# U.S. Department of Energy

Oakland Operations Office, Oakland, California

# ACTION MEMORANDUM FOR A CHANGE IN SCOPE OF RESPONSE AT DOMESTIC SEPTIC SYSTEMS 3 AND 6

at the

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH
UNIVERSITY OF CALIFORNIA, DAVIS

*Prepared for*

**United States Department of Energy**
Oakland Operations Office
1301 Clay Street
Oakland, California 94612-5208

*Prepared by*

**Weiss Associates**
5801 Christie Avenue
Emeryville, California 94608-1827

April 26, 2002
Rev. 0

DOE Oakland Operations Contract DE-AC03-96SF20686

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Appendix A. Risk-Based Action Standard Recalculation for Mercury

# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ALARA | as-low-as-reasonably achievable |
| ARAR | applicable or relevant and appropriate requirement |
| bgs | below ground surface |
| CERCLA | Comprehensive Environmental Response, Compensation and Liability Act |
| CFR | Code of Federal Regulations |
| COPC | constituent of potential concern |
| CVRWQCB | Central Valley Regional Water Quality Control Board |
| DGI | Data Gaps Investigation |
| DHS | California Department of Health Services |
| DL | designated-level |
| DOE | United States Department of Energy |
| DSS | domestic septic system |
| DSSI | Domestic Septic Systems Investigation |
| DST | domestic septic tank |
| EE/CA | Engineering Evaluation/Cost Analysis |
| EPA | United States Environmental Protection Agency |
| FFA | Federal Facility Agreement |
| ft | feet |
| Hg | mercury |
| HI | hazard index |
| LEHR | Laboratory for Energy-Related Health Research |
| MCL | maximum contaminant level |
| MCLG | maximum contaminant level goal |
| mg/kg | milligrams per kilogram |
| NCP | National Oil and Hazardous Substances Contingency Plan |
| NEPA | National Environmental Policy Act |

| | |
|---|---|
| pCi/g | picoCuries per gram |
| PRG | preliminary remediation goal |
| RA | removal action |
| Ra-226 | radium-226 |
| RAO | removal action objective |
| RBAS | risk-based action standard |
| ROD | Record of Decision |
| RWQCB | Regional Water Quality Control Board |
| SVOC | semi-volatile organic compound |
| UC Davis | University of California, Davis |
| USFWS | United States Fish and Wildlife Services |
| µg/kg | micrograms per kilogram |

# 1. PURPOSE

The purpose of this action memorandum is to document a change in the scope of response from that described in the *Final Action Memorandum for the Southwest Trenches, Radium-226/Strontium-90 Treatment Systems, and Domestic Septic System A*reas (Final Action Memorandum) (WA, 1998a) approved by the United States Department of Energy (DOE) and the United States Environmental Protection Agency (EPA) for non-time critical removal actions (RAs) at the former Laboratory for Energy-Related Health Research (LEHR or the Site) located at the University of California, Davis (UC Davis) (Figure 1-1).

The proposed change in the scope of response will be executed by DOE in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act. The scope change will continue to meet the criteria for non-time-critical RAs under the National Oil and Hazardous Substances Contingency Plan (NCP) as described in 40 Code of Federal Regulations (CFR), Section 300.415, and will be performed under the authority of Executive Order 12580.

This document was prepared in accordance with DOE and EPA Guidance (DOE, 1994 and EPA, 1993).

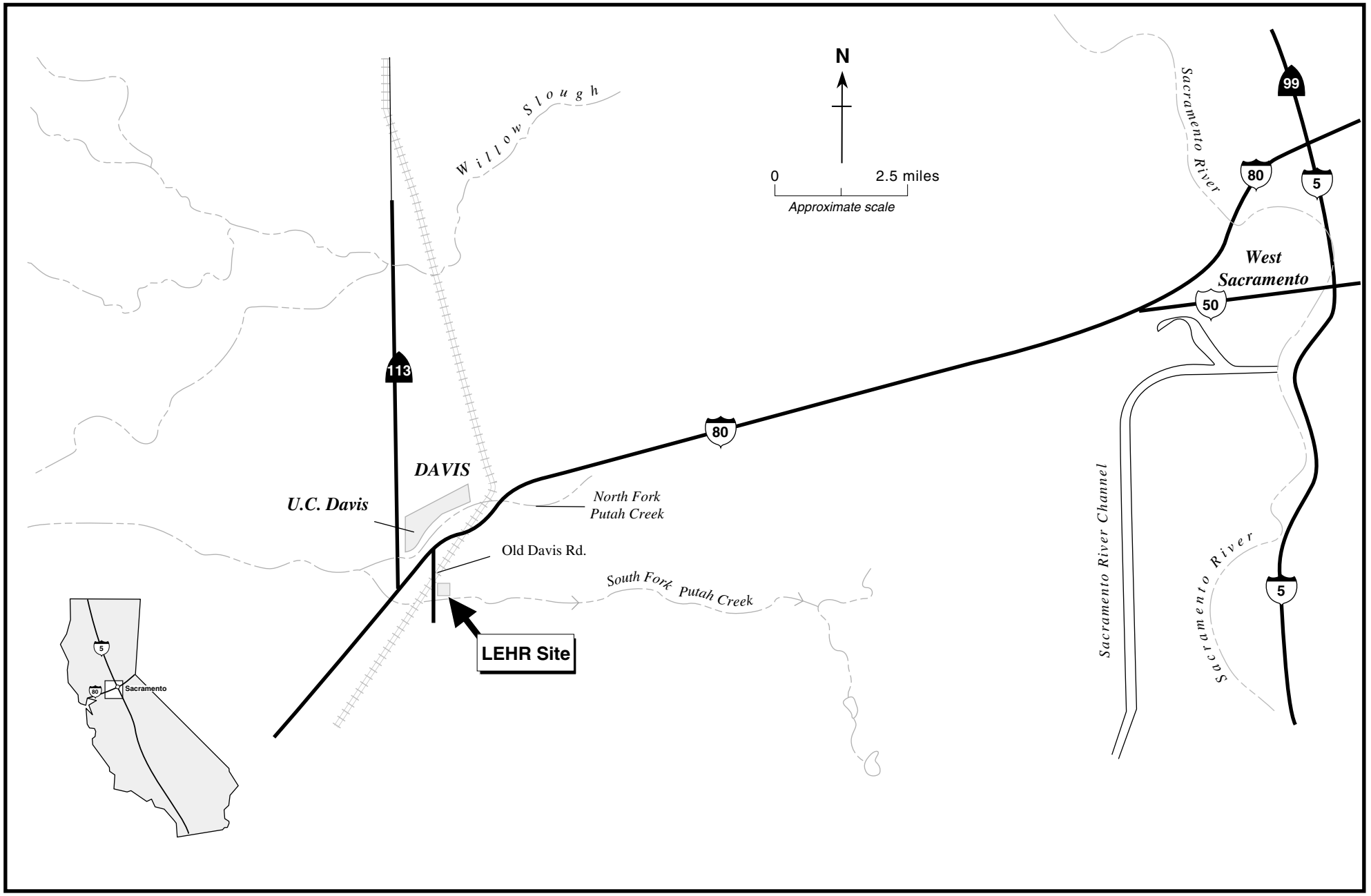


Figure 1-1. LEHR Site Location

Weiss Associates

# 2. SITE CONDITIONS AND BACKGROUND

This action memorandum addresses a change in the scope of response proposed in the Final Action Memorandum (WA, 1998a) for Domestic Septic Systems 3 and 6 at LEHR.

The Final Action Memorandum (WA, 1998a) describes the Site, including the physical location, characteristics, a removal area evaluation and all releases and/or threatened releases into the environment of a hazardous substance, pollutant, or contaminant. This action memorandum discusses new data indicating a change in the nature and extent of site contamination that requires a change in the scope of response from that previously proposed in the Final Action Memorandum (WA, 1998a).

## 2.1 Domestic Septic Systems 3 and 6 Background

Beginning in 1958, the domestic septic systems (DSSs) served LEHR offices and laboratories. DSS 6 is the oldest DSS at LEHR. A plan dated December 12, 1958 shows it connected to the "Animal Holding Building." Domestic Septic Tank (DST) 3 was apparently installed during the construction of Buildings H-215 and H-216 between 1962 and 1964, because the capacity of the tank serving existing Building H-217 may have become insufficient (Weiss, 2001). The locations of DSSs 3 and 6 are shown on Figure 2-1.

Liquid wastes and sewage were discharged to DSTs 3 and 6 prior to the Site's connection to the UC Davis Wastewater Treatment Plant in 1971. At that time, DSTs 3 and 6 were reportedly backfilled with sand and the influent/effluent lines for each tank were reportedly cut and capped (IT Corp., 1996). No formal closure reports for these DSTs are known to exist (Dames & Moore, 1994).

## 2.2 Actions Taken Pursuant to the Approved Action Memorandum

The Final Action Memorandum authorizing response activities at the DSSs was approved in 1998. Investigation activities approved in the Final Action Memorandum were conducted in the summer of 2001 in accordance with the *Work Plan for the Removal Actions at the Southwest Trenches, Radium-226/Strontium-90 Treatment Systems, and Domestic Septic System Areas* (WA, 2000a) and the Final Domestic Septic Systems Investigation and Removal Action Work Plan (WA, 2001). The investigation activities were intend to characterize the extent of contamination and determine the locations of the DSSs. Except for DSSs 3 and 6,the investigation results , indicate that no further action is required. These results will be summarized in the DOE Remedial Investigation/Feasibility Study prepared for the Site (WA, 2002). The results of the DSSs 3 and 6 investigation indicating a need for further action are summarized below.

### *2.2.1 Domestic Septic System 3*

During the 2001 Domestic Septic Systems Investigation (DSSI), five soil borings were drilled surrounding the DSS 3 location where Ra-226 was previously detected at a maximum concentration of 1.45 pCi/g (Figure 1-3). Seventeen soil samples (including two field duplicates) were collected from the five borings and analyzed for gamma emitters and Ra-226. The soil samples were collected every four ft starting eight ft bgs, the termination point of the former drain field. Three samples were collected per boring: the first composite sample was collected from 8 to 12 ft bgs, the second composite sample was collected from 12 to 16 ft bgs, and the third composite sample was collected from 16 to 20 ft bgs. All of the DSS 3 sample locations are shown on Figure 2-2.

To characterize DSS 3, samples were collected from the following locations (Figure 1-3) and analyzed for radionuclides, metals, nitrate, pesticides/polychlorinated biphenyls, semi-volatile organic compounds (SVOCs), volatile organic compounds and hexavalent chromium (full suite of constituents of concern (COCs)):

- The distribution box;
- Adjacent to the DST 3 tank bottom at a depth of 9 to 11 ft bgs;
- Directly below the first point of perforation on the eastern leach line at four ft bgs;
- Five ft below the first perforations in the eastern leach line;
- Directly below the approximate midpoint of the eastern leach line at four ft bgs; and,
- Below the midpoint of the eastern leach line at eight ft bgs.

To determine if residual sludge was present at the bottom of DST 3, an aluminum casing was driven to the bottom of the tank using the backhoe bucket. The tank contents were removed from the casing using a hand auger and visually inspected for signs of moisture or discoloration. There were no indications that sludge remained at the bottom of DST 3.

### *2.2.2 Domestic Septic System 6*

During the 2001 DSSI, an approximately five-ft by five-ft area around the mercury (Hg) detection was excavated and containerized for off-site disposal (Figure 2-3) in accordance with the W*ork Plan for Removal Actions in the Southwest Trenches, Ra/Sr Treatment Systems, and Domestic Septic Systems Areas* (WA, 2000a). The following samples were collected and analyzed for a full suite of COCs to characterize DSS 6:

- A two-point composite soil sample from beneath the first points of perforation on the southern leach lines;

- A two-point composite soil sample from beneath the first points of perforation on the northern leach lines;
- A two-point composite sample from beneath the effluent lines; and,
- A concrete sample from a portion of the DSS 6 tank floor.

Samples were also collected from the following locations and analyzed for Hg:

- The excavation side walls and floor;
- A four-point composite sample of the leach field gravel;
- Six inches and one ft west of the southeastern leach line;
- Six inches and one foot below the gravel/soil interface on the southeastern leach line; and,
- Beneath the leach line midpoints and endpoints.

## 2.3 Release or Threatened Release into the Environment of Hazardous Substance, or Pollutant, or Contaminant

### *2.3.1 Domestic Septic System 3*

At DSS 3, cadmium, copper, lead, manganese, Hg, silver and radium-226 (Ra-226) were detected above their respective soil background levels (> 4 ft bgs) and lowest risk-based action standard (RBAS) values. Seventeen constituents were detected above their respective preliminary remediation goals (PRGs) for residential soil. The constituents detected in DSS 3 soil samples in concentrations that exceed the lowest RBAS, background and/or the PRGs for residential soil are summarized in Table 2-1.

The distribution box sediment sample and the soil sample collected beneath the first point of perforation had the maximum reported concentrations for the majority of the detected constituents (Tables 2-1 and 2-2). The maximum reported Hg concentration, 751 milligrams per kilogram (mg/kg), was detected in the distribution box sediment sample. Hg concentrations in soil ranged from 0.35 mg/kg to 498 mg/kg. There were only five soil samples collected from the DSS 3 area; therefore, the extent of Hg contamination is not fully known. The DSS 3 Hg concentrations are shown on Figure 2-2.

Ra-226 was detected above the soil background level of 0.75 pCi/g in two DSS 3 area samples. The maximum reported concentration of Ra-226, 2.44 pCi/g, was detected in soil sample SSD3C020, collected beneath the first point of perforation on the eastern leach line (Figure 2-2). The Ra-226 contamination appears to be limited to the distribution box sediment and immediately below the first point of perforation. The DSS 3 Ra-226 concentrations are shown on Figure 2-2.

Four SVOCs were reported in concentrations that exceeded their respective lowest RBAS values and PRGs for residential soil in soil sample SSD3C022 (Table 2-1).

### *2.3.2 Domestic Septic System 6*

At DSS 6, antimony, barium, copper, lead and Hg were detected above their respective soil background levels (> 4 ft bgs) and lowest RBAS values. Fourteen constituents were detected above their respective PRGs for residential soil. The constituents detected in DSS 6 soil samples in concentrations that exceed the lowest RBAS, background and/or the PRGs for residential soil are summarized in Table 2-3.

Hg was detected above background and the lowest RBAS in 31 of 34 DSS samples at concentrations ranging from 0.26 to 101 mg/kg, and was reported at concentrations above the lowest RBAS and residential PRGs in samples collected beneath all four leach lines. Based on analytical results, the Hg appears to be limited to the upper seven ft of soil. The lateral extent of contamination has not been fully defined, but should be limited to the areas surrounding the leach. Five samples were collected from the sidewalls and floor of the DSS 6 RA excavation. The Hg concentrations in these samples ranged from 0.13 to 3 mg/kg. The DSS 6 Hg concentrations are shown on Figure 2-3.

Four SVOCs were detected above their respective lowest RBAS and PRG for residential soil in sample SSD6C001A/B (Table 2-3). This two point composite sample was collected beneath the first points of perforation on the northern leach lines.

Hexavalent chromium, at 0.13 mg/kg, was only constituent detected above the lowest site soil backgrounds in the concrete sample from the DST 6 tank bottom. However, the hexavalent chromium concentration was well below the lowest RBAS and residential PRG concentrations.

## 2.4 State and Local Authorities' Roles

### *2.4.1 State and Local Actions To Date*

Site investigation began in 1984 under the guidance of the Central Valley Regional Water Quality Control Board (CVRWQCB). After the Site's listing on the National Priorities List in 1994, environmental investigation and cleanup oversight responsibility was transferred to the EPA with input from the California Department of Toxic Substance Control (DTSC), the California Department of Health Services (DHS), and the CVRWQCB. These agencies are also signatories for the Federal Facility Agreement (FFA) which became effective in 1999 (EPA, Region 9, et. al). Under the FFA these state agencies are involved with the initiative, development, selection and enforcement of response actions at the Site.

### *2.4.2 Potential for Continued State/Local Response*

No state or local response actions are anticipated other than continued oversight of site cleanup activities under CERCLA. DOE will provide the necessary funding and support for the RAs, and future monitoring and maintenance.

