7.0 SCREENING AND BASELINE ECOLOGICAL RISK ASSESSMENT

An ERA defines the likelihood of harmful effects on plants and animals as a result of exposure to chemical constituents. There are two types of ERAs: screening and baseline. A SERA depends on available site data and is conservative in all regards. A baseline ecological risk assessment (BERA) requires even more site-specific exposure and effects information, including such measurements as body burden measurements and bioassays, and often uses less conservative assumptions. A SERA or equivalent is needed to evaluate the possible risk to plants and wildlife from current and future exposure to contamination at Load Line 2. A BERA will follow completion of the SERA.

The initial regulatory guidance for an ERA is contained in EPA's *Risk Assessment Guidance for Superfund (RAGS), Volume II, Environmental Evaluation Manual* (EPA 1989b) and in subsequent documents (EPA 1991b, 1992c). Further discussion on the scientific basis for assessing ecological effects and risk is presented in *Ecological Assessments of Hazardous Waste Sites: A Field and Laboratory Reference Document* (EPA 1989c). Other early 1990s guidance is provided in the *Framework for Ecological Risk Assessment* (EPA 1992c). A second generation of guidance consists of the *Procedural Guidance for Ecological Risk Assessments at U.S. Army Exposure Units* (Wentsel et al. 1994) and in its replacement, the *Tri-Service Procedural Guidelines for Ecological Risk Assessments* (Wentsel et al. 1996). In addition, the recently published *Ecological Risk Assessment Guidance* (EPA 1997c, 1998b) supersedes *RAGS, Volume II* (EPA 1989b). This latter guidance makes the distinction between the interrelated roles of screening and baseline ERAs. Briefly, SERAs utilize conservative assumptions for exposures and effects, while BERAs mean increasingly unit-specific, more realistic (and generally less conservative) exposures and effects. Newly published EPA guidance (EPA 1997c) was used because it provided the clearest information on preliminary SERAs. The Army has a protocol for site-wide ERA at RVAAP. One of the cardinal points in this document is the value of extrapolation from one AOC to another. For example, extrapolation of findings at Load Line 1 to Load Line 2 is an important time-and cost-saving activity. Additionally, the Ohio EPA has guidance, and that too is being used, especially for the hierarchy for ecological screening values (ESVs) and toxicity reference values (TRVs) (Ohio EPA 2003). Emphasis was placed on Level I, Level II (SERA), and Level III (BERA).

These documents discuss an overall approach to considering ecological effects and to identifying sources of information necessary to perform ERAs. However, they do not provide all the details. Thus, professional knowledge and experience are important in ERAs to compensate for this lack of specific guidance and established methods. This professional experience comes from a team of risk scientists, who are representatives from RVAAP, USACE, Ohio EPA, and SAIC.

The following sections present the scope and objectives of SERA activities (Section 7.1); the procedural framework (Section 7.2); and the four steps to complete the screening and extrapolation work, hereafter referred to as the SERA, with emphasis on problem formulation (Section 7.3). The results are presented in Section 7.4. Finally, there is an Uncertainties section (Section 7.5) and a Summary (Section 7.6) that comprise the final two sections of the SERA.

For the BERA or Tier III, the following sections present the scope and objectives (Sections 7.7), the procedural framework (Section 7.8), and the problem formulation (Section 7.9). The results are presented in Section 7.10. There is an uncertainties section (Section 7.11) and a master summary of both extrapolated HQs from Load Line 1 and BERA results (Section 7.12).

7.1 SCOPE AND OBJECTIVES FOR SCREENING ECOLOGICAL RISK ASSESSMENT

The scope of the SERA is to characterize, in a preliminary way, the risk to plant and animal populations at Load Line 2, including its aquatic environments, from analytes that are present in the surface soil, sediment, and surface water. This is done for both current and future conditions. Unlike the BERA, which focuses on individuals, the SERA focuses on populations or groups of interbreeding individuals. In the SERA process, individuals are addressed only if they are protected under the Endangered Species Act.

The SERA used site-specific analyte concentration data for surface soil, sediment, and surface water from various geographical parts of Load Line 2. Deep groundwater is not a medium of concern for ecological receptors. However, shallow groundwater is expected to flow into the drainage ditches and ponds on Load Line 2. Groundwater is treated as surface water once it surfaces and mixes with existing surface water. Risks to ecological receptors that could be exposed to the media were evaluated by performing a multi-step screening process in which, after each step, the detected analytes in the media were either eliminated from further consideration and deemed to pose negligible risk or carried forward to the next step in the screening process to a final conclusion of being a chemical of potential ecological concern (COPEC). COPECs are analytes whose concentrations are great enough to pose potential adverse effects to ecological receptors. The screening steps are described in detail in Section 7.3.4. COPECs are usually the starting point for more definitive BERAs. The Army conducted ground-truthing investigations of plants and animals at WBG near Load Line 2 (SAIC 2002), and completed a draft final SERA for Load Line 1. These documents provided some of the framework for this SERA for Load Line 2. However, the screening process for surface soil at Load Line 2 is different from the process that was utilized for Load Line 1, per scope changes advanced by the Army, and as described below in Section 7.3.4.

7.2 PROCEDURAL FRAMEWORK FOR SCREENING ECOLOGICAL RISK ASSESSMENT

According to the *Framework for Ecological Risk Assessment* (EPA 1992c), the SERA process consists of three interrelated phases: problem formulation, analysis (composed of exposure assessment and ecological effects assessment), and risk characterization. In conducting the SERA for Load Line 2, these three phases were partially completed by performing four interrelated steps. Each has the following parts.

- **Problem Formulation:** Problem formulation establishes the goals, breadth, and focus of the SERA and provides a characterization (screening step) of chemical stressors (chemicals that restrict growth and reproduction or otherwise disturb the balance of ecological populations and systems) present in the various habitats at the site. The problem formulation step also includes a preliminary characterization of the components, especially the receptor species, in the ecosystem likely to be at risk. It can also include the selection of assessment and measurement endpoints as a basis for developing a conceptual model of stressors, components, and effects (Section 7.3).

- **Exposure Assessment:** Exposure assessment defines and evaluates the concentrations of the chemical stressors. It also describes the ecological receptors and defines the route, magnitude, frequency, duration, and spatial pattern of the exposure of each receptor population to a chemical stressor (Section 7.4).

- **Effects Assessment:** Effects assessment evaluates the ecological response to chemical stressors in terms of the selected assessment and measurement endpoints. The effects assessment results in a profile of the ecological response of populations of plants and animals to the chemical concentrations or doses and to other types and units of stress to which they are exposed. Data from both field observations and controlled laboratory studies are used to assess ecological effects (Section 7.4).

- **Risk Characterization:** Risk characterization integrates exposure and effects or the response to chemical stressors on receptor populations using HQs, which are ratios of exposure to effect. The results are used to define the risk from contamination at Load Line 2, in contrast to background (naturally occurring) risk, and to assess the potential for population and ecosystem recovery based on Load Line 1 findings (Section 7.4).

The SERA is organized by the four interrelated steps of the EPA framework. Sections 7.3 and 7.4 detail the technical issues and data evaluation procedures associated with each step. Section 7.5 evaluates the degree of reliability or uncertainty of these methodological steps and the data used. Finally, Section 7.6 provides the summary.

7.3 PROBLEM FORMULATION FOR SCREENING ECOLOGICAL RISK ASSESSMENT

The first step of EPA's approach to the SERA process, problem formulation (data collection and evaluation), includes:

- determination of the scope of the assessment (as discussed in Section 7.1);
- formulation of an ecological CSM of Load Line 2 based on existing information and reasonable assumptions, including habitats, populations, and any threatened and endangered (T&E) species (Section 7.3.1);
- selection of EUs (Section 7.3.2);
- descriptions of habitats, biota, and T&E species (Section 7.3.3); and
- identification of preliminary COPECs (Sections 7.3.4 and 7.3.5).

7.3.1 Ecological Conceptual Site Model

The ecological CSM of Load Line 2 has been developed for the SERA using available site-specific information and professional judgment. The constituent source, exposure media, receptors, and the routes by which they are exposed to constituents are described below. Figure 7-1 shows the ecological CSM. Each part is briefly explained below.

- **Constituent Source and Source Media.** Constituent sources at Load Line 2 were defined in the introductory sections of this RI report. Chemical constituents from these sources are now present in surface soil, sediment, and surface water. Groundwater is shown in the CSM for the sake of completeness.
- **Release Mechanisms.** These mechanisms include plant/animal uptake and, to a lesser extent, volatilization. Leaching to surface water and to groundwater may be an additional release mechanism.
- **Exposure Media.** Sufficient time (more than 10 years) has elapsed for the soil and sediment constituents in original sources to have migrated to potential exposure media, resulting in possible exposure of plants and animals that come into contact with these media.

Sediment and surface water are also present in the creeks, drainage ditches, and small ponds at Load Line 2. Groundwater is not considered an exposure medium because ecological receptors are unlikely to contact

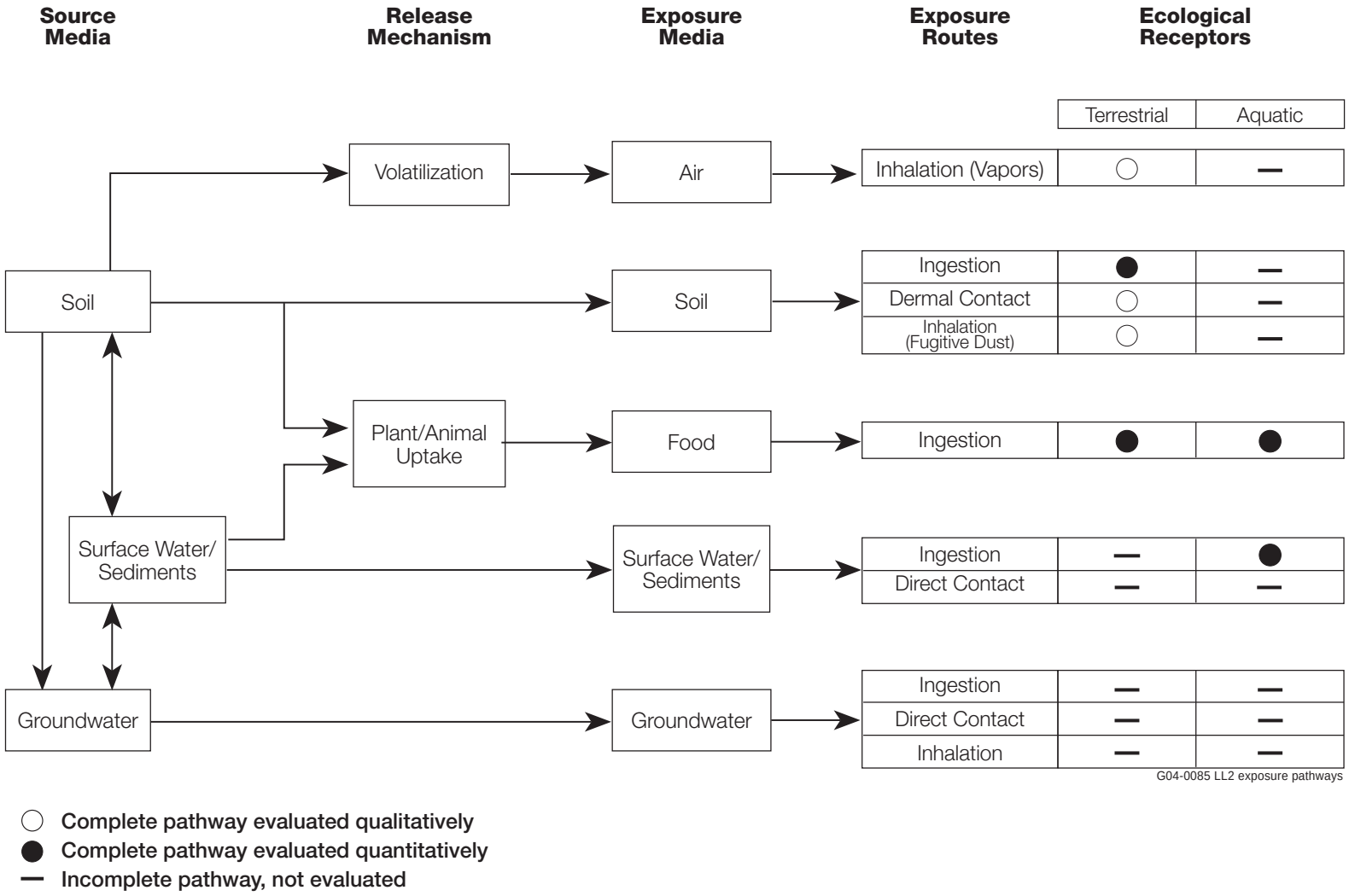


Figure 7-1. Exposure Pathways for Terrestrial and Aquatic Receptors

groundwater at its depth of greater than 5 ft bgs. Groundwater, once it surfaces, is assumed to be the same as surface water where a complete pathway is possible. Air is not considered an exposure medium because potential volatile organics are believed to have dissipated. Thus, surface soil, sediment, surface water (for direct exposure), and biota (e.g., indirect exposure via the food chain) were retained as the exposure media for this SERA.

Exposure Routes. Terrestrial animals potentially may come into contact with soil by means of incidental ingestion, dermal contact, and inhalation of dust. Aquatic organisms are exposed directly from the sediment and water.

Ingestion of soil and biota by animals are two complete exposure routes evaluated quantitatively for terrestrial animals. The exposure of animals to constituents in soil by dermal contact and inhalation is likely to be a small fraction of these two routes. Furthermore, the available toxicity data are almost exclusively for the ingestion pathway (Sample et al. 1996). By contrast, direct exposure to constituents in surface soil, sediment, and surface water are complete pathways for plants and earthworms, sediment-dwelling organisms, and fish, respectively. A complete exposure route is contact of biota with soils at Load Line 2. Plants are exposed directly by root uptake from soil and serve as throughputs to animals. The exposure pathways are evaluated quantitatively using site measurements and published exposure parameters.

Ecological Receptors. Terrestrial and aquatic animal receptors are recognized in the ecological CSM (Figure 7-1).

7.3.2 Selection of Exposure Units

From the ecological assessment viewpoint, an EU is the investigation area and some of the surrounding area where ecological receptors are likely to gather food, seek shelter, reproduce, and move around. As a result of these activities, ecological receptors potentially are exposed to the site constituents. However, for this SERA, the EU is defined on the basis of the historical use of various processes: receiving, handling, and shipping. The spatial boundaries of the ecological EUs are the same as the spatial boundaries of aggregates defined for nature and extent, fate and transport, and the human health risk assessment (Figure 4-1). These proposed EUs for Load Line 2 are as follows.

Terrestrial EUs:

- Explosive Handling Areas Aggregate,
- Preparation and Receiving Areas Aggregate,
- Packaging and Shipping Areas Aggregate,
- Perimeter Area Aggregate, and
- North Ditches Aggregate.

Sediment EUs:

- Kelly's Pond and Exit Drainages Aggregate, and
- North Ponds Aggregate.

Surface Water EU:

- Kelly's Pond and Exit Drainages Aggregate.

The distinction between EUs is based on location and history of the units. Each of the EUs is spatially separated. The exact history of waste applications and spills at each EU is uncertain. This uncertainty regarding waste applications and spills provides further justification for the distinction between the EUs.

7.3.3 Description of Habitats and Populations

This section provides a description of the ecological resources at Load Line 2. Habitats and plant communities are discussed in Section 7.3.3.1, animals are discussed in Section 7.3.3.2, aquatic habitats are discussed in Section 7.3.3.3, and protected species are discussed in Section 7.3.3.4. All of this information shows that Level I in the Ohio EPA guidance is met. There are ecological resources present in the form of vegetation and animal life in both terrestrial and aquatic ecosystems. Thus, Level II was justified.

7.3.3.1 Plant community types

The Load Line 2 AOC occupies a total area of about 216 acres (Table 7-1). This area includes forests and woodlands, shrublands, grasslands, wetlands, old railroad beds, paved and unpaved roads, and buildings. The vegetated areas provide habitat for the many plants and animals at Ravenna. Information on plant communities at Load Line 2 was gleaned from the *Plant Community Survey For The Ravenna Army Ammunition Plant* (SAIC 1999). The RVAAP plant community survey was based on a combination of color infrared and black-and-white aerial photogrammetry available from the mid-1990s and field surveys conducted in 1998 and 1999.

Table 7-1. Plant Communities and Other Habitat Recorded at Load Line 2

Plant Community Type	Acres	Area (%)
Forest Formations		
Pine Plantations	5.98	2.8
Fagus grandifolia - *Acer saccharum* - (*Liriodendron tulipifera*) Forest Alliance	11.69	5.4
Acer rubrum Successional Forest	45.74	21.2
Fraxinus pennsylvanica - *Ulmus americana* - *Celtis* (*occidentalis, laevigata*) Temporarily Flooded, Forest Alliance	21.83	10.1
Shrubland Formations		
Dry, Mid-successional, Temperate, Cold-deciduous Shrubland	30.41	14.1
Dry, Late-successional, Temperate, Cold-deciduous Shrubland	29.89	13.8
Herbaceous Formations		
Dry, Early Successional, Herbaceous Field	63.67	29.4
Buildings	7.03	3.3
Total	216.24	100.0

Forest formations

Forest formations at RVAAP correspond to plant communities with closed tree canopies. Forest formations occupy approximately 13,330 acres at RVAAP. Note that some areas at RVAAP contain plant communities dominated by tree species, but intermixed with patches of shrubs as a result of past disturbance. The following types of forest formations occur at the Load Line 2 AOC.

Pine plantations (planted timber stands). The plantation community type is characterized by nearly pure stands of eastern white pine (*Pinus strobus*), usually planted in rows. The forest canopy is closed and very little herbaceous vegetation is present on the forest floor. This community is a relatively minor component of the RVAAP forests. At Load Line 2, it occurs in the northwestern corner of the AOC

between the Load Line 2 road and the railroad tracks. This community occurs in a very small area of the Load Line 2 AOC, covering about 6 acres or 2.8% of the total area of the AOC (Table 7-1).

Lowland or submontane cold-deciduous forests

***Fagus grandifolia* - *Acer saccharum* - (*Liriodendron tulipifera*) Forest alliance.** This forest alliance describes a diverse community common to mesic, gently sloping sites throughout the east-central United States and southern Canada. At RVAAP, many of the most mature upland stands correspond to this alliance. American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*) dominate the canopy. Other common trees include yellow-poplar (*Liriodendron tulipifera*), northern red oak (*Quercus rubra*), white ash (*Fraxinus americana*), black cherry (*Prunus serotina*), American basswood (*Tilia americana*), various hickories (*Carya* spp.), and occasionally white oak (*Quercus alba*). Shrub and herbaceous species are generally sparse, probably as a result of heavy browsing by deer. Spicebush (*Lindera benzoin*), American hornbeam (*Carpinus caroliniana*), and eastern hop-hornbeam (*Ostrya virginiana*) were frequently observed in the understory. Mayapple (*Podophyllum peltatum*) and New York fern (*Thelypteris noveboracensis*) were frequently observed in the herbaceous layer. This community is located along the east-central side of Load Line 2 near the intersection of Remalia Road and the main Load Line 2 access road. This forest type makes up about 12 acres or 5.4% of the Load Line 2 AOC (Table 7-1).

***Acer rubrum* Successional forest.** This transitional forest community is very common at RVAAP. It is characterized by a high abundance of red maple (*Acer rubrum*) often in nearly pure stands. Green ash (*Fraxinus pennsylvanica*), white ash (*Fraxinus americana*), black cherry (*Prunus serotina*), and sugar maple (*Acer saccharum*) often are present, but never dominant. In some cases, the canopy is very dense and little to no ground cover is present. In other cases, the canopy is somewhat open and old field species such as blackberry (*Rubus allegheniensis*), goldenrod (*Solidago* spp.), dogbane (*Apocynum cannabinum*), and self-heal or heal-all (*Prunella vulgaris*) form a dense herbaceous layer. In general, stand age is fairly even. This forest type is located throughout the Load Line 2 AOC; it makes up about 46 acres or 21.2% of the Load Line 2 AOC (Table 7-1).

Seasonally flooded, cold-deciduous forest

***Fraxinus pennsylvanica* - *Ulmus americana* - *Celtis* (*occidentalis, laevigata*) Temporarily flooded forest alliance.** This forest alliance is associated with floodplains near streams and rivers and other temporarily flooded areas. Some of these areas may qualify as jurisdictional wetlands. Characteristic tree species include green ash (*Fraxinus pennsylvanica*), American elm (*Ulmus americana*), hackberry (*Celtis occidentalis*), and red maple (*Acer rubrum*). Black walnut (*Juglans nigra*), white ash (*Fraxinus americana*), swamp white oak (*Quercus bicolor*), cottonwood (*Populus deltoides*), and black willow (*Salix nigra*) also are present. Sycamore (*Platanus occidentalis*) and silver maple (*Acer saccharinum*), two species often associated with floodplain forests, generally are not abundant at RVAAP. The understory and shrub layers are dense and include species such as American elm, northern arrowwood (*Viburnum recognitum*), silky dogwood (*Cornus amomum*), elderberry (*Sambucus canadensis*) and willows (*Salix* spp.). Herbaceous species include wingstem (*Verbesina alternifolia*), jewelweed (*Impatiens biflora* and *I. pallida*), false nettle (*Boehmeria cylindrica*), jack-in-the-pulpit (*Arisaema triphyllum*), smartweeds (*Polygonum* spp.), sedges (*Carex* spp.), and many others. At Load Line 2, an example of this community is located north of the intersection of Remalia Road and the interior Load Line 2 access road along the east-central side of the AOC. This forest type makes up about 22 acres or 10.1% of the Load Line 2 AOC (Table 7-1).

Shrubland formations

Shrubland formations at RVAAP correspond to plant communities where the dominant life form is shrub. The term shrub corresponds to both true shrub species and young tree species (seedlings and saplings).

For example, successional areas at RVAAP that contain young trees or young trees mixed with shrubs were classified as shrubland if the majority of the vegetation did not exceed 20 ft in height. Note that many areas at RVAAP that were classified as shrubland are successional areas comprised mostly of young trees mixed with shrubs (i.e., mature old fields). Without disturbance, many of these areas will probably develop into young forest communities within approximately 5 to 15 years. The following types of shrubland formations occur at the Load Line 2 AOC.

Dry, mid-successional, temperate, cold-deciduous shrubland. The dry, mid-successional, temperate, cold-deciduous, shrubland community describes a plant grouping at RVAAP that is frequently encountered in previously disturbed areas (e.g., former agricultural fields and other disturbed areas) that have had sufficient recovery time for invasion by shrub species. This community is present throughout the Load Line 2 AOC covering large (> 10 acres), as well smaller areas (< 1 acre). It is characterized by shrub species covering more than 50% of the area with relatively few large trees (~20 ft in height). Common shrub species include gray dogwood (*Cornus racemosa*), northern arrowwood (*Viburnum recognitum*), blackberry (*Rubus allegheniensis*), hawthorn (*Crataegus* spp.), and multiflora rose (*Rosa multiflora*). Typical pioneer tree species include red maple (*Acer rubrum*), wild black cherry (*Prunus serotina*), white ash (*Fraxinus americana*), and black locust (*Robinia pseudoacacia*). A dense herbaceous community is present with common species such as goldenrod (*Solidago* spp.), dogbane (*Apocynum cannabinum*), self-heal or heal-all (*Prunella vulgaris*), yarrow (*Achillea millefolium*), strawberry (*Fragaria virginiana*), black-eyed Susan (*Rudbeckia hirta*), sheep sorrel (*Rumex acetosella*), and fescue grasses (*Festuca* spp., mostly *Festuca arundinacea*). This community represents an advanced stage of an "Old Field Community." This shrubland formation makes up about 30 acres or 14.1% of the Load Line 2 AOC (Table 7-1).

Dry, late-successional, cold-deciduous shrubland. This community is a more advanced stage of the dry, mid-successional, cold-deciduous shrubland. At this stage, young pioneer trees generally less than 20 ft in height are dominant. Common species include red maple (*Acer rubrum*), wild black cherry (*Prunus serotina*), white ash (*Fraxinus americana*), and black locust (*Robinia pseudoacacia*). Shrub and herbaceous species are still present although to a lesser extent than in younger stages of the Old Field Community. An example of this community is located in the central portion of Load line 2. This shrubland formation makes up about 30 acres or 13.8% of the Load Line 2 AOC (Table 7-1).

Herbaceous vegetation formations

Herbaceous formations at RVAAP correspond to plant communities where the dominant life form is herbaceous (non-woody). Herbaceous formations occupy approximately 3,400 acres at RVAAP. The following types of herbaceous vegetation formations occur at the Load Line 2 AOC.

