APPENDIX A

HAZARD AND ACCIDENT ANALYSIS AND ECOLOGICAL RISK ASSESSMENT FOR MERCURY REFLASKING ENVIRONMENTAL ASSESSMENT

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A.1 HAZARD AND ACCIDENT ANALYSIS

This section discusses the systematic identification and assessment of hazards associated with reflasking activities at the Defense National Stockpile Center (DNSC) depots located in New Haven, Indiana and Warren, Ohio, and includes semi-quantitative evaluation of the potential internal, Natural Phenomena Hazards, and other external events that could cause the identified hazards to develop into accidents. This appendix presents the potential consequences and risks of accident sequences, to workers (immediate and collocated) and members of the public.

A.1.1 HAZARD IDENTIFICATION

A hazard survey of the mercury storage areas and handling operations was conducted for the two depots. The materials for the survey were gathered from a visit to the Warren Depot, from phone calls, and from information from various documents in the library established for the *Mercury Reflasking Environmental Assessment* (EA). In particular, phone calls and review of documents were used to establish significant differences between the two sites. The primary focus of the hazard survey was to identify those specific hazards that exist for the No Action Alternative (i.e., continued storage) and activities associated with transferring the mercury into new containers. Additional technical information was obtained on each discrete material and energy source that has the potential to damage or harm workers or the public.

The inspection reports for the mercury storage areas were reviewed for information about past releases of mercury. The results of this review are described in Section 1.1. Further information about past releases is summarized in the *Mercury Investigation Report* (TVA 2000). At both the New Haven and Warren depots, no mercury has escaped from the warehouses and no members of the public have been affected.

A.1.2 FREQUENCY AND CONSEQUENCE ANALYSIS

Accident scenarios begin with the occurrence of some initiating event. The frequency of the initiating event is the unmitigated frequency for the postulated scenario. Characteristics of the facility that may serve to prevent the accident from occurring or to mitigate the consequences are factored into the specific evaluation of the mitigated frequency of occurrence. These frequencies are estimated without using detailed quantitative analysis and rely on knowledge of frequency databases and the results of similar studies.

These largely qualitative analyses result in the estimation of mitigated and unmitigated annual frequencies of occurrence of the postulated accident scenarios. These are then assigned to high, moderate, low, or negligible categories of frequency, such as the example given in Table A–1. This table is adapted from the *Guidelines for Hazard Evaluation Procedures* (CCPS 1992) and is similar to a table given in the *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports* (DOE-STD-3009-94) (DOE 1994a).

Table A–1. Frequency Classification Table

Frequency Category	Estimated Annual Frequency of Occurrence	Description
High	f > 1E-2	Incidents that may occur several times during the lifetime of the facility. (Incidents that commonly occur.)
Moderate	1E-2 ≥ f > 1E-4	Accidents that are not anticipated to occur during the lifetime of the facility. Natural phenomena of this probability class include: design basis earthquake, 100-yr flood, maximum wind gust, etc.
Low	1E-4 ≥ f > 1E-6	Accidents that will probably not occur during the life cycle of the facility. This class includes most design basis accidents.
Negligible	f < 1E-6	Accidents that are not credible.

The consequence analysis starts with determination of accident source terms. Once a source term has been determined, consequences due to atmospheric dispersion are evaluated. Based on the maximum amount of hazardous material inventory present and a worst-case release pathway, a qualitative and/or semi-quantitative assessment of public and worker consequences are made and assigned to the high, moderate, low, or negligible consequence category. Table A–2 gives an example of consequence severity categorizations used for the public. These are based on *Guidance for Preparation of DOE 5480.22 (TSR) and DOE 5480.23 (SAR) Implementation Plans* (DOE-STD-3011-94) and are consistent with general industry practice even though, of course, there is an element of subjective judgement in the definition of the categories (DOE 1994b).

Table A–2. Public Consequence Classification

Frequency Category	Description	Consequence Level
Negligible	Less than low offsite impact	<0.1×1 mg/m^3
Low	Negligible offsite impact	<1 mg/m^3
Moderate	Minor offsite impact	Not defined (subjective)
High	Considerable offsite impact	>1 mg/m^3

Because accidents are short term in nature and can result in large releases, various organizations have developed standards that specifically apply to emergencies and are different from worker protection standards. Emergency Response Planning Guidelines (ERPGs) are published by the American Industrial Hygiene Association (AIHA) (AIHA 1999). ERPG-2 (Level 2) is defined as “the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual’s ability to take protective actions.” [Note, the use of the term “nearly all individuals” means that the ERPGs are intended to be protective of all except a few unusually or hyper susceptible members of the population. Therefore, ERPGs are protective of children and of the elderly.] The use of the ERPG-2 as protective of members of the public has been implicitly endorsed by the U.S. Environmental Protection Agency (EPA), because the toxic endpoints that EPA has published for substances that are regulated by the Risk Management Program, Title 40 of the Code of Federal Regulations (CFR) Part 68, are in fact ERPG-2s, where these are available. It is a reasonable premise to state that EPA considers that the risks associated with accident concentrations below ERPG-2 can be considered to be “low.” It was similar thinking on the Department of Energy’s part that led to the "moderate" category not being defined as shown in Table A–2 (i.e., the concentration transitions directly from "high" to "low" as it falls below the ERPG-2).

For mercury, AIHA has not published an "official" ERPG-2. For some guidance on how to proceed, it is pertinent to turn again to EPA and the toxic endpoints that it has published in its Risk Management Program, 40 CFR 68. As noted previously, these toxic endpoints for chemicals covered by the regulations are the ERPG-2s when these are available. For chemicals for which ERPG-2s are not available, EPA used the Level of Concern for extremely hazardous substances regulated under Section 302 of the Emergency Planning and Community Right-to-Know Act (see the *Technical Guidance for Hazards Analysis* [EPA 1987]). The Level of Concern for extremely hazardous substances is based upon:

- One tenth of the Immediately Dangerous to Life and Health (IDLH) level, developed by the National Institute of Occupational Safety and Health (NIOSH) using IDLH values developed before 1994, or, if no IDLH is available;
- One tenth of an estimated IDLH derived from toxicity data; the IDLH is estimated as described in Appendix D of *Technical Guidance for Hazards Analysis* (EPA 1987).

This process for selecting surrogate ERPG-2s is described in *Risk Management Program Offsite Consequence Analysis Guidance* (EPA 1998b). Based on this precedent, the surrogate ERPG-2 chosen for mercury is 1 mg/m^3, i.e., one tenth of the IDLH of 10 mg/m^3. Thus, this is the accident concentration level above which the public would be considered to be exposed to moderate or high concentrations and below which the concentrations would be considered low or negligible, depending on how small these concentrations are.

For workers, the IDLH values are more appropriate than ERPGs. These values are based on effects that might occur to unprotected workers as a consequence of a 30-minute exposure. Therefore IDLH values as defined by NIOSH are used to define high consequences to facility and collocated workers (NIOSH 1997). Table A–3 gives an example of consequence severity categories for workers.

Table A–3. Facility and Collocated Worker Consequence Classification

Frequency	Description	Consequence Level
Negligible	Negligible onsite impact	<0.1×10 mg/m^3
Low	Minor onsite impact	<10 mg/m^3
Moderate	Moderate onsite impact	Not defined (subjective)
High	Considerable onsite impact	>10 mg/m^3

Source: TBP.

Assignments of consequence levels such as those shown in Tables A–2 and A–3 are sometimes criticized on the grounds that the chosen levels are very much higher than workplace limits such as the Threshold Limit Values (TLVs) from the American Conference of Government Industrial Hygienists (ACGIH) or the Occupational Safety and Health Administration's (OSHA's) Permissible Exposure Limits (PELs). For example, for mercury, the surrogate ERPG-2 of 1 mg/m^3 for public exposure is 40 times the 8-hr TLV and 10 times the 15-minute PEL. The general answer to this criticism is that these standards are not comparable. TLVs and PELs are designed to be protective of workers in the everyday work environment where they are constantly at risk of exposure to hazardous materials. ERPGs and IDLHs are designed for public and workers respectively subject to one-time exposures of short duration during an accident or emergency. In fact, as related in Appendix D.3 of *Technical Guidance for Hazards Analysis*

(EPA 1987), ACGIH advises against using or applying the TLV levels outside the work environment. Since most PELs are based on TLVs, the same restriction applies to them.

No pathways other than airborne are considered in the analysis for the Warren Depot. All facilities at that location are built on an 18-ft deep slag bed with no surface water outfalls, and therefore no runoff to nearby surface water is credible. In addition, any spilled mercury is not likely to penetrate the slag depth and reach any groundwater sources before cleanup occurs. Similarly, no pathways other than the airborne ones are considered in the analysis for the New Haven Depot.

A.1.2.1 Consequences Due to Spills

Consequences due to spills of mercury are based on evaporation from a liquid pool. Evaporation flux is based on parameters such as material vapor pressure and molecular weight, air velocity inside the building, pool temperature, and spill area as described in *Handbook of Chemical Hazard Analysis Procedures* (FEMA 1988). Spill area is estimated based on amount of mercury spilled or is limited by physical constraints such as the area of the catch pan. Spill area estimates are conservative for high specific gravity liquids such as mercury because the correlation used to estimate spill area is based on spills of more free-flowing liquids (FEMA 1988).

Given a spill of mercury inside a building, the liquid is expected to evaporate and the vapor vented from the building by prevailing winds at ground level through open doors. This is a conservative assumption because the actual release point is more likely to be at the elevated roof vent. A Gaussian plume dispersion model is used for the collocated receptor in the depot offices at a distance of 200 ft (60 m), and for public receptors at the east fence, a distance of approximately 400 ft (122 m) at the Warren Depot. At the New Haven Depot, the distance to the nearest site boundary is 500 ft (152 m). The distance to the collocated worker in the depot offices is approximately 2,200 ft (671 m); however, the more conservative 500 ft (152 m) is also used for the collocated worker. Dispersion parameters for the Gaussian plume model are estimated as described in *Handbook on Atmospheric Dispersion* (Briggs 1982). The Gaussian model has been incorporated into an Excel spreadsheet calculation.

For workers within the building, the airborne material is assumed to be dispersed instantaneously into a hemisphere 3 ft (10 m) in diameter. This is a conservative assumption because natural convection currents inside the building are likely to disperse any airborne material into a larger volume. The worker walks through the hemisphere at a rate of 3.3 ft/sec (1 m/sec) for a maximum exposure time of 10 seconds.

A.1.2.2 Consequences Due to Fires

Fire characteristics, such as burn rate and toxic combustion gases, are dependent upon the fuel(s) being burned and contaminants present in the fuel. The exact characteristics of a fire in the warehouse are unknown. Therefore, the accident analysis must be based on bounding assumptions.

The rate of suspension for mercury vapor is estimated assuming the total aerosol mass is suspended over a 1-hour period. This period is selected to allow direct comparison with the 1-hour exposure ERPG-2 toxicity limit. However, since toxicity is directly proportional to concentration and inversely proportional to exposure time, the assumption of a particular suspension time is not significant since exposure time is defined to be equal to suspension time.

In a postulated fire, the high temperature products of combustion may cause overheating and collapse of the roof. This allows high rates of air (oxygen) inflow to maximize combustion rates and allows the combustion products to rise vertically due to their buoyancy. The elevated plume is carried downwind and the combustion products diffuse away from the plume centerline, including downward towards the ground.

In the immediate vicinity of the fire, convection currents and downdrafts can cause high combustion product concentrations at ground level beneath the plume centerline. At greater distances, ground-level concentrations become small due to the higher plume elevation. For flat terrain, ground-level concentrations increase with distance, reach a maximum, and then decrease. In comparison with nonbuoyant plumes, buoyant plumes produce lower ground concentrations.

For purposes of computing maximum mercury vapor concentrations, a downwind receptor is assumed to be located at the point of maximum concentration. Concentrations are estimated assuming Gaussian dispersion from a plume that rises 82 ft (25 m) above the roof vent located at a height of 15 ft (5 m). This is a conservative assumption because fires of any significant size can be shown to produce plumes higher than 100 ft (30 m). Atmospheric stability, distance, and wind speed parameters are selected to maximize the estimated concentration. This concentration is assumed to bound the concentrations at all other downwind points away from the immediate vicinity of the fire. Due to entrainment, concentrations adjacent to the fire may be higher. However, such exposures are within the facility boundary and can be limited by requiring facility evacuation in the event of a fire.

These calculations are not applicable to areas in the immediate vicinity of the fire due to downdrafts and local wind gusts. These effects can result in high concentrations of high-temperature smoke containing hazardous constituents. Workers in the immediate vicinity are expected to evacuate the area. Consequences in the vicinity but beyond 164-328 ft (50-100 m) are also estimated to result in low risk due to the predicted magnitudes of plume rise.

