APPENDIX B
SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT

This appendix presents the ERA approach and results for the TVA Ash Response EE/CA for the non-time-critical removal action for the Dredge Cell and Swan Pond Embayment areas. The objective of the ERA process is to evaluate potential risks to terrestrial and aquatic ecological receptors from exposure to constituents in ambient media. This ERA is intended to provide input for risk management decision-making for the failed dredge cell and the embayment west of Dike 2, while maintaining a conservative approach protective of wildlife populations and communities at the TVA Kingston facility.

In accordance with EPA guidance, an ERA is comprised of a SLERA and, if necessary, a BERA (EPA 1997). Figure B-1 provides an overview of the ecological risk approach that encompasses the EPA eight-step ERA process (EPA 1997). An expanded view of the components of each step is provided on Figure B-2 (EPA 1999, 2000a). The SLERA provides a conservative estimate of potential ecological risks and compensates for uncertainty by incorporating numerous conservative assumptions. The purpose of a SLERA is to determine whether there is a high probability that there are no ecologically significant risks (EPA 2000a, 1997); otherwise, a BERA is warranted, except where early actions will reduce potential ecological risks to acceptable levels. If need for a BERA is indicated, the information developed in the SLERA is used to help focus the BERA. The BERA is more complex than the SLERA and uses more realistic and site-specific information about potential exposures and effects in order to evaluate potential ecological risks.

The ERA guidance (EPA 1997) includes clearly identified points in the process for stakeholder communication and decision-making, consistent with EPA guidelines (EPA 1998, 1999, 2000a). These SMDPs allow for collaborative decision-making that results in the efficient use of time and resources. These decisions must then be captured in subsequent decision-making documents and actions. Generally, the following types of decisions are considered at the SMDPs:

- Whether no further action is appropriate based on concerns for wildlife,
- Whether further ERA is warranted, and
- Whether remedial actions can be implemented to reduce or prevent risks to wildlife.

In this assessment, the SLERA evaluates the potential risks to terrestrial and aquatic ecological receptors exposed to detected constituents in ash and surface water west of Dike 2. A SLERA for all areas of the Site (west of Dike 2 and River System) was presented in the non-time-critical removal action EE/CA Work Plan (Jacobs 2009). This SLERA focuses on the area west of Dike 2 and includes data from recent surface water samples collected in the embayment. At the time of the Work Plan SLERA, surface water samples from west of Dike 2 that are representative of potential current and near-term aquatic exposures had not yet been validated. This data gap has been filled in the current SLERA. The ash that will remain in the area west of Dike 2 at the conclusion of the time-critical removal action is primarily considered a potential risk to terrestrial ecological receptors; however, this assessment also assesses potential risks to aquatic and sediment-associated biota. To be conservative, the SLERA evaluates potential exposures to ash in this area as if it were soil (ash as soil) as well as if it were sediment (ash as sediment). The ash that will remain in the rivers at the conclusion of the time-critical removal action is primarily considered a potential risk to aquatic ecological receptors.

A SLERA evaluates the potential risk to ecological receptors exposed to site-related and legacy constituents. The SLERA conducted for the TVA Kingston Ash Release west of Dike 2 consists of the first two steps of the eight-step approach illustrated on Figures B-1 and B-2. The remainder of this section discusses those steps for terrestrial and aquatic receptors, and the resultant SMDP, as follows:

- Section B.1 – Step 1: Screening-Level Problem Formulation and Ecological Effects Evaluation
- Section B.2 – Step 2: Screening-Level Exposure Estimate and Risk Calculation
- Section B.3 – SMDP and Reporting

B.1 STEP 1: SCREENING-LEVEL PROBLEM FORMULATION AND ECOLOGICAL EFFECTS CHARACTERIZATION

The screening-level problem formulation serves to define the reasons for the SLERA and to define the methods for analyzing/characterizing risks (EPA 1998, 1997). The background information on site characterization, receptors, and ecosystem characteristics is vital to the problem formulation, as is information on the sources and effects of the stressors (EPA 1998).

B.1.1 Screening-Level Problem Formulation

The screening-level problem formulation provides information used to establish the overall goals of an ERA (EPA 1999, 1998). In addition, once these are established, the problem formulation is used to develop a conceptual site model (CSM) for the ERA. The specific goal of this effort is a conservative evaluation of the likelihood for adverse effects (and the ecological significance of predicted adverse effects) to wildlife that may be exposed to site-related constituents.

The screening level problem formulation encompasses a variety of topics for areas where ecological exposures are likely to occur, and remedial actions to eliminate exposure pathways are not yet selected. Problem formulation produces three outputs: (1) assessment endpoints that adequately reflect management goals and the ecosystem the goals are meant to protect, (2) a CSM that describes the relationships between stressors and the assessment endpoints, and (3) a plan for analyzing the potential risks to the assessment endpoints (EPA 1998, 2000a).

The remainder of this section provides an overview of the following components that comprise the screening-level problem formulation for the sites.

- Characterization of environmental setting,
- Identification of constituents detected in relevant media,
- Description of constituent fate and transport pathways,
- Description of constituent mechanisms of ecotoxicity,
- Description of potentially affected receptors,
- Identification of potentially complete exposure pathways and CSM, and
- Identification of generic assessment and measurement endpoints.

Characterization of Environmental Setting. The TVA Kingston Ash Release occurred at the KIF, which is located in the Tennessee River Valley near the confluence of the Emory and Clinch Rivers. The river valley is bounded on the northwest and southeast by ridges reflective of the Valley and Ridge Physiographic Province, and is impounded by Watts Bar Dam.

On Monday, December 22, 2008, a dike containing the KIF dredge cells failed, releasing about 5.4 million cubic yards of ash and bottom ash. The spilled material covered about 300 acres of adjacent parts of the Emory River, including most of Swan Pond Embayment, and reservoir shore lands. The remainder of this section describes the terrestrial and aquatic habitat included in the evaluation of the Kingston Ash Release west of Dike 2, which is the focus of this EE/CA.

Terrestrial Habitat. Dominant plant communities west of Dike 2 at the TVA Kingston Ash Release site included a variety of wetland species found along the outer bases of the dikes. A band of riparian trees

and shrubs, including sycamore, willow, boxelder, and alder occurred along much of the outer edge adjacent to the reservoir. Similar bottomland hardwoods and riparian vegetation occurred along other parts of the shoreline of Swan Pond Embayment and on the islands in the embayment. Other affected areas of the reservoir shoreline included landscaped areas, suburban lawns, bottomland hardwoods, and upland hardwoods.

The vegetation at the site appeared to support a diversity of wildlife, including shorebirds and waterfowl, amphibians, reptiles, and small mammals. Swan Pond Embayment was heavily used by Canada geese, wood ducks, great blue and green herons, great egrets, belted kingfishers, and double-crested cormorants. A variety of songbirds, semi-aquatic mammals, turtles, and water snakes were also abundant in the riparian vegetation along the shoreline of these rivers and other areas west of Dike 2. Ospreys are common in the area, often nesting on natural and man-made structures on and around the site. Heron colonies also occur near the fossil plant; the closest being approximately 0.3 mile upstream of the release. A second colony including great blue herons and double-crested cormorants occurs just downstream of the junction of the Emory and Clinch rivers.

Aquatic Habitat. The TVA Kingston Ash Release site west of Dike 2 included wetlands in the vicinity of the site that are typically associated with shoreline margins, in floodplains of tributary streams, small islands, and at the heads of reservoir coves. These wetlands included a mix of forested, shrub, and/or herbaceous vegetation depending on the land use. National Wetland Inventory maps show narrow fringe wetlands along the shorelines and three small island wetlands in this area. Between the mouth of Swan Pond Creek embayment and Swan Pond Circle Road, there were narrow fringe wetlands along the shoreline, and wetlands in narrow patches along the margins of the southernmost ash cells.

The dredge cell failure released ash into the Swan Pond Embayment, completely covering the aquatic habitat in this portion of Watts Bar Reservoir. Recent aerial photographs show that the ash slide eliminated wetlands in the spill area. The ash spill also affected wetlands in the ash pond area.

Identification of Constituents Detected in Relevant Media. Ash as soil, ash as sediment, and surface water are the environmental media associated with the TVA Kingston Ash Release west of Dike 2 EE/CA with which direct contact by ecological receptors is possible. A suite of 25 inorganic constituents, including heavy metals and common macronutrients, was analyzed in ambient media. Of these, 21 inorganics were detected in ash and 16 were detected in surface water, all of which are included in the SLERA and discussed in more detail below. Ash was also analyzed for a suite of PAHs, all of which were below detection limits. The exception was one sample with 2-methylnaphthalene, which is addressed in the uncertainty section. Potential ecological risks associated with groundwater releases to surface water will be evaluated as part of the BERA for the river system.

Description of Constituent Fate and Transport Pathways. Knowledge about the potential constituent fate and transport pathways is vital to understanding which constituents and receptors are associated with complete exposure pathways. This is because a constituent may reach an ecological receptor in a variety of ways. In addition, the pathway and route of exposure may have a strong influence on the ecological effect of a constituent. This information is used in the development of a CSM. Constituent fate and transport pathways for the TVA Kingston Ash Release are illustrated in the screening level CSM (Figure B-3).

Description of Constituent Mechanisms of Ecotoxicity. The mechanisms of ecotoxicity for constituents vary depending on a wide range of factors, such as constituent concentrations, the receptor species exposed, the exposure route (e.g., ingestion or direct contact), and physical factors (e.g., soil pH, temperature, moisture content). Some of the effects that could be observed in wildlife are mortality, reduced reproductive ability, decreased fertility, decreased offspring survival, alteration of immune and

behavioral function, decreased hatching success of eggs/larvae, and retarded growth (Sample et al. 1996; EPA 2001a). Described below are the mechanisms of ecotoxicity for the types of inorganic constituents of ash detected at the TVA Kingston ash release west of Dike 2. These descriptions of constituent mechanisms of toxicity are presented without consideration of constituent concentrations, as the descriptions are intended to convey an understanding of possible effects, rather than to describe the concentrations at which these effects might occur.