Dry, early successional, herbaceous field. This community describes a frequent plant grouping at RVAAP that is present in recently disturbed areas that have not had sufficient recovery time for significant invasion by shrub species. It is characterized by a dense herbaceous community with common species including goldenrod (*Solidago* spp.), clasping-leaf dogbane (*Apocynum cannabinum*), self-heal or heal-all (*Prunella vulgaris*), yarrow (*Achillea millefolium*), strawberry (*Fragaria virginiana*), black-eyed Susan (*Rudbeckia hirta*), sheep sorrel (*Rumex acetosella*), and fescue grasses (*Festuca* spp., mostly *Festuca arundinacea*). Young shrubs frequently are present, but cover less than 50% of the area. Trees are rare. Common shrub species include gray dogwood (*Cornus racemosa*), northern arrowwood (*Viburnum recognitum*), blackberry (*Rubus allegheniensis*), and multiflora rose (*Rosa multiflora*). This herbaceous formation makes up about 64 acres or 29.4% of the Load Line 2 AOC (Table 7-1).

***Nuphar lutea* - *Nymphaea odorata* Permanently flooded, herbaceous alliance.** This alliance occurs in permanently flooded areas such as shallow ponds or lakes with depths generally less than 1.5 ft. Wetland plants such as spatterdock (*Nuphar lutea*) and white water lily (*Nymphaea odorata*) dominate the

community. At RVAAP ponds, spatterdock is much more common than white water lily. Duckweed species (*Lemna* spp.) and pondweed species (*Potamogeton* spp.) also are common. An example of this alliance occurs in the ponds just outside the northeast corner of the AOC. Although this formation does not actually occur within the Load Line 2 AOC, it is included because the ponds were identified as potential exposure points. This formation makes up about 2.5 acres in the vicinity of Load Line 2 AOC.

Buildings. There are several buildings still standing within the Load Line 2 AOC. These areas occupy a total of about 7.03 acres or 3.3% of the Load Line 2 AOC (Table 7-1).

7.3.3.2 Forestry resources, management, and unique habitats

Load Line 2 is within Forest Management Compartment 7 of the 10 compartments designated within the RVAAP and Compartment 7 has a total area of 2,860 acres. While each compartment is further subdivided into cutting units, the cutting unit boundaries reflect topographic features (e.g., creeks and roads) rather than forest types. Of Compartment 7's total area, 2,046 acres are in sawtimber (994 acres), poletimber (681 acres), and timber stands considered to be of adequate regeneration (371 acres). No specific timber stand improvement prescriptions are currently in place for Forest Management Compartment 7, although limited harvesting is scheduled as sawtimber clearing for powerline right-of-way maintenance. The timber harvest schedule for RVAAP forests shows Forest Management Compartment 7 being harvested during 2008 with an expected allowable harvest of over 600,000 board ft (Doyle Rule) (OHARNG 2001, Morgan 2003a).

Sensitive habitats and special interest areas

The Ohio Department of Natural Resources (ODNR) and the U.S. Fish and Wildlife Service did not identify any sensitive habitats on or near Load Line 2 during their natural heritage data searches (OHARNG 2001). No Special Interest Areas have been designated within or include any portion of Load Line 2 (OHARNG 2001, Morgan 2003a). Special Interest Areas include communities that host state-listed species, are representative of historic ecosystems, or are otherwise noteworthy (OHARNG 2001).

Jurisdictional wetlands

There have been two jurisdictional delineations performed in recent years at RVAAP to support National Environmental Protection Agency requirements of specific project proposals. All of these maps and delineations are on file in the RTLS Environmental Office (OHARNG 2001). No wetland delineations have been performed on the AOCs (Morgan 2003b). However, it is probable that jurisdictional wetlands would be found within Load Line 2 if a jurisdictional delineation were to be performed (Morgan 2003b).

7.3.3.3 Animal populations

The plant communities at RVAAP and Load Line 2 provide habitat that supports many species of animals. For RVAAP, results of 1992-1993 ODNR surveys included 27 mammals, 154 birds, 12 reptiles, 19 amphibians, 47 fish (including 6 hybrids), 4 crayfish, 17 mussels and clams, 11 aquatic snails, 26 terrestrial snails, 37 damselflies and dragonflies, 58 butterflies, and 485 moths. Several game species, such as deer, are managed through hunts scheduled during the fall months (ODNR 1997).

The plant communities within the Load Line 2 AOC provide habitats that support many of the below mentioned species of animals. Nearly 60% of the Load Line 2 AOC is covered by open habitats (shrublands and herbaceous fields). Based on RVAAP-wide studies, common bird species that use the late-stage successional habitats include the song sparrow (*Melospiza melodia*), common yellowthroat (*Geothylpis trichas*), gray catbird (*Dumetella carolinensis*), rufous-sided towhee (*Pipilo erythrophthalmus*), American goldfinch (*Carduelis tristis*), and blue-winged warbler (*Vermivora pinus*). Common large mammals

include white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), and woodchuck (*Marmota monax*), while eastern cottontail (*Sylvilagus floridanus*), white-footed mouse (*Peromyscus leucopus*), short-tailed shrew (*Blarina brevicauda*), and meadow vole (*Microtus pennsylvanicus*) are common small mammals (ODNR 1997).

Woodland bird species, such as the wood thrush (*Hylocichla mustlina*), are likely to be found within the small beech-maple-yellow poplar stand along the east side of the AOC. This woodlot and its edges also provide habitat for species such as the red-eyed vireo (*Vireo olivaceous*), yellow-throated vireo (*Vireo flavifrons*), eastern wood-pewee (*Contopus virens*), and Acadian flycatcher (*Empidonax virescens*) in addition to permanent residents typified by the tufted titmouse (*Parus bicolor*), black-capped chickadee (*Parus atricapillus*), American crow (*Corvus brachyrhynchos*), bluejay (*Cyanocitta cristata*), and red-bellied (*Melanerpes carolinus*) and downy (*Picoides pubescens*) woodpeckers (ODNR 1997).

The ponds and associated riparian habitat support several animal species. Common wetland birds found are red-winged blackbirds (*Agelaius phoeniceus*), great blue herons (*Ardea herodias*), tree swallows (*Tachycineta bicolor*), wood ducks (*Aix sponsa*), and mallards (*Anas platyrhynchos*). Muskrat (*Ondatra zibethicus*) are likely inhabitants of most ponds (ODNR 1997).

7.3.3.4 Aquatic habitats

Aquatic EUs consist of perennial streams and a settling pond. There are other water bodies, especially ditches, but they are not full-fledged EUs because they are ephemeral.

Streams and ditches

A total of six drainage ditch channels are located within the Load Line 2 AOC. Three drainage ditch channels, comprising the North Ditches Aggregate, drain surface water from the northern two-thirds of the site and three channels, comprising the South Ditches Aggregate, drain the southern one-third of the site. The approximate lengths of these drainage ditch channels are as follows: north/east 4,000 ft, north/middle 4,000 ft, and north/west 3,750 ft. The approximate length of the south/east ditch is 3,500 ft; the south/middle is 1,750 ft; and the south/west ditch is 750 ft. The drainage ditch channels at Load Line 2 receive storm water runoff from surrounding areas, as well as from Load Line 2. These drainage ditches are dry except during precipitation events.

Ponds

The North Ponds Aggregate and Kelly's Pond and Exit Drainages Aggregate will also be evaluated as part of this facility's surface water investigation. The facility surface water investigation is intended to systematically document the presence/absence of Ravenna site-specific contaminants at defined locations and any movement of those contaminants from AOCs to other locations, including off-site.

The North Ponds Aggregate, comprising a series of four ponds, lies just outside the northern boundary of this AOC. These ponds are 0.45 acres, 0.7 acres, 0.24 acres, and 1.12 acres in size, respectively, beginning with the pond in the northeast quadrant of the four ponds and continuing clockwise. The Kelly's Pond and Exit Drainages Aggregate is located just 600 ft south of the southern tip of the AOC and south of South Service Road. Kelly's Pond proper covers about 1.4 acres. An additional 750 to 1,000 linear ft of aquatic habitat exists within the exit drainage channel that flows east from Kelly's Pond toward, and then along, State Route 5.

Currently, no specific information exists about the fish communities of the North Ponds. In general, there are 13 fish species associated with the ponds at RVAAP and include bluegill (*Lepomis macrochirus*),

green sunfish (*Lepomis cyanellus*), pumpkinseed (*Lepomis gibbosus*) and warmouth (*Lepomis gulosus*) sunfish, largemouth bass (*Micropterus salmoides*), grass pickerel (*Esox americanus vermicula*), mudminnow (*Umbra limi*), and golden shiner (*Notemigonus crysoleucas*) (ODNR 1997). Most ponds support between three and five species (ODNR 1997). The pond fish communities appear to be the result of intentional and accidental introductions and account for species such as channel catfish (*Ictalurus punctatus*) and fathead minnows (*Pimephales promelas*) (ODNR 1997). The fish community in Kelly's Pond is composed exclusively of fathead minnows and channel catfish (ODNR 1997).

The planned end use for all RVAAP ponds is an unrestricted, recreational fishery (Morgan 2003b). Currently, the North Ponds have unrestricted fishing (i.e., catch-and-keep with wading permitted) (Morgan 2003b). These ponds are suspected borrow pits for the development of the on-site rail lines and do not receive any surface water runoff from the Load Line 2 area (Morgan 2003b and 2004). Kelly's Pond is a catch-and-release fishery with no wading permitted (OHARNG 2001, Morgan 2003b). The no-wading restriction was put in place to keep potentially contaminated pond sediments from being stirred up and re-suspended (Morgan 2003b).

7.3.3.5 Threatened and endangered species

The relative isolation and protection of habitat at RVAAP has created an important area of refuge for a number of plant and animal species considered rare by the state of Ohio. To date, 54 state-listed species are confirmed to be on RVAAP property. None of these are known to exist within the Load Line 2 AOC (OHARNG 2001, Morgan 2003a).

Federal

There are no federal-listed plants or animals currently known to occur at RVAAP. A site-wide bat survey was performed in 1999. Bat species captured included little brown bats, big brown bats, northern long-eared bats, red bats, and hoary bats. Although the federal endangered Indiana bat (*Myotis sodalis*) has been documented nearby (Morgan 1996), the Indiana bat was not identified during any surveys and is not known to occur on RVAAP (OHARNG 2001).

Several species listed as under Federal Observation (formerly Federal Candidate Species, Category 2) occur on RVAAP. These species include the Cerulean Warbler (*Dendroica cerulea*), Henslow's Sparrow (*Ammodramus henslowii*), and the butternut tree (*Juglans cinerea*) (ODNR 1997). None of these species have been documented at Load Line 2 (Morgan 2003a).

State

State-listed endangered species include three birds [Northern Harrier (*Circus cyaneus*), Common Barn Owl (*Tyto alba*), and Yellow-bellied Sapsucker (*Sphyrapicus varius*)], a lamprey [Mountain Brook Lamprey (*Ichthyomyzon greeleyi*)], and a butterfly [Graceful Underwing (*Catocala gracilis*)] (ODNR 1997). None of these species have been documented at Load Line 2 (Morgan 2003a).

Portage County has more rare species, especially plants, than any other county in Ohio. This is reflected in the number of species occurring on the RVAAP that are listed as State Potentially Threatened. These species include two trees [the gray birch (*Betula populifolia*) and the butternut (*Juglans cinerea*), four woody species [Northern rose azalea *Rhododendron nudiflorum* var. *roseum*), large cranberry (*Vaccinium macrocarpon*), hobblebush (*Viburnum alnifolium*), and fox grape (*Vitus labrusca*)], and four herbaceous species [round-leaved sundew (*Drosera rotundifolia*), closed gentian (*Gentiana clausa*), blunt mountain-mint (*Pychanthemum muticum*), and woodland horsetail (*Equisetum sylvaticum*)]. Two additional plant species that are suspected to occur on the RVAAP are the long beech fern (*Phegopteris connectilis*) and eel-grass

(*Vallisneria americana*) (ODNR 1997). None of these species have been documented at Load Line 2 (Morgan 2003a).

Species that are state-listed as of Special Concern [listed either by the Ohio Department of Wildlife (ODOW) or the Heritage Program (Heritage)] include the woodland jumping mouse (*Napaeozapus insignis*) (ODOW), four birds [the Solitary Vireo (*Vireo solitarius*) (Heritage), Sharp-shinned Hawk (*Accipiter striatus*) (ODOW), Sora (*Porzana carolina*) (ODOW), and Virginia Rail (*Rallus limicola*) (ODOW)], and two herpetiles [the four-toed salamander (*Hemidactylium scutatum*) (ODOW) and the smooth green snake (*Opheodrys vernalis*) (Heritage)] (ODNR 1997). None of these species have been documented at Load Line 2 (Morgan 2003a).

7.3.4 Overview of Identification of Preliminary Constituents of Potential Ecological Concern

The identification of preliminary COPECs was done through a systematic process involving both (1) standard SERA activities, and (2) Load Line 1 extrapolations to Load Line 2. For soil, both activities are used, and the exact methods are shown in Figure 7-2 and presented in the text below. For sediment and surface water, only standard SERA activities were performed. Because Load Line 1 information was key to the Load Line 2 work, the methods for Load Line 1 are explained (Section 7.3.4.1) separately from Load Line 2 methods (Section 7.3.4.2).

7.3.4.1 Load Line 1: Identification of preliminary constituents of potential ecological concern

For Load Line 1, the identification of preliminary COPECs began with the SRCs that were identified using the background and frequency-of-detection/WOE screens described in Chapter 4.0 of the RI for Load Line 1 (SAIC 2002). This pre-screening entailed comparing the EU-specific maximum concentrations against ESVs specified by Ohio EPA for protection of generic life. The pre-screening step is described in more detail below.

For Load Line 1, the results of analysis of environmental media samples were organized and evaluated by EU. Analytes that were not detected (i.e., were less than analytical blank concentrations and/or MDLs) were dropped in Chapter 4.0. More specifically, analytes other than explosives and propellants must have been detected in more than 5% of the samples to be considered as SRCs and carried forward to the risk assessment (see Section 4.1). Additionally, a background screen was conducted, as explained in Chapter 4.0. Regarding blanks, the maximum sample concentration must be more than 10 times the highest blank concentration for all common laboratory contaminants (e.g., acetone, 2-butanone, methylene chloride, and the phthalates) or 5 times the highest blank concentration for other chemical constituents. Inorganic constituents that are considered essential nutrients were retained for further assessment.

Chapter 4.0 presents the list of constituents detected in surface soil, sediment, and surface water at Load Line 1, along with an indication of whether they were retained for further evaluation. Detected analytes from the background and frequency-of-detection/WOE screens (Chapter 4.0) were identified as SRCs. The soil SRCs were carried forward to a multi-step, EU-specific pre-screening process for identifying the COPECs. The sediment and surface water SRCs were carried forward to a pre-screening process, which was EU-specific, by media, using MDCs and ESVs for protection of generic life.

Regarding EU-specific ESV screens for soil, Ohio EPA's preferences (Ohio EPA 2001) are, in order of preference, Efroymson et al. (1997a) PRGs; Efroymson et al. (1997b) plant soil screening values; Efroymson et al. (1997c) soil invertebrate and microorganism soil screening values; followed by the Ecological Data Quality Levels (EDQLs) values from EPA Region 5 (EPA 1998a). These can be found in Appendix R, Table R-1.

Regarding the EU-specific ESV screens for sediment, Ohio EPA's preferences are, in order of preference, concensus-based sediment quality guidelines (MacDonald et al. 2000) and EPA Region 5 EDQLs (EPA 1998a). The preferred sediment ESVs are provided in Appendix R, Table R-2.

Regarding the EU-specific ESV screens for surface water, Ohio EPA's preferences are, in order of preference: State Water Quality Standards (WQSs), as given in Chapters 3745-1 and 3745-2 of the Ohio Administrative Code (OAC) for the Ohio River Basin (Ohio EPA 2002); EPA National Ambient Water Quality Criteria (NAWQC) (EPA 2002), or EPA Tier II values as compiled by Suter and Tsao (1996); and EDQLs from EPA Region 5 (EPA 1998a). An Ohio State WQS is always the first choice value if one is published for a given analyte because it represents a codified standard. If an analyte does not have an Ohio WQS published in Chapter 3745-1 of the OAC, the next preferred value to use as an ESV is an EPA NAWQC, followed by an EPA Tier II value, or a Region 5 EPA EDQL, as described in the preceding hierarchy. The preferred surface water ESVs have been provided in Appendix R, Table R-3. Note that for some analytes, the preferred ESV is from the OAC.

Another criterion for identifying preliminary COPECs was whether the analytes were considered persistent, bioaccumulative, and toxic (PBT) compounds. The PBT compounds were identified as any inorganic SRCs whose maximum bioaccumulation factor (BAF) was ≥ 2, or any organic analytes whose log octanol-water partition coefficient (K_{ow}) was ≥ 4. BAFs and log K_{ow} values are presented in Appendix R, Table R-4. Any analyte that was identified as a PBT compound was automatically considered at preliminary COPEC, even if the analyte's maximum concentration was less than the preferred ESV.

7.3.4.2 Load Line 2: Identification of preliminary constituents of potential ecological concern

The methods that were used to identify preliminary COPECs in sediment and surface water at Load Line 1 were also used to identify preliminary COPECs in these media at Load Line 2. For soil, a different methodology was used at Load Line 2 than the one described above for Load Line 1. The process for identifying preliminary COPECs in soil at Load Line 2 is described below.

The site-wide SERA protocol (Army Corps of Engineers 2003) specifies comparison of ecological risk already performed at Load Line 1 to other load lines, including Load Line 2. Comparisons were made between one EU at Load Line 2 and its equivalent EU at Load Line 1. Thus, the following Load Line 2 and Load Line 1 soil EUs were compared:

- Load Line 2 Explosives Handling Area Aggregate to Load Line 1 Explosives Handling Area Aggregate,
- Load Line 2 Preparation and Receiving Areas Aggregate to Load Line 1 Preparation and Receiving Areas Aggregate,
- Load Line 2 Packaging and Shipping Areas Aggregate to Load Line 1 Packaging and Shipping Areas Aggregate,
- Load Line 2 Perimeter Area Aggregate to Load Line 1 Perimeter Area Aggregate, and
- Load Line 2 North Ditches Aggregate to Load Line 1 Perimeter Area Aggregate.

The ecological screening process for surface soil at Load Line 2 consisted of a sequential series of steps that evaluated, and often compared, parameters associated with Load Line 2 and Load Line 1. The ecological screening process for soil is depicted as a flowchart on Figure 7-2. As shown in the flowchart, the ecological screening process for surface soil consists of three major subprocesses, which are shown as

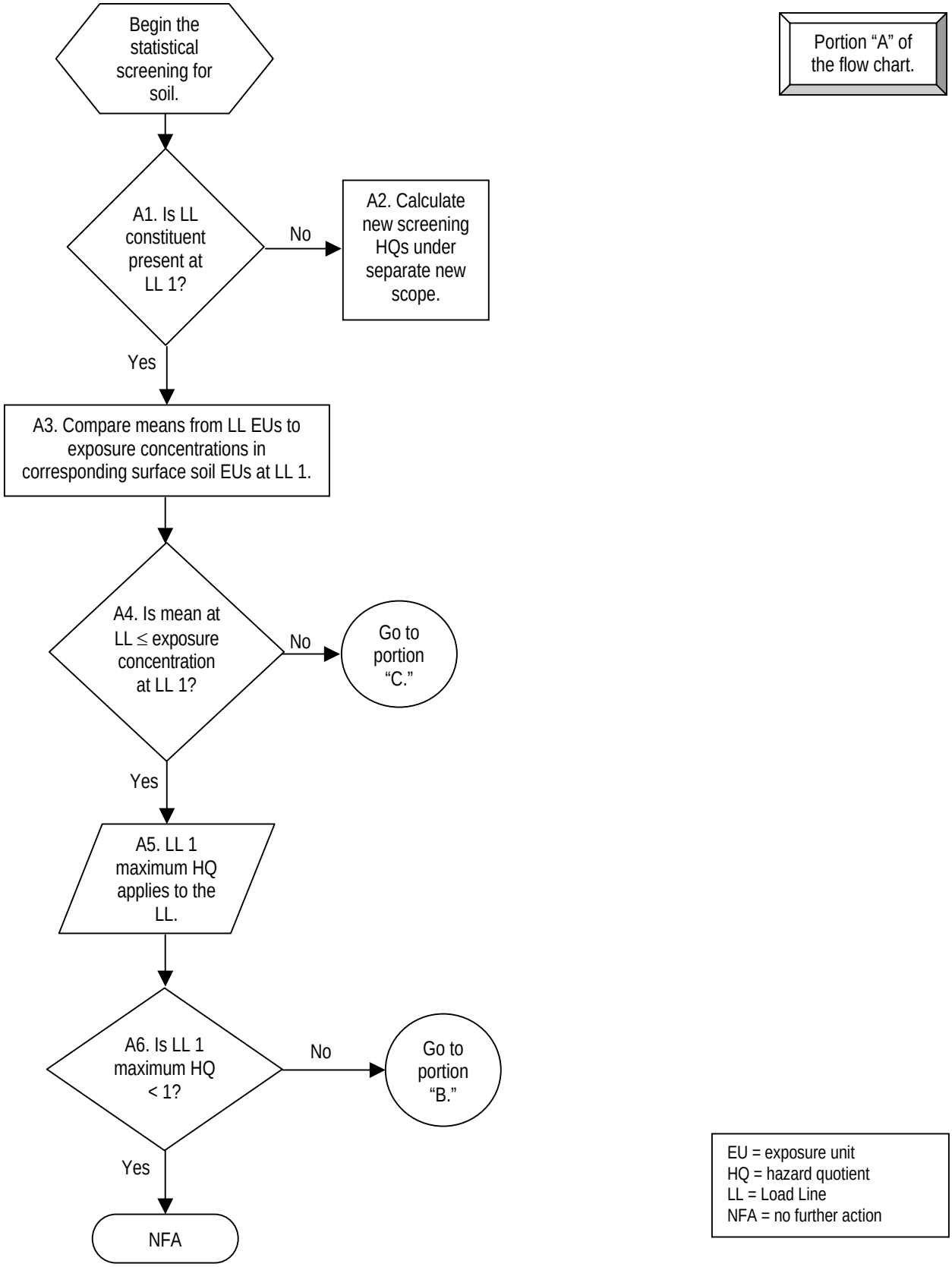
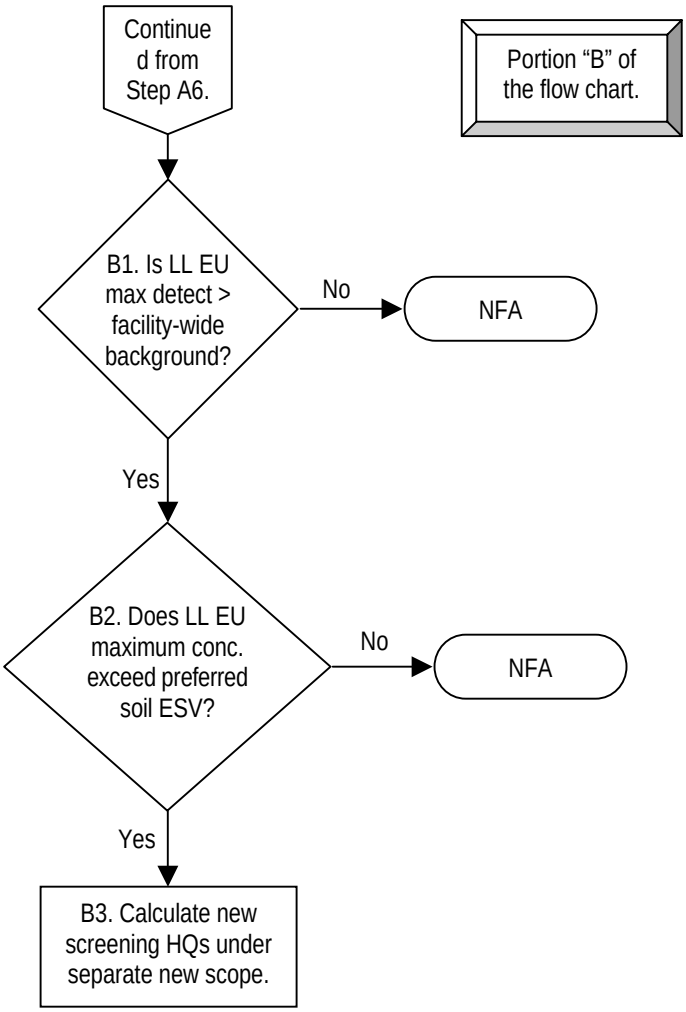
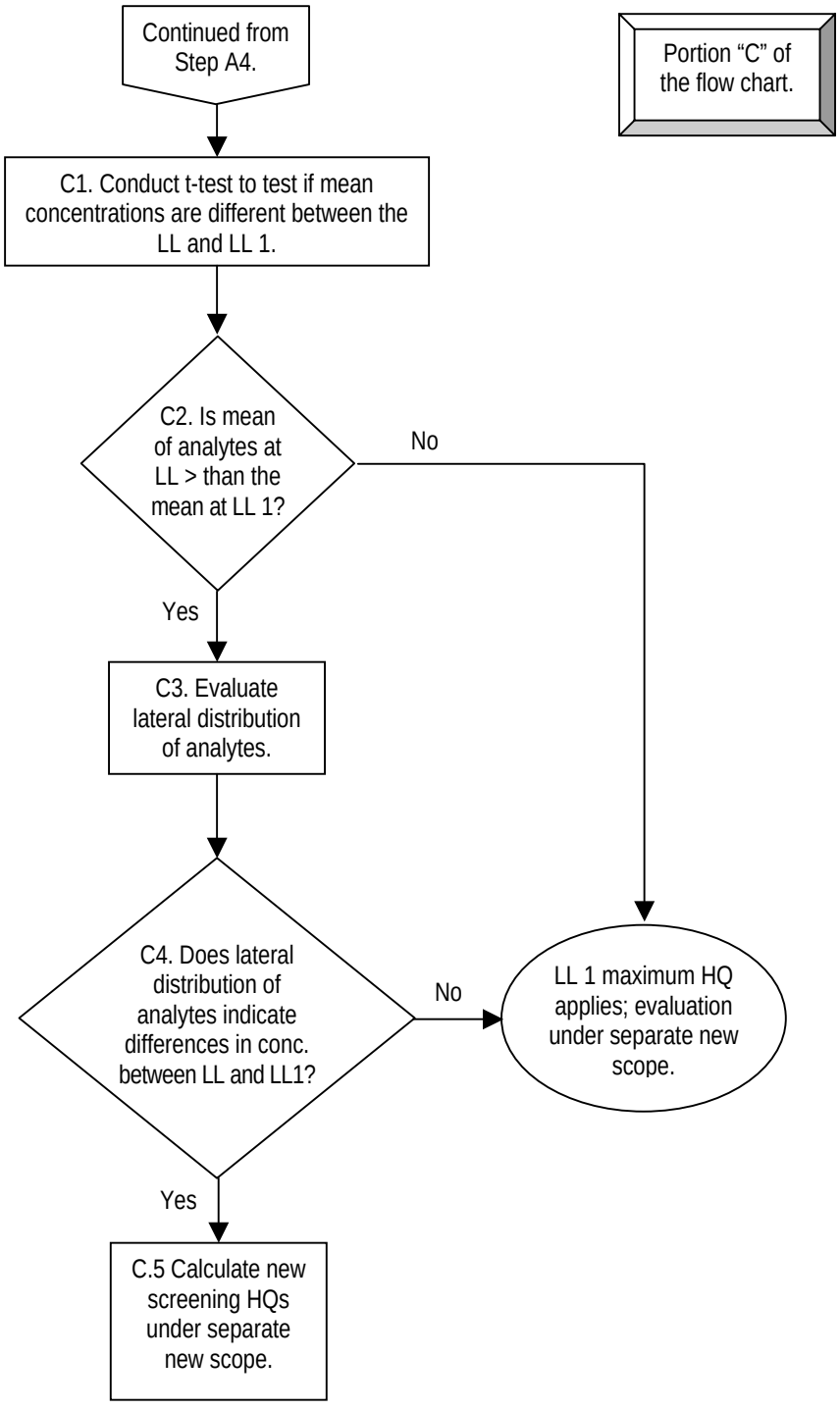