A.1.2.3 Risk Analysis

The final risk is determined by combining frequency and estimated consequences using the three-by-three matrix illustrated in Figure A–1. Using Figure A–1, risk is also assigned to high, moderate, low, or negligible categories: “Situations of Major Concern” are high risk (squares 7, 8 and 9); “Situations of Concern” are medium risk (squares 4, 5 and 6); squares 1, 2, and 3 on the matrix are low risk; and if either the frequency or consequence severity is negligible, so is the risk.

A.1.3 ACCIDENT ANALYSIS

The results of the hazard identification and accident analysis are documented in Tables A–4 and A–5 for the New Haven and Warren depots, respectively. Detailed calculations are shown in Tables A–6 and A–7 for the New Haven Depot and Tables A–8 and A–9 for the Warren Depot.

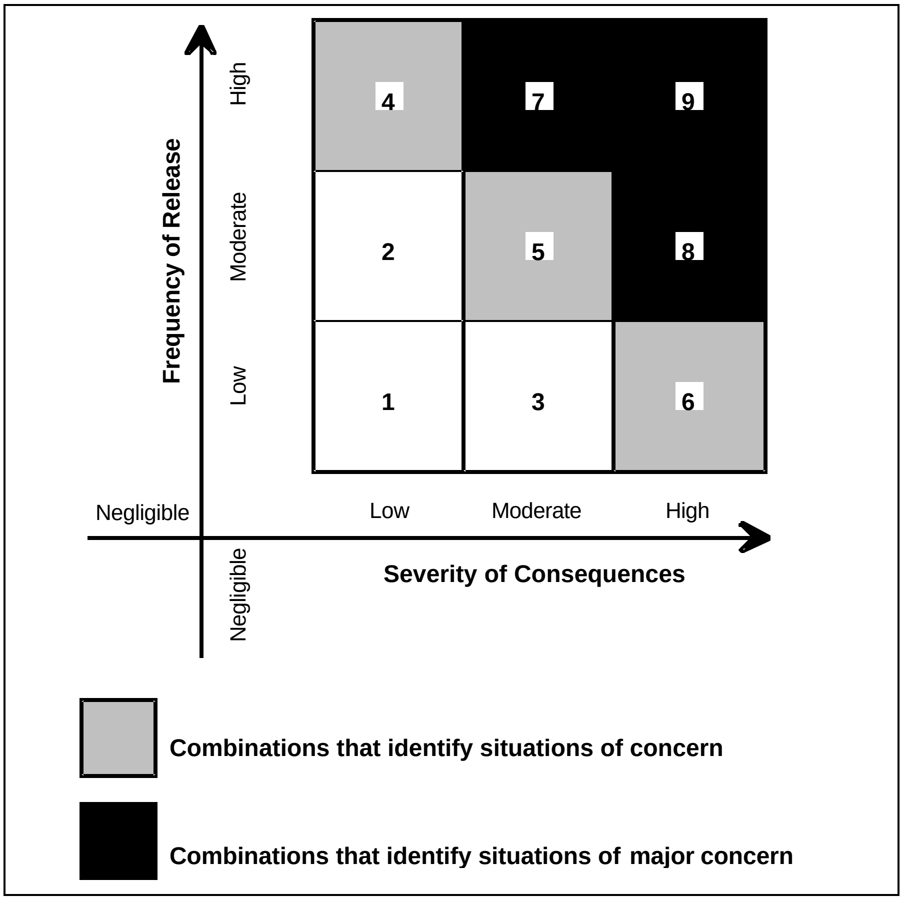

Figure A–1. Frequency and Consequence Ranking Matrix

For the purposes of this *Mercury Reflasking EA*, frequency was obtained by making a qualitative judgment of the likelihood of occurrence of the various scenarios based on experience with similar analyses. For example, events that involve moving or handling flasks are considered to be in the "high" frequency category (i.e., there are a large number of them and a general rule of thumb from similar activities such as waste management projects is that one container will be dropped for every thousand moved). Events involving the dropping of complete pallets with rupture of all the flasks are considered less likely and therefore assigned to the next lowest category, "moderate." An extreme event such as a large fire releasing a large fraction of the mercury inventory is considered to have a negligible probability based on the general lack of combustible materials and ignition sources, together with the availability of sprinklers. These examples illustrate the level of engineering judgment that was applied to determine the appropriate frequency assignment.

Table A–4. Hazards and Accident Analysis Matrix for the New Haven Depot

Activities	Hazards	Postulated Accident Scenario	Frequency	Material at Risk	Receptors	Consequences (mg/m³)	Consequence Level	Risk	Comments
1.0 No Action Alternative									
1.1 Storage	Fire	Building fire involving multiple flasks/pallets	N	N/A					No ignition sources other than forklift fuel (see Scenario 1.4).
1.2 Storage	Toxicological	Slow leak/release of liquid mercury	H	Single flask	Immediate	2.65E-03	N	N	
					Collocated	5.06E-05	N		
					Public	5.06E-05	N		
1.3 Storage	Toxicological	Wooden pallets collapse resulting in breach of multiple flasks	M	Three pallets	Immediate	6.25E-01	N	N	
					Collocated	1.20E-02	N		
					Public	1.20E-02	N		
1.4 Material Handling	Fire	Fire involving forklift fuel system engulfs single pallet	L	Single pallet	Immediate	Negligible	N	L	Fire limited to single pallet by fire suppression system.
					Collocated	8.14E-01	N		
					Public	8.14E-01	L		
1.5 Material Handling	Mass/gravity/height	Single flask dropped during handling resulting in breach	H	Single flask	Immediate	2.65E-03	N	N	
					Collocated	5.06E-05	N		
					Public	5.06E-05	N		
1.6 Material Handling	Mass/gravity/height	Single pallet dropped during handling resulting in breach	M	Single pallet	Immediate	3.64E-01	N	N	
					Collocated	6.97E-03	N		
					Public	6.97E-03	N		
1.7 Material Handling	Kinetic energy/linear	Forklift punctures flasks while moving pallet	M	Single pallet	Immediate	3.64E-01	N	N	
					Collocated	6.97E-03	N		
					Public	6.97E-03	N		
2.0 Reflask into 76-lb Flasks									
2.1 Material Handling	Fire	Fire involving forklift fuel system engulfs single pallet	L	Single pallet	Immediate	Negligible	N	L	Fire limited to single pallet by fire suppression system.
					Collocated	8.14E-01	N		
					Public	8.14E-01	L		

Activities	Hazards	Postulated Accident Scenario	Frequency	Material at Risk	Receptors	Consequences (mg/m^3)	Consequence Level	Risk	Comments
2.2 Material Handling	Mass/gravity/ height	Single pallet dropped during handling resulting in breach	M	Single pallet	Immediate	3.64E-01	N	N	
					Collocated	6.97E-03	N		
					Public	6.97E-03	N		

Table A–4. Hazards and Accident Analysis Matrix for the New Haven Depot (Continued)

Activities	Hazards	Postulated Accident Scenario	Frequency	Material at Risk	Receptors	Consequences (mg/m^3)	Consequence Level	Risk	Comments
2.3 Material Handling	Kinetic energy/linear	Forklift punctures flasks while moving pallet	M	Single pallet	Immediate	3.64E-01	N	N	
					Collocated	6.97E-03	N		
					Public	6.97E-03	N		
2.4 Reflasking	Mass/gravity/ height	Single flask dropped during reflasking resulting in breach	H	Single flask	Immediate	2.65E-03	N	N	
					Collocated	5.06E-05	N		
					Public	5.06E-05	N		
2.5 Reflasking	Toxicological	Contents of single flask spilled during reflasking	H	Single flask	Immediate	2.65E-03	N	N	
					Collocated	5.06E-05	N		
					Public	5.06E-05	N		
2.6 Staging after reflasking	Toxicological	Slow leak/release of liquid mercury	M	Single flask	Immediate	2.65E-03	N	N	New flasks not susceptible to leakage unless improperly closed.
					Collocated	5.06E-05	N		
					Public	5.06E-05	N		
2.7 Staging after reflasking	Toxicological	Pallets collapse resulting in breach of multiple flasks	N	N/A					New pallets not susceptible to collapse.
3.0 Reflask into 1-t Containers									
3.1 Material Handling	Fire	Fire involving forklift fuel system engulfs single pallet	L	Single pallet	Immediate	Negligible	N	L	Fire limited to single pallet by fire suppression system.
					Collocated	8.14E-01	N		
					Public	8.14E-01	L		
3.2 Material Handling	Mass/gravity/ height	Single pallet dropped during handling resulting in breach	M	Single pallet	Immediate	3.64E-01	N	N	
					Collocated	6.97E-03	N		
					Public	6.97E-03	N		
3.3 Material Handling	Kinetic energy/linear	Forklift punctures flasks while moving pallet	M	Single pallet	Immediate	3.64E-01	N	N	
					Collocated	6.97E-03	N		
					Public	6.97E-03	N		
3.4 Reflasking	Mass/gravity/ height	Single flask dropped during reflasking resulting in breach	H	Single flask	Immediate	2.65E-03	N	N	
					Collocated	5.06E-05	N		
					Public	5.06E-05	N		

Activities	Hazards	Postulated Accident Scenario	Frequency	Material at Risk	Receptors	Consequences (mg/m^3)	Consequence Level	Risk	Comments
3.5 Reflasking	Toxicological	Contents of single flask spilled during reflasking	H	Single flask	Immediate	2.65E-03	N	N	
					Collocated	5.06E-05	N		
					Public	5.06E-05	N		

Table A–4. Hazards and Accident Analysis Matrix for the New Haven Depot (Continued)

	Activities	Hazards	Postulated Accident Scenario	Frequency	Material at Risk	Receptors	Consequences (mg/m^3)	Consequence Level	Risk	Comments
3.6	Reflasking	Toxicological	Contents of 1-t container leak during reflasking	M	Single 1-t container	Immediate Collocated Public	2.78E-01 5.32E-03 5.32E-03	N N N	N	
3.7	Staging after reflasking	Toxicological	Slow leak/release of liquid mercury	M	Single 1-t container	Immediate Co-located Public	2.78E-01 5.32E-03 5.32E-03	N N N	N	New containers not susceptible to leakage unless improperly closed.
4.0	**Natural Phenomena Hazard Events**									
4.1	All activities	Earthquake	Earthquake results in building damage and causes pallets and/or mercury containers to fall	M	Entire inventory	Immediate Co-located Public	2.01E+00 3.85E-02 3.85E-02	L N N	L	
4.2	All activities	High wind or tornado	High winds result in roof failure and cause pallets and/or mercury containers to fall	M	Entire inventory	Immediate Co-located Public	2.01E+00 3.85E-02 3.85E-02	L N N	L	
4.3	All activities	Lightning strike	Lightning strike causes small building fire involving limited number of mercury containers	N	N/A					Lightning strike as initiator of building fire not considered credible.
4.4	All activities	Severe winter weather	Snow load causes roof collapse resulting in mercury containers falling	L	Minimal	Immediate Co-located Public	Negligible Negligible Negligible	N N N	N	
5.0	**External Events**									

	Activities	Hazards	Postulated Accident Scenario	Frequency	Material at Risk	Receptors	Consequences (mg/m^3)	Consequence Level	Risk	Comments
5.1	All activities	Aircraft crash	Aircraft crash into building resulting in fire, mercury container breach	N	N/A					Very limited target area given type of aircraft, flight vectors, and size of storage area within building.

Table A–4. Hazards and Accident Analysis Matrix for the New Haven Depot (Continued)

	Activities	Hazards	Postulated Accident Scenario	Frequency	Material at Risk	Receptors	Consequences (mg/m^3)	Consequence Level	Risk	Comments
5.2	All activities	Surface transportation	Vehicle or train crash into building resulting in mercury container breach	N	N/A					Concrete block construction precludes significant damage.
5.3	All activities	Adjacent fire/explosion	Fire/explosion at nearby building impacts mercury containers	N	N/A					No facilities located within 200 ft (61 m). Fire wall separates mercury storage area from remainder of warehouse.

Key: H, high; L, low; M, moderate; N, negligible; N/A, not applicable.

