ASSESSMENT PLAN
for the
NATURAL RESOURCE DAMAGE ASSESSMENT
of the
GRAND CALUMET RIVER, INDIANA HARBOR SHIP CANAL, INDIANA HARBOR, AND ASSOCIATED LAKE MICHIGAN ENVIRONMENTS

Prepared for:

U.S. Department of the Interior

U.S. Fish and Wildlife Service
and
National Park Service

State of Indiana

Department of Environmental Management
and
Department of Natural Resources

October 1997

Prepared by:

John C. Weiss, Robert E. Unsworth, and Eric Ruder
Industrial Economics, Incorporated
2067 Massachusetts Avenue
Cambridge, MA 02140

617-354-0074

TABLE OF CONTENTS

TABLE OF CONTENTS (cont.)

TABLE OF CONTENTS (cont.)

LIST OF ACRONYMS

AOC	Area of Concern
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation and Liability Information System
CFR	Code of Federal Regulations
CWA	Clean Water Act
DOI	United States Department of the Interior
EBGCR	East Branch, Grand Calumet River
EPA	United States Environmental Protection Agency
FDCA	Food, Drug and Cosmetic Act
FWS	United States Fish and Wildlife Service
GCR	Grand Calumet River
GIS	Geographic Information System
IBI	Index of Biotic Integrity
IDEM	Indiana Department of Environmental Management
IDNL	Indiana Dunes National Lakeshore
IDNR	Indiana Department of Natural Resources
IHC	Indiana Harbor Ship Canal
IJC	International Joint Commission
IWPCB	Indiana Water Pollution Control Board
NCP	National Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPS	National Park Service
NRDA	Natural Resource Damage Assessment
OPA	Oil Pollution Act
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
ppm	part per million
PRP	Potentially Responsible Party
QAPP	Quality Assurance Project Plan
RAP	Remedial Action Plan
RCDP	Restoration and Compensation Determination Plan
RCRA	Resource Conservation and Recovery Act
USACE	United States Army Corps of Engineers
USC	United States Code
USGS	United States Geological Survey
USX	United States Steel Corporation
WBGCR	West Branch, Grand Calumet River

CHAPTER 1 INTRODUCTION

The United States Fish and Wildlife Service (FWS), the National Park Service (NPS), the Indiana Department of Environmental Management (IDEM), and the Indiana Department of Natural Resources (IDNR) have initiated a natural resource damage assessment (NRDA) to address natural resource injuries resulting from the release of hazardous substances and oil to the waters of, and to the habitats associated with, the Grand Calumet River (GCR), the Indiana Harbor Ship Canal (IHC), Indiana Harbor, and Lake Michigan, including land within the boundaries of the Indiana Dunes National Lakeshore (IDNL) (Figures 1-1 and 1-2). This Assessment Plan will serve as the guiding document for all damage assessment activities.

Authority to Conduct a Natural Resource Damage Assessment

Pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended (42 U.S.C. 9601 *et seq.*), the Oil Pollution Act (OPA, 33 U.S.C. 2701 *et seq.*), and the Federal Water Pollution Control Act (the "Clean Water Act" (CWA)), as amended (33 U.S.C. 1251 *et seq.*), federal and state officials act on behalf of the public as trustees for natural resources. The Secretary of the United States Department of the Interior (DOI) acts as a federal trustee pursuant to the National Contingency Plan (NCP) (40 Code of Federal Regulations (CFR) Part 300.600) and Executive Order 12580, issued on January 23, 1987. For this NRD action, the Secretary delegated his authority as the Department's natural resource trustee to the Director of FWS (242 Departmental Manual 6). In 1987, the Governor of the State of Indiana delegated trusteeship for resources in that State to IDEM and IDNR.

Two sets of regulations have been promulgated to guide trustees in the assessment of natural resource injuries and damages. In 1987, under the authority of CERCLA and CWA, DOI issued regulations (43 CFR Part 11) for conducting damage assessments following the discharge of oil or the release of hazardous substances. The purpose of the DOI regulations is "to provide standardized and cost-effective procedures for assessing natural resource damages." When trustees complete an assessment according to these procedures, the results "shall be accorded the evidentiary status of a rebuttable presumption" *(43 CFR 11.11)*. However, "the assessment procedures set forth in [the regulations] are not mandatory" *(43 CFR 11.10)*. In 1996, the National Oceanic and Atmospheric Administration (NOAA), acting on behalf of the United States Department of Commerce (another federal trustee) and under the authority of OPA, issued regulations at 15 CFR Part 990 for the assessment of damages resulting from a discharge or substantial threat of discharge of oil into or upon the navigable waters of the United States, adjoining shorelines, or the Exclusive Economic Zone. In this case, where both hazardous substances and oil have been released, application of the DOI regulations is appropriate, though the NOAA regulations may also provide useful guidance. Therefore, the damage assessment described in this Assessment Plan will follow the regulations promulgated by DOI at 43 CFR Part 11.

Figure 1-1

General Location of Assessment Area

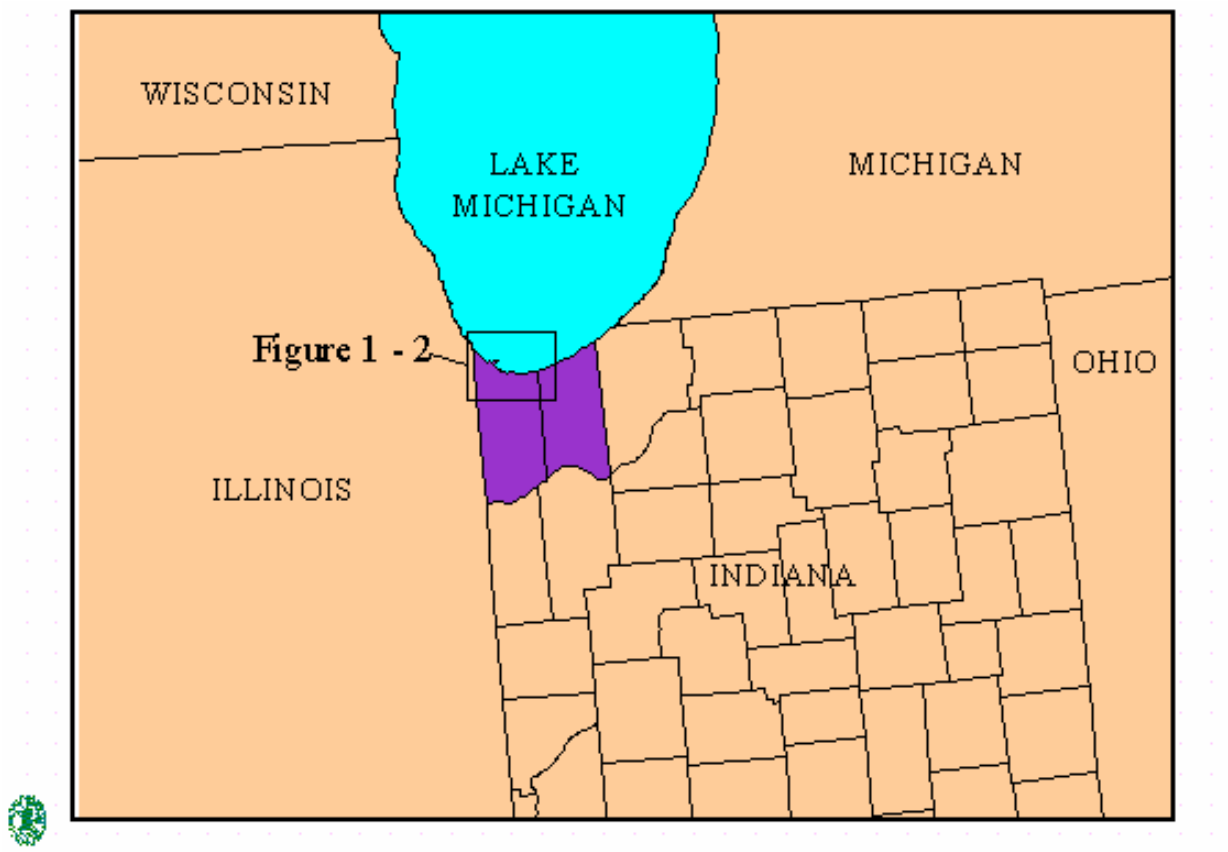


Figure 1-2

General Assessment Area Map

As required by the DOI regulations, the trustees' decision to proceed with this assessment is based on the results of a Preassessment Screen, which was completed in June 1996 (USFWS et al. 1996). The Preassessment Screen, which focused on the GCR and IHC, shows that the trustees have a reasonable probability of making a successful damage claim. In accordance with the DOI regulations, the Preassessment Screen was based on a rapid review of readily available information.

Purpose of the Assessment Plan

The purpose of this Assessment Plan is to document the trustees' basis for conducting a damage assessment, and to organize the proposed approach for determining and quantifying natural resource injuries and calculating the damages associated with those injuries. By developing an Assessment Plan, the trustees can ensure that the NRDA will be completed at a reasonable cost relative to the magnitude of damages sought. The trustees also intend for this Plan to communicate proposed assessment methodologies to potentially responsible parties (PRPs) and to the public in an effective manner so that these groups can productively participate in the assessment process.

This Assessment Plan lays out the steps the trustees will undertake in calculating the two primary components of a damage claim: the cost to restore, rehabilitate, replace, and/or acquire equivalent resources for the injured resources, and "compensable values," or the monetary value of the natural resource services that were lost prior to the restoration of injured resources to their "baseline" condition.[1] Baseline is the condition or conditions that would have existed in the assessment area had the discharge of oil or release of hazardous substances under investigation not occurred *(43 CFR 11.14(e))*. The concept of baseline in the context of this damage assessment is discussed further in Chapters 3 and 4.

Decision to Perform a Type B Assessment

The DOI regulations provide for two types of assessments. A "Type A" assessment is a simplified assessment, requiring minimal field observation, that generates a damage claim through the application of a general computer model. A "Type B" assessment comprises a more comprehensive set of studies and analyses. Use of the Type A model is generally limited to the assessment of relatively minor, short duration discharges or releases that occur in coastal or marine environments or in the Great Lakes (other conditions, listed at 43 CFR 11.33(b), may also warrant use of the Type A model). A Type B assessment is warranted when a Type A assessment is not.

In this case, a number of the conditions that would support the use of a Type A approach are not satisfied, including:

[1] The third component of a damage claim is the "reasonable and necessary" costs incurred by the trustees to complete the damage assessment *(43 CFR 11.15(a)(3))*.

- ? The discharge or release was not of a short duration. In this case, discharges and releases of oil and hazardous substances have occurred over a period of many years.

- ? The discharge or release was not minor. In this case, discharges and releases of oil and hazardous substances have had a significant adverse effect on the natural resources within the assessment area.

- ? The discharge or release was not a single event. In this case, multiple discharges and releases have occurred.

Therefore, the trustees have determined that a Type B assessment is warranted in this case.

Preliminary Estimate of Damages

As part of the planning process for a Type B assessment, the trustees are required to prepare a preliminary estimate of natural resource damages. The purpose of this estimate is to guide the trustees in the selection of specific technical, economic, or other methodologies for completing the assessment. The trustees should proceed with the assessment if there is sufficient confidence that the value of calculated damages will exceed the costs of performing the proposed damage assessment activities. The trustees are not required to make public the results of the preliminary estimate of damages until the assessment is complete.

The trustees have completed a preliminary estimate of damages and are confident that the value of damages determined through an NRDA will exceed their estimate of the potential assessment costs. An important factor that reduces potential assessment costs is the existence, and availability, of relevant data that federal and state agencies and PRPs have already collected. As described later in this Plan, the trustees intend to make use of these data to the maximum extent possible.

Coordination with Other Governmental Activities

The DOI regulations require the coordination of a damage assessment, to the extent possible, with response actions or other investigations being performed pursuant to the NCP (i.e., Superfund site cleanup activities). This requirement generally reflects circumstances in which a damage assessment is being undertaken with respect to a single site. In this case, a wide range of cleanup and other investigation and response activities (pursuant to CERCLA, CWA, the Resource Conservation and Recovery Act (RCRA), and a variety of state and regional environmental initiatives) are planned or underway at the numerous "sites" located within the Grand Calumet River watershed. At a minimum, the trustees intend to take into consideration the objectives of these activities during the continued planning and implementation of this assessment. Whenever possible, the trustees will explicitly coordinate damage assessment activities with other investigations and will ensure that appropriate

consideration is given to parties undertaking or completing remediation or restoration activities that satisfy the trustees' NRDA objectives. To facilitate this process, the trustees are working closely with the Region 5 office of the U.S. Environmental Protection Agency (EPA). An EPA Region 5 representative will serve as the trustees' main point of contact for information on the Agency's activities in the Grand Calumet River watershed.

Coordination among the trustees is also an essential component of a cost-effective damage assessment. With this in mind, the trustees have signed a Memorandum of Understanding, dated February 1997, that provides a framework for coordination and cooperation among the trustees and for the implementation of the trustees' activities in furtherance of their natural resource trustee responsibilities. The Indiana Department of Environmental Management acts as lead administrative trustee and is the central point of contact for the parties that would like to communicate with any or all of the trustee agencies.

Participation in the Assessment by Non-Trustee Parties

The trustees invite public participation in this natural resource damage assessment. The trustees will solicit public comments from PRPs, other affected federal or state agencies or Indian tribes, and any other interested members of the public following the completion of all major planning documents, including:

- The Assessment Plan;
- The Restoration and Compensation Determination Plan; and
- Assessment Plan addenda that describe significant additions or changes to the approach described in this Plan.

