Table 7-18. Results of hazard quotient calculations for the WAG 5 ecological risk assessment.

Site	Site Description and Size (m^2)	Contaminant of Potential Concern	Hazard Quotient[a]	Maximum Exposure Concentration (mg/kg)	Surface Soil Exposure Concentration (mg/kg)	Subsurface Soil Exposure Concentration (mg/kg)	Background Concentration[b] (mg/kg)	Depth Range Detected (ft)	Data Gaps
ARA-01	Chemical evaporation pond (2,990 m^2)	**Antimony**	**≤ 1 to ≤10**	1.68E+01	1.68E+01	4.7E+00	4.8	0 to 2	No TRVs for birds or reptiles
		Arsenic	**≤ 1 to ≤ 20**	2.58E+01	2.21 E+01	2.21E+01	5.8	0 to 2	No TRVs for reptiles
		Cadmium	**≤ 1 to ≤ 1000**	3.80E+00	3.80E+00	1.90E+00	2.2	0 to 2	No TRVs for reptiles
		Chromium(III)	≤ 1[c]	6.90E+01	6.90E+01	2.85E+01	33	0 to 2	No TRVs for reptiles
		Copper	**≤ 1 to ≤ 10**	2.55E+01	2.55E+01	1.11E+01	22	0 to 2	No TRVs for reptiles
		Lead	**≤ 1 to ≤ 50**	4.39E+01	2.53E+01	2.76E+01	17	0 to 2	No TRVs for reptiles
		Selenium	**≤ 1 to ≤ 100**	2.77E+01	2.77E+01	0	0.22	0 to 2	No TRVs for reptiles
		Silver	≤ 1 to ≤ 3[c]	1.27E+01	1.27E+01	7.8E+00	NA	0 to 2	No TRVs for reptiles
		Thallium	**≤ 1 to ≤ 400**	5.92E+01	3.73E+01	3.58E+01	0.43	0 to 2	No TRVs for reptiles
		Vanadium	**≤ 1 to ≤ 100**	6.80E+01	6.81E+01	4.98E+01	45	0 to 2	No TRVs for reptiles
		Zinc	**≤ 1 to ≤ 20**	2.33E+02	2.33E+02	6.23E+01	150	0 to 2	No TRVs for reptiles
ARA-02	Septic tank soils (139 m^2)	Arsenic	<1	7.5E+00	7.5E+00	7.5E+00	5.8	2 to 10	No TRVs for reptiles
		Barium	<1	1.00E+03	1.00E+03	1.00E+03	300	2 to 10	No TRVs for reptiles
		Chromium(III)	≤1[d]	1.83E+02	1.83E+02	1.83E+02	33	2 to 10	No TRVs for reptiles
		Copper	≤ 1[d]	2.63E+01	2.63E+01	2.63E+01	22	2 to 10	No TRVs for reptiles
ARA-03	Pad near ARA-627 (84 m^2)	Arsenic	< 1	8.90E+00	0	6.23E+00	5.8	0 to 3	No TRVs for reptiles
ARA-12	Radiological waste leach pond (5,748 m^2)	Arsenic	≤ 1 to ≤ 7[e]	7.28E+00	7.28E+00	7.08E+00	5.8	0 to 7	No TRVs for reptiles
		Cadmium	**≤ 1 to ≤ 2,000**	6.06E+00	6.52E+00	3.22E+00	2.2	0 to 3	No TRVs for reptiles
		Chromium(III)	**≤ 1 to ≤ 9**	4.69E+02	4.69E+02	1.73E+02	33	0 to 7	No TRVs for reptiles
		Copper	**≤ 1 to ≤ 300**	6.23E+02	6.23E+02	6.25E+01	22	2 to 7	No TRVs for reptiles
		Lead	**≤ 1 to ≤ 300**	1.58E+02	1.58E+02	5.42E+01	17	0 to 4	No TRVs for reptiles
		Manganese	**≤ 1 to ≤ 40**	5.70E+02	5.70E+02	4.71E+02	490	0 to 0.5	No TRVs for reptiles
		Mercury	**≤ 1 to ≤ 90**	1.40E+00	1.4E+00	3.6E-01	0.050	0 to 3	No TRVs for reptiles
		Selenium	**≤ 1 to ≤ 30**	2.70E+00	1.4E+00	2.7E+00	0.22	0 to 4	No TRVs for reptiles
		Silver	≤ 1	5.70E+00	5.7E+00	4.8E-01	NA	0 to 4	No TRVs for birds or reptiles
		Zinc	**≤ 1 to ≤ 50**	3.76E+02	3.23E+02	3.76E+02	150	0 to 7	No TRVs for reptiles
ARA-16	ARA-I radionuclide tank in concrete vault (61 m^2)	Fluoride	< 1	4.77E+00	4.77E+00	0	NA	0 to 1	No TRVs for reptiles

Table 7-18. (continued).

Site	Site Description and Size (m^2)	Contaminant of Potential Concern	Hazard Quotient[a]	Maximum Exposure Concentration (mg/kg)	Surface Soil Exposure Concentration (mg/kg)	Subsurface Soil Exposure Concentration (mg/kg)	Background Concentration[b] (mg/kg)	Depth Range Detected (ft)	Data Gaps
ARA-25	Soil beneath the ARA-626 hot cells (178 m^2)	Aroclor-1254	< 1	1.60E-01	1.60E-01	1.60E-01	NA	0 to 5	No TRVs for reptiles
		Arsenic	**≤ 1 to ≤ 20**	4.06E+01	4.06 E+01	4.06E+01	5.8	0 to 5	No TRVs for reptiles
		Chromium(III)	< 1[c]	9.84E+01	9.84E+01	9.84E+01	33	0 to 5	No TRVs for reptiles
		Cobalt	**<1 to ≤90**	1.04E+02	1.04E+02	1.04E+02	11	0 to 5	No TRVs for reptiles
		Copper	**≤ 1 to ≤ 40**	2.27E+02	2.27E+02	2.27E+02	22	0 to 5	No TRVs for reptiles
		Lead	**≤ 1 to ≤ 900**	1.43E+03	1.43E+03	1.43E+03	17	0 to 5	No TRVs for reptiles
		Manganese	**≤ 1 to ≤ 6**	1.40E+03	1.40E+03	1.40E+03	490	0 to 5	No TRVs for reptiles
		Mercury	**≤ 1 to ≤ 3**	9.70E-02	9.70E-02	9.70E-02	0.050	0 to 5	No TRVs for reptiles
		Nickel	**≤ 1 to ≤ 6**	3.88E+01	3.88E+01	3.88E+01	35	0 to 5	No TRVs for reptiles
		Selenium	**≤ 1 to ≤ 3**	6.59E-01	6.59E-01	6.59E-01	0.22	0 to 5	No TRVs for reptiles
		Silver[g]	**≤ 1**	7.24E+00	7.24E+00	7.24E+00	NA	0 to 5	No TRVs for reptiles
		Vanadium	**≤ 1 to ≤ 100**	1.04E+02	1.04E+02	1.04E+02	45	0 to 5	No TRVs for reptiles
		Zinc	**≤ 1 to ≤ 20**	8.55E+02	8.55E+02	8.55E+02	150	0 to 5	No TRVs for reptiles
PBF-04	PBF Control Area oil tank (11 m^2)	Xylene	< 1	6.00E+01	0	6.0E+01	NA	Subsurface	No TRVs for birds, reptiles, or plants
PBF-10	PBF evaporation pond (1,820 m^2)	**Chromium(III)**	**≤ 1 to ≤ 3**	3.09E+02	3.09E+02	0	33	0 to 0.5	No TRVs for reptiles
PBF-16	SPERT-II leach pond (3,570 m^2)	**Lead**	**≤ 1 to ≤ 60**	3.20E+01	3.20E+01	3.20E+01	17	> 8	No TRVs for reptiles
		Mercury	**≤ 1 to ≤ 50**	7.10E-01	7.1E-01	7.1E-01	0.050	> 8	No TRVs for reptiles
PBF-21	Large leach pond (288 m^2)	**Cobalt**	**≤ 1 to ≤ 6**	1.26E+01	0	0	11	5 to 8	No TRVs for reptiles
		Copper	**≤ 1 to ≤ 2**	2.33E+01	1.26E+01	2.33E+01	22	5 to 8	No TRVs for reptiles
PBF-22	Leach pond (5,008 m^2)	Aroclor-1248	< 1	1.20E-01	1.2E-01	1.2E-01	NA	0 to 1	No TRVs for reptiles
		Aroclor-1254	< 1	1.20E-01	1.2E-01	1.2E-01	NA	0 to 1	No TRVs for reptiles
		Arsenic	**≤ 1 to ≤ 8**	1.22E+01	6.72E+00	8.11E+00	5.8	0 to 10	No TRVs for reptiles
		Copper	**≤ 1 to ≤ 20**	4.84E+01	4.84E+01	3.57E+01	22	0 to 10	No TRVs for reptiles
		Lead	**≤ 1 to ≤ 40**	6.84E+01	1.82E+01	1.4E+01	17	0 to 10	No TRVs for reptiles
		Mercury	**≤ 1 to ≤ 20**	2.70E-01	2.6E-01	2.7E-01	0.050	0 to 7	No TRVs for reptiles
		Nickel	**≤ 1 to ≤ 10**	4.10E+01	3.45E+01	4.1E+01	35	0 to 7	No TRVs for reptiles

Table 7-18. (continued).

Site	Site Description and Size (m^2)	Contaminant of Potential Concern	Hazard Quotient[a]	Maximum Exposure Concentration (mg/kg)	Surface Soil Exposure Concentration (mg/kg)	Subsurface Soil Exposure Concentration (mg/kg)	Background Concentration[b] (mg/kg)	Depth Range Detected (ft)	Data Gaps
		Selenium	**≤ 1 to ≤ 20**	1.70E+00	1.5E+00	1.7E+00	0.22	0 to 10	No TRVs for reptiles
		Silver[f]	≤ 1 to ≤ 3	1.19E+00	1.19E+01	1.19E+01	NA	0 to 7	No TRVs for birds or reptiles
PBF-26	SPERT-IV Lake (20,092 m^2)	Aroclor-1254	≤ 1 to ≤ 9	1.30E+01	1.3E+01	1.3E+01	NA	0 to 0.5	No TRVs for reptiles
		Arsenic	≤ 1 to ≤ 8	7.90E+00	7.7E+00	7.7E+00	5.8	0 to 0.5	No TRVs for reptiles
		Chromium(III)	≤ 1 to ≤ 2	6.40E+01	6.4E+01	6.4E+01	33	0 to 0.5	No TRVs for reptiles
		Copper	≤ 1 to ≤ 100	2.34E+02	2.34E+02	2.34E+02	22	0 to 0.5	No TRVs for reptiles
		Lead	≤ 1 to ≤ 100	4.30E+01	4.3E+01	2.38E+01	17	0 to 0.5	No TRVs for reptiles
		Mercury	≤ 1 to ≤ 20	3.40E-01	3.4E-01	3.4E-01	0.050	0 to 0.5	No TRVs for reptiles
		Nickel	≤ 1 to ≤ 20	4.50E+01	4.5E+01	4.5E+01	35	0 to 0.5	No TRVs for reptiles
		Silver[g]	≤ 1 to ≤ 4	3.70E+01	3.7E+01	3.7E+01	NA	0 to 0.5	No TRVs for birds or reptiles
		Zinc	≤ 1 to ≤ 40	2.59E+02	2.59E+02	2.59E+02	150	0 to 0.5	No TRVs for reptiles

a. Hazard quotients of more than 1 for contaminants of potential concern are shown in bold text. Each entry in the column represents the range of hazard quotients calculated across functional groups and threatened and endangered (T/E) species.
b. Background concentrations are the 95%/95% UTLs for composite samples from Rood, Harris, and White (1996). NA = not applicable, a background value is not identified for the contaminant.
c. See Section 7.4.3.1
d. See Section 7.4.3.2
e. See Section 7.4.3.4
f. See Section 7.4.3.10
g. See Section 7.4.3.11.

This table shows that the order of magnitude for the largest observed HQ across all functional groups within the site varies by at least three orders of magnitude. If information was not available to derive a TRV, then an HQ could not be developed for that particular contaminant and functional group or C2 species combination. These data gaps are identified in Table 7-18 and in Appendix I.

An HQ greater than the target value indicates that exposure to a given contaminant (at the concentrations and for the duration and frequencies of exposure estimated in the exposure assessment) may cause adverse health effects in exposed populations. However, the level of concern associated with exposure may not increase linearly as HQ values exceed the target value. Therefore, the HQ values cannot be used to represent a probability or a percentage because an HQ of 10 does not necessarily indicate that adverse effects are 10 times more likely to occur than an HQ of 1. It is only possible to infer that the greater the HQ, the greater the concern about potential adverse effects to ecological receptors.

7.4.2 Uncertainty Association with Hazard Quotients

For a WAG ERA, an HQ is used as an indicator of risk. The HQ is a ratio of the calculated contaminant dose for a receptor to the TRV. These ratios provide a quantitative index of risk to defined functional groups or individual receptors under assumed exposure conditions. The ratio, or HQ method, is commonly used in both human health and ERAs. It is used in WAG ERAs to eliminate from further assessment contaminants and sites that pose no risk to the ecosystem.

In general, the significance of exceeding a target HQ (Table 7-15) value depends on the perceived, "value" (ecological, social, or political) of the receptor, the nature of the endpoint measured, and the degree of uncertainty associated with the process as a whole. Therefore, the decision to take no further action, order corrective action, or perform additional assessment should be approached on a site-, chemical-, and species-specific basis. Because the unit of concern in ERA is usually the population as opposed to the individual, with the exception of T/E species (EPA 1992), exceeding conservative screening criteria does not necessarily mean that significant adverse effects are likely.

An HQ of less than the target value (traditionally 1.0 for nonradionuclide contaminants) implies a "low likelihood" of the adverse effects from that contaminant. Nonradiological and radiological contaminants are treated separately because these two classes of contaminants cause different effects in exposed receptors. The effects from the nonradioactive metals are expected to cause systemic toxicity,while the effects to reproductive processes are typically associated with exposure to ionizing radiation. A separate approach in which the target HQ is set to 1/n, where n is the number of nonradiological or radiological contaminants of concern, also could be used. This approach would be too conservative for nonradiological contaminants because it assumes cumulative (simultaneous) exposure to all nonradionuclides and that all contaminants within a given group behave synergistically in a given receptor. Given that all receptors within a functional group may not be simultaneously exposed to all contaminants, and that a synergistic effect may not be seen, this approach may be more stringent than necessary to protect all ecological receptors from nonradiological effects. Therefore, the HQ is set to 1 for all nonradiological contaminants. This method may underestimate risk because the method does not account for cumulative exposure to multiple contaminants by a given receptor.