Table A–5. Hazards and Accident Analysis Matrix for the Warren Depot

Activities	Hazards	Postulated Accident Scenario	Frequency	Material at Risk	Receptors	Consequences (mg/m^3)	Consequence Level	Risk	Comments
1.0 No Action Alternative									
1.1 Storage	Fire	Building fire involving multiple flasks/pallets	N	N/A					No ignition sources other than forklift fuel (see Scenario 1.4).
1.2 Storage	Toxicological	Slow leak/release of liquid mercury	H	Single flask	Immediate Collocated Public	2.65E-03 2.98E-04 7.77E-05	N N N	N	
1.3 Storage	Toxicological	Wooden pallets collapse resulting in breach of multiple flasks	M	Three pallets	Immediate Collocated Public	6.25E-01 7.03E-02 1.84E-02	N N N	N	
1.4 Material Handling	Fire	Fire involving forklift fuel system engulfs single pallet	L	Single pallet	Immediate Collocated Public	Negligible 8.14E-01 8.14E-01	N N L	L	Fire limited to single pallet by fire suppression system.
1.5 Material Handling	Mass/gravity/ height	Single flask dropped during handling resulting in breach	H	Single flask	Immediate Collocated Public	2.65E-03 2.98E-04 7.77E-05	N N N	N	
1.6 Material Handling	Mass/gravity/ height	Single pallet dropped during handling resulting in breach	M	Single pallet	Immediate Collocated Public	3.64E-01 4.09E-02 1.07E-02	N N N	N	
1.7 Material Handling	Kinetic energy/linear	Forklift punctures flasks while moving pallet	M	Single pallet	Immediate Collocated Public	3.64E-01 4.09E-02 1.07E-02	N N N	N	
2.0 Reflask into 76-lb Flasks									
2.1 Material Handling	Fire	Fire involving forklift fuel system engulfs single pallet	L	Single pallet	Immediate Collocated Public	Negligible 8.14E-01 8.14E-01	N N L	L	Fire limited to single pallet by fire suppression system.
2.2 Material Handling	Mass/gravity/ height	Single pallet dropped during handling resulting in breach	M	Single pallet	Immediate Collocated Public	3.64E-01 4.09E-02 1.07E-02	N N N	N	

	Activities	Hazards	Postulated Accident Scenario	Frequency	Material at Risk	Receptors	Consequences (mg/m³)	Consequence Level	Risk	Comments
2.3	Material Handling	Kinetic energy/linear	Forklift punctures flasks while moving pallet	M	Single pallet	Immediate	3.64E-01	N	N	
						Collocated	4.09E-02	N		
						Public	1.07E-02	N		

Table A–5. Hazards and Accident Analysis Matrix for the Warren Depot (Continued)

Activities	Hazards	Postulated Accident Scenario	Frequency	Material at Risk	Receptors	Consequences (mg/m^3)	Consequence Level	Risk	Comments
2.4 Reflasking	Mass/gravity / Height	Single flask dropped during reflasking resulting in breach	H	Single flask	Immediate Collocated Public	2.65E-03 2.98E-04 7.77E-05	N N N	N	
2.5 Reflasking	Toxicological	Contents of single flask spilled during reflasking	H	Single flask	Immediate Collocated Public	2.65E-03 2.98E-04 7.77E-05	N N N	N	
2.6 Staging after reflasking	Toxicological	Slow leak/release of liquid mercury	M	Single flask	Immediate Collocated Public	2.65E-03 2.98E-04 7.77E-05	N N N	N	New flasks not susceptible to leakage unless improperly closed.
2.7 Staging after reflasking	Toxicological	Pallets collapse resulting in breach of multiple flasks	N	N/A					New pallets not susceptible to collapse.
3.0 Reflask into 1-t Containers									
3.1 Material Handling	Fire	Fire involving forklift fuel system engulfs single pallet	L	Single pallet	Immediate Collocated Public	Negligible 8.14E-01 8.14E-01	N N L	L	Fire limited to single pallet by fire suppression system.
3.2 Material Handling	Mass/gravity / Height	Single pallet dropped during handling resulting in breach	M	Single pallet	Immediate Collocated Public	3.64E-01 4.09E-02 1.07E-02	N N N	N	
3.3 Material Handling	Kinetic energy/linear	Forklift punctures flasks while moving pallet	M	Single pallet	Immediate Collocated Public	3.64E-01 4.09E-02 1.07E-02	N N N	N	
3.4 Reflasking	Mass/gravity / height	Single flask dropped during reflasking resulting in breach	H	Single flask	Immediate Collocated Public	2.65E-03 2.98E-04 7.77E-05	N N N	N	
3.5 Reflasking	Toxicological	Contents of single flask spilled during reflasking	H	Single flask	Immediate Collocated Public	2.65E-03 2.98E-04 7.77E-05	N N N	N	
3.6 Reflasking	Toxicological	Contents of 1-t container leak during reflasking	M	Single 1-t container	Immediate Collocated Public	2.78E-01 3.13E-02 8.17E-03	N N N	N	

	Activities	Hazards	Postulated Accident Scenario	Frequency	Material at Risk	Receptors	Consequences (mg/m^3)	Consequence Level	Risk	Comments
3.7	Staging after reflasking	Toxicological	Slow leak/release of liquid mercury	M	Single 1-t container	Immediate Collocated Public	2.78E-01 3.13E-02 8.17E-03	N N N	N	New containers not susceptible to leakage unless improperly closed.

Table A–5. Hazards and Accident Analysis Matrix for the Warren Depot (Continued)

Activities	Hazards	Postulated Accident Scenario	Frequency	Material at Risk	Receptors	Consequences (mg/m^3)	Consequence Level	Risk	Comments
4.0 Natural Phenomena Hazard Events									
4.1 All activities	Earthquake	Earthquake results in building damage and causes pallets and/or mercury containers to fall	M	Entire inventory	Immediate Collocated Public	2.03E+00 2.28E-01 5.94E-02	L N N	L	
4.2 All activities	High wind or tornado	High winds result in roof failure and cause pallets and/or mercury containers to fall	M	Entire inventory	Immediate Collocated Public	2.03E+00 2.28E-01 5.94E-02	L N N	L	
4.3 All activities	Lightning strike	Lightning strike causes small building fire involving limited number of mercury containers	N	N/A					Lightning strike as initiator of building fire not considered credible.
4.4 All activities	Severe winter weather	Snow load causes roof collapse resulting in mercury containers falling	L	Minimal	Immediate Collocated Public	Negligible Negligible Negligible	N N N	N	
5.0 External Events									
5.1 All activities	Aircraft crash	Aircraft crash into building resulting in fire, mercury container breach	N	N/A					Very limited target area given type of aircraft, flight vectors, and size of storage area within building.
5.2 All activities	Surface transportation	Vehicle or train crash into building resulting in mercury container breach	N	N/A					Concrete block construction precludes significant damage.

Table A–5. Hazards and Accident Analysis Matrix for the Warren Depot (Continued)

	Activities	Hazards	Postulated Accident Scenario	Frequency	Material at Risk	Receptors	Consequences (mg/m^3)	Consequence Level	Risk	Comments
5.3	All activities	Adjacent fire/explosion	Fire/explosion at nearby building impacts mercury containers	N	N/A					No facilities located within 200 ft (61 m). Fire wall separates mercury storage area from remainder of warehouse.

Key: H, high; L, low; M, moderate; N, negligible; N/A, not applicable.

Table A–6. Concentrations Due to Mercury Releases at the New Haven Depot

Atmospheric Dispersion Estimates

Location	Value (Chi/Q) (sec/m^3)	Assumptions
Worker[a]	3.82E-02	Dispersion into 10-m hemisphere; 10 sec exposure
Public at ground-level[b]	7.30E-04	150 m; Stability Class=D; 4.5 m/sec
Collocated worker elevated[c]	3.40E-05	Released at 30 m height; Stability Class=D; 4.5 m/sec; maximum at 400 m
Public elevated[b]	3.40E-05	Released at 30 m height; Stability Class=D; 4.5 m/sec; maximum at 400 m

Event	Molecular Weight (g/gmole)	Vapor Pressure at 20C (mm Hg)	Amount (lb)	Area (ft^2)	Airborne Flux (mg/sec/m^2)	Airborne Release Rate (mg/sec)	Facility Concentration (mg/m^3)	Onsite Concentration (mg/m^3)	Offsite Concentration (mg/m^3)
Single flask spill	2.01E+02	1.20E-03	7.60E+01	1.74E+01	4.30E-02	6.93E-02	2.65E-03	5.06E-05	5.06E-05
Single stack spill	2.01E+02	1.20E-03	1.14E+04	4.10E+03	4.30E-02	1.64E+01	6.25E-01	1.20E-02	1.20E-02
Forklift fuel fire			3.80E+03			2.39E+04	Negligible	8.14E-01	8.14E-01
Single pallet spill	2.01E+02	1.20E-03	3.80E+03	2.39E+03	4.30E-02	9.54E+00	3.64E-01	6.97E-03	6.97E-03
Metric ton container spill	2.01E+02	1.20E-03	2.20E+03	1.83E+03	4.30E-02	7.29E+00	2.78E-01	5.32E-03	5.32E-03
Earthquake spill	2.01E+02	1.20E-03	1.24E+05	1.33E+04	4.30E-02	5.31E+01	2.03E+00	3.85E-02	3.85E-02

[a] Predicted facility airborne concentration divided by the rate of release for the facility worker location. This quantity should be multiplied by the airborne release rate; e.g., for the single flask spill, Chi/Q (0.0382 sec/m^3)×Airborne Release Rate (0.0693 mg/sec)=facility concentration (mg/m^3).

[b] Predicted offsite airborne concentration divided by the rate of release.

[c] Predicted onsite airborne concentration divided by the rate of release.

Table A–7. Consequences Due to Mercury Releases at the New Haven Depot

	Comparison Criteria		Involved Worker			Noninvolved Worker			General Public		
Event	ERPG-2 Equivalent (mg/m^3)	IDLH (mg/m^3)	Facility Concentration (mg/m3)	Ratio to IDLH	Consequence Level	Onsite Concentration (mg/m^3)	Ratio to IDLH	Consequence Level	Offsite Concentration (mg/m^3)	Ratio to ERPG-2	Consequence Level
Single flask spill	1.00E+00	1.00E+01	2.65E-03	2.65E-04	Negligible	5.06E-05	5.06E-06	Negligible	5.06E-05	5.06E-05	Negligible
Single stack spill	1.00E+00	1.00E+01	6.25E-01	6.25E-02	Negligible	1.20E-02	1.20E-03	Negligible	1.20E-02	1.20E-02	Negligible
Forklift fuel fire	1.00E+00	1.00E+01	Negligible	N/A	Negligible	8.14E-01	8.14E-02	Negligible	8.14E-01	8.14E-01	Low
Single pallet spill	1.00E+00	1.00E+01	3.64E-01	3.64E-02	Negligible	6.97E-03	6.97E-04	Negligible	6.97E-03	6.97E-03	Negligible
Single 1-t container spill	1.00E+00	1.00E+01	2.78E-01	2.78E-02	Negligible	5.32E-03	5.32E-04	Negligible	5.32E-03	5.32E-03	Negligible
Earthquake spill	1.00E+00	1.00E+01	2.01E+00	2.01E-01	Low	3.85E-02	3.85E-03	Negligible	3.85E-02	3.85E-02	Negligible

Key: ERPG-2, Emergency Response Planning Guidelines, Level 2; IDHL, Immediately Dangerous to Life and Health.

Table A–8. Concentrations Due to Mercury Releases at the Warren Depot

Atmospheric Dispersion Estimates

Location	Value (Chi/Q) (sec/m³)	Assumptions
Worker[a]	3.82E-02	Dispersion into 10-m hemisphere; 10 sec exposure
Collocated worker[b]	4.29E-03	60 m; Stability Class=D; 4.5 m/sec
Public at ground-level[c]	1.12E-03	120 m; Stability Class=D; 4.5 m/sec
Collocated worker elevated[b]	3.40E-05	Released at 30 m height; Stability Class=D; 4.5 m/sec; maximum at 400 m
Public elevated[c]	3.40E-05	Released at 30 m height; Stability Class=D; 4.5 m/sec; maximum at 400 m

Event	Molecular Weight (g/gmole)	Vapor Pressure at 20C (mm Hg)	Amount (lb)	Area (ft²)	Airborne Flux (mg/sec/m²)	Airborne Release Rate (mg/sec)	Facility Concentration (mg/m³)	Onsite Concentration (mg/m³)	Offsite Concentration (mg/m³)
Single flask spill	2.01E+02	1.20E-03	7.60E+01	1.74E+01	4.30E-02	6.93E-02	2.65E-03	2.98E-04	7.77E-05
Single stack spill	2.01E+02	1.20E-03	1.14E+04	4.10E+03	4.30E-02	1.64E+01	6.25E-01	7.03E-02	1.84E-02
Forklift fuel fire			3.80E+03			2.39E+04	Negligible	8.14E-01	8.14E-01
Single pallet spill	2.01E+02	1.20E-03	3.80E+03	2.39E+03	4.30E-02	9.54E+00	3.64E-01	4.09E-02	1.07E-02
Metric ton container spill	2.01E+02	1.20E-03	2.20E+03	1.83E+03	4.30E-02	7.29E+00	2.78E-01	3.13E-02	8.17E-03
Earthquake spill	2.01E+02	1.20E-03	1.24E+05	1.33E+04	4.30E-02	5.31E+01	2.03E+00	2.28E-01	5.94E-02

[a] Predicted facility airborne concentration divided by the rate of release for the facility worker location. This quantity should be multiplied by the airborne release rate; e.g., for the single flask spill, Chi/Q (0.0382 sec/m³)×Airborne Release Rate (0.0693 mg/sec)=facility concentration (mg/m³).

[b] Predicted onsite airborne concentration for the collocated worker (ground level or elevated release) divided by the airborne rate of release.

[c] Predicted offsite airborne concentration for the public (ground level or elevated release) divided by the airborne rate of release.