Trace metals (such as chromium, copper, lead, mercury, and zinc) are relatively well understood with respect to their potential adverse impacts on plants and wildlife (Newman 1998). Chromium, copper, and zinc are among the trace metals that are essential for healthy enzyme function, and some organisms cannot survive without these metals. However, these and other naturally occurring constituents may cause adverse effects when exposure occurs at concentrations that significantly exceed background concentrations. The toxicity and effects of trace metals may be greatly influenced by biotic and abiotic factors, including pH, organic carbon content, and the presence of sulfides in sediments or the matrix in which they occur (Leland and Kuwabara 1985). These factors affect the nature of the inorganic and organic complexes formed by the metal and its bioavailability. For conservative purposes, metal bioavailability in the SLERA is assumed to be 100% for constituents of potential ecological concern (COPEC) identified at the site.

Imbalances in the essential trace metals may cause a decrease in photosynthetic ability, poor spawning/hatching success, teratogenesis, susceptibility to predation and disease, reduced growth, mortality, histopathological changes, organ dysfunction of the liver or kidneys, neurological defects, changes in respiration and osmoregulation, and anemia. Trophic transfer is a pathway of concern for some metals, notably selenium and mercury, which are known to bioaccumulate to varying degrees in the environment (EPA 2000b). Because these constituents are naturally occurring, many organisms have a limited capacity to biotransform and/or eliminate naturally occurring inorganics (Leland and Kuwabara 1985, Newman 1998).

Description of Potentially Affected Receptors. The identification of the categories of receptors potentially affected at the site is integral to the development of the CSM. The categories of receptors are intentionally generic at the SLERA stage of the assessment process. For this site the potentially affected receptors include herbivorous mammals, omnivorous mammals, carnivorous mammals, piscivorous mammals, herbivorous birds, omnivorous birds, carnivorous birds, piscivorous birds, amphibians, reptiles, soil invertebrates, herbaceous plants, woody plants, rooted macrophytes, benthic invertebrates, bottom fish, and pelagic fish. If a BERA is performed, these general types of receptors will be refined and expanded to identify representative guilds and surrogate species to be further evaluated.

This stage of the screening-level problem formulation typically involves the identification of threatened and endangered species potentially exposed at the site. There are several plants, invertebrates, amphibians, reptiles, fish and birds listed as species of conservation concern in Roane County, as evaluated by the TVA Regional Natural Heritage Program. This list, which is presented in Table B-1 (Attachment B-1), consists of 38 plants, 11 invertebrates, three amphibians, one reptile, five fish, five birds, and two mammals, and includes all rare, threatened or endangered species known or expected to occur in the habitat present at the site. Currently, there have been no threatened or endangered species identified in the area west of Dike 2. If a BERA is warranted, this list of species of concern will be used to inform the process of selecting the representative guilds and surrogate species to be further evaluated. However, the assessment and protection of individuals of any species is outside the scope and intent of the ERA process for CERCLA sites.

Identification of Potentially Complete Exposure Pathways and Conceptual Site Model. A complete exposure pathway is “one in which the constituent can be traced or expected to travel from the source to a

receptor that can be affected by the chemicals" (EPA 2001b). Therefore, a constituent, its migration from the source, a receptor, and the mechanisms of toxicity of that constituent must be demonstrated before a complete exposure pathway can be identified. The components of an exposure pathway have already been discussed. The table below summarizes the possible exposure routes for the general types of terrestrial and aquatic receptors (EPA 1999).

Organism	Possible Exposure Routes
Terrestrial animals	Ingestion, inhalation, dermal contact, food chain
Soil invertebrates	Ingestion, inhalation, dermal contact
Terrestrial plants	Direct contact, leaf absorption of fugitive dust, leaf absorption of constituents in dust deposited on leaves, root uptake of groundwater, surface water, or porewater
Aquatic animals	Dermal or gill absorption, ingestion, food chain
Benthic invertebrates	Ingestion, inhalation, dermal contact
Aquatic plants	Direct contact, leaf absorption of fugitive dust, leaf absorption of constituents in dust deposited on leaves, root uptake of groundwater, surface water, or porewater

Although inhalation is listed as a possible exposure route, under most exposure conditions inhalation pathways do not represent a significant contribution to ecological receptor risk (EPA 2005), and are not evaluated quantitatively under most circumstances. Given that fugitive dust is a release mechanism of particular interest at the site, inhalation will be qualitatively evaluated if a BERA is warranted for areas with exposed ash. In addition, while dermal exposure is listed as a possible exposure route, under most exposure conditions dermal pathways do not represent a significant contribution to ecological receptor risk. Feathers of birds, fur on mammals, and scales on reptiles are thought to reduce potential dermal exposure by limiting the contact of the skin surface with the contaminated media (EPA 2005).

A CSM of potentially complete pathways was developed for the TVA Kingston Ash Release site. The CSM includes a graphical illustration of the potentially complete exposure pathways (Figure B-3). It integrates the potential sources of concern, the media in which they are present, the exposure routes by which they interact with ecological receptors, and the various types of potentially exposed ecological receptors. The receptors depicted in the CSM are representative of potential receptor categories (e.g., trophic levels and feeding guilds) and are presented only for visual aid; the receptors in the CSM are not necessarily the specific species that would be included in the BERA, should one become necessary. The CSM serves as a predictive model to link the constituents and the receptors. The CSM also helps to identify uncertainties and key assumptions about the site and is patterned after the EPA guidance on building appropriate CSMs (EPA 1999, 1998).

Identification of Generic Assessment and Measurement Endpoints. Assessment endpoints are the explicit expression of the ecological values to be protected (EPA 1999). The selection of assessment endpoints depends on knowledge of the receiving environment, knowledge about the constituents released (including ecotoxicological properties and concentrations that cause adverse impacts), and understanding of the values that will drive risk management decision-making (Suter, et al. 1995).

The EPA guidance states "For the SLERA, assessment endpoints are any adverse effects on ecological receptors, where receptors are plant and animal populations and communities, habitats, and sensitive environments (EPA 1997). Many of the screening ecotoxicity values are based on generic assessment endpoints (e.g., protection of aquatic communities from changes in structure or function) and are assumed to be widely applicable to sites around the United States". However, the identification of assessment endpoints is limited by the availability of ecotoxicity screening values for all media.

Since direct measurement of assessment endpoints is often difficult (or impossible), surrogate endpoints (called measurement endpoints) are used to provide the information necessary to evaluate whether the values associated with the assessment endpoint are being protected. A measurement endpoint is a measurable ecological characteristic and/or response to a stressor (EPA 1998). Measurement endpoints are also referred to as measures of potential effect (EPA 1998). For the SLERA, the measurement endpoints for assessing effects are the constituent screening toxicity values.

B.1.2 Screening-Level Ecological Effects Characterization (Screening Ecotoxicity Values)

The screening-level ecological effects characterization involves the identification of screening ecotoxicity values that are used for the media of concern at the site. Screening ecotoxicity values are constituent concentrations in environmental media below which there is negligible risk to receptors exposed to those media (EPA 2000a).

The following sources of screening values have been identified for use in the screening-level ecological effects characterization for this site:

- Soil: *EPA Ecological Soil Screening Levels* (EPA 2008, http://www.epa.gov/ecotox/ecossl/), and EPA Region 4 Ecological Soil Screening Values (ESVs) (EPA 2001c)
- Sediment: *EPA Region 4 Ecological Sediment Screening Values* (EPA 2001c)
- Surface Water: *National Recommended Water Quality Criteria* (EPA 2006) and EPA Region 4 Ecological Surface Water Screening Values (EPA 2001c)

These screening values are presented in Tables B-2 (soil), B-3 (sediment), and B-4 (surface water) in Attachment B-1 for all constituents evaluated at the site. Ambient water quality criteria for hardness-dependent metals were adjusted to account for the relatively low hardness of water in the Emory River, which ranges from 16 mg/L (as $CaCO_3$) to 135 mg/L. To be conservative, a hardness of 20 mg/L was used to adjust the ambient water quality criteria.

B.2 STEP 2: SCREENING-LEVEL EXPOSURE ESTIMATE AND RISK CALCULATION

This step of the SLERA is comprised of the estimation of ecological exposures, risk estimation, risk characterization, and the evaluation of uncertainties (EPA 1999, 2001a). These form the foundation of evidence to support the scientific management decision point.

B.2.1 Estimation of Screening-Level Exposures

The exposure concentrations used in the SLERA are the maximum detected concentrations (EPA 2000a, 2001c). For conservative purposes, all data representative of current and future conditions west of Dike 2 have been used to generate maximum concentrations for ash as surface soil, ash as sediment, and surface water for the current SLERA. These data are expected to be a conservative representation of the conditions that will exist following completion of the time-critical removal action, because there has been no evidence of a temporal trend in surface water and the constituent concentrations in ash will not increase over time. The ash data have been pooled into a single data set to identify the maximum concentration for both soil and sediment.

