivores (M122A)	1.24E+01	1.62E-01	1.07E+01	2.48E+02
Pygmy rabbit	1.20E+01	2.51E-01	2.49E+01	3.27E+02
Mammalian herbivores (M123)	2.44E+01	5.69E+00	2.11E+01	4.89E+02
Mammalian insectivores (M210)	5.48E+00	3.13E-02	1.56E+00	5.76E+01
Mammalian insectivores (M210A)	1.07E+01	6.10E-02	3.05E+00	1.12E+02
Townsend's western big-eared bat & small-footed myotis	1.37E+00	7.82E-03	3.91E-01	1.44E+01
Mammalian insectivores (M222)	2.46E+00	1.40E-02	7.02E-01	2.59E+01
Mammalian carnivore (M322)	7.29E+00	4.17E-02	2.08E+00	7.68E+01
Mammalian omnivores (M422)	7.70E+00	8.83E-01	2.54E+00	8.97E+01
Mammalian omnivores (M422A)	2.29E+02	2.62E+01	7.55E+01	2.66E+03
Reptilian insectivores (R222)	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-
Plants	-	-	-	-

Table 3-4. (continued).

Functional groups	Calcium	Chloride	Chloroform	Chromium VI
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	-	-	-	7.93E+02
Avian herbivores (AV122)	-	-	-	2.18E+01
Avian herbivores (AV132)	-	-	-	4.90E+01
Avian herbivores (AV142)	-	-	-	4.95E+02
Avian herbivores (AV143)	-	-	-	1.98E+02
Trumpeter swan	-	-	-	3.56E+02
Avian insectivores (AV210)	-	-	-	4.83E+00
Black tern	-	-	-	1.21E+01
Avian insectivores (AV210A)	-	-	-	5.51E+00
Avian insectivores (AV221)	-	-	-	4.24E+00
Avian insectivores (AV222)	-	-	-	3.23E+00
Avian insectivores (AV222A)	-	-	-	5.23E+00
Avian insectivores (AV232)	-	-	-	3.10E+00
Avian insectivores (AV233)	-	-	-	1.64E+01
White-faced ibis	-	-	-	2.76E+01
Avian insectivores (AV241)	-	-	-	1.94E+01
Avian insectivores (AV242)	-	-	-	1.00E+01
Avian carnivores (AV310)	-	-	-	1.18E+01
Northern goshawk & peregrine falcon	-	-	-	1.06E+02
Avian carnivores (AV322)	-	-	-	5.40E+00
Bald eagle, ferruginous hawk, & loggerhead shrike	-	-	-	2.80E+02
Avian carnivores (AV322A)	-	-	-	3.29E+01
Avian carnivores (AV333)	-	-	-	3.38E+01
Avian carnivores (AV342)	-	-	-	7.34E+01
Avian omnivores (AV422)	-	-	-	1.70E+01
Avian omnivores (AV432)	-	-	-	9.58E+01
Avian omnivores (AV433)	-	-	-	1.40E+02
Avian omnivores (AV442)	-	-	-	3.57E+01
Mammalian herbivores (M121)	-	-	1.78E+01	6.69E+01
Mammalian herbivores (M122)	-	-	9.67E-01	2.01E+00
Mammalian herbivores (M122A)	-	-	1.07E+00	1.84E+00
Pygmy rabbit	-	-	8.26E-01	4.53E+00
Mammalian herbivores (M123)	-	-	2.05E+00	2.41E+00
Mammalian insectivores (M210)	-	-	4.83E+00	2.61E-01
Mammalian insectivores (M210A)	-	-	9.40E+00	5.08E-01
Townsend's western big-eared bat & small-footed myotis	-	-	1.21E+00	6.52E-02
Mammalian insectivores (M222)	-	-	2.17E+00	1.17E-01
Mammalian carnivore (M322)	-	-	6.43E+00	5.21E-01
Mammalian omnivores (M422)	-	-	1.58E+00	4.25E-01
Mammalian omnivores (M422A)	-	-	2.03E+02	2.94E+01
Reptilian insectivores (R222)	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-
Plants	-	-	-	-

Table 3-4. (continued).

Functional groups	Copper	Cyanide	Di-2-ethylhexylphthalate	Di-n-octylphthalate
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	2.51E+01	1.37E-01	-	-
Avian herbivores (AV122)	3.51E+00	2.15E-02	-	-
Avian herbivores (AV132)	1.32E+01	9.02E-02	-	-
Avian herbivores (AV142)	7.21E+01	8.70E-01	-	-
Avian herbivores (AV143)	2.89E+01	3.48E-01	-	-
Trumpeter swan	5.18E+01	6.25E-01	-	-
Avian insectivores (AV210)	3.55E+00	3.18E-02	-	-
Black tern	8.89E+00	7.96E-02	-	-
Avian insectivores (AV210A)	4.05E+00	3.63E-02	-	-
Avian insectivores (AV221)	3.12E+00	2.80E-02	-	-
Avian insectivores (AV222)	2.38E+00	2.13E-02	-	-
Avian insectivores (AV222A)	3.85E+00	3.45E-02	-	-
Avian insectivores (AV232)	2.28E+00	2.04E-02	-	-
Avian insectivores (AV233)	1.21E+01	1.08E-01	-	-
White-faced ibis	2.03E+01	1.82E-01	-	-
Avian insectivores (AV241)	1.43E+01	1.28E-01	-	-
Avian insectivores (AV242)	7.37E+00	6.60E-02	-	-
Avian carnivores (AV310)	8.66E+00	3.36E-01	-	-
Northern goshawk & peregrine falcon	7.82E+01	3.03E+00	-	-
Avian carnivores (AV322)	3.98E+00	3.56E-02	-	-
Bald eagle, ferruginous hawk, & loggerhead shrike	2.06E+02	1.85E+00	-	-
Avian carnivores (AV322A)	2.43E+01	2.17E-01	-	-
Avian carnivores (AV333)	2.49E+01	2.23E-01	-	-
Avian carnivores (AV342)	5.41E+01	4.84E-01	-	-
Avian omnivores (AV422)	9.51E+00	4.28E-02	-	-
Avian omnivores (AV432)	5.74E+01	2.76E-01	-	-
Avian omnivores (AV433)	8.38E+01	4.03E-01	-	-
Avian omnivores (AV442)	2.02E+01	9.22E-02	-	-
Mammalian herbivores (M121)	2.89E+02	1.83E+00	6.48E+03	4.41E+04
Mammalian herbivores (M122)	2.09E+01	1.41E-01	2.86E+02	7.23E+02
Mammalian herbivores (M122A)	2.24E+01	1.54E-01	2.98E+02	6.47E+02
Pygmy rabbit	1.95E+01	1.24E-01	2.92E+02	1.99E+03
Mammalian herbivores (M123)	2.95E+01	2.02E-01	5.88E+02	1.27E+03
Mammalian insectivores (M210)	1.70E+01	2.61E-01	1.29E+02	8.45E+01
Mammalian insectivores (M210A)	3.30E+01	5.08E-01	2.52E+02	1.65E+02
Townsend's western big-eared bat & small-footed myotis	4.24E+00	6.52E-02	3.23E+01	2.11E+01
Mammalian insectivores (M222)	7.61E+00	1.17E-01	5.81E+01	3.79E+01
Mammalian carnivore (M322)	6.95E+01	5.21E-01	1.72E+02	1.13E+02
Mammalian omnivores (M422)	1.39E+01	2.34E-01	1.83E+02	1.39E+02
Mammalian omnivores (M422A)	6.35E+02	1.16E+01	5.42E+03	4.11E+03
Reptilian insectivores (R222)	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-
Plants	-	-	-	-

Table 3-4. (continued).

Functional groups	Fluoride	Lead	Manganese	Mercury
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	-	1.11E+01	5.72E+01	1.69E-01
Avian herbivores (AV122)	-	5.36E-01	7.25E+00	2.63E-02
Avian herbivores (AV132)	-	1.39E+00	2.52E+01	1.09E-01
Avian herbivores (AV142)	-	7.45E+02	1.51E+02	5.32E-01
Avian herbivores (AV143)	-	2.98E+02	6.02E+01	2.13E-01
Trumpeter swan	-	5.35E+02	1.08E+02	3.83E-01
Avian insectivores (AV210)	-	2.12E-01	5.14E+00	5.30E-02
Black tern	-	5.31E-01	1.29E+01	1.33E-01
Avian insectivores (AV210A)	-	4.84E-01	5.87E+00	6.05E-02
Avian insectivores (AV221)	-	1.86E-01	4.52E+00	4.66E-02
Avian insectivores (AV222)	-	1.42E-01	3.45E+00	3.55E-02
Avian insectivores (AV222A)	-	2.30E-01	5.58E+00	5.75E-02
Avian insectivores (AV232)	-	1.36E-01	3.30E+00	3.40E-02
Avian insectivores (AV233)	-	7.20E-01	1.75E+01	1.80E-01
White-faced ibis	-	1.21E+00	2.94E+01	3.03E-01
Avian insectivores (AV241)	-	8.53E-01	2.07E+01	2.13E-01
Avian insectivores (AV242)	-	4.40E-01	1.07E+01	1.10E-01
Avian carnivores (AV310)	-	3.88E-01	1.25E+01	1.29E-01
Northern goshawk & peregrine falcon	-	3.50E+00	1.13E+02	1.17E+00
Avian carnivores (AV322)	-	1.78E-01	5.75E+00	5.93E-02
Bald eagle, ferruginous hawk, & loggerhead shrike	-	9.24E+00	2.99E+02	3.08E+00
Avian carnivores (AV322A)	-	1.09E+00	3.51E+01	3.62E-01
Avian carnivores (AV333)	-	1.11E+00	3.60E+01	3.71E-01
Avian carnivores (AV342)	-	2.42E+00	7.83E+01	8.07E-01
Avian omnivores (AV422)	-	3.55E-01	1.56E+01	1.49E-01
Avian omnivores (AV432)	-	2.02E+00	9.17E+01	9.52E-01
Avian omnivores (AV433)	-	2.94E+00	1.34E+02	1.39E+00
Avian omnivores (AV442)	-	7.46E-01	3.29E+01	3.20E-01
Mammalian herbivores (M121)	-	1.27E+01	1.86E+02	2.03E-01
Mammalian herbivores (M122)	-	5.96E-01	8.53E+00	1.55E-02
Mammalian herbivores (M122A)	-	5.78E-01	9.01E+00	1.70E-02
Pygmy rabbit	-	8.60E-01	8.42E+00	1.37E-02
Mammalian herbivores (M123)	-	7.60E-01	1.78E+01	2.23E-01
Mammalian insectivores (M210)	-	1.16E-01	4.69E+00	2.61E-02
Mammalian insectivores (M210A)	-	2.26E-01	9.15E+00	5.08E-02
Townsend's western big-eared bat & small-footed myotis	-	2.90E-02	1.17E+00	6.52E-03
Mammalian insectivores (M222)	-	5.21E-02	2.11E+00	1.17E-02
Mammalian carnivore (M322)	-	2.26E-01	6.25E+00	8.68E-02
Mammalian omnivores (M422)	-	1.79E-01	6.38E+00	1.63E-02
Mammalian omnivores (M422A)	-	1.10E+01	1.89E+02	7.27E-01
Reptilian insectivores (R222)	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-
Plants	-	-	-	-

Table 3-4. (continued).

Functional groups	Methylene chloride	Nickel	Nitrates	PCBs
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	-	1.06E+03	2.78E+02	2.72E+01
Avian herbivores (AV122)	-	7.83E+01	4.37E+01	9.16E-01
Avian herbivores (AV132)	-	2.11E+02	1.83E+02	2.11E+00
Avian herbivores (AV142)	-	3.63E+03	8.85E+02	2.07E+01
Avian herbivores (AV143)	-	1.45E+03	3.54E+02	8.28E+00
Trumpeter swan	-	2.61E+03	6.36E+02	1.49E+01
Avian insectivores (AV210)	-	1.80E+01	9.70E+01	2.12E-01
Black tern	-	4.51E+01	2.43E+02	5.31E-01
Avian insectivores (AV210A)	-	2.06E+01	1.11E+02	2.42E-01
Avian insectivores (AV221)	-	1.58E+01	8.53E+01	1.86E-01
Avian insectivores (AV222)	-	1.21E+01	6.50E+01	1.42E-01
Avian insectivores (AV222A)	-	1.95E+01	1.05E+02	2.30E-01
Avian insectivores (AV232)	-	1.16E+01	6.23E+01	1.36E-01
Avian insectivores (AV233)	-	6.12E+01	3.30E+02	7.20E-01
White-faced ibis	-	1.03E+02	5.55E+02	1.21E+00
Avian insectivores (AV241)	-	7.25E+01	3.90E+02	8.53E-01
Avian insectivores (AV242)	-	3.74E+01	2.01E+02	4.40E-01
Avian carnivores (AV310)	-	4.40E+01	2.37E+02	1.02E+01
Northern goshawk & peregrine falcon	-	3.97E+02	2.14E+03	9.22E+01
Avian carnivores (AV322)	-	2.02E+01	1.09E+02	2.37E-01
Bald eagle, ferruginous hawk, & loggerhead shrike	-	1.05E+03	5.63E+03	1.23E+01
Avian carnivores (AV322A)	-	1.23E+02	6.63E+02	1.45E+00
Avian carnivores (AV333)	-	1.26E+02	6.80E+02	1.49E+00
Avian carnivores (AV342)	-	2.74E+02	1.48E+03	3.23E+00
Avian omnivores (AV422)	-	3.99E+01	1.96E+02	7.27E-01
Avian omnivores (AV432)	-	2.27E+02	1.27E+03	4.10E+00
Avian omnivores (AV433)	-	3.31E+02	1.85E+03	5.98E+00
Avian omnivores (AV442)	-	8.37E+01	4.22E+02	1.52E+00
Mammalian herbivores (M121)	1.76E+01	1.45E+03	1.10E+02	2.84E+00
Mammalian herbivores (M122)	9.01E-01	4.91E+01	5.64E+00	9.43E-02
Mammalian herbivores (M122A)	9.97E-01	4.83E+01	6.16E+00	8.70E-02
Pygmy rabbit	7.63E-01	6.53E+01	4.96E+00	1.92E-01
Mammalian herbivores (M123)	2.05E+00	9.56E+01	1.21E+01	1.14E-01
Mammalian insectivores (M210)	1.08E+01	1.08E+01	1.04E+01	1.30E-02
Mammalian insectivores (M210A)	2.11E+01	2.11E+01	2.03E+01	2.54E-02
Townsend's western big-eared bat & small-footed myotis	2.71E+00	2.71E+00	2.61E+00	3.26E-03
Mammalian insectivores (M222)	4.86E+00	4.86E+00	4.68E+00	5.85E-03
Mammalian carnivore (M322)	1.44E+01	1.44E+01	1.39E+01	6.95E-02
Mammalian omnivores (M422)	2.77E+00	1.70E+01	9.35E+00	1.41E-02
Mammalian omnivores (M422A)	8.23E+01	5.24E+03	2.78E+02	8.37E-01
Reptilian insectivores (R222)	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-
Plants	-	-	-	-

Table 3-4. (continued).

Functional groups	Phosphate	Selenium	Silver	Sodium
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	-	4.37E+00	-	-
Avian herbivores (AV122)	-	2.07E-01	-	-
Avian herbivores (AV132)	-	5.00E-01	-	-
Avian herbivores (AV142)	-	4.61E+01	-	-
Avian herbivores (AV143)	-	1.84E+01	-	-
Trumpeter swan	-	3.31E+01	-	-
Avian insectivores (AV210)	-	5.30E-02	-	-
Black tern	-	1.33E-01	-	-
Avian insectivores (AV210A)	-	6.05E-02	-	-
Avian insectivores (AV221)	-	4.66E-02	-	-
Avian insectivores (AV222)	-	3.55E-02	-	-
Avian insectivores (AV222A)	-	5.75E-02	-	-
Avian insectivores (AV232)	-	3.40E-02	-	-
Avian insectivores (AV233)	-	1.80E-01	-	-
White-faced ibis	-	3.03E-01	-	-
Avian insectivores (AV241)	-	2.13E-01	-	-
Avian insectivores (AV242)	-	1.10E-01	-	-
Avian carnivores (AV310)	-	1.29E-01	-	-
Northern goshawk & peregrine falcon	-	1.17E+00	-	-
Avian carnivores (AV322)	-	5.93E-02	-	-
Bald eagle, ferruginous hawk, & loggerhead shrike	-	3.08E+00	-	-
Avian carnivores (AV322A)	-	3.62E-01	-	-
Avian carnivores (AV333)	-	3.71E-01	-	-
Avian carnivores (AV342)	-	8.07E-01	-	-
Avian omnivores (AV422)	-	1.20E-01	-	-
Avian omnivores (AV432)	-	6.78E-01	-	-
Avian omnivores (AV433)	-	9.91E-01	-	-
Avian omnivores (AV442)	-	2.52E-01	-	-
Mammalian herbivores (M121)	-	4.11E+01	1.67E+02	4.83E+04
Mammalian herbivores (M122)	-	1.06E+00	8.05E+00	1.74E+03
Mammalian herbivores (M122A)	-	1.00E+00	8.63E+00	1.73E+03
Pygmy rabbit	-	1.81E+00	7.52E+00	2.18E+03
Mammalian herbivores (M123)	-	2.02E+00	1.70E+01	3.42E+03
Mammalian insectivores (M210)	-	1.70E-01	6.52E+00	4.29E+02
Mammalian insectivores (M210A)	-	3.30E-01	1.27E+01	8.36E+02
Townsend's western big-eared bat & small-footed myotis	-	4.24E-02	1.63E+00	1.07E+02
Mammalian insectivores (M222)	-	7.61E-02	2.93E+00	1.93E+02
Mammalian carnivore (M322)	-	2.26E-01	8.68E+00	5.71E+02
Mammalian omnivores (M422)	-	2.79E-01	8.03E+00	6.63E+02
Mammalian omnivores (M422A)	-	8.29E+00	2.38E+02	1.97E+04
Reptilian insectivores (R222)	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-
Plants	-	-	-	-

Table 3-4. (continued).

Functional groups	Sulfates	Toluene	Zinc
Amphibian insectivores (A232)	-	-	-
Avian herbivores (AV121)	-	-	2.03E+01
Avian herbivores (AV122)	-	-	3.29E+00
Avian herbivores (AV132)	-	-	1.42E+01
Avian herbivores (AV142)	-	-	6.63E+01
Avian herbivores (AV143)	-	-	2.65E+01
Trumpeter swan	-	-	4.76E+01
Avian insectivores (AV210)	-	-	1.06E+01
Black tern	-	-	2.65E+01
Avian insectivores (AV210A)	-	-	1.21E+01
Avian insectivores (AV221)	-	-	9.32E+00
Avian insectivores (AV222)	-	-	7.10E+00
Avian insectivores (AV222A)	-	-	1.15E+01
Avian insectivores (AV232)	-	-	6.81E+00
Avian insectivores (AV233)	-	-	3.60E+01
White-faced ibis	-	-	6.06E+01
Avian insectivores (AV241)	-	-	4.27E+01
Avian insectivores (AV242)	-	-	2.20E+01
Avian carnivores (AV310)	-	-	2.59E+01
Northern goshawk & peregrine falcon	-	-	2.33E+02
Avian carnivores (AV322)	-	-	1.19E+01
Bald eagle, ferruginous hawk, & loggerhead shrike	-	-	6.16E+02
Avian carnivores (AV322A)	-	-	7.24E+01
Avian carnivores (AV333)	-	-	7.43E+01
Avian carnivores (AV342)	-	-	1.61E+02
Avian omnivores (AV422)	-	-	1.77E+01
Avian omnivores (AV432)	-	-	1.18E+02
Avian omnivores (AV433)	-	-	1.73E+02
Avian omnivores (AV442)	-	-	3.84E+01
Mammalian herbivores (M121)	7.32E+01	1.25E+03	3.19E+01
Mammalian herbivores (M122)	5.64E+00	6.43E+01	1.63E+00
Mammalian herbivores (M122A)	6.16E+00	7.02E+01	1.79E+00
Pygmy rabbit	4.96E+00	5.64E+01	1.41E+00
Mammalian herbivores (M123)	8.10E+00	1.38E+02	3.60E+00
Mammalian insectivores (M210)	7.04E+00	1.21E+02	4.43E+00
Mammalian insectivores (M210A)	1.37E+01	2.36E+02	8.64E+00
Townsend's western big-eared bat & small-footed myotis	1.76E+00	3.03E+01	1.11E+00
Mammalian insectivores (M222)	3.16E+00	5.44E+01	3.04E+00
Mammalian carnivore (M322)	9.38E+00	1.61E+02	2.74E+02
Mammalian omnivores (M422)	4.21E+00	1.07E+02	3.31E+00
Mammalian omnivores (M422A)	1.25E+02	3.19E+03	1.32E+03
Reptilian insectivores (R222)	-	-	-
Reptilian carnivores (R322)	-	-	-
Plants	-	-	-

where

Dose	=	radiation dose estimate (Gy/day)
TC	=	tissue radionuclide concentration (pCi/g)
$\bar{E}$	=	average decay energy per disintegration (MeV/dis)
FA	=	fraction of decay energy absorbed (unitless)
ED	=	exposure duration (fraction of year spent in affected area) (unitless).

Since tissue levels of radionuclides are derived by multiplying the concentration of radionuclide in soil by a radionuclide-specific concentration factor (CF) for all terrestrial animals or terrestrial plants, the above equation can be rewritten as:

$$Dose = \frac{CS \times CF \times ED \times \bar{E} \times FA \times 3{,}200\ dis/day\text{-}pCi}{6.24 \times 10^9\ MeV/g\text{-}Gy} \tag{3-15}$$

where

Dose	=	internal radiation dose estimate (Gy/day)
CS	=	concentration of contaminant in soil ingested (pCi/g)
CF	=	concentration factor (unitless)
ED	=	exposure duration (unitless)
$\bar{E}$	=	average decay energy per disintegration (MeV/dis)
FA	=	fraction of decay energy absorbed (unitless). Solving for the concentration of contaminant in soil (CS) and redefining this concentration as an EBSL, the external EBSL for radiological contaminants in soil is estimated using the equation:

$$EBSL = \frac{TRV \times 6.24 \times 10^9\ MeV/g\text{-}Gy}{CF \times ED \times \bar{E} \times FA \times 3{,}200\ dis/day\text{-}pCi} \tag{3-16}$$

where

EBSL	=	internal ecologically based screening level for radionuclides in soil (pCi/g)
TRV	=	toxicity reference value (Gy/day)
CF	=	concentration factor (unitless)

ED = exposure duration (unitless)

$\bar{E}$ = average decay energy per disintegration (MeV/dis)

FA = fraction of decay energy absorbed (unitless).

Contaminant-specific $\bar{E}$ values for the radionuclides of concern are listed in Table 3-5. Assumptions used in the calculation of the $\bar{E}$ values were that for radiations whose energy would be deposited in small tissue volume (ß,α), the FA was set equal to 1. For γ radiations, the FA was conservatively set equal to 0.3 (30%). Only radiations with an intensity of 1% or greater were considered, and Auger and conversion electrons were not considered. The $\bar{E}$ values were calculated using the following equation (Kocher 1981):

$$\bar{E} = \sum_{i}^{1} Y_i E_i \tag{3-17}$$

where

$\bar{E}$ = average decay energy per disintegration (MeV/dis)

Y_i = yield or intensity

E_i = energy of radiation, for ß = average energy.

Radionuclide concentration factors (CFs) for plants are presented in Table 3-5. These CFs for plants were taken from Baes et al. (1984). Note that faunal CFs were not available for any of the radionuclides except for Sr-90. The CF for Sr-90 (used for mammalian herbivores) was calculated by dividing the deer mouse carcass concentration (Arthur 1987) by the soil concentration (Arthur and Markham 1983). A second value for the CF for Sr-90 for mammalian herbivores was derived by dividing the pronghorn carcass concentration by the soil concentration (Markham et al. 1980). The most conservative of these two values was used. For the other radionuclides, the CF values for animals are assumed to be 1 for contaminants and receptors.

Preliminary TRVs for functional groups/contaminant combinations are presented in Table 3-6. Derivation of these TRVs is discussed in Section 3.2. The resulting EBSLs are then divided by the SUF to result in WAG 9-specific EBSLs. WAG 9-specific internal ESBLs for radiological functional group/contaminant pairs are presented in Table 3-7.

3.1.2.2.2 External Radiation Dose—External dose EBSLs are derived using formulas outlined in Shleien (1992). Dose rate to tissue in an infinite medium uniformly contaminated by a gamma emitter is calculated as:

$$\dot{D} = \frac{2.12 \times \bar{E} \times C}{\rho} \tag{3-18}$$

Table 3-5. WAG 9 CFs, Ēs and FAs.

		Ē (MeV/dis)		FA	
Parameter	Plant CF (unitless)	Alpha and/or beta	Gamma	Alpha and/or beta	Gamma
Co-60	2.00E-02	9.58E-02	2.50E+00	1	0.3
Cs-137	8.00E-02	1.71E-01	5.96E-01	1	0.3
Sr-90	1.11E+00	5.83E-01	no dose	1	0.3
U-238	8.50E-03	4.19E+00	3.47E-05	1	0.3

where

$\dot{D}$ = external dose rate to tissue (rads/hr)

$\bar{E}$ = average gamma decay energy per disintegration (MeV/dis)

C = concentration of contaminant (μCi/cm³)

ρ = density of the medium (g/cm³).

Solving the equation for the concentration in soil (C) assuming an acceptable dose to animals is 1 mGy/day (0.1 rad/day which is equal to 4.12E-03 rad/hr) (IAEA 1992) and redefining this concentration as an EBSL, the EBSL for external dose from radiological contaminants in soil is estimated using the equation:

$$EBSL = \frac{\dot{D} \times 10^6 \; pCi/g}{2.12 \times \bar{E}} \tag{3-19}$$

where

EBSL = external ecologically based screening level for radionuclides in soil (pCi/g)

$\dot{D}$ = external dose rate to tissue (rads/hr)

$\bar{E}$ = average gamma decay energy per disintegration (MeV/dis).

This equation conservatively estimates the dose to burrowing terrestrial functional groups (AV322A, M122A, M210A, and M422A). This equation also conservatively reflects that these functional groups spend 100% of their time with external exposure. For the nonburrowing functional groups, it is conservatively assumed that they are exposed to 50% (hemisphere) of radiation.

Table 3-6. WAG 9 soil radiological TRVs.

Functional Group	Co-60	Cs-137	Sr-90	U-238
Amphibian insectivores (AV232)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Avian herbivores (AV121)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Avian herbivores (AV122)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Avian herbivores (AV132)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Avian herbivores (AV142)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Avian herbivores (AV143)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Trumpeter swan	5.00E-04	5.00E-04	5.00E-04	5.00E-04
Avian insectivores (AV210)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Black tern	5.00E-04	5.00E-04	5.00E-04	5.00E-04
Avian insectivores (AV210A)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Avian insectivores (AV221)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Avian insectivores (AV222)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Avian insectivores (AV222A)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Avian insectivores (AV232)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Avian insectivores (AV233)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
White-faced ibis	5.00E-04	5.00E-04	5.00E-04	5.00E-04
Avian insectivores (AV241)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Avian insectivores (AV242)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Avian carnivores (AV310)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Northern goshawk/Peregrine falcon	5.00E-04	5.00E-04	5.00E-04	5.00E-04
Avian carnivores (AV322)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Bald eagle, ferruginous hawk/loggerhead shrike	5.00E-04	5.00E-04	5.00E-04	5.00E-04
Burrowing owl (AV322A)	5.00E-04	5.00E-04	5.00E-04	5.00E-04
Avian carnivores (AV333)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Avian carnivores (AV342)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Avian omnivores (AV422)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Avian omnivores (AV432)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Avian omnivores (AV433)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Avian omnivores (AV442)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Mammalian herbivores (M121)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Mammalian herbivores (M122)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Mammalian herbivores (M122A)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Pygmy rabbit	5.00E-04	5.00E-04	5.00E-04	5.00E-04
Mammalian herbivores (M123)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Mammalian insectivores (M210)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Mammalian insectivores (M210A)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Townsend's western big-eared bat & small-footed myotis	5.00E-04	5.00E-04	5.00E-04	5.00E-04
Mammalian insectivores (M222)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Mammalian carnivores (M322)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Mammalian omnivores (M422)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Mammalian omnivores (M422A)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Reptilian insectivores (R222)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Reptilian carnivores (R322)	1.00E-03	1.00E-03	1.00E-03	1.00E-03
Plants	1.00E-02	1.00E-02	1.00E-02	1.00E-02

Table 3-7. WAG 9-specific internal dose soil radiological EBSLs (pCi/g).

Functional groups	Co-60	Cs-137	Sr-90	U-238
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	9.21E+03	2.23E+04	8.69E+03	1.86E+03
Avian herbivores (AV122)	2.30E+03	5.58E+03	2.17E+03	4.64E+02
Avian herbivores (AV132)	3.54E+03	8.58E+03	3.34E+03	7.15E+02
Avian herbivores (AV142)	9.21E+03	2.23E+04	8.69E+03	1.86E+03
Avian herbivores (AV143)	3.54E+03	8.58E+03	3.34E+03	7.15E+02
Trumpeter swan	4.61E+03	1.12E+04	4.34E+03	9.29E+02
Avian insectivores (AV210)	9.21E+03	2.23E+04	8.69E+03	1.86E+03
Black tern	4.61E+03	1.12E+04	4.34E+03	9.29E+02
Avian insectivores (AV210A)	3.54E+03	8.58E+03	3.34E+03	7.15E+02
Avian insectivores (AV221)	9.21E+03	2.23E+04	8.69E+03	1.86E+03
Avian insectivores (AV222)	3.54E+03	8.58E+03	3.34E+03	7.15E+02
Avian insectivores (AV222A)	3.54E+03	8.58E+03	3.34E+03	7.15E+02
Avian insectivores (AV232)	2.30E+03	5.58E+03	2.17E+03	4.64E+02
Avian insectivores (AV233)	3.54E+03	8.58E+03	3.34E+03	7.15E+02
White-faced ibis	4.61E+03	1.12E+04	4.34E+03	9.29E+02
Avian insectivores (AV241)	3.54E+03	8.58E+03	3.34E+03	7.15E+02
Avian insectivores (AV242)	9.21E+03	2.23E+04	8.69E+03	1.86E+03
Avian carnivores (AV310)	9.21E+03	2.23E+04	1.22E+04	1.86E+03
Peregrine falcon & northern goshawk	1.49E+04	3.62E+04	1.97E+04	3.01E+03
Avian carnivores (AV322)	9.21E+03	2.23E+04	1.22E+04	1.86E+03
Bald eagle, ferruginous hawk & loggerhead shrike	2.34E+04	5.66E+04	3.08E+04	4.71E+03
Burrowing owl (AV322A)	4.61E+03	1.12E+04	6.08E+03	9.29E+02
Avian carnivores (AV333)	3.54E+03	8.58E+03	4.68E+03	7.15E+02
Avian omnivores (AV342)	9.21E+03	2.23E+04	8.69E+03	1.86E+03
Avian omnivores (AV422)	3.38E+03	8.19E+03	3.19E+03	6.82E+02
Avian omnivores (AV432)	2.99E+04	7.23E+04	2.82E+04	6.02E+03
Avian omnivores (AV433)	2.30E+03	5.58E+03	2.17E+03	4.64E+02
Avian omnivores (AV442)	4.67E+04	1.13E+05	4.41E+04	9.42E+03
Mammalian herbivores (M121)	9.21E+03	2.23E+04	8.69E+03	1.86E+03
Mammalian herbivores (M122)	9.21E+03	2.23E+04	8.69E+03	1.86E+03
Mammalian herbivores (M122A)	9.21E+03	2.23E+04	8.69E+03	1.86E+03
Pygmy rabbit	1.15E+03	2.79E+03	1.09E+03	2.32E+02
Mammalian herbivores (M123)	2.30E+03	5.58E+03	2.17E+03	4.64E+02
Mammalian insectivores (M210)	9.21E+03	2.23E+04	8.69E+03	1.86E+03
Mammalian insectivores (M210A)	9.21E+03	2.23E+04	8.69E+03	1.86E+03
Townsend's western big-eared bat & small-footed myotis	1.15E+03	2.79E+03	1.09E+03	2.32E+02
Mammalian insectivores (M222)	2.30E+03	5.58E+03	2.17E+03	4.64E+02
Mammalian carnivore (M322)	9.21E+03	2.23E+04	8.69E+03	1.86E+03
Mammalian omnivores (M422)	2.30E+03	5.58E+03	3.13E+03	4.64E+02
Mammalian omnivores (M422A)	2.30E+03	5.58E+03	3.13E+03	4.64E+02
Reptilian insectivores (R222)	2.30E+03	5.58E+03	2.17E+03	4.64E+02
Reptilian carnivores (R322)	2.30E+03	5.58E+03	2.17E+03	4.64E+02
Plants	2.30E+06	1.40E+06	6.03E+04	1.09E+06

The dose rate (D) for use in the external EBSL calculation is 4.12E-03 rads/hr as discussed above. Contaminant-specific Ė and FA values for the radionuclides of concern are listed in Table 3-5. ESBLs for external dose from radiologically contaminated soil are presented in Table 3-8.

3.1.2.3 Water and Sediment Ecologically Based Screening Levels. There are three locations of surface water and sediment contaminants at the WAG 9 assessment site. These locations are:

- Industrial Waste Pond and Cooling Tower Blowdown Ditches (ANL-01)—standing water and sediment
- Industrial Waste Lift Station Discharge Ditch (ANL-35)—standing water
- ANL Sewage Lagoons (ANL-04)—standing water and sediment (no data on contamination of standing water).

The concentrations of contaminants detected in standing water at the Industrial Waste Pond and Cooling Tower Blowdown Ditches (ANL-01) and the Industrial Waste Lift Station Discharge Ditch (ANL-35) were compared with toxicological benchmarks for screening contaminants for effects on aquatic biota (Suter et al. 1992) in Section 2.4.3, Tables 2-15 and 2-16. The contaminants whose maximum concentrations exceeded the corresponding screening criteria or for which screening criterion were not located are listed in Table 3-9.

The sediment contaminants detected at the Industrial Waste Pond and Cooling Tower Blowdown Ditches (ANL-01) and the ANL Sewage Lagoons (ANL-04) were compared with toxicological benchmarks for screening contaminants for effects on sediment-associated biota (Hull and Suter 1993) in Tables 2-17 and 2-18. The contaminants whose maximum concentrations exceeded the corresponding screening criteria or for which screening criteria were not located are listed in Table 3-10.

Potential exposure pathways are defined as the route contaminants follow in order to reach potential receptors. Potential routes by which aquatic birds may be exposed to site-related contaminants include: (1) inhalation of fugitive dust that may be resuspended from the soil surface; (2) inhalation of organics that may volatilize from the soil surface; and (3) ingestion of sediment, forage, and surface water. While incidental ingestion of soil while grooming or preening is another possible route of exposure, it is considered small relative to the contribution from inhalation and direct ingestion routes. Similarly, dermal absorption of site-related contaminants is not considered a complete exposure pathway for water birds, since most metals and lipophilic organics will not be readily absorbed through a bird's dense feathers. Inhalation of dust and/or vapors is expected to contribute smaller doses to waterfowl relative to direct ingestion of sediments, forage, and surface water. Thus, aquatic birds could be exposed to contaminants present in air, sediments, aquatic vegetation, aquatic invertebrates and/or surface water. The relative concentration of contaminants in these media will determine the exposure likely to occur to various waterfowl and other aquatic species. The potential risks as a result of surface water or sediment exposure must be assessed in the ERA.

Table 3-8. External dose soil radiological EBSLs (pCi/g).

Functional groups	Co-60	Cs-137	Sr-90	U-238
Amphibian insectivores (A232)	1.57E+03	6.60E+03	-	1.13E+08
Avian herbivores (AV121)	1.57E+03	6.60E+03	-	1.13E+08
Avian herbivores (AV122)	1.57E+03	6.60E+03	-	1.13E+08
Avian herbivores (AV132)	1.57E+03	6.60E+03	-	1.13E+08
Avian herbivores (AV142)	1.57E+03	6.60E+03	-	1.13E+08
Avian herbivores (AV143)	1.57E+03	6.60E+03	-	1.13E+08
Trumpeter swan	1.57E+03	6.60E+03	-	1.13E+08
Avian insectivores (AV210)	1.57E+03	6.60E+03	-	1.13E+08
Black tern	1.57E+03	6.60E+03	-	1.13E+08
Avian insectivores (AV210A)	7.85E+02	3.30E+03	-	5.66E+07
Avian insectivores (AV221)	1.57E+03	6.60E+03	-	1.13E+08
Avian insectivores (AV222)	1.57E+03	6.60E+03	-	1.13E+08
Avian insectivores (AV222A)	7.85E+02	3.30E+03	-	5.66E+07
Avian insectivores (AV232)	1.57E+03	6.60E+03	-	1.13E+08
Avian insectivores (AV233)	1.57E+03	6.60E+03	-	1.13E+08
White-faced ibis	1.57E+03	6.60E+03	-	1.13E+08
Avian insectivores (AV241)	1.57E+03	6.60E+03	-	1.13E+08
Avian insectivores (AV242)	1.57E+03	6.60E+03	-	1.13E+08
Avian carnivores (AV310)	1.57E+03	6.60E+03	-	1.13E+08
Peregrine falcon & northern goshawk	1.57E+03	6.60E+03	-	1.13E+08
Avian carnivores (AV322)	1.57E+03	6.60E+03	-	1.13E+08
Bald eagle, ferruginous hawk & loggerhead shrike	1.57E+03	6.60E+03	-	1.13E+08
Burrowing owl (AV322A)	7.85E+02	3.30E+03	-	5.66E+07
Avian carnivores (AV333)	1.57E+03	6.60E+03	-	1.13E+08
Avian omnivores (AV342)	1.57E+03	6.60E+03	-	1.13E+08
Avian omnivores (AV422)	1.57E+03	6.60E+03	-	1.13E+08
Avian omnivores (AV432)	1.57E+03	6.60E+03	-	1.13E+08
Avian omnivores (AV433)	1.57E+03	6.60E+03	-	1.13E+08
Avian omnivores (AV442)	1.57E+03	6.60E+03	-	1.13E+08
Mammalian herbivores (M121)	1.57E+03	6.60E+03	-	1.13E+08
Mammalian herbivores (M122)	1.57E+03	6.60E+03	-	1.13E+08
Mammalian herbivores (M122A)	7.85E+02	3.30E+03	-	5.66E+07
Pygmy rabbit	7.85E+02	3.30E+03	-	5.66E+07
Mammalian herbivores (M123)	1.57E+03	6.60E+03	-	1.13E+08
Mammalian insectivores (M210)	1.57E+03	6.60E+03	-	1.13E+08
Mammalian insectivores (M210A)	7.85E+02	3.30E+03	-	5.66E+07
Townsend's western big-eared bat & small-footed myotis	7.85E+02	3.30E+03	-	5.66E+07
Mammalian insectivores (M222)	1.57E+03	6.60E+03	-	1.13E+08
Mammalian carnivore (M322)	1.57E+03	6.60E+03	-	1.13E+08
Mammalian omnivores (M422)	1.57E+03	6.60E+03	-	1.13E+08
Mammalian omnivores (M422A)	7.85E+02	3.30E+03	-	5.66E+07
Reptilian insectivores (R222)	1.57E+03	6.60E+03	-	1.13E+08
Reptilian carnivores (R322)	1.57E+03	6.60E+03	-	1.13E+08
Plants	1.57E+03	6.60E+03	-	1.13E+08

Table 3-9. Retained standing water contaminants.