Figure 7-2. Flow Chart Depicting the Statistical and Ecological Screening Process for Surface Soil at Ravenna Load Lines



LL = Load Line
HQ = hazard quotient
EU = exposure unit
NFA = no further action
conc. = concentration
max. = maximum
Note: Step B2 includes a PBT screen, where a PBT compound is an inorganic analyte whose BAF >= to 2, or an organic analyte whose log Kow >= to 4. If the analyte is a PBT compound, it automatically carries forward to Step B3; otherwise, Step B2 governs as indicated.
PBT = persistent, bioaccumulative, and toxic
BAF = bioaccumulation factor
Kow = octanol-water partition coefficient

Figure 7-2. Flow Chart Depicting the Statistical and Ecological Screening Process for Surface Soil at Ravenna Load Lines (continued)



LL = Load Line
conc. = concentration
HQs = hazard quotients

Figure 7-2. Flow Chart Depicting the Statistical and Ecological Screening Process for Surface Soil at Ravenna Load Lines (continued)

portions A, B, and C of the flowchart. Each of these subprocesses is briefly described below. Each subprocess contains two to six steps. Most of the steps in each of the three portions of the flowchart are decision points that lead to one of two actions or conclusions based on the outcome of the activity associated with the step. For any detected constituent in surface soil at Load Line 2, the ecological screening process always began with the steps depicted in portion A of the flowchart and continued to any subsequent portions until a decision was made for either NFA or further analysis deferred to a separate scope of work. Whether the screening process utilized portions B or C of the flowchart for a given constituent depended on the outcome of the steps in portion A, as discussed below.

The ecological screening for analytes in soil began with the steps depicted in portion A of the soil screening process flowchart (Figure 7-2). Portion A of the flowchart consists of six steps (A1 through A6). One of the six steps (A6) can end with a decision of NFA for the constituent, whereas two of the steps (A4 and A6) can lead to additional evaluation of the constituent as depicted in other portions of the flowchart before the decision of NFA or risk management analysis is made. If the constituent from Load Line 2 was not present in soil at Load Line 1 (Step A1), a screening HQ will be calculated as part of a deferred, separate scope of work that is not addressed in this SERA. If the soil constituents at Load Line 2 were also present in soil at Load Line 1 (Step A1), the mean concentrations from the Load Line 2 EU samples were compared to the exposure concentrations from corresponding EUs from Load Line 1 (Step A3). The exposure concentrations were the lower of the maximum detect or the UCL_{95} of the mean, and represent the numerical values used to calculate the screening HQs for Load Line 1. For most analytes, the exposure concentrations were UCL_{95}. Constituents at Load Line 2 whose mean concentrations exceeded the exposure concentrations from corresponding EUs at Load Line 1 were further evaluated via steps presented in portion C of the flowchart. Portion C of the flowchart is described below. Constituents whose mean soil concentrations in EUs from Load Line 2 were $\leq$ the exposure concentrations in soil from corresponding Load Line 1 EUs were further evaluated by utilizing the Load Line 1 SERA maximum HQs for those constituents (Step A5). If the Load Line 1 maximum screening HQs exceeded 1, the constituents were further evaluated per the steps presented in portion B of the flowchart; otherwise, the conclusion was NFA for that constituent (Step A6). Portion B of the flowchart is described below.

Portion B of the flowchart that depicts the soil ecological screening process for Load Line 2 shows the steps for evaluating constituents that remain after step A6 (i.e., constituents in Load Line 2 soil EUs whose means were $\leq$ the exposure concentrations of that constituent in soil at Load Line 1 and whose screening HQs at Load Line 1 were $\geq$ 1). Portion B of the flowchart contains three steps (B1, B2, and B3). If the MDC of the constituent at the Load Line 2 EU did not exceed the facility-wide background concentration (Step B1), the conclusion was NFA for that constituent. Otherwise, the evaluation of the constituent continued by comparing the MDC in the Load Line 2 EU against the hierarchy of soil ESVs (Step B2). The ESVs include plant protection levels developed at WBG (SAIC 2002) and intended to be extrapolated to the other AOCs at RVAAP. If the MDC of the constituent did not exceed the soil ESV, and the constituent was not a PBT compound, a conclusion of NFA was appropriate for that constituent; otherwise, the constituent was deemed in need of a screening HQ to be calculated as part of a deferred, separate scope of work that is not addressed in this SERA (Step B3).

Portion C of the flowchart begins with the constituents from Step A4 (i.e., constituents that are present in soil at Load Line 2 EUs and Load Line 1 corresponding EUs but whose means at Load Line 2 exceeded the exposure concentrations Ls at Load Line 1). A t-test was performed to evaluate if the concentrations were different between Load Line 1 and Load Line 2 (Step C1). If the t-test indicated that the concentrations were not significantly different (Step C2), then the maximum HQ from the corresponding soil EU at Load Line 1 applied to the Load Line 2 EU. However, if the t-test (Step C1) indicated that the mean soil concentrations at Load Line 2 EUs were greater than the mean soil concentrations at Load Line 1 corresponding EUs (Step C2), then the evaluation continued by assessing the lateral distribution of the constituents (Step C3). If the lateral distribution of constituents at Load Line 2 indicated that there are real differences in

concentrations between Load Line 2 and Load Line 1, then the constituent was deemed in need of a screening HQ to be calculated as part of a deferred, separate scope of work that is not addressed in this SERA (Step C5). Lateral proximity of 50 ft or less was assumed to mean a difference. If the lateral distribution of constituents indicated no real differences between the means at comparable EUs from Load Line 2 and Load Line 1, then the maximum HQ from the corresponding soil EU at Load Line 1 applied to the Load Line 2 EU.

7.4 RESULTS OF PRELIMINARY CONSTITUENTS OF POTENTIAL ECOLOGICAL CONCERN

7.4.1 Load Line 2 Soil Preliminary Constituents of Potential Ecological Concern

Regarding the first question in portion A (step A1), the only new analyte identified at Load Line 2 relative to Load Line 1 is benzoic acid. Benzoic acid was detected at each of the soil EUs. Benzoic acid is evaluated further in the BERA.

Regarding portion A (step A6) and portion B (step B1) of the methods flowchart, Table 7-2 summarizes the Load Line 2 analytes that are justified for NFA according to the four criteria [i.e., maximum Load Line 1 HQ <1, MDC at Load Line 2 < background, no Load Line 1 HQ because analyte was eliminated during Load Line 1 ESV and PBT prescreen, or no Load Line 1 HQ because there was no available TRV during the SERA]. The Preparation and Receiving Areas Aggregate had the most analytes (31) that qualified for NFA, whereas the Perimeter Area Aggregate has the fewest number (8 analytes). The rationale that justified the most NFAs at three of the five EUs was the NFA because of no Load Line 1 HQ due to absence of a TRV. At the North Drainage Ditches Aggregate, the rationale for the most NFAs was that the Load Line 2 maximum detects were below background. At the Perimeter Area Aggregate, the rationale that accounted for the most NFAs was that the analytes had no Load Line 1 HQs because the analytes had been eliminated during the Load Line 1 ESV prescreen. Tables that contain the detailed information and comparisons for identifying the Load Line 2 analytes that qualify for NFA are presented in Appendix R, as follows.

- Appendix R, Table R-5: detected soil analytes at Load Line 2, by EU, along with their concentrations and the concentrations in corresponding EUs at Load Line 1; also, any new constituent is identified by the presence of a blank row.

- Appendix R, Table R-6: comparisons between mean concentrations of analytes from Load Line 2 against the exposure concentrations from Load Line 1, listing the maximum HQs from Load Line 1, and the comparison of MDCs of analytes from Load Line 2 versus background concentration.

- Appendix R, Table R-7: Load Line 2 analytes whose mean concentrations did not exceed the Load Line 1 exposure concentrations and were deemed justified for NFA because their maximum HQ from Load Line 1 was less than 1, or, their MDC at Load Line 2 EU was less than background.

- Appendix R, Table R-8: Load Line 2 analytes whose mean concentrations did not exceed the Load Line 1 exposure concentrations and were deemed justified for NFA because they did not have corresponding HQs at Load Line 1 due to being eliminated during the Load Line 1 ESV and PBT pre-screen.

- Appendix R, Table R-9: Load Line 2 analytes whose mean concentrations did not exceed the Load Line 1 exposure concentrations and were deemed justified for NFA because they did not have corresponding HQs at Load Line 1 due to the absence of published TRVs for the SERA.

Table 7-2. Summary of Soil Load Line 2 Analytes Whose Means Do Not Exceed the Load Line 1 Exposure Concentration and Are Justified for No Further Action

Analyte	CAS Number	Rationales for NFA			
		NFA Because Load Line 1 Max. HQ < 1	NFA Because Load Line 2 Max. Det. < Bkg.	NFA Because the Analyte was Eliminated During the Load Line 1 ESV Pre-screening	NFA Because the Analyte Had no Load Line 1 HQ due to the Absence of a TRV
Explosives Handling Areas Aggregate					
Metals					
Cobalt	7440-48-4	X			
Cyanide	57-12-5	X			
Potassium	7440-09-7				X
Silver	7440-22-4			X	
Vanadium	7440-62-2		X		
Organics-Explosives					
1,3,5-Trinitrobenzene	99-35-4				X
Organics-Pesticide/PCB					
Aldrin	309-00-2			X	
4,4'-DDD	72-54-8			X	
4,4'-DDE	72-55-9				X
Endrin	72-20-8			X	
Endrin Aldehyde	7421-93-4				X
gamma-Chlordane	5103-74-2				X
Heptachlor	76-44-8				X
Heptachlor Epoxide	1024-57-3				X
Lindane	58-89-9			X	
PBC-1260	11096-82-5			X	
Organics-Semivolatiles					
Anthracene	120-12-7				X
Benzo(*a*)anthracene	56-55-3				X
Benzo(*b*)fluoranthene	205-99-2				X
Carbazole	86-74-8				X
Chrysene	218-01-9				X
Fluoranthene	206-44-0				X
Phenanthrene	85-01-8				X
Preparation And Receiving Areas Aggregate					
Metals					
Beryllium	7440-41-7			X	
Calcium	7440-70-2				X
Cyanide	57-12-5			X	
Magnesium	7439-95-4				X
Potassium	7440-09-7				X
Silver	7440-22-4			X	
Sodium	7440-23-5				X
Vanadium	7440-62-2		X	X	
Organics-Explosives					
1,3-Dinitrobenzene	99-65-0			X	
2,4-DNT	121-14-2			X	
2,4,6-Trinitrotoluene	118-96-7	X			

Table 7-2. Summary of Soil Load Line 2 Analytes Whose Means Do Not Exceed the Load Line 1 Exposure Concentration and Are Justified for No Further Action (continued)

Analyte	CAS Number	Rationales for NFA			
		NFA Because Load Line 1 Max. HQ < 1	NFA Because Load Line 2 Max. Det. < Bkg.	NFA Because the Analyte was Eliminated During the Load Line 1 ESV Pre-screening	NFA Because the Analyte Had no Load Line 1 HQ due to the Absence of a TRV
Organics-Pesticides/PCBs					
beta-BHC	319-85-7				X
delta-BHC	319-86-8			X	
Endrin Aldehyde	7421-93-4				X
Organics-Semivolatiles					
Acenaphthene	83-32-9			X	
Acenaphthylene	208-96-8			X	
Anthracene	120-12-7				X
Benzo(*a*)anthracene	56-55-3				X
Benzo(*b*)fluoranthene	205-99-2				X
Benzo(*g,h,i*)perylene	191-24-2				X
Benzo(*k*)fluoranthene	207-08-9				X
Butylbenzyl phthalate	85-68-7			X	
Carbazole	86-74-8				X
Chrysene	218-01-9				X
Dibenzofuran	132-64-9				X
Dibenzo(*a,h*)anthracene	53-70-3			X	
Fluoranthene	206-44-0				X
Fluorene	86-73-7	X			
Indeno(1,2,3-*cd*)pyrene	193-39-5			X	
Phenanthrene	85-01-8				X
Pyrene	129-00-0	X			
Packaging And Shipping Areas Aggregate					
Metals					
Beryllium	7440-41-7			X	
Calcium	7440-70-2				X
Cobalt	7440-48-4	X			
Magnesium	7439-95-4				X
Nickel	7440-02-0	X			
Potassium	7440-09-7				X
Selenium	7782-49-2		X	X	
Sodium	7440-23-5				X
Thallium	6533-73-9			X	
Vanadium	7440-62-2		X		
Organics-Explosives					
2-Amino-4,6-DNT	35572-78-2				X
4-Amino-2,6-DNT	19406-51-0				X
HMX	2691-41-0				X
RDX	121-82-4				X
Organics-Pesticides/PCBs					
PCB-1260	11096-82-5				X
Organics-Semivolatiles					
Benzo(*a*)anthracene	56-55-3				X
Benzo(*a*)pyrene	50-32-8				X
Benzo(*b*)fluoranthene	205-99-2				X
Benzo(*g,h,i*)perylene	191-24-2				X
Benzo(*k*)fluoranthene	207-08-9				X

Table 7-2. Summary of Soil Load Line 2 Analytes Whose Means Do Not Exceed the Load Line 1 Exposure Concentration and Are Justified for No Further Action (continued)

Analyte	CAS Number	Rationales for NFA			
		NFA Because Load Line 1 Max. HQ < 1	NFA Because Load Line 2 Max. Det. < Bkg.	NFA Because the Analyte was Eliminated During the Load Line 1 ESV Pre-screening	NFA Because the Analyte Had no Load Line 1 HQ due to the Absence of a TRV
Dibenzo(*a,h*)anthracene	53-70-3			X	
Chrysene	218-01-9				X
Di-n-butylphthalate	84-74-2			X	
Indeno(1,2,3-*cd*)pyrene	193-39-5			X	
Pyrene	129-00-0	X			
Organics-Volatiles					
Toluene	108-88-3			X	
Perimeter Area Aggregate					
Metals					
Nickel	7440-02-0			X	
Potassium	7440-09-7				X
Thallium	6533-73-9			X	
Vanadium	7440-62-2		X		
Organics-Pesticides/PCBs					
alpha-Chlordane	5103-71-9			X	
beta-BHC	319-85-7			X	
4,4'-DDE	72-55-9			X	
Dieldrin	60-57-1			X	
North Drainage Ditches Aggregate					
Metals					
Aluminum	7429-90-5		X		
Arsenic	7440-38-2		X		
Barium	7440-39-3		X	X	
Calcium	7440-70-2		X		X
Chromium	7440-47-3		X	X	
Cobalt	7440-48-4	X	X		
Iron	7439-89-6		X		
Lead	7439-92-1		X	X	
Magnesium	7439-95-4		X	X	
Manganese	7439-96-5		X		
Mercury	7487-94-6	X			
Potassium	7440-09-7		X		X
Selenium	7782-49-2		X		
Thallium	6533-73-9			X	
Vanadium	7440-62-2		X		

BHC = Benzene hexachloride.
CAS = Chemical Abstract Service.
DDD = Dichlorodiphenyldichlorethane.
DDE = Dichlorodiphenyldichloroethylene.
DNT = Dinitrotoluene.
Det. = Detected.
ESV = Ecological screening value.
HMX = Octahydro-1,3,5-tetranitro-1,3,5-tetrazocine.
HQ = Hazard quotient.
Max. = Maximum.
NFA = No further action.
PCB = Polychlorinated biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
TRV = Toxicity reference value.
X = The analyte is justified NFA because of this condition.

Regarding portion B (step B2) of the methods flowchart, Table 7-3 summarizes the Load Line 2 analytes, by EU, that were retained after the ESV and PBT screen. Twelve metals, two pesticides, one PCB, and one semivolatile were retained at one or more EUs following the ESV and PBT screen. The Explosives Handling Area Aggregate had the most retained analytes (10 metals, 2 pesticides, and 1 PCB). The North Drainage Ditches Area Aggregate had no retained analytes. The Packaging and Shipping Areas Aggregate had the second highest number of retained analytes (10 metals and 1 PCB), followed by the Preparation and Receiving Areas Aggregate (7 metals, 1 PCB, and 1 semivolatile). The Perimeter Area Aggregate only had four retained analytes, all metals. The most frequent rationale for retaining the analytes at all four EUs was that the Load Line 2 maximum detect exceeded the ESV. All Load Line 2 soil analytes that were retained after the ESV and PBT screen will need a screening HQ to be calculated as part of a deferred, separate scope of work that is not addressed in this SERA. The table that contains the detailed information and comparisons for identifying the Load Line 2 soil analytes that qualify for ESV and PBT

Table 7-3. Summary of Soil Load Line 2 Analytes that Remained After the Exposure Unit-Specific ESV and PBT Screen (preliminary COPEC)

Analytes	CAS Registry Number	Explosives Handling Area Aggregate	Preparation and Receiving Areas Aggregate	Packaging and Shipping Areas Aggregate	Perimeter Area Aggregate
Metals					
Aluminum	7429-90-5	Max > ESV	Max > ESV	Max > ESV	Max > ESV
Antimony	7440-36-0	NA	Max > ESV	NA	NA
Arsenic	7440-38-2	NA	Max > ESV	NA	Max > ESV
Barium	7440-39-3	Max > ESV	Max > ESV	Max > ESV	NA
Cadmium	7440-43-9	Max > ESV; PBT compound	Max > ESV; PBT compound	Max > ESV; PBT compound	NA
Chromium	7440-47-3	Max > ESV	NA	Max > ESV	NA
Copper	7440-50-8	Max > ESV	NA	Max > ESV	NA
Iron	7439-89-6	Max > ESV	NA	Max > ESV	Max > ESV
Lead	7439-92-1	Max > ESV; PBT compound	Max > ESV; PBT compound	Max > ESV; PBT compound	NA
Manganese	7439-96-5	Max > ESV	Max > ESV	Max > ESV	Max > ESV
Mercury	7487-94-6	Max > ESV; PBT compound	NA	Max > ESV; PBT compound	NA
Zinc	7440-66-6	Max > ESV; PBT compound	NA	Max > ESV; PBT compound	NA
Organics-Pesticides/PCBs					
4,4'-DDT	50-29-3	Max > ESV; PBT compound	NA	NA	NA
Dieldrin	60-57-1	Max > ESV; PBT compound	NA	NA	NA
PCB-1254	11097-69-1	No ESV; PBT compound	No ESV; PBT compound	No ESV; PBT compound	NA
Organics-Semivolatiles					
Benzo(*a*)pyrene	50-23-8	NA	Max > ESV; PBT compound	NA	NA

CAS = Chemical Abstract Service.
COPEC = Contaminant of potential ecological concern.
DDT = Dichlorodiphenyltrichloroethane.
ESV = Ecological screening value.
Max = Maximum detected concentration at the exposure unit.
NA = Not applicable because the analyte was ineligible for ESV screening at this exposure unit.
PBT = Persistent, bioaccumulative, and toxic.
PCB = Polychlorinated biphenyl.
X = Load Line 2 analyte remains after the exposure unit-specific ESV and PBT screen (it is a preliminary COPEC).

screening, and the tables showing the soil ESV and PBT screens for the five EUs are presented in Appendix R, as follows.

- Appendix R, Table R-10: Load Line 2 analytes whose means did not exceed the Load Line 1 exposure concentrations but needed the ESV and PBT screening because the maximum HQs for these analytes at corresponding EUs at Load Line 1 exceeded 1 and the Load Line 2 maximum concentrations exceeded background.

- Appendix R, Tables R11-R14: soil ESV and PBT screens for the four EUs at Load Line 2 that had analytes qualifying for ESV and PBT screening.

Regarding portion C (step C2) of the methods flowchart, Table 7-4 summarizes the Load Line 2 analytes whose means were not different from the means at Load Line 1, per the t-test, so the Load Line 1 maximum HQ that is listed applies. The Preparation and Receiving Areas Aggregate had the most analytes (10) in this category (6 metals, 2 pesticides, and 2 semivolatiles), whereas the North Drainage Ditches Aggregate had the fewest (1 metal). The Explosives Handling Areas Aggregate had the second highest number of analytes (eight) in this category (two metals, one pesticide, four semivolatiles, and one volatile). The tables that contains the detailed information and comparisons for identifying the Load Line 2 analytes whose means did not differ from those at Load Line 1 are presented in Appendix R, as follows.

- Appendix R, Table R-15: Load Line 2 analytes, by EU, whose means exceeded the Load Line 1 exposure concentrations and had t-test for differences between means at Load Line 2 and Load Line 1.

- Appendix R, Table R-16: Load Line 2 analytes whose means exceeded the Load Line exposure concentrations, but whose means did not exceed the means at Load Line 1, per the t-tests.

Regarding portion C (Steps C3 and C4) of the methods flowchart, Table 7-5 summarizes the Load Line 2 analytes whose means are truly different as verified by the t-tests and supported by spatial distribution evaluation. Eight metals comprised this classification of analytes. These analytes listed in Table 7-5 will need a screening HQ to be calculated as part of a deferred, separate scope of work that is not addressed in this SERA (Step C5). The tables that contain the detailed information and comparisons for identifying the Load Line 2 analytes whose means truly are different based on t-test and spatial distribution evaluation are presented in Appendix R, as follows.