B.2.2 Screening-Level Risk Calculations

To estimate risk in the SLERA, HQs were calculated for each medium. An HQ is the unitless ratio of a constituent concentration in media to the screening ecotoxicity value for that constituent in that medium considered protective of wildlife. As indicated previously, maximum constituent concentrations and

conservative screening ecotoxicity values for ash as soil and ash as sediment collected west of Dike 2 were used for the SLERA calculations. HQs equal to or less than a value of 1 (reported using one significant digit) indicate that adverse impacts to wildlife are unlikely (EPA 2000a, 2001a). Constituents detected below their corresponding background concentration were not screened out, since background screening does not occur until later in the ERA process. HQs exceeding a value of 1 indicate that further assessment may be necessary to evaluate the potential for adverse impacts to wildlife. Therefore, the constituents with HQs greater than 1 are identified as COPECs and, where a BERA is deemed necessary, carried forward for further evaluation at a later time. In addition, constituents commonly associated with fly ash will be identified as COIs and carried forward regardless of the SLERA HQ screening results, including: arsenic, chromium, copper, lead, mercury, nickel, selenium, thallium, vanadium, and zinc.

The lack of screening ecotoxicity values for some constituents is one of the main contributors to uncertainty associated with the SLERA evaluation. HQs cannot be calculated for constituents that lack screening ecotoxicity values. Therefore, a constituent that lacks a screening value will be identified as a COPEC.

The occurrence of constituents detected in ash and surface water are presented in Tables B-5 and B-6 (Attachment B-1), along with the total number of collected samples, the frequency of detection, the range of detection/quantitation limits, the range of detected concentrations for each constituent detected, and the mean for each detected constituent. In the SLERA, the exposure point concentrations for each constituent are set equal to the maximum detected concentration.

The occurrence of constituents detected in ash as soil west of Dike 2 is summarized on Table B-5. Table B-7 (Attachment B-1) presents the maximum HQs calculated for ash as surface soil. Sixteen inorganics were detected with maximum concentrations above their corresponding ESVs (i.e., an HQ greater than 1) and four constituents were identified as essential nutrients.

The occurrence of constituents detected in ash as sediment west of Dike 2 is summarized on Table B-5. Table B-8 (Attachment B-1) presents the maximum HQs calculated for ash as sediment. Five inorganics were detected with maximum concentrations above their corresponding ESVs, ten constituents did not have an ESV available, two inorganics were identified as COIs, and four constituents were identified as essential nutrients.

The occurrence of constituents detected in surface water west of Dike 2 is summarized on Table B-6. Table B-9 (Attachment B-1) presents the maximum HQs calculated for surface water. Five inorganics were detected with maximum concentrations above their corresponding ESVs, four constituents did not have an ESV available, two inorganics were identified as COIs, and four constituents were identified as essential nutrients.

COPECs for ash as soil, ash as sediment, and surface water are summarized in Table B-10 (Attachment B-1).

B.2.3 Evaluation of Uncertainties

Uncertainty is “the imperfect knowledge concerning the present or future state of the system under consideration; a component of risk resulting from imperfect knowledge of the degree of hazard or of its spatial and temporal distribution,” (EPA 1997). Uncertainties that may lead to either an overestimate or underestimate of risk are associated with each stage of risk assessment. Uncertainty is inherent to ERA, in part, because the sciences of ecology and ecotoxicology are relatively young and not yet fully developed (Kapustka and Landis 1998, Newman 1998, Emlen and Springman 2007, Kapustka 2008, Suter 2008). Uncertainty also exists in many aspects of the toxicology relied upon for conducting ERAs

(Newman 1998, Lovett Doust, et al., 1993, Dale, et al. 2008). The types of uncertainties that may exist in an ERA are discussed in greater detail in Table B-11 (Attachment B-1).

As indicated in Tables B-5 and B-6, only constituents detected at least once in ash and/or surface water were carried through in the SLERA screening process. Constituents that were not detected and, therefore, not carried forward into the SLERA include the following: four constituents in ash, including one COI (antimony, cadmium, molybdenum, and silver); and nine constituents in surface water, including six COIs (beryllium, cadmium, cobalt, copper, mercury, nickel, silver, thallium, and zinc). Consequently, it is not possible to conduct a quantitative evaluation of these constituents.

One of 11 samples of ash included one PAH, 2-methylnaphthalene, at a concentration above the detection limit. However, re-analysis of the sample did not detect 2-methylnaphthalene. The sample was collected from an area of the ash that was subjected to extensive heavy equipment traffic during regrading and removal of the ash. Inspection of the chromatogram supports the conclusion that the presence of 2-methylnaphthalene is likely attributable to deposition from equipment exhaust, rather than inadequate combustion of coal. Although there is some uncertainty associated with the origin of this low level PAH concentration, the assessment that ash poses potential risks to ecological receptors is unchanged.

There also is uncertainty associated with detected constituents for which ecological screening values are not available. These COPECs are typically carried forward in the BERA for further evaluation. In the event that a BERA is not performed because the selected remedial actions will eliminate exposures, the lack of one or more screening values introduces a minimal degree of uncertainty.

B.3 SMDP AND REPORTING CONCLUSIONS

This first SMDP is purposefully flexible (per the EPA paradigm) to occur after Steps 2 or 3a, depending on the results obtained at Step 2. The purpose of the flexibility of the first SMDP is so that additional evaluation of risks can occur and reporting can be streamlined into a single report, where warranted. The results of the SLERA are expressed in terms of the following conclusions or recommended actions:

- There is adequate information to conclude that ecological risks are negligible and therefore no need for remediation on the basis of ecological risk;
- The information is not adequate to make a decision at this point, and the ecological risk assessment process will continue to Step 3; or
- The information indicates a potential for adverse ecological effects, and a more thorough assessment is warranted.

B.3.1 Terrestrial Environment

As described above, and summarized in Table B-10, the SLERA for terrestrial habitat west of Dike 2 at the TVA Kingston Ash Release indicates the following:

- Ash as soil: Sixteen inorganic constituents in ash as soil were selected as COPECs because maximum concentrations exceeded an HQ of 1.

Based on the available evidence, the possibility of adverse ecological risks for ecological receptors potentially exposed to ash as soil west of Dike 2 cannot be excluded.

B.3.2 Aquatic Environment

As described above and summarized in Table B-10, the SLERA for aquatic habitat west of Dike 2 at the TVA Kingston Ash Release indicates the following:

- Ash as sediment: Seventeen inorganic constituents in ash as sediment were selected as COPECs because maximum concentrations exceeded an HQ of 1, an ESV was not available, or constituents were identified as COIs in fly ash.
- Surface Water: Eleven inorganic constituents in surface water were selected as COPECs because maximum concentrations exceeded an HQ of 1, an ESV was not available, or constituents were identified as COIs in fly ash.

Based on the available evidence, the possibility of adverse ecological risks for ecological receptors potentially exposed to COPECs in ash as sediment and surface water cannot be excluded.

B.3.3 SMDP for Dredge Cell and Embayment

The information indicates a potential for adverse ecological effects for terrestrial and aquatic receptors in the areas west of Dike 2. Although a more thorough assessment is warranted, all viable remedial action alternatives for the Dredge Cell and Embayment entail the complete removal of ash from the embayment and capping of the Dredge Cell with clean soil. Given that the remedies for this area of the site will eliminate the potential exposure pathways for ecological receptors, a BERA is not warranted at this time and no additional data are needed to support the selection of a remedial action to protect ecological receptors in the Dredge Cell and Embayment. However, if unforeseen actions in the future result in leaving quantities of ash in the embayment that may pose a risk to ecological receptors, these potential risks would be evaluated as necessary.

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ATTACHMENT B-1

Tables and Figures

Table B-1
Summary of Federal and State Listed Species Based on Records of Occurrence
Kingston Fly Ash Recovery Project
Kingston, Tennessee

Scientific Name	Common Name	EO Ranks	County	State Status	Federal Status
Plants					
Agalinis auriculata	Earleaf Foxglove	E	ROANE	END	
Asplenium scolopendrium var. americanum	American Hart's-tongue Fern	X?	ROANE	END	LT
Aureolaria patula	Spreading False-foxglove	E	ROANE	SPCO	
Bolboschoenus fluviatilis	River Bulrush	E	ROANE	SPCO	
Carex gravida	Heavy-fruited Sedge	E	ROANE	SPCO	
Carex oxylepis var. pubescens	Hairy sharp-scaled Sedge	H	ROANE	SPCO	
Cimicifuga rubifolia	Appalachian Bugbane	E	ROANE	THR	
Cypripedium acaule	Pink Lady-slipper	E	ROANE	S-CE	
Delphinium exaltatum	Tall Larkspur	E	ROANE	END	
Diervilla lonicera	Northern Bush-honeysuckle	E	ROANE	THR	
Diervilla sessilifolia var. rivularis	Mountain Bush-honeysuckle	E	ROANE	THR	
Draba ramosissima	Branching Whitlow-wort	E	ROANE	SPCO	
Elodea nuttallii	Waterweed	E	ROANE	SPCO	
Helianthus occidentalis	Mcdowell Sunflower	E	ROANE	SPCO	
Hydrastis canadensis	Goldenseal	E	ROANE	S-CE	
Juglans cinerea	Butternut	E	ROANE	THR	
Juncus brachycephalus	Short-head Rush	E	ROANE	SPCO	
Leucothoe racemosa	Fetter-bush	E	ROANE	THR	
Liatris cylindracea	Slender Blazing-star	E	ROANE	THR	
Lilium canadense	Canada Lily	E	ROANE	THR	
Liparis loeselii	Loesel's Twayblade	E	ROANE	THR	
Lonicera dioica	Mountain Honeysuckle	E	ROANE	SPCO	
Marshallia grandiflora	Large-flowered Barbara's-buttons	H	ROANE	END	
Myurella julacea	Myurella moss	H	ROANE	S-P	
Panax quinquefolius	American Ginseng	E	ROANE	S-CE	
Pedicularis lanceolata	Swamp Lousewort	E	ROANE	SPCO	
Platanthera flava var. herbiola	Pale Green Orchid	E	ROANE	THR	
Platanthera integrilabia	Monkey-face Orchid	X?	ROANE	END	C
Preissia quadrata	Blister ribbon	E	ROANE	THR	
Pseudognaphalium helleri	Heller's Catfoot	E	ROANE	SPCO	
Ruellia purshiana	Pursh's Wild-petunia	E	ROANE	SPCO	
Solidago ptarmicoides	Prairie Goldenrod	E	ROANE	END	
Spiraea virginiana	Virginia Spiraea	E	MORGAN	END	LT
Spiranthes lucida	Shining Ladies'-tresses	E	ROANE	THR	
Symphyotrichum pratense	Barrens Silky Aster	E	ROANE	END	
Thuja occidentalis	Northern White Cedar	H	ROANE	SPCO	
Villosa perpurpurea	Purple Bean	H	ROANE	END	LE
Viola tripartita var. tripartita	Three-parted Violet	E	ROANE	SPCO	
Invertebrates					
Caecidotea incurva	Incurved Cave Isopod	H	ROANE	TRKD	
Cumberlandia monodonta	Spectaclecase	H	ROANE	TRKD	C
Epioblasma turgidula	Turgid Blossom Pearlymussel	X	ROANE	EXTI	LE
Fusconaia cor	Shiny Pigtoe Pearlymussel	X	ROANE	END	LE
Fusconaia cuneolus	Fine-rayed Pigtoe	H, X	ROANE	END	LE
Io fluvialis	Spiny Riversnail	E	ROANE	TRKD	
Lampsilis abrupta	Pink Mucket	E	ROANE	END	LE
Lampsilis virescens	Alabama Lampmussel	H	ROANE	END	LE
Lithasia geniculata	Ornate Rocksnail	H	ROANE	TRKD	
Plethobasus cooperianus	Orange-foot Pimpleback	H	ROANE	END	LE
Pleurobema rubrum	Pyramid Pigtoe	E	ROANE	TRKD	

