

**Remedial
Investigation/Feasibility
Study Work Plan**

**Pines Area of Investigation
AOC II
Docket No. V-W-'04-C-784**

Volume 6

**Ecological Risk Assessment
Work Plan**

ENSR Corporation

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ACRONYMS

AOC I	Administrative Order on Consent, 2003 and as amended, 2004; Docket No. V-W-03-730
AOC II	Administrative Order on Consent, 2004; Docket No. V-W-'04-C-784
AUF	Area Use Factor
AWQC	Ambient Water Quality Criteria
BAF	Bioaccumulation Factor
BCC	Bioaccumulative Chemical of Concern
BCG	Biota Concentration Guide
BERA	Baseline Ecological Risk Assessment
CCB	Coal Combustion By-product
cfs	Cubic Feet per Second
COPEC	Constituent of Potential Ecological Concern
CSM	Conceptual Site Model
EB	East Branch
Eco-SSL	Ecological Soil Screening Level
EIV	Ecotoxicological Intervention Value
ERA	Ecological Risk Assessment
ERAGS	Ecological Risk Assessment Guidance for Superfund
ER-L	Effects Range-Low
ESL	Ecological Screening Level
FSP	Field Sampling Plan
GIS	Geographical Information System
GLWQI	Great Lakes Water Quality Initiative
HASP	Health and Safety Plan
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
IDEM	Indiana Department of Environmental Management
IDNL	Indiana Dunes National Lakeshore
IDNR	Indiana Department of Natural Resources
KD	Kintzele Ditch
LC ₅₀	Lethal Concentration in 50% of test animals
LEL	Low Effect Level
LOAEL	Lowest Observed Adverse Effect Level
MB	Mainstem Branch
MWSE	Municipal Water Service Extension
NCP	National Contingency Plan

NIPSCO	Northern Indiana Public Service Company
NIRPC	Northwestern Indiana Regional Planning Commission
NOAA	National Oceanographic and Atmospheric Administration
NOAEL	No Observed Adverse Effect Level
NPS	National Park Service
OMOE	Ontario Ministry of the Environment
ORNL	Oak Ridge National Laboratory
PAH	Polycyclic Aromatic Hydrocarbon
PCDD	Polychlorinated Dibenzodioxin
PCDF	Polychlorinated Dibenzofuran
PEMC	Palustrine Emergent Marsh Seasonally Flooded
PFO1A	Palustrine Forested Broad-leaved Deciduous Temporarily Flooded
PFO1C	Palustrine Forested Broad-leaved Deciduous Seasonally Flooded
PCRTPC	Porter County Regional Transportation and Planning Commission
QAPP	Quality Assurance Project Plan
QMP	Quality Management Plan
RAL	Removal Action Level
RI/FS	Remedial Investigation and Feasibility Study
ROW	Right of Way
SAP	Sampling and Analysis Plan
SB	South Branch
SCV	Secondary Chronic Value
SERA	Screening-level Ecological Risk Assessment
SMDP	Scientific/Management Decision Point
SMS	Site Management Strategy
SOW	Statement of Work
SQL	Sample Quantitation Limit
SQuiRT	Screening Quick Reference Table
sq. mi.	Square Mile
TDD	Total Daily Dose
TL	Trophic Level
TRV	Toxicity Reference Value
UCL	Upper Confidence Limit
USEPA	United States Environmental Protection Agency
USDOE	United States Department of Energy
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

WB West Branch
WQS Water Quality Standards

DISCLAIMER

This document is a document prepared under a federal administrative order on consent and revised based on comments received from the U.S. Environmental Protection Agency (USEPA). This document has been approved by USEPA, and is the final version of the document.

1.0 INTRODUCTION

In April 2004, the United States Environmental Protection Agency (USEPA) and the Respondents (Brown Inc., Ddalt Corp., Bulk Transport Corporation and Northern Indiana Public Service Company (NIPSCO)) signed an Administrative Order on Consent (AOC II) (Docket No. V-W-'04-C-784) to conduct a Remedial Investigation and Feasibility Study (RI/FS) at the Pines Area of Investigation, or the Area of Investigation, as set forth in Exhibit I to AOC II located in the environs of the Town of Pines, Indiana. The components of the RI/FS Work Plan are set out in AOC II (Section VII. 20) and the Statement of Work (SOW) (Task 2), which is provided as an attachment to AOC II. The Work Plan has been developed in seven volumes, which together provide the comprehensive approach and specific details for conducting the RI/FS for the Area of Investigation. These volumes are as follows:

- Volume 1 – Work Plan Overview
- Volume 2 – Field Sampling Plan (FSP)
- Volume 3 – Quality Assurance Project Plan (QAPP)
- Volume 3 – Health and Safety Plan (HASP)
- Volume 5 – Human Health Risk Assessment Work Plan (HHRA)
- Volume 6 – Ecological Risk Assessment Work Plan (ERA)
- Volume 7 – Quality Management Plan (QMP)

This ERA Work Plan is a component (Volume 6) of the RI/FS Work Plan. The ERA Work Plan has been prepared to follow the requirements in AOC II and the SOW, as well as to be compliant with the National Contingency Plan (NCP) (USEPA, 1990).

