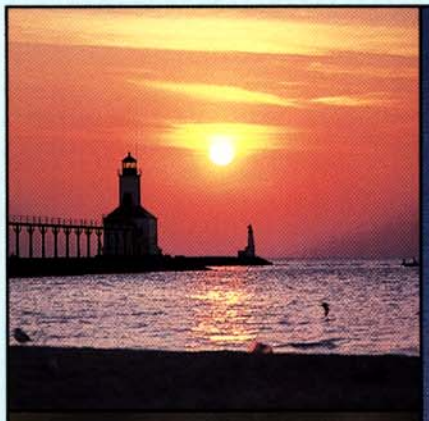
WATER RESOURCE AVAILABILITY IN THE LAKE MICHIGAN REGION, INDIANA



STATE OF INDIANA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER

1994

WATER RESOURCE AVAILABILITY IN THE LAKE MICHIGAN REGION, INDIANA

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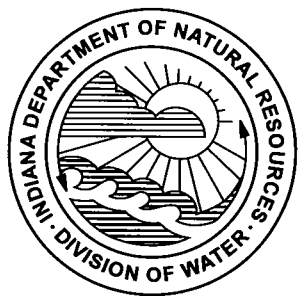
Water Resource Assessment 94-4



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MAJOR ACRONYMS AND ABBREVIATIONS

DOW	Division of Water
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
IGS	Indiana Geological Survey
IJC	International Joint Commission
ISBH/ISDH	Indiana State Board of Health/Indiana State Department of Health
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
USACE	U.S. Army Corps of Engineers
bg	billion gallons
cfs	cubic feet per second
°F	degrees Fahrenheit
I.C.	Indiana Code
m.s.l.	mean sea level
gpd	gallons per day
gpm	gallons per minute
MCL	maximum contaminant level
mg	million gallons
mgd	million gallons per day
mg/L	milligrams per liter
ml	milliliter
SMCL	secondary maximum contaminant level
sq. mi.	square miles

SELECTED CONVERSION FACTORS

Multiply	By	To obtain
	AREA	
Acres	43,560	Square feet
	0.001562	Square miles
	VOLUME	
Acre-feet	0.3259	Million gallons
	43,560	Cubic feet
	FLOW	
Cubic feet per second	0.646317	Million gallons per day
Gallons per minute	0.002228	Cubic feet per second
Gallons per minute	0.0014	Million gallons per day

WATER RESOURCE AVAILABILITY IN THE LAKE MICHIGAN REGION, INDIANA

INTRODUCTION

Water is a vital resource which greatly influences Indiana's socio-economic development. Ground-water and surface-water supplies serve a diversity of human needs, ranging from non-withdrawal uses such as instream recreation to large water withdrawals for public supply, industry, power generation and agriculture. Demands on the water resource are expected to increase as Indiana's economy and population continue to grow. Effective management of the water resource is possible only through a continuing assessment of the interactions between water availability and use.

BACKGROUND AND APPROACH

Issues concerning water supply and use in Indiana historically have been addressed on a case-by-case basis. The need for a comprehensive approach to conservation and management of Indiana's water resource led to the 1983 enactment of the Water Resource Management Act (I.C. 13-2-6.1).

Under this legislative mandate, the Natural Resources Commission must 1) conduct a continuing assessment of water resource availability, 2) conduct and maintain an inventory of significant withdrawals of surface water and ground water, and 3) plan for the development and conservation of the water resource for beneficial uses.

The legislation further mandates the continuing investigation of 1) low stream-flow characteristics, 2) water use projections, 3) the capabilities of streams and aquifers to support various uses, and 4) the potential for alternative water supply development.

The Indiana Department of Natural Resources, Division of Water, serving as the commission's technical staff, is achieving these legislative directives through ongoing investigations of water resource availability, water use, and conflicts involving limited water supply or competing uses.

Although conflicts between supply and demand typically are of a local nature, ongoing assessments of water availability and use are being conducted on a regional scale using the 12 water management basins designated by the Natural Resources Commission (figure 1).

A drainage basin, or watershed, is defined by the land surface divide that separates surface-water runoff between two adjoining regions (figure 2). A basin encompasses all of the land that eventually drains to a common river.