Table B-1
Summary of Federal and State Listed Species Based on Records of Occurrence
Kingston Fly Ash Recovery Project
Kingston, Tennessee

Scientific Name	Common Name	EO Ranks	County	State Status	Federal Status
Amphibians					
Cryptobranchus alleganiensis	Hellbender	E, H	ROANE	NMGT	
Gyrinophilus palleucus	Tennessee Cave Salamander	E	ROANE	THR	
Hemidactylium scutatum	Four-toed Salamander	E	ROANE	NMGT	
Reptiles					
Ophisaurus attenuatus longicaudus	Eastern Slender Glass Lizard	H	ROANE	NMGT	
Fish					
Cycleptus elongatus	Blue Sucker	E	ROANE	THR	
Cyprinella monacha	Spotfin Chub	X?	ROANE	THR	LT
Hemitremia flammea	Flame Chub	H	ROANE	NMGT	
Percina aurantiaca	Tangerine Darter	E	MORGAN	NMGT	
Phoxinus tennesseensis	Tennessee Dace	E	ROANE	NMGT	
Birds					
Accipiter striatus	Sharp-shinned Hawk	H	ROANE	NMGT	
Aimophila aestivalis	Bachman's Sparrow	E	ROANE	END	
Haliaeetus leucocephalus	Bald Eagle	AC, BC	ROANE	NMGT	
Pandion haliaetus	Osprey	E, X	ROANE		
Colonial Wading Bird Colony		AC, E	ROANE		
Mammals					
Myotis grisescens	Gray Bat	AC, E	ROANE	END	LE
Sorex longirostris	Southeastern Shrew	E, H	ROANE	NMGT	

Source: Tennessee Valley Authority Regional Natural Heritage Program
Element Occurrence (EO) Ranks are summarized for species with multiple occurrences

Element Occurrence (EO) Rank
AC - Excellent; good; or fair estimated viability
BC - Good or fair estimated viability
E - Verified extant (viability not assessed)
H - Historical
X - Extirpated
X? - Possibly extirpated

State Status
END - Endangered
EXTI - Extirpated
NMGT - In Need of Management
S-CE - Special Concern, Commercially Exploited
S-P - Special Concern, Possibly Extirpated
SPCO - Species of Concern
THR - Threatened
TRKD - Tracked by TN natural Heritage Program

Federal Status
C - Candidate
LE - Listed Endangered
LT - Listed Threatened

Table B-2
Soil Ecological Screening Values for Use in the Preliminary SLERA
Kingston Fly Ash Recovery Project
Kingston, Tennessee

Chemical Name	Region 4 Ecological Screening Values [a] (mg/kg)	EPA EcoSSL [b] (mg/kg)
Aluminum	50	NA
Antimony	3.5	0.27
Arsenic	10	18
Barium	165	330
Beryllium	1.1	21
Boron	0.5	NA
Cadmium	1.6	0.36
Chromium	0.4	26
Cobalt	20	13
Copper	40	28
Iron	200	NA
Lead	50	11
Magnesium	NA	NA
Manganese	100	220
Mercury	0.1	NA
Molybdenum	2	NA
Nickel	30	38
Selenium	0.81	0.52
Silver	2	4.2
Thallium	1	NA
Tin	53	NA
Titanium	1000	NA
Vanadium	2	7.8
Zinc	50	46

Notes:
[a] Region 4 Ecological Screening Values (EPA, 2001c).
[b] EPA Ecological Soil Screening Levels (EcoSSL) (EPA, 2005, 2008).

EPA = United States Environmental Protection Agency.
mg/kg = Milligrams per kilogram.
NA = Not available.
SLERA = Screening-level ecological risk assessment.

Table B-3
Sediment Ecological Screening Values for Use in the Preliminary SLERA
Kingston Fly Ash Recovery Project
Kingston, Tennessee

Chemical Name	Region 4 Ecological Screening Values [a] (mg/kg) Effect Value
Aluminum	NA
Antimony	2
Arsenic	7.24
Barium	NA
Beryllium	NA
Boron	NA
Cadmium	0.676
Chromium	52.3
Cobalt	NA
Copper	18.7
Iron	NA
Lead	30.2
Magnesium	NA
Manganese	NA
Mercury	0.13
Molybdenum	NA
Nickel	15.9
Selenium	NA
Silver	0.733
Thallium	NA
Tin	NA
Titanium	NA
Vanadium	NA
Zinc	124

Notes:
[a] Region 4 Ecological Screening Values (EPA, 2001c).

EPA = United States Environmental Protection Agency.
mg/kg = Milligrams per kilogram.
NA = Not available.
SLERA = Screening-level ecological risk assessment.

Table B-4
Surface Water Ecological Screening Values for Use in the Preliminary SLERA
Kingston Fly Ash Recovery Project
Kingston, Tennessee

	Ambient Water Quality Criteria [a] (mg/L)*			Region 4 Ecological Screening Values [b] (mg/L)*	
Chemical Name	**CMC**	**CCC**		**CSV**	
Aluminum	0.75	0.087	1	0.087	8
Antimony	NA	NA		0.16	
Arsenic	0.34	0.15	2	0.19	9
Beryllium	NA	NA		0.00053	
Boron	NA	NA		0.75	
Cadmium	0.00042	0.00008	2,3	0.00066	9,10
Chromium	0.016	0.011	4	0.011	
Chromium (III)	0.15	0.02	2,3	0.11732	9,10
Chromium (VI)	0.016	0.011	2	0.011	
Copper	0.003	0.0023	2,3	0.00654	9,10
Iron	NA	1	5	1	
Lead	0.01	0.00041	2,3	0.00132	9,10
Mercury	0.0014	0.00077	6	0.000012	
Nickel	0.12	0.013	2,3	0.08771	9,10
Selenium	20	0.005	7	0.005	
Silver	0.0002	NA	2,3	0.000012	
Thallium	NA	NA		0.004	
Zinc	0.03	0.03	2,3	0.05891	9,10
Alkalinity, Total as CaCO3	NA	20	5	NA	

Notes:
[a] National Ambient Water Quality Criteria (AWQC) (EPA, 2006) and Tennessee Water Quality Criteria (TDEC, 2008).
Tennessee has adopted the National Water Quality Criteria for the following constituents: arsenic, cadmium, chromium (III), chromium (VI), copper, lead, mercury, nickel, silver, zinc, and the CCC for selenium.
The CMC for selenium is a Tennessee Water Quality Criteria (TDEC, 2008).
[b] Region 4 Ecological Screening Values (EPA, 2001c).

* Footnotes for AWQC and Region 4 ESVs
1 Based on pH 6.5-9.0; total recoverable concentration.
2 Dissolved concentration.
3 Based on 20 mg/L total hardness.
4 Chromium VI used as surrogate, dissolved concentration.
5 Non-priority pollutant (USEPA Red Book, 1976).
6 Dissolved concentration, based on inorganic mercury.
7 The CMC = 1/[(f1/185.9 µg/L)=(f2/12.83 µg/L)], where f1 and f2 are fractions of selenium that are treated as selenite, and selenate, respectively.
8 Based on pH 6.5-9.0.
9 Ambient Water Quality Criterion.
10 Based on 20 mg/L total hardness.