1.1 Overview of ERA Workplan

The purpose of the ERA Work Plan is to outline the tasks and procedures to be used to support the ERA for the Area of Investigation. The ERA Work Plan has evolved from the previous discussion and outline of ecological risk issues presented in the Site Management Strategy (SMS) conditionally approved by USEPA on November 4, 2004 and the final submitted in January 2005 (ENSR, 2005a). USEPA comments on the ERA Work Plan were received on March 24, 2005. Selected agency comments were further clarified and discussed with USEPA staff including Ed Karecki (May 10, 2005) and Tim Drexler (May 12, 2005). Following submittal of the revised ERA Work Plan, additional comments were received, discussed and consensus reached (teleconference of July 15, 2005 with

Drexler and Karecki). This final ERA Work Plan incorporates these USEPA comments and additional discussion, as warranted.

The ERA will evaluate the potential for ecological risk posed by coal combustion by-product (CCB)-derived constituents in the Pines Area of Investigation. Following USEPA guidance (see Section 1.3 below), the ERA will be conducted using a tiered process, the first tier of which is the Screening-level Ecological Risk Assessment (SERA). Because the results of the SERA will determine what, if any, additional ecological risk assessment may be needed for the Area of Investigation, this Work Plan focuses on the methods to be used to develop the SERA.

The SERA will evaluate risk to three major ecosystems of interest: surface waterbodies, wetlands, and terrestrial uplands.

The SERA will:

- Evaluate the potential risk of CCB-derived constituents in surface water and sediments in the Brown Ditch system and other affected waterbodies to aquatic communities (fish and benthos), wetland plants, and wildlife receptors;
- Evaluate the potential risk due to groundwater transport of CCB-derived constituents and subsequent wetland plant root uptake and exposure to wildlife receptors in wetlands; and
- Evaluate the potential risk due to CCBs present at the ground surface and exposure to CCB-derived constituents by terrestrial ecological receptors in upland terrestrial areas.

The SERA will identify constituents of potential ecological concern (COPECs) by comparison of media concentrations (measured or predicted) of CCB-derived constituents in surface water, groundwater, sediments, soils, plant, and prey item tissue to medium-specific screening benchmarks and/or acceptable total daily doses for wildlife receptors, and background levels. The exposure pathways of interest are indicated in the ecological conceptual site model (CSM) discussed in Section 2.5.

As discussed during the August 18, 2004 teleconference between ENSR, USEPA, and the National Park Service (NPS), a phased approach to sampling and ecological risk assessment of the three targeted ecosystems will be used. This approach is described in the RI/FS Work Plan – Volume 1 – Overview, and presented briefly below.

1.2 Phased Approach for RI Investigation and Ecological Risk Assessment

The work proposed in the FSP – Volume 2 of the RI/FS Work Plan, is designed to address the ERA objectives, to fill the data gaps identified in the SMS, and to address the strategy items identified in that document. To conduct the RI in an efficient and focused manner, it is necessary to first obtain the information for the CSM, and then refine that model where needed to answer outstanding questions or fill data gaps. To accomplish this, the RI investigations supporting the ERA will be conducted using a

phased approach. The work described in the FSP is the first phase of investigation. Any additional work will be conducted in a subsequent phase.

One objective of the ERA is to determine if there are risks posed to ecological receptors by CCB-derived constituents present in the aquatic environment, most notably the Brown Ditch system, but also including other relevant surface water bodies and wetland areas within the Area of Investigation. In addition, potential risks to receptors within the terrestrial environment are to be addressed where CCBs are present in locations that overlap with areas of significant ecological habitat.

Accordingly, for the Pines Area of Investigation SERA, evaluation of ecological exposure pathways and relevant receptors based on the FSP investigation work will be divided into two parts: an aquatic evaluation and a terrestrial evaluation. Each evaluation will have its own sampling and analysis work plan and activities.

1.2.1 Aquatic Evaluation

The aquatic evaluation will focus on the exposure pathways associated with exposure to surface water and sediments (including historically dredged material where it may occur) in the Brown Ditch tributary system and two man-made ponds adjacent to areas of historic fill placement. Surface water and sediment from the Yard 520 Stormwater Retention Area will also be sampled and evaluated for potential ecological risk. Ecological receptors to be evaluated include aquatic plants, fish, amphibians, benthic invertebrates, and avian and mammalian wildlife.

The need for additional aquatic sampling and assessment will be determined based on the results of the groundwater investigations (see the FSP). Proposed groundwater investigations include study of groundwater levels, groundwater chemistry, groundwater flow directions, and interactions with surface water. Based on the refined characterization of groundwater migration and chemistry, additional waterbodies of potential interest may be identified, including wetland areas or ponds not previously evaluated. These waterbodies would be sampled and assessed in follow-on work. The SERA for the aquatic environment will be prepared after the completion of both phases of sampling and evaluation.

1.2.2 Terrestrial Evaluation

The scope of the terrestrial investigation will be based on the identification of areas of ecological habitat coupled with the visual inspection for CCBs as described in Section 2.1.5 of the FSP. The visual inspection will identify where suspected CCBs may be present along streets and in residential areas, and in other areas of the Area of Investigation. Based on the visual inspection under the FSP, areas of suspected CCBs will be evaluated to determine if the materials are CCBs. The next step is to evaluate whether there are areas of overlap between the areas of CCBs and ecological habitats. This is critical because potential ecological risk can occur only in areas where CCBs are present and overlap with areas of ecological habitat. To identify upland habitats, methods applicable for general habitat evaluation will be used (non-wetland or mixed wetland/upland habitats), which consist

principally of an integrated use of desk-top delineation of upland habitats from available maps and aerial photographs coupled with a field inspection and confirmation. The resulting habitat maps will combine aerial photos or Geographic Information System (GIS) figures, with vegetative cover and specific habitat types mapped. In areas where CCBs are present as determined by visual inspection (see FSP Section 2.1.5), ecological habitat will be identified through the following criteria:

- Minimum size of ≥ 1 acre of undeveloped land;
- Low level of disturbance based on land use (not lawns, maintained areas, agricultural land, or storage areas);
- Distance or proximity to major roadways based on representative widths of existing right-of-ways (ROWs) (as defined by the entities responsible for the various roadways (i.e., state, county, or Town of Pines); and
- Level of vegetative cover or estimate of habitat quality.