At this level in the ERA approach at the INEEL, both exposure and toxicity assumptions are generally "worst case," and represent the upper bound of potential risks to ecological receptors. The HQ approach does not consider variability and uncertainty in either exposure or toxicity estimates, and, therefore, does not represent a statistical probability of occurrence of adverse ecological effects. Hazard quotients provide essentially a "yes or no" determination of risk and are, therefore, well suited for screening-level assessments (EPA 1988b). A limitation of the quotient method is that it does not predict the degree of risk or the magnitude of effects associated with specified levels of contamination

(EPA 1988b), However, "modified quotient methods" are available that attempt to address this issue. For example, in the study of toxicity in fish, a method is used (Barnthouse et al. 1986) in which the conclusions are expressed as "no concern," "possible concern," and "high concern," depending on the ratio of the contaminant concentration to the reference (Barnthouse et al. 1986).

7.4.3 Risk Evaluation

This section describes the results of the evaluation of risk associated with exposure of the functional groups, T/E species, and species of concern to contaminants at WAG 5 sites of concern. Of the 55 ARA and PBF sites at WAG 5, 16 sites were originally retained for analysis in the WAG 5 ERA. Four sites (ARA-10, ARA-23, ARA-24, and PBF-12) were eliminated in the EBSL and background screening process (refer to Tables 7-8 through 7-10). Twelve sites (ARA-01, ARA-02, ARA-03, ARA-12, ARA-16, kARA-25, PBF-04, PBF-10, PBF-16, PBF-21, PBF-22, and PBF-26) were evaluated in the subsequent phases of the WAG 5 ERA. Twenty-three organic and 19 inorganic compounds were identified as COPCs in surface and subsurface soil at these WAG 5 sites of concern. Risks to ecological receptors were evaluated using dose predictions and HQ calculations (see Appendix I) for receptors at these 11 sites. The results of the HQ calculations are summarized in Table 7-18. Nine sites were shown to pose risk to ecological receptors including ARA-01, ARA-02, ARA-12, ARA-25, PBF-10, PBF-16, PBF-21, PBF-22, and PBF-26. Site PBF-10 is the site of a lined surface 1,820-m^2 (19,600-ft^2) impoundment that received effluent from 1972 to 1984. These effluents included chromium-contaminated coolant water and demineralizer system discharges containing resins, sulfuric acid, and sodium hydroxide. Portions of the pond were remediated in 1994, and in 1995, the liner was removed. The pond berm was bulldozed, and the area was graded and seeded with native grasses. Chromium is the only remaining COPC in the subsurface soil (the exposure concentration is 8.89 mg/kg) with HQs ranging from 2 for avian herbivores to 10 for avian insectivores. Because few positive habitat features are associated with this site, it may generally be discounted as contributing significantly to chronic COPC exposures for ecological receptors. The results of the risk evaluation are described for each of the seven remaining sites in the paragraphs below. Table 7-19 provides a summary of the results of the WAG 5 ERA process for all sites. It is important to reiterate that these results are based on dose predictions and comparisons to TRVs derived from the literature. Actual risks to ecological receptors from exposure to COPCs in soil at WAG 5 cannot be determined without additional site-specific investigations such as bioaccumulation studies and analyses of fate and transport and bioavailability.

7.4.3.1 ARA-01 (ARA-I Chemical Evaporation Pond). Site ARA-01 consists of a 2,990-m^2 unlined surface impoundment. The pond has not received wastewater since 1988 and is usually dry. The vegetation at the site includes grasses and shrubs, and the site is surrounded by areas of native vegetation. The COPCs are metals in surface and subsurface soil (from 0 to 7 ft). Hazard quotients for antimony, arsenic, cadmium, chromium, copper, lead, selenium, silver, thallium, vanadium, and zinc ranged from 1 to 1,000. Risks from these metals to reptiles could not be evaluated because of the lack of toxicity data to develop TRVs. In addition, risks to avian species could not be evaluated for antimony. The HQs for the COPCs at ARA-01 are discussed below.

- The HQs for exposure to antimony in soil at ARA-01 were 2 for mammalian omnivores (M422) and 10 for mammalian insectivores (M222). The site exposure concentrations of antimony are 16.8 mg/kg in surface soil and 14.7 mg/kg in subsurface soil. The maximum exposure is 16.8 mg/kg. The 95%/95% INEEL background for antimony is 4.8 mg/kg.

- The HQs for exposure to arsenic ranged from 5 to 8 for avian insectivores (AV221, 222, 222A); 3 for mammalian herbivores (M122, 122A); 3 to 20 for mammalian insectivores (M210A, 222), including three special concern bat species (Townsend's western big-eared bat, small-footed myotis, and long-eared myotis); and 4 for mammalian omnivores (M422).

Table 7-19. Summary of WAG 5 ERA results.[a]

Operable Unit	Site	Description	Ecological Risk Assessment Results
ARA-I			
5-10	**ARA-01**	**Chemical evaporation pond (ARA-745)**	**The COPCs include inorganics in surface and subsurface soil. Hazard quotients exceed 1.0 for terrestrial receptor exposures to antimony, arsenic, cadmium, copper, lead, selenium, silver, thallium, vanadium, and zinc.**
5-07	ARA-02	Septic tank soils and seepage pit (ARA-746)	The COPCs include barium, chromium(III), and copper. The HQs for barium are < 1 for all receptors; therefore, there is no expected risk to terrestrial receptors from exposure to barium. Chromium(III) exceeded a HQ of 1 only for plants and was eliminated as a COPC because only one of 6 sample concentrations exceeded the INEEL background value. The HQ for copper was 1 for mammalian insectivores. All other receptor HQs were less than 1. Copper was eliminated as a COPC because only one of 6 sample concentrations exceeded the INEEL background value. See Section 7.4.3.2.
5-07	ARA-03	Pad near ARA-627 (lead sheeting)	Arsenic is the COPC in surface and shallow subsurface soil. HQs are < 1 for all receptors; therefore, there is no expected risk to terrestrial receptors from exposure to arsenic.
—	ARA-04	Sewage Treatment Facility (ARA-737)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997) because it received only sanitary waste. There was no evidence of hazardous waste, and no contaminant source was found. See Table 7-2.
5-01	ARA-05	Evaporation pond to NE (ARA-744)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). No waste was generated or disposed of at the site. It received parking lot runoff only. See Table 7-2.
5-01	ARA-16	Radionuclide tank (ARA-729)	Fluoride is the COPC in surface soil. HQs are < 1 for all receptors; therefore, there is no expected risk to terrestrial receptors from exposure to fluoride.
5-01	ARA-17	Drain (ARA-626)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). There was neither history of hazardous waste being disposed of in the drain nor a contaminant source. See Table 7-2.
5-12	**ARA-25**	**ARA-I Soils Beneath the ARA-626 Hot Cells**	**The COPCs include metals in surface (and assumed in subsurface) soils. The HQs were < 1for chromium III and Aroclor-1254. The potential for risk applies to terrestrial receptors exposed to arsenic, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, vanadium, and zinc.**

Table 7-19. (continued)

Operable Unit	Site	Description	Ecological Risk Assessment Results
ARA-II			
5-05	ARA-06	SL-1 Burial Ground	The site has been capped. The pathway has been eliminated. See Table 7-2.
—	ARA-07	Seepage pit to east (ARA-720A)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). There was no evidence of hazardous waste entering this system and no contaminant source. See Table 7-2.
—	ARA-08	Seepage pit to west (ARA-720B)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). There was no evidence of hazardous waste entering this system and no contaminant source. See Table 7-2.
—	ARA-09	Septic tank (ARA-738)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). The site received only sanitary waste. There was neither evidence of hazardous waste nor a contaminant source. See Table 7-2.
—	ARA-10	Septic tank east (ARA-613)	The site was eliminated in ecologically based screening level (EBSL) screening. See Table 7-7.
—	ARA-11	Septic tank west (ARA-606)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). The site received only sanitary waste. There was neither evidence of hazardous waste nor a contaminant source. See Table 7-2.
5-01	ARA-19	Detention tank for fuel oil/radionuclides (ARA-719)	The tank was removed and residual soils will be assessed under OU 5-12, ARA-23.
5-12	ARA-23	Radiologically contaminated surface soils around ARA I and II	The site was eliminated in EBSL screening. See Table 7-8.
ARA-III			
5-06	**ARA-12**	**Radioactive waste leach pond**	**The COPCs include metals in surface and subsurface soil. HQs were < 1 for silver. Potential risk applies to terrestrial receptors from exposure to arsenic, cadmium, chromium, copper, manganese, mercury, selenium, and zinc. HQs for cadmium were as high as 2,000.**
5-11	ARA-13	Sanitary sewer leach field and septic tank (ARA-740)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). Soil sampling indicated no contamination above background. There was no contaminant source. See Table 7-2.
—	ARA-14	Septic tank and drain field (ARA-739)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). There was no evidence of the site receiving hazardous waste and no contaminant source. See Table 7-2.

Table 7-19. (continued)

Operable Unit	Site	Description	Ecological Risk Assessment Results
5-01	ARA-15	Radionuclide tank (ARA-735)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). The tank and any contaminated soil were removed. There was no contaminant source. See Table 7-2.
5-01	ARA-18	Radionuclide tank (ARA-736)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). The tank and any contaminated soil were removed. There was no contaminant source. See Table 7-2.
5-12	ARA-24	ARA-III windblown soils	The site was eliminated in EBSL screening. See Table 7-8.
ARA-IV			
5-06	ARA-20	Test Area contaminated leach Pit 1	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). The pit was cleaned up to below acceptable risk-based levels as part of a 1987 D&D effort. There was neither a contaminant pathway nor source. See Table 7-2.
—	ARA-21	Test Area septic tank and leach Pit 2	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). There was no evidence of the site receiving hazardous waste and no contaminant source. See Table 7-2.
—	ARA-22	Control area septic tank and leach Pit 3 (ARA-617)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). There was neither a record of this site receiving hazardous constituents nor a contaminant source. See Table 7-2.
PBF Control Area			
—	PBF-01	Control area septic tank (PBF-724), seepage pit (PBF-735)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). There was no evidence that this site received hazardous constituents and no contaminant source. See Table 7-2.
—	PBF-02	Control area septic tanks (PBF-738, 739), seepage pit (PBF-736)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). There was no evidence of receiving hazardous constituents and no contaminant source. See Table 7-2.
—	PBF-03	Control area septic tank for PBF-632 and seepage pits (PBF-745, 748)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). There was no evidence that this site received hazardous waste and no contaminant source. See Table 7-2.
5-04	PBF-04	Control area oil tank at PBF-608 (substation) outside PBF fence	Xylene is the COPC in surface soil at this very small site (11 m^2). HQs are < 1 for all mammalian receptors; therefore, there is no expected risk to terrestrial receptors from exposure to xylene. Risks to birds, reptiles, and plants could not be evaluated..

Table 7-19. (continued)

Operable Unit	Site	Description	Ecological Risk Assessment Results
5-12	PBF-32	Fuel oil tank (PBF-742)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). All remaining contamination was at basalt bedrock a depth greater than 3 m (10 ft). There was no contaminant pathway. See Table 7-2.
PBF Reactor Area (SPERT-I)			
5-08	PBF-05	Warm waste injection well (PBF-301)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). The well has a steel casement to a depth of 33.5 m (110 ft). No pathway. See Table 7-2.
5-03	PBF-06	Blowdown pit for reactor boiler by PBF-621	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). There was no evidence of hazardous contaminants entering the ditch and no contaminant source. See Table 7-2.
5-03	PBF-07	Oil drum storage (PER-T13)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). There was neither a contaminant source nor a pathway. See Table 7-2.
5-13	**PBF-08**	**Corrosive waste disposal sump brine tank (PBF-731)**	**The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). An unlined concrete sump extending 5.5 m (18 ft) below ground surface. There was no contaminant pathway. See Table 7-2.**
—	PBF-09	Septic tank and drain field (PBF-728)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). There was no evidence that this site received hazardous waste and no contaminant source. See Table 7-2.
5-13	PBF-10	Evaporation pond (PBF-733)	Chromium is the COPC in surface soil. Based on dose predictions and HQ calculations, there is a potential for risk to terrestrial receptors from exposure to chromium in soil at this site. HQs for chromium ranged from 1 to 3.
5-08	PBF-11	Seepage pit (PBF-750)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). There was no contaminant source. See Table 7-2.
5-02	PBF-12	Leach pond	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). The site was remediated. There was no contaminant source. See Table 7-2.
5-03	PBF-13	Rubble pit	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). This site contained construction debris only. The area was cleaned up and backfilled. There was no contaminant source. See Table 7-2.
5-08	PBF-15	Corrosive waste injection well (PBF-302)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). There was no contaminant pathway. See Table 7-2.

Table 7-19. (continued)

Operable Unit	Site	Description	Ecological Risk Assessment Results
5-03	PBF-28	Cooling tower area and drainage ditch	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). This site received cooling tower effluent only. There was no contaminant source. See Table 7-2.
5-12	PBF-30	Abandoned septic system	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). There was no evidence of hazardous constituents disposed of to this system. There was no contaminant source. See Table 7-2.
PBF-WEDF (SPERT-II)			
5-04	PBF-14	Inactive fuel oil tank (front of PBF-612)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). The site was remediated. There was no contaminant source. See Table 7-2.
5-09	**PBF-16**	**Leach pond**	**COPCs include lead and mercury in soil.**
—	PBF-17	Septic tank and seepage pit (PBF-725)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). There was neither evidence of hazardous waste nor a contaminant source. See Table 7-2.
5-12	PBF-31	Fuel oil tank (PBF-732)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). All remaining contamination was at basalt bedrock at a depth greater than 3 m (10 ft). There was no contaminant pathway. See Table 7-2.
PBF-WERF (SPERT-III)			
5-04	PBF-19	Inactive fuel oil tank at PBF-609 (west side of WERF)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). Contaminated soil was removed when the tank was removed in 1986 and the area was paved over. There was neither a contaminant source nor a pathway. See Table 7-2.
5-09	PBF-20	Small leach pond	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). There was no contaminant source. See Table 7-2.
5-02	**PBF-21**	**Large leach pond**	**COPCs are cobalt and copper in subsurface soil (depths of 5 to 8 ft). HQs are between 1 and 6 for cobalt and ≤ 2 for copper. Risks are considered very low because of the depth of the contamination and the exposure concentrations barely exceed background values for both contaminants.**
—	PBF-27	Septic tank (PBF-726) and seepage pit	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). There was neither evidence of hazardous waste nor a contaminant source. See Table 7-2.