Industrial Waste Pond and 3 Cooling Tower Blowndown Ditches (ANL-01)		
Aluminum	Fluoride	Sulfate
Antimony	Iron	Vanadium
Arsenic	Lead	Zinc
Barium	Magnesium	Tritium
Beryllium	Manganese	Pu-239
Cadmium	Nitrate	Th-228
Calcium	OCDD	Sr-90
Chromium	Phosphate	Co-60
Cobalt	Potassium	Cs-137
Copper	Silver	
Dicamba	Sodium	
Industrial Waste Lift Station Discharge Ditch (ANL-35)		
Copper	Bromoform	

3.1.2.4 Uncertainty Associated with Functional Groups. The selection of receptors parameters used to develop EBSLs is designed to ensure that each member of the functional groups is conservatively represented. Because all members of a functional group are considered similar, it is reasonable to assume that all members of a group will be equally exposed to site-related contaminants Quantification of EBSLs for each functional group is expected to provide sufficient data to assess the general condition of the ecosystem and to be adequately protective of the majority of species potentially inhabiting WAG 9. In addition, T/E species are included on the list of receptors for which EBSLs are calculated. Hence, uncertainty associated with the selection of receptor parameters is expected to minimally influence EBSL estimates.

3.1.2.5 Uncertainty Associated with the Ingestion Rate Estimation for Terrestrial Receptors. Intake (ingestion) estimates used for the terrestrial receptors are based upon data in the scientific literature, when available. Food ingestion rates are calculated by use of allometric equations (Nagy 1987) reported in the Guidance Manual (Nagy 1987). Uncertainties associated with the use of allometric equations could result in either an over- or underestimation of the true dose rate, since not all of these values are known exactly.

3.1.2.6 Uncertainty Associated with the Receptor Site Usage. The calculation of EBSLs incorporated the probability that the receptors may use or inhabit the entire WAG 9 assessment area. The SUF is defined as the affected area (ha) divided by the home range (ha) of the receptor. If a given receptor's home range is larger than the affected area, then it is reasonable to assume that the receptor may not spend

Table 3-10. Retained sediment contaminants.

Industrial Waste Pond and 3 Cooling Tower Blowndown Ditches (ANL-01)		
1,1,1-trichloroethane	Cyanide	Silver
2,4,5-TP	Diethylhexylphthalate	Sodium
Aluminum	Di-n-butylphthalate	Sulfide
Antimony	Fluoride	Sulfate
Arsenic	Iron	Toluene
Barium	Lead	Vanadium
Beryllium	Magnesium	Zinc
Cadmium	Manganese	Cs-137
Calcium	Mercury	Co-60
Chloride	Nickel	Th-230
Chloroform	Nitrate	U-238
Chromium	Phosphate	
Cobalt	Potassium	
Copper	Selenium	
ANL Sewage Lagoons (ANL-04)		
Aluminum	Copper	Silver
Antimony	Cyanide	Sodium
Arsenic	Lead	Vanadium
Barium	Magnesium	Zinc
Beryllium	Mercury	Cs-137
Calcium	Nickel	Sr-90
Chromium	Potassium	
Cobalt	Selenium	

100% of its life within the WAG 9 area. For example, the WAG 9 area is estimated to be 688.25 ha, while the home range for the mammalian omnivores (M422A) is 6,400 ha, yielding a SUF of 0.496. Incorporation of the site use factor adjusts the EBSL to account for the estimated time the receptor spends on the site. The less time spent on the site the higher the EBSL.

For other receptors, such as the small mammals (M122A and M422), that have relatively small home ranges, the SUF is set equal to 1. This approach implies that, given the small home range of the receptor relative to the size of WAG 9, it is likely that the receptor would spend 100% of its life onsite. Uncertainty associated with using the entire area of WAG 9 as the affected area exists, since this assumption implies that the entire site (688.25 ha) is contaminated at levels equal to the mean concentrations found in the soil samples. Since it is likely that the entire WAG 9 is not equally contaminated, this assumption could substantially affect EBSL estimates. Use of a smaller area (e.g., only those areas covered by grassland or sagebrush) as the affected area would increase EBSLs.

3.1.2.7 Uncertainty Associated with the PUFs and BAFs. Using PUFs to estimate plant concentrations has the advantages of being easy to use and requires minimum data inputs (i.e., the measured or estimated concentration of metal in soil and a PUF taken from the literature). A PUF of 0.01 indicates that the plant concentration should be 1/100th of the total concentration in soil. For this SLERA, PUFs for metals are taken from Baes et al. (1984). Although preference is given to studies that reported the steady-state concentration of metals in plants at edible maturity, various soil properties are not considered and data for numerous plant species (both animal feeds and those consumed by humans) are combined. Since root uptake of metals is a complex process that depends on various soil properties (e.g., pH, CEC, and organic matter content) as well as the metal and type of plant involved, however, the use of generic or crop-specific PUFs taken from the literature may not accurately estimate the concentration of metals in plants for all environmental conditions and species that may occur on WAG 9. The PUF for organics is estimated using the geometric mean regression equation developed by Travis and Arms (1988) and using log K_{ow} values. The reliability of estimated PUFs is directly related to the reliability of the K_{ow} values used for the organics. Since K_{ow} values can vary greatly, use of the Travis and Arms (1988) equation to estimate a PUF for organics may over- or underestimate the true EBSL for organics.

There is a great deal of uncertainty associated with the BAFs used to calculate EBSLs. Very few BAFs are available in the scientific literature, since they must be both contaminant- and receptor-specific. In the absence of site-specific BAFs, a value of 1.0 is assumed for all contaminants and receptors of concern. This assumption could over- or underestimate the true EBSL for the contaminant, and the magnitude of error cannot be quantified. Baes et al. (1984) reports BAFs for contaminants to beef and milk, all of these are less than 1 for the contaminants at WAG 9. If the terrestrial receptors of concern accumulate metals and PCBs in a similar way and to a comparable degree as beef and dairy cattle, the use of a BAF of 1 for all contaminants and receptors would overestimate EBSLs. On the other hand, if the terrestrial receptors of concern for WAG 9 accumulate metals and PCBs to much larger degree than beef and dairy cattle, the assumption of BAFs equal to 1 could underestimate the true EBSLs for the contaminant.

3.1.2.8 Uncertainty Associated with Soil Ingestion. The exposure assessment incorporates percentage of soil ingested by each representative of the functional groups. Although food ingestion rates have the greatest effect on intake estimates, soil ingestion rates could also influence intake rates and, therefore, EBSL estimates. The EPA *Wildlife Exposure Factors Handbook* (EPA 1993a) was used to assign

soil ingestion parameters to four of the functional groups and Arthur and Gates (1988) was used to assign percent soil ingested to one species. Where information did not exist in the literature on soil ingestion rates for terrestrial biota, soil ingestion rates are assumed to be 2% of the food ingestion rate for all burrowing mammals and birds who consume whole terrestrial prey and 1% for all other receptors. Estimating the percent soil ingested may over- or under-estimate the EBSL since the effect of the estimated values on the overall EBSL outcome is dependent on the concentration of contaminant in the soil.

3.1.2.9 Uncertainty Associated with the Radiological EBSL Equation. Equation 3-14 was taken from an International Atomic Energy Agency (IAEA) report titled *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards* (IAEA 1992). This equation was for the estimation of dose rates to plants. This IAEA report observed a six-fold bioconcentration of Cs-137 (e.g., carnivory, or consumption of certain plants) for certain species not incorporated into the human food-chain calculation. This factor and the observed bioconcentration of Sr-90 was not incorporated into the equation for the purposes of this SLERA. This may under- or over-estimate the EBSL values for those particular radionuclides.

3.2 Ecological Effects Assessment

The ecological effects assessment includes gathering qualitative and quantitative toxicity information for the contaminants being evaluated. The qualitative information is used to describe the properties and potential fate and transport of the contaminants. The quantitative information is used to develop toxicity reference values (TRV)s. A TRV is defined as a dose (mg/kg-day) for a receptor that is likely to be without appreciable risk of deleterious effects from chronic exposure.

The contaminants at the WAG 9 include both radionuclides and nonradionuclides. The ecological effects assessment and development of TRVs are discussed in Section 3.2.1 for radionuclides and in Section 3.2.2 for nonradionuclides.

3.2.1 Radionuclides

For radiological protection, injury is caused by absorption of energy in living tissue from the decay of radionuclides. As in the case of chemical toxicants, the dose of radiation absorbed by any individual organism is a function of its anatomy, physiology, ecology, and behavior.

Studies on the effects of radionuclides have shown that the rate of chronic exposure is more important than the total dose in assessing radiotoxicity (IAEA 1992). The TRV values for all radionuclides and all animal functional groups was 1 mGray/day (mGy/day) which is the chronic dose below which there do not appear to be changes observed in terrestrial animal populations (IAEA 1992). For terrestrial plants, the equivalent dose was 10 mGy/day, and this value was applied as the TRV for terrestrial plants for all radionuclides. The studies that are the basis of the IAEA (1992) results are summarized below.

The breeding success of swallows and wrens was unaffected at dose 0.7–6 mGy/day rates of (IAEA 1992).

Redback vole populations (*Clethrionomys gapperi*) were unaffected at dose rates of 15 mGy/hour (IAEA 1992). Chronic exposure of pigs and donkeys to 1 mGy/day was found to be a NOEL (Garner and Barber 1966, as sited in IAEA 1992). Chronic exposure of 4 mGy/day produced measurable declines in the number, motility, and viability of sperm in the dog, while exposure rates of <1.2 mGy/day failed to produce sperm count changes in dogs (IAEA 1992).

No significant differences in sex ratios, age distributions, or life spans were observed between lizards exposed to 20 mGy/day for 5 years and control iguanid lizards (IAEA 1992). Conflicting results occurred when females of two other lizard species occupying the same enclosures became sterile, reproduction was blocked after one or two years, and the populations later drifted towards extinction. IAEA (1992) suggests that the ovaries of the two affected species (which live longer and mature slower than the iguanid lizards) would accumulate a greater total dose before sexual maturation. As identified above, the more conservative TRV for all animal functional groups is 1 mGy/day from the IAEA (1992) report.

The IAEA (1992) concluded that invertebrates appear to be more affected by indirect than direct effects. The direct effects of radiation on terrestrial invertebrates, insects in specific, are most likely limited by responses in fertility rather than mortality.

3.2.2 Nonradionuclides

A three stage process was used to determine the ecological effects of exposure to nonradionuclides:

- Select quantified critical exposure (QCE) levels
- Apply uncertainty adjustment factors (AFs)
- Develop toxicity reference values (TRVs)

Section 3.2.2.1 provides an overview of the methodology for completing these steps. Section 3.2.2.2 contains a description of the toxicity information used to determine QCE levels and AFs for the contaminants at WAG 9 sites. Derivation of the resulting TRVs for each contaminant/functional group is presented in Appendix D. The approach for TRV derivation was developed by Ludwig et al. (1994) for use at the Rocky Mountain Arsenal Superfund site in Commerce City, CO, and is generally based on the EPA reference dose approach as modified by Lewis et al. (1990).

3.2.2.1 Overview of Ecological Effects Assessment for Nonradionuclides. The exposure effects assessment for WAG 9 sites was initiated by reviewing the toxicological literature and relevant databases for each contaminant of potential concern (COPC) and receptors to identify QCEs from the best available studies. Those studies reflecting reproductive competence were most preferred, since population-level impacts are of greatest concern for ecological risk assessment. However, studies considering nonlethal endpoints and reporting no observable adverse effects level (NOAELs) were more commonly available. Lethal endpoints were used only when more appropriate data were not available. The criteria for selecting QCEs for this screening are discussed in detail in the *Guidance Manual for Conducting Screening Level Ecological Risk Assessment* (Van Horn et al. 1995). Once identified, these QCEs were adjusted for (1) the degree of taxonomic difference between the key and test species; (2) the conditions under

which the toxicity data are obtained; and (3) the endpoint of interest [e.g., no-observed-adverse-effect-level (NOAEL)] and the endpoint measured [e.g., chronic lowest-observed-adverse-effect-level (LOAEL) or death]. The adjustment factors (AFs) applied are presented on Table 3-11. A discussion detailing the development and use of AFs is given in VanHorn et al. (1995).

TRVs were derived by selecting the experimental studies with the most appropriate and conservative QCEs for a specific contaminant and applying appropriate adjustment factors using the algorithm:

$$TRV = \frac{QCE}{AF} \tag{3-20}$$

where

QCE = quantified critical exposure level

AF = $[I] \times [R] \times [Q_1] \times [Q_2] \times [Q_3] \times [U] \times [M]$.

The derivation of each TRV for a COPC/functional group pair is presented in a data summary sheet in Appendix D. When the test organism and the receptor (or all members of a functional group) were in the same taxonomic order and trophic category (R = 1), the corresponding TRV was chosen. Otherwise, the most conservative TRV (the minimum TRV) for each COPC was chosen for each mammalian or avian receptors. Little information was found describing the effects of COPCs on reptilian, or invertebrate receptors.

3.2.2.2 Toxicity Information. The following sections summarize the information used in determining the TRVs for the non-radiological contaminants identified at WAG 9 sites. The tables in Appendix D present the TRV development for the studies identified for each COPC. The TRVs developed for each contaminant and functional group are listed in Table 3-3.

3.2.2.2.1 Inorganic Contaminants—Many of the inorganic contaminants are metals. Soils represent the most concentrated source of metals in the terrestrial environment. The health risks posed by trace metals in soils are not determined solely by their quantity. A number of contaminant, environmental and biological conditions and processes influence the accessibility and availability of metals to organisms, and hence their toxicological significance. First, speciation is a major determinant of the fate, bioavailability, absorption, and toxicologic characteristics of metal compounds. Second, the distribution coefficient between soil and water (K_d) depends upon both the properties of the metal and the composition of the soil. This coefficient also governs the bioavailability of a metal to organisms contacting the soil, with weakly bound metals highly bioavailable and more strongly bound metals less bioavailable. Other influential factors include (1) the characteristics of the interface (e.g., lung, skin, intestine), (2) the reactivity of the metal with the interface, and (3) the concurrent presence of other metals or other substances that may stimulate or inhibit metal uptake.

Table 3-11. AF values and criteria for their use in developing TRVs for INEL.

Adjustment Factor[a]	Qualitative Ranking	Value	Criteria
I	Low	1	Variability is low
	Medium	2	Variability is moderate or average
	High	3	Variability is high, or information on variability is inadequate
R	Low	1	Test organism and functional group are in same taxonomic order and trophic category
	Medium	2	Test organism and functional group are in different trophic category or different taxa
	High	3	Test organism and functional group are in different trophic categories
Q_1	Low	0.1	Experimental endpoint is highly unlikely to occur in the field
	Medium	0.5	Experimental endpoint is moderately unlikely to occur in the field
	High	1	Experimental endpoint is likely to occur in the field
Q_2	Low	1	Study was of chronic duration
	Medium	2	Study was of subchronic duration
	High	3	Study was of acute duration
Q_3	Low	1	NOAEL
	Medium	2	LOAEL
	High	3	Adverse effect level or frank effect level
U	Low	1	High quality studies
	Medium	2	Studies of reasonable quality
	High	3	Studies with flawed design or incomplete information
M	—	0.5	Soluble metal salt administered in drinking water
	—	1	Exposure medium comparable to those at INEL

a. I = Intrataxon variability
R = Intertaxon variability
Q_1 = Risk assessor's certainty that the COPC actually causes the critical effect in the receptor, and that it is an ecologically significant effect
Q_2 = Extrapolation from short- to long-term exposure durations
Q_3 = Extrapolation across endpoint types to estimate a NOAEL
U = Any residual uncertainty in the data evaluation process and estimation of other AFs based on data quality, study design, and known but otherwise unaccounted for extrapolation issues
M = Correction of differences in metal bioavailability between QCE studies where soluble salts are administered via drinking water and INEL exposure conditions (i.e., metal species are encountered in soil and dietary items).

Antimony (CAS 7440-36-0)—Antimony causes a number of toxic effects in animals, including suppression of weight gain, shortened life span, and damage to liver, heart, thyroid, and kidneys. Trivalent compounds (e.g., antimony trioxide, antimony trisulfide) are about 10 times more toxic than pentavalent forms. The gastrointestinal absorption of trivalent antimony is about 15–36% (Weitz and Ober 1965; van Bruwaene et al. 1981; Gerber et al. 1982). The acute toxicity of antimony trioxide is low, with an oral LD_{50} in rats of greater than 20 g/kg (Smyth and Carpenter 1948).

In chronic studies, 5 mg/L potassium antimony tartrate (approximately 0.35 mg/kg-day) in a drinking water is associated with slightly decreased life spans in rats (Schroeder et al. 1970) and female mice (Kanisawa and Schroeder 1969). Endpoints examined in these chronic (lifetime) studies included growth and body weight, median life span, longevity, tumor incidence, and histopathology. Other ecologically relevant endpoints (e.g., reproduction) were not examined, and only one dose was administered. Although rats appeared to be more sensitive than mice in these studies, the effects reported are of questionable ecological significance.

The recommended screening benchmark concentration for phytotoxicity in soil for antimony of 5 mg/kg was used as the TRV for terrestrial plants (Suter et al. 1993). No information on the toxicological effects of antimony on avian or reptile receptors was located.

Arsenic (CAS 7440-38-2)—Arsenic is a metalloid element that is widespread in all environmental media, making up about 0.0005% of the earth's crust. The potential toxicity of arsenic to any organism is dependent on its chemical form. Arsenic can exist in four valence states: As^{3-}, metallic (As^0), trivalent arsenite (As^{+3}), and pentavalent arsenate (As^{+5}). Trivalent arsenic forms organic derivatives of arsine (AsH_3) containing one, two, or three alkyl or aryl groups. Remaining valence positions can be filled by hydrogen, halogens, some metals, oxygen, or sulfur. Pentavalent arsenic can form similar but fewer types of compounds (Penrose 1974).

The toxic potency of arsenic is dependent on its chemical form. Inorganic arsenicals are generally more toxic than organic arsenicals, and trivalent forms are more toxic than pentavalent forms. Toxicity is related to aqueous solubility, and the order of toxicity (from greatest to least) is: arsines > inorganic arsenites > organic trivalent compounds > inorganic arsenates > organic pentavalent compounds > arsonium compounds > elemental arsenic (Eisler 1988a). Chemical properties contributing to its toxicity include its ability to bind to protein sulfhydryl groups and to substitute for phosphorus in some biochemical reactions.

These chemical properties may also be responsible for its apparent essentiality in several mammalian species (*e.g.*, Frost 1983; Uthus 1992). In fact, arsenical feed additives are used to promote growth in a number of agricultural species (Eisler 1988a). Recent studies have suggested that arsenic has a physiological role in the formation of various metabolites of methionine metabolism (Uthus 1992). The arsenic requirement for growing chicks and rats is approximately 25 μg/kg diet (Uthus 1992). Species differences in the pharmacokinetic disposition of arsenic have significant effects on their sensitivity to its toxic effects. In addition, animals exposed to sublethal levels of arsenic can develop tolerance to subsequent exposures (Eisler 1988a).

A LOAEL of 1.5 mg/kg-day was established for the rat in a chronic study using sodium arsenate (Byron et al. 1967). The TRV for mammalian receptors was developed using this study. It was noted that

arsenic pharmacokinetics are unique in the rat. Excretion is much slower than in other species. A NOAEL of 2.3 mg/kg-day was reported (Eisler 1988a) for sheep and was used for TRV development for mammalian herbivore.

An LD_{50} of 39 mg/kg-day that was established in an acute study (NAS 1977) for the mallard duck was used to develop TRVs for avian receptors. For mammalian receptors, a NOAEL of 2.3 mg/kg-day that was established for domestic sheep in a subacute dietary study (Eisler 1988) and a LOAEL that was established for the rat in a chronic study (Byron et al. 1967), were used to derive TRVs.

No information on the toxicological effects of arsenic on reptiles or invertebrates was located. The recommended screening benchmark concentration for phytotoxicity in soil for arsenic of 10 mg/kg was used as the TRV for terrestrial plants (Suter et al. 1993).

Beryllium (CAS 7440-41-7)—Limited toxicity data is available for oral exposure to beryllium. Decreases in growth have been reported for rats exposed to beryllium. However, significant changes in organs and other physiochemical changes were not reported. Data on the teratogenicity or reproductive effects of beryllium are limited.

No adverse effects were observed in a rat chronic oral study at 5 mg/L beryllium in drinking water (Schroeder and Mitchner 1975). This study was used as the basis for deriving a TRV.

Beryllium has been reported to produce embryolethality and terata in chick embryos (Puzanova et al. 1978) when administered subgerminally. However, no dietary toxicity studies from beryllium exposure to birds was located and a TRV was not derived.

No information on the toxicological effects of beryllium on reptile or terrestrial plant receptors was located.

Chromium(III) (CAS 7440-47-3)—Chromium(III) is an essential nutrient (required for insulin function) in mammals. However, it is interconvertible in the environment with the more toxic species chromium(VI), depending primarily on the redox potential and pH of soil (Bartlett 1991).

Approximately 0.5 to 3% of ingested inorganic chromium(III) compounds are absorbed by the gastrointestinal tract (Outridge and Scheuhammer 1993). Because of its limited ability to permeate biological membranes, endocytosis by mucosal cells is the most likely means of entry of chromium(III) into the blood. In the blood, chromium(III) tends to bind to plasma proteins such as transferrin, with little penetration into erythrocytes. Transferrin-bound chromium(III) is rapidly cleared from the blood and appears mainly in the liver (reviewed by Cohen et al. 1993; Outridge and Scheuhammer 1993).

There is little evidence that biomagnification of chromium occurs in terrestrial food chains (Outridge and Scheuhammer 1993). Rather, chromium concentrations usually exhibit a pattern of "biominification" (reviewed by Outridge and Scheuhammer 1993).

Rats exposed to high concentrations of chromium oxide in their diets for more than two years showed no decreased body weight, food consumption, or life span, or histological abnormalities in major organs (Ivankovic and Preussmann 1975). TRVs for mammals were calculated from this study.

Plants play an important role in the biogeochemistry of chromium, containing approximately three orders of magnitude higher concentrations of this element than animal tissues (Outridge and Scheuhammer 1993). Chromium(III) accumulates in the roots of plants but has low mobility for transport to stems and leaves (Wallace et al. 1977; Carey 1982). Within roots, it may form a variety of complexes with organic materials (Outridge and Scheuhammer 1993).

In solution culture experiments, bush beans grown with 10^{-5} M chromium sulfate ($Cr_2(SO_4)_3$ (approximately 1 mg chromium(III)/L) showed no adverse effects. Diminished growth was seen in ten species of crop plants exposed to 100 mg/L chromium nitrate ($Cr(NO_3)_3$), but not 10 mg/L (approximately 2 mg chromium(III)/L) (Fiussello and Novo 1977). Assuming a K_d of 850 for chromium (Baes et al. 1984), and adjusting the stated concentration for percent chromium(III) in the compounds used, then the corresponding soil concentrations can be estimated as:

$$[\textit{Chromium (III) in soil} = K_d \times [\textit{Chromium (III)}] \textit{ in pore water} \qquad (3\text{-}21)$$

No information on the toxicological effects of chromium (III) on avian, reptile, or invertibrate receptors was located.

Chromium (VI) (CAS 7440-47-3)—As mentioned previously, chromium(VI) is generally more toxic than chromium(III). Although most chromium(VI) is reduced to chromium(III) in the acidic environment of the stomach (Donaldson and Barreras 1966), chromium(VI) compounds are absorbed significantly more efficiently from the gastrointestinal tract (2 to 10% of administered dose) than chromium(III) compounds (Outridge and Scheuhammer 1993). Once absorbed, chromium(VI) is quickly reduced to the trivalent form. The damaging effects of chromium(VI) are due to its greater membrane permeability, which allows it to cross biological membranes and oxidize cellular components not normally accessible to chromium(III). As a result, the differences in systemic toxicity are primarily attributable to differential solubilities and absorption rates of the two valence states (Franchini and Mutti 1988).

Chromium(VI) compounds are absorbed significantly more efficiently from the gastrointestinal tract (2 to 10% of administered dose) than chromium(III) compounds. Once absorbed into the blood, chromium(VI) is rapidly taken up by erythrocytes via the general anion channel, and reduced to the trivalent form by various intracellular agents (e.g., glutathione, vitamins C and E, cytochrome P450, DT-diaphorase). Uptake and subsequent reactions appear to be similar in other cell types. Despite the rapidity of these uptake processes, chromium(VI)'s mobility and the limited supply of extracellular reductants causes it to be distributed more widely in the body than chromium(III). The intracellular reduction of chromium(VI) to chromium(III) generates unstable intermediate chromium(V) and chromium(IV) ions, active oxygen species (hydroxyl and superoxide radicals, singlet oxygen), and thiyl and organic radicals that are responsible for the cytotoxicity, mutagenicity, and carcinogenicity of the hexavalent form (reviewed by Manzo et al. 1992; Cohen et al. 1993; O'Flaherty 1993; Outridge and Scheuhammer 1993).

As noted above, chromium exhibits a pattern of biominification rather than biomagnification in ecological food webs. Because the speciation of chromium(VI) taken up by plants is poorly understood, it is assumed to be the primary form of exposure to herbivores. However, because chromium(VI) is immediately converted to chromium(III) in animal tissues, carnivorous receptors will be primarily exposed to the less toxic trivalent form. Development of TRVs based on chromium(VI) for receptors higher in the food chain is thus highly conservative, and will tend to overestimate chromium-related risk to these receptors.

Rosomer et al. (1961) reported a subchronic NOAEL of 100 mg/kg in the diet for chickens. These data are used to estimate a TRV for avian functional groups.

Pregnant female mice receiving 250 mg/L potassium dichromate in drinking water throughout gestation showed no clinical signs of toxicity, but produced significantly fewer viable offspring (Trivedi et al. 1989). In the dog, 6 mg/L in drinking water (approximately 0.3 mg/kg-day) was a chronic NOAEL (Steven et al. 1976). A similar level was without observable effects in a study by Anwar et al. (1961) (cited by Outridge and Scheuhammer 1993). Based on these results, TRVs were derived for mammalian functional groups.

In plants as in animals, chromium(VI) is more toxic than chromium(III). Decreased yield was observed in bush beans (Wallace et al. 1977) and ten species of crop plants (Fiussello and Novo 1977) grown in culture media containing chromium(VI) salts. A TRV was derived from the work of Wallace et al. (1977).

No information on the toxicological effects of chromium (VI) on reptile or invertebrate receptors was located.

Copper (CAS 7440-50-8)—Copper is widely distributed in nature and is an essential element required for the normal function of several critical enzymes, and is essential for utilization of iron. Copper deficiency is therefore usually a greater health concern than copper excess.

Copper absorption in the gastrointestinal tract is normally regulated by body stores. Absorbed copper is transported to the liver, where it may be incorporated into ceruloplasmin (a copper transport and donor molecule) and excreted into the plasma, stored as metallothionein or in lysosomes, or excreted via the bile (reviewed by Nederbragt et al. 1984).

Depressed food intake, body weight gain, egg number and weight, and organ weights are associated with copper excess in poultry (Stevenson and Jackson 1981). Stevenson and Jackson (1981) conducted a pair-feeding study to determine if these effects were associated with direct toxicity or the accompanying marked reduction in food intake. Body weight, food intake, organ weights, egg production, egg weight, clinical chemistry parameters, and organ Cu, Fe, and Zn concentrations were monitored in laying hens fed varying concentrations of copper in their diet for six weeks (Stevenson and Jackson 1981). A NOAEL of 24 mg/kg/day was identified and used to develop TRVs for avian functional groups.

High doses of copper have caused liver and kidney damage as well as anemia in a number of species. Hébert et al. (1993) observed that the forestomach is also a target in rats and mice. This well-designed subchronic feeding study examined histopathology, clinical pathology, reproductive toxicity, and tissue metal

accumulation in males and females of both species. A QCE of 66 mg/kg/day (NOAEL) was identified from this study and used to develop TRVs.

A chronic feeding study in mink (Aulerich et al. 1982) was used to derive the TRV. The purpose of this study was to determine whether copper supplements would improve growth and survival. Endpoints examined included effects on growth, blood chemistry, reproductive performance, and kit survival and development. The QCE from this study is a NOAEL of 24 mg/kg/day.

An oral NOAEL was established in a chronic study of young calves (Cunningham 1946). The study confirms that young calves are susceptible to copper. A TRV was developed using this information.

The recommended screening benchmark concentration for phytotoxicity in soil for copper of 40 mg/kg was used as the TRV for terrestrial plants (Suter et al. 1993).

No information on the toxicological effects of copper on reptile and invertebrate receptors was located.

Cyanide—Many chemical forms of cyanide are present in the environment (e.g., metallocyanide, synthetic organocyanides, free CN). Only free cyanide is the primary toxic agent. Cyanides are readily absorbed through multiple pathways (inhalation, ingestion, dermal) and are rapidly distributed through the body. However, there are no reports of cyanide biomagnification or cycling in living systems. Cyanide is a potent and rapid asphyxiant. However, diagnosis of acute cyanide poisoning is often difficult because signs and symptoms are nonspecific and toxicity is influenced by a variety of factors. Deficiences of vitamin B12, iodine, and sulfur amino acids can modify its biocidal properties.

A rat chronic oral toxicity study (Howard and Hanzal 1955) indicated a NOAEL of 20.4 mg/kg-day that was used to generate a TRV for mammalian receptors.

Cyanides have been used as feeding stimulants for some insects. Instar larvae of the armyworm prefer cyanogenic foods, such as foliage of the lima bean. However, data are scarce for other invertebrates. As such, a cyanide TRV was not developed for invertebrates.

No information on the toxicological effects of cyanide on reptile receptors was located.

Lead (CAS 7439-92-1)—Lead is a comparatively rare metal, with an average concentration of 16 mg/kg in the earth's crust (Eisler 1988b). Lead affects the kidney, blood, bone and central nervous system. Effects of lead on the nervous system is both functional and structural. Lead toxicity varies widely with the form and dose of administered lead. Lead has four stable valence forms: elemental, monovalent, divalent and tetravalent. In general, organolead compounds are more toxic than inorganic lead. In nature, lead occurs mainly as divalent, Pb^{2+}. Ingestion of lead shot by migratory waterfowl is a significant cause of mortality in these species.

Hatchlings of chickens, quail, and pheasants are relatively tolerant to moderate lead exposure (Eisler 1988b). There was no effect on hatchling growth of these species at dietary levels of 500 mg/kg or on survival to 2,000 mg/kg lead (Hoffman et al. 1985 as cited in Eisler 1988b). For avian herbivores, a TRV

was estimated using a study by Dieter and Finley (1978) in mallards. Altricial species are generally more sensitive to lead than precocial species (Eisler 1988b) of avian insectivores. An oral study using European starlings by Osborn et al. (1983) was used to generate a TRV for trimethyllead chloride. Since organic lead compounds are generally more toxic than inorganic lead, the TQs generated using this TRV should be interpreted with caution. American Kestrel (*Falco sparverius*) exposed to 50 mg/kg-day metallic lead in diets did not exhibit effects on survival or reproductive success (Colle et al. 1980). Using these studies, TRVs were developed for avian functional groups.

Studies by Kimmel et al. (1980) using rats administered lead in drinking water, by Zmudzki et al. (1983) of lead toxicity in calves, and by Demayo et al (1982) using dogs were used to develop TRVs for mammalian receptors

A study on the toxicity of lead nitrate to the isopod (*Porcellio scaber*) reports a critical concentration of 2,000 μg/g lead in food on a dry weight basis for reproduction (Hopkin and Hames 1994).

The recommended screening benchmark concentration for phytotoxicity in soil for lead of 50 mg/kg was used as the TRV for terrestrial plants (Suter et al. 1993).

No information on the toxicological effects of lead on reptiles was located.

Manganese (CAS 7439-96-6)—Manganese affects the central nervous system in humans. However, it is important to recognize the substantial difference in species' requirements for manganese. Toxic levels of manganese in humans do not meet the nutritional requirements of rats.

The bioavailability of different forms of manganese varies considerably depending on different exposure conditions. There is potentially higher bioavailability of manganese from drinking water than food. It is also important to recognize that various dietary factors as well as the form of manganese can have a significant bearing on the dose absorbed from the gastrointestinal tract. For instance, many constituents of a vegetarian diet (e.g., tannins, oxalates, phytates, fiber, calcium, and phosphorus) have been found to inhibit manganese absorption presumably by forming insoluble complexes in the gut. Thus, herbivores are more likely to be resistant to manganese toxicity. Also the form of manganese can significantly influence toxicity. For example, mice receiving the two soluble forms of manganese (chloride and acetate salts) were found to gain significantly less weight than controls, While mice consuming the insoluble forms of manganese (carbonate and dioxide salts) appeared to actually gain slightly more weight than controls.

A study reporting the minimum manganese requirements for growth and reproduction in chickens was used to develop a TRV for avian receptors. The study reported a NOAEL of 2.9 mg/kg-day. Guinea fowl were found to have reduced hatchability and increased deformed embryos when fed diets deficient in manganese (Offiong and Abed 1980).

For rats, the estimated requirement is 50 mg Mn/kg diet (ATSDR 1990). A dietary reproduction study in rats exposed to 250 ppm manganese (13 mg/kg-day) by Laskey et al. (1982) was used to develop a TRV.

No information on the toxicity of manganese to reptiles or invertebrates was located.

The recommended screening benchmark concentration for phytotoxicity in soil for manganese of 500 mg/kg was used as the TRV for terrestrial plants (Suter et al. 1993).

Mercury (CAS 7439-96-5)—The chemistry of mercury in the environment is complex, not only because of its various oxidation states but also because of biotic and abiotic methylation and demethylation processes, complexation with organic and inorganic ligands, and the differential solubility and volatility of various forms. As speciation is a major determinant of the fate, bioavailability, absorption, and toxicologic characteristics of mercury compounds, lack of knowledge of the state of the mercury in INEL soils is a large source of uncertainty in both exposure assessment and TRV development.

Although the generally more toxic organic forms of mercury are unlikely to persist in the environment, they (in particular, methylmercury) may be formed in biotic tissues and are known to biomagnify through ecosystems, particularly aquatic systems (reviewed by Wren, 1986; Scheuhammer, 1987). Thus, to ensure that mercury TRVs for the SLERA are protective of receptors at all levels of ecological organization, TRVs are developed from studies investigating the toxic effects of organic mercurials. It is noted that this measure is highly conservative and will tend to overestimate risks for receptors lower in the food web, as the majority of mercury in soil and plants (i.e., the majority of exposure to plants and soil-dwelling and herbivorous animals) is expected to be inorganic.

Because of its chemical stability and lipophilicity, methylmercury readily penetrates the blood-brain barrier. The central nervous system is thus a major target organ in both mammals and birds. However, reproductive effects have been reported at even lower doses. Methylmercury can be converted to inorganic mercury both in tissues and by microflora in the gut. The homolytic cleavage of the mercury-carbon bond leads to generation of reactive intermediates, e.g., methyl and metal radicals, which cause cellular damage (reviewed by Wren, 1987; Scheuhammer, 1987; Manzo et al. 1992).

The effects of mercury on avian herbivores, insectivores, and carnivores were evaluated as follows. For herbivores, the effects of organic mercury compounds on galliformes (domestic chickens, quail, pheasants) have been investigated by several groups. However, no study was reviewed that identified a NOAEL. The lowest LOAEL for relevant endpoints (reproductive success) of several similar studies was found in Fimreite (1979). Reduced egg production, shell thickness, and hatchability in pheasants fed seed treated with organomercurial fungicide were observed. This study was selected over others due to its use of a wild species and lower dose levels. A TRV was derived from this study.

Three goshawks were fed a diet of chickens that had eaten wheat dressed with an organomercurial fungicide (Borg et al. 1970). Their tissues contained 10 to 40 ppm of mercury, mostly as methylmercury. The hawks died after 30 to 47 days; their total mercury intake was about 20 mg/bird. A TRV was derived for raptors from this study.

Khera and Tabacova (1973) and Khera (1973) examined the effects of subchronic methylmercury exposure on the reproductive competence of male and female rats. The NOAEL identified for both sexes was 0.25 mg/kg-day. A TRV for small mammals was derived from this work. Much less information is available regarding methylmercury toxicity to herbivores. Eisler (1987) cited a study of acute methylmercury toxicity in mule deer (*Odocoileus hemionus hemionus*), in which 17.88 mg/kg was said to be the LD_{50}. A number of studies have examined the effects of chronic methylmercury ingestion on carnivorous mammals, particularly

cats (e.g., Albanus et al. 1972; Charbonneau et al. 1976; Eaton et al. 1980) and mink (e.g., Aulerich et al. 1974; Wobeser et al. 1976; Wren et al. 1987). The study by Charbonneau et al. (1976) was considered superior to other available studies due to its long duration (two years), use of relatively large group sizes, detailed examination of endpoints, identification of both no-effect and effect levels, and administration of mercury via both contaminated fish and addition to diet. A TRV was calculated from this study.

A TRV of 0.3 mg/kg was assigned for mercury for terrestrial plants based on the toxicological benchmark (Suter et al. 1993).

No information on the toxicological effects of mercury on reptiles or invertebrates was located.

Nickel (CAS 7440-02-0)—Nickel is a naturally occurring silvery metal that is found in the earth's crust (ATSDR, 1988a). Organic complexing agents may restrict soil movement and availability of nickel through the formation of organo-nickel complexes (ATSDR, 1988a). However, nickel ferrite appears to be the most probable nickel species to precipitate in soil.

Small amounts of nickel can be essential for normal growth and reproduction (ATSDR, 1988a). Oral exposure to high concentrations of nickel has been reported to adversely affect the hematological system and reproduction.

Toxicity studies in chicks by Weber and Reid (1968) and in mallards (Eastin and O'Shea, 1981) were used to develop TRVs for avian herbivores.

Rats fed 5 mg/kg/day nickel sulfate in a two-year dietary study did not produce hepatic changes or altered body weights (Ambrose et al. 1976). This NOAEL was supported by a rat subchronic drinking water study conducted by American Biogenics Corp. (ABC, 1986) and a rat reproductive study by RTI (1987). Using the Ambrose study, a TRV for small mammals was developed. For mammalian herbivores, a subchronic study (O'Dell et al. 1979 as cited in NAS, 1980) of cows that did not exhibit reduced food intake or growth rate when fed 250 mg/kg-d nickel carbonate was used to develop a TRV. A dietary study exposing dogs to 1,000 ppm Ni did not result in adverse effects (Ambrose et al. 1976) and was used to develop a TRV for mammalian carnivores.