- Appendix R, Table R-17: Load Line 2 analytes whose mean concentrations exceeded the Load Line 1, exposure concentrations and whose means exceeded the means at Load Line 1, per the t-tests.

- Appendix R, Table R-18: Load Line 2 analytes whose mean concentrations exceeded the Load Line 1, exposure concentrations and whose means exceeded the means at Load Line 1, per the t-tests, plus lists the mean, minimum, and maximum distances between pairs of samples, starting with the locations of the highest concentrations.

- Appendix R Figures R-1 through R-8 show Load Line 2 analytes whose mean concentrations are greater than the means at comparable EUs at Load Line 1, per the t-tests, and have at least five detects and seem clustered because many pairs are within 50 ft of each other.

Note that the spatial distribution figures show that beryllium and nickel are considerably more concentrated at Load Line 2 than at Load Line 1 at the Explosives Handling Areas Aggregate.

Table 7-4. Summary of Soil Load Line 2 Soil Analytes Whose Means Were Not Different From Those at Load Line 1 per T-Test and Whose Load Line 1 HQ Applies

Analysis Type	Load Line 2 Analytes	CAS Registry Number	Load Line1 Max. HQ
Explosives Handling Areas Aggregate			
Metals	Arsenic	7440-36-0	6.10E+00
Metals	Thallium	6533-73-9	2.01E+01
Organics-Pesticides/PCBs	alpha-Chlordane	5103-71-9	2.00E-01
Organics-Semivolatiles	Benzo(*a*)pyrene	50-32-8	5.00E-02
Organics-Semivolatiles	Bis(2-ethylhexyl)phthalate	117-81-7	5.44E-04
Organics-Semivolatiles	Fluorene	86-73-7	6.00E-03
Organics-Semivolatiles	Pyrene	129-00-0	8.30E-05
Organics-Volatiles	Acetone	67-64-1	3.98E-05
Preparation and Receiving Areas Aggregate			
Metals	Chromium	7440-47-3	1.10E+02
Metals	Copper	7440-50-8	9.00E-01
Metals	Iron	7439-89-6	3.02E+03
Metals	Mercury	7487-94-6	1.41E+00
Metals	Nickel	7440-02-0	1.00E-01
Metals	Zinc	7440-66-6	1.95E+02
Organics-Pesticides/PCBs	4,4'-DDT	50-29-3	3.05E+01
Organics-Pesticides/PCBs	Dieldrin	60-57-1	7.73E+00
Organics-Semivolatiles	Di-n-butylphthalate	84-74-2	2.50E-03
Organics-Semivolatiles	Pentachlorophenol	87-86-5	2.77E-02
Packaging and Shipping Areas Aggregate			
Metals	Antimony	7440-36-0	9.00E-01
Organics-Semivolatiles	Fluorene	86-73-7	8.17E-04
Perimeter Areas Aggregate			
Metals	Cadmium	7440-43-9	1.89E+00
Metals	Chromium	7440-47-3	4.20E+01
Metals	Cobalt	7440-48-4	5.66E-01
Metals	Lead	7439-92-1	3.41E+01
Metals	Mercury	7487-94-6	2.00E-01
Metals	Selenium	7782-49-2	1.20E+00
Metals	Zinc	7440-66-6	4.62E+01
North Ditches Aggregate			
Metals	Cadmium	7440-43-9	1.89E+00

CAS = Chemical Abstract Service.
DDT = Dichlorodiphenyltrichloroethane.
Max. HQ = Maximum hazard quotient.
PCB = Polychlorinated biphenyl.

Table 7-5. Summary of Soil Load Line 2 Analytes Whose Concentrations Are Truly Greater Than Those Same Analyte's Concentrations at Load Line 1, and thus Require Subsequent Hazard Quotient Calculation

Analysis Type	Load Line 2 Analyte	CAS Registry Number	Explosives Handling Areas Aggregate	Preparation and Receiving Areas Aggregate	Packaging and Shipping Areas Aggregate	Perimeter Area Aggregate	North Ditches Aggregate
Metals	Beryllium	7440-41-7	X			X	
Metals	Calcium	7440-70-2	X				
Metals	Cobalt	7440-48-4		X			
Metals	Magnesium	7439-95-4	X				
Metals	Nickel	2/2/7440	X				X
Metals	Selenium	7782-49-2	X	X			
Metals	Silver	7440-22-4			X		
Metals	Zinc	7440-66-6					X

CAS = Chemical Abstract Service.
X = Load Line 2 analyte concentration is truly different than Load Line 1 concentration [Load Line 2 mean > Load Line 1 95% UCL; Load Line 2 mean > Load Line 1mean, per t-test; and spatial analysis (clustering minimum distance between highest concentrations is < 50 ft) indicates Load Line 2 is > Load Line 1] so subsequent hazard quotient calculation is warranted.

7.4.2 Load Line 2 Sediment Preliminary Constituents of Potential Ecological Concern

Constituents in sediment that were retained after the EU-specific ESV and PBT screens were identified as preliminary COPECs and are summarized in Table 7-6. The rationale for retaining the analytes (i.e., maximum detect > ESV, PBT compound, or no ESV) is also presented in Table 7-6 for each retained analyte. Twenty-eight analytes (including 7 metals, 4 pesticides, 4 explosives, and 13 semivolatiles) were retained in one or both of the two EUs. The EU with the most retained analytes (27) was Kelly's Pond and Exit Drainages Aggregate. The North Ponds Aggregate only had three retained analytes (two metals and one explosive). The most frequent rationale for retaining the 27 analytes at the Kelly's Pond and Exit Drainages Aggregate was that the maximum detect exceeded the ESV (16 of 27). These preliminary COPECs will be analyzed for HQ beginning in Section 7.7.

The tables showing the sediment ESV and PBT screens for the two EUs are presented in Appendix R, as follows.

- Appendix R, Tables R19 and R20: sediment ESV and PBT screens for the two EUs at Load Line 2.

7.4.3 Load Line 2 Surface Water Preliminary Constituents of Potential Ecological Concern

Constituents in surface water that were retained after the EU-specific ESV and PBT screens were identified as preliminary COPECs and are summarized in Table 7-7. The rationale for retaining the analytes (i.e., maximum detect > ESV, PBT compound, or no ESV) is also presented in Table 7-7 for each retained analyte. Three metals (cadmium, calcium, and magnesium) and one semivolatile [bis(2-ethylhexyl)phthalate] were retained following the ESV and PBT screen for surface water. None of the retained analytes exceeded the ESV. The rationale for retaining two of the analytes was PBT compound status, whereas the other two analytes (calcium and magnesium) had no ESV. These preliminary COPECs will be analyzed for HQ beginning in Section 7.7.

Table 7-6. Summary of Sediment Analytes in Load Line 2 and the Rationale(s) Why They Are to be Carried Forward to Receptor-Specific Screening for Identification of Sediment COPECs

SRCs Remaining After the EU-Specific ESV and PBT Pre-Screen	Rationale for Selection at	
	Kelly's Pond and Exit Drainages Aggregate	North Ponds Aggregate
Inorganics		
Antimony	No ESV	—
Beryllium	No ESV	—
Cadmium	PBT compound	PBT compound
Calcium	No ESV	—
Lead	Max >ESV; PBT compound	PBT compound
Magnesium	No ESV	—
Silver	Max >ESV	—
Semivolatile Organic Compounds		
Anthracene	Max >ESV; PBT compound	—
Bis(2-ethylhexyl)phthalate	PBT compound	—
Benzo(*a*)anthracene	Max >ESV; PBT compound	—
Benzo(*a*)pyrene	Max >ESV; PBT compound	—
Benzo(*b*)fluoranthene	PBT compound	—
Benzo(*g,h,i*)perylene	Max >ESV; PBT compound	—
Benzo(*k*)fluoranthene	Max >ESV; PBT compound	—
Chrysene	Max >ESV; PBT compound	—
Dibenzo(*a,h*)anthracene	Max >ESV; PBT compound	—
Fluoranthene	Max >ESV; PBT compound	—
Indeno(1,2,3-*cd*)pyrene	Max >ESV; PBT compound	—
Phenanthrene	Max >ESV; PBT compound	—
Pyrene	Max >ESV; PBT compound	—
Pesticide/PCBs		
4,4'-DDE	Max >ESV; PBT compound	—
4,4'-DDT	PBT compound	—
Beta-BHC	Max >ESV	—
Endrin Ketone	No ESV	—
Explosives		
4-Amino-2,6-dinitrotoluene	No ESV	—
2,4-Dinitrotoluene	Max >ESV	—
2,4,6-Trinitrotoluene	No ESV	—
Nitrocellulose	—	No ESV

BHC = Benzene hexachloride.
COPEC = Constituent of potential ecological concern.
DDD = Dichlorodiphenyldichloroethane.
DDT = Dichlorodiphenyltrichloroethane.
ESV = Ecological screening value.
EU = Exposure unit.
Max = Maximum detected concentration.
PBT = Persistent, bioaccumulative, and toxic.
PCB = Polychlorinated biphenyl.
SRC = Site-related chemical.
— = SRC not applicable to EU.

Table 7-7. Summary of Surface Water Analytes in Load Line 2 and the Rationale(s) Why They Are to be Carried Forward to Receptor-Specific Screening for Identification of Surface Water COPECs

SRCs Remaining After the EU-Specific ESV and PBT Pre-screen	Rationale for Selection
	Kelly's Pond and Exit Drainages Aggregate
Metals	
Cadmium	PBT compound
Calcium	No ESV
Magnesium	No ESV
Organics-Semivolatile	
Bis(2-ethylhexyl)phthalate	PBT compound

COPEC = Contaminant of potential ecological concern.
ESV = Ecological screening value.
EU = Exposure unit.
PBT = Persistent, bioaccumulative, and toxic.
SRCs = Site-related chemicals.

The table showing the surface water ESV and PBT screens for the one EU is presented in Appendix R, as follows.

- Appendix R, Table R-21: surface water ESV and PBT screens for Kelly's Pond and Exit Drainage Aggregate.

7.4.4 Future Preliminary Risk to Ecological Receptors

The HQs for the terrestrial plants and animals at Load Line 1 are considered to be the same or similar in the future because soil contaminant concentrations are not expected to change much over time. Likewise, vegetation and animal species are expected to be the same or similar at the load line, although the same habitats may change through ecological succession.

In the aquatic habitats, the ecological environment is expected to change from year to year because of new input of sediments and changes in sedimentation. Thus, the HQs for sediment and surface water may vary accordingly.

7.4.5 Summary of Preliminary Constituents of Potential Ecological Concern

For Load Line 2, the ESV part of the work was completed for sediment and surface water much as was done for Load Line1. There were a few analytes retained as candidates for later HQ evaluation. For soil, additional steps were added in which comparisons of various types were made between Load Line 2 and Load Line 1 chemical concentrations. Only one new soil analyte, benzoic acid, was detected at Load Line 2 that was not on the analyte list for Load Line 1. Many Load Line 2 analytes were deemed suitable for NFA by virtue of various conditions such as having concentrations less than Load Line 1, or less than background, or having maximum Load Line 1 HQs less than 1, or having no Load Line 1 HQs due to elimination during the Load Line 1 ESV pre-screen or absence of screening TRV. However, there were numerous Load Line 2 analytes whose Load Line 1 maximum HQ exceeded 1 and whose maximum concentrations exceeded background, so those analytes qualified for further HQ work. In addition, several Load Line 2 soil analytes qualified for additional HQ work by virtue of having mean concentrations that truly exceeded the Load Line 1 means at comparable EUs, as verified by t-tests and spatial distribution evaluation. All of the soil, sediment, and surface water analytes from Load Line 2 that qualified for further HQ work will be undertaken in the BERA (Sections 7.7 through 7.11).

7.5 UNCERTAINTIES

Uncertainties in the Load Line 2 SERA are discussed in this section by the four interrelated steps of the EPA approach to SERA: problem formulation, exposure assessment, effects assessment, and risk characterization. The uncertainty section also contains specific evaluations of the COPECs.

7.5.1 Uncertainties in Problem Formulation

Environmental concentrations of analytes in the soil, sediment, and surface water at Load Line 2 were based on a limited number of samples. A degree of uncertainty exists about the actual spatial distribution of constituents. Exposure concentrations could be overestimated or underestimated, depending on how the actual data distribution differs from the measured data distribution. Because the estimated UCL_{95} of the mean concentrations or MDC was used as the EPC concentration to calculate HQs at Load Line 1, the estimates of risk from COPECs are conservative (i.e., protective). Using UCL_{95} or maximum concentrations decreases the likelihood of underestimating the risk posed by each COPEC and increases the likelihood of overestimating the risk.

The full distribution and abundance of organisms comprising the ecological receptors at Load Line 2 has not been quantified by field studies. The lack of quantitative data introduces uncertainties concerning whether, and to what extent, the risk characterization based on the selected receptor species underestimates or overestimates the risk to organisms that were not used in the risk computations but that occur at Load Line 2. On-site reconnaissance has established the nature and quality of habitat and has confirmed the presence of vegetation types and of active, visible animal species. Observations made during this reconnaissance justify assumptions about the presence of unobserved organisms that are essential to normal ecosystem functioning, such as soil-dwelling worms and arthropods and herbivorous insects. This area falls within the acceptable range of each species. Note that the extrapolations of no ecological effects at WBG may moderate this type of uncertainty and show HQs at Load Line 2 to be an overestimate of risk.

It is possible that one (or more) unobserved species at Load Line 2 is more sensitive than the ecological receptors for which toxicity data are available for use in the SERA. It does not necessarily follow that these unevaluated, more sensitive species are at significantly greater risk than the species estimated in this SERA because exposure concentrations for ecological receptors in this SERA could be greater than those for more sensitive receptors due to different dietary regimes.

7.5.2 Uncertainties in Exposure Assessment

The actual movement of analytes from the Load Line 2 constituent source media to ecological receptors has not been measured for this SERA. This introduces uncertainties about the actual modes and pathways of exposure, bioavailability of constituents, and the actual exposure concentrations of these analytes to the ecological receptors. Actual exposure concentrations can differ from the measured environmental concentrations as a result of physical and chemical processes during transport from source to receptor and as a result of biomagnification through the food web. Actual exposure concentrations in physical media are sometimes less than the total measured concentrations because a portion of the total constituent is not bioavailable to the receptors. These processes have not been evaluated quantitatively in this SERA.

BAFs for soil and sediment to biota, and bioconcentration (BCFs) for surface water to biota, used for the PBT evaluation are not available for some analytes. Instead, default values were used. It is not known whether this substitution overestimates or underestimates exposure. However, the default values are thought to be conservative, so it is likely that exposures will not be underestimated.

Literature-derived factors to describe dietary intake and bioaccumulation of elements may not reflect actual diets and bioaccumulation at the site. However, the literature values are assumed to be sufficiently similar to site-specific values that exposures neither will be underestimated nor overestimated.

Exposure concentrations are likely to be overestimated because of conservative exposure factors. Exposure factors include published BAFs, irrespective of species and environmental conditions. In particular, it should be noted that, while the largest BAFs may overestimate bioaccumulation at Load Line 2 by at least one order of magnitude for some COPECs, very high bioaccumulation, as well as biomagnification, are well-documented for other constituents, although not necessarily all those likely detected.

Finally, the exposure of plants and animals to constituents below detection limits was not considered in the SERA. In addition, the exposure of ecological receptors to tentatively identified compounds is not considered, which could result in an underestimation of exposure.

7.5.3 Uncertainties in Effects Assessment

The preferred ESVs for the three media were based on concentrations reported to have no observed effects on most organisms. This SERA provides findings for COPEC-specific risk estimates. An evaluation of risk from COPEC mixtures cannot be conducted without additional data and evaluation of alternative models of COPEC interaction.

There are no available ESVs for some analytes, especially organics, for each of the three media. This contributes to uncertainty associated with likely underestimates of risk. Sometimes, lack of ESVs based on soil-plant studies caused use of ESVs based on hydroponic studies; hydroponic studies are inferior to soil-plant studies and this contributed additional uncertainty. This lack of data makes an analyte a COPEC of uncertain risk until it undergoes the HQ analysis in the EU- and receptor-specific screen, which begins in Section 7.7.

7.5.4 Uncertainties in Risk Characterization

The uncertainties described above ultimately produce uncertainty in the quantification of current and future risks to terrestrial and aquatic animals at Load Line 2. Five additional areas of uncertainty in the risk characterization exist: off-site risk, cumulative risk, future risk, background risk, and extrapolation risk.

7.5.4.1 Off-site risk

The risks to off-site receptors could be characterized with the benefit of clearly identified body burden data from on-site receptors; pathways (especially any surface water pathways); as well as any constituent tracer studies and off-site plant, animal, and habitat surveys. However, those analyses are beyond the scope of this SERA. Off-site receptors can be exposed to constituents via physical and organismal transport processes, but evaluating the magnitude of this exposure would require additional studies. It is unlikely that off-site receptors would have lower toxicity thresholds for constituents than the thresholds used for on-site receptors. In addition, there is little reason to expect that constituents migrating off-site would be concentrated above measured concentrations at Load Line 2 unless a constituent bioconcentrates in organisms that migrate on and off the site. In general, the risk to most off-site receptors is likely to be overestimated, rather than underestimated, by the risk estimate for on-site receptors.

7.5.4.2 Cumulative risk

The SERA estimates the risk to populations of ecological receptors from individual constituents. Yet, in nature, receptors are exposed simultaneously to mixtures of constituents. Generally, the methods used are

sufficiently conservative, resulting in individual risks that are overestimated. Nevertheless, cumulative risk is possible when several living plants and animals are affected simultaneously. Harmful effects in ecosystems (including effects on individual organisms) may cascade throughout the system and have indirect effects on the ability of a population to persist in the area even though individual organisms are not sensitive to the given constituents in isolation. Therefore, the ecological risk characterization for Load Line 2 may underestimate actual risks to plants and animals from cumulative risks.

7.5.4.3 Future risk

A third area of uncertainty in the ecological risk characterization is the future risk to plants and animals from contamination at Load Line 2. The SERA characterizes the current risk based on chronic exposure to measured concentrations of toxicants with the potential to persist in the environment for extended periods of time. HQs for animals estimate the risk to animal species that would be natural parts of future successional stages at these areas. Nevertheless, possible mechanisms exist that could significantly increase (e.g., erosion and leaching to surface water or groundwater) or decrease (e.g., enhanced microbial degradation) the risk to future plants and animals at the sites.

7.5.4.4 Background risk

Another source of uncertainty is ecological risk relative to background conditions. Although only inorganics with concentrations above background were examined in the COPEC screening, some COPECs are above background only by statistically small amounts. The conservative approach to comparing site concentrations to background likely overestimates the risk from COPECs compared to background.

7.5.4.5 Extrapolation risk

Yet another source of uncertainty revolves around the extrapolations of Load Line 1 data, including HQs, to Load Line 2. No one load line and no one EU is exactly like its companion. Differences in concentrations and chemical mixtures introduce variation into extrapolations.

7.5.5 Summary of Uncertainties

The most important uncertainties in the Load Line 2 SERA are those surrounding the estimates of the constituent concentrations to which ecological receptors are actually exposed (exposure concentrations), the concentrations that present an acceptable level of risk of harmful effects (ESVs), and the extrapolation of HQs from Load Line 1 to Load Line 2. These uncertainties arise from multiple sources, but especially from the lack of site-specific data on constituent transport and transformation processes, bioavailability of contaminants, organism toxicity, and the response of plant and animal populations to stressors in their environments. Despite these uncertainties, the available site-concentration data and published exposure and effects information should allow for the identification of preliminary COPECs that require calculation of screening HQs under a deferred scope of work not addressed in this SERA. The Load Line 2 COPECs are defined as sediment and surface water analytes whose maximum detect exceeds the preferred ESV, or that are PBT compounds, or have no ESV; or soil analytes that either (1) were not detected at comparable EUs at Load Line 1, (2) had means less than the exposure concentrations at comparable EUs at Load Line 1 but had maximum detects > background and a Load Line 1 HQ > 1, or (3) had means greater than exposure concentrations at comparable EUs at Load Line 1 and means greater than means at comparable EUs at Load Line 1 (per T-Test and spatial evaluation). Thus, the purpose of the SERA is fulfilled.

7.6 SUMMARY OF THE SCREENING ECOLOGICAL RISK ASSESSMENT

7.6.1 Methods

A screening SERA was performed in accordance with written guidance from the EPA, as well as the Army's draft protocol for site-wide ERA at Ravenna. One of the most important features of the Army's draft protocol is the value of extrapolation from one AOC to another. This SERA utilized the Army's draft protocol to extrapolate ecological risk finding for soils at Load Line 1 EUs to soils from comparable EUs at Load Line 2. This guidance recognizes step-by-step procedures. The present SERA includes problem formulation, exposure assessment and effects assessment, and culminates in risk characterization with attention to uncertainties and summarization. The scope of this SERA was to identify preliminary COPECs, which can be eliminated from further consideration or require calculation of screening HQs under a separate scope of work not addressed by this SERA.

The Load Line 2 site contains sufficient terrestrial and aquatic (surface water and sediment) habitat to support various classes of ecological receptors. For example, terrestrial habitats at Load Line 2 include old fields, woodlots, and grassy areas. Various classes of receptors, such as vegetation, small and large mammals, and birds, have been observed at the site. Thus, the presence of suitable habitat and observed receptors at the site warrants a SERA. Also, the Ohio EPA protocol (Level I) was met, and Level II was needed.

The identification of preliminary COPECs for sediment and surface water began with the SRCs from each of the EUs associated with these media. The two EUs for sediment included the Kelly's Pond and Exit Drainage Aggregate, and the North Ponds Aggregate. The MDCs of each SRC were compared to the corresponding preferred ESV. Each SRC was also evaluated to determine if it qualified as a PBT compound (i.e., had a BAF ≥ 2 for inorganics, or a log $K_{ow} \geq 4$ for organics). A sediment or surface water SRC was identified as a preliminary COPEC at a Load Line 2 EU if it met any of the following conditions: (1) its MDC > the preferred ESV, (2) it had no ESV, or (3) it was a PBT compound.

Identifying soil preliminary COPECs entailed a multi-step process that first compared the Load Line 2 mean concentrations of analytes from each of the five EUs to the exposure concentrations from comparable EUs at Load Line 1 to see if the concentrations were different. If the Load Line 2 means did not exceed the Load Line 1 exposure concentrations, then the maximum screening HQs from Load Line 1 were applied to Load Line 2. If the Load Line 1 HQ exceeded 1 and the Load Line 2 MDC exceeded background, the Load Line 2 analyte was considered a preliminary COPEC. If the Load Line 1 HQ was < 1, but the Load Line 2 MDC > background, the Load Line 2 analyte underwent an ESV and PBT screen. Soil analytes in the ESV and PBT screen were identified as preliminary COPEC per the same criteria as was described for sediment and surface water. Lastly, any Load Line 2 analytes whose means exceeded the means at comparable EUs at Load Line 1 (as verified by t-tests and spatial distribution analysis) were identified as preliminary COPECs.