Table 7-19. (continued)

Operable Unit	Site	Description	Ecological Risk Assessment Results
PBF-MWSF (SPERT-IV			
5-09	**PBF-22**	**Leach pond (PBF-758)**	**The COPCs are metals in surface and subsurface soils. The potential for risk occurs from terrestrial receptor exposures to arsenic, copper, lead, mercury, nickel, and selenium.**
5-03	PBF-24	Blowdown pit (adjacent to PBF-716)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). There was neither evidence of hazardous waste nor a contaminant source. See Table 7-2.
—	PBF-25	Septic tank and leach pit (PBF-727 and 757)	The site was eliminated in ecological site screening and data gap identification in the WAG 5 Work Plan (DOE-ID 1997). There was neither evidence of hazardous waste nor a contaminant source. See Table 7-2.
5-02	**PBF-26**	**Lake (adjacent to PBF-758)**	**The COPCs are Aroclor-1254 and metals in surface soil. The potential for risk to terrestrial receptors occurs from exposure to Aroclor-1254, arsenic, chromium, copper, lead, mercury, nickel, and zinc.**

a. Sites shown in bold are those with a potential for risk to ecological receptors.

The calculated site exposure concentrations of arsenic are 22.1 mg/kg in surface soil and 17.3 in subsurface soil. The INEEL mean background for arsenic is 4.46 mg/kg.

- The HQs for exposure to cadmium (the maximum is in surface soil at 3.80 mg/kg and the subsurface soil concentration is 1.9 mg/kg) ranged from 3 for avian carnivores (AV322), avian insectivores (AV210), and avian herbivores (AV122); to a maximum of 1,000 for mammalian insectivores (M222). The INEEL 95%/95% UTL background concentration for cadmium is 2.2 mg/kg. Therefore, an average species may be exposed to the same magnitude of risk from exposure to background.

- Assuming chromium is present in soil at ARA-01 in the trivalent state [chromium(III)] (see previous discussion in Section 7.3.4), only avian insectivores (AV221 and AV222) have HQs of 1.0 from exposure to chromium at the maximum concentrations of 69.0 mg/kg (surface) and 28.5 mg/kg (subsurface). These groups are modeled with conservative BAFs (1.0) and it is not anticipated that this exposure will occur. The INEEL 95%/95% UTL background concentration for chromium, 33 mg/kg, is close to the site exposure concentrations. Therefore, this contaminant was eliminated as a COPC.

- The HQs for copper at ARA-01 ranged from 1 to 5 for avian insectivores and mammals including the pygmy rabbit and bats. The maximum copper concentration at ARA-01 is 25.5 (surface and subsurface soils). The INEEL 95%/95% UTL background concentration for copper is 22 mg/kg (Rood, Harris, and White 1996).

- The HQs for lead ranged from 1 for avian insectivores (AV210) to 60 for avian insectivores (AV222). Other groups with HQs exceeding 1.0 include avian herbivores (AV122), insectivores (AV210A, 221, and 222A), avian carnivores (AV322), loggerhead shrike, and avian omnivores (AV422). The site exposure concentrations for lead are 25.3 mg/kg in surface soil and 27.6 mg/kg in subsurface soil. The mean INEEL background concentration for lead is 12.9 mg/kg.

- The HQs for exposure to selenium in surface soil (22.7 mg/kg) at ARA-01 ranged from 2 for avian insectivores (AV210) and avian omnivores (AV422) to 300 for mammalian insectivores (M222). Mammalian herbivores (including pygmy rabbit) also have HQs exceeding 1.0. The INEEL 95%/95% UTL background concentration for selenium is 0.22 mg/kg, two orders of magnitude lower than the site exposure concentration.

- Thallium exposure concentrations at ARA-01 are 37.3 mg/kg in surface soil and 35.8 mg/kg in subsurface soil. The HQs for exposure to thallium at these concentrations ranged from 2 for avian omnivores (AV422) to a maximum of 300 for mammalian insectivores (M222). The special concern bat species and pygmy rabbit also are potentially at risk from exposure to thallium in soil at this site. The INEEL mean background concentration for thallium is 0.237 mg/kg, two orders of magnitude lower than the site exposure concentrations.

- The HQs for silver at ARA-01 ranged from 2 for avian insectivores to a maximum of 3 for plants. Avian insectivores are modeled using the conservative BAF default of 1.0 (herbivores are modeled with a BAF of 0.4) to assess exposure. This level of exposure to avian insectivores is not anticipated to occur and the use of more realistic BAF would likely reduce the HQs for these receptors. The silver benchmark is taken from Will and Suter (1995), who state that "There were no primary reference data showing toxicity of Ag to plants grown in soil. Confidence is low in the benchmark because it is based on a report of unspecified toxic effects on plants grown in a surface soil with the addition of 2 ppm Ag

(Kabata-Pendias and Pendias 1984)." Therefore, this contaminant was eliminated as a COPC at this site.

- The HQs for exposure to vanadium in surface (68.0 mg/kg) and subsurface soil (49.8 mg/kg) at ARA-01 ranged from 1 for the pygmy rabbit to 200 for avian insectivores (AV221, 222). Plants, the special concern bat species, mammalian omnivores (M422), insectivores (M123, 210, 210A, 222), herbivores (M122, 122A), avian omnivores (AV422), and insectivores (AV210, 210A, 222A) also have HQs exceeding 1.0. The INEEL 95%/95% UTL background concentration for vanadium is 45 mg/kg.

- The HQs for zinc at ARA-01 ranged from 1 from mammalian herbivores (M122) to 20 for avian insectivores (AV221). Mammalian insectivores (M222), mammalian herbivores (M122A), and other avian insectivores have HQs greater than 1.0 from zinc exposure. The site concentration for zinc is 233 mg/kg in surface and subsurface soils. The INEEL 95%/95% UTL background zinc concentration is 150 mg/kg.

In summary, based on dose and HQ calculations and background comparisons, the primary potential risk-drivers at ARA-01 include antimony, arsenic, cadmium, copper, selenium, silver, thallium, vanadium, and zinc in soil. However, many of the higher (>100) HQs are shown for avian insectivores. In most cases, avian insectivores are modeled using the conservative BAF default of 1.0 (see Table 7-15) to assess exposure. This level of exposure to these species (avian insectivores) is not anticipated to occur and the use of more realistic BAF would likely reduce the HQs for these receptors significantly.

7.4.3.2 ARA-02 (ARA-I Sanitary Waste Leach Field and Seepage Pit). ARA-02 is a 223-m^2 site that consists of three septic tanks, a seepage pit, and piping that are no longer in use. The site vegetation includes grasses and shrubs. Only the soils external to the septic tank and seepage pit were assessed for the ERA. The soils surrounding the seepage pit were eliminated from further evaluation in Table 7-8, 7-9, and 7-10. The contaminants for which the HQ equaled or exceeded 1 include barium, chromium, and copper. Risks from these metals to reptiles could not be evaluated because of the lack of toxicity data to develop TRVs. Risks to plants could not be evaluated for acetone, and birds could not be assessed for threats from exposure to acetone or silver. The HQs for the COPCs at the seepage pit are discussed below.

- Barium HQs at ARA-02 were all below 1.0.

- Chromium HQs (which assume chromium is in the trivalent state in soil) showed only a potential risk to plants at 1.0. Chromium was detected in subsurface soil (at a depth of 8 to 8.5 ft) at exposure concentrations of 183 mg/kg. The next highest hit (out of 6) is 24.3 mg/kg. The INEEL background value is 33 mg/kg for chromium. The contaminant is eliminated from further evaluation for this site.

- The maximum copper HQs at ARA-02 seepage pit was 1 for mammalian insectivores (M222). Mammalian insectivores also are potentially at risk from exposure to copper at 26.3 mg/kg in subsurface soil at 8 to 8.5 ft. The INEEL background concentration for copper is 22 mg/kg. The next highest detected concentration (out of 6) was 9.9 mg/kg. Mammalian insectivores are modeled using the conservative BAF default of 1.0 (see Table 7-15) to assess exposure. This level of exposure to these species is not anticipated to occur and the use of more realistic BAF would likely reduce the HQs for these receptors significantly. Therefore, the contaminant was eliminated from further evaluation for this site.

The risk evaluation indicates that ARA-02 has limited risk to ecological receptors from exposure to soils external to the seepage pit.

7.4.3.3 ARA-03 Pad Near ARA-27. The ARA-03 site is an 84-m^2 (900-ft^2) area of surface soil contaminated with radionuclides from an unknown source. The radionuclide contamination was not retained for evaluation in the ERA (see Table 7-8). The site was covered with lead sheeting, which was removed in 1991. Soils were excavated to a depth of 1.1 m (3.5 ft) in a 60-m^2 (676-ft^2) area during a 1994 removal action. The area was subsequently backfilled and seeded. The site is currently covered primarily by crested wheatgrass. Arsenic was the only COPC in surface and subsurface soils and all HQs were less than 1.0 (see Appendix I).

7.4.3.4 ARA-12 (ARA-III Radioactive Waste Leach Pond). Site ARA-12 is a 5,748-m^2 (1.4-acre) unlined surface impoundment in a natural depression. The pond has not been active since 1991 and is usually dry except during periods of high precipitation. The site is unfenced and covered predominantly with grasses, and some junipers and willows. Hazard quotients for arsenic, cadmium, chromium, copper, lead, mercury, selenium, silver, and zinc equal or exceed 1. Risks from these metals to reptiles could not be evaluated because of the lack of toxicity data to develop TRVs. The HQs for the COPCs at ARA-12 are discussed below.

- The HQs for arsenic ranged from 1 to 7 for avian insectivores (AV221, 222, 222A), three bat species of special concern, and mammalian insectivores (M222) and omnivores (M422). The arsenic concentration at ARA-12 is 7.28 mg/kg for samples obtained from 0 to 7 ft. The INEEL background (Rood, Harris, and White 1996) concentration for arsenic is 5.80 mg/kg. However, it is recognized that arsenic concentrations across WAG 5 may be considerably higher (Martin et al. 1990) than the Site-wide background concentration developed by Rood, Harris, and White (1996). No known source of this contaminant is associated with ARA-12. Because the site concentration is so close to the background concentration, the contaminant was eliminated from further evaluation.

- The HQs for cadmium ranged from 1 to 2,000 for both avian and mammalian species including several species of special concern (the loggerhead shrike, burrowing owl, pygmy rabbit, and three bat species), and plants. The cadmium concentration in surface soil at ARA-12 is 6.52 mg/kg. The INEEL-wide background for cadmium is 2.20 mg/kg (Rood, Harris, and White 1996).

- The HQs for chromium(III) ranged from 1 to 9 for avian insectivores (AV210A, 221, 222, and 222A), the loggerhead shrike, and plants. In the absence of speciation analysis for metals, this assessment was performed assuming chromium in soil at WAG 5 is present in the trivalent form. The chromium concentration in surface soil at ARA-12 is 469 mg/kg. The INEEL-wide background concentration for chromium is 33 mg/kg.

- The HQs for copper at ARA-12 ranged from 1 to 300 for avian insectivores and mammals including the pygmy rabbit and bats. The maximum copper concentration at ARA-12 is 623 mg/kg (surface soil). The INEEL background concentration for copper is 22 mg/kg (Rood, Harris, and White 1996).

- The HQs for lead at ARA-12 ranged from less than 1 to 300. The HQs exceed 1.0 for all mammalian and avian herbivores, insectivores, and omnivores groups from lead exposure at this site. The site concentration for lead is 158 mg/kg. The INEEL-wide background for lead in 17 mg/kg (Rood, Harris, and White 1996).

- The manganese HQs for avian receptors ranged between 1 (AV210, AV222A) and 2 (AV221, AV222). For mammalian herbivores, HQs ranged from 10 (pygmy rabbit) to 40 (M122, M122A). HQs for mammalian insectivores were between 2 (M210) and 40 (M222), including HQs ranging from 7 to 10 for three bat species of concern. The manganese HQ for plants was 1. The maximum site concentration is 570 mg/kg in surface soil. The INEEL background concentration for manganese is 490 mg/kg (Rood, Harris, and White 1996).

- The HQs for mercury ranged from 1 to 90 for plants and for avian herbivores (AV121 and 122) and mammals including the pygmy rabbit and bats. Mercury was detected at 1.40 mg/kg in surface soil at ARA-12, which is two orders of magnitude higher than the INEEL background soil concentration for mercury of 0.05 mg/kg (Rood, Harris, and White 1996).

- The HQs for selenium ranged from 1 to 30 for avian insectivores (AV221, 222, and 222A) and mammalian species including the three bat species of special concern. The selenium concentration in soil at ARA-12 is 1.37 mg/kg. The INEEL background concentration for selenium is 0.22 mg/kg (Rood, Harris, and White 1996).

The HQs for silver at ARA-12 were 1 for avian insectivores and plants. Avian insectivores are modeled using the conservative BAF default of 1.0 (herbivores are modeled with a BAF of 0.4) to assess exposure. This level of exposure to these species (avian insectivores) is not anticipated to occur and the use of more realistic BAF would likely reduce the HQs for these receptors. The silver benchmark is taken from Will and Suter (1995), who state that "There were no primary reference data showing toxicity of Ag to plants grown in soil. Confidence is low in the benchmark because it is based on a report of unspecified toxic effects on plants grown in a surface soil with the addition of 2 ppm Ag (Kabata-Pendias and Pendias 1984)." Therefore, this contaminant was eliminated as a COPC at this site.

- The HQs for zinc ranged from 1 to 50 for birds, including the loggerhead shrike, mammals including the pygmy rabbit and the three bat species of special concern. The zinc concentration at ARA-12 is 376 mg/kg. The INEEL-wide background concentration for zinc is 150 mg/kg (Rood, Harris, and White 1996).

In summary, based on dose and HQ calculations and background comparisons, the primary potential risk-drivers at ARA-12 include cadmium, chromium, copper, lead, manganese, mercury, selenium, silver, and zinc in soil. Because few positive habitat features are associated with this site, it may generally be discounted as contributing significantly to chronic COPC exposures for ecological receptors.

7.4.3.5 ARA-16 ARA-I Radionuclide Underground Storage Tank in Concrete Vault. Potential receptors at this site were assessed for exposure to fluoride. The TRVs for plants and reptiles could not be assessed because toxicity data were not available. However, all other terrestrial receptors had HQs less than 1.0. This site is removed as a concern.