Table 2-1. Domestic Septic System 3 Investigation Sampling Analytical Results Summary

| Constituent | Total Samples | Number of Samples > Background[1] | Number of Samples > RBAS[2] | Number of Samples > PRG[3] | Maximum Concentration | Sample Identification | Depth (ft) |
|---|---|---|---|---|---|---|---|
| **General Chemistry** | | | | | **mg/kg** | | |
| Hexavalent Chromium | 5 | 3 | 0 | 1 | 0.836 | SSD3C019 | 9- 11.3 |
| Nitrate | 5 | 3 | NE | NE | 101 | SSD3C023 | 8 |
| **Metals** | | | | | **mg/kg** | | |
| Arsenic | 5 | 1 | NE | 5 | 44.1 | SSD3C020 | 4 |
| Barium | 5 | 0 | 5 | 0 | 222 | SSD3C020 | 4 |
| **Cadmium** | **5** | **3** | **4** | **0** | **2.6** | **SSD3C020** | **4** |
| Chromium | 5 | 5 | 0 | 1 | 249 | SSD3C020 | 4 |
| Copper | 5 | 1 | 5 | 0 | 106 | SSD3C020 | 4 |
| Iron | 5 | 0 | NE | 5 | 37,900 | SSD3C023 | 8 |
| **Lead** | **5** | **1** | **5** | **0** | **21.8** | **SSD3C020** | **4** |
| **Manganese** | **5** | **1** | **5** | **0** | **752** | **SSD3C022** | **4.5** |
| **Mercury** | **5** | **5** | **5** | **2** | **498** | **SSD3C020** | **4** |
| Molybdenum | 5 | 4 | NE | 0 | 26.2 | SSD3C020 | 4 |
| Nickel | 5 | 3 | NE | 5 | 285 | SSD3C023 | 8 |
| Selenium | 5 | 4 | 0 | 0 | 10.7 | SSD3C020 | 4 |
| **Silver** | **5** | **4** | **4** | **0** | **186** | **SSD3C020** | **4** |
| Zinc | 5 | 1 | 0 | 0 | 116 | SSD3C020 | 4 |
| **Pesticides** | | | | | **µg/kg** | | |
| alpha-Chlordane | 5 | NA | 1 | NE | 806 | SSD3C020 | 4 |
| gamma-Chlordane | 5 | NA | 1 | NE | 1,150 | SSD3C020 | 4 |
| Heptachlor epoxide | 5 | NA | 1 | 0 | 12.8 | SSD3C022 | 4.5 |

Table 2-1. Domestic Septic System 3 Investigation Sampling Analytical Results Summary (continued)

| Constituent | Total Samples | Number of Samples > Background[1] | Number of Samples > RBAS[2] | Number of Samples > PRG[3] | Maximum Concentration | Sample Identification | Depth (ft) |
|---|---|---|---|---|---|---|---|
| **Radionuclides** | | | | | **pCi/g** | | |
| Bismuth-214 | 5 | 1 | NE | NE | 2.18 | SSD3C020 | 4 |
| Carbon-14 | 5 | 1 | 0 | 0 | 0.155 | SSD3C023 | 8 |
| Cesium-137 | 5 | 1 | 0 | 1 | 0.0619 | SSD3C020 | 4 |
| Lead-210 | 5 | 1 | 0 | 3 | 1.72 | SSD3C020 | 4 |
| Lead-214 | 5 | 1 | NE | 0 | 2.33 | SSD3C020 | 4 |
| Potassium-40 | 5 | 0 | NE | 5 | 11.7 | SSD3C023 | 8 |
| **Radium-226** | **5** | **1** | **5** | **1** | **2.44** | **SSD3C020** | **4** |
| Strontium-90 | 5 | 4 | 0 | 0 | 2.01 | SSD3C020 | 4 |
| Thorium-228 | 5 | 0 | 5 | 5 | 0.595 | SSD3C021 | 8.5 |
| Thorium-232 | 5 | 0 | 5 | 0 | 0.525 | SSD3C020 | 4 |
| Uranium-233/234 | 5 | 1 | NE | 0 | 1.1 | SSD3C020 | 4 |
| Uranium-238 | 5 | 1 | NE | 0 | 0.649 | SSD3C020 | 4 |
| **SVOCs** | | | | | **µg/kg** | | |
| Benzo(a)anthracene | 5 | NA | 1 | 1 | 6,540 | SSD3C022 | 4.5 |
| Benzo(a)pyrene | 5 | NA | 1 | 1 | 1,660 | SSD3C022 | 4.5 |
| Benzo(b)fluoranthene | 5 | NA | 1 | 1 | 5,600 | SSD3C022 | 4.5 |
| Benzo(k)fluoranthene | 5 | NA | 0 | 1 | 3,680 | SSD3C022 | 4.5 |
| Dibenzo(a,h)anthracene | 5 | NA | 1 | 1 | 1,150 | SSD3C022 | 4.5 |
| Indeno(1,2,3-cd)pyrene | 5 | NA | 0 | 1 | 1,110 | SSD3C022 | 4.5 |

Table 2-1. Domestic Septic System 3 Investigation Sampling Analytical Results Summary (continued)

**Notes**

Highlighted constituents (indicated with **bold type**) were detected above background and the lowest risk-based action standard.

[1]Site-specific background for greater than four feet below ground surface.

[2]The lowest risk-based action standard.

[3]The preliminary remediation goal for residential soil.

**Abbreviations**

| | |
|---|---|
| ft | feet |
| mg/kg | milligrams per kilogram |
| NA | not applicable |
| NE | not established |
| pCi/g | picoCurie per gram |
| PRG | preliminary remediation goal |
| RBAS | risk-based action standard |
| SVOCs | semivolatile organic compounds |
| µg/kg | micrograms per kilogram |

Table 2-2. Domestic Septic System 3 Distribution Box Sediment Sample Analytical Results

| Constituent | Concentration | Units | RBAS [1] | Lowest Background [2] | PRG [3] |
|---|---|---|---|---|---|
| **General Chemistry** | | | | | |
| Formaldehyde | 1,920 | µg/kg | 1,700 | NA | 9,200,000 |
| Hexavalent Chromium | 0.0943 | mg/kg | 3.8 | 0.054 | 0.2 |
| **Metals** | | | | | |
| Antimony | 1.2 | mg/kg | 0.3 | 1.4 | 31 |
| Arsenic | 54.4 | mg/kg | NE | 8.14 | 0.39 |
| Barium | 345 | mg/kg | 53 | 211 | 5,400 |
| Beryllium | 0.44 | mg/kg | NE | 0.564 | 150 |
| Cadmium | 5.1 | mg/kg | 0.38 | 0.51 | 9 |
| Chromium | 591 | mg/kg | 721.9 | 125 | 210 |
| Copper | 219 | mg/kg | 28 | 48.8 | 2,900 |
| Iron | 36,500 | mg/kg | NE | 44,000 | 23,000 |
| Lead | 69.6 | mg/kg | 0.044 | 9.5 | 400 |
| Manganese | 350 | mg/kg | 36 | 750 | 1,800 |
| Mercury | 751 | mg/kg | 0.22 | 0.248 | 23 |
| Molybdenum | 83.3 | mg/kg | NE | 0.26 | 390 |
| Nickel | 97.4 | mg/kg | NE | 246 | 150 |
| Selenium | 11.1 | mg/kg | 58 | 1.2 | 390 |
| Silver | 150 | mg/kg | 3.8 | 0.55 | 390 |
| Vanadium | 93.5 | mg/kg | NE | 66.8 | 550 |
| Zinc | 223 | mg/kg | 3400 | 72.4 | 23,000 |
| **Pesticides** | | | | | |
| alpha-Chlordane | 718 | µg/kg | 800 | NA | 1,600[4] |
| gamma-Chlordane | 1,240 | µg/kg | 810 | NA | 1,600[4] |
| **Radionuclides** | | | | | |
| Bismuth-214 | 1.78 | pCi/g | NE | 0.54 | NE |
| Cesium-137 | 0.0736 | pCi/g | 0.1 | 0.00695 | 0.02 |
| Lead-210 | 2.29 | pCi/g | 9.6 | 1.6 | 0.78 |
| Lead-214 | 1.94 | pCi/g | NE | 0.55 | NE |
| Potassium-40 | 7.28 | pCi/g | NE | 14 | 0.068 |
| Radium-226 | 2.31 | pCi/g | 0.0042 | 0.752 | 1.5 |
| Strontium-90 | 0.692 | pCi/g | 10 | 0.056 | 14 |
| Thorium-228 | 0.435 | pCi/g | 0.032 | 0.627 | 0.041 |
| Thorium-232 | 0.414 | pCi/g | 0.022 | 0.63 | 24 |

Table 2-2. Domestic Septic System 3 Distribution Box Sediment Sample Analytical Results (continued)

| Constituent | Concentration | Units | RBAS [1] | Lowest Background [2] | PRG [3] |
|---|---|---|---|---|---|
| Thorium-234 | 1.45 | pCi/g | 3.2 | 0.78 | NE |
| Uranium-233/234 | 1.67 | pCi/g | NE | 0.559 | 18 |
| Uranium-238 | 1.05 | pCi/g | NE | 0.565 | 18 |

**Notes**

[1] The lowest risk-based action standard.

[2] The lowest site-specific background value.

[3] The preliminary remediation goal for residential soil.

[4] For total chlordane.

**Abbreviations**

| | |
|---|---|
| mg/kg | milligrams per kilogram |
| NA | not applicable |
| NE | not established |
| pCi/g | picoCuries per gram |
| PRG | preliminary remediation goal |
| RBAS | risk-based action standard |
| µg/kg | micrograms per kilogram |

Table 2-3. Domestic Septic System 6 Investigation Sampling Analytical Results Summary

| Constituent | Number of Samples | Number of Samples > Background[1] | Number of Samples > RBAS[2] | Number of Samples > PRG[3] | Maximum Concentration | Sample Identification | Depth (ft) |
|---|---|---|---|---|---|---|---|
| **General Chemistry** | | | | | **mg/kg** | | |
| Hexavalent Chromium | 3 | 2 | 0 | 0 | 0.198 | SSD3C06A/B | 3.25 |
| **Metals** | | | | | **mg/kg** | | |
| **Antimony** | **6** | **1** | **3** | **0** | **1.9** | **SSD3C004A/B** | **3.75** |
| Arsenic | 6 | 4 | 0 | 6 | 9.3 | LEHR-S-T603 | 13 |
| **Barium** | **6** | **3** | **6** | **0** | **221** | **LEHR-S-T602** | **8** |
| **Copper** | **6** | **2** | **6** | **0** | **75.2** | **SSD6C001A/B** | **4** |
| Chromium | 16 | 11 | 0 | 0 | 166 | SSD6F027 | 3 |
| Iron | 6 | 0 | NE | 6 | 43,200 | LEHR-S-T603 | 13 |
| Lead | 16 | 1 | 16 | 0 | 9.6 | SSD6C004A/B | 3.75 |
| Manganese | 6 | 0 | 6 | 0 | 709 | LEHR-S-T603 | 13 |
| **Mercury** | **34** | **31** | **31** | **9** | **101** | **SSD6C012** | **4** |
| Molybdenum | 6 | 3 | NE | 0 | 0.41 | SSD6C001A/B | 4 |
| Nickel | 6 | 3 | NE | 6 | 274 | SSD6C03A/B | 3.25 |
| Silver | 6 | 2 | 0 | 0 | 1 | SSD6C004A/B | 3.75 |
| Thallium | 6 | 2 | NE | 0 | 2 | SSD6C004A/B | 3.75 |
| Vanadium | 6 | 3 | NE | 0 | 84.8 | LEHR-S-T603 | 13 |
| Zinc | 6 | 5 | 0 | 0 | 179 | SSD6C001A/B | 4 |
| **Radionuclides** | | | | | **pCi/g** | | |
| Actinium-228 | 6 | 1 | NE | NE | 0.67 | LEHR-S-T603 | 13 |
| Bismuth-212 | 6 | 1 | NE | NE | 0.45 | LEHR-S-T602 | 8 |
| Bismuth-214 | 6 | 3 | NE | NE | 0.61 | LEHR-S-T602 | 8 |
| Cesium-137[4] | 6 | 0 | 0 | 2 | 0.0549 | SSD6C001A/B | 4 |
| Lead-210 | 6 | 1 | 0 | 2 | 1.75 | SSD6C004A/B | 3.75 |

Table 2-3. Domestic Septic System 6 Investigation Sampling Analytical Results Summary (continued)

| Constituent | Number of Samples | Number of Samples > Background[1] | Number of Samples > RBAS[2] | Number of Samples > PRG[3] | Maximum Concentration | Sample Identification | Depth (ft) |
|---|---|---|---|---|---|---|---|
| **Radionuclides (continued)** | | | | | **pCi/g** | | |
| Lead-214 | 6 | 4 | NE | NE | 0.75 | LEHR-S-T602 | 8 |
| Potassium-40 | 6 | 0 | NE | 6 | 12.8 | SSD6C001A/B | 4 |
| Radium-226 | 6 | 0 | 6 | 0 | 0.56 | LEHR-S-T603 | 13 |
| Strontium-90 | 6 | 2 | 0 | 0 | 0.211 | SSD6C001A/B | 4 |
| Thallium-208 | 6 | 2 | NE | NE | 0.242 | LEHR-S-T602 | 8 |
| Thorium-228 | 3 | 0 | 3 | 3 | 0.499 | SSD6C002A/B | 3.25 |
| Thorium-232 | 3 | 0 | 3 | 0 | 0.429 | SSD6C003A/B | 3.25 |
| Tritium | 6 | 1 | 0 | 0 | 2.3 | LEHR-S-T602 | 8 |
| Uranium-233/234 | 3 | 2 | NE | 0 | 0.737 | SSD6C001A/B | 4 |
| **SVOCs** | | | | | **µg/kg** | | |
| Benzo(a)anthracene | 6 | NA | 1 | 2 | 14,400 | SSD6C001A/B | 4 |
| Benzo(a)pyrene | 6 | NA | 1 | 1 | 788 | SSD6C001A/B | 4 |
| Benzo(b)fluoranthene | 6 | NA | 1 | 2 | 8,330 | SSD6C001A/B | 4 |
| Benzo(k)fluoranthene | 6 | NA | 0 | 1 | 7,000 | SSD6C001A/B | 4 |
| Dibenzo(a,h)anthracene | 6 | NA | 1 | 1 | 2,980 | SSD6C001A/B | 4 |
| Indeno(1,2,3-cd)pyrene | 6 | NA | 0 | 1 | 1,260 | SSD6C001A/B | 4 |

Table 2-3. Domestic Septic System 6 Investigation Sampling Analytical Results Summary (continued)

**Notes**

[1] Lowest site-specific background.

[2] The lowest risk-based action standard.

[3] The preliminary remediation goal for residential soil.

[4] Samples collected less than four feet below ground surface were compared to the zero to four feet background value.

**Abbreviations**

| | |
|---|---|
| ft | feet |
| mg/kg | milligrams per kilogram |
| NA | not applicable |
| NE | not established |
| pCi/g | picoCurie per gram |
| PRG | preliminary remediation goal |
| RBAS | risk-based action standard |
| SVOCs | semi-volatile organic compounds |
| µg/kg | micrograms per kilogram |

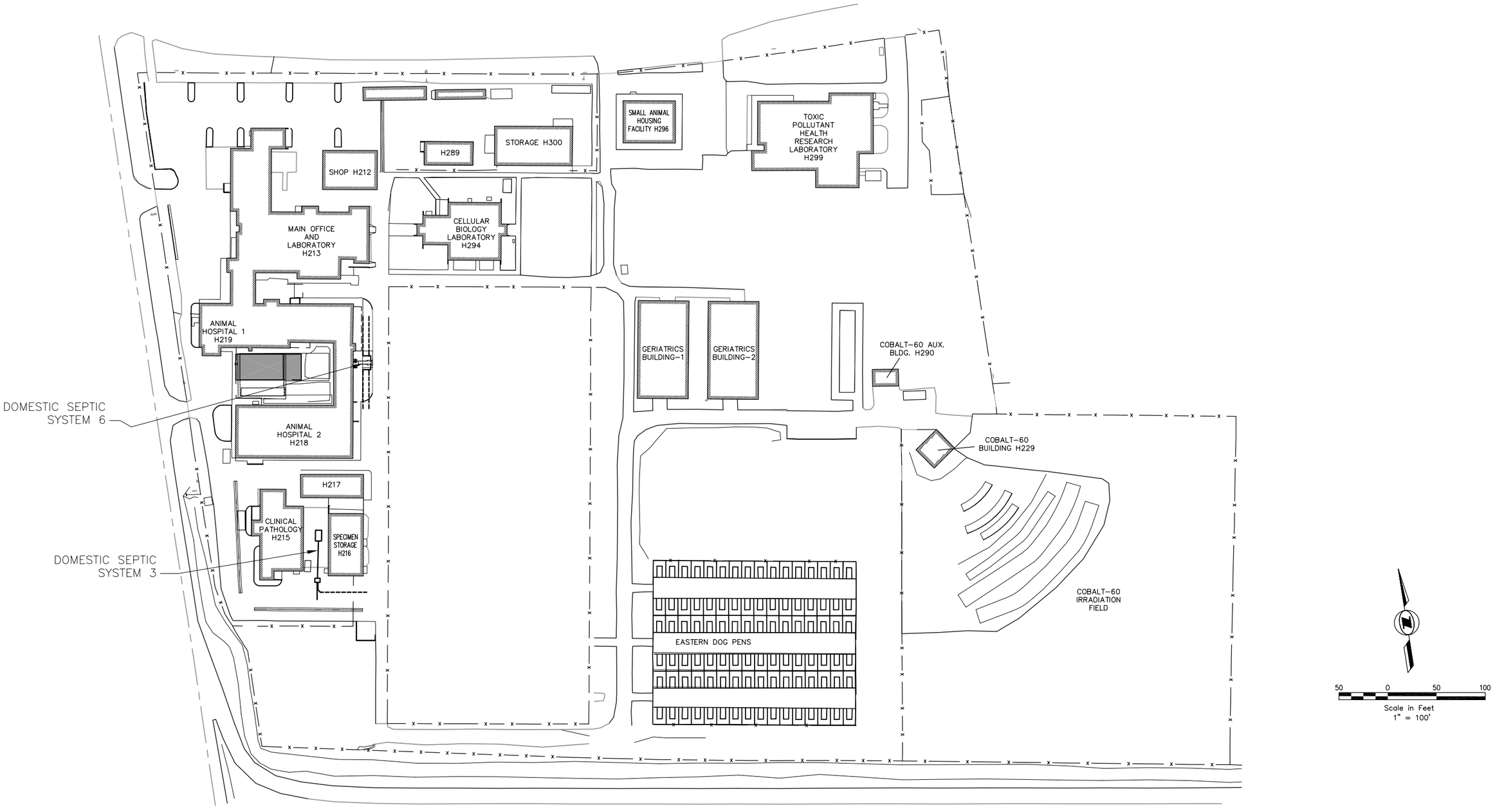


Figure 2-1. Locations of Domestic Septic Systems 3 and 6 and LEHR Facility Buildings

