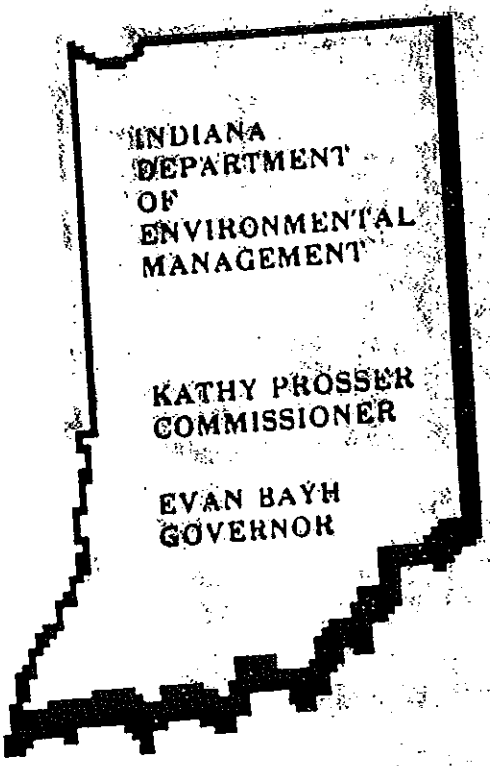
THE
REMEDIAL ACTION PLAN
FOR THE
INDIANA HARBOR CANAL,
THE
GRAND CALUMET RIVER
AND THE
NEARSHORE LAKE MICHIGAN
-STAGE ONE-



JANUARY 1991

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INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

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January 30, 1991

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Dear Chairmen Durnil and Fulton:

On behalf of the Indiana Department of Environmental Management (IDEM) and the Citizens' Advisory for Remediation of the Environment (CARE) Committee, I am pleased to submit to the International Joint Commission (IJC) the Indiana Harbor and Canal, the Grand Calumet River, and the Nearshore Lake Michigan Stage One Remedial Action Plan (RAP).

On January 22, 1991, the CARE Committee unanimously adopted the Stage One RAP for submittal to the IJC.

The CARE Committee represents the community located in the Area of Concern and has been paramount to the public participation process of the Stage One RAP. Members on the CARE Committee include mayors, representatives of labor, education, and industry and environmental activists. We are submitting the Stage One RAP to the IJC in final form, however, we recognize that it is a living document and therefore have bound the text in three ring binders. This will allow the text to be updated from time to time as new information becomes available.

In conclusion, on behalf of the IDEM and the CARE Committee, I would like to acknowledge with grateful appreciation the splendid support that Dr. John Hartig and the staff of the IJC provided us in the development of the Stage One RAP.

Sincerely yours,

Kathy Prosser

Kathy Prosser
Commissioner

cc: John Hartig

Acknowledgments

The Department of Environmental Management would like to acknowledge the following people for the contributions they made to this document:

The Citizens Advisory for Remediation of the Environment (CARE) Committee:

The Honorable Robert Pastrick, Mayor, City of East Chicago

The Honorable Thomas V. Barnes, Mayor, City of Gary

The Honorable Thomas M. McDermott, Mayor, City of Hammond

Mr. Frank Citek, Plant Manager, Amoco Refinery

Mr. John D. Fekete, Representing the Indiana Steel Industry Advisory Commission

Mr. Peter Wilke, Vice President, Hammond Lead Products

Mr. William Willett, Vice President, Service Employees Union, Local 208

Dr. Mark Reshkin, Associate Vice Chancellor for Academic Affairs Indiana University Northwest

Mr. Charles E. Oberlie, President, Northwest Indiana Forum

Ms. Lorraine Stasek, Citizen and Teacher

Ms. Zemmer P. Morris, Chairperson, Gary Alliance for Responsible Development (GARD)

Ms. Dorreen Carey, Executive Director, Grand Cal Task Force

Ms. Susan Greer, Executive Director, People Against Hazardous Waste Landfill Sites

Ms. Glenda Daniel, Executive Director, Lake Michigan Federation

and Dr. John Hartig, International Joint Commission

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Executive Summary
of the
Remedial Action Plan
for the
Indiana Harbor and Canal, the Grand Calumet River,
and the Nearshore Lake Michigan

The International Joint Commission, an organization established by the United States and Canada to protect the Great Lakes, has designated this area as one of forty-two polluted "areas of concern" around the lakes. Each state and province has agreed to submit a Remedial Action Plan (RAP) for these polluted areas in three stages. Stage 1 identifies the problem, Stage 2 identifies remedial measures and Stage 3 identifies when the area is cleaned up.

This is Stage 1 of the Remedial Action Plan, the identification of the environmental problems in the Area of Concern known as the Indiana Harbor and Canal, the Grand Calumet River and the Nearshore Lake Michigan. This area is located about 15 miles southeast of Chicago, Illinois, in the northwestern corner of Indiana, and is commonly known as 'the Region'.

Environmental problems in the Region are both historical and extensive in nature. This area produces more steel than any other region of comparable size in the country. The Region also has four oil refineries, six crude oil pipelines and eighteen refined petroleum companies.

One byproduct of this heavily industrialized area is waste. There are five Superfund sites, more than 400 other cleanup sites and 462 registered underground storage tanks, of which 150 reportedly leak.

There is major groundwater contamination in the harbor area. With a high water table, groundwater becomes surface water and causes large oil slicks in the river and harbor. A 1960s television documentary, "Too Thick to Navigate, Too Thin to Cultivate," described how the river often caught fire because of a thick layer of petroleum on the surface. Although surface water quality has improved, eleven billion gallons of untreated wastewater enter the river and harbor through combined sewer overflows each year.

Fish communities in the river and harbor have been depressed for many years. A combination of a lack of food resources, low dissolved oxygen, and toxic stress have resulted in a lack of a stable resident fish community. Some bottom dwelling fish collected by IDEM staff have been observed to have deformed lower jaws, swollen abdomens, swollen eyes, and bloody fins. (The bloody fins may be caused by internal hemorrhaging). Since surface water quality has improved, and considering the fact that it is the bottom-dwelling fish which are deformed; it seems that in-place pollutants, the sediments, are the most significant environmental concern in the river, the harbor, and the nearshore Lake Michigan area.

The current state of sediment transport equilibrium in the harbor and canal allows over 180 million pounds of sediment to enter Lake Michigan each year. Along with the sediment, 420 pounds of PCBs, 2,300 pounds of cadmium, 110,000 pounds of lead, etc. are also transported to the Lake. This material will continue to enter the Lake at these high rates for many years if the existing sediment in the harbor is not removed.

Today, a three-mile footprint of sediment can be seen stretching into Lake Michigan by satellite infrared photographs. The infrared photographs also show that public water supply intake pipes for the cities of Hammond, Whiting and East Chicago are within one half mile of the sediments. This means that there is a potential threat to the drinking water supplies of those communities if dredging does not occur within the next few years.

Other documented sources of pollution to the Indiana Harbor, the Grand Calumet River system, and to the Nearshore Lake Michigan include direct discharges from steel mills, oil refineries, and chemical manufacturing plants; and discharges from three municipal wastewater treatment facilities.

Enforcement action is pending against many of these direct dischargers. Indirect discharges are numerous and much more difficult to identify, regulate and correct. Documented indirect discharges include storm water discharges, lagoon leakage, landfill drainage, nonpermitted outfalls and groundwater. In addition, atmospheric deposition of air toxics are believed to be a contributing factor to the degraded water quality in the Area of Concern.

Kathy Prosser, Commissioner of the Indiana Department of Environmental Management, appointed a committee of fourteen community leaders from the area to assist the State in addressing these environmental problems. The group, the Citizens' Advisory for Remediation of the Environment (CARE Committee), consists of the three city mayors located in the Area of Concern, representatives of industry, education, small business, and environmentalists. In the fall of 1990, the CARE Committee unanimously agreed that all environmental beneficial uses specified in the International Joint Commission Great Lakes Water Quality Agreement were impaired in the Indiana Harbor Canal, the Grand Calumet River, and the Nearshore Lake Michigan Area of Concern. The following pages provide a summary of each impaired beneficial use, the existing conditions, and the source or cause of the problems as found in this document.

Summary Environmental Problems Affecting the Indi[illegible] Harbor and Canal, the Grand Calumet River and the Nearshore Lake Michigan Area of Concern

IMPAIRED USE EVALUATION	EXISTING CONDITIONS	SOURCE OR CAUSE OF THE PROBLEM
i) Restriction on Fish and Wildlife Consumption Use impairment confirmed	**No fish should be eaten from the Grand Calumet River or the Indiana Harbor and Canal. In Lake Michigan, Brown Trout and Lake Trout over 23", Chinook over 32", Catfish and Carp should not be eaten. Chinook Salmon over 21", Lake Trout between 20 to 23 inches, Coho Salmon over 26 and Brown Trout up to 23" should not be eaten by children age 15 or under, pregnant women, women who may become pregnant, or nursing mothers. All others should limit their consumption to one meal per week.** * No known restriction on wildlife consumption.	- Contaminated Sediments - Industrial and Municipal Effluents - Combined Sewer Overflows - Urban Runoff - Input from Industries and Municipalities - Spills - Groundwater Contamination
ii) Tainting of fish and wildlife flavour Use impairment confirmed	IDEM staff have identified degraded fish populations. Tainting of the fish has occurred.	- Contaminated Sediments - Industrial and Municipal Effluents - Combined Sewer Overflows - Urban Runoff - Input from Industries and Municipalities - Spills - Groundwater Contamination
iii) Degradation of fish and wildlife populations Use impairment confirmed	Extremely pollution tolerant forms of fish such **Carp** and **Oligochactes** are dominant. There is a lack of a stable fish community in the river and harbor. As of yet, wildlife surveys have not been conducted.	- Contaminated Sediments - Industrial and Municipal Effluents - Combined Sewer Overflows - Urban Runoff - Input from Industries and Municipalities - Spills - Groundwater Contamination
iv) Fish tumors or other deformities Use impairment confirmed	IDEM Environmental scientist have discovered river and canal carp (bottom dwellers) with eroded fins, swollen eyes, swollen abdomens, deformed lower jaws and bloody fins. The bloody fins may be caused by internal hemorrhage.	- Contaminated Sediments - Input from Industries

Summary of Environmental Problems Affecting the **Indiana Harbor and Canal**, the **Grand Calumet River** and the **Nearshore Lake Michigan Area of Concern**

IMPAIRED USE EVALUATION	EXISTING CONDITIONS	SOURCE OR CAUSE OF THE PROBLEM
v) Bird or animal deformities or reproduction problems Use impairment likely	The U.S. Fish and Wildlife will be conducting wildlife studies in this area in the near future. Great Lakes Studies have found deformities in migratory birds. The Area of Concern has many migratory species. Although it is not known if these birds were contaminated in this areas, bird and animal deformities or reproduction problems are likely.	- Toxics - Contaminated Fish Tissue - Degraded Water Quality - Contaminated Sediments - Combined Sewer Overflows - Input - Urban Runoff - Groundwater - Air Toxics
vi) Degradation of Benthos Use impairment confirmed	A sampling of benthic organisms showed that only sludge worms inhabited the Indiana Harbor, suggesting that severe pollution exist. Studies concluded that sediments were toxic or avoided by other benthic organisms.	- Contaminated Sediments - Industrial and Municipal Effluents - Combined Sewer Overflows - Urban Runoff - Input from Industries and Municipalities - Spills - Groundwater Contamination
vii) Restrictions on dredging activities Use impairment confirmed	Due to the concern of contaminated sediments and the disposal concerns. no dredging activities have occurred in serveral years.	- Contaminated Sediments
viii) Eutrophication or undesirable algae Use impairment confirmed	Species of diatoms, which favor eutrophic conditions, have increased in abundance in the near shore Lake Michigan waters. The waters of the Grand Calumet River and the Indiana Harbor and Canal have persistent water quality problems leave in and the near shore Lake Michigan and the river and the harbor have decreased water clarity.	- Combined Sewer Overflows - Urban Runoff - Input from Industries and Municipalities

Summary Environmental Problems Affecting the Indi a Harbor and Canal, the Grand Calumet River and the Nearshore Lake Michigan Area of Concern

IMPAIRED USE EVALUATION	EXISTING CONDITIONS	SOURCE OR CAUSE OF THE PROBLEM
ix) Restrictions on drinking water consumption, or taste and odour problems Use impairment likely	The Area of Concern is serviced by public drinking water supply from Lake Michigan waters. There appears to be no public safety problems with this water. The CARE Committee unanoumisy voted that there were restrictions with drinking water from the Grand Calumet River and the Indiana Harbor, although this is not a public water supply.	- Contaminated Sediments - Industrial and Municipal Effluents - Combined Sewer Overflows - Urban Runoff - Input from Industries and Municipalities - Spills - Groundwater Contamination
x) Beach closings Use impairment confirmed	Due to poor water quality, swimming is not recommended in the river or canal. Along the nearshore waters of Lake Michigan, the Hammond beach has been closed for several years. In 1990, Chicago beaches and the Indiana Dunes National Lakeshore were closed due to high coliform counts, but the source may or may not have been from the Area of Concern.	- Combined Sewer Overflows
xi) Degradation of anesthetics Use impairment confirmed	Debris litter the Banks of the Grand Calumet River and the Canal. The banks of the harbor appear to be saturated with petroleum. The river and the harbor often have an oily sheen. The nearshore Lake Michigan waters often appear murky.	- Contaminated Sewer Overflows - Groundwater Contamination - Spills
xii) Added cost to agriculture or industry Use impairment confirmed	Due to the accumulation of sediments in the harbor, and restrictions for removal of the sediment due to environmental concerns, industry reports shipping capacity is reduced by 15% and therefore has a substantial increase in shipping cost.	- Contaminated Sediments

Summary of Environmental Problems Affecting the **Indiana Harbor and Canal**, the **Grand Calumet River** and the **Nearshore Lake Michigan Area of Concern**

IMPAIRED USE EVALUATION	EXISTING CONDITIONS	SOURCE OR CAUSE OF THE PROBLEM
xiii) Degradation of phytoplankton and zooplanton populations Use impairment confirmed	The lack of suitable habitat results in a scarcity of aquatic and terrestrial organisms associated with the Grand Calumet River and the Indiana Harbor Canal. Phytoplanton counts are very low in the Nearshore Lake Michigan waters in the Area of Concern.	- Contaminated Sediments - Industrial and Municipal Effluents - Combined Sewer Overflows - Urban Runoff - input from Industries and Municipalities - Spills - Groundwater Contamination
xiv) Loss of fish and wildlife habitat Use impairment confirmed	A combination of lack of food resources, low dissolved oxygen and toxic stress have resulted in the lack of a stable resident fish community in the Indiana Harbor and canal and the Grand Calumet River. The wildlife has greatly diminished this century.	- Industrialization - Draining and Filling of Wetlands - Degraded Water Quality - Contaminated Sediments

Table of Contents

Page

Acknowledgments . . . . . *i*
Executive Summary . . . . . *ii*
Table of Contents . . . . . *iiii*
Introduction. 1

Chapter I; History of the Area of Concern

Overview. 3
Natural Resource Modification 3
Settlement History and Industrialization. 5

Chapter II; The Land

Overview. 9
Location of the Area of Concern 9
Topography. 9
Soil Types. 10
Unsewered Areas 10
Drainage Basin Size 10
Sewer Service Areas 10
Urban/Suburban/Residential Land Use 11
Recreational Land Use 11
Agricultural Land Use 11
Industrial Land Use 11
Solid and Hazardous Waste 11
CERCLA. 11
Superfund (NPL) Sites 16
State Site Cleanup. 20
RCRA. 24
Permitting Program. 24
Solid Waste Activities. 24
Underground Storage Tank Program. 25
Emergency Planning. 25
Wildlife Habitat Near the Indiana Harbor. 26
Wildlife Habitat Near the Grand Calumet River 26
Wildlife Habitat Near the Nearshore Area of Lake Michigan 27

Chapter III; Section A, The Water

Overview. 28
Surface Water 29
Water Supply in the Nearshore Lake Michigan 29
Water Supply in the Indiana Harbor and Canal. 30
Biological Studies of the Grand Calumet River 30
Biological Studies of the Indiana Harbor and Canal. 30
Biological Studies of the Nearshore Lake Michigan 32
Biota Impairments 34
Eutrophication. 34
Fish Consumption Advisories 34
Commercial Fishing in the Nearshore Lake Michigan 34
Sport Fishing in the Nearshore Lake Michigan. 35
Sport Fishing in the Indiana Harbor and Canal 35
Sport Fishing in the Grand Calumet River. 35
Contact Recreation in the Indiana Harbor and Canal. 35
Contact Recreation in the Grand Calumet River 35
Contact Recreation in the Nearshore Lake Michigan 35
Noncontact Recreation in the Indiana Harbor Canal 36
Noncontact Recreation in the Grand Calumet River. 36
Noncontact Recreation in Lake Michigan. 36
Beach Closings. 36
Aesthetic Impact. 36
Navigation in the Grand Calumet River 37
Navigation in the Indiana Harbor and Canal. 37
Navigation in the Nearshore Lake Michigan 37
Sediments of the Indiana Harbor Canal and the Grand Calumet River 37
The U.S. EPA's ARCS Program 38
Groundwater 39
Groundwater Contamination 39

Chapter III; Section B, Sources of Pollution

Overview. 41
Major Pollutants of Concern in the Surface Waters 41
Metals 42
Cyanide 42
Organics. 42
Conventional Parameters 42
Industrial Point Sources. 43
Municipal Wastewater Sources. 46
Minor Industrial Dischargers. 50
Continuous Point Sources. 51
Intermittent Point Sources. 51
Combined Sewer Overflows. 51
Nonpoint Sources of Water Pollution 54
Urban Runoff. 54
Air Deposition (Also see Chapter IV). 54
Groundwater Contamination 54

Chapter III; Section C, Water Quality Standards

Overview. 55
Designated Use. 55
Antidegradation Policy. 55
Water Quality Standards Revision. 55

Chapter IV; The Air

Overview 57
Atmospheric Deposition 57
Air Quality Standards. 58
Air Quality Guidelines 59
Air Quality Objectives 59
Air Quality Program. 60
Particulate Matter 60
Sulfur Dioxide 60
Ozone. 61
Carbon Monoxide (CO) 61
Lead 62
Air Toxics 62

Chapter V; Conclusions and Recommendations 64

Chapter VI; Public Comments. 66

Bibliography 70
Glossary of Terms. 76

INTRODUCTION

The Great Lakes is a unique natural resource containing 20% of the world's surface fresh water. These waters also form a portion of the international boundary between the United States and Canada, and both countries have jurisdiction over their use. In order to protect this vast resource and cooperatively address problems along their common border, the U.S. and Canada interact through an agency known as the International Joint Commission (IJC).

The International Joint Commission was established by the U.S. and Canada as a result of the Boundary Waters Treaty of 1909, which set forth the rights and obligations of both countries regarding common boundary waters. In 1972, the first Great Lakes Water Quality Agreement was signed, 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 in the Great Lakes that have failed to meet the objectives of the Water Quality Agreement. These locations are referred to as "Areas of Concern." Currently, there are forty-two Areas of Concern around the Great Lakes.

The area including the Indiana Harbor and Canal, the Grand Calumet River, and the nearshore Lake Michigan, has been determined by the International Joint Commission to be an Area of Concern.

In 1985, each U.S. state and Canadian province with jurisdiction over a portion of the Great Lakes agreed to provide the International Joint Commission (IJC) with a Remedial Action Plan (RAP) for each site within its jurisdiction that had been designated as an Area of Concern.

In 1987, the Great Lakes Water Quality Agreement was amended, establishing specific requirements for the Remedial Action Plan. Each Remedial Action Plan must include; according to Annex 2 of the 1987 amendments, 4(a)I through 4(a)viii.

- *a definition and detailed description of the environmental problem in the Area of Concern, including a definition of the beneficial uses that are impaired, the degree of impairment and the geographic extent of such impairment;*
- *a definition of the causes of the use impairment, including a description of all known sources of pollutants involved and an evaluation of other possible sources;*
- *an evaluation of remedial measures in place;*
- *an evaluation of alternative additional measures to restore beneficial uses;*
- *a selection of additional remedial measures to restore beneficial uses and a schedule for their implementation;*
- *an identification of the persons or agencies responsible for implementation of remedial measures;*

- *a process for evaluating remedial measure implementation and effectiveness; and*

- *a description of surveillance and monitoring processes to track the effectiveness of remedial measures and the eventual confirmation of the restoration of uses.*

The 1987 amendments to Annex 2 further required that the Remedial Action Plans should be submitted to the Commission for review and comment at three stages:

- *when a definition of the problem has been completed.*

- *when remedial and regulatory measures are selected.*

- *when monitoring indicates that identified beneficial uses have been restored.*

This is the first of the three stages of the Remedial Action Plan for the Indiana Harbor and Canal, the Grand Calumet River and the nearshore Lake Michigan.

Chapter I

History of the Area of Concern

Overview

More than 150 years ago, the Indians opened a new channel to Lake Michigan in Illinois by pulling their canoes through the marshland. The Area of Concern was once a beautiful coastal area, abundant in wildlife, wetlands and sand dunes.

Industrialization became possible by changing the courses of rivers, draining and filling wetlands with sand and slag, construction of landfills into Lake Mighigan, and continued sand mining of the dunes.

Increased exploitation of natural resources has greatly transformed the original appearance of the landscape from a natural to a man-made one.

Natural Resource Modification

It is appropriate that we should begin the Remedial Action Plan with a historical perspective of the Area of Concern.

The following is an excerpt from a paper entitled "Moving toward a Remedial Action Plan for the Grand Calumet River and the Indiana Harbor Canal" written by Dr. Mark Reshkin, Dr. Michael Hollowaty, Robert Tolpa and Michael Milkulka.

> The first substantial modification of the Calumet Region began in 1851, as railroad tracks were pushed through the Calumet Lake Plain to link the rapidly growing City of Chicago with such older cities as Fort Wayne and Indianapolis and eastern seaboard cities. Tracks were laid down on the flanks of ancient shoreline beach ridges and the abundant dune sands were used to construct railroad bed elevations. This railroad building, during the last quarter of the nineteenth century culminated in an awesome concentration of railroad lines criss-crossing the Calumet Region at the head of Lake Michigan, as Chicago became the rail hub of the nation. Sand mining and dredging soon became a major activity in the Calumet Lake Plain such that no dune ridges remain today in the area surrounding the Grand Calumet River and the Indiana Harbor Canal.
>
> Industrialization, at least in part, became possible by changing the courses of rivers, draining and filling extensive wetland with sand and slag, construction of landfills into Lake Michigan, creation of deep water ports and navigable canals and continued sand mining of dunes and interdunal areas . . ."

. . . More than 150 years ago, the Indians opened a new channel to Lake Michigan in Illinois by pulling their canoes through the marshland between the river, Wolf and Calumet Lakes, thus causing drainage from the west flowing arm of the river (the Little Calumet) to drain into Lake Michigan about 12 miles south of the Chicago River's mouth. The northern arm of the river (the Grand Calumet) continued to flow eastward emptying into Lake Michigan at the old mouth. However, the growth of vegetation and drifting sand accumulation at the mouth, combined with the decrease in discharge, closed the mouth before 1872; and caused reversal of the direction of stream flow westward merging with the flow of the Little Calumet River and emptying into the Lake Michigan at the Chicago outlet. The Grand Calumet River thus became little more than a bayou. Indeed, the marshy wetland character of the Lake Chicago Plain, probably more than any other single factor, was responsible for the region not having earlier experienced the effects of the industrial revolution. The major drainage changes of the early twentieth century resulted in the acceleration of industrial development such that the area is today one of the nation's main urban-industrial regions . . ."

. . . In 1870, a harbor at the mouth of Calumet River in south Chicago was started and, though repeated attempts were made to dredge the Grand Calumet River for commercial navigation to a point one-half mile east of Hammond, the project was abandoned by 1903. U.S. Steel Corporation relocated the river one-half mile southward during the construction of its Gary plants, and the river has received waste waters from these plants and urban runoff ever since.

Several drainage changes in Illinois during the twentieth century have shifted the drainage of much of the Calumet Lake Plain from the Gulf of St. Lawrence to the Mississippi River. The Chicago Sanitary and Ship Canal was completed in 1900 and set the pattern for these changes. It reversed the flow of the Chicago River away from Lake Michigan southward, through the lake plain and morainal area to Lockport, Illinois, and the Des Plaines River. In 1922 the Calumet Sag Canal was completed, diverting Little Calumet River flow west of Burns Ditch; and the Grand Calumet flow away from Lake Michigan at Calumet Harbor, south-westward to the Chicago Sanitary and Ship Canal.

At the western edge of the Calumet Lacustrine Plain, three lakes existed prior to land modification. Wolf, George and Berry Lakes were remains of a former large bay of Lake Michigan. Only Wolf Lake remains intact today because Berry Lake was drained to allow for development of Whiting and East Chicago; and Lake George has been extensively filled with slag and sand by adjacent industries.

The construction of harbors, canals and landfills began at the dawning of the twentieth century. Prior to this time only the harbors at Chicago and Michigan City served the south end of Lake Michigan. Indiana Harbor in East Chicago began with construction of an outer breakwater, built some 1800 feet out into the lake. By 1903, the Indian Ship Canal was begun and was navigable one mile inland by 1909. In 1925, the Federal government accepted deed to the completed waterway.

Settlement History and Industrialization

The Grand Calumet River and the Indiana Harbor Canal are part of the Calumet Region, essentially the bottom lands of Lake Chicago, the ancestor of Lake Michigan. The area's past land use is helpful in understanding current environmental quality and the prospects for remediation. Two stages are recognizable in terms of how humans modified this area: an early period, beginning some 12,000 years ago and lasting into the 19th century, during which human activities were adapted to the constraints of the natural environment, a hunter-gatherer stage; and a later period, continuing into the present, when, at an ever-accelerating pace, man altered the area to satisfy industrial and residential land use demands.

The environmental impact of the Indians and later, the fur traders was neither extensive nor damaging. There is no report of the game being over hunted, fires running destructively out of control, nor major imprints being made from villages. The white man who moved into the area in the 1830's did not encounter an untouched landscape, but it was a landscape which bore more the imprint of nature than of man.

The situation changed quickly as the area was opened for settlement during the 1830's and came into private ownership of a new culture group. This later stage of land use is characterized by extensive modification of the topography and drainage, the flora and fauna, and an ever increasing exploitation of the natural resources. Pioneer settlement began as isolated farmsteads, trading posts, and hunting and trapping lodges. This stage of occupancy involved few changes by man of the natural environment.

Increased occupancy and the changing use of the area with time, however, has greatly transformed the original appearance of the landscape from a natural to a man-made one. The fate of the area was decided with the arrival of the railroads in the 1850's and the establishment of the first major industries at the close of the 19th century. Development accelerated when George H. Hammond located a meat packing plant in 1869 on the site of the

city now bearing his name; and was followed by the location in 1889 of what later became the world's largest oil refinery, the Standard Oil Company facility, in what is now Whiting.

The reasons for locating the Standard 0:1 Refinery (now Amoco Corporation) in Whiting were quite interesting. Standard Oil had purchased large oil fields around Lima, Ohio for the distillation of the crude into kerosene, fuel oil, lubricating oils and various greases. Gasoline was not a desirable product and therefore, was usually disposed of at night in streams and creeks. Unfortunately, the Lima crude was high in sulfur content and its kerosene and fuel oil did not sell well in Pennsylvania and Ohio.

Anxious to recoup its losses, the company built an eight-inch crude pipeline to Chicago to sell their products to the rapidly growing population of the Midwest.

Here, however, the plans of Standard Oil were derailed by the aroused citizenship of South Chicago, which would not put up with "the rotten eggs" odor of the Lima crude products; and the city reluctantly withdrew the city permit to build the refinery at the foot of 100th Street and Lake Michigan. Thus, the Standard Oil case presented one of the very few environmental community actions in the late 19th century.

The refinery was moved to Whiting and the newly acquired Frasch process removed the hydrogen sulfide and its odors from the Ohio crude, and made the kerosene and fuel oil perfectly sellable.

East Chicago incorporated the same year, 1901, as a result of the region's first steel manufacturing industry, which became Inland Steel Corporation.

Inland's management found that thirty of their fifty acres purchased were under water and decided to use the waste materials from their open hearth furnace operation to landfill and recover the submerged land.

(Inland Steel wishes to point out that recovering the submerged land was then, and continues to be, permitted by the U.S. Army Corps of Engineers. According to Inland Steel, it was approved not only to recover land, but also to fill a shoal area considered a hazard to shipping.)

The number of the open hearth steel-making furnaces grew rapidly. By 1905 it was apparent that Inland required a steady supply of high quality pig iron, and by 1907, the first iron blast furnace was put into operation. The slag and flue dust from this operation were added to Inland's landfill which kept creeping into Lake Michigan. By 1912, there was an addition of another blast furnace and two coke batteries. By 1943, the plant produced over 3.5 million ingot tons of steel annually from eight blast

furnaces, six coke batteries and thirty-six open hearth furnaces. The plant also produced some one million tons of slag (both blast furnace and steel furnaces), 200,000 tons of flue dust and 250,000 tons of coal and coke effluents which went into the atmosphere. In addition, the stacks of the open hearth furnaces discharged approximately 50,000 tons of iron oxide dust into the atmosphere every year.

Another steel company of the early period in East Chicago was the Youngstown Sheet and Tube company, which came into existence in 1923 on the Indiana Harbor Canal across from the well established plant of the Inland Steel Company.

By 1929, the Youngstown Sheet and Tube Company employed 4,500 workers and was producing 1.7 million tons of steel using three blast furnaces and 16 open hearth units. The plant also had at its disposal three coke batteries, and a sinter plant was added in 1942.

Gary was founded in 1906, when the United States Steel Corporation began construction of its mills along the lakefront further east. The plant was based on the same basic design as the Inland Steel Company in East Chicago, but the layout was on a much larger scale. The plant's equipment included four blast furnaces and twenty-eight open hearth furnaces, all of which were put in operation by 1909.

The production capacity of the United States Steel, Gary Works, by 1910, was estimated to be 5.0 million ingot tons. The volume of effluent-waste materials was estimated to be approximately twice as large as that of Inland Steel Company.

There were two major differences between these two plants. Inland was landfilling its selected waste materials into compartmentalized patches of Lake Michigan and depositing the unwanted materials on land within the Indiana Harbor Works; the Gary Works deposited most of its waste materials on land without creating new land; however, it also was regularly using the adjacent Grand Calumet River as an open canal for discharging waste waters from its rolling mills, solid and liquid wastes from its pickling lines (ferrous sulfate) and many other wastestreams. The potential use of the Grand Calumet River for this purpose was envisioned from the very beginning of the plant's planning period, starting in 1906.