Table A–9. Consequences Due to Mercury Releases at the Warren Depot

Event	Comparison Criteria		Involved Worker			Non Involved Worker			General Public		
	ERPG-2 Equivalent (mg/m^3)	IDLH (mg/m^3)	Facility Concentration (mg/m^3)	Ratio to IDLH	Consequence Level	Onsite Concentration (mg/m^3)	Ratio to IDLH	Consequence Level	Off site Concentration (mg/m^3)	Ratio to ERPG-2	Consequence Level
Single flask spill	1.00E+00	1.00E+01	2.65E-03	2.65E-04	Negligible	2.98E-04	2.98E-05	Negligible	7.77E-05	7.77E-05	Negligible
Single stack spill	1.00E+00	1.00E+01	6.25E-01	6.25E-02	Negligible	7.03E-02	7.03E-03	Negligible	1.84E-02	1.84E-02	Negligible
Forklift fuel fire	1.00E+00	1.00E+01	Negligible	N/A	Negligible	8.14E-01	8.14E-02	Negligible	8.14E-01	8.14E-01	Low
Single pallet spill	1.00E+00	1.00E+01	3.64E-01	3.64E-02	Negligible	4.09E-02	4.09E-03	Negligible	1.07E-02	1.07E-02	Negligible
Single 1-t container spill	1.00E+00	1.00E+01	2.78E-01	2.78E-02	Negligible	3.13E-02	3.13E-03	Negligible	8.17E-03	8.17E-03	Negligible
Earthquake spill	1.00E+00	1.00E+01	2.03E+00	2.03E-01	Low	2.28E-01	2.28E-02	Negligible	5.94E-02	5.94E-02	Negligible

Key: ERPG-2, Emergency Response Planning Guidelines, Level 2; IDHL, Immediately Dangerous to Life and Health.

The accident scenarios considered for the analysis are described in Section 4.0 of the *Mercury Reflasking EA*. In addition, Section 3.0 contains descriptions of the affected environments and Section 2.0 contains descriptions of the sites.

No Action Alternative:

- Building fire involving multiple flasks/pallets
- Leak from a single flask of mercury into a drip pan
- Collapse of a pile of three wooden pallets with breach of all of the flasks in the pile
- Fire involving a forklift truck engulfs a single pallet
- Single flask drop and breach
- Single pallet dropped during handling, with breach of all flasks
- Forklift punctures flasks
- Earthquake results in building damage and breach of some flasks
- High winds or tornadoes damage the building and breach some flasks
- Lightning strike
- Severe winter weather
- Aircraft crash
- Vehicle or train crash into building
- Nearby fire or explosion

Additional Scenarios Considered for Reflasking Mercury into New 76-lb Flasks or 1-t Containers:

- Spillage from a 1-t (1.1-ton) container

A.2 ECOLOGICAL RISK ASSESSMENT

The purpose of the ecological risk assessment is to provide an evaluation of current (baseline) ecological risks at DNSC's mercury storage areas under the No Action Alternative and comparative risks associated with various alternatives. This risk assessment analyzed the potential for adverse effects associated with exposure to mercury in the mercury storage areas located in New Haven, Indiana, and Warren, Ohio. The potential for adverse ecological effects resulting from alternative actions was also evaluated.

A.2.1 DESCRIPTION OF THE ECOLOGICAL RISK ASSESSMENT PROCESS

The purpose of the ecological risk assessment is to evaluate the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to unit-related constituents based on a screening approach. The methodology used in this assessment is based on methods presented by EPA but was simplified because most of the risk evaluations were done for hypothetical scenarios (EPA 1997, 1998a).

The accident analysis identified airborne mercury as the only contaminant of concern at the New Haven and Warren depots, and forms of mercury were evaluated as contaminants of potential ecological concern (COPECs). The methodology followed in the evaluation of ecological risk from the identified COPECs consisted of four interrelated steps: problem formulation, exposure assessment, effects assessment, and risk characterization. The first three steps were performed concurrently.

The potential effects to ecological receptors of mercury was estimated from information provided in the description of alternatives.

A.2.2 PROBLEM FORMULATION

Problem formulation establishes the goals, breadth, and focus of the ecological risk assessment through the following:

- Characterization of ecological communities
- Selection of assessment endpoints
- Presentation of an ecological conceptual site model
- Development of an analysis plan (establishing measures of effects)

A.2.2.1 Media of Potential Concern

Media of potential concern are defined as any media through which ecological receptors may be exposed to constituents, either directly or through biotransfer mechanisms. Analyses presented in Section A.1 indicate that soil and surface water may become contaminated by deposition from airborne releases of mercury during an accident.

A.2.2.1.1 Identification of Forms of Mercury and Other Constituents of Potential Ecological Concern

EPA guidance for airborne mercury deposited on soil surfaces specifies that the mercury should be assumed to be 2 percent methyl mercury in dry soil (EPA 1999c). For this evaluation it was assumed that mercury in surface water would initially be elemental mercury only.

A.2.2.2 Characterization of Ecological Communities

The ecosystem potentially at risk comprises habitat surrounding the mercury storage depots and any habitat that may be impacted by accidental releases associated with the proposed alternatives. The ecological settings at the New Haven and Warren depots are described in Section 3.0 of the *Mercury Reflasking EA.*

A.2.2.3 Ecological Assessment Endpoints

The ecological risk assessment for the mercury storage depots analyzes whether ecological resources are likely to be harmed by the proposed alternatives. The protection of ecological resources, such as habitats and plant and animal species, is a principal motivation for conducting a risk assessment. Ecological endpoints are selected to determine whether these protection goals are met. Unlike the human health risk assessment process, which focuses on individual receptors, the ecological risk assessment focuses on populations or groups of interbreeding, nonhuman, nondomesticated receptors. Accordingly, assessment endpoints generally refer to characteristics of populations and ecosystems.

A.2.2.4 Representative Ecological Receptor Selection Criteria

Potential receptor species likely to be exposed to unit-related constituents are selected to represent assessment endpoints based principally on:

- Receptor's susceptibility (through exposure and sensitivity) to mercury and other potential alternative-related constituents
- Mechanisms of constituent toxicity
- Potential species present
- Potential complete exposure pathways
- Receptor's importance in the community food web
- Amount of available data describing a receptor's potential for exposure
- Toxicological effects that may result from exposure
- Extent to which receptors are protected by policy/management goals

The results of this analysis indicate that the most appropriate assessment endpoint species are those described below.

Terrestrial Exposure Classes and Receptors

The terrestrial exposure classes and their ecological receptors that were evaluated are:

- Plants and soil-dwelling invertebrates
  - Terrestrial plants
  - Earthworms
- Worm-eating and/or insectivorous mammals and birds
  - Short-tailed shrews
  - American robins

After evaluation of the eight selection criteria, plants and earthworms and other soil-dwelling invertebrates were identified as appropriate receptors for further evaluation. They are exposed to COPECs in surface and/or subsurface soil in the environs of the mercury storage depots by ingestion and direct contact. Exposure by inhalation in air or suspended particles is assumed to be negligible for these receptors. It is assumed that earthworms ingest only soil and are exposed to the full-measurement constituent concentration. Plants, earthworms, and other soil-dwelling invertebrates are an important component of the diet of insectivorous mammals and birds.

Short-tailed shrews and American robins were identified as appropriate receptors for further evaluation. They are exposed to COPECs in surface soil in the environs of the mercury storage depots by ingestion and direct contact and by ingestion of plants and soil-dwelling invertebrates. Exposure by inhalation in air or suspended particles is assumed to be negligible for these receptors.

Exposure of herbivorous mammals to COPECs in surface soil was not further evaluated because bioaccumulation of mercury to plants is less than bioaccumulation in the diets of omnivores, and evaluation of omnivores has been determined to be sufficiently protective of herbivores.

Aquatic Exposure Classes and Receptors

The aquatic exposure classes and their ecological receptors that were evaluated are:

- Fish and other aquatic animals
- Fish-eating carnivores
  - Great blue heron

Fish and aquatic animals were identified as appropriate receptors for further evaluation. Fish and aquatic animals are exposed primarily to constituents in surface water/sediment and in the food they ingest. The exposure concentration for these animals is assumed to be equal to the environmental concentration because the aquatic toxicity thresholds used are expected to protect aquatic life from all exposure pathways, including ingestion of contaminated plants and animals. Herons are exposed primarily by ingestion of fish and other aquatic animals.

A.2.2.5 Ecological Conceptual Site Model

The conceptual site models present the ecological receptors at the mercury storage depots that are potentially exposed to hazardous substances across several pathways. A complete exposure pathway consists of the following four elements:

- A source and mechanism of constituent release to the environment
- An environmental transport mechanism for the released constituents
- A point of contact with the contaminated medium
- A route of constituent entry into the receptor at the exposure point

The accident analysis predicts that at the New Haven and Warren depots, mercury is released as vapor or airborne particles that are transported to the surrounding soil and water. Because mercury deposited onto soil or into water bodies is persistent, chronic exposure to contaminated soil and water was assumed. Ecological receptors are exposed by direct contact and uptake from contaminated soil and surface water and by ingestion of contaminated food.

A.2.2.6 Ecological Risk Assessment Analysis Plan for Alternatives

The analysis plan includes two categories of measures to evaluate the risk hypotheses identified in the conceptual site model: measures of effect (also termed measurement endpoints) and measures of exposure. The measurement endpoints are selected based on *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (EPA 1997).

A.2.2.6.1 Measures of Exposure

Measures of exposure are the amounts, in dosage or concentration, that the receptors are predicted to receive. These include concentrations of constituents in the impacted media and concentrations or dosages of the constituents to which the receptor is exposed. For mercury, benchmark values for soil, surface water, and sediment were established (see Section A.2.5). Predicted concentrations of mercury below the benchmark values indicate that the alternative poses no potential unacceptable impact to ecological receptors.

If the measured concentration or estimated dose is less than the concentration or dose expected to have the potential to produce an adverse effect (i.e., the ratio of the two is less than 1), the risk is considered acceptable (protective of the ecological receptor). Any quotient greater than or equal to 1 indicates that the COPEC has the potential for harm to ecological receptors. Methods to estimate exposure are discussed in Section A.2.3.

A.2.2.6.2 Measures of Effect

The most appropriate measurement endpoints relating to the assessment endpoints are predicted concentrations of COPECs in soil, surface water, and sediment that result in harm to the ecological receptors. Measures of effect are discussed in Section A.2.4.

A.2.3 ECOLOGICAL EXPOSURE ASSESSMENT

The exposure assessment evaluates potential exposures of ecological receptors to unit-related constituents and consists of the following:

- Description of the spatial distribution of COPECs
- Description of the spatial and temporal distribution of ecological receptors
- Quantification of receptor exposures that may result from overlap of these distributions

A.2.3.1 Site-Specific and Alternative-Specific Constituent Distribution

The area of the habitat in the environs of the two mercury storage depots is described in Section 3.0 of the *Mercury Reflasking EA*. The concentration of mercury in soil and surface water after an onsite accident was estimated from the predicted airborne concentrations associated with each scenario. For nonfire events, it was assumed that all mercury is present as vapor and is deposited by wet deposition. For the fire scenarios, it was assumed that all mercury is particulate and is deposited by dry and wet deposition. Site-specific data were not available to model deposition rates. Instead, the following assumptions were used. The unitized average annual wet deposition rate for vapors was assumed to be 70 g/m^2-yr per mg/m^3. This value is similar to predicted deposition rates for other vapors at a distance similar to the onsite and offsite locations. The unitized average annual total deposition rate for particulate mercury was assumed to be 120 g/m^2-yr per mg/m^3. This value is similar to predicted deposition rates for particulate mercury at a distance similar to the onsite and offsite locations (Hadden 2000).

To calculate soil concentrations, deposition for 1 hour was assumed, consistent with the calculation of airborne concentrations in Section A.1. Therefore, unitized rates were divided by 8,766 hr/yr. The rates were then multiplied by 1 hour and by 1,000 mg/g resulting in a deposition rate in mg/m^2. It was assumed that exposures would be integrated over the top 7.9 in (20 cm) of soil, so the deposition rate was divided by 0.02 m. The resulting concentration in mg/m^3 was converted to mg/kg by using a soil density of 1,600 kg/m^3. The combined conversion factor was thus 1,000 mg/g × 1 hr / (8,766 hr/yr × 0.02 m × 1,600 kg/m^3), and the unitized concentration terms for soil were 0.25 mg/kg per mg/m^3 for vapors and 0.43 mg/kg per mg/m^3 for particulates.

Surface water concentrations were estimated similarly, except that it was assumed that deposited mercury would be distributed through an onsite or offsite pond assumed to be 66 ft (2 m) deep. Therefore, the conversion factor was 1,000,000 ug/g × 1 hr / (8,766 hr/yr × 2 m × 1,000 l/m^3), and the unitized concentration terms for surface water were 4.0 ug/l per mg/m^3 for vapors and 6.8 ug/l per mg/m^3 for particulates. Exposure in flowing water bodies was assumed to be negligible because deposited mercury would rapidly be diluted by the water flow.