7.4.3.6 ARA-25 ARA-I Soils Beneath the ARA-626 Hot Cells. Potential receptors at this site were assessed for exposure to metals and Aroclor-1254. Hazard quotients for chromium and Aroclor-1254 were less than 1. Hazard quotients exceeded 1 for arsenic, copper, lead, manganese, mercury, nickel, selenium, silver, vanadium and zinc.

- Aroclor-1254 HQs were all less than 1.0. However, plants and reptilian receptors were not assessed because no toxicity data were available. The maximum Aroclor-1254 concentration in surface soil at ARA-25 is 0.160 mg/kg. No INEEL background concentration is available for Aroclor-1254.

- The arsenic HQs range from ≤1 to 5 for avian insectivores (AV221, 222, 222A) and from ≤1 to 20 for mammalian insectivores (M222), including HQs of ≤1 for three bat species of concern. The HQs are ≤1 for mammalian omnivores (M422, M422A). The maximum arsenic concentration at ARA-25 is 40.6 mg/kg for surface soil samples. The INEEL background concentration for arsenic is 5.80 mg/kg (Rood, Harris, and White 1996). No TRV data are available to assess reptilian receptors (R222, R322).

- The HQs for chromium(III) were all less than 1. In the absence of speciation analysis for metals, this assessment was performed assuming chromium in soil at WAG 5 is present in the trivalent form. The maximum chromium concentration in surface soil at ARA-25 is 98.4 mg/kg. The INEEL background concentration for chromium is 33 mg/kg (Rood, Harris, and White 1996). No TRV data are available to assess reptilian receptors (R222, R322).

- The HQs for cobalt at ARA-25 ranged from <1 to 2 for avian herbivores (AV121, AV122), 2 to 40 for avian insectivores (AV210A, AV221, 222, 222A), 4 to 5 for three bat species of special concern, and from <1 to 50 for mammalian herbivores (M121, M 122, M122A, M123) including an HQ of 20 for the pygmy rabbit. The HQs for mammalian insectivores (M210, M210A, M222) ranged from 1 to 90, and from ≤1 to 7 for mammalian omnivores (M422, M422A). The maximum cobalt soil concentration is 104 mg/kg. The INEEL background concentration for cobalt is 11 mg/kg (Rood, Harris, and White 1996). No TRV data are available to assess reptilian receptors (R222, R322).

- The HQs for copper at ARA-25 range from ≤1 to 5 for avian insectivores (AV210A, AV221, 222, 222A), 3 to 10 for mammalian herbivores including the pygmy rabbit (M121, M 122, M122A, M123) and ≤1 to 40 for mammalian insectivores (including an HQ of 2 for all bats). The HQ is 4 for mammalian omnivores (M422). The maximum copper concentration in soil at ARA-25 is 227 mg/kg. The INEEL background concentration for copper is 22 mg/kg (Rood, Harris, and White 1996). No TRV data are available to assess reptilian receptors (R222, R322).

- The HQs for lead at ARA-25 range from 2 to 30 for avian herbivores (AV121, AV122), 20 to 900 for avian insectivores (AV210A, AV221, 222, 222A). The HQs ranged from ≤1 to 4 for mammalian herbivores (M121, M 122, M122A, M123), including an HQ of 1 for the pygmy rabbit, and from ≤1 to 20 for mammalian insectivores (including an HQ of ≤1 for bats). The HQs were ≤1 to 3 for mammalian omnivores (M422, M422A). The lead HQ for plants is 1. The maximum site concentration for lead is 1430 mg/kg and the INEEL background is 17 mg/kg (Rood, Harris, and White 1996). No TRV data are available to assess reptilian receptors (R222, R322).

- The manganese HQs for avian insectivores (AV221, AV222) range from ≤1 to 2. For mammalian herbivores (M122, M122A), HQs range from 1 (pygmy rabbit) to 3. The HQs for mammalian insectivores ranged from ≤1 to 6 (M210, M210A, M222), including HQs of ≤1 for three bat species of concern. The manganese HQ for plants is 3. The maximum site concentration is 1400 mg/kg in surface soil. The INEEL background concentration for manganese is 490 mg/kg (Rood, Harris, and White 1996). No TRV data are available to assess reptilian receptors (R222, R322).

- The HQs for mercury were <1 for all receptors except mammalian insectivores (M222), for which the HQ was 3. Mercury was detected at 0.097 mg/kg in surface soil at ARA-25, and exceeds the INEEL background soil concentration for mercury of 0.05 mg/kg (Rood, Harris, and White 1996). No TRV data are available to assess reptilian receptors (R222, R322).

- The HQs for nickel were <1 for all receptors except avian insectivores (AV222A) with an HQ of 2 and mammalian insectivores (M222) for which the HQ was 6. Nickel was detected at 38.8 mg/kg in surface soil at ARA-25, and exceeds the INEEL background soil concentration of 35 mg/kg (Rood, Harris, and White 1996). No TRV data are available to assess reptilian receptors (R222, R322).

- The HQs for selenium were <1 for all receptors except mammalian insectivores (M222) for which the HQ is 3. Selenium was detected at 0.659 mg/kg in surface soil at ARA-25, and exceeds the INEEL background soil concentration of 0.22 mg/kg (Rood, Harris, and White 1996). No TRV data are available to assess reptilian receptors (R222, R322).

- The HQs for silver at ARA-25 are <1 for all receptors except plants, for which the HQ is 1. Silver was detected at 7.24 mg/kg in surface soil at ARA-25 and no INEEL background concentration is available. The silver benchmark of 2 ppm is taken from Will and Suter (1995), who state that "There were no primary reference data showing toxicity of Ag to plants grown in soil. Confidence is low in the benchmark because it is based on a report of unspecified toxic effects on plants grown in a surface soil with the addition of 2 ppm Ag (Kabata-Pendias and Pendias 1984. No TRV data are available to assess reptilian receptors (R222, R322).

- The HQs for zinc range from 1 to 50 for birds, including the loggerhead shrike, mammals including the pygmy rabbit and the three bat species of special concern. The HQ for plants is 30. The zinc concentration at ARA-25 is 855 mg/kg. The INEEL background concentration for zinc is 150 mg/kg (Rood, Harris, and White 1996). No TRV data are available to assess reptilian receptors (R222, R322).

In summary, based on dose and HQ calculations and background comparisons, the primary potential risk-drivers at ARA-25 include arsenic, copper, lead, manganese, mercury, selenium, silver, vanadium and zinc in soil.

7.4.3.7 PBF-04 Control Area Oil Tank. Potential receptors at this site were assessed for exposure to xylene. Plants, avian, and reptile receptors could not be assessed because of the lack of toxicity data. However, all other terrestrial receptors had HQs less than 1.0. This site is removed as a concern.

7.4.3.8 PBF-10 Evaporation Pond. Potential receptors at this site were assessed for exposure to chromium(III). The chromium HQs for avian insectivores were 2 (AV222) and 3 (AV221, AV222A) and 2 for plants. The site maximum concentration is 309 mg/kg in surface soil. The INEEL background concentration for chromium is 33 mg/kg (Rood, Harris, and White 1996).

7.4.3.9 PBF-16 SPERT-II Leach Pond. This site is a fenced, unlined surface impoundment that was used for disposal of demineralizer effluent, water softener waste, and discharges from drains in reactor building from 1959 to 1964. The site is approximately 3,570 m^2 (38,400 ft^2). Lead and mercury are the COPCs for PBF-16. Site exposure concentrations are 32 mg/kg and 0.71 mg/kg, respectively.

The HQs for lead ranged from 1 for mammalian insectivores to 60 for avian insectivores. Avian herbivores, omnivores, and carnivores also have HQs greater than 1.0 (at a maximum of 4.0 for the loggerhead shrike). Insectivores (both avian and mammalian) are modeled using the conservative BAF default of 1.0 to assess exposure. This level of exposure to insectivores is not anticipated to occur and the use of more realistic BAF would likely reduce the HQs for these receptors. The maximum lead concentration used at PBF-16 was 32.0 mg/kg in subsurface soil below 8 ft of clean fill. The 95%/95% UTL for lead composite background samples at the INEEL is 17 mg/kg (Rood, Harris, and White 1996).

The HQs for mercury ranged up to 50 for mammalian insectivores at PBF-16. Avian and mammalian herbivores have HQs that exceed 1.0 including the pygmy rabbit (HQ = 10). The maximum site concentration for mercury is 0.71 mg/kg in subsurface soil below 8 ft of clean fill. The 95%/95% UTL for mercury composite background samples at the INEEL is 0.05 mg/kg (Rood, Harris, and White 1996).

7.4.3.10 PBF-21 SPERT-III Large Leach Pond. This pond received waste from the sump pump in the SPERT-III reactor building from 1958 to 1968. The pond was backfilled with clean fill, leveled, and seeded with native vegetation in 1983 as part of the D&D program. The 288-m^2 (3,099-ft^2) site is surrounded by native sagebrush. Only cobalt and copper exposures produced HQs equal to or in excess of 1. The HQs for cobalt ranged from 1 for avian insectivores (AV222) to 6 for mammalian insectivores (M222). Other species with HQs exceeding 1.0 include avian insectivores (AV221) and mammalian herbivores (M122, 122A, and 123). The site exposure concentration of cobalt is 12.6 mg/kg in subsurface soil, which exceeds the INEEL mean background value for cobalt of 4.7 mg/kg. Therefore, potential risks from exposure to cobalt are expected to be minimal. The HQ for copper was 2 for mammalian insectivores (M222) at a concentration of 23.5 mg/kg in subsurface soil. The INEEL background concentration for copper is 22 mg/kg (Rood, Harris, and White 1996).

7.4.3.11 PBF-22 SPERT-IV Leach Pond. This leach pond *was* an unlined impoundment that received effluent from the SPERT-IV reactor until 1970. In the early 1980s, the pond received contaminated primary coolant effluent from the PBF Reactor. In 1985, a limited amount of radionuclide-contaminated soil was removed from the pond. The vegetation at the 5,008-m^2 (1.2-acre) site includes tall sagebrush, rabbitbrush, and grasses. The HQs for arsenic, copper, lead, mercury, nickel, selenium, and silver equal or exceed 1. Risks from these metals to reptiles could not be evaluated because of the lack of toxicity data to develop TRVs. The HQs for the COPCs at PBF-22 are discussed below.

- Aroclor-1248 and Aroclor-1254 HQs were all less than 1.0. However, plants and reptilian receptors were not assessed because no toxicity data were available.

- The HQs for arsenic ranged from 1 to 8 for avian insectivores (AV221, 222, and 22A), mammalian insectivores (M222) including bats, and mammalian omnivores (M422). The calculated arsenic concentration at PBF-22 is 8.11 mg/kg. The INEEL mean concentration for arsenic is 4.46 mg/kg background with a standard deviation of 0.67 mg/kg (Rood, Harris, and White 1996). The site concentration is close to the mean background value; therefore, ecological risks from arsenic at PBF-22 are considered low.

- The HQs for copper ranged from 2 to 20 for avian insectivores and mammals, including the pygmy rabbit and three bat species of special concern. The calculated concentration of copper at PBF-22 is 48.4 mg/kg in surface soil. The INEEL mean background concentration for copper is 13.2 mg/kg (Rood, Harris, and White 1996).

- The HQs for lead ranged from 2 to 40 for birds including the loggerhead shrike, a species of concern. The calculated exposure concentrations for lead at PBF-22 is 18.2 mg/kg. The average INEEL-wide background concentration for lead is 12.9 mg/kg (Rood, Harris, and

White 1996). This concentration is very close to the mean site concentration; therefore, ecological risks from lead at PBF-22 are considered low.

- The HQs for mercury ranged from 2 to 20 at PBF-22 for avian herbivores (AV122) and mammals including the pygmy rabbit. The calculated site concentration of mercury is 0.259 mg/kg. The INEEL mean background soil concentration for mercury is 0.03 mg/kg (Rood, Harris, and White 1996).

- The HQs for selenium ranged from 1 to 20 for avian insectivores and mammals including three bat species of special concern. The calculated PBF-22 concentration of selenium is 1.70 mg/kg. The INEEL mean background concentration for selenium is 0.12 mg/kg (Rood, Harris, and White 1996).

- The HQs for silver at PBF-22 ranged from 2 for plants to a maximum of 3 for avian insectivores. Avian insectivores are modeled using the conservative BAF default of 1.0 (herbivores are modeled with a BAF of 0.4) to assess exposure. This level of exposure to avian insectivores is not anticipated to occur and the use of more realistic BAF would likely reduce the HQs for these receptors. The silver benchmark is taken from Will and Suter (1995), who state that "There were no primary reference data showing toxicity of Ag to plants grown in soil. Confidence is low in the benchmark because it is based on a report of unspecified toxic effects on plants grown in a surface soil with the addition of 2 ppm Ag (Kabata-Pendias and Pendias 1984)." Therefore, this contaminant was eliminated as a COPC at this site.

The primary potential risk drivers at PBF-22 include copper, mercury, and selenium in soil.

7.4.3.12 PBF-26 SPERT-IV Lake. Site PBF-26 is a 20,092-m^2 (about 5-acre) unlined surface impoundment that was used for discharge of reactor secondary cooling water until 1992. The site has been revegetated with crested wheatgrass and is adjacent to tall sagebrush and basalt outcrop communities. Hazard quotients for Aroclor-1254, arsenic, chromium, copper, lead, mercury, nickel, silver, and zinc equal or exceed 1. Reptiles could not be evaluated because of the lack of toxicity data to develop TRVs. The HQs for the COPCs at PBF-26 are discussed below.

- The HQs were equal to 9 for avian insectivores (AV222A) and mammalian herbivores (M122A) exposure to Aroclor-1254 in soil at PBF-26. For the pygmy rabbit, the HQ was equal to 1. The site concentration of Aroclor-1254 is 13.0 mg/kg in surface soil.

- The chromium HQs for avian insectivores were 1 for AV222A and 2 for AV222. The PBF-26 concentration of chromium is 64 mg/kg. The INEEL-wide background concentration for chromium is 33 mg/kg (Rood, Harris, and White 1996). Avian insectivores are modeled with a default BAF of 1.0. Exposure at this level is highly unlikely. Therefore, risk to ecological receptors resulting from exposure to chromium at PBF-26 is considered low.

- The HQs ranged from 2 to 100 for copper for avian herbivores (AV122), insectivores (AV210, 210A, 222, 222A), mammals including the pygmy rabbit and three bat species of special concern, and plants. The maximum site concentration of copper is 234 mg/kg. The INEEL 95%/95% UTL background concentration for copper is 22 mg/kg (Rood, Harris, and White 1996).