The United States Steel Corporation, in order to put some of its byproducts to better use and meet the growing demand for portland cement by burgeoning American cities and the expanding infrastructure of roads, sewers, gas distribution and power generating stations, decided in 1903 to build a huge cement plant on the west side of what would be Gary. This plant employed the kiln clinkering process and used, as raw materials, the blast furnace slag and limestone fines generated at USSC-Gary Works. By

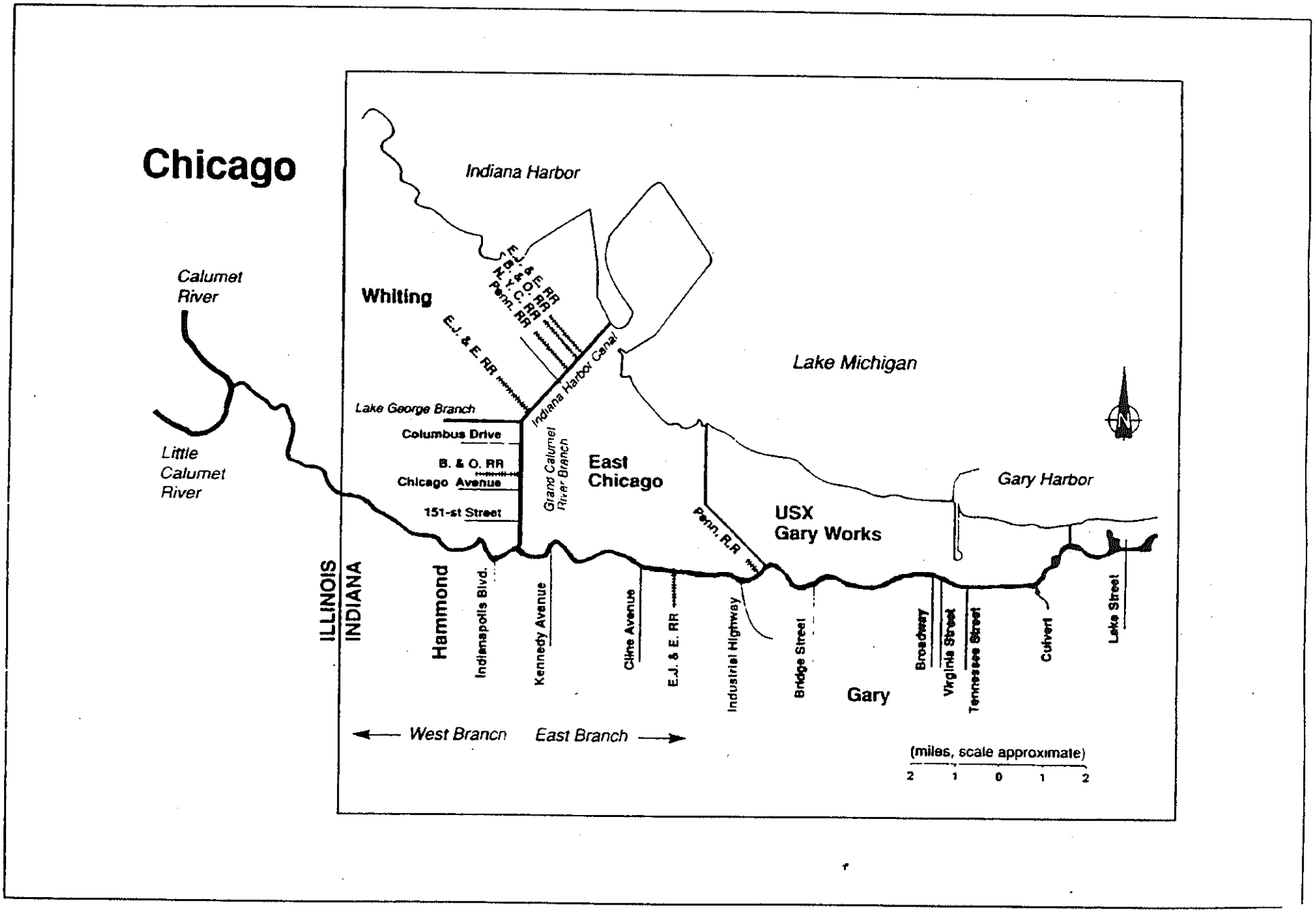
1950, it consisted of 14 rotating kilns and was considered to be the largest such installation in the world.

Urban-residential development progressed inland from this belt such that industry became hemmed in, and began filling in Lake Michigan to gain land for expansion. That need for additional land for industrial development has now mostly ceased and efforts are underway to reclaim currently unused coastal industrial lands for recreational, residential, and other commercial uses."

Today, Northwest Indiana produces more steel than any other region in the United States and maintains the largest petroleum refinery in the United States. Throughout the years the steel and fuel produced here have provided our nation with machinery, automobiles, and farming equipment.

The area has paid a heavy price in the service to the nation. During the past one hundred years, this heavily industrialized area has become environmentally degraded.

FIGURE 2A. *Grand Calumet River/Indiana Harbor Canal Area of Concern*



Chapter II

THE LAND

Overview

This chapter reviews the location, topography, soil types, the drainage basin, sewer service areas, and land use within the Area of Concern.

A considerable portion of the land around the Indiana Harbor and Canal, the Grand Calumet River and the nearshore Lake Michigan is heavily industrialized primarily as a large steel production and processing center and petroleum refinery complex. This area produces more steel than any other region of comparable size in the United States. It has four oil refineries, six crude oil pipelines and 18 refined petroleum product companies.

One byproduct of this highly industrialized area is waste. Within the Area of Concern are three Superfund Sites, more than 400 RCRA Sites, 23 companies which either treat, store or dispose of hazardous waste, and there are more than 462 underground storage tanks, of which 150 are reported to be leaking.

The extensive industrial land use has greatly influenced wildlife populations in the area by reducing available habitat and contamination of the ecosystem.

Location of the Area of Concern

The Area of Concern is located about 15 miles south of Chicago, Illinois, and is in the northwestern most part of the State of Indiana. The area includes the Indiana Harbor Canal, all of the Grand Calumet River of Indiana, and the nearshore Lake Michigan as designated in Figure 2A.

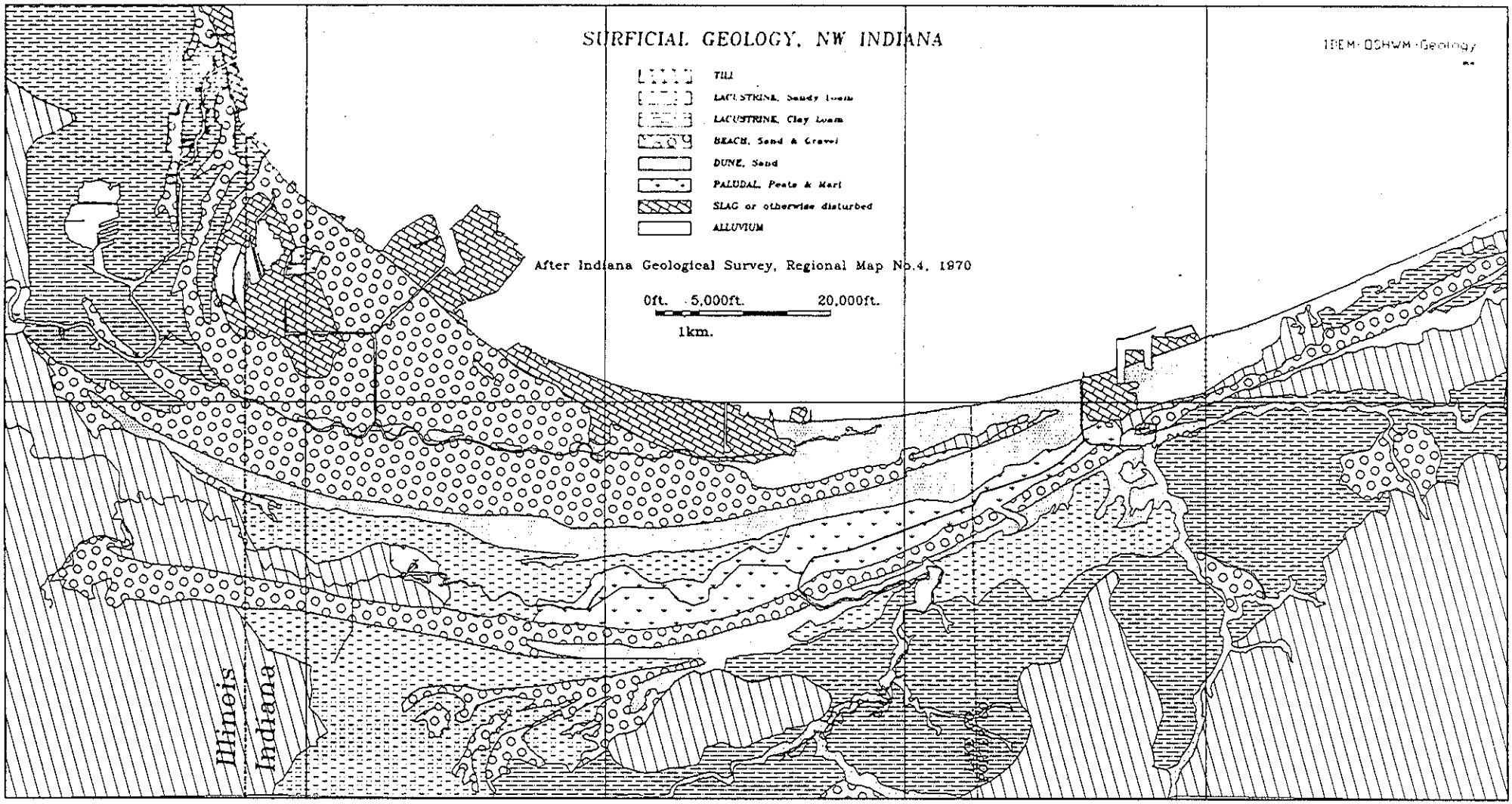
Topography

The Calumet Lakes Plain is a generally low relief area that occupies the bed of glacial Lake Chicago and three subsequent lakes which developed prior to the establishment of Lake Michigan some 2,500 years ago. Radiometric dating of sediments in the Grand Calumet River Basin suggests that these unconsolidated earth materials are no older than 4,000 years and were deposited during the Nipissing, Algome and modern-day Lake Michigan stages.

Several coastal area lakes developed in the Basin, as the Great Lake's level dropped from Nipissing through Algoma to the present-day Lake Michigan. Among those at the western edge of the Basin, were Calumet, Hyde, Wolf, Berry and George. Today, only Lake Calumet, Wolf Lake and small remnants of Lake George remain after the filling and drainage changes of the past century.

The southern basin of Lake Michigan is smooth-sided with a maximum depth of 163m (Wickham, et. al., 1987). The slope of the basin in the vicinity of Indiana Harbor is very gentle, with a 40m change in depth over a distance of 30 to 40 km.

FIGURE 2B


SURFICIAL GEOLOGY, NW INDIANA
TILL
LACUSTRINE, Sandy Loam
LACUSTRINE, Clay Loam
BEACH, Sand & Gravel
DUNE, Sand
PALUDAL, Peats & Marl
SLAG or otherwise disturbed
ALLUVIUM
After Indiana Geological Survey, Regional Map No.4, 1970
0ft. 5,000ft. 20,000ft.
1km.
IEM-OSHWM-Geology
Illinois
Indiana

Soil Types

The original soils of this heavily developed area are primarily Oakville and Texas. The area is characterized by narrow, elongated parallel ridges separated by sloughs. About 45 percent of this area is Oakville soils and 45 percent is Texas soils. The remaining area is represented by miscellaneous soil types. Many of the miscellaneous soil types are referred to as "urban". This is defined as areas that have been filled with earth, cinders, basic slag, trash, or any combination of these and smoothed over so the soil is unable to be identified. (Lake County Soil Survey, 1990.)

The Oakville soils are on the ridges and are excessively drained. They have a black coarse textured surface layer about two inches thick. Below this are brown and light brown, loose, coarse-textured materials.

The Texas soils are in depressions between the ridges, and are very poorly drained. Their surface layer is black muck about 30 inches thick. It is underlain by grayish-brown, coarse-textured material.

The land types that make up the other 10 percent of the area are dune land, lake beaches, marsh and urban land. Most of the urban land was formerly Oakville and Texas soils.

The Kankakee Outwash and Lacustrine Plain are the low-lying outwash and flood plain for the glacially derived rivers. They are composed primarily of sand and fine gravel deposits (Hartke et al., 1975). These deposits of heterogeneous till are the result of three separate glaciers which had covered the area, and they are up to 400 ft. thick (USACE, 1986). The underlying bedrock is more than 4,000 ft. thick and is composed of limestone, dolomite, sandstone, and shale resting on a granitic basement (Hartke et al., 1975). (See Figure 2B)

The soils located in the Area of Concern are prone to aquifer contamination, allowing for the rapid seepage of contaminates to enter the groundwater.

Drainage Basin Size

The drainage basin encompasses nearly 43,000 acres, according to the U.S. Environmental Protection Agency (EPA) Grand Calumet Master Plan (1985). This estimate takes into consideration the area's sanitary and storm sewer systems and the divergence of flow in the west branch of the Grand Calumet River.

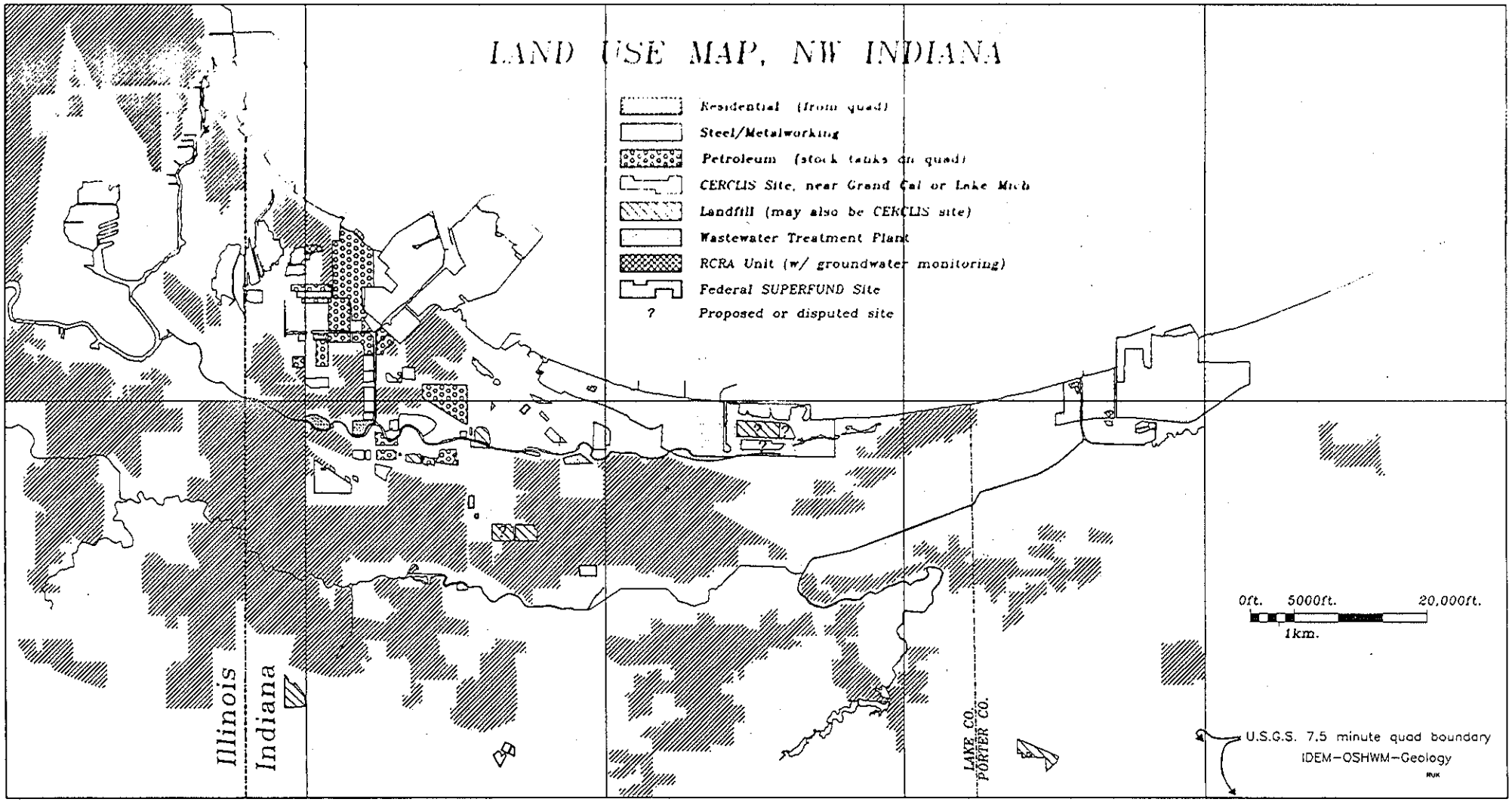
Unsewered Areas

The area around the Indiana Harbor and the Grand Calumet River is heavily urbanized and is a sewer serviced area. Therefore, it is unlikely that septic systems play a significant role in waste treatment.

Sewer Service Areas

Three municipal wastewater treatment plants, serving the East Chicago, Gary, and Hammond Sanitary Districts, discharge into the Grand Calumet River System (U.S. EPA, 1985). Two of the three plants service areas beyond city limits. Gary services Hobart, Merrillville, and numerous satellite communities surrounding their border. Hammond services Whiting, Munster, and Highland. East Chicago services the area contained with its legal boundary.

FIGURE 2C


LAND USE MAP, NW INDIANA
Residential (from quad)
Steel/Metalworking
Petroleum (stock tanks on quad)
CERCLIS Site, near Grand Cal or Lake Mich
Landfill (may also be CERCLIS site)
Wastewater Treatment Plant
RCRA Unit (w/ groundwater monitoring)
Federal SUPERFUND Site
? Proposed or disputed site
Illinois
Indiana
LAKE CO.
PORTER CO.
0ft. 5000ft. 20,000ft.
1km.
U.S.G.S. 7.5 minute quad boundary
IDEM–OSHWM–Geology
RVK

Urban/Suburban/Residential Land Use

The Area of Concern is a heavily populated area, although the population of the combined area decreased from approximately 337,000 in 1970 to about 291,000 in 1980 (IIT Research Institute. 1984). It is estimated that an additional 18,000 residents have moved since 1980, because of the past recession.

Recreational Land Use

There are several city and county parks along the Lake Michigan shoreline and there are several city playgrounds and ball fields adjacent to the Grand Calumet River. Adjacent to the Hammond filtration plant is the 4-acre Hammond Lakefront Park which is a popular fishing site. Jeorse Park is the only recreational area immediately east of the Indiana Harbor providing a small beach with 500 feet of lakefront. Marquette Park in Gary and Wihala Park in Whiting also provide outdoor recreational activities.

Agricultural Land Use

The extensive industrial and residential use of the land around the Indiana Harbor and the Grand Calumet River does not allow for appreciable agricultural use. However, there are several garden plots adjacent to the Grand Calumet River in residential areas. (See Figure 2C)

Industrial Land Use

The land around the Indiana Harbor is heavily industrialized primarily as a large steel production and processing center (USACE, 1986) and petroleum refinery complex. Steel plants and docks belonging to LTV Steel are along the northwest side of the outer harbor, as well as the main stem of the harbor. Inland Steel Company's docks and plants are along the southeast side of the outer harbor and the main stem of the canal. The USS - Gary Works (USX) is located along the shore of Lake Michigan.

Solid and Hazardous Waste

Located in the Area of Concern are five Superfund (National Priority List)-(NPL) Sites, 56 CERCLA Sites (the Comprehensive Environmental Response, Compensation, and Liability Act Information System), 423 RCRA sites and 23 TSD companies which either treat, store or dispose of hazardous waste. Additionally, there are over 462 reported Underground Storage Tanks (UST's) in the Area of Concern. (See Figures 2C and 2E)

CERCLA

As part of their mission to safeguard the environment, the Indiana Department of Environmental Management (IDEM) and the United States Environmental Protection Agency (EPA) identify and investigate abandoned uncontrolled hazardous waste sites for possible remediation through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by SARA, better known as Superfund.

CERCLA is a deliberate and structured process to determine what, if any, cleanup actions should be taken at uncontrolled hazardous waste sites as funding becomes available. The site evaluation process consists of two major phases; Site Assessment Program and the Remedial Program.

Site Assessment Program

This phase involves four major activities -- preliminary assessment (PA), screening site inspection (SSI), expanded site inspection (ESI), and the Hazard Ranking System (HRS). The purpose of the Site Assessment Program is the identification and evaluation of abandoned hazardous waste sites to determine whether they qualify for placement on the National Priorities List (NPL) for cleanup under CERCLA. Not all sites will have to go through the total evaluation process. Many sites are likely to drop out of the process if evidence warrants. As new sites are discovered, they are entered into EPA's database, the Comprehensive Environmental Response, Compensation, and Liability Inventory System (CERCLIS), a system designed to track sites through the different stages of investigation under CERCLA. As new sites are identified they will either be subject to emergency removal if an immediate public health threats exists, or they will undergo evaluation through the site assessment process.

Following the completion of the PA, SSI, and if necessary an ESI, the determination must be made as to which sites qualify for placement on the NPL and which sites should be considered for possible State action.

The HRS is an established scoring system designed to reflect the relative risk to public health and the environmental from the migration of a hazardous substance by potential pathways involving groundwater, surface water, air, or through direct contact and is a composite of the four possible migration pathways. Among the key factors affecting the score are the severity of current and future impact on groundwater, surface water, air and soil, and the number and proximity of population potentially at risk. Threats to drinking water supplies are particularly significant.

Facilities scoring higher than the established threshold score 28.5 (scale 0 - 100), may be nominated for the NPL. Sites that do not score high enough to make the NPL, but still may represent an environmental or public health threat, are potential candidates for State-initiated cleanup action.

Remedial Program

The second or remedial planning phase involves evaluating a site in sufficient detail to identify the magnitude and extent of contamination, the populations affected, and the most-cost-effective alternative for correcting problems at the site. This second phase consists of two activities -- a remedial investigation (RI) and a feasibility study (FS). The RI/FS is a lengthy, detailed, scientific effort to determine the nature and extent of site contamination, and to develop alternatives for a remedy that is protective of human health and the environment. These two phases result in a record of decision (ROD), followed by remedial design (RD) and remedial action (RA).

Negotiations with potentially responsible parties (PRP's) for recovery of investigation, engineering, and removal/remedy costs occur during this time. Sites found to be Resource Conservation and Recovery Act (RCRA) facilities will be referred to RCRA for possible enforcement action.

CERCLIS IN THE AREA OF CONCERN

Near the Indiana Harbor and Canal, the Grand Calumet River and the nearshore Lake Michigan of Lake County Indiana, there are fifty two sites which are listed in the Comprehensive Environmental Response, Compensation, and Liability Inventory System (CERCLIS). The sites are:

American Chemical Service, Inc. . . . . .Listed NPL Site
420 South Colfax Avenue
Griffith, Indiana 46319

Amoco Whiting REF
2815 Indianapolis Boulevard
Indianapolis, Indiana 46394

Anderson Development Co
3400 West 4th Avenue
Gary, Indiana 46404

Ashland Chemical
1801 167th Street
Hammond, Indiana 46320

Bairston W. Company
2809 Calumet Avenue
Hammond, Indiana 46320

Black Beauty Products Site
7100 West 9th Avenue
Gary, Indiana 46402

Black Oak Landfill
35th and Burr Street
Gary, Indiana

Bongi Cartage
1249 West Clark
Gary, Indiana 46406

Calumet Containers
136th Street and State Line
Hammond, Indiana 46320

Calumet College AKA Amoco Research FAC
2300-2500 New York Avenue
Hammond, Indiana 46394

Chemical Haulers
5723 Kennedy Avenue
Hammond, Indiana 46321

Citco Petroleum Company
East Chicago Avenue
East Chicago, Indiana 46312

Cities Service Company East Chicago REF
Cline Avenue
East Chicago, Indiana 46312

Conservation Chemical Company
6500 Industrial Highway
Gary, Indiana 46406

DuPont & Company
5215 Kennedy Avenue
East Chicago, Indiana 46312

East Chicago City Dump
East Chicago, Indiana 46312

Energy Cooperative Inc
3500 Indianapolis Boulevard
East Chicago, Indiana 46312

Federated Metals Corporation Whiting
2300 Indianapolis Boulevard
Hammond, Indiana 46394

Gary City Landfill
15th and Colfax
Gary, Indiana 46406

Gary Developing Company, Inc
479 North Cline Avenue
Gary, Indiana 46406

General American Transport Corporation
4245 Railroad Avenue
East Chicago, Indiana 46312

General American Transport Corporation
4520 Euclid Avenue
East Chicago, Indiana 46312

Hammond Valve Corporation
1844 Summer Street
Hammond, Indiana 46320

Hammond Sludge Lagoon
Hammond Sanitary District
Hammond, Indiana 46321

House's Junk Yard
E of Clark Street 1/8 mile W of JCT
Gary, Indiana 46406

Industrial Cinder, Inc. Site #77
West of Clark, South of RR Tracks
Gary, Indiana 46402

Industrial Disposal Corporation
2000 Gary Avenue
East Chicago, Indiana 46312

Inland Steel Company
3210 Watling Street
East Chicago, Indiana 46312

Lake Sandy Jo/M & M Landfill. . . . . .Listed NPL Site
3615 West 25th Avenue
Gary, Indiana

LTV Steel Company Inc
141 141st Street
Hammond, Indiana 46320

M & T Chemical Inc.
415 East 151st Street
East Chicago, Indiana 46312

Mid Continental Coke Company
370 North Clark Road
Gary, Indiana 46406

Midco Site I. . . . . .Listed NPL Site
7400 West 15th Street
Gary, Indiana

Midco Site II. . . . . Listed NPL Site
Gary, Indiana

Mobil Chemical Company
Phosphorus Division Gary Plant
1040 Michigan Street
Gary, Indiana 46403

Ninth Avenue Dump/Red Top. . . . . Listed NPL Site
9th Avenue and Cline Avenue
Gary, Indiana 46402

Old Hammond City Dump
Kennedy Avenue & 160th Street
Hammond, Indiana 46320

Pollution Control of Indiana
4343 Kennedy Avenue
East Chicago, Indiana 46312

Purex Corporation
Cline Avenue P.O. Box 509
East Chicago, Indiana 46312

R & R Industrial Park
1745 165th Street
Hammond, Indiana 46320

Sheffield Scrap
4648 Sheffield
Hammond, Indiana 46325

Shell Oil Company Terminal
2400 Michigan Street
Hammond, Indiana 46320

Site #75
Gary, Indiana 46410

Standard Alloys Corporation
4527 Columbia
Hammond, Indiana 46337

Stauffer Chemical Company
2000 Michigan Street
Hammond, Indiana 46320

Tyler Street Dump Site
756 Tyler Street
Gary, Indiana 46402

Union Carbide Corporation East Chicago
4550 Kennedy Avenue
East Chicago, Indiana 46312

USS Lead REF Inc.
5300 Kennedy Avenue
East Chicago, Indiana 46312

USSC Gary Works
1 North Broadway
Gary, Indiana 46401

Vista Chemical Company
2204 Michigan Street
Hammond, Indiana 46320

Vulcan Materials Company
459 North Cline Avenue
Gary, Indiana 46406

Western Scrap Corporation
6901 West Chicago
Gary, Indiana 46406

Superfund (NPL) Sites

From the CERCLIS list, there have been five sites in the Area of Concern which have been placed on the U.S. EPA's National Priorities List (NPL). These sites are commonly referred to as 'Superfund Sites.' The following is a brief summary of the activities relating to each of the Superfund Sites in the Area of Concern:

MIDCO I
Gary, Indiana

The Midwest Solvent Recovery Company, referred to as Midco I, is located at 7400 West 15th Avenue, Gary. Operations began in April, 1973. On December 21, 1976, a fire destroyed more than 14,000 drums on the site, essentially halting the operation. The site was scored and proposed for inclusion on the NPL in December, 1982. In July, 1985, a Federal Consent Decree was signed which required the responsible parties to investigate and remediate the site.

Data results from sampling efforts were submitted in a revised final remedial investigation report dated October, 1987. A final feasibility study, prepared in 1988, includes incineration and solidification as possible remediation alternatives.

In January, 1989, the U.S. EPA, Region V and the IDEM agreed that the favored alternative which meets all criteria would include excavation and solidification of the contaminated soils, ground water pumping and treatment, installation of a deep well to accept reinjected ground water, and a RCRA cover. Long-term testing and ground water monitoring will be performed to assure no migration of ground water from the deep well.

On June 30, 1989, the Record of Decision (ROD), detailing the preferred remedy as described above, was signed by the U.S. EPA. The IDEM concurred with this decision.

The U.S. EPA Regional Counsel and the U.S. Department of Justice have initiated litigation to enforce a U.S. EPA Unilateral Order for performance of the remedy.

MIDCO II
Gary, Indiana

The Midco II site is located at 5900 Industrial Highway (U.S. 12) in Gary, Indiana. Operations began on January 1, 1977, less than one month after a fire occurred at Midco I. This site was operated by the same party in a similar fashion to Midco I. It involved solvent recycling, waste storage, neutralization of caustics and acids, and disposal in pits. On August 17, 1977, a large fire consumed most of the waste on the Midco II property.

The Federal Consent Decree negotiated for Midco I was amended to include Midco II. The Midco II Remedial Investigation data revealed that the site was contaminated primarily with metals.

On June 30, 1989, the ROD detailing the preferred remedy, which includes soil vapor extraction, ground water treatment and deep well disposal, was signed by the U.S. EPA. The IDEM concurred with this decision.

The U.S. EPA Regional Counsel and the U.S. Department of Justice have initiated litigation to enforce a U.S. EPA Unilateral Order for performance of the remedy.

NINTH AVENUE DUMP
Gary, Indiana

The Ninth Avenue Dump is an abandoned 20-acre waste site located one quarter mile east of Cline Avenue at 7537 West 9th Avenue in Gary, Indiana. Disposal operations began in 1973 and continued through 1980.

In May, 1985, the site was reclassified from Category II (CERCLA enforcement lead) to Category I (Superfund financed). The State assisted the U.S. EPA in the oversight of the RI/FS. Samples obtained during the remedial investigation confirmed that the site is heavily contaminated with organic compounds. There is an oil layer on top of the ground water which contains most of the contaminants.

In May, 1988 it was decided that the remedy be phased; the first phase addressing the oil layer. The second phase (full site remedy) would address the ground water, soil, and sediments.