Predicted airborne, soil, and surface water mercury concentrations under each accident scenario are presented in Table A–10 for the New Haven and Warren depots.

A.2.3.2 Site-Specific Ecological Receptor Distribution

It was assumed that all terrestrial habitats support plants and animals represented by the ecological receptors described in Section A.2.2.5. It was also assumed that the ecological receptors are present at all times on each exposure unit.

A.2.3.3 Site-Specific and Alternative-Specific Quantification of Exposure

It was assumed that plants, earthworms, short-tailed shrews, and American robins are the receptors likely to have the greatest potential exposures to mercury in soils, while aquatic biota and great blue herons are likely to have the greatest exposure to mercury in surface water.

Daily intake of each constituent is calculated to quantify exposures of terrestrial receptors to inorganic mercury and methyl mercury. Conversion of the environmental concentration of each COPEC to an estimated daily intake for a receptor at the site is necessary prior to evaluation of potentially toxic effects. Exposure rates for the receptors are based on ingestion of constituents from these media and from consumption of other organisms. The ecological risk assessment does not attempt to measure potential risk from dermal and/or inhalation exposure routes given the insignificance of these pathways relative to the major exposure pathways (e.g., ingestion) and due to the scarcity of data available for these pathways. Direct contact and ingestion are evaluated for plants (contact only) and earthworms in soil.

Daily intake of each constituent was calculated to quantify exposures of top predators of aquatic biota to each COPEC. Exposure rates for the great blue heron are based on ingestion of constituents from sediment and surface water and also from consumption of other organisms exposed to these media.

Table A–10. Estimated Airborne, Soil, and Surface Water Concentrations Resulting from Mercury Transfer Accident Scenarios

		New Haven Depot			Warren Depot		
		Airborne Concentration (mg/me)[a]	Soil Concentration (mg/kg)[b]	Surface Water Concentr-ation (ug/l)[c]	Airborne Concentration (mg/m^3)[d]	Soil Concentration (mg/kg)[b]	Surface Water Concentr-ation (ug/l)[c]
1.0 No Action Alternative							
1.2 Storage, slow release	Onsite	5.06E-05	1.27E-05	2.02E-04	2.98E-04	7.45E-05	1.19E-03
	Offsite	5.06E-05	1.27E-05	2.02E-04	7.77E-05	1.94E-05	3.11E-04
1.3 Storage, breach of multiple flasks	Onsite	1.20E-02	3.00E-03	4.80E-02	7.03E-02	1.76E-02	2.81E-01
	Offsite	1.20E-02	3.00E-03	4.80E-02	1.80E-02	4.50E-03	7.20E-02
1.4 Handling, fire engulfing one pallet	Onsite	8.14E-01	3.50E-01	5.54E+00	8.14E-01	3.50E-01	5.54E+00
	Offsite	8.14E-01	3.50E-01	5.54E+00	8.14E-01	3.50E-01	5.54E+00
1.5 Handling, breach of one dropped flask	Onsite	5.06E-05	1.27E-05	2.02E-04	2.98E-04	7.45E-05	1.19E-03
	Offsite	5.06E-05	1.27E-05	2.02E-04	7.77E-05	1.94E-05	3.11E-04
1.6 Handling, breach of all flasks in pallet	Onsite	6.97E-03	1.74E-03	2.79E-02	4.09E-02	1.02E-02	1.64E-01
	Offsite	6.97E-03	1.74E-03	2.79E-02	1.07E-02	2.68E-03	4.28E-02
1.7 Handling, breach of all flasks in pallet	Onsite	6.97E-03	1.74E-03	2.79E-02	4.09E-02	1.02E-02	1.64E-01
	Offsite	6.97E-03	1.74E-03	2.79E-02	1.07E-02	2.68E-03	4.28E-02
2.0 Reflask into 76-lb Flasks							
2.1 Handling, fire engulfing one pallet	Onsite	8.14E-01	3.50E-01	5.54E+00	8.14E-01	3.50E-01	5.54E+00
	Offsite	8.14E-01	3.50E-01	5.54E+00	8.14E-01	3.50E-01	5.54E+00
2.2 Handling, breach of one dropped pallet	Onsite	6.97E-03	1.74E-03	2.79E-02	4.09E-02	1.02E-02	1.64E-01
	Offsite	6.97E-03	1.74E-03	2.79E-02	1.07E-02	2.68E-03	4.28E-02
2.3 Handling, breach of all flasks in pallet	Onsite	6.97E-03	1.74E-03	2.79E-02	4.09E-02	1.02E-02	1.64E-01
	Offsite	6.97E-03	1.74E-03	2.79E-02	1.07E-02	2.68E-03	4.28E-02
2.4 Reflasking, breach of single flask	Onsite	5.06E-05	1.27E-05	2.02E-04	2.98E-03	7.45E-04	1.19E-02
	Offsite	5.06E-05	1.27E-05	2.02E-04	7.77E-05	1.94E-05	3.11E-04
2.5 Reflasking, single flask spilled	Onsite	5.06E-05	1.27E-05	2.02E-04	2.98E-04	7.45E-05	1.19E-02
	Offsite	5.06E-05	1.27E-05	2.02E-04	7.77E-05	1.94E-05	3.11E-04
2.6 Staging after reflasking, release from single flask	Onsite	5.06E-05	1.27E-05	2.02E-04	2.98E-04	7.45E-05	1.19E-03
	Offsite	5.06E-05	1.27E-05	2.02E-04	7.77E-05	1.94E-05	3.11E-04

		New Haven Depot			Warren Depot		
		Airborne Concentration (mg/me)[a]	**Soil Concentration (mg/kg)[b]**	**Surface Water Concentr-ation (ug/l)[c]**	**Airborne Concentratio n (mg/m³)[d]**	**Soil Concentration (mg/kg)[b]**	**Surface Water Concentr -ation (ug/l)[c]**
3.0 Reflask into 1-t Containers							
3.1 Handling, fire engulfing one pallet	Onsite	8.14E-01	3.50E-01	5.54E+00	8.14E-01	3.50E-01	5.54E+00
	Offsite	8.14E-01	3.50E-01	5.54E+00	8.14E-01	3.50E-01	5.54E+00
3.2 Handling, breach of all flasks in pallet	Onsite	6.97E-03	1.74E-03	2.79E-02	4.09E-02	1.02E-02	1.64E-01
	Offsite	6.97E-03	1.74E-03	2.79E-02	1.07E-02	2.68E-03	4.28E-02

Table A–10. Estimated Airborne, Soil, and Surface Water Concentrations Resulting from Mercury Transfer Accident Scenarios (Continued)

		New Haven Depot			Warren Depot		
		Airborne Concentration (mg/me)[d]	**Soil Concentration (mg/kg)[b]**	**Surface Water Concentr-ation (ug/l)[c]**	**Airborne Concentration (mg/m^3)[da]**	**Soil Concentration (mg/kg)[b]**	**Surface Water Concentr-ation (ug/l)[c]**
3.3 Handling, breach of all flasks in pallet	Onsite	6.97E-03	1.74E-03	2.79E-02	4.09E-02	1.02E-02	1.64E-01
	Offsite	6.97E-03	1.74E-03	2.79E-02	1.07E-02	2.68E-03	4.28E-02
3.4 Reflasking, breach of one dropped flask	Onsite	5.06E-05	1.27E-05	2.02E-04	2.98E-04	7.45E-05	1.19E-03
	Offsite	5.06E-05	1.27E-05	2.02E-04	7.77E-05	1.94E-05	3.11E-04
3.5 Reflasking, single flask spilled	Onsite	5.06E-05	1.27E-05	2.02E-04	2.98E-04	7.45E-05	1.19E-03
	Offsite	5.06E-05	1.27E-05	2.02E-04	7.77E-05	1.94E-05	3.11E-04
3.6 Reflasking, 1-t container leak	Onsite	5.32E-03	1.33E-03	2.13E-02	3.13E-02	7.83E-03	1.25E-01
	Offsite	5.32E-03	1.33E-03	2.13E-02	8.17E-03	2.04E-03	3.27E-02
3.7 Staging after reflasking, 1-t container leak	Onsite	5.32E-03	1.33E-03	2.13E-02	3.13E-02	7.83E-03	1.25E-01
	Offsite	5.32E-03	1.33E-03	2.13E-02	8.17E-03	2.04E-03	3.27E-02
4.0 Natural Phenomena							
4.1 Evaluation-based earthquake	Onsite	3.85E-02	9.63E-03	1.54E-01	2.28E-01	5.70E-02	9.12E-01
	Offsite	3.85E-02	9.63E-03	1.54E-01	5.94E-02	1.49E-02	2.38E-01
4.2 High winds	Onsite	3.85E-02	9.63E-03	1.54E-01	2.28E-01	5.70E-02	9.12E-01
	Offsite	3.85E-02	9.63E-03	1.54E-01	5.94E-02	1.49E-02	2.38E-01

a Data from Table A–4.

b Calculated as described in the text, airborne concentration evaluation (mg/m^3) × mg/kg per mg/m^3.

c Calculated as described in the text, airborne concentration evaluation (mg.m^3) × mg/l per mg/m^3.

d Data from Table A–5.

The first step in measuring exposure rates for terrestrial wildlife is the calculation of food ingestion rates for the receptors. EPA's *Wildlife Exposure Factors Handbook* (EPA 1993) was used as the source for these data. A unit-specific exposure dose of each constituent is calculated using a food chain uptake model. This algorithm accounts for exposure via incidental ingestion of contaminated soil, ingestion of plants grown in contaminated soil, and ingestion of lower trophic level animals associated with contamination. The soil exposure equation for lower trophic level receptors, i.e., short-tailed shrews and American robins is as follows:

$$ED_{soil} = C_s \times [(SP \times I_p) + (BAF \times I_a) + (I_s \times ST)] / BW$$

where:

ED_{soil} = soil exposure dose for terrestrial receptor (mg/kg/day)

C_s = predicted concentration in soil (mg/kg)

SP = soil-to-plant uptake factor (unitless); SP_v for shrews and SP_r for robins

I_p = receptor-specific ingestion rate of plant material (kg/day)

BAF_{inv} = constituent-specific bioaccumulation factor for transfer from soil to invertebrate tissue (kg soil/kg/tissue), 0.34 for mercury in soil (EPA 1999c).

I_a = receptor-specific ingestion rate of animal material (kg/day)

I_s = receptor-specific ingestion rate of soil (kg/day)

ST = bioavailability factor (unitless) for constituents ingested in soil (assumed to be 1.0 for all constituents and receptors)

BW = body weight (kg)

Where it is assumed that the vegetation consumed by a given receptor comprises largely leaves, stems, and roots of plants, values of soil-to-plant uptake factor for short-tailed shrews (SP_v) are used to calculate their exposure to constituents (EPA 1993). Where it is assumed that the vegetation consumed by a receptor is predominantly berries and fruits, values of soil-to-plant uptake factor for American robins (SP_r) are used to calculate their exposure constituents by ingestion of soil invertebrates.

Exposures were not calculated for plants and earthworms since their toxicity benchmarks are direct measurements of soil constituent concentrations rather than dietary exposures.

Bioaccumulation is the process by which constituents are absorbed from ingested soil, food, and water and retained in tissues. It is quantified by the calculation of bioaccumulation factor, which is a proportionality constant relating the constituent concentration in tissue to the concentration in the exposure medium (Amdur et al. 1991, EPA 1989). Bioaccummulation may be a significant component of exposure to COPECs for the receptors. For the terrestrial receptors, bioaccumulation is evaluated by means of specific soil-to-plant and soil-to-invertebrate tissue bioaccumulation factors. Soil-to-plant uptake factors are obtained from EPA for inorganics (EPA 1999c).

Adjusted bioaccumulation factors for vegetative (leaf and stem) and reproductive (seed and fruit) parts of plants (SP_V and SP_r, respectively) and for soil-to-invertebrate and ingestion-to-tissue uptake were taken from EPA guidance for incinerator risk assessment (EPA 1999c).

For the terrestrial receptor's exposure to surface water (i.e., great blue heron), the following algorithm is used:

$$ED_{sw} = [(C_{sw} \times I_{sw}) + C_{sw} \times BCF \times I_a] / BW$$

where:

ED_{sw} = surface water exposure dose for terrestrial receptor (mg/kg/day)

C_{sw} = RME concentration in surface water (mg/l)

I_{sw} = receptor-specific ingestion rate of surface water (l/day)

BCF = constituent-specific water-to-tissue bioconcentration factor for prey (l/kg)

I_a = receptor-specific ingestion rate of animal material (kg/day)

BW = body weight (kg)

The exposure dose to terrestrial receptors to surface water includes a term for calculating food chain intake using bioconcentration factors.

For aquatic receptors (e.g., amphibians, minnows, invertebrates, and larger fish), COPEC intake rates are calculated only to estimate exposure of fish-eating predators, as risk is characterized by comparing receptor toxicity concentrations for water and sediment with concentrations in surface water and sediment samples, respectively. The bioconcentration factor for total mercury species was assumed to be 5,000, slightly above the geometric mean of several measurements of mercury uptake by aquatic biota (DOE 1995).