- The HQs ranged from 1 to 80 for lead for avian species including the loggerhead shrike and burrowing owl, and the HQs were equal to 1 for bats and mammalian omnivores (M422). The maximum concentration of lead in surface soil at PBF-26 is 43 mg/kg. The INEEL-wide 95%/95% UTL background concentration for lead is 17 mg/kg (Rood, Harris, and White 1996).

- The HQs ranged from 1 to 20 for mercury for avian herbivores (AV121, 122) and mammals including the pygmy rabbit and three bat species of special concern. The mercury HQ was equal to 1 for plants. The maximum concentration of mercury at PBF-26 is 0.34 mg/kg. The INEEL 95%/95% UTL background soil concentration for mercury is 0.05 mg/kg (Rood, Harris, and White 1996).

- The HQs ranged from 1 to 20 for nickel for avian insectivores (AV210, 210A, 221, 222, and 222A), mammals including bats, and plants. The maximum site concentration of nickel is 45 mg/kg. The INEEL 95%/95% UTL background concentration for nickel is 35 mg/kg (Rood, Harris, and White 1996).

- The HQs for silver at PBF-26 ranged from 3 for plants to a 2 and a maximum of 4 for avian insectivores. Avian insectivores are modeled using the conservative BAF default of 1.0 (herbivores are modeled with a BAF of 0.4) to assess exposure. This level of exposure to avian insectivores is not anticipated to occur and the use of more realistic BAF would likely reduce the HQs for these receptors. The silver benchmark is taken from Will and Suter (1995), who state that "There were no primary reference data showing toxicity of Ag to plants grown in soil. Confidence is low in the benchmark because it is based on a report of unspecified toxic effects on plants grown in a surface soil with the addition of 2 ppm Ag (Kabata-Pendias and Pendias 1984)." Therefore, this contaminant was eliminated as a COPC at this site.

- The HQs ranged from 2 to 30 for zinc for avian species including the loggerhead shrike, for mammals including the pygmy rabbit and three bat species of special concern, and for plants. The maximum concentration of zinc is 259 mg/kg. The INEEL-wide 95%/95% UTL background concentration for zinc is 150 mg/kg (Rood, Harris, and White 1996).

The primary potential risk drivers at PBF-26 include Aroclor-1254, arsenic, chromium, copper, lead, mercury, nickel, and zinc.

7.4.4 Discussion of Uncertainty

Uncertainty is inherent in the risk process and has been discussed in detail throughout this document. Principal sources of uncertainty lie within the use of data not specifically collected for ecological risk assessment and in the development of the exposure assessment. Uncertainties inherent in the exposure assessment are associated with estimation of receptor ingestion rates, selection of acceptable HQs, estimation of site usage, and estimation of PUFs and BAFs. Additional uncertainties are associated with the depiction of site characteristics, the determination of the nature and extent of contamination, and the derivation of TRVs. A large area of uncertainty is the inability to evaluate risk to many receptors because of the lack of appropriate toxicity data for many chemicals. This is especially a problem for certain receptors such as reptiles. The species for which TRVs could not be developed for WAG 5 COPCs are identified in Table 7-18. In addition, because of the conservative nature of the EBSL development, EBSLs for some chemicals are lower than their sample quantitation and detection limits. In the WAG 5 analysis, this occurs for PCBs and some other organics. All of these uncertainties likely influence risk estimates. The major sources and effects of uncertainties in the ERA are reviewed in Table 7-20.

Table 7-20. Source and effects of uncertainties in the ecological risk assessment.

Uncertainty factor	Effect of uncertainty (level of magnitude)	Comments
Estimation of ingestion rates (soil, water, and food)	May result in an overestimate or underestimate of risk (moderate).	Few intake (ingestion estimates used for terrestrial receptors are based on data in the scientific literature [preferably site-specific]) when available. Food ingestion rates are calculated by using allometric equations available in the literature (Nagy 1987). Soil ingestion values are generally taken from Beyer, Connor, and Gerould (1994).
Estimation of concentration factors and plant uptake factors	May result in an overestimate or underestimate of risk, and the magnitude of error cannot be quantified (high).	Few BAFs or PUFs are available in the literature because they must be both contaminant- and receptor-specific. In the absence of more specific information, PUFs and BAFs are obtained from Baes et al. (1984) for metals and elements, and from Travis and Arms (1988) for organics.
Estimation of toxicity reference values	May result in an overestimate (high) or underestimate (moderate) of risk.	To compensate for potential uncertainties in the exposure assessment, various adjustment factors are incorporated to extrapolate toxicity from the test organism to other species.
Conservative TRVs may exceed background concentrations for inorganics	May result in an overestimate (high) of risk.	The nature of the TRVs results in risk being shown at INEEL background concentrations for metals. This can result in an erroneous indication of risk to certain receptors.
Lack of appropriate toxicity data to derive TRVs	Results in the inability to evaluate risk for many receptors and chemicals.	Those receptor groups and chemicals that could not be evaluated are data gaps in the assessment.
Use of functional grouping	May result in an overestimate (moderate) of risk.	Functional groups were designed as an assessment tool that ensures that the ERA addresses all species potentially present at the facility. A hypothetical species is developed using input values that represent the greatest exposure of the combined functional group members.
Site use factor	May result in an overestimate (high) or underestimate (low) of risk.	The SUF is a percentage of the site of concern area compared to the home range of the receptor species. When the home range is not known for a species, a default value of 1.0 is used. This can results in an overestimate of the risk at small sites.

7.4.5 Waste Area Group 5 Ecological Risk Assessment Summary

The objectives of this assessment were to define the extent of contamination for each site at the WAG level; determine the potential effects from contaminants on environmental receptors, habitats, or special environments; determine the potential effects from contaminants to other ecological receptors at the WAG 5; and identify sites and COPCs to be assessed in the OU 10-04 ERA. The approach is an extension of the screening-level ecological risk assessment (SLERA) methodology used at the INEEL (VanHorn, Hampton, and Morris 1995). This methodology uses conservative exposure modeling and input parameters to identify contaminants and sites that may pose a risk to the environment.

A summary of the WAG 5 ERA results for all sites is provided in Table 7-19. The sites that were retained for further evaluation or were eliminated from further evaluation in the WAG 5 ERA throughout the various phases of the assessment are summarized in the table. Of the 55 ARA and PBF sites at WAG 5, 16 sites were originally retained for analysis in the WAG 5 ERA. These are ARA-01, ARA-02, ARA-03, ARA-10, ARA-12, ARA-16, ARA-23, ARA-24, ARA-25, PBF-04, PBF-10, PBF-12, PBF-16, PBF-21, PBF-22, and PBF-26. The initial screening compared contaminant exposure-point concentrations to INEEL-wide background concentrations for inorganics and certain radionuclides, and to minimum EBSLs. This screening step eliminated radionuclides as COPCs at all sites, and the ARA-02 (seepage pit), ARA-10, ARA-23, ARA-24, and PBF-12 were completely eliminated from further assessment.

The remaining sites (ARA-01, ARA-02 septic tank soils, ARA-03, ARA-12, ARA-16, ARA-25, PBF-04, PBF-10, PBF-16, PBF-21, PBF-22, and PBF-26) were evaluated in the subsequent phases of the WAG 5 ERA. The COPCs in surface and subsurface soil included four organic and 17 inorganic compounds at these WAG 5 sites. Receptor dose predictions and HQ calculations were completed for these remaining sites and contaminants (see Appendix I). The HQ evaluation indicates that exposure to contaminants in soil at ARA-02 (septic tank soils), ARA-03, ARA-16, and PBF-04 do not result in HQs greater than 1.0 to ecological receptors at WAG 5. At ARA-01 potential risks exist to ecological receptors from exposure to antimony, arsenic, cadmium, copper, lead, selenium, thallium, vanadium, and zinc in soil. The potential risk-drivers at ARA-12 include cadmium, chromium, copper, manganese, mercury, selenium, and zinc in surface and subsurface soil. Potential risk drivers at ARA-25 include arsenic, cobalt, copper, lead, manganese, mercury, nickel, selenium, silver, vanadium, and zinc. At PBF-10, chromium is the only COPC in surface soil. Lead and mercury were identified as the COPCs for PBF-16. Cobalt and copper were identified as COPCs for PBF-21. The primary risk drivers at PBF-22 include arsenic, copper, mercury, lead, and selenium in soil. At PBF-26, potential risk drivers include Aroclor-1254, chromium, copper, lead, mercury, nickel, and zinc.

The WAG 5 ERA provides a means to identify those contaminants that have the potential for causing adverse effects to ecological receptors (i.e., potential risk-drivers). Actual risks to ecological receptors from exposure to COPCs in soil at WAG 5 cannot be determined without additional site-specific investigations such as bioaccumulation studies and analyses of fate and transport to determine bioavailability and toxicity of contaminants to ecological receptor organisms. It also is important to recognize that many other factors besides chemical contamination are likely impacting ecological receptors at WAG 5. These factors include habitat degradation caused by human activity and development, and the availability of other suitable (and presumably uncontaminated) habitat in proximity to impacted areas. Factors such as these can affect ecological receptors both adversely and favorably. The effects of such physical impacts are not accounted for in the WAG 5 ERA.

The WAG 5 ERA incorporates levels of uncertainty that could either overestimate or underestimate the actual risk to these receptors. To compensate for potential uncertainties, the WAG 5 ERA incorporates various conservative assumptions and AFs that are designed to be conservative rather than result in a conclusion of no indication of risk when risk may exist. Regardless of the inclusion of AFs, other uncertainties exist that could affect the estimation of risk associated with WAG 5.

For example, the basis of the TRVs developed for nonradionuclides is the effect to the individual. This conservative approach is very commonly used because of the large uncertainty inherent in extrapolating effects data from test to field organisms (multiple receptors). Exposure modeling (i.e., transport of contaminants in the food chain from the subsurface to surface) is simplistically modeled because of the lack of site-specific data. However, it is important to remember individual ecological receptors are currently present at the site and have greater exposures than most receptors in human health scenarios.

The results of this assessment will be used in the development of the OU 10-04 comprehensive RI/FS for performing the baseline ERA. As part of the OU 10-04 ERA, it is expected that TRV values will be reviewed, less conservative modeling approaches will be evaluated, and a population and community assessment methodology will be developed. The results of the WAG ERAs will be summarized and used to direct future sampling to support the OU 10-04 ERA effort, as well as to evaluate overall risk to INEEL ecological receptors.

At this time, sampling data gaps at WAG 5 are known that would prevent the results from being rolled up into the OU 10-04 ERA. The results of the assessment at this phase will be used to identify data gaps at the INEEL-wide level.

The primary value of the WAG 5 ERA is to provide input into the OU 10-04 ERA. To address cleanup decisions being made at the WAG level, an effort has been made to include less conservative values to allow more realistic assessment at the WAG level. It is recognized, however, that finalizing the WAG ERAs prior to the OU 10-04 comprehensive RI/FS may result in possible review of previous decisions. The risk of this occurring is unlikely given the extent and nature of the contamination at the INEEL. However, monitoring of ecological resources should be included in any decision, and these results should be reviewed at the appropriate time.

7.5 Transition to the INEEL-wide Ecological Risk Assessment

The WAG 5 ERA represents the second phase of the four-phased approach to ERA proposed in Figure 7-1. The first phase is the SLERA or site data gap analysis (SDGA), which is a "preassessment" performed at the WAG level. The preassessment is performed to reduce the number of sites and contaminants to be addressed in subsequent assessments and is used to (1) better define the extent and nature of individual WAG sites of contamination and identify sites at which no COPCs are found, (2) reduce the number of COPCs to be addressed in the WAG ERA by eliminating those that clearly pose a low likelihood for risk, (3) identify sites for which further data are needed, and (4) identify other data gaps. Screening-level risk assessments also serve to support problem formulation and drive media and pathways to be evaluated for WAG ERAs. Because the risk assessment tasks based on the FFA/CO (DOE-ID 1991) are ongoing and additional sites may be identified, the approach is also used to screen new sampling data and additional sites. The results of this phase play no role in setting remedial action levels. Details of SLERA methodology can be found in the INEEL ERA guidance manual (VanHorn, Hampton, and Morris 1995).

In phase two, the results of the first phase screening are subjected to an additional COPC screening to finalize sites and contaminants for the WAG ERA. Potential risks to ecological receptors are evaluated at the WAG level using an approach that parallels the human health risk assessment methodology. The WAG ERA applies aspects of the methodologies developed for the SLERA and provides a site-by-site assessment of those contaminants that were not eliminated from further evaluation in the preliminary screening process. It is the next level of screening that primarily provides input to the OU 10-04 ERA.

The WAG ERA represents the assessment of the "no action" alternative for remediation at the WAG level. The WAG ERA results (1) provided a list of COPCs to be addressed for the OU 10-04ERA and (2) identified WAG 5 level data gaps that must be addressed before performing the INEEL-wide ERA. The results of the WAG ERA and associated data gaps will be evaluated and discussed in more detail in the INEEL-wide RI/FS. The results of the WAG ERA also may support risk assessments to evaluate WAG remedial actions or additional assessments if necessary.

The third phase of the ERA process is the OU-10-04 ERA, which is performed to integrate WAG ERAs to evaluate risk to INEEL-wide ecological resources. This assessment is conducted to evaluate effects resulting from past contamination, and their potential for adversely impacting INEEL-wide ecological resources including residual impacts from completed interim or remedial actions.

The OU 10-04 ERA will integrate the results of the WAG ERAs to determine whether contamination at the WAGs contributes to potential risk to populations and communities on an ecosystem-wide basis (over the entire INEEL). Phase 4 of the INEEL ERA process includes finalizing the OU 10-04 ROD and associated RD/RA activities. The OU 10-04 ERA is contrasted with the previous phases of the process in Table 7-21.

Table 7-21. Comparison of waste area group ecological risk assessment components for phases of the INEEL-wide ecological risk assessment.