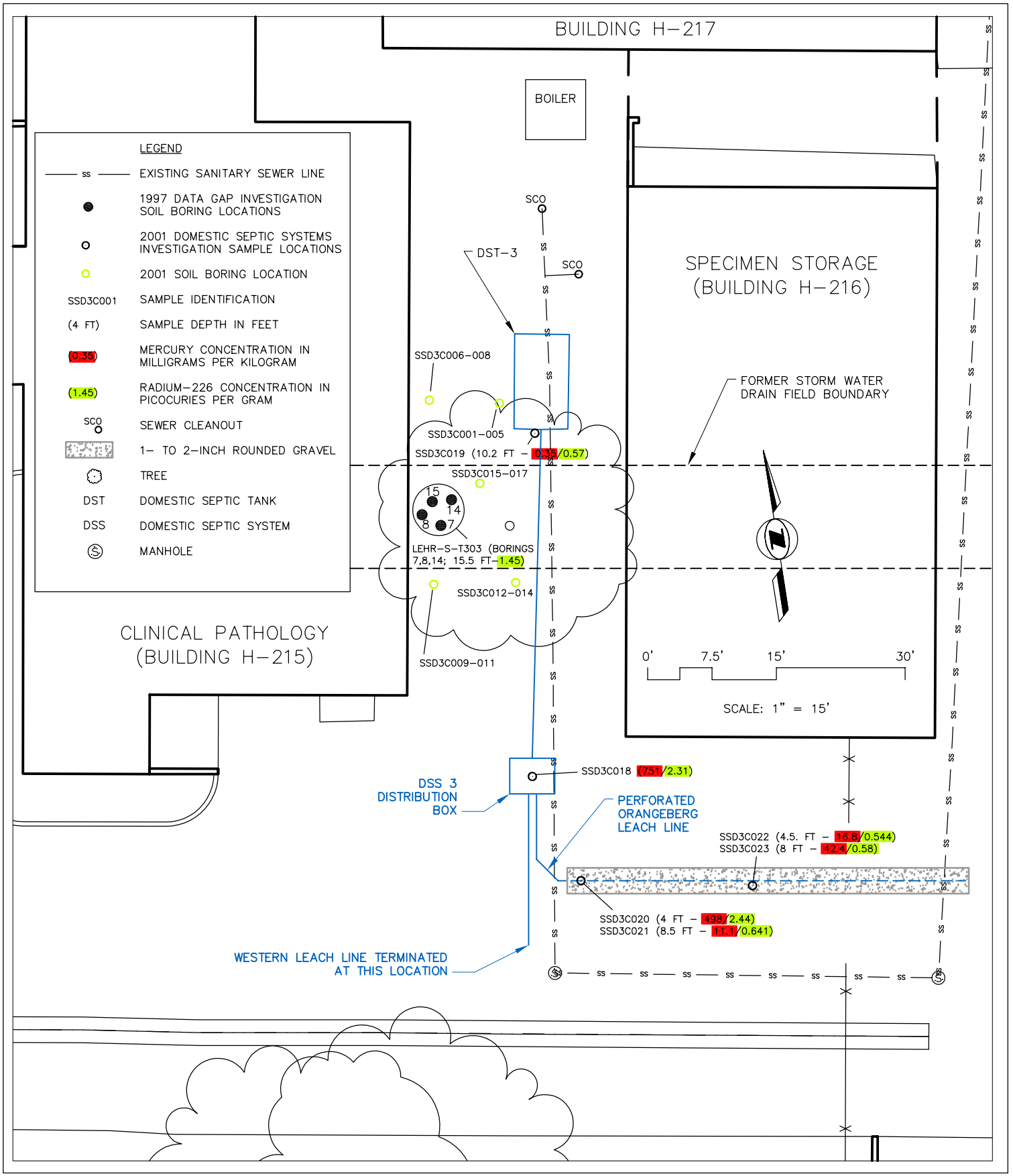


Figure 2-2. Domestic Septic System 3 Sample Locations Showing Mercury and Radium-226 Concentrations

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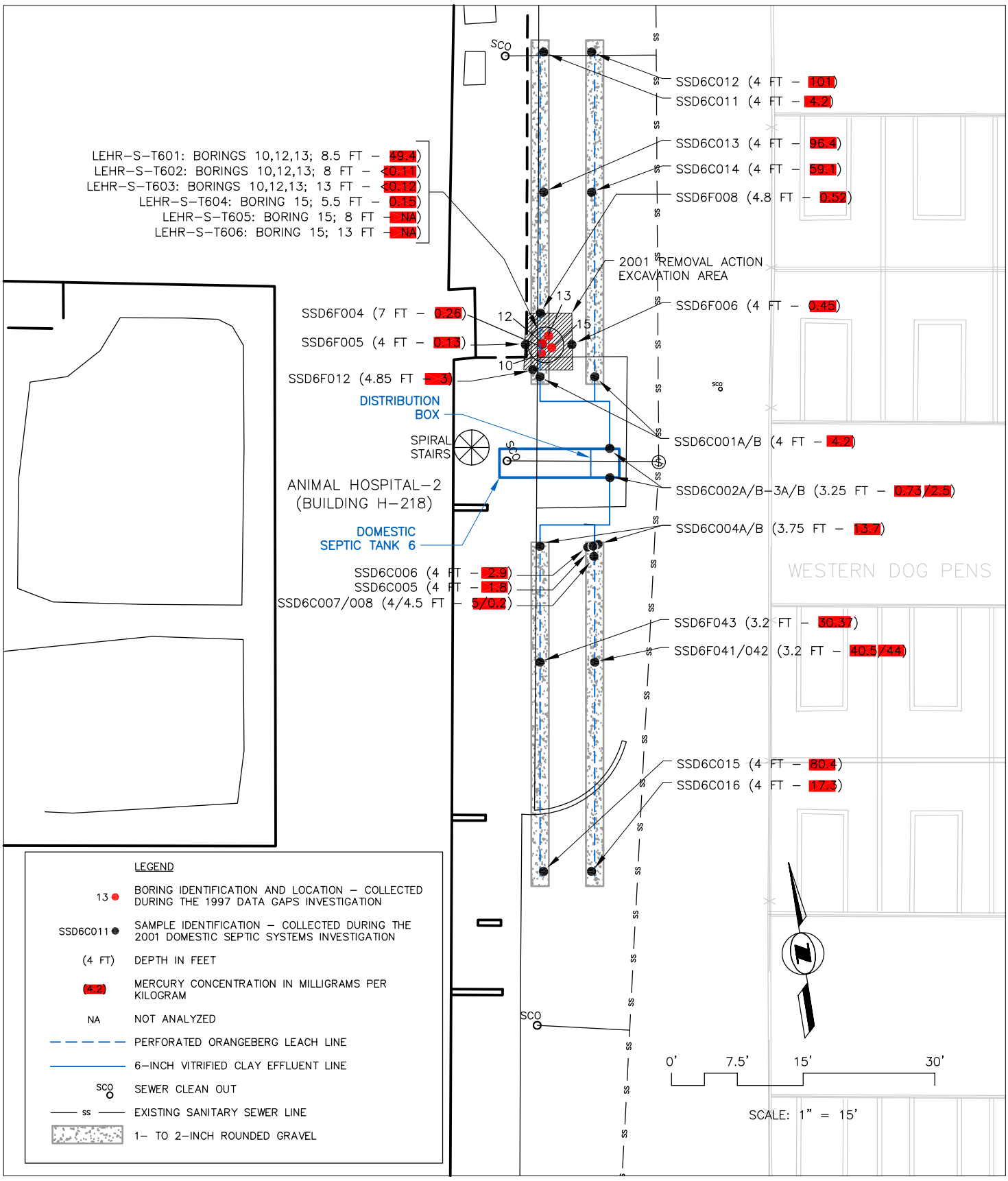


Figure 2-3. Domestic Septic System 6 Sample Locations and Mercury Concentrations

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# 3. THREATS TO PUBLIC HEALTH OR WELFARE OR THE ENVIRONMENT, AND STATUTORY AND REGULATORY AUTHORITIES

## 3.1 Threats to Public Health or Welfare

The EPA (EPA, 1991) indicates that where the cumulative potential carcinogenic risk to an individual based on reasonable maximum exposure from both current and future land uses is less than $10^{-4}$ and the hazard index (HI) is less than 1, remedial action is generally not warranted unless there are adverse environmental impacts. In the case where water is delivered to any user of a public water system where the maximum contaminant levels (MCLs) or non-zero MCL goals are exceeded, action is generally warranted. The EPA $10^{-4}$ to $10^{-6}$ risk range is a target within which risk should be managed as part of a cleanup action. Once a decision has been made to undertake cleanup, the preference is to achieve the more protective end of the range (i.e., $10^{-6}$).

RBAS values have been calculated for the LEHR site soils and are presented in the *Draft Final Determination of Risk-Based Action Standards for DOE Areas* (WA, 1997b). RBAS values specific to DSSs 3 and 6 were recalculated for Hg based on predicted post-RA contaminant distribution and lithology. These RBAS and associated calculations and assumptions are presented as Appendix A. The residual contaminant levels in the DSSs 3 and 6 soil above the applicable RBAS values are discussed in Section 2.

The RAs discussed in this Action Memorandum are intended to provide a remedy which eliminates or controls the threat posed by residual waste in the DSSs 3 and 6. A site-wide Record of Decision (ROD), to be completed in 2004, will evaluate the effectiveness of these RAs, and determine if additional action or controls are necessary.

### *3.1.1 Criteria for Determining the Existence of Threats to Public Health or Welfare*

In accordance with the NCP, the following criteria must be considered in determining the appropriateness of a non-time-critical RA (40 CFR, Section 300.415) to address threats to public welfare or the environment:

Criterion (i) *Actual or potential exposure to hazardous substances or pollutants or contaminants by nearby populations*: COC concentrations at DSSs 3 and 6 may result in a greater than $10^{-4}$ excess cancer risk for exposed on-site personnel if the RAs are not conducted.

Criterion (ii*) Actual or potential contamination of drinking water supplies*: Ground water monitoring data indicate that no significant impact to ground water drinking supplies has occurred from the removal sites.

Criterion (iii*) Hazardous substances or pollutants or contaminants in drums, barrels, tanks or other bulk storage containers:* None.

Criterion (iv) *High levels of hazardous substances or pollutants or contamination in soils, largely at or near the surface*: The contaminant concentrations in the DSSs 3 and 6 area soil may result in a greater than $10^{-4}$ excess cancer risk for exposed on-site personnel if the RAs are not conducted.

Criterion (v) *Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released*: Rainwater infiltration in the areas of contamination may encourage downward migration of contaminants.

Criterion (vi) *Threat of fire or explosion*: None.

Criterion (vii*) The availability of other appropriate federal or state responses to respond to the release*: None.

Criterion (viii*) Other situations or factors that may pose threats to public health or welfare or the environment*: None.

## 3.2 Threats to the Environment

The only potential threat to the environment from contaminants in the soil at DSSs 3 and 6 is the possible contamination of ground water. Available data suggests that the environmental resources, including ground water resources, have not been significantly affected by the COCs at DSSs 3 and 6. Additional data will become available after 2004 when a site-wide risk assessment, including ecological risks, will be completed.

### *3.2.1 Animal and Food Chain Risks*

Threats to animal and food chain receptors from pollutants or contaminants in the DSSs 3 and 6 have not been studied in sufficient detail to allow positive conclusions about the presence and/or extent of potential risks. A site-wide ecological risk assessment will be completed in conjunction with the Remedial Investigation/Feasibility Study in 2004 (EPA, Region 9, Administrative Order). An exposure pathway analysis for animals and the food chain was conducted in 1997 and is presented in the *Draft Final Ecological Scoping Assessment for DOE Areas* (WA, 1997a). This assessment was conducted for the entire LEHR site and indicated that potentially complete exposure pathways exist at the Site through which biological receptors may be exposed to

contaminated media based on the available characterization data. However, the presence of complete pathways through which biological receptors may be exposed to contaminated media is not necessarily equivalent to the presence of significant risk or hazard to these receptors.

### *3.2.2 Threats to Surface Waters and Sensitive Ecosystems*

Surface waters and sensitive ecosystems are not affected by the contaminants at DSSs 3 and 6 because the COCs are below ground and hence do not come into contact with surface water runoff. Likewise, sensitive ecosystems are not exposed to the contaminants.

### *3.2.3 Threats to Ground Water*

Constituents in the DSSs soil may impact underlying ground water above the ground water goals. Potential ground water impacts will be evaluated in the confirmation report following the RAs. The ground water goals are the EPA or DHS MCLs for drinking water or more stringent state water quality goals which are determined to be applicable or relevant in the ROD.

### *3.2.4 Threats to Air Quality*

No threats to air quality are associated with the DSSs 3 and 6 COCs.

# 4. ENDANGERMENT ASSESSMENT

Actual or threatened releases of hazardous substances/pollutants and contaminants from this site, if not addressed by implementing the response actions described in this action memorandum, may present a future endangerment to public health, welfare, or the environment.

If no action is taken, residual levels of COCs will remain in the DSSs soil. Potential future exposure to the public and the environment could occur if the COCs are not removed or controlled. However, short-term impacts are unlikely if the Site remains in its current state of use and management. Ground water quality may be impacted if no action is taken.

# 5. EXEMPTION FROM STATUTORY LIMITS

Because the RAs will be performed and funded by DOE, they are not subject to the Superfund-financed cost limitations of 12 months and $2 million prescribed in 40 CFR Section 300.415(a)(5).

# 6. PROPOSED ACTIONS AND ESTIMATED COSTS

## 6.1 Proposed Actions

The removal action objectives (RAOs) for the DSSs 3 and 6 RAs are:

- Mitigate potential excess cumulative cancer risk to an individual from exposure to site contaminants to a level within a nominal range of $10^{-4}$ to $10^{-6}$, using $10^{-6}$ as the point of departure;
- Reduce potential non-cancer HIs to levels below 1;
- Mitigate potential impact to ground water;
- Mitigate potential ecological risks during and after the RAs;
- Mitigate hazardous waste; and,
- Minimize impact to site university research.

### *6.1.1 Proposed Action Description*

To achieve the above-listed objectives, RAs consisting of excavation and off-site disposal of the excavated material are planned for DSSs 3 and 6.

Site-specific RBASs which correlate with the cancer risk and non-cancer risk RAOs were developed for the DSSs 3 and 6 areas (WA, 1997b). The proposed actions are designed to meet the RBASs.

***Recommended Removal Action for DSSs 3 and 6:*** The recommended change in the proposed scope of response for DSSs 3 and 6 will achieve the RAOs and eliminate the potential for public and environmental exposure to residual levels of COCs present at the DSSs. This change in scope complies with all applicable or relevant and appropriate requirements (ARARs) listed in the *Engineering Evaluation/Cost Analysis for Southwest Trenches, Ra-226/Sr-90, Treatment System and Domestic Septic System Areas* (WA, 1998b).

The planned sequence of RA activities and associated assumptions are summarized below, and will be discussed in detail in the RA Work Plan.

#### 6.1.1.1 Removal Action Sequence

The general scope of work for the DSSs 3 and 6 RAs consists of removal of sources of contamination and associated soil, followed by confirmation sampling and analysis, backfilling and compaction of the excavation, and site restoration. All excavated waste and structures will be managed as potentially mixed waste and disposed at an appropriate facility after characterization. A separate waste management plan will be prepared to address waste shipment and disposal. The RA sequence for the areas is:

1. Mobilize equipment and personnel to the site;
2. Conduct site setup activities including site feature protection and establishment of storage and work areas;
3. Survey underground utilities and protect any utilities that may interfere with removal activities;
4. Remove pavement in the RA work area;
5. Remove and stockpile overburden soil;
6. Excavate and remove structures, piping, leachfields and associated soil;
7. Load waste into containers for storage (concurrent with excavation);
8. Characterize and designate waste (concurrent with waste generation);
9. Transport, weigh and store waste containers from the construction area;
10. Sample to determine whether driver COCs have been adequately removed (concurrent with excavation);
11. Conduct a preliminary evaluation (Phase I) to determine whether RAOs have been attained;
12. Present Phase I data evaluation results to DOE and regulatory agencies;
13. Collect confirmation samples from the DSSs 3 and 6 excavation limits;
14. Survey excavation limits and confirmation sampling locations;
15. Backfill and compact the excavations;
16. Restore site features and paving;
17. Demobilize equipment and personnel from the site; and,
18. Evaluate confirmation sample analytical results, perform Phase II data evaluation and prepare the RA Confirmation Report.

To determine successful attainment of the RAOs and completion of the DSSs 3 and 6 RAs, confirmation samples will be collected following material/waste removal activities. The confirmation sample analytical results will be compared to background soil values, RBASs, PRGs and ground water-protective designated-level soil concentrations.

### *6.1.2 Contribution to Remedial Performance*

The selected RA is intended to provide an effective final remedial action for DSSs 3 and 6. A ROD for the DOE areas will be prepared in 2004, after both DOE and UC Davis have completed their remedial actions. The ROD will evaluate the RAs performed under this action memorandum and previous RAs to determine whether additional action is necessary.

### *6.1.3 Engineering Evaluation/Cost Analysis*

A Draft Final EE/CA (WA, 1998b) covering DSSs removal actions was submitted to the overseeing regulatory agencies and the public on January 20, 1998. The release of the EE/CA was advertised in three local newspapers, and a fact sheet describing the proposed RAs was prepared and distributed for comment to the parties listed on the Site mailing list. Comments received during the 30-day public comment period from the Davis South Campus Superfund Oversight Committee and from the Native American Heritage Commission were responded to. The Draft Final EE/CA was approved by the Remedial Project Managers team with minor modifications to four pages. These pages were revised, and submitted to all recipients of the Draft Final EE/CA. The Draft Final version was approved by the regulatory agencies as the Final EE/CA.

The alternatives for the DSSs evaluated in the 1998 EE/CA included Alternative 1, No Action and Alternative 2, Excavation, Off-Site Disposal and Institutional Controls. The change in the scope of response at the DSSs 3 and 6 described in this Action Memorandum is a small deviation from Alternative 2 presented in the Draft Final EE/CA (WA, 1998b), which was the proposed and approved alternative. The change in the scope of response entails an increase in the volume of material excavated at DSS 3 from 0 to 100 cubic yards due to the additional contamination found during the 2001 investigation and from 26 to 185 cubic yards at DSS 6 due to a larger area of contamination found during the DSS 6 RA. The change in the scope of response is consistent with the overall scope of the 1998 EE/CA Alternative 2 chosen and approved in the Final Action Memorandum (WA, 1998a).

### *6.1.4 Applicable or Relevant and Appropriate Requirements*

Potential ARARs for CERCLA sites fall into three broad categories based on the chemicals of concern, the site location and conditions, and the RA being considered: Action-Specific, Location-Specific, and Chemical-Specific. Federal, state and local requirements in each category are provided in Tables 6-1 through 6-3. These ARARs, along with risk evaluation data, potential ground water impacts and other considerations, were used to develop the RAOs.

### *6.1.5 National Environmental Policy Act*

The National Environmental Policy Act (NEPA) requires an assessment of potential impacts that may result from implementing an RA. Section 7 of the EE/CA (WA, 1998a) reviewed environmental impacts associated with the originally proposed scope of response in a manner that is consistent with NEPA and with DOE environmental compliance guidelines and concluded that the RAs will impact a relatively small area of previously-disturbed land, and would have little effect on the environment. The change in scope response described in this action memorandum does not present a significant change from the impacts evaluated in the EE/CA and does not alter the conclusion that no long-term, significant, and adverse environmental impacts are likely from any of the proposed activities.

