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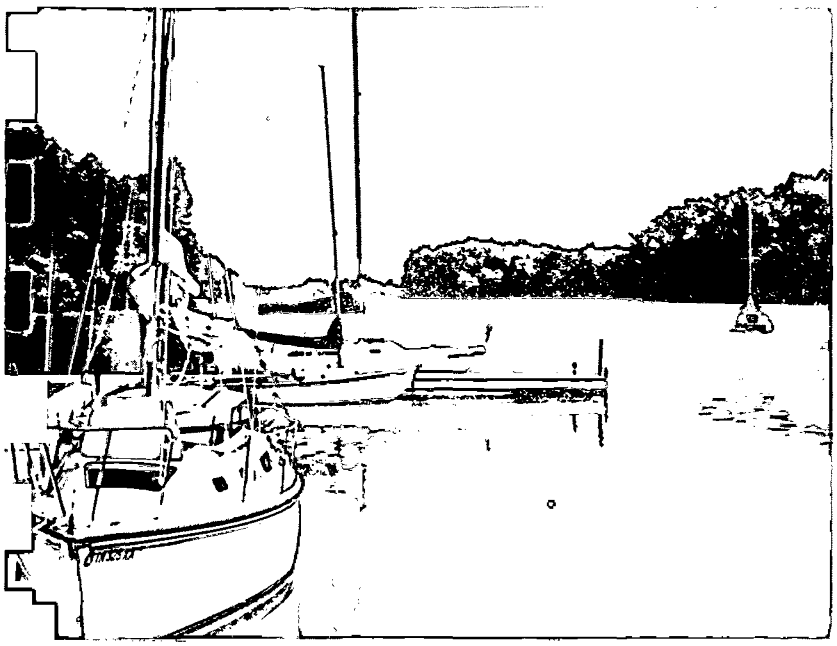
INDIANA 305(b) REPORT



1986-1987

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EXECUTIVE SUMMARY

The 1986-87 305(b) Report is organized into four major sections, and Indiana's activities and concerns in each area are summarized or discussed as follows:

1. Surface Water Quality - This section includes a discussion of the present status of water quality in Indiana rivers, lakes and streams that were assessed during this reporting period as well as any water quality trends that were apparent; a discussion of the toxics information which has been compiled; a discussion of the lake and nonpoint source assessments; and a summary discussion of the waters assessed in each major river basin.

2. Water Pollution Control Program - This section includes a discussion of the point source control programs including the construction grants, NPDES permitting, pretreatment, compliance, and enforcement programs; the nonpoint source control program; and the various monitoring programs used to obtain water quality data.

3. Ground Water Quality - This section describes Indiana's ground water resources; ground water quality; nonpoint source impacts; and geographic areas of concern.

4. Special Concerns and Recommendations - This section highlights Indiana's special concerns and includes proposed recommendations for future actions by the state and the federal government.

There are about 90,000 miles of rivers, streams, ditches and drainageways in Indiana. Of these, approximately 20,000 miles have sufficient all-weather flow and other physical characteristics necessary to support both the fishable and swimmable uses. Approximately 25% of these miles were assessed for this report. Additional stream miles could support the fishable use during high flow periods but the majority of these remaining miles are dry much of the year.

There are approximately 560 public-owned inland lakes and reservoirs in Indiana with a combined surface area of some 104,540 acres. Indiana also controls 154,000 acres (43 shoreline miles) of Lake Michigan. Some assessment was made for nearly all of these waters.

Although much of Indiana's wetland resource has been lost, there are an estimated 100,000 acres of wetlands remaining, mostly in the northern part of the state. Although no formal water quality assessment has been made of these areas, the state is unaware of any wetland problems related to point source discharges. The main concern of the state regarding wetlands is preventing the future loss of these areas through draining and filling.

Different, more stringent criteria were used to determine the extent of support of designated uses in this report than in those prepared in previous years. Of the waters assessed, 68% of the river and stream miles and over 99% of the total inland lake and reservoir acreage fully supported their designated uses. All of Indiana's portion of Lake Michigan was considered to only partially support designated uses due to the lakewide fish consumption advisory for certain species.

Of the stream miles assessed it was estimated that the swimmable goal was supported in 78% and the fishable goal was supported in 81%. Although both the fishable and swimmable goals were supported in over 99% of the total lake and reservoir acres assessed, many are considered threatened by point and/or nonpoint sources of pollution. All of Lake Michigan governed by Indiana supported the "swimmable" goal but was not considered to support the "fishable" goal due to the lakewide fish consumption advisory.

The major causes of nonsupport of uses were: fecal coliform bacteria, organic enrichment and dissolved oxygen problems, pesticides, priority organic compounds and ammonia. There is also an indication that chlorine was moderately affecting uses in most places where it is used as a disinfectant. The sources of substances most often contributing to nonsupport of uses were: industrial and municipal/semi-public point sources, combined sewer overflows, and agricultural nonpoint sources. Impacts due to nonpoint sources were most often considered only minor to moderate, however.

In the past two years, the state has done considerable monitoring for toxic substances in fish tissue and sediments. Over 2,300 stream miles and almost 54,700 inland lake and reservoir acres were monitored in some way for toxics. Of the river and stream miles monitored, about 40% were considered to have elevated levels of toxic substances. Most of these miles were due to the occurrence of fish consumption advisories or to the presence of sediment contamination at medium to high levels of concern. Pesticides, PCBs and metals were the substances most often causing these problems. Only about 2% of the inland lake and reservoir acres monitored were found to have toxic substances (primarily metals) in sediments at levels of medium to high concern. No fish tissue samples from lakes or reservoirs have been found to contain toxic substances at levels above Food and Drug Administration action levels. All of Indiana's portion of lake Michigan is considered to be affected by toxics due to the lakewide fish consumption advisory.

In order to improve water quality, an increased level of wastewater treatment has been provided by both municipalities and industries throughout the state. The percentage of the population served by primary treatment facilities decreased from 6% to 0% from 1972 to 1988, while the percentage served by advanced treatment facilities increased from 0% to 51% in the same time period. About 39% of Indiana's population has adequate individual septic tank disposal systems or are served by semi-public facilities. Since 1972, Indiana has received over $1.2 billion in federal construction grants money and has spent over $170 million in state money and $180 million in local matching funds for new or upgraded municipal wastewater treatment plants and sewer systems. There is no precise information on the amount of money spent for industrial waste treatment or control, but there were 176 claims for more than $1,045,182,000 in tax exemptions for industrial wastewater treatment or control facilities in 1987. There were only 102 claims for $369,187,000 in 1978.

Indiana has a plentiful ground water resource serving 60% of its population for drinking water and filling many of the water needs of business, industry and agriculture. Although most of Indiana's ground water has not been shown to have been adversely impacted by man's activities, over 200 sites of ground water contamination have been documented. These problems affect over 900 individual wells and several hundred thousand people.

The substances most frequently detected as well water contaminants in the state are chlorinated volatile organic chemicals, petroleum products, and nitrate. Monitoring wells at waste disposal sites most often indicate ground water pollution from inorganic chemicals like heavy metals. There is not a great deal of ground water data yet regarding pesticides, but about 10% of the private wells and 2% of the non-community wells tested contain excessive nitrate levels. These are thought to primarily be nonpoint source in origin.

The sources of ground water contamination most commonly reported in the state are hazardous material spills, leaking underground storage tanks and waste disposal activities. However, there are a wide variety of both contamination sources and their associated chemical pollutants which have been documented in Indiana's ground water.

There are some geographic areas of concern in the state for prevention, detection and correction of ground water quality impacts. These include areas geologically vulnerable to contamination, priority public supply well fields, and potential sole source aquifers. Special attention through continued and expanded ground water protection efforts should be focused in these areas.

In 1987, Indiana completed a comprehensive Ground Water Protection Strategy which addresses the problems documented in this report. Information needs and solutions to these problems are also discussed. Implementation of the 160 recommendations in this plan over the next five years is an important goal for increased effort to safeguard the resource.

I. INTRODUCTION

The State of Indiana, with a surface area of approximately 36,532 square miles, has approximately 5.5 million inhabitants. Although nearly 70 percent of the land in the state (16 million acres) is still devoted to agriculture, Indiana also has a diverse manufacturing economy. Most of these economic pursuits in some way depend on or affect Indiana's water resources. Also, much of the wastes produced by Indiana's inhabitants is ultimately discharged to surface waterways after receiving some form of treatment.

In addition to the demands placed on the water resource by agriculture, industry, utilities and municipalities, the increased leisure time available to Indiana residents as a result of the many technological advances over the last few decades has produced a rapid growth in recreational usage of Indiana's waters. Boating, fishing, swimming, water skiing, and "enjoying nature" are recreational activities which have recently place heavier demands for a share of the water resource. There is now much greater concern for the preservation of some of Indiana's waterways in their natural state and to protect the waters and riparian habitat for fish, other aquatic life forms, and wildlife.

Although the population of Indiana and its demands on the water resource have increased greatly since the turn of the century, the extent of the water resource remains essentially the same. Of the estimated 90,000 total miles of water courses in Indiana, only about 20,000 miles of streams and rivers are large enough to support all designated uses throughout most of the year (see Section II). These miles include 356 miles of the Ohio River, which forms the border between Indiana and Kentucky, and approximately 200 miles of the lower Wabash River, which forms the border between Indiana and Illinois. For purposes of this report, waterways in Indiana have been divided into seven drainage basins.

Indiana has approximately 560 publicly owned lakes, ponds, and reservoirs with a total area of approximately 104,540 acres. Three of these are over 5,000 acres in size (24,890 total acres). Indiana's publicly owned lakes, ponds and reservoirs have a gross storage capacity of around 606 billion gallons. Indiana also controls some 241 square miles (154,240 acres) of Lake Michigan and has approximately 43 miles of Lake Michigan shoreline.

Indiana has other wetland areas that are also a part of the water resource. These are commonly described as marshes, swamps, bogs, patholes, sloughs, and shallow ponds or remnant lakes. Wetlands are considered to be the most productive aquatic habitats for both plants and animals as they provide breeding and nesting areas, abundant food sources, and excellent protection or cover. They also serve as sediment and nutrient traps and provide flood control. Wetland inventories now underway indicate that more than 90 percent of Indiana's wetlands have been filled or drained and are now utilized for other purposes. Of the non open water wetlands remaining (estimated at a little over 100,000 acres) most are located in the northern two tiers of counties and along the Ohio River. Wetlands in the remaining part of the state consist of small, widely scattered pockets or narrow bands along rivers and streams.

Section 305(b) of the Clean Water Act requires the states to report to Congress every two years on their activities and the progress they have made toward meeting the goals of the Act. This report discusses Indiana's activities and progress in 1986-87.