Each public comment period will last for a period of at least 30 calendar days. The public comment period for this Assessment Plan began on October 10, 1997, the day the Notice of Availability was published in the Federal Register; therefore, the comment period will end on November 10, 1997. Comments may be submitted in writing to:

Ms. Elizabeth Admire
Indiana Department of Environmental Management
100 North Senate Avenue
P.O. Box 6015
Indianapolis, IN 46206-6015

In addition, the trustees will soon open a public reading room that will provide access to documents used by the trustees during the planning and implementation of the damage assessment. As this assessment proceeds, the trustees will continue to seek out opportunities to encourage and facilitate public participation in the damage assessment process.

The trustees have also invited, and will continue to encourage, the active participation of PRPs in the implementation of this damage assessment. It is the intention of the trustees to work cooperatively with PRPs at each stage of the assessment and to take advantage of the expertise that PRPs may be able to provide. The trustees recognize that PRPs are currently planning, conducting, and participating in activities that will better characterize environmental conditions in the assessment area and will perhaps help to address natural resource injuries. The trustees strongly encourage PRPs to assist them in understanding the nature and extent of natural resource injuries, both by participating in the collection of data relevant to this natural resource damage assessment and by providing them with documentation of PRP activities (e.g., work plans, results, data analyses) as this information becomes available.

Organization of the Assessment Plan

Chapter 2 of this Assessment Plan provides background information that establishes the framework for this damage assessment. Chapter 3 describes the specific activities the trustees propose to undertake to document the nature and degree of injuries to natural resources. Chapter 4 provides an introduction to the concept of damages, with an emphasis on the costs of restoration and potential methods by which the trustees will calculate other natural resource damages. While it is not feasible at this time to complete a detailed Restoration and Compensation Determination Plan, which would include the identification of a preferred restoration alternative from among a set of alternatives, Chapter 4 describes the types of restoration alternatives likely to be considered, the categories of compensable values for which the trustees might claim damages, and the economic methodologies the trustees would likely use to estimate these compensable values. Chapter 5 outlines the trustees' approach for ensuring that any original data collection undertaken by the trustees to support this assessment conforms to generally accepted standards of quality assurance and quality control. Chapter 6 lists the information sources referred to in this Assessment Plan. Chapter 7 is a glossary of terms used in the Plan.

This damage assessment will address injuries to a variety of natural resources associated with the release of hazardous substances and oil from numerous sources in an area of extensive industrial activity. The complex nature of this assessment requires the trustees to communicate effectively the proposed plan for calculating natural resource damages. As a first step toward achieving this objective, the trustees include in this chapter background information on the geographic scope of the assessment area, the history of industrial activity within that area, the nature of hazardous substance and oil releases to the environment, and the natural resources subject to injury resulting from those releases.

Geographic Scope of the Assessment Area

As noted in Chapter 1, this damage assessment will focus on the Grand Calumet River, Indiana Harbor Canal, Indiana Harbor, and associated Lake Michigan environments, and on the riparian and upland habitats closely associated with these waters, including lands within the boundaries of the Indiana Dunes National Lakeshore. The following descriptions establish more specific boundaries for what will be referred to as the "assessment area" (see Figure 2-1).

Grand Calumet River

The Grand Calumet River comprises two east-west oriented branches that meet at the southern end of the Indiana Harbor Canal. The east branch of the Grand Calumet River (EBGCR) originates at the Marquette Park Lagoons, just east of the United States Steel (USX) Gary Works facility. The EBGCR flows west from this point for approximately ten miles to its confluence with the Canal. The west branch of the Grand Calumet River (WBGCR) usually flows both east and west, with a hydraulic divide typically present in the vicinity of Indianapolis Boulevard. The assessment area will include the Marquette Park Lagoons, the EBGCR, and the reach of the WBGCR between the hydraulic divide and the canal, along with the riparian, wetland and upland habitats closely associated with these stretches of the river.

Indiana Harbor Canal and Indiana Harbor

The Indiana Harbor Canal flows north for approximately three miles from its confluence with the east and west branches of the Grand Calumet River before turning to the northeast and flowing for an additional two miles through Indiana Harbor and into Lake Michigan. The Lake George Branch of the canal extends to the west from the point where the main canal turns to the northeast. The assessment area will include the entire length of the canal and harbor, including the Lake George Branch.

Figure 2-1

Detailed Assessment Area Map

Lake Michigan

The trustees have not defined a specific boundary within which Lake Michigan resources will be subject to assessment. The establishment of such a boundary depends upon a better understanding of injuries to Grand Calumet River and Indiana Harbor Canal resources and the nature of the relationship between the river and canal and the lake. At a minimum, the trustees will review existing information to assess the extent to which the Grand Calumet River and Indiana Harbor Canal contribute to the degradation or diminishment in value of lake resources and the services these resources provide.

Indiana Dunes National Lakeshore

The Indiana Dunes National Lakeshore is a unit of the National Park system comprising more than 12,000 acres east of and adjacent to the USX Gary Works. The trustees will include the IDNL in the assessment area due to the park's proximity to known sources of contamination. The focus of trustee efforts will be on the western portion of the park, including portions of the Marquette Park Lagoon system.

History of Industrial Activity and Identification of Potentially Responsible Parties

The industrial development of the assessment area and environs began in the mid-nineteenth century (approximately 1851) when new railroad lines traversed the area to connect the city of Chicago with other cities in the midwest and along the eastern seaboard. By 1923, the cornerstones of future industrial activity were in place. These cornerstones include:

- The Amoco (formerly Standard Oil Co.) refinery in Whiting, constructed in 1889, which for a time was the world's largest petroleum refinery and continues to be one of the largest refineries in the United States;
- Indiana Harbor and the main branch of the Indiana Harbor Canal, construction of which occurred between 1901 and 1911 (construction of the Lake George Branch ended in 1914, having failed to achieve the original objective of connecting Lake George to the harbor and lake);
- The Inland Steel Corporation facility in East Chicago, constructed in 1901;
- The U.S. Steel facility in Gary, constructed in 1909; and
- The LTV Steel Company (formerly Youngstown Sheet and Tube) facility in East Chicago, constructed in 1923.

(see IDEM 1991, USACOE 1995)

These cornerstones established northwest Indiana as a major industrial center, leading other establishments to locate facilities in the area. The land north of the Grand Calumet River is now one of the most heavily industrialized areas in the U.S.

Today, the results of nearly a century of industrial development are evident in the number of sites in northwest Indiana that are subject to some form of environmental control or enforcement under federal and state regulatory programs, as described below.

? Based on National Pollutant Discharge Elimination System (NPDES) records maintained by the EPA, five facilities are considered to be the major point source dischargers to the Grand Calumet River, Indiana Harbor Canal, Indiana Harbor and Lake Michigan (IDEM 1991).

? Fifty-two properties located in the vicinity of the Grand Calumet River and Indiana Harbor Canal are listed in the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) as sites containing potentially uncontrolled hazardous wastes that require investigation. Five of these sites are currently listed on the EPA National Priorities List (NPL), 40 CFR Part 300, Appendix B, which is a list of hazardous waste sites posing the greatest threat to human health, welfare, and the environment (IDEM 1991).

? More than 400 facilities located in the vicinity of the Grand Calumet River and Indiana Harbor Canal are subject to regulation under RCRA, meaning they generate, transport, or treat, store or dispose of hazardous wastes. Twenty-three of these are classified as treatment, storage or disposal facilities, and nine have been identified as land disposal facilities (IDEM 1991).

? Three large municipal wastewater treatment plants (serving the Hammond, Gary, and East Chicago Sanitary Districts) discharge to the Grand Calumet River and Indiana Harbor Canal. In addition, the river and canal receive discharges totaling more than 11 billion gallons per year from 12 combined sewer overflow outfalls (IDEM 1991).

Based on information available at this time, and in accordance with the statutory provisions in section 107(a) of CERCLA, the Trustees have compiled an initial list of PRPs who may be liable for damages associated with injuries to natural resources occurring in the assessment area. The trustees may identify additional PRPs following the review of additional information.

Hazardous Substances and Oil Present in the Assessment Area

The trustees will focus the assessment on natural resource injuries and damages which are associated with the release of polychlorinated biphenyls (PCBs), oil and oil-related compounds, and metals. The purpose of this section is to briefly describe these three categories of contaminants, focusing on general characteristics, sources and environmental effects.

Polychlorinated biphenyls

PCBs are synthetic compounds that were produced commercially in the United States between 1929 and 1977, when their production in this country was banned. The principal manufacturer of PCBs in the United States was the Monsanto Chemical Co. Monsanto's PCBs were sold under the registered trademark of Aroclor.

PCBs found wide use in commercial and industrial applications due to their favorable properties, including chemical stability, low flammability and ability to serve as an electrical insulator. Common uses of PCBs ranged from dielectric fluids in capacitors and transformers, to heat transfer fluids, hydraulic fluids, lubricating and cutting oils, to additives in pesticides, paints, copying paper, adhesives, sealants and plastics. Their most common use was in capacitor and transformer dielectric fluids. As a result of their widespread use, the release of PCBs to the environment can occur through a variety of mechanisms, including past uncontrolled use, past disposal practices, illegal disposal and accidental releases (Erickson 1997).

The chemical stability of PCBs makes them highly persistent in the environment after they have been released. Because they are lipophilic and have relatively low water solubilities, PCBs tend to accumulate in soils and sediments. Having accumulated in these environmental media, PCBs become available to biological organisms, typically moving through the food chain from invertebrates to fish, birds, mammals and other wildlife. Despite general declines in observed concentrations of PCBs in wildlife since the manufacture of PCBs ceased twenty years ago, concentrations still occur at levels that cause adverse effects in exposed organisms. The results of field and laboratory studies indicate that PCBs can be associated with a range of such effects, including impaired reproductive ability in fish, mammals and birds (Beyer et al. 1996, Eisler 1986).

Oil and related compounds

Oil is a term used to classify a variety of complex mixtures of organic compounds and trace elements generally associated with the petrochemical industry. In general, four classes of petroleum hydrocarbons make up the non-animal or plant oils: alkanes, naphthenes, aromatics and alkenes. Crude or refined oils have the potential to enter the environment wherever they are used, manufactured, stored or otherwise handled. Releases to the environment can occur as a result of direct discharge to the land surface or to surface water, and can move through the environment via numerous pathways, including the discharge of ground water to surface water, and surface water runoff. Oil can be harmful to the environment as a result of both its physical and chemical properties.

A subcategory of the aromatic hydrocarbons is the group of chemicals known as polycyclic aromatic hydrocarbons, or PAHs. In addition to their occurrence as constituents in petroleum products, PAHs are also formed as a product of incomplete combustion. Sixteen PAHs are classified as priority pollutants by the EPA. Exposure to PAHs has been associated with a variety of adverse effects in fish, birds, mammals and other wildlife (Beyer et al. 1996).

Metals

Metals are naturally-occurring elements that are often found, as a result of industrial and commercial activity, at elevated concentrations in the environment. The group of metals that can be toxic, particularly at high doses, are commonly referred to as the "heavy metals." These metals include aluminum, arsenic, beryllium, bismuth, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, strontium, thallium, tin, titanium, and zinc. Cadmium, lead and mercury are among the more prominent metals which have been associated with adverse effects observed in natural resources. Adverse effects associated with exposure to metals have been observed in invertebrates, fish, birds and mammals (Beyer et al. 1996).

Natural Resources in the Assessment Area

Prior to the period of industrial development, the assessment area was characterized by a plain of coastal sediments, the most prominent features of which were the globally-rare dune and swale habitats running parallel to the shoreline. Today only scattered dune and swale remnants are preserved. Nevertheless, the Grand Calumet River and Indiana Harbor Canal environment continues to comprise a wide range of natural resources; more importantly, the area has the capacity to support a much richer and much more diverse suite of resources than are currently present.

The DOI regulations define five categories of natural resources for which natural resource damages may be sought: surface water resources, ground water resources, air resources, geologic resources, and biological resources. Surface water resources include both the water column and associated bed or bank sediments. The following sections briefly describe each of these categories in the context of the assessment area.

Surface water resources

The surface water resources in the assessment area include the water and the bed and bank sediments of the EBGCR, WBGCR, Indiana Harbor Canal, Indiana Harbor, Lake Michigan, and Marquette Park Lagoons. These resources are particularly important in the context of this damage assessment, as they have been and continue to be the principle receptors of hazardous substances and oil released to the environment within the assessment area. The contamination of these resources has both direct and indirect impacts on the health of biological resources. For example, contaminated sediments can cause injury to benthic invertebrate populations, which in turn can result in injuries to resident fish populations for whom the invertebrates are a source of food. Similarly, injury to invertebrates and/or fish resulting from exposure to contaminated sediments and surface water can lead to injury in local insectivorous or piscivorous bird populations. In addition, contaminated sediments serve as a source of continuing releases of hazardous substances to the water column.

Ground water resources

Ground water resources include the water in a saturated subsurface zone and the rocks or sediments through which this water flows. Ground water resources serve as a potential pathway for contaminants to migrate from their source to surface water resources. Since ground water within the assessment area is not used as a public drinking water supply (as a result of contamination), the assessment of these resources will focus on establishing part of the pathway component of the injury assessment. The Calumet Aquifer, a shallow ground water aquifer within the assessment area, has been documented to be directly connected with the waters of the Grand Calumet River, Indiana Harbor Canal and Lake Michigan (IDEM 1991).