### *6.1.6 Project Schedule*

A general RA schedule is presented in Table 6-4.

Table 6-4. Planned LEHR Domestic Septic Systems 3 and 6 Removal Action Schedule

| Activity | Schedule |
|---|---|
| Prepare Removal Actions Work Plan | March 2002 |
| Field Work | |
| Removal Actions at DSSs 3 and 6 | May - June 2002 |
| Confirmation Sampling (concurrent with removal action activities) | May - June 2002 |
| Off-Site Waste Disposal | June 2002 - January 2003 |
| Domestic Septic Systems 3 and 6 Confirmation Report | September 2002 |

## 6.2 Estimated Costs

The total estimated cost for the DSSs 3 and 6 RAs and associated waste management is $1,100,000.

Table 6-1. Chemical-Specific Requirements for the LEHR Facility

| Requirement/Authority | Comments | ARAR Category |
|---|---|---|
| **Federal** | | |
| Solid Waste Disposal Act, Resource Conservation and Recovery Act, (42 USC §6921, 40 CFR Part 261) | Requires identification and listing of hazardous waste. If waste is listed in 40 CFR 261 or tested according to specified test methods or by applying knowledge of the hazardous characteristics of the waste, and the waste is determined to be hazardous, compliance with 40 CFR 262, Standards Applicable to Generators of Hazardous Waste, is required. | Applicable |
| Clean Water Act (33 USCA 1251-1376, 40 CFR 122, 125, 136) | Both on-site and off-site discharges from CERCLA sites to surface waters are required to meet substantive Clean Water Act limitations, monitoring requirements and best management practices. | Applicable |
| Safe Drinking Water Act (42 USCA 300 and 40 CFR 141.11-16, 141.50-51) | Establishes maximum contaminant levels (MCLs) as health-based standards and maximum contaminant level goals (MCLGs) as health goals for public water supply systems. The LEHR site is not a public water supply system. However, this requirement is relevant and appropriate. | Relevant and Appropriate |
| Establishment of Cleanup Levels at CERCLA Sites with Radioactive Contamination (EPA, 1997, OSWER Directive No. 9200.4-18) | Cleanup should generally achieve a carcinogenic risk within the $1x10^{-4}$ to $1x10^{-6}$ range based on the reasonable maximum exposure for an individual. A specific risk estimate near $1x10^{-4}$ may be considered acceptable if justified based on site-specific conditions. | To Be Considered |
| Supplemental Information on the Implementation of the Final Rule on Radiological Criteria for License Termination, 64 FR 234, Dec. 7, 1999 | Provides screening values for surface soil contamination release levels and information on NRC dose modeling. Supplements the NRC Final Rule on Radiological Criteria for License Termination 62 FR 39058 July 21, 1997. Surface soil screening values equivalent to 25 mrem/yr are provided for Strontium-90 and Radium-226. | To Be Considered |
| **State and Local** | | |
| Criteria for Identifying Hazardous Wastes (CCR, Title 22, 66261.21–33) | Tests for identifying hazardous characteristics are set forth in these regulations. If a chemical is either listed or tested and found hazardous, then remedial actions must comply with the applicable CCR Title 22 requirements. | Applicable |

Table 6-1. Chemical-Specific Requirements for the LEHR Facility (continued)

| Requirement/Authority | Comments | ARAR Category |
|---|---|---|
| Standards Applicable to Generators of Hazardous Waste (California Code of Regulations, Title 22, Chapter 12, Articles 1-4) | Any generator of hazardous waste located in California must meet the applicable requirements of Chapter 12 of 22 CCR. Chapter 12 provides requirements for waste hazardous waste determination, manifesting, generator identification numbers, pre-transport requirements and recordkeeping and reporting. | Applicable |
| Land Disposal Restrictions (California Code of Regulations, Title 22, Chapter 18) | This chapter identifies hazardous wastes that are restricted from land disposal and defines those limited circumstances under which an otherwise prohibited waste may continue to be land disposed. The requirements of Chapter 18 apply to persons who generate hazardous waste. | Applicable |
| Porter-Cologne Water Quality Control Act (California Water Code, Div. 7, § 13000, et. seq. and 23 CCR Chap. 15, 2510-2559, 2580-2601) | Establishes authority for state and regional water boards to determine site-specific waste discharge requirements and to regulate disposal of waste to land. Contains corrective action requirements stating that a COC not exceed background values unless it is technically or economically infeasible, in which case the default clean-up values would be the Basin Plan Water Quality Objectives. | Applicable |

Table 6-1. Chemical-Specific Requirements for the LEHR Facility (continued)

| Requirement/Authority | Comments | ARAR Category |
|---|---|---|
| Central Valley Regional Water Quality Control Board Basin Plan, "Policy for Investigation and Cleanup of Contaminated Sites" and "Policy for Application of Water Quality Objectives" | Describes water basins in the Central Valley Region, establishes beneficial uses of ground and surface waters, establishes water quality objectives and numerical standards, establishes implementation plans to meet water quality objectives and protect beneficial uses, and incorporates statewide water quality control plans and policies. Any activity, including but not limited to, the discharge of contaminated soils or waters, or *in-situ* treatment or containment of contaminated soils or waters, must not result in actual water quality exceeding water quality objectives.<br><br>The "Policy for Investigation and Cleanup of Contaminated Sites" establishes and describes policy for investigation and remediation of contaminated sites. It also includes implementation actions for setting ground water and soil cleanup levels. Cleanup levels for soils should be equal to levels that would achieve background concentrations in ground water unless such levels are technically and economically infeasible to achieve. In such cases, soil cleanup levels are such that ground water will not exceed applicable ground water quality objectives.<br><br>The "Policy for Application of Water Quality Objectives" defines water quality objectives and explains how the Regional Water Quality Control Board (RWQCB) applies numerical and narrative water quality objectives to ensure the reasonable protection of beneficial uses of water and how the RWQCB applies Resolution No. 68-16 to promote the maintenance of existing high quality waters. Applies to all cleanups of discharges that may affect water quality. | Applicable |
| State Water Resources Control Board Resolution No. 68-16, "Anti-degradation Policy" | Requires that high quality surface and ground waters be maintained to the maximum extent possible. Degradation of waters will be allowed (or allowed to remain) only if it is consistent with the maximum benefit to the people of the State, does not unreasonably affect present and anticipated beneficial uses, and does not result in water quality less than that prescribed in RWQCB and State Water Resources Control Board policies, as defined by the substantive requirements. If degradation is allowed, the discharge must meet best practicable treatment or control, which must prevent pollution or nuisance and result in the highest water quality consistent with maximum benefit to the people of the state. | Applicable |

Table 6-1. Chemical-Specific Requirements for the LEHR Facility (continued)

| Requirement/Authority | Comments | ARAR Category |
|---|---|---|
| State Water Resources Control Board Resolution No. 92-49 (as amended April 21, 1994) | Establishes requirements for investigation and cleanup and abatement of discharges. Among other requirements, dischargers must clean up and abate the effects of discharges in a manner that promotes the attainment of either background water quality, or the best water quality that is reasonable if background water quality cannot be restored. Requires the application of Title 23, CCR, Section 2550.4, requirements to cleanups. | Relevant and Appropriate[1] |
| State Water Resources Control Board Resolution No. 88-63, "Sources of Drinking Water Policy" | Specifies that, with certain exceptions, all ground and surface waters have municipal or domestic water supply beneficial uses. Applies in determining beneficial uses for water that may be affected by discharges of waste. SWRCB Resolution 88-63 applies to all sites that may be affected by discharges of waste to ground water or surface water. California State primary MCLs are relevant and appropriate; however, the most stringent federal or state standard will be the ARAR for the removal action. | Applicable |

Table 6-1. Chemical-Specific Requirements for the LEHR Facility (continued)

**Notes**

1 The following standard is set forth in Title 22 CCR Section 66264.94, Title 22 CCR Section 66265.94, Title 23 CCR Section 2550.4, and SWRCB Res. No. 92-49 Section IIIG: "Concentration limits for a constituent of concern greater than background values for that constituent can be established only if it is demonstrated that it is technologically or economically possible to achieve the background value for that constituent; in no event shall a concentration limit greater than background for a constituent of concern exceed the lowest concentration that is technologically or economically achievable." The U.S. Department of Energy reserves their position that this standard is a Federal ARAR via its incorporation in Title 22 CCR Section 66264.94 which was federally authorized via EPA's authorization of the State of California RCRA program.

**Abbreviations and Acronyms**

| | |
|---|---|
| ARAR | Applicable or Relevant and Appropriate Requirement |
| CERCLA | Comprehensive Environmental Response, Compensation and Liability Act of 1980 |
| COC | chemical of concern |
| EPA | U.S. Environmental Protection Agency |
| FR | Federal Register |
| MCLGs | maximum contaminant level goals |
| MCLs | maximum contaminant levels |
| mrem/y | millirem per year |
| NRC | Nuclear Regulatory Commission |
| RCRA | Resource Conservation and Recovery Act |
| RWQCB | Regional Water Quality Control Board |
| SWRCB | State Water Resources Control Board |
| USC | United States Code |
| USCA | United States Code Annotated |
| CCR | California Code of Regulations |
| CFR | Code of Federal Regulations |
| OSWER | Office of Solid Waste Emergency Response |

Table 6-2. Location-Specific Requirements for the LEHR Facility

| Requirement/Authority | Comments | ARAR Category |
|---|---|---|
| **Federal** | | |
| Endangered Species Act of 1973 (16 USC § 1531 et seq., 50 CFR Parts 10, 11, 17, 200, 402, & 424, and 40 CFR 257.3) | Facilities or practices shall not cause or contribute to the taking of any endangered or threatened species of plants, fish, or wildlife. Activities will be evaluated to determine their impact on listed species and species proposed for listing and their habitat. If jeopardy or adverse modification will result from any site activities, a determination will be made based on a consultation with the United States Fish and Wildlife Services (USFWS) regarding the need for mitigation measures and/or an incidental take statement. Specific mitigation measures will be identified and implemented per USFWS guidelines. | Applicable |
| Executive Order 11988 (floodplain management) and 11990 (protection of wetlands) (40 CFR 6, 10 CFR 1022) | Directs all Federal agencies to avoid, if possible, development and other activities in the 100-year base floodplain. Where the 100-year floodplain cannot be avoided, special considerations and studies for new facilities and structures are needed. Design and siting are to be based on scientific, engineering, and architectural studies; consideration of human life, natural processes, and cultural resources; and the planned lifespan of the project. Federal agencies are required to: 1) reduce the risk of flood loss; 2) minimize the impact of floods on human safety, health, and welfare, and 3) restore and preserve the natural and beneficial values served by floodplains in carrying out agency responsibility. 44 Federal Register 12594 states that DOE can meet requirements of these Executive Orders through applicable DOE and NEPA procedures. | Applicable |
| National Historic Preservation Act of 1966 (16 USC 470 et seq., Public Law 89-665 and amendments of 1980, Public Law 96-515, 36 CFR 800) | Requires federal agencies to take into account the effects of their projects on historic properties listed, or eligible for listing, on the National Register of Historic Properties and to afford the Advisory Council a reasonable opportunity to comment on them. | Applicable |
| Fish and Wildlife Coordination Act (16 USC 661-666) | Requires action to preserve endangered species or threatened species. Prior to conducting any ground-disturbing activities, surveys will be conducted for species of concern. | Applicable |

Table 6-2. Location-Specific Requirements for the LEHR Facility (continued)

| Requirement/Authority | Comments | ARAR Category |
|---|---|---|
| **State And Local** | | |
| California Endangered Species Act (California Fish and Game Code, § 2050–2068) | Requires action to preserve endangered species or threatened species. Prior to conducting any ground-disturbing activities, surveys will be conducted for species of concern. | Applicable |

**Abbreviations:**
NEPA National Environmental Policy Act
USFWS U.S. Fish and Wildlife Service
CFR Code of Federal Regulations
USC United States Code

Table 6-3. Action-Specific Requirements for the LEHR Facility

| Requirement | Comments | ARAR Category |
|---|---|---|
| **Federal** | | |
| Clean Water Act § 404 (33USC 1344, 33CFR 328 and 40 CFR 230) | Establishes a national program to control the discharge of dredged or fill materials into "waters of the United States." "Waters of the United States" is defined to include all tributaries of navigable waters and nearly all wetlands. Although no permit would be required for actions affecting a wetland, the substantive provisions of Section 404, including agency coordination prior to construction, state water quality certification, and possibly even mitigation for loss, may be applicable. These requirements may apply if RAs cause turbid water to enter drainages, or if RAs impact wetlands adjacent to Putah Creek. | Applicable |
| National Pollution Discharge Elimination System (40 CFR Parts 122, 123, 124, implemented by State Water Resources Control Board Order No. 92-08 DWQ) | Regulates pollutants in discharge to stormwater associated with construction activities (clearing, grubbing, or excavation) involving the disturbance of five acres or more. Ensures stormwater discharges do not contribute to a violation of surface water quality standards. Includes measures to minimize and/or eliminate pollutants in stormwater discharges and monitoring to demonstrate compliance. The Domestic Septic Systems 3 and 6 removal actions (RAs) will affect far less than five acres. However, this requirement is relevant and appropriate. | Relevant and Appropriate |
| National Emissions Standards for Hazardous Air Pollutants (42USC 7401-7671, 40 CFR 61, Subparts H) | Emissions of radionuclides from any U.S. Department of Energy (DOE) facility to the ambient air shall not exceed levels that would result in an effective dose equivalent of 10 millirem per year (mrem/yr). Dust generated from excavation activities would be subject to this requirement. | Applicable |
| Federal Facilities Compliance Act of 1992, (PL 102-386) | This act amends the Solid Waste Disposal Act and states that all federal agencies are subject to all substantive and procedural requirements of federal, state, and local solid and hazardous waste laws in the same manner as any private party. | Applicable |
| 10 CFR 835 Occupation Radiation Protection | Provides for the protection of radiation workers at DOE facilities. Includes dose limits and requirements to reduce the dose to levels that are as-low-as-reasonably achievable (ALARA). | Applicable |
| Radioactive Waste Management (DOE Order 435.1) | Specifies requirements for managing DOE radioactive waste, including off-site disposal requirements for radioactive waste shipped to commercial facilities. Although not promulgated standards, these requirements constitute requirements for protection of the public with which the proposed action would comply. | Applicable |

Table 6-3. Action-Specific Requirements for the LEHR Facility (continued)

| Requirement | Comments | ARAR Category |
|---|---|---|
| Radiation Protection of the Public and the Environment (DOE Order 5400.5) | This Order establishes requirements for DOE facilities and operations for control of radiation exposure to the public. Although not promulgated standards, the DOE Order requirements were developed for protection of the public and the environment and are mandatory requirements for DOE activities. Chapter I adopts the International Commission on Radiological Protection recommendation that radiation dose to individuals be based on consideration of levels that are ALARA. Chapter II establishes DOE public dose limits for all exposure modes and DOE sources of radiation of 100 mrem/yr effective dose equivalent. The public dose limit specifically applies to remedial actions. This radiation dose limit also forms the basis for the release of radionuclides to the environment and the release of properties for unrestricted use discussed in Chapter IV. | Applicable |
| Noise Control Act of 1972, as amended by the Quiet Communities Act of 1978 (40 CFR 204, 205, 211) | Construction and transportation equipment noise levels (e.g., portable air compressors, and medium and heavy trucks), process equipment noise levels, and noise levels at the property boundaries of the project are regulated under this Act. State or local agencies typically enforce these levels. | Applicable |
| Standards for Protection Against Radiation (10 CFR 20, Subparts B, C & E)) | DOE activities conducted at LEHR are not subject to the NRC's licensing requirements. However, DOE policy articulated in DOE Order 5400.5 is to adopt and implement standards generally consistent with those of the NRC for DOE facilities and activities not subject to licensing authority. The NRC standards for radiation protection and occupational exposure dose limits are in Subparts B and C. Subpart E defines radiological criteria for unrestricted use of sites with residual radioactivity. | Relevant and Appropriate |
| Licensing Requirements for Land Disposal of Radioactive Waste (10 CFR 61) | Establishes requirements for radiation protection, access restrictions, future impacts, siting, drainage, final cover, buffer zones, ground water monitoring and waste disposal. | Relevant and Appropriate |

Table 6-3. Action-Specific Requirements for the LEHR Facility (continued)

| Requirement | Comments | ARAR Category |
|---|---|---|
| **State and Local** | | |
| Yolo-Solano Air Quality Management District Rules and Regulations, Rule 2.3, Ringlemann Chart | Establishes a permissible limit on visible emissions (Ringlemann Chart) resulting from construction activities, such as soil disturbance during an RA. | Applicable |
| Prohibited Acts (Health and Safety Code § 41700) | Prevents discharge of pollutants into the air that will cause injury, detriment, nuisance, or annoyance to any considerable number of persons or the public. Regulation applicable to excavation activities during RAs. | Applicable |
| Control of Radioactive Contamination in the Environment (California Health and Safety Code, § 114705, et. seq.) | Details administration of programs of surveillance and control of those activities that could lead to the introduction of radioactive materials into the environment. Applicable unless activity is governed by DOE statutory authority. | Applicable |
| Radiation Control Law (California Health and Safety Code, § 114960, et. seq.) | Institutes and maintains a regulatory program for sources of ionizing radiation so as to provide for compatibility with standards and regulatory programs of the federal government and an integrated system within the state. Applicable unless activity is governed by DOE statutory authority. | Applicable |
| State Department of Health Service Radiation Regulations (17 CCR, Chapter 5, Subchapter 4, § 30100, et. seq.) | Presents regulations of the Department of Health Services pertaining to radiation such as standards for protection against radiation, low-level radioactive waste disposal, and transportation regulations. Applicable unless activity is governed by DOE statutory authority or regulation. | Applicable |

**Abbreviations and Acronyms:**

| | |
|---|---|
| ALARA | As-Low-As-Reasonably-Achievable |
| ARAR | Applicable or Relevant and Appropriate Requirement |
| DOE | United States Department of Energy |
| DWQ | definition? |
| LEHR | Laboratory for Energy-Related Health Research |
| mrem/yr | millirem per year |
| NRC | Nuclear Regulatory Commission |
| RA | Removal Action |
| PL | definition? |

# 7. EXPECTED CHANGE IN THE SITUATION SHOULD ACTION BE DELAYED OR NOT TAKEN

If the DSSs 3 and 6 RAs are delayed or not taken, residual contamination will limit beneficial use of the site and increase DOE's overall management and cleanup costs for the Site.