Component of Assessment	Screening Level Ecological Risk Assessment (Phase 1)	WAG ERA (Phase 2)	OU 10-04 Baseline ERA (Phase 3)
Stressor and receptor identification (contaminants and sites of potential concern)	Track 1 and Track 2 investigations and all FFA/CO sites and contaminants	SLERA COPC and site retention lists	WAG transition ERA COPC and site retention lists
Spatial scale	WAG assessment area	Sites within the WAG assessment area	OU 10-04 or WAG level for individual sites
Temporal scale	Current	Current, future (buried waste)	Current, future (buried waste)
Contaminant concentration in media of interest	Average concentration across the WAG—human health sampling	Average concentration for each site—human health sampling and modeling for buried waste	To be determined.
Exposure assessment	Ecologically based screening level (EBSL) soil and water	Dose across media	Dose across media
Risk characterization	Screening level quotient (SLQ)—unranked	HQ-ranked	HQ-ranked and qualitative discussion
Cumulative risk	Multiple sites combined across the WAG—average concentration	Multiple contaminants—individual sites—average concentration	Multiple contaminants across multiple WAGs
Assessment endpoints	WAG functional groups and individual T/E species—semiquantitative	WAG functional groups and Individual T/E species—quantitative and qualitative	EPA assessment endpoint criteria (to be determined)—quantitative, semiquantitative, and qualitative
Measurement endpoints	Exposure model parameters	Exposure model parameters	To be determined—ecological components based on assessment endpoints and COPCs from waste area group ecological risk assessments (WAG ERAs).

7.6 References

40 CFR 300, *Code of Federal Regulations*, Title 40, "Protection of the Environment," Part 300, "National Oil and Hazardous Substances Pollution Contingency Plan."

42 USC § 9601 et seq., *United States Code*, October 21, 1976, "Resource Conservation and Recovery Act."

Abbey, H. K., and N. Platonow, 1968, "Toxicity of Vanadium in Calves," *Vet. Record*, Vol. 82, p. 292.

ABC, 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, North Carolina 27709, American Biogenics Corp.

ACOE, 1987, *Corps of Engineers Wetland Delineation Manual,* Technical Report Y-87-1, U.S. Army Engineers Waterways Experiment Station, Vicksburg, Mississippi, 100 pp., with appendices.

Adams, W. J., R. A. Kimberle, and J. W. Barnett, Jr., 1992, "Sediment Quality and Aquatic Life Assessment," *Environmental Science and Technology*, Vol. 26, No. 10, pp. 1865–1875.

Adriano, D. C., 1986, *Trace Elements in the Terrestrial Environment*, New York: Springer-Verlag.

Albanus, L. L., et al., 1972, "Toxicity for Cats of Methylmercury in Contaminated Fish from Swedish Lakes and of Methylmercury Hydroxide Added to Fish," *Environmental Research*, Vol. 5, No. 4, pp. 425–429.

Allen, J. G., H. G. Masters, R. L. Peet, et al., 1983, "Zinc Toxicity in Ruminants," *Journal of Comparative Pathology*, Vol. 93, pp. 363–377.

Ambrose, A. M., et al., 1976, "Long-Term Toxicologic Assessment of Nickel in Rats and Dogs," *Journal of Food Science and Technology*, Vol. 13, pp. 181–187.

Ammerman, C. B. et al. 1973, "Toxicity of Certain Minerals to Domestic Animals: A Review," *Florida Agriculture Experiment Station Research Bulletin,* No. AL73-6, University of Florida, Gainsville, Florida.

Anwar, R. A., et al., 1961, "Chronic Toxicity Studies III. Chronic Toxicity of Cadmium and Chromium in Dogs," *Archive of Environmental Health,* Vol. 3, pp. 456–467.

Arthur, W. J., and R. J. Gates, 1988, "Trace Element Intake Via Soil Ingestion in Pronghorns and in Black-Tailed Jack Rabbits," *Journal of Range Management*, Vol. 41, pp. 162–166.

Arthur, W. J., J. W. Connely, D. K. Halford, and T. D. Reynolds, 1984, *Vertebrates of the Idaho National Engineering Laboratory,* DOE/ID-12099, U.S. Department of Energy, Idaho Operations Office.

ATSDR, 1993a, *Toxicological Profile for Cadmium*, U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Atlanta, Georgia.

ATSDR, 1993b, *Toxicological Profile for Zinc*, U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Atlanta, Georgia.

ATSDR, 1992a, *Toxicological Profile for Antimony*, U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Atlanta, Georgia.

ATSDR, 1992b, *Toxicological Profile for Manganese*, U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Atlanta, Georgia.

ATSDR, 1992c, *Toxicological Profile for Polyaromatic Hydrocarbons*, U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Atlanta, Georgia.

ATSDR, 1992d, *Toxicological Profile for Vanadium*, U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Atlanta, Georgia.

ATSDR, July 1992, *Toxicological Profile for Barium and Compounds*, PB93-110658, U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Atlanta, Georgia.

ATSDR, 1988, *Toxicological Profile for Nickel*, U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Atlanta, Georgia.

Aulerich, R. J. et al., 1987, "Chronic Toxicity of Dietary Fluorine in Mink," *Journal of Animal Science*, Vol. 65, pp. 1759–1767.

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*, Vol. 55, No. 2, pp. 337–343.

Aulerich, R. J., and R. K. Ringer, 1977, "Current Status of PCB Toxicity, Including Reproduction in Mink," *Archives of Environmental Contamination and Toxicology*, Vol. 6, p. 279.

Aulerich, R. J., R. K. Ringer, and J. Iwamoto, 1974, "Effects of Dietary Mercury on Mink," *Archives of Environmental Contamination and Toxicology*, Vol. 2, pp. 43–51.

Baes, C. F. III, et al., 1984, *A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides Through Agriculture*, ORNL-5786, U.S. Department of Energy, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Barnthouse, L. W., G. W. I. Suter, and A. E. Rosen, 1990, "Risk of Toxic Contaminants to Exploited Fish Populations: Influence of Life History, Data Uncertainty and Exploitation Intensity," *Environmental Toxicology and Chemistry*, Vol. 9, pp. 297–311.

Barnthouse, L. W., et al., 1986, *User's Manual for Ecological Risk Assessment*, Environmental Sciences Division Publication No. 2679, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Bartlett, R. J., and J. M. Kinble, 1976, "Behavior of Chromium in Soils: II. Hexavalent Forms," *Journal Environmental Quality*, Vol. 5, No. 1, pp. 383–386.

Bean, J. R., and R. H. Hudson, 1976, "Acute Oral Toxicity and Tissue Residues of Thallium Sulfate in Golden Eagles (Aquila Chrysaetos)," *Bulletin of Environmental Contamination and Toxicology*, Vol. 15, No. 1, pp. 118–121.

Beijer, K., and A. Jernelov, 1979, "Methylation of Mercury in Natural Waters," 201–210 pp., *The Biochemistry of Mercury in the Environment*, ed. J. O. Nriagu, Elsevier/North-Holland Biomedical Press, New York.

Belthoff, J. R., L. R. Power, and T. D. Reynolds, 1998, "Breeding Birds at the Idaho National Engineering Laboratory, 1985–1991," submitted to *Great Basin Naturalist*.

Beyer, W. N., E. E. Connor, and D. Gerould, 1994, "Estimates of Soil Ingestion by Wildlife," *Journal of Wildlife Management*, 58 2, pp. 375–382.

Bird, D. M., et al., 1983, "Synergistic Effects of Aloclor 1254 and Mirex on the Semen Characteristics of American Kestrels," *Archives of Environmental Contamination and Toxicology*, Vol. 12, pp. 633–640.

Borg, K., et al., 1970, "Experimental Secondary Methyl Mercury Poisoning in the Goshawk, *Accipiter G. gentiles L.*," *Environmental Pollution*, Vol. 1, pp. 91–104.

Brewer, G., 1940, "A Statistical Study of Cobalt Polycythemia in the Dog," *American Journal of Physiology*, Vol. 128, pp. 345–348.

Brunner, M. J., et al., 1996, *An Assessment of the Chronic Toxicity and Oncogenicity of Aroclor-1016, 1242, 1254, and 1260 Administered in Diets to Rats,* Battelle Study No. SC920192, Chronic Toxicity and Oncogenicity Report, Columbus, Ohio.

Burt, W. H., and R. P. Grossenheider, 1980, *A Field Guide to the Mammals*, New York: Houghton Mifflin Co.

Byron, W. R., et al., 1967, "Pathologic Changes in Rats and Dogs from Two-Year Feeding of Sodium Arsenite or Sodium Arsenate," *Toxicology and Applied Pharmacology*, Vol. 10, pp. 132–147.

Callahan, M. A., et al., 1979, *Water-Related Environmental Fate of 129 Priority Pollutants,* EPA 440/4-79-029a, U.S. Environmental Protection Agency, Office of Water Planning and Standards, Washington, D.C.

CDC, 1994, *Rare, Threatened, and Endangered Plants and Animals of Idaho*, 3rd ed., Conservation Data Center, Idaho Department of Fish and Game, Boise, Idaho, 39 pp.

Charbonneau, S. M., et al., 1976, "Chronic Toxicity of Methylmercury in the Adult Cat," Interim report, *Toxicology*, Vol. 5, No. 3, pp. 337–49.

Cohen, M. D., et al., 1993, "Mechanisms of Chromium Carcinogenicity and Toxicity," *Critical Review of Toxicology*, Vol. 23, No. 3, pp. 255–281.

Colle, A., et al., 1980, "Lead Poisoning in Monkeys: Functional and Histopathological Alterations of the Kidneys," *Toxicology*, Vol. 18, pp. 145–158.

Craig, T. H., April 1979, *The Raptors of the Idaho National Engineering Laboratory*, IDO, 12089, U.S. Department of Energy, Idaho Operations Office, 28 pp.

Cunningham, I. J., 1946, "The Toxicity of Copper to Bovines," *New Zealand Journal of Science and Technology*, Vol. 27A, p. 372.

Dahlgren, R. B., R. L. Linder, and C. W. Carlson, 1972, "Polychlorinated Biphenyls: Their Effects on Penned Pheasants," *Environmental Health Perspectives*, Vol. 1, pp. 89–101.

Dahlgren, R. B., and R. L. Linder, 1971, "Effects of Polychlorinated Biphenyls on Pheasant Reproduction, Behavior, And Survival," *Journal of Wildlife Management*, Vol. 35, No. 2, pp. 315–319.

DeMayo, A., et al., 1982, "Toxic Effects of Lead and Lead Compounds on Human Health, Aquatic Life, Wildlife, Plants, and Livestock," *CRC Critical Review Environmental Control*, Vol. 12, pp. 257–305.

Dieter, M. P., and M. T. Finley, 1978, "Erythrocyte Gamma-Aminolevulinic Acid Dehydrates Activity in Mallard Ducks: Duration of Inhibition After Lead Shot Dosage," *Journal of Wildlife Management*, Vol. 42, pp. 621–625 (cited in Eisler 1988).

Diller, L. V., and D. R. Johnson, 1988, "Food Habits, Consumption Rates, and Predation Rates of Western Rattlesnakes and Gopher Snakes in Southwestern Idaho," *Herpetologica*, Vol. 44, No. 2, pp. 228–233.

DiPaolo, J. A, 1964, "The Potentiation of Lymphosarcomas in Mice by Manganous Chloride," *Fed. Proc.* 23: 393 (Abstract).

DOE, July 1994, Memorandum, *Incorporating Ecological Risk Assessment into Remedial Investigation/Feasibility Study Work Plans*, U.S. Department of Energy.

DOE, 1993, *Draft Policy Framework and Implementation Plan for Using Ecological Risk Assessment at DOE Facilities*, U.S. Department of Energy.

DOE-ID, May 1997, *Final Work Plan for Waste Area Group 5 Operable Unit 5-12 Comprehensive Remedial Investigation/Feasibility Study*, DOE-ID-10555, U.S. Department of Energy, Idaho Operations Office.

DOE-ID, December 4, 1991, *Federal Facility Agreement and Consent Order for the Idaho National Engineering Laboratory*, U.S. Department of Energy, Idaho Operations Office; U.S. Environmental Protection Agency, Region 10; State of Idaho Department of Health and Welfare.

Donaldson, R. M., and R. F. Barreras, 1966, "Intestinal Absorption of Trace Quantities of Chromium," *Journal of Laboratory and Clinical Medicine*, Vol. 68, pp. 484–493.

Dragun, J., 1988, *The Soil Chemistry of Hazardous Material*, Hazardous Materials Control Research Institute.

Drinker, K. R., P. K. Thompson, and M. Marsh, 1927, "An Investigation of the Effect of Long-Continued Ingestion of Zinc, in the Form of Zinc Oxide, by Cats and Dogs, Together with Observations upon the Excretion and Storage of Zinc," *American Journal of Physiology*, Vol. 80, pp. 31–64.

Dunning, J. P., 1993, *CRC Handbook of Avian Body Masses*, Boca Raton, Florida: CRC Press.

Eastin, W. C., Jr., and T. J. O'Shea, 1981, "Effects of Dietary Nickel on Mallards," *Journal of Toxicology and Environmental Health*, Vol. 7, No. 6, pp. 883–892.

Eaton, R. D., D. C. Secord, and P. Hewitt, 1980, "An Experimental Assessment of the Toxic Potential of Mercury in Ringed Seal Liver for Adult Laboratory Cats," *Toxicology and Applied Pharmacology*, Vol. 55, No. 3, pp. 514–521.

Edwards, N. T., 1983, "Polycyclic Aromatic Hydrocarbons (PAHs) in the Terrestrial Environment—A Review," *Journal of Environmental Quality,* Vol. 12, pp. 427–441.

EG&G, June 7 1994, *Decision Documentation Package: PBF-04*, EG&G Idaho, Inc.

EG&G, 1993, Program Directive 3.7, "Data Characterization Process in Environmental Restoration," EG&G Idaho, Inc.

EG&G, 1993, *Decision Documentation Package: PBF-26*, EG&G Idaho, Inc.

Eisler, R., 1988a, *Arsenic Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, U.S. Fish Wildlife Service Biological Report 85(1.12), U.S. Fish and Wildlife Service.

Eisler, R., 1988b, *Lead Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, U.S. Fish and Wildlife Service Biological Report, 85(1.14), U.S. Fish and Wildlife Service.

Eisler, R., 1987a, *Mercury Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, U.S. Fish and Wildlife Service Biological Report 85(1.10), U.S. Fish and Wildlife Service.

Eisler, R., 1987b, *Polyaromatic Hydrocarbons Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, U.S. Fish and Wildlife Service Biological Report 85(1.11), U.S. Fish and Wildlife Service.

Eisler, R., 1986, *Polychlorinated Biphenyls Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, U.S. Fish and Wildlife Service Biological Report 85(1.7), U.S. Fish and Wildlife Service.

Eisler, R., 1985a, *Cadmium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, U.S. Fish and Wildlife Service Biological Report 85(1.2), U.S. Fish and Wildlife Service.

Eisler, R., 1985b, *Selenium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, U.S. Fish and Wildlife Service Biological Report 85(1.5), U.S. Fish and Wildlife Service.