7.6.2 Soil Chemicals of Potential Ecological Concern

Only one new soil analyte, benzoic acid, was detected at Load Line 2 that was not on the analyte list for Load Line 1. A summary of the Load Line 2 soil preliminary COPECs, organized by EUs, and the rationales for why the analytes were preliminary COPECs is presented in Table 7-8. The Explosives Handling Areas Aggregate contained the most preliminary COPECs for soil (15 metals, 2 pesticides, and 1 PCB), whereas the North Ditches Aggregate had the fewest preliminary COPECs for soil (3 metals). The Packaging and Shipping Areas Aggregate had the second highest number of preliminary COPECs (11 metals and 1 PCB). The Preparation and Receiving Areas Aggregate had nine metals, one PCB, and one semivolatile that were preliminary COPECs. The Perimeter Area Aggregate had five metals that were

Table 7-8. Summary of Preliminary COPECs for soil at Load Line 2 Exposure Units

Load Line 2 Analyte	Rationale for Selection of the Preliminary COPEC			
	Load Line 2 Max. Det. > ESV	**Load Line 2 Analyte Had No ESV**	**Load Line 2 Analyte is a PBT Compound**	**Load Line 2 Mean > Load Line 1 Mean per T-Test and Spatial Distribution evaluation**
Explosive Handling Areas Aggregate				
Metals				
Aluminum	X			
Barium	X			
Beryllium				X
Cadmium	X		X	
Calcium				X
Chromium	X			
Copper	X			
Iron	X			
Lead	X		X	
Magnesium				X
Manganese	X			
Mercury	X		X	
Nickel				X
Selenium				X
Zinc	X		X	
Organics-Pesticides/PCBs				
4,4'-DDT	X		X	
Dieldrin	X		X	
PCB-1254		X	X	
Preparation and Receiving Areas Aggregate				
Metals				
Aluminum	X			
Antimony	X			
Arsenic	X			
Barium	X			
Cadmium	X		X	
Cobalt				X
Lead	X		X	
Manganese	X			
Selenium				X
Organics-Pesticides/PCBs				
PCB-1254		X	X	
Organics-Semivolatiles				
Benzo(*a*)pyrene	X		X	
Packaging and Shipping Areas Aggregate				
Metals				
Aluminum	X			
Barium	X			
Cadmium	X		X	
Chromium	X			
Copper	X			
Iron	X			
Lead	X		X	

Table 7-8. Summary of Preliminary COPECs for soil at Load Line 2 Exposure Units (continued)

Load Line 2 Analyte	Rationale for selection of the preliminary COPEC			
	Load Line 2 Max. Det. > ESV	Load Line 2 Analyte Had No ESV	Load Line 2 Analyte is a PBT Compound	Load Line 2 Mean > Load Line 1 Mean per T-Test and Spatial Distribution Evaluation
Manganese	X			
Mercury	X		X	
Selenium				X
Zinc	X		X	
Organics-Pesticides/PCBs				
PCB-1254		X	X	
Perimeter Area Aggregate				
Metals				
Aluminum	X			
Arsenic	X			
Beryllium				X
Iron	X			
Manganese	X			
North Ditches Aggregate				
Metals				
Nickel				X
Zinc				X

COPEC = Contaminant of potential ecological concern.
DDT = Dichlorodiphenyltrichloroethane.
ESV = Ecological screening value.
Max. Det. = Maximum detect.
PBT = Persistent, bioaccumulative, and toxic.
PCB = Polychlorinated biphenyl.
X = This is a rationale for selecting the analyte as a preliminary COPEC.

identified as preliminary COPECs. At all EUs except the North Ditches Aggregate, the rationale that was responsible for identifying the most preliminary COPECs was the "maximum detection exceeded the ESV." The rationale that was responsible for identifying the fewest preliminary COPECs was "No ESV," which only identified PCB-1254 at three of the four EUs. For the North Ditches Aggregate, both preliminary COPECs were identified by the rationale of the Load Line 2 means > Load Line 1 means, per t-tests and the spatial distribution evaluation. There is one new analyte, benzoic acid, run at Load Line 2 compared to Load Line 1. All of these preliminary COPECs require further evaluation by having screening HQs calculated, but that process will be performed under a separate scope of work not addressed by this SERA.

7.6.3 Sediment Chemicals of Potential Ecological Concern

A summary of the Load Line 2 sediment preliminary COPECs, organized by the two EUs, and the rationales for why the analytes were preliminary COPECs is presented in Table 7-9. The Kelly's Pond and Exit Drainages Aggregate contained the most preliminary COPECs for sediment (7 metals, 4 pesticides, 3 explosives, and 13 semivolatiles), whereas the North Ponds Aggregate had only 3 preliminary COPECs for sediment (2 metals and 1 explosive). Most of the sediment preliminary COPECs were identified by virtue of having a maximum detect exceeding the ESV (16 of 28). Approximately one-third of the preliminary COPECs for sediment were selected by virtue of having no

Table 7-9. Summary of Preliminary COPECs for Sediment at Load Line 2 Exposure Units

Load Line 2 Sediment Analyte	Rationale for selection of preliminary COPECs		
	Load Line 2 Analyte Max. Det. > ESV	Load Line 2 Analyte had No ESV	Load Line 2 Analyte is a PBT Compound
Kelly's Pond and Exit Drainages Aggregate			
Metals			
Antimony		X	
Beryllium		X	
Cadmium			X
Calcium		X	
Lead	X		X
Magnesium		X	
Silver	X		
Organics-Explosives			
4-Amino-2,6-dinitrotoluene		X	
2,4-Dinitrotoluene	X		
2,4,6-Trinitrotoluene		X	
Organics-Pesticides/PCBs			
Beta-BHC	X		
4,4'-DDE	X		X
4,4'-DDT			X
Endrin Ketone		X	
Organics-Semivolatiles			
Anthracene	X		X
Bis(2-ethylhexyl)phthalate			X
Benzo(*a*)anthracene	X		X
Benzo(*a*)pyrene	X		X
Benzo(*b*)fluoranthene			X
Benzo(*g,h,i*)perylene	X		X
Benzo(*k*)fluoranthene	X		X
Chrysene	X		X
Dibenzo(*a,h*)anthracene	X		X
Fluoranthene	X		X
Indeno(1,2,3-*cd*)pyrene	X		X
Phenanthrene	X		X
Pyrene	X		X
North Ponds Aggregate			
Metals			
Cadmium			X
Lead			X
Organics-Explosives			
Nitrocellulose		X	

BHC = Benzene hexachloride.
COPEC = Contaminant of potential ecological concern.
DDE = Dichlorodiphenyldichloroethylene.
DDT = Dichlorodiphenyltrichloroethane.
ESV = Ecological screening value.
Max. Det. = Maximum detect.
PBT = Persistent, bioaccumulative, and toxic.
PCB = Polychlorinated biphenyl.
X = This is a rationale for selecting the analyte as a preliminary COPEC.

ESVs. Only five sediment analytes were preliminary COPECs solely by virtue being PBT compounds. All of these preliminary COPECs require further evaluation by having screening HQs calculated, but that process will be performed under a separate scope of work not addressed by this SERA.

7.6.4 Surface Water Chemicals of Potential Ecological Concern

A summary of the Load Line 2 surface water preliminary COPECs and the rationales for why the analytes were preliminary COPECs is presented in Table 7-10. Four preliminary COPECs (three metals and one semivolatile) were identified at the Kelly's Pond and Exit Drainages Aggregate. The rationales that were responsible for identifying the preliminary COPECs included no ESV for calcium and magnesium, and being PBT compounds for cadmium and bis(2-ethylhexyl)phthalate. All of these preliminary COPECs require further evaluation by having screening HQs calculated, but that process will be performed under a separate scope of work not addressed by this SERA.

Table 7-10. Summary of Preliminary COPECs for Surface Water at the Load Line 2 Exposure Unit

LL 2 Surface Water Analyte	LL 2 Analyte Max. Det. > ESV	LL 2 Analyte had No ESV	LL 2 Analyte is a PBT Compound
Kelly's Pond and Exit Drainages Aggregate			
Metals			
Cadmium			X
Calcium		X	
Magnesium		X	
Organics-Semivolatiles			
Bis(2-ethylhexyl)phthalate			X

COPEC = Contaminant of potential ecological concern.
ESV = Ecological screening value.
Max. Det. = Maximum detect.
PBT = Persistent, bioaccumulative, and toxic.
X = This is a rationale for selecting the analyte as a preliminary COPEC.

7.6.5 Conclusions

In conclusion, there are many constituents eliminated by the methodical comparative extrapolation approach of Load Line 1 to Load Line 2. However, there still remains a few preliminary COPECs for soil at all five of the terrestrial EUs, for sediment at both EUs, and for surface water at one EU. The soil preliminary COPECs included many by virtue of the maximum Load Line 2 detect exceeding the ESV, as well as several Load Line 2 analytes whose EU means were greater than the means at comparable EUs at Load Line 1. A few Load Line 2 soil analytes were preliminary COPECs by virtue of being PBT compounds, but most of them were already preliminary COPECs by virtue of other rationales. Only one new analyte, benzoic acid, had not been on the analyte list for Load Line 1. Most of the sediment preliminary COPECs were identified by virtue of having a maximum detect exceeding the ESV (16 of 28). Approximately one-third of the preliminary COPECs for sediment were selected by virtue of having no ESVs. Only four sediment analytes were preliminary COPECs solely by virtue being PBT compounds. Two of the surface water preliminary COPECs were identified by virtue of having no ESV and were nutrients, while the other two analytes were preliminary COPECs by virtue of being PBT compounds. Preliminary COPECs based on maximum detects exceeding ESVs were limited to two metals and one pesticide. All of the preliminary COPECs identified in this SERA require further evaluation by having screening HQs calculated beginning in Section 7.7.

7.7 SCOPE AND OBJECTIVES FOR THE BASELINE ECOLOGICAL RISK ASSESSMENT

The scope of the BERA or Ohio Level III ERA is to characterize the risk to plant and animal populations at Load Line 2, including its aquatic environments, from analytes that are present in the surface soil, sediment, and surface water. The principal tool is the HQ for a variety of specific ecological receptors. Details about the general, as well as the SERA, scope and objectives are found in Section 7.1.

7.8 PROCEDURAL FRAMEWORK FOR THE BASELINE ECOLOGICAL RISK ASSESSMENT

According to the *Framework for Ecological Risk Assessment* (EPA 1992c), the BERA process (like the SERA) consists of three interrelated phases: problem formulation, analysis (composed of exposure assessment and ecological effects assessment), and risk characterization. See Section 7.2 for details about these phases.

The BERA is organized by the four interrelated steps of the EPA framework. Sections 7.9 and 7.10 detail the technical issues and data evaluation procedures associated with each step followed by the HQ results. Section 7.11 evaluates the degree of reliability or uncertainty of these methodological steps and the data used. Finally, Section 7.12 provides the summary of BERA methods and results.

7.9 PROBLEM FORMULATION FOR THE BASELINE ECOLOGICAL RISK ASSESSMENT

The first step of EPA's approach to the BERA process, problem formulation (data collection and evaluation), includes the same parts as SERA detailed in Section 7.3.

7.9.1 Ecological Conceptual Site Model

The ecological CSM of Load Line 2 has been developed for the BERA using available site-specific information and professional judgment. The constituent source, exposure media, receptors, and the routes by which they are exposed to constituents are recognized. Figure 7-1 shows the ecological CSM whose parts are explained in Section 7.3.1. The big difference between the SERA and BERA CSMs is the greater specificity of ecological receptors for the BERA.

7.9.2 Selection of Exposure Units

From the ecological assessment viewpoint, an EU is the investigation area and some of the surrounding area where ecological receptors are likely to gather food, seek shelter, reproduce, and move around. The BERA depends on the same six terrestrial EUs and the same sediment/surface water EUs as did the SERA (see Section 7.3.2).

7.9.3 Description of Habitats and Populations

The habitats and populations are defined in a multi-page section in the SERA (see Section 7.3.3).

7.9.4 Review of Preliminary Chemicals of Potential Ecological Concern from the Screening Ecological Risk Assessment

Part of the SERA activities examined the interrelationships of Load Line 1 and Load Line 2. Sections 7.1 through 7.6 provided the scope, methods, results, and uncertainties associated with that relationship as governed by the Army's RVAAP site-wide ERA (USACE 2003). Even though the results are provided in Section 7.4 and summarized in Section 7.6, the findings are restated below to facilitate the set-up and

subsequent analysis in the BERA. Therefore, the preliminary COPEC identification process and results will not be repeated in detail but will be briefly summarized in this section. The purpose of this review is to clearly identify, in one place, those preliminary COPECs that will be used in the BERA.

A summary of the process that was used to identify preliminary COPECs is presented in Section 7.9.4.1, whereas summaries of the results of the identification of COPECs for soil, sediment, and surface water are presented in Sections 7.9.4.2 through 7.9.4.4, respectively. The preliminary COPECs that were identified as part of the Level II Screening were inputted into this Level III BERA as the starting constituents for which receptor-specific HQs are calculated as an indication of ecological risk.

7.9.4.1 Summary of the methodology to identify preliminary COPECs for the Level II Screening

Media- and EU-specific COPECs for surface soil (0 to 1 ft depth), sediment, and surface water were identified from SRCs by applying a multi-step process of sequential screening activities that were each designed to either eliminate the SRC from further consideration for risk evaluation, or to carry the SRC forward for further evaluation that led to the SRC being identified as a preliminary COPEC. The process for identifying soil COPECs at Load Line 2 was more complex than the process for identifying sediment and surface water COPECs because it entailed various comparisons between the soil constituents at Load Line 2 and Load Line 1, as described in detail in Section 7.4.3.2. Although the identification of soil COPECs was the most complex process of the three media, two processes were utilized in the COPEC identification for all three media: (1) comparison of EU-specific MDCs of SRCs against media- and contaminant-specific ESVs, and (2) identifying SRCs that were considered persistent, bioaccumulative, and toxic (PBT) compounds. PBT compounds were identified as any inorganic SRC whose maximum BAF was ≥ 2, or any organic SRC whose log octanol-water partition coefficient (K_{ow}) was ≥ 4. Thus, SRCs for surface soil, sediment, and surface water were subjected to EU-specific ESV and PBT screens, and were identified as preliminary COPECs and carried forward to this Level III BERA if they met one or more of the following three conditions: (1) their MDC > the ESV, (2) the SRC was a PBT compound, or (3) the SRC had no ESV.

For surface soil, three additional conditions led to a SRC being identified as a preliminary COPEC: (a) the SRC at Load Line 2 had not been detected at the comparable EU at Load Line 1, (b) the Load Line 2 mean concentration > Load Line 1 mean per t-test plus spatial analysis (clustering minimum distance between highest concentrations is < 50 ft), or (c) if the Load Line 2 mean SRC concentration was not significantly greater than the mean from the comparable EU at Load Line 1 and the Load Line 1 maximum HQ > 1.

7.9.4.2 Summary of soil preliminary COPECs from the Level II Screen

The Level II Screen identified the following, EU-specific list of soil preliminary COPECs from vie EUs, based on the results of the ESV and PBT screen as well as the Load Line 2 versus Load Line 1 SRC comparisons.

Explosives Handling Area Aggregate Soil Preliminary COPECs

- Aluminum (maximum detect > ESV)
- Barium (maximum detect > ESV)
- Beryllium (Load Line 2 mean > Load Line 1 mean)
- Cadmium (maximum detect > ESV; PBT compound)
- Calcium (Load Line 2 mean > Load Line 1 mean)
- Chromium (maximum detect > ESV)
- Copper (maximum detect > ESV)

- Iron (maximum detect > ESC)
- Lead (maximum detect > ESV; PBT compound)
- Magnesium (Load Line 2 mean > Load Line 1 mean)
- Manganese (maximum detect > ESV)
- Mercury (maximum detect > ESV; PBT compound)
- Nickel (Load Line 2 mean > Load Line 1 mean)
- Selenium (Load Line 2 mean > Load Line 1 mean)
- Zinc (maximum detect > ESV; PBT compound)
- Benzoic acid (detected at Load Line 2 but not at Load Line 1)
- PCB-1254 (no ESV; PBT compound)
- 4,4'-DDT (maximum detect > ESV; PBT compound)
- Dieldrin (maximum detect > ESV; PBT compound)

This list of preliminary COPECs carried forward to, and was inputted into, the Level III BERA.

Preparation and Receiving Areas Aggregate Soil Preliminary COPECs

- Aluminum (maximum detect > ESV)
- Antimony (maximum detect > ESV)
- Arsenic (maximum detect > ESV)
- Barium (maximum detect > ESV)
- Cadmium (maximum detect > ESV; PBT compound)
- Cobalt (Load Line 2 mean > Load Line 1 mean)
- Lead (maximum detect > ESV; PBT compound)
- Manganese (maximum detect > ESV)
- Selenium (Load Line 2 mean > Load Line 1 mean)
- PCB-1254 (no ESV; PBT compound)
- Benzo(*a*)pyrene (maximum detect > ESV; PBT compound)

This list of preliminary COPECs carried forward to, and was inputted into, the Level III BERA.

Packaging and Shipping Areas Aggregate Soil Preliminary COPECs

- Aluminum (maximum detect > ESV)
- Barium (maximum detect > ESV)
- Cadmium (maximum detect > ESV; PBT compound)
- Chromium (maximum detect > ESV)
- Copper (maximum detect > ESV)
- Iron (maximum detect > ESC)
- Lead (maximum detect > ESV; PBT compound)
- Manganese (maximum detect > ESV)
- Mercury (maximum detect > ESV; PBT compound)
- Silver (Load Line 2 mean > Load Line 1 mean)
- Zinc (maximum detect > ESV; PBT compound)
- PCB-1254 (no ESV; PBT compound)

This list of preliminary COPECs carried forward to, and was inputted into, the Level III BERA.

Perimeter Area Aggregate Soil Preliminary COPECs

- Aluminum (maximum detect > ESV)
- Arsenic (maximum detect > ESV)
- Beryllium (Load Line 2 mean > Load Line 1 mean)
- Iron (maximum detect > ESC)
- Manganese (maximum detect > ESV)

This list of preliminary COPECs carried forward to, and was inputted into, the Level III BERA.

North Ditches Aggregate Soil Preliminary COPECs

- Nickel (Load Line 2 mean > Load Line 1 mean)
- Zinc (Load Line 2 mean > Load Line 1 mean)

This list of preliminary COPECs carried forward to, and was inputted into, the Level III BERA.

7.9.4.3 Summary of sediment preliminary COPECs from the Level II Screen

The Level II Screen identified the following, EU-specific list of sediment preliminary COPECs from two EUs, based on the results of the ESV and PBT screen.

Kelly's Pond and Exit Drainages Aggregate Sediment Preliminary COPECs

- Antimony (no ESV)
- Beryllium (no ESV)
- Cadmium (PBT compound)
- Calcium (no ESV)
- Lead (maximum detect > ESV; PBT compound)
- Magnesium (no ESV)
- Silver (maximum detect > ESV)
- Anthracene (maximum detect > ESV; PBT compound)
- Bis(2-ethylhexyl)phthalate (PBT compound)
- Benzo(*a*)anthracene (maximum detect > ESV; PBT compound)
- Benzo(*a*)pyrene (maximum detect > ESV; PBT compound)
- Benzo(*b*)fluoranthene (PBT compound)
- Benzo(*g,h,i)*perylene (maximum detect > ESV; PBT compound)
- Benzo(*k*)fluoranthene (maximum detect > ESV; PBT compound)
- Chrysene (maximum detect > ESV; PBT compound)
- Dibenzo(*a,h*)anthracene (maximum detect > ESV; PBT compound)
- Fluoranthene (maximum detect > ESV; PBT compound)
- Indeno(1,2,3-*cd*)pyrene (maximum detect > ESV; PBT compound)
- Phenanthrene (maximum detect > ESV; PBT compound)
- Pyrene (maximum detect > ESV; PBT compound)
- Beta-BHC (maximum detect > ESV)
- 4,4'-DDE (maximum detect > ESV; PBT compound)
- 4,4'-DDT (PBT compound)
- Endrin ketone (no ESV)
- 4-Amino-2,6-DNT (no ESV)

- 2,4-DNT (maximum detect > ESV)
- 2,4,6-TNT (no ESV)

This list of preliminary COPECs carried forward to, and was inputted into, the Level III BERA.

North Ponds Aggregate Sediment Preliminary COPECs

- Cadmium (PBT compound)
- Lead (PBT compound)
- Nitrocellulose (no ESV)

This list of preliminary COPECs carried forward to, and was inputted into, the Level III BERA.

7.9.4.4 Summary of surface water preliminary COPECs from the Level II Screen

The Level II Screen identified the following, EU-specific list of surface water preliminary COPECs from the sole EU, based on the results of the ESV and PBT screen.

Kelly's Pond and Exit Drainages Aggregate Surface Water Preliminary COPECs

- Cadmium (PBT compound)
- Calcium (no ESV)
- Magnesium (no ESV)
- Bis(2-ethylhexyl)phthalate (PBT compound)

This list of preliminary COPECs carried forward to, and was inputted into, the Level III BERA.

7.9.5 Baseline Ecological Risk Assessment or Level III Ecological Exposure Assessment

For Level III, mathematical models are used to calculate the exposure of specific ecological receptors to COPECs, and the exposures are compared to chemical TRVs. COPECs are constituents that remain after the screening step (Sections 7.1 through 7.6). Published chemical- and receptor-specific TRVs were used for COPECs. Each of these toxicity benchmarks is defined later in the text. The BERA steps (Sections 7.7 through 7.12) culminate in an sample management decision plan, which will result in (1) NFA, (2) an sample management decision plan to decide whether to conduct a removal or other remedial action, or (3) to conduct a more detailed ERA, including field surveys and sampling.

The methods for performing ecological exposure assessment are presented in the following subsections, which describe

- the Level III approach to using screening and analysis methods (Section 7.9.5.1),
- receptor-specific parameters to be used in the exposure equations (Section 7.9.5.2),
- methods and equations to estimate exposure to COPECs (Section 7.9.5.3), and
- receptor- and chemical-specific exposure parameters (Section 7.9.5.4).

7.9.5.1 Site-specific methods approach

The Level III evaluation used an estimate of the reasonable maximum exposure (RME) concentrations in environmental media at each EU to identify COPECs and ecological receptors that require no further analysis. The RME concentration was defined as the lower of the 95% UCL of the mean and the MDC. The methods used to calculate RME concentration for each COPEC at each EU are described in Chapter 4.0.

For direct exposure (terrestrial plants, terrestrial invertebrates, aquatic biota, and benthic invertebrates), the HQ was calculated by dividing the RME concentration in soil, surface water, or sediment by the TRV. For ingestion exposures (mammals and birds), the average daily dose (ADD) was calculated using the exposure equations presented in Section 7.9.5.2. The HQ was calculated by dividing the ADD by the TRV (Section 7.9.6).

Internal concentrations of COPECs were calculated for terrestrial plants, terrestrial invertebrates, aquatic biota, and benthic invertebrates by multiplying the RME concentration of the COPEC by a chemical- and species-specific bioconcentration factor (BCF) or BAF (BCFs and BAFs are defined and described in Section 7.9.5.4). Internal concentrations in plants, terrestrial invertebrates, benthic invertebrates, aquatic plants, and aquatic biota were used to calculate ADDs to terrestrial herbivores, terrestrial invertivores, riparian herbivores, and riparian carnivores. Internal concentrations of COPECs in animal prey (small mammals and fish) were used to calculate ADDs to carnivores (Section 7.9.5.3).

Internal concentrations of COPECs in small mammals were calculated by multiplying the ADD by a chemical- and species-specific BAF (Section 7.9.5.4). Internal concentrations of COPECs in fish were used along with sediment or surface water concentrations to calculate the ADD of riparian carnivores (Section 7.9.5.3).

7.9.5.2 Receptor parameters

Calculation of receptor-specific ADDs requires parameters that describe the home range, body weight, food and water intake rates, and diet distribution. The representative receptors for the Level III BERA are described in Section 7.9.5.3. Receptor parameters are not needed for plants, earthworms, benthic invertebrates, or aquatic biota because doses for these receptors are empirically based on contaminant concentrations in soil, sediment, or surface water, rather than calculated. Receptor parameters for the other indicator receptors are shown in Tables R-22 through R-29.

7.9.5.3 Ecological receptors and exposure evaluation for COPECs

The dose that results from the exposure of a receptor to chemicals in soil, sediment, or surface water, both directly and through food chains, is the product of the concentration of the chemical in the ingested medium and exposure factors. Exposure factors describe how much of the available chemical is taken up by the receptor per unit of concentration in the medium. Exposures were calculated for the EU-specific Level III analysis assuming that the most likely contaminated food item makes up 100% of the diet and all of the ingested food is absorbed. It is further assumed that the receptor is present in the vicinity of the site 100% of the time, but it does not necessarily feed on the site all of the time. Therefore, an area use factor (AUF) is calculated for each receptor at each EU (see Section 7.9.5.4).

Equations used to calculate exposure to COPECs were adapted from equations presented in Ohio EPA guidance (Ohio EPA 2003); terms used in this section may differ from those used in the guidance, but the mathematical meaning of each equation matches the corresponding equation in the Ohio EPA guidance (Ohio EPA 2003). Equations are given here for

- terrestrial plants,
- terrestrial invertebrates,
- terrestrial mammals and birds (rabbit, shrew, fox, and hawk),
- aquatic biota (aquatic invertebrates and fish),
- benthic invertebrates (aquatic insect larvae, crayfish, snails, clams and bivalves),
- riparian herbivores (muskrat and mallard), and
- riparian carnivores (mink and heron).

Terrestrial plants and invertebrates are exposed by direct contact with soil. Terrestrial animals and birds are exposed to COPECs by ingestion of food and soil. Three kinds of equations were required to calculate the exposures of all terrestrial receptors: an equation for exposure by ingestion of plants and soil; an equation for exposure by ingestion of terrestrial invertebrates and soil; and an equation for exposure of carnivores by ingestion of animal prey and soil.