A.2.4 ECOLOGICAL EFFECTS ASSESSMENT

The effects assessment defines and evaluates the potential ecological response to COPECs in terms of the selected measurement endpoints. The effects assessment includes the derivation of toxicity reference values which are the basis of the evaluation. Section A.2.5 uses the results of the effects assessment to identify scenarios that pose a potential for harm under each proposed alternative. Toxicity values for plants, soil invertebrates, mammals, and birds were lowest observed adverse effects levels taken from EPA guidance (EPA 1999c) and a compilation of toxicity values by Sample et al. (1996). The toxicity value for aquatic biota is the water quality criterion for mercury in freshwater. Toxicity reference values for inorganic and methyl mercury are presented in Tables A–11 and A–12, respectively.

To expedite the evaluation of potential exposures, screening values for mercury in soil, surface water, and sediment were derived. For soil, the exposure dose parameter (see Section A.2.3) was set equal to the toxicity reference value (Section A.2.4) for each terrestrial receptor. Then the exposure equation was solved for the soil concentration, which became the soil screening value for each receptor.

Benchmarks were calculated for inorganic mercury assuming that 98 percent of total mercury deposited on dry soil remains inorganic and 99 percent of total mercury in surface water remains inorganic. Benchmarks were calculated for methyl mercury by assuming that 2 percent of total mercury deposited on dry soil and 1 percent of mercury in surface water is methylated. The resulting screening values are given in Tables A–11 and A–12, respectively. The lower benchmark for each receptor was used in the subsequent risk evaluation. Predicted concentrations of mercury in soil and surface water were compared to these screening values, and the ratio was used as the hazard quotient (HQ) for each receptor and each scenario.

A.2.5 ECOLOGICAL RISK CHARACTERIZATION

Risk characterization integrates exposures and effects on receptors using HQs (ratios of exposure and effect concentrations). The resulting data are used to define the risk from COPECs at each exposure group and to assess the risk to ecological receptors. Risk characterization includes two main steps: risk

Table A–11. Screening Values for Inorganic Mercury

Receptor	Plants	Soil Inverte-brates	Short-tailed Shrew	American Robin	Great Blue Heron
TRV[a] (mg/kg BW/day)	0.35	2.5	28.6	3.25	3.25
SP[b]	NA	NA	0.18	0.04	NA
Ip[c] (kg/day)	NA	NA	0.00124	0.0608	NA
BAF_{inv}[d]	NA	NA	0.34	0.34	NA
BCF[e]	NA	NA	NA	NA	5000
Ia[f] (kg/day)	NA	NA	0.00828	0.0608	0.422
BAF_{mamm}[g]	NA	NA	13	13	NA
Is[h] (kg/day)	NA	NA	0.00124	0.01265	NA
Iw[i] (l/day)	NA	NA	NA	NA	0.045
BW[j] (kg)	NA	NA	0.017	0.08	2.39
Screening value[k] (mg/kg or ug/l)	0.35	2.5	113.7	7.3	368.47

[a] Toxicity reference value.

[b] Soil-to-plant transfer factor: to vegetative parts for shrew and heron; to reproductive parts for robin (EPA 1999c).

[c] Ingestion rate of plant tissue (EPA 1993).

[d] Soil-to-soil invertebrate transfer factor (EPA 1999c).

[e] Water-to-tissue bioconcentration factor (DOE 1995).

[f] Ingestion rate of animal tissue (EPA 1993).

[g] Food-to-tissue uptake factor for mammals and birds (EPA 1999c).

[h] Ingestion rate of soil (EPA 1993).

[i] Ingestion rate of water (EPA 1993).

[j] Body weight (EPA 1993).

[k] Calculated by solving exposure equations for predicted concentration in soil (C_s), sediment, (C_{sed}), or water (C_w) when the exposure dose equals the toxicity reference value. (ED = TRV).

Key: NA, not applicable.

estimation and risk description. Risk estimation uses the results of the exposure and effects assessments to calculate an HQ for each COPEC.

HQs for each receptor under each scenario are presented in Table A–13 for the New Haven Depot and Table A–14 for the Warren Depot. HQs ranged from below 10^{-5} to about 8. Due to uncertainties, HQs slightly greater than 1 may indicate risk when it is possible that there is no risk. An HQ much greater than 1 indicates almost certain adverse ecological effects; whereas, an HQ much less than 1 indicates risk is almost certainly acceptable. The magnitude of this uncertainty regarding HQs near 1 varies among sites, COPECs, and receptors because of the different sources and magnitudes of uncertainty in the exposure and effects estimates. Because of these uncertainties, the exposure and effects assessments in the ecological risk assessment are designed to minimize the probability of falsely concluding that there is no risk when in fact there is risk. As a result, COPECs with HQs less than 1 are unlikely to cause risk to the endpoint receptors and are not discussed further. The focus of the risk characterization is on those COPECs with HQs greater than 1.

The risk description has two main elements: the ecological risk summary, which summarizes the results of the risk estimation, and the interpretation of ecological significance, which describes the magnitude of the identified risks to the assessment endpoints.

Table A–12. Screening Values for Methyl Mercury

Receptor	Plants	Soil Inverte-Brates	Short-tailed Shrew	American Robin	Great Blue Heron
TRV[a] (mg/kg BW/day)	0.35	2.5	0.325	0.0640	0.0640
SP[b]	NA	NA	0.137	0.137	NA
Ip[c] (kg/day)	NA	NA	0.0012	0.061	NA
BAF_{inv}[d]	NA	NA	8.25	8.25	NA
BCF[e]	NA	NA	NA	NA	11168
Ia[f] (kg/day)	NA	NA	0.0083	0.061	0.422
BAF_{mamm}[g]	NA	NA	1.96	1.96	NA
Is[h] (kg/day)	NA	NA	0.0012	0.013	NA
Iw[i] (l/day)	NA	NA	NA	NA	0.045
BW[j] (kg)	NA	NA	0.017	0.08	2.39
Screening value[k] (mg/kg or ug/l)	0.35	2.50	3.96	0.490	3.249

a Toxicity reference value.

b Soil-to-plant transfer factor: to vegetative parts for shrew and heron; to reproductive parts for robin (EPA 1999c).

c Ingestion rate of plant tissue (EPA 1993).

d Soil-to-soil invertebrate transfer factor (EPA 1999c).

e Water-to-tissue bioconcentration factor (EPA 1999c).

f Ingestion rate of animal tissue (EPA 1993).

g Food-to-tissue uptake factor for mammals and birds (EPA 1999c).

h Ingestion rate of soil (EPA 1993).

i Ingestion rate of water (EPA 1993).

j Body weight (EPA 1993).

k Calculated by solving exposure equations for predicted concentration in soil (C_s), sediment, (C_{sed}), or water (C_w) when the exposure dose equals the toxicity reference value (ED = TRV).

Key: NA, not applicable.

A.2.5.1 Hazards to Plants and Soil Invertebrates

Under all scenarios at both the depots, the highest HQ was 1.0 for plants in the case of a fire. Because the fire scenario is considered to be extremely unlikely and because the HQ is not above 1, risks to plants and soil invertebrates are considered to be negligible.

A.2.5.2 Hazards to Terrestrial Animals

No scenario caused an HQ above 1 for short-tailed shrews, but fire scenarios resulted in an HQ just below 1 for American robins. HQs for onsite exposure after earthquake or high winds were below 1, indicating that these unlikely events are unlikely to cause harm to insectivorous birds. In addition, insectivorous birds are unlikely to obtain all of their food onsite, and there is uncertainty that HQs close to 1 indicate harm to ecological populations.

Fire scenarios resulted in HQs above 1 for great blue herons. Other scenarios resulted in HQs near or below 1.

Table A–13. Hazard Quotients for Chronic Exposure of Ecological Receptors Under the No Action Alternative and Mercury Transfer Accident Scenarios at the New Haven Depot

		Plants[a]	Soil Inverte-brates[b]	Short-tailed Shrew[c]	American Robin[d]	Aquatic Biota[e]	Great Blue Heron[f]
1.0 No Action Alternative							
1.2 Storage, slow release	Onsite	3.61E-05	5.06E-06	3.19E-06	2.58E-05	2.63E-04	6.23E-05
	Offsite	3.61E-05	5.06E-06	3.19E-06	2.58E-05	2.63E-04	6.23E-05
1.3 Storage, breach of multiple flasks	Onsite	8.57E-03	1.20E-03	7.58E-04	6.12E-03	6.23E-02	1.48E-02
	Offsite	8.57E-03	1.20E-03	7.58E-04	6.12E-03	6.23E-02	1.48E-02
1.4 Handling, fire engulfing one pallet	Onsite	1.00E+00	1.40E-01	8.84E-02	7.14E-01	7.19E+00	1.70E+00
	Offsite	1.00E+00	1.40E-01	8.84E-02	7.14E-01	7.19E+00	1.70E+00
1.5 Handling, breach of one dropped flask	Onsite	3.61E-05	5.06E-06	3.19E-06	2.58E-05	2.63E-04	6.23E-05
	Offsite	3.61E-05	5.06E-06	3.19E-06	2.58E-05	2.63E-04	6.23E-05
1.6 Handling, breach of all flasks in pallet	Onsite	4.98E-03	6.97E-04	4.40E-04	3.56E-03	3.62E-02	8.58E-03
	Offsite	4.98E-03	6.97E-04	4.40E-04	3.56E-03	3.62E-02	8.58E-03
1.7 Handling, breach of all flasks in pallet	Onsite	4.98E-03	6.97E-04	4.40E-04	3.56E-03	3.62E-02	8.58E-03
	Offsite	4.98E-03	6.97E-04	4.40E-04	3.56E-03	3.62E-02	8.58E-03
2.0 Reflask into 76-lb Flasks							
2.1 Handling, fire engulfing one pallet	Onsite	1.00E+00	1.40E-01	8.84E-02	7.14E-01	7.19E+00	1.70E+00
	Offsite	1.00E+00	1.40E-01	8.84E-02	7.14E-01	7.19E+00	1.70E+00
2.2 Handling, breach of one dropped pallet	Onsite	4.98E-03	6.97E-04	4.40E-04	3.56E-03	3.62E-02	8.58E-03
	Offsite	4.98E-03	6.97E-04	4.40E-04	3.56E-03	3.62E-02	8.58E-03
2.3 Handling, breach of all flasks in pallet	Onsite	4.98E-03	6.97E-04	4.40E-04	3.56E-03	3.62E-02	8.58E-03
	Offsite	4.98E-03	6.97E-04	4.40E-04	3.56E-03	3.62E-02	8.58E-03
2.4 Reflasking, breach of single flask	Onsite	3.61E-05	5.06E-06	3.19E-06	2.58E-05	2.63E-04	6.23E-05
	Offsite	3.61E-05	5.06E-06	3.19E-06	2.58E-05	2.63E-04	6.23E-05
2.5 Reflasking, single flask spilled	Onsite	3.61E-05	5.06E-06	3.19E-06	2.58E-05	2.63E-04	6.23E-05
	Offsite	3.61E-05	5.06E-06	3.19E-06	2.58E-05	2.63E-04	6.23E-05
2.6 Staging after reflasking, release from single flask	Onsite	3.61E-05	5.06E-06	3.19E-06	2.58E-05	2.63E-04	6.23E-05
	Offsite	3.61E-05	5.06E-06	3.19E-06	2.58E-05	2.63E-04	6.23E-05
3.0 Reflask into 1-t Containers							
3.1 Handling, fire engulfing one pallet	Onsite	1.00E+00	1.40E-01	8.84E-02	7.14E-01	7.19E+00	1.70E+00
	Offsite	1.00E+00	1.40E-01	8.84E-02	7.14E-01	7.19E+00	1.70E+00
3.2 Handling, breach of all flasks in pallet	Onsite	4.98E-03	6.97E-04	4.40E-04	3.56E-03	3.62E-02	8.58E-03
	Offsite	4.98E-03	6.97E-04	4.40E-04	3.56E-03	3.62E-02	8.58E-03

Table A–13. Hazard Quotients for Chronic Exposure of Ecological Receptors Under the No Action Alternative and Mercury Transfer Accident Scenarios at the New Haven Depot (Continued)

		Plants[a]	Soil Inverte-brates[b]	Short-tailed Shrew[c]	American Robin[d]	Aquatic Biota[e]	Great Blue Heron[f]
3.3 Handling, breach of all flasks in pallet	Onsite	4.98E-03	6.97E-04	4.40E-04	3.56E-03	3.62E-02	8.58E-03
	Offsite	4.98E-03	6.97E-04	4.40E-04	3.56E-03	3.62E-02	8.58E-03
3.4 Reflasking, breach of one dropped flask	Onsite	3.61E-05	5.06E-06	3.19E-06	2.58E-05	2.63E-04	6.23E-05
	Offsite	3.61E-05	5.06E-06	3.19E-06	2.58E-05	2.63E-04	6.23E-05
3.5 Reflasking, single flask spilled	Onsite	3.61E-05	5.06E-06	3.19E-06	2.58E-05	2.63E-04	6.23E-05
	Offsite	3.61E-05	5.06E-06	3.19E-06	2.58E-05	2.63E-04	6.23E-05
3.6 Reflasking, 1-t container leak	Onsite	3.80E-03	5.32E-04	3.36E-04	2.71E-03	2.76E-02	6.55E-03
	Offsite	3.80E-03	5.32E-04	3.36E-04	2.71E-03	2.76E-02	6.55E-03
3.7 Staging after reflasking, 1-t container leak	Onsite	3.80E-03	5.32E-04	3.36E-04	2.71E-03	2.76E-02	6.55E-03
	Offsite	3.80E-03	5.32E-04	3.36E-04	2.71E-03	2.76E-02	6.55E-03
4.0 Natural Phenomena							
4.1 Evaluation-based earthquake	Onsite	2.75E-02	3.85E-03	2.43E-03	1.96E-02	2.00E-01	4.74E-02
	Offsite	2.75E-02	3.85E-03	2.43E-03	1.96E-02	2.00E-01	4.74E-02
4.2 High winds	Onsite	2.75E-02	3.85E-03	2.43E-03	1.96E-02	2.00E-01	4.74E-02
	Offsite	2.75E-02	3.85E-03	2.43E-03	1.96E-02	2.00E-01	4.74E-02

[a] Benchmark is 0.35 mg/kg.
[b] Benchmark is 2.50 mg/kg.
[c] Benchmark is 3.96 mg/kg.
[d] Benchmark is 0.490 mg/kg.
[e] Benchmark is 0.77 ug/L.
[f] Benchmark is 3.25 ug/L.