# 8. OUTSTANDING POLICY ISSUES

There are no outstanding policy issues associated with the change in the scope of response at DSSs 3 and 6.

# 9. ENFORCEMENT

The RAs are governed by the LEHR Federal Facility Agreement, Administrative Docket Number 99-17, In the Matter of The U.S. Department of Energy, Laboratory for Energy-Related Health Research (EPA, Region 9, et. al.), entered into by the following parties:

- EPA, Region 9;
- CVRWQCB;
- DHS;
- DTSC; and,
- DOE.

# 10. RECOMMENDATION

This decision document describes the proposed change in the scope of response at DSSs 3 and 6 at the LEHR Federal Facility in Davis, California, developed in accordance with CERCLA as amended, and is consistent with the NCP. This decision is based on the administrative record for the Site.

Conditions at the Site meet the NCP Section 300.415(b)(2) criteria for an RA. The estimated total cost for the RA is $1,100,000, which will be funded by DOE.

The undersigned approves implementation of the RAs for DSSs 3 and 6 at LEHR.

for Roger Liddle
Acting Assistant Manager for Environment and Nuclear Energy
Oakland Operations Office
U.S. Department of Energy

April 30, 2002
Date

# 11. REFERENCES

United States Department of Energy (DOE) 1994, Removal Actions under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), DOE/EH-0435,Office of Environmental Guidance, Washington, DC.

United States Environmental Protection Agency (EPA), 1991, Role of the Baseline Risk Assessment in Superfund Remedy Selection Decision, Directive 9355.0-30,Office of Solid Waste and Emergency Response, Washington, DC.

EPA, 1993, Guidance on Conducting Non-Time Critical Removal Actions under CERCLA, Directive 9360.0-32, Office of Solid Waste and Emergency Response, Washington, DC.

Dames & Moore (D&M), 1994, Remedial Investigation, Feasibility Study and Environmental Assessment Work Plan, LEHR Environmental Restoration, UC Davis.

EPA, Region 9, et. al, Federal Facility Agreement Under Section 120, Docket Number 99-17, In the Matter of The U.S. Department of Energy, Laboratory for Energy-Related Health Research (LEHR).

EPA, Region 9, Administrative Order on Consent for Removal Action and Remedial Investigation/Feasibility Study (University of California Operable Unit), In the Matter of Laboratory for Energy-Related Health Research/Old Campus Landfill, Davis, CA, Site Number CA2890190000, US EPA Docket Number 99-16.

WA, 1997a, Draft Final Ecological Scoping Assessment for DOE Areas for the U.S. Department of Energy for Energy-Related Health Research, University of California at Davis, California, August.

WA, 1997b, Draft Final Determination of Risk-Based Action Standards for DOE Areas for the Laboratory for Energy-Related Health Research at University of California, Davis, Volumes 1 and 2, August, Rev. C.

WA, 1998a, Final Action Memorandum for the Southwest Trenches, Radium-226/Strontium-90 Treatment Systems, and Domestic Septic System Areas at the Laboratory For Energy-Related Health Research, University of California at Davis, California, April 27, Rev. 0.

WA, 1998b, Draft Final Engineering Evaluation/Cost Analysis for Southwest Trenches, Ra-226/Sr-90, Treatment System and Domestic Septic System Areas, Laboratory for Energy-Related Health Research, University of California, Davis, January, Rev. E.

WA, 2000a, Work Plan for Removal Actions in the Southwest Trenches, Ra/Sr Treatment Systems, and Domestic Septic System Areas at the Laboratory for Energy-Related Health Research, University of California, Davis, July 24, Rev. 0.

WA, 2001, Final Domestic Septic Systems Investigation and Removal Action Work Plan for the Laboratory for Energy-Related Health Research, University of California, Davis, August, Rev. 0.

WA, 2002, Draft DOE Areas Remedial Investigation Report for the Laboratory for Energy-Related Health Research, University of California, Davis, February, Rev. B.

# APPENDIX A

## RISK-BASED ACTION STANDARD RECALCULATION FOR MERCURY

# A. RISK-BASED ACTION STANDARD RECALCULATION FOR MERCURY

The general site-wide risk-based action standard (RBAS) value for mercury was calculated in the Draft Determination for Risk-Based Action Standards for DOE Areas (WA, 1997). The site-wide RBAS value was based on two assumptions that will not apply to post-removal action (RA) mercury contamination at DSS 3 and 6. The two assumptions were:

- Contamination is present in surface soil; and,
- Contamination is present between 0 and 15 feet (ft) below ground surface (bgs).

These two assumptions will not apply after the RA because excavation activities will remove all mercury contamination down to 10 ft bgs at DSS 3 and 7 ft bgs at DSS 6, and clean fill will be installed up to ground surface. Thus, more realistic site-specific assumptions about the location of mercury contamination should be made and RBAS values re-calculated for DSS 3 and 6.

## A.1 Approach

Risk Based Action Standards (RBAS) were recalculated for mercury for use during the DSS 3 and 6 RAs. The RBAS values will be used to guide the decision process during RA activities.

The DSS 3 and 6 RBAS values were recalculated using the same approach used in Draft Determination for Risk-Based Action Standards for DOE Areas (WA, 1997). The calculations were performed for the non-carcinogenic effects related to mercury under Risk Scenario 2 (East Residential Farmer). Calculations were not performed for Risk Scenarios 1 (On-Site Researcher) and 3 (South Residential Farmer) because all contaminant migration pathways under these scenarios will be closed upon RA completion at DSS 3 and 6. Migration to ground water will be the only possible pathway because any remaining post-RA contamination will be covered with clean fill and located at least 10 ft bgs at DSS 3 and 7 ft bgs at DSS 6. Migration to ground water is a closed pathway under Scenarios 1 and 3 as explained in the Draft Determination for Risk-Based Action Standards for DOE Areas (WA, 1997). The remaining pathways, which are direct contact, atmospheric dispersion, and surface water runoff, will be closed for all three Scenarios due to the clean fill that will overly any residual contamination. The exposure pathway analysis is shown in Table A-1.

The soil profile used for the recalculations is the same as that used to determine designated-level (DL) residual soil concentrations in the Radium/Strontium Treatment Systems area as shown in Appendix D of the Final Ra/Sr Treatment Systems Area Removal Action Confirmation Report (WA, 2001). The Radium/Strontium Treatment Systems area soil profile was used because it closely resembles the lithology in borings in the DSS 3 and 6 vicinities. The soil profile will be updated and

RBAS values recalculated if DL borings indicate the Radium/Strontium Treatment Systems area soil profile is not representative of lithologic conditions at DSS 3 and 6.

Mercury was assumed to remain within the first foot of soil at the base of each excavation. The planned excavation depth at DSS 3 is 10 ft bgs and the assumed post RA contaminated depth interval is between 10 and 11 ft bgs. The planned excavation depth at DSS 6 is 7 ft bgs and the assumed contamination interval was 7 to 8 feet bgs. The contaminated interval assumptions were based on previously collected site characterization samples at DSS 6, which indicate mercury attenuates rapidly (sorbs strongly) with depth upon entering the native soil. For example, DSS 6 sample LEHR-S-T601 contained 49.4 mg/kg of mercury 5.5 ft bgs and sample SSD6F004 contained only 0.26 mg/kg of mercury at 7 ft bgs. DL sampling will be conducted prior to the RAs and the contaminated interval assumptions and RBAS values will be updated if mercury is found more than one foot below the planned excavations. The physical parameters used to model mercury migration from the vadose zone to ground water are shown in Table A-2.

The RBAS values were recalculated using chemical properties and toxicity information from the US EPA Superfund Chemical Data Matrix (US EPA, 1996) and Integrated Risk Information System, respectively. Mercury was assumed to exist as mercuric chloride. The mercury RBAS calculations for DSS 3 and 6 are shown in Tables A-4 and A-5, respectively. The calculation results are shown below in Table A-6.

Table A-6. Risk-Based Action Standard Recalculation Results

| Area | Risk-Based Action Standard (mg/kg) |
|---|---|
| Domestic Septic System 3 | 6.8 |
| Domestic Septic System 6 | 8.3 |

**Abbreviation**
mg/kg milligrams per kilogram

Table A-1. Risk Scenario 2—Residential Farmer

| Source | Transport Mechanism | Exposure Route | Pathway Complete? | Rationale |
|---|---|---|---|---|
| DSS 3 and 6 Post RA Soil Contamination | Direct contact | Dermal exposure | No | No direct access to on-site soil assumed. |
| | | Direct ingestion | No | Resident assumed not to cross LEHR Site boundary and ingest source soil directly. |
| | Migration in saturated/unsaturated zone via diffusion, advection, etc. | Ground water ingestion | Yes | Ground water ingestion from residential well assumed. Receptor is assumed downgradient of contamination source. |
| | Subsurface diffusion/volatilization | Inhalation | No | Mercury is in a non-volatile form |
| | Dispersion and deposition of particulates in air | Inhalation of particulates | No | No contact between subsurface soil and atmosphere for dispersion. |
| | | Deposition with dermal exposure/Direct ingestion | No | |
| | | Deposition with impacted food ingestion | No | |
| | Precipitation and surface water runoff | Incidental ingestion of surface water | No | No contact between subsurface soil and surface water. |
| | | Dermal exposure to surface water | No | |
| | | Aquatic food ingestion | No | |
| | Direct exposure | External radiation | No | Mercury is not a radiological constituent |

Table A-2. One-Dimensional Vadose Zone Modeling Physical Parameters

| Soil Type Parameter | Unit | NCLYSLT Clayey Sandy Silt |
|---|---|---|
| Solid density (ρs) | $kg/m^3$ | 2,570 |
| Bulk density (ρB) | $kg/m^3$ | 1,700 |
| Vertical hydraulic conductivity (Kz) | cm/sec | 7.08E-05 |
| Intrinsic permeability | $m^2$ | 7.22E-14 |
| Porosity (f) | % | 0.354 |

**Abbreviations**

| | |
|---|---|
| % | percent |
| cm/sec | centimeter per second |
| $kg/m^3$ | kilogram per cubic meter |
| $m^2$ | square meter |

## Table A-3. Mercury Chemical-Specific and Toxicological Parameters

| Parameter | Unit | |
|---|---|---|
| MCL | mg/l | 0.002 |
| Mol. Wt. | g/mole | 232.68 |
| RfDo | mg/kg-day | 0.0003 |
| RfDi | mg/kg-day | none |
| Sfo | 1/(mg/kg-day) | none |
| Sfi | 1/(mg/kg-day) | none |
| $K_d$ | ml/g | 52 |

**Abbreviations**

$K_d$ adsorption coefficient
MCL maximum contaminant level
Mol. molecular
$RfD_0$ reference dose
RfDi reference dose inhalation
Sfi slope factor inhalation
Sfo slope factor oral
Wt. weight

**References**

Lyman, W.J., Ph.D., Reehl, W.F., and Rosenblatt, D.H., Ph.D, 1982, Handbook of Chemical Property Estimation Methods, Environmental Behavior of Organic Compounds, American Chemical Society, Washington, D.C.

State of California Environmental Protection Agency, Department of Toxic Substances Control, 1994, Preliminary Endangerment Assessment Guidance Manual, January 1994.

Stephens, D.B., 1996, Vadose Zone Hydrology, CRC Lewis Publishers, Boca Raton, Florida.

Thibault, D.H., Sheppard, M.I., and Smith, P.A., 1990, A Critical Compilation and Review of Default Soil Solid/Liquid Partition Coefficients, Kd, for use in Environmental Assessments, March 1990.

US Department of Energy, 1996 RESRAD-BASELINE for Windows, Version 2.20, Radiological Health Risk Section, Environmental Assessments Division, Argone National Laboratory.

US Environmental Protection Agency (EPA), 2000, Region 9 Preliminary Remediation Goal (PRG) Table, November 2000.

US EPA , 1998, Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Vol. 2, EPA-530-D-98-001B.

US EPA , 1998, Superfund Chemical Data Matrix

Weiss Associates, 1997, Draft Final One-Dimensional Vadose Zone Modeling for the Laboratory for Energy-Related Health Research (LEHR), University of California at Davis, California, April 1997.

Table A-4. Domestic Septic System 3 Mercury Risk-Based Action Standard Calculation

**Scenario 2, RBAS value and Hazard Quotients for mercury, 10-11 ft deep contaminated interval, Domestic Septic System 3**

**Target HQ 1.00E+00**

| Analyte | Soil Conc. (mg/kg) | Ground Water Ingestion HQ | Swimming Ingestion HQ | Dermal Swimming HQ | Dermal Showering HQ | Soil Ingestion HQ | Dermal Soil HQ | Inhalation HQ | Fish Ingestion HQ | Plant Ingestion HQ | Meat Ingestion HQ | Milk Ingestion HQ | HQ Across Pathways |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | 6.77 | 9.95E-01 | 0.00E+00 | 0.00E+00 | 4.86E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.000E+00 |

## Ground Water Ingestion Pathway

### Scenario 2, HQ Back Calculation - Non-Carcinogens, Ground Water Concentration Conversion Factors

| Analyte | Soil Concentration (10-11 ft bgs) (mg/kg) | Ground Water/Soil Ratio (mg/L)/(mg/kg) | Ground Water Concentration (mg/L) |
|---|---|---|---|
| mercury (hg) | 6.77 | 4.83E-04 | 3.27E-03 |

WDP Soil Profile

Summary Table

### Scenario 2, HQ Back Calculation - Ingestion of chemicals in drinking water.

| Chemical | CW (mg/L) | Child IR (L/d) | Adult IR (L/d) | EF (d/yr) | Child ED (yr) | Adult ED (yr) | Child BW (Kg) | Adult BW (Kg) | Child AT (days) | Adult AT (days) | I (mg/kg-day) | RfDo (mg/kg-day) | HQ (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | 3.27E-03 | 1.0 | 2 | 350 | 6 | 24 | 15 | 70 | 2190 | 8760 | 2.99E-04 | **0.0003** | 9.95E-01 |

CW = Chemical Concentration in Water (mg/L)
IR = Ingestion Rate (L/d)
EF = Exposure Frequency (d/yr)
ED = Exposure Duration (yr)
BW = Body Weight (Kg)
AT = Averaging Time (days)
I = Intake (mg/kg-day) = $CW \times IR_{child} \times EF \times ED_{child} / BW_{child} / AT_{child} + CW \times IR_{adult} \times EF \times ED_{adult} / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = I / RfDo

## Showering - Dermal Pathway

### Scenario 2, HQ Back Calculation - Dermal Contact With Chemicals in Water While Showering.

From GW ingestion

Summary Table

| Chemical | CW (mg/L) | SA ($cm^2$) | PC (cm/hr) | ET (hr/d) | EF (d/yr) | Child ED (yr) | Adult ED (yr) | CF ($1L/1000cm^3$) | Child BW (Kg) | Adult BW (Kg) | Child AT (days) | Adult AT (days) | AD (mg/kg-day) | RfDo (mg/kg-day) | HQ (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | 3.27E-03 | 23,000 | 0.001 | 0.25 | 350 | 6 | 24 | 0.001 | 15 | 70 | 2190 | 8760 | 1.46E-06 | 0.0003 | 4.86E-03 |

CW = Chemical Concentration in Water (mg/L)
SA = Skin Surface Area Available for Contact ($cm^2$)
PC = Dermal Permeability Constant (cm/hr) - chemical specific. Values from Table I-1.
ET = Exposure Time (hr/d)
EF = Exposure Frequency (d/yr)
ED = Exposure Duration (yr)
CF = Volumetric Conversion Factor for Water ($1L/1000cm^3$)
BW = Body Weight (Kg)
AT = Averaging Time (days)
AD = Absorbed Dose (mg/kg-day) = $CW \times SA \times PC \times ET \times EF \times ED_{child} \times CF / BW_{child} / AT_{child} + CW \times SA \times PC \times ET \times EF \times ED_{adult} \times CF / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = AD / RfDo

## Surface Water Concentration Calculation

### Storm Water Runoff Modeling - see Attachment E (WA, 1997).

### Scenario 2, HQ Back Calculation - Possible LEHR Impact of Non-Radionuclides to Putah Creek Surface Water

| Contaminant of Concern | OU1/OU2 Surface Soil Concentration MAX (mg/kg) | OU1/OU2 Surface Soil Concentration AVERAGE (mg/kg) | SWL-1/SWL-2 Storm Water Concentration MAX (mg/L) | SWL-1/SWL-2 Storm Water Concentration AVERAGE (mg/L) | Dilution Factor MIN (-) | Dilution Factor AVERAGE (-) | Putah Creek Conc. PCU/PCD Only MAX (mg/L) | Putah Creek Conc. PCU/PCD Only AVERAGE (mg/L) | Putah Creek Conc. Contributed by LEHR MAX (mg/L) | Putah Creek Conc. Contributed by LEHR AVERAGE (mg/L) | Putah Creek Conc. From LEHR/ Surface Soil Conc. MAX (mg/L)/(mg/kg) | Putah Creek Conc. From LEHR/ Surface Soil Conc. AVERAGE (mg/L)/(mg/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | 5.70E-01 | 3.10E-01 | <2.00E-04 | <2.00E-04 | 3.65E+01 | 1.37E+02 | 9.00E-04 | 5.00E-04 | 5.48E-06 | 1.46E-06 | 9.61E-06 | 4.72E-06 |

Cadmium not detected in storm water samples

Table A-4. Domestic Septic System 3 Mercury Risk-Based Action Standard Calculation

Calculations:
Dilution Factor = Creek Flow/Storm Runoff Flow
Putah Creek Concentration Contributed by LEHR = Storm Water Concentration/Dilution Factor