In September, 1988, the State signed the ROD for the Phase I operable unit remedy. The full site remedy, as documented in the Full Site ROD signed June 30, 1989, involves excavation and incineration of oil contaminated soils. A cap will be placed over the site. Ground water will be pumped, treated and reinjected within the contaminated area under the first phase, which will promote flushing of the remaining contaminants from the native soils.

On June 30, 1989, the U.S. EPA signed the ROD for the full site remedy as described above. The IDEM concurred with the ROD.

To date, the IDEM and the U.S. EPA have worked with the PRPs to initiate both the Phase I and Phase II remedies. Plans have been approved by both agencies for the Phase I remedy. Design studies for the full site remedy will commence during 1990. Actual construction of the Phase I remedy commenced late in 1990.

Lake Sandy Jo (Gary)

The LSJ site is a former borrow pit of gravel material located at 3615 West 25th Avenue in Gary. From 1971 to 1980 the site was used as a dump for demolition debris but also became an illegal dumping ground for industrial and chemical wastes. The site was placed on the National Priorities List in 1982 and a Remedial Investigation/Feasibility Study was conducted from 1984 to 1986. On September 26, 1986, the U.S. EPA, with IDEM concurrence executed a Record of Decision which specified the use of a site cover, subsurface drainage blanket, prairie grass vegetative cover, and placement of potentially impacted residents on a water distribution system to protect the public and environment.

In early January 1991, the Remedial Action (RA) at the LSJ site was officially completed when the U.S. EPA submitted a letter to the contractor, U.S. Army Corps of Engineers (ACOE) stating satisfaction with water distribution system to approximately 55 nearby residents. The ACOE recently finalized the design for the system and will begin the bidding process for construction contractors. It is expected that the system will be completed in

the fall of 1991. Approximately 75 residents that are potentially affected by ground water contamination from the site were asked if they desired municipal water hook-up. Only 55 accepted the water supply. IDEM will indefinitely provide operation and maintenance for the on-site operable units and quarterly sample ground water and residential wells to assure protection of the local community and environment.

IDEM Superfund has been working with the U.S. EPA and the U.S. A.C.O.E. to begin the construction of the water distribution system. An Amended State Superfund Contract is currently being executed by IDEM and the U.S. EPA prior to the initiation of the contracting process. IDEM must temporarily accept transfer of several easements from the U.S. EPA prior to project completion. As a result, Superfund staff is active in determining the necessary procedures for aquisition and transfer of property. These property interests will in turn be transferred to the Gary-Hobart Water Corp.

Next Steps

Superfund staff will identify and coordinate procedures necessary for the State's receipt and transfer of property prior to RA completion.

American Chemical Service (ACS)

Currently, Phase III of the Remedial Investigation at the ACS site is nearing completion. This is the last phase of investigation needed for further defining the horizontal and vertical extent of ground water contamination. The Feasibility Study for this site began in October 1990 to begin screening the technologies necessary for Remedial Action. On-site soil and ground water is highly contaminated with a wide array of organic and inorganic compounds and heavy metals. Many technologies are being considered for handling the various chemical compounds.

Background

The ACS site is located at 420 South Colfax Avenue in Griffith and includes the ACS facility, an inactive portion of the Griffith Municipal Landfill, and the Kapica/Pazmey Corporation property. ACS is an active solvent recovery and chemical manufacturing facility operating under RCRA Part B Interim Status. Over 1200 Potential Responsible Parties have been identified for this site, however only approximately 212 are signatories to the Consent Order to conduct the RI/FS. Buried drums and waste sludges were consistently found during the investigations at various depths throughout the site and contaminated ground water has primarily remained close.

Next Steps

IDEM will participate in the Feasibility Study in 1991 by providing the EPA with applicable State requirements for each remedial alternative considered later in the FS process. IDEM will also sign an acceptable Record of Decision following the FS process.

State Site Cleanup

IDEM has a program for the cleanup of abandoned waste sites not on the Superfund list. The State Cleanup Program operates in a manner similar to the Federal Superfund Program. Like superfund, sites are scored and selected for State Cleanup based upon environmental and public health threat. IDEM is currently taking action under State Cleanup authorities at one site.

CALUMET CONTAINERS CORPORATION
Hammond, Indiana

Calumet Containers Corporation is a cleanup site that is being managed by State Cleanup Section II, Office of Environmental Response, IDEM. Although an immediate removal was conducted by the U.S. EPA, the remedial activities will be conducted by the State. This site did not score high enough on the NPL for the U.S. EPA to conduct any further action. Therefore, the State will require the Potentially Responsible Parties (PRPs) to remediate the site.

Calumet Containers Corporation, a Division of Steel Container Corporation, was a drum reconditioning operation located at 136th and State Line Road in Hammond, Indiana. This facility received, stored, cleaned and recycled metal containers ranging in size from five-gallon pails to 55-gallon drums along with various-sized fiber drums. The drums originated mainly from the paint, ink and graphic arts industries. The site is located in both Indiana and Illinois. This drum reconditioning operation began in the 1960s and terminated with a fire in 1982.

After the fire, the U.S. EPA did an immediate removal at the site. Approximately 5,500 gallons of liquid waste and 30 cubic yards of solid waste were removed in May, 1982.

Early in 1984, the U.S. EPA conducted a planned removal of approximately 1,310 tons of solids and sludge and 4,000 gallons of flammable liquids.

Soil and ground water samples taken after the fire revealed elevated levels of heavy metals, volatile organic compounds, semi-volatile compounds and other inorganic constituents.

A geophysical investigation was completed by the U.S. EPA that identified several locations of potential contamination and buried materials in the vicinity of the former plant. A site survey, topographic survey and site grid were completed at that time.

Soil and tanker sampling was completed in October, 1987, and monitoring well installation was completed in December, 1987.

In June and December, 1988, surface and ground water samples were taken both on and off the site. The samples were submitted for full scan analysis. Metals, semi-volatiles and other inorganics were the primary contaminants detected.

In January and March, 1989, special notice letters were sent to 77 PRPs. On April 10, 1989, about 50 of the notified PRPs met with IDEM staff, to discuss their response to the notice letters.

The PRPs responded by letter in June, 1989, that a group of them would be interested in signing an agreement with the State to do an RI/FS. The PRPs have formed committees, and met in July and August of 1989. The Statement of Work is going through final revisions.

The IDEM Office of Legal Counsel, in conjunction with the Indiana Attorney General's Office and the Illinois EPA, is composing a Consent Decree which mandates the remediation of the site. The Consent Decree calls for the PRPs to submit a full scale RI/FS.

RCRA Program

The Area of Concern has a high concentration of hazardous waste facilities regulated under The Resource Conservation and Recovery Act (RCRA). Current records indicate 23 companies in the area either treat, store, or dispose of hazardous waste. RCRA is designed to prevent uncontrolled hazardous waste sites. Under RCRA, the U.S. EPA must phase out the land disposal of hazardous waste and induce industry to reduce the amount of waste it creates. Whoever creates the hazardous waste is known as the generator, and whoever moves the waste from one location to another is the transporter. Those who treat (T), store (S), or dispose (D) of hazardous wastes are called TSDs. A business concern can be in one category or in all three. There are specific standards for generators, transporters, and TSDs. Nine TSD facilities dispose of hazardous waste in landfills or surface impoundments. Tables 2A and 2B list these facilities.

Facility Management Plans (FMPs) for all nine land disposal facilities in the Grand Calumet River/Indiana Harbor Canal area have been completed. Eight of these facilities are slated for closure. The FMP process is a mechanism for coordinating permit and enforcement activities, and the cleanup of past releases, in order to achieve the following benefits: bring all land disposal units at a facility into compliance with RCRA standards; achieve proper closure and post-closure care of facilities that will not receive a RCRA operating permit; determine the threat to human health and the environment from operating and non-operating solid waste management units by conducting RCRA Facility Assessments; achieve cleanup or other appropriate remedy at facilities with significant environmental problems; and maximize cost recovery for the cleanup or corrective action.

Table 2A

Hazardous Waste Land Disposal Facilities in the Area of Concern

Site # and Name of Facility	Location
Gary Development	Gary
Conservation Chemical	Gary
General American Transportation	East Chicago
Inland Steel	East Chicago
U.S.X. Corps. - Gary Works*	Gary
U.S.S. Lead Refinery	East Chicago
Federated Metals	Hammond
Luria Brothers	Gary
Mercier	Gary

*IDEM has issued a final denial of the U.S.X. Corp. - Gary Works' permit application. All other facilities are pending closure, or have completed closure.

Table 2B

AOC Facilities Which Treat, Store, or Dispose (TSDs) of Hazardous Waste:

American Recovery Co., Inc. (Breslube)	East Chicago
Citgo Petroleum Corp.	East Chicago
Indiana Harbor WWS	East Chicago
KA Steel Chemicals, Inc.	Gary
Lehigh Portland Chemical Co.	Gary
Hammond Valve Company	Hammond
La Salle Steel	Hammond
Rhone-Poulene (Stauffer Chemical Company)	Hammond
Amoco Whiting Refinery - Lakefront	Whiting
Amoco Whiting Refinery - S.T.F. & Ref.	Whiting
Pollution Control Industries (PCI)	East Chicago
Safety-Kleen	Portage

Permitting Program

All operating hazardous waste storage, treatment and disposal facilities must adhere to the design and operation standards established under RCRA and the deadlines established by the Hazardous and Solid Waste Act (HSWA) Amendments of 1984. Consistent with the HSWA November, 1988 deadlines, U.S. EPA, Region V and IDEM issued a final determination on the permit application for one hazardous waste land disposal facility in the Area of Concern. The hazardous waste land disposal facility was the U.S. Steel, Gary Works, HWD-5 landfill. A final permit denial was issued by IDEM and U.S. EPA. Consequently, U.S. Steel has submitted a closure plan for the landfill. The other eight hazardous waste land disposal facilities in the area are undergoing closure.

HSWA required existing hazardous waste incinerators to have their permit status resolved prior to November, 1989. The only existing incinerator in Northwest Indiana, Amoco Whiting, was issued a final permit in November, 1989. Stauffer proposes to permit an industrial furnace as an incinerator. The application will also include storage of waste.

HSWA required all treatment and storage facilities to submit their permit applications by November, 1988 or face closure due to loss of interim status. Final permit action on treatment and storage facilities must occur by November 1992. The long-term thrust of the permitting program in the Area of Concern will focus on treatment and storage facilities and in post-closure care permits. Owners and operators of hazardous waste disposal facilities that close after July 26, 1982, without obtaining a RCRA permit, are required to obtain a permit to cover the post-closure care period.

Solid Waste Activities

There are two municipal landfills in the AOC-Gary Development and the Gary City Dump. Both are inspected a minimum of once every three weeks by IDEM. These two landfills are currently the subject of litigation by the State. Each has less than five years of capacity, although their life expectancies could be shortened, depending on the results of the legal actions under way against them.

As other dump sites are discovered, they are either brought into compliance through upgrading and permitting, or closed. If the owner/operator cannot be identified, a site is normally placed on the CERCLA candidate list for evaluation as a potential NPL site.

Alternative technologies (including recycling, waste-to-energy, composting, waste reduction, and state-of-the-art sanitary landfilling), need to be explored in order to improve the environmental soundness of solid waste management. As a result of the HSWA, a new section has been added to RCRA dealing with solid waste management. Nationally, U.S. EPA is considering new standards for the design and siting of municipal solid waste facilities. Once U.S. EPA adopts these new criteria, IDEM will conform to them. This will likely occur through IDEM's adoption of a solid waste permit program that is at least as stringent as the U.S. EPA criteria.

Underground Storage Tank Program

There are over 462 reported Underground Storage Tanks (USTs) in the Area of Concern. All owners/operators of USTs are required to notify the State of the whereabouts and existence of USTs using U.S. EPA forms. Several years ago, IDEM requested the Northern Indiana Regional Planning Commission (NIRPC) to assist in completion of the Lake County UST inventory, but there are still unregistered tanks in the area. The IDEM is starting a cooperative program with the State Fire Marshal's Office which will utilize both local and State inspectors for identification of additional tank locations.

The Federal UST Regulations which became effective December 22, 1988, established new tank standards, leak detection requirements, and upgrade requirements for existing tanks. These new upgrade requirements have a compliance schedule based on the age of the tanks.

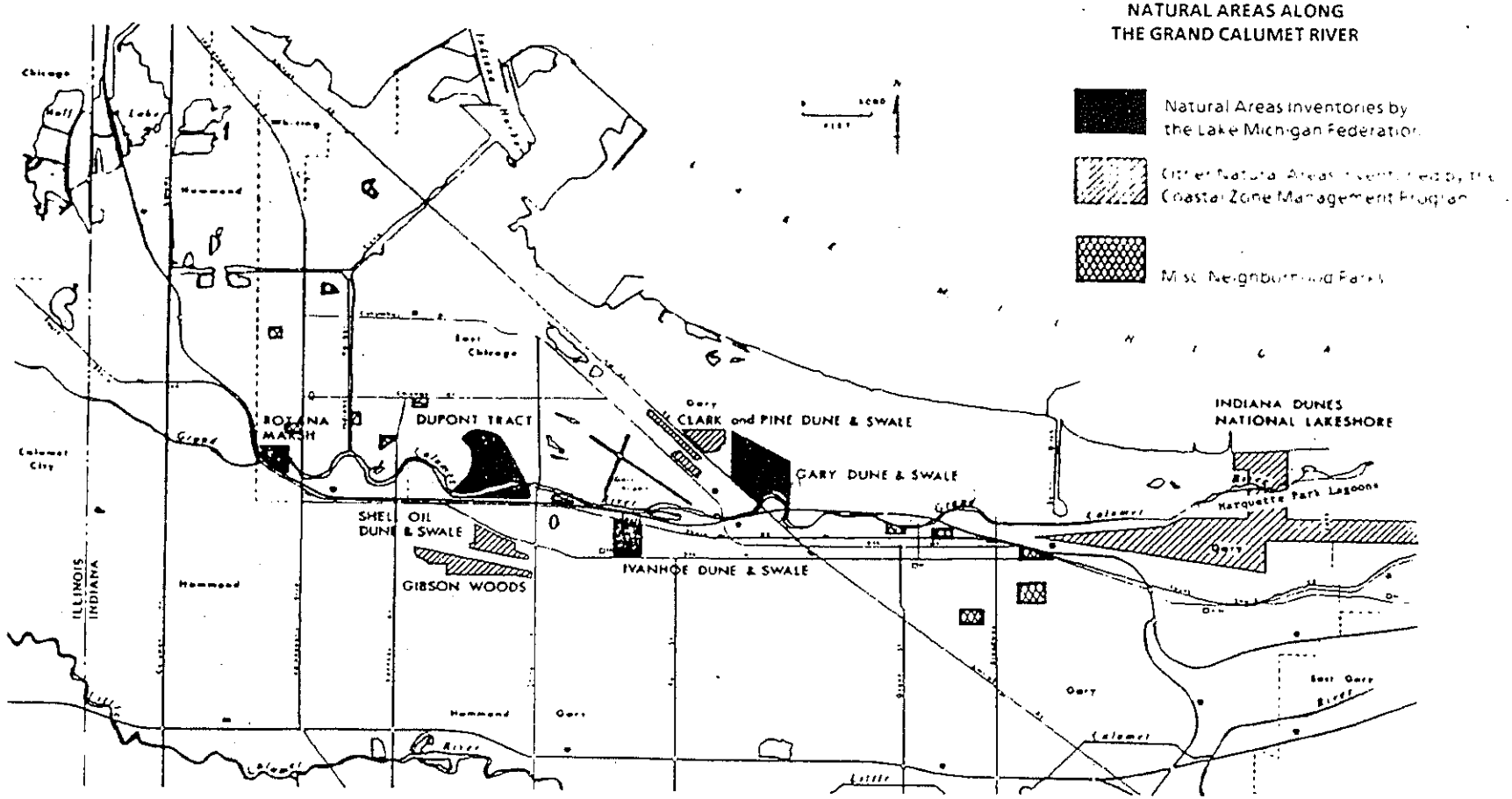
The potential exists for leaking tanks to contribute significantly to groundwater and surface water contamination. Over 150 leaking tank reports have been filed for Lake County in the Area of Concern since mid 1987. Underground Storage Tank cleanups are supervised and overseen on a case by case basis. Sites are computer tracked to assure compliance with the proper steps and approvals. Corrective action plans are reviewed and approved for site specific cleanup needs. The new Excess Liability Fund law which became effective on July 1, 1990, sets site compliance for owners and operators to meet in order to be eligible for cleanup funds from the program. If owners and operators fail to follow program procedures, enforcement action will be initiated.

Emergency Planning

With its high industrial base and extensive freeway and interstate system, Lake County continues to be ranked as the number two county in Indiana experiencing accidental releases of oils and hazardous chemicals. This high level of incidents dictates that IDEM's Emergency Response Branch, in conjunction with Lake County's emergency response and prevention planning officials, continue to give high priority to the emergency planning issues in Lake County.

Indiana's SARA Title III Program, administered by IDEM, is specifically designed to foster the communication and exchange of chemical information from those facilities which manufacture, store or handle hazardous chemicals to the response community for planning purposes and to the public to enhance their knowledge of potential chemical risks in their community. In 1987, the Lake County Emergency Response Commission was established to meet these objectives. Through the determined and dedicated efforts of this Commission, which is comprised of volunteers representing municipal and county governments, response and health officials, civil defense officials, media, hospital and industry representatives, and citizen organizations, a comprehensive emergency plan has been developed which addresses response issues across the entire county and lays a groundwork for coordination of response mechanisms throughout Lake County. Implementation of this Title III plan will result in providing emergency response capabilities to those areas of Lake County which lack response resources, and promote more effective use of existing resources in Lake County.

FIGURE 2D. *Natural Areas Along the GCR/IHC*



SOURCE: Adapted From Lake Michigan Federation, 1984.

IDEM, with assistance of the U.S. EPA and the Lake County Emergency Response Commission, are currently developing an intensive program to enhance facility compliance with Title III. Specifically targeting facilities located in the Calumet River Basin, the effort first will be directed toward identification of the chemical handling facilities which have not complied with hazardous chemical reporting provisions. Enforcement strategies will be developed by IDEM and U.S. EPA.

Wildlife Habitat near the Indiana Harbor and Canal Area

The extensive industrial land use in the Area of Concern has greatly influenced the wildlife habitat. There are few undisturbed open areas in the vicinity of the harbor because of the extent of industrialization (USACE, 1986). Dominant plant species tend to be aggressive weedy types such as ragweeds, goldenrods, garden sunflowers, and sweet clover. Common tree species are the cottonwood and tree of heaven. Wildlife species primarily are composed of small mammals characteristically found in urban environments.

Few bird species other than gulls have been observed foraging or resting in the harbor, probably because of limited benthic food source, and lack of a shallow water habitat (USACE, 1986). The Indiana Department of Natural Resources (IDNR) has not observed any waterfowl on the harbor during aerial waterfowl counts. In the fall of 1990, there have been several reported sightings of two blue heron near the canal, and ducks and geese have been seen on canal waters. Also, in the fall of 1990, Inland Steel reported having seen hundreds of mallards, canvasbacks, mergangers, rails, and other miscellaneous waterfowl foraging in the turning basin of the harbor.

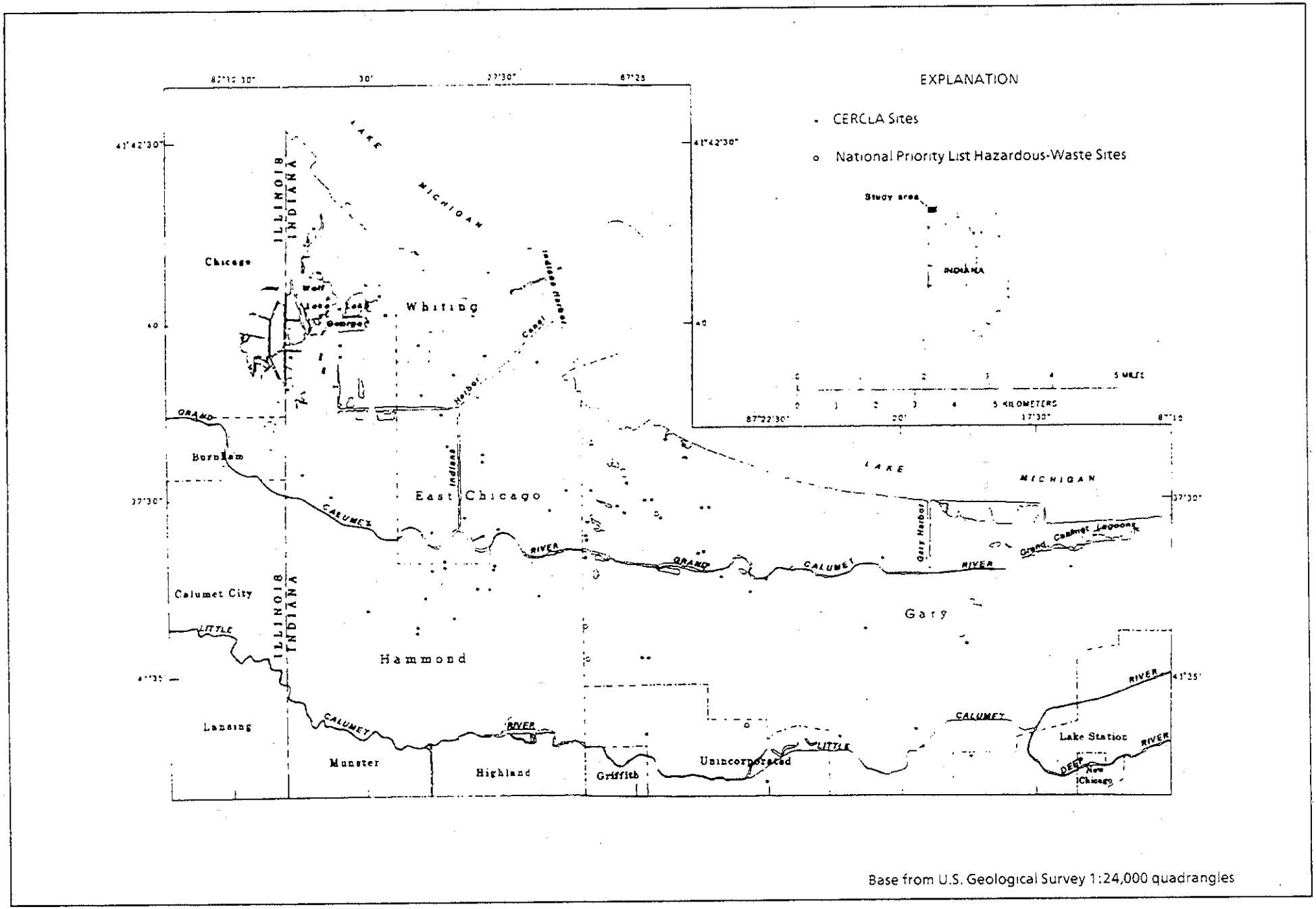
Wildlife Habitat Near the Grand Calumet River

The wildlife populations currently existing near the Grand Calumet River are greatly influenced by available habitat and contaminants in the ecosystem. Historical data exists for reptiles, amphibians, and birds in Marquette Park lagoon, however, current site-specific data is lacking (Reshkin et. al. 1981). The Gibson Woods and Clarke and Pine nature preserves contain remnant tracks of dune and swale topography and associated rare plant and animal species (IDNR, 1985). Examples of wildlife include Franklin's ground squirrel, Blanding's turtle, glass lizard, black crowned night heron, night herons, significant populations of green herons, as well as an occasional blue heron, and 10-12 resident snowy egrets. Muskrat and turtle are in evidence.

The only Federally endangered species whose range includes the Grand Calumet River area is the Indiana bat (Myotis sodalis). This species utilizes caves during the winter, and woodlands, (primarily riparian), during the summer, when maternity colonies make use of trees with loose bark. This bat forages for insects over wooded stream corridors. No specific information is available for the Area of Concern, however, lactating Indiana bats have recently been collected near the Kankakee River about 40 miles from this area (Brack and Holmes, 1982).

Five candidate plant species for Federally endangered species are found in Lake County, Indiana. Numerous state threatened and endangered species occur in the vicinity of the Grand Calumet River including the black tern, American bittern, and black crowned night heron.

FIGURE 2E. *Study Area and Locations of Hazardous-Waste Sites*



Base from U.S. Geological Survey 1:24,000 quadrangles

Tree species observed along the banks of the river include Sumac, Oak, Cattail, Mulberry, Black Willow, and Chinese Elm. Area vegetation in undisturbed areas include Dogwood shrubs, Catalpa. Horsetail, Honeysuckle, Butterflyweed, wild grapes, Spear grasses, and wild rice. (Grand Calumet Currents, Fall 1989).

One natural area of particular note is Roxana Marsh, located west of the East Chicago Sanitary District. A survey found the habitat of this freshwater wetland to include dense stands of cattails which were rated as ". . . excellent cover for wildlife" (Lake Michigan Federation, 1984). This survey also observed that cattails are spreading to shoreline areas adjacent to the marsh, through natural succession. Roxana Marsh and other natural areas along the river and harbor are depicted in Figure 2D. These areas are especially important as potential refuge and nursery areas for aquatic species.

The Marquette Park Lagoon, once the headwaters of the Grand Calumet River but now isolated from the river, draws bass fisherman. As many as 100 migratory swans have been seen on the lagoons as well as a few passing sandhill cranes.

IDNR rated quality wetlands in Indiana's coastal zone, which included five wetland areas along the Grand Calumet River (IDNR, 1979). (See Figure 2D)

Wildlife Habitat Near the Nearshore of Lake Michigan Area

The southern portion of Lake Michigan is an area of convergence for migrating loons, geese, waterfowl, and other shore birds (Brock, 1986).

Large numbers of waterfowl use the waters of nearshore Lake Michigan adjacent to Jeorse Park during migration (USACE, 1986), and it is one of only two areas along the Indiana shoreline which are heavily used by diving ducks during migration (mid-October through December). Several species of waterfowl use the wind-sheltered area for nesting and foraging activities. Several thousands of greater and lesser scaup have been sighted in the area during the three-week peak migration period.

Nearshore areas of Lake Michigan are within the range of the federally endangered Indiana bat (Myotis sodalis) and Piping Plover (Charadrius melodus). In addition, some state endangered. threatened, or special concern species including double-breasted cormorant, common loon, osprey, and Forster's tern (Brock, 1986) utilize the Area of Concern during migration.

Jeorse Park, along the nearshore area and east of Indiana Harbor, contains a large mowed area of Kentucky Blue Grass and a few American Basswood (USACE, 1986). Sandbar Willow is invading the sandy beach in the eastern portion of the park, and petioled sunflower and cottonwood saplings are scattered along the edge of the sandy area. A stand of large cottonwoods is also growing along the easternmost edge of the areas.

Chapter III

THE WATER

Overview

Section A of this chapter reviews the many aspects of the water within the Area of Concern such as groundwater, surface water, navigation, public drinking water supply, fishing, swimming and waste disposal. It also deals with the impacts water pollution has had on the biological community in the water.

Studies show that the macroinvertebrate community in the river and harbor is dominated by pollution tolerant forms. However, this represents an improvement over earlier conditions when few organisms could survive.

Fish communities in the river and harbor have been depressed for many years. A combination of a lack of food resources, low dissolved oxygen, and toxic stress has resulted in lack of a stable resident fish community. Some bottom dwelling fish collected by IDEM staff have been observed to have deformed lower jaws, swollen abdomens, swollen eyes, and bloody fins. The bloody fins may be caused by internal hemorrhaging.

Fish from the Grand Calumet River and the Indiana Harbor and Canal should not be eaten due to elevated levels of PCBs. There are fish advisories for the amount of fish eaten from Lake Michigan waters.

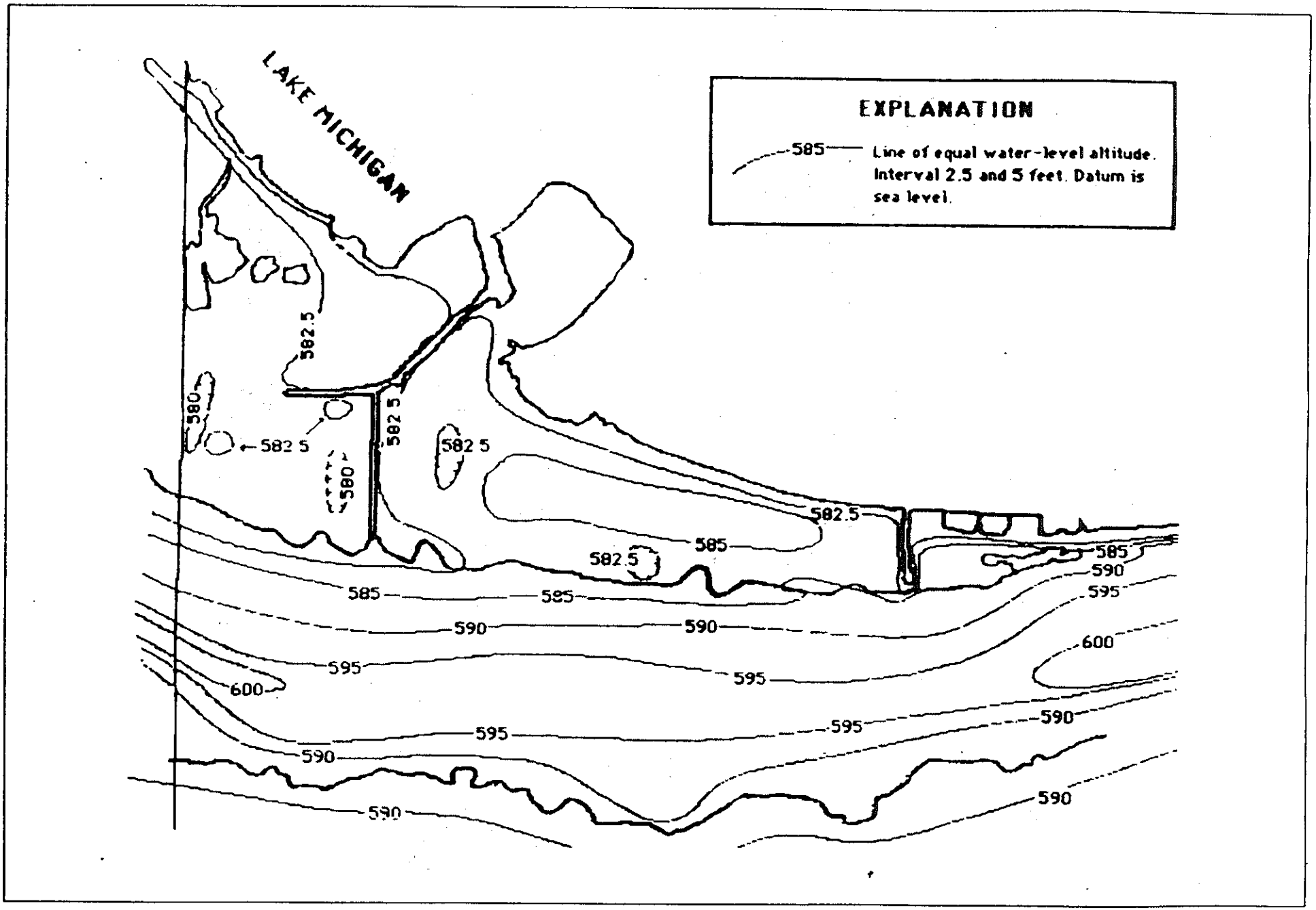
Due to poor water quality and deep soft sediments swimming in the Grand Calumet River and the Indiana Harbor Canal is not recommended. Beach closings have occurred in the nearshore Lake Michigan area due to bacteria present at unhealthy elevated levels.