Terrestrial plants

Exposure equations are not needed for exposure of terrestrial plants to COPECs because the TRV for plants is the concentration in soil. Therefore, the measure of exposure for plants to a COPEC is the RME concentration of the COPEC in soil at each EU (mg/kg dry weight).

Terrestrial soil invertebrates

Exposure equations are not needed for terrestrial invertebrates because the TRV for terrestrial invertebrates is the concentration in soil. Therefore, the measure of exposure for terrestrial invertebrates is the RME concentration of the COPEC in soil at each EU (mg/kg dry weight).

Terrestrial herbivores (cottontail rabbit)

It was assumed that terrestrial herbivores are exposed by ingestion of plants and soil. The equation for exposure of terrestrial herbivores to a single COPEC in contaminated soil by ingestion of plants and soil (Ohio EPA 2003) is

$$ADD_{total} = ADD_P + ADD_S \quad \textbf{(7-1)}$$

where

ADD_{total}	=	average daily dose (mg/kgBW/d) from all ingestion combined,
ADD_P	=	average daily dose (mg/kgBW/d) from ingestion of plants,
ADD_S	=	average daily dose (mg/kgBW/d) from ingestion of soil.

The equation for exposure by ingestion of plants (Ohio EPA 2003) is

$$ADD_P = RME \times SP_V \times CF \times I_P \times AUF \quad \textbf{(7-2)}$$

where

RME	=	RME concentration of COPEC in soil (mg/kg dry weight),
SP_V	=	soil-to-plant BCF [mg/kg dry weight per mg/kg dry soil (= kg dry soil/kg dry weight)]. SPv indicates a diet of vegetative plants,
CF	=	correction factor, dry weight to wet weight; assuming 85% water content of plants (Ohio EPA 2003), CF = (1 – 0.85) = 0.15,
I_P	=	plant ingestion rate (kg fresh plant/kgBW/d),
AUF	=	area use factor, ratio of an organism's home range to the area of contamination (see Section 7.9.5.4).

The equation for exposure by ingestion of soil (Ohio EPA 2003) is

$$ADD_S = RME \times I_S \times AUF \quad \textbf{(7-3)}$$

where

RME = RME concentration of COPEC in soil (mg/kg dry weight),
I_S = soil ingestion rate (kg dry soil/kgBW/d),
AUF = area use factor, ratio of an organism's home range to the area of contamination (see Section 7.9.5.4).

Terrestrial invertivore (short-tailed shrew)

It was assumed that terrestrial invertivores were exposed by ingestion of terrestrial invertebrates (earthworms) and soil. The equation for exposure of terrestrial invertivores to a single COPEC in contaminated soil by ingestion of terrestrial invertebrates and soil (Ohio EPA 2003) is

$$ADD_{total} = ADD_A + ADD_S \quad \textbf{(7-4)}$$

where

ADD_{total} = average daily dose (mg/kgBW/d) from all ingestion combined,
ADD_A = average daily dose (mg/kgBW/d) from ingestion of animals,
ADD_S = average daily dose (mg/kgBW/d) from ingestion of soil.

The equation for exposure by ingestion of animals (terrestrial invertebrates) (Ohio EPA 2003) is

$$ADD_A = RME \times BAF_i \times CF_i \times I_A \times AUF \quad \textbf{(7-5)}$$

where

RME = RME concentration of COPEC in soil (mg/kg dry weight),
BAF_i = soil-to-soil invertebrate BCF [mg/kg dry weight per mg/kg dry soil for inorganic COPECs (= kg dry soil/kg dry weight)],
CF_i = correction factor (earthworms) [(0.13) for As, Cd, Cr, Cu, Hg, Mn, Ni, Pb, Zn, PCBs, and 1 for all other COPECs—fraction dry weight worm/kg wet weight],
I_A = animal ingestion rate (kg fresh animal/kgBW/d),
AUF = area use factor, ratio of an organism's home range to the area of contamination (see Section 7.9.5.4).

The equation for exposure by ingestion of soil (Ohio EPA 2003) was:

$$ADD_S = RME \times I_S \times AUF \quad \textbf{(7-6)}$$

where

RME = RME concentration of COPEC in soil (mg/kg dry weight),
I_S = soil ingestion rate (kg dry soil/kgBW/d),
AUF = area use factor, ratio of an organism's home range to the area of contamination (see Section 7.9.5.4).

Terrestrial carnivores (red fox and red-tailed hawk)

It was assumed that terrestrial carnivores were exposed by ingestion of small mammals (shrews) and soil. The equation for exposure of terrestrial carnivores by ingestion of animal prey and soil (Ohio EPA 2003) is

$$ADD_{total} = ADD_P + ADD_A + ADD_S \quad \textbf{(7-7)}$$

where

ADD_{total} = average daily dose (mg/kgBW/d) from all ingestion combined,
ADD_P = average daily dose (mg/kgBW/d) from ingestion of plants,
ADD_A = average daily dose (mg/kgBW/d) from ingestion of animals,
ADD_S = average daily dose (mg/kgBW/d) from ingestion of soil.

The equation for exposure by ingestion of plants (Ohio EPA 2003) is

$$ADD_P = RME \times SP_r \times CF \times I_P \times AUF \quad \textbf{(7-8)}$$

where

RME = RME concentration of COPEC in soil (mg/kg dry weight),
SP_r = soil-to-plant BCF [mg/kg dry weight per mg/kg dry soil (= kg dry soil/kg dry weight)]. SPr indicates a diet of fruit for the fox (hawks are assumed not to consume plant matter),
CF = correction factor, dry weight to wet weight; assuming 90% water content of fruit, CF = (1 – 0.90) = 0.10,
I_P = plant ingestion rate (kg fresh plant/kgBW/d),
AUF = area use factor, ratio of an organism's home range to the area of contamination (see Section 7.9.5.4).

The equation for exposure by ingestion of animals (terrestrial invertebrates) (Ohio EPA 2003) is

$$ADD_A = C_S \times I_A \times AUF \quad \textbf{(7-9)}$$

where

C_S = concentration in the prey resulting from RME exposure (mg/kgBW);

$$C_S = ADD_{total(shrew)} \times BAF_{TP} / IR_{F(shrew)} \quad \textbf{(7-10)}$$

where

BAF_{TP} = food-to-prey BAF [mg/kgBW of prey per mg/kg food (= kg food/kg BW of prey),
$IR_{F(shrew)}$ = ingestion rate of food by shrew,
I_A = animal ingestion rate (kg fresh animal/kgBW/d),
AUF = area use factor, ratio of an organism's home range to the area of contamination (see Section 7.9.5.4).

The equation for exposure by ingestion of soil (Ohio EPA 2003) is

$$ADD_S = RME \times I_S \times AUF \quad \textbf{(7-11)}$$

where

RME	=	RME concentration of COPEC in soil (mg/kg dry weight),
I_S	=	soil ingestion rate (kg dry soil/kgBW/d),
AUF	=	area use factor, ratio of an organism's home range to the area of contamination (see Section 7.9.5.4).

Receptor-specific intake parameters are discussed in Section 7.9.5.2 and chemical-specific BCFs and BAFs are discussed in Section 7.9.5.4.

Benthic invertebrates

Exposure equations are not needed for benthic invertebrates because the TRV for benthic invertebrates is the concentration in sediment. Therefore, the measure of exposure of benthic invertebrates is the concentration of the COPEC in sediment (mg/kg dry weight).

Riparian herbivores (muskrat and mallard duck), sediment

Riparian herbivores are exposed to COPECs in sediment by ingestion of food and sediment. It was assumed that their food is rooted aquatic plants that have taken up COPECs from sediment. The equation for exposure of aquatic herbivores to a single COPEC in sediment (Ohio EPA 2003) is

$$ADD_{total} = ADD_P + ADD_{Sed} \quad \textbf{(7-12)}$$

where

ADD_{total}	=	average daily dose (mg/kgBW/d) from all ingestion combined,
ADD_P	=	average daily dose (mg/kgBW/d) from ingestion of plants,
ADD_{Sed}	=	average daily dose (mg/kgBW/d) from ingestion of sediment.

The equation for exposure by ingestion of plants (Ohio EPA 2003) is

$$ADD_P = RME \times [0.5 \times (SP_V \times CF_V) + 0.5 \times (SP_r \times CF_r)] \times I_P \times AUF \quad \textbf{(7-13)}$$

where

RME	=	RME concentration of COPEC in sediment (mg/kg dry weight),
0.5	=	exposure adjustment factor for a diet of 50% vegetative parts and 50% seeds for mallard ducks (Ohio EPA 2003),
SP_V	=	sediment-to-plant BCF [mg/kg dry weight per mg/kg dry sediment (= kg dry sediment/kg dry weight)], SPv is used for the dietary fraction comprising vegetative plants,
CF_V	=	correction factor, dry weight to wet weight; assuming 85% water content of vegetative parts of plants (Ohio EPA 2003), $CF_V = (1 – 0.85) = 0.15$,

SP_r	=	sediment-to-plant BCF [mg/kg dry weight per mg/kg dry sediment (= kg dry sediment/kg dry weight)], SP_r is used for the dietary fraction comprising plant seeds,
CF_r	=	correction factor, dry weight to wet weight; assuming 10% water content of plant seeds (Ohio EPA 2003), CF = (1 – 0.1) = 0.9,
I_P	=	plant ingestion rate (kg fresh plant/kgBW/d),
AUF	=	area use factor, ratio of an organism's home range to the area of contamination (see Section 7.9.5.4).

The equation for exposure by ingestion of sediment (Ohio EPA 2003) is

$$ADD_{Sed} = RME \times I_S \times AUF \quad \textbf{(7-14)}$$

where

RME	=	RME concentration of COPEC in sediment (mg/kg dry weight),
I_S	=	sediment ingestion rate (kg dry sediment/kgBW/d),
AUF	=	area use factor, ratio of an organism's home range to the area of contamination (see Section 7.9.5.4).

Receptor-specific intake parameters are discussed in Section 7.9.5.2 and chemical-specific BAFs are discussed in Section 7.9.5.4.

Riparian carnivores (mink and heron), sediment

Riparian carnivores are exposed to COPECs in sediment by ingestion of food and sediment. It was assumed that their food is fish at Trophic Level 4. The entry of COPECs into the food chain was assumed to be uptake by benthic invertebrates from sediment. The equation for exposure of riparian carnivores to a single COPEC in sediment (Ohio EPA 2003) is

$$ADD_{total} = ADD_A + ADD_{Sed} \quad \textbf{(7-15)}$$

where

ADD_{total}	=	average daily dose (mg/kgBW/d) from all ingestion combined,
ADD_A	=	average daily dose (mg/kgBW/d) from ingestion of animals,
ADD_{Sed}	=	average daily dose (mg/kgBW/d) from ingestion of sediment.

The equation for exposure by ingestion of animals (fish) (Ohio EPA 2003) is:

$$ADD_A = RME \times BSAF \times FCM \times I_A \times AUF \quad \textbf{(7-16)}$$

where

RME	=	RME concentration of COPEC in sediment (mg/kg dry weight),
BSAF	=	sediment-to-benthic invertebrate BAF [mg/kgBW of benthic invertebrate per mg/kg dry sediment (= kg dry sediment/kgBW)],
FCM	=	food-chain multiplier, 1.0 for inorganic COPECs and chemical-specific for organic COPECs (Ohio EPA 2003) (see Section 7.9.5.4),
I_A	=	fish ingestion rate (kg wet weight/kgBW/d),

AUF = area use factor, ratio of an organism's home range to the area of contamination (see Section 7.9.5.4).

The equation for exposure by ingestion of sediment (Ohio EPA 2003) is

$$ADD_{Sed} = RME \times I_S \times AUF \quad \textbf{(7-17)}$$

where

RME = RME concentration of COPEC in sediment (mg/kg dry weight),
I_S = sediment ingestion rate (kg dry sediment/kgBW/d),
AUF = area use factor, ratio of an organism's home range to the area of contamination (see Section 7.9.5.4).

Receptor-specific intake parameters are discussed in Section 7.9.5.2 and chemical-specific BAFs are discussed in Section 7.9.5.4.

Aquatic biota

Exposure equations are not needed for aquatic biota because the TRV for aquatic biota is the concentration in surface water. Therefore, the measure of exposure of aquatic biota is the concentration of the COPEC in surface water at the EU (mg/L).

Riparian herbivores (muskrat and mallard), water

It was assumed that riparian herbivores are exposed to COPECs in surface water by ingestion of food and water. It was assumed that their food is floating aquatic plants that have taken up COPECs from surface water. The equation for exposure of aquatic herbivores to a single COPEC in surface water (Ohio EPA 2003) is

$$ADD_{total} = ADD_P + ADD_W \quad \textbf{(7-18)}$$

where

ADD_{total} = average daily dose (mg/kgBW/d) from all ingestion combined,
ADD_P = average daily dose (mg/kgBW/d) from ingestion of plants,
ADD_W = average daily dose (mg/kgBW/d) from ingestion of surface water.

The equation for exposure by ingestion of plants (Ohio EPA 2003) is

$$ADD_P = RME \times WP \times I_P \times AUF \quad \textbf{(7-19)}$$

where

RME = RME concentration of COPEC in surface water (mg/L),
WP = water-to-plant BCF [mg/kg wet weight per mg/L (= L/kg wet weight)],
I_P = plant ingestion rate (kg fresh plant/kgBW/d),
AUF = area use factor, ratio of an organism's home range to the area of contamination (see Section 7.9.5.4).

The equation for exposure by ingestion of surface water (Ohio EPA 2003) is

$$ADD_W = RME \times IR_W \times AUF \quad \textbf{(7-20)}$$

where

RME	=	RME concentration of COPEC in surface water (mg/L),
IR_W	=	water ingestion rate (L/kgBW/d),
AUF	=	area use factor, ratio of an organism's home range to the area of contamination (see Section 7.9.5.4).

Receptor-specific intake parameters are discussed in Section 7.9.5.2 and chemical-specific BAFs are discussed in Section 7.9.5.4.

Riparian carnivores (mink and heron), water

Riparian carnivores are exposed to COPECs in surface water by ingestion of food and water. It was assumed that their food is fish at Trophic Level 4. The equation for exposure of riparian carnivores to a single COPEC in contaminated surface water (Ohio EPA 2003) is

$$ADD_{total} = ADD_A + ADD_{SW}, \quad \textbf{(7-21)}$$

where

ADD_{total}	=	average daily dose (mg/kgBW/d) from all ingestion combined,
ADD_A	=	average daily dose (mg/kgBW/d) from ingestion of aquatic animals (assumed to be fish at Trophic Level 4),
ADD_{SW}	=	average daily dose (mg/kgBW/d) from ingestion of surface water.

The equation for exposure by ingestion of aquatic animals (Ohio EPA 2003) is

$$ADD_A = RME \times BAFaq \times I_A \times AUF \quad \textbf{(7-22)}$$

where

RME	=	concentration of COPEC in surface water (mg/L),
BAFaq	=	water-to-aquatic biota BAF for prey [mg/kg wet weight per mg/L surface water (=L surface water/kg fresh tissue)],
I_A	=	animal intake (kg fresh animal/kg body weight-d),
AUF	=	area use factor, ratio of an organism's home range to the area of contamination (see Section 7.9.5.4).

The equation for exposure by ingestion of surface water (Ohio EPA 2003) is

$$ADD_{SW} = RME \times IR_W \times AUF \quad \textbf{(7-23)}$$

where

RME	=	RME concentration of COPEC in surface water (mg/L),
IR_W	=	water ingestion rate (L/kgBW/d),

AUF = area use factor, ratio of an organism's home range to the area of contamination (see Section 7.9.5.4).

Receptor-specific intake parameters are discussed in Section 7.9.5.2 and chemical-specific BCFs and BAFs are discussed in Section 7.9.5.4.

7.9.5.4 Uptake factors (BCFs and BAFs)

For some COPECs the BCF and BAF values used in the ADD equations are available in guidance or other published literature. For some COPECs these values must be estimated. The order of preference (Ohio EPA 2003) for use of BCFs and BAFs is: (1) government agency guidance; (2) published values in the open scientific literature; and (3) calculations based on chemical properties. BCFs and BAFs can be estimated using chemical properties of the COPECs such as the logarithm of the octanol-water partitioning coefficient [$\log(K_{OW})$] and the soil-to-water partitioning coefficient (K_d). Chemical-specific BCFs and BAFs for terrestrial plants, terrestrial invertebrates, mammals, and birds are presented in Table R-30. Chemical-specific BCFs and BAFs for aquatic plants, benthic invertebrates, and fish are presented in Table R-31. Receptor-specific parameters were also needed to calculate some BAFs when empirically derived factors were not available. Receptor-specific parameters are presented in Section 7.9.5.2, and in Tables R-22 through R-29.

BCFs for terrestrial plants (SP_V and SP_r)

Chemical concentrations in terrestrial plants were calculated by using factors for uptake from soil into the aboveground portion of plants. The concentration in aboveground vegetative and reproductive portions of plants through root uptake from soil is a function of the chemical-specific soil concentration and chemical-specific plant BCFs (SP_v for vegetative portions and SP_r for reproductive portions).

Empirically determined SP_vs and SP_rs were used in preference to calculated or estimated values. Default values were not used if values based on chemical properties were available.

As specified by Ohio EPA (2003), SP_vs and SP_rs for inorganic COPECs were taken from Baes et al. (1984). SP_vs for some organic COPECs were taken from EPA (1999). For organic COPECs with no published values, SP_vs were calculated using an equation developed by Travis and Arms (1988). The equation is

$$\log(SP_v) = 1.588 - 0.578 \times \log(K_{OW}) \quad \textbf{(7-24)}$$

where

SP_v = soil-to-plant BCF (kg dry soil/kg plant or g dry soil/g plant),
K_{OW} = octanol-water partitioning coefficient (L/kg).

Values of SP_v, SP_r, and $\log(K_{OW})$ are given in Table R-30.

BAFs for terrestrial invertebrates (BAF-S)

Chemical concentrations in terrestrial invertebrates were calculated using uptake factors from soil into the invertebrate tissue. The concentration accumulated in invertebrate tissues through direct contact with and ingestion of soil and detritus is a function of the chemical-specific soil concentration and chemical-specific invertebrate bioaccumulation factors BAFs (BAF-S).

There are few published BAFs for uptake of COPECs from soil by terrestrial invertebrates. Measured values for arsenic, cadmium, chromium, lead, manganese, mercury, nickel, and zinc (Sample et al. 1999) were used and are included in Table R-30. Additional values for inorganics were taken from EPA (1999). Following EPA (1999) guidance, BAF-S values for other inorganic COPECs were calculated as the average of available measured values (e.g., Sample et al. 1999).

For organic COPECs that have no published values, default values were calculated using the following equation (Ohio EPA 2003):

$$BAF\text{-}S = (y_L/x \times f_{oc}) \times (K_{OW})^{b-a} \quad \textbf{(7-25)}$$

where

BAF-S	=	soil-to-terrestrial invertebrate BAF (kg dry soil/kg fresh invertebrate),
y_L	=	organic lipid content [default value of 0.01 for earthworm (Ohio EPA 2003)], (kg lipid/kg fresh invertebrate),
x	=	proportionality constant [0.66 (Ohio EPA 2003)],
f_{oc}	=	fraction of organic carbon in soil, 0.01 (kg carbon/kg dry soil),
K_{OW}	=	octanol-water partitioning coefficient (L/kg),
b-a	=	non-linearity constant [0.07 (Ohio EPA 2003)].

The value of 0.01 for f_{oc} was the geometric mean of f_{oc} for soil EUs. These values are included in Table R-30.

BAFs for terrestrial mammals (BAF_{TP})

Published soil-to-animal BAFs are predominantly available only for terrestrial invertebrates. Ohio EPA (2003) guidance states that ingestion-to-beef uptake factors (Ba) presented by Baes et al. (1984) are to be used as BAFs to calculate the uptake of inorganic COPECs by mammals and birds.

The units of Ba are (mg retained/kg tissue)/(mg ingested/d). This value is a measure of the fraction of each day's intake of a COPEC in beef that is retained in tissue. Ohio EPA (2003) guidance assumes that the fraction of COPEC that is retained is the same for mammals and birds and does not vary with body weight. To calculate the BAF for mammal or bird receptors (BAF_{TP}), Ba was multiplied by the body weight of the receptor to put the uptake factor in terms of total ingestion of COPEC per day. That is,

$$BAF_{TP} = Ba \times BW, \quad \textbf{(7-26)}$$

where

BAF_{TP}	=	BAF for mammal or bird receptor [mg retained / (mg ingested/d)],
Ba	=	ingestion-to-beef transfer factor [(mg retained/kg tissue)/(mg ingested/d) (Baes et al. 1984)],
BW	=	body weight of receptor (kg).

Values of Ba and BAF_{TP} are given in Table R-30.

BCFs for aquatic plants rooted in sediment

Aquatic plants rooted in sediment were assumed to have the same BCFs for vegetative and reproductive parts as for terrestrial plants (SP_V and SP_r, respectively). SP_Vs and SP_rs for inorganic COPECs were taken from EPA (1999) and Baes et al. (1984) and are provided in Table R-30. SP_rs for organic COPECs were assumed to be the same as SP_Vs.

BAFs for benthic invertebrates (BSAF)

There are few published BSAF values for uptake of COPECs from sediment. BSAFs from EPA (1999) were used for inorganic and organic COPECs when values were available in that reference. For inorganic COPECs without published values, the value proposed by EPA (1999), which was the arithmetic mean of all available values for inorganics (0.9), was used. For organic COPECs without published values, the BSAFs were calculated by using the equation for terrestrial invertebrates (Section 7.9.5.4). The value of f_{OC} was 0.01, the measured value in Kelly's Pond. These values are included in Table R-31.

BCFs for floating aquatic plants (WP)

Floating aquatic plants were assumed to take up COPECs from water. The BCFs for water-to-plant bioaccumulation are termed WP. Values of WP for inorganic COPECs were taken from EPA (1999). Values of WP for organic COPECs were calculated by an empirically derived equation for uptake from water by algae (Southworth et al. 1978). The equation is:

$$\log(WP) = 0.819 \times \log(K_{OW}) - 1.146 \qquad \textbf{(7-27)}$$

BAFs for aquatic animals (BAFaq)

Chemical concentrations in aquatic biota were calculated using factors for uptake from surface water into the tissue of aquatic biota. The concentration in aquatic macroinvertebrates through uptake from surface water is a function of the chemical-specific surface water concentration and chemical-specific BCF. It was assumed that organic COPECs can bioaccumulate up the food chain. To calculate a BAFaq for an organic COPEC, the BCF is multiplied by the food-chain multiplier (FCM) for that COPEC. The hierarchy of sources for BAFs (Ohio EPA 2003) used in the screening level ERA was: (1) field-measured BAFs; (2) predicted BAFs derived by multiplying a laboratory-measured BCF by an FCM (EPA 1995); and (3) predicted BAFs derived by multiplying a BCF calculated from the K_{OW} by an FCM (EPA 1995).

Published BCFaq values for aquatic animals are presented in Table R-31. Measured values for mercury and nickel were taken from EPA (1999). For organic COPECs that have no published BCFaq, the following equation (EPA 1999) was used to estimate the BCF:

$$\log(BCFaq) = 0.91 \times \log(K_{OW}) - 1.975 \times \log[(6.8E\text{-}07 \times K_{OW}) + 1] - 0.786 \qquad \textbf{(7-28)}$$

where

BCFaq	=	water-to-aquatic biota BCF [mg/kg fresh tissue per mg/L (= L/kg)],
K_{OW}	=	octanol-water partitioning coefficient.

Calculated BCFaq values are also presented in Table R-31.

BAFaq is calculated by using FCMs that account for bioaccumulation of COPECs through the food chain (EPA 1995). BAFaq is calculated as:

$$BAFaq = BCF \times FCM \quad \textbf{(7-29)}$$

where

BCF = water-to-tissue BCF (L/kg body wt),
FCM = food-chain multiplier (unitless). FCMs specific to Trophic Level 4 are assumed.

Food Chain Multipliers

FCMs are factors that are used to quantify bioaccumulation through the food chain. As chemicals from the environment pass up the food chain, they may become successively more concentrated at each trophic level. This is especially true of organic chemicals that are not metabolized rapidly. Typically, organic chemicals that dissolve in lipids bioaccumulate because they are stored in body fat, and the more soluble in lipids the chemical is, the more it bioaccumulates. To model this tendency quantitatively, EPA (1995) measured BAFs for organic chemicals taken up through the food chain from water by fish. An FCM was derived for each chemical tested by dividing the observed BAF by the K_{ow}. EPA (1995) was able to show an orderly relationship between FCM and K_{ow} for many organic chemicals taken up by fish at Trophic Levels 2, 3, and 4. By using this relationship, the concentration of a chemical in fish tissue, normalized to lipid content, can be calculated by multiplying the concentration of the chemical dissolved in water by the BCF of the chemical and by the chemical's FCM.