One disadvantage of using a drainage divide as the boundary of a water management unit is the potential oversight of factors that influence water resource issues but are located geographically outside of the basin. On the other hand, the basin approach allows local conditions or problems to be evaluated as parts of a unified hydrologic system. This integrated approach to a basin's water resource stems primarily from a recognition of the interrelated elements of the hydrologic cycle (figure 2), a continual exchange of water between the atmosphere and earth.

A comprehensive assessment of a basin's water resource requires an understanding of the socioeconomic setting, physical environment and hydrologic regime (figure 3). The complex interactions among these natural and manmade factors define the availability of a suitable water supply, which subsequently influences urban and industrial expansion, economic and agricultural development, and population growth. The water availability reports prepared by the Division of Water address these interactions in an attempt to comprehensively assess the water resource and its potential for further development.

PURPOSE AND SCOPE

This report describes the availability, distribution, quality and use of surface water and ground water in the

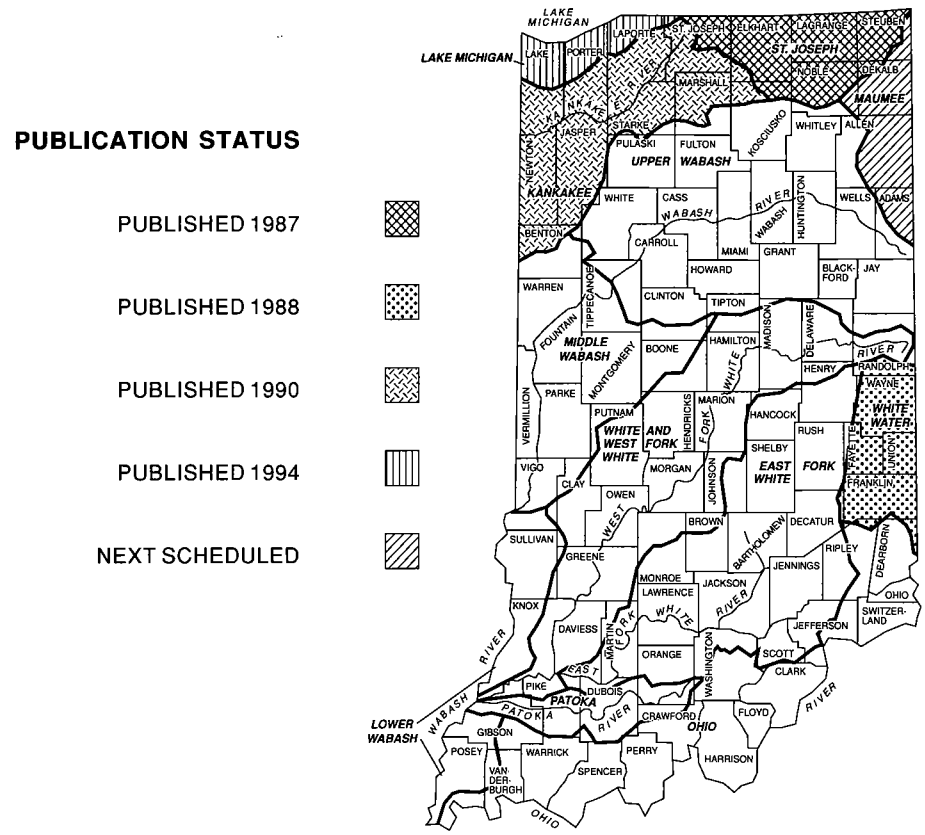


Figure 1. Location of Indiana water management basins and status of water availability reports

Lake Michigan Region, Indiana (figure 4). The fourth in a series of 12 regional investigations (figure 1), the report is intended to provide background hydrologic information for persons interested in managing or developing the region's water resource.

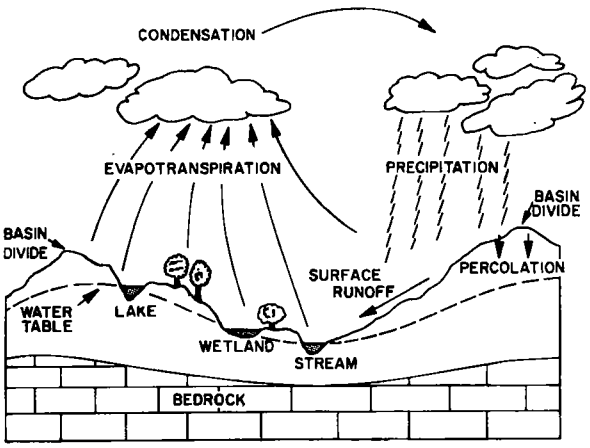
The Lake Michigan Region in Indiana is predominantly urban and is one of the state's most heavily populated and industrialized areas. It has been described as the area having the greatest concentration of iron and steel mills and electric-generating facilities in the world. The Region also maintains one of the largest refineries in the United States. The highly developed industrial/urban complex is served by major transportation networks including rail systems, interstate and local highways, and the St. Lawrence inland water navigation system. Yet, the Region also contains hundreds of acres of natural areas including wetland, woodland, and dune and swale ecosystems.