Due to sediment accumulations (in the Indiana Harbor), ships must "light load" to safely navigate. This represents a substantial cost to industry.

Of greatest concern are the environmental consequences of sediment accumulations in the harbor and canal and the Grand Calumet River. Studies have shown that the current state of sediment transport in the harbor and canal allows over 180 million pounds of sediment to enter Lake Michigan each year. Along with the sediment, 420 pounds of PCBs, 2,300 pounds of cadmium, 110,000 pounds of lead, etc., are also transported to the Lake. This material will continue to enter the Lake at these high rates for many years if the existing sediment is not removed.

Today, a three-mile footprint of sediment can be seen stretching into Lake Michigan by satellite infrared images. The infrared images also show that public water supply intake pipes for the cities of Hammond, Whiting and East Chicago are within one half mile of the sediments. This means that there is a potential threat to the drinking water supplies to those communities if dredging does not occur within the next few years.

FIGURE 3A. *Ground Water Flow System (USGS, 1987)*



Groundwater contamination is significant in the Area of Concern and due to the high water table, the groundwater often becomes surface water. Thus, petroleum sometimes floats on the harbor and canal.

Section B provides an overview on the known sources of pollution in the Area of Concern and an overview of those sources.

Section A

Surface Water - Hydrology

The area was formerly drained by a single Calumet River, which was made up of the present Little Calumet River and the Grand Calumet River. The segment of this river which corresponded to the Little Calumet River flowed to the west into Illinois, where it formed a hairpin turn to the north and then to the east. At the eastern turn, the river was in the course of what is now the west branch of the Grand Calumet River. The segment of this river which corresponded to the Grand Calumet River flowed to the east, where it discharged into Lake Michigan just to the east of the Marquette Lagoons in Gary.

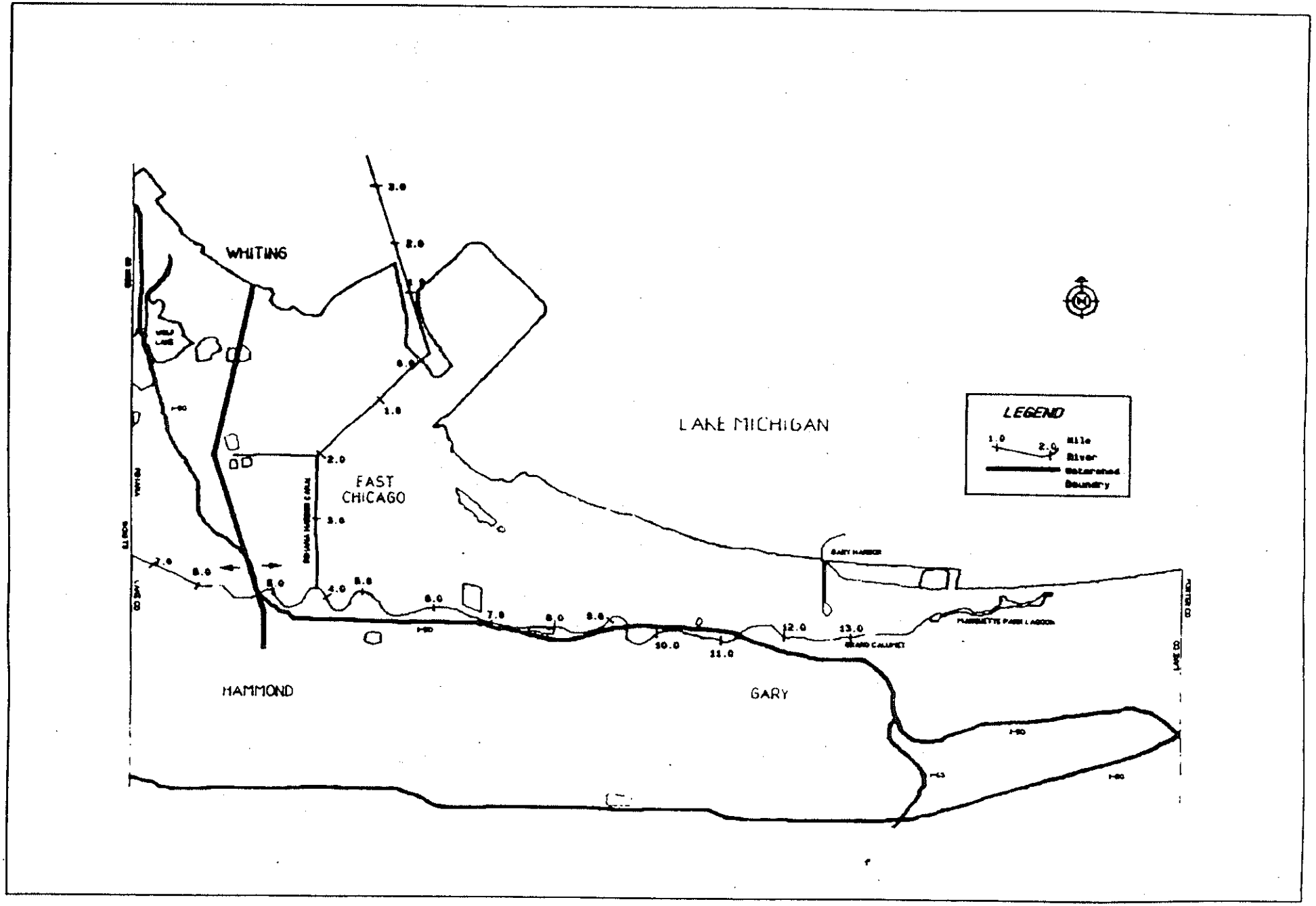
The modern flow system of the Grand Calumet River consists of two branches oriented east-west and a canal section oriented north-south. The east branch of the Grand Calumet River always flows west to the junction of the east branch with the west branch and the Harbor Canal. The point where all these channels meet is referred to as the triple junction. The Indiana Harbor Canal begins at the triple junction and flows directly north toward Lake Michigan. About halfway to Lake Michigan, however, it turns to the northeast. At that point, another arm of the Canal goes due west, and is known as the Lake George Arm of the Indiana Harbor Canal.

The West Branch of the River has a hydraulic divide which fluctuates depending on the amount of water flowing from the East Branch, the stage of Lake Michigan, the wind direction and speed, and the amount of discharge from the Hammond and East Chicago sewage treatment plants. At times, no divide on the branch exists, and all flow in the West Branch is toward the west. Most frequently, a divide between easterly and westerly flow exists near the boundary between East Chicago and Hammond. Further complicating the picture is estuarine flow in the Harbor itself. This flow generally consists of relatively cold Lake Michigan water intruding the Harbor Canal along the bottom, eventually mixing upward with the warm waters of the Canal which return into Lake Michigan. The thermal contrast necessary to drive this estuarine flow is provided because most of the water discharged to the river and harbor system is wastewater and noncontact cooling water.

Water Supply in the Nearshore Lake Michigan

There are three public water intakes in the nearshore Lake Michigan that serve the Area of Concern communities. The Whiting intake is about 1.5 miles west of the harbor entrance. The East Chicago, Indiana intake is located 9,688 feet (approaching 2 miles) east/northeast of the East Chicago Water Filtration

FIGURE 3B. *Harbor and River Miles*



Plant. The Hammond water supply is also taken from Lake Michigan and the intake is located about one mile north of the Hammond Filtration Plant.

Water Supply in the Indiana Harbor and Canal

Indiana Harbor is not a source of municipal drinking water. However, water from the harbor enters the nearshore Lake Michigan which is the water supply for the Area of Concern (AOC).

Biological Studies of the Grand Calumet River

The Indiana Department of Environmental Management has collected fish from both branches of the river for contaminant analyses. Fish communities in the river have been depressed for many years. A combination of low dissolved oxygen toxic stress have resulted in a lack of a stable resident fish community. The fish community is especially poor in the west branch of the river.

Some bottom dwelling fish collected by IDEM staff have been observed to have deformed lower jaws, swollen abdomens, swollen eyes, and bloody fins. The bloody fins may be caused by internal hemorrhaging.

The macroinvertebrate community in the Grand Calumet River is currently dominated by pollution tolerant forms including snails, midges, and oligochaetes (IDEM, 1987). However, this represents an improvement over earlier conditions when few organisms could survive in the benthic environment (U.S. EPA 1985). An exception to this condition is the Marquette Park lagoons. This area is upstream of industrial discharges and is connected to the river proper only by partially-constricted culverts. Although the lagoons have elevated levels of ammonia and potential contaminant input from adjacent landfills (Reshkin et. al., 1981), a diversity of periphyton and benthic invertebrate species occur in the lagoons (Hardy, 1984).

IDEM biologists conducted limnological studies of the three Marquette Park lagoons in 1986. The results indicated the lagoon that is farthest to the east and the middle lagoon have very good water quality with low total phosphorus and total nitrogen concentrations. The plankton counts were low to moderate with green species dominant in the middle lagoon. The farthest west lagoon had moderately high water column average nutrient concentrations (Total P 0.105, NH_3N 1.65, TKN 4.1 [mg/l]). The west lagoon is clearly impacted by nonpoint runoff from industrial areas. The bluegreens Microcystis and Phormidium were present in large numbers, although green species were dominant. The sediment and fish tissue from the west lagoon was collected by IDEM biologists in 1988. Toxic analyses of a large run of parameters including PCBs, metals, and pesticides produced no exceedances of FDA criteria.

Biological Studies of the Indiana Harbor and Canal

The lack of suitable habitat results in a scarcity of aquatic and terrestrial organisms associated with Indiana Harbor and Canal.

Macroinvertebrate communities are characterized by the presence of pollution tolerant organisms, predominantly oligochaetes (segmented worms). A brief sampling of benthic organisms conducted by the Federal Water Pollution

Control Authority (FWPCA) in 1967 showed that only sludgeworms inhabited the Indiana Harbor, suggesting that severe pollution exists (IIT Research Institute, 1974). A comparison of oligochaete fauna in the Calumet-Indiana Harbor region with other shallow areas in Lake Michigan suggested that 75-90 percent of the worm fauna in the Calumet-Indiana Harbor region were Limnodrillus hoffmeister, a species known to be tolerant of extreme pollution. Species diversity increased in the harbor sediment relative to upstream sampling locations (Polls and Dennison, 1984). In addition, densities of oligochaetes have increased from the early 1960s based on evidence from more recent sampling periods (U.S. EPA, 1985; Polls and Dennison, 1984; U.S. EPA, 1977; Polls et. al. 1983; and Potos, 1981). Brannon et. al. (1986) state that pollution-tolerant benthic invertebrate densities have increased in recent years and are greater in the Canal versus the Harbor and nearshore Lake Michigan. Sediment bioassays were conducted using Indiana Harbor and Canal sediments (Gannon and Beeton, 1969). They concluded that Indiana Harbor sediments were toxic or avoided by benthic organisms. Two of five samples stimulated growth of phytoplankton or algae.

Harbor sediment from the locations was tested again in late 1987 using a multitrophic level series of toxicity test using algae, and three invertabrates, as well as the effects upon the enzymatic activity of the indigenous microbid community (Burton etal., 1989). These investigators did find toxicity representative of ecosystem degredation and verification of extensive chemical contamination.

In the summer of 1987, IDEM biologists placed Hester Dendy artificial substrate samplers at six sites in the Indiana Harbor and the Grand Calumet River. The samplers were suspended from bridges at Bridge Street, Virginia Avenue, Cline Avenue, Kennedy Avenue, Indianapolis Boulevard, Lake George Canal, and Dickey Road. The samplers were recovered in six weeks. Examination of the resulting macroinvertebrate fauna indicated that:

1. *There was evidence of moderate organic pollution at every site.*
2. *Most of the sites were probably stressed by toxic compounds as well.*
3. *Bridge Street had the most depressed macroinvertebrate community.*
4. *Metals and PCBs probably were not the cause of depressed conditions at most sites.*
5. *The effect of PAHs and cyanide on the aquatic community in the river and harbor should be investigated.*
6. *Nutrient inputs into the Indiana Harbor and Grand Calumet River were relatively low.*
7. *The Lake George Canal and Indianapolis Boulevard stations had surprisingly good macroinvertebrate communities compared to the rest of the effluent shed.*

In the summer of 1988, IDEM biologists collected a macroinvertebrate sample at the Dickey Road CORE station. A single Baetis larvae and one species of Bryozoa was recovered along with the usual dominant pollution tolerant fauna (oligochaeta, diptera, gastropoda). Baetid mayflies and bryozoans are commonly found in less polluted waterways.

Biological monitoring by the Indiana State Board of Health (ISBH) beginning in 1979 has shown an increasingly diverse aquatic community in the Indiana Harbor Canal and lower Grand Calumet River. Extremely pollution tolerant forms such as Carp and Oligochaetes are losing dominance to more sensitive species such as Golden Shiners and Bryozoans (IDEM, 1987). Some fish species (especially Goldfish and Golden Shiners) appeared to be reproducing successfully in these waters in 1986 and 1987. However, the aquatic community still appears to be adversely impacted by moderate organic pollution and toxic stress. Bannon et. al. (1986) calculated a predicted uptake of PCB's from Indiana Harbor sediments and determined that fish living in Indiana Harbor Canal upstream of the railroad bridges would exceed the safety level for human consumption.

Biological Studies of the Nearshore Lake Michigan

A study by the Indiana State Board of Health (1982) was designed to provide the data base necessary for the protection of water quality in the Indiana portion of Lake Michigan. The 240 square miles of Lake Michigan under Indiana's jurisdiction were sampled from April through November, 1980, and May through October, 1981. Analyses for as many as 34 limnological parameters were made at each station, including measurements of the physical environment and various organic and inorganic constituents. The temperature regime in the study played a major role in water quality in the Indiana portion of Lake Michigan. Although temperature usually does not improve or impair the lake's quality, it can control dispersal of other constituents within the lake. The thermal bar which develops in the spring effectively prohibits mixing of nearshore water with those waters offshore. Permanent thermal stratification was not evident in the study area during either year. There was, however, temporary thermal layering that resembled the epilimnion, thermocline, and hypolimnion stratification of temperate lakes. Similar to the thermal bar situation, the interference of surface-bottom water mixing due to the temperature was noted. Significant differences in many parameters was evident during certain periods between surface and bottom samples when the lake was "stratified".

Another significant phenomenon observed in the Indiana State Board of Health (ISBH) 1982 study was primarily anthropogenic in origin. The large industrial and municipal complex in the Calumet area appears to be adversely impacting the lake. Water quality of the areas sampled in and around the Indiana Harbor Canal was significantly "lower" than other areas, particularly those located offshore. Levels of dissolved solids, cyanides, phenolics, nutrients, and metals were consistently elevated in this area when compared to other lake samples. Other harbor areas were not detectably different from other nearshore waters.

Comparisons among the ISBH (1982) study and others (Snow, 1974; Rockwell et. al., 1980; Torrey, 1976) indicate that concentrations of many parameters are elevated from historic levels. These data suggest that nearshore areas of Lake Michigan have poorer water quality than open lake areas, especially near the industrialized acres of the Indiana Harbor Canal (ISBH, 1982). Harrison et. al. (1977) demonstrated through the use of dye studies, that contaminants are transported from Indiana Harbor to Lake Michigan, and that under certain conditions can be transported to the Chicago area. These data indicate that the nearshore region in the study area has poorer water quality than other nearby industrialized and heavily populated areas.

Lake-wide studies conducted in the early 1970's reported that the abundance of zooplankton at all stations in Indiana waters were considerably higher (10 times) than values reported for other areas in Lake Michigan. The Indiana waters were characterized by low numbers of calanoid copepods relative to cyclopoid copepods and cladocerans, indicating a response to eutrophication in the nearshore waters. It was concluded that the changes in the zooplankton population would most likely result in changes in the fish population (IIT Research Institute, 1974).

Phytoplankton was also noted in the ITT Research Institute (1974) study indicating that species of diatoms, which favor eutrophic conditions, have increased in relative abundance. The changes in the diatom florae appeared initially in the nearshore waters of Lake Michigan and later in the open lake, indicating that the changes were caused by nutrient pollution rather than by natural phenomena.

Diatoms were reported to be most abundant in the nearshore lake in 1984, although the species were not identified (ISBH, 1957-1984). Diatoms peaked in March and November, and reached lows in January and June. These peaks were predictable as they followed the spring and fall overturn periods where nutrients accumulate in the hypolimnion and become available for growth. Blue-green algae follow a similar pattern.

IDEM examination of phytoplankton samples taken from the public water supply intakes of East Chicago, Gary, Hammond, Michigan City, and Whiting reveal few significant changes from 1971 to 1989. Pennate diatoms were dominant and phytoplankton counts were very low compared to those of inland Indiana lakes. Population peaks continued to occur in spring and fall with somewhat higher numbers in Fall months. Although monthly phytoplankton counts reveal no definite trends, 1988 and 1989 counts at the five Lake Michigan stations were slightly higher than those of the early 1980s. There does seem to be an increase in the appearance of small particles of organic detritus in phytoplankton samples. The origin of this detritus is not known, but could be algal remains.

Macrobiological surveys for nearshore Lake Michigan in the study area are relatively few. However, some surveys have been completed. Macroinvertebrate communities in Lake Michigan have been studied by Moxley and Alley (1973), Alley and Moxley (1975), and Nalpa et. al. (1985). These studies include nearshore areas and data near the study area, but also discuss population information from other portions of Lake Michigan. The macroinvertebrates found in Lake Michigan include members of Oligochaeta, Hirudinea (leeches), Amphipoda (scuds), Ispopda (sow bugs), Diptera (true flies), Pelecypoda (bivalve mollusks) and Gastrapoda (snails). Seventy-nine species were collected. The taxa with the most species were Oligochaeta-Tubificidae (sludge worms) and Diptera-Chironomidae (midge larva). In a study by Polls and Dennison (1984), six stations in nearshore Lake Michigan within the study area were sampled for macroinvertebrates. A total of 14 families were collected with the greatest number of individuals in the taxa Nematoda, Tubificidae, Chironomidae, and Sphaeridae. In four additional studies (Gannon and Beeton, 1969; U.S. EPA, 1977; Potos, 1981; Limno-Tech, 1984) benthic organisms were virtually absent from the Indiana Harbor and the Canal, however, at the outer reaches of the harbor some organisms were collected. The invertebrates collected included Oligochaetes, Hirundineans, Dipterans, Amphipods, Gastropods, and Pelecypoda. The most abundant organisms sampled were Oligochaetes.

Fishery surveys for nearshore Lake Michigan are also relatively few and generally of limited scope. Goodyear et. al. (1982) surveyed Lake Michigan for spawning and nursery areas. Twenty-four species were found in Indiana waters. Some of these species are found near Indiana Harbor at Hammond and Gary, although no reference to successful reproduction at Indiana Harbor are cited. Twenty-two species of fish are reported to occur in Lake Michigan in the Indiana Harbor Area according to USACE (1985). The Indiana Department of Natural Resources stocked Lake Trout, Brown Trout, and Chinook Salmon in Lake Michigan at Jeorse Park near Indiana Harbor (USACE, 1985). Polls and Dennison (1984) sampled fish from Lake Michigan near Indiana Harbor as well as in the harbor and canal proper in November and December. They collected 16 species of fish from nearshore Lake Michigan and 8 species from the harbor. The lake sample included a variety of fish, whereas half the harbor sample included pollution-tolerant species such as Alewife, Gizzard Shad, Carp, and Goldfish. Species diversity decreases as the sampling points approach Indiana Harbor and the predominance of more pollution-tolerant species increases.

Biota Impairments

The quality of biological habitat in portions of the Grand Calumet River and the Indiana Harbor is poor. The aquatic community appears to be adversely impacted by both organic pollution and toxic stress.

Eutrophication

Little information has been found subsequent to the early 1970s relative to eutrophic conditions in the nearshore Lake Michigan.

Fish Consumption Advisories

The 1990 Fish Advisory states that no fish should be eaten from the waters of the Grand Calumet River and the Indiana Harbor Canal. The 1990 Lake Michigan advisory suggests the following for the Area of Concern:

Brown Trout over 23 inches, Lake Trout over 23 inches, Chinook over 32 inches, Catfish and Carp should not be eaten. Chinook Salmon between 21-32 inches, Lake Trout between 20 to 23 inches, Coho Salmon over 26 inches, and Brown Trout up to 23 inches should not be eaten by children age 15 or under, pregnant women, women who may become pregnant, or nursing mothers. All others should limit their consumption to one meal (0.23 kg) per week.

Commercial Fishing in the Nearshore Lake Michigan

The Indiana Department of Natural Resources has issued 20 Lake Michigan commercial fishing licenses annually for the past several years. Legislative action banned the use of gill nets as a gear type in 1989. Currently, commercial fishermen are employing "trap" nets or "impoundment" nets as the replacement gear. The gear changeover allowed the catch of the target commercial species (yellow perch) while protecting against nontarget losses (principally trout and salmon). The total commercial fishing harvest dropped in 1989 from the previous few years. This is attributed to a limited effort by some commercial fishermen, as well as lack of experience with a new gear type. However, some fishermen are showing trap net catches equal to or above those reported with gill nets. (IDNR, 1990)

Sport Fishing in the Nearshore Lake Michigan

Chinook Salmon are stocked annually in Lake Michigan from Inland Steel property and from Whiting Park. The Department of Natural Resources also stocks Chinook and Coho Salmon, and Steelhead Trout elsewhere in the Lake and tributaries (not the Grand Calumet River or the Indiana Harbor and Canal). The entire southern end of the Lake provides a high quality salmonid fishery. Yellow Perch and Rainbow Smelt are also utilized in the sport fishery and provide many quality fishing opportunities for shoreline and boat anglers.

Sport Fishing in the Indiana Harbor and Canal

Sport fishing is not generally pursued within the harbor because of the heavy commercial traffic, the lack of a suitable launch facility, and fishing advisories.

Sport Fishing in the Grand Calumet River

No record of sport fishing in the river is available. However, in the fall of 1989, East Chicago Sanitary District staff reported observations of salmon in the channel connecting the wastewater treatment plant outfall with the Grand Calumet River. As previously stated, no fish should be eaten from waters of the river. The reported sighting does, however, indicate improvement of water quality. It should also be noted that in the 1960's, not even algae lived in the river.

Contact Recreation in the Indiana Harbor and Canal

Due to large vessel navigation in the harbor and degraded water quality and contaminated sediments in the Canal, full body contact recreation in these waters is not recommended.

Contact Recreation in the Grand Calumet River

Due to degraded water quality and contaminated sediment accumulations, full body contact recreation in the waters of the Grand Calumet River is not recommended.

Contact Recreation in the Nearshore Lake Michigan

There are a variety of contact recreation areas along the nearshore Lake Michigan. Nine recreational areas are situated along the Lake Michigan Shoreline with space available for sport fishing and four sites designated for public swimming. The nine recreational sites follow:

1. *The Robert A. Pastrick Marina*
2. *Jeorse Park*
3. *Indiana Dunes National Lakeshore - West Beach*
4. *Wihala Beach County Park*
5. *Marquette Park*
6. *Northern Indiana Public Service Company (NIPSCO) - Dean H. Mitchell Station*
7. *Commonwealth Edison Stateline Station*
8. *Hammond Lakefront Park*
9. *Whiting Park*

The Robert A. Pastrick Marina is located in East Chicago adjacent to Jeorse Park. It provides for 288 boats in wet slips, 260 in dry dock storage, 3 launching ramps, and fueling docks. Phase two of the Pastrick Marina project will create 800 additional slips. The Hammond Lakefront Park, which is under construction, will have 800 wet slips and 200 dry storage spaces, along with a launching ramp and fueling dock.

The Gary Marina, in the proposal stage, may yield 475 wet slips and accommodate 275 boats in dry storage and may be developed within the breakwater owned by the US Steel Corporation.

Noncontact Recreation in the Indiana Harbor Canal

Noncontact recreation is defined as activities such as bicycling, jogging, walking, hiking, picnicking, snowmobiling, and bird watching. To date, there is no such recreation in the harbor. Access to the Indiana Harbor Canal is very limited as no public property, such as parks, border the harbor.

Noncontact Recreation in the Grand Calumet River

Noncontact recreation may be occurring near the Grand Calumet River, however, information on such activity is unavailable, except for the Grand Calumet Task Force's annual 'River Awareness' canoe trip. Additionally, water quality of the river in the past has not made it an attractive place to participate in recreational activities.

Noncontact Recreation in Lake Michigan

The Lake Michigan Basin is one of the major water-oriented recreational areas in the nation. Although the recreational areas are scattered throughout the entire basin, the population is most concentrated on the southern portion of Lake Michigan, resulting in crowding of the facilities in that part of the basin.

Beach Closings

Hammond Beach has been closed for several years due to high coliform counts. Hammond is in the Area of Concern.

Although there have been improvements in the past few years, the high coliform counts generally follow a heavy rain due to combined sewer overflows. There were beach closings at Chicago beaches and at the Indiana Dunes National Lakeshore in 1990, but the cause of the high coliform counts may or may not have been from the Area of Concern.

Aesthetic Impact

Although crude oil occasionally washes up onto nearshore Lake Michigan bathing beaches, the problem seems to have diminished considerably in the past few years.

Debris litters the Grand Calumet River and the Canal.

The Indiana Harbor and Canal are unsightly. The banks appear to be oil saturated.

Navigation in the Grand Calumet River

The west branch of the Grand Calumet River is not navigable, even by canoes, due to sediment accumulation and bridges that were constructed over the waterway. The east branch of the river, while navigable by very small boats and canoes, is not safe for such activity. In several areas, low-lying cables cross the river and remnants of now razed bridges lay just beneath the water.

Navigation in the Nearshore Lake Michigan

The nearshore area is available for small boat navigation. Larger ships navigate further off shore due to the existence of a shoal area closer in towards shore. Part of this area, called Indiana Shoals, is the area upon which a portion of Inland Steel is built.

Navigation in the Indiana Harbor and Canal

The Indiana Harbor is a major shipping port for industrial suppliers and oil tankers. During the period of 1978 to 1987, waterborne commerce at Indiana Harbor averaged 15,665,495 tons (USACE, 1990). The principal commodities received were iron ore (67 percent) and limestone (11 percent). Traffic at the harbor consisted of lakewide receipts (between United States ports on the Great Lakes systems), and internal receipts (entire movements that take place on inland waterways, eg., traffic between ports or landings). Inland Steel reports that they receive international water traffic from Wabash and Labrador at its docks along the Canal. The principal commodities received at Indiana Harbor are iron ore and limestone. The major shipments from Indiana Harbor to other Great Lakes ports were gasoline and distillate fuel oil. The USACE reports that in some areas of the Harbor, it is no longer safe to navigate due to the accumulation of sediments. Due to environmental concerns, the harbor has not been dredged in many years. The average volumes of government and private dredged material removed from the Indiana Harbor during the 18-year period 1955 to 1972, were 89,5000 and 127,000 cubic yards per year, respectively. The average volume pr dredging action for the same period were 161,000 and 176,000 cubic yards (USACE, 1990). During the 10-year period 1963 to 1972, the average volumes of dredged material per dredging action were 174,000 and 138,000 cubic yards . . ."

Sediments of the Indiana Harbor Canal and the Grand Calumet River

The current state of sediment transport in the harbor and canal allows over 180 million pounds of sediment to enter Lake Michigan each year. Along with the sediment, 420 pounds of PCBs, 2,300 pounds of cadmium, 110,000 pounds of lead, etc. are also transported to the Lake. This material will continue to enter the Lake at these high rates for many years if the existing sediment is not removed. These rates of transport of contaminants from the IHC to the Lake are estimated to be about double what they would be with the maintained navigation channel. Maintenance of a deepened channel traps sediments that would otherwise be transported to the Lake. (USACE, 1990)

The amount of time necessary to allow the natural forces of scour, mixing, transport, ultimate burial on the bottom of the deep portion of Lake Michigan and contaminant degradative processes to eliminate the sediment pollution problem in the IHC without remedial or navigation dredging action can only be crudely estimated to be on the order of many decades, and even then only if the contaminant sources are essentially stopped. Contaminant sources in this context include the Indiana Harbor Canal and the Grand Calumet River watershed's existing land pollution problems, which act as a long term reservoir from which contaminated soils will be eroded to become polluted stream sediments.

Today, a three mile footprint of sediment can be seen stretching into Lake Michigan by satellite infrared image. The infrared image also show that public water supply in take pipes for the cities of Hammond, Whiting and East Chicago are within one half mile of the sediments. This means that potential threat exist to the drinking water supplies of those communities.

The USACEs have committed to the State to have a new draft dredge and dredge spoils plan submitted for public comment prior to July, 1991.

It is important to note that as late as 1986, the USACE proposed dredging of the Indiana Harbor Canal. However, local opposition prevented the project from moving forward. Since 1986, 720 million pounds of sediment along with 1,680 pounds of PCBs, 9,200 pounds of cadmium, and 44,000 pounds of lead have entered Lake Michigan from the Indiana Harbor. In order to protect Lake Michigan, the community must resolve the sediment issue.

SOURCE	SEDIMENT YIELD TONS/YEAR 1974	1984
POINT SOURCE DISCHARGES	64,500	28,500
COMBINED SEWER OVERFLOW	11,000	11,000
URBAN RUNOFF	51,500	51,500
TOTAL ANNUAL YIELD	127,000	91,000

The U.S. EPA's ARCS Program

The U.S. EPA's Assessment and Remediation of Contaminated Sediments (ARCS) program is currently involved in numerous studies of sediments collected from the Indiana Harbor. These studies include bench-scale treatability studies of the sediment, a human health risk assessment, and a contaminated sediment aquatic life assessment.