Further refinement of criteria would be presented in a Work Plan addendum.

The resulting maps and designated ecological habitats will be compared to areas where CCBs have been identified to be present to provide indication of potential exposure. Based on the degree of overlap, further evaluation of CCBs (including potential additional sampling) may be required for completion of the terrestrial evaluation. This work would be conducted in a subsequent phase of investigation. The SERA for the terrestrial environment will be prepared after the completion of both phases of sampling and evaluation.

1.3 Guidance and Methodology

The SERA for the Pines Area of Investigation will be conducted following the general tiered approach and methodology provided by the USEPA's Framework for Ecological Risk Assessment (USEPA, 1992), Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessment, Interim Final (USEPA, 1997), Guidelines for Ecological Risk Assessment (USEPA, 1998a), and The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments (USEPA, 2001).

Conducting assessments in a tiered, step-wise manner allows the risk assessor and risk manager to maximize the use of available information and sampling data, while providing the opportunity to reduce the uncertainties inherent in the ecological risk assessment process through the use of focused supplemental data collection to fill key data gaps identified in the previous tier of the assessment, as necessary.

A SERA is considered the first tier of the ecological risk assessment process. Where the results of the SERA indicate sufficient potential ecological risk, further ecological risk assessment may be warranted. The SERA includes identification and evaluation of both assessment and measurement endpoints. Assessment endpoints describe the characteristics of an ecosystem that have an intrinsic environmental value that is to be protected (i.e., protection of a warmwater fish community). Because assessment endpoints often cannot be measured directly, a set of surrogate endpoints (measurement endpoints) are generally selected for ecological risk assessment. Such measurement endpoints should have measurable attributes (e.g., comparison of media concentrations to screening benchmarks, results of food web models) (USEPA, 1997, 1998a). These measurement endpoints provide a quantitative metric for evaluating potential effects of constituents on the ecosystem components at risk.

This approach is consistent with the eight-step process delineated for ecological risk assessment by USEPA Ecological Risk Assessment Guidance for Superfund (ERAGS) (USEPA, 1997) and with USEPA Region 5 policy.

1.4 Superfund Ecological Risk Assessment Process

As discussed above, the ERA will be conducted in accordance with the eight-step ecological risk assessment process provided by USEPA (USEPA, 1997). This process is presented in Figure 1-1 and described in more detail in the sub-sections below.

1.4.1 Screening-Level Ecological Risk Assessment (SERA)

The SERA is designed to serve as Steps 1 and 2 of USEPA's eight-step ecological risk assessment process (Figure 1-1) following the ERAGS (USEPA, 1997). The SERA represents the initial screening of the Pines Area of Investigation for potential risk to ecological receptors.

In the SERA, maps, historical information, existing field data, literature results, media concentrations, available biological inventories, regulatory agency information regarding sensitive species and habitats (e.g., threatened and endangered species), etc., are collected and evaluated. A reconnaissance will be conducted as part of the SERA to identify local biota and habitats, to document and justify potential elimination of portions of the Pines Area of Investigation as non-habitat, as appropriate, and to provide context for the development of the ecological CSM.

A major component of the SERA is an evaluation of whether potentially complete exposure pathways exist, linking constituents to potential ecological receptors. If such complete exposure pathways do not exist then there is no potential for ecological risk. For the Pines Area of Investigation SERA, the initial sampling will focus on the exposure pathways associated with surface water and sediments. Subsequent sampling rounds will be used to further evaluate the groundwater transport – surface water discharge exposure pathway, and the CCB exposure pathway following the ecological risk assessment approach discussed in Section 1.2.

Where complete exposure pathways exist, they will be screened using measurement endpoints that rely on available data, using conservative assumptions and inferred generic assessment endpoints (e.g., protection of surface water receptors). Media concentrations will be compared to well-established, conservative criteria or screening benchmarks and background levels. The results of food web modeling will be used to develop preliminary hazard quotients for the purpose of quantitatively assessing the potential for ecological risk.

Based on the results of the completed SERA, a scientific/management decision point (SMDP) will be reached at the end of Step 2, where a conclusion will be made either that (1) the available data indicate the potential for ecological risk and further investigation is warranted (see below), (2) the available data indicate no potential for ecological risk and no further work is warranted, or (3) there are data gaps that must be addressed before the presence or absence of risk can be concluded (e.g., additional sampling or analysis).