No information on the toxicological effects of nickel on reptile or invertebrate receptors was located.

Nitrate—Homo sapiens have been identified as the most sensitive species. Several studies (Bosch et al 1950, Walton 1951, Sattelmacher 1962, Simon et al 1964) indicate that infants ingestion of formula made with nitrate-contaminated groundwater at concentrations greater than 10 mg/L caused cyanosis. In infants, the pH of the gastrointestinal system is higher than in adults and this allows for the growth of nitrate-reducing bacteria. These bacteria convert nitrate to nitrite which then causes methemoglobinemia. Therefore, for humans, the NOAEL is 1.6 mg nitrate as nitrogen/kg-d. Nitrates are a normal component of the human and animal diet.

However, in animal studies, the NOAELs and LOAELs identified are typically much higher. In animal studies, Hugot et al (1980) identified a LOAEL of 900 mg nitrates as nitrogen/kg-d. This LOAEL is based on a three generation study of rats at doses of 90 or 160 mg nitrate as nitrogen/kg-d administered as sodium nitrate. There were no effects on the reproductive capabilities, but small decreases in birth weight,

growth rate during lactation, and changes in organ weights at weaning were observed. A LOAEL of 90 mg nitrates as nitrogen was identified, and assuming that 10% of the nitrate is converted to nitrite a LOAEL of 900 mg nitrates as nitrogen/kg-d.

Reproductive NOAELs have been observed for hamsters and mice at 66 mg/kg-d (FDA 1972a, b) when administered on days 6-10 and 6-15 of gestation, respectively. For rabbits and rats, the reproductive NOAEL of 41 mg nitrates as nitrogen/kg-d when administered on days 6-6-18 and 6-15 of gestation. respectively. Another reproductive NOAEL was determined by Sleight and Atallah (1968). This study was for 143–204 days for guinea pigs. Four dose levels was administered as 12, 102, 507, and 1,130 mg nitrates as nitrogen/kg-d. Nitrate at the highest dose level reduced the number of live births, but no adverse effects were observed at the other dose levels.

In drinking water, Druckrey et al (1963) supplied rats with 20 mg nitrates as nitrogen/kg-d for three generations. No teratogenic effects or adverse effects on reproduction were detected in any generation. Assuming that 10% of the nitrate is converted to nitrite, a NOAEL of 200 mg nitrates as nitrogen/kg-d was established.

Toxicological information on five nitrates was located. Three contain toxic metals—aluminum, copper and uranium. The TRVs for these nitrates were based on the metals. The two remaining nitrates contain essential elements - potassium and sodium. The most sensitive of these two (sodium nitrate) was used for the total nitrate component.

Selenium (CAS 7782-49-2)—Selenium is a critical nutrient and a key component of several enzymes (Eisler, 1985). It is often found in high concentrations in areas where soils have been derived from Cretaceous rocks (Eisler 1985). Selenium does accumulate to high concentrations in certain species of plants (e.g., *Aster*, *Astragalus*) (Eisler 1985). Livestock species ingesting these plants have been reported to exhibit toxic symptoms such as abnormal movements, labored breathing, dilated pupils, bloating, diarrhea, and rapid pulse. No effective treatment is known for counteracting the toxic effects of high levels of ingested selenium. Prolonged exposure to more moderate levels of selenium results in skin lesions involving alopecia, hoof necrosis and loss, emaciation and increased serum transaminases and alkaline phosphatase in animals (TOXNET 1994). Selenium has been reported to cause growth retardation, decreased fertility, embryotoxicity, fetotoxicity, and teratogenic effects in animals (TOXNET 1994). Birds appear to be particularly susceptible to selenium, particularly in the area of reproductive success. Malformations in chickens and waterfowl have been widely reported (EPA 1993b).

Selenium deficiency is often a greater threat to health than selenium poisoning (Eisler 1985). Selenium deficiency has been documented in a variety of species including fish, quail, ducks, poultry, rats, dogs, domestic grazing animals, antelope, monkeys, and humans (Eisler 1985). Selenium can also reduce the toxicity of other heavy metals such as thallium, arsenic, and copper (Wilber 1980).

A study by Ort and Latshaw (1978) evaluating the effects of sodium selenite in chickens was used to derive a TRV. A TRV was derived for other avian herbivores using a dietary study by Heinz et al. (1987) which evaluated selenium toxicity in mallards. A dietary study using black-crowned night herons by Smith et al. (1988) was also used to derive a TRV.

In a study by Rosenfeld and Beath (1954), selenium administered as potassium selenate to sire and pregnant rats through five breeding cycles did not affect reproduction, the number of young reared or on the reproduction of two successive generations of dam and sires in groups receiving 1.5 ppm selenium.

Selenium doses as low as 3.2 mg/kg body weight have resulted in death in sheep (Eisler 1985). A TRV was developed from this study.

No information on the toxicity of selenium in reptiles or invertebrates was located.

The recommended screening benchmark concentration for phytotoxicity in soil for selenium of 1 mg/kg was used as the TRV for terrestrial plants (Suter et al. 1993).

Silver (CAS 7440-22-4)—The precious metal silver is relatively rare in the earth's crust and does not occur regularly in animal tissues. As a result, the toxicity of silver has been little studied. Approximately 1–10% of ingested silver is absorbed; as much as 18% may be retained. Silver-protein complexes accumulate in the liver, and biliary excretion (complexed with glutathione) is the major route of elimination. In most tissues, silver is deposited as large granules. With rare exceptions, these deposits are not associated with adverse effects. The LD_{50} of silver in rats is relatively high at 24 mg/kg (reviewed by Rungby, 1990).

Silver causes a conditioned deficiency of selenium in rats, decreasing tissue levels of selenium and the selenoprotein glutathione peroxidase (Ganther, 1980). Silver ions complex strongly to sulfhydryl groups and cause peroxidation of hepatocellular membrane lipids (Rungby et al. 1987, Shinogi and Maeizumi, 1993). Because of its affinity for sulfhydryls, the degree of binding to cellular macromolecules and toxicity of silver is mitigated by induction of the divalent metal-binding protein metallothionein (Shinogi and Maeizumi, 1993). Exposure of fetal and adult rats to silver results in deposition in the central nervous system (Rungby and Danscher, 1983a, b). Pyramidal cells in the developing hippocampus appears to be a sensitive target, exhibiting reduced cellular volume in both pre- and postnatally exposed rats (Rungby et al. 1987; Rungby, 1990).

The mammalian TRVs for silver are based on a subchronic study by Rungby and Danscher (1984) in which mice exposed to approximately 18 mg/kg/day were observed to be "hypoactive." Although silver deposits occurred in certain motor centers of the brain, no association between the concentration of deposits and the extent of hypoactivity was found.

No information on the toxicological effects of silver on avian, reptiles, amphibian, or plant receptors was located.

Sodium (CAS 7440-23-5)—Sodium is essential for all living organisms as it is important in maintenance of osmotic pressure, body fluid balance, and hydration of the tissues.

Only one acute toxicity study had available data for sodium. An LD_{50} was reported for mice given 4,000 mg/kg intraperitoneally (TOXNET).

No data on the toxicological effects of sodium to avian, reptilian, and plant species were available. Hence, TRVs for all avian and reptilian functional groups and plants could not be established.

Sulfate—Sulfates are generally of low toxicity. Several studies indicate no adverse effects when sulfate compounds are administered (Brown and Gamatero 1970, Sasse and Baker 1974, Paterson et al. 1979) and others that list effects of loose feces and decrease intake (Bird 1972, L'Estrange et al 1969). These five studies were conducted using pigs, chicken, pigs, and sheep. One study did list an LD_{50} for a single dose injection of sodium sulfate monohydrate in mice of 45.6 mg/kg-d (Nofre et al. 1963). To develop TRVs, studies identified for sodium sulphate were used.

Zinc (CAS 7440-66-6)—Zinc is found naturally in the environment and is present in all foods (ATSDR 1988b). It is an essential element and occurs in the environment in the 2+ state. Zinc is likely to be strongly sorbed to soil. Relatively little land disposed zinc is expected to be in a soluble form. Bioconcentration factors of soil zinc by terrestrial plants, invertebrates, and mammals are 0.4, 8, and 0.5, respectively (ATSDR 1988b).

Excessive dietary zinc has been shown to cause copper deficiency and anemia (ATSDR 1988). Cadmium has also resulted in the redistribution of zinc to the liver and kidney. Health effects associated with zinc exposure include anemia, liver necrosis, fetal resorption and, in extreme cases, cessation of reproduction (ATSDR 1988b).

Only one study revealed a NOAEL for chickens and this value was applied only to the functional groups containing galliforms. A decrease in egg production was observed in chickens fed 20 mg/kg zinc sulfate in their diet. A LOAEL of 12 mg/kg-day was used to establish a TRV (Stahl et al. 1990).

A rat developmental study by Schlicker and Cox (1968) was used to develop a TRV. A study of sheep by Allen et al. (1983) revealed pathological changes in liver and kidney. Using this study, a TRV was developed. A feeding study evaluating zinc oxide exposure in ferrets (Straube et al. 1980) was used to develop a TRV. A study using dogs by Drinker et al. (1927) was used as the basis for deriving a TRV.

No information on the toxicological effects of zinc on reptiles was located.

A study on the toxicity of zinc nitrate to the isopod (*Porcellio scaber*) reports a critical concentration of 1,000 µg/g (mg/kg) zinc in food on a dry weight basis for reproduction (Hopkin and Hames 1994). The bioconcentration factor for zinc for terrestrial plants is 0.4 and the maximum detected concentration in site soil is 2,400 mg/kg. Therefore, the conservatively estimated plant concentration of 960 mg/kg falls below the critical concentration. Thus, although there is an absence of invertebrate toxicity data for soil, there is some evidence that the concentrations of zinc at the site would not result in adverse effects in invertebrates.

The recommended screening benchmark concentration for phytotoxicity in soil for zinc of 20 mg/kg was used as the TRV for terrestrial plants (Suter et al. 1993).

3.2.2.2.2 Organic Contaminants—The following section summarizes the information used in determining the TRVs listed in Table 3-3 for organic contaminants.

1,1,1-trichloroethane (CAS 71-55-6)—A multi-generational study was modified to include screening for dominant lethal and teratogenic effects for drinking water exposure to both male and female ICR Swiss mice (Lane et al 1982). Three dose levels were studied: 100, 300 and 1,000 mg/kg-d. No significant differences were observed at any dose level and the study did include two-generations. Therefore

the maximum dose level is considered to be a NOAEL. In addition, the National Cancer Institute (NCI 1977) conducted a two year study to determine if there are any carcinogenic properties to 1,1,1-trichloroethane from ingestion. Based on the results of this study a NOAEL of 5,615 mg/kg-d was established. A dose level of 10,000 mg/kg-d administered to mice for 6 weeks also did not show any adverse effects.

However, a single dose of 11,240 mg/kg-d administered orally to female mice has been shown to be a LD_{50} (Verschueren, 1983). Other LD_{50} are 5,660 mg/kg-d for female rabbits and 9,470 mg/kg-d for male guinea pigs (Verschueren, 1983).

The majority of the toxicity of 1,1,1-trichloroethane is attributed to its inhalation. Inhalation of 1,1,1-trichloroethane depresses the central nervous system and causes irritation and inflammation of the lungs with the effects becoming more obvious at higher doses (Torkelson et al 1958).

2-Butanone (Methyl ethyl ketone, MEK) (CAS 71-36-3)—2-Butanone is poisonous by inhalation, ingestion, and intraperitoneal routes. It is a skin and eye irritant and affects the peripheral and central nervous systems. Ingestion causes gastrointestinal tract effects (Sax and Lewis, 1987).

Cox et al. (1975) conducted a multi-generational study with measurement of development toxicity endpoints in rats. Male weanling rats were given an average of 0, 538, 1,644, 5,089 mg/kg-day 2-butanol (2-butanone's primary metabolite) in drinking water, while females were given an average of 0, 594, 1,771, 4,571 mg/kg-day. After 8 weeks exposure, males and females were mated. F1 generations showed decreased number of live births, decreased number of pups per litter, decreased mean body weight per pup, and increased number of developmental effects in pups born in animals in the high dose group.

No information on the toxicological effects of 2-butanone on reptile, invertebrate, or avian receptors or on terrestrial plants was located.

2,3,7,8-Tetrachloro Dibenzodioxin (TCDD) (CAS 1746-01-6). TCDD is a deadly poison by ingestion, skin contact, and intraperitoneal routes. Its causes death in rats by hepatic cell necrosis. Death can follow a lethal dose by weeks. Acute and subacute exposure results in hepatic necrosis, thymic atrophy, hemorrhage, lymphoid depletion, and chloracne. TCDD is an eye irritant and an experimental carcinogen, teratogen, tumorigen, and neoplastigen (Sax and Lewis, 1987).

Toxicity equivalence factors (TEF)s for dioxin-like compounds were published in EPA (1989). The concentrations of all detected dioxin and furan compounds were multiplied by the corresponding TEF to obtain an equivalent concentration of 2,3,7,8-TCDD.

Opresko et al. (1994), reported a study by Murray et al. (1979) during which rats were orally administered 0.000001, 0.00001, and 0.0001 mg/kg body weight of TCDD daily in the diet. Fertility and neonatal survival was significantly reduced among rats receiving 0.0001 and 0.00001 mg/kg/d. Because no significant difference were observed at the 0.000001 mg/kg/d dose level and the study considered exposure through 3 generations (> 1 year) including critical lifestages (reproduction), this dose was considered to be a chronic NOAEL.

A toxological study (Nosek et al. 1992) using ring-necked pheasants was also reported in Opresko et al. (1994). The study lasted 10 weeks during which weekly intraperitoneal injections were administered at

three dose levels: 0.00001, 0.0001 and .001 mg/kg body weight. Egg production and hatchability was significantly reduced among birds receiving the .001 mg/kg/week dose. No significant effects were observed at the other two dose levels. The weekly intraperitoneal injection exposure route used in this study is believed to be comparable to oral routes of exposure (EPA 1993c). Because no significant differences were observed at the two lower dose levels and the study considered exposure through a critical lifestage (reproduction), the 0.001 mg/kg/week dose was considered to be a chronic NOAEL.

No information on the toxicity of TCDD to amphibian, avian, or reptilian functional groups or to plants was located.

Acetone (CAS-67-64-1)—Acetone is a common air contaminant that is moderately toxic by various routes. It is a skin and eye irritant and is narcotic in high concentration (Sax and Lewis, 1987)

Acetone was administered via gavage for 90 days to group of albino rats (30 each sex per group) at treatment levels of 0, 100, 500, or 2500 mg/kg-day (EPA 1986b). Body weights, clinical chemistry, hematology, histopathologic parameters, food consumption, and organ weights were measured. No effects were observed at the 100 mg/kg-day dose. Histopathologic studies showed that rats in the 2,500 mg/kg-day group had a marked increase in tubular degeneration of the kidneys and hyaline droplet accumulation with increasing dose.

No information on the toxicological effects of acetone on reptile, invertebrate, or avian receptors or on terrestrial plants was located.

Butylbenzylphthalate (BBP) (CAS 85-68-7)—Limited data are the carcinogenic potential of BBP in animals are available. Female rats fed 0, 6000, and 12,000 mg/kg daily for 103 weeks exhibited a significant increase in mononuclear cell leukemia or lymphoma at the high dose rate. The qualitative weakness of the carcinogenic response does not provide a compelling basis to model dose-response data. Subchronic exposure to BBP by rats caused hematological effects, kidney atrophy, and testicular lesions at some of the higher dose levels. Male rats given BBP by gastric intubation for 14 days experienced liver morphological and biochemical changes at a dose rate of 160 mg/kg-day.

The National Toxicology Program (1985) conducted a 26-week subchronic study of potential toxic effects of BBP. Fifteen male rats per group were fed either 0, 17, 51, 159, 470, or 1417 mg/kg-day in the diet. There were no deaths attributable to BBP toxicity. Terminal mean organ weight was significantly lower in the 1417 mg/kg-day group for the heart, kidney, lung, seminal vesicles, and testes. Animals in this group also exhibited reduced hemoglobin, total RBC, and hematocrit levels. For the 470 mg/kg-day group, animals exhibited significantly increased absolute liver weights and increased liver-to-body weight ratios. No adverse effects were observed at the 159 mg/kg-day dose level or below. The NOAEL of 159 mg/kg-day was used to derive the TRV for BBP.

No information on the toxicological effects of BBP on avian, reptilian, invertebrate, or terrestrial plant receptors was located.

Chloroform (CAS 67-66-3)—Chloroform is a central nervous system depressant, and chronic exposure may cause liver and kidney damage (Proctor and Hughes, 1978). Liver effects are more characteristic of chronic exposures than kidney injury or central nervous system depression (Sittig, 1981).

Sex-linked differences in effects associated with exposure to chloroform have been observed. Females tend to experience more severe effects, probably due to chloroform's affinity for adipose tissue (Fry et al. 1972). Chloroform is considered highly fetotoxic but not teratogenic (Schwetz et al. 1974). Mice given 60 mg/kg-day chloroform via toothpaste gavage for 1.5 years exhibited an increased incidence of renal cortex tumors (Roe et al. 1979).

Thompson et al. (1974) evaluated the potential for fetotoxic effects by administering 20, 35, 50, or 126 mg/kg-day chloroform to rats and rabbits via gavage during gestation. No maternal or fetal adverse effects were observed. A study conducted by Ruddick (1980) supports these findings. Ruddick (1980) gave rats 100 mg/kg-day via gavage during gestation and observed no adverse effects.

Male and female beagle dogs (12 each group) were given 15 or 30 mg/kg chloroform in gelatin capsules for 7.5 years (Heywood et al. 1979). The minimum dose adjusted for treatment schedule is 12.9 mg/kg-day. A dose-related increase in SOGT levels and nodules of altered hepatocytes were observed at both treatment levels. This critical study was of chronic duration, used a fairly large number of dogs, and measured multiple endpoints but only two treatment doses were used and a NOAEL was not established.

No information on the toxicological effects of chloroform on reptile, invertebrate, or avian receptors or on terrestrial plants was located.

Di-2-ethylhexyl-phthalate (DEHP) (CAS 117-81-7)—Di-2-ethylhexyl-phthalate (DEHP) is a man-made chemical that is commonly added to plastics to make them flexible. It is a colorless liquid with almost no odor. It can move out of plastic materials into the environment over long periods and is widespread in the environment. A large amount of plastic that contains DEHP is buried at landfill sites. It does not evaporate easily, and thus very little will be present in the air. When it is released to water, it dissolves very slowly into underground water or surface waters that contact it. Although DEHP dissolves more easily in materials such as gasoline, paint removers, and oils than it does in water, it has been found in groundwater near waste disposal facilities. When DEHP is released to soil, it usually attaches strongly to the soil and does not move very far away from where it was released. It takes many years before DEHP in buried or discarded materials disappears from the environment.

Guinea pigs were fed diets containing DEHP for a period of 1 year (Carpenter et al. 1953 and ATSDR, 1993). 23 males and 23 females consumed feed containing 19 mg/kg-day and 24 males and 23 females consumed feed containing 64 mg/kg-day. No treatment-related effects were observed on mortality, body weight, kidney weight, or gross pathology and histopathology of kidney, liver, lung, spleen, or testes. Statistically significant increases in relative liver weights were observed in both groups of treated females. A LOAEL in this species was determined to be 19 mg/kg-day.

No information on the toxicological effects of DEHP on avian, reptilian, invertebrate, or terrestrial plant receptors was located.

Di-n-octylphthalate (CAS 117-84-0)—The highest concentration of this chemical recorded in soil was 56 mg/kg. There is limited toxicity information on this compound and the EPA oral reference dose has been withdrawn (TOXNET). The study used to derive the former oral RfD reported a LOAEL of 175 mg/kg-day (Piekacz 1971), which equates to a NOAEL of 87.5 mg/kg-day. Assuming a rat body weight of 350 grams, the calculated intake is 30.6 mg/day. To achieve this intake at the WAG 2 site, a

rat would have to consume 30.6 mg di-n-octyl phthalate/(56 mg/kg soil-day) or 0.55 kg of soil per day. This equates to approximately ingesting soil at a rate of 1.5 times its body weight per day. Although ingestion at this rate is unlikely to occur, a TRV for this compound was developed given the relatively high concentration found on-site.

Little toxicity and environmental fate information is available. This compound is reported to be mildly toxic by ingestion, and is a severe skin and eye irritant under acute exposure. The EPA oral reference dose has been withdrawn (TOXNET) for this chemical. The study used to derive the former oral RfD reported a LOAEL of 175 mg/kg-day (Peikacz 1971).

The TRV developed for small mammals is based on a chronic rat feeding study by Piekacz 1971.

No information on the toxicological effects of di-n-octylphthalate on avian, reptile, or invertebrate receptors was located.

The recommended toxicological benchmark identified for di-n-octylphthalate exposure to terrestrial plants of 200 mg/kg-day was used as the TRV to di-n-octylphthalate due to the lack of further information (Suter et al. 1993).

Methylene chloride (dichloromethane) (CAS 75-09-2)—Inhaled methylene chloride is metabolized to carbon dioxide in animals leading to the formation of carboxyhemoglobin and subsequent oxygen deprivation. There is no data on the potential toxicity of methylene chloride when ingested.

Four groups of 85 each male and female rats were fed 5, 50, 125, and 250 mg/kg-day for 2 years (National Cancer Association 1982). Many effects were evaluated. Treatment-related histological alternations of the liver were evident at the low dose of 50 mg/kg-day. No adverse effects were observed at the 5 mg/kg-day level.

No information on the toxicological effects of methylene chloride on reptile, invertebrate, or avian receptors or on terrestrial plants was located.

Polychlorinated Biphenyls (PCB)s (CAS 1336-36-3)—PCBs comprise a physicochemically and toxicologically diverse group of 209 compounds whose widespread use and chemical stability have made them ubiquitous in the environment. The chemical properties of commercial PCB mixtures depend on their degree of chlorination. PCB congeners with five to seven chlorine atoms per molecule are the most abundant in environmental matrices and the most bioaccumulative, while those that are more highly chlorinated are more tightly bound to particles and hence less bioavailable (reviewed by McFarland and Clarke 1989; Safe 1992).

Because of their generally low acute toxicity, effects on environmental receptors are more likely to be sublethal and chronic than acute. Toxicity and risk assessment of PCB mixtures is complicated by the fact that the 209 congeners differ markedly in both the severity and the nature of their biological effects. The lack of definition of PCB congeners present at INEL is thus a major source of uncertainty in the SLERA. The toxic potency of individual congeners is dependent upon their structure. While the approximate isostereomers of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)—i.e., coplanar molecules with chlorine atoms

in the lateral (but not ortho) ring positions—are the most toxic (and carcinogenic in some species), many others manifest very low acute or chronic toxicity.

The most toxic congeners are also the most potent inducers of mixed-function oxidases as well as some Phase II enzyme activities (reviewed by Safe 1992). These enzymes metabolize not only the inducing PCBs but also a variety of endogenous molecules, such as steroid hormones, that are necessary for normal physiological function. As a result, PCBs may exert adverse effects on development and reproduction in various vertebrate species, including birds (e.g., Koval et al. 1987). In addition, there is considerable difference in the sensitivity of various species to these compounds. Particularly sensitive species include some birds, guinea pigs, and mink (McConnell 1985).

Dahlgren and Linder (1971) and Dahlgren et al. (1972) examined the effects of Aroclor 1254 exposure in pheasants. A resultant TRV was developed for avian herbivores. Nine to 10 mg/kg-day Aroclor 1254 reduced sperm concentrations in American kestrels, *Falco sparverius* (Bird et al. 1983). A TRV was derived from this study.

Linder et al. (1974) identified NOAELs for Aroclors 1254 in a two-generation reproductive study in rats. The TRV for mammals was developed from this work. Many studies have focused on the toxicity of various PCBs to mink, a sensitive species (Eisler 1986; EPA 1993). Related species such as otter and ferret are considerably less susceptible. A TRV was derived from the work of Hornshaw et al. (1983), in which mink were exposed in the diet to PCBs metabolized in fish tissue..

For terrestrial plants, the recommended toxicological benchmark identified for PCB exposure was used as the TRV (Suter et al. 1993).

No information on the toxicological effects of PCBs on reptile or invertebrate receptors was located.

Toluene (CAS 108-88-3)—Most of the toxicological data for toluene focus on exposures via inhalation. EPA (1984) reported that pregnant mice treated with 430 to 870 mg/kg-day by gavage experienced an increased fetal mortality rate. Maternal toxicity was not observed.

The oral toxicity of toluene was evaluated in a subchronic gavage study (NTP 1989). Male and female rats were given toluene in corn oil at levels of 0, 223, 444, 888, 1,775, or 3,550 mg/kg-day for 13 weeks. Groups of 10 rats per sex per treatment group were used. All animal receiving 3,550 mg/kg-day died within the first week. Toxic effects including prostration, hypoactivity, ataxia, piloerection, lacrimation, excessive salivation, and body tremors were observed in animals given the 1,775 mg/kg-day dose. Pathological findings include changes in liver, kidney, and bladder weights. Histopathologic liver lesions, hepatocellular hypertrophy, and nephrosis were observed in animals given 1,775 mg/kg-day. No toxic effects were seen in animals receiving 888 mg/kg-day or less.

The recommended toxicological benchmark identified for toluene exposure to terrestrial plants was used as the TRV (Suter et al. 1993).

No information on the toxicological effects of toluene on reptile, invertebrate, or avian receptors was located.

4. Screening Level Evaluation

Ecologically based screening levels (EBSLs) were calculated for the contaminant and receptors of concern for WAG 9 to; 1) provide a rational, consistent, conservative (ecologically protective) approach: 2) to screen sites that may require further investigation (i.e., a comprehensive baseline risk assessment), and 3) to prioritize sites based on comparison of mean soil concentrations with EBSLs. EBSLs are defined as the minimum, ecologically based concentration of contaminants allowable in soil derived from site-specific exposure scenarios for key receptors of concern.

4.1 Risk Estimation

Exposure parameters used to calculate EBSLs for the key receptors of concern are outlined in Section 3. Screening Level Quotients (SLQs) are calculated using the following equation.

$$SLQ = \frac{CS}{EBSL} \tag{4-1}$$

where

SLQ	=	screening level quotient;
CS	=	average concentration of contaminant in soil (mg/kg or pCi/g);
EBSL	=	minimum ecologically based screening level (mg/kg or pCi/g)

SLQs are derived for all contaminants and for each functional groups and T/E species identified in WAG 9. Tables 4-1 and 4-2 present the SLQs for the nonradiological contaminants in surface and subsurface soils, respectively. Tables 4-3 and 4-4 present the internal dose SLQs for the radiological contaminants in surface and subsurface soils while tables 4-5 and 4-6 present the external dose SLQs for the radiological contaminants in surface and subsurface soils, respectively. If there were no data available to derive TRVs EBSLs could not be derived for that particular combination of contaminant and functional group or T/E species. Thus, no SLQ was estimated and these data gaps are indicated as dashes in Tables 4-1 through 4-6.

Average (versus upper-bound or maximum) soil concentration data were used because soil sampling at WAG 9 tended to be biased toward areas that are known or suspected to be highly contaminated. Hence, use of average concentration data is more representative of the range of concentrations to which ecological receptors inhabiting WAG 9 are likely to be exposed. If the average concentration of a contaminant in soil does not exceed its EBSL (i.e., SLQs are less than 1 for nonradiological contaminants and 0.1 for radiological contaminants), adverse effects from exposure to that contaminant by ecological receptors are not expected, and no further evaluation of that contaminant/site is required. Hence, the SLQ is an indicator of risk.

Table 4-1. Nonradiological screening level quotients (SLQs) for WAG 9 surface soil.

Functional groups	Antimony	Arsenic	Calcium	Chromium VI
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	-	1.64E-01	-	6.27E-01
Avian herbivores (AV122)	-	**2.72E+00**	-	**2.28E+01**
Avian herbivores (AV132)	-	**1.07E+00**	-	**1.02E+01**
Avian herbivores (AV142)	-	6.17E-02	-	**1.00E+00**
Avian herbivores (AV143)	-	1.54E-01	-	**2.51E+00**
Trumpeter swan	-	8.59E-02	-	**1.40E+00**
Avian insectivores (AV210)	-	**1.42E+01**	-	**1.03E+02**
Black tern	-	**5.68E+00**	-	**4.12E+01**
Avian insectivores (AV210A)	-	**1.25E+01**	-	**9.03E+01**
Avian insectivores (AV221)	-	**1.62E+01**	-	**1.17E+02**
Avian insectivores (AV222)	-	**2.12E+01**	-	**1.54E+02**
Avian insectivores (AV222A)	-	**1.31E+01**	-	**9.51E+01**
Avian insectivores (AV232)	-	**2.21E+01**	-	**1.60E+02**
Avian insectivores (AV233)	-	**4.19E+00**	-	**3.03E+01**
White-faced ibis	-	**2.49E+00**	-	**1.80E+01**
Avian insectivores (AV241)	-	**3.54E+00**	-	**2.56E+01**
Avian insectivores (AV242)	-	**6.85E+00**	-	**4.97E+01**
Avian carnivores (AV310)	-	**5.83E+00**	-	**4.23E+01**
Northern goshawk & peregrine falcon	-	6.46E-01	-	**4.68E+00**
Avian carnivores (AV322)	-	**1.27E+01**	-	**9.21E+01**
Bald eagle, ferruginous hawk, & loggerhead shrike	-	2.45E-01	-	**1.77E+00**
Avian carnivores (AV322A)	-	**2.08E+00**	-	**1.51E+01**
Avian carnivores (AV333)	-	**2.03E+00**	-	**1.47E+01**
Avian carnivores (AV342)	-	9.35E-01	-	**6.77E+00**
Avian omnivores (AV422)	-	**6.34E+00**	-	**2.92E+01**
Avian omnivores (AV432)	-	**1.12E+00**	-	**5.19E+00**
Avian omnivores (AV433)	-	7.67E-01	-	**3.55E+00**
Avian omnivores (AV442)	-	**3.02E+00**	-	**1.39E+01**
Mammalian herbivores (M121)	4.64E-02	1.22E-01	-	**7.43E+00**
Mammalian herbivores (M122)	**1.05E+00**	**7.17E+01**	-	**2.47E+02**
Mammalian herbivores (M122A)	**1.00E+00**	**7.44E+01**	-	**2.71E+02**
Pygmy rabbit	**1.03E+00**	**4.80E+01**	-	**1.10E+02**
Mammalian herbivores (M123)	5.08E-01	**2.12E+00**	-	**2.06E+02**
Mammalian insectivores (M210)	**2.26E+00**	**3.86E+02**	-	**1.91E+03**
Mammalian insectivores (M210A)	**1.16E+00**	**1.98E+02**	-	**9.78E+02**
Townsend's western big-eared bat & small-footed myotis	**9.04E+00**	**1.54E+03**	-	**7.62E+03**
Mammalian insectivores (M222)	**5.03E+00**	**8.59E+02**	-	**4.25E+03**
Mammalian carnivore (M322)	**1.70E+00**	**2.90E+02**	-	**9.54E+02**
Mammalian omnivores (M422)	**1.61E+00**	**1.37E+01**	-	**1.17E+03**
Mammalian omnivores (M422A)	5.41E-02	4.61E-01	-	**1.69E+01**
Reptilian insectivores (R222)	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-
Plants	-	-	-	-
Frequency >1	9/12	30/40	NA	39/40

Table 4-1. (continued).

Functional groups	Copper	Cyanide	Lead	Mercury
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	**3.38E+00**	**1.00E+01**	**3.07E+00**	**7.31E+00**
Avian herbivores (AV122)	**2.41E+01**	**6.38E+01**	**6.38E+01**	**4.69E+01**
Avian herbivores (AV132)	**6.41E+00**	**1.52E+01**	**2.47E+01**	**1.13E+01**
Avian herbivores (AV142)	**1.17E+00**	**1.58E+00**	4.59E-02	**2.31E+00**
Avian herbivores (AV143)	**2.93E+00**	**3.94E+00**	1.15E-01	**5.78E+00**
Trumpeter swan	**1.63E+00**	**2.19E+00**	6.38E-02	**3.22E+00**
Avian insectivores (AV210)	**2.38E+01**	**4.31E+01**	**1.61E+02**	**2.32E+01**
Black tern	**9.53E+00**	**1.72E+01**	**6.44E+01**	**9.28E+00**
Avian insectivores (AV210A)	**2.09E+01**	**3.78E+01**	**7.06E+01**	**2.04E+01**
Avian insectivores (AV221)	**2.71E+01**	**4.91E+01**	**1.83E+02**	**2.64E+01**
Avian insectivores (AV222)	**3.56E+01**	**6.44E+01**	**2.41E+02**	**3.47E+01**
Avian insectivores (AV222A)	**2.20E+01**	**3.98E+01**	**1.49E+02**	**2.14E+01**
Avian insectivores (AV232)	**3.71E+01**	**6.72E+01**	**2.51E+02**	**3.62E+01**
Avian insectivores (AV233)	**7.02E+00**	**1.27E+01**	**4.75E+01**	**6.84E+00**
White-faced ibis	**4.17E+00**	**7.54E+00**	**2.82E+01**	**4.06E+00**
Avian insectivores (AV241)	**5.93E+00**	**1.07E+01**	**4.01E+01**	**5.78E+00**
Avian insectivores (AV242)	**1.15E+01**	**2.08E+01**	**7.77E+01**	**1.12E+01**
Avian carnivores (AV310)	**9.78E+00**	**4.08E+00**	**8.81E+01**	**9.53E+00**
Northern goshawk & peregrine falcon	**1.08E+00**	**4.52E-01**	**9.77E+00**	**1.06E+00**
Avian carnivores (AV322)	**2.13E+01**	**3.85E+01**	**1.92E+02**	**2.08E+01**
Bald eagle, ferruginous hawk, & loggerhead shrike	4.11E-01	7.43E-01	**3.70E+00**	4.00E-01
Avian carnivores (AV322A)	**3.49E+00**	**6.32E+00**	**3.15E+01**	**3.40E+00**
Avian carnivores (AV333)	**3.40E+00**	**6.16E+00**	**3.07E+01**	**3.32E+00**
Avian carnivores (AV342)	**1.57E+00**	**2.83E+00**	**1.41E+01**	**1.53E+00**
Avian omnivores (AV422)	**8.91E+00**	**3.21E+01**	**9.62E+01**	**8.28E+00**
Avian omnivores (AV432)	**1.48E+00**	**4.97E+00**	**1.70E+01**	**1.29E+00**
Avian omnivores (AV433)	**1.01E+00**	**3.40E+00**	**1.16E+01**	8.87E-01
Avian omnivores (AV442)	**4.19E+00**	**1.49E+01**	**4.58E+01**	**3.85E+00**
Mammalian herbivores (M121)	2.93E-01	7.50E-01	**2.69E+00**	**6.07E+00**
Mammalian herbivores (M122)	**4.05E+00**	**9.74E+00**	**5.73E+01**	**7.92E+01**
Mammalian herbivores (M122A)	**3.77E+00**	**8.91E+00**	**5.91E+01**	**7.26E+01**
Pygmy rabbit	**4.33E+00**	**1.11E+01**	**3.97E+01**	**8.97E+01**
Mammalian herbivores (M123)	**2.87E+00**	**6.78E+00**	**4.50E+01**	**5.52E+00**
Mammalian insectivores (M210)	**5.00E+00**	**5.26E+00**	**2.95E+02**	**4.72E+01**
Mammalian insectivores (M210A)	**2.56E+00**	**2.70E+00**	**1.51E+02**	**2.42E+01**
Townsend's western big-eared bat & small-footed myotis	**2.00E+01**	**2.10E+01**	**1.18E+03**	**1.89E+02**
Mammalian insectivores (M222)	**1.11E+01**	**1.17E+01**	**6.56E+02**	**1.05E+02**
Mammalian carnivore (M322)	**1.22E+00**	**2.63E+00**	**1.51E+02**	**1.42E+01**
Mammalian omnivores (M422)	**6.09E+00**	**5.87E+00**	**1.91E+02**	**7.54E+01**
Mammalian omnivores (M422A)	1.33E-01	1.19E-01	**3.11E+00**	**1.69E+00**
Reptilian insectivores (R222)	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-
Plants	-	-	-	-
Frequency >1	37/40	37/40	37/40	38/40

Table 4-1. (continued).

Functional groups	Nickel	Selenium	Silver	Sodium	Zinc
Amphibian insectivores (A232)	-	-	-	-	-
Avian herbivores (AV121)	4.32E-02	1.08E-01	-	-	**1.81E+01**
Avian herbivores (AV122)	5.84E-01	**2.28E+00**	-	-	**1.12E+02**
Avian herbivores (AV132)	2.16E-01	9.41E-01	-	-	**2.59E+01**
Avian herbivores (AV142)	1.26E-02	1.02E-02	-	-	**5.56E+00**
Avian herbivores (AV143)	3.14E-02	2.55E-02	-	-	**1.39E+01**
Trumpeter swan	1.75E-02	1.42E-02	-	-	**7.74E+00**
Avian insectivores (AV210)	**2.53E+00**	**8.86E+00**	-	-	**3.47E+01**
Black tern	**1.01E+00**	**3.54E+00**	-	-	**1.39E+01**
Avian insectivores (AV210A)	**2.22E+00**	**7.77E+00**	-	-	**3.05E+01**
Avian insectivores (AV221)	**2.89E+00**	**1.01E+01**	-	-	**3.96E+01**
Avian insectivores (AV222)	**3.78E+00**	**1.32E+01**	-	-	**5.19E+01**
Avian insectivores (AV222A)	**2.34E+00**	**8.18E+00**	-	-	**3.21E+01**
Avian insectivores (AV232)	**3.95E+00**	**1.38E+01**	-	-	**5.41E+01**
Avian insectivores (AV233)	7.46E-01	**2.61E+00**	-	-	**1.02E+01**
White-faced ibis	4.43E-01	**1.55E+00**	-	-	**6.08E+00**
Avian insectivores (AV241)	6.30E-01	**2.20E+00**	-	-	**8.64E+00**
Avian insectivores (AV242)	**1.22E+00**	**4.27E+00**	-	-	**1.67E+01**
Avian carnivores (AV310)	**1.04E+00**	**3.64E+00**	-	-	**1.43E+01**
Northern goshawk & peregrine falcon	1.15E-01	4.03E-01	-	-	**1.58E+00**
Avian carnivores (AV322)	**2.27E+00**	**7.92E+00**	-	-	**3.11E+01**
Bald eagle, ferruginous hawk, & loggerhead shrike	4.37E-02	1.53E-01	-	-	5.99E-01
Avian carnivores (AV322A)	3.71E-01	**1.30E+00**	-	-	**5.09E+00**
Avian carnivores (AV333)	3.62E-01	**1.27E+00**	-	-	**4.96E+00**
Avian carnivores (AV342)	1.67E-01	5.82E-01	-	-	**2.28E+00**
Avian omnivores (AV422)	**1.15E+00**	**3.91E+00**	-	-	**2.08E+01**
Avian omnivores (AV432)	2.02E-01	6.93E-01	-	-	**3.11E+00**
Avian omnivores (AV433)	1.38E-01	4.74E-01	-	-	**2.13E+00**
Avian omnivores (AV442)	5.46E-01	**1.87E+00**	-	-	**9.60E+00**
Mammalian herbivores (M121)	3.15E-02	1.14E-02	1.99E-01	1.00E-02	**1.15E+01**
Mammalian herbivores (M122)	9.32E-01	4.43E-01	**4.13E+00**	2.79E-01	**2.26E+02**
Mammalian herbivores (M122A)	9.47E-01	4.70E-01	**3.85E+00**	2.80E-01	**2.06E+02**
Pygmy rabbit	7.00E-01	2.60E-01	**4.42E+00**	2.23E-01	**2.61E+02**
Mammalian herbivores (M123)	4.78E-01	2.32E-01	**1.95E+00**	1.42E-01	**1.02E+02**
Mammalian insectivores (M210)	**4.22E+00**	**2.77E+00**	**5.09E+00**	**1.13E+00**	**8.31E+01**
Mammalian insectivores (M210A)	**2.17E+00**	**1.42E+00**	**2.61E+00**	5.81E-01	**4.27E+01**
Townsend's western big-eared bat & small-footed myotis	**1.69E+01**	**1.11E+01**	**2.04E+01**	**4.53E+00**	**3.32E+02**
Mammalian insectivores (M222)	**9.41E+00**	**6.18E+00**	**1.13E+01**	**2.52E+00**	**1.21E+02**
Mammalian carnivore (M322)	**3.17E+00**	**2.08E+00**	**3.82E+00**	8.50E-01	**1.34E+00**
Mammalian omnivores (M422)	**2.69E+00**	**1.68E+00**	**4.13E+00**	7.33E-01	**1.12E+02**
Mammalian omnivores (M422A)	8.73E-03	5.67E-02	1.39E-01	2.47E-02	2.79E-01
Reptilian insectivores (R222)	-	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-	-
Plants	-	-	-	-	-
Frequency >1	17/40	24/40	10/12	3/12	38/40

Table 4-2. Nonradiological SLQs for WAG 9 subsurface soil.