A.2.5.3 Hazards to Aquatic Biota

Airborne release of mercury to an onsite or offsite pond under most scenarios was predicted to cause HQs below 1, with a predicted HQ around 8 for release of mercury by a fire. The evaluation-based earthquake and high winds were predicted to cause HQs slightly above 1 for onsite aquatic biota at the Warren Depot. Breach of a single flask was not predicted to cause harm to aquatic biota.

A.2.6 ECOLOGICAL RISK ASSESSMENT UNCERTAINTY

Uncertainty is inherent in each step of the ecological risk assessment process. Major factors contributing to uncertainty in this risk assessment are discussed qualitatively in the following sections:

- Problem formulation

- Exposure assessment
- Effects assessment
- Risk characterization

Table A–14. Hazard Quotients for Chronic Exposure of Ecological Receptors Under the No Action Alternative and Mercury Transfer Accident Scenarios at the Warren Depot

		Plants[a]	Soil Inverte-brates[b]	Short-tailed Shrew[c]	American Robin[d]	Aquatic Biota[e]	Great Blue Heron[f]
1.0 No Action Alternative							
1.2 Storage, slow release	Onsite	2.13E-04	2.98E-05	1.88E-05	1.52E-04	1.55E-03	3.67E-04
	Offsite	5.55E-05	7.77E-06	4.91E-06	3.96E-05	4.04E-04	9.56E-05
1.3 Storage, breach of multiple flasks	Onsite	5.02E-02	7.03E-03	4.44E-03	3.59E-02	3.65E-01	8.65E-02
	Offsite	1.29E-02	1.80E-03	1.14E-03	9.18E-03	9.35E-02	2.22E-02
1.4 Handling, fire engulfing one pallet	Onsite	1.00E+00	1.40E-01	8.84E-02	7.14E-01	7.19E+00	1.70E+00
	Offsite	1.00E+00	1.40E-01	8.84E-02	7.14E-01	7.19E+00	1.70E+00
1.5 Handling, breach of one dropped flask	Onsite	2.13E-04	2.98E-05	1.88E-05	1.52E-04	1.55E-03	3.67E-04
	Offsite	5.55E-05	7.77E-06	4.91E-06	3.96E-05	4.04E-04	9.59E-05
1.6 Handling, breach of all flasks in pallet	Onsite	2.92E-02	4.09E-03	2.58E-03	2.09E-02	2.12E-01	5.03E-02
	Offsite	7.64E-03	1.07E-03	6.76E-04	5.46E-03	5.56E-02	1.32E-02
1.7 Handling, breach of all flasks in pallet	Onsite	2.92E-02	4.09E-03	2.58E-03	2.09E-02	2.12E-01	5.03E-02
	Offsite	7.64E-03	1.07E-03	6.76E-04	5.46E-03	5.56E-02	1.32E-02
2.0 Reflask into 76-lb Flasks							
2.1 Handling, fire engulfing one pallet	Onsite	1.00E+00	1.40E-01	8.84E-02	7.14E-01	7.19E+00	1.70E+00
	Offsite	1.00E+00	1.40E-01	8.84E-02	7.14E-01	7.19E+00	1.70E+00
2.2 Handling, breach of one dropped pallet	Onsite	2.92E-02	4.09E-03	2.58E-03	2.09E-02	2.12E-01	5.03E-02
	Offsite	7.64E-03	1.07E-03	6.76E-04	5.46E-03	5.56E-02	1.32E-02
2.3 Handling, breach of all flasks in pallet	Onsite	2.92E-02	4.09E-03	2.58E-03	2.09E-02	2.12E-01	5.03E-02
	Offsite	7.64E-03	1.07E-03	6.76E-04	5.46E-03	5.56E-02	1.32E-02
2.4 Reflasking, breach of single flask	Onsite	2.13E-03	2.98E-04	1.88E-04	1.52E-03	1.55E-02	3.67E-03
	Offsite	5.55E-05	7.77E-06	4.91E-06	3.96E-05	4.04E-04	9.56E-05
2.5 Reflasking, single flask spilled	Onsite	2.13E-04	2.98E-05	1.88E-05	1.52E-04	1.55E-03	3.67E-04
	Offsite	5.55E-05	7.77E-06	4.91E-06	3.96E-05	4.04E-04	9.56E-05
2.6 Staging after reflasking, release from single flask	Onsite	2.13E-04	2.98E-05	1.88E-05	1.52E-04	1.55E-03	3.67E-04
	Offsite	5.55E-05	7.77E-06	4.91E-06	3.96E-05	4.04E-04	9.56E-05
3.0 Reflask into 1-t Containers							
3.1 Handling, fire engulfing one pallet	Onsite	1.00E+00	1.40E-01	8.84E-02	7.14E-01	7.19E+00	1.70E+00
	Offsite	1.00E+00	1.40E-01	8.84E-02	7.14E-01	7.19E+00	1.70E+00
3.2 Handling, breach of all flasks in pallet	Onsite	2.92E-02	4.09E-03	2.58E-03	2.09E-02	2.12E-01	5.03E-02
	Offsite	7.64E-03	1.07E-03	6.76E-04	5.46E-03	5.56E-02	1.32E-02

3.3 Handling, breach of all flasks in pallet	Onsite	2.92E-02	4.09E-03	2.58E-03	2.09E-02	2.12E-01	5.03E-02
	Offsite	7.64E-03	1.07E-03	6.76E-04	5.46E-03	5.56E-02	1.32E-02

Table A–14. Hazard Quotients for Chronic Exposure of Ecological Receptors Under the No Action Alternative and Mercury Transfer Accident Scenarios at the Warren Depot (Continued)

		Plants[a]	Soil Inverte-brates[b]	Short-tailed Shrew[c]	American Robin[d]	Aquatic Biota[e]	Great Blue Heron[f]
3.4 Reflasking, breach of one dropped flask	Onsite	2.13E-04	2.98E-05	1.88E-05	1.52E-04	1.55E-03	3.67E-04
	Offsite	5.55E-05	7.77E-06	4.91E-06	3.96E-05	4.04E-04	9.56E-05
3.5 Reflasking, single flask spilled	Onsite	2.13E-04	2.98E-05	1.88E-05	1.52E-04	1.55E-03	3.67E-04
	Offsite	5.55E-05	7.77E-06	4.91E-06	3.96E-05	4.04E-04	9.56E-05
3.6 Reflasking, 1-t container leak	Onsite	2.24E-02	3.13E-03	1.98E-03	1.60E-02	1.63E-01	3.85E-02
	Offsite	5.84E-03	8.17E-04	5.16E-04	4.17E-03	4.24E-02	1.01E-02
3.7 Staging after reflasking, 1-t container leak	Onsite	2.24E-02	3.13E-03	1.98E-03	1.60E-02	1.63E-01	3.85E-02
	Offsite	5.84E-03	8.17E-04	5.16E-04	4.17E-03	4.24E-02	1.01E-02
4.0 Natural Phenomena							
4.1 Evaluation-based earthquake	Onsite	1.63E-01	2.28E-02	1.44E-02	1.16E-01	1.18E+00	2.81E-01
	Offsite	4.24E-02	5.94E-03	3.75E-03	3.03E-02	3.09E-01	7.31E-02
4.2 High winds	Onsite	1.63E-01	2.28E-02	1.44E-02	1.16E-01	1.18E+00	2.81E-01
	Offsite	4.24E-02	5.94E-03	3.75E-03	3.03E-02	3.09E-01	7.31E-02

[a] Benchmark is 0.35 mg/kg.
[b] Benchmark is 2.50 mg/kg.
[c] Benchmark is 3.96 mg/kg.
[d] Benchmark is 0.490 mg/kg.
[e] Benchmark is 0.77 ug/l.
[f] Benchmark is 3.25 ug/l.

A.2.6.1 Uncertainties in Problem Formulation

There is uncertainty about what substances may be released to environmental media under the proposed alternatives. In particular, the fraction of methyl mercury in dry soil may be overestimated. There is also uncertainty about what organisms potentially exposed at the storage sites or in the environs of accidental releases are at most risk. If more sensitive receptors are present at the depot, then they may not be adequately addressed by the assessment endpoints evaluated.

A.2.6.2 Uncertainties in Exposure Assessment

The receptor species listed as potentially present at the unit are a limited subset of the species that may utilize the area to some extent for at least a portion of the year. The species evaluated are considered to provide a conservative representation of the range of exposures that may be experienced by other species not evaluated.

In calculating constituent intakes, conservative exposure factors are assumed in order to be protective of all potential receptors. Low-end estimates of body weights and high-end estimates of ingestion rates are assumed in order to model the highest potential dose to the receptor. Conservatism also is employed in estimating bioavailability, and percent contaminated plant and animal materials in the diet. The conservative exposure factors and exposure concentrations used provide confidence that calculated intakes are reasonably conservative estimates for receptor populations. Intakes from dermal and inhalation exposures are not quantifiable for ecological receptors. However, this does not significantly increase the uncertainty of the estimated total intake because, for most receptors, intakes via these routes are likely to be minimal relative to intakes via ingestion.

A.2.6.3 Uncertainties in Effects Assessment

There is uncertainty associated with the toxicity reference values because the toxicity data are not site-specific. Limitations in toxicity values include variations in physiological or biochemical factors that may exist among species, behavioral and ecological parameters that may make species' sensitivity to a contaminant different from that of the test organism, and limited information on long-term effects on natural populations. In addition, most laboratory studies use highly bioavailable forms of chemicals during toxicity related derivations. Since most chemicals in nature are bound or associated with inorganic matrices or organics, many are not as bioavailable as the forms used in the laboratory studies. The combination of maximum intakes and conservative toxicity reference values provide confidence that the HQs resulting from the evaluation are conservative.

A.2.6.4 Uncertainties in Risk Characterization

Uncertainty in the risk characterization is a direct result of the methodology employed. The conservative methodology and assumptions used in the COPEC selection, exposure assessment, and toxicity assessment are expected to overestimate, rather than underestimate, the potential for COPECs to pose risk to assessment endpoints. By overestimating risk, the actual risk of deleterious effects is likely to be less than indicated by the calculated ecological quotients.

A.2.7 SITE-SPECIFIC AND ALTERNATIVE-SPECIFIC EVALUATION OF IMPACTS

The objective of the ecological risk assessment is to evaluate the likelihood that adverse ecological effects may occur as a result of exposure to mercury. Tables A–15 and A–16 present a summary of the likelihood of accidents and their consequences at the New Haven and Warren depots, respectively.

Low overall risks to aquatic biota and their predators at an onsite or offsite pond were predicted for an extremely unlikely forklift fire that consumes a pallet of flasks. These risks were the same for the No Action Alternative and both reflasking alternatives. Reflasking the mercury into 1-t (1.1-ton) containers presented similar risks as the No Action Alternative and reflasking into 76-lb (34-kg) flasks. Low overall risks to terrestrial biota and to aquatic biota and their predators at an onsite or offsite pond were predicted for accidents initiated by an earthquake or high winds.

In the unlikely event of an accident with the release of mercury outside the storage building, accident response could include evaluation of mercury concentrations in surrounding soil and surface water. Accident cleanup would likely include remediation of areas where mercury concentrations exceed soil and surface water quality criterion.