II. SURFACE WATER QUALITY

Current Status and Designated Use Support

There are roughly 90,000 miles of surface drainage ways in Indiana. This total includes temporarily filled artificial ditches as well as permanent streams, all of which are "Waters of the State" protected by the Indiana Stream Pollution Control Laws. Most of these drainage ways do not even appear on detailed 1:24,000 scale United States Geological Survey (USGS) maps. Because of the way streams are formed in nature, the number of miles of temporary headwater streams is far larger than the miles of permanent streams.

There are probably no more than 10,000 miles of permanently flowing streams in Indiana which appear on a 1:500,000 scale USGS map. All of these are assumed to have enough depth and habitat the year around to be "fishable" and "swimmable". The remaining 80,000 stream miles could be assumed to be only intermittently flowing. Of this total, only about 20,000 miles of these "intermittent streams" appear on the more detailed 1:24,000 scale USGS maps. The remaining 60,000 miles of "intermittent" surface drainages probably hold water only periodically following heavy rainfalls and could not be "fishable."

Since 1979, the state has investigated over 250 "intermittent streams" appearing on 1:24,000 scale USGS maps to determine their existing and potential uses. About 50% of those examined have had adequate depth and habitat to be "fishable" (and probably "swimmable" as well). This proportion of "fishable" headwater streams remained fairly constant throughout each physiographic region of the state. If only half of the 20,000 miles of the larger "intermittent streams" and none of the smaller temporary drainage ditches (60,000 miles) are capable of supporting these uses, there must be at least 70,000 miles of streams in the state which cannot realistically be expected to meet the goals of the Clean Water Act because of natural physical constraints. This leaves approximately 20,000 miles of surface waterways which could be assessed as to their degree of support of designated uses and Clean Water Act goals. Table 1 shows the total size of various types of waterbodies classified for various uses.

The goal of all water pollution control programs is to provide water quality sufficient to protect designated uses. For example, recreation (e.g. swimming and wading) and the propagation of aquatic life are designated uses for most waters in Indiana. These waterbodies are often spoken of as having "swimmable" and "fishable" uses. To determine whether these uses are supported, a variety of chemical and biological information must be assembled and applied with a degree of professional judgment. Table 2 summarizes how such information was used in this report to assess water quality. In addition, a "threatened" category was applied when a water body supported

TABLE 1. *SUMMARY OF CLASSIFIED USES FOR INDIANA WATERBODIES.*

CLASSIFIED USE	TOTAL SIZE CLASSIFIED FOR USE		
	RIVERS (MILES)	LAKES (ACRES)	LAKE MICHIGAN (SHORELINE MILES)
Aq. Fish & Wildlife	90,000 (20,000)*	104,540	43
Domestic water supply	**	32,000	43
Recreation	90,000 (20,000)*	104,540	43
Agriculture	90,000 (20,000)*	104,540	43
Industrial	90,000 (20,000)*	104,540	43
Navigation	--	--	43
Nondegradation	90,000 (20,000)*	104,540	43
Other (specify)	--	--	--
Unclassified	--	--	--

* *Although there are approximately 90,000 miles of watercourses and drainageways in Indiana which would technically fall under the jurisdiction of the water quality standards, only about 20,000 miles could reasonably be expected to meet these designated uses during most of the year due to natural conditions. (see text for further explanation).*

** *Standards for domestic water supply apply at the point of withdrawal for use. Approximately 20 different rivers and streams have domestic water supply intakes.*

TABLE 2. *CRITERIA FOR EVALUATING SUPPORT OF DESIGNATED USES*

ASSESSMENT BASIS	ASSESSMENT DESCRIPTION	SUPPORT OF DESIGNATED USE		
		FULLY SUPPORTING	PARTIALLY SUPPORTING	NOT SUPPORTING
Evaluated	No site-specific ambient data or data more than five years old. Assessment is based on land use, location of sources, citizen complaints, etc. Predictive models use estimated inputs.	No sources (point or nonpoint) are present that could interfere with the use. Data indicate or it is predicted that criteria are attained.	Sources are present but may not affect use or no sources present but complaints on record.	Magnitude of sources indicate use is likely to be impaired. Criteria exceedences predicted.
Monitored (Chemistry)	Fixed station sampling or survey sampling. Chemical analysis of water, sediment, or biota.	For all pollutants, criteria exceeded in ≤10% of measurements and mean of measurements is less than criteria. No fish consumption advisory exists.	For any one pollutant, criteria exceeded 11-25% and mean of measurements is less than criteria; or criteria exceeded ≤10% and mean is greater than criteria. A "general" fish consumption advisory exists.	For any one pollutant, criteria exceeded >25% or criteria exceeded 11-15% and mean of measurements is greater than criteria. A complete ban on consumption of fish is recommended.
Monitored (Biology)	Site visit by qualified biological personnel. Rapid bioassessment protocols may be used.	Use fully supported; no evidence of modification of community (within natural range of control/ecoregion).	Some uncertainty about use support; some modification of community noted.	Use clearly not supported; definite modification of community.

CLASSIFICATION GUIDELINES FOR MULTIPLE USE WATERBODIES

Fully Supporting = All uses are fully supported.
Partially Supporting = One or more uses partially supported and remaining uses are fully supported.
Not Supporting = One or more uses not supported.

designated uses but had anticipated new sources or adverse trends of pollution.

In past years the state has applied a slightly different method for assessing use support. Previously, fish consumption advisories alone did not constitute nonsupport of uses if a diverse and well-balanced aquatic community was present in a water body. Now, uses for aquatic life are considered not supported or only partially supported if an advisory exists.

A second change in methods for evaluating water quality is the combining of recreational uses ("swimmable") and aquatic life ("fishable") uses into a single category of use assessment. Previously, waterbodies were assessed as either supporting or not supporting individual uses. Many waterbodies fully supported aquatic life but only partially supported recreational uses. The degree of support of each use was tabulated separately. Under the present system, a waterbody fully supports uses only when both aquatic life and recreational uses are fully supported. This change has increased the number of miles of streams indicated as not supporting all uses, even though water quality itself may not have deteriorated since the previous assessments.

Tables 3 and 4 summarize the current status of use support in waterbodies of Indiana. There are roughly 20,000 miles of rivers and streams in Indiana which are potentially both "fishable" and "swimmable". About one-quarter of these miles were assessed for support of uses. Of those miles assessed, 68% were judged to be fully supporting all uses. Another 19% were partially supporting uses, while 13% did not support uses. When separated into Clean Water Act goal categories, 78% of all stream miles fully supported the fishable goal and 81% were "swimmable". Only about 1% of the assessed miles have been officially designated as having uses less than "fishable" and "swimmable". Figure 1 shows the degree of use support for the larger rivers and streams assessed. Many of the smaller streams assessed could not be shown on a map of this scale.

Enough information was available to assess nearly all of the state's publicly owned inland lakes. All but about 0.2% of the lake acreage in the state fully supported uses. The number of acres considered not meeting the "swimmable" goal was roughly equal to the number not meeting the "fishable" goal. No lakes in Indiana are designated for less than "swimmable" and "fishable" uses.

A more complete discussion of the trophic classification, current status, trends, and support of designated uses of Indiana Lakes and reservoirs can be found in the Lake Information and Assessment Section. Additional information can be found in the Indiana Lake Classification System and Management Plan which was revised in 1986.

There are 43 miles of Lake Michigan shoreline in Indiana. All of the miles were assessed by a combination of physical, chemical and biological information. Because of the consumption advisory in effect for some fish species in Lake Michigan, all 43 miles were judged to be only partially supporting the fishable use. None of the lake has been designated for less

TABLE 3. *SUPPORT OF DESIGNATED USES BY VARIOUS WATERBODY TYPES (EXCLUDING OHIO RIVER MAINSTEM).*

DEGREE OF USE SUPPORT	RIVERS AND STREAMS (MILES)			LAKES (ACRES)			LAKE MICHIGAN (SHORELINE MILES)		
	EVALUATED	MONITORED	TOTAL ASSESSED	EVALUATED	MONITORED	TOTAL ASSESSED	EVALUATED	MONITORED	TOTAL ASSESSED
Size fully supporitng	1,294	2,225	3,519	40,867	63,494	104,361	--	--	--
Size threatened*	(177)	(459)	(636)	**	--	--	--	--	--
Size partially supporting	89	893	982	40	23	63	--	43	43
Size not supporting	49	631	680	67	49	116	--	--	--
TOTAL	1,432	3,749	5,181	40,974	63,566	104,540	0	43	43

* *Size threatened is a subset of the size fully supporting and is not included in the totals entered in the last line.*

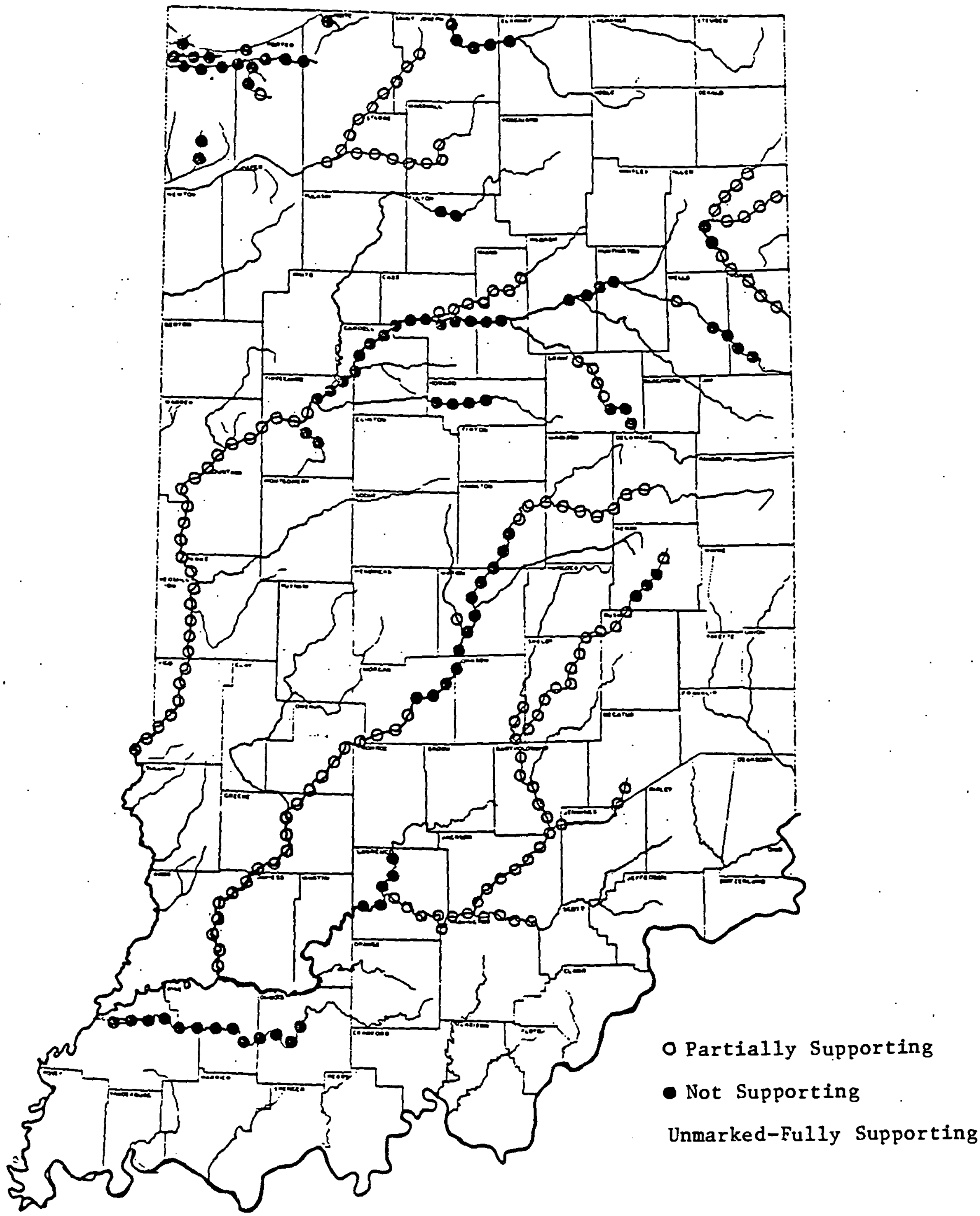
** *All lakes are considered threatened to some extent by nonpoint urban and agricultural sources.*