The eastern shore of the Lake Michigan Region, where the Indiana Dunes State Park and Indiana Dunes National Lakeshore have preserved much of the dune and wetland areas, provides a sharp contrast to the western urban/industrial complex.

Four Indiana counties lie partly within the Lake Michigan Region (table 1). The largest city within the Region is Gary, in Lake County. Other major population centers, including Hammond and East Chicago, coalesce with Gary to form a nearly continuous urban environment along the western shore of Lake Michigan.

The study region is bounded on the north by Lake Michigan and the Michigan state line; on the west by the Illinois state line; and on the south by the crest of the Valparaiso Moraine (figure 4). About 2 percent of Indiana's land area lies within the Lake Michigan Region.

The Lake Michigan Region, as defined in this study, encompasses a total of approximately 604 sq. mi.



Water that falls to the earth as precipitation follows many paths on its way back to the atmosphere. Precipitated water may be intercepted and taken up by plants; it may infiltrate the soil; it may be stored in small depressions, wetlands and lakes; or it may flow over the land surface to a nearby stream channel.

Some of the water used by plants returns to the atmosphere through the process of transpiration. Some of the water in streams, lakes and soils returns to the atmosphere through the process of evaporation.

Precipitated water that is not taken up by plants, evaporated, or stored in upper portions of the ground surface can percolate through open spaces in soil and rock formations to become ground water. A portion of the slowly moving ground water eventually returns to the surface as seepage to springs, lakes, wetlands and rivers. Some of the discharged water is evaporated from the surface to re-enter the atmosphere, and the hydrologic cycle continues.

Figure 2. Major components of Hydrologic cycle

(square miles) of land in northwest Indiana and approximately 241 sq. mi. of Lake Michigan. The Region, as it exists today, forms a portion of two separate major drainage basins. Of the total area in the Region, about 81 percent (489 sq. mi.) is drained by streams that flow directly into the Indiana portion of Lake Michigan. The remaining 115 sq. mi. or 19 percent is drained by streams that flow either into the state of Illinois or Michigan.

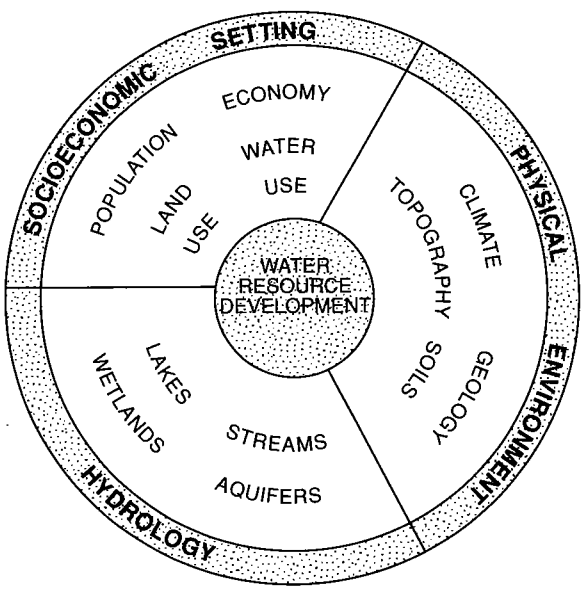


Figure 3. Factors influencing water availability

Most of the streamflow leaving the Region to enter the state of Michigan eventually reaches Lake Michigan. However, little if any, of the streamflow leaving the Region to enter the state of Illinois reaches Lake Michigan. The latter travels through the Mississippi River Basin and into the Gulf of Mexico (figure 4).