CCC = Criterion Continuous Concentration.
CMC = Criterion Maximum Concentration.
CSV = chronic screening value.
EPA = United States Environmental Protection Agency
ESV = ecological screening value.
mg/L = milligrams per liter.
µg/L = micrograms per liter.
TDEC = Tennessee Department of Environment and Conservation

Table B-5
Ash West of Dike 2 Risk Assessment Dataset
Kingston Fly Ash Recovery Project
Kingston, Tennessee

Constituent [a]	CASN	Frequency of Detection (FOD) [b] number of detects / number of samples	FOD %	Detects Min - Max (mg/kg)	Detection Limits Min - Max (mg/kg)	Maximum Location	Exposure Point Concentration [c] (mg/kg)
Metals/Inorganics							
Aluminum	7429-90-5	52 - 52	100	8710 - 45200	– - –	KIF-GP 02-04-SD-123108-MT(KIF-GP 02-04-SD-123108-MT)	45200 m
Antimony	7440-36-0	0 - 52	0	– - –	11.8 - 15.6	–	–
Arsenic	7440-38-2	52 - 52	100	2.78 - 166	– - –	KIF-GP 44-46-SD-123108-MT(KIF-GP 44-46-SD-123108-MT)	166 m
Barium	7440-39-3	52 - 52	100	69.7 - 1410	– - –	KIF-S-2-SD-123108-MT(KIF-S-2-SD-123108-MT)	1410 m
Beryllium	7440-41-7	47 - 52	90.4	1.66 - 9.6	1.18 - 1.56	KIF-S-4-SD-123108-MT(KIF-S-4-SD-123108-MT)	9.6 m
Boron	7440-42-8	48 - 52	92.3	14.8 - 212	11.8 - 15.6	KIF-GP 00-02-SD-123108-MT(KIF-GP 00-02-SD-123108-MT)	212 m
Cadmium	7440-43-9	0 - 52	0	– - –	1.18 - 1.56	–	–
Calcium	7440-70-2	52 - 52	100	1460 - 30900	– - –	KIF-S-2-SD-123108-MT(KIF-S-2-SD-123108-MT)	30900 m
Chromium	7440-47-3	52 - 52	100	9.64 - 66	– - –	KIF-GP 02-04-SD-123108-MT(KIF-GP 02-04-SD-123108-MT)	66 m
Cobalt	7440-48-4	42 - 52	80.8	13.1 - 29.7	11.8 - 15.6	KIF-GP 02-04-SD-123108-MT(KIF-GP 02-04-SD-123108-MT), KIF-S-4-SD-123108-MT(KIF-S-4-SD-123108-MT)	29.7 m
Copper	7440-50-8	52 - 52	100	8.49 - 102	– - –	KIF-GP 44-46-SD-123108-MT(KIF-GP 44-46-SD-123108-MT), KIF-GP 46-48-SD-123108-MT(KIF-GP 46-48-SD-123108-MT)	102 m
Iron	7439-89-6	52 - 52	100	9840 - 39700	– - –	KIF-GP 26-28-SD-123108-MT(KIF-GP 26-28-SD-123108-MT)	39700 m
Lead	7439-92-1	52 - 52	100	10.7 - 46	– - –	KIF-GP 46-48-SD-123108-MT(KIF-GP 46-48-SD-123108-MT)	46 m
Magnesium	7439-95-4	52 - 52	100	662 - 6230	– - –	KIF-AFA01-RA-010609-MT(KIF-AFA01-RA-010609-MT)	6230 m
Manganese	7439-96-5	52 - 52	100	45.6 - 698	– - –	KIF-AFA19-RA-011209-MT(KIF-AFA19-RA-011209-MT)	698 m
Mercury	7439-97-6	4 - 12	33.3	0.136 - 0.209	0.122 - 0.155	KIF-DREDGECELL_EECA02-AA-090109	0.209 m
Molybdenum	7439-98-7	0 - 52	0	– - –	11.8 - 15.6	–	–
Nickel	7440-02-0	52 - 52	100	7.37 - 64.4	– - –	KIF-AFA05-RA-010609-MT(KIF-AFA05-RA-010609-MT)	64.4 m
Potassium	7440-09-7	52 - 52	100	642 - 7040	– - –	KIF-GP 46-48-SD-123108-MT(KIF-GP 46-48-SD-123108-MT)	7040 m
Selenium	7782-49-2	45 - 52	86.5	2.64 - 17.8	2.66 - 3.12	KIF-GP 48-50-SD-123108-MT(KIF-GP 48-50-SD-123108-MT)	17.8 m
Silver	7440-22-4	0 - 52	0	– - –	1.18 - 1.56	–	–
Sodium	7440-23-5	46 - 52	88.5	283 - 1790	236 - 312	KIF-GP 02-04-SD-123108-MT(KIF-GP 02-04-SD-123108-MT)	1790 m
Thallium	7440-28-0	4 - 52	7.69	2.65 - 3.8	2.36 - 3.12	KIF-GP 30-32-SD-123108-MT(KIF-GP 30-32-SD-123108-MT)	3.8 m
Vanadium	7440-62-2	52 - 52	100	15.6 - 163	– - –	KIF-GP 02-04-SD-123108-MT(KIF-GP 02-04-SD-123108-MT)	163 m
Zinc	7440-66-6	52 - 52	100	23.5 - 94.7	– - –	KIF-189 LAKESHORE DR-SD-1(KIF-189 LAKESHORE DR-SD-1	94.7 m

– = not detected/ not analyzed/ not applicable
CASN = chemical abstracts registry number
mg/kg = milligrams per kilogram

[a] Constituents that were not detected in ash will be evaluated qualitatively within the Uncertainties Section.
For duplicate samples, the highest detected value or the lowest detection limit were used.
[b] Frequency of detection (FOD) = number of detects / total number of samples analyzed.
[c] The exposure point concentration (EPC) was set as the maximum detected concentration (m).

Table B-6
Surface Water West of Dike 2 Risk Assessment Dataset
Kingston Fly Ash Recovery Project
Kingston, Tennessee

Constituent [a]	CASN	Frequency of Detection (FOD) [b]				Detects				Detection Limits				Maximum Location	Exposure Point Concentration [c]	
		number of detects / number of samples			FOD %	Min (mg/L)	-	Max (mg/L)		Min (mg/L)	-	Max (mg/L)			(mg/L)	
Metals/Inorganics																
Aluminum	7429-90-5	48	-	48	100	0.256	-	2.09		–	-	–		KIF-CWDITCH-SW-082009,KIF-SETTB-SW-082009	2.09	m
Antimony	7440-36-0	32	-	48	66.7	0.00202	-	0.009		0.002	-	0.002		KIF-SETTB-SW-082009	0.009	m
Arsenic	7440-38-2	48	-	48	100	0.0123	-	0.0792		–	-	–		KIF-SETTB-SW-073009	0.0792	m
Barium	7440-39-3	48	-	48	100	0.0793	-	0.22		–	-	–		KIF-SETTB-SW-082009	0.22	m
Beryllium	7440-41-7	0	-	48	0	–	-	–		0.002	-	0.002		–	–	
Boron	7440-42-8	48	-	48	100	0.154	-	1.93		–	-	–		KIF-SETTB-SW-082009	1.93	m
Cadmium	7440-43-9	0	-	48	0	–	-	–		0.001	-	0.001		–	–	
Calcium	7440-70-2	48	-	48	100	31.9	-	80.7		–	-	–		KIF-SETTB-SW-082009	80.7	m
Chromium	7440-47-3	5	-	48	10.4	0.00204	-	0.0032		0.002	-	0.002		KIF-SETTB-SW-082009	0.0032	m
Cobalt	7440-48-4	0	-	48	0	–	-	–		0.002	-	0.002		–	–	
Copper	7440-50-8	0	-	48	0	–	-	–		0.005	-	0.005		–	–	
Iron	7439-89-6	48	-	48	100	0.0775	-	3.1		–	-	–		KIF-CWDITCH-SW-082009	3.1	m
Lead	7439-92-1	4	-	48	8.33	0.00207	-	0.00238		0.002	-	0.002		KIF-CWDITCH-SW-080509	0.00238	m
Magnesium	7439-95-4	48	-	48	100	9.44	-	15.1		–	-	–		KIF-CWDITCH-SW-080209	15.1	m
Manganese	7439-96-5	48	-	48	100	0.017	-	1.18		–	-	–		KIF-CWDITCH-SW-082009	1.18	m
Mercury	7439-97-6	0	-	48	0	–	-	–		0.0002	-	0.0002		–	–	
Molybdenum	7439-98-7	48	-	48	100	0.00948	-	0.161		–	-	–		KIF-SETTB-SW-072309	0.161	m
Nickel	7440-02-0	0	-	48	0	–	-	–		0.005	-	0.005		–	–	
Potassium	7440-09-7	48	-	48	100	1.74	-	6.65		–	-	–		KIF-SETTB-SW-071409	6.65	m
Selenium	7782-49-2	46	-	48	95.8	0.00254	-	0.0359		0.002	-	0.002		KIF-SETTB-SW-082009	0.0359	m
Silver	7440-22-4	0	-	48	0	–	-	–		0.002	-	0.002		–	–	
Sodium	7440-23-5	48	-	48	100	1.37	-	3.67		–	-	–		KIF-SETTB-SW-082009	3.67	m
Thallium	7440-28-0	0	-	48	0	–	-	–		0.002	-	0.002		–	–	
Vanadium	7440-62-2	48	-	48	100	0.00668	-	0.0722		–	-	–		KIF-SETTB-SW-072309	0.0722	m
Zinc	7440-66-6	0	-	48	0	–	-	–		0.05	-	0.05		–	–	

– = Not detected/ not analyzed/ not applicable.
CASN = Chemical abstracts registry number.
mg/L = Milligrams per liter.

[a] Constituents that were not detected in surface water will be evaluated qualitatively within the Uncertainties Section.
For duplicate samples, the highest detected value or the lowest detection limit were used.
[b] Frequency of detection (FOD) = number of detects / total number of samples analyzed.
[c] The exposure point concentration (EPC) was set as the maximum detected concentration (m).