Data and results of these studies will become available in 1991 and will provide the community with useful information in addressing the Sediment issue.

IDEM's Remedial Action Plan Coordinator is a member of the U.S. EPA ARC's Management Committee.

Groundwater

The shallow groundwater in the area is contained in a thin (up to 50 feet thick) surficial, lacustrine sand. This overlays an aquiclude formed by lacustrine clays and glacial till. Underlying the aquiclude is a fractured limestone bedrock aquifer. The bedrock system discharges to Lake Michigan or to wells and springs. The shallow sand system discharges to the Little Calumet River, the Grand Calumet River, the Indiana Harbor Canal, and directly to Lake Michigan. The shallow aquifer is the most easily contaminated and is in direct communication with surface water.

The shallow groundwater flow system is complex. The system is driven by low gradients, 0.0001 and less, with broad divides. The divide which separates flow to the Grand Calumet River and the Little Calumet River is under the ridge that separates surface runoff. There is a broad divide between flow to the Grand Calumet River and directly to Lake Michigan in the area to the west of the Indiana Harbor Canal. To the west of the Canal, the divide is extremely broad in the notch formed by the Lake George Arm of the Canal and the Canal, but to the northwest a narrow ridge of groundwater acts as a divide. These relationships can be seen on Figure 3A. Also on Figure 3A, several small depressions in the water table with elevations below 580 feet exist, i.e., below the level of Lake Michigan. These depressions have been interpreted to be the result of drainage to sewers and are indicative of the numerous local flow cells.

Digital modeling of the groundwater system indicates that the shallow water table has been lowered several feet from predevelopment conditions. This lowering has been accomplished by downward leakage and/or by drainage into sewers and ditches. Furthermore, drains modeled in the shallow groundwater system create fully penetrating flow cells. Without drainage, the water table would be at or near the land surface everywhere, as in the predevelopment wetland which existed here. (USGS, 1988) (See Figure 3A)

Groundwater Contamination

During the past few years, the Indiana Department of Environmental Management (IDEM) has sponsored studies to learn the extent and magnitude of groundwater contamination in the area surrounding the Indiana Harbor Canal and the Grand Calumet River. The area groundwater is not used as a source of drinking water supply. None the less, it is important that we understand the full extent of groundwater contamination, so that we might initiate remedial measures which prevent contaminated groundwater migration into noncontaminated areas and endangerment of aquatic life in the river and canal.

IDEM has contracted study services through the Northwest Indiana Regional Planning Commission (NIRPC). The purpose of the study is to take all information gathered thus far from the NIRPC, the Indiana Department of Natural Resources (IDNR), the IDEM, the United States Geological Survey (USGS) and other sources, and analyze, categorize and summarize the data in a form readily accessible and understandable to IDEM and to the public. Results of this study are due in the spring of 1991.

The IDEM has also contracted groundwater studies through the U.S. Geological Survey. The objective of this study is to assess the potential for groundwater contaminants to migrate to Lake Michigan, the river or to the harbor. The study is complete but results have not been released to the public, awaiting full evaluation for quality assurance and quality control of data.

However, based upon written and verbal communication with the USGS, the IDEM has learned that:

1. *Sewers receive significant contributions of area groundwater. . . (The sewers act as a groundwater collection system in many areas, thus, some treatment is provided at area wastewater treatment plants.)*

2. *The river receives the majority of the remaining groundwater that is discharged from the subsurface.*

3. *The rest of the discharged groundwater goes to Lake Michigan and the underlying bedrock.*

4. *Groundwater under the steel and petrochemical land use areas generally had the most contamination for inorganic ions and organic chemicals.*

5. *The groundwater under the steel land use areas generally had the highest values for analyzed metals.*

6. *The wells on the commercial and light industrial land-use generally had groundwater that was less contaminated than the wells on the steel and petrochemical land-use areas and greater than the wells on residential and park land use areas.*

7. *Groundwater probably contributes more than ten percent of the total load to the Grand Calumet River of ammonia, chromium, and cyanide; 5 to 10 percent of the dissolved solids, sulfate, copper, iron, and lead; 1 to 5 percent of the chloride, fluorine, and chloride; and less than one percent of the nitrate plus nitrite, phosphorus plus orthophosphate, mercury and zinc.*

Chapter III - Section B

SOURCES OF POLLUTION

Overview

The documented sources of pollution to the Indiana Harbor, the Grand Calumet River system, and to the Nearshore Lake Michigan include direct discharges from steel mills, oil refineries, and chemical manufacturing plants, and discharges from three municipal wastewater treatment facilities.

Enforcement action is pending against many of these dischargers. Due to tougher water pollution laws and tougher enforcement of those laws, the amount of pollutants entering the waterways has significantly reduced over the past years. With Indiana's new Water Quality Standards, a further decrease of pollutants entering these waters is expected.

Water quality data have shown problems in these waters with several parameters including ammonia, dissolved oxygen, total phosphorus, chloride, sulfates, oil and grease, bacteria, cyanide, lead, copper, mercury and PCBs.

In addition to direct discharges, studies indicate many pollutants may be getting into the system from nonpoint sources, combined sewer overflows, landfills or groundwater contamination, rather than from individual or municipal point sources.

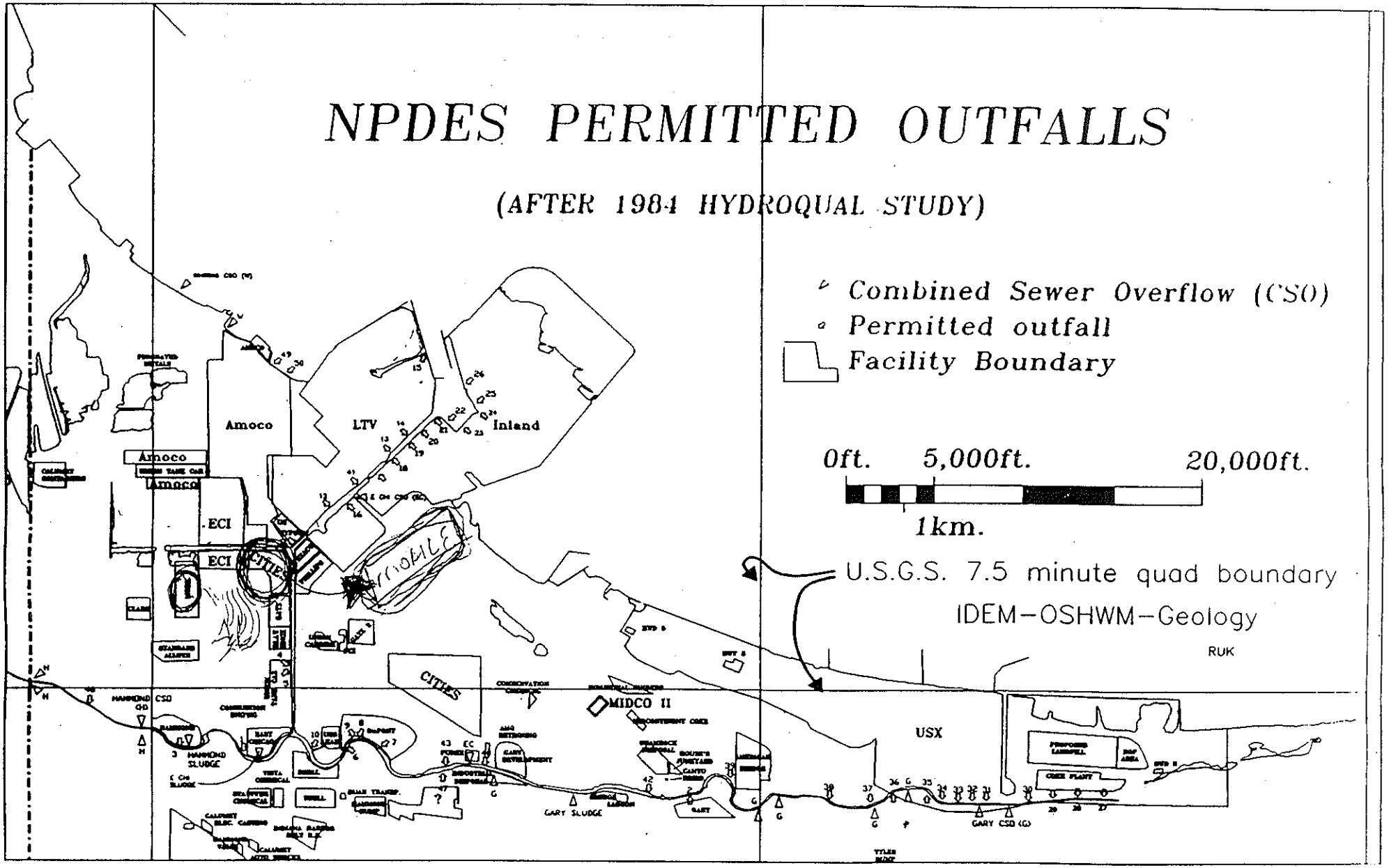
It is estimated that each year, eleven billion gallons of untreated wastewater enter the river, harbor and nearshore area through combined sewer overflows. Indirect discharges are numerous and much more difficult to identify, regulate and correct. Documented indirect discharges include storm water discharges, lagoon leakage, landfill drainage, and nonpermitted outfalls.

Major Pollutants of Concern in the Surface Waters

Historically, water quality monitoring data have shown problems in these waters with several parameters including ammonia, dissolved oxygen, total disolved solids, total phosphorus, chlorides, fluorides, sulfates, oil and grease, bacteria, cyanide, several metals (e.g., iron, lead, copper, mercury) and PCBs. More recent monitoring data from 1988-89 indicate that many of these same parameters are still at levels which exceed applicable water quality standards although most are found at lower levels than in the past (IDEM, 1990). These problems still exist in spite of the installation of new or expanded treatment facilities, partly because of poor management and operation of the municipal Publicly Owned Treatment Works (POTS)s, the recent increased productivity of the industrial facilities, and the application of new, more stringent water quality standards for this area.

Substantial problems have existed with oil sheens on the surface of much of the Grand Calumet River, especially in the vicinity of now-closed refineries and the barge transfer facilities (between river miles 4.0 and Lake Michigan, including the Lake George Branch). Historically, fat-oil-and-grease (FOG)

FIGURE 3C


NPDES PERMITTED OUTFALLS
(AFTER 1984 HYDROQUAL STUDY)
Combined Sewer Overflow (CSO)
Permitted outfall
Facility Boundary
0ft.
5,000ft.
20,000ft.
1km.
U.S.G.S. 7.5 minute quad boundary
IDEM–OSHWM–Geology
RUK
Amoco
LTV
Inland
ECI
CITIES
MIDCO II
USX
GARY SLUDGE
GARY CSO (G)
HAMMOND CSO
HAMMOND SLUDGE

levels have been high throughout the Indiana Harbor and the Grand Calumet River system. Significant reservoirs of FOG and petroleum-based materials persist in the sediments. It may not be possible to eliminate the oil sheen problem until the historical deposits (ie., the sediments), as well as current sources, such as highway runoff and combined sewer overflows, are eliminated.

Metals

In the past, total iron, mercury, lead and copper were occasionally found in concentrations of concern in the Indiana Harbor and the Grand Calumet River surface waters. Although concentrations of metals do not appear to have increased substantially, IDEM surface water monitoring in 1988-89 indicates that mercury, copper and lead are found at concentrations which often exceed newly promulgated water quality standards (IDEM, 1990).

Recent (1988-89) samples collected from the nearshore area of Lake Michigan indicate that copper. cadmium, and mercury were occasionally present in concentrations which exceed State water quality standards.

Cyanide

This substance has been a problem in the Indiana Harbor and the Grand Calumet River in the past, and recent sampling (1988-89) indicates that cyanide concentrations exceed water quality standards 30% to 70% of the time. Comparisons of cyanide concentrations in past samples with recent ones would indicate that substantial reductions in cyanide have occurred over this time, even though concentrations still are often higher than the newly promulgated standards. Cyanide does not appear to be a problem in the nearshore Lake Michigan water (IDEM, 1990).

Organics

Little historical information is available on organic substances in the Indiana Harbor and the Grand Calumet River, although phenol levels may have been of concern. In a 1988 IDEM survey of both ambient water and effluents in the Indiana Harbor and the Grand Calumet River, approximately 145 organic parameters were sampled. Of this number, only 35 were found at detectable levels in either ambient water or effluent samples. Of these, only 1,2-dichloroethane was found at levels which exceeded the newly promulgated water quality standards. Although acetone was also found in high concentrations in some ambient water samples; this appeared to be a sample contamination problem rather than an ambient water problem. Of the 35 organic parameters found above detectable levels, only 11 of these were detected in effluents (IDEM, 1990). This may indicate that many organics may be getting into the system from nonpoint sources, combined sewer overflows, landfills or groundwater contamination, rather than from individual or municipal point sources.

Conventional Parameters

Recent IDEM surveys and sampling in the Indiana Harbor and the Grand Calumet River (1988-89) show that problems still exist in portions of this system with dissolved oxygen, ammonia, bacteria and dissolved solids. Ammonia levels frequently exceed water quality standards in the upper portion of the east branch of the Grand Calumet River, the west branch of the Grand Calumet River and in the Indiana Harbor Canal. Dissolved oxygen levels in the West

Branch were measured at 0.0 mg/l several times in 1988-89, and were also below applicable standards frequently in the Indiana Harbor Canal. Low dissolved oxygen levels were rarely found in the East Branch of the Grand Calumet River during this time period. These parameters have historically been problems in this system. Although standards are not always attained, the magnitude and frequency of the exceedences are generally much less now than in the past. Bacterial levels have never been low enough to consistently support recreational uses. These bacterial levels probably remain high due to the large number of combined sewer overflows, frequent by-passing at the POTWs and runoff from urban areas. In recent years, nearshore Lake Michigan waters only rarely experienced dissolved oxygen, ammonia or bacteriological problems, except for isolated incidents involving bypassing or combined sewer overflows.

Industrial Point Sources

Industrial point sources have been classified by the U.S. EPA as either major or minor dischargers. Based on a review of NPDES records maintained by the Agency, five major industries discharge into the river, harbor and nearshore area, including:

- *Amoco Corporation*
- *Inland Steel Corporation*
- *LTV Steel Company'*
- *USS - Gary Works (USX)*
- *DuPont Corporation*

A brief description of each major industrial point source is provided in the following discussion. This information is based on the NPDES permits and recent IDEM sampling data.

USS - GARY WORKS (USX)

The USS Gary Works, operated by USX, produces iron and steel products, coke, and coal chemicals. The facility has 24 permitted outfalls discharging into Lake Michigan and the Grand Calumet River. Approximately 350 million gallons per day (MGD) of cooling water and process wastewaters are discharged from the outfalls entering the Grand Calumet River, and an additional 200 MGD is recycled within the facility. Treatment is provided for process wastewaters and some cooling waters.

The present National Pollutant Discharge Elimination System (NPDES) permit for USX became effective on June 1, 1983, and expired on May 31, 1988. The permit regulates 24 separate outfalls to the Lake Michigan and the Grand Calumet River. The effluent limitations are based on Federal guidelines for the Iron and Steel Manufacturing Point Source Category (40 CFR 420), Indiana Water Quality Standards for the Grand Calumet River, and a Consent Decree issued September 27, 1977 (as modified July 10, 1980).

Effluent limitations at each outfall vary according to the type of waters discharged. Depending on the particular outfall, the permit controls iron, total suspended solids (TSS), pH, ammonia, cyanide, phenols, oil and grease, zinc, lead, total residual chlorine and chromium. At several outfalls monitoring is required only for sulfate, fluoride, chloride, iron, and water temperature. The permit also includes two special conditions. The first is a

characterization and monitoring study designed to minimize the discharge of cokemaking and ironmaking wastewater pollutants. The second condition is an organic pollutant monitoring study designed to determine the presence and quantity of certain toxic organic pollutants in process wastewaters. The permitted effluent limitations will be revised in the permit which is to be reissued in the near future.

In November 1987, the U.S. EPA initiated an administrative enforcement action against USX Corporation for discharging coke plant wastewater to the Gary Sanitary District in violation of pretreatment standards for ammonia, phenols, and cyanide. Violations cited in this Order were also later cited in the civil action filed by the United States in Federal District Court in October, 1988. Other violations cited were failure to report spill incidents (at least 25 spills since 1983) and discharging process wastewater through cooling water outfalls. In July, 1990, a consent decree was filed in the U.S. District Court in which USX agreed to:

- *Spend at least $25 million to upgrade its wastewater treatment equipment and related facilities.*
- *Spend $7.5 million to investigate and clean up contaminated sediments on the Grand Calumet River bottom, and determine the makeup and toxicity of sediments in the riverbed from the headwaters to Columbus Street and develop a plan to remove or contain them between the headwaters and GSD by September 1995.*
- *Pay a $1.6 million civil penalty for past water pollution violations, and various stipulated penalties for future violations.*
- *Develop a comprehensive management plan by June 30, 1991, to permit direct discharge of coke plant wastewater.*
- *Finalize a corrective action plan to reduce the amount of ammonia, cyanide and phenols in wastewater discharged from the coke plant and blast furnaces.*
- *Improve overall system to collect and treat wastewater from the steel-making finishing process at the plant.*
- *Design a program to reduce the visible oil and grease discharged from the steel plant.*
- *Install improved outfall monitoring locations and additional monitoring equipment at selected outfalls.*
- *Meet tighter effluent standards and conduct additional monitoring at selected locations.*

According to Discharge Monitoring Reports submitted to the State from USX, in 1989 the steel company discharged 880,926 pounds of chloride, 105 pounds of cyanide, 5,361 pounds of fluoride, .11 pounds of lead, 12,742 pounds of ammonia nitrogen, 245,506 pounds of oil and grease, 363 pounds of total phenolics, 36,452 pounds of total suspended solids, 204,613 pounds of total sulfate and .11 pounds of zinc into the Grand Calumet River and nearshore Lake Michigan waters.

INLAND STEEL COMPANY

The Inland Steel Company plant in East Chicago is an integrated steel and coke production facility. The plant produces iron, coke, coal chemicals, steel and steel products, as well as a portion of its own electricity. The discharges consist of cooling waters and process wastewaters amounting to 455 MGD. Wastewater treatment is provided for industrial process waters and sanitary wastewaters. About 370 MGD of cooling and treated process waters are recycled within the plant.

The current Inland Steel NPDES permit became effective on March 6, 1984, and expired on February 28, 1989. The permit is currently being revised. The permit regulates 13 separate outfalls to the Indiana Harbor and the Grand Calumet River. Effluent limitations are based on federal guidelines for Iron and Steel Manufacturing Point Source Categories and water quality standards for the Indiana Harbor Ship Canal, Grand Calumet River and Lake Michigan. Pollutants regulated by the permit vary from outfall to outfall, due to the different wastewaters discharged. The permit limits the discharge of suspended solids, oil and grease, pH, lead, zinc, cyanide, phenols, ammonia, BOD, and fecal coliforms. The permit also requires monitoring at several outfalls for chromium, copper, nickel, zinc, lead, chlorine residual, chloride, sulfate and fluoride. Additionally, the permit requires several unique study programs and subsequent construction to reduce process wastewater contamination of noncontact cooling waters, increase recycled water usage, and reduce priority pollutant discharges.

In October, 1990, the U.S. EPA filed a lawsuit in federal court alleging that Inland violated several federal environmental laws including the Clean Water Act. This multimillion dollar lawsuit is pending before the court.

LTV STEEL COMPANY

The LTV Steel Company, formerly Jones and Laughlin Steel Company Indiana Harbor Works, and formerly owned by Youngstown Sheet and Tube Company, manufactures sheet, tube and structural steel shapes. The facility has five active direct outfalls and three internal monitoring points which discharge about 180 MGD of cooling and process waters into the Indiana Harbor Canal. The permit also authorizes four emergency overflow/stormwater discharge points. Another 57 MGD, which was discharged prior to 1981, is recycled within the plant. About 58.6 MGD of process wastewaters receive physical-chemical treatment prior to discharge. The average pollutant characteristics of the 1988 discharge are: 9.33 mg/l of TSS, 0.602 mg/l of ammonia, 0.0103 mg/l of cyanide, 18.91 mg/l of chloride, 22.54 mg/l of sulfate, 0.357 mg/l of fluoride, 53.17 ug/l of chromium, 277.5 ug/l of iron, 22 ug/l of lead and 89.08 ug/l of phenolics.

The LTV Steel NPDES permit was reissued on September 30, 1986, and will expire on September 29, 1991. Depending on the type of wastewater discharged, permit effluent limitations exist for ammonia, phenols, cyanide, oil and grease, pH, suspended solids, tin, zinc, lead, chromium, and temperature. These limitations are based on Indiana Water Quality Standards, Federal Effluent Guidelines for the Iron and Steel Point Source Category (40 CFR 420) and the Wasteload Allocation Study for the Indiana Harbor and the Grand Calumet River. The facility continues to violate its NPDES permit,

particularly for the parameters of phenols, lead and zinc. Additionally, oil spills have occurred from LTV's oil recovery project pit. In October of 1990, the Indiana Department of Environmental Management filed a multimillion dollar lawsuit against LTV Steel for violations of the NPDES Permit and for violations of two Administrative Agreed Orders. The matter is pending before the court.

According to Discharge Monitoring Reports provided by LTV Steel to the State, in 1989, the Company discharged 163,147 pounds of chloride, 118 pounds of Chromium, 173 pounds of cyanide, 2,681 pounds of fluoride, 2,453 pounds of iron, 110 pounds of lead, 33,571 pounds of oil and grease, 123,314 pounds of solids, 210,064 pounds of sulfate, 107 pounds of tin, and 628 pounds of zinc, into the Indiana Harbor.

E. I. DUPONT DE NEMOURS AND COMPANY

The most recent NPDES permit for the DuPont facility became effective on March 29, 1985, and expired on February 28, 1990. Limitations were included on oil and grease, pH, BOD, total suspended solids, dissolved solids, chlorides, sulfates, and ammonia. A fact sheet accompanying the permit indicated that the company now only manufactures one herbicide, fluorosultonic acid, and two silica products. Historically, however, the facility was quite large and manufactured many toxic substances.

DuPont recently reported 36 potential waste management units buried on site, many of which are buried in large quantities. Many of the contaminants may be mobile in the environment and threaten aquatic life in the Grand Calumet River. DuPont began a plan of ground water assessment on May 1, 1990. It is believed that contaminates have entered the river via storm water pipes and/or ground water. Further study is underway.

According to Discharge Monitoring Reports submitted to the State by Dupont, in 1989 the company discharged 772 pounds of Chloride, 244,351 pounds of Dissolved Solids, 774 pounds of Suspended Solids, and 182,179 pounds of Sulfate into the Grand Calumet River.

U.S.S. LEAD REFINERY, INC.

U.S.S. Lead Refinery, Inc., had one permitted outfall discharging to the Grand Calumet River, but it has ceased to discharge process wastes. It is in bankruptcy proceedings. A partial interim Agreed Order was issued on March 28, 1990, for violations of total lead. This facility is currently undergoing 'Superfund' evaluation.

MUNICIPAL WASTEWATER SOURCES

Three municipal wastewater treatment plants, serving the East Chicago, Gary and Hammond sanitary districts, discharge into the Indiana Harbor and the Grand Calumet River system. Brief descriptions of each of these plants, their NPDES limitations, pollutant loadings to the Indiana Harbor and the Grand Calumet River, and compliance histories are provided in this section.

THE HAMMOND SANITARY DISTRICT

The existing NPDES limitations for the Hammond Sanitary District include CBOD5, TSS, phosphorus, ammonia-nitrogen, fecal coliform, total residual chlorine, cadmium, chromium, copper, cyanide, iron, lead, mercury, nickel, zinc, oil and grease, phenols, total dissolved solids, chlorides, sulfates, fluoride, and pH.

The Hammond Sanitary District (HSD) was required to abate combined sewer overflows to the Grand and Little Calumet Rivers and Wolf Lake by July 1, 1977, install sewage treatment plant additions and advanced waste treatment by December 31, 1972, and abate polluted storm sewer discharges to Lake Michigan by December 31, 1970 (Technical Committee on Water Quality, 1970).

Failure to complete the storm sewer work by the specified deadline resulted in a 180-day notice by the Enforcement Division of U.S. EPA on October 12, 1971. Complete sewer separation of the Robertsdale area of Hammond resulted in May 1973, with discharge of only chlorinated storm water to Lake Michigan. The same 180-day notice required the completion of the plant work by December 7, 1973 (Snow, 1974). Actual improvements were completed in 1977 (U.S. EPA, 1985).

During the summer of 1980, Chicago beaches were closed on numerous occasions due to contamination by fecal matter and grease balls. An investigation determined that the source of the material was the Robertsdale Pumping Station of the HSD. In 1980, the United States and the State of Indiana filed a civil action against the HSD. HSD discovered the cross-connections and leaks between its sanitary system and the storm system via dye testing and implemented corrective actions, pursuant to a preliminary injunction by the District Court. A second order required the elimination of inflow sources to the sanitary sewer system and the construction of a five-mile force main to ensure wastewater from Lever Brothers reached the HSD treatment plant. The second order also required a $50,000 penalty. This work was completed in 1981.

On July 6, 1983, U.S. EPA again filed suit against HSD for its discharge of sludge to the Grand Calumet River, from its sludge lagoons located east of Columbia Avenue on the Grand Calumet River. As part of a comprehensive settlement entered in District Court on December 16, 1986, the HSD was required to construct and operate adequate sludge handling facilities, close its sludge lagoons, implement its approved pretreatment program and a pay a $50,000 fine. The State of Indiana was co-plaintiff in that action. HSD failed to live up to the terms of that agreement. On March 16, 1988, the U.S. EPA initiated contempt proceedings against HSD for its failure to close its sludge lagoons in a timely fashion and for failure to implement its pretreatment program. An investigation related to two fish kills in the Calumet River in Illinois and discovery in that case, led to the realization that the problems at HSD were much more severe than the complaint filed in court in 1988 alleged.

Since that time, construction of additional nitrification facilities (four tanks), three additional final clarifiers, installation of dry weather bleedback pumps in the combined sewer overflow pumping stations and the installation of additional sludge thickening facilities, has occurred. These modifications significantly improved effluent quality. An illegal bypass has

also been eliminated pursuant to an IDEM Commissioner's Order, and all flows bypassing the tertiary filters are now routed through chlorination and discharged via the main plant outfall. (The former superintendent of the HSD has agreed to plead guilty to four felony counts for having submitted falsified Discharge Monitoring Reports to the State and to the U.S. EPA.) In addition, many process control improvements have been implemented through the assistance of a management contract. Contract assistance has also been utilized to implement the pretreatment program. Numerous additional improvements to the wastewater treatment plant and sewer system are still required, however.

Based upon past history, the ability of the Hammond Sanitary District to operate its wastewater treatment plant and its sewerage collection system with long-term compliance of State and federal standards remains questionable without diligent oversight by the State of Indiana and the U.S. EPA. Noncompliance issues remain before the federal court.

According to Discharge Monitoring Reports submitted to the State from Hammond, in 1989 this community discharged 1,145,821 pound of Chloride, 41 pounds of Chromium, 47 pounds of cyanide, 6.674 pounds of Fluoride, 732 pounds of Iron, 31 pounds of Lead, 1 pound of mercury, 7,265 pounds of ammonia nitrogen, 109 pounds of phenolics, 1,838 pounds of phosphorus, 3,568,886 pounds of dissolved solids, and 1,100,497 pounds of sulfates into the Grand Calumet River. This does not include discharges from Combined Sewer Overflows (CSO)s.

THE GARY SANITARY DISTRICT

The Gary facility is a 60 MGD advanced wastewater treatment (AWT) plant. The plant uses an activated sludge process with two-stage nitrification, phosphorus removal, and sand filtration. Historical data provided by the Gary Sanitary District indicate a slight reduction in treated flow over the last 20 years, from an annual average of 48.5 MGD in 1968 to 45.3 MGD in 1989. However, due to unreported CSO discharges, all data are suspect of inaccuracy.

The latest NPDES permit for the Gary POTW was reissued on September 30, 1985, and expires August 31, 1990. The permit contains limits for BOD, suspended solids, fecal coliform, phosphorus, phenol, cyanide, ammonia, oil and grease dissolved oxygen, total residual chlorine and pH.

The Gary Sanitary District (GSD) was required to implement phosphorus reduction by December 31, 1972, and install advanced treatment and eliminate or control combined sewer overflows, by July 1, 1977 (Technical Committee on Water Quality, 1970). The State of Indiana, through its Stream Pollution Control Board, initiated a civil action against the GSD. Later, the U.S. EPA issued a 180-day notice to GSD, to implement phosphorous removal, advanced waste treatment and combined sewer overflow control. GSD was set to begin implementation of its phosphorous control and overflow control programs in early 1973 (upon the receipt of federal funds) when construction was delayed due to a citizen suit against the bond sales (Snow, 1974).

As a result of this delay, GSD failed to comply with the July 1, 1977, deadline for secondary treatment and therefore remained a long way from advanced waste treatment.

On January 23, 1978, the United States filed a civil action against GSD. On January 25, 1978, the State of Indiana filed a supplemental complaint and a motion to intervene. On December 15, 1978, the United States filed a motion for preliminary injunction against GSD and that motion was resolved via a Consent Preliminary Order. GSD agreed to bring its facilities into compliance with secondary treatment by April 1, 1979, and also to implement a litany of critical actions for proper operation of its plant by that date.

On June 15, 1983, a final Consent Decree, specifying the complete actions required by the GSD to achieve compliance with advanced waste treatment limitations was entered by the Court. This decree also contained extensive requirements on the proper operation of the treatment plant, collection system, and pretreatment program and was intended to result in long-term compliance. It did not.

The United States filed a motion to enforce the terms of the 1983 judgment in September, 1984. A lengthy period of negotiation ensued over the terms and schedules of a modified decree. Prior to reaching agreement, on July 15, 1986, the United States filed a separate civil action alleging that the GSD was improperly storing polychlorinated biphenyls (PCBs) in the Ralston Street lagoon and needed to implement measures to properly close this sludge lagoon pursuant to the requirements of the Toxic Substances Control Act. The Ralston Street sludge lagoon is on the banks of the Grand Calumet River immediately downstream of United States Steel. It contains 600,000 yards^3 of sludge and 60,000 pounds. of PCBs. The two cases were consolidated by a stipulated order on June 16, 1987, and a Modified Consent Decree resolving the 1984 and 1986 suits was entered with the Court on September 8, 1987.