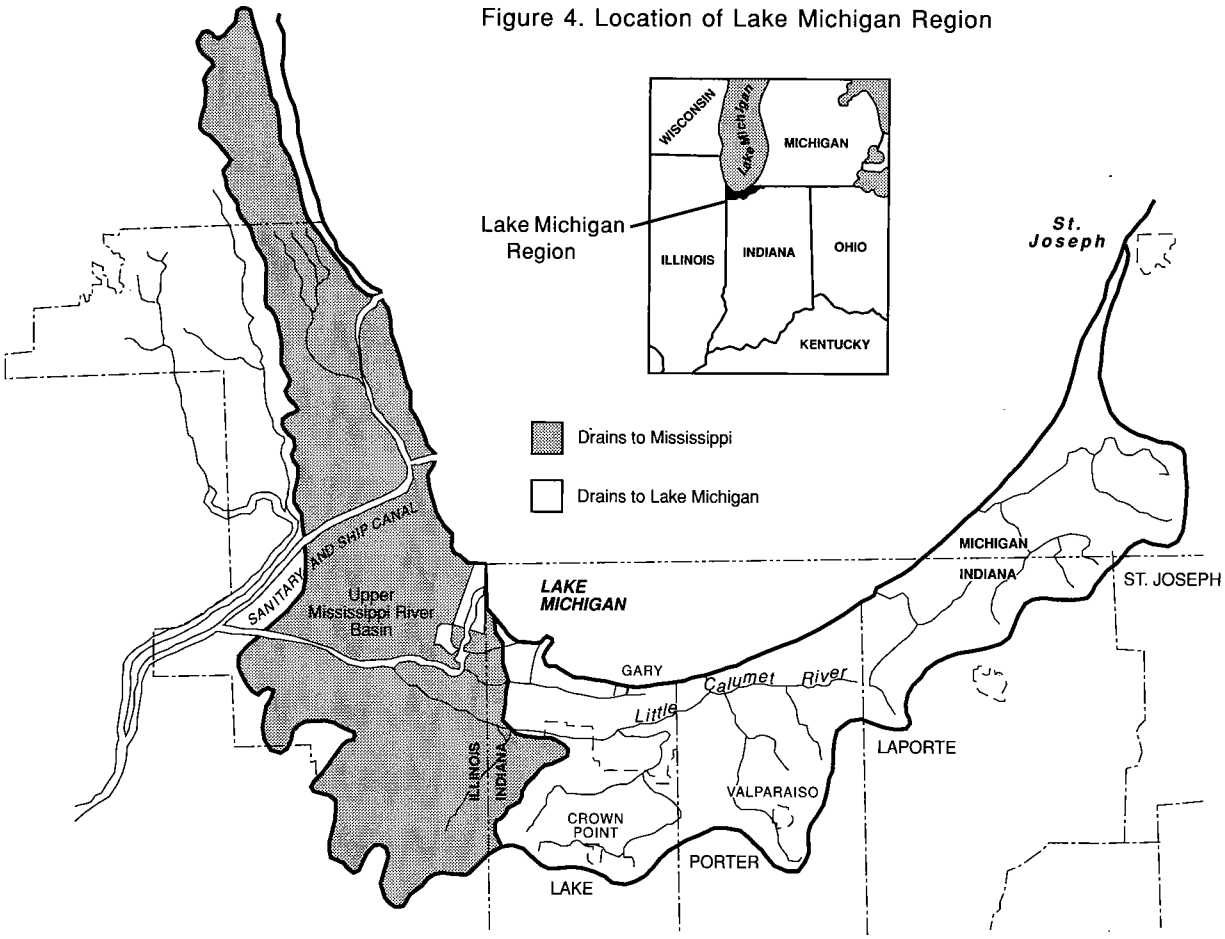
Streams of the Region include the Little Calumet, Grand Calumet, Galena, Trail Creek and an extensive network of smaller tributary streams and ditches. Surface drainage within the Lake Michigan Region is quite complex. The natural hydrology has been altered considerably because of modification of the landscape, urbanization and industrializaton of the Region.

Although the Lake Michigan Region drainage system covers parts of two drainage basins in three states, this report examines only the Indiana portion unless otherwise indicated. In general, discussions apply to in-basin portions of Lake, Porter and LaPorte Counties, which constitute 99.5 percent of the study area (figure 4, table 1).

Unless otherwise noted, data in this report are compiled only for areas lying within the study boundary. However, some economic, land use and agricultural information are for entire counties.

The information presented in this report should be suitable as a comprehensive reference source for public and private interests including governmental, agricultural, commercial, industrial, and recreational. However, the report is not intended for evaluating site-specific water resource development projects. Persons involved in such projects should contact the Division

Figure 4. Location of Lake Michigan Region



of Water for further information.