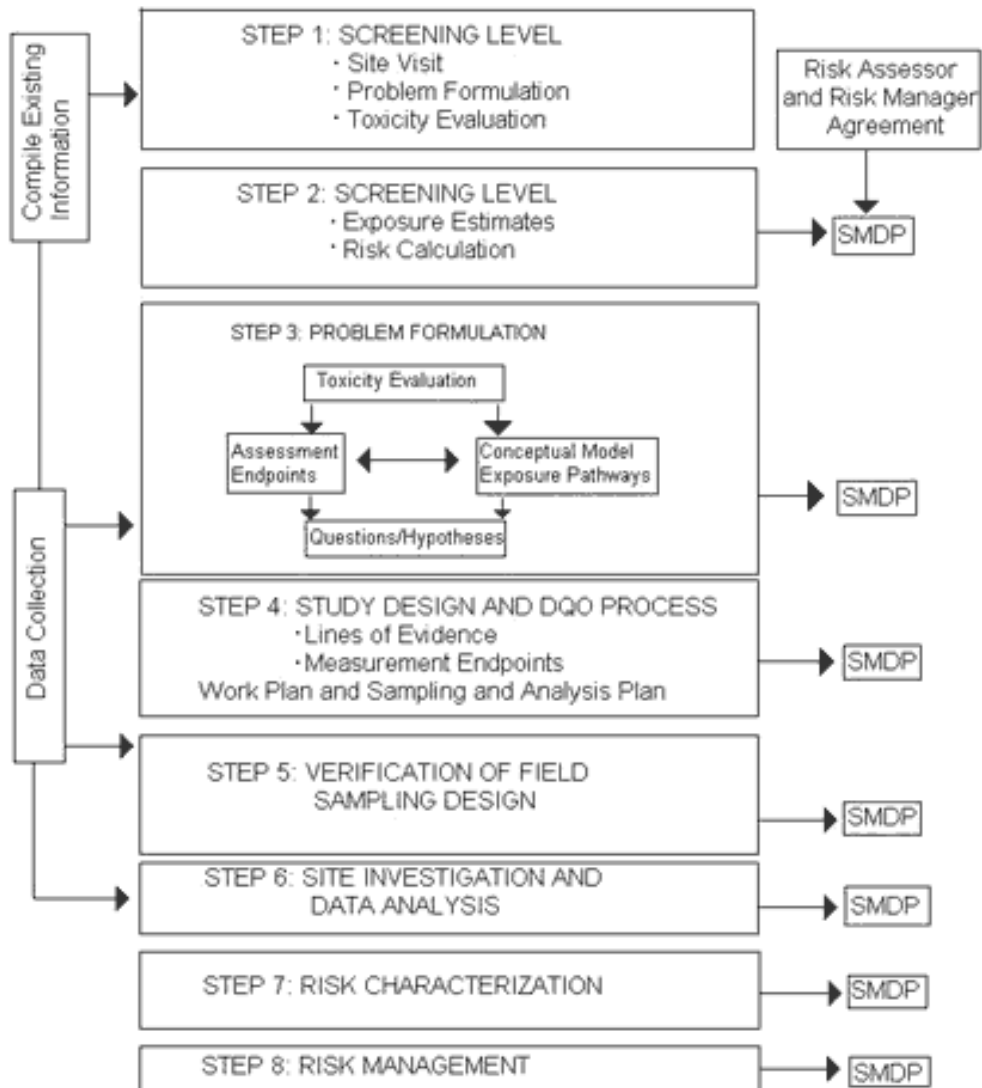
1.4.2 Baseline Ecological Risk Assessment (BERA)

As warranted by the results of the SERA, a baseline ecological risk assessment (BERA) may be required. The BERA constitutes Steps 3 through 7 of the ERAGS process (Figure 1-1). The BERA is a comprehensive ecological risk assessment, usually (but not always) much more detailed and location-specific in scope and the number of the measurement endpoints. The BERA generally incorporates location-specific data, biota, and exposure pathways, with less reliance on literature values or generic assumptions and is designed to address the data gaps identified in the SERA.

The BERA may include detailed habitat characterization, field surveys, location-specific fate and transport modeling, toxicity testing, tissue chemical analyses, food web modeling, bioavailability studies, sediment porewater analyses, or other field or analytical investigations. Habitat characterization is conducted to a more detailed scale than in the SERA. Assessment and measurement endpoints are location-specific and tailored to ecological receptors identified or expected to be present in the area under investigation. BERAs often employ several measurement endpoints to evaluate the assessment endpoints and may integrate the results of these endpoints in a weight-of-evidence evaluation. As with the SERA, the BERA can uncover additional data gaps that may need to be addressed. The results of the BERA may be used to evaluate potential ecological risk or whether remedial activities may be warranted for certain habitats within the study area.

The need for a BERA has not yet been established nor is the scope or extent of its investigation or evaluation tasks predictable. If required, a work plan or technical memorandum will be prepared for submittal USEPA. Accordingly, the ERA Work Plan addresses just the tasks and activities associated with the SERA.

Figure 1-1 Schematic Diagram of the Superfund Eight-Step ERA Process



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¹ Figure available from USEPA at <http://www.epa.gov/region5/superfund/ecology/html/8stepera.html>

2.0 SERA PROBLEM FORMULATION

2.1 Pines Area of Investigation

Between 2000 and 2004, the Indiana Department of Environmental Management (IDEM) and USEPA responded to homeowners by conducting sampling of private water supply wells in a portion of the Town of Pines. In some of these samples, boron and molybdenum were detected at concentrations above USEPA's Removal Action Levels (RALs) (USEPA, 1998b). These concentrations in groundwater are suspected by the USEPA to be derived from CCBs. CCBs have been disposed at a permitted Restricted Waste Facility known as Yard 520, and CCBs are suspected to have been used as fill in areas within the Area of Investigation outside of Yard 520. Yard 520 is operated by Brown Inc., and most of the CCBs at Yard 520 were generated during combustion of coal at NIPSCO's Michigan City Generating Station.