TABLE 4. *ATTAINMENT OF CLEAN WATER ACT GOALS.*

GOAL ATTAINMENT	RIVERS AND STREAMS (MILES)		LAKES (ACRES)		LAKES MICHIGAN (SHORELINE MILES)	
	FISHABLE GOAL	SWIMMABLE GOAL	FISHABLE GOAL	SWIMMABLE GOAL	FISHABLE GOAL	SWIMMABLE GOAL
Size meeting	4,089	4,269	104,424	104,361	--	43
Size not meeting	1,092	912	116	179	43	--
Size not attainable*	77	77	--	--	--	--
TOTAL	5,258	5,258	104,540	104,540	43	43

* *Includes all streams designated as "limited use" in state water quality standards.*

Figure 1. Degree of use support for larger rivers and streams assessed.



than "fishable" and "swimmable" uses. The Grand Calumet River and Indiana Harbor Ship Canal, which drain into Lake Michigan at East Chicago, have been designated an International Joint Commission (IJC) Area of Concern but they were evaluated as "rivers or streams".

It has been estimated that in presettlement times there were approximately 5.6 million acres of wetlands in Indiana. These ranged from permanently flooded lakes and ponds to wet meadows and wooded areas with predominantly hydric soils. The majority of these wetlands have been drained to create farmland, but others have been drained or filled to permit construction of homes, businesses, industries, boat docks, parking lots, roads, railroads, parks, wastefills or just for landscaping purposes. It is now estimated that, other than the open water wetlands represented by lakes and reservoirs, Indiana only has a little over 100,000 acres of wetlands left. Most of these are marshes and shrub swamps, although bogs and wooded swamps are also present. These wetlands provide spawning areas for some fish, support many other kinds of wildlife, serve as sediment and nutrient traps, and aid in flood control. At this time no significant wetland areas are known to be adversely affected by point source wastewater discharges in Indiana.

Since January 1986, the State of Indiana has received approximately 120 Public Notices from the U.S. Army Corps of Engineers regarding Water Quality Certification under Section 401 of the Federal Clean Water Act for dredge and fill permit application. Approximately 20% would have involved the filling of significant wetlands and, of those, 95% were denied. Unfortunately, some of Indiana's wetlands are still disappearing and being altered as they are illegally drained and filled for various purposes. The greatest potential for further wetland protection in Indiana lies in educating the public to the requirements of the 404 environmental review and 401 certification process and of the contribution to better water quality and wildlife habitat provided by wetlands.

Tables 5 and 6 summarize the causes and sources of nonsupport of uses in Indiana waterbodies, respectively. The five major pollutant categories contributing to nonsupport of uses, in descending order of importance, were priority organics (mostly PCBs), fecal coliform bacteria, organic enrichment/low dissolved oxygen concentrations, organochlorine pesticides, and ammonia. Nonpoint runoff from agricultural practices was the source which accounted for the largest number of miles or acres impacted, although most impacts were considered moderate or minor. Other important sources contributing to use impairment were municipal or semi-public discharges, combined sewer overflows, industrial discharges, urban runoff, and derelict coal mine runoff. The causes and sources of nonsupport of uses is discussed in more detail in the basin by basin summaries.

<u>Trends in Water Quality</u>

In an effort to statistically describe water quality trends, data from the Fixed Station Water Quality Monitoring Network were compiled for fecal coliform, biochemical oxygen demand (BOD), arsenic, cadmium, copper, lead,

TABLE 5. *TOTAL SIZES OF WATERBODIES NOT FULLY SUPPORTING USES AFFECTED BY VARIOUS CAUSE CATEGORIES.*

CAUSE CATEGORY	RIVERS AND STREAMS (MILES)		LAKES (ACRES)		LAKE MICHIGAN (SHORELINE MILES)	
	MAJOR IMPACT	MODERATE /MINOR IMPACT	MAJOR IMPACT	MODERATE /MINOR IMPACT	MAJOR IMPACT	MOOERATE /MINOR IMPACT
Unknown toxicity	9	7	--	--	--	--
Pesticides	68	232	12	--	--	43
Priority organics	184	590	27	--	--	43
Nonpriority organics	--	8	--	--	--	--
Metals	66	194	15	45	--	--
Ammonia	65	246	22	100	--	--
Chlorine	--	*	22	77	--	--
Other inorganics	--	--	--	--	--	--
Nutrients	82	173	122	12	--	--
pH	44	113	30	--	--	--
Siltation	14	167	--	**	--	--
Organic enrich./DO	192	320	82	52	--	--
Salinity	--	--	--	--	--	--
Thermal modification	--	6	--	--	--	--
Flow alterations	4	13	--	--	--	--
Other habitat alt.	14	***	--	--	--	--
Pathogens (fecal coliforms)	413	375	45	89	--	--
Radiation	--	--	--	--	--	--
Oil and grease	20	7	--	--	--	--

* *Assumed to be moderately affecting use wherever it is used as a disinfectant (amount is unknown).*

** *Siltation is affecting most of our lakes and reservoirs to an undetermined extent.*

*** *Channelization has had moderate impact on many miles (amount is unknown).*

TABLE 6. *TOTAL SIZES OF WATERBODIES NOT FULLY SUPPORTING USES AFFECTED BY VARIOUS SOURCE CATEGORIES.*

CAUSE CATEGORY	RIVERS AND STREAMS (MILES)		LAKES (ACRES)		LAKE MICHIGAN (SHORELINE MILES)	
	MAJOR IMPACT	MODERATE /MINOR IMPACT	MAJOR IMPACT	MODERATE /MINOR IMPACT	MAJOR IMPACT	MODERATE /MINOR IMPACT
Point Sources						
Industrial	165	225	15	--	--	43
Municipal/Semi-Public	285	217	99	--	--	43
CSO	386	130	45	12	--	43
Storm Sewers	75	4	--	45	--	--
Nonpoint Sources						
Agriculture	47	934	12	85	--	43
Silviculture	--	--	--	--	--	--
Construction	26	56	--	--	--	--
Urban runoff	70	108	35	22	--	--
Resource Extract.	49	121	30	--	--	--
Land Disposal	12	1	--	--	--	--
Hydro/habitat mod.	--	*	40	--	--	--
Other	57	73	--	--	--	--
Aerial Deposition	--	--	--	--	--	43
Spills, unknown	57	73	--	--	--	--

* *Many stream miles in the state have been moderately affected by habitat modification (amount is unknown).*

cyanide, dissolved oxygen (DO) and un-ionized ammonia. Comparisons of 16 of the stream CORE stations were made for three different time periods (1982-83, 1984-85 and 1986-87) for each of the parameters using t-tests. These CORE stations were selected because they were believed to be indicative of general statewide water quality conditions; had established, unchanged locations; and had sufficient databases. These nine parameters were selected primarily because laboratory detection limits and quality assurance for these parameters have not changed since 1982.

In this trend analysis, both nondetectable and actual measured concentrations were used in all comparisons. Nondetectable values were designated as minimum detectable values for computations. For example, a BOD value of less than 1.0 mg/l was included in a calculation as 1.0 mg/l.

Data were analyzed using the SAS program PROC t-test. Statistics calculated included sample size, arithmetic or geometric mean, standard deviation, standard error, minimum value, statistic, confidence limit, and P-value. P-values less than 0.05 were considered significant.

The direct examination for specific pathogens in water is too costly, time consuming, and unwieldy for routine investigations. Instead, water is examined for an indicator of fecal contamination. When such an indicator is found in significant numbers, it is assumed that the water is potentially dangerous. In recent years, public health agencies have used fecal coliform bacteria as the indicator of fecal contamination. Inasmuch as fecal coliform concentrations in steams may be influenced by factors other than waste discharge, such as agricultural and urban runoff, a great deal of care must be used in interpreting bacteriological data.

The geometric mean fecal coliform concentrations per 100 ml at the 16 CORE stations evaluated ranged from 64-1,072 in 1982-83, 53-1,334 in 1984-85 and 106-5,232 in 1986-87. During the 1986-87 reporting period, 13 of the 16 CORE stations had geometric mean concentrations that met the partial body contact criteria. Significant increases in fecal coliform concentrations compared to previous years data were noted below the Michigan City POTW at station TC-0.5. Michigan City is currently in the process of constructing additional treatment facilities and has had several incidents of bypassing plant upsets and other problems during this construction period. This probably accounts for these increased fecal coliform levels. Hopefully, completion of construction at this plant will eliminate this problem. Although no statistically significant trends were observed at the other 15 stations, fecal coliform concentrations did appear to be increasing over this time period at stations on the St. Joseph River below South Bend and on the Wabash River below Lafayette. These increases are thought to be due to increased incidents of combined sewer overflows at these localities.

The biochemical oxygen demand (BOD) of a stream or waste effluent is the amount of oxygen required for the biological breakdown of organic material under aerobic conditions. The BOD test is very important to determining the strength of polluting substances and the degree of self-purification that has occurred in a stream below the point of waste discharge.

Domestic sewage and some industrial wastes contain high concentrations of organic material which is readily broken down by microorganisms. If environmental conditions are suitable, populations of microorganisms involved in this process increase rapidly and establish a demand for oxygen for respiration (BOD). The BOD of a stream is highest immediately below the point where organic materials are discharged and decreases downstream.

Table 7 shows water quality at Indiana's CORE stations relative to BOD levels. Although BOD levels at only one station (BD-1) demonstrated a statistically significant change, levels at most have already reached concentrations typically classified as "clean" to "fairly clean." As many of these BOD values are at or approach background levels, statistically significant changes would be difficult, if not impossible to achieve.