Air resources

Air resources are typically assessed in the context of their ability to serve as a pathway for hazardous substances to reach, and potentially injure, other resource categories. The trustees do not consider an assessment of the air pathway to be a cost-effective use of assessment resources, as deposition of airborne contaminants is assumed to play a relatively minor role in causing the potential injuries that will be the focus of this damage assessment. The trustees would reevaluate this assumption upon receipt of information suggesting that the air pathway is significant in the context of injuries to GCR/IHC resources.

Geologic resources

Geologic resources include soils and sediments that are not otherwise accounted for under the definition of surface water or ground water resources. In this case, geologic resources include the soils and sediments located in upland and wetland areas closely associated with the Grand Calumet River, and the soils of lands within the Indiana Dunes National Lakeshore.

Biological resources

Along with surface water resources, biological resources comprise a key component of this damage assessment. The trustees will focus on the assessment of injuries to three categories of biological resources: benthic invertebrates, fish and birds. As described in Chapter 3, the food web relationship between these resources will provide the framework for their assessment.

Benthic invertebrates

The benthic invertebrate community has frequently been used to assess the environmental quality of aquatic ecosystems. These organisms are sensitive to both physical and chemical changes in the environment. They also have sufficiently long life cycles and low motility, and, therefore, reflect past and present environmental conditions. An unstressed community supports a large number of different

groups with relatively few individuals within each group. However, when a community is stressed, the number of benthic groups decreases and the relative number of individuals in the remaining tolerant groups increases.

There have also been several studies conducted on the benthic organisms within both branches of the GCR and the IHC. IDEM has sampled macroinvertebrates at a number of locations for several years and has consistently found five main groups of organisms at nearly every site (Bright 1988, IDEM 1992 and 1994). Bright evaluated collections from the east and west branches of the GCR, IHC, and Lake George Canal, and noted that "no intolerant species were present at any of the sites." However, he noted that the presence of many facultative organisms (e.g., dragonflies, certain midges, snails) indicated that severe oxygen depletions do not occur, but that the benthic fauna were stressed by toxic chemicals.

Fish

Fish diversity within the GCR/IHC has improved in recent years, although it continues to rate poorly relative to the historic diversity of these waters. Between 1985 and 1988, 43 fish collections were made in the GCR/IHC system in order to determine the index of biotic integrity (IBI), a measure of fish community health (Simon et al. 1988). A total of 21 fish species were collected during these studies, with the largest number occurring within the IHC (14 species). USFWS fish sampling in the EBGCR in 1994 revealed 10 species of fish at five locations (Sobiech et al. 1994). Golden shiner were the most abundant, and bluntnose minnow was the only species taken at all five locations. The most upstream station (just upstream of the Tennessee Street crossing) had only two species and three individuals; species diversity and fish numbers increased in a downstream direction. However, low numbers of individuals and low fish species diversity were observed throughout. The IBI rating at all five locations was "very poor."

Birds

The wetlands of the Grand Calumet River basin are geographically located in such a manner as to provide high-quality nesting, resting, feeding, and loafing opportunities for migratory birds (Brock 1986). These inland waters provide resting and loafing areas for waterfowl, especially diving ducks that feed offshore in Lake Michigan. The river and canal serve as wintering areas for hundreds of diving ducks (Custer et al. 1996) and dabbling ducks. During the springtime, this area serves as a migration stop-over area for thousands of horned grebes, common mergansers, scaup, teal, mallard, and many species of shorebirds. Each year during the spring migration, observers have noted waterfowl (primarily diving ducks) that have been acutely oiled as a result of their foraging activities in the Grand Calumet River, resulting in the impairment or inhibition of these birds' ability to fly (USFWS 1996a).

Confirmation of Exposure

Prior to undertaking a "Type B" assessment, the trustees must "confirm that at least one of the natural resources identified as potentially injured in the preassessment screen has in fact been exposed to the oil or hazardous substance" *(43 CFR 11.34(a)(1))*. The trustees' Preassessment Screen identifies resources within each of the five categories listed above as potentially injured. In order to document exposure, the trustees must show that "all or part of a natural resource is, or has been, in physical contact with oil or a hazardous substance, or with media containing oil or a hazardous substance" *(43 CFR 11.14(q))*. The following data summary satisfies this requirement by confirming exposure of sediments in the GCR/IHC to PCBs. This summary is one example of the type of data that is available to confirm the exposure of natural resources in the assessment area to oil and hazardous substances. Confirmation of exposure could also be achieved using data associated with the invertebrate, fish and bird communities in the assessment area.

Sediment quality in the GCR and IHC has been evaluated on numerous occasions over the past 20 years. During this period, federal and state agencies, potentially responsible parties and independent researchers have collected and analyzed sediment samples for a variety of purposes, including the documentation of PCB and other contaminant concentrations. More than 300 sediment samples have been collected from the IHC and Indiana Harbor alone since 1977 (USACE 1995).

The Army Corps of Engineers (the "Corps") is authorized to maintain the federal navigation channel in the IHC and Indiana Harbor (i.e., to ensure adequate navigation depths). However, the Corps has been unable to remove sediments from the channel since 1972 due to the inability to site a dredge spoil disposal facility. Efforts to characterize both the nature and extent of sediments requiring dredging have included sampling activities within the navigation channel in 1977, 1979, 1980, 1983, 1984, 1985, 1987, 1988 and 1993. Concentrations of PCBs detected in samples collected in 1977 are summarized in Table 2-1.

In 1991, USX initiated a sediment characterization study as part of a 1990 Consent Decree entered into with the EPA. Sediment samples were collected from 59 of 62 transects located at fairly regular intervals along the EBGCR, the WBGCR (between Indianapolis Boulevard and the GCR/IHC confluence) and the IHC (between the GCR/IHC confluence and Columbus Drive). Figure 2-2 presents the PCB concentrations detected in the upper five feet of sediment at each of these locations (as reported in a 1993 revised data summary following additional review of the original 1991 data summary, which reported significantly higher PCB concentrations). In 1994, IDEM collected sediment samples from five locations in the EBGCR, WBGCR and IHC. Table 2-2 lists the PCB concentrations detected in these samples.

Table 2-1

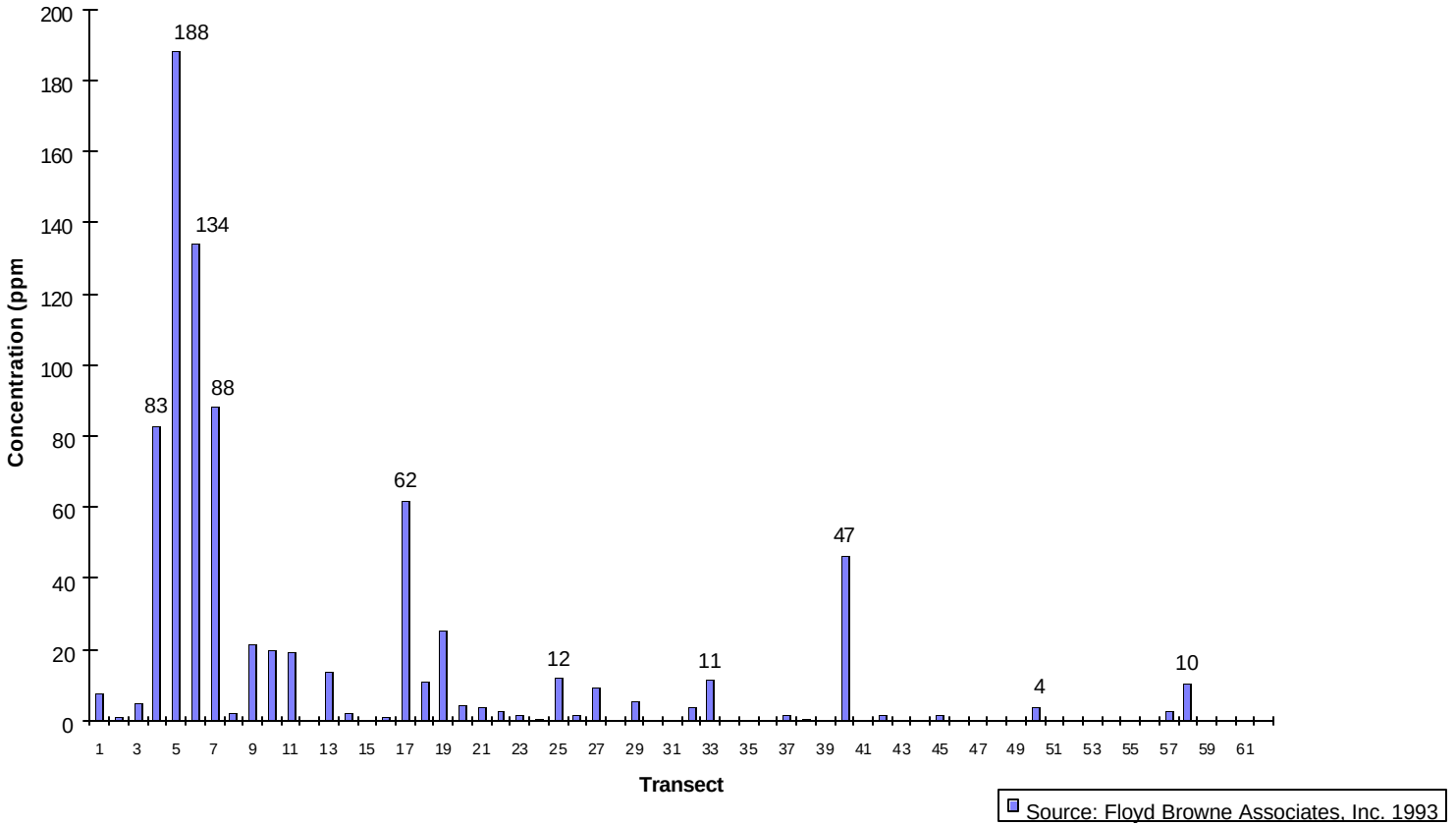
Total PCB Concentrations in IHC and Indiana Harbor Sediments, 1977

Sample Number	Concentration (ppm dry weight)	Location
1	5.6	GCR Branch, between Columbus Drive and The Forks
2	21.3	Lake George Branch at Indianapolis Boulevard
3	25.7	The Forks
4	20.9	IHC, between Canal Street and Dickey Place at small turning basin
5	23.1	IHC, between Dickey Road and Pennsylvania RR
6	6.5	IHC, between Pennsylvania RR and E. J. and E. Railway bridge
7	9.5	Indiana Harbor, downstream of E. J. and E. Railway bridge
8	3.4	Indiana Harbor, upstream side of large turning basin
9	4.4	Indiana Harbor, turning basin
10	1.5	Indiana Harbor, outer harbor
11	1.4	Indiana Harbor, outer harbor
12	0.043	Indiana Harbor, mouth of harbor
13	0.098	Lake Michigan, near harbor mouth

ppm = part per million
Source: USEPA 1977, as reported in USFWS 1996b

The concentrations of PCBs detected in sediments collected during the sampling efforts described above confirm that this natural resource has been exposed to a hazardous substance. While PCBs are contaminants of particular concern to the trustees, the natural resources in the assessment area have in fact been exposed to a variety of oils and hazardous substances. The purpose of this damage assessment is to document the cumulative injuries resulting from exposure to multiple contaminants and to determine the appropriate scope and scale of restoration and compensation.

Figure 2-2
Total PCB Concentrations in GCR and IHC Sediments



Notes:

? Transects 1-53 are located in the EBGCR; transects 54-56 are in the WBGCR; transects 57-62 are in the IHC.

? PCB results were not reported for transects 12,28,30,34-36, and 41.

? Concentrations were below detection limits at transects 15,31, 39, 43-44, 48-49, 52-56, and 59-62.

? Transects 46 and 47 were intended to be located upstream and downstream of a pipeline. These transects were eliminated from the study after field checks failed to verify the location or existence of the pipeline. Transect 51 was eliminated from the study due to unsafe field conditions.

Table 2-2

Total PCB Concentrations in GCR and IHC Sediments
1994 IDEM Sampling

Location	Approximate Concentration (ppm dry weight)
Dickey Road (IHC)	13
Bridge Street (EBGCR)	8
Cline Avenue (EBGCR)	4
Kennedy Avenue (EBGCR)	16
Indianapolis Boulevard (WBGCR)	8

Source: IDEM 1995

CHAPTER 3 INJURY DETERMINATION AND QUANTIFICATION

Introduction

The injury assessment, comprising both injury determination and injury quantification, is the process that informs the trustees' ultimate claim for natural resource restoration costs and, if warranted, "compensable values," or compensation for losses incurred prior to the completion of restoration activities. The DOI regulations instruct the trustees to take the following steps in completing the injury determination phase of the assessment:

? Identify and categorize each potentially injured resource;

? Select and implement injury determination methodologies and specific testing and sampling methods for each potentially injured resource, taking into consideration the DOI definitions of injury and the acceptance criteria for a determination of injury within each resource category. The injury definitions and the acceptance criteria are provided in the DOI regulations *(43 CFR 11.62)*.

? Determine the pathway by which the potentially injured resources have been exposed to oil or hazardous substances.