**Scenario 2, Back Calculation of Concentration Ratio, Concentration in Putah Creek/Concentration in On-site Soil**

| Chemical | $C_{soil}$ mg/kg | Csw/Csoil, on-site [mg/kg(sw)]/[mg/kg(soil)] | Csw mg/kg |
|---|---|---|---|
| mercury (hg) | N/A | 4.72E-06 | #VALUE! |

**Swimming Ingestion/Dermal Pathways**

Summary Table

**Scenario 2, HQ Back Calculation - Ingestion of Chemicals in Surface Water While Swimming.**

| Chemical | CW (mg/L) | CR (L/d) | EF (d/yr) | Child ED (yr) | Adult ED (yr) | Child BW (Kg) | Adult BW (Kg) | Child AT (days) | Adult AT (days) | I (mg/kg-day) | RfDo (mg/kg-day) | HQ (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | #VALUE! | 0.13 | 90 | 6 | 24 | 15 | 70 | 2190 | 8760 | #VALUE! | 0.0003 | #VALUE! |

CW = Chemical Concentration in Water (mg/L)
CR = Contact Rate (L/d)
EF = Exposure Frequency (d/yr)
ED = Exposure Duration (yr)
BW = Body Weight (Kg)
AT = Averaging Time (days)
I = Intake (mg/kg-day) = $CW \times CR_{child} \times EF \times ED_{child} / BW_{child} / AT_{child} + CW \times CR_{adult} \times EF \times ED_{adult} / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = I / RfDo

Summary Table

**Scenario 2, HQ Back Calculation - Dermal Contact With Chemicals in Surface Water While Swimming**

| Chemical | CW (mg/L) | SA (cm2) | PC (cm/hr) | ET (hr/d) | EF (d/yr) | Child ED (yr) | Adult ED (yr) | CF (1L/1000cm3) | Child BW (Kg) | Adult BW (Kg) | Child AT (days) | Adult AT (days) | AD (mg/kg-day) | RfDo (mg/kg-day) | HQ (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | #VALUE! | 23,000 | 0.001 | 0.5 | 90 | 6 | 24 | 0.001 | 15 | 70 | 2190 | 8760 | #VALUE! | 0.0003 | #VALUE! |

CW = Chemical Concentration in Surface Water (mg/L)
SA = Skin Surface Area Available for Contact ($cm^2$)
PC = Dermal Permeability Constant (cm/hr) - chemical specific. Values from Table I-1.
ET = Exposure Time (hr/d)
EF = Exposure Frequency (d/yr)
ED = Exposure Duration (yr)
CF = Volumetric Conversion Factor for Water ($1L/1000cm^3$)
BW = Body Weight (Kg)
AT = Averaging Time (days)
AD = Absorbed Dose (mg/kg-day) = $CW \times SA \times PC \times ET \times EF \times ED_{child} \times CF / BW_{child} / AT_{child} + CW \times SA \times PC \times ET \times EF \times ED_{adult} \times CF / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = AD / RfDo

Table A-4. Domestic Septic System 3 Mercury Risk-Based Action Standard Calculation

**Soil Pathways**

**Scenario 2, On-site to Off-site Soil Concentration Calculation**
**ISCST3 Modeling- see Attachment D (WA 1997).**

**Scenario 2, On-site to Off-site Soil Concentration Conversion, Back HQ Calculation - Non Carcinogens**

| Analyte | On-site Soil Concentration (0-15 ft bgs) (mg/kg) | -site Soil/On-site S oncentration Rati (mg/kg)/(mg/kg) | Off-site Soil Concentration (mg/kg) |
|---|---|---|---|
| mercury (hg) | N/A | **7.88E-08** | #VALUE! |

Summary Table

**Scenario 2, Back HQ Calculation - Ingestion of Chemicals in Soil**

| Chemical | CS (mg/kg) | Child IR (mg/d) | Adult IR (mg/d) | CF ($10^{-6}$ kg/mg) | FI (unitless) | EF (d/yr) | Child ED (yr) | Adult ED (yr) | Child BW (Kg) | Adult BW (Kg) | Child AT (days) | Adult AT (days) | I (mg/kg-day) | RfDo (mg/kg-day) | HQ (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | #VALUE! | 200 | 100 | 1.00E-06 | 1 | 350 | 6 | 24 | 15 | 70 | 2190 | 8760 | #VALUE! | 0.0003 | #VALUE! |

CS = Chemical Concentration in Soil (mg/kg)
IR = Ingestion Rate (mg/d)
CF = Conversion Factor ($10^{-6}$ kg/mg)
FI = Fraction Ingested From Contaminated Source (unitless)
EF = Exposure Frequency (d/yr)
ED = Exposure Duration (yr)
BW = Body Weight (Kg)
AT = Averaging Time (days)
I = Intake (mg/kg-day) = $CS \times IR_{child} \times CF \times FI \times EF \times ED_{child} / BW_{child} / AT_{child} + CS \times IR_{adult} \times CF \times FI \times EF \times ED_{adult} / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = I / RfDo

Summary Table

**Scenario 2, Back HQ Calculation - Dermal Contact With Chemicals in Soil**

| Chemical | CS (mg/kg) | CF ($10^{-6}$ kg/mg) | Child SA ($cm^2$) | Adult SA ($cm^2$) | AF ($mg/cm^2$) | ABS (unitless) | EF (d/yr) | Child ED (yr) | Adult ED (yr) | Child BW (Kg) | Adult BW (Kg) | Child AT (days) | Adult AT (days) | AD (mg/kg-day) | RfDo (mg/kg-day) | HQ (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | #VALUE! | 1.00E-06 | 2,000 | 5,000 | 0.2 | 0.01 | 350 | 6 | 24 | 15 | 70 | 2190 | 8760 | #VALUE! | 0.0003 | #VALUE! |

CS = Chemical Concentration in Soil (mg/kg)
CF = Conversion Factor ($10^{-6}$ kg/mg)
SA = Skin Surface Area Available for Contact ($cm^2$)
AF = Soil to Skin Adherence Factor ($mg/cm^2$)
ABS = Absorption Factor (unitless)
EF = Exposure Frequency (d/yr)
ED = Exposure Duration (yr)
BW = Body Weight (Kg)
AT = Averaging Time (days)
AD = Absorbed Dose (mg/kg-day) = $CS \times CF \times SA_{child} \times AF \times ABS \times EF \times ED_{child} / BW_{child} / AT_{child} + CS \times CF \times SA_{adult} \times AF \times ABS \times EF \times ED_{adult} / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = AD / RfDo

**Inhalation Pathway**

**Scenario 2, Indoor and Outdoor Air Calculations - see Attachment C (WA, 1997).**

**Scenario 2, Indoor and Outdoor Air Concentration Conversion Factor Calculations, Back Risk Calculation.**

| Analyte | Fwd-Calc Soil Conc (mg/kg) | Indoor Air Conversion $(mg/m^3)/(mg/kg)$ | Outdoor Air Conversion $(mg/m^3)/(mg/kg)$ | Indoor Air Conc. ($mg/m^3$) | Outdoor Air Conc. ($mg/m^3$) |
|---|---|---|---|---|---|
| ***Non-Carcinogens*** | | | | | |
| mercury (hg) | N/A | | 5.80E-13 | #VALUE! | #VALUE! |

Table A-4. Domestic Septic System 3 Mercury Risk-Based Action Standard Calculation

## Scenario 2, Back HQ Calculation -Inhalation of Airborne (Vapor Phase) Chemicals

Summary Table

| Chemical | Indoor $CA_i$ ($mg/m^3$) | Outdoor $CA_o$ ($mg/m^3$) | Child IR ($m^3/hr$) | Adult IR ($m^3/hr$) | Indoor ET (hr/d) | Outdoor ET (hr/d) | EF (d/yr) | Child ED (yr) | Adult ED (yr) | Child BW (Kg) | Adult BW (Kg) | Child AT (days) | Adult AT (days) | Indoor I (mg/kg-day) | Outdoor I (mg/kg-day) | RfDi mg/kg-day | HQ (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | #VALUE! | #VALUE! | 0.416666667 | 0.833333333 | 16.08 | 7.92 | 350 | 6 | 24 | 15 | 70 | 2190 | 8760 | #VALUE! | #VALUE! | N/A | 0 |

CAi = Chemical Concentration in Indoor Air ($mg/m^3$)
CAo = Chemical Concentration in Outdoor Air ($mg/m^3$)
IR = Inhalation Rate ($m^3/hr$)
ET = Exposure Time (hr/d)
EF = Exposure Frequency (d/yr)
ED = Exposure Duration (yr)
BW = Body Weight (Kg)
AT = Averaging Time (days)
$I_{indoor}$ = Indoor Air Intake (mg/kg-day) = $CA_{indoor} \times IR_{child} \times ET_{indoor} \times EF \times ED_{child} / BW_{child} / AT_{child} + CA_{indoor} \times IR_{adult} \times ET_{indoor} \times EF \times ED_{adult} / BW_{adult} / AT_{adult}$
$I_{outdoor}$ = Outdoor Air Intake (mg/kg-day) = $CA_{outdoor} \times IR_{child} \times ET_{outdoor} \times EF \times ED_{child} / BW_{child} / AT_{child} + CA_{outdoor} \times IR_{adult} \times ET_{outdoor} \times EF \times ED_{adult} / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = $(I_{indoor} + I_{outdoor}) / RfDo$

## Fish Ingestion

## Scenario 2. Fish Calculation - see Attachment G (WA, 1997)

Surface Water

| Inorganic Chemical *Non-Carcinogens* | Csw mg/L | Bcf L/kg | Cfish mg/kg | Csoil mg/kg | Cfish/Csoil, on-site mg/kg(fish)]/[mg/kg(soil)] |
|---|---|---|---|---|---|
| mercury (hg) | #VALUE! | 64000 | 3.02E+01 | 100 | 3.02E-01 |

Kow = Octanol/water partition coefficient.
Bcf = Bioconcentration factor for fish (L/kg)
Csw = Chemical concentration in surface water contributed by the LEHR site (mg/L)
CFish = COC concentration in fish (mg/kg).

a = Values from Fetter, 1993; Lyman et al, 1990; CalEPa, 1994; Stephens, 1996; USDOE, 1996; Weiss Associates, 1997.
b = Log(Bcf) = 0.76 Log(Kow) - 1.23, Veith et al., 1980.
c = Cfish = Csw x Bcf, CalEPA, 1993.
d = Values from Aquire database, USEPA, 1996. Chromium, barium, molybdenum, thallium and vanadium from PNNL, 1996.

## Scenario 2. Back Calculation of Concentration Ratio, Concentration in Off-site Fish Media/Concentration in On-site Soil

| Organic Chemical *Non-Carcinogens* | Csoil, on-site mg/kg | Cfish/Csoil, on-site mg/kg(fish)]/[mg/kg(soil | Cfish mg/kg |
|---|---|---|---|
| mercury (hg) | N/A | 3.02E-01 | #VALUE! |

Summary Table

## Scenario 2, Back HQ Calculation - Ingestion of Chemicals in Fish

| Chemical | CF (mg/kg) | IR (kg/day) | FI (unitless) | EF (days/yr) | Child ED (yr) | Adult ED (yr) | Child BW (Kg) | Adult BW (Kg) | Child AT (days) | Adult AT (days) | I (mg/kg-day) | RfDo (mg/kg-day) | HQ (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | #VALUE! | 0.054 | 0.5 | 26 | 6 | 24 | 15 | 70 | 2190 | 8760 | #VALUE! | 0.0003 | #VALUE! |

CF = Chemical Concentration in Fish (mg/kg)
IR = Ingestion Rate (kg/meal)
FI = Fraction Ingested From Contaminated Source (unitless)
EF = Exposure Frequency (meals/yr)
ED = Exposure Duration (yr)
BW = Body Weight (Kg)
AT = Averaging Time (days)
I = Intake (mg/kg-day) = $CF \times IR \times FI \times EF \times ED_{child} / BW_{child} / AT_{child} + CF \times IR \times FI \times EF \times ED_{adult} / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = I / RfDo

## Fruit and Vegetable Ingestion

## Scenario 2. Vegetable and Fruit Media Calculation -see Attachment F (WA, 1997).

Table A-4. Domestic Septic System 3 Mercury Risk-Based Action Standard Calculation

| Inorganic Chemical | Csoil mg/kg | Cap mg/m3 | Css mg/Kg | Kpapt m3/Kg(fm) | Kps Kg/Kg(dm) e | biodim Kg(dm)/Kg(fm) f | Cveg mg/Kg(fm) g | Cveg/Csoil [mg/kg(fm)]/ [mg/kg(soil)] |
|---|---|---|---|---|---|---|---|---|
| ***Non-Carcinogens*** | | | | | | | | |
| mercury (hg) | 13.7 | 7.92986E-12 | 0.00000788 | 3300 | 0.55 | 0.2 | 8.67E-07 | 6.34E-08 |

Kow = Octanol/Water partition coefficient.
Cap = COC concentration in particulate phase of ambient outdoor air at exposure location from chemical deposition calculation (ug/m3) or (pCi/m3).
Css = COC concentration in surface soil at exposure location from chemical deposition calculation (mg/kg) or (pCi/kg).
Kpapt = Plant-air partition coefficient for particle bound contamination (m3-air / kg-plant fresh mass).
Kps = Plant-soil partition coefficient ((mg/kg-plant fresh mass)/(mg/kg-soil)) = (kg-soil/kg-plant fresh mass).
biodim = Ratio of vegetable/fruit dry mass to fresh mass (kg-dry mass)/(kg-fresh mass).
Cveg = COC concentration in vegetable/fruit media (mg/kg-fresh mass) or (pCi/kg-fresh mass).

a = Values from Fetter, 1993; Lyman et al, 1990; CalEPA, 1994; Stephens, 1996; USDOE, 1996; Weiss Associates, 1997.
b = Value from McKone and Ryan, 1989.
c = Organic compounds: Kps (Kg/Kgfm) = 7.7 Kow-0.58 Travis and Arms, 1988.
d = Calculation for organic compounds: Cveg = Cap x Kpapt + Css x Kps. Cal EPA, 1993.
e = Values from Baes et al., 1984.
f = Value from Cal EPA, 1993.
g = Calculation for inorganic compounds and radionuclides: Cveg = Cap x Kpapt + Css x Kps x biodim. Cal EPA, 1993.

## Scenario 2. Back Calculation of Concentration Ratio - Concentration in Off-site Vegetation/Concentration in On-site Soil

| Chemical | Csoil mg/kg | Cveg/Csoil [mg/kg(fm)]/[mg/kg(soil)] | Cveg mg/kg(fm) |
|---|---|---|---|
| ***Non-Carcinogens*** | | | |
| mercury (hg) | N/A | 6.34E-08 | #VALUE! |

Summary Table

## Scenario 2, Back HQ Calculation - Ingestion of Chemicals in Fruits and Vegetables

| Chemical | CF (mg/kg) | IR (kg/day) | FI (unitless) | EF (days/yr) | Child ED (yr) | Adult ED (yr) | Child BW (Kg) | Adult BW (Kg) | Child AT (days) | Adult AT (days) | I (mg/kg-day) | RfDo (mg/kg-day) | HQ (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | #VALUE! | 0.08 | 0.5 | 350 | 6 | 24 | 15 | 70 | 2190 | 8760 | #VALUE! | 0.0003 | #VALUE! |

CF = Chemical Concentration in Food (mg/kg)
IR = Ingestion Rate (kg/day)
FI = Fraction Ingested From Contaminated Source (unitless)
EF = Exposure Frequency (days/yr)
ED = Exposure Duration (yr)
BW = Body Weight (Kg)
AT = Averaging Time (days)
I = Intake (mg/kg-day) = $CF \times IR \times FI \times EF \times ED_{child} / BW_{child} / AT_{child} + CF \times IR \times FI \times EF \times ED_{adult} / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = I / RfDo

## Meat Ingestion

## Scenario 2. Beef Calculation - see Attachment F (WA, 1997).

| Inorganic Chemical | Bt (inorganics) d/kg f | Cap mg/m3 | Css mg/kg | Inhc m3/d | Kpapt m3/kg | Ivbc kg(fm)/d | Isc kg/d | Kps kg/kg[dm] g | biodim kg(dm)/kg(fm) h | Cbeef mg/kg | Csoil, on-site mg/kg | Cbeef/Csoil, on-site (mg/kg)/(mg/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Non-Carcinogens*** | | | | | | | | | | | | |
| mercury (hg) | 0.00035 | 5.8E-11 | 1.07737E-06 | 122 | 3300 | 60 | 0.4 | 0.55 | 0.2 | 6.66143E-09 | 13.7 | 4.87E-10 |

Kow = Octanol/water partition coefficient.
Bt = Biotransfer factor for beef cattle (d/kg).
Cap = COC concentration in particulate phase of ambient outdoor air at exposure location from chemical deposition calculation (ug/m3).
Css = COC concentration in surface soil at exposure location from chemical deposition calculation (mg/kg).
Inhc = Daily inhalation rate of cattle (m3/d)
Kpapt = Plant-air partition coefficient for particle-bound contamination (m3-air / kg-plant fresh mass).
Ivbc = Ingestion of pasture by beef cattle (kg-fresh mass/day).
Isc = Ingestion of soil by cattle (kg/day)
Kps = Plant-soil partition coefficient ((mg/kg-plant dry mass)/(mg/kg-soil)) = (kg-soil/kg-plant dry mass).
biodim = Ratio of vegetable/fruit dry mass to fresh mass (kg-dry mass)/(kg-fresh mass).
Cbeef = COC concentration in beef media (mg/kg)

a = Values from Fetter, 1993; Lyman et al, 1990; CalEPA, 1994; Stephens, 1996; USDOE, 1996; Weiss Associates, 1997.
b = Log(Bt) = Log(Kow) - 7.6, Travis and Arms, 1988.
c = Value from McKone and Ryan, 1989.
d = Organic compounds: Kps = 7.7 Kow-0.58 (Travis and Arms, 1988).
e = Calculation: Cbeef = Cap x (Inhc + Kpapt x Ivbc) x Bt + Css x (Isc + Kps x biodim x Ivbc) x Bt. (Cal EPA, 1993).
f = Values from Ng et al., 1982. Except arsenic, beryllium, antimony, selenium, thallium and vanadium from Baes et al., 1984.
g = Values from Baes et al., 1984.
h = Value from Cal EPA, 1993.