To address the boron and molybdenum detections above the USEPA RALs, the Respondents agreed to extend the municipal water service from Michigan City to selected portions of the Town of Pines. This agreement was documented in an Administrative Order on Consent, referred to as AOC I. Additional sampling of other private wells indicated some concentrations near or exceeding USEPA RALs. To address this, the Respondents voluntarily approached the USEPA to discuss extending the municipal water service to a larger area, which incorporates the primary areas of interest, under an amendment to AOC I. The Respondents also signed AOC II to conduct an RI/FS for the Area of Investigation, as identified in the order. As noted in Section 1.0, AOC II requires the Respondents to develop an ERA Work Plan as a component of the RI/FS Work Plan.

Figure 2-1 identifies the Pines Area of Investigation as defined by AOC II. The area is located primarily in the Town of Pines, in Porter County, Indiana. It is located immediately west of the city limits of Michigan City, Indiana, and about 1,500 feet south of the southern shore of Lake Michigan. The Indiana Dunes National Lakeshore (IDNL), managed by the NPS, is located between Lake Michigan and the Town of Pines. A small portion of the IDNL is included within the Area of Investigation for the RI/FS. Figure 2-2 is a U.S. Geological Survey (USGS) topographic map showing specific features in the vicinity of the Area of Investigation, particularly the various branches associated with the Brown Ditch tributary system.

The land use in the region varies from the relatively undeveloped areas of the IDNL, where the land has been preserved for recreational uses, to the highly developed industrial zones such as Burns Harbor and Michigan City. Industrial land use includes coal-fired power generating stations and fully-integrated steel mills. Selected areas have also been developed for residential housing, including the Town of Pines and Beverly Shores, which is located north of the Town of Pines along the shore of Lake Michigan.

2.2 Pines Area of Investigation Habitats

The Pines Area of Investigation consists of a diverse set of aquatic, wetland, and terrestrial systems. These areas are described further below.

2.2.1 Brown and Kintzele Ditch Systems

The major significant surface water feature within the Pines Area of Investigation is Brown Ditch (see Figure 2-2). Brown Ditch is an interconnected network of man-made channels extending into locally-significant interdunal wetlands, including the eastern portions of the Great Marsh and the so-called Calumet-Glenwood wetlands, as well as a small portion of the Lake Border Moraine (Shedlock and Harkness, 1984). These wetlands are located between the three distinct sand dune ridges (Tolleston Dune-Beach Complex, Calumet Dune-Beach Complex, Glenwood Dune-Beach Complex), which are aligned in a southwest-northeast orientation parallel to the Lake Michigan shoreline and represent former lake stages (beaches) of Lake Michigan.

Brown Ditch is a legal drain under the jurisdiction of the drainage board of Porter County (Shedlock and Harkness, 1984). Brown Ditch is only one of a number of channels (e.g., Burns Ditch, Derby Ditch, Kintzele Ditch) that were excavated in the vicinity of the Area of Investigation in the early 1900s with the express purpose of draining the interdunal wetlands and presumably making land available for use (Arihood, 1975; Shedlock and Harkness, 1984).

Brown Ditch has several long east-west channels south of the Calumet dune. It crosses the dune ridge in a short north-south channel just prior to entering the IDNL. From there, Brown Ditch flows northeast through Great Marsh to join as a tributary to Kintzele Ditch, which then flows into Lake Michigan (see Figure 2-2). Inspection of aerial photographs of the period 1970-1990 indicates that a portion of a western channel of Brown Ditch was relocated during the 1980-1990 interval (PCRTPC, 1970; NIRPC, 1980, 1990, 2000). The segment of the channel that had previously crossed through the middle of the current Yard 520 (Figure 2-2) was relocated to the south to run along the southern border of Yard 520 parallel to Railroad Avenue (see Figure 2-1). The original channel is rejoined just east of Yard 520.

For purposes of the ERA Work Plan, the following branch channel systems were identified for further investigation (see Figure 2-2). The portion of the channel which is located to the south and southeast of Yard 520 and which runs parallel to the railroad for much of its approximate 5,000 ft length is defined as the west branch (WB) of Brown Ditch. The WB includes both areas of historic as well as relocated flow. Two small tributaries (i.e., not channelized watercourses) arise in the southwestern portion of the Area of Investigation and flow north into the WB. These are identified as south branches (SB) SB-1 and SB-2. SB-1 drains land located in proximity to the former Lawrence Dump, while SB-2 drains an area adjacent to the closed Pines Landfill. The east branch (EB) of Brown Ditch consists of an approximate 6,000 ft channelized section located to the east of Yard 520, approximately equidistant from Second Place in the Town of Pines and the active railroad corridor. The WB and EB flow

together just south of a crossing with Route 20 and constitute what is termed the Mainstem Branch (MB) of Brown Ditch. The MB flows due north about 1,750 ft under Routes 20 and 12 and the power easement/Calumet Trail before entering IDNL property. The MB then turns northeast before its eventual confluence with Kintzele Ditch (KD). The Kintzele Ditch system is located to the east of the Brown Ditch system and includes both channelized and natural tributary systems.

Brown Ditch is a low-gradient channel with representative slopes of between 0.03 – 0.11% in the areas south of the IDNL and about 0.2% between Route 12 and its confluence with Kintzele Ditch. This low-gradient profile translates into generally low flow conditions, with several sections subject to ponding upstream of the IDNL (Shedlock and Harkness, 1984). The drainage basin for Brown Ditch is estimated at 4.7 square miles (sq. mi.), with approximately 1.0 sq. mi. located in the IDNL (Shedlock and Harkness, 1984).