The DOI regulations provide for a process for collecting data on the effects of a discharge of oil or release of hazardous substances in the absence of any relevant existing data. In this case, relevant data have been collected over a period of many years. Because of the DOI regulations' emphasis on conducting a cost-effective assessment, the trustees will use existing data to the extent consistent with generally accepted quality standards both to document injuries and to define and focus additional data collection efforts. The collection of new data will occur according to the procedures and requirements of the DOI regulations.

Injury determination is followed by quantification of the documented injuries. During the injury quantification stage, the trustees evaluate the effect of the discharges or releases in terms of the reduction in the quantity and quality of natural resource services relative to the baseline level of services. The DOI regulations instruct the trustees to take the following steps in completing the injury quantification phase of the assessment:

? Measure the extent of the injuries documented in the injury determination phase;

? Estimate the baseline conditions of the injured resources;

? Identify the baseline services provided by the injured resources;

? Determine the recoverability of the injured resources; and

? Estimate the reduction in services relative to baseline resulting from the discharges or releases.

The reduction in services is the measure by which the trustees determine, in the damage determination phase, both the appropriate course of action to restore injured resources to their baseline conditions and the magnitude of compensable values.

The following sections describe the specific activities the trustees will undertake to determine and quantify injury to natural resources in the assessment area. The trustees have developed this portion of the Assessment Plan with the intention of achieving three objectives:

(1) Document the nature and scale of injuries to natural resources that are "indicators" of the broader range of potential injuries, such that the development of a comprehensive restoration plan is possible;

(2) Complete the injury assessment in the most cost-effective manner possible, balancing the need for clear and convincing documentation of injuries with the need for an expeditious assessment at a reasonable cost; and

(3) Satisfy the requirements for an injury assessment provided in the DOI regulations.

With regard to the third objective, any details concerning assessment activities that can not be provided in this Plan will be documented in specific work plans that will be made available for public review as they are developed. This applies in particular to the collection and analysis of environmental samples from the assessment area. In order to bring the PRP community and the public into the assessment process as early as possible, this Plan has been developed in advance of the creation of detailed sampling plans (i.e., plans that include information such as sample numbers, locations, and physical and chemical analyses). The Assessment Plan may be modified at any stage of the assessment as new information becomes available *(43 CFR 11.32(e)(1))*.

Pathway Determination

The injury determination studies described below will help to document that there is an injury pathway that begins with sources of oil and hazardous substances, continues through various environmental media (i.e., ground water, surface water, sediments and soils) and eventually reaches biological resources such as invertebrates, fish, and birds. To complement these studies, the trustees expect to evaluate separately the first part of this pathway, from the sources of oil and hazardous substances to the environmental media where they become available to the food chain. This report will be based on a review of available information documenting past and current operating and disposal practices, as well as information regarding regulatory enforcement actions, at the facilities located within

the assessment area. This pathway analysis will also use existing information to document the annual discharge of contaminated sediments from the GCR/IHC to Lake Michigan.

Injury Determination

The trustees' approach to injury determination will be to document the impact of oil and hazardous substances on the resources of the assessment area by focusing on selected resources that represent key elements of the assessment area ecosystem. Specifically, the trustees will examine:

? **Surface water** - the immediate receptor of oil and hazardous substances from point and non-point sources, and a medium in which biological resources are potentially exposed to oil and hazardous substances;

? **Ground water** - a potentially significant pathway by which oil and hazardous substances reach surface water;

? **Sediments** - the medium in which many contaminants discharged or released to surface water come to be located, thus becoming a secondary source of contamination that results in the propagation of contaminants throughout the food chain;

? **Benthic invertebrates** - biological resources at the base of the food chain that are particularly susceptible to injury as a result of direct contact with contaminated sediments. Disruption or impairment of the invertebrate community might result in the impairment of higher-level organisms that depend on invertebrates for food (e.g., fish, birds);

? **Fish** - important biological resources in terms of both their position in the food chain and their relationship to human uses of the environment; and

? **Birds** - higher-level biological resources that are susceptible to injury through direct contact with or ingestion of oil and hazardous substances and thus can further demonstrate the need for restoration of the assessment area.

This section describes a series of tasks that together are expected to confirm injuries at these various levels of the assessment area ecosystem, thereby providing the basis for a damage claim comprising both primary restoration costs and appropriate compensable values. The following information is provided for each task:

? **Objective** - the specific purpose of the task in the context of the overall damage assessment;

? **Operative Injury Definition** - the relevant basis for injury as described in the DOI regulations;

? **Regulatory Conformance** - information the trustees must consider in order to satisfy the requirements of the DOI regulations;

? **Background Information** - important facts that will guide the trustees as they undertake the task; and

? **Approach** - a description of the specific steps the trustees will take to complete the task.

The trustees reserve the right to expand the assessment to include additional resources (e.g., other biological resources, such as mammals). Specific tasks to evaluate additional injuries would be documented as modifications to this Assessment Plan, which would be made available for review by the PRPs and the interested public.

Task 1 - Evaluate surface water with respect to applicable water quality criteria

Objective

Document injury to surface water (water column) resources and establish surface water as a link in the exposure pathway to other potentially injured resources.

Operative Injury Definition

Surface water injury has resulted from the discharge of oil or release of a hazardous substance if the trustees can measure concentrations in excess of applicable water quality criteria established by section 304(a)(1) of the CWA, or by other federal or state laws or regulations that establish such criteria, in surface water that before the discharge or release met the criteria and was committed for use as a habitat for aquatic life, water supply, or recreation *(43 CFR 11.62(b)(1)(iii))*.

Regulatory Conformance

The acceptance criterion for injury to surface water is the measurement of concentrations of oil or a hazardous substance in two samples. If the samples are from the same medium they must be from different locations separated by a straight line distance of not less than 100 feet, or, in the case of water samples, from the same location but collected at different times *(43 CFR 11.62(b)(2)(i))*. In evaluating existing data, the trustees will provide documentation that previously collected samples satisfy this criterion. The trustees will also provide documentation showing that existing data are the result of sample collection and analysis that was conducted using generally accepted methods *(43 CFR 11.64(b)(2) and (4))*.

Background Information

Water quality standards for Indiana surface waters are established by the Indiana Water Pollution Control Board (IWPCB). In March 1990, the IWPCB adopted new Water Quality Standards for Lake Michigan and the GCR/IHC that are consistent with the CWA goal of water quality that provides for the protection of fish, shellfish, wildlife and recreation in and on the water. The new standards, which include numerical criteria for approximately 90 pollutants, upgraded the GCR/IHC to the same aquatic life and recreational uses as other warm water streams in Indiana. The IWPCB adopted the standards not only to protect and enhance the waters of the GCR/IHC but also to protect the uses and quality of Lake Michigan waters (IDEM 1991).

Approach

IDEM has collected surface water data from the GCR and IHC through routine annual water quality monitoring. In this task, the trustees will compare observed concentrations to existing water quality criteria. The analysis is expected to be conducted using a geographic information system (GIS) in order to more easily illustrate spatial relationships. Data will be adjusted, as necessary, to provide direct comparability with criteria that incorporate measures of specific physical parameters (e.g., hardness).

Task 2 - Document the discharge of contaminated ground water to surface water

Objective

Identify and characterize ground water discharges to surface water within the assessment area that contain oil or hazardous substances and thus represent a continuing source of contaminants that have the potential to injure natural resources.

Operative Injury Definition

The trustees intend to focus their evaluation of ground water resources on ground water as an injury pathway.

Regulatory Conformance

The trustees evaluation of the ground water resource as an exposure pathway will, to the extent necessary, include determination of the characteristics listed at 43 CFR 11.63(c)(3) - (5) (e.g., hydrogeologic conditions, contaminated ground water mobility, and contaminated ground water transport rates).

Background Information

A shallow ground water aquifer exists in the thin layer of sand (less than 50 feet thick) beneath much of the assessment area. This aquifer discharges to the GCR, IHC, and Lake Michigan. This aquifer is designated as non-potable due to the presence of hazardous substances in the ground water. However, contamination of this aquifer can have an adverse impact on the surface water bodies to which it discharges. An assessment of the ground water system by the United States Geological Survey (USGS) concluded that a significant amount of the shallow ground water is collected by area sewer systems (and thus may be subject to some treatment), but that most of the remaining ground water discharges to the GCR/IHC. The USGS also found that ground water under areas used by the steel and petrochemical industries generally has the greatest degree of inorganic and organic contamination (IDEM 1991).

Approach

The evaluation of contaminated ground water discharge to surface water will include the review, analysis, and interpretation of ground water data previously collected within the assessment area. These data include the results of USGS ground water monitoring as well as ground water monitoring conducted at individual industrial facilities (e.g., as part of a RCRA regulatory action). The trustees tentatively plan to retain the services of one or more experts in contaminated ground water transport to conduct this review. The reviewer will be asked to address the following questions:

1. At what points along the GCR and IHC is contaminated ground water known or likely to be discharging to surface water?

2. What contaminants are being released to the surface water as a result of this discharge?

3. What are the likely sources of the contaminated ground water?

4. At what rate is contaminated ground water discharging to surface water?

5. Is the discharge of contaminated ground water likely to represent an important factor contributing to the contamination of the GCR/IHC?

Task 3 - Characterize the nature and extent of soil and sediment contamination

Objective

Document contaminant concentrations in the soils and sediments of the Grand Calumet River, Indiana Harbor Canal, Indiana Harbor, Marquette Park Lagoons and associated off-river habitats (e.g., wetlands); establish the sediment link in the pathway between contaminant sources and biological

resources; and provide the data necessary for the eventual formulation of an appropriate restoration plan.

Operative Injury Definition

An injury to a surface water resource has resulted from the discharge of oil or release of a hazardous substance if the trustees can measure concentrations of substances in suspended, bed, bank, or shoreline sediments sufficient to have caused injury to biological resources *(43 CFR 11.62(b)(1)(v))*. Similarly, geologic resources (e.g., wetland soils) are injured if they contain concentrations of substances sufficient to cause injury to other resources (e.g., surface water, ground water, biological). The DOI regulations also provide ten specific measures of injury to geologic resources, including concentrations of substances sufficient to: raise soil pH above 8.5 or lower it below 4.0; impede soil microbial respiration; cause a toxic response in soil invertebrates; and/or cause a phytotoxic response, such as retardation of plant growth *(43 CFR 11.62(e))*.

Regulatory Conformance

The acceptance criterion for injury to the sediment portion of surface water resources is the measurement of concentrations of oil or a hazardous substance in two samples from different locations separated by a straight-line distance of not less than 100 feet *(43 CFR 11.62(b)(2)(i)(B))*. In evaluating existing data and collecting new data, the trustees will provide documentation showing that this criterion has been satisfied. The trustees will also provide documentation showing that existing data and new data are the result of sample collection and analysis conducted using generally accepted methods *(43 CFR 11.64(b)(2) and (4))*. No acceptance criteria are provided for injury to geologic resources.

Background Information

As noted in Chapter 2, sediments in the assessment area have been sampled and analyzed on numerous occasions over the past 20 years. In light of this wealth of potentially useful data, the trustees' goal is only to identify and fill significant data gaps. In order to accomplish this goal, the trustees propose to undertake the phased approach described below.

Approach

Review of Existing Data

The trustees will submit for third-party review the complete data packages associated with at least two previous sampling and analysis efforts: the Sediment Characterization Study completed for USX by Floyd Browne Associates, and the Sediment Trap Investigation completed by the Army Corps of Engineers. These two studies provide significant coverage of the assessment area with regard to sediment chemistry. The Floyd Browne study included samples from the entire length of the EBGCR

and from the IHC upstream of the navigation channel, while the Army Corps study included samples collected within the navigation channel. However, as these studies were not prepared in an NRDA context, it is necessary for the trustees to confirm that they provide data that are acceptable for such a purpose. If the data are judged to have been obtained in accordance with standard quality assurance procedures, the trustees will proceed to collect additional data only from portions of the river, canal and harbor that have not already been sufficiently characterized (as defined in the following step).

Data gap analysis

Following the review of existing data, the trustees will undertake a detailed analysis of the geology and hydrology of the GCR/IHC environment in order to identify those areas for which existing data do not provide adequate characterization. In particular, the trustees will consider variations in factors such as depositional environments and sediment characteristics along the river and canal as a means of assessing whether significant differences in contaminant concentrations could be expected between locations at which samples were collected during previous studies.

The trustees will also survey and characterize the riverine and upland habitats associated with the river as a step toward identifying and prioritizing off-river sampling locations. The focus of this effort will be on wetlands associated with the river that may be contaminated. In order to develop a comprehensive restoration plan, the trustees require additional information on these important components of the assessment area ecosystem. In accomplishing this sub-task, the trustees will seek only to build on existing, reliable data that may be available.

Additional sampling and analysis

As described earlier in this chapter, the trustees plan to develop and make available for public review detailed sampling plans prior to the commencement of environmental sampling activities. The trustees anticipate collecting three types of sediment or soil samples: "mid-stream," or samples from the bed of the GCR/IHC between the banks; "softside," or samples from the river bank or channel side; and "floodplain," or samples from areas outside of the river bank and channel side (e.g., wetlands). At a minimum, the trustees will address the following issues during the development of study plans for the collection and analysis of sediments and soils;

- The appropriate **type of samples** within each study area (i.e., samples from discrete points ("grab" sampling) or combinations of samples from multiple points ("composite" sampling));
- The **number of samples** from each study area that will be sufficient to provide a complete characterization of the area;
- The **locations of samples** within each study area that will be sufficient to provide a complete characterization of the area;
- The **depth of each sample** such that results will sufficiently document the nature and extent of contamination in each study area; and

? The **scope of the chemical analysis** for each set of samples. At a minimum, the trustees will analyze sediment and soil samples for the primary contaminants of concern (PCBs, oil-related compounds (e.g., PAHs), and metals) using standard analytic protocols established by the EPA. The trustees may also analyze samples for the presence of additional hazardous substances (e.g., volatile organic compounds).