Table A-4. Domestic Septic System 3 Mercury Risk-Based Action Standard Calculation

## Scenario 2. Back Calculation of Concentration Ratio - Concentration in Off-site Beef Media/Concentration in On-site Soil

| Organic Chemical | Csoil, on-site mg/kg | Cbeef/Csoil, on-site mg/kg(beef))/[mg/kg(soil)] | Cbeef mg/kg(fm) |
|---|---|---|---|
| ***Non-Carcinogens*** | | | |
| mercury (hg) | N/A | 4.87E-10 | #VALUE! |

Summary Table

## Scenario 2, Back HQ Calculation - Ingestion of Chemicals in Meat

| Chemical | CF (mg/kg) | IR (kg/day) | FI (unitless) | EF (days/yr) | Child ED (yr) | Adult ED (yr) | Child BW (Kg) | Adult BW (Kg) | Child AT (days) | Adult AT (days) | I (mg/kg-day) | RfDo (mg/kg-day) | HQ (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | #VALUE! | 0.25 | 1 | 350 | 6 | 24 | 15 | 70 | 2190 | 8760 | #VALUE! | 0.0003 | #VALUE! |

CF = Chemical Concentration in Food (mg/kg)
IR = Ingestion Rate (kg/day)
FI = Fraction Ingested From Contaminated Source (unitless)
EF = Exposure Frequency (days/yr)
ED = Exposure Duration (yr)
BW = Body Weight (Kg)
AT = Averaging Time (days)
I = Intake (mg/kg-day) = $CF \times IR \times FI \times EF \times ED_{child} / BW_{child} / AT_{child} + CF \times IR \times FI \times EF \times ED_{adult} / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = I / RfDo

## Scenario 2. Milk Media Calculation - see Attachment F (WA, 1997).

| Inorganic Chemical | Bk d/Kg f | Cap mg/m3 | Css mg/kg | Inhc m3/d | Kpapt m3/kg(fm) | Ivdc kg(fm)/d | Isc kg/d | Kps kg/kg(dm) g | biodim kg(dm)/kg(fm) h | Cmilk mg/kg i | Csoil, on-site mg/kg | Cmilk/Csoil, on-site (mg/kg)/(mg/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Non-Carcinogens*** | | | | | | | | | | | | |
| mercury (hg) | 0.001 | 5.8E-11 | 1.07737E-06 | 122 | 3300 | 85 | 0.4 | 0.55 | 0.2 | 2.68E-08 | 13.7 | 1.96E-09 |

Kow = Octanol/water partition coefficient.
Bk = Biotransfer factor for dairy cattle (d/kg).
Cap = COC concentration in particulate phase of ambient outdoor air at exposure location from chemical deposition calculation (ug/m3) or (pCi/m3).
Css = COC concentration in surface soil at exposure location from chemical deposition calculation (mg/kg) or (pCi/kg).
Inhc = Daily inhalation rate for cattle (m3/d)
Kpapt = Plant-air partition coefficient for particle-bound contamination (m3-air / kg-plant fresh mass).
Ivdc = Ingestion of pasture by dairy cattle (kg-fresh mass/day).
Isc = Ingestion of soil by cattle (kg/day)
Kps = Plant-soil partition coefficient ((mg/kg-plant fresh mass)/(mg/kg-soil)) = (kg-soil/kg-plant fresh mass).
biodim = Ratio of pasture dry mass to fresh mass (kg-dry mass)/(kg-fresh mass).
Cmilk = COC concentration in dairy milk media (mg/kg) or (pCi/kg).

a = Values from Fetter, 1993; Lyman et al, 1990; CalEPA, 1994; Stephens, 1996; USDOE, 1996; Weiss Associates, 1997.
b = Log(Bk) = Log(Kow) - 8.1, Travis and Arms 1988.
c = Value from McKone and Ryan 1989.
d = Organic compounds: Kps (Kg/Kgfm) = 7.7 Kow-0.58 Travis and Arms, 1988.
e = Calculation for organic compounds: Cmilk = Cap x (Inhc + Kpapt x Ivdc) x Bk + Css x (Isc + Kps x Ivdc) x Bk. Cal EPA, 1993.
f = Values from Baes et al., 1984.
g = Values from Baes et al., 1984.
h = Value from Cal EPA, 1993.
i = Calculation for inorganic compounds and radionuclides: Cmilk = Cap x (Inhc + Kpapt x Ivdc) x Bk + Css x (Isc + Kps x Ivdc x biodim) x Bk. Cal EPA 1993.

## Scenario 2. Back Calculation of Concentration Ratio - Concentration in Off-site Milk Media/Concentration in On-site Soil

| Organic Chemical | Csoil mg/kg | Cmilk/Csoil, on-site ng/kg(milk))/[mg/kg(soi | Cmilk mg/kg |
|---|---|---|---|
| ***Non-Carcinogens*** | | | |
| mercury (hg) | N/A | 1.96E-09 | #VALUE! |

Summary Table

## Scenario 2, Back HQ Calculation - Ingestion of Chemicals in Milk

| Chemical | CF (mg/kg) | unit conv CF (mg/L) | IR (L/d) | FI (unitless) | EF (d/yr) | Child ED (yr) | Adult ED (yr) | Child BW (Kg) | Adult BW (Kg) | Child AT (days) | Adult AT (days) | I (mg/kg-day) | RfDo (mg/kg-day) | HQ (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | #VALUE! | #VALUE! | 0.17 | 1 | 350 | 6 | 24 | 15 | 70 | 2190 | 8760 | #VALUE! | 0.0003 | #VALUE! |

Table A-4. Domestic Septic System 3 Mercury Risk-Based Action Standard Calculation

Abbreviations

CF = Chemical Concentration in Milk (mg/kg)

unit conv for CF = CFmg/kg(milk) x 1.035 kg(milk)/L(milk) = CF mg/L

IR = Ingestion Rate (L/d)

FI = Fraction Ingested From Contaminated Source (unitless)

EF = Exposure Frequency (d/yr)

ED = Exposure Duration (yr)

BW = Body Weight (Kg)

AT = Averaging Time (days)

$I = Intake\ (mg/kg\text{-}day) = CF \times IR \times FI \times EF \times ED_{child} / BW_{child} / AT_{child} + CF \times IR \times FI \times EF \times ED_{adult} / BW_{adult} / AT_{adult}$

RfDo = Oral Reference Dose (mg/kg-d)

HQ = Calculated Hazard Quotient (unitless) = I / RfDo

**End of Calculations**

Table A-5. Domestic Septic System 6 Mercury Risk-Based Action Standard Calculation

**Scenario 2, RBAS value and Hazard Quotients for mercury, 7-8 ft deep contaminated interval, Domestic Septic System 6**

**Target HQ 1.00E+00**

| Analyte | Soil Conc. (mg/kg) | Ground Water Ingestion HQ | Swimming Ingestion HQ | Dermal Swimming HQ | Dermal Showering HQ | Soil Ingestion HQ | Dermal Soil HQ | Inhalation HQ | Fish Ingestion HQ | Plant Ingestion HQ | Meat Ingestion HQ | Milk Ingestion HQ | HQ Across Pathways |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | 8.29 | 9.95E-01 | 0.00E+00 | 0.00E+00 | 4.86E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.000E+00 |

## Ground Water Ingestion Pathway

### Scenario 2, HQ Back Calculation - Non-Carcinogens, Ground Water Concentration Conversion Factors, .

| Analyte | Soil Concentration (7-8 ft bgs) (mg/kg) | Ground Water/Soil Ratio (mg/L)/(mg/kg) | Ground Water Concentration (mg/L) |
|---|---|---|---|
| mercury (hg) | 8.29 | 3.94E-04 | 3.27E-03 |

WDP Soil Profile

Summary Table

### Scenario 2, HQ Back Calculation - Ingestion of chemicals in drinking water.

| Chemical | CW (mg/L) | Child IR (L/d) | Adult IR (L/d) | EF (d/yr) | Child ED (yr) | Adult ED (yr) | Child BW (Kg) | Adult BW (Kg) | Child AT (days) | Adult AT (days) | I (mg/kg-day) | RfDo (mg/kg-day) | HQ (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | 3.27E-03 | 1.0 | 2 | 350 | 6 | 24 | 15 | 70 | 2190 | 8760 | 2.99E-04 | **0.0003** | 9.95E-01 |

CW = Chemical Concentration in Water (mg/L)
IR = Ingestion Rate (L/d)
EF = Exposure Frequency (d/yr)
ED = Exposure Duration (yr)
BW = Body Weight (Kg)
AT = Averaging Time (days)
I = Intake (mg/kg-day) = $CW \times IR_{child} \times EF \times ED_{child} / BW_{child} / AT_{child} + CW \times IR_{adult} \times EF \times ED_{adult} / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = I / RfDo

## Showering - Dermal Pathway

### Scenario 2, HQ Back Calculation - Dermal Contact With Chemicals in Water While Showering.

From GW ingestion

Summary Table

| Chemical | CW (mg/L) | SA ($cm^2$) | PC (cm/hr) | ET (hr/d) | EF (d/yr) | Child ED (yr) | Adult ED (yr) | CF ($1L/1000cm^3$) | Child BW (Kg) | Adult BW (Kg) | Child AT (days) | Adult AT (days) | AD (mg/kg-day) | RfDo (mg/kg-day) | HQ (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | 3.27E-03 | 23,000 | 0.001 | 0.25 | 350 | 6 | 24 | 0.001 | 15 | 70 | 2190 | 8760 | 1.46E-06 | 0.0003 | 4.86E-03 |

CW = Chemical Concentration in Water (mg/L)
SA = Skin Surface Area Available for Contact ($cm^2$)
PC = Dermal Permeability Constant (cm/hr) - chemical specific. Values from Table I-1.
ET = Exposure Time (hr/d)
EF = Exposure Frequency (d/yr)
ED = Exposure Duration (yr)
CF = Volumetric Conversion Factor for Water ($1L/1000cm^3$)
BW = Body Weight (Kg)
AT = Averaging Time (days)
AD = Absorbed Dose (mg/kg-day) = $CW \times SA \times PC \times ET \times EF \times ED_{child} \times CF / BW_{child} / AT_{child} + CW \times SA \times PC \times ET \times EF \times ED_{adult} \times CF / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = AD / RfDo

## Surface Water Concentration Calculation

### Storm Water Runoff Modeling - see Attachment E (WA, 1997).

### Scenario 2, HQ Back Calculation - Possible LEHR Impact of Non-Radionuclides to Putah Creek Surface Water

| Contaminant of Concern | OU1/OU2 Surface Soil Concentration MAX | OU1/OU2 Surface Soil Concentration AVERAGE | SWL-1/SWL-2 Storm Water Concentration MAX | SWL-1/SWL-2 Storm Water Concentration AVERAGE | Dilution Factor MIN | Dilution Factor AVERAGE | Putah Creek Conc. PCU/PCD Only MAX | Putah Creek Conc. PCU/PCD Only AVERAGE | Putah Creek Conc. Contributed by LEHR MAX | Putah Creek Conc. Contributed by LEHR AVERAGE | Putah Creek Conc. From LEHR/ Surface Soil Conc. MAX | Putah Creek Conc. From LEHR/ Surface Soil Conc. AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (mg/kg) | (mg/kg) | (mg/L) | (mg/L) | (-) | (-) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L)/(mg/kg) | (mg/L)/(mg/kg) |
| mercury (hg) | 5.70E-01 | 3.10E-01 | <2.00E-04 | <2.00E-04 | 3.65E+01 | 1.37E+02 | 9.00E-04 | 5.00E-04 | 5.48E-06 | 1.46E-06 | 9.61E-06 | 4.72E-06 |

Cadmium not detected in storm water samples

Calculations:
Dilution Factor = Creek Flow/Storm Runoff Flow

Table A-5. Domestic Septic System 6 Mercury Risk-Based Action Standard Calculation

Putah Creek Concentration Contributed by LEHR = Storm Water Concentration/Dilution Factor

**Scenario 2, Back Calculation of Concentration Ratio, Concentration in Putah Creek/Concentration in On-site Soil**

| Chemical | $C_{soil}$ mg/kg | Csw/Csoil, on-site mg/kg(sw)]/[mg/kg(soil)] | Csw mg/kg |
|---|---|---|---|
| mercury (hg) | N/A | 4.72E-06 | #VALUE! |

**Swimming Ingestion/Dermal Pathways**

**Scenario 2, HQ Back Calculation - Ingestion of Chemicals in Surface Water While Swimming.**

Summary Table

| Chemical | CW (mg/L) | CR (L/d) | EF (d/yr) | Child ED (yr) | Adult ED (yr) | Child BW (Kg) | Adult BW (Kg) | Child AT (days) | Adult AT (days) | I (mg/kg-day) | RfDo (mg/kg-day) | HQ (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | #VALUE! | 0.12 | 90 | 6 | 24 | 15 | 70 | 2190 | 8760 | #VALUE! | 0.0003 | #VALUE! |

CW = Chemical Concentration in Water (mg/L)
CR = Contact Rate (L/d)
EF = Exposure Frequency (d/yr)
ED = Exposure Duration (yr)
BW = Body Weight (Kg)
AT = Averaging Time (days)
I = Intake (mg/kg-day) = $CW \times CR_{child} \times EF \times ED_{child} / BW_{child} / AT_{child} + CW \times CR_{adult} \times EF \times ED_{adult} / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = I / RfDo

**Scenario 2, HQ Back Calculation - Dermal Contact With Chemicals in Surface Water While Swimming**

Summary Table

| Chemical | CW (mg/L) | SA (cm2) | PC (cm/hr) | ET (hr/d) | EF (d/yr) | Child ED (yr) | Adult ED (yr) | CF (1L/1000cm3) | Child BW (Kg) | Adult BW (Kg) | Child AT (days) | Adult AT (days) | AD (mg/kg-day) | RfDo (mg/kg-day) | HQ (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | #VALUE! | 23,000 | 0.001 | 0.5 | 90 | 6 | 24 | 0.001 | 15 | 70 | 2190 | 8760 | #VALUE! | 0.0003 | #VALUE! |

CW = Chemical Concentration in Surface Water (mg/L)
SA = Skin Surface Area Available for Contact ($cm^2$)
PC = Dermal Permeability Constant (cm/hr) - chemical specific. Values from Table I-1.
ET = Exposure Time (hr/d)
EF = Exposure Frequency (d/yr)
ED = Exposure Duration (yr)
CF = Volumetric Conversion Factor for Water ($1L/1000cm^3$)
BW = Body Weight (Kg)
AT = Averaging Time (days)
AD = Absorbed Dose (mg/kg-day) = $CW \times SA \times PC \times ET \times EF \times ED_{child} \times CF / BW_{child} / AT_{child} + CW \times SA \times PC \times ET \times EF \times ED_{adult} \times CF / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = AD / RfDo

**Soil Pathways**

**Scenario 2, On-site to Off-site Soil Concentration Calculation**
**ISCST3 Modeling- see Attachment D (WA 1997).**

**Scenario 2, On-site to Off-site Soil Concentration Conversion, Back HQ Calculation - Non Carcinogens**

| Analyte | On-site Soil Concentration (0-15 ft bgs) (mg/kg) | -site Soil/On-site S oncentration Rati (mg/kg)/(mg/kg) | Off-site Soil Concentration (mg/kg) |
|---|---|---|---|
| mercury (hg) | N/A | **7.88E-08** | #VALUE! |

**Scenario 2, Back HQ Calculation - Ingestion of Chemicals in Soil**

Summary Table

| Chemical | CS (mg/kg) | Child IR (mg/d) | Adult IR (mg/d) | CF ($10^{-6}$ kg/mg) | FI (unitless) | EF (d/yr) | Child ED (yr) | Adult ED (yr) | Child BW (Kg) | Adult BW (Kg) | Child AT (days) | Adult AT (days) | I (mg/kg-day) | RfDo (mg/kg-day) | HQ (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | #VALUE! | 200 | 100 | 1.00E-06 | 1 | 350 | 6 | 24 | 15 | 70 | 2190 | 8760 | #VALUE! | 0.0003 | #VALUE! |

CS = Chemical Concentration in Soil (mg/kg)
IR = Ingestion Rate (mg/d)
CF = Conversion Factor ($10^{-6}$ kg/mg)
FI = Fraction Ingested From Contaminated Source (unitless)

Table A-5. Domestic Septic System 6 Mercury Risk-Based Action Standard Calculation

EF = Exposure Frequency (d/yr)
ED = Exposure Duration (yr)
BW = Body Weight (Kg)
AT = Averaging Time (days)
I = Intake (mg/kg-day) = $CS \times IR_{child} \times CF \times FI \times EF \times ED_{child} / BW_{child} / AT_{child} + CS \times IR_{adult} \times CF \times FI \times EF \times ED_{adult} / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = I / RfDo

Summary Table

**Scenario 2, Back HQ Calculation - Dermal Contact With Chemicals in Soil**

| Chemical | CS (mg/kg) | CF ($10^{-6}$ kg/mg) | Child SA ($cm^2$) | Adult SA ($cm^2$) | AF ($mg/cm^2$) | ABS (unitless) | EF (d/yr) | Child ED (yr) | Adult ED (yr) | Child BW (Kg) | Adult BW (Kg) | Child AT (days) | Adult AT (days) | AD (mg/kg-day) | RfDo (mg/kg-day) | HQ (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | #VALUE! | 1.00E-06 | 2,000 | 5,000 | 0.2 | 0.01 | 350 | 6 | 24 | 15 | 70 | 2190 | 8760 | #VALUE! | 0.0003 | #VALUE! |

CS = Chemical Concentration in Soil (mg/kg)
CF = Conversion Factor ($10^{-6}$ kg/mg)
SA = Skin Surface Area Available for Contact ($cm^2$)
AF = Soil to Skin Adherence Factor ($mg/cm^2$)
ABS = Absorption Factor (unitless)
EF = Exposure Frequency (d/yr)
ED = Exposure Duration (yr)
BW = Body Weight (Kg)
AT = Averaging Time (days)
AD = Absorbed Dose (mg/kg-day) = $CS \times CF \times SA_{child} \times AF \times ABS \times EF \times ED_{child} / BW_{child} / AT_{child} + CS \times CF \times SA_{adult} \times AF \times ABS \times EF \times ED_{adult} / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = AD / RfDo