The 1987 Decree specified that the final limitations of the NPDES permit were to be met immediately and also specified an extensive remedial program covering every aspect of wastewater treatment plant operation and maintenance. Specifically, the Decree covered hiring of personnel, training, maintenance, detailed corrective measures on various pieces of equipment, and even spare parts to be maintained. It also addressed overflows and bypasses, user charges, pretreatment, grant completion, and closure of the Ralston Street Lagoon. The Decree further specified that the $1 million penalty imposed be suspended, provided that compliance with the decree's terms and conditions was maintained.

The District's violations of the 1987 Decree are outlined in the United States' Motion to Confirm Penalty is Due and Owing filed with the Court on July 15, 1988, and its Motion to Show Cause Why GSD Should Not be Held in Contempt of Court filed September 25, 1989. Both motions are pending before the Court, and a trial on the merits of both motions underway while this Stage One Remedial Action Plan (RAP) is being prepared.

Over the past ten years the United States and the State of Indiana have awarded grants for in excess of 95 million dollars wastewater treatment plant improvements to the Gary Sanitary District.

According to Discharge Monitoring Reports submitted by the GSD to the State, in 1989 the City of Gary discharged 459,994 pounds of chloride, 247 pounds of chromium, 46 pounds of cyanide, 22,636 pounds of fluoride, 6,442 pounds of iron, 170 pounds of lead, .96 pounds of mercury, 3,633 pounds of

ammonia nitrogen, 219 pounds of phenolics, 2,674 pounds of phosphorus, 1,686,366 pounds of dissolved solids, 100,668 pounds of suspended solids, and 309,151 pounds of sulfate.

This does not include discharges through combined sewer overflows.

THE EAST CHICAGO SANITARY DISTRICT

The East Chicago Sanitary District (ECSD) completed construction of a new wastewater treatment facility in the spring of 1988. This plant consists of a Class IV, 15 MGD facility with two 4.2 million gallon oxidation ditches, five 100 foot diameter clarifiers, six sand filters for tertiary treatment, post-aeration and ultraviolet disinfection. Phosphorus removal is achieved with the addition of ferric sulfate. Average effluent data for 1989 as compared with 1982 data is provided as follows:

Parameter	1982	1989	% Improvement
$TBOD_5$ mg/L	73	2.1	97%
TSS mg/L	99	5.2	95%
$TBOD_5$ lb/day	10,415	249	97%
TSS lb/day	15,013	637	95%

Combined sewer overflow from the Magoun Avenue Pumping Station flows to a CSO storage lagoon for aeration and settling before discharge. Combined sewer overflow from the Alder Street Pumping Station discharges directly to the Grand Calumet River. Michigan Avenue Pumping Station discharges CSO to the Indiana Harbor Ship Canal. The Toll Road Pumping Station discharges stormwater to the Grand Calumet River. Stormwater is discharged to the Indiana Harbor Ship Canal from the Canal Street Pumping Station.

The East Chicago Sanitary District has compiled priority pollutant data on a semiannual basis since July, 1988, in accordance with permit requirements. The data has shown significant reductions and elimination of pollutants found previously in the influent, effluent and sludge. According to Discharge Monitoring Reports submitted by East Chicago to the State, the ECSD discharged 173,044 pounds of chloride, 1,474 pounds of fluoride, 99 pounds of iron, 246 pounds of ammonia nitrogen, 138 pounds of phosphorus, 727,445 pounds of dissolved solids, 7,615 pounds of total suspended solids, and 164,547 pounds of total sulfate. The level of priority pollutants present in the East Chicago wastewater is significantly below the chronic or acute toxicity levels as established by regulation. It should be noted that the East Chicago Sanitary District has made positive efforts towards compliance with its NPDES Permit during the past several years.

Minor Industrial Dischargers

Minor industrial dischargers to the Grand Calumet River include: Vulcan Materials Company, American Steel Foundries, Blaw Knox Foundry, Industrial Disposal and Explorer Pipeline Company and Citco Petroleum Corporation. The American Steel Foundries discharges into the Indiana Harbor.

Continuous Point Sources

The continuous point sources of pollutants to the Indiana Harbor and the Grand Calumet River, and eventually to the harbor, include the three POTWs and the numerous direct industrial discharges discussed in the previous chapter. Pollutant loadings for conventional parameters to the Indiana Harbor and the Grand Calumet River are presented in the Indiana Harbor and the Grand Calumet River Master Plan. The rates of sediment deposition and resuspension have not been fully determined, hence, it is not possible to relate these loadings to final harbor loadings.

Intermittent Point Sources

Intermittent point sources of pollutants to the Indiana Harbor and the Grand Calumet River include combined sewer overflows (CSOs), unintentional sewer overflows and bypasses, and intermittent industrial discharges. The specific relationship between Indiana Harbor and the Grand Calumet River pollutant loadings and ultimate harbor loadings has not been established.

Combined Sewer Overflows

CSO outfalls discharge an estimated 11 billion gallons of raw wastewater to the Indiana Harbor and the Grand Calumet River, on an annual basis. These CSO discharges can include significant quantities of toxic pollutants from industrial discharges contributing to the sewer system upstream of CSO overflows. Annual discharge volume estimates for the reported CSO points are listed, as billions of gallons per year, in Table 3A.

If the annual overflow volume estimates for each outfall are grouped and summed according to sanitary district boundaries, it is found that the CSO problem is distributed more-or-less equally (i.e., roughly one-third of the problem is attributed to each sanitary district). In actuality, however, the impact on each subarea will depend more strongly on what pollutant loads are associated with each CSO and CSO locations relative to areas of oxygen deficiencies and sediment accumulation.

CSO outfalls in the Indiana Harbor and the Grand Calumet River have been shown to be sources of contaminants adversely affecting nearshore water quality in southern Lake Michigan. Fecal coliform organisms, the principal analog parameter for sewerage pollution from CSOs, are short-lived in sunlight and die off in a matter of hours or days. Therefore, it is most probable that CSOs from the Indiana Harbor and the lower half of the Grand Calumet River have the most direct, adverse impact on beaches along the southwest Lake Michigan coast.

It is calculated that 57% of the CSO volume, on an annual basis, stems from discharge points downstream of river mile 8.0 (Cline Avenue). Impacts of CSO and other waste sources on Lake Michigan was investigated in a study performed for the Great Lakes National Program Office of the U.S. EPA.

TABLE 3A

COMBINED SEWER OVERFLOWS TO THE GRAND CALUMET RIVER
LOCATIONS AND CHARACTERISTICS
(U.S. EPA 1985)

Map CSO Number	Mile-Segment[1] [Cross St.]	Sanitary District	Est. Annual Overflow Vol. [References below]
1	12.6-E.Br.	Gary	1.25 bg/year (U.S. EPA, 1983)
2	12.3-E.Br. [Virginia St.]	Gary	0.59 bg/year (U.S. EPA, 1983)
3	11.2-E.Br. [Hwy 90]	Gary	0.09 bg/year (U.S. EPA, 1983)
4	11.0-E.Br. [Buchanan St.]	Gary	0.27 bg/year (U.S. EPA, 1983)
5	10.0-E.Br. [Bridge St.]	Gary	0.43 bg/year (U.S. EPA, 1983)
6	9.4-E.Br. [Hwy 90]	Gary	0.89 bg/year (U.S. EPA, 1983)
7	7.6-E.Br.	Gary	0.75 bg/year (U.S. EPA, 1983)
9	4.7-E.Br. [Kennedy Ave.]	Hammond	1.80 bg/year (U.S. EPA, 1983)
11	6.0-W.Br. [Columbia Ave.]	Hammond (pump sta.)	1.22 bg/year (U.S. EPA, 1983)
12	6.0-W.Br. [Columbia Ave.]	Hammond	0.09 bg/year (U.S. EPA, 1983)

TABLE 3A (Continued)

COMBINED SEWER OVERFLOWS TO THE GRAND CALUMET RIVER
LOCATIONS AND CHARACTERISTICS
(U.S. EPA 1985)

Map CSO Number below]	Mile-Segment[1] [Cross St.]	Sanitary District	Est. Annual Overflow Vol. [References
13 (N/A)	1.7-S.Ca. [Turning basin]	E. Chicago	0.23 bg/year

(1) River miles, as delineated in ISBH 1984. Name of Segment or Reach: E.Br.= East Branch; W.Br. = West Branch; M.St. = Main Stem; S.Ca. = Ship Canal, from Lake George Branch to Harbor.

Nonpoint Sources of Water Pollution

Nonpoint sources of contaminant input to the Grand Calumet River and the Indiana Harbor Canal include urban runoff, seepage of contaminated ground water from waste lagoons, landfills, and industrial properties contiguous to the river.

To date, a number of studies are underway to learn the extent of nonpoint source contamination to the river and harbor. As these studies are made final and made public, the data will be incorporated into the Remedial Action Plan process.

Urban Runoff

Urbanization has affected natural vegetation and natural infiltration characteristics of the Area of Concern Watershed and has led to degraded water quality in the river and harbor. In the summer of 1990, the U.S. EPA and the IDEM contracted the services of the Lake County Soil Conservation District to investigate sources of urban runoff in the Area of Concern. The results of this plan are expected in 1991.

Significant sources of urban runoff are storm water discharges and combined sewer overflows.

Air Deposition

Air Toxics are believed to be transported from the source into the river, the harbor and into the Great Lakes. This issue of Air Deposition merits a separate chapter in this Remedial Action Plan. Please see Chapter IV, 'The Air'.

Groundwater Contamination

The USGS, in cooperation with the IDEM recently completed a preliminary report to characterize ground water contaminants in the Area of Concern. Upon completion of quality assurance quality control review, it will be publicized and also included in the Remedial Action Plan. Further discussion of this study is found in the beginning of the previous chapter.

Chapter III - Section C

WATER QUALITY STANDARDS

Overview

Water Quality Standards for the surface waters of the State of Indiana are established by the Indiana Water Pollution Control Board (IWPCB). New Water Quality Standards were adopted for Lake Michigan and the Grand Calumet River and the Indiana Harbor Canal, effective March 3, 1990. The New Water Quality Standards are consistent with the goal of the federal Clean Water Act for water quality that provides for the protection of fish, shellfish, wildlife, and recreation in and on the water. Under these new standards, the Indiana portion of Lake Michigan was designated as a State resource water and was afforded the protection that goes with this designation (i.e., existing water quality shall be maintained or improved with no degradation). The new standards provided numerical criteria for approximately 100 substances and specified that mixing zones would not be granted for discharges to the lake. The Ammonia criteria standards are less restrictive than the Great Lakes Water Quality Agreement values (i.e. Aquatic Life) for some specific sites and daily maximums.

The new water quality standards upgraded the river and harbor to the same aquatic life and recreational uses as other warm water streams in Indiana. They also provided for numerical criteria for approximately 90 pollutants. These standards were adopted not only to protect and enhance waters of the Indiana Harbor and the Grand Calumet River but to further protect the uses and quality of Lake Michigan waters. Further, the new standards state that Lake Michigan and specific tributary streams shall be capable of supporting a salmonid fishery.

Designated Use

Section 131.10(b) of 40 CFR specifies that in designating water body uses and the corresponding criteria for protection of said uses, the State must consider the designated uses and water quality standards of downstream waters. Adopted standards for the water body under consideration must provide for attainment and maintenance of the duly established water quality standards of downstream waters.

Antidegradation Policy

Section 131.6(d) of 40 CFR specifies that the State adopt an antidegradation policy consistent with Section 131.12. Pursuant to the latter section, the State must identify methods for implementing the antidegradation policy such that existing instream uses are maintained and protected. The NPDES program and the Waste Load Allocation (WLA) are utilized by the State for maintaining and protecting the designated uses of the Indiana Harbor and the Grand Calumet River and Lake Michigan.

Water Quality Standards Revision

40 CFR 131.20 requires that each State review its promulgated water

quality standards at least once every three years and either revise or adopt standards protective of the aquatic systems under examination. Section 131.11 of 40 CFR specifies that states must adopt water quality criteria protective of designated uses. Such criteria are to be based on sound scientific rationale. The last revision to the State water quality standards for the Indiana Harbor and the Grand Calumet River occurred in 1990. Prior to that time, the U.S. EPA published new guidelines for deriving water quality criteria, in November 1980 (45 CFR 79318). These guidelines were later revised, in February, 1984 (49 CFR 4551). Ambient water quality criteria were published for 65 Section 307(a)(l) priority pollutants, as well as for ammonia, chlorine, and DO. The 1990 revisions to the water quality standards for the Indiana Harbor and the Grand Calumet River reflect this information.

As part of the Remedial Action Plan, water quality will be evaluated and improvements will be documented in the State Water Quality Report

A copy of Indiana's New Water Quality Standard is available on request.

Chapter IV

THE AIR

Overview

Atmospheric deposition occurs when airborne pollution particles are deposited from the atmosphere to a medium. There are two types of atmospheric deposition which occur: wet deposition and dry deposition acid rain. The phenomenon of acid rain consists of both wet and dry deposition. Airborne nitrogen and sulfur compounds react with moisture in the air and are precipitated to earth in the form of liquid nitric and sulfuric acid during wet deposition. Dry deposition occurs when nitrogen and sulfur particles fall to earth during dry weather periods and react with surface water, rain, dew, and fog to form the acidic compounds. Research indicates that atmospheric deposition contributes from 46% to 99% of the lead, 7% to 90% of the PCBs, 22% to 97% of the DDTs, and 72% to 96% of benxo-a-pyrene entering the Great Lakes waters, depending on contributions from other media to each of the respective lakes.

IDEM has participated in several special high risk point source studies to evaluate risk impacts from toxic emissions at various places. The Lake County area of southeast Chicago was included in a study by U.S. EPA to determine if the combined air toxic sources create an increased cancer risk for people living in this area. The coke ovens were cited as the largest sources of toxic air pollutants and accounted for the greater percentage of predicted increased cancer risks in the area.

Atmospheric Deposition

The atmospheric deposition of toxic substances is of increasing concern to IDEM and the public. Toxics may be invisible, odorless, and persistent in the environment. Sources of toxics (which include PAHs, dioxins, furans, PCBs, heavy metals, insecticides and organic solvents) include fossil fuel combustion, waste incineration, coke ovens and industrial, commercial and consumer solvent usage (evaporation).

In 1986, the Great Lake States' governors and environmental administrators signed agreements requiring the Best Available Control Technology (BACT) be installed on all new and existing sources of persistent air toxic pollutants which impact the Great Lakes. These agreements are known as the "Great Lakes Toxic Substance Control Agreement" and "Toxic Substances Management in the Great Lakes Basin Through the Permitting Process," respectively. These agreements set permitting limits, control requirements and interagency communication procedures for sources releasing the air toxics of concern. The first set of pollutants to be addressed are:

mercury
alkylated lead compounds
polychlorinated biphenyls (PCBs)
hexachlorobenzene
benzo-a-pyrene
2,3,7,8-tetrachlorodibenzo-p-dioxins (dioxins)
2,3,7,8-tetrachlorodibenzofurans (furans)

The phenomenon of atmospheric desposition and long range transport has been clearly demonstrated in research done on Isle Royale in Lake Superior. There are no known direct sources of chemical contaminants to Siskiwit Lake on Isle Royale; however several toxic chemicals have been detected in the lake's waters. The discovery of these compounds, such as toxaphene and insecticide, which is used extensively on cotton crops in the southern United States but very little in the Great Lakes area, indicates that toxic chemicals are transported through the air into the region. Data suggests that normal weather patterns bring pollutants to the Great Lakes from as far away as Mexico and Central America. Research indicates that atmospheric deposition contributes from 46% to 99% of the lead, 7% to 90% of the PCBs, 22% to 97% of the DDTs and 72% to 96% of benzo-a-pyrene entering the Great Lakes waters, depending on contributions from other media to each of the respective lakes.

IDEM has recently proposed an aggressive program to control air toxics which will compliment expected amendments to the Federal Clean Air Act. The proposed program is based on implementation of Maximum Achievable Control Technology (MACT) requirements. Included in this proposal are provisions to implement BACT on all new and existing sources of the seven Great Lakes priority pollutants. Because much of the deposition of air toxics into the Great Lakes occurs through long range transport, efforts have been made to include provisions to address this problem in the proposed Clean Air Act amendments.

Air Quality Standards

Under the Clean Air Act, U.S. EPA has established National Ambient Air Quality Standards (NAAQS) for six criteria air pollutants. These are listed below, along with their sources and the potential adverse health effects they can cause:

Sulfur dioxide is emitted mostly from coal, oil and coke oven gas combustion sources. It contributes to coughs, colds, asthma, bronchitis and other complications.

Nitrogen dioxide is formed when nitrogen is emitted from fossil fuel combustion and reacts with oxygen in the air. It lowers human resistance to pneumonia, flu, bronchitis, etc., and is a key ingredient in urban smog.

Ozone is formed when hydrocarbons, nitrogen dioxide and other chemicals react with sunlight. It is a toxic form of oxygen which can damage the lungs and lowers human resistance to pneumonia, flu, bronchitis, etc.

Lead in Lake County comes from three major sources. Lead in gasoline is being phased out by the U.S. EPA. Lead damages the kidneys, nerves, blood and is of special concern in small children and the unborn.

Particulate matter includes soot and dust. Small particles (less than 10 microns) cause or aggravate lung problems such as bronchitis, and can also carry and deposit poisons into the lungs.

Carbon monoxide is given off predominantly by motor vehicles. It slows peoples reflexes, causes drowsiness and is a special threat to pregnant women and people with heart problems.

Small children and elderly people are much more susceptible to the adverse health effects associated with exposure to these pollutants. Table 4A lists the criteria pollutants and their NAAQS.

In addition to establishing NAAQS, U.S. EPA's role under the Clean Air Act involves adopting certain national programs such as New Source Performance Standards (NSPS), National Emissions Standards for Hazardous Air Pollutants (NESHAPS), implementing the Federal Motor Vehicles Control Program (FMVCP) and determining the adequacy of state plans. Much of the authority of implementing these programs has been delegated by U.S. EPA to IDEM.

Air Quality Guidelines

The Clean Air Act requires the states to develop and implement a plan (i.e., State Implementation Plan or SIP) to attain the NAAQS.

Regions of Lake County are currently classified as nonattainment of NAAQS for particulate matter, ozone, carbon monoxide and sulfur dioxide. The nonattainment status means that air quality in these areas has not complied with the NAAQS. IDEM uses monitored data as well as dispersion modeling data to determine the compliance status and ambient concentrations for these criteria pollutants. Source specific emission limitations have been set by the Air Pollution Control Board in Title 326 of the Indiana Administrative Code for compliance of the NAAQS.

Air Quality Objectives

An overall objective for IDEM has been to develop the rules and policies which make up an adequate SIP so that all areas of the State meet the NAAQS, and in the process, protect public health.

National Ambient Air Quality Standards for air toxics have not been established. IDEM has been active in developing an air toxics program which will compliment expected Federal Clean Air Act amendments in 1990. Air toxic emissions are screened to estimate toxic concentrations at the property line to determine whether an increased risk exists in the vicinity of the emissions. IDEM applies appropriate safety factors to standards or benchmarks established by OSHA or U.S. EPA's Cancer Assessment Group to develop acceptable ambient air concentrations for toxic air pollutants. If unacceptable concentrations are determined from this screening process, a more detailed model is run to more closely estimate ambient concentrations and associated health risk impact.

IDEM currently regulates air toxics under U.S. EPA's NESHAPS Program. Air emissions of toxics are also regulated, to some extent, by rules which require reductions in criteria pollutants, primarily VOC (volatile organic compounds) and particulate matter (metals), in order to attain National Ambient Air Quality Standards.

IDEM also has air toxics monitors in Hammond collecting data on the ambient concentrations of these pollutants. The monitored data is compared to emissions data to estimate contributions from certain sources. Comparing the monitored concentrations to the OSHA or U.S. EPA standard for health risk assessments is also done.

Air Quality Program

Regions of Lake County are currently classified as nonattainment of NAAQS for particulate matter, ozone, carbon monoxide and sulfur dioxide.

The development of plans to meet the air quality standards embraces a comprehensive program of inventory development consisting of point, area and mobile sources, modeling, control strategy formulation and testing. Once control measures are established, enforcement activities are initiated to ensure compliance. A major portion of the enforcement activity in Lake County is conducted by the Gary and Hammond local air pollution agencies. IDEM also has a Lake County Consolidated Air Quality Monitoring work group which consists of two full time IDEM staff members who perform quality assurance of monitored data and enforcement work in the area. In addition, IDEM, in early 1991 established a Northwest Indiana Office which will provide additional full time staff in Lake County.

The following addresses IDEM's air quality programs for the pollutants which have exceeded the NAAQS in areas of Lake County. Also included is an overview of IDEM's air toxics program.

Particulate Matter

On July 1, 1987, U.S. EPA published revisions to Title 40 of the Code of Federal Regulations (CFR) Part 50 changing the NAAQS for particulate matter. U.S. EPA changed the requirements of this regulation from an ambient air quality standard for Total Suspended Particulates (TSP) to a standard for inhalable particles only, or particles with a nominal diameter of 10 micrometers or less (PM-10). The change in how the NAAQS for PM-10 is defined resulted in a lifting of the construction ban and restored the responsibility for developing a new PM-10 plan to the State.

On September 30, 1987, IDEM submitted to U.S. EPA its initial plan for the development of the PM-10 State Implementation Plan (SIP). This plan involves the compilation of emissions data and air quality monitoring data and the technical analysis of these data for the development of rules in an effort to bring this area into attainment of the PM-10 standard. The Lake County PM-10 plan will include source specific emission limits, fugitive dust control plans, measures meant to assure continuous compliance and improved enforceability.

OAM will release the draft PM-10 control strategy for Lake County during the summer of 1990. This plan will require substantial reductions of particulate matter emissions from many facilities in Lake County. The proposed rules will also provide OAM with effective tools to enforce existing particulate matter emission limits.

Sulfur Dioxide

IDEM has developed new emission limitations for sources in Lake County in order to meet the NAAQS for sulfur dioxide. These rules were adopted by the Air Pollution Control Board on November 10, 1988. The rules developed by IDEM restrict fuel use, require the use of lower sulfur fuels, set emission limits for steel mills, refineries and other facilities in this area and will significantly reduce sulfur dioxide emissions in Lake County. IDEM believes the current implementation of this rule will bring this area into attainment for sulfur dioxide NAAQS during 1990.

Ozone

Ozone is a secondary pollutant, meaning it is not directly emitted from a smokestack or tailpipe, but instead, it is formed when volatile organic compounds (VOC) react with nitrogen oxides (NOx) and carbon monoxide (CO) in the presence of sunlight. VOC, NOx and CO are considered precursors of ozone. Lake County shares ozone problems with the rest of the Chicago Metropolitan area due to its heavy industrial base, large population, motor vehicle traffic and unique meterological conditions caused by the pressure of Lake Michigan. Figure 4A shows an emissions summary comparison between the Chicago Metro Area and Lake and Porter Counties of Northwest Indiana for VOC, NOx and CO from the 1989 Chicago area SIP/FIP. This figure shows that the emissions in Lake County originate mostly from point sources which can potentially be controlled. The states of Indiana, Illinois, Wisconsin and Michigan, along with U.S. EPA, have begun a cooperative effort known as the Lake Michigan Ozone Study (LMOS), to address this regional problem. This twelve million technical study is funded by the four states and U.S. EPA, and is implemented through a Memorandum of Understanding signed by all parties in 1989.

The purpose of the LMOS is to develop the best available understanding of the relationship between precursor emissions and ambient ozone concentrations in the Lake Michigan region through the use of measured data and photochemical reactive grid modeling techniques. The LMOS schedule calls for the collection of monitored data during June and July of 1990 and 1991, the technical evaluation and quality assurance of the data by the end of each year's collection (1990 and 1991, respectively) and completion of the photochemical grid modeling by the end of 1992. The study is scheduled to be completed by March of 1993.

In the meantime, IDEM has been improving existing rules for controlling NOx, VOC and CO emissions to make progress in attaining the ozone NAAQS. Current Air Pollution Control Board Rules regulate emissions from industrial facilities such as coating operations, metal degreasing, gasoline marketing, oil refining and petroleum storage. In 1987, the APCB has also passed new rules requiring VOC reductions from the coke oven by-product recovery plants in Northwest Indiana. U.S. EPA recently promulgated additional rules to control benzene emissions. Additional commercial operations regulated by IDEM include metal cleaning operations, surface coatings, printing and other operations involving organic solvent usage.

Motor vehicle traffic is another source of VOC, NOx and CO emissions in this area. Rules affecting motor vehicle emissions include anti-tampering and fuel switching rules and the inspection/maintenance (I&M) program. In 1990, the enforcement mechanism for the I&M program was revised to require that each motorist provide a certificate of compliance (proof of passing an emissions test) before new license plates are issued. This latest requirement will greatly improve the effectiveness of this program.

Carbon Monoxide (CO)

A portion of East Chicago is nonattainment for CO. No violations of the CO standard have been recorded since 1981. The CO SIP has been submitted but has not yet been approved by U.S. EPA. IDEM anticipates that the recent changes in the motor vehicle I&M program should result in SIP approval and redesignation of this area to attainment.

Lead

IDEM has recently passed new lead rules which were approved by U.S. EPA on April 19, 1988. These rules set specific emission limits for the three lead sources in Lake County. Implementation of these emission limits should provide for attainment of the lead NAAQS for this area in the near future. The federal phase-out of lead in gasoline has also greatly reduced emissions of lead.

Air Toxics

At this time, IDEM is in the process of developing rules which establish a regulatory program for hazardous air pollutants. These rules will expand on any air toxics rules which are included in 1990 Clean Air Act legislation. IDEM has concluded that these rules are necessary to establish a control program and to fulfill its statutory mandate to protect the public health.

IDEM currently implements the state and federal NESHAPS (National Emission Standards for Hazardous Air Pollutants) program. The NESHAPS program regulates certain source categories which emit any of the following hazardous air pollutants: asbestos, benzene, beryllium, radionucleides, mercury, vinyl chloride and inorganic arsenic. Other than the NESHAPS standards and the criteria pollutants standards, no other standards have been set for air toxics to date.

Air emissions of toxics are also regulated to some extent by rules which require reductions in criteria pollutants, primarily VOC (volatile organic compounds) and particulate matter (metals), in order to attain National Ambient Air Quality Standards.

IDEM has participated in several special high risk point source studies to evaluate risk impacts from toxic emissions at various places. A new rule reducing benzene emissions by over 50% from the coke oven by-product recovery plants in Lake and Porter Counties, has recently been approved as a result of one of these studies. The Lake County area, southeast of Chicago was included in a study by U.S. EPA to determine if the combined air toxic sources creates an increased cancer risk for people living in this area. The coke ovens were cited as the largest sources of toxic air pollutants and accounted for the greater percentage of predicted increased cancer risks in the area.

IDEM and U.S. EPA Region V have established two air toxic monitoring sites in Northwest Indiana. These monitors are co-located with existing particulate monitors. Samples from these monitors will be analyzed to determine ambient air concentrations of numerous halogenated compounds, hydrocarbons, formaldehyde and heavy metals. These sites represent the first long term ambient toxic monitoring efforts performed in Northwest Indiana.

IDEM currently has a toxic emission inventory which was initiated through questionnaires in 1985. New toxic release data has been made available to the public through the 1986 Superfund Amendments and Reauthorization Act (SARA). Section 313 of this law requires reporting by facilities meeting certain requirements of the releases of over 300 toxic chemicals to the environment. These toxic releases must be reported to U.S. EPA, and the data must be made available to the public.

In addition to traditional sources of air toxics (i.e., industries), IDEM has attempted to quantify emissions of air toxics from such sources as wood burning stoves, coal burning boilers and mobile sources.

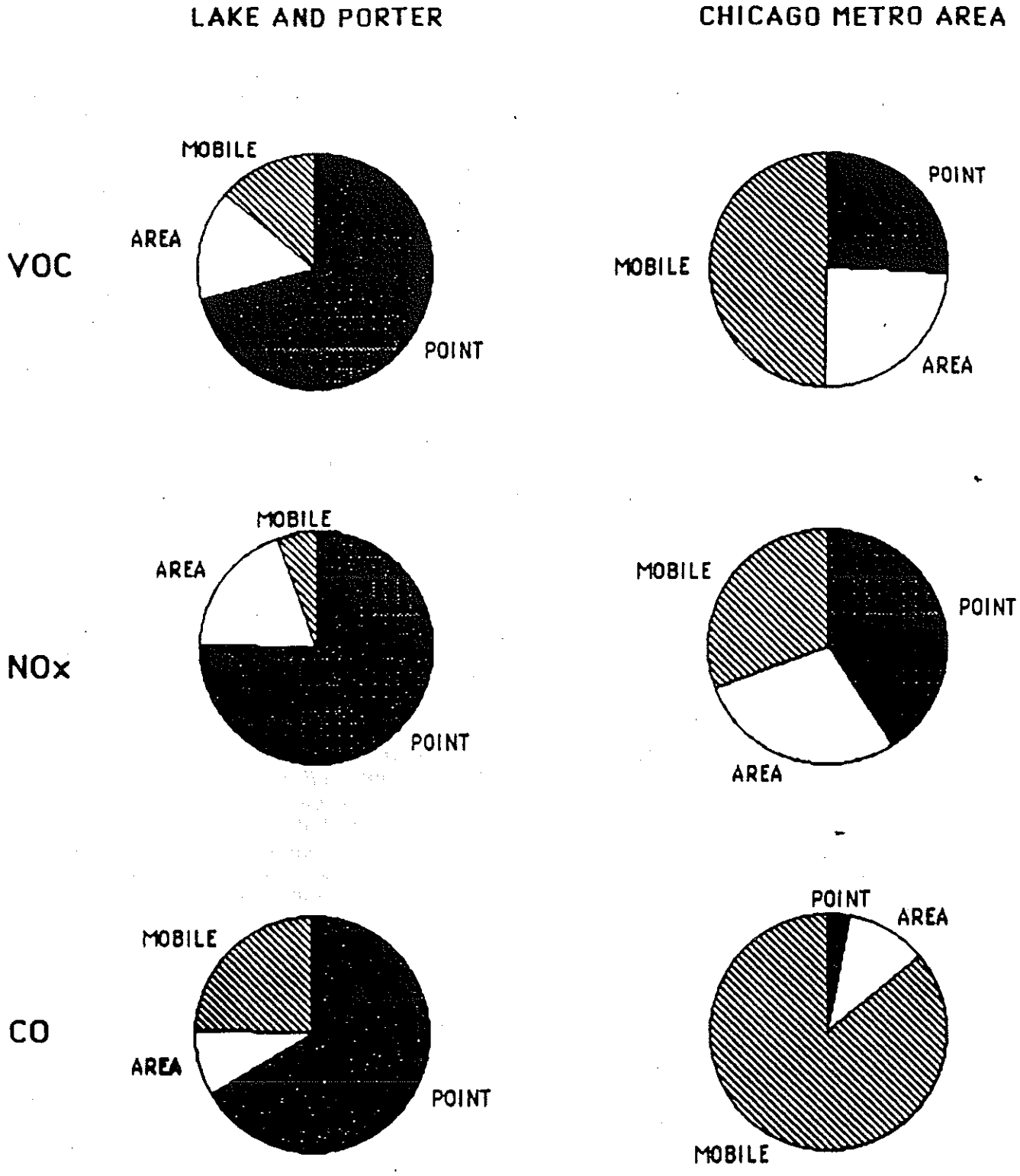
At the present time, the extent of the water quality problem associated with atmospheric deposition is unclear in the Area of Concern. However, atmospheric deposition appears to be a significant pathway for entry of many of the pollutants of concern into the Great Lakes. To gain a better understanding of the process of atmospheric deposition, IDEM is participating in a study being conducted as part of the Great Lakes Toxic Substance Control Agreement. IDEM is currently involved in the Great Lakes Toxic Emission Inventory Scoping Study as part of this Agreement. This study will identify the mechanisms required for developing a consistent regional air toxics inventory for the Great Lakes States of Indiana, Illinois, Michigan, Minnesota, Ohio, Pennsylvania, New York and Wisconsin.