Each sample location will be accurately recorded (for example, through the use of global positioning system technology), as will the physical characteristics (color, grain size, etc.) of each sample.

Task 4 - Evaluate the impact of sediment contamination on invertebrate communities

Objective

Document injury to two resource categories: sediments (by demonstrating that they are injurious to other resources) and the invertebrate community (thus documenting the impairment of an important link in the assessment area food chain).

Operative Injury Definition

As noted above, an injury to a surface water resource has resulted from the discharge of oil or release of a hazardous substance if the trustees can measure concentrations of substances in suspended, bed, bank, or shoreline sediments sufficient to have caused injury to biological resources. In general, an injury to a biological resource has occurred if concentrations of discharged oil or released hazardous substances are sufficient to cause the invertebrates or their offspring to have undergone at least one of the following adverse changes in viability: death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformations *(43 CFR 11.62(f)(1)(i))*.

Regulatory Conformance

The DOI regulations describe four acceptance criteria for demonstrating injuries to biological resources in general:

(1) The biological response (i.e., the injury) is often the result of exposure to oil or hazardous substances;

(2) Exposure to oil or hazardous substances is known to cause this biological response in free-ranging organisms;

(3) Exposure to oil or hazardous substances is known to cause this biological response in controlled experiments; and

(4) The biological response measurement is practical to perform and produces scientifically valid results.

Eighteen different biological responses in six categories of injury have, by rule, been determined to meet the acceptance criteria *(43 CFR 11.62(f)(4))*. These responses are listed in Table 3-1. The trustees will use these responses to document injury whenever possible; other responses that satisfy the acceptance criteria will be measured as necessary.

Background Information

Ingersoll et al. (1993) confirmed the results of previous work - that the GCR/IHC system has a depauperate benthic invertebrate community. Except for two individual chironomids collected at Columbus Drive, no other insects were present in grab samples from the canal and harbor. Bivalve molluscs were rare, occurring only at three stations in the canal and harbor. Tubificids were the most abundant organisms at all stations, with *Limnodrilus hoffmeisteri*, a species considered tolerant of organic enrichment and metal contamination, dominating. The abundance of oligochaetes was extremely high at one station, approaching one million individuals per square meter.

Bright (1988) observed that benthic fauna at six sampling locations in the GCR and IHC appeared to be stressed by toxic chemicals during the period 1986-1988. In general, the benthic community was dominated by relatively tolerant species, while species occurring in similar but unstressed habitats were notably absent. Hoke et al. (1993) observed the toxicity of sediments to invertebrates at each of 13 locations in the GCR/IHC during the period 1988-1990. The results of this study suggest that petroleum hydrocarbons, PAHs and metals are among the primary contaminants affecting the benthic invertebrate community. Sobiech et al. (1994) observed that the invertebrate community in the easternmost five miles of the EBGCR is severely impaired by toxic sediments. In particular, this stretch of the river was characterized by a low number of individuals, low organism density, and low species diversity.

Approach

As part of the sediment characterization effort, the trustees will collect samples to use in testing the toxicity of the sediments to benthic invertebrate species. Selected species will be exposed to both GCR/IHC sediments and suitable control sediments. As noted above, laboratory toxicity testing is an accepted way to measure death as a biological response to hazardous substances. One category of injury is documented if the trustees measure a statistically significant difference in total mortality or mortality rates between population samples in exposure chambers and population samples in control chambers *(43 CFR 11.62(f)(4)(i)(E))*. The trustees also propose to measure the bioaccumulation of contaminants in benthic invertebrates. This analysis will be conducted concurrently with sediment toxicity testing, and will provide valuable information regarding the link between sediment contamination and injuries to biological species such as fish and birds.

Table 3-1
Biological Responses for Determining Injury
that Satisfy the DOI Acceptance Criteria
(43 CFR 11.62(f)(4))

Injury Category	Response
Death	Brain cholinesterase (ChE) activity Fish kills Wildlife kills In situ bioassay Laboratory toxicity testing
Disease	Fin erosion
Behavioral abnormalities	Clinical behavioral signs of toxicity Avoidance
Cancer	Fish neoplasm
Physiological malfunctions	Eggshell thinning Reduced avian reproduction Cholinesterase (ChE) enzyme inhibition Delta-aminolevulinic acid dehydrase (ALAD) inhibition Reduced fish reproduction
Physical deformation	Overt external malformations Skeletal deformities Internal whole organ and soft tissue malformation Histopathological lesions

The objective of a sediment toxicity test is to determine whether contaminants in sediment are injurious to benthic organisms. The tests can be used to measure interactive toxic effects of complex contaminant mixtures in sediment. Toxicity is determined by measuring a statistically significant increase in mortality (or other endpoint) in the exposed population relative to that measured in a control population. The analysis would follow a standard EPA protocol (EPA/600/R-94/024) by exposing surrogate test species (*Hyalella azteca* and/or *Chironomus tentans*) to the sediment.

The objective of a sediment bioaccumulation test is to determine the extent to which contaminants in sediment are taken up by and retained in the tissue of benthic organisms. Having established such uptake, it is reasonable to assume that these contaminants would be accumulated by fish and/or birds through the ingestion of these benthic organisms. The sediment would be exposed to a surrogate test species (*Lumbriculus variegatus*) in accordance with a standard EPA protocol (EPA/600/R-94/024). The test species for the bioaccumulation test differs from the species used for

the toxicity test due to the ability of *L. variegatus* to survive exposure to environmental contaminant concentrations.

At a minimum, the trustees will address the following issues during the development of study plans for the collection and toxicity/bioaccumulation analysis of sediments;

- The appropriate **type of samples** within each study area (i.e., samples from discrete points ("grab" sampling) or combinations of samples from multiple points ("composite" sampling));
- The **number of samples** from each study area that will be sufficient to provide a complete characterization of the area;
- The **locations of samples** within each study area that will be sufficient to provide a complete characterization of the area; and
- The **depth of each sample** such that results will sufficiently document the nature and extent of contamination in each study area.

Task 5 - Evaluate the impact of oil and hazardous substances on fish populations

Objective

Document injury to fish populations in the GCR/IHC and further document the disruption of the assessment area ecosystem caused by the presence of oil and hazardous substances.

Operative Injury Definition

An injury to fish has occurred if concentrations of discharged oil or released hazardous substances are sufficient to:

- Cause the biological resource or its offspring to have undergone at least one of the following adverse changes in viability: death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformations;
- Exceed action or tolerance levels established under section 402 of the Food, Drug and Cosmetic Act (FDCA), 21 USC 342, in edible portions of organisms; or
- Exceed levels for which an appropriate state health agency has issued directives to limit or ban consumption of such organism *(43 CFR 11.62(f)(1)(iii))*.

Regulatory Conformance

See the description under Task 4 for information on relevant portions of the DOI regulations governing the determination of injuries to biological resources.

Background Information

Injury to fish is established without further assessment as a result of two existing conditions in the GCR/IHC. First, concentrations of PCBs in edible portions of fish tissue collected from the GCR have exceeded the 2 part per million (ppm) action level established by the Food and Drug Administration under section 402 of the FDCA (IDEM 1994). Second, in 1985 the Indiana State Board of Health issued a directive to limit the consumption of fish caught from the waters of southern Lake Michigan and the GCR/IHC (ISBH 1986). This consumption advisory, which states that no fish from the GCR/IHC should be eaten, remains in effect today (IDEM 1997).

In addition, fish species diversity has been severely reduced in the GCR/IHC when compared to historic accounts of fish species diversity in the Calumet River system and when compared to the biological integrity expected in tributaries to the Great Lakes in the "central corn belt plain" ecoregion (Meek and Hildebrand 1910, Gerking 1945, Simon 1991, Simon et al. 1988, Sobiech et al. 1994). The inability of the GCR/IHC to support and maintain biological integrity as defined in Karr and Dudley (1981) is due to the death and extirpation of all but the most pollution tolerant fish species.

The purpose of undertaking an additional assessment of injury to fish is to document the impact of oil and hazardous substances on the organisms themselves. A better understanding of this impact will guide the trustees in developing an appropriate restoration plan aimed at restoring the health and natural diversity of the GCR/IHC fish community.

Approach

The trustees' assessment of the impact of hazardous substances and oil in the GCR/IHC on fish populations is limited by the fishery's reduced numbers and species diversity. For the purpose of this assessment, the trustees will undertake an investigation of physical deformations of fish in the GCR/IHC. Specifically, the trustees will investigate the following types of ailments: external malformations, skeletal deformities, internal whole organ and soft tissue malformation, and histopathological lesions *(43 CFR 11.62(f)(4)(vi)(A-D))*. The trustees will employ standard methods to preserve and analyze tissues for malformations and lesions. In addition, the trustees anticipate utilizing flow cytometric analysis techniques on liver samples to investigate alterations in cellular DNA content, which can be a precursor to cancer. The trustees anticipate conducting these investigations on free-ranging catfish present in the GCR/IHC. However, in the event that wild catfish cannot be found in sufficient numbers, the trustees are considering the possibility of utilizing caged or released fish, or shifting the focus of these studies to another aquatic organism known to be present in the GCR/IHC.

The trustees will supplement this original assessment of the impact of contaminants on fish with a comprehensive literature review. The purpose of this review will be to compare the results of the site-specific studies to results that have been reported previously. The trustees expect that such a review will confirm that effects observed in the assessment area are comparable to effects observed in other systems with similar levels of contamination. The trustees will retain the services of an expert in the field of aquatic toxicology to perform this review.

Task 6 - Evaluate the impact of oil and hazardous substances on bird populations

Objective

Document injury to bird populations in the assessment area and further document the disruption of the assessment area ecosystem caused by the presence of oil and hazardous substances.

Operative Injury Definition

An injury to birds has occurred if concentrations of discharged oil or released hazardous substances are sufficient to cause the birds or their offspring to have undergone at least one of the following adverse changes in viability: death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformations *(43 CFR 11.62(f)(1)(i))*.

Regulatory Conformance

See the description under Task 4 for information on relevant portions of the DOI regulations governing the determination of injuries to biological resources.

Background Information

Each spring since 1992, many waterfowl (primarily common mergansers) have been observed in the GCR/IHC to be oiled to the degree that their ability to fly is impaired. This type of oiling can ultimately lead to death from hypothermia, starvation or increased susceptibility to predation. The trustees have documented oil-related mortality in several species of birds in the GCR/IHC (USFWS 1996a). This mortality provides documentation in support of injury to surface water ("concentrations and duration of hazardous substances sufficient to have caused injury . . . to biological resources" *(43 CFR 11.62(b)(1)(v))*) and to the birds themselves (in accordance with the definition of "wildlife kills" *(43 CFR 11.62(f)(4)(i)(C))*).

In addition to the mortality of adult birds caused by acute oiling in the GCR/IHC, the trustees' observations of bird populations in the GCR/IHC lead them to believe that eggs of some species of birds have failed to hatch as a result of exposure to hazardous substances during incubation. This would represent an injury in accordance with the definition of reduced avian reproduction *(43 CFR*

11.62(f)(4)(v)(B)). In addition to oil-related hazardous substances (i.e., PAHs), other hazardous substances that have been detected in birds and their eggs in and around the GCR/IHC include PCBs and metals. Species for which exposure to these hazardous substances has been documented include: herring gull (eggs), great blue heron (eggs), black-crowned night heron (eggs and chicks), wintering lesser scaup, peregrine falcon (eggs), and barn swallow (eggs and chicks) (USFWS 1996a).

Approach

The trustees' assessment of the impact of oil and hazardous substances on avian populations in the assessment area will focus on limited additional investigations of barn swallows and peregrine falcons in order to more fully document the adverse effects of exposure to hazardous substances. Specifically, the trustees will investigate the following types of physical deformations in barn swallows nesting under GCR/IHC bridges and at a reference site: external malformations, skeletal deformities, internal whole organ and soft tissue malformation, and histopathological lesions *(43 CFR 11.62(f)(4)(vi)(A-D))*. The trustees will employ standard methods to preserve and analyze tissues for malformation and lesions. The trustees will also chemically analyze sibling barn swallow chick samples that were collected concurrently with the samples collected for histological evaluation.

In order to assess potential physiological malfunction injuries (i.e., reduced avian reproduction), the trustees may conduct additional chemical analysis of failed eggs of both peregrine falcons and barn swallows. In addition, a laboratory egg injection investigation may be conducted with barn swallow eggs from a suitable reference site and/or with eggs from a commercially available surrogate species to document effects observed in barn swallow and peregrine falcon eggs of the GCR/IHC.

The trustees will supplement this original assessment of the impact of contaminants on birds with a comprehensive literature review. The purpose of this review will be to compare the results of the site-specific studies to results that have been reported previously. The trustees expect that such a review will confirm that effects observed in the assessment area are comparable to effects observed in other systems with similar levels of contamination. The trustees will retain the services of an expert in the field of avian toxicology to perform this review.