The contents of the report follow the generalized scheme shown in figure 3. An overview of the population, economy, land use, and categories of water use is followed by a discussion of climate, geology and soils. The report then describes the Region's surface-water and ground-water hydrology, including water quality. The final section of the report summarizes current and potential water use, and examines areas of past or potential conflicts between water demand and available water supply.

Because the report is written for a wide spectrum of readers, key technical words within the text are italicized the first time they appear, and where appropriate thereafter. Brief definitions are given in the glossary. An appendix includes data tabulations and illustrations which supplement the information found within the body of the report.

Water-use information presented in this report was derived from data compiled by the Division of Water on a continuing basis. Water-well records and other data on file at the division were used to define the hydrogeologic conditions of the basin.

Field investigations conducted by the Division of Water and the Indiana Geological Survey between 1986 and 1988 provided additional data on the geology and ground-water quality of the basin. A series of gamma-ray logs and test borings in areas of sparse geologic data were conducted in order to better define the Region's geology and the hydraulic characteristics of surficial materials. The collection and analysis of 25 water-well samples yielded information on ambient ground-water quality throughout the study region.

The remainder of the information in this report was derived, summarized or interpreted from data, maps and technical reports by various state and federal

Table 1. Area of Indiana counties within the Lake Michigan Region

County	Total area (sq mi)	In-region area (sq mi)	Percent of total region area
Lake	501	266	44.0
LaPorte	600	138	22.9
Porter	419	197	32.6
St. Joseph	459	3	0.5
Total	1979	604	100

agencies. Specific sources of data are referenced within the report. A list of selected references is included at the end of the report.

PREVIOUS INVESTIGATIONS

Because published and unpublished documents relating to the Lake Michigan Region in Indiana and Illinois are so numerous, only the primary sources used to prepare this report are discussed below. These primary documents and other major references are cited at the end of the report. Additional sources of information are listed within these cited references.

The first attempt in the Region to systematically collect and record all available information on the water resource in Lake and Porter Counties was published by the Lake-Porter Regional Transportation and Planning Commission (1970, revised in 1971). The water resource inventory includes summaries of water uses and sources, water quality programs and sampling results, summaries and outlines of related planning studies, and an extensive bibliography. The Northwest Indiana Regional Planning Commission (1976) prepared a regional plan for Northwest Indiana which includes a description of the region's water resource, population and economic base and sets forth a comprehensive plan for future development. Major components of the plan are land use, housing, and economic development. The Great Lakes Basin Commission (GLBC) in 1975 and 1976 published a Great Lakes Framework Study which encompassed the Lake Michigan Region. The GLBC study includes a framework study report, 25 appendix volumes and an environmental impact statement. The framework study was developed to provide an information base, identify problems, and determine future needs for the Great Lakes Basin; it includes surveys of the physical, biological, social and political resources which make up the Great Lakes Basin. A report by the Governor's Water Resources Study Commission (1980) assessed various aspects of water availability and use for 18 planning and development regions in the state of Indiana. The Lake Michigan Region lies primarily in one of these planning and development regions. Topics addressed in the 1980 report include flood hazard mitigation, land use, soil erosion, sedimentation, water supply, water quality, drainage, irrigation, fish and wildlife habitat, and outdoor recreation.

The geology and ground-water resources of several Indiana counties lying wholly or partly within the Region are addressed in a series of reports by the Indiana Department of Natural Resources and the U.S. Geological Survey (Rosenshein, 1961, 1962, 1963; Rosenshein and Hunn, 1962a, 1968a, 1968b). Maps and reports by the Indiana Geological Survey describe the surficial and bedrock geology of northwestern Indiana (Wayne 1956,1958,1963; Pinsak and Shaver, 1964; Lineback, 1970; Schneider and Keller, 1970; Doheny and others, 1975; Gray, 1982, 1983, 1989; Droste and Shaver, 1982, 1983; Shaver and others, 1986; Gray and others, 1987; Thompson, 1987). Various aspects of geology which are important to environmental planning were presented by Hartke and others (1975) for Lake and Porter Counties and by Hill and others (1979) for LaPorte County. A regional groundwater assessment was compiled by the Northwestern Indiana Regional Planning Commission (1981).