Table B-7
SLERA Constituents of Potential Ecological Concern in Ash as Soil
Kingston Fly Ash Recovery Project
Kingston, Tennessee

Constituent	Frequency of Detection (FOD) number of detects / number of samples			FOD %	Maximum Concentration Detect (mg/kg)	Maximum Concentration RL (mg/kg)	Ecological Screening Level (ESLs) [a] (mg/kg) Value	Ecological Screening Level (ESLs) [a] (mg/kg) *Source*	Maximum Hazard Quotient (HQ) [b] (unitless)	SLERA COPEC? [c] (YES/no)	SLERA COPEC? [c] Rational
Metals/Inorganics											
Aluminum	52	/	52	100	45,200	–	50	*R4*	900	**YES**	HQ > 1
Arsenic	52	/	52	100	166	–	18	*EcoSSL*	9	**YES**	HQ > 1
Barium	52	/	52	100	1,410	–	330	*EcoSSL*	4	**YES**	HQ > 1
Beryllium	47	/	52	90.4	9.6	1.56	21	*EcoSSL*	0.5	no	HQ ≤ 1
Boron	48	/	52	92.3	212	15.6	0.5	*R4*	400	**YES**	HQ > 1
Calcium	52	/	52	100	30,900	–	NA		NA	no	NT
Chromium	52	/	52	100	66	–	26	*EcoSSL*	3	**YES**	HQ > 1
Cobalt	42	/	52	80.8	29.7	15.6	13	*EcoSSL*	2	**YES**	HQ > 1
Copper	52	/	52	100	102	–	28	*EcoSSL*	4	**YES**	HQ > 1
Iron	52	/	52	100	39,700	–	200	*R4*	200	**YES**	HQ > 1
Lead	52	/	52	100	46	–	11	*EcoSSL*	4	**YES**	HQ > 1
Magnesium	52	/	52	100	6,230	–	NA		NA	no	NT
Manganese	52	/	52	100	698	–	220	*EcoSSL*	3	**YES**	HQ > 1
Mercury	4	/	12	33.3	0.209	0.155	0.1	*R4*	2	**YES**	HQ > 1
Nickel	52	/	52	100	64.4	–	38	*EcoSSL*	2	**YES**	HQ > 1
Potassium	52	/	52	100	7,040	–	NA		NA	no	NT
Selenium	45	/	52	86.5	17.8	3.12	0.52	*EcoSSL*	30	**YES**	HQ > 1
Sodium	46	/	52	88.5	1,790	312	NA		NA	no	NT
Thallium	4	/	52	7.69	3.8	3.12	1	*R4*	4	**YES**	HQ > 1
Vanadium	52	/	52	100	163	–	7.8	*EcoSSL*	20	**YES**	HQ > 1
Zinc	52	/	52	100	94.7	–	46	*EcoSSL*	2	**YES**	HQ > 1

Notes:
– = Not applicable.
mg/kg = Milligrams per kilogram.
NA = Not available.
RL = Reporting limit.
SLERA = Screening Level Ecological Risk Assessment.

[a] See Table 6-2 for sources of soil ecological screening levels (ESLs).
[b] The hazard quotient (HQ) is the ratio of the maximum detected concentration to the surface soil screening level. HQs are rounded to the nearest whole number.
[c] Constituents with a hazard quotient (HQ) greater than 1 (HQ > 1) or without a screening level (NSL) were considered constituents of potential ecological concern (COPECs) for screening level assessment unless they were essential nutrients and thus considered non-toxic (NT). Constituents related to fly ash were identifed as Constituents of Interest (COIs), and were considered COPECs regardless of screening.

Table B-8
SLERA Constituents of Potential Ecological Concern in Ash as Sediment
Kingston Fly Ash Recovery Project
Kingston, Tennessee

Constituent	Frequency of Detection (FOD) number of detects / number of samples			FOD %	Maximum Concentration Detect (mg/kg)	Maximum Concentration RL (mg/kg)	Ecological Screening Level (ESLs) [a] (mg/kg) Value	Ecological Screening Level (ESLs) [a] (mg/kg) *Source*	Maximum Hazard Quotient (HQ) [b] (unitless)	SLERA COPEC? [c] (YES/no)	SLERA COPEC? [c] Rational
Metals/Inorganics											
Aluminum	52	/	52	100	45,200	–	NA		NA	**YES**	NSL
Arsenic	52	/	52	100	166	–	7.24	*R4*	20	**YES**	HQ > 1
Barium	52	/	52	100	1,410	–	NA		NA	**YES**	NSL
Beryllium	47	/	52	90.4	9.6	1.56	NA		NA	**YES**	NSL
Boron	48	/	52	92.3	212	15.6	NA		NA	**YES**	NSL
Calcium	52	/	52	100	30,900	–	NA		NA	no	NT
Chromium	52	/	52	100	66	–	52.3	*R4*	1	**YES**	COI
Cobalt	42	/	52	80.8	29.7	15.6	NA		NA	**YES**	NSL
Copper	52	/	52	100	102	–	18.7	*R4*	5	**YES**	HQ > 1
Iron	52	/	52	100	39,700	–	NA		NA	**YES**	NSL
Lead	52	/	52	100	46	–	30.2	*R4*	2	**YES**	HQ > 1
Magnesium	52	/	52	100	6,230	–	NA		NA	no	NT
Manganese	52	/	52	100	698	–	NA		NA	**YES**	NSL
Mercury	4	/	12	33.3	0.209	0.155	0.13	*R4*	2	**YES**	HQ > 1
Nickel	52	/	52	100	64.4	–	15.9	*R4*	4	**YES**	HQ > 1
Potassium	52	/	52	100	7,040	–	NA		NA	no	NT
Selenium	45	/	52	86.5	17.8	3.12	NA		NA	**YES**	NSL
Sodium	46	/	52	88.5	1,790	312	NA		NA	no	NT
Thallium	4	/	52	7.69	3.8	3.12	NA		NA	**YES**	NSL
Vanadium	52	/	52	100	163	–	NA		NA	**YES**	NSL
Zinc	52	/	52	100	94.7	–	124	*R4*	0.8	**YES**	COI

Notes:
– = Not applicable.
COI = Constituent of Interest.
mg/kg = Milligrams per kilogram.
NA = Not available.
RL = Reporting limit.
SLERA = Screening Level Ecological Risk Assessment.

[a] See Table 6-3 for sources of sediment ecological screening levels (ESLs).
[b] The hazard quotient (HQ) is the ratio of the maximum detected concentration to the sediment screening level. HQs are rounded to the nearest whole number.
[c] Constituents with a hazard quotient (HQ) greater than 1 (HQ > 1) or without a screening level (NSL) were considered constituents of potential ecological concern (COPECs) for screening level assessment unless they were essential nutrients and thus considered non-toxic (NT). Constituents related to fly ash were identifed as Constituents of Interest (COIs), and were considered COPECs regardless of screening.

Table B-9
SLERA Constituents of Potential Ecological Concern in Surface Water
Kingston Fly Ash Recovery Project
Kingston, Tennessee

Constituent	Frequency of Detection (FOD) number of detects / number of samples			FOD %	Maximum Concentration Detect (mg/L)	Maximum Concentration RL (mg/L)	Ecological Screening Level (ESLs) [a] (mg/L) Value	Ecological Screening Level (ESLs) [a] (mg/L) *Source*	Maximum Hazard Quotient (HQ) [b] (unitless)	SLERA COPEC? [c] (YES/no)	SLERA COPEC? [c] Rational
Metals/Inorganics											
Aluminum	48	/	48	100	2.09	–	0.087	*R4*	20	**YES**	HQ > 1
Antimony	32	/	48	66.7	0.009	0.002	0.16	*R4*	0.06	no	HQ ≤ 1
Arsenic	48	/	48	100	0.0792	–	0.19	*R4*	0.4	**YES**	COI
Barium	48	/	48	100	0.22	–	NA		NA	**YES**	NSL
Boron	48	/	48	100	1.93	–	0.75	*R4*	3	**YES**	HQ > 1
Calcium	48	/	48	100	80.7	–	NA		NA	no	NT
Chromium	5	/	48	10.4	0.0032	0.002	0.011	*R4*	0.3	**YES**	COI
Iron	48	/	48	100	3.1	–	1	*R4*	3	**YES**	HQ > 1
Lead	4	/	48	8.33	0.00238	0.002	0.00132	*R4*	2	**YES**	HQ > 1
Magnesium	48	/	48	100	15.1	–	NA		NA	no	NT
Manganese	48	/	48	100	1.18	–	NA		NA	**YES**	NSL
Molybdenum	48	/	48	100	0.161	–	NA		NA	**YES**	NSL
Potassium	48	/	48	100	6.65	–	NA		NA	no	NT
Selenium	46	/	48	95.8	0.0359	0.002	0.005	*R4*	7	**YES**	HQ > 1
Sodium	48	/	48	100	3.67	–	NA		NA	no	NT
Vanadium	48	/	48	100	0.0722	–	NA		NA	**YES**	NSL

Notes:
– = Not applicable.
COI = Constituent of Interest.
mg/L = Milligrams per liter.
NA = Not available.
RL = Reporting limit.
SLERA = Screening Level Ecological Risk Assessment.

[a] See Table 6-4 for sources of surface water ecological screening levels (ESLs).
[b] The hazard quotient (HQ) is the ratio of the maximum detected concentration to the surface soil screening level. HQs are rounded to the nearest whole number.
[c] Constituents with a hazard quotient (HQ) greater than 1 (HQ > 1) or without a screening level (NSL) were considered constituents of potential ecological concern (COPECs) for screening level assessment unless they were essential nutrients and thus considered non-toxic (NT). Constituents related to fly ash were identifed as Constituents of Interest (COIs), and were considered COPECs regardless of screening.