Functional groups	1,1,1-trichloroethane	2-Butanone	2,3,7,8TCDD	Acetone
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	-	-	4.06E-03	-
Avian herbivores (AV122)	-	-	1.67E-01	-
Avian herbivores (AV132)	-	-	7.53E-02	-
Avian herbivores (AV142)	-	-	7.34E-03	-
Avian herbivores (AV143)	-	-	1.83E-02	-
Trumpeter swan	-	-	1.02E-02	-
Avian insectivores (AV210)	-	-	7.72E-01	-
Black tern	-	-	3.09E-01	-
Avian insectivores (AV210A)	-	-	6.77E-01	-
Avian insectivores (AV221)	-	-	8.79E-01	-
Avian insectivores (AV222)	-	-	**1.15E+00**	-
Avian insectivores (AV222A)	-	-	7.13E-01	-
Avian insectivores (AV232)	-	-	**1.20E+00**	-
Avian insectivores (AV233)	-	-	2.27E-01	-
White-faced ibis	-	-	1.35E-01	-
Avian insectivores (AV241)	-	-	1.92E-01	-
Avian insectivores (AV242)	-	-	3.72E-01	-
Avian carnivores (AV310)	-	-	3.17E-01	-
Northern goshawk & peregrine falcon	-	-	3.51E-02	-
Avian carnivores (AV322)	-	-	6.90E-01	-
Bald eagle, ferruginous hawk, & loggerhead shrike	-	-	1.33E-02	-
Avian carnivores (AV322A)	-	-	1.13E-01	-
Avian carnivores (AV333)	-	-	1.10E-01	-
Avian carnivores (AV342)	-	-	5.08E-02	-
Avian omnivores (AV422)	-	-	2.24E-01	-
Avian omnivores (AV432)	-	-	3.99E-02	-
Avian omnivores (AV433)	-	-	2.73E-02	-
Avian omnivores (AV442)	-	-	1.07E-01	-
Mammalian herbivores (M121)	6.97E-03	8.52E-02	1.04E-01	**2.33E+00**
Mammalian herbivores (M122)	1.35E-01	**1.59E+00**	**5.54E+00**	**4.33E+01**
Mammalian herbivores (M122A)	1.23E-01	**1.43E+00**	**6.11E+00**	**3.91E+01**
Pygmy rabbit	1.55E-01	**1.89E+00**	**2.32E+00**	**5.15E+01**
Mammalian herbivores (M123)	6.20E-02	7.27E-01	**3.07E+00**	**1.98E+01**
Mammalian insectivores (M210)	5.33E-02	3.34E-02	**4.41E+01**	4.68E-01
Mammalian insectivores (M210A)	2.73E-02	1.71E-02	**2.27E+01**	2.40E-01
Townsend's western big-eared bat & small-footed myotis	2.13E-01	1.33E-01	**1.77E+02**	**1.87E+00**
Mammalian insectivores (M222)	1.19E-01	7.43E-02	**9.83E+01**	**1.04E+00**
Mammalian carnivore (M322)	4.00E-02	2.51E-02	**3.31E+01**	3.52E-01
Mammalian omnivores (M422)	6.96E-02	4.82E-01	**2.68E+01**	**1.29E+01**
Mammalian omnivores (M422A)	2.35E-03	1.63E-02	9.03E-01	4.35E-01
Reptilian insectivores (R222)	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-
Plants	-	-	-	-
Frequency	0/12	3/12	12/40	8/12

Table 4-2. (continued).

Functional groups	Antimony	Arsenic	Beryllium	Butylbenzylphthalate
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	-	8.77E-02	-	-
Avian herbivores (AV122)	-	**1.45E+00**	-	-
Avian herbivores (AV132)	-	5.70E-01	-	-
Avian herbivores (AV142)	-	3.30E-02	-	-
Avian herbivores (AV143)	-	8.24E-02	-	-
Trumpeter swan	-	4.59E-02	-	-
Avian insectivores (AV210)	-	**7.60E+00**	-	-
Black tern	-	**3.04E+00**	-	-
Avian insectivores (AV210A)	-	**6.66E+00**	-	-
Avian insectivores (AV221)	-	**8.65E+00**	-	-
Avian insectivores (AV222)	-	**1.13E+01**	-	-
Avian insectivores (AV222A)	-	**7.01E+00**	-	-
Avian insectivores (AV232)	-	**1.18E+01**	-	-
Avian insectivores (AV233)	-	**2.24E+00**	-	-
White-faced ibis	-	**1.33E+00**	-	-
Avian insectivores (AV241)	-	**1.89E+00**	-	-
Avian insectivores (AV242)	-	**3.66E+00**	-	-
Avian carnivores (AV310)	-	**3.12E+00**	-	-
Northern goshawk & peregrine falcon	-	3.45E-01	-	-
Avian carnivores (AV322)	-	**6.79E+00**	-	-
Bald eagle, ferruginous hawk, & loggerhead shrike	-	1.31E-01	-	-
Avian carnivores (AV322A)	-	**1.11E+00**	-	-
Avian carnivores (AV333)	-	**1.08E+00**	-	-
Avian carnivores (AV342)	-	4.99E-01	-	-
Avian omnivores (AV422)	-	**3.39E+00**	-	-
Avian omnivores (AV432)	-	5.98E-01	-	-
Avian omnivores (AV433)	-	4.10E-01	-	-
Avian omnivores (AV442)	-	**1.62E+00**	-	-
Mammalian herbivores (M121)	2.77E-02	6.52E-02	2.01E-03	2.48E-02
Mammalian herbivores (M122)	6.25E-01	**3.83E+01**	9.51E-02	7.16E-01
Mammalian herbivores (M122A)	5.98E-01	**3.97E+01**	1.04E-01	7.24E-01
Pygmy rabbit	6.13E-01	**2.57E+01**	4.45E-02	5.50E-01
Mammalian herbivores (M123)	3.03E-01	**1.13E+00**	5.26E-02	3.67E-01
Mammalian insectivores (M210)	**1.35E+00**	**2.06E+02**	7.10E-01	**3.12E+00**
Mammalian insectivores (M210A)	6.92E-01	**1.06E+02**	3.64E-01	**1.60E+00**
Townsend's western big-eared bat & small-footed myotis	**5.40E+00**	**8.24E+02**	**2.84E+00**	**1.25E+01**
Mammalian insectivores (M222)	**3.00E+00**	**4.59E+02**	**1.58E+00**	**6.95E+00**
Mammalian carnivore (M322)	**1.01E+00**	**1.55E+02**	5.33E-01	**2.34E+00**
Mammalian omnivores (M422)	9.59E-01	**7.30E+00**	4.37E-01	**2.00E+00**
Mammalian omnivores (M422A)	3.23E-02	2.46E-01	1.47E-02	6.76E-02
Reptilian insectivores (R222)	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-
Plants	-	-	-	-
Frequency >1	4/12	28/40	2/12	6/12

Table 4-2. (continued).

Functional groups	Calcium	Chloride	Chloroform	Chromium VI
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	-	-	-	5.98E-02
Avian herbivores (AV122)	-	-	-	**2.18E+00**
Avian herbivores (AV132)	-	-	-	9.68E-01
Avian herbivores (AV142)	-	-	-	9.58E-02
Avian herbivores (AV143)	-	-	-	2.39E-01
Trumpeter swan	-	-	-	1.33E-01
Avian insectivores (AV210)	-	-	-	**9.83E+00**
Black tern	-	-	-	**3.93E+00**
Avian insectivores (AV210A)	-	-	-	**8.61E+00**
Avian insectivores (AV221)	-	-	-	**1.12E+01**
Avian insectivores (AV222)	-	-	-	**1.47E+01**
Avian insectivores (AV222A)	-	-	-	**9.06E+00**
Avian insectivores (AV232)	-	-	-	**1.53E+01**
Avian insectivores (AV233)	-	-	-	**2.89E+00**
White-faced ibis	-	-	-	**1.72E+00**
Avian insectivores (AV241)	-	-	-	**2.44E+00**
Avian insectivores (AV242)	-	-	-	**4.73E+00**
Avian carnivores (AV310)	-	-	-	**4.03E+00**
Northern goshawk & peregrine falcon	-	-	-	4.47E-01
Avian carnivores (AV322)	-	-	-	**8.78E+00**
Bald eagle, ferruginous hawk, & loggerhead shrike	-	-	-	1.69E-01
Avian carnivores (AV322A)	-	-	-	**1.44E+00**
Avian carnivores (AV333)	-	-	-	**1.40E+00**
Avian carnivores (AV342)	-	-	-	6.46E-01
Avian omnivores (AV422)	-	-	-	**2.78E+00**
Avian omnivores (AV432)	-	-	-	4.95E-01
Avian omnivores (AV433)	-	-	-	3.39E-01
Avian omnivores (AV442)	-	-	-	**1.33E+00**
Mammalian herbivores (M121)	-	-	2.15E-01	7.09E-01
Mammalian herbivores (M122)	-	-	**3.96E+00**	**2.36E+01**
Mammalian herbivores (M122A)	-	-	**3.59E+00**	**2.58E+01**
Pygmy rabbit	-	-	**4.64E+00**	**1.05E+01**
Mammalian herbivores (M123)	-	-	**1.87E+00**	**1.97E+01**
Mammalian insectivores (M210)	-	-	7.94E-01	**1.82E+02**
Mammalian insectivores (M210A)	-	-	4.08E-01	**9.33E+01**
Townsend's western big-eared bat & small-footed myotis	-	-	**3.18E+00**	**7.27E+02**
Mammalian insectivores (M222)	-	-	**1.77E+00**	**4.05E+02**
Mammalian carnivore (M322)	-	-	5.97E-01	**9.10E+01**
Mammalian omnivores (M422)	-	-	**2.42E+00**	**1.12E+02**
Mammalian omnivores (M422A)	-	-	1.88E-02	**1.61E+00**
Reptilian insectivores (R222)	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-
Plants	-	-	-	-
Frequency >1	NA	NA	7/12	29/40

Table 4-2. (continued).

Functional groups	Copper	Cyanide	Di-2-ethylhexylphthalate	Di-n-octylphthalate
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	**1.04E+00**	**7.37E+00**	-	-
Avian herbivores (AV122)	**7.45E+00**	**4.68E+01**	-	-
Avian herbivores (AV132)	**1.98E+00**	**1.12E+01**	-	-
Avian herbivores (AV142)	3.63E-01	**1.16E+00**	-	-
Avian herbivores (AV143)	9.07E-01	**2.89E+00**	-	-
Trumpeter swan	5.05E-01	**1.61E+00**	-	-
Avian insectivores (AV210)	**7.37E+00**	**3.16E+01**	-	-
Black tern	**2.94E+00**	**1.26E+01**	-	-
Avian insectivores (AV210A)	**6.45E+00**	**2.77E+01**	-	-
Avian insectivores (AV221)	**8.38E+00**	**3.60E+01**	-	-
Avian insectivores (AV222)	**1.10E+01**	**4.72E+01**	-	-
Avian insectivores (AV222A)	**6.80E+00**	**2.92E+01**	-	-
Avian insectivores (AV232)	**1.15E+01**	**4.93E+01**	-	-
Avian insectivores (AV233)	**2.17E+00**	**9.32E+00**	-	-
White-faced ibis	**1.29E+00**	**5.54E+00**	-	-
Avian insectivores (AV241)	**1.83E+00**	**7.87E+00**	-	-
Avian insectivores (AV242)	**3.55E+00**	**1.53E+01**	-	-
Avian carnivores (AV310)	**3.02E+00**	**3.00E+00**	-	-
Northern goshawk & peregrine falcon	3.35E-01	3.32E-01	-	-
Avian carnivores (AV322)	**6.58E+00**	**2.83E+01**	-	-
Bald eagle, ferruginous hawk, & loggerhead shrike	1.27E-01	5.45E-01	-	-
Avian carnivores (AV322A)	**1.08E+00**	**4.64E+00**	-	-
Avian carnivores (AV333)	**1.05E+00**	**4.52E+00**	-	-
Avian carnivores (AV342)	4.84E-01	**2.08E+00**	-	-
Avian omnivores (AV422)	**2.75E+00**	**2.35E+01**	-	-
Avian omnivores (AV432)	4.56E-01	**3.65E+00**	-	-
Avian omnivores (AV433)	3.12E-01	**2.50E+00**	-	-
Avian omnivores (AV442)	**1.29E+00**	**1.09E+01**	-	-
Mammalian herbivores (M121)	9.06E-02	5.50E-01	1.67E-02	3.00E-03
Mammalian herbivores (M122)	**1.25E+00**	**7.15E+00**	3.78E-01	1.83E-01
Mammalian herbivores (M122A)	**1.17E+00**	**6.54E+00**	3.62E-01	2.05E-01
Pygmy rabbit	**1.34E+00**	**8.13E+00**	3.69E-01	6.65E-02
Mammalian herbivores (M123)	8.88E-01	**4.97E+00**	1.84E-01	1.04E-01
Mammalian insectivores (M210)	**1.54E+00**	**3.86E+00**	8.35E-01	**1.56E+00**
Mammalian insectivores (M210A)	7.92E-01	**1.98E+00**	4.28E-01	8.03E-01
Townsend's western big-eared bat & small-footed myotis	**6.17E+00**	**1.54E+01**	**3.34E+00**	**6.26E+00**
Mammalian insectivores (M222)	**3.44E+00**	**8.60E+00**	**1.86E+00**	**3.49E+00**
Mammalian carnivore (M322)	3.77E-01	**1.93E+00**	6.27E-01	**1.18E+00**
Mammalian omnivores (M422)	**1.88E+00**	**4.31E+00**	5.91E-01	9.55E-01
Mammalian omnivores (M422A)	4.12E-02	8.71E-02	1.99E-02	3.22E-02
Reptilian insectivores (R222)	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-
Plants	-	-	-	-
Frequency >1	27/40	36/40	2/12	4/12

Table 4-2. (continued).

Functional groups	Fluoride	Lead	Manganese	Mercury
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	-	**1.25E+00**	**7.95E+00**	8.60E-01
Avian herbivores (AV122)	-	**2.60E+01**	**6.28E+01**	**5.52E+00**
Avian herbivores (AV132)	-	**1.01E+01**	**1.80E+01**	**1.33E+00**
Avian herbivores (AV142)	-	1.87E-02	**3.02E+00**	2.72E-01
Avian herbivores (AV143)	-	4.68E-02	**7.55E+00**	6.81E-01
Trumpeter swan	-	2.60E-02	**4.20E+00**	3.79E-01
Avian insectivores (AV210)	-	**6.57E+01**	**8.85E+01**	**2.73E+00**
Black tern	-	**2.63E+01**	**3.53E+01**	**1.09E+00**
Avian insectivores (AV210A)	-	**2.88E+01**	**7.75E+01**	**2.40E+00**
Avian insectivores (AV221)	-	**7.48E+01**	**1.01E+02**	**3.11E+00**
Avian insectivores (AV222)	-	**9.81E+01**	**1.32E+02**	**4.08E+00**
Avian insectivores (AV222A)	-	**6.06E+01**	**8.16E+01**	**2.52E+00**
Avian insectivores (AV232)	-	**1.02E+02**	**1.38E+02**	**4.26E+00**
Avian insectivores (AV233)	-	**1.94E+01**	**2.60E+01**	8.05E-01
White-faced ibis	-	**1.15E+01**	**1.55E+01**	4.78E-01
Avian insectivores (AV241)	-	**1.63E+01**	**2.20E+01**	6.80E-01
Avian insectivores (AV242)	-	**3.17E+01**	**4.26E+01**	**1.32E+00**
Avian carnivores (AV310)	-	**3.59E+01**	**3.63E+01**	**1.12E+00**
Northern goshawk & peregrine falcon	-	**3.98E+00**	**4.02E+00**	1.24E-01
Avian carnivores (AV322)	-	**7.83E+01**	**7.91E+01**	**2.44E+00**
Bald eagle, ferruginous hawk, & loggerhead shrike	-	**1.51E+00**	**1.52E+00**	4.71E-02
Avian carnivores (AV322A)	-	**1.28E+01**	**1.30E+01**	4.00E-01
Avian carnivores (AV333)	-	**1.25E+01**	**1.26E+01**	3.90E-01
Avian carnivores (AV342)	-	**5.76E+00**	**5.81E+00**	1.80E-01
Avian omnivores (AV422)	-	**3.92E+01**	**2.92E+01**	9.75E-01
Avian omnivores (AV432)	-	**6.92E+00**	**4.96E+00**	1.52E-01
Avian omnivores (AV433)	-	**4.74E+00**	**3.40E+00**	1.04E-01
Avian omnivores (AV442)	-	**1.87E+01**	**1.38E+01**	4.53E-01
Mammalian herbivores (M121)	-	**1.10E+00**	**2.44E+00**	7.15E-01
Mammalian herbivores (M122)	-	**2.34E+01**	**5.33E+01**	**9.33E+00**
Mammalian herbivores (M122A)	-	**2.41E+01**	**5.05E+01**	**8.55E+00**
Pygmy rabbit	-	**1.62E+01**	**5.41E+01**	**1.06E+01**
Mammalian herbivores (M123)	-	**1.83E+01**	**2.56E+01**	6.50E-01
Mammalian insectivores (M210)	-	**1.20E+02**	**9.69E+01**	**5.56E+00**
Mammalian insectivores (M210A)	-	**6.16E+01**	**4.97E+01**	**2.85E+00**
Townsend's western big-eared bat & small-footed myotis	-	**4.80E+02**	**3.88E+02**	**2.22E+01**
Mammalian insectivores (M222)	-	**2.68E+02**	**2.16E+02**	**1.24E+01**
Mammalian carnivore (M322)	-	**6.17E+01**	**7.28E+01**	**1.67E+00**
Mammalian omnivores (M422)	-	**7.80E+01**	**7.14E+01**	**8.88E+00**
Mammalian omnivores (M422A)	-	**1.27E+00**	**2.40E+00**	1.99E-01
Reptilian insectivores (R222)	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-
Plants	-	-	-	-
Frequency >1	NA	37/40	40/40	21/40

Table 4-2. (continued).

Functional groups	Methylene chloride	Nitrates	PCBs	Phosphate
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	-	3.92E-02	**1.73E+00**	-
Avian herbivores (AV122)	-	2.49E-01	**5.13E+01**	-
Avian herbivores (AV132)	-	5.95E-02	**2.23E+01**	-
Avian herbivores (AV142)	-	1.23E-02	**2.27E+00**	-
Avian herbivores (AV143)	-	3.08E-02	**5.68E+00**	-
Trumpeter swan	-	1.71E-02	**3.16E+00**	-
Avian insectivores (AV210)	-	1.12E-01	**2.22E+02**	-
Black tern	-	4.49E-02	**8.85E+01**	-
Avian insectivores (AV210A)	-	9.84E-02	**1.94E+02**	-
Avian insectivores (AV221)	-	1.28E-01	**2.52E+02**	-
Avian insectivores (AV222)	-	1.68E-01	**3.31E+02**	-
Avian insectivores (AV222A)	-	1.04E-01	**2.04E+02**	-
Avian insectivores (AV232)	-	1.75E-01	**3.45E+02**	-
Avian insectivores (AV233)	-	3.31E-02	**6.52E+01**	-
White-faced ibis	-	1.96E-02	**3.88E+01**	-
Avian insectivores (AV241)	-	2.79E-02	**5.51E+01**	-
Avian insectivores (AV242)	-	5.41E-02	**1.07E+02**	-
Avian carnivores (AV310)	-	4.61E-02	**4.60E+00**	-
Northern goshawk & peregrine falcon	-	5.10E-03	5.10E-01	-
Avian carnivores (AV322)	-	1.00E-01	**1.98E+02**	-
Bald eagle, ferruginous hawk, & loggerhead shrike	-	1.93E-03	**3.82E+00**	-
Avian carnivores (AV322A)	-	1.65E-02	**3.25E+01**	-
Avian carnivores (AV333)	-	1.60E-02	**3.16E+01**	-
Avian carnivores (AV342)	-	7.38E-03	**1.46E+01**	-
Avian omnivores (AV422)	-	5.56E-02	**6.46E+01**	-
Avian omnivores (AV432)	-	8.61E-03	**1.15E+01**	-
Avian omnivores (AV433)	-	5.90E-03	**7.86E+00**	-
Avian omnivores (AV442)	-	2.58E-02	**3.08E+01**	-
Mammalian herbivores (M121)	**8.16E+00**	9.93E-02	**1.66E+01**	-
Mammalian herbivores (M122)	**1.60E+02**	**1.93E+00**	**4.98E+02**	-
Mammalian herbivores (M122A)	**1.44E+02**	**1.77E+00**	**5.40E+02**	-
Pygmy rabbit	**1.89E+02**	**2.20E+00**	**2.45E+02**	-
Mammalian herbivores (M123)	**7.01E+01**	8.97E-01	**4.11E+02**	-
Mammalian insectivores (M210)	**1.33E+01**	**1.04E+00**	**3.60E+03**	-
Mammalian insectivores (M210A)	**6.82E+00**	5.36E-01	**1.85E+03**	-
Townsend's western big-eared bat & small-footed myotis	**5.32E+01**	**4.18E+00**	**1.44E+04**	-
Mammalian insectivores (M222)	**2.96E+01**	**2.33E+00**	**8.03E+03**	-
Mammalian carnivore (M322)	**9.98E+00**	7.85E-01	**6.77E+02**	-
Mammalian omnivores (M422)	**5.19E+01**	**1.17E+00**	**3.33E+03**	-
Mammalian omnivores (M422A)	**1.75E+00**	3.93E-02	**5.61E+01**	-
Reptilian insectivores (R222)	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-
Plants	-	-	-	-
Frequency >1	12/12	7/40	39/40	NA

Table 4-2. (continued).

Functional groups	Silver	Sodium	Sulfates	Toluene	Zinc
Amphibian insectivores (A232)	-	-	-	-	-
Avian herbivores (AV121)	-	-	-	-	**6.70E+00**
Avian herbivores (AV122)	-	-	-	-	**4.14E+01**
Avian herbivores (AV132)	-	-	-	-	**9.59E+00**
Avian herbivores (AV142)	-	-	-	-	**2.06E+00**
Avian herbivores (AV143)	-	-	-	-	**5.14E+00**
Trumpeter swan	-	-	-	-	**2.86E+00**
Avian insectivores (AV210)	-	-	-	-	**1.28E+01**
Black tern	-	-	-	-	**5.13E+00**
Avian insectivores (AV210A)	-	-	-	-	**1.13E+01**
Avian insectivores (AV221)	-	-	-	-	**1.46E+01**
Avian insectivores (AV222)	-	-	-	-	**1.92E+01**
Avian insectivores (AV222A)	-	-	-	-	**1.18E+01**
Avian insectivores (AV232)	-	-	-	-	**2.00E+01**
Avian insectivores (AV233)	-	-	-	-	**3.78E+00**
White-faced ibis	-	-	-	-	**2.25E+00**
Avian insectivores (AV241)	-	-	-	-	**3.19E+00**
Avian insectivores (AV242)	-	-	-	-	**6.19E+00**
Avian carnivores (AV310)	-	-	-	-	**5.27E+00**
Northern goshawk & peregrine falcon	-	-	-	-	5.84E-01
Avian carnivores (AV322)	-	-	-	-	**1.15E+01**
Bald eagle, ferruginous hawk, & loggerhead shrike	-	-	-	-	2.21E-01
Avian carnivores (AV322A)	-	-	-	-	**1.88E+00**
Avian carnivores (AV333)	-	-	-	-	**1.83E+00**
Avian carnivores (AV342)	-	-	-	-	8.44E-01
Avian omnivores (AV422)	-	-	-	-	**7.70E+00**
Avian omnivores (AV432)	-	-	-	-	**1.15E+00**
Avian omnivores (AV433)	-	-	-	-	7.87E-01
Avian omnivores (AV442)	-	-	-	-	**3.55E+00**
Mammalian herbivores (M121)	7.07E-02	1.04E-02	**1.89E+00**	2.91E-03	**4.27E+00**
Mammalian herbivores (M122)	**1.46E+00**	2.88E-01	**2.46E+01**	5.65E-02	**8.35E+01**
Mammalian herbivores (M122A)	**1.36E+00**	2.90E-01	**2.25E+01**	5.17E-02	**7.60E+01**
Pygmy rabbit	**1.57E+00**	2.30E-01	**2.80E+01**	6.44E-02	**9.64E+01**
Mammalian herbivores (M123)	6.92E-01	1.47E-01	**1.71E+01**	2.63E-02	**3.78E+01**
Mammalian insectivores (M210)	**1.81E+00**	**1.17E+00**	**1.97E+01**	3.00E-02	**3.07E+01**
Mammalian insectivores (M210A)	9.27E-01	6.00E-01	**1.01E+01**	1.54E-02	**1.58E+01**
Townsend's western big-eared bat & small-footed myotis	**7.22E+00**	**4.68E+00**	**7.88E+01**	1.20E-01	**1.23E+02**
Mammalian insectivores (M222)	**4.02E+00**	**2.60E+00**	**4.39E+01**	6.68E-02	**4.48E+01**
Mammalian carnivore (M322)	**1.36E+00**	8.78E-01	**1.48E+01**	2.25E-02	4.96E-01
Mammalian omnivores (M422)	**1.47E+00**	7.57E-01	**3.29E+01**	3.38E-02	**4.12E+01**
Mammalian omnivores (M422A)	4.94E-02	2.55E-02	**1.11E+00**	1.14E-03	1.03E-01
Reptilian insectivores (R222)	-	-	-	-	-
Reptilian carnivores (R322)	-	-	-	-	-
Plants	-	-	-	-	-
Frequency >1	8/12	3/12	12/12	0/12	34/40

Table 4-3. Radiological SLQs for WAG 9 surface soil (internal dose).

Functional groups	Co-60	Cs-137	Sr-90	U-238
Amphibian insectivores (A232)	-	-	-	-
Avian herbivores (AV121)	1.99E-05	1.34E-04	1.02E-04	1.29E-03
Avian herbivores (AV122)	7.94E-05	5.38E-04	4.10E-04	5.17E-03
Avian herbivores (AV132)	5.16E-05	3.49E-04	2.66E-04	3.36E-03
Avian herbivores (AV142)	1.99E-05	1.34E-04	1.02E-04	1.29E-03
Avian herbivores (AV143)	5.16E-05	3.49E-04	2.66E-04	3.36E-03
Trumpeter swan	3.97E-05	2.69E-04	2.05E-04	2.58E-03
Avian insectivores (AV210)	1.99E-05	1.34E-04	1.02E-04	1.29E-03
Black tern	3.97E-05	2.69E-04	2.05E-04	2.58E-03
Avian insectivores (AV210A)	5.16E-05	3.49E-04	2.66E-04	3.36E-03
Avian insectivores (AV221)	1.99E-05	1.34E-04	1.02E-04	1.29E-03
Avian insectivores (AV222)	5.16E-05	3.49E-04	2.66E-04	3.36E-03
Avian insectivores (AV222A)	5.16E-05	3.49E-04	2.66E-04	3.36E-03
Avian insectivores (AV232)	7.94E-05	5.38E-04	4.10E-04	5.17E-03
Avian insectivores (AV233)	5.16E-05	3.49E-04	2.66E-04	3.36E-03
White-faced ibis	3.97E-05	2.69E-04	2.05E-04	2.58E-03
Avian insectivores (AV241)	5.16E-05	3.49E-04	2.66E-04	3.36E-03
Avian insectivores (AV242)	1.99E-05	1.34E-04	1.02E-04	1.29E-03
Avian carnivores (AV310)	1.99E-05	1.34E-04	7.32E-05	1.29E-03
Peregrine falcon & northern goshawk	1.23E-05	8.29E-05	4.52E-05	7.97E-04
Avian carnivores (AV322)	1.99E-05	1.34E-04	7.32E-05	1.29E-03
Bald eagle, ferruginous hawk & loggerhead shrike	7.83E-06	5.30E-05	2.89E-05	5.09E-04
Burrowing owl (AV322A)	3.97E-05	2.69E-04	1.46E-04	2.58E-03
Avian carnivores (AV333)	5.16E-05	3.49E-04	1.90E-04	3.36E-03
Avian omnivores (AV342)	1.99E-05	1.34E-04	1.02E-04	1.29E-03
Avian omnivores (AV422)	5.41E-05	3.66E-04	2.79E-04	3.52E-03
Avian omnivores (AV432)	6.13E-06	4.15E-05	3.16E-05	3.99E-04
Avian omnivores (AV433)	7.94E-05	5.38E-04	4.10E-04	5.17E-03
Avian omnivores (AV442)	3.92E-06	2.65E-05	2.02E-05	2.55E-04
Mammalian herbivores (M121)	1.99E-05	1.34E-04	1.02E-04	1.29E-03
Mammalian herbivores (M122)	1.99E-05	1.34E-04	1.02E-04	1.29E-03
Mammalian herbivores (M122A)	1.99E-05	1.34E-04	1.02E-04	1.29E-03
Pygmy rabbit	1.59E-04	1.08E-03	8.20E-04	1.03E-02
Mammalian herbivores (M123)	7.94E-05	5.38E-04	4.10E-04	5.17E-03
Mammalian insectivores (M210)	1.99E-05	1.34E-04	1.02E-04	1.29E-03
Mammalian insectivores (M210A)	1.99E-05	1.34E-04	1.02E-04	1.29E-03
Townsend's western big-eared bat & small-footed myotis	1.59E-04	1.08E-03	8.20E-04	1.03E-02
Mammalian insectivores (M222)	7.94E-05	5.38E-04	4.10E-04	5.17E-03
Mammalian carnivore (M322)	1.99E-05	1.34E-04	1.02E-04	1.29E-03
Mammalian omnivores (M422)	7.94E-05	5.38E-04	2.85E-04	5.17E-03
Mammalian omnivores (M422A)	7.94E-05	5.38E-04	2.85E-04	5.17E-03
Reptilian insectivores (R222)	7.94E-05	5.38E-04	4.10E-04	5.17E-03
Reptilian carnivores (R322)	7.94E-05	5.38E-04	4.10E-04	5.17E-03
Plants	7.94E-08	2.15E-06	1.48E-05	2.20E-06
Frequency >1	0/40	0/40	0/40	0/40

Table 4-4. Radiological SLQs for WAG 9 subsurface soil (internal dose).

Functional groups	Cs-137
Amphibian insectivores (A232)	-
Avian herbivores (AV121)	1.57E-05
Avian herbivores (AV122)	6.27E-05
Avian herbivores (AV132)	4.08E-05
Avian herbivores (AV142)	1.57E-05
Avian herbivores (AV143)	4.08E-05
Trumpeter swan	3.14E-05
Avian insectivores (AV210)	1.57E-05
Black tern	4.08E-05
Avian insectivores (AV210A)	4.08E-05
Avian insectivores (AV221)	1.57E-05
Avian insectivores (AV222)	4.08E-05
Avian insectivores (AV222A)	4.08E-05
Avian insectivores (AV232)	6.27E-05
Avian insectivores (AV233)	4.08E-05
White-faced ibis	3.14E-05
Avian insectivores (AV241)	4.08E-05
Avian insectivores (AV242)	1.57E-05
Avian carnivores (AV310)	1.57E-05
Peregrine falcon & northern goshawk	9.68E-06
Avian carnivores (AV322)	1.57E-05
Bald eagle, ferruginous hawk & loggerhead shrike	6.18E-06
Burrowing owl (AV322A)	3.14E-05
Avian carnivores (AV333)	4.08E-05
Avian omnivores (AV342)	1.57E-05
Avian omnivores (AV422)	4.27E-05
Avian omnivores (AV432)	4.84E-06
Avian omnivores (AV433)	6.27E-05
Avian omnivores (AV442)	3.09E-06
Mammalian herbivores (M121)	1.57E-05
Mammalian herbivores (M122)	1.57E-05
Mammalian herbivores (M122A)	1.57E-05
Pygmy rabbit	1.25E-04
Mammalian herbivores (M123)	6.27E-05
Mammalian insectivores (M210)	1.57E-05
Mammalian insectivores (M210A)	1.57E-05
Townsend's western big-eared bat & small-footed myotis	1.25E-04
Mammalian insectivores (M222)	6.27E-05
Mammalian carnivore (M322)	1.57E-05
Mammalian omnivores (M422)	6.27E-05
Mammalian omnivores (M422A)	6.27E-05
Reptilian insectivores (R222)	6.27E-05
Reptilian carnivores (R322)	6.27E-05
Plants	2.51E-07
Frequency >1	0/40

Table 4-5. Radiological SLQs for external dose for WAG 9 surface soil.

Functional Group	Co-60	Cs-137	Sr-90	U-238
Amphibian insectivores (A232)	1.17E-04	4.54E-04	-	2.12E-08
Avian herbivores (AV121)	1.17E-04	4.54E-04	-	2.12E-08
Avian herbivores (AV122)	1.17E-04	4.54E-04	-	2.12E-08
Avian herbivores (AV132)	1.17E-04	4.54E-04	-	2.12E-08
Avian herbivores (AV142)	1.17E-04	4.54E-04	-	2.12E-08
Avian herbivores (AV143)	1.17E-04	4.54E-04	-	2.12E-08
Trumpeter swan	1.17E-04	4.54E-04	-	2.12E-08
Avian insectivores (AV210)	1.17E-04	4.54E-04	-	2.12E-08
Black tern	1.17E-04	4.54E-04	-	2.12E-08
Avian insectivores (AV210A)	1.17E-04	4.54E-04	-	2.12E-08
Avian insectivores (AV221)	1.17E-04	4.54E-04	-	2.12E-08
Avian insectivores (AV222)	2.33E-04	9.09E-04	-	4.24E-08
Avian insectivores (AV222A)	1.17E-04	4.54E-04	-	2.12E-08
Avian insectivores (AV232)	1.17E-04	4.54E-04	-	2.12E-08
Avian insectivores (AV233)	2.33E-04	9.09E-04	-	4.24E-08
White-faced ibis	1.17E-04	4.54E-04	-	2.12E-08
Avian insectivores (AV241)	1.17E-04	4.54E-04	-	2.12E-08
Avian insectivores (AV242)	1.17E-04	4.54E-04	-	2.12E-08
Avian carnivores (AV310)	1.17E-04	4.54E-04	-	2.12E-08
Peregrine falcon & northern goshawk	1.17E-04	4.54E-04	-	2.12E-08
Avian carnivores (AV322)	1.17E-04	4.54E-04	-	2.12E-08
Bald eagle, ferruginous hawk & loggerhead shrike	1.17E-04	4.54E-04	-	2.12E-08
Burrowing owl (AV322A)	2.33E-04	9.09E-04	-	4.24E-08
Avian carnivores (AV333)	1.17E-04	4.54E-04	-	2.12E-08
Avian omnivores (AV342)	1.17E-04	4.54E-04	-	2.12E-08
Avian omnivores (AV422)	1.17E-04	4.54E-04	-	2.12E-08
Avian omnivores (AV432)	1.17E-04	4.54E-04	-	2.12E-08
Avian omnivores (AV433)	1.17E-04	4.54E-04	-	2.12E-08
Avian omnivores (AV442)	1.17E-04	4.54E-04	-	2.12E-08
Mammalian herbivores (M121)	2.33E-04	9.09E-04	-	4.24E-08
Mammalian herbivores (M122)	1.17E-04	4.54E-04	-	2.12E-08
Mammalian herbivores (M122A)	1.17E-04	4.54E-04	-	2.12E-08
Pygmy rabbit	2.33E-04	9.09E-04	-	4.24E-08
Mammalian herbivores (M123)	1.17E-04	4.54E-04	-	2.12E-08
Mammalian insectivores (M210)	1.17E-04	4.54E-04	-	2.12E-08
Mammalian insectivores (M210A)	1.17E-04	4.54E-04	-	2.12E-08
Townsend's western big-eared bat & small-footed myotis	2.33E-04	9.09E-04	-	4.24E-08
Mammalian insectivores (M222)	1.17E-04	4.54E-04	-	2.12E-08
Mammalian carnivore (M322)	1.17E-04	4.54E-04	-	2.12E-08
Mammalian omnivores (M422)	1.17E-04	4.54E-04	-	2.12E-08
Mammalian omnivores (M422A)	2.33E-04	9.09E-04	-	4.24E-08
Reptilian insectivores (R222)	2.33E-04	9.09E-04	-	4.24E-08
Reptilian carnivores (R322)	1.17E-04	4.54E-04	-	2.12E-08
Plants	1.17E-04	4.54E-04	-	2.12E-08
Frequency >1	0/40	0/40	NA	0/40

Table 4-6. Radiological SLQs for external dose for WAG 9 subsurface soil.