Although occasional water quality violations for some of the remaining seven parameters have been observed, mean concentrations at 16 CORE stations reveal that recommended criteria and/or state standards are generally met, and no trends were observed with these parameters. For example, all mean concentrations of un-ionized ammonia at the 16 CORE stations were below the maximum allowable un-ionized ammonia concentration of 0.02 mg/l for cold water species. As a result of many values at or approaching background or undetectable levels, statistically significant improvements have become difficult, if not impossible, to achieve.

Some information has also been compiled to show trends in the water quality of lakes and reservoirs. This trend information is presented in the lake assessment section of this report.

Public Health/Aquatic Life Concerns

The release of toxic materials into the aquatic environment produces effects in several ways: 1) when present in sufficient amounts to be acutely toxic, they may directly kill fish and other aquatic organisms; 2) when present in lesser amounts, these substances can reduce densities and growth rates of aquatic organisms and/or bioacumulate in their tissues until they are unsafe for human consumption; and 3) toxic materials in the water could directly affect human health by contaminating public water supplies. At this time, we have no data which indicate that there have been any adverse human health effects from contaminated water supplies or primary contact recreation activities (e.g., swimming) due to toxic substances in surface waters. Any of these situations results in greater public concern that many other types of water pollution problems.

TABLE 7. *WATER QUALITY RELATIVE TO BOD_5 LEVELS AT 16 OF INDIANA'S CORE STATIONS.*

WATER QUALITY AND BOD_5 CONCENTRATION		NO. OF CORE STATIONS		
	MG/L	1982-83	1984-85	1986-87
Very Clean	1.0	0	0	0
Clean	2.0	7	5	8
Fairly Clean	3.0	8	10	6
Doubtful	5.0	1	1	2
Bad	10.0	0	0	0
Mean BOD_5 values (mg/l)		2.84	2.85	2.78

In the last several years, advances in analytical capabilities and techniques and the generation of more and better information as to the toxicity of these substances has led to an increased concern about their presence in the effects on the aquatic environment and associated human health. These concerns have resulted in more time and money being spent on the collection, analysis and interpretation of data on toxic substances in Indiana waters. The following portion of this report focuses primarily on the studies Indiana has done in 1986 - 1987, to discover the scope of the toxic problems and the causes and possible solutions to these problems.

Because many pollutants are likely to be found in fish tissue and bottom sediments at levels higher than in the water column, much of the data on toxic substances were obtained through the fish tissue and in-place sediment monitoring programs as well as the bioassay data and biosurvey studies. Other than for certain metals, cyanide and a few other substances, there has not been extensive monitoring of ambient surface waters for priority pollutants in Indiana. The proposed revisions to Indiana's general water quality standards regulation (327 IAC 2-1) include numerical criteria for numerous priority pollutants as well as procedures to calculate appropriate criteria for others. Indiana anticipates an increased need for surface water monitoring for the priority pollutants as a result of these revisions.

The total size of the various types of waterbodies monitored for toxics and determined to have elevated levels of toxics is shown on Table 8. Of the 1,106 total lake acres shown to have elevated levels of toxics, most are included only because contaminants in bottom sediments were found at levels judged to be a medium of high concern. In only 27 of these lake acres are toxic substances impairing the uses of lakes. Decatur County Reservoir (City Park Lake) at Greensburg currently has a state issued fish consumption advisory recommending against eating any fish from this reservoir. An advisory recommending that no one fish, wade or swim in Springwood Lake, located in a city park in Richmond (Wayne County), was issued by the City Parks Department as a precautionary measure due to high sediment concentrations of cyanide. No fish tissue samples have been collected from this lake since renovation of the lake, which would include sediment removal and replacement of the stunted fish community, is under consideration. Fish samples collected from all other lakes included on this list have been found to have tissue contaminant concentrations well below FDA action levels.

Over half of the 922 river and stream miles determined to have elevated levels of toxic substances were placed in this category, at least in part, due to fish consumption advisories. Most of the remainder of these miles are due to contaminants in sediment at medium to high levels of concern. In most instances, these rivers and streams supported diverse communities of aquatic organisms. These waterbodies are listed in Table 9 and are located on Figure 2.

A list of waters which may require additional point source controls for toxic substances (the 304 (1) "short list") is being prepared and will be submitted to EPA as a separate document. This document will include all the required 304 (1) lists.

TABLE 8. *TOTAL SIZE OF WATERBODIES MONITORED AND AFFECTED BY TOXICS.*

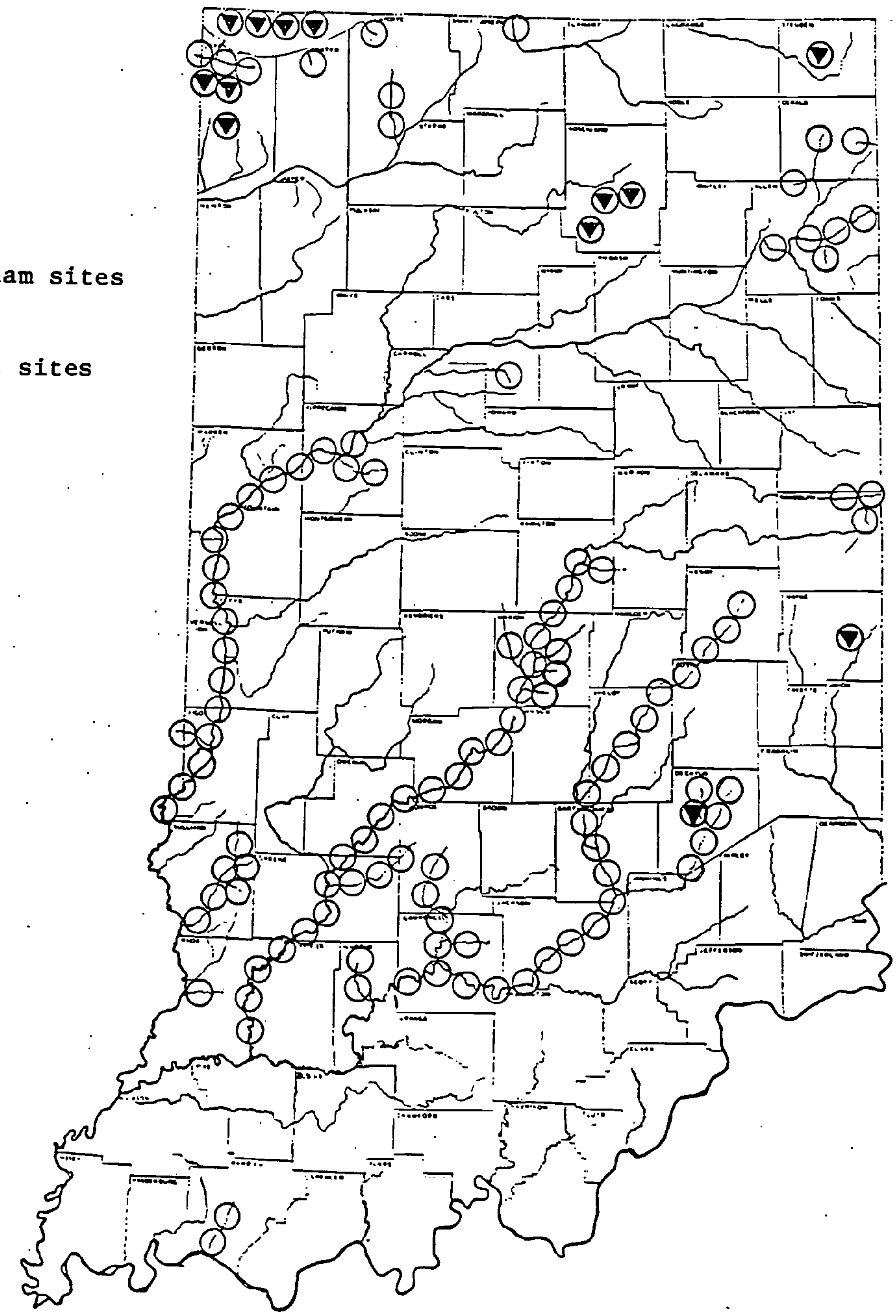
WATERBODY	SIZE MONITORED FOR TOXICS	SIZE WITH ELEVATED LEVELS OF TOXICS
Rivers (miles)	2,306	922
Lakes (acres)	54,686	1,106
Estuaries (miles)	--	--
Coastal waters (miles)	--	--
Great Lakes (miles)	43	43
Freshwater wetlands (acres)	--	--
Tidal wetlands (acres)	--	--

TABLE 9. ***WATERBODIES WITH ELEVATED LEVELS OF TOXIC SUBSTANCES.***

WATERBODY	COUNTY
Lake Michigan Basin	
St. Joseph River	St. Joseph
Trail Creek	LaPorte
Burns Ditch	Porter
Grand Calumet River	Lake
Indiana Harbor Canal	Lake
Maumee River Basin	
Maumee River	Allen
Spy Tun	Allen
Harvester Ditch	Allen
Willow Creek	Allen
Cedar Creek	Dekalb
Teutsch Ditch	Dekalb
Kankakee River Basin	
Travis Dtich	LaPorte
Wabash River Basin	
Wabash River	Tippecanoe/Warren/Fountain/Vermillion/Parke/Vigo
Elliot Ditch	Tippecanoe
Wea Creek	Tippecanoe
Phillips Ditch	Cass
Little Mississinewa River	Randolph
Mississinewa River	Randolph
Sugar Creek	Vigo
Smalls Creek	Knox
Busseron Creek	Sullivan
Sulphur Creek	Sullivan
Mud Creek	Sullivan
West Fork of White River Basin	
West Fork of White River	Hamilton/Marion/Johnson/Morgan/Owen/Greene/Daviess/Pike
Stoney Creek	Hamilton
Eagle Creek	Marion
Fall Creek	Marion
Pleasant Run	Marion
Pogues Run	Marion
Richland Creek	Monroe/Owen/Greene
East Fork of White River Basin	
Big Blue River	Henry/Rush/Shelby/Johnson
Driftwood River	Bartholomew

Waterbody	County
Sand Creek	Decatur/Jennings/ Bartholomew/Jackson
Muddy Fork of Sand Creek	Decatur
Clear Creek	Monroe
Salt Creek	Lawrence
Pleasant Run	Lawrence
Boggs Creek	Martin
East Fork of White River	Bartholonew/Jackson/ Lawrence
Ohio River Basin	
Cypress Creek	Warrick
Lakes	
Lake Michigan	Lake/Porter/LaPorte
Wolf Lake - channel	Lake
Lake George - north basin (Hammond)	Lake
Cedar Lake - north basin	Lake
Little Center Lake	Steuben
Pike Lake	Kosciusko
Center Lake	Kosciusko
Palestine Lake - west basin	Kosciusko
Springwood Park Lake	Wayne
Decatur County Reservoir	Decatur

Figure 2. Assessed sites with elevated levels of toxic substances.