Injury Quantification

The DOI regulations state that the specific resources or services to quantify and the methodology for doing so should be based upon the following factors:

(1) The degree to which a particular resource or service is affected by the discharge or release;

(2) The degree to which a given resource or service can be used to represent a broad range of related resources and services;

(3) Consistency of the measurement with the requirements of the economic methodology to be used in the damage determination phase;

(4) The technical feasibility of quantifying changes in a given resource or service at reasonable cost; and

(5) Preliminary estimates of services at the assessment area and control area based on resource inventory techniques *(43 CFR 11.71(d))*.

The regulations list a variety of natural resource services that trustees may choose to quantify, including but not limited to: provision of habitat, food and other needs of biological resources, recreation, other products or services used by humans, flood control, ground water recharge, and waste assimilation *(43 CFR 11.71(e))*.

Considering the five factors listed above, the trustees have determined that injury quantification in this case is best served by focusing on two important services provided by the potentially injured resources: the loss or impairment of surface water and sediment (including wetland areas characterized as geologic resources) as habitat for biological resources, and the loss or impairment of recreational fishing opportunities. The latter service is intended to represent the human uses of injured biological resources, consistent with the second factor listed above.

The DOI regulations describe two general approaches for quantifying injuries to natural resources. The first, which the trustees will employ to quantify surface water and sediment injury, involves the measurement of the scale of the injury itself. The trustees will document the geographic area in which surface water and sediment have been injured and will then document the extent to which services in this area have been reduced from their baseline condition. The

second approach, which the trustees will employ to quantify lost recreational fishing opportunities, is the direct quantification of services. As described at 43 CFR 11.71(f), direct quantification of services is appropriate if the following conditions are met:

(1) The change in the services from baseline can be demonstrated to have resulted from the injury to the natural resource;

(2) The extent of the change in the services resulting from the injury can be measured without also calculating the extent of change in the resource (e.g., measuring the loss of fishing opportunities does not depend on the measurement of physical changes in fish); and

(3) The services to be measured are anticipated to provide a better indication of damages caused by the injury than would direct quantification of the injury itself.

The first condition is met due to the existence of a consumption advisory for the GCR/IHC. The second condition is met because the trustees can estimate the likely "fishing pressure," or use, of the GCR/IHC in the absence of oil or hazardous substances, either through comparisons to use levels in other river systems and/or through interviews with local anglers and resource managers. The third condition is met because the value of the potentially injured biological resources is attributable largely to the human use of those resources. Therefore, measurement of lost human uses provides a more reliable indication of damages associated with injury to fish populations than would quantification of particular injuries to the fish.

Quantification of injuries to surface water and geologic resources

As described above, the steps in the injury quantification process include measuring the extent of injuries, estimating baseline conditions and services, determining resource recoverability, and estimating the service reduction. The trustees' approach to each of these steps is described below for the quantification of injuries to surface water and geologic resources (i.e., the surface waters and sediments that provide habitat for biological resources).

Extent of injury

To document the extent of surface water injury, the trustees will generate a detailed map of the assessment area depicting those areas where concentrations of oil or hazardous substances in surface water, sediments and/or soils are sufficient to have injured the resource or to have caused injury to other resources. As described in the DOI regulations, the trustees should measure areal variation in concentrations "in sufficient detail to approximately map the boundary separating areas with concentrations above baseline from areas with concentrations equal to or less than baseline" *(43 CFR 11.71(h)(2)(i))*. The trustees will complete a similar exercise for those resources characterized as geologic (e.g., wetland soils), documenting the surface area of soils with reduced suitability as habitat for biota relative to baseline *(43 CFR 11.71(k)(2))*.

Baseline services determination

As noted in Chapter 1, "baseline" is the condition or conditions that would have existed in the assessment area had discharges of oil or releases of hazardous substances under investigation not occurred. The baseline services are those services that would have been provided by injured resources but for the discharges of oil or releases of hazardous substances. Whenever possible, the baseline level of services should be based upon historical data. If appropriate historical data are not available, the trustees should, if possible, collect baseline data from reference (or "control") locations that are as similar to the assessment area as possible in all respects other than the discharge of oil or release of hazardous substances.

In their baseline condition, sediments and soils provided a particular quantity and quality of habitat for biological resources. The trustees will use historical data from the assessment area and, if possible, from suitable reference locations, to make a reasonable determination of the habitat quantity and quality. While the baseline concentrations of the oil and hazardous substances that are the focus of this assessment are zero, other impacts of industrialization may have contributed to the loss or degradation of habitat services. The trustees will use available data to determine as accurately as possible the degree to which services would have been reduced even in the absence of oil and hazardous substances.

The trustees recognize that it will be a challenge to establish a concrete service level that represents "baseline" conditions. However, the DOI regulations permit the trustees to use baseline data that are not expected to represent fully the baseline conditions, subject to the trustees' ability to document that:

? Substitute baseline data shall not cause the difference between baseline and the conditions in the assessment area to exceed the difference that would be expected if the baseline were completely measured; and

? It is either not technically feasible or not cost-effective to measure the baseline conditions fully and that these baseline data are as close to the actual baseline conditions as can be obtained subject to these limitations *(43 CFR 11.72(b)(5))*.

The trustees believe that, for the purpose of this assessment, the use of "substitute" baseline data will not result in an overestimate of resource injuries. The trustees also believe that it is not cost-effective to attempt to fully measure baseline conditions.

Resource recoverability analysis

The trustees note that habitat quality in the assessment area has been improving. For example, biological studies have documented a gradual shift from more- to less-pollution tolerant fish and

invertebrate species in the GCR/IHC and a gradual increase in the relative abundance of

biota. However, it is generally predicted that the persistence of contaminants such as PCBs creates a situation in which it will likely take many decades or more for surface water, sediments and soils to return to their baseline conditions through natural processes.

As part of the injury quantification process, trustees are required to estimate the time needed for injured resources to recover to their baseline condition, both without restoration efforts beyond planned or ongoing response activities, and with proposed restoration alternatives. Since the trustees have not yet completed an assessment of injuries and have not yet developed specific restoration alternatives, it is not possible to undertake this analysis at this time. The trustees will incorporate this analysis into the development of restoration alternatives and the completion of a restoration plan.

Service reduction quantification

The trustees will quantify the reduction in services by measuring the area of those habitats that have been degraded relative to their baseline condition. If data are available to document service losses that would have occurred absent discharges of oil and releases of hazardous substances, then the measure of lost services will be less than the total acreage of sediment and soil habitat in which oil and hazardous substances are detected.

Quantification of injuries to biological resources

As described above, the trustees will quantify injuries to biological resources through the direct measurement of lost services associated with one representative and important human use of the resources (recreational fishing) that can be used as an indicator of a broad range of related resources and services (e.g., wildlife viewing, recreational boating). By quantifying the reduction in this single use, the trustees recognize that they may underestimate the actual damages associated with injuries to biological resources.

Baseline services determination

As with surface water and geologic resources, the trustees will rely on available historical data from the assessment area or suitable reference locations to document the baseline level of recreational fishing services. Specifically, the trustees will estimate the number of recreational fishing trips that anglers would have taken to the GCR/IHC in the absence of discharges of oil or releases of hazardous substances (but taking into consideration other factors that might influence fishing pressure). Such an estimate can be derived through comparisons to use levels in other river systems and/or through interviews with local anglers and resource managers.

Resource recoverability analysis

Since the trustees have not yet completed an assessment of and have not yet developed specific restoration alternatives, it is not possible to undertake a resource recoverability analysis at this time. The trustees will incorporate this analysis into the development of restoration alternatives and the completion of a restoration plan. The trustees do note, however, that the recoverability of the GCR/IHC as a source of recreational services will track closely with, and be dependent upon, the recovery of both aquatic and terrestrial habitats.

Service reduction quantification

The trustees will quantify the reduction in services as the difference between the level of recreational fishing services estimated to be provided by the GCR/IHC with and without the discharge of oil and release of hazardous substances. The trustees believe that the direct quantification of a reduction in recreational fishing opportunities will augment data on the impairment of surface water and sediment as habitat for biological resources. Any double counting of lost services that results from calculating both loss of fish habitat and loss of recreational fishing opportunities will be eliminated in the damage determination and restoration planning phase of the assessment. See 43 CFR §11.83(a)(3)(iii).

Introduction

In the damage determination phase, the trustees determine the type and magnitude of compensation required to restore injured natural resources to the appropriate baseline condition and to address the public's loss of natural resource services for the period preceding restoration to baseline (the "interim loss"). The DOI rules define two measures of compensation: the cost of restoration (i.e., restoration, rehabilitation, replacement, and/or acquisition of the equivalent), and the monetary value (the "compensable value") of the interim loss. Trustees are precluded from considering compensable value damages that are based on purely speculative uses of injured resources in their baseline condition ("only committed uses of the resource or services over the recovery period will be used to measure the change from the baseline" and "the baseline uses must be reasonably probable, not just in the realm of possibility") *(43 CFR 11.84(b)(2))*.

Implementation of the damage determination phase is dependent upon completion of a Restoration and Compensation Determination Plan (RCDP). The RCDP lists a range of restoration alternatives, includes the selection of one alternative and the rationale supporting that selection, identifies the methodologies the trustees will use to determine the costs of the selected alternative, and identifies the methodologies the trustees will use to determine compensable values. The RCDP is to be of sufficient detail to evaluate the alternatives and select the one that is most appropriate (using specific criteria described in this chapter).

Ideally, the RCDP would be a component of the Assessment Plan. However, if existing data are not sufficient to develop the RCDP concurrently with the Assessment Plan, the DOI regulations include provisions for postponing RCDP development pending completion of the injury determination or quantification phase. In such cases, the RCDP is to be made available for a separate public review. The trustees in this case have determined that it is not feasible to complete the RCDP at this time. However, the trustees have developed this chapter in the interest of providing PRPs and the public with a clear sense of the anticipated nature and scope of the damage determination.

Baseline

Chapter 3 described the trustees' approach to baseline in the context of quantifying lost services, which is an essential component in the calculation of compensable values. The trustees must also consider baseline in the context of restoration. Specifically, the trustees must be prepared to describe more completely the conditions (i.e., the baseline) that they seek to restore. As stated in the DOI regulations, baseline, in general,

> should reflect conditions that would have been expected at the assessment area had the discharge of oil or release of hazardous substances not occurred, taking into account

> both natural processes and those that are the result of human activities *(43 CFR 11.72(b)(1))*.

Thus, it is clear that the baseline condition of the GCR/IHC assessment area is not a pre-industrial, pristine waterway, but rather an industrial waterway (and associated habitats) in which the impacts of industrialization on natural resources are not aggravated or amplified through the introduction of oil and hazardous substances. Accordingly, baseline for surface water, sediment and soil in the GCR/IHC assessment area can be described as an environment in which oil or hazardous substances no longer contribute to the impairment of their use as habitat for biological resources. In its baseline condition, the GCR/IHC also would not be subject to fish consumption advisories due to the presence of oil or hazardous substances.

This expression of baseline is consistent with an existing program intended to address environmental concerns in northwest Indiana. In 1909, following passage of the Boundary Waters Treaty, the International Joint Commission (IJC) was established by the United States and Canada in order to cooperatively address problems along the portion of our common border located in the Great Lakes. In 1972, the U.S. and Canada signed the first Great Lakes Water Quality Agreement, which established objectives and criteria for the restoration and enhancement of water quality in the Great Lakes system. Since 1973, the IJC Water Quality Board has included in its reports descriptions of problem areas (referred to as "Areas of Concern" (AOCs)) in the Great Lakes that have failed to meet the objectives of the Agreement. The area including the GCR/IHC and nearshore Lake Michigan has been determined by the IJC to be an AOC. In 1985, each U.S. state and Canadian province with jurisdiction over a portion of the Great Lakes agreed to provide the IJC with a Remedial Action Plan (RAP) for each AOC within its jurisdiction.

Stage I and Stage II of the RAP for the GCR/IHC and Lake Michigan (IDEM 1991) outline 14 types of environmental problems within the AOC. Two of these problems (restrictions on fish and wildlife consumption and loss of fish and wildlife habitat) are most relevant to the trustees' representation of baseline conditions -- GCR/IHC habitat that does not present a risk of adverse effects resulting from exposure to oil and hazardous substances. The trustees believe that the absence of such risk will result in GCR/IHC habitat that supports stable fish and wildlife communities.

Restoration

The process of selecting a restoration alternative begins with the identification of a reasonable number of potential alternatives, each of which may include one or more specific actions designed to achieve restoration, rehabilitation, replacement, or acquisition of equivalent resources. Restoration and rehabilitation involve actions that return injured resources to their baseline condition (i.e., the physical, chemical, or biological properties that the injured resources would have exhibited or the services that would have been provided by the resources had the discharges of oil or releases of hazardous substances not occurred). Both replacement and acquisition of the equivalent involve substituting for the injured resources other resources that provide the same or substantially similar services. The trustees must compare the range of active alternatives to a "no action-natural recovery" alternative involving

minimal management of injured resources beyond actual or planned response actions. The trustees will base the selection of a restoration alternative upon the careful consideration of each alternative with respect to the following ten factors, at a minimum:

(1) Technical feasibility;

(2) The relationship of the expected costs of the proposed actions to the expected benefits of restoration;

(3) Cost-effectiveness;

(4) The results of any actual or planned response actions;

(5) Potential for additional injury resulting from the proposed actions, including long-term and indirect impacts, to the injured resources or other resources;

(6) The natural recovery period;

(7) Ability of the resources to recover with or without alternative actions;

(8) Potential effects of the action on human health and safety;

(9) Consistency with relevant federal, state, and tribal policies; and

(10) Compliance with applicable federal, state, and tribal laws

(43 CFR 11.82(d)).