Functional Group	Cs-137
Amphibian insectivores (A232)	5.30E-05
Avian herbivores (AV121)	5.30E-05
Avian herbivores (AV122)	5.30E-05
Avian herbivores (AV132)	5.30E-05
Avian herbivores (AV142)	5.30E-05
Avian herbivores (AV143)	5.30E-05
Trumpeter swan	5.30E-05
Avian insectivores (AV210)	5.30E-05
Black tern	5.30E-05
Avian insectivores (AV210A)	5.30E-05
Avian insectivores (AV221)	5.30E-05
Avian insectivores (AV222)	1.06E-04
Avian insectivores (AV222A)	5.30E-05
Avian insectivores (AV232)	5.30E-05
Avian insectivores (AV233)	1.06E-04
White-faced ibis	5.30E-05
Avian insectivores (AV241)	5.30E-05
Avian insectivores (AV242)	5.30E-05
Avian carnivores (AV310)	5.30E-05
Peregrine falcon & northern goshawk	5.30E-05
Avian carnivores (AV322)	5.30E-05
Bald eagle, ferruginous hawk & loggerhead shrike	5.30E-05
Burrowing owl (AV322A)	1.06E-04
Avian carnivores (AV333)	5.30E-05
Avian omnivores (AV342)	5.30E-05
Avian omnivores (AV422)	5.30E-05
Avian omnivores (AV432)	5.30E-05
Avian omnivores (AV433)	5.30E-05
Avian omnivores (AV442)	5.30E-05
Mammalian herbivores (M121)	1.06E-04
Mammalian herbivores (M122)	5.30E-05
Mammalian herbivores (M122A)	5.30E-05
Pygmy rabbit	1.06E-04
Mammalian herbivores (M123)	5.30E-05
Mammalian insectivores (M210)	5.30E-05
Mammalian insectivores (M210A)	5.30E-05
Townsend's western big-eared bat & small-footed myotis	1.06E-04
Mammalian insectivores (M222)	5.30E-05
Mammalian carnivore (M322)	5.30E-05
Mammalian omnivores (M422)	5.30E-05
Mammalian omnivores (M422A)	1.06E-04
Reptilian insectivores (R222)	1.06E-04
Reptilian carnivores (R322)	5.30E-05
Plants	5.30E-05
Frequency >1	0/40

The meaning of SLQ close to the target value are sometimes difficult to interpret. Due to the conservation inherent in the screening methodology any value under 1 for nonradionuclides and 0.100 for radionuclides will be excluded as a risk to ecological receptors.

4.1.1 Risk Analysis of the ANL-W Windblown Area

This section summarizes the screening level risk assessment performed on the ANL-W Windblown Area that was performed as part of the Remedial Investigation/Feasibility Study performed for Operable Unit 10-06. A detailed discussion of the approach and methods used is presented in *Remedial Investigation/Feasibility Study Report for Operable Unit 10-06: Radionuclide-Contaminated Soils at the Idaho National Engineering Laboratory (DRAFT)* (Jessmore et al. 1995). As presented in this report, none of the contaminants exceed their respective EBSLs.

4.1.2 Uncertainty Associated With Screening Level Quotients

The process of deriving EBSLs consists of establishing an acceptable target screening level quotient (SLQ) for exposure to site-related contaminants and back-calculating the corresponding maximum soil concentration that will not cause adverse effects in exposed ecological populations. Non-radiological or radiological contaminants are treated separately, since these two classes of contaminants cause different effects in exposed populations. Effects from the non-radioactive metals are expected to cause systemic toxicity, while the health effect associated with exposure to ionizing radiation is typically cancer in human and reproductive in ecological organisms. A separate approach in which the target SLQ is set to 1/n, where n is the number of non-radiological or radiological contaminants of concern, could also be used. This approach would be conservative in that it assumes cumulative (simultaneous) exposure to all non-radionuclides and that all contaminants within a given group of contaminants behave synergistically in a given receptor. Given that all receptors within a functional group may not be simultaneously exposed to all contaminants, and that all contaminants within a group may not behave synergistically in all receptors, this approach may yield EBSLs that are more stringent than necessary to protect all ecological receptors. Therefore, the SLQ is set to 1.0 for all nonradiological contaminants. This method may underestimate EBSLs in that it does not account for cumulative exposure to multiple contaminants by a given receptor. On the other hand, this approach may be more realistic given the amount of conservatism already built in to the calculation of EBSLs.

Unlike the nonradiological contaminants the dose from multiple radiological contaminants to ecological receptors can be considered cumulative. It is highly unlikely that all receptors within a functional group are simultaneously exposed to all contaminants identified as present as the facility. Therefore for WAG 9 the SLQ was set to 0.1. It may be more appropriate to set the SLQ to 1/n for multiple radiological contaminants, but with the conservative values used for the WAG 9 screening (see discussion in Section 2.4) 0.1 is more appropriate.

4.2 Risk Evaluation

The results of the SLQ assessment in Table 4-1 shows that several mean levels of nonradionuclides contaminants exceed their corresponding EBSLs for surface soils. The SLQs for antimony, arsenic, chromium, copper, cyanide, lead, mercury, nickel, selenium, silver, sodium, and zinc are greater than 1.0. For the subsurface contaminants, the SLQs for 2-butanone, 2,3,7,8-TCDD, acetone, antimony, arsenic, beryllium,

butylbenzylphthalate, chloroform, chromium, copper, cyanide, di-n-octylphthalate, lead, manganese, mercury, methylene chloride, nitrates, PCBs, silver, sodium, sulfates, and zinc are greater than 1.0. This indicates that these contaminants may potentially cause adverse effects to populations of exposed ecological receptors and will need to be addressed further in the ERA or subsequent screening.

The results of the SLQ assessment in Tables 4-3 and 4-4 shows that the mean concentrations of radionuclides do not exceed their respective EBSLs for internal exposure from surface and subsurface soil. The results of the SLQ assessment of the external dose from soil contamination are shown in Tables 4-5 and 4-6. The SLQs for none of the mean concentrations of Cs-137 exceeds its respective EBSL for external exposure from subsurface soil.

As discussed in Section 2.4.3 and 3.1.2 the radionuclides and several of the nonradiological contaminants identified as present at the Industrial Waste Pond and 3 Cooling Tower Blowdown Ditches, the Industrial Waste Lift Station Discharge Ditch, and the ANL Sewage Lagoons may potentially cause adverse effects to populations of ecological receptors. These sites will need to be addressed further in the ERA.

4.2.1 Uncertainty

The SLERA, by definition, is a conservative screening level approach to preliminarily assess the potential for risk to ecological receptors from WAG 9 sources. The SLERA incorporates levels of uncertainty that could either over- or underestimate the actual risk to these receptors. To compensate for potential uncertainties, the SLERA incorporates various adjustment factors which are designed to error on the side of conservatism rather than result in a conclusion of nonrisk when a risk may exist. Regardless of the adjustment factor inclusions, uncertainties exist which could effect the estimation of true risk associated with WAG 9.

Principal sources of uncertainty lie within the development of an exposure assessment. Uncertainties inherent in the exposure assessment are associated with development of functional groups, estimation of ingestion rates, selection of acceptable screening level quotients, estimation of site usage by receptors, and estimation of plant uptake factors and bioaccumulation factors. Additional uncertainties are associated with the depiction of site characteristics, the determination of the nature and extent of contamination, and the derivation of toxicity reference values all of which are likely to influence risk estimates.

4.3 Summary

The objectives of this SLERA were to identify those sites of concern, the contaminants, and to identify data gaps. During the performance of the SLERA, the values for the Track 1 and 2 results (either the maximum or the UCL) were used to determine potential risk to ecological receptors. This will result in more conservative results than if the actual data was assessed. Most sites did have some data available to assess. If a new contaminant is subsequently identified then development of the associated EBSLs will be required. If the average for a contaminant sampled subsequent to this SLERA is greater than the average addressed by this analysis, that contaminant must be reanalyzed even if had been previously eliminated.

Subsequently, it should also be possible to examine the sites that are contributing the most to the contaminant average and to perform a more refined spatial analysis. At a limited scale this could be included in the final ERA for this WAG.

The most noticeable data gaps occur in the ecological based knowledge, such as BAFs, PUFs, and TRVs. Of concern are the lack of BAFs and PUFs for all contaminants in general. The lack of TRVs for certain functional groups and the conservatism inherent in the TRV development will also need to be addressed in the ERA. This is particular true for those functional groups representing insectivores and carnivores. A more thorough literature search may yield the information necessary to make more realistic decisions concerning these values. This may eliminate the potential risk that is evidenced in the case of the carnivores, and provide the information necessary to perform the analysis, in the case of insectivores. It may be desirable to perform site specific data collection aimed at gathering information directed at these functional group data gaps.

SLERA endpoints for WAG 9 nonradionuclides were not attained. That is, all SLQs are not less than 1. The frequency with which the SLQs exceeded one is listed for each contaminant on Tables 4-1 and 4-2. In surface soils, the SLQs for antimony, arsenic, chromium, copper, cyanide, lead, mercury, nickel, selenium, silver, sodium, and zinc exceeded the SLERA endpoint for 40% to 100% of the functional groups and T/C species. In subsurface soils, the SLQs for 2-butanone, TCDD, acetone, antimony, arsenic, beryllium, butylbenzylphthalate, chloroform, chromium, copper, cyanide, di-n-octylphthalate, lead, manganese, mercury, methylene chloride, PCBs, silver, sodium, sulfate, and zinc exceeded one for 23% to 100% of the functional groups and T/E species. Additionally, SLQs could not be developed for some contaminants and receptors because toxicological information was unavailable. Consequently, no management decisions regarding actual risk from nonradionuclides can be made using this SLERA.

For radionuclides, the SLERA endpoints (SLQs were less than 0.1) were attained for all functional groups and T/E species (see Tables 4-3 through 4-6).

It will be necessary to incorporate any additional site contaminant data as data collection is finalized. For six (ANL-04, ANL- 05, ANL-01, ANL-01A, ANL-09, and ANL-35) of the ten sites of concern listed on Table 2-2, extensive data collection has been performed. Also, for a seventh site, ANL-61A, six samples were collected, two of which showed PCB contamination in subsurface soil. However, for the remaining three sites (ANL-29, ANL-36, and ANL-62) little or no data was available. Single data points for ANL-29 and ANL-36 were located in the MAX data base (Rood 1994). These indicated that silver was present in the subsurface and surface soil, respectively, at these sites. No data was located for ANL-62. Although these sites are considered to have only minor potential for environmental risk, site contaminant data should be collected and screened for risk to ecological receptors.

For those functional groups determined to be at potential risk as a result of this screening, the first step is to determine if it is possible to use the site specific data available from sources at the INEL. A more detailed discussion of the sites that are driving the analysis should be included potentially using a limited spatial analysis. Use of site specific data, instead of conservative assumptions, would allow a more realistic interpretation of the potential risk.

5. SUMMARY OF DATA GAPS

No sites that require additional sampling to fill identified data gaps were identified after review of the Track 1, Track 2, and other investigation docuemnts for each operable unit. Additional sampling of groundwater may be necessary depending on the results of validation of previous groundwater monitoring results for dioxin/furans as discussed in Section 5.1. In addition, insufficient information is available to support development of site specific EBSLs and evaluation of aquatic pathways. These deficiencies are addressed in Section 5.2.

5.1 Groundwater Issues

Groundwater contamination at ANL-W is mainly the result from the EBR-II Leach Pit and the Sewage Lagoon Ponds. The two data gaps identified for groundwater are to model the loss of 1 million gallons of water from the sewage lagoons and to further evaluate groundwater flow direction and contaminants in the groundwater in the vicinity of the EBR-II Leach Pit. Results of these activities will be incorporated into the ERA if groundwater ingestion is identified as an exposure pathway for ecological receptors.

5.2 Additional WAG 9 Ecological Data Gaps

This section briefly describes ecological and toxicological data gaps identified in the WAG 9 SLERA.

Site-specific data for ecological EBSL input parameters (e.g., ingestion rates, home ranges, etc.) are lacking. In addition, insufficient data exist to support development of site-specific, biological-based exposure factors such as bioaccumulation factors (BAFs), plant uptake factors (PUFs), and toxicity reference values (TRVs) for various contaminants/receptor combinations.

Such factors as BAFs, PUFS, and TRVs have not been identified for various functional groups, or were extrapolated for the SLERA (specifically, insect and insectivore values). A more thorough search of existing literature and databases will be conducted for the ERA. This effort should identify additional and/or more realistic exposure factors for use in the baseline assessment. Subsequently, less conservative and more realistic SLQs can be produced.

Basic ecological characterization of surface water sites is necessary to assess potential exposures to WAG 9 aquatic receptors. A more thorough field assessment of the Industrial Waste Pond and Sewage Lagoons is necessary to identify ecological components and additional pathways that could require specific evaluation in the baseline assessment.

6. TRANSITION FROM SLERA TO ERA

The results of this SLERA will support performance of an ERA or additional screenings, if necessary, to be included in the Remedial Investigation/Baseline Risk Assessment (RI/BRA) for OU 9-04. Additional data (i.e., BAFs, TRVs, PUFs) identified through a more comprehensive literature search will be incorporated in the ERA.

Very conservative assumptions were applied in conducting this SLERA to identify all WAG 9 potential sites and contaminants of concern and those ecological receptors having highest potential for being adversely affected as a result of exposure to those sites/contaminants. Subsequent efforts will be focused on those WAG 9 contaminants and sites shown to be potential contributors to ecological risk. A more detailed analysis of risk using existing SLERA data, site-specific biological factors, and more possibly complete analytical data will be conducted the in ERA or other screening. Subsequently, less conservative, more realistic risk estimate values can be calculated and management decisions regarding ecological risk can be formulated.

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Appendix A

Site Descriptions

Appendix A

Site Descriptions

A-1 OU 9-01

A-1.2 Sanitary Sewage Lagoons (ANL-04)

The sanitary sewage lagoons are located at the Sanitary Sewage Treatment Facility, north of the ANL-W facility. Two lagoons were constructed in 1965 along with a third built later in 1974. According to engineering drawings, the three sanitary sewage lagoons cover approximately two acres. With references to ANL-W Plot Plan located at the beginning of this document, the lagoons' approximate dimensions are: (#1)—46 × 46 × 2.1 m (150 × 150 × 7 ft), (#2)—15 × 30 × 2.1 m (50 × 100 × 7 ft), and (#3)—38 × 122 × 2.1 m (125 × 400 × 7 ft). The lagoons receive all sanitary wastes originating at ANL-W, with the exception of the Transient Reactor Test Facility and the Sodium Components Maintenance Shop. Sanitary waste discharged is from rest rooms, change facilities, drinking fountains, and the Cafeteria. The three lagoons are sealed with a 0.32–0.63 cm (0.125–0.25 in.) bottom bentonite liner and are situated approximately 183 m (600 ft) above the groundwater.

A large leak in the northeast corner of the third lagoon was detected after its construction in 1974. This leak resulted in the loss of over a million gallons of waste water through fissures that were not sealed completely by the bentonite. This was rectified by using a 30 ml hypalon liner over the northeast corner and sealing the seams. A study in 1992 confirmed that the Sanitary Lagoons are functioning as evaporative ponds and not as percolating ponds, suggesting that the bentonite and hypalon liner has remained intact. Between 1975 and 1981, photo processing solutions were discharged from the Fuel Assembly and Storage Building to the Sanitary Waste Lift Station, which discharges to the lagoons. The manager of Fuel Assembly and Storage Building during that period, estimates that approximately 1.32 Troy ounces of silver were discharged to the Sanitary Waste Lift Station. It has not been confirmed whether the silver was released to the sanitary lagoons or if it remained in the lift station. However, risk-based calculations show that the estimated silver concentration for the given amount (1.32 Troy oz.) is well below that required to exceed a risk greater than 1×10^{-6}. Furthermore, photo processing was discontinued at the Fuel Assembly and Storage Building in 1981 and subsequently, there has been no further releases to the lift station, or subsequently the sewage lagoons. With the exception of an occasional point source of low level medical radionuclides, there has been no known radioactive hazardous substances released into the Sewage Lagoons. Periodic sampling of the Sewage Lagoon and a radionuclide detector placed in the lift station (Sanitary Waste Lift Station-788) supplying the Sewage Lagoons support these conclusions. However, because no prior sludge samples were analyzed for metals and radionuclides, seven sludge samples were collected in 1994. The results from this sampling were used in a Track 1 risk evaluation in 1995 which indicates that the maximum concentrations of arsenic and chromium (assuming it is all hexavalent chromium) exceed risk-based soil concentrations. A data gap was identified by the EPA and IDHW to model the loss of 1 million gallons of water from the sewage lagoons.

A-1.3 Sludge Pit W of T-7 (Imhoff Tank) (ANL-19)

The Imhoff Tank and sludge pit collected sanitary waste from the power plant (Bldg. 768), the Fuel Cycle Facility (Bldg. 765), the Laboratory and Office building (Bldg. 752), and the Fire House (Bldg. 759). The Imhoff Tank was used to settle out the sanitary wastes from 1963 to 1966. After settling, the sludge from the Imhoff Tank was pumped to the adjacent sludge pit. Liquid effluent from the Imhoff Tank was discharged to the EBR-II Leach Pit, approximately 61 m (200 ft) to the west. The Imhoff Tank was approximately 3.7 × 7.3 × 5.5 m (13 × 24 × 18 ft). The sludge pit was a 0.9 m (3 ft) diameter by 3.7 m (13 ft) tall vertical cylinder located 1.5 m (5 ft) south of the Imhoff Tank. Engineering drawings indicate that all industrial wastes and laboratory chemicals were discharged separately through industrial waste lines that bypassed the Imhoff Tank/sludge pit. It is unlikely that hazardous constituents were disposed in the Imhoff Tank and sludge pit. The Imhoff Tank and sludge pit were cut down to 0.3 m (1 ft) below grade and filled with dirt in 1978.

Based on the condition of the tank, a No Further Action Determination was recommended and signed by the Remedial Project Managers (RPMs) in the Track 1 Decision Documentation Package.

A-1.4 EBR-II Sump (ANL-28)

The EBR-II Sump is a 2,500 L (660 gal) underground coated carbon steel tank, 1.5 m (5 ft) in diameter by 1.4 m (4.5 ft) in depth located just southwest of the Power Plant (Bldg. 768). The Sump is believed to have been installed in the early 1970s and is currently in use. The tank is a centralized collection facility for cooling tower blowdown, ion exchange regeneration effluent, and small quantities of laboratory chemicals from the water chemistry laboratory in the Power Plant before discharging via a pipe to the Main Cooling Tower Blowdown Ditch. Currently, the Power Plant is not operating and ANL-W is circulating water in the cooling tower basin to keep it from freezing.

The sump was originally used to raise the pH of low-pH water derived from the cooling tower blowdown wastewater. Prior to 1980 hexavalent chromium was used as a corrosion inhibitor and hence, low levels of chromates were discharged through the sump, although this hexavalent chromium was chemically modified to trivalent chromium, thus resulting in low-pH waste water. The pH of waters discharging through the sump is typically between 6 and 9, but it can vary between 4 and 11. A neutralization tank was installed inside the Power Plant in 1985 to ensure that the pH of discharged waters stays between 4 and 11.

Since 1980, a phosphate-based corrosion inhibitor was used instead of hexavalent chromium. Chromates have not been discharged through this sump since July 1980. The caustic injection system and pumps have since been removed from the sump, and wastewater currently flows directly through the sump to an underground pipe that discharges at the Main Cooling Tower Blowdown Ditch. Total discharges through the sump are estimated at 438 million gallons over 23 years. No sludges or sediment remain at the bottom of the tank. Therefore, a No Further Action Determination was recommended and signed by the RPMs in the Track 1 Decision Documentation Package.

A-1.5 Industrial Waste Lift Station (ANL-29)

The Industrial Waste Lift Station was installed on the east side of the ANL-W site in 1972. It receives the industrial waste effluents from the Zero Power Physics Reactor support wing (Bldg. 774), the Lab and Office Building (Bldg. 752), the EBR-II Engineering Laboratories (Bldgs. 772 and 789), and the Fuel Manufacturing Facility (Bldg. 704). The waste effluents from these facilities are then discharged, from the lift station, to the Industrial Waste Lift Station Discharge Ditch (ANL-35), also known as the North Ditch, which is located north of the Hot Fuel Examination Facility. The only contaminant of potential concern identified from process knowledge of water released to the Industrial Waste Lift Station is silver. Sludge samples collected in 1986 from the Industrial Waste Lift Station detected silver at 23,700 mg/kg. Silver recovery units were installed on photo processing units at ANL-W in September 1986 and solutions containing silver were not allowed to be directly discharged into the industrial waste systems. However, on October 3, 1990, photo processing solution was inadvertently discharged directly into the Industrial Waste Lift Station, bypassing the silver recovery units installed at the EBR-II Engineering Laboratory (Bldg. 772). Sludge samples collected in 1990 indicate 28 mg/kg of total silver. In 1990, the silver recovery units throughout ANL-W were modified and operating procedures were updated to prevent any further silver releases. A Track 1 investigation was originally performed for this site and based on the above information it was determined that the potential health risks are less than the lower limit of the NCP target risk range. A No Further Action Determination was recommended for the site but was never finalized. Additional sludge samples were collected from the bottom of the lift station in 1995 and analyzed for total silver, TCLP silver, and gamma spectrometry. Results of the gamma spectrometry indicate that Cs-137 was detected at a maximum concentration of 8.7 pCi/g. However, this sludge is located 4.6 m (15 ft) below ground surface and the only complete exposure pathway is groundwater of which this value is less than the risk-based concentration. The maximum detected soil concentration of silver is 5,400 mg/kg and this concentration does not result in a potential health risk greater than the lower limit of the NCP target risk range.

Because the potential health risk associated with silver at this site is less than the lower limit of the NCP target risk range, a No Further Action Determination was recommended and signed by the RPMs in the Track 1 Decision Documentation Package.

A-1.6 Sanitary Waste Lift Station (ANL-30)

The Sanitary Waste Lift Station (Bldg. 778) was built in 1965. It receives all sanitary waste originating at ANL-W, with the exception of the Transient Reactor Test Facilities (Bldg. nos. 720, 721, 722, 724, and T-15) and the Sodium Components Maintenance Shop (Bldg. 793). The Sanitary Waste Lift Station, which consists of a sump approximately 1.8 m (6 ft) in diameter and 4.9 (16 ft) deep, and discharges to the Sanitary Sewage Lagoons (ANL-04). Between 1975 and 1981, photo processing solutions were discharged from the Fuel Assembly and Storage Building to the Sanitary Waste Lift Station. The manager of Fuel Assembly and Storage Building during that period, estimates that approximately 1.32 Troy ounces of silver was discharged to the Sanitary Waste Lift Station. Photo processing was discontinued at the Fuel Assembly and Storage Building in 1981 and consequently, there has been no further releases to the Sanitary Waste Lift Station.

Because the maximum detected silver concentration was less than the risk-based soil concentration, a No Further Action Determination was recommended in the Track 1 Decision Documentation Package.

A-1.7 TREAT Photo Processing Discharge Ditch (ANL-36)

The Transient Reactor Test (TREAT) Photo Processing Discharge Ditch is located approximately 6.1 m (20 ft) northeast of and parallel to the Photo Lab (Bldg. 724) and the TREAT Office Building (Bldg. 721). The ditch is actually a very shallow [i.e., 15 cm (6 in.)] linear depression approximately 165 m (540 ft) long by approximately 1.8 m (6 ft) wide. Approximately 1,500 L (400 gal) of photo processing solutions are estimated to have been discharged to the ditch over the two year period from 1977–1979. It is unlikely that the photo processing solutions actually had an impact on the entire length of the ditch because of the small volume of solutions discharged to the ditch at any one time, and the relatively short length of time it was used. Wastes discharged to the ditch were generated in the Photo Lab. In 1987, twenty soil samples were collected from the ditch and qualitatively screened by x-ray spectrometry. Of these twenty soil samples, three were analyzed for total silver.

Because the maximum detected silver concentration was less than the risk-based soil concentration, a No Further Action Determination was recommended and signed by the RPMs in the Track 1 Decision Documentation Package.

A-1.8 Knawa Butte (ANL-60)

The Knawa Butte is located due north of the Hot Fuel Examination Facility-North (Bldg. 785) near the security fence. As ANL-W began to expand, previously undisturbed areas within the security perimeter became the site for new facilities. Miscellaneous construction debris, including refuse concrete, and also rocks and dirt from the excavation of the Hot Fuel Examination Facility and the Experimental Breeder Reactor-II (Bldg 767) basements were disposed at Knawa Butte. The butte was used as a construction refuse pile until September 1972 when a service request was made to renovate the existing pile and convert it to a doughnut-shaped mound.

The butte continued to be utilized as a disposal area until October 1975, when it was decided, because of tightened security control, that construction refuse should be disposed of elsewhere. ANL-W personnel concluded that future excavation material (i.e., rock and dirt) would be dumped into a man-made depression, which developed during construction of the Zero Power Physics Reactor mound, located approximately 457 m (1,500 ft) south of ANL-W. The butte was then covered with clean soil and planted with grasses to aid the ecological recovery of the area. During May of 1986, a security bunker was installed in the northern-most section of the butte. The bunker was used to store ammunition and continues to be utilized by ANL-W Security today. In September of 1992, several three feet deep holes were dug in the Knawa Butte that verified that its contents were actually excavation and construction debris.

Because no sources of hazardous constituents exist at this site a No Further Action determination was recommended and signed by the RPMs in the Track 1 Decision Documentation Package.

A-1.9 EBR-II Transformer Yard (ANL-61)

The EBR-II Transformer Yard located south of the EBR-II Power Plant (Bldg. 768) is the site of PCB and diesel fuel contamination. The PCB contamination is due to historic (i.e., prior to 1978) leakage from four transformers. All four transformers were replaced and the majority of the contaminated soil was removed during a clean-up action from 1988 through 1992. Approximately 54 m^3 (70 yd^3) of PCB-contaminated soil was removed and transported to an offsite disposal facility. The concrete pads supporting the transformers were solvent cleaned, etched, and coated with epoxy resin as a temporary mitigation measure. Additional soil sampling was performed in 1991 and an additional 386 m^3 (505 yd^3) of PCB-contaminated soil and concrete were removed in 1992. One hundred and sixty-six verification soil samples were collected in 1992. Three of these verification soil samples had PCB concentrations greater than the Toxic Substances Control Act Action Limit of 25 mg/kg. These soil samples were collected directly below Transformer #3 and directly above the basalt at approximately 2.3–2.4 m (7.5–8.0 ft) below ground surface. At these locations, the soil was removed to bedrock and a bentonite barrier was placed directly above the basalt. The area was then backfilled with clean soil and new transformers installed. Thirty-eight additional verification soil samples were collected in a ditch south of the transformer yard. Two of the soil samples has PCB concentrations greater than the 25 mg/kg action limit. Therefore, fourteen verification soil samples were collected in this area. Two soil samples had PCB concentrations above the action limit. The soil was removed and 12 additional verification samples were collected. Those 12 soil samples had PCB concentrations below the action limit. Six soil samples were collected east of the transformer yard. Two soil samples located near an underground storage tank had PCB concentrations of 55 mg/kg and 39 mg/kg. This soil will be excavated when the tank is removed in 1998.

A No Further Action Determination was recommended and signed by the RPMs in the Track 1 Decision Documentation Package pending removal of the last section of PCB-contaminated soil. However, because this soil near the underground storage tank has not been removed, and no risk evaluation has been performed for this area of contaminated soil, it is identified as a new site (ANL-61A) and is discussed in Step 2.

A-1.10 Sodium Boiler Building Hotwell (ANL-62)

The Sodium Boiler Building (Bldg. 766) condensate hotwell, built in 1962, is located north of the EBR-II Power Plant (Bldg 768). This hotwell, which is identical to the EBR-II Power Plant condensate hotwell (Bldg. 768), receives water from the steamtrap and condensate drains. Water contained in the Sodium Boiler Building Hotwell sump is pumped back into the system instead of being discharged to the environment.

The boiler feedwater treatment program, from initial startup to September 1986, utilized a 35% solution of hydrazine as an oxygen scavenger and morpholine as a neutralizing amine. In September 1986 the treatment program was modified and now uses a carbohydrazide as an oxygen scavenger and a blended neutralizing amine (dimethylisopropanolamine and aminomethylpropanol). Tritium, produced in the EBR-II Reactor, migrates through the evaporator and superheater tube walls to the steam system. The level of the tritium in the condensate averages about 10^{-5} μCi/mL, which is below the DOE Order 5480.11 limits on effluent discharge of radionuclides to the environment of 3×10^{-3} μCi/mL. To verify there has been no migration of tritium from the condensate to the

groundwater table, tritium analyses were performed on a monthly basis until November 1995 when it was changed to a quarterly basis on groundwater from the two production wells at ANL-W. Tritium has not been detected, with tritium not being detected.

The total discharge of hydrazine from the Sodium Boiler Building hotwell is less than 4 mg/year during normal operation. Although trace quantities of hydrazine are present in the condensate, these minute amounts will scavenge oxygen in the hotwell or the industrial waste feeder ditch and be consumed.

Because no hazardous constituents have been identified as being present at this site, a No Further Action Determination was recommended and signed by the RPMs in the Track 1 Decision Documentation Package.

A-1.11 Septic Tank 789-A (ANL-63)

This septic tank is located approximately 18 m (60 ft) northeast of the Equipment Building (Bldg 789-A) and was believed to have been installed in the late 1950s. No buildings currently discharge to the septic tank and it was not shown on any ANL-W engineering drawings. An employee who worked at ANL-W in 1961 reported that construction trailers located near the septic tank were being dismantled and moved at that time. The septic tank was not in use and the outer ANL-W fence was located approximately 33 m (100 ft) to the west of the tank/trailers. Therefore, it is assumed that the septic tank only received sanitary waste effluent from the temporary construction trailers prior to the beginning of operations at ANL-W. The tank was inadvertently discovered in 1986 when a fire hydrant in the vicinity was being replaced. It is reported that there was fluid in the tank and a sample was collected for radioactive analysis. The analytical results are reported to have indicated no radioactive contamination, although the actual laboratory results can not be located.

Because this septic tank did not receive any hazardous constituents a No Further Action Determination was recommended and signed by the RPMs in the Track 1 Decision Documentation Package.

A-2 OU 9-02

OU 9-02 consists of one site, the EBR-II Leach Pit (ANL-08). The EBR-II Leach Pit is located between the inner and outer security fences in the southwest corner of the ANL-W facility. The pit is an irregularly shaped, unlined underground basin approximately 5.5 m (18 ft) wide by 12 m (40 ft) long; the bottom of the Leach Pit is 4.6 m (15 ft) below ground surface. The Leach Pit was excavated into basalt bedrock in 1959 with explosives. An 20 cm (8 in.) thick reinforced-concrete slab lid was installed 1.5 m (5 ft) below land surface and covered with native soil to prevent ingress of wildlife and precipitation. In 1991, as part of a Track 2 investigation soil samples were collected from the leach pit, the interbeds below the leach pit, and surface locations in the leach pit and a groundwater sample was collected from a well drilled downgradient from the leach pit. Groundwater and soil samples were analyzed for VOCs, semivolatile organic compounds, metals, radionuclides, anions, and pH. The results indicate the sludge samples in the leach pit and the soil samples collected below the leach pit in the interbeds had contamination. Results from the Track 2 type risk assessment indicate that cadmium concentrations exceed the TCLP limit and are considered hazardous waste. A

Track 2 type risk assessment was performed which indicated that OCDD detected in the groundwater presents a potential risk of 1E-06, or at the lower limit of the NCP target risk range. Groundwater concentrations of radionuclides exceed the risk-based levels but soil concentrations of metals are below levels which are indicative of potential adverse health effects. Cs-137, Co-60, Sr-90, and I-129 soil concentrations exceed threshold concentrations established for decontamination and decommissioning of INEL sites (EG&G 1986), but below the lower limit of the NCP target risk range. Based on the results of this investigation the overburden and lid were removed in the fall of 1993 as part of a removal action conducted under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended. The majority of the sludge was removed in December 1993, the bottom of the Leach Pit was lined with 5 to 7 cm (2–3 in.) of bentonite clay and backfilled to grade. Samples were collected from the basalt. A risk evaluation performed on the concentration of the COPCs in the basalt and in the remaining sludge indicates that the total potential adverse health effects are 6E-06, which is at the lower limit of the NCP target risk range (i.e., 1E-06).

A Track 2 Summary Report was completed and signed by the RPMs that recommends a removal action. In the summary report following the removal action, ANL-W stated that the groundwater flow pattern in the vicinity of the leach pit would be addressed in the WAG 9 comprehensive RI/FS.

A-3 OU 9-03

OU 9-03 consists of three miscellaneous sites.

A-3.1 ANL Open Burn Pits #1, #2, and #3 (ANL-05)

Three abandoned open burn pits are located at ANL-W. Two of the pits (#2 and #3) are located side by side approximately 91 m (300 ft) north of the north security fence and pit #1 is located between the north security fences. The pits were initially used to burn construction wastes, such as paper and wood as early as 1960. In addition, approximately 150 gals of organic wastes from analytical chemistry operations were disposed in the burn pits from 1965-1970. The exact locations of where the organic compounds were dumped is not known. These organic laboratory wastes were collected in a 5-gal glass carboy that was emptied into the pits prior to scheduled burns. After a burn the pits were covered with a layer of native soil. Interviews with employees who worked at the site at the time indicate that approximately 25–30 gals per year of organic laboratory wastes were disposed in the pits over a 5-year period from 1965–1970, for a total of 150 gals. The organic wastes consisted primarily of toluene, xylene, hexane, isopropyl alcohol, butyl cellosolve, tributylphosphate, and mineral oil. Mineral oil accounted for approximately 50% of the organic mixture. Random soil samples were collected from the burn pits in 1988 and 1994. A preliminary risk assessment was performed which indicates that the potential risk from exposure to U-238 is 1E-06, or at the lower limit of the NCP target risk range. Based on the results of the risk assessment no further action was recommended in the revised OU 9-03 Track 2 Summary Report.

A-3.2 Industrial/Sanitary Waste Lift Station (Bldg. 760) (ANL-31)

The Industrial/Sanitary Waste Lift Station (Bldg. 760) is actively used on the sanitary side, however the industrial side is inactive. Both the industrial and sanitary sides of the waste lift station are approximately 1.8 × 1.8 × 4.2 m (6 × 6 × 14 ft) reinforced concrete. No hazardous constituents have been identified as being routed through the sanitary waste side. Acids and bases identified in the Initial Assessment for the "ANL Interceptor Canal" were discharged through the industrial waste side of the lift station. In 1995, samples were collected from the water and sludge and were analyzed for metals and radionuclides. Results from a Track 2 risk assessment indicate that several radionuclides pose a potential risk at the lower limit of the NCP target risk range. Therefore, a removal action was initiated to remove the source at this site (i.e., water, sludge, and piping) in November 1995 and no further action was recommended in the revised OU 9-03 Track 2 Summary Report.

A-3.3 Fuel Oil Spill by Building 755 (ANL-34)

ANL-34 is the site of a 50-gallon spill of #5 fuel oil from an above-ground storage tank. The #5 fuel oil was heated in order for it to flow into the tank. A sight glass used as a control mechanism failed when a certain pressure was exceeded during filling. At the time of the spill, the tank was surrounded by a large earthen berm approximately 1.2 m (4 ft) high and 18.3 × 18.3 m (60 ft × 60 ft) square at the inside base of the berm. The spilled fuel oil occupied an area approximately 1.5 m × 6.1 m (5 ft × 20 ft) and was confined within the berm area. A risk assessment was performed on the most mobile (i.e., naphthalene) and the most hazardous (i.e., benzene) constituents of fuel oil. The risk assessment indicates that the risk would be below the lower limit of the NCP target risk range. Based on this information the revised OU 9-03 Track 2 Summary Report recommends no further action.

A-4 OU 9-04

OU 9-04 consists of five sites. These sites are involved with the transport of surface water runoff, cooling tower blowdown water and other liquid waste disposal ditches to the Industrial Waste Pond.

A-4.1 Industrial Waste Pond and Three Cooling Tower Blowdown Ditches (ANL-01)

The Industrial Waste Pond (IWP) is an unlined, approximately 1.2 ha (3-acre) evaporative seepage pond fed by the Interceptor Canal and site drainage ditches. The pond was excavated in 1959, with a maximum water depth of about 4 m (13 ft), and is still in use today. During this time, the Cooling Tower Blowdown ditches have been rerouted several times. ANL-W auxiliary cooling tower blowdown ditches convey industrial wastewater from a the EBR-II Power Plant and the Fire Station (Bldg. nos 768 and 759) to the Industrial Waste Pond. The IWP was originally included with the Main Cooling Tower Blowdown Ditch (MCTBD) as a Land Disposal Unit under the RCRA Consent Order and Compliance Agreement on the basis of potentially corrosive liquid wastes

discharged with the cooling tower effluent. However, ANL-W conducted a field demonstration with the EPA and State of Idaho representatives in attendance in July 1988 that showed that any potentially corrosive wastes discharged to the IWP were neutralized in the MCTBD before reaching the IWP. On that basis, EPA removed the IWP as an Land Disposal Unit and re-designated it as a Solid Waste Management Unit. Currently, all three ditches (i.e., Ditches A, B, and C) discharge to the MCTBD, which then discharges to the IWP. Because of the physical separation of these ditches to the pond, each ditch and the IWP will be screened separately. Samples have been collected from the soil, sludge, and water present in the IWP and soil samples have been collected from the ditches. Risk assessments performed at the site indicate that it is unlikely that exposure to metals and radionuclides will cause adverse health effects. However, the risk assessment only evaluated the soil ingestion exposure pathway. Therefore, a data gap is evaluation of other exposure pathways in a risk assessment.

A-4.2 The Main Cooling Tower Blowdown Ditch (ANL-01A)

The Main Cooling Tower Blowdown Ditch (MCTBD) runs from the westside of the cooling tower north in between the security fence to the Industrial Waste Pond. It is an unlined channel approximately 213 m (700 ft) in length, 0.9 to 4.6 m (3 to 15 ft) wide. From 1962 to present the ditch has been utilized to convey industrial wastewater from the Cooling Tower to the Industrial Waste Pond. The main source of impurities to the Industrial Waste Pond were water treatment chemicals used to regenerate the ion exchange resin which removes minerals from cooling tower water used in the EBR-II steam system. From 1962 to July 1980, a chromate-based corrosion inhibitor was added to the Cooling Tower water. The blowdown contained significant quantities of hexavalent chromium. Ion exchange column regeneration discharges have occurred from 1962 to March 1986. Regeneration of these column is accomplished with sulfuric acid for cation columns and sodium hydroxide for anion columns. A neutralization tank was installed from March–October 1986. A few discharges of regeneration water occurred but they were in small batches and were monitored before discharge. Since October 1986, after the tank was installed, reagents are being neutralized in a tank prior to discharge to the pond.

In January 1986, a pH measurement of 1.86 was measured in the effluent discharged to the MCTBD. This classified the liquid wastes as corrosive according to 40 CFR 261.22. The site was then classified as a Land Disposal Unit under RCRA. In February 1986, pH measurements were taken at the outfall to the MCTBD at 10-minute intervals during a regeneration episode; over the 4-hour observation period, pH measurements at the outfall ranged between 1.6 and 2.0 for a total of approximately 40 minutes. A temporary neutralization system was installed in March and a permanent neutralization tank was installed in October 1986. In 1995, 21 soil samples were collected and analyzed for pH and soil buffering capacity. These measurements indicate that the pH in the soil ranged from 6.9 to 8.2 with the soil buffering capacity ranging from 26 to 165. A letter was submitted to the IDHW-DEQ requesting that this site be reclassified from a Land Disposal Unit to a Solid Waste Management Unit. Risk assessments performed at the site indicate that exposure to metals and radionuclides will not cause adverse health effects. However, the risk assessment only evaluated the soil ingestion exposure pathway. Therefore, a data gap is evaluation of other exposure pathways in a risk assessment.