○ = stream sites

▼ = lake sites

Fishkill Reports

A diverse healthy fish population is considered an indication of good water quality. Serious public concern is generated when dead and dying fish are noted in the aquatic environment since this is usually evidence of a severe water quality problem and may indicate the long-term loss of use of the affected waters for a fishery.

A fishkill can result from the accidental or intentional spill of a toxic compound or oxygen-depleting material into the aquatic environment. Fishkills may also occur downstream of a continuous industrial or municipal discharge which may release, due to a system upset, an atypical effluent containing high concentrations of pollutants.

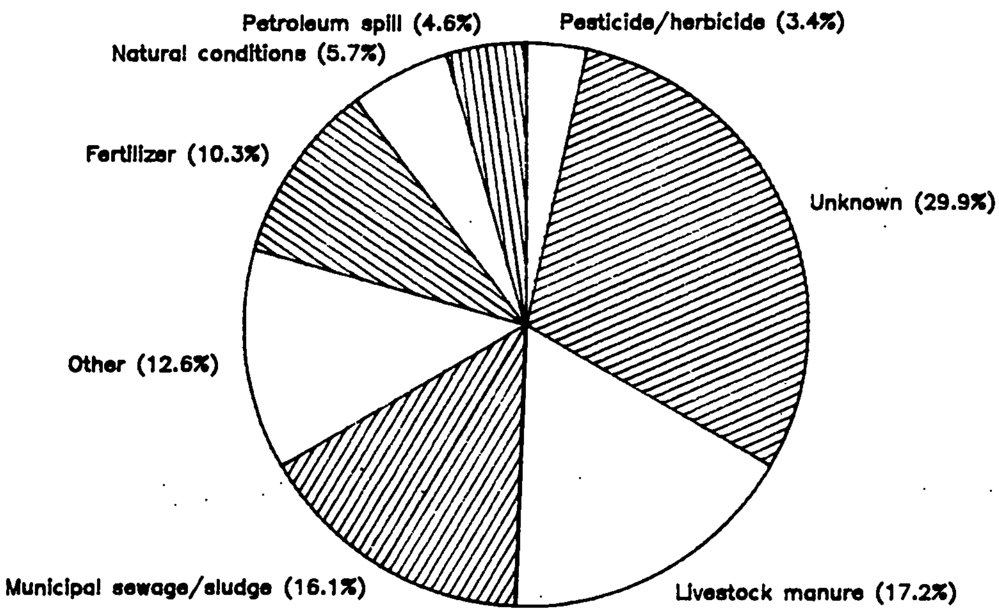
A total of 87 fishkills were reported in 1986 and 1987, an increase from the 1984-1985 (53) and 1982-83 (59) periods, but lower than the 1980-81 period (106). Although many of the causes of fishkills were unknown (29.9%) livestock manure from feeding operations (17.2%), municipal sewage/sludge (16.1%) and liquid fertilizer spills (10.3%), and other sources (12.6%) were responsible for most fishkills for which causes were determined (Figure 3). The causes grouped in the "other" category included tomato waste, chlorine, brine water, thermal waste and hydrofluoric acid.

In 46 (53%) of the 87 fishkills reported during 1986 and 1987, no counts or estimates of the number of fish killed were made, mainly due to late notification of the kill. In the 41 fishkills in which counts or estimates of the number of fish killed were made, a total of 454,222 fish were reported killed. Of this total, four fishkills were responsible for 96% (436,058 fish) of the fish killed, with one kill in Eagle Creek below the Speedway POTW (Marion County) accounting for 392,535 fish. Table 10 categorizes the reported 1986-87 fish kills as to size (number of fish killed) and the number for each size category.

Table 10. Size categories (numbers of fish killed) and numbers of fishkills reported per category in 1986-87.

Number of Fish Killed	Number of Fishkills Reported
Unknown	46
0-500	25
500-1000	6
1000-10000	5
10,000-100,000	4
more than 100,000	1
Total	87

Figure 3. Causes of 1986-87 fishkills.



Toxicity Testing Program

Toxicity tests are used by the state to screen wastewaters for potentially toxic effects. These tests can measure both acute (short term) and chronic (long term) effects on aquatic life. During 1986-87, 45 acute and 19 chronic toxicity tests were conducted on both industrial and municipal wastewaters in the state. Summaries of the results of these tests are shown in Tables 11 and 12, respectively.

Little or no acute toxicity was observed in 60% of the tests conducted. Likewise, 63% of the chronic tests conducted showed no toxicity. Toxicity associated with industrial effluents was greater than that associated with effluents from public owned treatment works (POTW). Only 19% of the POTW's had acute effluent toxicity (average LC_{50} = 92%) compared to 68% of the industrial effluents (average LC_{50} = 39%).

The U.S. EPA has conducted 25 Ames tests on wastewater effluents in Indiana. These tests measure potential for mutagenicity (the capacity of a substance to cause changes in chromosomes) associated with oral exposures, such as using the water for drinking. Results of these tests are shown in Table 13. It should be noted that the relationship between Ames testing and human health effects is little known. The results are used for screening purposes only.

Effluent toxicity tests are used to determine whether toxicity reduction measures are needed at a facility. Toxicity testing as a method for determining compliance with water quality standards is becoming a more frequent requirement in NPDES permits. The goal of the program is to eliminate all toxicity associated with wastewater discharges.

Fish Tissue Analysis

During 1986 and 1987, the State compiled data on contaminants in the tissue of 205 fish samples from 102 sites throughout Indiana. Many of these samples had been collected before 1986 but the chemical analyses were incomplete until recently. A list of parameters which were analyzed is shown in Table 14.

All of the fish samples collected from 27 lakes (Table 15), representing about 50,000 acres of surface water in Indiana, contained "safe" levels of contaminants. A sample from North Twin Lake in Bloomington contained chlordane which exceeded U.S. Food and Drug Administration (FDA) action levels. However, this small, shallow lake was permanently drained in 1987. Therefore, no lakes in Indiana (except Lake Michigan, discussed below) are presently known to contain fish unsafe for human consumption. A fishing ban for Springwood Lake in Richmond and the consumption advisory for the Decatur County Reservoir near Greensburg were not based on tissue samples collected from these waterbodies.

Fish samples collected in 1985 and 1986 from Lake Michigan showed that large chinook salmon, brown trout, and lake trout continue to have residues of

TABLE 11. *ACUTE TOXICITY TEST RESULTS 1986 - 87*

	DISCHARGER	RECEIVING STREAM	DAPHNID LC50 (% effluent)	OBSERVED TOXICANTS
Lake Michigan Basin	South Bend POTW	St. Joseph River	No Toxicity	--
	Elkhart POTW	St. Joseph River	No Toxicity	--
	Mishawaka POTW	St. Joseph River	No Toxicity	--
	Goshen POTW	Elkhart River	90%	Ammonia Surfactants
	Anderson Co., (Michigan City)	Trail Creek tributary	23%	--
	NIPSCO (Chesterton)	Lake Michigan	72%	--
	Portage POTW *	Burns Ditch	No Toxicity	--
Maumee River Basin	Universal Tool & Stamping (Butler)	Teutsch Ditch	73% (1/86) No Toxicity (11/87)	Chromium --
	GCI, (Huntertown)	Willow Creek	35%	Ammonia Copper Surfactants
	Phelps Dodge Magnet Wire, (Fort Wayne)	Harvester Ditch	63%	Phenols
Kankakee River Basin	Plymouth POTW	Yellow River	No Toxicity	--
	LaPorte POTW	Travis Ditch	>100%	Copper
	Roll Coater * (Kingsburg)	Travis Ditch	<3%	Surfactants
Wabash River Basin	Warsaw Black Oxide, (Burket)	Williamson Ditch	44% (2/86) >100% (10/87)	Copper Zinc Cyanide
	Lafayette POTW	Wabash River	No Toxicity	--
	Hartford City POTW	Big Lick Creek	No Toxicity	--
	Hunting POTW	Little Wabash River	100%	--
	Marion POTW	Mississinewa River	No Toxicity	--
	Crawfordsville POTW	Sugar Creek	No Toxicity	--
	Kokomo POTW	Wildcat Creek	No Toxicity	--
	Laketon Refining, (Laketon)	Flack Ditch	34%	Cyanide Petroleum
	Warsaw POTW *	Walnut Creek	No Toxicity	--
	Logansport POTW *	Wabash River	100%	--
Wabash River Basin	Wm Pfarrer Co., (Walton)	Phillips Ditch	4%	Copper Chromium Zinc Ammonia Chlorides
	D & H Manufacturing, * (Albany)	Halfway Creek	2%	Zinc
	Terre Haute POTW *	Wabash River	90% (fathead minows)	--
	Eli Lilly, ** (Clinton)	Wabash River	75%	--

TABLE 11. ACUTE TOXICITY TEST RESULTS 1986 - 87 (con't)

	DISCHARGER	RECEIVING STREAM	DAPHNID LC_{50} (% effluent)	OBSERVED TOXICANTS
W.F. White River Basin	Elwood POTW	Duck Creek	No Toxicity	--
	Mooresville POTW	White Lick Creek	No Toxicity	--
	Muncie POTW *	W. F. White River	No Toxicity	--
	Anderson POTW *	W. F. White River	No Toxicity	--
	Westinghouse Electric, * (Muncie)	W. F. White River	No Toxicity	--
E.F. White River Basin	Eli Lilly, (Greenfield)	Leary Ditch	No Toxicity (8/86) ** >100% effluent (8/86)	-- Ammonia
	Crane NWSC, (Crane) *	Boggs Creek	75%	--
	Greensburg POTW	Gas Creek	No Toxicity	--
	Bedford POTW *	E. F. White River	80%	--
	Bloomington South POTW *	Clear Creek	No Toxicity	--
Ohio River Basin	Alcoa, (Newburgh) *	Ohio River	11%	--
	South Dearborn RSD *	Tanners Creek	No Toxicity	--
	Madison POTW *	Ohio River	No Toxicity	--
	Richmond POTW *	E. F. Whitewater River	No Toxicity	--
	Dana Corp, (Hagarstown) *	Trib. to Whitewater River	No Toxicity	--
	General Electric, (Mt. Vernon)	Ohio River	No Toxicity (7/87) ** 45% (11/85)	--