The U.S. Geological Survey (USGS) and the National Parks Service have been studying the hydrology and hydrochemistry of Indiana Dunes since 1973. The first study of the National Lakeshore was a general assessment of both surface- and ground-water quality throughout the Lakeshore (Arihood, 1975). A more detailed study of surface-water quality, of both biological and chemical characteristics, was done by Hardy (1984). Much of the USGS work was done in the area around Cowles Bog National Natural Landmark, a 56-acre tract at the western end of the Great Marsh. Several studies were initiated to assess the potential for changes in the water table and ground-water quality caused by seepage from fly-ash settling ponds and from dewatering for excavation (Marie, 1976; Meyer and Tucci, 1979; and Gillies and Lapham, 1980; Hardy, 1981; Cohen and Shedlock, 1986; Wilcox and others, 1986; and Shedlock and others, 1987). In 1988, Ban-

aszak and Fenelon discussed water quality in a thin water-table aquifer adjacent to Lake Michigan within a highly industrialized region of Indiana, and Watson and Fenelon described the geohydrology of the same aquifer. A preliminary analysis of the shallow groundwater system in the vicinity of the Grand Calumet River/Indiana Harbor Canal was provided by Watson and others (1989). In 1992, the geohydrology and hydrochemistry of the unconsolidated aquifer system at the Indiana Dunes National Lakeshore and the surrounding area are described by Shedlock and others, and the geohydrology and water quality of the Calumet Aquifer in the vicinity of the Grand Calumet River/ Indiana Harbor Canal are discussed by Fenelon and Watson (1993).

The quality of the environment in the heavily industrialized Northwest Indiana has been the focus of a number of studies and planning efforts over the past several decades. Summary tables and a brief description of major environmental studies and sampling projects are presented by the Indiana Department of Environmental Management (IDEM), 1988b. The IDEM report also includes an extensive bibliography and a detailed description of known contamination sites and potential contamination sources.

The U.S. Environmental Protection Agency (US EPA) has funded a number of initiatives to identify, understand, and mitigate environmental problems in the region. One initiative was a four-phase groundwater strategy study for Lake and Porter counties prepared by the Indiana State Board of Health (1983b). A Master Plan for Improving Water Quality in the Grand Calumet River and Indiana Harbor Canal was developed by the U.S. EPA (1985a). More recent initiatives include: a Northwest Indiana Environmental Action Plan (IDEM, 1987); a draft Northwest Indiana Environmental Action Plan/Area of Concern Remedial Action Plan, IDEM (1988b); the Stage One-Remedial Action Plan (RAP) for the Indiana Harbor and Canal, the Grand Calumet River, and the Nearshore Lake Michigan, IDEM (1991); and the Stage Two- RAP: Water Quality Component (1993).

The surface-water hydrology of the Region has been addressed primarily by the U.S. Army Corps of Engineers (USACE) and the Indiana Department of Natural Resources (IDNR), especially in regard to acute flooding problems in the Region. In 1948, the U.S. Army Corps of Engineers was directed by Congress to study the flooding problems along the Little Calumet River drainage system. A report by the USACE in 1965 identifies areas subject to flooding along the Little Calumet River and its tributaries. The IDNR contracted with Horner and Shifrin (1968) to provide discharge hydrographs at various points along the Little Calumet River and its tributaries in Indiana and to also include information on the low flow, flow duration and flood frequency characteristics of the Little Calumet River and its tributaries. The IDNR (1971a) published a summary report on hydrologic data for the Little Calumet River and tributarties for use in flood plain management. In 1973, the U.S. Army Corps of Engineers published a series of reports describing floodplain information on numerous streams and ditches including Deep River, Turkey Creek, Hart Ditch, and Cady Marsh Ditch. An engineer's report and final environmental impact statement were also prepared by the USACE in 1973 which defined Little Calumet flood control options; supplemental information was added in 1984. The Little Calumet River Basin Commission (1976) published a summary of publications and studies related to flooding along the Little Calumet River.

Crawford and Wangsness (1987) define the streamflow and water quality of the Grand Calumet River in Lake County, Indiana and Cook County, Illinois during October 1984.