A-4.3 The ANL-W Interceptor Canal (ANL-09)

The ANL-W Interceptor Canal was utilized to transport industrial waste to the Industrial Waste Pond and to divert spring runoff and other natural waters around the ANL-W facility for flood control. Between 1962 and 1975, two 4-in. pipes transported liquid industrial wastes and cooling tower effluent to the Interceptor Canal. One line transported cooling tower blowdown water and regeneration effluent while the other line originated at the Industrial Waste Lift Station (Bldg. 760) and transported industrial wastes. Liquid radioactive wastes were discharged through the same line as the industrial wastes, but they were diverted to the EBR-II Leach Pit. Discharge of industrial wastes was discontinued in 1973, and discharge of cooling tower blowdown water was discontinued in 1975.

During clean out operations at the Interceptor Canal in October 1969, abnormal background radioactivity was detected. Wastewater was diverted to an adjacent parallel ditch and radioactive liquid waste was accidentally discharged, resulting in contamination to the surface soils of the adjacent ditch (ANL-01 Ditch B). Additional radiation surveys in 1969, 1973, and 1975 indicated that the entire length of the Interceptor Canal was contaminated. Approximately 3,471 m^3 (4,540 yd^3) of contaminated soil was identified. Approximately 139 m^3 (182 yd^3) was disposed at the RWMC from 1975 to 1976 and approximately remaining 809 m^3 (1,058 yd^3) of contaminated soil was removed and stockpiled on site (this stockpiled soil is being evaluated as part of the OU 10-06 RI/FS). The rest of the contaminated soil was left in place. Another survey conducted in 1993 indicated that two small areas had elevated readings above background. Therefore, additional soil sampling was performed in 1994. These soil samples were analyzed for metals and radionuclides. A Track 2 risk assessment was performed which indicates some metals and radionuclides exceed the lower limit of the NCP target risk range.

A-4.4 The Industrial Waste Lift Station Discharge Ditch (ANL-35)

The Industrial Waste Lift Station Discharge Ditch, also known as the North Ditch, is located inside the security fences. The ditch is approximately 152 m (500 ft) in length with a bottom width of 0.91–1.2 m (3–4 ft). At any one time, there is approximately 5–8 cm (2–3 in.) of water in the ditch. The ditch receives industrial waste from a variety of facilities at ANL-W. From 1959 through 1966 the North Ditch was part of a surface water runoff ditch. From 1966 to 1972 the North Ditch received industrial wastewater from the Instrument and Test Facility (Bldg. 772) and the Sodium Process Demonstration Facility (Bldg. 789). After 1972 when the Industrial Waste Lift Station (Bldg. 778A), ANL-29, was installed, the North Ditch received waste from this lift station. Currently, the North Ditch receives wastewater from industrial waste sources discussed above.

In 1988, soil was excavated from the North Ditch in an effort to relieve clogging in the ditch by cattails and weeds. Analysis of soil samples remaining in the ditch and excavated indicate that all metals except beryllium were below risk-based concentrations. In addition, low levels of VOCs, dioxin/furans, and herbicides were detected. The soil was boxed and disposed at the bulky waste landfill at the INEL in August 1993. Additional soil samples were collected in 1994 and the risk assessment for these samples indicates risks at the lower limit of the NCP target risk ranges (i.e., 1E-06).

A-4.5 The Cooling Tower Riser Pits (ANL-53)

The Cooling Tower Riser Pits are located approximately 3 m (10 ft) east of the Main Cooling Tower. Each of the four pits is approximately 3.7 m (12 ft) deep with 23–38 cm (9–15 in.) of soil covering the rock bottom. During winter shutdown periods of the Main Cooling Tower, the riser pipes must be drained to prevent damage caused by freezing and the riser pits are used to collect this discharge. Soil samples were collected in 1989 at each of the riser pits and the north and south discharge pipes. The risk assessment performed in the Track 2 Preliminary Scoping Package indicates that the risk to human health is less than the lower limit of the NCP target risk range.

Appendix B

Previous Ecological Investigations

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This appendix provides summaries of each previous ecological investigation found to be pertinent to the SLERA process. A bibliography at the end of the appendix provides the full citation for each investigation summarized.

Anderson (1991). This study provides information that was necessary to prepare an environmental impact statement required for possible construction of a New Production Reactor (NPR) at the INEL. The study fulfills two objectives: 1) to quantify and characterize the vegetation at the NPR site, and 2) to collect vegetation data needed for refinement and verification of the INEL surface features map produced by the Idaho Department of Water Resources. Additionally as part of this study, samples were taken from a subset of INEL long-term vegetation monitoring sites to link current NPR-site samples to the long-term data base.

Arthur, Connelly, Halford, and Reynolds (1984). This report presents a comprehensive list of the vertebrates occurring on the INEL. Abundance, habitat use, and seasonal occurrence are described for each species. According to the article, five fish, one amphibian, nine reptile, 159 bird, and 37 mammal species have been recorded at the INEL. Some discussion of species of concern at the state and federal level is also provided. In conjunction with Reynolds et al. (1986), this report is useful for identifying endpoint species and for setting exposure parameters for wildlife.

Connelly (1982). This study describes the movements and radionuclide concentrations of sage grouse (*Centrocercus urophasianus*) summering from 1977 to 1981 near three INEL facilities (TRA/ICPP, RWMC, and CFA). The potential dose commitment to a person consuming a grouse that summered near these facilities is also discussed. Grouse feeding and loafing on lawns near these INEL facilities were captured and marked to provide information on home range and movements. The study provides information on distance of seasonal movements for females and juveniles, flocking characteristics and habitat use.

Connelly and Markham (1983). Movements and radionuclide concentrations in the muscle and gastrointestinal tract of sage grouse (*Centrocercus urophasianus*) summering near nuclear facilities of the INEL were studied from 1977 to 1980. The majority of grouse were located within 2 kilometers (km) of feeding areas on lawns surrounding the facilities during the summer months but were not near the facilities after September or mid-November. The grouse remained near the facilities for a mean number of 95 days/year (d/y). Mean radionuclide concentrations in muscle (0.29 pCi/g; $\underline{n}$ = 29) and gastrointestinal tract (0.80 pCi/g; $\underline{n}$ = 29) of sage grouse were higher at the TRA and Idaho Chemical Processing Plant (ICPP) than at offsite control areas. ^{51}Cr had the highest average concentration in the gastrointestinal tract and ^{137}Cs had the highest average concentration in muscle tissue. Levels of radionuclides in birds at the RWMC were not significantly higher than levels in control birds.

This paper is important for risk assessors because sage grouse are identified as commonly using facility lawns for feeding and loafing and are, therefore, potentially exposed to site contaminants. However, the concentrations of radionuclides in sage grouse were generally lower than those reported for waterfowl and mourning doves in the same areas. This was

likely a result of the greater use of TRA ponds by these other birds and the comparatively greater summer home range of sage grouse. Potential exposure of sage grouse and other birds should be evaluated on a site-specific basis during Problem Formulation.

Craig, Craig, and Powers (1985). Mammals made up 93.5% of the diet of long-eared owls at the INEL. The authors identify the mammalian species and calculate the percent biomass each species contributed toward the owls' diet.

The percent biomass contributed to the owls' diet by each species provides documented evidence for the development of an exposure model for the owl. This would be most helpful in the analysis phase of the risk assessment.

Craig, Halford, and Markham (1979). Concentrations of gamma-emitting radionuclides were determined in young from 17 nests of three species of raptor: American kestrel, long-eared owl, and marsh hawk. The nests were located near ICPP or TRA. Food habits were determined by examination of castings and prey remains found at the nests. Rodents captured near the TRA waste ponds were also analyzed for gamma radiation. ^{137}Cs had the highest concentration of any radionuclide. Northern harriers measured at 11 and 21 days of age had the most radionuclides detected (9) at the highest levels (up to 87 pCi/g). The American kestrel also had several radionuclides detected (8) with activity levels (up to 44 pCi/g) below those found in harriers. Long-eared owls monitored at 15 days of age had very few radionuclides detected (0 to 1) and had very low levels of activity (up to 0.4 pCi/g). Levels of radionuclides in the raptors' prey were approximately 4 to 290 times greater than the levels in the raptors at TRA. Doses to raptors from internal gamma radiation were estimated to range from 0 to 0.1 millirems per day (mrem/d). Based on these results, the authors suggest that raptors were exposed to radionuclides through their prey. Concentrations in raptors were diluted relative to their prey, most likely as a result of consumption of uncontaminated prey.

This article is significant for risk assessors in that it provides data on radionuclide exposure for raptors at the INEL and transfer through the terrestrial food chain.

Evenson (1981). This study was conducted to determine the potential effects of chronic radiation exposure on indigenous deer mice (*Peromyscus maniculatus*) from a dry radioactive leaching pond at the INEL TRA. Deer mice from the RWMC were also studies. Mean body and selected organ weights were taken as well as a host of other physiological characteristics. Overall, it is concluded that levels of radiation exposure were too low to cause recognizable somatic changes in the wild indigenous deer mice.

Filipovich (1983). Mark-release methods were used to examine species composition, density, and movement patterns of small mammals in crested wheatgrass (*Agropyron cristatum*) stands of the SL-1 radioactive waste disposal area and a control area, and in big sagebrush (*Artemisia tridentata*) communities surrounding these areas at the INEL.

Halford, Markham, and Dickson (1982). ^{137}Cs and ^{134}Cs were the two radionuclides most responsible for internal and external doses to wild, free-ranging waterfowl from a liquid radioactive waste pond at the INEL. Other contributors included ^{51}Cr, ^{58}Co, ^{60}Co, ^{66}Zn, ^{75}Se, and ^{131}I. The lowest and highest average internal doses for individual species were 330 mrad (range 1 to 1,300 mrad, $\underline{n} = 6$) for the lesser scaup (*Aythya affinis*) and 2,000 mrad (range 40 to 4,000, $\underline{n} = 2$) for the American coot (*Fulica americana*), respectively. An average internal dose for all wild waterfowl (700 mrad) was added to the ventral and dorsal external

dose to get the average total dose rate (1,900 mrad) for a wild waterfowl residing at the ponds for 6 days. Due to modeling factors and other assumptions, these estimates likely overestimate the actual exposure, possibly by a factor of five or more. Wing-clipped mallards held on the ponds for 43 to 145 days also had the internal, external, and total doses calculated. Waterfowl residing on the ponds for 145 days were exposed to an average total dose of 32,145 mrad.

Because this publication presents measured radiation dose rates to waterfowl and radionuclide activity in waterfowl muscle, it can be used as a "reality check" for risk assessors attempting to model waterfowl exposure to radionuclides at the INEL site. It is interesting to note that waterfowl contained higher radionuclide concentrations and received higher doses from internal radionuclides than other birds and small mammals studied near the liquid radioactive waste disposal area (cf. Halford and Markham 1978).

Halford, Markham, and White (1982). The biological elimination of nine gamma-emitting radioisotopes was studied in wing-clipped mallards held on a liquid radioactive waste pond at the INEL. Whole-body and feces-urine radioactivity counts were made for 51 days after the ducks were removed from the pond, then they were dissected and tissue analyzed. Body burdens of nine radionuclides were at an average of 90% of equilibrium with the radioactive waste pond water after 68 days on the pond. The biological half-lives in the mallards were 10 days (^{134}Cs), 10 days (^{131}I), 11 days (^{137}Cs), 22 days (^{140}Ba), 26 days (^{75}Se), 32 days (^{58}Co), 67 days (^{66}Zn), 67 days (^{67}Co), and 86 days (^{51}Cr). The gastrointestinal tract had the highest concentrations of radionuclides immediately after removal from the ponds, followed by the feathers, liver, and muscle. After 51 days, the feathers had the highest concentrations followed by the liver, muscle, and gut.

Halford and Millard (1978). An inventory of the terrestrial vertebrate fauna and the seasonal occurrence of each species was determined for the radioactive waste pond at the TRA. The pond was found to be a food, water, and habitat source for many species. Three reptile, 11 mammal, and 94 bird species were identified over a 4-year period. The bull snake was the only common reptile seen at the pond. The most abundant small mammal was the deer mouse. Mule deer were observed drinking from the pond on several occasions. Four raptor species were seen at the pond. Northern harriers nested near the site each year of the study and were common. Kestrels were the only other common raptor seen at the pond. Game birds frequenting the ponds included mourning doves, sage grouse, and waterfowl. Other birds commonly using the pond area were killdeer, spotted sandpipers, and barn swallows.

The identification of species inhabiting the TRA waste ponds will be very useful in determining the ecosystems components and the ecological endpoints during the problem formulation. The presence of these species at the TRA waste ponds also provides insight into the species likely to be found at other WAGs with ponds.

Halford, Millard, and Markham (1981). Wild waterfowl were collected from a liquid radioactive waste pond at the INEL and analyzed for radionuclide content. Up to 29 radionuclides were found in body tissues of the waterfowl. Eighty percent of the total radioactivity in the collected waterfowl tissues was from radionuclides with half-lives less than 1 year. Those radionuclides with half-lives of less than 15 hours were not detected due to their radioactive decay before analysis. The highest sum of all radionuclide concentrations occurred in the gastrointestinal tract, followed by feathers, liver, muscle, and skin. Certain radionuclides concentrated to a greater extent in some of the tissues versus others and the total average

radionuclide concentration in wild waterfowl was 27,798 pCi/g fresh weight. ^{60}Co and ^{137}Cs were the only two radionuclides detected in control waterfowl tissues at levels below 1 pCi/g.

The data in this paper on the activities of 29 gamma-emitting radionuclides in waterfowl have three potential uses for ecological risk assessors: (a) to calculate site-specific BAFs for waterfowl at the INEL site (assuming sediment and water activities of the nuclides have been measured); (b) as a "reality check" by risk assessors modeling transfer of radionuclides to waterfowl at the site; and (c) to calculate internal radiation dose rates. In addition, the paper may be of use to human-health risk assessors because it estimates the radiation dose to a human from consumption of contaminated waterfowl.

Howe and Flake (1988). Mourning doves at the INEL traveled up to 12.3 km from feeding and loafing sites to watering and nest sites. However, the average maximum distances for up to 40 doves was 3.1 and 3.7 km to watering and nest sites, respectively. These relatively short distances suggest mourning dove populations would be enhanced by the placement of permanent watering areas at distances of approximately 6 km apart.

The presence of doves and their use of the INEL habitats will help define ecosystem components and ecological endpoints in the problem formulation. The definition of distances traveled by the doves will also provide important information for developing a dove exposure model in the analysis phase of the ERA.

Ibrahim and Culp (1989). Concentrations of ^{239}Pu, ^{240}Pu, and ^{238}Pu were determined in water, net plankton, suspended particulates, and sediment at the TRA waste ponds. The oxidation states of plutonium were also measured and found to be mostly Pu^{+3} and Pu^{+4}, unlike larger natural water bodies, which usually support plutonium in the +5 and +6 oxidation states. The highest plutonium concentrations were found in net plankton, but sediments were found to be the main reservoir for plutonium in the pond. The lowest plutonium concentrations were in filtered water. This indicates that the plutonium is taken up by or bound to the plankton in the water column before eventually settling to the bottom sediments where it remains.

Johnson 1979. Trophic relationships of rabbits, black-tailed jackrabbits, pronghorn sheep, and cattle were examined on a cold desert shrub-steppe. Grasses were the most important foods of lagomorphs and livestock. Pronghorn depended mostly on basin big sagebrush.

Johnson and Hansen (1979a). This paper describes the food habits of coyotes on the INEL during a period when the black-tailed jackrabbit population densities were extremely low. A comparison of the use of coyote control areas versus areas where coyote control is prohibited. Supports the hypothesis that the coyote is highly selective rather than opportunistic.

Johnson and Hansen (1979b). This paper reports the trophic relationships between bushytail wood rats and Nuttall cottontails. This relationship was determined by analyzing fecal pellets of Nuttall cottontails collected from woodrat middens. The study suggests that activities of woodrats have little influence on the food habits of cottontails that inhabit woodrat den sites.

Johnson and Hansen (1979c). This paper demonstrates how the food intake of a coyote population might be elucidated from knowledge of the contents of scats and the digestibilities of prey.

Koehler and Anderson (1991). Habitat use and food selection data were collected for deer mice, montane voles, Ord's kangaroo rats, and Townsend's ground squirrels at the INEL.

Significantly more captures occurred in the native sagebrush habitat than in areas planted in crested wheatgrass or in disturbed areas, but over 30% of the captures were in wheatgrass. Voles and ground squirrels used the crested wheatgrass throughout the summer, while deer mice and kangaroo rats used the grass heavily only after seed set.

Kramber, Rope, Anderson, Glennon, and Morse (1992). This report describes the methods used to produce a vegetation map of the INEL and the vegetation types found on the INEL.

Kuzo, Fraley, Whicker, and Markham (1984). The distribution and kinetics of ^{238}Pu, ^{239,240}Pu, ^{241}Am, ^{242}Cm, and ^{244}Cm were studied in abiotic and biotic components of test reactor leaching ponds located on the INEL from June to July 1979. Highest transuranium concentrations were recorded for seston and periphyton with lowest concentrations for filtered water. Concentration ratios for each nuclide differed among components with highest values recorded for seston and periphyton matrices (10^4 to 10^5) and lowest values for sediments (10^2 to 10^3). Concentration ratios were similar for all plankton types (10^4). For each component, plutonium isotope concentration ratios were consistently higher than values for americium and curium nuclides. Intra-element differences were observed for concentration ratios between the isotopes of plutonium (^{239,240}Pu > ^{238}Pu) and also the isotopes of curium (^{244}Cm > ^{242}Cm). An in situ experiment monitoring sorption of the five transuranium isotopes by soil resulted in continued nuclide accumulation throughout a 15-day experiment with the overall soil nuclide concentrations positively correlated with nuclide concentrations in filtered water and/or seston. Model parameter estimates describing the fractional rates of increase were similar among ^{238}Pu, ^{241}Am, ^{242}Cm, and ^{244}Cm ranging from 4.4 to 0.59 $\times$ 10^{-3}/h to 6.0 $\times$ 10^{-3}/h. In contrast, this value for ^{239,240}Cs, 1.3 $\times$ 10^{-3} was lower than for the other nuclides. Possible explanations for the observed similarities and differences in the distribution and kinetics of the five transuranium nuclides are discussed.

Markham (1974). Routine environmental monitoring results are presented for the air, soil, surface water, and groundwater of the INEL in 1973. The data from onsite and nearby community sampling locations were compared to background concentrations and the applicable standards established by the U.S. Atomic Energy Agency. Some concentrations of radionuclides in air, soil, and surface water were above background concentrations but are infrequent and generally near known source areas for radionuclides.

Markham and Halford (1982). ^{137}Cs occurred frequently in mourning dove (*Zenaida macroura*) tissues from several areas on the INEL. The highest average concentrations in dove muscle tissue were found at the TRA and ICPP at 15.85 pCi/g (1976) and at 3.24 pCi/g (1974), respectively. Average radionuclide concentrations in the gastrointestinal tract of the doves were found to be highest (41.1 pCi/g) at the TRA. Twenty other radionuclides were detected in dove tissues and, of these, ^{134}Cs, ^{131}I, ^{60}Co, and ^{51}Cr were the most significant contributors to the total radiation dose for the dove.

This paper is of interest to risk assessors in that it documents mourning dove exposure to radionuclides at seven INEL facilities [TRA, ICPP, RWMC, Test Area North (TAN), Experimental Breeder Reactor-II (EBR-II), Auxiliary Reactor Area (ARA), and Naval Reactors Facility (NRF)] as well as several other locations. According to the authors, the radiation dose rates received by doves are similar to or less than the doses received by raptors, deer mice, or barn swallows studied at the TRA and ICPP. The exposure routes for

doves at various sites are discussed, including drinking and feeding. The levels of radionuclides reported for doves could be used to estimate the potential exposure to dove predators such as raptors.

Markham, Halford, Rope, and Kuzo (1988). Concentrations of ^{90}Sr, ^{238}Pu, $^{239,240}Pu$, ^{241}Am, ^{242}Cm, and ^{244}Cm were determined in tissues of mallard ducks (*Anas platyrhynochos*) maintained for 43 to 145 days on radioactive leaching ponds at the TRA. Highest concentrations of transuranics occurred in the gastrointestinal tract, followed closely by feathers. Approximately 75%, 18%, 6%, and 1% of the total transuranic activity in tissues analyzed were associated with the bone, feathers, gastrointestinal tract, and liver, respectively. Concentrations in gastrointestinal tracts were similar to concentrations in vegetation and insects in the littoral area of the ponds. The calculated total dose rate to the ducks from both ^{90}Sr and the transuranic nuclides was 0.69 mGy/d, of which 99% was to the bone. Based upon average concentrations in experimental ducks and on surveys of wild waterfowl using this area, a conservative estimate of transuranic activity exported by wild ducks using the ponds during one year was 305 nCi. Similarly, the total amount of ^{90}Sr exported in muscle, bone, and lung of wild ducks in one year was 68.70 μCi.

Markham and Trost (1986). Mourning doves of the INEL commonly ate only 11 species of plants. Of these Halogeton (*Halogeton glomeratus*) and Indian ricegrass (*Oryzopsis hymenoides*) made up 48% of the doves' diet. The remaining plant species included wheat (*Triticum aestivum*), barley (*Hordium vulgare*), oats (*Avena sativa*), pigweed (*Amaranthus glomeratus*), common vetch (*Vicia* spp.), collomia (*collomia* spp.), barnyard grass (*Echinochloa crusgalli*), Gromwell (*Lithospermum rudrale*), and cottonwood (*Populus* spp.). The presence of cereal grains indicated the doves were leaving the INEL for some of their food requirements. Grit was present in 63% of the crops and provided an average of 14% of the mass of the contents.

The study of doves will aid in the selection of measurement endpoints and exposure pathways within the problem formulation. The specific data regarding percentage of diet made up by different vegetation and grit will be useful in the exposure assessment during the analysis phase.

McBride, French, Dahl, and Detmer (1978). This report documents an original vegetation type map prepared in 1965 according to three species designations and provides general descriptions of the different vegetation types. A preliminary soil map was prepared and included in this report as well.

Millard, Whicker, and Markham (1990). Concentrations of radionuclides and potential effects on barn swallows were examined at the TRA waste ponds. The swallows were found to feed on pond arthropods and use contaminated mud for nest building. More than 20 radionuclides were detected in immature and adult birds. ^{51}Cr was found in the highest concentrations and 72% of the total dose resulted from ^{24}Na. Total mortality rate of the swallows was not found to be different from control populations, but the first clutch of young swallows was found to have lower growth rates and lower body weights than controls. These depressed growth factors were not found to be below the normal range of values, however, and could not be attributed to exposure to radioactivity.

Olson, Jeppesen, and Lee (1995). This report presents the status of soil mapping and includes soil descriptions for the INEL.

Parmenter (1985). This thesis reports the results of experiments conducted to test the validity of using Na-22 and tritiated water turnover to estimate food consumption in captive and semi-free ranging coyotes (*Canis latrans*). The researcher concludes that the calculated dry matter and energy intake rates of captive coyotes compare closely to those observed for other carnivores. The study provides data on biological variables that may be helpful in developing management plans for coyotes or other predators.

Peterson and Best (1986). This study sought to quantify Sage and Brewer's sparrow nestling diets and to identify factors influencing them in a sagebrush dominated community.

Reynolds, Connelly, Halford, and Arthur (1986). This paper provides the relative abundance, habitat use, and seasonal occurrence for the six fish, one amphibian, nine reptile, 164 bird, and 39 mammal species recorded on the Idaho National Environmental Research Park in southeastern Idaho.

Rope, Arthur, Craig, and Craig (1988). Concentrations of thirty elements were measured in strong-acid extracts of soil, sagebrush (*Artemisia tridentata* spp.) Leaves, and perennial grass from the INEL and two reference sites in southern Idaho. A bicarbonate-chelating extract of soil was used to estimate plant-available concentrations. The results provide baseline data prior to start-up of a coal-fired steam generation facility on the INEL and other developments in the region. In addition, existing impact from effluents from a nuclear fuel reprocessing facility in existence on the INEL for thirty years was evaluated. Based on the spatial distribution of element concentration, as well as comparison with reference sites, the authors conclude that concentrations of Zn, and perhaps Ni, Cd, and V, are currently elevated around the fuel reprocessing facility. The spatial distribution of these elements is similar to that of Cs-137 in soil, a radionuclide which is known to be emitted by the facility. Sagebrush and soil appear more responsive than perennial grass for long-term monitoring of element concentrations in this semi-arid environment.

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Appendix C

Species Excluded from the WAG 9 SLERA

Table C-1. Species excluded as data sources for the WAG 9 SLERA.

Functional group	Common name	Habitat[a]	Abundance/ seasons[b]	Regulatory status[c]	Criteria for exclusion
A232	Great basin spadefoot toad	w	R2		Geographic - Aquatic, sinks and spreading areas
	Western toad	w,d	U7		Incidental species
AV122	Black-chinned hummingbird	ag,d	U7		Possible but not recorded on INEL
	Calliope hummingbird	ag,d	U7		Possible but not recorded on INEL
	Sharp-tailed grouse	g, ss	I6		Incidental species
AV122	Broad-tailed hummingbird	ag,d	U7		Possible but not recorded on INEL
	Blue grouse	f	S6		Vagrant species
AV143	Ross' goose	w	I6		Incidental species
	White-fronted goose	w	I6		Incidental species
AV210	Gray flycatcher	g,ss,j	U7		Incidental species
	Western wood-pewee	d	I6		Incidental species
	Willow flycatcher	d	U7		Incidental species
	Dusky flycatcher	d	U7		Incidental species
	Common poor-will	j	I6		Incidental species
AV221	Black-and-white warbler	U	I6		Incidental species
	Swainson's thrush	U	I6		Incidental species
	Blue-gray gnatcatcher	U	I6		Incidental species
	Red-naped sapsucker	U	I6		Incidental species
	Lewis' woodpecker	U	I6		Incidental species
	MacGillivray's warbler	U	I6		Incidental species
	Orange-crowned warbler	U	I6		Incidental species
	American redstart	f	M6		Vagrant species
	Mountain chickadee	d,j	U7		Incidental species
	Lapland longspur	g,ss	U7		Incidental species
	Hairy woodpecker	ag,d	U7		Incidental species
	Black-capped chickadee	d,j	U7		Incidental species
AV222	Varied thrush	ss	W6		Vagrant species (winter)
	Flammulated owl		I6		Incidental species
	Harris' sparrow		I6		Incidental species
	Hermit thrush		I6		Incidental species
	Lincoln's sparrow		I6		Incidental species
	Northern mockingbird	j	S6		Geographical - Juniper woodland habitat
	Lapland longspur	g,ss	I7		Incidental species
	Western sandpiper	w	I6		Incidental species
	Semipalmated plover	w	I6		Incidental species
AV232	Virginia rail	w	U7		Incidental species

Table C-1. (continued).

Functional group	Common name	Habitat[a]	Abundance/ seasons[b]	Regulatory status[c]	Criteria for exclusion
	Marsh wren	w	U7		Incidental species
	Baird's sandpiper	w	I6		Incidental species
	Mountain plover	U	I6		Incidental species
	Orchard oriole	U	I6		Incidental species
AV233	Cattle egret	w	I6		Incidental species
	Black-necked stilt	w	I6		Incidental species
	Snowy egret	w	I6		Incidental species
AV242	Surf scoter	w	I6		Incidental species
	Barrow's goldeneye	w	S6, M5		Vagrant species
AV310	Gyrfalcon	sw	M6	-,SSC,S,-	Incidental species
AV322	Northern pygmy owl	d	U7	-,SSC,-,-	Incidental species
	Boreal owl		I6		Incidental species
	Western screech owl	d	U7		Incidental species
AV332	Northern saw-whet owl	sw	S6, M6, W6		Vagrant species
AV333	Green-backed heron	w	S6, M6		Vagrant species
AV342	Red-breasted merganser	w	I6		Incidental species
	Black-legged kittiwake	w	W6		Vagrant species (winter)
AV422	Hooded merganser	w	I6		Incidental species
	Double-crested cormorant	w	I6		Incidental species
	Blue jay	U	I6		Incidental species
	Clark's nutcracker	j	S4, M4, W5		Geographical - Juniper woodland habitat
AV433	Sandhill crane	U	I6		Incidental species
M122	Moose	sw	T6		Transient species - Rare
	Mountain sheep	N INEL	T6		Transient species - Rare
M132	Muskrat	w	S5,W5 (cyclic)		Geographical - Aquatic habitat (Big Lost River)
	Beaver	w	R4,S,W		Geographical - Aquatic habitat (Big Lost River)
M210	Yuma myotis	sw	U7		Incidental species
	Silver-haired bat	sw	U7		Incidental species
	Western pipistrelle	sw	U7	C2,SSC,S,-	Incidental species
	Fringed myotis	sw	U7	-,SSC,-,-	Incidental species
	Long-eared myotis	se, INEL, j	I2	C2,S	Geographical—juniper woodland observation restricted to SE INEL
M210A	Long-legged myotis	sw	U7		Incidental species
	Pallid bat	sw	U7		Incidental species
M322	Mountain lion	sw	T6		Transient species - Rare

Table C-1. (continued).

Functional group	Common name	Habitat[a]	Abundance/ seasons[b]	Regulatory status[c]	Criteria for exclusion
	Striped skunk	ag,d	U7		Incidental species
	Short-tailed weasel (ermine)	ag,d	U7		Incidental species
	Red fox	ag,d	U7		Incidental species
M422	Racoon	ag,d	U7		Incidental species
O242	Shorthead sculpin	w	R2		Geographical - Aquatic species (Big Lost River)
O243	Mountain whitefish	w	R2		Geographical - Aquatic species (Big Lost River)
	Speckled dace	w	R3		Geographical - Aquatic species (Big Lost River)
	Cutthroat trout	w	U7		Geographical - Aquatic species (Big Lost River)
O342	Rainbow trout	w	R2		Geographical - Aquatic species (Big Lost River)
	Brook trout	w	R3		Geographical - Aquatic species (Big Lost River)
	Utah chub	w	U7		Geographical - Aquatic species (Big Lost River)
O442	Kokanee salmon	w	M3		Geographical - Aquatic species (Big Lost River)
R222	Leopard lizard	NE INEL	R4		Geographical - Observations restricted to NE INEL
R232	Tiger salamander	w	U7		Incidental species
R322	Rubber boa	U	I6		Incidental species
	Ringneck snake	sw	U7	NL,SSC,-,-	Incidental species
	Common garter Snake	sw	U7		Incidental species
	Night snake	sw	U7	-,-,S,-	Incidental species

a.

ag	agricultural	g	Grassland
w	On or near water	sw	Sitewide
ss	Shrub-steppe	f	Facility complexes
d	Deciduous or riparian	U	Unknown
j	Juniper woodland	r	Riparian

b.

1	Abundant - very numerous and certain to be seen or sampled.
2	Common - likely but not certain to be observed or sampled.
3	Uncommon - found in limited numbers, not likely to be sampled or observed.
4	Occasional or local - a species that is not always present or is restricted in distribution.
5	Rare - a species that has a range including all or part of INEL, but has been documented $\leq$ seven times on INEL.
6	Vagrant or accidental- a species that is not expected to occur on INEL, but has been recorded there.
7	Possible occurrence - species for which sightings have been unverified or geographical range overlaps INEL (and preferred habitat occurs on INEL).
R	Breeder and year-round resident.
I	Incidental.
M	Migrant.
W	Winter visitor.
S	Summer visitor: no breeding records.
T	Transient.
U	Unknown.

c. Species management codes for Federal (FED), Bureau of Land Management (BLM), U. S. Forest Service Region 4 (USFS), and Audubon Blue List (AUDBL): C2 = category 2 species; 3c = no longer considered for listing; E = endangered species; NL = not listed; SSC = species of special concern; T = threatened species; S = sensitive.

Appendix D

Toxicity Reference Values for Each Contaminant/Functional Group

COPC: **1,1,1 Trichloroethane** CAS 71-55-6
(Trophic level and order)

Test Organisms: Mice
Exposure Medium: Oral in water
Test Endpoint: NOAEL
Reference: Lane, R. W., B. L. Riddle, and J. F. Borzelleca, 1982, "Effects of 1,2-dichloroethane and 1,1,1-trichoroethane in drinking water on reproduction and development in mice," *Toxicol. Appl. Pharmacol.* 63:409–421.
QCE: 1,000 mg/kg-day, body weight 0.035 kg (from study) water consumption: 6 ml/d (from study).

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Study exposure through 2 generations and included critical life stages.
Q_1	1	1	1	Ecologically relevant endpoint.
Q_2	2	2	2	Chronic
Q_3	1	1	1	NOAEL
U	2	2	2	Because no significant differences were observed at any dose level the maximum dose considered was a NOEAL.
M	1	1	1	Not applicable
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	1000	1000	1000	QCE = quantified critical endpoint
TRV	250.0	125.0	83.33	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	250	Test organism is in the same order and trophic level as the functional group members	none
2	125	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	83	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322,

COPC: **2-Butanone (Methyl ethyl ketone)** CAS 78-93-3

Test Organisms: Rat
Exposure Medium: Oral via drinking water
Test Endpoint: NOAEL
Reference: Cox, G. E., D. E. Barley, and K. Morganreidge, 1975, *Toxicity Studies in Rats With 2-Butanol Including Growth, Reproduction, and Teratologic Observations*, Food and Drug Research Laboratories, Inc., Report No. 91MR R 1673, Waverly, New York.
QCE: 1,771 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Multi-generational, multi-sex study
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	2	2	2	Subchronic-term (9-week) study per generation
Q_3	1	1	1	NOAEL
U	2	2	2	Numerous development endpoints measured. Long-term effects in parents not studied. Adequate number of animals tested. Supporting chronic toxicity studies with other species are lacking.
M	1	1	1	NA.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	1771	1771	1771	QCE = quantified critical endpoint
TRV	442.75	221.38	147.58	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	442.8	Test organism is in the same order and trophic level as the functional group members	none
2	221.4	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	147.6	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **2,3,7,8-Tetrachloro Dibenzodioxin (TCDD)**, CAS 1746-01-6

Test Organisms: Rat
Exposure Medium: Oral
Test Endpoint: NOAEL
Reference: Murray, F. J., F. A. Smith, K. D. Nitschke, D. G. Humiston, R. J. Kociba, and B. A. Schwetz, 1979, "Three-generation reproduction study of rats given 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in the diet," *Toxicol. Appl. Pharmacol.*, 50:241–252.
QCE: 0.000001 mg/kg-day

				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary reference - number and variety of rats not known.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	1	1	1	Long-term (3 generations, > 1 year) including critical lifestages (reproduction).
Q_3	1	1	1	NOAEL
U	3	3	3	Secondary reference. Insufficient information.
M	1	1	1	NA
Total AF	9.00	18.00	27.00	R * I * Q_1 * Q_2 * Q_3 * U * M = Total AF
QCE (mg/kg-day)	10^{-6}	10^{-6}	10^{-6}	QCE = quantified critical endpoint
TRV	1.11E-07	5.56E-08	3.70E-08	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.1E-07	Test organism is in the same order and trophic level as the functional group members	none
2	5.6E-08	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	3.7E-08	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **2,3,7,8-Tetracloro Dibenzodioxin (TCDD),** CAS 1746-01-6

Test Organisms: Ring-necked pheasants (omnivore)
Exposure Medium: Intraperitoneal injection
Test Endpoint: NOAEL
Reference: Nosek, J. A., S. R. Craven, J. R. Sullivan, S. S. Hurley, and R. E. Peterson, 1992, "Toxicity and reproductive effects of 2,3,7,8-tetrachlorodibenzo-p-dioxin in ring-necked pheasants," *J. Toxicol. Environ. Health.*, 35:187–198.
QCE: .000014 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source - no information on sex and age. Number of animals tested unknown.
Q_1	.1	.1	.1	Intraperitoneal injection unlikely in field
Q_2	1	1	1	10 weeks and during a critical lifestage (reproduction)
Q_3	1	1	1	NOAEL
U	3	3	3	Limited information in secondary source.
M	1	1	1	
Total AF	0.90	1.80	2.70	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	1.56E-05	7.78E-06	5.19E-06	QCE = quantified critical endpoint
TRV				Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.6E-5	Test organism is in the same order and trophic level as the functional group members	None
2	7.8E-6	Test organism is in a different order or trophic level from the functional group members	AV422, AV432, AV433, AV442
3	5.2E-6	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV310, AV322, AV333, AV342

COPC: **Acetone,** CAS 67-64-1

Test Organisms: Rat
Exposure Medium: Oral (gavage)
Test Endpoint: NOAEL
Reference: EPA, 1986, *Ninety-Day Gavage Study in Albino Rats Using Acetone,* Office of Solid Waste, Washington, DC.
QCE: 100 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	2	2	2	30 each sex/treatment group evaluated. No juveniles tested.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	2	2	2	Short-term (90-day) study
Q_3	1	1	1	NOAEL
U	2	2	2	Numerous endpoints measured. Adequate number of animals tested. Supporting chronic toxicity and reproductive studies are lacking.
M	1	1	1	NA
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	100	100	100	QCE = quantified critical endpoint
TRV	12.50	6.25	4.17	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	13	Test organism is in the same order and trophic level as the functional group members	none
2	6.3	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	4.2	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC:	**Antimony,** CAS 7440-36-0 Antimony Potassium Tartrate
Test Organisms:	Mice
Exposure Medium:	Water
Test Endpoint:	LOAEL-s — Apparent slight decrease in lifespan of female CD-1 mice (significance unknown)
Reference:	Schroeder, H. A., M. Mitchner, and J. J. Balassa, 1968, *Zirconium, Niobium, Antimony, Fluorine in Mice: Effects of Growth Survival and Tissue Levels,* Journal of Nutrition, 95:95–101.
QCE:	1.25 mg/kg-day, [5 mg Sb/L water * 7.5 mL water/day * 1 L/1,000mL] / 0.03 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity studies with adequate numbers of animals.
Q_1	0.5	0.5	0.5	Endpoint could occur in receptors, but of uncertain ecological significance
Q_2	1	1	1	Chronic study
Q_3	2	2	2	LOAEL endpoint
U	2	2	2	Large chronic study, but no reproductive endpoints examined.
M	0.5	0.5	0.5	Sb administered in water in study; greater bioavailability than in soil or diet
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	1.25	1.25	1.25	QCE = quantified critical endpoint
TRV	1.25	0.63	0.42	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.25	Test organism is in the same order and trophic level as the functional group members	none
2	0.63	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	0.42	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **Arsenic**

Test Organisms: Domestic sheep
Exposure Medium: Diet
Test Endpoint: NOAEL
Reference:
QCE: 2.3E+00