Data are, also being gathered by the Acid Deposition Network of U.S. EPA, which can be used to estimate the atmospheric loadings of pollutants into the Great Lakes. Specific data on fuel usages, agricultural tillage and other parameters will also be compiled and analyzed in an attempt to determine the impacts of atmospheric deposition on the Great Lakes' ecosystems.

In addition, IDEM, U.S. EPA and some industries operate a network of ambient air quality monitors for all criteria pollutants and many toxic compounds. The data from this monitor network provides an indication of the trends in actual deposition that occur. These trends are represented in Figures 4B (TSP), 4C (SO2) and 4D (PM-10). Actual emission totals for Lake County sources from 1984 to 1988 are represented in Figure 4E.

Since it is difficult to draw a line from where air emissions originate to where they are deposited, OAM has included all sources in Lake County in the following tables. Table 4B contains a list of all criteria pollutant sources in Lake County and the total emissions in tons per year. Table 4C contains a list of all sources in Lake County currently cited as being in violation of a state rule. Table 4D is a retrieval from OAM's TEIS (Toxic Emissions Inventory System) for Lake County. Table 4E contains a list of area, or nonpoint sources, which may contribute to atmospheric pollution and deposition in the AOC.

If deposition is determined to be a significant problem in the failure of the area to support beneficial uses, a high priority will be placed on all sources contributing to the problem, including point, area (nonpoint) and mobile sources. Enforcement of present and future SIP related limits will also serve as a mechanism to address the problem of atmospheric deposition. Additional emission limitations (i.e., rules and programs) may be required if atmospheric deposition is determined to be a significant contributor to the water quality in the AOC.


LAKE AND PORTER
CHICAGO METRO AREA
VOC
MOBILE
AREA
POINT
POINT
MOBILE
AREA
NOx
MOBILE
AREA
POINT
MOBILE
POINT
AREA
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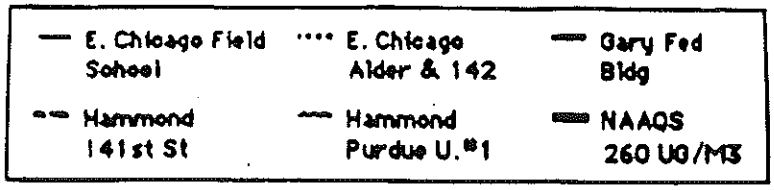
POINT
AREA
MOBILE

Figure 4A

SELECTED LAKE COUNTY TSP AIR MONITOR DATA
High 2nd High 24 Hr Readings



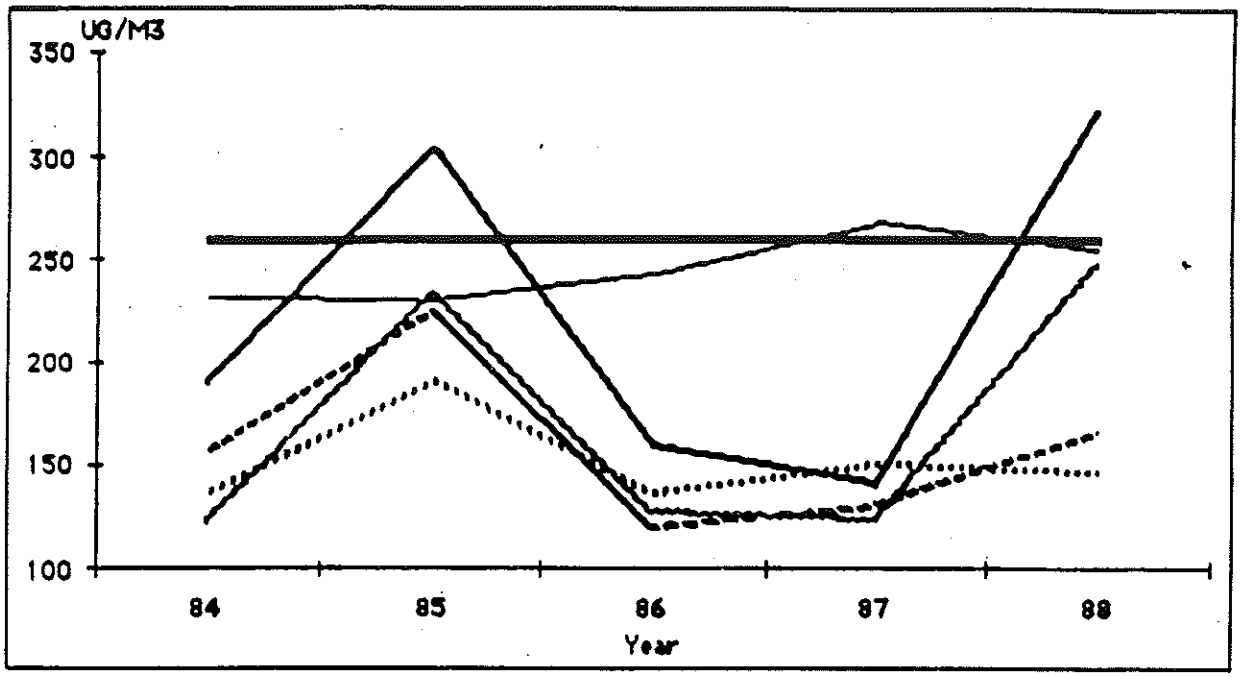


Figure 4B

SELECTED LAKE COUNTY SO2 AIR MONITOR DATA
High 2nd High 24 Hr Readings

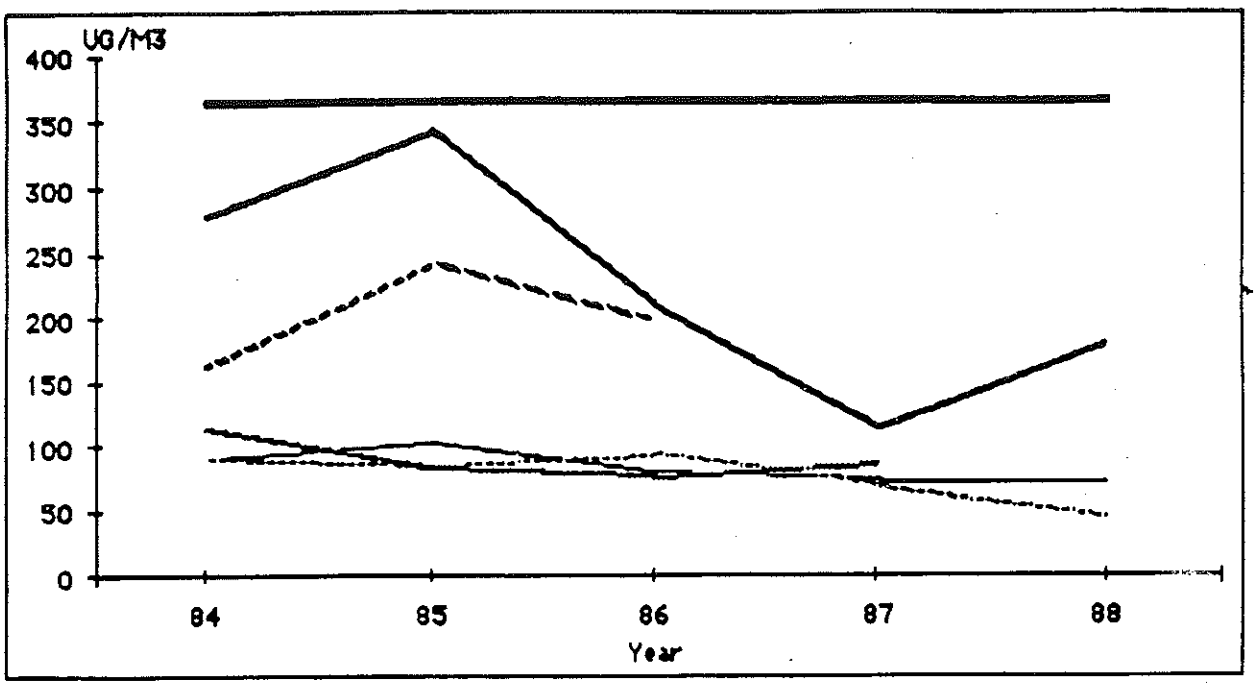


Figure 4C

Chapter V

Conclusions and Recommendations

The purpose of the Great Lakes Water Quality Agreement is to protect and restore beneficial uses of the Great Lakes. The purpose of the Remedial Action Plan is to protect and restore beneficial uses of the Northwest Indiana portion of the Great Lakes.

Based upon the studies presented in this document and by the unanimous decision of the Northwest Indiana Citizens' Advisory for the Remediation of the Environment (CARE) Committee, it is concluded that all fourteen 'beneficial uses' specified in the Great Lakes Water Quality Agreement are impaired in the Indiana Harbor and Canal, the Grand Calumet River, and the nearshore Lake Michigan 'Area of Concern'.

The CARE Committee has asked that the Stage One RAP: (1) include what toxics we should be most concerned about in the Indiana Harbor and Canal and the Grand Calumet River, (2) prioritize the toxics, and (3) somehow illustrate what impacts the toxics have on human health.

A report from the Indiana Department of Environmental Management toxicologist follows this chapter. It presents general toxicological effects that can result from human exposure to selected chemicals found in the river and harbor.

Every month, old studies are completed and new studies are initiated (i.e. human health studies, sediment characterization, natural resources damage assessments). Each new study helps us define the extent of the problem more accurately. If we delay Stage One awaiting further studies, it is unlikely that the Stage One Plan will be completed within the time frames mandated by the U.S. Congress. The Committee has made it clear that it is essential to move on to Stage Two, the selection of remedial measures. Therefore, in order to move forward to the Stage Two process, we must incorporate the studies and findings, which are not available in this Stage, into the Stage Two Process.

In 1991, we will receive more answers to the question of what we should be most concerned with when five studies are completed and made available to the public. The five studies are: (1) the Sediment Characterization of the Grand Calumet River Study, (2) The Fish and Wildlife Risk Assessment Study, (3) The Human Health Risk Assessment Study, (4) The U.S. Army Corps of Engineers Environmental Impact Statement of Maintenance Dredging of the Indiana Harbor, and (5) the U.S. Fish and Wildlife's Natural Resources Damage Assessment.

Based upon the studies already completed and presented in this Stage of the Remedial Action Plan, the evidence is clear that the greatest known negative environmental impact in the Area of Concern to Lake Michigan comes from contaminated bottom sediments.

Priorities of addressing the environmental conditions in this Area of Concern will come from the CARE Committee in the first months of the Stage Two process.

What has been accomplished in this Stage One Remedial Action Plan is that the community and the State have agreed on what the environmental benificial uses are in the Area of Concern and that those beneficial uses are impaired. We can now move on to the Stage Two process and identify what measures will be required to restore the beneficial uses.

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

INDIANAPOLIS

ICE MEMORANDUM

DATE: November 15, 1990

TO: Skip Bunner
Remedial Action Plan Coordinator

THRU: John L. Winters Jr.
David P. Nelsen

FROM: S. M. GhiasUddin, Toxicologist
Surveillance and Standard Branch. OWM

SUBJECT:

Remedial Action Plan (RAP): Toxicological Characteristics of Selected Pollutants found in the IHC/GCR System

This report is prepared to answer the three questions in your memo dated October 23, 1990. The three questions were:

1. What toxics we should be most concerned about in the IHC/GCR system
2. Prioritize the toxics
3. Somehow illustrate what impact toxics have on human health.

The IHC/GCR system (ambient water, sediment and its aquatic life or fish fauna) contains several pollutants or chemical toxicants of potential or known concern to human health. As a general rule of the thumb any chemical (including such common items as salt, alcohol or even water) can produce adverse effects when ingested in large volumes or quantities. Clearly determination of the toxicity assessment or the adverse effects of a chemical or a toxicant present in the IHC/GCR system will depend on three aspects:

1. how much of a chemical is present in the system,
2. the site of contact between a chemical and human being, either by dermal (skin, eye), inhalation (lungs) and/or ingestion (gastrointestinal tract (GI)) routes and
3. the exact amount of a chemical that will come in contact with humans.

In otherwords a true evaluation of toxicity assessment of a given chemical will depend upon degree of human exposure to any single chemical or multiple chemical toxicants present in the IHC/GCR system. To assess this one will need to know the exact amount of a chemical present in a media (water, soil or sediment, fish and air), determine the possible routes of human exposure (dermal absorption, oral ingestion or via inhalation) plus determine what is the frequency and duration of human exposure to these chemicals in the lifetime. A thorough and complete evaluation of all these aspects will give a true assessment of toxic effects of a chemical or a toxicant to human health. Since all the probable exposure routes including frequency and duration of human exposure in relation to RAP are not precisely known at this moment, we have therefore not attempted here to quantitatively determine the potential health effects that may arise from human exposure to one or more pollutants that are found in the IHC/GCR system. To answer the three questions above, we have presented in this report just the qualitative characteristics or general toxicological effects that can result from human exposure (dermal contact, oral ingestion or inhalation) to selected chemicals found in the IHC/GCR system.

For the purpose of this report, taking into account several toxicological endpoints for their potential toxic effects or hazards to human health, we have selected or prioritized only a few chemicals or toxicants based on the criteria of their high concentrations (10 mg/kg and over in sediments, except mercury and cyanides, or exceeding Indiana's Water Quality Standards in ambient waters) in the IHC/GCR system. A list of these selected chemicals considered to be potentially hazardous to human health is provided in Table 1. The exclusion of a chemical from this report (Table 1), however, does not mean that exposure to a particular chemical is without any risk. It must be made clear, all chemicals or toxicants detected in the IHC/GCR system may contribute in varying degrees to potential risks to human health.

For many of the chemicals or toxicants found in the IHC/GCR system there are water quality standards or criteria set by the State of Indiana for their allowable concentrations in the environment (water) to protect both the aquatic life and other water uses including human health. In addition, to protect human health there is currently a fish consumption advisory in effect for this area. However, to this date no sediment criteria are available to protect aquatic life and human health, and the efforts to develop them are underway by U.S. EPA.

The IHC/GCR system has been designated as Class "A" area of concern by the International Joint Commission. A score of chemicals, both inorganic and organic in nature, are found in this system. For quite a few chemicals or toxicants there is adequate toxicological information available to estimate Acceptable Intake Levels (AILs), or degree of carcinogenic risk. But for many other chemicals, toxicological data is limited to assess the exact health risk or the impact on human health resulting from exposure to these chemicals. However, to identify the risks to human health from exposure to pollutants found in the IHC/GCR system, we have attempted to summarize the characteristics of selected chemicals or toxicants in terms of several toxicological endpoints in Table 2.

Toxicological data in terms of Acceptable Intake Levels (AILs) based on Reference Dose (RfD) or Health Effects Document (HED) values for the prioritized chemicals and toxicants found in the IHC/GCR system are listed in Table 3. The AILs for short- (subchronic) and long-term (chronic), depending on the exposure route and frequency of exposure, could be used to assess the health risks associated with exposure to individual or multiple chemicals. Selected potential carcinogens found in the IHC/GCR system are listed separately in Table 4. This table also provides information on U.S. EPA cancer potency factors for each selected carcinogen, both for inhalation and ingestion exposure routes, for possible cancer risk assessment and U.S. EPA classification scheme for selected potential carcinogens.

Toxicological properties of selected pollutants found in the IHC/GCR system in terms of target organs, acute and/or chronic biological effects in relation to human health are presented in Table 5. In addition, from

the human health point of view, information on permissible levels or Threshold Limit Values (TLVs) proposed by the American Conference of Governmental Hygienists (ACGIH) and levels Immediately Dangerous to Life or Health (IDLH) for the selected chemicals (non-carcinogens) are also included in this table.

Please contact us if you have any other questions or concerns.

cc: Dennis Clark
Lee Bridges

Encls.: Tables 1 through 5

Table 1

Selected Potentially Hazardous Substances Found in the IHC/GCR System/a

Chemical	Concentration: Sediment/b (mg/kg)	Concentration: Ambient Water/c (ug/L)
I. Metals:		
Carcinogenic:		
Arsenic (As)	29.5	10 - 13
Cadmium (Cd)	45.0	
Chromium (Cr)	1,680.0	
Nickel (Ni)	140.0	
Non-Carcinogenic:		
Copper (Cu)	600.0	25 - 112
Iron (Fe)	326,000.0	
Lead (Pb, inorg.)	1,430.0	10 - 14
Manganese (Mn)	382,000.0	
Mercury (Hg)	2.2	
Zinc (Zn)	4,630.0	
Non-Metalloids:		
Cyanides	4.4	5 - 19
II. Organic Compounds:		
Carcinogenic:		
PAHs (11 Potential carcinogens)	11 - 3,300.0/d	
PCBs (Total)	102.3	
Arochlors	132.0	
CDFs	160.0	
DEHP (Bis(2-ethylhexyl)phthalate	26.0	
1,2-Dichloroethane (EDC)		5 - 40,500
Non-Carcinogenic:		
Acetone		10 - 22,700*
Chlorobenzene/@	100.0	
Dichlorobenzenes (o and p)/@	12 - 22	
1,2,4-Trichlorobenzene/@	13.9	
1,2,3-Trichloropropane/@	14.8	

/a Of the approximately 130 parameters analyzed, a score of chemicals, both inorganic (metals) and several organic compounds were detected in fish tissues collected in the IHC/GCR system (Indiana 305 (b) Report, 1988 - 89) Most of these compounds do not have FDA action levels by which to compare pollutant concentrations found in fish tissue.

Table 1, Continued

Generally PCBs and chlordane were the only compounds that exceeded FDA Action Levels in fish tissue. Moreover, there is currently a fish consumption advisory in effect in the IHC/GCR system, and since the RAP pertains to remediation of contaminated sediments in the area of concern, pollutants found exceeding FDA Action Levels in fish tissue are not shown in this table.

/b Based on the highest concentration (10 mg/kg or more, except mercury and cyanides) of contaminants found in IHC/GCR sediments as reported in "Information Summary Area of Concern: Grand Calumet River, Indiana" (Source: Table 4, U.S. Army Corps of Engineers, Final Draft Report, September 1989). Almost all the pollutants selected also exceeded the maximum background concentrations found in Indiana streams and lake sediments (see Table 18, Indiana 305 (b) Report, 1988 - 1989).

/c Of the approximately 145 parameters, only 35 were found in ambient waters at levels above the detection limits. The concentration ranges for the ones that exceeded Indiana's water quality standards are shown here (Source: Table 46, Indiana 305 (b) Report, 1988 - 89).

/d Range for 11 potential (PAHs) carcinogens: dibenzo(a,h)anthracene, indeno(1,2,3-c,d)pyrene, benzo(a)pyrene, chrysene, benzo(a)anthracene, benzo(k)fluoranthene, fluoranthene, anthracene, benzo(b)fluoranthene, phenanthrene and pyrene.

/@ Data obtained from 'Analysis Report for Grand Calumet River (Sediment) Samples", date of analyses: November 1989 for sampling points UG-9 and UG-10, and February 1990 for sampling points UG-1 through UG-10, provided by Dr. Zabick. Cf. U.S. EPA (Region V) communication from Mr. M. J. Mikulka dated April 3, 1990.

* This is thought to be due to sample contamination problem.

Table 2

Characteristics of Selected Chemicals or Toxicants Found in IHC/GCR System

Chemical	Toxicological Endpoints/a				
	Acute Toxicity	Chronic Toxicity	Reproduction/ Teratogenicity	Mutagenicity	Carcino-genicity
I. Metals:					
Carcinogenic:					
Arsenic (As)	x	x	x		x
Cadmium (Cd)	x	x	x		x
Chromium (Cr)	x	x	x	x	x
Nickel (Ni)		x	x		x
Non-Carcinogenic:					
Copper (Cu)		x			
Iron (Fe)		x			
Lead (Pb/inorg.)	x	x	x		
Manganese (Mn)		x			
Mercury (Hg)		x	x		
Zinc (Zn)			x		
Non-Metalloids:					
Cyanides	x	x			
II. Organic Compounds:					
Carcinogenic:					
PAHs		x			x
PCBs (Total, Arochlors)		x	x		x
CDFs		x	x	x	x
DEHP		x	x	x	x
1,2-Dichloroethane (EDC)					x
Non-Carcinogenic:					
Acetone	x	x			
Chlorobenzene		x			
Dichlorobenzenes (o & p)		x			
1,2,4-Trichlorobenzene		x			
1,2,3-Trichloropropane		x			

/a Toxicological endpoint is defined as a biological effect resulting from exposure of an organism (or a human being) to a chemical or a toxicant. It is used as an index of a chemical toxicity. Each toxicological endpoint is based on the criterion outlined by U.S. EPA 'Office of Waste Programs Enforcement' (OWPE). An "X" indicates the chemical meets the criteria for the particular toxicological endpoint.

Table 2, Continued

Among the several toxicological endpoints available only a few important endpoints associated with respect to human health are listed for chemicals selected (prioritized) based on the criteria of their high concentrations and/or frequency of occurrence in the IHC/GCR system. Other toxicological endpoints as hepatotoxicity, renal toxicity, behavioral and hemopoitic effects are discussed in Table 5.

Acute Toxicity: A chemical or toxicant is considered to be acutely toxic if it has an oral LD50 $\leq$ 100 mg/kg, an inhalation LC50 $\leq$ 400 mg/m^3 or a dermal LD50 $\leq$ 400 mg/kg

Chronic Toxicity: A chemical or a toxicant is considered to cause chronic toxicity if it causes serious irreversible biological effects other than cancer or reproductive effects after extended exposure to an oral dose of $\leq$ 100 mg/kg/day, inhalation concentration $\leq$ 400 mg/m^3 or a dermal dose $\leq$ 100 mg/kg/day.

Reproduction/Teratogenicity: A chemical or a toxicant is considered to be a reproductive toxin or a teratogen if there is a suggestive evidence of an effect in humans or at least one animal study in-vivo. A in-vitro evidence is considered sufficient to label a chemical having a reproducitve toxicity/teratogenicity hazard.

Reproductive toxicity in animals is usually expressed in terms of a change in fertility, litter size and survival, gestation survival and postnatal body weight changes.

Gross abnormalities, skeletal and visceral (soft tissue) malformations, microscopic abnormalities and funtional/behavioral deviations are attributed to teratogenic effects.

Mutagenicity: A chemical or a toxicant is considered as mutagenic if it has a positive result in at least one of the mammalian in-vivo or in-vitro bacterial or mammalian cell mutagenicity assays. Examples, chromosome alterations, bacterial mutations, DNA damage.

Carcinogenicity: A chemical or a toxicant is considered as a carcinogen if it is a known or suspected carcinogen, or it has been shown to be carcinogenic at a particular site in more than one species or it has been shown to increase the incidence of site-specific malignant tumors in a single species (or sex) and there is a statistically significant dose-response relationship in more than one exposed group.

Tumor frequency in whole animal tissues can be detected by gross observations or histological examination.

Table 3

Toxicity Data for Non-Carcinogenic Effects for Chemicals or Toxicants Found in IHC/GCR System/a

Chemical	Acceptable Intake Levels (AILs)			
	Oral Route		Inhalation Route	
	Subchronic (mg/kg/day)	Chronic (mg/kg/day)	Subchronic (mg/kg/day)	Chronic (mg/kg/day)
I. Metals:				
Carcinogenic:				
Arsenic (As)/?	-	-	-	-
Cadmium (Cd)/@	-	1.30E - 02	-	-
Chromium (Cr/III)	1.40E + 01	1.00E + 00	-	-
Chromium (Cr/VI)/?	2.50E - 02	5.00E - 03	-	-
Nickel (Ni)/?	1.40E - 02	1.00E - 02	-	-
Non-Carcinogenic:				
Copper (Cu)	3.70E - 02	3.70E - 02	-	1.00E - 02
Iron (Fe)	-	-	-	8.60E - 03
Lead (Pb, inorg.)	-	1.40E - 03	-	-
Manganese (Mn)	5.30E - 01	2.20E - 01	3.00E - 04	3.00E - 04
Mercury (Hg/Alkyl)	2.80E - 04	3.00E - 04	-	-
Mercury (Hg/inorg.)	1.40E - 03	1.40E - 03	-	-
Zinc (Zn)	2.10E - 01	2.10E - 01	-	-
Non-Metalloids:				
Cyanides/@@	2.90E - 02	-	-	-
II. Organic Compounds:				
Carcinogenic:				
PAHs/@	-	-	-	-
PCBs (Total, Arochlors)/@	-	-	-	-
CDFs/@	-	-	-	-
DEHP/@	-	2.00E - 02	-	-
1,2-Dichloro-ethane (EDC)/?	-	-	-	-
Non-Carcinogenic:				
Acetone	1.00E + 00	1.00E - 01	3.00E + 01	3.00E + 00
Chlorobenzene	2.70E - 01	2.70E - 02	5.70E - 02	5.70E - 03
Dichlorobenzenes (o & p)	-	-	-	-
1,2,4-Trichlorobenzene	-	2.00E - 02	-	-
1,2,3-Trichloropropane	-	6.00E - 03	-	-

Table 3, Continued

/a For toxicological properties and probable health hazards see Table 5. Acceptable Intake Levels (AILs) given in this table are based on Refernce Dose (RfD) or Health Effects Documents (HED) values developed by U.S. EPA Washington, DC., 1987 or Environmental Criteria and Assessment Office, U.S. EPA, Cincinnatti, Ohio, 1985, revised 1987 respectively.

AILs are useful in assessing the risk of subchronic (short-term) or chronic (long-term) exposure to individual chemical by oral or inhalation routes. The AILs are generally based on oral exposure. However, in some cases in the absence of more specicfic data, AILs for oral exposure may also be useful in assessing the risks of inhalation exposure. The probable health hazards resulting from exposure to individual non-carcinogenic or carcinogenic chemical or a toxicant are described in Table 5.

/@ Potential carcinogen also. See Table 4.

/@@ If not otherwise specified. The AIL would be variable with the kind of cyanide.

Table 4

Selected Potential Carcinogens Detected in IHC/GCR System/a

Chemical	U.S. EPA Cancer Potency Factors: Ingestion (mg/kg/day)	U.S. EPA Cancer Potency Factors: Inhalation (mg/kg/day)	U.S. EPA Carcinogenic Classification/b: Ingestion (Group)	U.S. EPA Carcinogenic Classification/b: Inhalation (Group)
I Metals:				
Arsenic	1.50E + 00/*	5.00E + 01	A	A
Cadmium	NA	6.10E + 00	D	B1
Chromium (vi)	NA	4.10E + 01	D	A
Nickel	NA	1.70E + 00 (NiS)	A	A
	NA	8.40E - 01 (Dust)	A	A
II. Organic Compounds:				
PAHs	1.15E + 01	6.11E + 00	B2	B2
Benzo(a)pyrene	1.15E + 01	6.11E + 00	B2	B2
PCBs/total	7.00E + 00	-/d	B2	B2
Arochlors	7.00E + 00	-/d	B2	B2
CDFs	1.56E + 05/c	-/d	B2	B2
DEHP Bis(2-ethylhexyl)phthalate	6.84E - 04	-/d	B2	B2
1,2-Dichloroethane (EDC)/e	9.10E - 02	9.10E - 02	B2	B2

/a Based on pollutants present in high concentrations in the IHC/GCR system (sediment) as reported in Table 4, U.S. Army Corps of Engineers, Final Draft Report, September 1989.

/b U.S. EPA Carcinogenic Assessment Group (CAG) classification:

- Group A: Human Carcinogen-based on sufficient evidence of carcinogenicity from epidemiological studies.
- Group B1: Probable human carcinogen-based on limited evidence of carcinogenicity in humans.
- Group B2: Probable human carcinogen-based on sufficient evidence of carcinogenicity in animals and inadequate evidence of carcinogenicity in humans.
- Group C: Possible human carcinogen-based on limited evidence of carcinogenicity in animals (Not shown in this table).
- Group D: Not classified as carcinogen-based on inadequate animal evidence of carcinogenicity in animals.

Table 4, Continued

/c Cancer potency factor for 2,3,7,8-TCDD. Concentrations of CDFs are converted corresponding to equivalent amounts of 2,3,7,8-TCDD based on Toxicity Equivalence Factors (TEQ) for different congeners of CDFs.

/d EPA has classified this chemical as a carcinogen but has not derived a cancer potency factor for it. In the absence of a more specific data, ingestion values may also be useful in assessing risks of inhalation exposure.

/e Found as contaminant in ambient water

N/A= EPA has not classified the chemical as a carcinogen and has not derived a cancer potency factor.

* Recent proposals by U.S. EPA 'Office of Drinking Water' do not classify arsenic as a human carcinogen by ingestion.

Table 5,

Toxicological Properties and Probable Health Hazards
of Selected (Prioritized) Chemicals Found in the IHC/GCR System

Chemical	Target Organs, Acute/& or Chronic Toxicity and Biological Effects/a	Carcinogenic/ Target Organs	Other Effects/ TLVs (TWA)/ IDLH/b
I. Metals:			
Carcinogens:			
Arsenic	Liver, kidneys, lungs, skin, lmyphatic system. Acute poisoning with non-specific symptoms may result in death. Chronic poisoning results in ulceration of the nasal septum, dermatitis, peripheral neuropathy, respiratory irritation and hypering of skin. Other symptoms include enlarged liver, kidney damage, aplastic anemia. Teratogenic in animals.	Carcinogen (skin, lung, upper respiratory tract carcinoma)	0.2 mg/m^3 OSHA Std. 10 ug/m^3 IDLH: N/A
Cadmium	Lungs, kidneys and lungs. High doses cause dehydration, vomitting, leading to venous thrombosis, embolism, coma and death. Acute inhalation results in severe lung damage and death. Chronic inhalation exposure leads to severe lung disease, with emphysema and scarring. Causes kidney damage and soft deformed bones. Accumulates in kidneys up to 50 years. Also accumulates in placenta.	Carcinogen (Lung cancer, inhalation)	Dust: 0.2 mg/m^3 Fumes: 0.1 mg/m^3 IDLH: N/A
Chromium	Kidneys, respiratory system, liver and skin. Produces histologic fibrosis of lungs, allergic irritation of skin.	Carcinogen (Lung Cancer, inhalation)	0.5 mg/m^3 Cr VI: 0.05 mg/m^3 IDLH: 500 mg/m^3

N/A = The substance is a potential human carcinogen and an IDLH has not been assigned.