Italic

* = *U.S. EPA Test*

** = *Consulting Company or Discharger Test*

TABLE 12. *CHRONIC TOXICITY TEST RESULTS 1986 - 87.*

DISCHARGER	RECEIVING STREAM	NO OBSERVABLE EFFECT LEVEL (% effluent)	PROBABLE INSTREAM TOXICITY AFTER MIXING
Bloomington South POTW *	Clear Creek	No Toxicity	No
Eli Lilly (Clinton) **	Wabash River	25%	No
Hammond POTW *	Grand Calumet River	No Toxicity	No
Gary POTW *	Grand Calumet River	No Toxicity	No
East Chicago POTW *	Grand Calumet River	< 100%	Yes
U.S. Steel (Gary) *			
Outfalls 002, 007, 018, 020, 030	Grand Calumet River	No Toxicity	No
Outfalls 010, 034	Grand Calumet River	<100%	Unknown
DuPont (East Chicago)*	Grand Calumet River	<30%	Unknown
LTV Steel (East Chicago)*	Indiana Harbor Canal	No Toxicity	No
Inland Steel (East Chicago)*			
Outfalls 008, 014	Indiana Harbor Canal	42-77%	Unknown
Outfalls 002, 011, 012	Indiana Harbor Canal	No Toxicity	No

* = *U.S. EPA Test*

** = *Consulting Company or Discharger Test*

TABLE 13. *RESULTS OF AMES TESTS FOR MUTAGENICITY IN WASTEWATER DISCHARGES DURING 1986 AND 1987.*

MUNICIPAL DISCHARGE	MUTAGENIC RESPONSE # OF POSITIVES IN 30 TESTS
Mishawaka POTW	None
Portage POTW	None
South Dearborn POTW	None
Muncie POTW	None
Anderson POTW	None
Terre Haute POTW	None
Bedford POTW	None
Richmond POTW	None
East Chicago POTW	Two
Bloomington POTW	One
Madison POTW	None
Warsaw POTW	None
Logansport POTW	None
INDUSTRIAL DISCHARGES	
Alco (Newburgh)	None
Eli Lilly (Greenfield)	None
Westinghouse (Muncie)	None
D & H Mfg. (Albany)	None
W. H. Pfarrer (Walton)	None...
Dana Corporation (Hagerstown)	None
Crane Naval Weapons Support Center (Craine)	None
Gridercraft (Huntertown)	One
Laketon Refining (Laketon)	
Outfall 001	Four
Outfall 002	None
Outfall 003	One
Roll Coater (Kingsbury)	None

TABLE 14. *LIST OF PARAMETERS FOR WHICH FISH FLESH SAMPLES WERE ANALYZED.*

- PCB (total) *
- Total BHC*
  - BHC (alpha)
  - BHC (beta)
  - BHC (delta)
  - BHC (gamma)
- Hexachlorobenzene
- Pentachloroanisole
- Total Heptachlor*
  - Heptachlor
  - Heptachlor Epoxide
- Total Chlordane*
  - Trans-Nonachlor
  - Cis-Nonachlor
  - Trans-Chlordane
  - Cis-Chlordane
  - Oxychlordane
- Aldrin/Dieldrin*
- Total DDT*
  - DDE, p, p'
  - DDE, o, p'
  - DDE, p, p'
  - DDD, o, p'
  - DDT, p, p'
  - DDT, p, p'
- Methoxychlor, p, p'
- Methoxychlor, o, p'
- Endrin *
- Mercury *
- Chromium
- Cadmium
- Copper
- Lead
- Arsenic
- % Lipid Content

* = *FDA Action Level Available*

TABLE 15. *LAKES MONITORED FOR TOXICS IN FISH AND SEDIMENTS IN 1985 AND 1986.*

LAKE/RESERVOIR	ACREAGE	LOCATION
*Monroe Reservoir	10,750	Monroe County
Lake Lemon	1,650	Brown/Monroe counties
*North Twin Lake	10	Monroe County
Yellowwood Lake	133	Brown County
*King Lake	19	Fulton County
*Palestine Lake	232	Kosciusko County
*Pike Lake	203	Kosciusko County
Dogwood Lake	1,300	Daviess County
*Eagle Creek Reservoir	1,500	Marion County
*Mississinewa Reservoir	3,180	Miami/Wabash counties
*Brookville Reservoir	5,260	Franklin/Union counties
Lake Shafer	1,291	White County
Lake Freeman	1,547	Carroll County
Huntington Reservoir	900	Huntington County
*Salamonie Reservoir	2,860	Wabash/Huntington counties
Cataract Reservoir	1,400	Putnam County
Mansfield Reservoir	2,060	Parke County
Greensburg Reservoir	23	Decatur County
*Versailles Lake	230	Ripley County
Hamilton Lake	802	Steuben County
Wolf Lake	385	Lake County
*Lake George (Hobart)	270	Lake County
Crooked Lake	802	Steuben County
*Morse Reservoir	1,463	Hamilton County
*Geist Reservoir	1,800	Marion County
Deam Lake	195	Clark County
Lake George (Hammond)	78	Lake County

* *Sampling completed in 1985.*

PCBs and certain pesticides above FDA action levels. However, all samples of yellow perch, white suckers, and coho salmon recently collected contained "safe" levels of contaminants.

The remaining fish tissue samples for which data became available in 1986-87 were from streams and rivers. Sites at which samples exceeded FDA action levels are shown in Figure 4 and listed in Table 16. It should be noted that much of the data presented in the table is of concentrations of contaminants in whole fish and FDA action levels are based on edible portions (i.e., fillets). Filleting whole fish samples has been shown to reduce the contaminant levels by 20 to 50%. Therefore, a number of the whole fish samples that exceeded FDA action levels probably would not have been violative if they had been analyzed as skinless fillets.

PCB contamination of fish is often correlated with point sources. Such discharges have been identified as contributing to PCB contamination in (1) the Little Mississinewa River near Union City, (2) Elliot Ditch, Wea Creek, and the Wabash River near Lafayette, (3) Clear Creek, Salt Creek, Pleasant Run, and the East Fork of White River near Bloomington and Bedford, and (4) Stoney Creek and the West Fork of White River near Noblesville and Indianapolis. Remedial actions are in progress at all of these locations.

Likewise, Lake Michigan fish have been contamination by PCBs from both point and nonpoint sources, many of which are in other states bordering the lake. PCB-contaminated fish recently collected in Burns Ditch and Trail Creek, which are direct tributaries to Lake Michigan, probably received their exposures to PCBs in the lake and simply migrated into the streams, since sediment sampling has failed to detect any significant PCB sources in the streams themselves. Indiana Harbor and the Grand Calumet River are known to have PCB-contaminated sediments but specific sources have not yet been identified.

To date, there are no known point sources which may have contributed to PCB contamination in St. Joseph River fish near South Bend. Sediment testing in several tributaries of the river in 1985 indicated some evidence of contamination, but subsequent testing of fish and/or sediments in these tributaries has not substantiated the earlier findings. Since the only contaminated fish occurred in the St. Joseph River at the downstream end near the state line, sources of PCBs outside the state are possible.

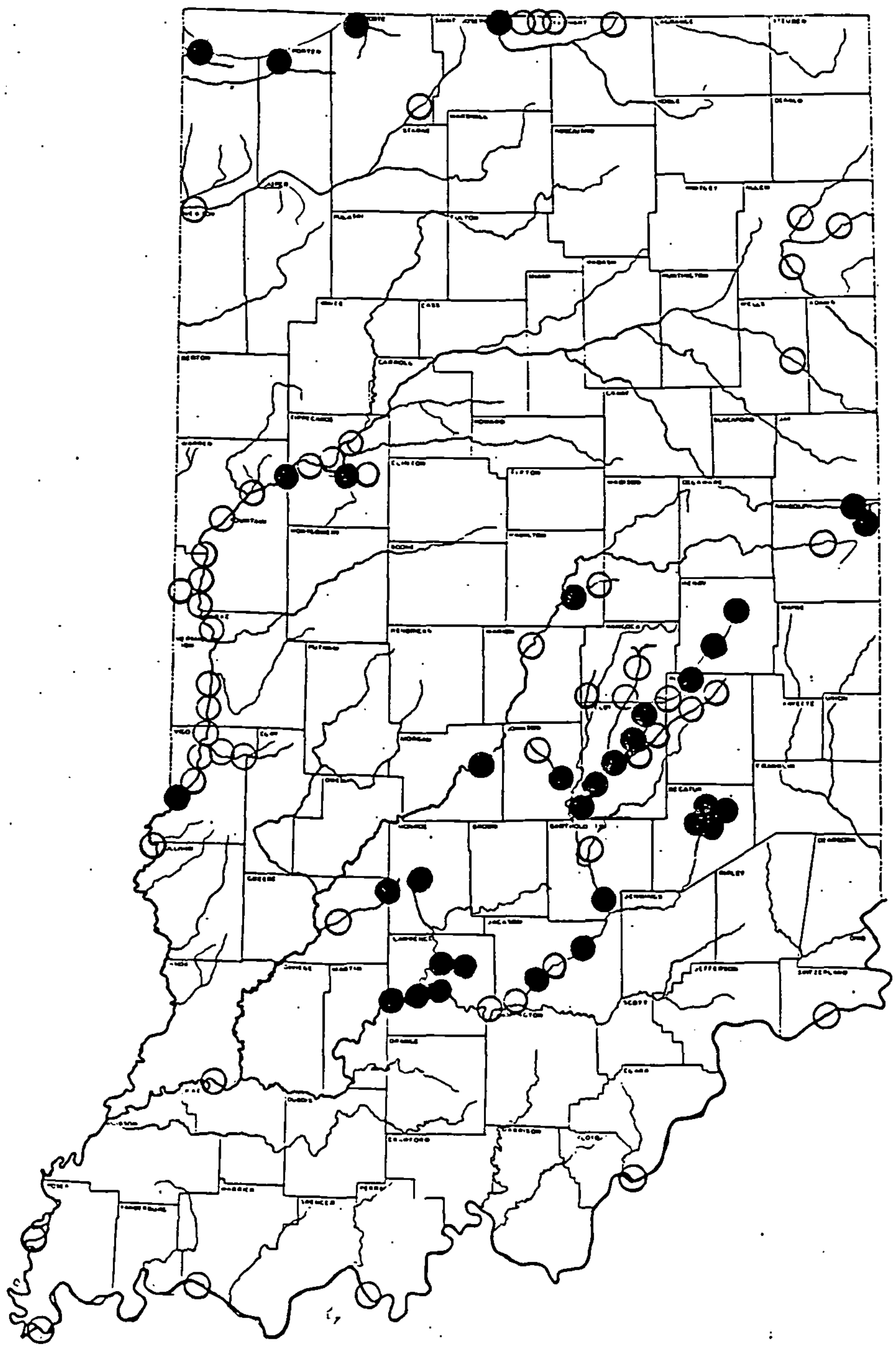
Chlordane and dieldrin, persistent pesticides banned from general agricultural use in 1980 and 1974, respectively, have also been common contaminants in fish (dieldrin contamination is now prevalent only in Lake Michigan fish). Extensive sampling of sediments, sludges, and effluents throughout the state has revealed very few point sources of these pesticides. Because of the agricultural use bans, the incidence of chlordane and dieldrin contamination in fish flesh is expected to decline each year in response to decreasing exposure from non-point sources such as farm field runoff.