**Inhalation Pathway**

**Scenario 2, Indoor and Outdoor Air Calculations - see Attachment C (WA, 1997).**

**Scenario 2, Indoor and Outdoor Air Concentration Conversion Factor Calculations, Back Risk Calculation.**

| Analyte | Fwd-Calc Soil Conc (mg/kg) | Indoor Air Conversion ($mg/m^3$)/(mg/kg) | Outdoor Air Conversion ($mg/m^3$)/(mg/kg) | Indoor Air Conc. ($mg/m^3$) | Outdoor Air Conc. ($mg/m^3$) |
|---|---|---|---|---|---|
| ***Non-Carcinogens*** | | | | | |
| mercury (hg) | N/A | | 5.80E-13 | #VALUE! | #VALUE! |

**Scenario 2, Back HQ Calculation -Inhalation of Airborne (Vapor Phase) Chemicals**

Summary Table

| Chemical | Indoor $CA_i$ ($mg/m^3$) | Outdoor $CA_o$ ($mg/m^3$) | Child IR ($m^3$/hr) | Adult IR ($m^3$/hr) | Indoor ET (hr/d) | Outdoor ET (hr/d) | EF (d/yr) | Child ED (yr) | Adult ED (yr) | Child BW (Kg) | Adult BW (Kg) | Child AT (days) | Adult AT (days) | Indoor I (mg/kg-day) | Outdoor I (mg/kg-day) | RfDi mg/kg-day | HQ (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | #VALUE! | #VALUE! | 0.416666667 | 0.833333333 | 16.08 | 7.92 | 350 | 6 | 24 | 15 | 70 | 2190 | 8760 | #VALUE! | #VALUE! | N/A | 0 |

CAi = Chemical Concentration in Indoor Air ($mg/m^3$)
CAo = Chemical Concentration in Outdoor Air ($mg/m^3$)
IR = Inhalation Rate ($m^3$/hr)
ET = Exposure Time (hr/d)
EF = Exposure Frequency (d/yr)
ED = Exposure Duration (yr)
BW = Body Weight (Kg)
AT = Averaging Time (days)
$I_{indoor}$ = Indoor Air Intake (mg/kg-day) = $CA_{indoor} \times IR_{child} \times ET_{indoor} \times EF \times ED_{child} / BW_{child} / AT_{child} + CA_{indoor} \times IR_{adult} \times ET_{indoor} \times EF \times ED_{adult} / BW_{adult} / AT_{adult}$
$I_{outdoor}$ = Outdoor Air Intake (mg/kg-day) = $CA_{outdoor} \times IR_{child} \times ET_{outdoor} \times EF \times ED_{child} / BW_{child} / AT_{child} + CA_{outdoor} \times IR_{adult} \times ET_{outdoor} \times EF \times ED_{adult} / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = $(I_{indoor} + I_{outdoor}) / RfDo$

**Fish Ingestion**

**Scenario 2. Fish Calculation - see Attachment G (WA, 1997)**

Surface Water

Table A-5. Domestic Septic System 6 Mercury Risk-Based Action Standard Calculation

| Inorganic Chemical | Csw mg/L | Bcf L/kg | Cfish mg/kg | Csoil mg/kg | Cfish/Csoil, on-site [mg/kg(fish)]/[mg/kg(soil)] |
|---|---|---|---|---|---|
| *Non-Carcinogens* | | | | | |
| mercury (hg) | #VALUE! | 64000 | 3.02E+01 | 100 | 3.02E-01 |

Kow = Octanol/water partition coefficient.
Bcf = Bioconcentration factor for fish (L/kg)
Csw = Chemical concentration in surface water contributed by the LEHR site (mg/L)
CFish = COC concentration in fish (mg/kg).

a = Values from Fetter, 1993; Lyman et al, 1990; CalEPa, 1994; Stephens, 1996; USDOE, 1996; Weiss Associates, 1997.
b = Log(Bcf) = 0.76 Log(Kow) - 1.23, Veith et al., 1980.
c = Cfish = Csw x Bcf, CalEPA, 1993.
d = Values from Aquire database, USEPA, 1996. Chromium, barium, molybdenum, thallium and vanadium from PNNL, 1996.

**Scenario 2. Back Calculation of Concentration Ratio, Concentration in Off-site Fish Media/Concentration in On-site Soil**

| Organic Chemical | Csoil, on-site mg/kg | Cfish/Csoil, on-site [mg/kg(fish)]/[mg/kg(soil)] | Cfish mg/kg |
|---|---|---|---|
| *Non-Carcinogens* | | | |
| mercury (hg) | N/A | 3.02E-01 | #VALUE! |

Summary Table

**Scenario 2, Back HQ Calculation - Ingestion of Chemicals in Fish**

| Chemical | CF (mg/kg) | IR (kg/day) | FI (unitless) | EF (days/yr) | Child ED (yr) | Adult ED (yr) | Child BW (Kg) | Adult BW (Kg) | Child AT (days) | Adult AT (days) | I (mg/kg-day) | RfDo (mg/kg-day) | HQ (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | #VALUE! | 0.054 | 0.5 | 26 | 6 | 24 | 15 | 70 | 2190 | 8760 | #VALUE! | 0.0003 | #VALUE! |

CF = Chemical Concentration in Fish (mg/kg)
IR = Ingestion Rate (kg/meal)
FI = Fraction Ingested From Contaminated Source (unitless)
EF = Exposure Frequency (meals/yr)
ED = Exposure Duration (yr)
BW = Body Weight (Kg)
AT = Averaging Time (days)
I = Intake (mg/kg-day) = $CF \times IR \times FI \times EF \times ED_{child} / BW_{child} / AT_{child} + CF \times IR \times FI \times EF \times ED_{adult} / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = I / RfDo

**Fruit and Vegetable Ingestion**

**Scenario 2. Vegetable and Fruit Media Calculation -see Attachment F (WA, 1997).**

| Inorganic Chemical | Csoil mg/kg | Cap mg/m3 | Css mg/Kg | Kpapt m3/Kg(fm) | Kps Kg/Kg(dm) e | biodim Kg(dm)/Kg(fm) f | Cveg mg/Kg(fm) g | Cveg/Csoil [mg/kg(fm)]/[mg/kg(soil)] |
|---|---|---|---|---|---|---|---|---|
| *Non-Carcinogens* | | | | | | | | |
| mercury (hg) | N/A | 7.92986E-12 | 0.00000788 | 3300 | 0.55 | 0.2 | 8.67E-07 | #VALUE! |

Kow = Octanol/Water partition coefficient.
Cap = COC concentration in particulate phase of ambient outdoor air at exposure location from chemical deposition calculation (ug/m3) or (pCi/m3).
Css = COC concentration in surface soil at exposure location from chemical deposition calculation (mg/kg) or (pCi/kg).
Kpapt = Plant-air partition coefficient for particle bound contamination (m3-air / kg-plant fresh mass).
Kps = Plant-soil partition coefficient ((mg/kg-plant fresh mass)/(mg/kg-soil)) = (kg-soil/kg-plant fresh mass).
biodim = Ratio of vegetable/fruit dry mass to fresh mass (kg-dry mass)/(kg-fresh mass).
Cveg = COC concentration in vegetable/fruit media (mg/kg-fresh mass) or (pCi/kg-fresh mass).

a = Values from Fetter, 1993; Lyman et al, 1990; CalEPA, 1994; Stephens, 1996; USDOE, 1996; Weiss Associates, 1997.
b = Value from McKone and Ryan, 1989.
c = Organic compounds: Kps (Kg/Kgfm) = 7.7 Kow-0.58 Travis and Arms, 1988.
d = Calculation for organic compounds: Cveg = Cap x Kpapt + Css x Kps. Cal EPA, 1993.
e = Values from Baes et al., 1984.
f = Value from Cal EPA, 1993.
g = Calculation for inorganic compounds and radionuclides: Cveg = Cap x Kpapt + Css x Kps x biodim. Cal EPA, 1993.

**Scenario 2. Back Calculation of Concentration Ratio - Concentration in Off-site Vegetation/Concentration in On-site Soil**

| Chemical | Csoil mg/kg | Cveg/Csoil [mg/kg(fm)]/[mg/kg(soil)] | Cveg mg/kg(fm) |
|---|---|---|---|
| *Non-Carcinogens* | | | |
| mercury (hg) | N/A | #VALUE! | #VALUE! |

Summary Table

**Scenario 2, Back HQ Calculation - Ingestion of Chemicals in Fruits and Vegetables**

| Chemical | CF (mg/kg) | IR (kg/day) | FI (unitless) | EF (days/yr) | Child ED (yr) | Adult ED (yr) | Child BW (Kg) | Adult BW (Kg) | Child AT (days) | Adult AT (days) | I (mg/kg-day) | RfDo (mg/kg-day) | HQ (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | #VALUE! | 0.08 | 0.5 | 350 | 6 | 24 | 15 | 70 | 2190 | 8760 | #VALUE! | 0.0003 | #VALUE! |

Table A-5. Domestic Septic System 6 Mercury Risk-Based Action Standard Calculation

CF = Chemical Concentration in Food (mg/kg)
IR = Ingestion Rate (kg/day)
FI = Fraction Ingested From Contaminated Source (unitless)
EF = Exposure Frequency (days/yr)
ED = Exposure Duration (yr)
BW = Body Weight (Kg)
AT = Averaging Time (days)
I = Intake (mg/kg-day) = $CF \times IR \times FI \times EF \times ED_{child} / BW_{child} / AT_{child} + CF \times IR \times FI \times EF \times ED_{adult} / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = I / RfDo

## Meat Ingestion

### Scenario 2. Beef Calculation - see Attachment F (WA, 1997).

| Inorganic Chemical | Bt (inorganics) d/kg f | Cap mg/m3 | Css mg/kg | Inhc m3/d | Kpapt m3/kg | Ivbc kg(fm)/d | Isc kg/d | Kps kg/kg[dm] g | biodim kg(dm)/kg(fm) h | Cbeef mg/kg | Csoil, on-site mg/kg | Cbeef/Csoil, on-site (mg/kg)/(mg/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Non-Carcinogens*** | | | | | | | | | | | | |
| mercury (hg) | 0.00035 | 5.8E-11 | 1.07737E-06 | 122 | 3300 | 60 | 0.4 | 0.55 | 0.2 | 6.66143E-09 | 13.7 | 4.87E-10 |

Kow = Octanol/water partition coefficient.
Bt = Biotransfer factor for beef cattle (d/kg).
Cap = COC concentration in particulate phase of ambient outdoor air at exposure location from chemical deposition calculation (ug/m3).
Css = COC concentration in surface soil at exposure location from chemical deposition calculation (mg/kg).
Inhc = Daily inhalation rate of cattle (m3/d)
Kpapt = Plant-air partition coefficient for particle-bound contamination (m3-air / kg-plant fresh mass).
Ivbc = Ingestion of pasture by beef cattle (kg-fresh mass/day).
Isc = Ingestion of soil by cattle (kg/day)
Kps = Plant-soil partition coefficient ((mg/kg-plant dry mass)/(mg/kg-soil)) = (kg-soil/kg-plant dry mass).
biodim = Ratio of vegetable/fruit dry mass to fresh mass (kg-dry mass)/(kg-fresh mass).
Cbeef = COC concentration in beef media (mg/kg)

a = Values from Fetter, 1993; Lyman et al, 1990; CalEPA, 1994; Stephens, 1996; USDOE, 1996; Weiss Associates, 1997.
b = Log(Bt) = Log(Kow) - 7.6, Travis and Arms, 1988.
c = Value from McKone and Ryan, 1989.
d = Organic compounds: Kps = 7.7 Kow-0.58 (Travis and Arms, 1988).
e = Calculation: Cbeef = Cap x (Inhc + Kpapt x Ivbc) x Bt + Css x (Isc + Kps x biodim x Ivbc) x Bt. (Cal EPA, 1993).
f = Values from Ng et al., 1982. Except arsenic, beryllium, antimony, selenium, thallium and vanadium from Baes et al., 1984.
g = Values from Baes et al., 1984.
h = Value from Cal EPA, 1993.

### Scenario 2. Back Calculation of Concentration Ratio - Concentration in Off-site Beef Media/Concentration in On-site Soil

| Organic Chemical | Csoil, on-site mg/kg | Cbeef/Csoil, on-site mg/kg(beef))/[mg/kg(soil)] | Cbeef mg/kg(fm) |
|---|---|---|---|
| ***Non-Carcinogens*** | | | |
| mercury (hg) | N/A | 4.87E-10 | #VALUE! |

Summary Table

### Scenario 2, Back HQ Calculation - Ingestion of Chemicals in Meat

| Chemical | CF (mg/kg) | IR (kg/day) | FI (unitless) | EF (days/yr) | Child ED (yr) | Adult ED (yr) | Child BW (Kg) | Adult BW (Kg) | Child AT (days) | Adult AT (days) | I (mg/kg-day) | RfDo (mg/kg-day) | HQ (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | #VALUE! | 0.25 | 1 | 350 | 6 | 24 | 15 | 70 | 2190 | 8760 | #VALUE! | 0.0003 | #VALUE! |

CF = Chemical Concentration in Food (mg/kg)
IR = Ingestion Rate (kg/day)
FI = Fraction Ingested From Contaminated Source (unitless)
EF = Exposure Frequency (days/yr)
ED = Exposure Duration (yr)
BW = Body Weight (Kg)
AT = Averaging Time (days)
I = Intake (mg/kg-day) = $CF \times IR \times FI \times EF \times ED_{child} / BW_{child} / AT_{child} + CF \times IR \times FI \times EF \times ED_{adult} / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = I / RfDo

### Scenario 2. Milk Media Calculation - see Attachment F (WA, 1997).

| Inorganic Chemical | Bk d/Kg f | Cap mg/m3 | Css mg/kg | Inhc m3/d | Kpapt m3/kg(fm) | Ivdc kg(fm)/d | Isc kg/d | Kps kg/kg(dm) g | biodim kg(dm)/kg(fm) h | Cmilk mg/kg i | Csoil, on-site mg/kg | Cmilk/Csoil, on-site (mg/kg)/(mg/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Non-Carcinogens*** | | | | | | | | | | | | |
| mercury (hg) | 0.001 | 5.8E-11 | 1.07737E-06 | 122 | 3300 | 85 | 0.4 | 0.55 | 0.2 | 2.68E-08 | 13.7 | 1.96E-09 |

Kow = Octanol/water partition coefficient.
Bk = Biotransfer factor for dairy cattle (d/kg).

Table A-5. Domestic Septic System 6 Mercury Risk-Based Action Standard Calculation

Cap = COC concentration in particulate phase of ambient outdoor air at exposure location from chemical deposition calculation (ug/m3) or (pCi/m3).
Css = COC concentration in surface soil at exposure location from chemical deposition calculation (mg/kg) or (pCi/kg).
Inhc = Daily inhalation rate for cattle (m3/d)
Kpapt = Plant-air partition coefficient for particle-bound contamination (m3-air / kg-plant fresh mass).
Ivdc = Ingestion of pasture by dairy cattle (kg-fresh mass/day).
Isc = Ingestion of soil by cattle (kg/day)
Kps = Plant-soil partition coefficient ((mg/kg-plant fresh mass)/(mg/kg-soil)) = (kg-soil/kg-plant fresh mass).
biodim = Ratio of pasture dry mass to fresh mass (kg-dry mass)/(kg-fresh mass).
Cmilk = COC concentration in dairy milk media (mg/kg) or (pCi/kg).

a = Values from Fetter, 1993; Lyman et al, 1990; CalEPA, 1994; Stephens, 1996; USDOE, 1996; Weiss Associates, 1997.
b = Log(Bk) = Log(Kow) - 8.1, Travis and Arms 1988.
c = Value from McKone and Ryan 1989.
d = Organic compounds: Kps (Kg/Kgfm) = 7.7 Kow-0.58 Travis and Arms, 1988.
e = Calculation for organic compounds: Cmilk = Cap x (Inhc + Kpapt x Ivdc) x Bk + Css x (Isc + Kps x Ivdc) x Bk. Cal EPA, 1993.
f = Values from Baes et al., 1984.
g = Values from Baes et al., 1984.
h = Value from Cal EPA, 1993.
i = Calculation for inorganic compounds and radionuclides: Cmilk = Cap x (Inhc + Kpapt x Ivdc) x Bk + Css x (Isc + Kps x Ivdc x biodim) x Bk. Cal EPA 1993.

## Scenario 2. Back Calculation of Concentration Ratio -Concentration in Off-site Milk Media/Concentration in On-site Soil

| Organic Chemical | Csoil mg/kg | Cmilk/Csoil, on-site (mg/kg(milk))/[mg/kg(soil | Cmilk mg/kg |
|---|---|---|---|
| *Non-Carcinogens* | | | |
| mercury (hg) | N/A | 1.96E-09 | #VALUE! |

Summary Table

## Scenario 2, Back HQ Calculation - Ingestion of Chemicals in Milk

| Chemical | CF (mg/kg) | unit conv CF (mg/L) | IR (L/d) | FI (unitless) | EF (d/yr) | Child ED (yr) | Adult ED (yr) | Child BW (Kg) | Adult BW (Kg) | Child AT (days) | Adult AT (days) | I (mg/kg-day) | RfDo (mg/kg-day) | HQ (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mercury (hg) | #VALUE! | #VALUE! | 0.17 | 1 | 350 | 6 | 24 | 15 | 70 | 2190 | 8760 | #VALUE! | 0.0003 | #VALUE! |

CF = Chemical Concentration in Milk (mg/kg)
unit conv for CF = CFmg/kg(milk) x 1.035 kg(milk)/L(milk) = CF mg/L
IR = Ingestion Rate (L/d)
FI = Fraction Ingested From Contaminated Source (unitless)
EF = Exposure Frequency (d/yr)
ED = Exposure Duration (yr)
BW = Body Weight (Kg)
AT = Averaging Time (days)
$I = Intake (mg/kg-day) = CF \times IR \times FI \times EF \times ED_{child} / BW_{child} / AT_{child} + CF \times IR \times FI \times EF \times ED_{adult} / BW_{adult} / AT_{adult}$
RfDo = Oral Reference Dose (mg/kg-d)
HQ = Calculated Hazard Quotient (unitless) = I / RfDo

**End of Calculations**