Table B-10
Summary of Constituents of Potential Ecological Concern
Kingston Fly Ash Recovery Project
Kingston, Tennessee

Analyte	Ash as Soil	Ash as Sediment	Surface Water
Aluminum	**YES**	**YES**	**YES**
Antimony	no	no	no
Arsenic	**YES**	**YES**	**YES**[1]
Barium	**YES**	**YES**	**YES**
Beryllium	no	**YES**	no
Boron	**YES**	**YES**	**YES**
Calcium	no	no	no
Chromium	**YES**	**YES**[1]	**YES**[1]
Cobalt	**YES**	**YES**	no
Copper	**YES**	**YES**	no
Iron	**YES**	**YES**	**YES**
Lead	**YES**	**YES**	**YES**
Magnesium	no	no	no
Manganese	**YES**	**YES**	**YES**
Mercury	**YES**	**YES**	no
Molybdenum	no	no	**YES**
Nickel	**YES**	**YES**	no
Potassium	no	no	no
Selenium	**YES**	**YES**	**YES**
Silver	no	no	no
Sodium	no	no	no
Thallium	**YES**	**YES**	no
Vanadium	**YES**	**YES**	**YES**
Zinc	**YES**	**YES**[1]	no

Notes:

[1] Constituent was not detected above appropriate screening value but was identified as a COPEC because it is considered a COI related to fly ash.

COPEC = Constituent of Potential Ecological Concern.
COI = Constituent of Interest.

Table B-11
Uncertainties in the Screening-Level Ecological Risk Assessments
Kingston Fly Ash Recovery Project
Kingston, Tennessee

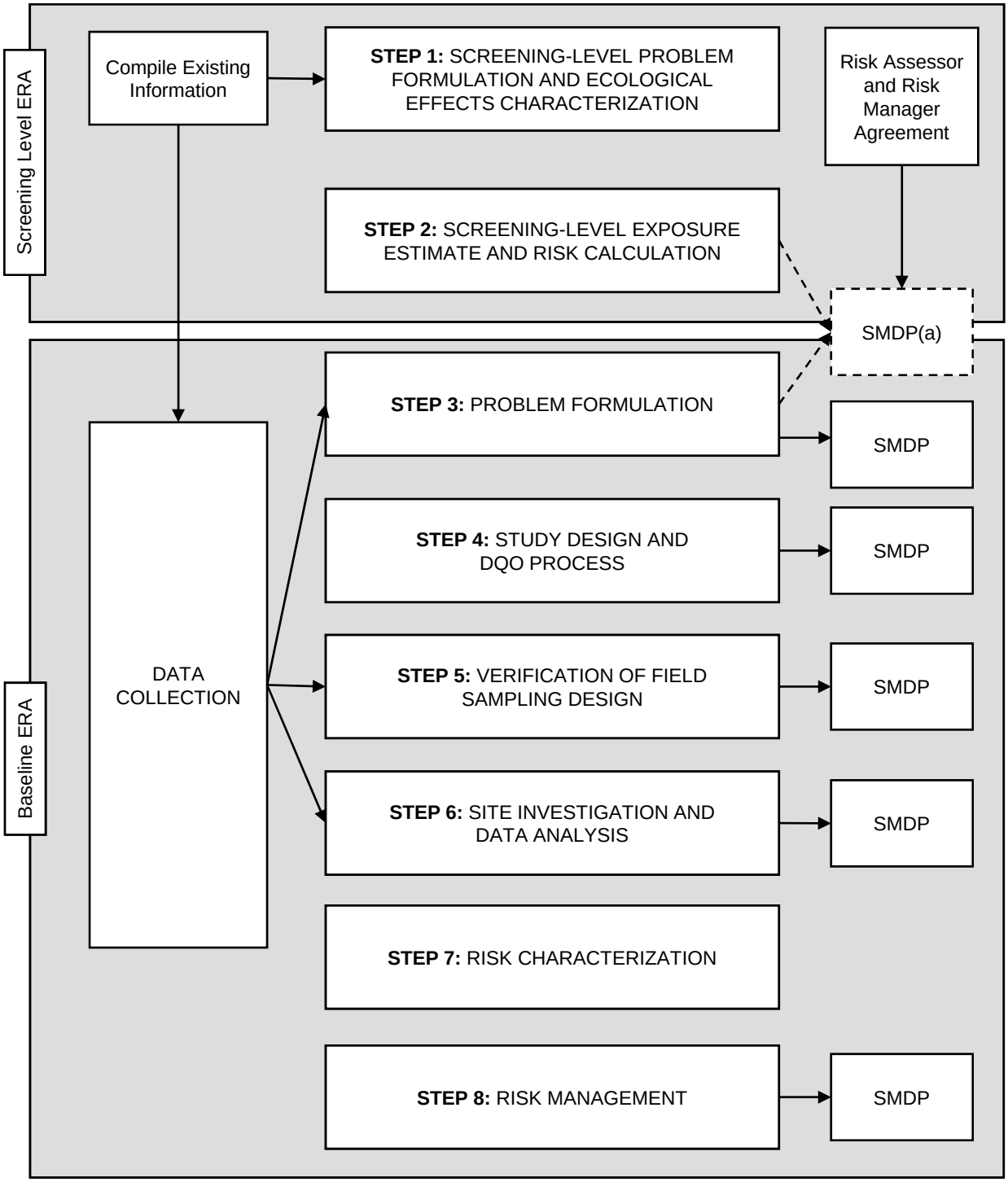
Assumptions	Description And Discussion Related To Uncertainties in ERA	Uncertainty in SLERA
Analytical Sampling and Data Analysis		
Use of maximum concentrations	Maximum concentrations are used to represent the upper estimate exposures. This practice compensates for uncertainty contributed by any situations with limited numbers of samples, but overestimates exposure and risk.	Overestimate of exposure and risk
Detection limits	Some detection limits may exceed ESVs or thresholds for adverse impacts. Constituents with detection limits above these values will be evaluated qualitatively in the uncertainty section of the ERA.	May underestimate risk or effect on risk estimate unknown
Degradation of chemicals not considered	The stability of constituents in ash is currently unknown. This ERA will be based on concentrations of target compounds, and little if any attention is given to degradation constituents that could be more toxic than the original constituent. Conversely, constituent concentrations may decrease over time due to natural physical processes.	Effect on risk estimate unknown
Selection of COPECs		
Coal Combustion Byproducts	Constituents identified as common coal combustion byproducts (i.e., vanadium, zinc, copper, chromium, nickel, lead, arsenic, mercury, selenium, and thallium) were identified as Constituents of Interest (COIs) and were retained in the risk assessment regardless of screening results.	Overestimate of risk
Toxicology and ESVs		
Toxicity and exposure data for a limited number of species	Uncertainties exist in many aspects of the toxicology relied upon for conducting ERAs (Newman 1998; Lovett Doust et al. 1993). Toxicity and wildlife exposure data are only available for a limited number of species (most of them laboratory test species) under a strictly defined set of test conditions that deviate from natural conditions (Sample et al., 1996; Suter, 1996; Sample et al. 1997). Constituents for which ESVs are not available cannot be evaluated in the SLERA.	Effect on risk estimate unknown
Laboratory testing	In current practice, more than 95 percent of the resources in toxicology are focused toward the study of single chemicals (Cassee et al., 1998), while wildlife exposures rarely occur on a chemical-specific basis. Simplistic extrapolations from laboratory species to wildlife species and testing conditions to field conditions are not likely accurate, and are rarely, if ever, validated against natural conditions (Power, 1996; Tannenbaum, 2003).	Effect on risk estimate unknown
Adaptation and tolerance	There is little consistency and no quantitative methodology for the consideration of the diminished bioavailability (and, thereby, diminished toxicity) even though this process is well documented (e.g., Alexander and Alexander, 1999; Alexander, 2000). Similarly, tolerance and adaptation are not considered directly (Millward and Klerks, 2002; Grant, 2002). Furthermore, the white rat often used in toxicological testing is bred to minimize differences between lab animals, thereby diminishing the genetic variability that gives wildlife some capability for adaptation and tolerance (Tannenbaum, 2003).	Overestimate of risk

Table B-11
Uncertainties in the Screening-Level Ecological Risk Assessments
Kingston Fly Ash Recovery Project
Kingston, Tennessee

Assumptions	Description And Discussion Related To Uncertainties in ERA	Uncertainty in SLERA
Predator-prey interactions	There are relatively few studies that actually evaluate the effects of toxicity on predator-prey interactions, or on competition for scarce resources (Atchison et al., 1996), the very conditions within which all wildlife exists (Kapustka and Landis, 1998).	Effect on risk estimate unknown
HQs		
HQs based on maximum	The SLERA HQs are based on the maximum detected concentrations and the most conservative ESVs available (EPA, 1997; 2000a).	Overestimate of risk
Elevated HQs for background concentrations	HQs may exceed a value of 1 for background concentrations of naturally occurring metals (Tannenbaum, 2003). Background concentrations of metals at the site were used for comparison only and as a result, elevated HQs could in part be attributed to these background concentrations.	Overestimate of risk
Interpretation of HQs	An HQ less than or equal to a value of 1 indicates that adverse impacts to wildlife are considered unlikely (EPA, 2001c). However, there is no clear guidance for interpreting the HQs that exceed a value of 1, except that this point of departure indicates that adverse effects of some kind may have occurred or may occur in the future.	Effect on risk estimate unknown
HQs for individual used to evaluate risks to populations	HQs are based on the types of impacts that could occur to individuals (i.e., those individuals exposed to maximum concentrations) and they completely fail to address ecological exposure and risk at spatial scale of populations (Tannenbaum, 2003; Durda and Preziosi, 1999).	Overestimate of risk to wildlife populations
HQs with unrealistic magnitudes	Some HQs are seen at magnitudes that suggest that every animal should die upon acute exposure (i.e., in the hundreds or thousands) (Tannenbaum et al., 2003). Often, physical conditions at a site demonstrate that this is not the case.	Overestimate of risk
No evaluation of dermal or inhalation pathways	The dermal and inhalation exposure pathways are generally considered “insignificant” due to protective fur and feathers. Under certain conditions, these exposure pathways may occur, but adequate information is rarely available by which to evaluate them (EPA, 2005).	Underestimate of risk

Notes:
COPEC = Constituent of potential ecological concern.
ERA = Ecological risk assessment.
ESV = Ecological screening value.
HQ = Hazard quotient.
SLERA = Screening level ecological risk assessment.