A trend toward declining levels of PCBs, chlordane, and dieldrin in fish collected at Indiana CORE Station is shown in Table 17. There are 18 sites

Figure 4. Results of fish tissue monitoring data from rivers and streams which became available in 1986-87.

○ = NO samples above FDA Action Levels

● = FDA Action Level was exceeded



ABLE 16. *SUMMARY OF FISH TISSUE RESULTS RECEIVED IN 1986-87.*

	YEAR SAMPLED	NUMBER OF SITES TESTED	NUMBER OF SAMPLES TESTED	PARAMETERS (and % of samples) EXCEEDING FDA ACTION LEVELS
Lakes	1985-86	27	53	None *See Text.
Lake Michigan	1986	1	31	PCBs (55%) Chlordane (58%) Dieldrin (52%) DDT (16%)
Streams				
East Fork of White River Basin				
Big Blue River	1983	10	10	PCBs (10%) Chlordane (90%)
Youngs Creek	1983	2	2	Chlordane (50%)
Muddy Fork of Sand Creek	1983	2	2	PCBs (50%) Chlordane (100%) Dieldrin (100%)
Sand Creek	1983	2	2 1	Chlordane (100%) Dieldrin (50%)
Clear Creek	1983	1	1	PCBs (100%)
Pleasant Run	1983	2	2	PCBs (100%) Chlordane (50%) Heptachlor (50%)
East Fork Mainstem	1985	9	14	PCBs (50%) Chlordane (43%)
Others	1983	8	8	None
Wabash River Basin				
Elliott Ditch	1984	2	2	PCBs (50%) Chlordane (50%)
Wabash River	1984-85	17	32	Dieldrin (3%) PCBs (3%)
Other	1984-85	3	3	None
West Fork of White River	1985	2	7	None
White River (Downstream from East and West Forks)	1985	1	4	None
Maumee River Basin				
Maumee River	1986	1	3	None
St. Joseph River	1986	1	3	None
St. Mary's River	1986	1	3	None
Kankakee River Basin	1986	2	6	None

TABLE 16. SUMMARY OF FISH TISSUE RESULTS RECEIVED IN 1986-87. (con't)

	YEAR SAMPLED	NUMBER OF SITES TESTED	NUMBER OF SAMPLES TESTED	PARAMETERS (and % of samples) EXCEEDING FDA ACTION LEVELS
Lake Michigan Basin				
Trail Creek	1986	1	3	Chlordane (33%) PCBs (33%)
Burns Ditch	1986	1	3	PCBs (67%) Chlordane (67%)
Indiana Harbor Canal	1986	1	2	PCBs (100%)
St. Joseph River	1986	2	6	PCBs (33%)
Judy Creek	1986	3	3	None
TOTALS		**102**	**205**	

TABLE 17. *A SUMMARY OF TRENDS IN FISH TISSUE CONTAMINANT LEVELS AT INDIANA CORE STATIONS.*

	NUMBER OF SAMPLES		% OF SAMPLES EXCEEDING FDA ACTION LEVELS: PCBs		Chlordane		Dieldrin	
SITE	1985-86	1979-84	1985-86	1979-84	1985-86	1979-84	1985-86	1979-84
Lake Michigan at Michigan City	5	4	0	50	0	50	0	0
Wabash River above Lafayette	4	12	0	25	0	50	0	25
Wabash River below Lafayette	4	10	25	30	0	20	0	30
Wabash River near Terre Haute	3	10	0	20	0	30	0	40
Wabash River west of Fairbanks	4	12	0	0	0	42	0	42
Indpls. Waterway Canal at Indpls.	4	13	0	92	0	38	0	15
White River at Centerton	3	11	33	73	33	100	0	0
East Fork White River - Williams	4	14	75	79	0	50	0	21
White River at Petersburg	4	11	0	0	0	55	0	0
Kankakee River - Kingsbury Wildlife	3	12	0	0	0	0	0	0
Kankakee River at Shelby	3	12	0	0	0	8	0	0
Indiana Harbor Canal at East Chicago	2	4	100	75	0	25	0	0
Burns Ditch at Portage	3	8	67*	0	67*	0	33*	0
Trail Creek above Michigan City	3	7	33*	0	33*	14	0	0
St. Joseph River at Bristol	3	11	0	0	0	0	0	0
St. Joseph River at South Bend	3	12	67	58	0	25	0	0
St. Joseph River at Fort Wayne	3	12	0	0	0	0	0	0
Maumee River at Fort Wayne	3	12	0	17	0	0	0	0
TOTAL SITES EXCEEDING ACTION LEVELS			5	10	1	11	0	6

* These numbers are excluded from the analysis due to bias (see text).

listed in the table which have been monitored for fish flesh contamination on a regular basis. Only 5 of the sites (28%) had fish which exceeded one or more FDA action levels in 1985-86, compared with 14 sites (78%) exceeding such levels from 1979-84. The drop in chlordane and dieldrin concentrations has been most dramatic. Excluding recent data on fish from Burns Ditch and Trail Creek (these were carp much larger (8-18 pounds) and fatter than those previously sampled and were probably recent migrants from Lake Michigan). Chlordane now exceeds the FDA action level at only 6% of the sites, compared to 72% of the sites during previous years. The dieldrin action level was not exceeded at any of these sites in 1985-86, while previously 33% of the sites had dieldrin action level violations.

A trend toward declining levels of contaminants in the fish collected is shown in Figure 5. These graphs depict levels of PCBs and pesticides in 2 to 4 pound carp from sites which have had fish consumption advisories issued. The concentrations are normalized by comparing only levels in body fat, which is where these contaminants accumulate. Variables associated with different species, ages, and percent fat are thereby eliminated. At each of the sites plotted, PCB, chlordane, and dieldrin levels have declined steadily since 1981. The amount of decline has ranged from 58% to 98% for each contaminant.

Fish tissue and sediment samples were collected from an additional 14 lakes and 62 stream sites in 1987. There are also plans to sample another 13 lakes and 40 stream sites in 1988. An abbreviated list of these sites is given in Table 18. The intent of this continued sampling program is to:

(1) determine whether fish consumption advisories on certain streams should be continued,

(2) evaluate the extent of contamination between widely spaced sampling stations where problems have been previously identified,

(3) gather data on additional streams and lakes which have not been previously examined, and

(4) continue to monitor trends in contaminant levels at selected sites.

Fish Consumption Advisories

Approximately 585 stream miles and all of Indiana's portion of Lake Michigan are affected by fish consumption advisories. Table 19 lists the Indiana waters affected by such advisories, the dates the advisories were issued, the pollutants of concern in these waters, the fish species included, and the scope of the advisories. Of the 585 river and stream miles affected by fish consumption advisories, 400 miles are covered by an advisory which allows limited consumption by some individuals. Consumption of no fish is recommended in 185 miles.

In most cases, these fish consumption advisories are based on whole fish data because this is the only type of data available. As specified by EPA,

Figure 5. Trends in PCB, chlordane and dieldrin concentrations in fish body fat samples at four CORE stations.