Flow measurements in Brown Ditch near the Town of Pines are typically low. Flow measurements were taken near the north-south channel which crosses through the Calumet dune ridge prior to its entry into the IDNL in the 1970s and 1980s (Arihood, 1975; Shedlock and Harkness, 1984). These values were 1.02 cubic feet per second (cfs) (10/15/73) and 0.79 cfs (7/16/82) during base flow or low flow months and 18.6 cfs (1/22/74) and 2.6 cfs (4/23/74) during winter-spring conditions. Estimating the area of the Brown Ditch watershed prior to its entry into the IDNL at 3.7 sq. mi. (as noted above), this places the base flow yield of the ditch at approximately 0.21 to 0.28 cfs/sq. mi. at that time.

The main sources of water to Brown Ditch are precipitation, surface water runoff, and groundwater discharge. Shallow groundwater discharge into Brown Ditch comes from the low relief water table mounds located below the dune ridges (Shedlock and Harkness, 1984). In 1982, the EB sat within the organic peat layer that is the underlayment of the Calumet-Glenwood wetlands and Great Marsh, with shallow penetration into the sand layer in sections closer to the lakeshore (Shedlock and Harkness, 1984). In 1983, the EB Brown Ditch was dredged down into the sand layer to improve drainage and reduce flooding (Shedlock and Harkness, 1984).

2.2.2 Wetland Areas

The Brown Ditch drainage system is associated with a series of wetland communities around the Area of Investigation. These wetlands are identified on the U.S. Fish and Wildlife Service (USFWS) 1987 National Wetlands Inventory Map (USFWS, 1987) with a variety of designations including: Palustrine Forested Broad-leaved Deciduous Temporarily Flooded (PFO1A), Palustrine Forested Broad-leaved Deciduous Seasonally Flooded (PFO1C), and Palustrine Emergent Marsh Seasonally Flooded (PEMC). These wetlands are located between the dune ridges and represent areas where Brown Ditch is likely to be ponded and support aquatic vegetation. In these areas, the ecology of Brown Ditch more likely approximates a linear wetland than a flowing channel.

2.2.3 Upland Habitat Areas

A terrestrial evaluation will be included as part of the SERA to evaluate potential ecological risk due to CCBs in upland habitat areas. Upland areas within the Area of Investigation consist of residential areas within the Town of Pines, forested areas, active or former agricultural areas, transportation corridors, and disposal areas. For purposes of the ERA Work Plan, the upland areas of interest will be those where CCBs were placed. Further investigation regarding the extent of CCBs will be conducted to identify potentially affected areas. General ecological habitats will be identified for the Area of Investigation, with special focus on the areas between Second Place in the Town of Pines and the northern border of EB of Brown Ditch (for details see Section 3.3.1). For purposes of the Problem Formulation, it was assumed that upland habitats of interest will likely include forested areas and old-fields (i.e., former agricultural areas reverting to shrubs and saplings).

2.2.4 Areas/Species of Special Concern

Information on areas and species of special concern was obtained from the IDNL and from Federal and State agencies.

2.2.4.1 Indiana Dunes National Lakeshore

A portion of the Area of Investigation lies within the IDNL. The IDNL is considered a significant regional ecological resource. The IDNL, authorized by Congress in 1966, is located approximately 50 miles southeast of Chicago, Illinois in the counties of Lake, Porter, and LaPorte in Northwest Indiana. The national lakeshore runs for nearly 25 miles along southern Lake Michigan, bordered by Michigan City, Indiana on the east, and Gary, Indiana on the west. The park contains approximately 15,000 acres, 2,182 of which are located in the Indiana Dunes State Park and which are managed by the Indiana Department of Natural Resources (IDNR) (<http://www.nps.gov/indu/home.htm>).

In addition to its historical and cultural importance, the IDNL is considered an ecological resource of the first magnitude. The IDNL has been extensively surveyed and inventoried, and is ranked 7th among National Parks in terms of its native plant diversity. It is reported that 1,445 vascular plant species are located within park boundaries (Pavlovic and Cole, 1991) of which over 90 are on the Indiana threatened or endangered list (NPS, 2004). Areas of special vegetation, defined as floristic elements considered "unique," "exemplary," "relict," or "threatened or endangered" have been identified for the IDNL (Wilhelm, 1980).

Vertebrate wildlife communities have been well characterized in the IDNL. Current information regarding species occurrence and ecology is available for amphibians and reptiles (Resetar, 1994), birds (e.g., Brock, 1997), and mammals (Whittaker et al., 1994). Information from these monographs was used in selecting potential representative species for risk evaluation of selected trophic guilds (see Section 3.2.2). Extensive additional information not listed here is also available regarding IDNL ecology and wildlife for consideration in the SERA.

2.2.4.2 Federal and State-listed Species of Concern

Requests were made to USFWS and IDNR regarding information on federal and state-listed endangered, threatened, or rare species, critical habitat, riparian area, and other sensitive natural resources. The USFWS response letter dated March 16, 2004 indicated that the Area of Investigation is within the range of three Federally-listed species: Indiana bat (*Myotis sodalis*), bald eagle (*Haliaeetus leucocephalus*) and pitcher's (or dune) thistle (*Cirsium pitcheri*) (Pruitt, 2004). The IDNR response letter dated April 13, 2004 indicated that two state-listed plant species had been recorded to occur within the Area of Investigation, namely the Baltic rush (*Juncus balticus* var. *littoralis*) and Tower-mustard (*Arabis glabra*) (Neyer, 2004). Copies of these letters are provided in the SMS (ENSR, 2005a).