The FCM for inorganic COPECs is 1.0 (EPA 1995). The FCMs used for organic COPECs were those for Trophic Level 4 and are presented in Table R-31.

Area Use Factors

Ecological receptors typically forage over a receptor-specific area termed the home range. Home ranges for many species of animals are available in published literature and compendia. It was assumed that receptors at each EU at Load Line 2 forage uniformly over a home range that includes the EU. The fraction of the ingestion exposure that comes from the EU is termed the AUF. For receptors with a home range larger than the EU, AUF is calculated as the area of the EU divided by the home range. For receptors with a home range smaller than the EU, such as the short-tailed shrew and muskrat, AUF is 1.0. AUFs for receptors exposed to COPECs in soil are shown in Table R-32, and AUFs for receptors exposed to COPECs in sediment and surface water are shown in Table R-33.

Ingestion Rates

Exposure equations require ingestion rates of plants (I_P), soil (I_S), animal tissue (I_A), sediment (I_S), and surface water (IR_W). These values are shown in the receptor parameter tables (Tables R-22 through R-29) and are summarized in Table R-34.

7.9.6 Effects Evaluation for Chemicals Of Potential Ecological Concern

Measures of toxicity were used as endpoints to compute HQs. Toxicity endpoints, termed TRVs were derived from published studies of exposure to contaminants under controlled conditions. TRVs were used for exposure of terrestrial plants, terrestrial invertebrates, terrestrial mammals, terrestrial birds, benthic invertebrates, riparian mammals, riparian birds, and aquatic biota.

7.9.6.1 Terrestrial plants and invertebrates

Toxicity endpoints for plants and terrestrial invertebrates were taken from Efroymson et al. (1997a) and Efroymson et al. (1997b), respectively (Ohio EPA 2003). These values are generally the LOAEL or the lower 5th percentile concentration for adverse effects for plants and earthworms exposed to soil amended with chemicals. TRVs for terrestrial plants are shown in Table R-35 and TRVs for terrestrial invertebrates are shown in Table R-36.

7.9.6.2 Terrestrial mammals and birds

The preferred endpoint for mammals and birds is a chronic NOAEL for a measure of population maintenance, such as reproduction. If a chronic NOAEL is not available, a substitute can be computed using one of the following procedures (Ohio EPA 2003).

- Divide a subchronic NOAEL for longer-term subchronic exposures by 3.
- Divide a subchronic NOAEL for sub-acute or short-term subchronic exposures by 10.
- Divide an acute NOAEL by 100.
- Divide a chronic LOAEL for a reproductive endpoint or a minor physiological change by 3.
- Divide a chronic LOAEL for an effect that would reduce survivability in the wild or a gross or severe physiological change by 10.
- Divide a subchronic LOAEL for longer-term subchronic exposure by 3 to convert to a chronic LOAEL, then divide by 3 or 10 to convert to a chronic NOAEL, as indicated in the third and fourth bullets.
- Divide a subchronic LOAEL for sub-acute or short-term subchronic exposure by 10 to convert to a chronic LOAEL, then divide by 3 or 10 to convert to a chronic NOAEL, as indicated in the third and fourth bullets.
- Divide an acute LOAEL by 1,000.
- Divide an LD_{50} by 10,000.

Chronic NOAELs for mammals, or their calculated equivalents, are shown in Table R-37. A TRV was calculated for each mammal by using allometric scaling to account for differences in toxicity related to body weight (Ohio EPA 2003). The equation used for this adjustment is

$$TRV = \text{chronic NOAEL} \times (BW_t / BW_w)^{1/4} \quad \textbf{(7-30)}$$

where

TRV	=	toxicity reference value (mg/kg body weight-d),
BW_t	=	body weight of the species used in toxicity testing (kg),
BW_w	=	body weight of the wildlife species (kg),
1/4	=	allometric scaling factor for mammals.

These adjusted values were used as TRVs for the computation of HQs for mammals and are shown in Table R-38.

Chronic NOAELs for birds, or their calculated equivalents, are shown in Table R-39. Body weight scaling was not conducted for birds (Ohio EPA 2003). Instead, an adjustment was based on the taxonomic distance between the test species and the ecological receptor, as follows:

- if the test species and the ecological receptor were in the same genus, no adjustment was made;
- if the test species and the ecological receptor were in the same family but not the same genus, the chronic NOAEL was multiplied by one-half order of magnitude (0.33);
- if the test species and the ecological receptor were in the same order but not the same family, the chronic NOAEL was multiplied by 0.1; and
- if the test species and the ecological receptor were not in the same order, the chronic NOAEL was multiplied by 0.01.

TRVs for birds are shown in Table R-40.

7.9.6.3 Aquatic biota

The Ohio EPA (2003) hierarchy of TRVs for aquatic biota is: (1) Ohio water quality criteria (Ohio EPA 2003), and (2) National Ambient Water Quality Criteria (found in Suter and Tsao 1996), Tier II values (found in Suter and Tsao 1996), and other toxicity values presented in Suter and Tsao (1996). TRVs for aquatic biota are intended to protect most aquatic species from harm by chronic exposure most of the time. TRVs for aquatic biota are shown in Table R-41.

7.9.6.4 Benthic invertebrates

The Ohio EPA (2003) hierarchy of TRVs for benthic invertebrates is the same as the hierarchy for SRVs (Ohio EPA 2003): (1) consensus-based TEC values (MacDonald, Ingersoll, and Berger 2000), and (2) *EPA Region 5 Corrective Action, Ecological Screening Levels (2003),* which can be found at URL http://www.epa.gov/reg5rcra/ca/edql.htm. TRVs for benthic invertebrates are presented in Table R-42.

7.9.6.5 Riparian mammals and birds

TRVs for riparian mammals and birds were computed as described for terrestrial mammals and birds. The TRVs are shown in Tables R-38 (mammals) and R-40 (birds).

7.10 RESULTS OF LEVEL III HAZARD QUOTIENT CALCULATIONS FOR CHEMICALS OF ECOLOGICAL CONCERN

HQ calculation tables for all of the ecological receptors are presented in Tables R-43 through R-80. The HQ calculation tables are organized by media, EU, and receptor within each EU. This section will not discuss in detail each of the HQs for each receptor, but briefly summarizes (1) contaminants that qualify for NFA due to HQs ≤ 1 for all receptors applicable for the given media, (2) chemicals of ecological concern (COECs due to HQs >1 for one or more receptors, and (3) COECs of uncertain risk due to "no TRVs" for one or more receptors. Note that COECs based on "No TRV" had three possible conditions: (1) one or more receptors did have a TRV and an HQ > 1, (2) one or more receptors had a TRV but the HQs were ≤ 1, or

(3) all of the receptors had "No TRV," which are identified in Table 7-11. The results of HQ calculations and subsequent summary of NFA analytes and COECs for surface soil (0 to 1 ft), sediment, and surface water are discussed in Sections 7.10.1, 7.10.2, and 7.10.3, respectively.

Table 7-11. Summary of COECs for Surface Soil at Load Line 2 Aggregates

COEC	Explosives Handling Aggregate		Preparation and Receiving Aggregate		Packaging and Shipping. Aggregate		Perimeter Area Aggregate		North Ditches Aggregate	
COECs per HQ > 1										
Inorganics										
Aluminum	Plant	181	Plant	202	Plant	258	Plant	232	NA	
	Rabbit	151	Rabbit	168	Rabbit	215	Rabbit	193		
	Shrew	574	Shrew	638	Shrew	817	Shrew	734		
Antimony	NA		Plant	12.5	NA		NA		NA	
			Rabbit	23.1						
			Shrew	62.2						
Arsenic	NA		Plant	1.5	NA		Plant	1.3	NA	
			Rabbit	4.0			Rabbit	3.6		
			Shrew	5.1			Shrew	4.5		
Barium	Shrew	< 1.1	Shrew	2.2	Shrew	2.2	NA		NA	
Cadmium	No HQ > 1		Plant	1.8	Shrew	1.3	NA		NA	
			Shrew	4.0						
Chromium	Plant	19.6	NA		Plant	38.6	NA		NA	
	Worm	48.9			Worm	96.6				
Copper	No HQ > 1		NA		No HQ > 1		NA		NA	
Iron	Plant	2,057	NA		Plant	2453	Plant	2209	NA	
Lead	Plant	2.5	Plant	19.0	Plant	3.9	NA		NA	
	Shrew	1.8	Worm	1.9	Shrew	2.8				
	--	--	Rabbit	2.2	--	--				
	--	--	Shrew	13.7	--	--				
Manganese	Plant	1.3	Plant	1.7	Plant	3.1	Plant	2.0	NA	
Selenium	No HQ > 1		NA		NA		NA		NA	
Zinc	Plant	3.6	NA		Plant	4.0	NA		Plant	1.9
	--	--			Worm	<1.1			--	--
Pesticides/PCBs										
PCB-1254	Shrew	7.2	Rabbit	4.3	Shrew	12.5	NA		NA	
	--	--	Shrew	69.2	--	--				
COECs per No TRV										
Inorganics										
Aluminum	No TRV[a]		No TRV[a]		No TRV[a]		No TRV[a]		NA	
Antimony	NA		No TRV[a]		NA		NA		NA	
Barium	No TRV[a]		No TRV[a]		No TRV[a]		NA		NA	
Beryllium	No TRV[b]		NA		NA		No TRV[b]		NA	
Calcium	No TRV[c]		NA		NA		NA		NA	
Cobalt	NA		No TRV[b]		NA		NA		NA	
Iron	No TRV[a]		NA		No TRV[a]		No TRV[a]		NA	
Magnesium	No TRV[c]		NA		NA		NA		NA	
Manganese	No TRV[a]		No TRV[a]		No TRV[a]		No TRV[a]		NA	
Silver	NA		NA		No TRV[b]		NA		NA	

Table 7-11. Summary of COECs for Surface Soil at Load Line 2 Aggregates (continued)

COEC	Explosive Handling Aggregate	Preparation and Receiving Aggregate	Packaging and Shipping Aggregate	Perimeter Area Aggregate	North Ditches Aggregate
Organics					
Benzoic Acid	No TRV[b]	NA	NA	NA	NA
Benzo(*a*)pyrene	NA	No TRV[b]	NA	NA	NA
Pesticides/PCBs					
4,4'-DDT	No TRV[b]	NA	NA	NA	NA
PCB-1254	No TRV[a]	No TRV[a]	No TRV[b]	NA	NA
Dieldrin	No TRV[b]	NA	NA	NA	NA

[a] HQ > 1 for one or more receptors (see above).
[b] HQ > 1 for no receptors.
[c] No TRVs for all receptors.
COEC = Constitient of ecological concern.
DDT = Dichlorodiphenyltrichloroethane.
HQ = Hazard quotient.
NA = Not applicable because not a chemical of preliminary ecological concern at this location.
PCB = Polychlorinated biphenyl.
TRV = Toxicity reference value.
-- = All other receptor HQs < 1 for this location.

7.10.1 Load Line 2 Soil Receptor Hazard Quotients

HQs were calculated for terrestrial receptors exposed to surface soil at five EUs and are discussed in Sections 7.10.1.1 through 7.10.1.5.

7.10.1.1 Explosives Handling Area Aggregate

Fifteen inorganic, one PCB, 2 pesticide, and one SVOC (benzoic acid) COPECs were inputted for HQ calculations for plants and earthworms, cottontail rabbits, and shrews, which are presented in Tables R-43, R-44, and R-45, respectively. For foxes and red-tailed hawks, four inorganic, two pesticide, and one PCB PBT COPECs were inputted for HQ calculations, which are presented in Tables R-46 and R-47, respectively.

Soil NFAs. Six inorganics (beryllium, cadmium, copper, mercury, nickel, and selenium) were the only inputted preliminary COPECs for surface soil that qualified for NFA because their HQs were less than 1 for all the terrestrial receptors.

Soil COECs per HQs > 1. HQs exceeding 1 for the six terrestrial receptors are summarized in Table 7-11.

For plants, seven inorganics had HQs > 1 (aluminum, barium, chromium, iron, lead, manganese, and zinc), with iron being highest (HQ = 2057) followed by aluminum (HQ = 181). For earthworms, chromium was the only COEC whose HQ > 1 (48.9).

For cottontail rabbits, aluminum was the only COPEC whose HQ was > 1 (HQ = 151). For shrews, three inorganics (aluminum, barium, and lead) and one PCB (PCB-1254) were the only COECs whose HQs > 1. Aluminum had the highest HQ (574).

For foxes and hawks no HQs exceeded 1.

Soil COECs per "No TRV." Six inorganics (aluminum, barium, beryllium, iron, magnesium, and manganese), one SVOC (benzoic acid), two pesticides (4,4'-DDT and dieldrin), and one PCB (PCB-1254) were soil COECs based on no TRVs for one or more terrestrial receptors at this EU (Table 7-11).

7.10.1.2 Preparation and Receiving Area Aggregate

Eight inorganic, one PCB, and one SVOC COPECs were inputted for HQ calculations for plants and earthworms, cottontail rabbits, and shrews, which are presented in Tables R-48, R-49, and R50, respectively. For foxes and red-tailed hawks, two inorganic, one PCB, and one SVOC PBT COPECs were inputted for HQ calculations, which are presented in Tables R-51 and R-52, respectively.

Soil NFAs. None of the inputted preliminary COPECs for surface soil qualified for NFA because they all either had at least 1 HQ > 1 or "No TRV" for at least one terrestrial receptor.

Soil COECs per HQs > 1. HQs exceeding 1 for these receptors are summarized in Table 7-11.

For plants, six inorganics had HQs > 1 (aluminum, antimony, arsenic, cadmium, lead, and manganese), with aluminum being highest (HQ = 202) followed by lead (HQ = 19.0). For earthworms, copper and lead were the only COECs whose HQs > 1, (HQ = 1.9).

For cottontail rabbits, four inorganics (aluminum, antimony, arsenic, and lead) and one PCB (PCB-1254) were the only COECs whose HQs > 1, with aluminum being highest (HQ = 167). For shrews, six inorganics (aluminum, antimony, arsenic, barium, cadmium, and lead) and one PCB (PCB-1254) were the only COECs whose HQs > 1. Aluminum had the highest HQ for shrews (638) followed by PCB-1254 (69.2).

For foxes and hawks, no HQs exceeded 1.

Soil COECs per "No TRV." Five inorganics (aluminum, antimony, barium, cobalt, and manganese), one SVOC [benzo(a)pyrene], and one PCB (PCB-1254) were soil COECs based on no TRVs for 1 or more terrestrial receptors at this EU (Table 7-11).

7.10.1.3 Packaging and Shipping Area Aggregate

Eleven inorganic and one PCB COPECs were inputted for HQ calculations for plants and earthworms, cottontail rabbits, and shrews, which are presented in Tables R-53, R-54, and R-55, respectively. For foxes and red-tailed hawks, four inorganic and one PCB PBT COPECs were inputted for HQ calculations, which are presented in Tables R-56 and R-57, respectively.

Soil NFAs. Two inorganics (copper and mercury) were the only inputted preliminary COPECs for surface soil that qualified for NFA because their HQs were less than 1 for all the terrestrial receptors.

Soil COECs per HQs > 1. HQs exceeding 1 for these receptors are summarized in Table 7-11.

For plants, six inorganics had HQs > 1 (aluminum, chromium, iron, lead, manganese, and zinc), with iron being highest (HQ = 2,453) followed by aluminum (HQ = 258). For earthworms, chromium and zinc were the only COECs whose HQs > 1, with chromium being the highest (HQ = 96.6).

For cottontail rabbits, aluminum was the only COEC whose HQ > 1 (HQ = 215). For shrews, four inorganic (aluminum, barium, cadmium, and lead) and one PCB (PCB-1254) were the only COECs whose HQs > 1. Aluminum had the highest HQ for shrews (817), followed by PCB-1254 (HQ = 12.5).

For foxes and hawks, no HQs exceeded 1.

Soil COECs per "No TRV." There were five inorganic (aluminum, barium, iron, manganese, and silver) COECs based on "No TRV" for one or more terrestrial receptors at this EU (Table 7-11).

7.10.1.4 Perimeter Area Aggregate

Five inorganic preliminary COPECs were inputted for HQ calculations for plants and earthworms, cottontail rabbits, and shrews, which are presented in Tables R-58, R-59, and R-60, respectively. There were no PBT COPECs for the Perimeter Area Aggregate, so there were no HQ tables for foxes or red-tailed hawks.

Soil NFAs. None of the inputted preliminary COPECs for surface soil qualified for NFA because they all either had at least 1 HQ > 1 or "no TRV" for at least one terrestrial receptor.

Soil COECs per HQs > 1. HQs exceeding 1 for the receptors are summarized in Table 7-11.

For plants, four of the five inorganics had HQs > 1 (aluminum, arsenic, iron, and manganese), with iron being highest (HQ = 2,209) followed by aluminum (HQ = 232). For earthworms, no HQs were > 1.

For cottontail rabbits, aluminum and arsenic were the only COECs whose HQs > 1, with aluminum being highest (HQ = 193) and arsenic (HQ = 3.4). For shrews, aluminum and arsenic were also the only COECs whose HQs > 1, with aluminum being highest (HQ = 734).

For foxes and hawks, HQ calculations were unnecessary because there were no PBT COPECs at this EU.

Soil COECs per "No TRV." There were four inorganic (aluminum, beryllium, iron, and manganese) COECs based on "No TRV" for one or more terrestrial receptors at this EU (Table 7-11).

7.10.1.5 North Ditches Aggregate

Two inorganic preliminary COPECs were inputted for HQ calculations for plants and earthworms, cottontail rabbits, and shrews, which are presented in Tables R-61, R-62, and R-63, respectively. For foxes and red-tailed hawks, one inorganic PBT COPEC was inputted for HQ calculations, which are presented in Tables R-64 and R-65, respectively.

Soil NFAs. Nickel was the only inputted preliminary COPEC for surface soil that qualified for NFA because its HQs were less than 1 for all the terrestrial receptors.

Soil COECs per HQs > 1. HQs exceeding 1 for the receptors are summarized in Table 7-11.

For plants, zinc was the only COEC whose HQ > 1 (HQ = 1.9). For earthworms, no HQs were > 1.

For cottontail rabbits, shrews, foxes, and hawks, no HQs > 1.

Soil COECs per "No TRV." There were no soil COECs based on "No TRV" at this EU (Table 7-11).

7.10.2 Load Line 2 Sediment Receptor Hazard Quotients

HQs were calculated for sediment receptors exposed to surface sediment at two EUs, and are discussed in Sections 7.10.2.1 and 7.10.2.2.

7.10.2.1 Kelly's Pond and Exit Drainages Aggregate

Seven inorganic, 13 SVOC, 4 pesticide, and 3 explosives preliminary COPECs were inputted for HQ calculations for sediment biota, muskrats, and mallards, which are presented in Tables R-66, R-67, and R-68, respectively. For mink and Great blue herons, 2 inorganic, 13 SVOC, and 2 pesticide PBT COPECs were inputted for HQ calculations, which are presented in Tables R-69 and R-70, respectively.

Sediment NFAs. Only one inputted sediment preliminary COPEC qualified for NFA, namely 4,4'-DDT, because it was the only one whose HQ did not exceed 1 for all aquatic receptors.

Sediment COECs per HQs > 1. HQs exceeding 1 for these five receptors are summarized in Table 7-12.

For sediment biota, 2 inorganics (lead. and silver), 11 SVOCs (all PAHs), 2 pesticides (4,4'-DDE and beta-BHC), and 1 explosive (2,4-DNT) were the COECs whose HQs > 1. Beta-BHC had the highest HQ (15.8), whereas all the other HQs ranged from 1.1 to 6.6.

For muskrats, mallards, and mink, there were no HQs > 1. For Great blue herons, two inorganics (cadmium and lead) and 7 SVOCs [bis(2-ethylhexyl)phthalate, benzo(*a*)anthracene, benzo(*a*)pyrene, benzo(*k*)fluoranthene, chrysene, dibenzo(*a,h*)anthracene, and indeno(1,2,3-*cd*)pyrene] were the only COECs whose HQs > 1. The maximum HQ was for benzo(*k*)fluorantheneene (HQ = 124,904), whereas the remaining HQs ranged from HQ = 15,233 for dibenzo(*a,h*)anthracene to HQ = 11 for cadmium.

Sediment COECs per "No TRV." Five inorganics (antimony, beryllium, calcium, magnesium, and silver), three SVOCs [anthracene, benzo(*a*)anthracene, and benzo(*b*)fluroanthene], one pesticide (endrin ketone), and two explosives (4-amino-2,6-DNT and 2,4,6-TNT) were the sediment COECs based on "No TRV" for one or more receptors at this EU (Table 7-12).

7.10.2.2 North Ponds Aggregate

Two inorganic and one explosives preliminary COPECs were inputted for HQ calculations for sediment biota, muskrats, and mallards, which are presented in Tables R-71, R-72, and R-73, respectively. For mink and Great blue herons, two inorganic PBT COPECs were inputted for HQ calculations, which are presented in Tables R-74 and R-75, respectively.

Sediment NFAs. None of the three inputted preliminary COPECs qualified for NFA because they either had HQs > 1 or had no TRV.

Sediment COECs per HQs > 1. HQs exceeding 1 for the five receptors are summarized in Table 7-12.

For sediment biota, muskrats, mallards, and mink, there were no inputted preliminary COPECs whose HQs > 1. For Great blue herons, cadmium and lead were the only PBT COECs whose HQs > 1. The highest HQ was for lead (HQ = 286), whereas the HQ for cadmium was HQ = 1.1.

Sediment COECs per "No TRV." There was only one sediment COEC based on "no TRV," namely nitrocellulose.

Table 7-12. Summary of COECs for Sediment at Load Line 2 Exposure Units

COEC	Kelly's Pond		North Pond	
COECs per HQ > 1				
Inorganics				
Cadmium	Heron	11.0	Heron	10.6
Lead	Sed. biota	1.3	--	
	Heron	462	Heron	286
Silver	Sed. biota	4.4	NA	
Semivolatile Organic Compounds				
Anthracene	Sed. biota	2.1	NA	
Benzo(*a*)anthracene	Sed. biota	4.2	NA	
	Heron	14,841		
Benzo(*a*)pyrene	Sed. biota	2.80	NA	
	Heron	216		
Benzo(*k*)fluoranthene	Sed. biota	1.3	NA	
	Heron	124,904		
Benzo(*g,h,i*)perylene	Sed. biota	1.2	NA	
Bis(2-ethylhexyl)phthalate	Heron	10,025	NA	
Chrysene	Sed. biota	4.2	NA	
	Heron	1714		
Dibenzo(*a,h*)anthracene	Sed. biota	2.5	NA	
	Heron	15,233		
Fluoranthene	Sed. biota	2.2	NA	
Indeno(1,2,3-*cd*)pyrene	Sed. biota	1.1	NA	
	Heron	1,721		
Phenanthrene	Sed. biota	1.9	NA	
Pyrene	Sed. biota	4.3	NA	
Explosives				
2,4-Dinitrotoluene	Sed biota	2.5	NA	
Pesticides/PCBs				
4,4'-DDE	Sed biota	6.6	NA	
Beta-BHC	Sed biota	15.8	NA	
COECs per "No TRV"				
Inorganics				
Antimony	No TRV[a]		NA	
Beryllium	No TRV[a]		NA	
Calcium	No TRV[b]		NA	
Magnesium	No TRV[b]		NA	
Silver	No TRV[c]		NA	
Semivolatile Organic Compounds				
Anthracene	No TRV[c]		NA	
Benzo(*a*)anthracene	No TRV[c]		NA	
Benzo(*b*)fluoranthene	No TRV[a]		NA	
Pesticides/PCBs				
Endrin Kketone	No TRV[b]		NA	

Table 7-12. Summary of COECs for Sediment at Load Line 2 Exposure Units (continued)

COEC	Kelly's Pond	North Pond
Explosives		
4-Amino-2,6-dinitrotoluene	No TRV[b]	NA
2,4,6-Trinitrotoluene	No TRV[a]	NA
Nitrocellulose	NA	No TRV[b]

[a] HQ > 1 for no receptors.
[b] No TRVs for all receptors.
[c] HQ > 1 for one or more receptors (see above).
BHC = Benzene hexachloride.
COEC = Constitient of ecological concern.
DDE = Dichlorodiphenyldichloroethylene.
HQ = Hazard quotient.
NA = Not applicable; not a chemical of preliminary ecological concern at this location.
PCB = Polychlorinated biphenyl.
TRV = Toxicity reference value.
-- = All other receptor HQs < 1 for this location.