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source with no data regarding variability of response.
Q_1	1	1	1	Relevant effect.
Q_2	2	2	2	Subacute duration.
Q_3	1	1	1	NOEL endpoint.
U	3	3	3	Secondary source, only one dose level.
M	1	1	1	
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	2.3	2.3	2.3	QCE = quantified critical endpoint
TRV	.13	.064	.0024	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.13	Test organism is in the same order and trophic level as the functional group members	none
2	.064	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	.0024	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **Arsenic (sodium arsenite)**

Test Organisms: Mallard duck
Exposure Medium: NA
Test Endpoint: LD_{50}
Reference:
QCE: 3.9E+01

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	Same trophic level but different order than members of functional groups
I	3	3	3	Secondary source with little supporting variation data
Q_1	1	1	1	Relevant effect
Q_2	3	3	3	Study duration was acute
Q_3	3	3	3	QCEL is and LD_{50}
U	3	3	3	Old study, secondary source
M	NA	NA	NA	
Total AF	81	162	243	
QCE (mg/kg-day)	39	39	39	
TRV	.48	.24	.16	

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.48	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	.24	Test organism is in a different order or trophic level from the functional group members	AV121, AV122, AV132
3	.16	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC: **Arsenic (sodium arsenate)**

Test Organisms: Rat
Exposure Medium: Diet
Test Endpoint: LOAEL
Reference:
QCE: 1.50

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	Different trophic level and order than members of functional groups.
I	2	2	2	Data do not show a good dose-response curve low-dose range.
Q_1	0.5	0.5	0.5	Arsenic pharmacokinetics are unique in the rat; excretion is much slower than in other species.
Q_2	1	1	1	Chronic study.
Q_3	2	2	2	LOAEL endpoint.
U	2	2	2	Good overall design.
M	1	1	1	Relevant exposure medium for INEL.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	1.5	1.5	1.5	QCE = quantified critical endpoint
TRV	.375	.188	.125	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.375	Test organism is in the same order and trophic level as the functional group members	none
2	.188	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	.125	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC:	**Beryllium,** CAS 7440-41-7 Beryllium sulfate
Test Organisms:	Rat
Exposure Medium:	Water
Test Endpoint:	NOAEL
Reference:	Schroeder, H. A., and M. Mitchner, 1975, *Life-Term Studies in Rats: Effects of Aluminum, Barium, Beryllium and Tungsten,* J. Nutr. 105:421–427.
QCE:	.36 mg/kg-day [5 mg Be/L water * 25 mL water/day * 1 L/1,000 mL]/ 0.35 kg BW) Water ingestion rate estimated using the equation by Suter (1993) of $IR_w = 0.09BW^{1.2044}$ for a 350 g rat.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity studies with adequate numbers of animals
Q_1	1	1	1	No endpoint observed
Q_2	1	1	1	Chronic study
Q_3	1	1	1	NOAEL endpoint
U	2	2	2	Large chronic study, but no reproductive endpoints examined
M	0.5	0.5	0.5	Beryllium administered in water in study; greater bioavailability than in soil or diet.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	.36	.36	.36	QCE = quantified critical endpoint
TRV	0.36	0.18	0.12	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.36	Test organism is in the same order and trophic level as the functional group members	none
2	.18	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	.12	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **Butylbenzylphthalate (BBP),** CAS 85-68-7

Test Organisms: Rat
Exposure Medium: Diet
Test Endpoint: NOAEL
Reference: National Toxicology Program (NTP), 1985, Twenty-six week subchronic study and modifed mating trial in F344 rats. Butyl benyl phthalate. Final Report. Project No. 12307-02-03, Hazelton Laboratories America, unpublished study, cited in IRIS.
QCE: 159 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Only 15 males per group were tested. No females or juveniles tested.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	2	2	2	Subchronic study
Q_3	1	1	1	NOAEL endpoint
U	2	2	2	Good overall design but no supporting studies of chronic duration available
M	1	1	1	Not applicable
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	159	159	159	QCE = quantified critical endpoint
TRV	13.25	6.63	4.42	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	13.25	Test organism is in the same order and trophic level as the functional group members	none
2	6.63	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	4.42	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322,

COPC: **Chloroform,** CAS 67-66-3

Test Organisms: Beagle dog
Exposure Medium: Diet (gelatin capsules)
Test Endpoint: LOAEL Liver effects
Reference: Heywood, R., R. J. Sortwell, P. R. B. Noel, et al., 1979, *Safety Evaluation of Toothpaste Containing Chloroform. III. Long-Term Study in Beagle Dogs,* Journal of Environmental Pathology and Toxicology, 2:835–851.
QCE: 12.9 mg/kg-day Adjusted for treatment schedule

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Eight each males and females were tested. No juveniles tested.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	1	1	1	Chronic (7.5-year) study
Q_3	2	2	2	LOAEL endpoint
U	2	2	2	Study used relatively small but adequate number of test animals and multiple endpoints were measured. Only two treatment doses were used and no NOEL was determined.
M	1	1	1	Not applicable
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	12.9	12.9	12.9	QCE = quantified critical endpoint
TRV	1.613	0.806	0.538	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.6	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.81	Test organism is in a different order or trophic level from the functional group members	M322, M422
3	0.54	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222

COPC: **Chloroform,** CAS 67-66-3

Test Organisms: Rabbits
Exposure Medium: Gavage during gestation
Test Endpoint: NOAEL
Reference: - Thompson, D. J., S. D. Warner, and V. B. Robinson, 1974, *Teratology Studies on Orally Administered Chloroform in the Rat and Rabbit,* Toxicology and Applied Pharmacology, 29:348–357.
- Ruddick, J. A., D. C. Villeneuve, I. Chu, and V. E. Valli, 1980, "Teratogenicity assessment of four halomethanes," *Teratology*, 21:66A, Abstract.
QCE: 20 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Number of females tested not reported in secondary source
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	3	3	3	Short-term exposure during gestation only
Q_3	1	1	1	NOAEL endpoint
U	3	3	3	Number of animals tested and endpoints measured not specified. Ruddick (1980) also obtained negative results in rats given oral doses of 100 mg/kg-day during gestation.
M	1	1	1	Not applicable
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	20	20	20	QCE = quantified critical endpoint
TRV	1.11	0.556	0.370	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.1	Test organism is in the same order and trophic level as the functional group members	none
2	0.56	Test organism is in a different order or trophic level from the functional group members	M121, M122, M122A, M123
3	0.37	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC: **Chloroform,** CAS 67-66-3

Test Organisms: Rats
Exposure Medium: Gavage during gestation
Test Endpoint: NOAEL
Reference: - Thompson, D. J., S. D. Warner, and V. B. Robinson, 1974, *Teratology Studies on Orally Administered Chloroform in the Rat and Rabbit,* Toxicity and Applied Pharmacology, 29:348–357.
- Ruddick, J. A., D. C. Villeneuve, I. Chu, and V. E. Valli, 1980, "Teratogenicity assessment of four halomethanes," *Teratology*, 21:66A, Abstract.
QCE: 20 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Number of females tested not reported in secondary source
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	3	3	3	Short-term exposure during gestation only
Q_3	1	1	1	NOAEL endpoint
U	3	3	3	Number of animals tested and endpoints measured not specified. Ruddick (1980) also obtained negative results in rats given oral doses of 100 mg/kg-day during gestation.
M	1	1	1	Not applicable
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	20	20	20	QCE = quantified critical endpoint
TRV	1.11	0.556	0.370	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.1	Test organism is in the same order and trophic level as the functional group members	none
2	0.56	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	0.37	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **Chromium (VI),** CAS 7440-47-3

Test Organisms: Chicken
Exposure Medium: Diet
Test Endpoint: NOAEL
Reference: Rosomer, G. L., W. A. Dudley, L. J. Machlin, and L. Loveless, 1961, *Toxicity of Cadmium and Chromium for the Growing Chick*, Poultry Science, 40:1171–1173.
QCE: 49 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source
Q_1	1	1	1	No endpoint observed
Q_2	2	2	2	Subchronic exposure duration
Q_3	1	1	1	NOAEL endpoint
U	3	3	3	Old study described in secondary source
M	1	1	1	Appropriate exposure medium for INEL
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	49	49	49	QCE = quantified critical endpoint
TRV	2.72	1.36	0.91	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.7	Test organism is in the same order and trophic level as the functional group members	none
2	1.4	Test organism is in a different order or trophic level from the functional group members	AV422, AV432, AV433,AV442
3	0.91	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: **Chromium (VI),** CAS 7440-47-3

Test Organisms: Dog
Exposure Medium: Water
Test Endpoint: NOAEL
Reference:
- Steven et al., (1976) cited in Eisler (1986).
- Steven, J. D., L. J. Davies, E. K. Stanley, R. A. Abbott, M. Ihnat, L. Bidstrup, and J. F. Jaworski, 1976, *Effects of Chromium in the Canadian Environment,* NRCC No. 15017, National Resources Council, Ottawa, Canada.
- Eisler, R., 1986, *Chromium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review,* U.S. Fish and Wildlife Service Biological Report, 85(1.6).

QCE: 0.30 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	No information (secondary source)
Q_1	1	1	1	No endpoint observed
Q_2	1	1	1	Chronic duration (4 years)
Q_3	1	1	1	NOAEL
U	3	3	3	Secondary source
M	0.5	0.5	0.5	Chromium administered in water
Total AF	4.5	9.0	13.5	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	0.30	0.30	0.30	QCE = quantified critical endpoint
TRV	0.07	0.03	0.02	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.07	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.03	Test organism is in a different order or trophic level from the functional group members	M322, M422
3	0.02	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222

COPC: **Chromium (VI),** CAS 7440-47-3

Test Organisms: Mice
Exposure Medium: Water
Test Endpoint: FEL-r
Reference: Trivedi, B., D. K. Saxena, R. C. Murthy, and S. V. Chandra, 1989, *Embroyotoxicity and Fetotoxicity of Orally Administered Hexavalent Chromium in Mice*, Reproductive Toxicology, 3(4);275–278.
QCE: 59 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers, variability assessed appropriately and not high.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	2	2	2	Subchronic exposure duration
Q_3	3	3	3	FEL endpoint
U	2	2	2	Well designed study, appropriate endpoints well characterized, but no NOAEL identified.
M	0.5	0.5	0.5	Cr administered in water
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	59	59	59	QCE = quantified critical endpoint
TRV	9.83	4.92	3.28	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	9.8	Test organism is in the same order and trophic level as the functional group members	none
2	4.9	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	3.3	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **Copper,** CAS 7440-50-8

Test Organisms: Cattle
Exposure Medium: Diet/oral
Test Endpoint: NOAEL
Reference: Cunningham, I. J., 1946, *The Toxicity of Copper to Bovines*, N.Z.J. Sci., Technol, 27A:372.
QCE: 390 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	No information available in the study. However, other studies confirm young calves are most susceptible.
Q_1	0.1	0.1	0.1	Endpoint unlikely to occur.
Q_2	1	1	1	Study was chronic (12–16 months)
Q_3	1	1	1	NOAEL
U	2	2	2	Sensitive population (young calves) studied, but limited information is provided.
M	1	1	1	NA
Total AF	.6	1.2	1.8	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	390	390	390	QCE = quantified critical endpoint
TRV	650	325	216.7	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	650	Test organism is in the same order and trophic level as the functional group members	none
2	325	Test organism is in a different order or trophic level from the functional group members	M121, M122, M122A, M123A
3	216.7	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC: **Copper,** CAS 7440-50-8

Test Organisms: Chicken
Exposure Medium: Diet
Test Endpoint: NOAEL
Reference: Stevenson, M. H., and N. Jackson, 1981, *An Attempt to Distinguish Between the Direct and Indirect Effects, in the Laying Domestic Fowls, of Added Dietary Sulphate*, British Journal of Nutrition, 46(1):71–76.
QCE: 24 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Rather small group sizes (n=6)
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	2	2	2	Subchronic duration
Q_3	1	1	1	NOAEL endpoint
U	2	2	2	Subchronic exposure and small group sizes, but detailed characterization of relevant endpoints (body weight, food intake, egg production, hepatic metals concentrations)
M	1	1	1	Relevant exposure medium for INEL
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	24	24	24	QCE = quantified critical endpoint
TRV	2.00	1.00	0.67	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.0	Test organism is in the same order and trophic level as the functional group members	none
2	1.0	Test organism is in a different order or trophic level from the functional group members	AV422, AV432, AV433,AV442
3	0.67	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: **Copper,** CAS 7440-50-8

Test Organisms: Mink
Exposure Medium: Diet
Test Endpoint: NOAEL
Reference: Aulerich, R. J., R. K. Ringer, M. R. Bleavins, and A. Napolitano, 1982, *Effects of Supplemental Dietary Copper on Growth, Reproductive Performance and Kit Survival of Standard Dark Mink and the Acute Toxicity of Copper to Mink,* Journal of Animal Science, 55(2):337–43.
QCE: 24 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Group sizes were small relative to observed variation in responses
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	1	1	1	Chronic exposure
Q_3	1	1	1	NOAEL endpoint
U	2	2	2	Parameters observed were relevant but not exhaustive
M	1	1	1	Relevant exposure medium for INEL
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	24	24	24	QCE = quantified critical endpoint
TRV	4.00	2.00	1.33	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	4.0	Test organism is in the same order and trophic level as the functional group members	M322
2	2.0	Test organism is in a different order or trophic level from the functional group members	M422A
3	1.3	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M422

COPC: **Copper,** CAS 7440-50-8

Test Organisms: Rat (F334/N)
Exposure Medium: Diet
Test Endpoint: NOAEL
Reference: Hebert, C. D., M. R. Elwell, G. S. Travlos, C. J. Fitz, and J. R. Bucher, 1993, *Subchronic Toxicity of Cupric Sulfate Administered in Drinking Water and Feed to Rats and Mice,* Fundamentals and Applied Toxicology, 21:461–475.
QCE: 66 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Males appeared to be more sensitive than females
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	2	2	2	Subchronic exposure
Q_3	1	1	1	NOAEL endpoint
U	2	2	2	Thorough and well-designed study, but subchronic duration prevented evaluation of long-term effects, e.g., development of tolerance as reported by others.
M	1	1	1	Relevant exposure medium for INEL.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	66	66	66	QCE = quantified critical endpoint
TRV	5.50	2.75	1.83	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	5.5	Test organism is in the same order and trophic level as the functional group members	none
2	2.8	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	1.8	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **Cyanide,** CAS 57-12-5

Test Organisms: American Kestrel
Exposure Medium: No vehicle indicated
Test Endpoint: LD50 Survival
Reference: Wiemeyer, S. N., E. F. Hill, J. W. Carpenter, and A. J. Krynitsky, 1986, *Acute Oral Toxicity of Sodium Cyanide in Birds*, J. Wildl. Dis. 22:538–546. As cited in Eisler, 1991.
QCE: 2.12 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source, number of animals not indicated
Q_1	1	1	1	Endpoint ecologically relevant
Q_2	3	3	3	Acute study
Q_3	3	3	3	Lethality endpoint
U	3	3	3	Limited information
M	1	1	1	Irrelevant
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	2.12	2.12	2.12	QCE = quantified critical endpoint
TRV	0.026	0.013	0.009	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.026	Test organism is in the same order and trophic level as the functional group members	AV310
2	.013	Test organism is in a different order or trophic level from the functional group members	AV322, AV333, AV342
3	.009	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV422, AV432, AV433, AV442

COPC: **Cyanide,** CAS 57-12-5

Test Organisms: Coyote
Exposure Medium: No vehicle reported
Test Endpoint: LD50
Reference: Sterner, R. T., 1979, *Effects of Sodium Cyanide and Diphacinone in Coyotes (Canis Latrans): Applications as Predacides in Livestock Toxic Collars,* Bull. Environ. Contam. Toxicol. 23:211–217. As cited in Eisler, R., 1991, *Cyanide Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review,* U.S. Fish Wildlife Service Biological Report, 85(1.23):55p.
QCE: 4.1 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	3	3	3	Acute study
Q_3	3	3	3	LD50 endpoint
U	3	3	3	Limited information
M	1	1	1	Appropriate exposure medium
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	4.1	4.1	4.1	QCE = quantified critical endpoint
TRV	0.05	0.03	0.02	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.05	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.03	Test organism is in a different order or trophic level from the functional group members	M322, M422
3	0.02	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222

COPC: **Cyanide,** CAS 57-12-5

Test Organisms: European Starling
Exposure Medium: No vehicle indicated
Test Endpoint: LD50 Survival
Reference: Wiemeyer, S. N., E. F. Hill, J. W. Carpenter, and A. J. Krynitsky, 1986, *Acute Oral Toxicity of Sodium Cyanide in Birds,* J. Wildl. Dis. 22:538–546. As cited in Eisler (1987).
QCE: 9 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source, number of animals not indicated
Q_1	1	1	1	Endpoint ecologically relevant
Q_2	3	3	3	Acute study
Q_3	3	3	3	Lethality endpoint
U	3	3	3	Limited endpoint
M	1	1	1	Not applicable.
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	9	9	9	QCE = quantified critical endpoint
TRV	0.11	0.06	0.04	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.11	Test organism is in the same order and trophic level as the functional group members	AV210A
2	0.06	Test organism is in a different order or trophic level from the functional group members	AV121, AV210, AV221, AV222, AV222A, AV232, AV233, AV241, AV242
3	0.04	Test organism is in a different order and trophic level from the functional group members	AV122, AV132, AV142, AV143, AV310, AV322, AV333, AV342, AV422, AV432, AV333, AV442

COPC: **Cyanide,** CAS 57-12-5

Test Organisms: Mallard
Exposure Medium: No vehicle indicated
Test Endpoint: LD50 Survival
Reference: E. F. Hill, Patuexent Wildlife Research Center, personal communication. As cited in Eisler, R., 1991, *Cyanide Hazards to Fish, Wildlife, and Invertebrates; A Synoptic Review*, U.S. Fish Wildlife Service Biological Report, 85(1.23):55p.
QCE: 1.43 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source, number of animals not indicated
Q_1	1	1	1	Endpoint ecologically relevant
Q_2	3	3	3	Acute study
Q_3	3	3	3	Lethality endpoint
U	3	3	3	Limited information
M	1	1	1	Not applicable
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	1.43	1.43	1.43	QCE = quantified critical endpoint
TRV	0.018	0.009	0.006	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.018	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	.009	Test organism is in a different order or trophic level from the functional group members	AV121, AV122, AV132
3	.006	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV142, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC: **Cyanide,** CAS 57-12-5

Test Organisms: Pigs (Sows)
Exposure Medium: Diet
Test Endpoint: LOAEL
Reference: Tewe, O. O., and J. H. Maner, 1981, *Performance and Pathophysiological Changes in Pregnant Pigs Fed Cassava Diets Containing Different Levels of Cyanide,* Res. Veter. Sci. 30:147–151. As cited in IRIS.
QCE: 9.45 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Limited number of animals
Q_1	0.5	0.5	0.5	Ecologically relevance questionable
Q_2	2	2	2	Subchronic study
Q_3	2	2	2	LOAEL endpoint
U	2	2	2	Limited information, but sensitive life stage tested.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	12.00	24.00	36.00	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	9.45	9.45	9.45	QCE = quantified critical endpoint
TRV	0.79	0.39	0.26	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.79	Test organism is in the same order and trophic level as the functional group members	none
2	0.39	Test organism is in a different order or trophic level from the functional group members	M422, M422A
3	0.26	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

COPC: **Cyanide,** CAS 57-12-5

Test Organisms: Rat
Exposure Medium: Diet
Test Endpoint: NOAEL Growth
Reference: - Howard, J. W., and R. F. Hanzal, 1955, *Chronic Toxicity for Rats of Food Treated with Hydrogen Cyanide.* J. Agric. Food Chem. 3:325–329.
- US EPA, 1984, *Health Effect Assessment for Cyanides,* Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH, for the Office of Emergency and Remedial Response, Washington, DC.
QCE: 10.8 mg/kg-day As specified in IRIS

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic study with adequate animals
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	1	1	1	Chronic study
Q_3	1	1	1	NOAEL endpoint
U	2	2	2	Multiple doses but no LOAEL identified, older study, but consistent with reproduction study results.
M	1	1	1	Appropriate exposure medium.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	10.8	10.8	10.8	QCE = quantified critical endpoint
TRV	5.40	2.70	1.80	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	5.40	Test organism is in the same order and trophic level as the functional group members	none
2	2.70	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	1.80	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **Di-2-ethylhexyl-phthalate (DEHP),** CAS 117-81-7

Test Organisms: Guinea Pig
Exposure Medium: Oral
Test Endpoint: LOAEL
Reference:
- Carpenter, C. P., C. S. Weil, and H. F. Smyth, 1953, "Chronic oral toxicity of di(2-ethylhexyl)Phthalate for rats and guinea pigs," *Arch. Incust. Hyg. Occup. Med.*, 8:219–226.
- Agency for Toxic Substances and Disease Registry, 1993, *Toxicological Profile for Di(2-Ethylhexyl) Phthalate*, US Department of Commerce, National Technical Information Series, April.

QCE: 19 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Males and females tested. No juveniles tested.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	1	1	1	Long-term (1-year) study
Q_3	1	1	1	LOAEL endpoint
U	2	2	2	Sufficient numbers of guinea pigs used and study measured multiple endpoints. Only two concentrations of DEHP tested. Corroborating chronic animal bioassays exist.
M	1	1	1	Not applicable
Total AF	4.00	8.00	12.00	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	119	119	119	QCE = quantified critical endpoint
TRV	29.75	14.88	9.92	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	29.75	Test organism is in the same order and trophic level as the functional group members	none
2	14.88	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	9.92	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **Di-n-octylphthalate,** CAS 117-84-0

Test Organisms: Rat
Exposure Medium: Diet
Test Endpoint: LOAEL Liver/kidney weights
Reference: Piekacz, H., 1971, "Effect of dioctyl and dibutyl phthalates on the organisms of rats after oral administration in prolonged experiment. II. Subacute and chronic toxicity," Rocz. Panstw. Zakl. Higl., 22(3): 295–307. As cited in HEAST, 1991.
QCE: 175 Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source
Q_1	0.5	0.5	0.5	Ecological relevance questionable
Q_2	1	1	1	Chronic duration
Q_3	2	2	2	LOAEL
U	3	3	3	Limited information, no reproductive endpoints evaluated.
M	1	1	1	Appropriate exposure medium
Total AF	9	18	27	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	175	175	175	QCE = quantified critical endpoint
TRV	19.44	9.72	6.48	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	19.44	Test organism is in the same order and trophic level as the functional group members	none
2	9.72	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	6.48	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322,

COPC: **Lead,** CAS 7439-92-1

Test Organisms: American Kestrel
Exposure Medium: Diet
Test Endpoint: NOAEL Survival, reproductive success
Reference: - Hoffman, D. J., J. C. Franson, O. H. Pattee, C. M. Bunck, and A. Anderson, 1985, *Survival, Growth, and Accumulation of Ingested Lead in Nestling American Kestrels (Falco Sparverius),* Comparative Biochemistry and Physiology, 80C:431–439.
- EPA, 1993, Wildlife Exposure Factors Handbook, Volumes I and II, EPA/600/R-93/187a and EPA/600/R-93/187b, Office of Research and Development, Washington, DC.
QCE: 0.015 mg/kg-day Specified (50 mg/kg or 0.05 mg/g in diet multiplied by kestrel diet intake of 0.3 g/gBW day-EPA, 1993)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Secondary source
Q_1	1	1	1	Endpoint ecologically relevant
Q_2	1	1	1	Chronic study
Q_3	1	1	1	NOAEL endpoint
U	2	2	2	Limited information. However, a study by Hoffman et al., 1985 reports a NOAEL of 25 mg/kg/d lead for nestling kestrels.
M	1	1	1	Appropriate exposure medium
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	0.015	0.015	0.015	QCE = quantified critical endpoint
TRV	0.004	0.002	0.001	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.004	Test organism is in the same order and trophic level as the functional group members	AV310
2	0.002	Test organism is in a different order or trophic level from the functional group members	AV322, AV333, AV342
3	0.001	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV422, AV432, AV433, AV442

COPC: **Lead,** CAS 7439-92-1

Test Organisms: Chicken
Exposure Medium: Diet
Test Endpoint: NOAEL Growth
Reference: Eisler, R., 1988, *Lead Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review,* Fish and Wildlife Service. Bio. Rep. No. 14. April, 1985.
QCE: 26 mg/kg-day 500 mg/kg in diet converted to dose by multiplying by 0.105 kg/day ingestion rate and dividing by 2 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source
Q_1	1	1	1	Endpoint ecologically relevant
Q_2	2	2	2	Subchronic study
Q_3	1	1	1	NOAEL endpoint
U	3	3	3	Limited information. Dietary NOAEL appears consistent for a variety of species.
M	1	1	1	Appropriate exposure medium
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	26	26	26	QCE = quantified critical endpoint
TRV	1.44	0.72	0.48	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.4	Test organism is in the same order and trophic level as the functional group members	none
2	0.72	Test organism is in a different order or trophic level from the functional group members	AV422, AV432, AV433,AV442
3	0.48	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: **Lead,** CAS 7439-92-1

Test Organisms: Cow (calves)
Exposure Medium: Diet (in hay and grain)
Test Endpoint: NOAEL
Reference: - Zmudzki, J., G. R. Bratton, C. Womac, and L. Rowe, 1983, *Lead Poisoning in Cattle: Reassessment of the Minimum Toxic Oral Dose,* Bull. Environ. Contam. 30:435–441.
- DeMayo, A., M. C. Taylor, K. W. Taylor, and P. V. Hodson, 1982, *Toxic Effects of Lead and Lead Compounds on Human Health, Aquatic Life, Wildlife, Plants, and Livestock,* CRC Crit. Rev. Environ. Control 12:257–305.
QCE: 3 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source
Q_1	1	1	1	No endpoint observed
Q_2	2	2	2	Subchronic study
Q_3	1	1	1	NOAEL endpoint
U	3	3	3	Limited information, secondary source. However, pregnant ewes given 3 mg/kg daily did not produce adverse effects (DeMayo, et. al., 1982).
M	1	1	1	Appropriate exposure medium
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	3	3	3	QCE = quantified critical endpoint
TRV	0.17	0.08	0.06	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.17	Test organism is in the same order and trophic level as the functional group members	none
2	0.08	Test organism is in a different order or trophic level from the functional group members	M121, M122, M122A, M123
3	0.06	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC: **Lead,** CAS 7439-92-1

Test Organisms: Dog
Exposure Medium: Diet
Test Endpoint: LOAEL Not specified
Reference: - DeMayo, A., Taylor, M. C., Taylor, K. W., and Hodson, P. V. 1982, *Toxic Effects of Lead and Lead Compounds on Human Health, Aquatic Life, Wildlife, Plants, and Livestock*, CRC Crit. Rev. Environ. Control 12:257–305.
- Rice, D. C., 1985, *Chronic Low-Lead Exposure from Birth Produces Deficits in Discrimination Reversal in Monkeys*, Toxicol. Appl. Pharmacol. 77:201–210.
QCE: 0.32 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source
Q_1	1	1	1	Endpoint not specified
Q_2	1	1	1	Chronic study
Q_3	2	2	2	LOAEL endpoint
U	2	2	2	Limited information. However, a chronic study in monkeys reported a similar LOAEL (0.1 mg/kg/day) for CNS effects (Rice, 1985).
M	1	1	1	Appropriate exposure medium
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	0.32	0.32	0.32	QCE = quantified critical endpoint
TRV	.0267	0.0133	0.0089	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.027	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.013	Test organism is in a different order or trophic level from the functional group members	M322, M422
3	0.0089	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222

COPC: **Lead,** CAS 7439-92-1

Test Organisms: Mallard
Exposure Medium: Single oral dose of lead shot
Test Endpoint: LOAEL Mortality, hematological effects
Reference: Dieter, M. P., and M. T. Finley., 1978. *Erythrocyte Gamma-Aminolevulinic Acid Dehydratase Activity in Mallard Ducks: Duration of Inhibition After Lead Shot Dosage,* J. Wildl. Manage. 42:621–625. As cited in Eisler, R., 1988, *Lead Hazards to Task, Wildlife, and Invertebrates; A Synoptic Review,* Fish and Wildlife Service Biological Report No. 14, April, 1985.
QCE: 151 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source, number of animals not indicated
Q_1	1	1	1	Endpoint ecologically relevant
Q_2	3	3	3	Acute study
Q_3	3	3	3	Lethality endpoint
U	3	3	3	Limited information
M	1	1	1	Impact of lead shot versus dietary form unknown
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	151	151	151	QCE = quantified critical endpoint
TRV	1.86	0.93	0.62	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.9	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.93	Test organism is in a different order or trophic level from the functional group members	AV121, AV122, AV132
3	0.62	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV142, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC: **Lead,** CAS 7439-92-1

Test Organisms: Rat
Exposure Medium: Drinking Water
Test Endpoint: LOAEL Pup malformations
Reference: - Kimmel, C. A., Grant, L. D., Sloan, C. S., and Gladen, B. C. 1980, *Chronic Low Level Lead Toxicity in the Rat. I. Maternal Toxicity and Perinatal Effects,* Toxicol. Appl. Pharmacol. 56:28–41.
- DeMayo, A., Taylor, M. C., Taylor, K. W., and Hodson, P. V. 1982, *Toxic Effects of Lead and Lead Compounds on Human Health, Aquatic Life, Wildlife, Plants, and Livestock,* CRC Crit. Rev. Environ. Control 12:257–305.
QCE: 0.375 mg/kg-day Specified (5 mg/l in water, rat water intake .25 L/day/0.35 kg BW).

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Secondary source
Q_1	1	1	1	Endpoint
Q_2	1	1	1	Chronic study
Q_3	2	2	2	LOAEL endpoint
U	2	2	2	Limited information. However, another chronic drinking water study in rats reported a LOAEL of 5 mg/L for survival (DeMayo et al., 1982).
M	0.5	0.5	0.5	Pb administered in water in study; greater bioavailability than in soil or diet.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	0.375	0.375	0.375	QCE = quantified critical endpoint
TRV	0.09	0.05	0.03	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.09	Test organism is in the same order and trophic level as the functional group members	none
2	0.05	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	0.03	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **Lead (Trimethyllead),** CAS 7439-92-1

Test Organisms: European Starling
Exposure Medium: Capsule
Test Endpoint: LOAEL Behavioral effects
Reference: Osborn, D., W. J. Eney, and K. R. Bull, 1983, *The toxicity of trialkyl lead compounds to birds,* Environ. Pollut. 31A:261–275. As cited in Eisler (1987).
QCE: 2.8 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source, number of animals not indicated
Q_1	1	1	1	Endpoint ecologically relevant
Q_2	2	2	2	Subchronic study
Q_3	2	2	2	LOAEL endpoint
U	3	3	3	Limited information: organoform of lead could impact toxicity
M	1	1	1	Impact of capsule form unknown
Total AF	36	72	108	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	2.8	2.8	2.8	QCE = quantified critical endpoint
TRV	0.08	0.04	0.03	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.08	Test organism is in the same order and trophic level as the functional group members	AV210A
2	0.04	Test organism is in a different order or trophic level from the functional group members	AV121, AV210, AV221, AV222, AV222A, AV232, AV233, AV241, AV242
3	0.03	Test organism is in a different order and trophic level from the functional group members	AV122, AV132, AV142, AV143, AV310, AV322, AV333, AV342, AV422, AV432, AV333, AV442

COPC:	**Manganese,** CAS 7439-96-5
Test Organisms:	Chicken
Exposure Medium:	Diet
Test Endpoint:	NOAEL Minimum requirement for growth and reproduction
Reference:	- Leeson, S., and J. D. Summers, 1982, *Effect of High Dietary Levels of Supplemental Zinc, Manganese, Copper, or Iron on Broiler Performance to Three Weeks of Age and Accumulation of These Minerals in Tissue and Excreta,* Nutrition Reports Int. 591–599. -Offiong, S. A., and S. M. Abed, 1980, *Fertility, Hatchability and Malformations in Guinea Fowl Embryos as Affected by Dietary Manganese,* British Poultry Sci. 21:371–375.
QCE:	2.9 mg/kg-day 55 mg/kg in diet converted to dose by multiplying by 0.105 kg/day ingestion rate and dividing by 2 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate number of animals, limited variability
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	1	1	1	Subchronic study, but not adjusted since this concentration identified as minimum requirement.
Q_3	1	1	1	NOAEL endpoint
U	1	1	1	Study results consistent with other studies in chickens and guinea fowl
M	1	1	1	Appropriate exposure medium
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	2.9	2.9	2.9	QCE = quantified critical endpoint
TRV	2.90	1.45	0.97	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.9	Test organism is in the same order and trophic level as the functional group members	none
2	1.5	Test organism is in a different order or trophic level from the functional group members	AV422, AV432, AV433,AV442
3	0.97	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: **Manganese,** CAS 7439-96-5

Test Organisms: Rat
Exposure Medium: Diet
Test Endpoint: LOAEL Decreased testosterone levels, delayed maturation of reproductive function
Reference: - Laskey, J. W., Rehnberg, G. L., and Hein, J. F., 1982, *Effects of Chronic Manganese (MN_3O_4) Exposure on Selected Reproductive Parameters in Rats*, J. Toxicol. Environ. Health, 9:677–687. As cited in ATSDR, 1990.
- ATSDR, Agency for Toxic Substance Disease Registry, 1990, *Draft: Toxicological Profile for Manganese*, 1990.
QCE: 13 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	1	1	1	Chronic study
Q_3	2	2	2	LOAEL endpoint
U	2	2	2	Secondary source, but study results consistent in mice.
M	1	1	1	Appropriate exposure medium.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	13	13	13	QCE = quantified critical endpoint
TRV	1.08	0.54	0.36	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.1	Test organism is in the same order and trophic level as the functional group members	none
2	0.54	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	0.36	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **Mercury nitrate monohydrate,** CAS 7783-34-8

Test Organisms: American black duck (herbivore)
Exposure Medium: Oral in diet
Test Endpoint: Adverse effect—significantly decreased reproduction, elevated tissue levels and brain lesions.
Reference: Finley, M. T. and R. C. Stendell, 1978. Survival and reproductive success of black ducks fed methylmercury, Environmental Pollution, 16:51–64.
QCE: 3 mg/kg-day (methylmercury)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on sex and agee, and number of animals tested unknown.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	1	1	1	Chronic exposure (28 weeks)
Q_3	2	2	2	Adverse effect level
U	3	3	3	Limited information. No NOAEL established. Test chemical methylmercury. Reproductive endpoints evaluated. ($HgCl_2$).
M	0.5	0.5	0.5	Methylmercury may be more toxic than mercuric nitrate.
Total AF	9.0	18.0	27.0	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	3	3	3	QCE = quantified critical endpoint
TRV	0.33	0.17	0.11	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.33	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.17	Test organism is in a different order or trophic level from the functional group members	AV121, AV122, AV132
3	0.11	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC: **Mercury nitrate monohydrate,** CAS 7783-34-8

Test Organisms: Chickens (omnivore)
Exposure Medium: Oral in drinking water
Test Endpoint: NOAEL
Reference: Thaxton, P., L. A. Cogburn, and C. R. Parkhurst, 1973, Dietary mercury as related to the blood chemistry in young chickens, *Poult. Sci.* 52:1212, as cited in National Academy of Sciences, 1980, Mineral Tolerance of Domestic Animals, Washington, DC.
QCE: 5 mg/kg-day ($HgCl_2$)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Eighty, young chickens exposed.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	2	2	2	Subchronic exposure (42 days)
Q_3	1	1	1	NOAEL
U	3	3	3	Limited information. No reproductive endpoint examined. NOAEL established. Test chemical mercuric chloride ($HgCl_2$).
M	0.5	0.5	0.5	Mercuric salt in drinking water may enhance metal bioavailability
Total AF	3.0	6.0	9.0	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	5	5	5	QCE = quantified critical endpoint
TRV	1.7	0.83	0.56	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.7	Test organism is in the same order and trophic level as the functional group members	None
2	0.83	Test organism is in a different order or trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.56	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV2222, AV222A, AV232, AV233, AV241, AV310, AV322, AV333, AV342

COPC: **Mercury nitrate monohydrate,** CAS 7783-34-8

Test Organisms: Dog (omnivore)
Exposure Medium: Oral in diet
Test Endpoint: LD_{100}
Reference: Venugopal, B. and T. D. Luckey, 1978, *The Toxicity of Metals in Mammals*, New York, Plenum Press.
QCE: 15 mg/kg-day (as mercuric chloride)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on sex and agee, and number of animals tested unknown. 108 animals tested.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	3	3	3	Lifetime exposure
Q_3	3	3	3	NOAEL
U	3	3	3	Limited information. No reproductive endpoint or sensitive life stage examined. Test chemical is mercuric chloride ($HgCl_2$). Route of exposure not specified.
M	1	1	1	Exposure medium appropriate
Total AF	81.0	162.0	243.0	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	15	15	15	QCE = quantified critical endpoint
TRV	0.19	0.09	0.06	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.19	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.09	Test organism is in a different order or trophic level from the functional group members	M322, M422
3	0.06	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222

COPC:	**Mercury nitrate monohydrate,** CAS 7783-34-8
Test Organisms:	Grey pheasants (omnivore)
Exposure Medium:	Oral in diet
Test Endpoint:	AEL—decreased reproductive ability
Reference:	McEwen, L. C., R. K. Tucker, J. O. Ells, and M. A. Haegele, 1973, Mercury-wildlife studies by the Denver Wildlife Research Center, In *Mercury in the Western Environment*, D. R. Buhler, Ed., Oregon State University, Corvallis, OR, p. 146–156.
QCE:	0.64 mg/kg-day (methylmercury)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source no information on sex and age, and number of animals tested unknown.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	2	2	2	Subchronic exposure (30 days)
Q_3	2	2	2	Adverse effect level
U	3	3	3	Limited information. Reproductive endpoint examined. NOAEL not established. Test chemical methylmercury.
M	0.5	0.5	0.5	Methylmercury may be more toxic than mercuric nitrate nonahydrate.
Total AF	18.0	36.0	54.0	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	0.64	0.64	0.64	QCE = quantified critical endpoint
TRV	0.04	0.02	0.01	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.04	Test organism is in the same order and trophic level as the functional group members	None
2	0.02	Test organism is in a different order or trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.01	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV310, AV322, AV333, AV342

COPC:	**Mercury nitrate monohydrate,** CAS 7783-34-8
Test Organisms:	Japanese quail (omnivore)
Exposure Medium:	Oral in diet
Test Endpoint:	NOAEL
Reference:	Hill and Schaffner, 1976, Sexual maturation and productivity of Japanese quail fed graded concentrations of mercuric chloride, Poultry Science, 55:1449, as cited in National Academy of Sciences, 1980, Mineral Tolerance of Domestic Animals. Washington, DC.
QCE:	4 mg/kg-day ($HgCl_2$)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on sex and agee, and number of animals tested unknown.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	1	1	1	Chronic exposure (1 year)
Q_3	1	1	1	NOAEL
U	3	3	3	Limited information. No NOAEL established. Reproductive endpoints and sensitive life stages not examined. Test chemical ($HgCl_2$).
M	1	1	1	Appropriate exposure medium.
Total AF	9.0	18.0	27.0	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	4	4	4	QCE = quantified critical endpoint
TRV	0.44	0.22	0.15	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.44	Test organism is in the same order and trophic level as the functional group members	None
2	0.22	Test organism is in a different order or trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.15	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV310, AV322, AV342