The next two sections describe the trustees' general restoration objectives for the assessment area and the types of actions the trustees are likely to consider when developing a comprehensive restoration plan. Both the objectives and the potential alternatives are subject to change, pending completion of the injury assessment.

Restoration objectives

The trustees' goal is to restore resources in the assessment area to their baseline condition. The trustees will emphasize restoration of the ability of the GCR/IHC and associated habitats to support viable, sustainable populations of the fish and wildlife that would be expected but for discharges of oil or releases of hazardous substances. With this general goal in mind, the trustees hope to achieve the following restoration and post-restoration objectives.

1. Address sources of contamination - As part of the restoration of resources in the assessment area, the trustees expect to address sources of contamination that have not been and are not expected to be addressed through other regulatory mechanisms (e.g., RCRA Corrective Action). Restoration of natural resources will not be successful without elimination of

continuing, injurious discharges and releases (including the discharge to surface water of contaminated ground water). As described in Chapter 1, the trustees' intention is to work cooperatively with federal and state agencies to coordinate restoration activities with other actions designed to address contamination issues in the assessment area. Specifically, the trustees' objective is to address sources of contamination to the GCR/IHC and IDNL and to address the release of contaminants from the GCR/IHC to Lake Michigan.

2. Minimize collateral injury during restoration - Any time physical restoration of natural resources is undertaken, there is a possibility that the restoration actions themselves will have unavoidable adverse impacts on the environment. For example, the removal of sediments from a river may require the use of heavy equipment on the river bank and the disturbance of river bank habitat. As noted above, one of the criteria the trustees will use to evaluate restoration alternatives is the potential for additional injury resulting from the proposed actions. In light of this criterion, the trustees will seek to minimize the occurrence of such collateral injuries. When developing the RCDP, the trustees will take into account, and potentially seek compensation for, unavoidable impacts that constitute injury to natural resources.

3. Restore lost and diminished functions of the assessment area ecosystem - A number of factors are associated with the general goal of restoring the ability of the GCR/IHC and associated habitats to support viable, sustainable populations of the fish and wildlife. These include improving water quality, improving the quality of bed and bank sediments, and improving the quality of wetlands associated with the GCR/IHC. In selecting a restoration alternative, the trustees' will be seeking a set of actions that achieves these objectives in a coordinated and cost-effective manner.

4. Restore lost and diminished human uses of assessment area resources - While the evaluation of injuries and damages associated with lost human use of assessment area resources focuses on recreational fishing, the trustees' objective is to restore the GCR/IHC and associated habitats' ability to support a variety of consumptive and non-consumptive uses, including boating, wildlife viewing and public education.

5. Restore public trust in the river - The assessment area as a whole is an important resource for northwest Indiana in terms of both its contribution to the local landscape and its influence on the valuable resources of Lake Michigan. By undertaking restoration activities, the trustees hope to achieve the objective of restoring the public's confidence in the quality of the assessment area's resources.

Potential restoration alternatives

As noted above, the trustees do not yet have sufficient information to develop specific restoration alternatives for the assessment area. However, the trustees can provide the following brief descriptions of the types of activities that might be appropriate for addressing a key element in the injury

equation, the sediments of the GCR/IHC and the Marquette Park Lagoons. It may be desirable to use a combination of activities to accomplish restoration objectives in the most cost-effective manner possible.

Capping may be accomplished through the placement of sand, gravel, clean sediment or a synthetic material over an area of contaminated sediments. A cap would be equally feasible for covering in-place sediments or sediments that have been removed and placed in another aquatic (usually deeper-water) location or an alternative disposal site. The design of a cap in the GCR and upper IHC would need to take into consideration the potential for the cap to preclude or inhibit planned uses of the waterway (such as fishing, or boating that requires a minimum draft). Capping costs are influenced by a number of factors including cap design, water depth and accessibility. The availability of a ready source of cap material (such as clean dredged sediments) can significantly reduce costs.

Containment entails the isolation of an entire portion of a waterway using physical barriers such as sheetpile and earthen dikes. The containment area may be used for the disposal of contaminated or other fill materials. The only portion of the assessment area for which containment might be feasible is the Lake George Branch of the IHC. Permanent containment of other reaches of the GCR/IHC would likely eliminate opportunities to restore natural resources.

Treatment processes for contaminated sediments include chemical and biological treatment as well as immobilization. The three primary considerations associated with treatment are: (1) whether treatment can be effective given the physical characteristics of the sediment (and the surrounding aquatic environment); (2) whether a sufficient level of control can be maintained during the application of the treatment technology (especially important when treatment requires a well-mixed system); and (3) whether the treatment itself would have an adverse impact on the aquatic ecosystem in which it is applied. Treatment of sediments can occur *in situ* or *ex situ.*

Removal technologies are available to physically remove contaminated sediments from a water body, ideally in a manner that minimizes the release of sediments and contaminants to the aquatic environment. One removal technique involves isolating sediments from river flow, allowing them to dewater in place, and removing them using conventional construction equipment. The primary alternatives for sediment removal are the various forms of environmental dredging. In general, there are two types of dredging: mechanical and hydraulic. Mechanical dredging involves dislodging the sediments using physical or mechanical force and lifting them out of the waterway for transport via other means (e.g., barge, truck) to a disposal location. Hydraulic dredging involves the removal and transport of sediments and water in the form of a slurry. The ability to implement an environmental dredging project, and the selection of the most appropriate dredging technique, depend upon a variety of factors including, but not limited to:

? The quantity of material to be removed;

? The character of the material (including the presence of large debris);

- ? Physical site restrictions, such as water depths, channel widths, and overhead obstructions (e.g., bridges);
- ? The availability of and distance to a suitable disposal facility;
- ? Compatibility of the dredging technique with proposed disposal operations;
- ? The availability of equipment in the project area; and
- ? The cost of using the dredging equipment.

The trustees will carefully consider all relevant factors before selecting a restoration alternative that involves the management of contaminated sediments.

The trustees will also consider alternatives other than, or in addition to, sediment management in order to achieve baseline restoration in the most cost-effective manner possible. These alternatives could include actions to improve the condition of natural resources through less direct means (e.g., controlling continuing releases of oil or hazardous substances), as well as actions that fall in the categories of replacing or acquiring equivalent resources to those that have been injured.

Compensable Values

Presented below are three areas in which the trustees believe the estimation of compensable values may be appropriate. The first two areas follow directly from the quantification of lost services described in Chapter 3, while the third does not depend directly on a quantified injury estimate. The trustees will continue to evaluate options for compensable value calculations during the period leading up to completion of the RCDP, and may add to or subtract from the compensable value analysis based on new information. Compensable values are traditionally reported in monetary terms, with the development of a plan for the use of recovered monies left to the post-assessment restoration planning phase. It is the trustees' intention to address the planned use of compensable value damages earlier in the process, as part of the RCDP. To this end, the trustees will, whenever possible, report compensable values in terms of service units rather than dollars in order to facilitate the identification of additional restoration actions that would adequately compensate the public for these interim losses.

Compensation for the interim loss of recreational opportunities

The quantification of injury to biological resources based on the evaluation of lost or diminished recreational fishing opportunities provides the data needed in identifying additional restoration actions using a "service-to-service" approach (i.e., identifying actions that will provide fishing opportunities, or other comparable opportunities to use the resources, that are equal in number to the present value of lost opportunities). The trustees will, in addition, complete an analysis that expresses the loss in

monetary terms. Calculating these compensable values in monetary terms will further ensure that the scale of additional restoration actions is appropriate.

The compensable value analysis for recreational fishing losses will involve application of the "unit value" methodology, which is defined in the DOI regulations as the application of "preassigned dollar values for various types of non-market recreational or other experiences by the public" *(43 CFR 11.83(c)(2)(vi))*. While the regulations encourage the use of region-specific values and values that "closely resemble the recreational or other experience lost," natural resource trustees have interpreted this methodology to incorporate all forms of "benefits transfer." Benefits transfer involves the application of existing values, data or models to a new valuation problem. Similar to the approach for evaluating baseline conditions, this approach will involve the broad-based collection and review of existing recreational (i.e., fishing) benefits literature, with an emphasis on region-specific data. Specifically, this analysis involves the following steps:

1. Full characterization of the nature of the lost fishing opportunities, including consideration of factors such as the wording of fish consumption advisories and the time period over which these advisories have been in effect;

2. A review of the economics and recreation literature to identify existing and relevant value estimates, data and models; and

3. Application of the available value estimates, data and models within a benefits transfer framework. In other words, the trustees will multiply the measure of lost use (e.g., "angler days") by an appropriate unit value for that use (e.g., $/day) over a specified number of years and will then calculate a present value over the range of years for which the loss has been or will be incurred.

The trustees may also conduct limited on-site interviews and/or focus groups with local anglers and resource managers to provide additional documentation for the values applied in the benefits transfer exercise. The trustees do not anticipate undertaking an original study (e.g., developing a travel cost model) to evaluate the impact of resource injury on recreational angler behavior.

Compensation for the interim loss of habitat

Compensable values based on the loss or degradation of fish and wildlife habitat are warranted if the habitats provide important services to the human population. In this case, fish and wildlife habitat do provide human uses, such as opportunities for recreational activity. Therefore, it is appropriate for the trustees to seek compensation for injuries to these habitats. One form that such compensation might take is the public acquisition of "replacement" habitats that are not currently protected under existing statutes or regulations.

The habitat equivalency approach (also referred to as the "environmental annuity" approach) is an appropriate methodology for determining the necessary scale of compensation based on the acquisition of equivalent resources, such as land. The basic premise of this approach is that the public

can be compensated for interim service losses through the provision of additional services of the same type in the future. The unique aspect of this approach is that the measure of compensable values is not dollars, but the diminished service itself. For example, the measure of compensable values can be expressed in terms of wetland (or other habitat) acres. In order to apply this methodology successfully, the trustees must take into consideration a number of factors which are best illustrated using the example of receiving compensation in the form of wetland acreage. Some of these factors are described below.

1. Is the baseline ecological value of injured habitat great enough to warrant the short-term impact that might be associated with physical restoration?

2. What is the nature of the loss associated with the injured habitat? Has the ecological value of the habitat been completely eliminated, or does the habitat retain some percentage of its baseline value?

3. How should the trustees describe the recovery path of the injured habitat? Is recovery linear (i.e., will habitat quality improve at a constant annual rate), or will most of the recovery occur during the latter years of the recovery period?

4. When will the first compensatory habitat be provided and on what schedule will the trustees receive the remainder?

5. Will the characteristics of compensatory habitat represent the full ecological value of that land? If not, how many years will pass before maximum value is achieved, and at what rate? At full value, will the compensatory habitat have the same ecological value as the baseline value of the injured habitat, or will it be necessary to apply compensation ratios (e.g., two-for-one compensation if the maximum value of the compensatory habitat is half that of the injured habitat)?

The following steps describe the process the trustees would use to complete the habitat equivalency analysis.

1. Inventory habitats (e.g., wetlands) that have been injured. The primary source of information for this inventory would be the results of floodplain sampling undertaken as part of this assessment.

2. Characterize the nature and extent of the injury, including the size of each parcel in which injury has been documented, and the loss of services relative to baseline.

3. Documentation of all other inputs to the analysis, including period of loss, length and type of assumed recovery, discount rate, etc. Each input would be accompanied by clear explanations of all assumptions.

4. Calculation of the present value loss of "wetland-acre-years," including documentation of the sensitivity of the analysis to any major assumptions.

Upon completion of the analysis, the trustees could, for example, proceed to inventory and assess potential "compensatory" habitats and to develop options for sets of habitats that would provide services equal to those that had been lost.

Compensation for interim losses associated with public development projects

As a result of injuries to resources in the assessment area, development activities may have been — or will be, for planned activities — more costly than they would have been in the absence of such injuries. In these cases, the economic value of the resource will have been reduced by the presence of oil or hazardous substances. The ability of a resource to support development activities represents a service provided by the resource; thus, added costs associated with injury to the resource represents a compensable value. The added cost approach fits within the regulatory definition of "other valuation methodologies" *(43 CFR 11.83(c)(3))*.

In this case, added costs would most likely be associated with the presence of contaminated river and canal sediments. Examples of development projects that might have been or might yet be affected by sediment contamination include, but are not limited to, road or bridge construction, construction or maintenance of public facilities located in the assessment area, and maintenance dredging of the IHC navigation channel.[2] Examples of added costs include those associated with project planning or permitting, sediment or other sample analyses, and sediment disposal and management, as well as the costs associated with the cancellation or delay of a project.

The trustees will informally survey local, state and federal resource management, development, and regulatory agencies to identify projects in the assessment area that have incurred, or are expected to incur, added costs as a result of natural resource injuries. For any project identified, the trustees will carefully review cost documentation to determine which, if any, represent compensable values. Added costs associated with future projects represent compensable values only if the project represents a committed use of the resource. A committed use is defined as a current public use or a planned public use of a resource for which there was a documented legal, administrative, budgetary, or financial commitment established before the release of the hazardous substance was detected *(43 CFR 11.14(h))*.

Implementation of the Damage Determination

As required by the DOI regulations, the trustees will take into account the following factors during the process of calculating natural resource damages.