7.10.3 Load Line 2 Surface Water Receptor Hazard Quotients

HQs were calculated for surface water receptors exposed to surface water at one EU (North Ponds Aggregate) and are discussed in Section 7.10.3.1.

7.10.3.1 North Ponds Aggregate

Three inorganic and one SVOC preliminary COPECs were inputted for HQ calculations for aquatic biota, muskrats, and mallards, which are presented in Tables R-76, R-77, and R-78, respectively. For mink and Great blue herons, two inorganic PBT COPECs were inputted for HQ calculations, which are presented in Tables R-79 and R-80, respectively.

Surface Water NFAs. None of the four inputted preliminary COPECs qualified for NFA because either they had at least one HQ > 1 or they had "no TRV."

Surface Water COECs per HQs > 1. For aquatic biota there were no HQs > 1. For muskrats, one SVOC [bis(2-ethylhexyl)phthalate was the only COEC whose HQ exceeded 1 (HQ = 1.1).

For mallards, there were no HQs >1.

For mink, neither of the two inputted PBT COPECs yielded HQs that exceeded 1. However, two COECs were identified for Great blue herons, namely cadmium (HQ = 3.2) and bis(2-ethylhexyl)phthalate (HQ = 12.5).

Surface Water COECs per "No TRV." There were no surface water COECs based on "no TRV" because each of the four inputted preliminary COPECs had a TRV for at least one aquatic receptor.

7.10.4 Future Risk to Ecological Receptors

The current HQs for the terrestrial plants and animals at the Load Line 2 EUs are assumed to be the same or similar to future HQs because most of the soil COEC concentrations are not expected to change dramatically over time, assuming there are no disturbances to the soil. For example, most inorganic

COECs like the heavy metals are fairly immobile in the soil and do not undergo biodegradation or transformation processes. Although some organic COECs can undergo biodegradation or transformations, these processes tend to be fairly slow for the types of COECs at Load Line 2 (e.g., pesticides, PAHs, and PCBs). Ecological succession could result in a change of specific vegetation composition, but the relatively small size of the terrestrial EUs at Load Line 2 should minimize changes in the types of ecological receptors. Thus, because the future concentrations of COECs, as well as the future types of ecological receptors are not expected to change dramatically from the current conditions, future risk is expected to be similar to the current risk indicated by the HQs.

Future risk in the aquatic habitats is more likely to change due to yearly inputs of new sediment and changes in sedimentation, which could affect sediment and surface water COEC concentrations. Thus, future HQs for sediment and surface water could vary accordingly. If new inputs of sediment are clean (i.e., free of COECs), future risk would decrease because the contaminated sediments would be covered or at least "diluted" with clean sediment. Conversely, if future inputs of sediment are also contaminated with COECs, risks to ecological receptors could stay the same or even increase, depending on the contaminant concentrations.

7.10.5 Summary of Hazard Quotient Calculations for the Baseline Ecological Risk Assessment

EU-specific preliminary COPECs for surface soil, sediment, and surface water from the Level II ESV screen were inputted to this Level III BERA where they underwent EU- and receptor-specific HQ calculations. Following the HQ calculations, the preliminary COPECs were classified into one of three categories: (1) NFA, (2) COECs per HQs > 1, or (3) COECs per "no TRV." The COECs based on "No TRV" met one of three conditions: (1) there were one or more receptors that did have TRVs and HQs > 1, (2) there were one or more receptors that did have TRVs but none of the HQs > 1, or (3) all of the receptors had "No TRV."

7.10.5.1 Soil HQ calculations summary

One or more NFAs were identified for three of the five terrestrial EUs. One or more COECs based on HQs > 1 were identified at all five terrestrial EUs. However, COECs based on "no TRVs" were identified at only four of the five EUs. The summary of soil NFAs and COECs by EU is presented below.

Explosives Handling Area Aggregate

- Soil NFAs: six inorganics.
- Soil COECs per HQs > 1: eight COECs (seven inorganics and one PCB) with the highest HQ of 2,057 for iron for plants.
- Soil COECs per "No TRVs": 11 COECs (7 inorganics, 1 SVOC, 2 pesticides, and 1 PCB).

Preparation and Receiving Area Aggregate

- Soil NFAs: None.
- Soil COECs per HQs > 1: seven COECs (six inorganics and one PCB) with the highest HQ of 638 for aluminum for shrews.
- Soil COECs per "No TRVs": 2 COECs (5 inorganics, 1 SVOC, and 1 PCB).

Packaging and Shipping Area Aggregate

- Soil NFAs: three inorganics.
- Soil COECs per HQs > 1: nine COECs (eight inorganics and one PCB) with the highest HQ of 2,453 for iron for plants.
- Soil COECs per "No TRVs": two COECs (five inorganics and one PCB).

Perimeter Area Aggregate

- Soil NFAs: None.
- Soil COECs per HQs > 1: four COECs (four inorganics) with the highest HQ of 2,209 for iron for plants.
- Soil COECs per "No TRVs": four COECs (inorganics).

North Ditches Aggregate

- Soil NFAs: one (nickel).
- Soil COECs per HQs > 1: one COEC (zinc) with an HQ = 1.9 for plants.
- Soil COECs per "No TRVs": None.

7.10.5.2 Sediment HQ calculations summary

Only one NFA was identified at one of the two sediment EUs. Two or more COECs based on HQs > 1 were identified at both sediment EUs. COECs based on "no TRVs" were identified at both sediment EUs. The summary of sediment NFAs and COECs by EU is presented below.

Kelly's Pond and Exit Drainages Aggregate

- Sediment NFAs: one (4,4'-DDT).
- Sediment COECs per HQs > 1: 18 COECs (3 inorganics, 12 SVOCs, 2 pesticides, and 1 explosive) with the highest HQ = 124,904 for benzo(*k*)fluoranthene for herons.
- Sediment COECs per "No TRVs": 11 COECs (5 inorganics, 3 SVOCs, 1 pesticide, and 2 explosives).

North Pond Aggregate

- Sediment NFAs: None.
- Sediment COECs per HQs > 1: two COECs (two inorganics) with the highest HQ = 286 for lead for herons.
- Sediment COECs per "No TRVs": one COEC (nitrocellulose).

7.10.5.3 Surface Water HQ Calculations Summary

There was only one surface water EU. The summary of surface water NFAs and COECs is presented below.

North Ponds Aggregate.

- Surface water NFAs: None.
- Surface water COECs per HQs > 1: two COECs [cadmium and bis(2-ethylhexyl)phthalate] with the highest HQ = 12.5 for bis(2-ethylhexyl)phthalate for herons.
- Surface water COECs per "No TRVs": None.

7.11 UNCERTAINTIES FOR THE BASELINE ECOLOGICAL RISK ASSESSMENT

Uncertainties in the Load Line 2 BERA are discussed briefly in this section by the four interrelated steps of the EPA approach to a BERA: problem formulation, exposure assessment, effects assessment, and risk characterization. An uncertainty section of a more general and SERA-specific nature is found in Section 7.5.

7.11.1 Uncertainties in Problem Formulation

Environmental concentrations of analytes in the soil, sediment, and surface water at Load Line 2 were based on a limited number of samples, and the uncertainties associated with this are found in the SERA, Section 7.5.1.

7.11.2 Uncertainties in Exposure Assessment

The actual movement of analytes from the Load Line 2 constituent source media to ecological receptors has not been measured for this BERA. This introduces uncertainties about the actual modes and pathways of exposure, bioavailability of constituents, and the actual exposure concentrations of these analytes to the ecological receptors. Actual exposure concentrations can differ from the measured environmental concentrations as a result of physical and chemical processes during transport from source to receptor and as a result of biomagnification through the food web. Actual exposure concentrations in physical media are sometimes less than the total measured concentrations because a portion of the total constituent is not bioavailable to the receptors. These processes have not been evaluated quantitatively in this SERA. Thus, the exposures could be overestimated based on the total measured concentration.

BAFs for soil and sediment to biota, and BCFs for surface water to biota, used for the PBT evaluation, are not available for some analytes. Instead, default values were used. It is not known whether this substitution overestimates or underestimates exposure. However, the default values are thought to be conservative, so it is likely that exposures will not be underestimated.

Literature-derived factors to describe dietary intake and bioaccumulation of elements may not reflect actual diets and bioaccumulation at the site. However, the literature values are assumed to be sufficiently similar to site-specific values that exposures neither will be underestimated nor overestimated.

Exposure concentrations are likely to be overestimated because of conservative exposure factors. Exposure factors include published BAFs, irrespective of species and environmental conditions. In particular, it should be noted that, while the largest BAFs may overestimate bioaccumulation at Load Line 2 by at least one order of magnitude for some COPECs, very high bioaccumulation, as well as biomagnification, are well-documented for other constituents, although not necessarily all those likely detected.

Finally, the exposure of plants and animals to constituents below detection limits was not considered in the BERA. In addition, the exposure of ecological receptors to tentatively identified compounds is not considered, which could result in an underestimation of exposure.

7.11.3 Uncertainties in Effects Assessment

The preferred TRVs for the three media were based on concentrations reported to have no observed effects or NOAELs for various organisms. This BERA provides findings for COPEC-specific HQs. An evaluation of risk from COPEC mixtures cannot be conducted without additional data and evaluation of alternative models of COPEC interaction.

There are no available TRVs for some analytes, especially organics, for each of the three media. This contributes to uncertainty associated with likely underestimates of risk. Sometimes, lack of TRVs based on soil-plant studies caused use of TRVs based on hydroponic studies; hydroponic studies are inferior to soil-plant studies and this contributed additional uncertainty.

Some of this uncertainty can be offset by field studies. For example, at RVAAP, there was a facility-wide surface water investigation that was performed by USACE with cooperation of the Ohio EPA. In the investigation, water and sediment samples were taken from locations along the major stream and tributaries, ponds, and wetlands throughout RVAAP at locations that could have been impacted by former facility activities and sites where the streams entered RVAAP. Fish were caught, identified, and released in the sampling locations corresponding to the water and sediment sample locations. Invertebrate biota were collected by Hester-Dendy samplers set in the same locations and by qualitative sampling of organic debris and rocks in the stream reach. Funnel traps were additionally placed in ponds and wetlands for further invertebrate sampling. The details of the study, locations, techniques, and results from this study are published in the Ravenna facility-wide surface water study: streams (USACE 2004) and Ravenna facility-wide surface water study: ponds and wetlands (USACE 2004).

Kelly's Pond was sampled for the facility-side surface water study; the detailed results are published in the Ponds and Wetlands volume. The results of analytical sampling indicate some low level residual contamination from facility processes (2,4-amino-2,4-DNT; 2,6-amino-2,6-DNT; TNT; RDX; and HMX) in the surface water. The biological parameters are still under investigation as impacts to the biotic community were present at the site. The cause of the impact is being investigated as the presence of a community altering invasive species was confirmed, as well as the low levels of explosive compounds. Further investigation and discussion will be needed to assess the possible impacts of the former facility operation or the impact of the invasive species in the pond. The results of the investigation and conclusions will be presented in the upcoming surface water report on ponds and wetlands.

7.11.4 Uncertainties in Risk Characterization

The uncertainties described above ultimately produce uncertainty in the quantification of current and future risks to terrestrial and aquatic animals at Load Line 2. Five additional areas of uncertainty in the risk characterization exist: off-site risk, cumulative risk, future risk, background risk, and extrapolation risk. See the SERA, Section 7.5.5, for additional information.

There is an additional topic for uncertainty—qualitative estimation for subsurface soil and quantitative risk estimation for surface soil. Table 7-13 shows that most all chemicals are more concentrated in the

Table 7-13. Comparison of Surface and Subsurface Maximum and Mean Concentrations at Load Line 2[a]

Contaminant Group	Number of Maximum Concentrations > in Subsurface	Soil Horizon Maximum Concentrations (mg/kg)				Soil Horizon Mean Concentrations (mg/kg)			Largest HQ and Implication for Ecological Risk
		Contaminant > in Subsurface	Surface (0 to 1 ft)	Subsurface (1 to 3 ft)	Number of Times Greater	Surface (0 to 1 ft)	Subsurface (1 to 3 ft)	Number of Times Greater	
Explosives Handling Area Aggregate									
Inorganics	1 of 23	Mercury	9.9E-01	7.1E+00	7.2	5.2E-02	8.1E-01	15.6	0.71[b] One increase[c]
Explosives	0 of 9								
Pesticides	0 of 9	--							
SVOCs	0 of 18	--							
VOCs	0 of 2	--							
Preparation and Receiving Areas Aggregate									
Inorganics	0 of 21	--							
Explosives	0 of 6	--							
Pesticides	0 of 9	--							
SVOCs	0 of 23	--							
VOCs	0 of 4	--							
Packaging and Shipping Areas Aggregate									
Inorganics	1 of 21	Lead	1.2E+03	1.5E+03	1.3	1.1E+02	5.2E+02	4.7	3.92[d] Small increases
Explosives	0 of 5	--							
Pesticides	0 of 2	--							
SVOCs	0 of 18	--							
VOCs	2 of 3	2-butanone	ND	3.6E-03	--	ND	3.6E-03	--	None
		Acetone	ND	1.7E-02	--	ND	1.7E-02	--	None
Perimeter Area Aggregate									
Inorganics	0 of 21	--							
Explosives	1 of 7	1,3,5-Trinitrobenzene	ND	6.7E+00	--	ND	6.7E+00	--	None
Pesticides	0 of 5	--							
SVOCs	0 of 2	--							
North Ditches Aggregate									
Inorganics	0 of 6	--							
Explosives	0 of 1	--							
VOCs	0 of 1	--							

Table 7-13. Comparison of Surface and Subsurface Maximum and Mean Concentrations at Load Line 2[a] (continued)

[a] = Maximum concentration not greater than background.
[b] = HQs range from 0.71 (earthworms) to 0.00001 (fox) (Tables R-43 through 47); factor of 10 could increase earthworm HQ to 7, but all wildlife would still be below 1.
[c] = Any increase to HQ keeps it below 1.
[d] = HQs range from 3.92 (plant) to 0.00009 (hawk) (Tables R-53 through 57); factor of 3.5 could increase plant HQ to 13.7 and rabbit HQ to 1.6.
HQ = Hazard quotient.
ND = Not detected.
SVOC = Semivolatile organic compound.
VOC = Volatile organic compound.

upper soil horizon compared to the deeper ones, but that a few show a reverse pattern. This comparison is narrated below.

Comparisons were made between surface soil and subsurface soil contaminants for both the mean and maximum concentrations. Those EUs with contaminants that were found to have maximum concentrations greater in subsurface soil than surface soil are discussed below. EUs with subsurface and surface soil data available were the Explosives Handling Area, Preparation and Receiving Area, Packaging and Receiving Area, and Perimeter Area Aggregates. Subsurface soils were not collected from the Change Houses and North Ditches Aggregates. Surface soil samples were collected from 0 to 1 ft bgs and subsurface samples were collected from 1 to 3 ft bgs.

In the Explosives Handling Area Aggregate, the maximum concentration of mercury was found in subsurface soil (Table 7-13). Mercury was 7.2 times greater in subsurface soil (7.1 mg/kg) than surface soil (0.99 mg/kg). When looking at the means, mercury was 15.6 times greater in subsurface soil (0.81) compared to surface soil (0.052 mg/kg). There were no maximum concentrations of explosives, pesticides, SVOCs, or VOCs in subsurface contaminants that were greater than surface contaminants.

There were no maximum concentrations of subsurface contaminants greater than surface contaminants in the Preparation and Receiving Areas and North Ditches Aggregates.

In the Packaging and Shipping Areas Aggregate, the maximum concentration of lead (1,500.0 mg/kg) was 1.3 times greater in subsurface soil than surface soil (1,200.0 mg/kg). However, the mean was 4.7 times greater in subsurface soil (520 mg/kg versus 110 mg/kg). There were no maximum concentrations of explosives, pesticides, or SVOCs in subsurface contaminants that were greater than surface contaminants. Two VOCs detected in subsurface soil (2-butanone and acetone) were not detected in surface soil.

In the Perimeter Area Aggregate, one explosive (1,3,5-TNB) was detected in subsurface soil but not in surface soil. There were no maximum concentrations of inorganics, pesticides, or SVOCs in subsurface contaminants that were greater than surface contaminants.

The biggest finding of these comparisons is that most all chemicals are more highly concentrated in the surface soil. In the few opposite cases, most have no impact on HQs, but a few do. For example, the mercury HQs could increase to 7 for the earthworm in the Explosives Handling Area Aggregate, and lead HQs could increase to 13.7 for the plants and 1.6 for the rabbit. However, the rest remain below 1.

7.11.5 Extrapolation Risk

Yet another source of uncertainty revolves around the extrapolations of Load Line 1 data, including HQs to Load Line 3. No one load line and no one EU is exactly like its companion. Differences in concentrations and chemical mixtures introduce variation into extrapolations.

7.11.6 Summary of Uncertainties

The most important uncertainties in the Load Line 2 BERA are those surrounding the estimates of the constituent concentrations to which ecological receptors are actually exposed (exposure concentrations) and the concentrations that present an acceptable level of risk of harmful effects (TRVs). These uncertainties arise from multiple sources, but especially from the lack of site-specific data on constituent transport and transformation processes, bioavailability of contaminants, organism toxicity, and the response of plant and animal populations to stressors in their environments. Despite these uncertainties, the available site-concentration data and published exposure and effects information are believed to provide a sufficiently credible picture of ecological risk that management decisions can be made with confidence.

7.12 SUMMARY OF EXTRAPOLATION OF LOAD LINE 1 HAZARD QUOTIENTS AND LOAD LINE 2 LEVEL III BASELINE RISK ASSESSMENT

7.12.1 Soil Chemicals of Ecological Concern

Soil COECs. Multiple COECs for surface soil were identified for each of the five terrestrial EUs at Load Line 2 (Table 7-14). The EU-specific soil COECs were identified by having met one of three conditions: (1) the preliminary COPEC RME concentration yielded an HQ > 1 for at least one ecological receptor exposed to the surface soil, (2) the Load Line 2 mean concentration for the soil SRC was ≤ the mean for that analyte at Load Line 1 so the maximum HQ for that SRC for soil receptors at Load Line 1 was applicable to Load Line 2 and the Load Line 1 maximum HQ >1, or (3) the Load Line 2 preliminary COPEC had no TRV for one or more receptors.

The Explosives Handling Area Aggregate had 15 COECs (10 inorganics, 1 SVOC, 3 pesticides, and 1 PCB), with 8 based on Load Line 2 HQs > 1, arsenic and thallium based on Load Line 1 maximum HQs >1, and 5 COECs based on "No TRVs."

The Preparation and Receiving Area Aggregate had 17 COECs (13 inorganics, 1 SVOC, 2 pesticides, and 1 PCB), with 9 based on Load Line 2 HQs > 1, 6 based on Load Line 1 maximum HQs > 1, and 7 COECs based on "No TRV" (5 of which are also COECs per HQs > 1).

The Packaging and Shipping Area Aggregate had 10 COECs (9 inorganics and 1 PCB), 9 of which were based on the Load Line 2 HQs > 1, and 6 COECs based on "No TRV" (5 of which were also COECs based on HQs >1).

The Perimeter Area Aggregate had 10 COECs (all inorganics), 4 of which were based on Load Line 2 HQs >1, with 5 more based on Load Line 1 maximum HQs > 1, and 4 COECs based on "No TRV" (3 of which were also COECs based on HQs > 1 for at least one receptor).

The North Ditches Aggregate had two inorganic COECs, one of which was based on the Load Line 2 HQ >1 and the other based on Load Line 1 maximum HQs > 1.

7.12.2 Sediment Chemicals of Ecological Concern

Sediment COECs. Two or more COECs for sediment were identified at both of the aquatic EUs at Load Line 2 (Table 7-15). The EU-specific sediment COECs were identified by having met one of two conditions: (1) the preliminary COPEC RME concentration yielded an HQ > 1 for one or more ecological receptors exposed to the sediment, or (2) there was no TRV for one or more receptors exposed to sediment at the EU.

The Kelly's Pond and Exit Drainages Aggregate had 25 COECs (8 inorganics, 12 SVOCs, 3 pesticides, and 2 explosive), 18 of which were based on Load Line 2 HQs > 1 and the rest based on "No TRV."

At the North Ponds Aggregate there were three COECs, including two inorganics based on Load Line 2 HQs > 1 and one COEC based on "No TRV" for all receptors.

7.12.3 Surface Water Chemicals of Ecological Concern

Only two COECs [cadmium and bis(2-ethylhexyl)phthalate] were identified for surface water at the sole surface water EU, the North Ponds Aggregate. These two COECs were based on HQs > 1 for one or more ecological receptors.

Table 7-14. Summary of Soil COECs, by Exposure Unit, for Load Line 2

BERA for Load Line 2			Load Line 2 Mean ≤ Load Line 1 Mean*		BERA for Load Line 2		
COECs per Load Line 2 HQ > 1			COECs per Load Line 1 HQ > 1		COECs per "No TRV"		
Explosive Handling Area Aggregate							
Aluminum	Lead	PCB-1254	Arsenic		Beryllium[a]	Aluminum[b]	PCB-1254[b]
Barium	Manganese		Thallium		Calcium[c]	Barium[b]	4,4'-DDT[a]
Chromium	Zinc				Magnesium[c]	Iron[b]	Dieldrin[a]
Iron					Benzoic Acid[a]	Manganese[b]	
Preparation and Receiving Areas Aggregate							
Aluminum	Cadmium	PCB-1254	Chromium	4,4'-DDT	Aluminum[b]	Manganese[b]	
Antimony	Copper		Iron	Dieldrin	Antimony[b]	Benzo(*a*)pyrene[a]	
Arsenic	Lead		Mercury		Barium[b]	PCB-1254[b]	
Barium	Manganese		Zinc		Cobalt[a]		
Packaging and Shipping Areas Aggregate							
Aluminum	Lead	PCB-1254	None		Barium[b]	Silver[a]	
Barium	Manganese				Aluminum[b]	PCB-1254[a]	
Chromium	Selenium				Iron[b]		
Iron	Zinc				Manganese[b]		
Perimeter Area Aggregate							
Aluminum	Manganese		Cadmium	Selenium	Aluminum[b]	Manganese[b]	
Arsenic			Chromium	Zinc	Beryllium[a]		
Iron			Lead		Iron[b]		
North Ditches Aggregate							
Zinc			Cadmium		None		

[a] No TRV for some receptors but no HQ > 1 for any other receptors.
[b] No TRV for some receptors but an HQ > 1 for one or more other receptors.
[c] No TRV for any ecological receptors at the exposure unit.
* not significantly different at $p < 0.05$ (t-test).
BERA = Baseline ecological risk assessment.
COEC = Chemical of ecologcial concern.
DDT = Dichlorodiphenyltrichloroethane.
HQ = Hazard quotient.
PCB = Polychlorinated biphenyl.
TRV = Toxicity reference value.

Table 7-15. Summary of Sediment COECs, by Exposure Unit, for Load Line 2

BERA for Load Line 2 COECs per Load Line 2 HQ > 1			BERA for Load Line 2 COECs per "No TRV"
Kelly's Pond			
Cadmium	Bis(2-ethylhexyl)phthalate	beta-BHC	Antimony[a]
Lead	Chrysene	2,4-Dinitrotoluene	Beryllium[a]
Silver	Dibenzo(*a,h*)anthracene		Calcium[b]
Anthracene	Fluoranthene		Magnesium[b]
	Indeno(1,2,3-*cd*)pyrene		Silver[c]
	Phenanthrene		Anthracene[c]
	Pyrene		Benzo(*a*)anthracene[c]
Benzo(*a*)anthracene	4,4'-DDE		Benzo(*b*)fluoranthene[a]
Benzo(*a*)pyrene			Endrin Ketone[b]
Benzo(*k*)fluoranthene			4-Amino-2,6-dinitrotoluene[b]
Benzo(*g,h,i*)perylene			2,4,6-Trinitrotoluene[a]
North Pond			
Cadmium	Lead		Nitrocellulose[b]

[a] No TRV for some receptors but no HQ > 1 for any other receptors.
[b] No TRV for any ecological receptors at the exposure unit.
[c] No TRV for some receptors but an HQ > 1 for one or more other receptors.
* not significantly different at $p < 0.05$ (t-test).
BERA = Baseline ecological risk assessment.
BHC = Benzene hexachloride.
COEC = Constitient of ecological concern.
DDE = Dichlorodiphenyldichloroethylene.
HQ = Hazard quotient.
TRV = Toxicity reference value.

THIS PAGE INTENTIONALLY LEFT BLANK.