Table 5, Continued

Chemical	Target Organs, Acute/& or Chronic Toxicity and Biological Effects/a	Carcinogenic/ Target Organs	Other Effects/ TLVs (TWA)/ IDLH/b
Nickel	Nasal cavities, lungs, skin. Acute effects may include pulmonary congestion and edema. Chronic exposure leads to allergic asthama, pneumonia, irritation of nasal passages associated with inhalation of nickel particulate matter. Oral ingestion of Ni may lead to nickel dermatitis.	Carcinogen (Lung Cancer, inhalation)	1.0 mg/m^3 IDLH: N/A
Non-Carcinogens:			
Copper	Respiratory system, skin, liver, kidneys. Causes irritation of mucous membrane, eyes and dermatitis. Distinct metal taste.		Dust: 1 mg/m^3 Fumes: 0.2 mg/m^3 IDLH: -
Iron	Orally Fe salts are basically nontoxic. Acute poisoning may result in GI tract damage. Iron pentacarbonyl, $Fe(CO)5$ is highly toxic to lung and brain. Prolong exposure to Ferric oxide (FeO) fumes produce benign pneumoconiosis (molting of the lungs). X-ray shadows indinguishable from fibrotic pneumoconiosis.		Salts: 1 mg/m^3 Fumes: 5 mg/m^3
Lead (Inorganic)	Gastrointestinal tract (GI), Central Nervous System (CNS), gigival tissue, hematopoietic system, learning disabilities. Acute toxicity produces general malaise and GI upset. CNS symptoms include convulsions and stupor leading to death. Chronic toxicity induces vague ill health with weight loss, anemia, hypotense, colic and constipation. Also induces stillbirths. In children growth may be impaired and longevity reduced.	Lead arsenate/ Chromate Carcinogenic	Children are sensitive to low levels effects. Dust & Fumes: 0.15 mg/m^3 Lead chromate 0.05 mg/m^3 IDLH: N/A

Table 5, Continued

Chemical	Target Organs, Acute/& or Chronic Toxicity and Biological Effects/a	Carcinogenic/ Target Organs	Other Effects/ TLVs (TWA)/ IDLH/b
II. Organic Compounds:			
Carcinogenic:			
PAHs	Lymphoid organs, bone marrow, intestinal epithelium, testes, adrenals and ovaries. Degeneration of bone marrow, lymphoid & hematopiotic damage, degeneration of thymus and thyroid glands, ovotoxicity, severe testicular damage, and weight loss.	Carcinogenic (Skin, lung and GI Tract)	
PCBs/ Arochlors	Skin, liver, dermatological effects (chloracne). Liver lesions, malignant neoplasms, reproductive effects resulting from oral ingestion, malignant melanomas.	Carcinogenic (Hepatocellular carcinomas)	Bioaccumulate in adipose tissue.
CDFs	Liver toxicity, Reproductive/ Developmental toxicity. Also mutagenic, neoplastic nodules. Liver damage and induces several enzyme systems (aryl hydrocarbon hydoxylases-AHA)	Carcinogenic (Hepatocellular carcinomas)	Bioaccumulate in adipose tissue.
DEHP	Causes liver, reproductive/ developmental and/or teratogenesis (toxicity to unborn or newborn). Major malformations include external, visceral and skeletal effects.	Carcinogenic/ Teratogenic	
1,2-Dichloroethane (EDC)	Liver and kidneys. Headache, dizziness, nausea, vomitting, abdominal pains, mucous membrane irritation.	Carcinogenic (GI tract and circulatory system tumors)	

Table 5, Continued

Chemical	Target Organs, Acute/& or Chronic Toxicity and Biological Effects/a	Carcinogenic/ Target Organs	Other Effects/ TLVs (TWA)/ IDLH/b
Manganese	Respiratory system, CNS, kidneys, blood. Insomnia, fever, dry throat, cough, tight chest, dyspnea, low back pain, vomitting, malaise, fatigue.		Dust: 5 mg/m^3 Fumes: 1 mg/m^3 IDLH: 10,00 mg/m^3
Mercury	Skin, respiratory system, CNS, kidneys, eyes. Similar to Cd in its toxicity. Acute toxicity (oral ingestion) produces severe vomitting, dehydration, coma and death. Highly mobile in body, has even distribution. Approximately 90% is absorbed from GI tract. Also crosses into brain, organic mercurials cause selective brian damage. Chronic poisoning (inorg. Hg) induces mental upset with irritability, indecision and varied types of nervous anxiety. Also crosses easily from skin. Mercurial compounds also cross placenta, cause fetal loss and teratogenesis seen principally in animals.		Hg/inorg: 0.1 mg/m^3 Organo alkyl: 0.01 mg/m^3 Other vapors: 0.05 mg/m^3 IDLH: Inorg. 25 mg/m^3 Organo alkyl 10 mg/m^3
Zinc	Respiratory system, liver and, pancreas. Dry throat, dyspnea, chills, fever, tight chest, vomitting, blurr vission. Sweet metal tast. Chronic exposure leads to fetal death and possibly teratogenesis, also anemia, liver and pancreatic fibrosis.		Zn Oxide: 5 mg/m^3 $ZnCl_2$ Fumes: 1 mg/m^3 IDLH: $ZnCl_2$ 2000 mg/m^3
Non-Metalloids:			
Cyanides	Cardiovascular system (CVS), CNS liver, kidneys, skin. Acute poisoning causes asphyxia and death. Chronic effects include weakness, confusion, nausia, vomitting, slow gasping respiration, eye and skin irritation.		AS CN 5 mg/m^3 IDLH: 50 mg/m^3

Table 5, Continued

Chemical	Target Organs, Acute/& or Chronic Toxicity and Biological Effects/a	Carcinogenic/ Target Organs	Other Effects/ TLVs (TWA)/ IDLH/b
Non-Carcinogenic:			
Acetone	Eye, skin and respiratory system. Causes irritation of eyes, nose and throat, dizziness and dermatitis.		2400 mg/m^3 (1000 ppm) IDLH: 20,000 ppm
Chloro-benzene	Liver, skin, eyes. Causes irritation to eyes and skin, drowsiness, incoordination and liver damage.		350 mg/m^3 (75 ppm) IDLH: -
Dichloro-benzenes (o & p)	Liver, kidneys, eyes and skin. High concentrations cause CNS depression, eye and skin irritation. Prolong exposure may cause weakness, dizziness and loss of weight.		o, 300 mg/m^3 (50 ppm) p, 450 mg/m^3 (75 ppm) IDLH: o, 1700 ppm p, 1000 ppm
1,2,4-Tri-chloro-benzene	Eyes and mucous membrane irritation.		-
1,2,3-Tri-chloro-propane	Liver, kidneys, eys and skin. Causes CNS depression and irritation of eyes and skin.		300 mg/m^3 (50 ppm) IDLH: 1000 ppm

/a Health effects or target organs may be based on animal studies and do not imply that human exposure may result in the same symptoms.

/b TLVs (TWA)= Threshold Limit Values (TLVs)-Time Weighted Average (TWA) refer to airborne concentrations of substances for a normal 8-hour workday and a 40-hour weekday, and represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect.

IDLH = Immediately Dangerous to Life or Health levels. This represent a maximum concentration of a susbstance (usually a non-carcinogen) from which in the event of a repirator failure one could escape without experiencing impairing or irreversible health effects. For potential carcinogens IDLHs are not assigned.

Chapter VI

Public Comments to the Final Draft Stage One Remedial Action Plan and a Response to Those Comments

1. Source: Roger Nanny, USDA

Comments:

p.8 The soil listed as "Texas" should be "Tawas". Under "Soil Types" it should be explained that the area now has a large area that is mapped as "urban". The definition of urban land will be found in the Lake County soil survey on p. 36. It is "areas that have been filled with earth, cinders, basic slag, trash, or any combination of these and smoothed over so the soil can no longer be identified".

p.9 The AC. of Agland used should be EST. from the map (Fig. 2C) and included in the report. This land may play an important part in future remediation sites.

p.11 The first paragraph refers to Fig. 3A but it should be Fig. 2D.

p. 12 The second paragraph refers to Fig. 2C is incorrect.

p. 48 Under urban runoff the reference to the "Lake County Soil Conservation Commission" should read "District", not Commission. The last sentence of the Paragraph refers to the "study", this should read "plan" not study.

p. 72 The Lake County soil survey should be listed in the bibliography.

October 3, 1990 - Attached is some information that may help you in the RAP-I in setting priorities and source and cause of toxic.

December 19, 1990 - Many of the above corrections were made except for the Name change from "Texas" to "Tawas" on page 8, paragraph 3 & 4.

IDEM Response

These corrections were incorporated into the final Stage One Remedial Action Plan.

2. Source: Grand Cal Task Force
Comments:

Thank you for your hard work putting together the Phase I document for the Remedial Action Plan for the Grand Calumet River/Indiana Harbor Ship Canal.

I have a few comments on Phase I and a general comment on the coordination of remedial solutions on the Grand Calumet River.

p. 20 It seems that Pollution Control Industries of America, Inc. (PCI) should be included here. What about Rhone-Poulenc. Are these not included because they do not have Part B RCRA Permits? Should there be a list of interim Part A permit holders for reference (I suggest yes, if this is why these facilities are not listed as TSDs).

IDEM Response

The above named facilities have been added to the final Stage One Remedial Action Plan.

3. *Source: Grand Cal Task Force (Continued)*
   Comments:

   In the tables section, it would be useful to list some number for chemicals limits established by the Indiana Water Quality Standards.

IDEM Response

A copy of the Indiana Water Quality Standards is available upon request.

4. *Source: Grand Cal Task Force (Continued)*
   Comments:

   We are missing some significant data, namely, the sediment characterization, please follow through with the suggestion and consensus that Phase I should not be bound after printing, but rather designed to be placed in looseleaf notebook form.

IDEM Response

The final Stage One Remedial Action Plan is in a looseleaf notebook form as requested.

5. *Source: Grand Cal Task Force (Continued)*
   Comments:

   After attempting and failing to access information contained in the USEPA Consent Decree with USX, concerning the suggested recycling of Grand Calumet River sediments in Sinter Plant or Blast Furnace process, I am concerned that coordination between the RAP and ongoing litigation will be difficult, if not impossible. Since most of the Grand Calumet River and Indiana Harbor Ship Canal is covered by pending litigation that will likely contain remedial actions directed toward the sediment problem, it seems there will be no avenues for public participation in the ongoing process of remedial solution selection or coordination between litigation remedies and remedies selected in the RAP process.

   This is not something that I have been able to look into in any detailed fashion, but unless some channels are opened between these parallel but separate processes of litigation and Remedial Action Plan development, the public participation process in the selection of remedial solutions will be made useless.

IDEM Response

It is the duty of the Indiana Department of Environmental Management to pursue enforcement action against dischargers that have violated a National Pollutant Discharge Elimination System (NPDES) Permit. It is the right of any party to join into those lawsuits if the court finds that the party has standing in the matter. Only the court can allow your organization to enter litigation proceedings through the due process of law. However, in the matter of the USX settlement, there was a public comment period before the order became final.

As litigation is resolved, the Remedial Action Plan Coordinator will coordinate cleanup efforts with the Citizens' Advisory for Remediation of the Environment (CARE) Committee.

6. *Source: City of East Chicago*
   Comment:

   I would like to compliment you on the fine job of editing the previous draft of the Remedial Action Plan for the Indiana Harbor Canal, the Grand Calumet River, and the Nearshore Lake Michigan. As per your request at the November 29th meeting, the following represent final comments on the revision of Stage I:

   1. Summary of Environmental Problems Affecting the Indiana Harbor and Canal, the Grand Calumet River and the Nearshore Lake Michigan Area of Concern Table, pg. 2 of 4. The Existing Conditions description for item viii appears to have verbage missing.

IDEM Response

Corrected, our regrets to Hobart.

7. *Source: City of East Chicago (Continued)*
   Comments:

   2. Pg. 9 "Hobert" is misspelled, the correct spelling is Hobart.

IDEM Response

Corrected

8. *Source: City of East Chicago (Continued)*
   Comments:

   3. Pg. 27-28. Water Supply in the Nearshore Lake Michigan. The City of Hammond has a water intake in the vicinity of the AOC. Reference is made later in the report (pg. 37) to Hammond, East Chicago and Whiting intakes being located within 1/2 mile of the three mile foot print of sediment. To maintain clarity in the report, it is important that the location of the Hammond water intake be reported.

   4. Pg. 29. Statement #7 which reads "Despite their polluted appearance,.....". This statement is a subjective comment. Whereas the water flowing under the Indianapolis Boulevard bridge are not crystal clear, objectionable floating material is not present. The banks support a lush population of vegetation including cattails and ducks are present at the ECSD discharge location into the river. We believe the adjective "polluted" should be removed.

IDEM Response

Corrected.

9. *Source: City of East Chicago (Continued)*
Comments:

5. Pg. 35. "Pasterick" is misspelled, correct spelling is Pastrick.

IDEM Response

Corrected, with regrets to Mayor Pastrick.

10. *Source: City of East Chicago (Continued)*
Comments:

6. Pg. 45. You have "suspended solids total" in the description for Dupont; did you intend for it to read "total suspended solids"?

IDEM Response

Yes, Corrected.

11. *Source: City of East Chicago (Continued)*
Comments:

In closing, we are very appreciative of the written description provided on our facility. It is important to us that the report does outline the problems, past and present, in the Area of Concern but it is also important to the City that progress be properly documented. Again, thank you for the opportunity to provide input to the document.

IDEM Response

East Chicago has certainly progressed and we appreciate the City's assistance in preparing the Remedial Action Plan.

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GLOSSARY OF TERMS

Accumulation - Storage and concentration of a chemical in tissue to an amount higher than intake of the chemical. May also apply to the storage and concentration of a chemical in aquatic sediments to levels above those that are present in the water column.

Acid - A substance that dissolves in water with the formation of hydrogen ions.

Activated Sludge Process - A biological wastewater treatment process in which a mixture of wastewater and activated sludge is agitated and aerated. The activated sludge is subsequently separated from the treated wastewater (mixed liquor) by sedimentation, and wasted or returned to the process as needed.

Acute Toxicity - Mortality that is produced within a short period of time-exposure, usually 24 to 96 hours.

Advanced Treatment - Preferred term is tertiary treatment.

Aeration - The bringing about of intimate contact between air and a liquid by one of the following methods: Spraying the liquid in the air; bubbling air through the liquid; or by agitation of the liquid to promote surface absorption of air.

Aerobic - The condition associated with the presence of free oxygen in the environment.

Air - The mixture of gases that surrounds the earth and forms its atmosphere, composed primarily of oxygen and nitrogen. It also contains carbon dioxide, some water vapor, argon, and traces of other gases.

Algae - Primitive plants, one or many celled, usually aquatic and capable of synthesizing their foodstuffs from carbon dioxide and water by photosynthesis.

Alkaline - The condition of wastewater containing sufficient amounts of substances to raise the pH above 7.0.

Ammonia - A chemical combination of hydrogen (H) and nitrogen (N) occurring extensively in nature; NH_3

Anaerobic - Requiring, or not destroyed by, the absence of air or free elemental oxygen.

Assimilative Capacity - The ability of a waterbody to transform and/or incorporate substances (e.g. nutrients) by the ecosystem, such that the water quality does not degrade below a predetermined level.

Bacteria - A group of universally distributed, rigid, essentially unicellular microscopic organisms lacking chlorophyll. Bacteria usually appear as spheroid, rod-like, or curved entities, but occasionally appear as sheets, chains, or branched filaments. Bacteria are usually regarded as plants.

Bacteria, aerobic - Bacteria that require free elemental oxygen for their growth.

Bacteria, coliform group - A group of bacteria, predominantly inhabitants of the intestine of man or animals but also found on vegetation including all aerobic and facultative anaerobic gram-negative, nonspore-forming bacilli that ferment lactose with gas formation.

Bacteria Count - A measure of the concentration of bacteria.

Bacteria, parasitic - Bacteria that thrive on other living organisms.

Bacteria, pathogenic - Bacteria that may cause disease in the host organism by their parasitic growth.

Benthic - Of or living on or in the bottom of a water body.

Benthos - Bottom dwelling organisms - the benthos comprise:

1. sessile animals such as sponges, some worms and many attached algae;
2. creeping forms such as snails and flatworms; and
3. burrowing forms which include most clams, worms, mayflies and midges.

Benzo(A)Pyrene - A PAH which is suspected carcinogen found in cigarette smoke. It is a by-product of combustion and is released to the aquatic environment during the steel and aluminum making processes.

Bioaccumulation - Uptake and retention of environmental substances by an organism from both its environment (i.e. directly from the water) and its food.

Biochemical Action - Chemical changes resulting from the metabolism of living organisms.

Bioconcentration - The ability of an organism to concentrate substances within its body at concentrations greater than in its surrounding environment or food.

Biomagnification - The concentrating of a chemical up the food chain.

Biota - Species of all the plants and animals occurring within a certain area or region.

B.O.D. - The quantity of oxygen utilized in the biochemical oxidation of organic matter in a specified time and at a specified temperature. It is not related to the oxygen requirements in chemical combustion, being determined entirely by the availability of the material as a biological food and by the amount of oxygen utilized by the micro-organisms during oxidation.

By-Pass - An arrangement of pipes, conduits, gates, and valves whereby the flow may be passed around a hydraulic structure or appurtenance.

Carcinogen - Cancer-causing chemicals or substances.

Chemical Oxygen Demand (COD) - A measure of the oxygen-consuming capacity of inorganic and organic matter present in wastewater. It is expressed as the amount of oxygen consumed from a chemical oxidation in a specific test.

Chronic Toxicity - Toxicity marked by a long duration, that produces an adverse effect on organisms. The end result of chronic toxicity can be death although the usual effects are sublethal (e.g. inhibits reproduction or growth). These effects are reflected by changes in the productivity and population structure of the community.

Community - Group of populations of plants and animals in a given ecological unit used in the broad sense to include groups of various sizes and degrees of integration.

Contaminant - A substance foreign to a natural system or present at unnatural concentrations in air, water, soil or food, causing use of those things to be limited. A naturally occurring substance may be found to exceed government guidelines or objectives, and thus, be called a contaminant.

Contamination - Any introduction into water of microorganisms, chemicals, wastes, or wastewater in a concentration that makes the water unfit for its intended use.

Conventional Pollutant - A term which includes nutrients, substances which decompose using oxygen in the process, material which produce an oily sludge deposit, and bacteria. Conventional pollutants include phosphorus, nitrogen, chemical oxygen demand, biochemical oxygen demand, oil and grease, volatile solids, total and fecal coliform bacteria, and chlorides.

Criteria - Numerical limits of pollutants established to protect specific water uses.

Decomposition - the breakdown of complex material into simpler substances by chemical or biological means.

Dioxin - A group of approximately 75 chemicals of the chlorinated dibenzodioxin family. 2,3,7,8-TCDD is considered the most toxic form.

Disease, water-borne - A disease caused by organisms or toxic substances which are carried by water. The most common water-borne diseases are typhoid fever, Asiatic Cholera, Dysemtery, and other intestinal disturbances.

Disinfection - The art of killing the larger portion of microorganisms in or on a substance with the probability that all the pathogenic bacteria are killed by the agent used.

Dissolved Oxygen - The amount of oxygen dissolved in water.

D.O. - The oxygen dissolved in sewage, water, or other liquid usually expressed in parts per million or percent of saturation.

Dredge Spoils - The material removed from the river, lake or harbor bottom during dredging operations.

Dredge Guidelines - Procedural directions designed to minimize the adverse effects of shoreline and underwater excavation with primary emphasis on the concentrations of toxic materials within the dredge spoils.

Ecosystem - The interacting complex of living organism and their nonliving environment; the biotic community and its abiotic environment.

Effluent - (1) A liquid which flows out of a containing space. (2) Sewage, water, or other liquid, partially or completely treated, or in its natural state, as the case may be, flowing out on a reservoir, basin, or treatment plant, or part thereof.

Environment - All biotic and abiotic factors that actually affect an individual organism at any point in its life cycle.

Erosion - The wearing away and transportation of soils, rocks and dissolved minerals from the land surface shorelines river bottoms by rainfall, running water, wave or current actions.

Escherichia Coli (E.Coli) - A species genus escherichia bacteria, normal inhabitant of the intestine of man and all vertibrates. This species is classified among the Coliform group.

Eutrophication - The process of nutrient enrichment that causes high productivity and biomass in an aquatic ecosystem. Eutrophication can be a natural process or it can be a cultural process accelerated by an increase of nutrient loading to a waterbody by human activity.

Foodchain - The process by which organisms in higher trophic levels gain energy by consuming organisms at lower trophic levels; the dependence for food of organisms upon others in a series beginning with plants and ending with the largest carnivores.

Great Lakes Water Quality Agreement - A joint agreement between Canada and the United States which commits the two countries to develop then implement plans to restore and maintain the many desirable uses of the waters in the Great Lakes Basin. Originally signed in 1978, the agreement was amended in 1987.

Groundwater - Subsurface water occupying the zone of saturation, from which wells and springs are fed. In a strict sense, the term applies only to water below the water table.

Guideline - Any suggestion or rule that guides or directs - suggested criteria for programs or effluent limitations.

Heavy Metals - Metals that can be precipitated by hydrogen sulfide in acid solution, for example, lead, silver, gold, mercury, bismuth, and copper.

Hydraulic Loading - The flow (volume per unit time) applied to a unit process.

Hydraulics - That branch of science or of engineering dealing with water or other fluid in motion.

Carcinogen - Cancer-causing chemicals or substances.

Chemical Oxygen Demand (COD) - A measure of the oxygen-consuming capacity of inorganic and organic matter present in wastewater. It is expressed as the amount of oxygen consumed from a chemical oxidation in a specific test.

Chronic Toxicity - Toxicity marked by a long duration, that produces an adverse effect on organisms. The end result of chronic toxicity can be death although the usual effects are sublethal (e.g. inhibits reproduction or growth). These effects are reflected by changes in the productivity and population structure of the community.

Community - Group of populations of plants and animals in a given ecological unit used in the broad sense to include groups of various sizes and degrees of integration.

Contaminant - A substance foreign to a natural system or present at unnatural concentrations in air, water, soil or food, causing use of those things to be limited. A naturally occurring substance may be found to exceed government guidelines or objectives, and thus, be called a contaminant.

Contamination - Any introduction into water of microorganisms, chemicals, wastes, or wastewater in a concentration that makes the water unfit for its intended use.

Conventional Pollutant - A term which includes nutrients, substances which decompose using oxygen in the process, material which produce an oily sludge deposit, and bacteria. Conventional pollutants include phosphorus, nitrogen, chemical oxygen demand, biochemical oxygen demand, oil and grease, volatile solids, total and fecal coliform bacteria, and chlorides.

Criteria - Numerical limits of pollutants established to protect specific water uses.

Decomposition - the breakdown of complex material into simpler substances by chemical or biological means.

Dioxin - A group of approximately 75 chemicals of the chlorinated dibenzodioxin family. 2,3,7,8-TCDD is considered the most toxic form.

Disease, water-borne - A disease caused by organisms or toxic substances which are carried by water. The most common water-borne diseases are typhoid fever, Asiatic Cholera, Dysemtery, and other intestinal disturbances.

Disinfection - The art of killing the larger portion of microorganisms in or on a substance with the probability that all the pathogenic bacteria are killed by the agent used.

Dissolved Oxygen - The amount of oxygen dissolved in water.

D.O. - The oxygen dissolved in sewage, water, or other liquid usually expressed in parts per million or percent of saturation.

Dredge Spoils - The material removed from the river, lake or harbor bottom during dredging operations.

Dredge Guidelines - Procedural directions designed to minimize the adverse effects of shoreline and underwater excavation with primary emphasis on the concentrations of toxic materials within the dredge spoils.

Ecosystem - The interacting complex of living organism and their nonliving environment; the biotic community and its abiotic environment.

Effluent - (1) A liquid which flows out of a containing space. (2) Sewage, water, or other liquid, partially or completely treated, or in its natural state, as the case may be, flowing out on a reservoir, basin, or treatment plant, or part thereof.

Environment - All biotic and abiotic factors that actually affect an individual organism at any point in its life cycle.

Erosion - The wearing away and transportation of soils, rocks and dissolved minerals from the land surface shorelines river bottoms by rainfall, running water, wave or current actions.

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Persistent Toxic Substance - Any toxic substance with a half-life in water greater than eight weeks.

Pesticide - Any substance used to kill plants, insects, fungi or other organisms - includes herbicides, insecticides, algicides and fungicides.

pH - A symbol denoting the negative logarithm of the hydrogen ion concentration in a solution. pH values run from 1 to 14. The number of 7 indicates neutrality.

Phenolics - Any of a number of compounds with the basic structure of phenol but with substitutions made onto this structure. Phenolics are produced during the coking of coal, the distillation of wood, the operation of gas works and oil refineries, from human and animal wastes, and the microbiological decomposition of organic matter.

Phosphorous - A highly reactive nonmetallic element, found in wastewater in three principal forms: orthophosphate ion, polyphosphates, and organic phosphorous compounds.

Photosynthesis - A process occurring in the cells of green plants and some micro-organisms in which solar energy is transformed into stored chemical energy.

Phytoplankton - Minute, microscopic aquatic vegetative life; plant portion of the plankton; the plant community in marine and freshwater situations which floats free in the water and contains many species of algae and diatoms.

Point Source - A source of pollution that is distinct and identifiable, such as an outfall pipe from an industrial plant.

Pollution (Water) - Anything causing or inducing objectionable conditions in any watercourses and affecting adversely the environment and use or uses to which the water thereof may be put.

Potable Water - Water that does not contain objectionable pollution, contamination, minerals, or infective agents and is considered satisfactory for domestic consumption.

Precipitation - The phenomenon that occurs when a substance held in solution in a liquid passes out of solution into a solid form.

Precipitation, chemical - Precipitation induced by the addition of chemicals.

Pressure, atmospheric - The pressure exerted by the atmosphere at any point. Such pressure decreases as the elevation of the point above sea level increases.

Process, biological - The process by which the life activities of bacteria, and other micro-organisms in search for food, breakdown complex organic materials into simple, more stable substances. Self-purification of sewage-polluted streams, sludge digestion, and all so-called secondary sewage treatments result from this process. Also called biochemical process.

Protozoa - The small one-celled animals including amoebae, ciliates, and flagellants.

Resuspension (of Sediments) - The remixing of sediment particles and pollutants back into the water by storms, currents, organisms and human activities such as dredging.

Secondary Treatment - Primary treatment plus bacterial action to remove organic parts of the waste.

Sediment - The soils on the bottom of a river or lake.

Sedimentation - The process of deposition by gravity of suspended matter.

Sewage, combined - A sewage containing both sanitary sewage and surface or storm water with or without industrial wastes.

Sewage, industrial - Sewage in which industrial wastes predominate.

Sewage, sanitary - (1) Domestic sewage with storm and surface water excluded. (2) Sewage discharging from the sanitary conveniences of dwellings (including apartment houses and hotels), office buildings, factories, or institutions. (3) The water supply of a community after it has been used and discharged into a sewer.

Sludge - (1) The accumulated solids separated from wastewater during processing, or deposits on bottoms of streams or other bodies of water. (2) The precipitate resulting from chemical treatment, coagulation, or sedimentation of wastewater.

Solids, total (TS) - The sum of dissolved and undissolved constituents in wastewater, usually stated in milligrams per liter.

Solids, volatile - The quantity of solids in water, sewage, or other liquid, lost on ignition of the total solids.

Solubility - Capability of being dissolved.

Stability - Absence of fluctuations in populations; ability to with stand perturbations without large changes in composition.

"Standard Methods" - Methods of analysis of water, wastewater, and sludge approved by the American Public Health Association, American Water Works association, and the Water Pollution Control Federation.

Suspended Solids - The solids that either float on the surface of, or are in suspension in sewage or other liquids.

System, collecting - A system of conduits (canals, ditches, pipe lines, tunnels, etc.) used to carry a water supply which is obtained from several different sources, such as different streams, to a common point. This point may be a reservoir, the intake of the main conduit or aqueduct, or the intake of the distributing system.

System, sewerage - A system of sewers and appurtenances for the collection, transportation, and pumping of sewage and industrial wastes.

Tertiary Treatment - Those processes that treat effluent from secondary treatment to remove or reduce nutrients, residual organics, and residual solids.

Total Organic Carbon (TOC) - A measure of the amount of carbon in a sample originating from organic matter only. The test is run by burning the sample and measuring the carbon dioxide produced.

Treatment - Any process involving the removal of solids or nonaqueous liquids from wastewater and/or transforming them into stable substances.

Treatment, biological sewage - Forms of sewage treatment in which bacterial or biochemical action is intensified to stabilize, oxidize and nitrify the unstable organic matter present. Intermittent sand filters, contact beds, trickling filters, activated sludge process are examples.

Treatment, complete - The removal of a high percentage of suspended, colloidal, and dissolved organic matter.

Treatment, primary - The first major (sometimes the only) treatment in a sewage treatment works, usually sedimentation. The removal of a high percentage of suspended matter but little or no colloical and dissolved matter.

Turbidity - Optical measure of suspended matter in liquids.

Velocity, subsidence - The vertical rate at which a solid particle settles in a liquid under the influence of gravity.

Velocity, turbulent - The velocity of water flowing in a conduit above which the flow will always be turbulent, and below which the flow may be either turbulent or laminar, depending upon circumstances.

Virus - A term now generally used to denote a living organism which passes through filters which strain out bacteria physically and is invisible by ordinary microscopic methods.

Wastewater - The spent water of a community. From the standpoint of source, it may be a combination of the liquid and water-carried wastes from residences, commercial buildings, industrial plants, and institutions, together with any groundwater, surface water, and storm water that may be present.

Wastewater Treatment Works - (1) An arrangement of devices and structures for treating wastewater, industrial wastes, and sludge. (2) A water pollution control plant.