Table A–15. Risk Matrix for Ecological Receptors at the New Haven Depot

Activities	Postulated Accident Scenario	Frequency	Location	Terrestrial Receptors: Consequences (Max HQ)	Terrestrial Receptors: Consequence Level	Terrestrial Receptors: Risk	Aquatic Receptors: Consequences (Max HQ)	Aquatic Receptors: Consequence Level	Aquatic Receptors: Risk
1.0 No Action Alternative									
1.2 Storage, slow release	Slow leak/release of liquid mercury	H	Onsite	3.61E-05	N	N	2.63E-04	N	N
			Offsite	3.61E-05	N		2.63E-04	N	
1.3 Storage, breach of multiple flasks	Wooden pallets collapse resulting in breach of multiple flasks	M	Onsite	8.57E-03	N	N	6.23E-02	N	N
			Offsite	8.57E-03	N		6.23E-02	N	
1.4 Handling,fire engulfing one pallet	Fire involving forklift fuel system engulfs single pallet	L	Onsite	1.00E+00	L	L	7.19E+00	M	L
			Offsite	1.00E+00	L		7.19E+00	M	
1.5 Handling, breach of one dropped flask	Single flask dropped during handling resulting in breach	H	Onsite	3.61E-05	N	N	2.63E-04	N	N
			Offsite	3.61E-05	N		2.63E-04	N	
1.6 Handling, breach of all flasks in pallet	Single pallet dropped during handling resulting in breach	M	Onsite	4.98E-03	N	N	3.62E-02	N	N
			Offsite	4.98E-03	N		3.62E-02	N	
1.7 Handling, breach of all flasks in pallet	Forklift punctures flasks while moving pallet	M	Onsite	4.98E-03	N	N	3.62E-02	N	N
			Offsite	4.98E-03	N		3.62E-02	N	
2.0 Reflask into 76-lb Flasks									
2.1 Handling, fire engulfing one pallet	Fire involving forklift fuel system engulfs single pallet	L	Onsite	1.00E+00	L	L	7.19E+00	M	L
			Offsite	1.00E+00	L		7.19E+00	M	

2.2	Handling, breach of one dropped pallet	Single pallet dropped during handling resulting in breach	M	Onsite	4.98E-03	N	N	3.62E-02	N	N
				Offsite	4.98E-03	N		3.62E-02	N	
2.3	Handling, breach of all flasks in pallet	Forklift punctures flasks while moving pallet	M	Onsite	4.98E-03	N	N	3.62E-02	N	N
				Offsite	4.98E-03	N		3.62E-02	N	

Table A–15. Risk Matrix for Ecological Receptors at the New Haven Depot (Continued)

	Activities	Postulated Accident Scenario	Frequency	Location	Terrestrial Receptors: Consequences (Max HQ)	Terrestrial Receptors: Consequence Level	Terrestrial Receptors: Risk	Aquatic Receptors: Consequences (Max HQ)	Aquatic Receptors: Consequence Level	Aquatic Receptors: Risk
2.4	Reflasking, breach of single flask	Single flask dropped during reflasking resulting in breach	H	Onsite	3.61E-05	N	N	2.63E-04	N	N
				Offsite	3.61E-05	N		2.63E-04	N	
2.5	Reflasking, single flask spilled	Contents of single flask spilled during reflasking	H	Onsite	3.61E-05	N	N	2.63E-04	N	N
				Offsite	3.61E-05	N		2.63E-04	N	
2.6	Staging after reflasking, release from single flask	Slow leak/release of liquid mercury	M	Onsite	3.61E-05	N	N	2.63E-04	N	N
				Offsite	3.61E-05	N		2.63E-04	N	
3.0	**Reflask into 1-t Containers**									
3.1	Handling, fire engulfing one pallet	Fire involving forklift fuel system engulfs single pallet	L	Onsite	1.00E+00	L	L	7.19E+00	M	L
				Offsite	1.00E+00	L		7.19E+00	M	
3.2	Handling, breach of all flasks in pallet	Single flask dropped during handling resulting in breach	M	Onsite	4.98E-03	N	N	3.62E-02	N	N
				Offsite	4.98E-03	N		3.62E-02	N	
3.3	Handling, breach of all flasks in pallet	Forklift punctures flasks while moving pallet	M	Onsite	4.98E-03	N	N	3.62E-02	N	N
				Offsite	4.98E-03	N		3.62E-02	N	
3.4	Reflasking, breach of one dropped flask	Single flask dropped during reflasking resulting in breach	H	Onsite	3.61E-05	N	N	2.63E-04	N	N
				Offsite	3.61E-05	N		2.63E-04	N	
3.5	Reflasking, single flask spilled	Contents of single flask spilled during reflasking	H	Onsite	3.61E-05	N	N	2.63E-04	N	N
				Offsite	3.61E-05	N		2.63E-04	N	

3.6	Reflasking, 1-t container	Contents of 1-t container leak during reflasking	M	Onsite	3.80E-03	N	N	2.76E-02	N	N
				Offsite	3.80E-03	N		2.76E-02	N	

Table A–15. Risk Matrix for Ecological Receptors at the New Haven Depot (Continued)

Activities	Postulated Accident Scenario	Frequency	Location	Terrestrial Receptors: Consequences (Max HQ)	Terrestrial Receptors: Consequence Level	Terrestrial Receptors: Risk	Aquatic Receptors: Consequences (Max HQ)	Aquatic Receptors: Consequence Level	Aquatic Receptors: Risk
3.8 Staging after reflasking, 1-t container leak	Slow leak/release of liquid mercury	M	Onsite	3.80E-03	N	N	2.76E-02	N	N
			Offsite	3.80E-03	N		2.76E-02	N	
4.0 Natural Phenomena									
4.1 Evaluation-based earthquake	Earthquake results in building damage and causes pallets and/or mercury containers to fall	M	Onsite	2.75E-02	N	N	2.00E-01	L	L
			Offsite	2.75E-02	N		2.00E-01	L	
4.2 High winds	High winds result in roof failure and cause pallets and/or mercury containers to fall	M	Onsite	2.75E-02	N	N	2.00E-01	L	L
			Offsite	2.75E-02	N		2.00E-01	L	
4.3 Lightning strike	Lightning strike causes small building fire involving limited number of mercury containers	N	Onsite	N/A	N/A		N/A	N/A	
			Offsite	N/A	N/A		N/A	N/A	
4.4 Severe winter weather	Snow load causes roof collapse resulting in mercury containers falling	L	Onsite		N/A		N/A	N/A	
			Offsite		N/A		N/A	N/A	
5.0 External Events									
5.1 Aircraft crash	Aircraft crash into building resulting in fire, mercury container breach	N	Onsite	N/A	N/A		N/A	N/A	
			Offsite	N/A	N/A		N/A	N/A	
5.2 Vehicle crash	Vehicle or train crash into building resulting in mercury container breach	N	Onsite	N/A	N/A		N/A	N/A	

			Offsite	N/A	N/A		N/A	N/A	
5.3 Adjacent fire/explosion	Fire/explosion at nearby building impacts mercury containers	N	Onsite	N/A	N/A		N/A	N/A	
			Offsite	N/A	N/A		N/A	N/A	

Key: H, high; L, low; M, moderate; N, negligible; N/A, not applicable.

Table A–16. Risk Matrix for Ecological Receptors at the Warren Depot

				Terrestrial Receptors			Aquatic Receptors		
Activities	**Postulated Accident Scenario**	**Frequency**	**Location**	**Consequences (Max HQ)**	**Consequence Level**	**Risk**	**Consequences (Max HQ)**	**Consequence Level**	**Risk**
1.0 No Action Alternative									
1.2 Storage, slow release	Slow leak/release of liquid mercury	H	Onsite	2.13E-04	N	N	1.55E-03	N	N
			Offsite	5.55E-05	N		4.04E-04	N	
1.3 Storage, breach of multiple flasks	Wooden pallets collapse resulting in breach of multiple flasks	M	Onsite	5.02E-02	N	N	3.65E-01	L	N
			Offsite	1.29E-02	N		9.35E-02	N	
1.4 Handling, fire engulfing one pallet	Fire involving forklift fuel system engulfs single pallet	L	Onsite	1.00E+00	L	L	7.19E+00	M	L
			Offsite	1.00E+00	L		7.19E+00	M	
1.5 Handling, breach of one dropped flask	Single flask dropped during handling resulting in breach	H	Onsite	2.13E-04	N	N	1.55E-03	N	N
			Offsite	5.55E-05	N		4.04E-04	N	
1.6 Handling, breach of all flasks in pallet	Single pallet dropped during handling resulting in breach	M	Onsite	2.92E-02	N	N	2.12E-01	L	N
			Offsite	7.64E-03	N		5.56E-02	N	
1.7 Handling, breach of all flasks in pallet	Forklift punctures flasks while moving pallet	M	Onsite	2.92E-02	N	N	2.12E-01	L	N

				Offsite	7.64E-03	N		5.56E-02	N	
2.0 Reflask into 76-lb Flasks										
2.1	Handling, fire engulfing one pallet	Fire involving forklift fuel system engulfs single pallet	L	Onsite	1.00E+00	L	L	7.19E+00	M	L
				Offsite	1.00E+00	L		7.19E+00	M	
2.2	Handling, breach of one dropped pallet	Single pallet dropped during handling resulting in breach	M	Onsite	2.92E-02	N	N	2.12E-01	L	N
				Offsite	7.64E-03	N		5.56E-02	N	

Table A–16. Risk Matrix for Ecological Receptors at the Warren Depot (Continued)

				Terrestrial Receptors			Aquatic Receptors		
Activities	**Postulated Accident Scenario**	**Frequency**	**Location**	**Consequences (Max HQ)**	**Consequence Level**	**Risk**	**Consequences (Max HQ)**	**Consequence Level**	**Risk**
2.3 Handling, breach of all flasks in pallet	Forklift punctures flasks while moving pallet	M	Onsite	2.92E-02	N	N	2.12E-01	L	N
			Offsite	7.64E-03	N		5.56E-02	N	
2.4 Reflasking, breach of single flask	Single flask dropped during reflasking resulting in breach	H	Onsite	2.13E-03	N	N	1.55E-02	N	N
			Offsite	5.55E-05	N		4.04E-04	N	
2.5 Reflasking, single flask spilled	Contents of single flask spilled during reflasking	H	Onsite	2.13E-04	N	N	1.55E-03	N	N
			Offsite	5.55E-05	N		4.04E-04	N	
2.6 Staging after reflasking, release from single flask	Slow leak/release of liquid mercury	M	Onsite	2.13E-04	N	N	1.55E-03	N	N
			Offsite	5.55E-05	N		4.04E-04	N	
3.0 Reflask into 1-t Containers									
3.1 Handling, fire engulfing one pallet	Fire involving forklift fuel system engulfs single pallet	L	Onsite	1.00E+00	L	L	7.19E+00	M	L
			Offsite	1.00E+00	L		7.19E+00	M	
3.2 Handling, breach of all flasks in pallet	Single flask dropped during handling resulting in breach	M	Onsite	2.92E-02	N	N	2.12E-01	L	N
			Offsite	7.64E-03	N		5.56E-02	N	
3.3 Handling, breach of all flasks in pallet	Forklift punctures flasks while moving pallet	M	Onsite	2.92E-02	N	N	2.12E-01	L	N
			Offsite	7.64E-03	N		5.56E-02	N	
3.4 Reflasking, breach of one dropped flask	Single flask dropped during reflasking resulting in breach	H	Onsite	2.13E-04	N	N	1.55E-03	N	N

				Offsite	5.55E-05	N		4.04E-04	N	
3.5	Reflasking, single flask spilled	Contents of single flask spilled during reflasking	H	Onsite	2.13E-04	N	N	1.55E-03	N	N
				Offsite	5.55E-05	N		4.04E-04	N	

Table A–16. Risk Matrix for Ecological Receptors at the Warren Depot (Continued)

Activities	Postulated Accident Scenario	Frequency	Location	Terrestrial Receptors: Consequences (Max HQ)	Terrestrial Receptors: Consequence Level	Terrestrial Receptors: Risk	Aquatic Receptors: Consequences (Max HQ)	Aquatic Receptors: Consequence Level	Aquatic Receptors: Risk
3.6 Reflasking, 1-t container leak	Contents of 1-t container leak during reflasking	M	Onsite	2.24E-02	N	N	1.63E-01	L	N
			Offsite	5.84E-03	N		4.24E-02	N	
3.8 Staging after reflasking, 1-t container leak	Slow leak/release of liquid mercury	M	Onsite	2.24E-02	N	N	1.63E-01	L	N
			Offsite	5.84E-03	N		4.24E-02	N	
4.0 Natural Phenomena									
4.1 Evaluation-based earthquake	Earthquake results in building damage and causes pallets and/or mercury containers to fall	M	Onsite	1.63E-01	L	L	1.18E+00	L	L
			Offsite	4.24E-02	N		3.09E-01	L	
4.2 High winds	High winds result in roof failure and cause pallets and/or mercury containers to fall	M	Onsite	1.63E-01	L	L	1.18E+00	L	L
			Offsite	4.24E-02	N		3.09E-01	L	

Key: H, high; L, low; M, moderate; N, negligible; N/A, not applicable.