[2] Damage calculations associated with the added cost of navigation channel maintenance dredging would take into account (i.e., would not double count) contributions that are already being made by PRPs.

Double Counting

Due to the ability of natural resources to provide more than one service, it is possible that a benefit or cost could be counted more than once during the damage determination, particularly during the estimation of compensable damages. For example, use of a survey-based methodology to measure the public's willingness-to-pay to restore a recreational fishery could double count a damage estimate based on a direct assessment of the value of lost trips to the fishery, since the survey would presumably capture at least some of the value the public places on their use of the fishery. The regulations specifically instruct the trustees to avoid double counting. Thus, the trustees will take appropriate steps to identify and account for any double counting that might result from the application of compensable damage methodologies such as those described above. In addition, the trustees will incorporate the effects of response actions into the estimation of damages in order to ensure that the damages account only for residual injuries.

Uncertainty

The assessment shall explicitly incorporate and report on uncertainty in the various assumptions and variables used to calculate damages, and the effect that these factors have on the resultant damage estimate. Such uncertainty analysis shall include, where appropriate, the derivation and application of probability estimates for the important assumptions and factors used to determine damages.

Discounting

The trustees will estimate damages in the form of expected present values. The DOI regulations provide specific guidance for determining the appropriate discount rate for present value calculations.

Substitutability

As part of the calculation of compensable values, the trustees will incorporate estimates of the public's ability to substitute resource services or uses for those of the injured resources. For example, estimation of lost or diminished recreational fishing opportunities will take into account the availability and use of substitute fisheries.

Scope of the analysis

Trustees are required to consider the scope of the analysis before estimating compensable values. In this case, the scope of the analysis will extend only to the state level and thus compensable values will be limited to those accruing to the state of Indiana and its residents. Note, however, that residents of other states also suffer losses as a result of injury to resources in the assessment area, and thus will also benefit from restoration activities.

The DOI regulations require the trustees to develop a Quality Assurance Project Plan (QAPP) that "satisfies the requirements listed in the NCP and applicable EPA guidance for quality control and quality assurance plans" *(43 CFR 11.31(c)(2))*. Such a plan is needed to ensure the validity of original data collected as part of the NRDA. An individual data gathering activity requires a QAPP that is tailored to that specific activity; therefore, since the trustees have not yet finalized specific data collection activities (particularly those involving the collection of environmental samples), it is not appropriate to include detailed QA documentation as part of this Assessment Plan. The trustees will develop QAPPs, as necessary, for inclusion in the detailed plans describing specific data collection tasks.

In general, a QAPP must provide sufficient detail to demonstrate that:

? The project technical and quality objectives (i.e., data quality objectives, when used) are identified and agreed upon;

? The intended measurements or data acquisition methods are appropriate for achieving project objectives;

? Assessment procedures are sufficient for confirming that data of the type and quality needed and expected are obtained; and

? Any limitations on the use of the data can be identified and documented (USEPA 1994).

Accordingly, QAPPs developed for this assessment will include the four types of elements called for by the EPA, as described below.

Project Management

This group of QAPP elements covers the basic area of project management, including the project history and objectives, roles and responsibilities of the participants, etc. These elements ensure that the project has a defined goal, that the participants understand the goal and the approach to be used, and that the planning outputs have been documented. Project management elements include project organization, problem definition and background, project description, and quality objectives and criteria for measurement data (USEPA 1994).

Measurement/Data Acquisition

This group of QAPP elements covers all aspects of measurement systems design and implementation, ensuring that appropriate methods for sampling, analysis, data handling, and quality

control are employed and are properly documented. Measurement and data acquisition elements describe the requirements related to the actual methods to be used for the collection, handling, and analysis of samples, as well as the management of the resultant data. Measurement and data acquisition elements include sample handling and custody requirements, analytical methods requirements, and instrument testing, inspection and maintenance requirements (USEPA 1994).

Assessment/Oversight

This group of QAPP elements addresses the activities for assessing the effectiveness of the implementation of the project and associated QA/QC. The purpose of assessment and oversight is to ensure that the QAPP is implemented as prescribed. Assessments include, but are not limited to, peer review, management systems review, and technical systems audit (USEPA 1994).

Data Validation and Usability

This group of QAPP elements covers the QA activities that occur after the data collection phase of the project is completed. Implementation of these elements determines whether or not the data conform to the specified criteria, thus satisfying the project objectives (USEPA 1994).

Beyer, W. Nelson, Gary H. Heinz and Amy W. Redmon-Norwood (editors). 1996. Environmental Contaminants in Wildlife: Interpreting Tissue Concentrations. SETAC Special Publications Series. Boca Raton, FL: CRC Press Inc.

Bright, G.R. 1988. Recent water quality in the Grand Calumet River as measured by benthic invertebrates. Proc. Indiana Acad. of Sci. 98: 229-233.

Brock, K.J. 1986. The birds of the Indiana Dunes. Indiana University Press, Bloomington, Indiana. 178 pp.

Custer, C.M., T.W. Custer, D.W. Sparks, R.K. Hines, and C.O. Kochanny. 1996. Movement patterns of wintering lesser scaup in Grand Calumet River - Indiana Harbor Canal. Indiana J. Great Lakes Res. 22: 95-99.

Eisler, R. 1986. Polychlorinated biphenyl hazards to fish, wildlife, and invertebrates: a synoptic review. Biol. Rep. No. 85(1.7). Fish and Wildlife Service, U.S. Department of the Interior, Washington, D.C.

Erickson, Mitchell D. 1997. Analytical Chemistry of PCBs. Boca Raton, FL: CRC Press, Inc.

Floyd Browne Associates, Inc. 1993. Sediment Characterization Study, U.S. Steel, Gary, Indiana. January 22.

Gerking, S.D. 1945. The distribution of the fishes of Indiana. Investigations of Indiana Lakes and Streams. 3(1): 1-137. Indiana Department of Conservation, Indianapolis. Indiana University, Department of Zoology, Bloomington.

Hoke, Robert A., John P. Giesy, Matthew Zabik, and Mike Unger. 1993. Toxicity of Sediments and Sediment Pore Waters from the Grand Calumet River-Indiana Harbor, Indiana Area of Concern. Ecotoxicology and Environmental Safety 26: 86-112.

Indiana Department of Environmental Management. 1991. The Remedial Action Plan for the Indiana Harbor Canal, the Grand Calumet River and the Nearshore Lake Michigan, Stage One. January.

Indiana Department of Environmental Management. 1992. Indiana 305(b) report - 1990-1991. Office of Water Management. 227 pp.

Indiana Department of Environmental Management. 1994. Indiana 305(b) report - 1992-1993. Office of Water Management. 486 pp.

Indiana Department of Environmental Management. 1995. 1994 Sediment and Tissue Sample Results. Office of Water Management, Water Quality Surveillance and Standards Branch, Biological Studies Section. November 7.

Indiana Department of Environmental Management. 1997. 1997 Indiana Fish Consumption Advisory. Indiana Department of Environmental Management, Indianapolis, Indiana. 71 pp.

Indiana State Board of Health. 1986. Public Health News press release dated March 13, 1986 issued by the Indiana State Board of Health. Indianapolis, Indiana. 2 pp.

Ingersoll, Christopher G., Denny R. Buckler, Eric A. Crecelius, and Thomas W. LaPoint. 1993. Assessment and Remedation of Contaminated Sediments (ARCS) Program: Biological and Chemical Assessment of Contaminated Great Lakes Sediment. United States Environmental Protection Agency, Great Lakes National Program Office, EPA Publication 905-R93-006. December.

Karr, J.R. and D.R. Dudley. 1981. Ecological perspective on water quality goals. Env. Mgmt. 5: 55-68.

Meek, S.E. and S.F. Hildebrand. 1910. A synoptic list of the fishes known to occur within fifty miles of Chicago. Field Mus. Nat. Hist. No. 142, Zoological series.

Simon, T.P. 1991. Development of Index of Biotic Integrity expectations for the ecoregions of Indiana. I. Central Corn Belt Plain. U.S. Environmental Protection Agency, Region V, Environmental Sciences Division, Monitoring and Quality Assurance Branch: Ambient Monitoring Section, Chicago, IL. EPA 905/9-91/025.

Simon, T.P., G.R. Bright, J. Rud, and J. Stahl. 1988. Water quality characterization of the Grand Calumet River basin using the index of biotic integrity. Proc. Indiana Acad. Sci. 98:257-265.

Sobiech, S.A., T.P. Simon, and D.W. Sparks. 1994. Pre-remedial biological and water quality assessment of the East Branch Grand Calumet River, Gary, Indiana, June 1994. U.S. Fish and Wildlife Service, Bloomington Field Office, Ecological Services. November.

United States Army Corps of Engineers. 1995. Comprehensive Management Plan - Feasibility Study and Draft Environmental Impact Statement, Indiana Harbor and Canal Maintenance Dredging and Disposal Activities.

United States Environmental Protection Agency. 1977. Indiana Harbor, Indiana: Report on the degree of pollution of bottom sediments. Great Lakes National Program Office.

United States Environmental Protection Agency. 1994. EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations. EPA QA/R-5, Draft Interim Final. August.

United States Fish and Wildlife Service. 1996a. Biological Opinion under Section 7 of the Endangered Species Act for the proposed maintenance dredging of the Indiana Harbor Canal and construction and operation of a confined disposal facility. May 21.

United States Fish and Wildlife Service. 1996b. Final Fish and Wildlife Coordination Act Report for the Indiana Harbor and Ship Canal Maintenance Dredging Disposal Project at East Chicago in Lake County, Indiana. September 16.

United States Fish and Wildlife Service, Indiana Department of Environmental Management, and Indiana Department of Natural Resources. 1996. Preassessment Screen and Determination, Grand Calumet River and Indiana Harbor Canal, Lake County, Indiana. June.

Avian Of or relating to birds.

Aquifer A water-bearing bed or layer of permeable rock, sand or gravel capable of yielding considerable quantities of water to wells or springs.

Baseline The condition or conditions that would have existed at the assessment area if discharges of oil or releases of hazardous substances had not occurred.

Benefits transfer The application of existing values, data or models to a new valuation problem.

Benthic Occurring on the bottom of a body of water.

Bioaccumulation The process by which materials (usually contaminants) build up in an organism (e.g. through consumption of other contaminated organisms or absorption through the skin).

Biota The animal and plant life of a region.

Chironomid A small, long-legged, two-winged fly.

Committed Use A current public use or a planned public use of a resource for which there was a documented legal, administrative, budgetary, or financial commitment established before the release of the hazardous substance was detected.

Compensable value The amount of money required to compensate the public for the loss in services provided by injured resources between the time of discharge or release and the time the resources and the services provided by those resources are fully returned to their baseline conditions.

Cytometry The process of counting and measuring cells in a biological organism.

Dabbling duck A duck that dips its body downward in shallow water in search of food on the bottom.

Damages The amount of money sought by natural resource trustees as compensation for injury to, destruction of, or loss of natural resources. The measure of damages is the cost of restoration, rehabilitation, replacement and/or acquisition of the equivalent of injured natural resources and the services those resources provide. Damages may also include the compensable value of all or a portion of the services lost, as well as the cost of conducting the natural resource damage assessment.

Depauperate Falling short of natural development or size (individual organism) or composed of few kinds of organisms (ecological system).

Dewater To remove the water from (e.g. by draining, pressing, or pumping).

Exclusive Economic Zone (EEZ) An oceanic zone under the control of and for use by the United States extending 200 nautical miles seaward from all shores.

Extirpation Complete removal or destruction.

"Facultative" organism An organism able to live and thrive under more than one set of conditions; adaptive.

Fauna The animal or animal life occurring, developed, or adapted for living in a specific environment.

Hardness A quality of water generally measured as the concentration of calcium and magnesium in the water.

Histopathology The study of the effects of disease on body tissues.

Injury A measurable adverse change, either short- or long-term, in the chemical or physical quality or the viability of a natural resource resulting either directly or indirectly from exposure to a discharge or oil or release of a hazardous substance.

Insectivorous Depending on insects for food.

in situ (ex situ) In place (not in place).

Lesion An abnormal change in the structure of an organ due to injury or disease.

Lipophilic Relating to or having a strong affinity for fats or other lipids, and promoting their absorption.

Motility An animal's ability to move from one location to another.

Natural resources Land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States, any State or local government, foreign government, or Indian tribe.

Non-point source Pollution from broad areas (e.g. fertilizer and pesticide application and leaking sewer systems) rather than from discrete points.

Odonate A predatory insect type (e.g. dragonflies and damselflies) characterized by an aquatic larval stage.

Oligochaete A worm with both male and female reproductive organs.

Pathway The route or medium through which oil or a hazardous substance is or was transported from the source of discharge or release to the injured resource.

Phytotoxic Poisonous to plants.

Piscivorous Depending on fish for food.

Point source Pollution originating from any discrete source (e.g. outflow from a pipe or ditch).

Riparian Of or relating to, or living or located on, the bank of a watercourse or lake.

Riverine Formed by, living or situated on the banks of a river.

Services The physical and biological functions performed by a resource, including the human uses of those functions. A resource may provide a service to another resource (for example, habitat for fish is a service provided by surface water).

Slurry A watery mixture or suspension of material that does not dissolve in water.

Trustee A designated federal or state natural resource management agency or an Indian tribe that has the authority to commence an action for natural resource damages.

Tubificid An aquatic worm.