2.2.5 Background Reference Areas

Background reference areas refer to locations in the environs of the Area of Investigation that are representative of regional conditions of climate, meteorology, geology and soils, land use, air deposition, and ecology. Media from these areas provide a useful benchmark for evaluation of conditions and concentrations, particularly for constituents with multiple sources such as metals. These constituents are naturally present in many geologic materials and can be naturally present in groundwater as well. They can also be associated with other sources, such as road salt, septic systems, and/or municipal landfills.

Concurrent with the RI/FS field work to be conducted within the Area of Investigation, background stations will be located and sampled in order to control for location-specific variables. Background samples will be taken for surface water, sediments, and soils.

2.3 Potential Exposure Pathways

Potentially complete exposure pathways for ecological receptors were identified through documents and reconnaissance of the Brown Ditch system. Exposure pathways for several groups of ecological receptors were identified as potentially relevant. Each exposure pathway includes a potential source of COPECs, an environmental medium (surface water, sediment or surface soil), and a potential exposure route. Following agency guidance, incomplete routes of exposure will not be evaluated in the SERA. This approach is used to focus the risk evaluation on exposure pathways that are considered to potentially complete and for which there are adequate data pertaining to the receptors, exposure, and toxicity for completion of the risk analysis. The selected exposure pathways are discussed below.

2.3.1 Exposure in Brown Ditch Surface Water and Sediment

Exposure of ecological receptors to COPECs will be considered for freshwater receptors in the Brown Ditch system (see Section 2.2.1 for description of sub-tributaries) and other potentially affected waterbodies (e.g., man-made ponds, groundwater-affected wetlands). Sediments, historic dredge

materials, and surface waters are the media of interest. The exposure pathway evaluated for aquatic receptors (i.e., benthic invertebrates, aquatic plants, fish) will be direct contact with sediment and surface water. Amphibians will also be assumed to be in direct contact with both surface water and sediment. In addition, the potential exposure of avian and mammalian receptors to COPECs from surface water, sediment and food items (via bioaccumulation) will be evaluated. The exposure pathways evaluated for avian and mammalian wildlife receptors will include ingestion of prey, ingestion of plants, inadvertent ingestion of the sediments, and drinking surface water.

2.3.2 Exposure Due to Groundwater Migration

Ecological receptors are not directly exposed to groundwater; however, exposure to constituents in groundwater may occur when groundwater enters a waterbody. Therefore, exposure of wetland vegetation to CCB-derived constituents through root uptake of groundwater from the shallow saturated zone will be considered a potentially complete exposure pathway.

In an initial aquatic investigation, the surface water and sediments of the Brown Ditch system, assumed to be the main receiving water for migration of shallow groundwater in the Area of Investigation, will be sampled and evaluated for potential ecological risk. Based on the results of the groundwater investigation, additional waterbodies, wetlands, and/or surface channels may be identified for further sampling and evaluation as part of the aquatic investigation.

2.3.3 Exposure Associated with CCB Areas

As part of the SERA terrestrial investigation, potential ecological risk due to CCB-derived constituents will be assessed. Exposure of terrestrial receptors will be considered for those terrestrial areas where CCBs were potentially placed or migrated via overland transport by surface runoff. It is expected that much of the CCBs were placed under and alongside roadways or as fill for residential areas, and so further investigation regarding the extent of CCBs will be conducted to identify potentially affected ecological habitats.

General ecological habitats will be identified for the Area of Investigation, with special focus on the areas between Second Place in the Town of Pines and the northern border of the EB of Brown Ditch since this is an area where it is suspected that CCBs have been used as fill. Areas which lack ecological habitat (see Section 1.2.2.) will be eliminated from further investigation due to incomplete exposure pathways. Finally, in areas containing ecological habitat, the limits of the CCBs as identified under the FSP (Section 2.1.5) will be compared to the available habitats to determine whether there are areas of overlap, and if so, what exposure pathways and receptors are relevant for assessment. CCBs will be the major medium of interest. Potential exposure pathways considered will include exposure of terrestrial plant, soil invertebrate, and wildlife receptors to COPECs.

2.4 Constituents of Potential Ecological Concern

Based on comparison of constituent concentrations detected in media sampled as part of the FSP to ecological screening benchmarks, COPECs will be identified. COPECs are a subset of the complete list of constituents detected in media in the Area of Investigation that are carried through the quantitative ecological risk assessment process. COPECs will be identified by comparing constituent-specific analytical data for environmental media to appropriate screening levels and background, and conducting a quantitative risk assessment for those constituents detected in an environmental medium in excess of the screening levels and background. Selection of COPECs focuses the analysis on the most likely risk drivers.

Risk calculations for wildlife receptors will be conducted using the COPECs identified in this step. To the extent practical, only CCB-derived constituents will be evaluated in the SERA. The specific methods used to identify COPECs are presented in Section 3.2.

Table A-1 in Appendix A provides the analyte list to be evaluated as part of the SERA. This list includes CCB analytes to be sampled as part of the RI/FS FSP, the Municipal Water Service Extension (MWSE) Sampling and Analysis Plan (SAP) (ENSR, 2004), and the Yard 520 SAP (ENSR, 2005b). This list includes, at USEPA's request, polychlorinated dibenzodioxins and dibenzofurans (PCDDs and PCDFs), radionuclides, and polycyclic aromatic hydrocarbons (PAHs).