COPC: **Mercury nitrate monohydrate,** CAS 7783-34-8

Test Organisms: Mice (omnivore)
Exposure Medium: Unspecified
Test Endpoint: NOAEL
Reference: Schroeder and Mitchener, 1975, Life-term effects of mercury, methylmercury and nine other trace metals on mice, *J. Nutr.* 105:452, as cited in National Academy of Sciences, 1980, Mineral Tolerance of Domestic Animals. Washington, DC.
QCE: 5 mg/kg-day (as mercuric chloride)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Secondary source so information on sex and agee, and number of animals tested unknown. 108 animals tested.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	1	1	1	Lifetime exposure
Q_3	1	1	1	NOAEL
U	3	3	3	Limited information. No reproductive endpoint or sensitive life stage examined. Test chemical is mercuric chloride ($HgCl_2$). Route of exposure not specified.
M	1	1	1	Exposure medium appropriate
Total AF	6.0	12.0	18.0	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	5	5	5	QCE = quantified critical endpoint
TRV	0.83	0.42	0.28	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.83	Test organism is in the same order and trophic level as the functional group members	None
2	0.42	Test organism is in a different order or trophic level from the functional group members	M422, M422A, M121, M123
3	0.28	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **Mercury nitrate monohydrate**

Test Organisms: Rats (omnivore)
Exposure Medium: Oral in diet
Test Endpoint: LD_{50}
Reference: Venugopal, B. and T. D. Luckey, 1978, *The Toxicity of Metals in Mammals*, New York, Plenum Press.
QCE: 37 mg/kg-day (as mercuric chloride)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on sex, age, and number of animals tested unknown.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	3	3	3	Duration of exposure unknown
Q_3	3	3	3	FEL - lethality
U	3	3	3	Limited information. No reproductive endpoint or sensitive life stage examined. No NOAEL established. Test chemical is mercuric chloride ($HgCl_2$).
M	1	1	1	Exposure medium appropriate
Total AF	81.0	162.0	243.0	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	37	37	37	QCE = quantified critical endpoint
TRV	0.46	0.23	0.15	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.46	Test organism is in the same order and trophic level as the functional group members	None
2	0.23	Test organism is in a different order or trophic level from the functional group members	M422, M422A, M121, M123
3	0.15	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **Mercury nitrate monohydrate,** CAS 7783-34-8

Test Organisms: Swine (omnivore)
Exposure Medium: Oral in diet
Test Endpoint: NOAEL
Reference: Chang C. W. J., R. M. Nakamura, and C. C. Brooks, 1977, Effect of varied dietary levels and forms of mercury on swine, *J. Anim. Sci.* 45:279, as cited in National Academy of Sciences, 1980, Mineral Tolerance of Domestic Animals, Washington, DC.
QCE: 5 mg/kg-day (as mercuric chloride)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on sex and agee, and number of animals tested unknown.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	2	2	2	Subchronic exposure (27 days)
Q_3	1	1	1	NOAEL
U	3	3	3	Limited information. No reproductive endpoint or sensitive life stage examined. Test chemical is mercuric chloride ($HgCl_2$).
M	1	1	1	Exposure medium appropriate
Total AF	18.0	36.0	54.0	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	5	5	5	QCE = quantified critical endpoint
TRV	0.28	0.14	0.09	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.28	Test organism is in the same order and trophic level as the functional group members	None
2	0.14	Test organism is in a different order or trophic level from the functional group members	M422, M422A
3	0.09	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M123, M210, M210A, M222, M322

COPC: **Mercury (Organic),** CAS 7439-97-56

Test Organisms: Cat
Exposure Medium: Diet
Test Endpoint: NOAEL
Reference: Charbonneau, S. M., I. C. Munro, E. A. Nera, F. A. Armstrong, R. F. Willes, F. Bryce, and R. F. Nelson, 1976, *Chronic Toxicity of Methylmercury in the Adult,* Interim Report, Toxicology, 5(3):337–49.
QCE: 0.02 mg/kg-day Either in naturally contaminated fish or added to diet.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Not rigorously examined, but no large variations within groups were evident
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	1	1	1	Chronic duration (2 years)
Q_3	1	1	1	NOAEL
U	2	2	2	Older study, but thoroughly performed. Dose-response well-characterized for neurological effects, but reproductive effects not considered.
M	1	1	1	Not applicable
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	.02	.02	.02	QCE = quantified critical endpoint
TRV	0.005	0.0025	0.0017	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.005	Test organism is in the same order and trophic level as the functional group members	M322
2	.003	Test organism is in a different order or trophic level from the functional group members	M422A
3	.002	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M422

COPC:	**Mercury (Organic),** CAS 7439-97-56	
Test Organisms:	Goshawk	
Exposure Medium:	Diet	
Test Endpoint:	FEL-1	Lethal dose
Reference:	Borg, K., Erne, E. Hanko, and H. Wanntorp, 1970, *Experimental Secondary Methyl Mercury Poisoning in the Goshawk, Accipiter G. gentilis L.,"* Environmental Pollution, 1:91–104.	
QCE:	0.64 mg/kg-day	Authors reported a total estimated Hg intake of 20 mg for each of 3 animals, over various survival times. The final weight of each animal at the 13 mg/kg dietary level was used to derive individual daily doses, which were averaged.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Small test population, but relatively low variation between individuals and sexed (CV<10%)
Q_1	1	1	1	Endpoint ecologically relevant
Q_2	2	2	2	Subchronic duration
Q_3	3	3	3	FEL based on lethality
U	3	3	3	Old study, inappropriate design for risk assessment
M	1	1	1	Appropriate exposure medium for INEL
Total AF	36	72	108	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	0.64	0.64	0.64	QCE = quantified critical endpoint
TRV	0.018	0.009	0.006	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.018	Test organism is in the same order and trophic level as the functional group members	AV310
2	0.009	Test organism is in a different order or trophic level from the functional group members	AV322, AV333, AV342
3	0.006	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV422, AV432, AV433, AV442

COPC: **Mercury (Organic),** CAS 7439-97-56

Test Organisms: Mule Deer
Exposure Medium: Single dose
Test Endpoint: FEL-1 (LD-50)
Reference: Eisler, R., 1987, *Mercury Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review,* U.S. Fish and Wildlife Service Biological Report, 85(1.10).
QCE: 18 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	From secondary source, no other information
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	3	3	3	Acute study
Q_3	3	3	3	LD-50
U	3	3	3	Secondary source, little supporting information
M	1	1	1	Appropriate exposure medium for INEL
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	18	18	18	QCE = quantified critical endpoint
TRV	0.22	0.11	0.07	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.22	Test organism is in the same order and trophic level as the functional group members	none
2	0.11	Test organism is in a different order or trophic level from the functional group members	M121, M122, M122A, M123
3	0.07	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC: **Mercury (Organic),** CAS 7439-97-56

Test Organisms: Pheasant
Exposure Medium: Diet
Test Endpoint: LOAEL-r Reduced egg production, shell thickness, reduced hatchability
Reference: Fimreite, N., 1979, *Accumulation and Effects of Mercury on Birds, in the Biogeochemistry of Mercury in the Environment,* J. O. Nriaqu, Ed., Elsevier/North Holland Biomedical Press, New York.
QCE: .18 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	2	2	2	From secondary source, no other information, cited in EPA, 1993, Wildlife Exposure Factors Handbook
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	2	2	2	Subchronic duration (12 weeks)
Q_3	2	2	2	LOAEL endpoint
U	2	2	2	Old study, secondary source, no NOAEL identified
M	1	1	1	Appropriate exposure medium for INEL
Total AF	16	32	48	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	.18	.18	.18	QCE = quantified critical endpoint
TRV	.011	.005	.004	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.011	Test organism is in the same order and trophic level as the functional group members	none
2	.005	Test organism is in a different order or trophic level from the functional group members	AV422, AV432, AV433,AV442
3	.004	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC:	**Mercury (Organic),** CAS 7439-97-56	
Test Organisms:	Rat	
Exposure Medium:	Diet	
Test Endpoint:	NOAEL	No effects on dams or offspring of female rats treated with methylmercury from weaning through parturition
Reference:	Khera and Tabacova, 1973, *Effects of Methylmercurie Chloride on the Progeny of Mice and Rats Treated Before or During Gestation,* Food and Cosmetic Toxicology, 11:245–254.	
QCE:	.25 mg/kg-day	Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Large groups, but information on variability lacking
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	2	2	2	Subchronic duration
Q_3	1	1	1	NOAEL endpoint
U	2	2	2	Highest dose level was NOAEL for sensitive and relevant endpoint, but exposure was not chronic.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	.25	.25	.25	QCE = quantified critical endpoint
TRV	0.03	0.02	0.01	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.03	Test organism is in the same order and trophic level as the functional group members	none
2	0.02	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	0.01	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **Methylene chloride (dichloromethane),** CAS 75-09-2

Test Organisms: Rat
Exposure Medium: Oral (diet)
Test Endpoint: NOAEL
Reference: National Cancer Association, 1982, *24-Month Chronic Toxicity and Oncogenicity Study of Methylene Chloride in Rats*, prepared by Hazleton Laboratories, Inc. Vienna, VA, unpublished data cited in IRIS.
QCE: 5 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Both sexes tested. No juveniles tested.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	1	1	1	Long-term (2-year) study
Q_3	1	1	1	NOAEL endpoint
U	1	1	1	Well-conducted study
M	1	1	1	Not applicable
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	5	5	5	QCE = quantified critical endpoint
TRV	2.50	1.25	0.83	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.5	Test organism is in the same order and trophic level as the functional group members	none
2	1.3	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	0.83	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **Nickel,** CAS 7440-02-0

Test Organisms: Chicken
Exposure Medium: Diet
Test Endpoint: NOAEL Growth
Reference: Weber, C. W., and Reid, B. L., 1968, *Nickel toxicity in growing chicks*, J. Nutr. 95:612–616.
QCE: 87 mg/kg-day 500 ppm in diet converted to a dose using an estimated ingestion rate* of 0.09 kg/day and a body weight of 500 g from the study.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Subchronic toxicity studies with adequate numbers of animals
Q_1	1	1	1	No endpoint observed
Q_2	2	2	2	Subchronic study
Q_3	1	1	1	NOAEL endpoint
U	3	3	3	Older study, reproductive endpoints not evaluated
M	1	1	1	Appropriate exposure medium
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	87	87	87	QCE = quantified critical endpoint
TRV	14.50	7.25	4.83	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	14.5	Test organism is in the same order and trophic level as the functional group members	none
2	7.25	Test organism is in a different order or trophic level from the functional group members	AV422, AV432, AV433,AV442
3	4.83	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

*Estimated as 0.0582 $Wt^{0.0651}$ (kg) as cited in EPA, 1993. Wildlife Exposure Factors Handbook.

COPC: **Nickel,** CAS 7440-02-0

Test Organisms: Cow
Exposure Medium: Diet
Test Endpoint: NOAEL No effect on food intake or growth rate
Reference: National Academy of Sciences, 1980, *Mineral Tolerance of Domestic Animals*, Washington, DC.
QCE: 250 mg/kg-day Specified as nickel carbonate

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source
Q_1	1	1	1	No endpoint observed
Q_2	2	2	2	Subchronic study
Q_3	1	1	1	NOAEL endpoint
U	3	3	3	Limited information or supporting studies.
M	1	1	1	Appropriate exposure medium
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	250	250	250	QCE = quantified critical endpoint
TRV	13.89	6.94	4.63	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	14	Test organism is in the same order and trophic level as the functional group members	none
2	6.9	Test organism is in a different order or trophic level from the functional group members	M121, M122, M122A, M123
3	4.6	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC: **Nickel** CAS 7440-02-0

Test Organisms: Dog
Exposure Medium: Diet
Test Endpoint: NOAEL Treatments had no effect on body weight gain
Reference: Ambrose, A. M., P. S. Larson, J. R. Borzelleca and G. R. Hennigar, Jr., 1976, *Long-Term Toxicologic Assessment of Nickel in Rats and Dogs,* J. Food Sci. Technol. 13:181–187.
QCE: 25 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity study with adequate numbers of animals
Q_1	1	1	1	No endpoint observed
Q_2	1	1	1	Chronic study
Q_3	1	1	1	NOAEL endpoint
U	2	2	2	Limited information or supporting studies.
M	1	1	1	Appropriate exposure medium
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	25	25	25	QCE = quantified critical endpoint
TRV	12.50	6.25	4.17	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	13	Test organism is in the same order and trophic level as the functional group members	M422A
2	6.3	Test organism is in a different order or trophic level from the functional group members	M322, M422
3	4.2	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222

COPC:	**Nickel,** CAS 7440-02-0	
Test Organisms:	Mallard	
Exposure Medium:	Diet	
Test Endpoint:	NOAEL	Egg production, hatchability, duckling survival; hematological parameters
Reference:	- Eastin, W. C., Jr. and O'Shea, T. J., 1981, *Effects of Dietary Nickel on Mallards*, J. Toxicol. Environ. Health 7(6):883–892. - White, D. H., and M. P. Dieter, 1978, *Effects of Dietary Vanadium in Mallard Ducks*, Journal of Toxicol. and Environ. Health, 4:43–50.	
QCE:	82 mg/kg-day	800 ppm in diet converted to a dose using an estimated ingestion rate of 0.121 kg/day ingestion rate and 1.17 kg BW as indicated in the 1978 White and Dieter study.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Subchronic toxicity study; variability not addressed
Q_1	1	1	1	No endpoint observed
Q_2	2	2	2	Subchronic study
Q_3	1	1	1	NOAEL endpoint
U	2	2	2	Reproductive endpoints evaluated, no LOAEL identified.
M	1	1	1	Appropriate exposure medium
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	82	82	82	QCE = quantified critical endpoint
TRV	10.25	5.13	3.42	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	10.3	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	5.1	Test organism is in a different order or trophic level from the functional group members	AV121, AV122, AV132
3	3.4	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV142, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC: **Nickel,** CAS 7440-02-0

Test Organisms: Rat
Exposure Medium: Diet
Test Endpoint: NOAEL Treatments had no effect on body weight gain
Reference:
- Ambrose, A. M., P. S. Larson, J. R. Borzelleca, and G. R. Hennigar, Jr., 1976, *Long-Term Toxicologic Assessment of Nickel in Rats and Dogs,* J. Food Sci. Technol. 13:181–187.
- ABC (American Biogenics Corp.), 1986, *Ninety-Day Gavage Study in Albino Rats Using Nickel,* Draft Final Report submitted to Research Triangle Institute, P.O. Box 12194, Research Triangle Park, NC 27709.
- RTI (Research Triangle Institute), 1987, *Two Generation Reproduction and Fertility Study of Nickel Chloride Administered to CD Rats in Drinking Water: Fertility and Reproductive Performance of the Po Generation (Part II of III) and F1 Generation (Part III of III),* Final study report, Report submitted to Office of Solid Waste Management, U.S. EPA, Washington, DC.

QCE: 5 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity study with adequate numbers of animals.
Q_1	1	1	1	No endpoint observed
Q_2	1	1	1	Chronic study
Q_3	1	1	1	NOAEL endpoint
U	2	2	2	Low survival in controls; however, another study by ABC, 1986 supports the 5 mg/kg/day NOAEL. A NOAEL for reproductive effects in a study by RTI (1987) was higher than the Ambrose study.
M	1	1	1	Appropriate exposure medium.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	5	5	5	QCE = quantified critical endpoint
TRV	2.50	1.25	0.83	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.50	Test organism is in the same order and trophic level as the functional group members	none
2	1.25	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	0.83	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **PCBs (Aroclor 1254),** CAS 1336-36-3

Test Organisms: American Kestrel
Exposure Medium: Diet
Test Endpoint: FEL-r Decreased sperm concentration
Reference: Bird, D. M., P. H. Tucker, G. A. Fox, and P. C. Laguë, 1983, *Synergistic Effects of Aroclor 1254 and Mirex on the Semen Characteristics of American Kestrels,* Archives of Environmental Contamination and Toxicology, 12:633–640.
QCE: 9.5 mg/kg-day 9–10 mg/kg/day stated in paper

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Considering the experimental subject was not a lab animal, group sizes were large and variability appeared low
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	1	1	1	Chronic duration
Q_3	3	3	3	FEL
U	2	2	2	Only examined males, no NOAEL identified
M	1	1	1	Not applicable
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	9.5	9.5	9.5	QCE = quantified critical endpoint
TRV	0.79	0.40	0.26	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.79	Test organism is in the same order and trophic level as the functional group members	AV310
2	.40	Test organism is in a different order or trophic level from the functional group members	AV322, AV333, AV342
3	.26	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV422, AV432, AV433, AV442

COPC:	**PCBs (Aroclor 1254),** CAS 1336-36-3	
Test Organisms:	Pheasant	
Exposure Medium:	Gelatin capsule	
Test Endpoint:	LOAEL-r	Egg production and chick survival not impacted but hatchability reduced
Reference:	-Dahlgren, R. B., and R. L. Linder, 1971, *Effects of Polychlorinated Biphenyls on Pheasant Reproduction, Behavior, and Survival,* Journal of Wildlife Management, 35(2):315–319. -Dahlgren, R. B., R. L. Linder, and C. W. Carlson, 1972, *Polychlorinated Biphenyls: Their Effects on Penned Pheasants,* Environmental Health Perspectives, 1:89–101.	
QCE:	1.8 mg/kg-day	12.5 mg/wk for 16 weeks; assumed BW of 1 kg (EPA, 1993, Wildlife Exposure Factors Handbook)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Relatively small group sizes, variability not addressed
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	2	2	2	Subchronic duration (39 weeks)
Q_3	2	2	2	LOAEL endpoint
U	2	2	2	Bolus dosing method might result in less absorption than daily exposure and exposure subchronic to adults only; however, effects noted were slight and variable, and dose-response unclear
M	1	1	1	Not applicable
Total AF	16	32	48	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	1.8	1.8	1.8	QCE = quantified critical endpoint
TRV	0.11	0.06	0.04	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.11	Test organism is in the same order and trophic level as the functional group members	none
2	0.06	Test organism is in a different order or trophic level from the functional group members	AV422, AV432, AV433,AV442
3	0.04	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: **PCBs (Aroclor 1254),** CAS 1336-36-3

Test Organisms: Rat
Exposure Medium: Diet
Test Endpoint: NOAEL-r
Reference: Linder, R. E., T. B. Baines, and R. D. Kimbrough, 1974, *The Effects of Polychlorinated Biphenyls on Rat Reproduction,* Food and Cosmetic Toxicology, 12:63–77.
QCE: .25 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Well-designed long-term study showed relatively low variability in response
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	1	1	1	Chronic study
Q_3	1	1	1	NOAEL endpoint
U	1	1	1	Thorough, well-designed and analyzed, relevant study
M	1	1	1	Not applicable
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	.25	.25	.25	QCE = quantified critical endpoint
TRV	0.25	0.13	0.08	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.25	Test organism is in the same order and trophic level as the functional group members	none
2	0.13	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	0.08	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **PCBs (Aroclor 1260),** CAS 1336-36-3

Test Organisms: Rat
Exposure Medium: Diet
Test Endpoint: NOAEL-r
Reference: Linder, R. E., T. B. Baines, and R. D. Kimbrough, 1974, *The Effects of Polychlorinated Biphenyls on Rat Reproduction*, Food and Cosmetic Toxicology, 12:63–77.
QCE: 5 mg/kg-day 100 ppm diet, 0.05 food factor for rats

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Well-designed long-term study showed relatively low variability in response
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	1	1	1	Chronic duration
Q_3	1	1	1	NOAEL endpoint
U	1	1	1	Thorough, well-designed and analyzed, relevant study
M	1	1	1	Not applicable
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	5	5	5	QCE = quantified critical endpoint
TRV	5.00	2.50	1.67	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	5.0	Test organism is in the same order and trophic level as the functional group members	none
2	2.5	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	1.7	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **PBCs (Metabolized in fish tissue),** CAS 1336-36-3

Test Organisms: Mink
Exposure Medium: Diet (Great Lakes fish)
Test Endpoint: NOAEL-r Reproduction, kit survival
Reference: Hornshaw, T. C., R. J. Aulerich, and H. E. Johnson, 1983, *Feeding Great Lakes Fish to Mink: Effect on Mink and Accumulation and Elimination of PCBs by Mink*, Journal of Toxicology and Environmental Health, 11:933–946.
QCE: .03 mg/kg-day 0.21 ppm in diet, 0.15 kg/kg BW food factor for mink (EPA, 1993)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Variation is moderate or average
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	2	2	2	Subchronic duration (39 weeks)
Q_3	1	1	1	NOAEL
U	2	2	2	Study of reasonable quality
M	1	1	1	Not applicable
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	.03	.03	.03	QCE = quantified critical endpoint
TRV	0.00375	0.001875	0.00125	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.004	Test organism is in the same order and trophic level as the functional group members	M322
2	.002	Test organism is in a different order or trophic level from the functional group members	M422A
3	.001	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M422

COPC: **Seleniumm,** CAS 7782-49-2

Test Organisms: Rat
Exposure Medium: Diet
Test Endpoint: NOAEL Reproduction, number of young reared
Reference: - Rosenfeld, I. and O. A. Beath, 1954, Effect of selenium on reproduction in rats, Proc. Soc. Exp. Biol. Med. 87:295–297.
- Nobunaga, T., H. Satoh and T. Suzuki, 1979, "Effects of sodium selenite on methylmercury embryotoxicity and teratogenicity in mice," Toxicology and Applied Pharmacology, 47(1):79–88.
QCE: 0.075 Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity studies with adequate nubmers of animals
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	1	1	1	Chronic study
Q_3	1	1	1	NOAEL endpoint
U	1	1	1	Older study, but analyzed 5 breeding cycles and 2 generations. A more recent study by Nobunaga et al. (1979) reports a NOAEL of 390 ug/kg/day selenite for mice reproductive success.
M	1	1	1	Appropriate exposure medium
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	0.075	0.075	0.075	QCE = quantified critical endpoint
TRV	0.075	0.038	0.025	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.075	Test organism is in the same order and trophic level as the functional group members	none
2	0.038	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	0.025	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322,

COPC: **Selenium,** CAS 7782-49-2

Test Organisms: Sheep
Exposure Medium: Diet
Test Endpoint: FEL Mortality
Reference: Eisler, R., 1985, Selenium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review, U.S. Fish and Wildlife Service, Biological Report, 85(1.5).
QCE: 3.2 Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	3	3	3	Acute study
Q_3	3	3	3	Lethal endpoint
U	3	3	3	Secondary source
M	1	1	1	Appropriate exposure medium
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	3.2	3.2	3.2	QCE = quantified critical endpoint
TRV	.04	.02	.013	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.15	Test organism is in the same order and trophic level as the functional group members	none
2	.02	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	.013	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC:	**Selenium (Sodium selenite)**
\Test Organisms:	Chicken
Exposure Medium:	Diet
Test Endpoint:	LOAEL Egg hatchability
Reference:	- Ort, J. F. and J. D. Latshaw, 1978, "The toxic level of sodium selenite in the diet of laying chickens," Journal of Nutrition, 108:1114–1120. - EPA, 1993, Ch. 9. Selenium Effects at Kesterson Reservoir, A Review of Ecological Assessment Case Studies from a Risk Assessment Perspective, EPA/630/R-92/005. - Eisler, R., 1985, Selenium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review, U.S. Fish and Wildlife Service, Biological Report, 85(1.5).
QCE:	0.3 5 mg/kg in diet converted to dose by multiplying by 0.105 kg/day ingestion rate and dividing by 2 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Limited information, secondary source
Q_1	1	1	1	Endpoint ecologically relevant
Q_2	1	1	1	Chronic study
Q_3	2	2	2	LOAEL endpoint
U	2	2	2	Study results consistent with other studies in chickens and quail
M	1	1	1	Appropriate exposure medium
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	0.3	0.3	0.3	QCE = quantified critical endpoint
TRV	0.03	0.01	0.01	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.03	Test organism is in the same order and trophic level as the functional group members	none
2	0.01	Test organism is in a different order or trophic level from the functional group members	AV422, AV432, AV433,AV442
3	0.01	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: **Selenium (Sodium selenite),** CAS 7782-49-2

Test Organisms: Mallard
Exposure Medium: Diet
Test Endpoint: NOAEL Egg hatchability
Reference:
- Heinz, G. H., D. J. Hoffman, A. J. Krynitsky, and D. G. Weller, 1987, "Reproduction of mallards fed selenium," Environmental Toxicology and Chemistry, 6:423–433.
- Eisler, R., 1985, Selenium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review, U.S. Fish and Wildlife Service, Biological Report, 85(1.5).
- EPA, 1993, Ch. 9. Selenium Effects at Kesterson Reservoir, A Review of Ecological Assessment Case Studies from a Risk Assessment Perspective, EPA/630/R-92/005.

QCE: 0.6 10 mg/kg in diet converted to dose by multiplying by 0.062 kg/day ingestion rate* and dividing by 1.1 kg BW.

*Estimated as 0.0582 $Wt^{0.0651}$ (kg) as cited in EPA, 1993. Wildlife Exposure Factors Handbook.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Limited information
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	1	1	1	Chronic study
Q_3	1	1	1	NOAEL endpoint
U	2	2	2	Study results consistent with other studies in chickens and quail
M	1	1	1	Appropriate exposure medium.
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	0.6	0.6	0.6	QCE = quantified critical endpoint
TRV	0.10	0.05	0.03	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.10	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.05	Test organism is in a different order or trophic level from the functional group members	AV121, AV122, AV132
3	0.03	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV142, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC: **Silver,** CAS 7440-22-4

Test Organisms: Mice
Exposure Medium: Drinking Water
Test Endpoint: FEL-n
Reference: Rungby and Danscher, 1984, *Hypoactivity in Silver-Exposed Mice,* Acta Pharmacol and Toxicol, 55(5):398–401.
QCE: 18 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	2	2	2	
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	2	2	2	Subchronic duration
Q_3	3	3	3	FEL based on neurological effects
U	2	2	2	Only one dose, no NOAEL identified.
M	0.5	0.5	0.5	Ag administered in drinking water
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	18	18	18	QCE = quantified critical endpoint
TRV	1.50	0.75	0.50	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.50	Test organism is in the same order and trophic level as the functional group members	none
2	0.75	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	0.50	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **Sodium,** CAS 7440-23-5

Test Organisms: Mice (omnivore)
Exposure Medium: Intraperitoneal injection
Test Endpoint: LD_{50}
Reference: *Acta Pharmacol. Toxicol.*, 52:80, 1983; *Hazardous Substance Database*, (HSDB), Online computer database, 1995.
QCE: 4,000 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	3	3	3	Duration of exposure unknown (probably acute)
^{3}	3	3	3	FEL - lethality
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages examined. No NOAEL established.
M	0.5	0.5	0.5	Appropriate exposure medium
Total AF	40.5	81.0	121.5	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	4,000	4,000	4,000	QCE = quantified critical endpoint
TRV	98.8	49.4	32.9	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	98.8	Test organism is in the same order and trophic level as the functional group members	None
2	49.4	Test organism is in a different order or trophic level from the functional group members	M422, M422A, M121, M123
3	32.9	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **Sodium Cyanide,** CAS 143-33-9

Test Organisms: Rats
Exposure Medium: Diet
Test Endpoint: NOAEL
Reference: - Howard, J. W., R. F. Hanzal, 1955, *Chronic Toxicity for Rats of Food Treated with Hydrogen Cyanide,* Agric. Food Chem. 3(4):325–329.
- US EPA, 1984, *Health Effect Assessment for Cyanides,* Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH, for the Office of Emergency and Remedial Response, Washington, DC.
QCE: 20.4 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	1	1	1	
Q_1	1	1	1	
Q_2	1	1	1	Chronic—2 year
Q_3	1	1	1	NOAEL
U	2	2	2	Adequate record keeping, small number of supportive studies
M	1	1	1	
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	20.4	20.4	20.4	QCE = quantified critical endpoint (CN-10.8)
TRV	10.2	5.1	3.4	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	10.2	Test organism is in the same order and trophic level as the functional group members	none
2	5.1	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	3.4	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **Sodium nitrate,** CAS 7631-99-4

Test Organisms: Juvenile turkeys (omnivore)
Exposure Medium: Oral in drinking water
Test Endpoint: LOAEL—delayed growth
Reference: Humphreys Vet. Toxicol., 3rd Ed., 1988: *Hazardous Substance Database* (HSDB), Online computer database, 1995.
QCE: 660 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Secondary source so information on number of animals tested unknown. Four-week old individuals exposed.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	3	3	3	Duration not specified
$_3$	2	2	2	LOAEL
U	2	2	2	Limited information. Sensitive life stages examined. NOAEL established for adults.
M	0.5	0.5	0.5	Sodium salt in water may enhance the bioavailability of sodium.
Total AF	12.0	24.0	36.0	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	660	660	660	QCE = quantified critical endpoint
TRV	55.0	27.5	18.3	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	55.0	Test organism is in the same order and trophic level as the functional group members	None
2	27.5	Test organism is in a different order or trophic level from the functional group members	AV422, AV432, AV433, AV442
3	18.3	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333

COPC: **Sodium nitrate,** CAS 7631-99-4

Test Organisms: Rats (omnivore)
Exposure Medium: Oral in diet
Test Endpoint: MLD
Reference: Venugopal, B. and T. D. Luckey, 1978. *The Toxicity of Metals in Mammals*, New York, Plenum Press.
QCE: 200 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	3	3	3	Duration of exposure unknown
3	3	3	3	FEL - lethality
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages examined. No NOAEL established.
M	1	1	1	Appropriate exposure medium
Total AF	81.0	162.0	243.0	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	200	200	200	QCE = quantified critical endpoint
TRV	2.5	1.2	0.82	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.5	Test organism is in the same order and trophic level as the functional group members	None
2	1.2	Test organism is in a different order or trophic level from the functional group members	M422, M422A, M121, M123
3	0.82	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **Sodium sulfate,** CAS 7757-82-6

Test Organisms: Dog (omnivore)
Exposure Medium: Intraperitoneal injection
Test Endpoint: LD_{50}
Reference: Venugopal, B. and T. D. Luckey, 1978. *The Toxicity of Metals in Mammals*, New York, Plenum Press.
QCE: 244 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	3	3	3	Duration of exposure unknown
$_3$	3	3	3	FEL - lethality
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages examined. No NOAEL established.
M	0.5	0.5	0.5	Intraperitoneal injection may enhance bioavailability of test compound.
Total AF	40.5	81.0	121.5	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	244	244	244	QCE = quantified critical endpoint
TRV	6.0	3.0	2.0	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	6.0	Test organism is in the same order and trophic level as the functional group members	M442A
2	3.0	Test organism is in a different order or trophic level from the functional group members	M322, M422
3	2.0	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222

COPC: **Sodium sulfate,** CAS 7757-82-6

Test Organisms: Rabbits (herbivore)
Exposure Medium: Intravenous injection
Test Endpoint: LD_{50}
Reference: Venugopal, B. and T. D. Luckey, 1978. *The Toxicity of Metals in Mammals*, New York, Plenum Press.
QCE: 65 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	3	3	3	Duration of exposure unknown
3	3	3	3	FEL - lethality
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages examined. No NOAEL established.
M	0.5	0.5	0.5	Intravenous injection may enhance bioavailability of test compound.
Total AF	40.5	81.0	121.5	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	65	65	65	QCE = quantified critical endpoint
TRV	1.6	0.8	0.54	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.6	Test organism is in the same order and trophic level as the functional group members	None
2	0.8	Test organism is in a different order or trophic level from the functional group members	M121, M122, M122A, M123
3	0.54	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC: **Sodium sulfate,** CAS 7757-82-6

Test Organisms: Rats (omnivore)
Exposure Medium: Intravenous injection
Test Endpoint: LD_{50}
Reference: Venugopal, B. and T. D. Luckey, 1978, *The Toxicity of Metals in Mammals*, New York, Plenum Press.
QCE: 115 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	3	3	3	Duration of exposure unknown
$_3$	3	3	3	FEL - lethality
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages examined. No NOAEL established.
M	0.5	0.5	0.5	Intravenous injection may enhance bioavailability of test compound.
Total AF	40.5	81.0	121.5	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	115	115	115	QCE = quantified critical endpoint
TRV	2.8	1.4	0.95	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.8	Test organism is in the same order and trophic level as the functional group members	None
2	1.4	Test organism is in a different order or trophic level from the functional group members	M422, M422A, M121, M123
3	0.95	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **Toluene,** CAS 108-88-3

Test Organisms: Rat
Exposure Medium: Oral (corn oil)
Test Endpoint: NOAEL
Reference: National Toxicology Program (NTP), 1989, *Toxicology and Carcinogenesis Studies of Toluene in F/344 Rats and B6C3F1 Mice,* Technical Report Series No. 371, Research Triangle Park, NC.
QCE: 223 mg/kg-day Adjusted for treatment schedule

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Males and females tested. No juveniles tested.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	2	2	2	Subchronic (13-week) exposure
Q_3	1	1	1	NOAEL
U	2	2	2	Small number of animals per treatment group tested. Supporting chronic toxicity studies for reproductive and development effects are lacking.
M	1	1	1	Not applicable
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	223	223	223	QCE = quantified critical endpoint
TRV	27.88	13.94	9.29	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	27.9	Test organism is in the same order and trophic level as the functional group members	none
2	13.9	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	9.29	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC: **Zinc (zinc oxide) CAS 7440-66-6**

Test Organisms: Dog
Exposure Medium: Diet
Test Endpoint: NOAEL Hematological and gastrointestinal effects
Reference:
- Drinker, K. R., P. K. Thompson, and M. Marsh, 1927, "An investigation of the effect of long-continued ingestion of zinc, in the form o f zinc oxide, by cats and dogs, together with observations upon the excretion and storage of zinc," American Journal of Physiology, 80:31–64.
- ATSDR, Agency for Toxic Substance Disease Registry, 1988, Draft: Toxicological Profile for Zinc, December.

QCE: 63

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source, unspecified number of animals
Q_1	0.5	0.5	0.5	Ecologically relevance questionable
Q_2	2	2	2	Subchronic duration
Q_3	1	1	1	NOAEL
U	3	3	3	Older study
M	1	1	1	Appropriate exposure medium
Total AF	9	18	27	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	63	63	63	QCE = quantified critical endpoint
TRV	7.00	3.50	2.33	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	7.00	Test organism is in the same order and trophic level as the functional group members	M422A
2	3.50	Test organism is in a different order or trophic level from the functional group members	M322, M422
3	2.33	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222

COPC: **Zinc (zinc oxide),** CAS 7440-66-6

Test Organisms: Ferret
Exposure Medium: Diet
Test Endpoint: NOAEL Anemia/kidney effects
Reference: - Straube, E. F., Schuster, N. H., and Sinclair, A. J., 1980, "Zinc toxicity in the ferret," Journal of Comparative Pathology, 90:355–361.
- ATSDR, Agency for Toxic Substance Disease Registry, 1988, Draft: Toxicological Profile for Zinc, December.
QCE: 142

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source, unspecified number of animals
Q_1	0.5	0.5	0.5	Ecologically relevance questiionable
Q_2	2	2	2	Subchronic duration
Q_3	1	1	1	NOAEL
U	3	3	3	Limited information on data quality
M	1	1	1	Appropriate exposure medium
Total AF	9	18	27	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	142	142	142	QCE = quantified critical endpoint
TRV	15.78	7.89	5.26	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	15.78	Test organism is in the same order and trophic level as the functional group members	M322
2	7.89	Test organism is in a different order or trophic level from the functional group members	M422A
3	5.26	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M422

COPC: **Zinc (zinc oxide),** CAS 7440-66-6

Test Organisms: Rat
Exposure Medium: Diet
Test Endpoint: LOAEL Developmental effects
Reference: - Schlicker, S. A. and D. H. Cox, 1968, "Maternal dietary zinc and development and zinc, iron and copper content of the rat fetus," Journal of Nutrition, 95:287–294.
- ATSDR, Agency for Toxic Substance Disease Registry, 1988, Draft: Toxicological Profile for Zinc, December.
QCE: 200

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source, unspecified number of animals
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	1	1	1	Chronic duration
Q_3	2	2	2	LOAEL
U	3	3	3	Older study, limited information on study design
M	1	1	1	Appropriate exposure medium
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	200	200	200	QCE = quantified critical endpoint
TRV	11.11	5.56	3.70	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	11.11	Test organism is in the same order and trophic level as the functional group members	none
2	5.56	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	3.70	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322,

COPC: **Zinc (zinc oxide),** CAS 7440-66-6

Test Organisms: Sheep
Exposure Medium: Diet
Test Endpoint: LOAEL Pathological changes in liver and kidney; gastrointerstinal lesions
Reference: - Allen, J. G., Masters, H. G., Peet, R. L., et. al., 1983, "Zinc toxicity in ruminants," Journal of Comparative Pathology, 93:363–377.
- ATSDR, Agency for Toxic Substance Disease Registry, 1988, Draft: Toxicological Profile for Zinc, December.
QCE: 18.6

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source, unspecified number of animals
Q_1	0.5	0.5	0.5	Ecologically relevance questionable
Q_2	2	2	2	Subchronic duration
Q_3	2	2	2	LOAEL
U	3	3	3	Limited information on study conditions
M	1	1	1	Appropriate exposure medium
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	18.6	18.6	18.6	QCE = quantified critical endpoint
TRV	1.03	.52	.34	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.03	Test organism is in the same order and trophic level as the functional group members	none
2	.52	Test organism is in a different order or trophic level from the functional group members	M121, M123, M422, M422A
3	.34	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

COPC:	**Zinc (zinc sulfate)**
Test Organisms:	Chicken
Exposure Medium:	Diet
Test Endpoint:	LOAEL Decreased egg production
Reference:	- Stahl, J. L., Greger, J. L., and M. E. Cook, 1990, "Breeding hen and progeny when hens are fed excessive dietary zinc," Poultry Science, 69:259–263. - Hoadley, J. E., S. H. Tao, and M. R. W. Fox, 1989, "Dietary cadmium and zinc effects on peripheral neuromuscular development," 73rd Annual Meeting of the Federation of American Societies for Experimental Biology, New Orleans, LA., March 19–23, 1989, Federation of American Society for Experimental Biology, 4929.
QCE:	12 20 mg/kg in diet converted to dose by 0.105 kg/day ingestion (from study) and 0.172 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order or trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic study with adequate number of animals
Q_1	1	1	1	Endpoint ecologically relevant
Q_2	1	1	1	Chronic duration
Q_3	2	2	2	LOAEL
U	1	1	1	High quality study
M	1	1	1	Appropriate exposure medium
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U * M$ = Total AF
QCE (mg/kg-day)	12	12	12	QCE = quantified critical endpoint
TRV	6.00	3.00	2.00	Toxicity Reference Value = QCE/Total AF

Appropriate Functional Groups:

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	6.00	Test organism is in the same order and trophic level as the functional group members	none
2	3.00	Test organism is in a different order or trophic level from the functional group members	AV422, AV432, AV433,AV442
3	2.00	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342