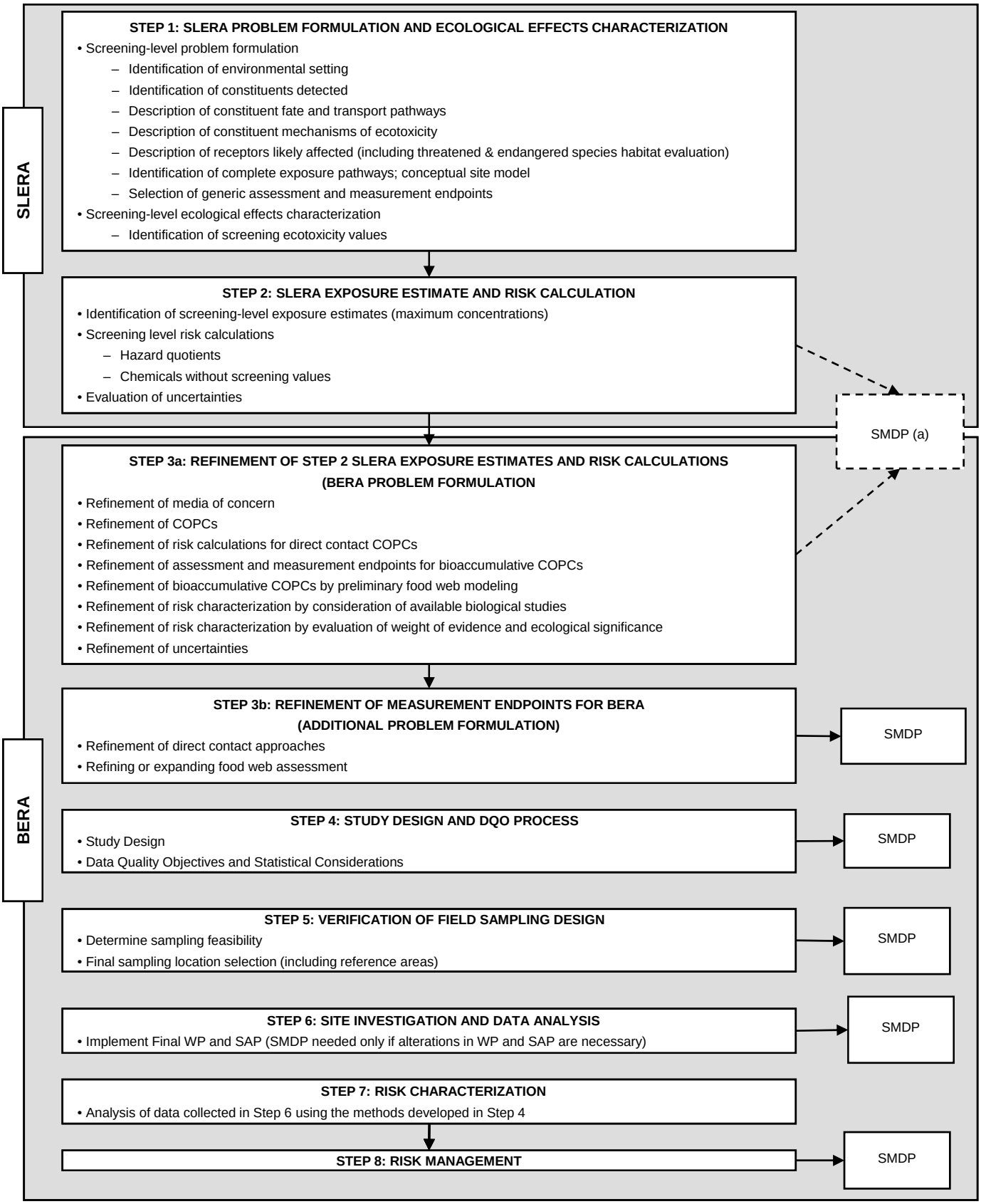
Figure B-1
Eight-Step Ecological Risk Assessment Process



Notes:

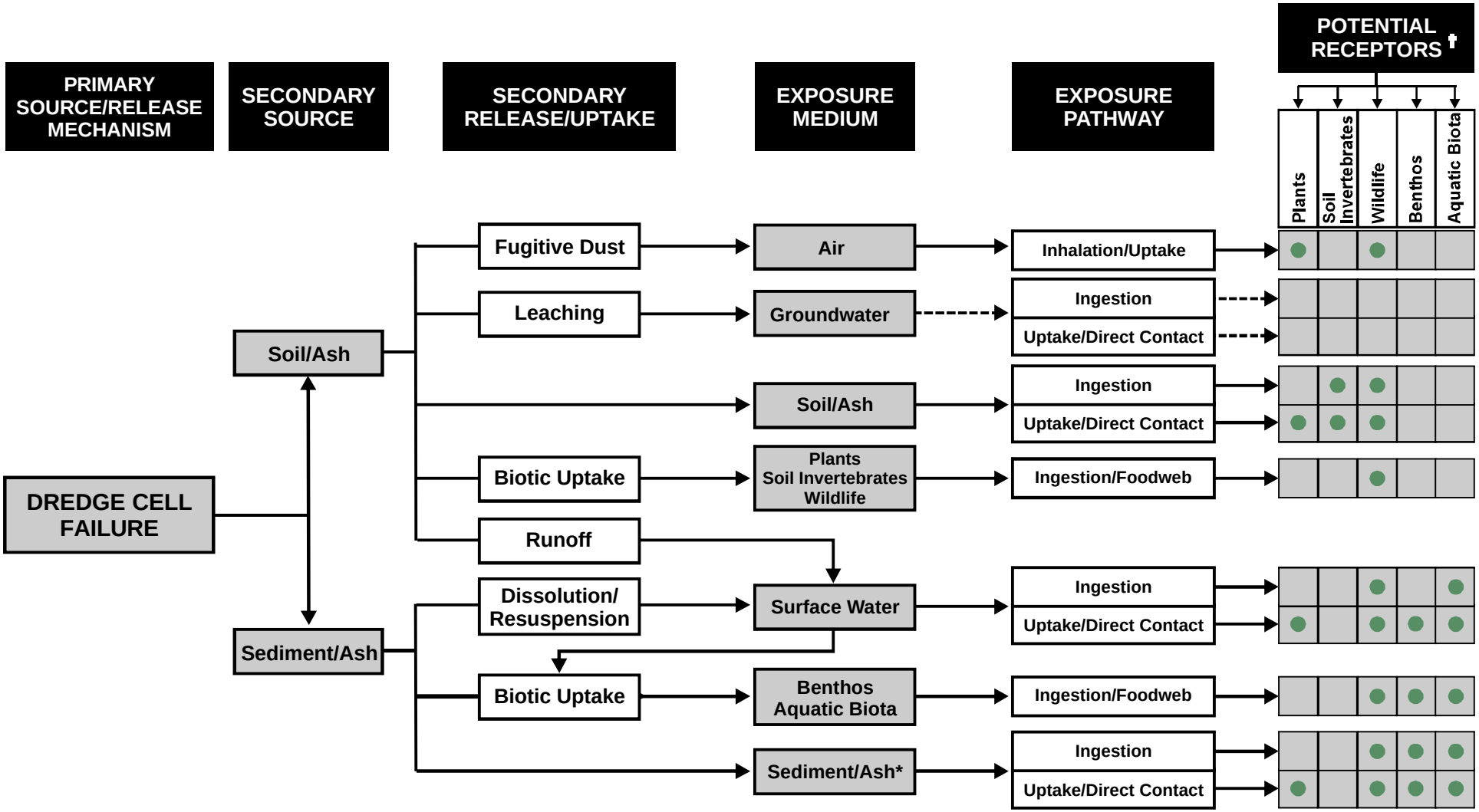
(a) SMDP occurs EITHER after Step 2 or after Step 3a
ERA Ecological Risk Assessment
SMDP Scientific Management Decision Point
Source Adapted from USEPA, 2000a.

Figure B-2
Expanded Eight-Step Ecological Risk Assessment Process



Notes:

(a)	SMDP occurs EITHER after Step 2 or after Step 3a	(Section)	Section number in parentheses corresponds with text of the Risk Assessment Work Plan
COPCs	Constituents of Potential Concern	SMDP	Scientific Management Decision Point
DQO	Data Quality Objectives	SW/SD	Surface water and sediment
GW	Groundwater	WP	Work Plan
SAP	Sampling and Analysis Plan	BERA	Baseline ERA
Source: Adapted from USEPA, 1997 and 2000		SLERA	Screening-level ERA



Ecological receptor groups include terrestrial plants (soil and air exposures), aquatic plants (surface water and sediment exposures), soil invertebrates (e.g., earthworms), wildlife (e.g.,birds, mammals, amphibians, reptiles), benthos (e.g.,mussels, infauna, and epibenthic invertebrates), and aquatic biota (e.g., fish and invertebrates).

● Indicates potentially complete exposure pathway for this receptor.

--- ▶ Indicates a release and transport pathway that is incomplete for the Site.

* Exposure to sediment/ash includes exposures to interstitial water for benthos and aquatic plants.

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Figure B-3
Ecological Conceptual Exposure Model