2.5 Preliminary Conceptual Site Model

A preliminary ecological CSM was developed to provide a clear and concise description of how ecological receptors may come into contact with COPECs via release mechanisms and exposure to CCBs, sediment, and/or surface water (Figure 2-3). The CSM will be finalized as part of the problem formulation step of the SERA, including information from the RI investigations, and will explicitly identify the ecological resources that are to be evaluated. These will be defined within the risk assessment process as a set of assessment endpoints. Assessment endpoints will be selected to evaluate wildlife and habitats of ecological and/or socioeconomic importance. Finally, the CSM will describe how potential risk to assessment endpoints will be quantified through a series of analyses or measurement endpoints. A preliminary discussion of the ecological communities and potential receptors is given below.

Figure 2-3 provides a schematic representation of the potential CCB-derived constituent release mechanisms, the exposure pathways, and potential ecological communities or wildlife receptors to be assessed. The two primary release mechanisms for CCB-derived constituents at the Pines Area of Investigation to reach potential ecological receptors are (1) the infiltration and percolation of CCB-derived constituents into the groundwater, with secondary releases occurring via groundwater connections to surface water and transport to the shallow saturated zones in wetlands; and (2) surface run-off, erosion, or migration of CCB-derived constituents into surface water bodies (e.g., man-made ponds) or shallow soils.

Migration to surface water can lead to increases in constituent concentrations in various aquatic media (i.e., surface water, sediments, and fish tissue) and can result in exposure pathways to higher trophic level ecological receptors. Concentrations of CCB-derived constituents may be transported via the groundwater in the shallow saturated zone and can lead to wetland plant root uptake and translocation into leafy plant tissue. This could result in potential exposure to wetland plants (e.g., phytotoxicity) as well as constituent exposure to foraging herbivores.

The other major potential release mechanism is the erosion of CCBs from areas of historic placement of fill in roadways into upland soil within sections of the Area of Investigation. This may result in the potential exposure of terrestrial ecological receptors. As noted earlier, the importance of this exposure pathway is uncertain due to the lack of knowledge of where the CCBs have been placed in or migrated to ecological habitats. As indicated in Figure 2-3, this pathway will be fully evaluated once the appropriate locations of overlap of ecological habitat and CCBs have been established.

The relevant potential exposure pathways identified in the preliminary CSM include:

- Exposure of aquatic, benthic, plant, amphibian, avian, and mammalian receptors to CCB-derived constituents in surface water of the Brown Ditch system, adjacent man-made ponds/basins, and other potentially affected water bodies (as indicated by groundwater investigation results);
- Exposure of aquatic, benthic, plant, amphibian, avian, and mammalian receptors to CCB-derived constituents in sediments of the Brown Ditch system, adjacent man-made ponds/basins, and other potentially affected water bodies (as indicated by groundwater investigation results);
- Exposure of wetland vegetation to CCB-derived constituents through root uptake of groundwater from the shallow saturated zone (as indicated by groundwater investigation results);
- Potential exposure of avian and mammalian receptors (herbivores, omnivores, insectivores and carnivores) to CCB-derived constituents in Brown Ditch system, adjacent man-made ponds/basins, and other potentially affected water bodies through bioaccumulation by ingestion of food items (plants, insects, fish);
- Exposure of terrestrial vegetation and soil invertebrates to CCB-derived constituents in upland terrestrial habitat areas potentially affected by historic fill areas; and
- Potential exposure of terrestrial avian and mammalian receptors (herbivores, omnivores, insectivores, and carnivores) to CCB-derived constituents in upland terrestrial habitat areas potentially affected by historic fill areas through bioaccumulation by ingestion of food items (plants, insects, mammals).

2.5.1 Assessment and Measurement Endpoints

As part of the CSM, ecologically-based assessment and measurement endpoints relevant to the protection of potential ecological receptors at the Pines Area of Investigation were developed (Table 2-1). Assessment endpoints describe the characteristics of an ecosystem that have an intrinsic environmental value that is to be protected (i.e., protection of warmwater fish community; no potential risk to endangered species). Typically, assessment endpoints and receptors are selected for their potential exposure, ecological significance, economic importance, and/or societal relevance.

Because assessment endpoints often cannot be measured directly, a set of surrogate endpoints (measurement endpoints) are generally selected for ecological risk assessment that relate to the assessment endpoints and have measurable attributes (e.g., comparison of media concentrations to screening benchmarks, results of food web models) (USEPA, 1997, 1998a). These measurement endpoints provide a quantitative metric for evaluating potential effects of constituents on the ecosystem components at risk. The assessment endpoints selected for the SERA are:

- Protection and maintenance of fish and water column invertebrate communities;
- Protection and maintenance of freshwater benthic invertebrate populations;
- Protection and maintenance of indigenous wetland plant community;
- Protection and maintenance of indigenous amphibian community;
- Protection and maintenance of semi-aquatic wildlife receptors (i.e., wildlife receptors expected to forage or breed within the aquatic habitat areas);
- Protection and maintenance of indigenous terrestrial plant and soil invertebrate communities in upland habitat areas; and
- Protection and maintenance of terrestrial wildlife receptors (i.e., wildlife receptors expected to forage or breed within upland habitat areas).

Associated measurement endpoints for each assessment endpoint are presented in Table 2-1. Additional information on the nature of the community or wildlife receptors is given in Section 3.2. Based on the results generated by the measurement endpoint comparison, estimates of potential ecological risk will be made.