EPA, August 1996, *Proposed Guidelines for Ecological Risk Assessment,* EPA/630/R-95/002B, U.S. Environmental Protection Agency, Risk Assessment Forum, Washington, D.C.

EPA, 1993, *Great Lakes Water Quality Initiative Criteria Documents for the Protection of Wildlife (Proposed): DDT, Mercury, 2,3,7,8-TCDD, PCBs*, EPA/822/R-93-007, U.S. Environmental Protection Agency, Office of Science and Technology, Washington, D.C.

EPA, December 1993, *Wildlife Exposure Factors Handbook,* EPA/600/R-93/187B, U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C.

EPA, February 1992, *Framework-for Ecological Risk Assessment,* PB93-102192, EPA/63 O/R-92/001, U.S. Environmental Protection Agency, Office of Research and Development, Risk Assessment Forum, 55 pp.

EPA, 1988a, *Joint Memorandum of the Office of Emergency and Remedial Response and the Office of Waste Programs Enforcement*, U.S. Environmental Protection Agency (as cited in EPA 1991).

EPA, 1988b, *Review of Ecological Risk Assessment Methods,* EPA/230/10-88-041, U.S. Environmental Protection Agency, Office of Planning and Evaluation, Washington, D.C.

EPA, 1984, *Health Effects Assessment for Barium,* EPA/540/1-86/021, prepared by Environmental Criteria and Assessment Office, Cincinnati, Ohio, for the U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response.

EPA , 1980, *Ambient Water Quality Criteria Document for Polynuclear Aromatic Hydrocarbons,* U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Washington, D.C.

Fimreite, N., 1979, "Accumulation and Effects of Mercury on Birds," *Biogeochemistry of Mercury in the Environment,* ed. J. O. Nriagu, New York: Elsevier/North Holland Biomedical Press.

Formigli, L., et al., 1986, "Thallium-Induced Testicular Toxicity in the Rat," *Environmental Research,* Vol. 40, No. 2, pp. 531–539.

Franchini, I., and A. Mutti, 1988, "Selected Toxicological Aspects of Chromium(VI) Compounds," *Science of the Total Environment,* Vol. 71, No. 3, pp. 379–387.

Frost, D. V., 1983, "What Do Losses in Selenium and Arsenic Bioavailability Signify for Health?" *Science of the Total Environment,* Vol. 28, pp. 455–466.

Gabler, K. I., 1997, "Distribution and Habitat Requirements of the Pygmy Rabbit (*Brachylagus idahoensis*) on the Idaho National Engineering and Environmental Laboratory," M.S. Thesis (unpublished), Idaho State University, Pocatello, Idaho.

Ganther, H. E., 1980, "Interactions of Vitamin E and Selenium with Mercury and Silver," *Annals of the New York Academy of Science,* Vol. 355, pp. 212–226.

Gerber, G. B., J. Maes, and B. Eykens, 1982, "Transfer of Antimony and Arsenic to the Developing Organism," *Archives of Toxicology,* Vol. 49, pp. 159–168.

Griffin, S, and P. Turck, 1991 "Bioavailability in Rabbits of Sodium Arsenite Absorbed to Soils," *Toxicologist,* Vol. 11, p. 718.

Halverson, A. W., I. S. Palmer, and P. L. Guss, 1966, "Toxicity of Selenium to Post-Weanling Rats," *Toxicology and Applied Pharmacology,* Vol. 9, pp. 477–484.

Hammons, A. S., J. E. Huff, H. M. Braunstein, J. S. Drury, C. R. Shriner, E. B. Lewis, B. L. Whitfield, and L. E. Towill, 1978, *Reviews of the Environmental Effects of Pollutants: IV Cadmium,* EPA 600/1-78-026, U.S. Environmental Protection Agency, 251 pp.

Hampton, N. L., et al., February 1995, *A Preliminary Survey of the National Wetlands Inventory as Mapped for the Idaho National Engineering Laboratory,* INEL-95/0101, Lockheed Martin Idaho Technologies Company.

Hanson, R. W., 1994, *Raptor Use of the Idaho National Engineering Laboratory,* M.S. Thesis, South Dakota State University, Brookings, South Dakota, 172 pp.

Harper, N., et al., 1995, "Immunosuppressive Activity of Polychlorinated Biphenyl Mixtures and Congeners: Nonadditive (antagonistic) Interactions," *Fundamentals and Applied Toxicology*, Vol. 27, pp. 131–139.

Harris, M., et al., 1993, "Comparative Potencies of Aroclors 1232, 1242, 1248, 1254, and 1260 in Male Wistar Rats—Assessment of the Toxic Equivalency Factor (TEF) Approach for Polychlorinated Biphenyls (PCBs)," *Fundamentals and Applied Toxicology*, Vol. 20, pp. 456–463.

Hebert, C. D., et al., 1993, "Subchronic Toxicity of Cupric Sulfate Administered in Drinking Water and Fed to Rats and Mice," *Fundamentals and Applied Toxicology*, Vol. 21, p. 461–475.

Heinz, G. H., and S. D. Haseltine, 1983, "Altered Avoidance Behavior of Young Black Ducks Fed Cadmium," *Environmental Toxicology Chemistry*, Vol. 2, pp. 419–421.

Heinz, G. H., et al., 1987, "Reproduction of Mallards Fed Selenium," *Environmental Toxicology and Chemistry*, Vol. 6, pp. 423–433.

Hill, C. H., 1979, "The Effect of Dietary Protein Levels on Mineral Toxicity in Chicks," *Journal of Nutrition*, Vol. 109, pp. 501–507.

Hillman-Mason, K. Y., K. J. Poor, D. W. Lodman, and S. D. Dunstan, October 1994, *Preliminary Scoping Track 2 Summary Report for Operable Unit 5-08 and 5-09*, Rev. 0, INEL-94/0108, Lockheed Martin Idaho Technologies Company.

Hoffman, D. J., et al., 1985, "Survival, Growth, and Accumulation of Ingested Lead in Nestling American Kestrels *(Falco sparverius)*," *Comparative Biochemistry and Physiology*, 8OC, pp. 431–439.

Hong, C., et al., 1993, "Toxic Potential of Non-ortho and Mono-ortho Coplanar Polychlorinated Biphenyls in Aroclors, Seals, and Humans," *Arch. Environ. Contam. Toxicol.* 25:118-123.

Hoover, R. L., and D. L. Wills, ed., 1987, *Managing Forest Lands for Wildlife*, developed in cooperation with the U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Region, Colorado Division of Wildlife.

Hopkin, S. P., and C. A. C. Hames, 1994, "Zinc, Among a 'Cocktail' of Metal Pollutants, Is Responsible for the Absence of the Terrestrial Isopod *Porcellio scaber* from the Vicinity of a Primary Smelting Works," *Ecotoxicology*, Vol. 2, pp. 68–78.

Huck, D. W., and A. J. Clawson, 1976, "Excess Dietary Cobalt in Pigs," *Journal of Animal Science*, Vol. 43, p. 1231.

IDFG, Idaho Department of Fish and Game web site 'http://www2.state.id.us/fishgame.html'.

INPS, 1997, *Results of the Thirteenth Annual Idaho Rare Plant Conference, February 11-12,1997, Boise, Idaho*, Idaho Native Plant Society.

INPS, 1996, *Results of the Twelfth Annual Idaho Rare Plant Conference, February 13-15, 1996, Boise, Idaho*, Idaho Native Plant Society.

INPS, 1995, *Results of the Eleventh Annual Idaho Rare Plant Conference, February 7–8, 1995, Boise, Idaho*, Idaho Native Plant Society.

Kabata-Pendias, A., and H. Pendias, 1984, *Trace Elements in Soils and Plants*, Boca Raton, Florida: CRC Press, Inc.

Kanisawa, M., and H. A. Schroeder, 1969, "Life Term Studies on the Effect of Trace Elements of Spontaneous Tumor in Mice and Rats," *Cancer Research*, Vol. 29, No. 4, pp. 892–895.

Khera, K. S., 1973, "Reproductive Capability of Male Rats and Mice Treated with Methylmercury," *Toxicology and Applied Pharmacology*, Vol. 24, p. 167.

Khera, K. S., and S. A. Tabacova, 1973, "Effects of Methylmercuric Chloride on the Progeny of Mice and Rats Treated Before or During Gestation," *Food and Cosmetic Toxicology*, Vol. 11, pp. 245–254.

Kimmel, C. A., et al., 1980, "Chronic Low Level Lead Toxicity in the Rat. I. Maternal Toxicity and Perinatal Effects," *Toxicology and Applied Pharmacology*, Vol. 56, pp. 28–41.

Kopp, S. J., et al., 1985, "Cardiovascular Dysfunction and Hypersensitivity to sodium Pentobarbital Induced by Chronic Barium Chloride Ingestion," *Toxicology and Applied Pharmacology*, Vol. 77, No. 2, pp. 303–314.

Koval, P. J., T. J. Peterle, and J. D. Harder, 1987, "Effects of Polychlorinated Biphenyls on Mourning Dove Reproduction and Circulating Progesterone Levels," *Bulletin of Environmental Contamination and Toxicology*, Vol. 39, pp. 663–670.

Kramber, W. J., et al., March 1992, "Producing a Vegetation Map of the Idaho National Engineering Laboratory Using LANDSAT Thematic Mapper Data," *Proceedings of ASPRS 1992 Annual Meeting, Albuquerque, New Mexico*.

Kubena, L. F. and T. D. Philips, 1982, "Toxicity of Vanadium in Female Leghorn Chickens," *Poultry Science*, Vol. 62, pp. 47–50.

Laskey, J. W., G. L. Rehnberg, and J. F. Hein, 1982, "Effects of Chronic Manganese (MN_3O_4) Exposure on Selected Reproductive Parameters in Rats," *Journal of Toxicology and Environmental Health*, 9:677–687 (as cited in ATSDR 1990).

Levin, S. A., et al., 1989, *Ecotoxicology: Problems and Approaches*, New York: Springer-Verlag, 547 pp.

Lewis, S. C., J. R. Lynch, and A. I. Nikiforov, 1990, "A New Approach to Deriving Community Exposure Guidelines From No-Observed-Adverse-Effect-Levels," *Regulatory Toxicology and Pharmacology*, Vol. 11, pp. 314–330.

Linder, R. E., T. B. Baines, and R. D. Kimbrough, 1974, "The Effect of Polychlorinated Biphenyls on Rat Reproduction," *Food and Cosmetic Toxicology*, Vol. 12, pp. 63–77.

Ludwig, D. F., et al., 1994, "Toxicity Reference Values for Ecological Risk Assessment," submitted for publication.

Manzo, L., et al., 1992, "Metabolic Studies as a Basis for the Interpretation of Metal Toxicity," *Toxicology Letters*, Vol. 64165, pp. 677–686.

Marks, T. A., T. A. Ledoux, and J. A. Morre, 1982, "Teraogenicity of a Commercial Xylene Mixture in the Mouse," *Journal of Toxicology and Environmental Health*, Vol. 9, pp. 97–105.

Martin, K. L., C. J. Barnard, A. L. Freeman, M. R. Groh, K. T. Kissell, S. J. Lord, G. L. Olsen, P. D. Randolph, and R. N. Wilhelmsen, September 1990, *Preliminary Assessment of Surface Soils at Active EG&G Idaho Facilities Data Document*, EGG-ESQ-9225, EG&G Idaho, Inc.

Matthews, H. B., and M. W. Anderson, 1975, "Effect on Chlorination on the Distribution and Excretion of Polychlorinated Biphenyls," *Drug Metab. Dispos.*, 3(5):371-380.

Maughan, J. T., 1993, *Ecological Assessment of Hazardous Waste Sites*, New York: Van Nostrand Reinhold, 352 pp.

McConnell, E. E., 1985, "Comparative Toxicity of PCBs and Related Compounds in Various Species of Animals," *Environmental Health Perspectives*, Vol. 60, pp. 29–33.

McKee, J. E., and H. W. Wolf, 1963, *Water Quality Criteria*, Publication No. 3-A, California State Water Resources Control Board, 548 p.

Montgomery, J. H., and L. M. Welkom, 1990, *Groundwater Chemicals Desk Reference*, Chelsea, Michigan: Lewis Publishers.

Morris, R. C., 1998, *Potential Use of Habitats Within and Surrounding Facilities at the Idaho National Engineering and Environmental Laboratory by Sensitive Species: A Biological Assessment*, Draft ESRF-026, Environmental Science and Research Foundation, Idaho Falls, Idaho.

Nagy, K. A., 1987, "Field Metabolic Rate and Food Requirement Scaling in Mammals and Birds," *Ecological Monograph*, Vol. 57, pp. 111–128.

NAS, 1980, *Mineral Tolerance of Domestic Animals,* National Academy of Science, Washington, D.C.

Nederbragt, H., T. S. Van den Ingh, and P. Wensvoort, 1984, *Pathobiology of Copper Toxicity*, Vet Q, Vol. 6, No. 4, pp. 179–185.

NRCC, 1978, *Effects of Arsenic in the Canadian Environment*, NRCC 15391, National Research Council of Canada, Ottawa, Canada, 349 pp.

O'Flaherty, E. J., 1993, "A Pharmacokinetic Model for Chromium," *Toxicology Letters*, Vol. 68, pp. 145–158.

Offiong, S. A., and S. M. Abed, 1980, "Fertility, Hatchability, and Malformations in Guinea Fowl Embryos as Affected by Dietary Manganese," *British Poultry Science*, Vol. 21, pp. 371–375.

Olson, G. L., D. J. Jeppesen, and R. D. Lee, January 1995, *The Status of Soil Mapping for the Idaho National Engineering Laboratory,* INEL-95/0051, EG&G Idaho.

Ort, J. F., and J. D. Latshaw, 1978, "The Toxic Level of Sodium Selenite in the Diet of Laying Chickens," *Journal of Nutrition*, Vol. 108, pp. 1114–1120.

Osborn, D. W., J. Eney, and K. R. Bull, 1983, "The Toxicity of Trialkyl Lead Compounds to Birds," *Environmental Pollution*, Vol. 31A, pp. 261–275 (as cited in Eisler 1988).

Outridge, P. M., and A. M. Scheuhammer, 1993, "Bioaccumulation and Toxicology of Chromium Implications for Wildlife," *Review of Environmental Contamination and Toxicology*, Vol. 130, pp. 31–77.

Pattee, O. H., S. N. Wiemeyer, and D. M. Swineford, 1988, "Effects on Dietary Fluoride on Reproduction in Eastern Screen Owls," *Arch. Environ. Contam. Toxicol.*, Vol. 17, pp. 213–218.