The Chicago and Calumet Rivers were diverted from the Lake Michigan watershed by the construction of the Sanitary and Ship Canal (Main Canal) in 1900 and the Calumet-Sag Channel in 1922. Cooley, (1913) prepared an early brief of facts and issues concerning the diversion of waters of the Great Lakes. The Chicago Diversion resulted in numerous legal actions, the earliest which culminated in the Supreme Court decision-Sanitary District of Chicago v United States, 161 U.S.405 (1925) which allowed the Secretary of War to issue diversion permits. Keifer and Associates (1978) performed a study to determine flows crossing the Lake Michigan diversion boundary line at the Grand Calumet River in Hammond, Indiana and the Little Calumet River at Munster, Indiana. An evaluation of flow measurements and accounting methods for the Lake Michigan diversion was prepared by Harza Engineering Company in 1981. A manual of procedures for Lake Michigan diversion accounting was prepared by the Northeastern Illinois Planning Commission (1985). The latter publication also has a bibliography of legal actions related to the Chicago diversion. Espey and others (1987) prepared, for the U.S. Army Corps of Engineers, the findings of a committee for review of

diversion flow measurements and accounting procedures for the Lake Michigan Diversion. The Espey publication includes a narrative on the history of the diversion, including a discussion on the most recent U.S. Supreme Court amendment (1980) to the diversion permit.

As a result of high water levels on the Great Lakes in the 1950's, the U.S. House of Representatives requested the U.S. Army Corps of Engineers (1965c) to determine the feasibility of measures to prevent the recurrence of damages related to high lake levels. Extremely high lake levels recurring in the early 1970's generated additional concern. A report was presented to the International Joint Commission (IJC) by the International Great Lakes Levels Board (1973) concerning potential changes in regulation plans at existing regulatory sites on the lakes as a means of alleviating problems caused by high lake levels. The Great Lakes Basin Commission in their Great Lakes Basin Framework Study, devoted an appendix to discussion of Great Lakes levels and flows (1975b). In 1981, the International Great Lakes Diversion and Consumptive Use Study Board examined effects of consumptive use and diversions on water levels and flows of the Great Lakes Basin. Record high lake levels occurring in 1985 and 1986 resulted in a series of studies and publications concerning Great Lakes water levels. Bixby (1985) prepared, for the Center for the Great Lakes, an overview of Great Lakes Water levels. The U.S. Army Corps of Engineers (1985) prepared a publication about Great Lakes water level facts. Briefings were held by the Corps and the International Joint Commission (1985) with Senators and representatives of the Great Lakes basin states concerning water levels of the lakes. The Great Lakes Commission (1986) published a report concerning water level changes and factors influencing the Great Lakes. A recent investigation has been undertaken by the International Great Lakes Levels Board-International Joint Commission at the request of the United States and Canadian governments to examine and report on methods of alleviating the adverse consequences of fluctuating water levels in the Great Lakes-St. Lawrence River Basin using the most up-to-date techniques and information. Phase I of the IJC investigation, a progress report, was completed in 1989. Phase II, which produced a final recommendations document, was completed in 1993.

Shoreline erosion in the Indiana Coastal Zone has been addressed primarily by the Indiana Department of Natural Resources and the U.S. Army Corps of Engineers. A fairly comprehensive summary of studies preceeding 1979 was prepared by the Indiana Department of Natural Resources (1979b). More recent studies include U.S Army Corps of Engineers (1982), Davis and others (1981), Wood and Davis (1986), and Wood and others (1988).

ACKNOWLEDGEMENTS

The following divisions of the Indiana Department of Natural Resources (IDNR) provided valuable data and assistance during the preparation of this report: Engineering, Fish and Wildlife, Forestry, Nature Preserves, Soil Conservation, State Parks, Outdoor Recreation and Geological Survey (now part of Indiana University). The following organizations also made significant contributions: Indiana Department of Environmental Management; Indiana State Department of Health; Indiana Department of Highways; Indiana State Library (Indiana Division, Government Documents, Data Center); Purdue University (Department of Agronomy); Indiana University (School of Public and Environmental Affairs, Indiana Business Research Center); Illinois Department of Energy and Natural Resources (Water Survey, Geological Survey); National Oceanic and Atmospheric Administration (National Weather Service); U.S. Department of Interior (Fish and Wildlife Service, Geological Survey); U.S. Environmental Protection Agency (Region 5); and U.S. Department of Agriculture (Soil Conservation Service, Agricultural Stabilization and Conservation Service).

The authors of this report thank residents of the Lake Michigan Region for their cooperation during a 1987 ground-water sampling project. In addition, well-drilling contractors contributed water-well records and cooperated with a gamma-ray logging project.

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