Pritzl, M. C., et al, 1974, "The Effect of Dietary Cadmium on Development of Young Chickens" *Poultry Science*, Vol. 53, pp. 2026–2029.

Perry, H. M., et al., 1989, "Hypertension and Associated Cardiovascular Abnormalities Induced by Chronic Barium Feeding," *Journal of Toxicology and Environmental Health*, Vol. 28, No. 3, pp. 373–388.

Perry, H. M., et al., 1985, "Barium-Induced Hypertension," *Adv. Mod. Environ. Toxicol. Inorganic Drinking Water Cario. Vaic. Dis.*, Vol. 9, pp. 221–229.

Perry, H. M., et al., 1983, "Cardiovascular Effects of Chronic Barium Ingestion," *Proc. 17th Ann. Conf. Trace Substances in Environ. Health*, Vol. 17, University of Missouri Press, Columbia, Missouri.

Pritzl, M.C., et al., 1974, "The Effect of Dietary Cadmium on Development of Young Chickens," *Poultry Science*, Vol. 53, pp. 2026–2029.

Rai, O., L. E. Eary, and J. M. Zachara, 1989, "Environmental Chemistry of Chromium," *The Science of Total Environment*, Vol. 86, pp. 15–23.

Reynolds, T. D., 1994, *Idaho National Environmental Research Park*, DOE/ER-065 IP, Department of Energy National Environmental Research Parks, U.S. Department of Energy, Office of Energy Research, Washington, D.C., pp. 19–22.

Reynolds, T. D., et al., 1986, "Vertebrate Fauna of the Idaho National Engineering Laboratory," *Great Basin Naturalist*, Vol. 46, pp. 513–527.

Rood, S. M., G. A. Harris, and G. J. White, August 1996, *Background Dose Equivalent Rates and Surficial Soil Metal and Radionuclide Concentrations for Idaho National Engineering Laboratory*, INEL-94/0250, Rev. 1, Lockheed Martin Idaho Technologies Company.

Rosenfeld, I., and O. A. Beath, 1954, "Effect of Selenium on Reproduction in Rats," *Procedures of the Society of Experimental Biological Medicine*, Vol. 87, pp. 295–297.

Rosomer, G. L., et al., 1961, "Toxicity of Cadmium and Chromium for the Growing Chick," *Poultry Science*, Vol. 40, pp. 1171–1173.

RTI, 1987, *Two Generation Reproduction and Fertility Study on 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)*, Research Triangle Institute, Final study report, submitted to U.S. Environmental Protection Agency, Office of Solid Waste Management, Washington D.C.

Rungby, J., 1990, "An Experimental Study on Silver in the Nervous System and on Aspects of Its General Cellular Toxicity," *Danish Medical Bulletin*, Vol. 37, No. 5, pp. 442–449.

Rungby, J., 1987, "Silver-Induced Lipid Peroxidation in Mice: Interactions with Selenium and Nickel," *Toxicology*, Vol. 45, No. 2, pp. 135–142.

Rungby, J., and G. Danscher, 1984, "Hypoactivity in Silver-Exposed Mice," *Acta Pharmacology and Toxicology*, Vol. 55, No. 5, pp. 398–401.

Rungby, J., and G. Danscher, 1983a, "Localization of Exogenous Silver in Brain and Spinal Cord of Silver Exposed Rats," *Acta Neuropathologica*, Vol. 60, No. 1-2, pp. 92–98.

Rungby, J., and G. Danscher, 1983b, "Neuronal Accumulation of Silver in Brains of Progeny from Argyric Rats," *Acta Neuropathologica*, Vol. 61, No. 3-4, pp. 258–262.

Sabbioni, R., et al., 1980, "Metabolic Fate of Different Inorganic and Organic Species of Thallium in the Rat," *The Science of the Total Environment*, Vol. 15, pp. 123–135.

Safe, S., 1994, "Polychlorinated Biphenyls (PCBs): Environmental Impact, Biochemical and Toxic Responses, and Implications for Risk Assessment," *Crit. Rev. Toxicol.*, 24(2):87–149.

Safe, S., 1992, Toxicology, "Structure-Function Relationships, and Human and Environmental Health Impacts of Polychlorinated Biphenyls: Progress and Problems," *Environmental Health Perspective*, Vol. 100, pp. 259–268.

Sample, B. E., D. M. Opresko, and G.W. Suter II, 1996, *Toxicological Benchmarks for Wildlife: 1996 Revision*, ES/ER/TM-86/R3, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Sax, N. I., and R. J. Lewis, Sr., 1987, *Hazardous Chemicals Desk Dictionary*, New York: Van Nostrand Reinhold Company.

Scheuhammer, A. M., 1987, "The Chronic Toxicity of Aluminum, Cadmium, Mercury, and Lead in Birds: A Review," *Environmental Pollution*, Vol. 46, No. 4, pp. 263–296.

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*, Vol. 95, pp. 287–294.

Schroeder, H. A., M. Mitchner, and A. P. Nasor, 1970, "Zirconium, Niobium, Antimony, Vanadium and Lead in Rats: Life Term Studies," *Journal of Nutrition*, Vol. 100, pp. 59–68.

Schroeder, H. A., et al., 1968, "Zirconium, Niobium, Antimony, Vanadium, and Lead in Rats: Life Term Studies," *Journal of Nutrition*, 95: 1095–1101.

Schroeder, H. A. and J. J. Balassa, 1967, "Arsenic, Germanium, Tin and Vanadium in Mice: Effects on Growth, Survival and Tissue Levels," *Journal of Nutrition*, Vol. 92, pp. 245–252.

Schroeder, W. H., et al., 1987, "Toxic Trace Elements Associated with Airborne Particulate Matter: A Review," *J. Air Pollut. Control Assoc.*, Vol. 37, pp. 1267–1285.

Schultz, D. E., et al., 1989, "Complete Characterization of Polychlorinated Biphenyl Congeners in Commercial Aroclor and Clophen Mixtures by Multidimensional Gas Chromatography—Electron Capture Detection," *Environ. Sci. Technol.*, 23(7):852–859.

Schwartz, T. R., et al., 1987, "Are Polychlorinated Biphenyl Residues Adequately Described by Aroclor Mixture Equivalents? Isomer-Specific Principal Components Analysis of Such Residues in Fish and Turtles," *Environ. Sci. Technol.*, Vol. 21, pp. 72–76.

Schwetz, B., et al., 1974. "Embryo and Fetotoxicity of Inhaled Carbon Tetrachloride, 1,1-Dichloroethane, and Methyl Ethyl Ketone in Rats," *Toxicology and Applied Pharmacology*, Vol. 28, pp. 452–464.

Shaw, P. A., 1933, "Toxicity and Deposition of Thallium in Certain Game Birds," *Journal of Pharmacology and Experimental Therapeutics*, 48(4):478–487.

Shinogi, M., and S. Maeizumi, 1993, "Effect of Preinduction of Metallothioncin on Tissue Distribution of Silver and Hepatic Lipid Peroxidation," *Biological and Pharmacological Bulletin*, Vol. 16, No. 4, pp. 372–374.

Smith, G. J., et al., 1988, "Reproduction in Black-Crowned Night Herons Fed Selenium," *Lake and Reservoir Management*, Vol. 4, No. 2, pp. 175–180.

Smyth, H. F., Jr., and C. P. Carpenter, 1948, "Further Experience with the Range Finding Test in the Industrial Toxicology Laboratory," *Journal of Industrial Hygiene and Toxicology*, Vol. 30, pp. 63–68.

Stahl, J. L., J. L. Greger, and M. E. Cook, 1990, "Breeding Hen and Progeny When Hens Are Fed Excessive Dietary Zinc," *Poultry Science*, Vol. 69, pp. 259–263.

Steele, M. J., et al., 1990, "Assessing the Contribution From Lead in Mining Wastes to Blood Lead," *Regulatory Toxicology and Pharmacology*, Vol. 11, pp. 158–190.

Steven, J. D., et al., 1976, *Effects of Chromium in the Canadian Environment*, NRCC 15017, National Research Council of Canada, Ottawa.

Stevenson, M. H., and N. Jackson, 1981, "An Attempt to Distinguish Between the Direct and Indirect Effects, in the Laying Domestic Fowl, of Added Dietary Copper Sulfate," *British Journal of Nutrition*, Vol. 46, No. 1, pp. 71–76.

Straube, E. F., N. H. Schuster, and A. J. Sinclair, 1980, "Zinc Toxicity in the Ferret," *Journal of Comparative Pathology*, Vol. 90, pp. 355–361.

Suter, G. W. II, 1993, *Ecological Risk Assessment*, Chelsea, Michigan: Lewis Publishers, 538 pp.

Suter, G. W. II, March 1989, Chapter 2, "Ecological Endpoints," *Ecological Assessments of Hazardous Waste 91 Sites: A Field and Laboratory Reference Document,* W. Warren-Hicks, B. R. Parkhurst, and S. S. Baker, ed., EPA 1600/3-89/013, U.S. Environmental Protection Agency.

Suter, G. W. II, M. E. Will, and C. Evans, September 1993, *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota on the Oak Ridge Reservation, Oak Ridge, Tennessee*, ORNL/ER-139ES/ER/TM-85, Energy Systems Environmental Restoration Program, ORNL Environmental Restoration Program, Oak Ridge National Laboratory.

Tarasenko, N.Y., O. A. Pronin, and A. A. Silaev, 1977, "Barium Compounds as Industrial Poisons (an experimental study)," *J. Hyg. Epidemol. Microbiol. Immunol.*, Vol. 21, pp. 361–373.

TOXNET, 1994, National Library of Medicine, On-line Computer Database.

Travis, C. C., and A. D. Arms, March 1988, "Bioconcentration of Organics in Beef, Milk, and Vegetation," *Environmental Science and Technology*, Vol. 22, pp. 271–274.

Trivedi, B., et al., 1989, "Embryotoxicity and Fetotoxicity of Orally Administered Hexavalent Chromium in Mice," *Reproductive Toxicology*, Vol. 3, No. 4, pp. 275–278.

Turk, J. L., and F. H. Kratzer, 1960, "The Effects of Cobalt in the Diet of Chicks," *Poultry Science*, Vol. 39, p. 1302 (abstract).

U.S. Bureau of Mines, May 26, 1989, "Antimony in the 1st quarter of 1989," *Mineral Industry Series*, U.S. Bureau of Mines, Pittsburgh, Pennsylvania.

Ungvary, G., et al., 1980, "Studies on the Embryotoxic Effect of Ortho-, Meta-, and Para-xylene," *Toxicology*, Vol. 18, pp. 61–74.

USFWS, April 30, 1996, Letter from the U.S. Fish and Wildlife Service to T. Reynolds, Environmental Science and Research Foundation, SP# 1-4-96-SP-185, update to SP#1-4-95-255, File #506.0000.

USFWS, July 16, 1997, Letter from the U.S. Fish and Wildlife Service to T. Reynolds, Environmental Science and Reseat Foundation, SP# 1-4-97-SP-242, update to SP#1-4-96-185, File #506.000.

Uthus, E. O., 1992, "Evidence for Arsenic Essentially," *Environmental Geochemistry and Health*, Vol. 14, No. 2, pp. 55–58.

Van Bruwaene, R., et al., 1982, "Metabolism of Antimony-124 in Lactating Dairy Cows," *Health Physics*, 43(5):733–738.

VanHorn, R. L., N. L. Hampton, and R. C. Morris, April 1995, *Guidance Manual for Conducting Screening Level Ecological Risk Assessment at the INEL*, INEL-95/0190, Lockheed Martin Idaho Technologies Company.

Wakeley, J. S., 1978, "Factors Affecting the Use of Hunting Sites by Ferruginous Hawks," *Condor*, Vol. 80, pp. 316–326.

Weber, C. W., and B. L. Reid, 1968, "Nickel Toxicity in Growing Chicks," *Journal of Nutrition*, Vol. 95, pp. 612–616.

Weitz, A., and K. E. Ober, 1965, "Physiological Distribution of Antimony after Administration of Sb-124 Labeled Tartar Emetic," *Bulletin of the World Health Organization*, Vol. 33, pp. 137–142.

White, D. H., and M. P. Dieter, 1978, "Effects on Dietary Vanadium in Mallard Ducks," *Journal of Toxicology and Environmental Health*.

Wilber, C. G., 1980, "Toxicology of Selenium: A Review," *Clinical Toxicology*, Vol. 17, pp. 171–230.

Will, M. E., and G. W. II Suter, September 1995, *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants*, ES/ER/TM-85/R2, Oak Ridge National Laboratory, Environmental Restoration Division, Environmental Restoration Program, Oak Ridge, Tennessee.

Will, M. E., and G. W. Suter II, September 1995, *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1995 Revision*, ES/ER/TM-85/R2, Lockheed Martin Energy Systems, Inc., Oak Ridge, Tennessee.

Wills, J. H., G. E. Groblewski, and F. Coulstone, 1981, "Chronic and Multigeneration Toxicities of Small Concentrations of Cadmium in the Diet Rates," *Ecotoxicol. Environ. Safety*, Vol. 5, pp. 452–464.

Witmer, C. M., R. Harris, and S. I. Shupack, 1991, "Oral Bioavailability of Chromium from a Specific Site," *Environmental Health Perspective*, Vol. 92, pp. 105–110.

Wobeser, G. A., N. O. Nielson, and B. Schiefer, 1976, "Mercury and Mink. 2. Experimental Methylmercury Intake in Mink," *Canadian Journal of Comparative Medicine*, Vol. 40, pp. 34–45.

WHO, 1981, *Recommended Health-Based Limits in Occupational Exposure to Selected Organic Solvents*, Technical Report No. 664, World Health Organization, Geneva.

Wren, C. D., et al., 1987, "The Effects of Polychlorinated Biphenyls and Methylmercury, Singly and in Combination, on Mink, II: Reproduction and Kit Development," *Archives of Environmental Contamination and Toxicology*, Vol. 16, pp. 449–454.

Wren, C. D., 1986, "A Review of Metal Accumulation and Toxicity in Wild Animals, I. Mercury," *Environmental Research*, Vol. 40, No. 1, pp. 210–244.

Zitco, V., 1975, "Toxicity and Pollution Potential of Thallium," *The Science of the Total Environment*, 4(2):185–192.

Zmudzki, J., et al., 1983, "Lead Poisoning in Cattle: Reassessment of the Minimum Toxic Oral Dose," *Bulletin of Environmental Contaminants*, Vol. 30, pp. 435–441.