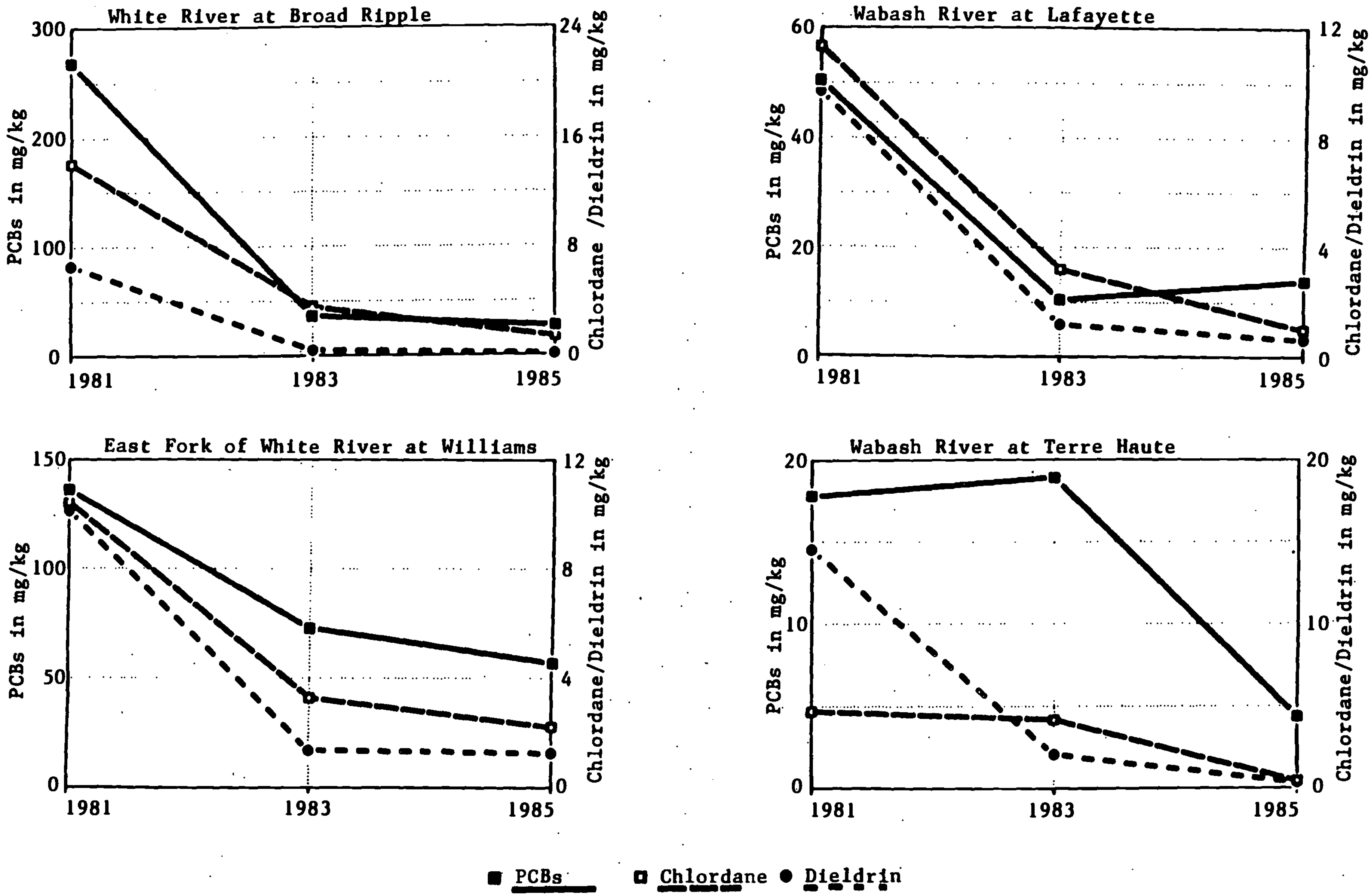


TABLE 18. *CONTINUING PROGRAM OF FISH TISSUE AND SEDIMENT MONITORING.*

	SITES SAMPLED	COUNTY(S)
COLLECTIONS COMPLETED IN 1987 (DATA NOT YET AVAILABLE)		
Lakes		
Winona Lake	2	Kosciusko
Center Lake	2	Kosciusko
Lake Wawasee	3	Kosciusko
Wabee Lake	2	Kosciusko
Lake Manitou	2	Fulton
Shipshewana Lake	3	LaGrange
Henderson Lake	2	Noble
Sylvan Lake	3	Noble
Crooked Lake	4	Noble
Lake of the Woods	2	Marshall
Maxinkukee Lake	2	Marshall
Cedar Lake	2	Lake
Patoka Reservoir	4	Dubois/Orange/Crawford
Carlson Pond	1	Porter
Lake Michigan	1	
Streams		
East Fork of White River Basin		
Muddy Fork of Sand Creek	2	Decatur
Sand Creek	4	Decatur/Jennings
Big Blue River	4	Henry/Rush/Shelby/Johnson
Flatrock River	2	Rush/Shelby
Sugar Creek	2	Shelby/Johnson
Clear Creek	3	Monroe
Salt Creek	1	Lawrence
Pleasant Run	2	Lawrence
East Fork of White River	5	Jackson/Lawrence/Martin
West Fork of White River Basin		
Stouts Creek	1	Monroe
Richland Creek	2	Monroe
Stoney Creek	1	Hamilton
West Fork of White River	16	Delaware to Daviess
Wabash River Basin		
Wildcat Creek	2	Howard
Sugar Creek	2	Montgomery

	SITES SAMPLED	COUNTY(S)
Walnut Fork	2	Montgomery
Wabash River	6	Wells/ Tippecanoe/Vigo
Grand Cal/Indiana Harbor Canal	5	Lake
COLLECTION PLANNED IN 1988		
Lakes		
Snow Lake	2	Steuben
Lake James	2	Steuben
Jimmerson Lake	2	Steuben
Long Lake	2	Steuben
Marsh Lake	2	Steuben
Middle Center Lake	2	Steuben
James Lake	2	Kosciusko
Tippecanoe Lake	2	Kosciusko
Olin Lake	2	LaGrange
Oliver Lake	2	LaGrange
Kokomo Reservoir #2	2	Howard
Bischoff Reservoir	2	Ripley
Cedarville Reservoir	2	Allen
Lake Michigan	1	
Streams		
Wabash River Basin		
Eel River	5	Whitley/Wabash/Miami /Cass
Tippecanoe river	8	Kosciusko/Fulton/Pulaski/White
Mississinewa River	6	Randolph/Delaware/Grant
Salamonie River	1	Jay
St. Joseph River Basin		
Elkhart River	2	Elkhart
St. Joseph River	6	Elkhart/St. Joseph
Kankakee River	2	LaPorte/Newton
Maumee River Basin		
Maumee River	1	Allen
St. Marys River	1	Allen
St. Joseph River	1	Allen
Lake Michigan Basin		
Trail Creek	1	LaPorte
Burns Ditch	1	Porter
Grand Cal/ Indiana Harbor Canal	5	Lake

TABLE 19. *Current Indiana fish consumption advisories.*

RIVER, STREAM OR LAKE	DATE ISSUED	POLLUTANTS OF CONCERN	FISH SPECIES INVOLVED	SCOPE OF ADVISORY
Richland Creek in Monroe, Owen and Greene counties.	1983	PCBs	all	No more than 1 meal (½ lb.) per week. Child-bearing age women and children should not eat any fish.
Clear Creek, Pleasant Run Creek, and Salt Creeks (Downstream of Monroe Reservoir Dam) in Monroe and Lawrence counties.	1987	PCBs	all	No fish should be eaten.
Eilliot Ditch and Wea Creek in Tippecanoe County.	1983	PCBs	all	No fish should be eaten.
East Fork of White River from Columbus to Bedford.	1987	PCBs and Chlordane	all	No more than I meal (½ lb.) per week. Child-beraring age women and children should not eat any fish.
East Fork of White River from Bedford to Williams Dam.	1987	PCBs	all	No fish should be eaten.
East Fork White River below Williams Dam in Lawrence County.	1987	PCBs and Chlordane	catfish	No catfish should be eaten. All others should be limited to 1 meal (½ lb.) per week. Child-bearing age women and children should not eat any fish.
Wabash River from just north of Lafayette to Darwin, Illinois.	1987	PCBs and Chlordane	carp	Carp consumption should be limited to 1 meal (½ lb.) per week. Child-bearing age women and children should not eat any carp.
West Fork of White River from Noblesville downstream to Broad Ripple.	1985	PCBs	all	Do not consume fish from these areas.
West Fork of White River from Broad Ripple downstream to Martinsville.	1985	PCBs and Chlordane	all	Do not consume fish from these areas.
West Fork of White River from Martinsville downstream to Petersburg.	1985	PCBs and Chlordane	all	No more than 1 meal (½ lb.) per week. Child-bearing age women and children should not eat any fish.
West Fork of White River at Petersburg.	1985	Chlordane	carp	Carp should not be eaten.
Stoney Creek downstream from Wilson Ditch south of Noblesville.	1985	PCBs	all	Do not consume fish from these areas.
Little Mississinewa River near Union City	1985	PCBs	all	Do not consume fish from this river.
Mississinewa River - 1 mile above and below confluence of Little Mississinewa River.	1985	PCBs and Chlordane	all	Do not consume fish from this area.
St. Joseph River downstream of South Bend.	1985	PCBs and Chlordane	carp smallmouth bass redhorse suckers	Do not consume carp from this area. Smallmouth bass and redhorse suckers should not be eaten more than once/week (½ lb.) Child-bearing age women and children should not consume any fish from this area.
Maumee River below Fort Wayne.	1985	PCBs	all	Fish prepared and consumed as skinless fillets should be within acceptable limits. Child-bearing age women and children should not consume fish from this area.

Table 19. Current Indiana fish consumption advisories. *(con't)*

RIVER, STREAM OR LAKE	DATE ISSUED	POLLUTANTS OF CONCERN	FISH SPECIES INVOLVED	SCOPE OF ADVISORY
Lake Michigan (Joint Lake Michigan Fish Consumption Advisory).	1987	PC8s, Chlordane, Dieldrin, DDT	lake trout under 20" coho under 26" chinook under 21" brook trout rainbow trout pink salmon smelt yellow perch	Fish in this group pose lowest risk. FDA action levels met at least 90% of time.
Lake Michigan (Joint Lake Michigan Fish Consumption Advisory).	1987	PC8s, Chlordane, Dieldrin, DDT	lake trout 20"-23" coho over 26" chinook 21"-32" brown trout under 23"	One or more contaminants above FDA action levels in at least 50% of fish tested. Consume no more than 1 meal/wk. (½ lb.). Child-bearing age women and children should not consume any fish.
Lake Michigan (Joint Lake Michigan Fish Consumption Advisory).	1987	PC8s, Chlordane, Dieldrin, DDT	lake trout over 23" chinook over 32" brown trout over 23" carp catfish	No one should consume these species.
8ig 8lue River in Rush, Henry, Shelby and Johnson counties.	1987	PC8s and Chlordane	all	No more than 1 meal (½ lb.) per week. Child-bearing age women and children should not eat any fish.
Driftwood River in 8artholomew County.	1987	PC8s and Chlordane	all	No more than 1 meal (½ lb.) per week. Child-bearing age women and children should not eat any fish.
Sand Creek and Muddy Fork of Sand Creek near Greensburg and Decatur County Reservoir.	1987	PC8s, Chlordane, Dieldrin	all	No fish should be eaten.
Sand Creek at all other areas in Decatur County.	1987	PC8s, Chlordane, Dieldrin	all	No more than 1 meal (½ lb.) per week. Child-bearing age women and children should not eat any fish.
The Grand Calumet River (East and West 8ranches) and the Indiana Harbor Ship Canal in Lake County.	1986	PC8s	all	No fish should be eaten.

whole fish are collected for analysis for Indiana's CORE program, and laboratory constraints have not allowed for many additional fillet samples to be analyzed. In order to adequately inform the public as to the potential risks of consuming fish from certain areas, fish consumption advisories are issued when either whole fish or fillet data show contaminant values in excess of FDA action levels, even though these action levels are based on edible portions of fish (fillets). Most of the pollutants of concern are concentrated in fat of the fish and studies have shown that skinning and filleting fish and removing any excess fat before cooking can substantially reduce (20 percent to 50 percent) contaminant levels in these fish. Cooking fish in such a way as to allow fats and oils to drip away from the fish (broiling, barbecuing, baking on a rack) can further reduce the level of contaminants to which consumers are exposed. The State Board of Health recommends that all fish caught in Indiana waters be skinned and filleted before consumption.

The pollutants of concern (PCBs and pesticides) for fish in Indiana waters are persistent substances that, for the most part, are no longer used to any extent in agriculture or industry. The persistent nature of these substances has made them available to the aquatic life over a long period of time and they have bioconcentrated in the fish to levels which sometimes exceed the FDA action levels.

Several additional fish tissue samples from rivers, streams, and lakes were collected in 1987, but results of these analyses are not yet available. Until these data become available, the existing fish consumption advisories will remain in effect.

Sediment Contamination

Sediment monitoring is becoming increasingly important as a tool for detecting loadings of pollutants in streams and lakes. Many potential toxicants are easier to assess in sediments because they accumulate there at levels far greater than normally found in the water column. Also, sediments are less mobile than water and can be used more reliably to locate sources of pollutants. Nutrients, many organic compounds and heavy metals can become tightly bound to the fine particulate silts and clays of the sediment reservoir where they remain until they are released to the overlying water and made available to the biological community through physical, chemical or bioturbation processes. Remedial pollution projects may include the removal of contaminated sediments as a necessary step.

The state has compiled over 500 records of sediment samples taken in lakes, reservoirs and streams throughout Indiana. These include samples from 95 stream locations and 73 sites on 40 lakes and reservoirs (Figure 6) collected in 1985-1987. Chemical analyses for the priority pollutants listed in Table 20 were conducted by the ISBH laboratories prior to 1987; samples collected in 1987 were similarly analyzed by Hazelton Laboratories America, Inc., Madison, Wisconsin. To assess contamination from nutrients (total nitrogen and phosphorous) information obtained from studies by other laboratories (Purdue University, USGS, U.S. EPA was examined.

Figure 6. Lakes and reservoirs sampled for sediments.

1 - Carlson Pond (Porter)
2 - Cedar Lake (Lake)
3 - Center Lake (Kosciusko)
4 - Crooked Lake (Noble, Whitley)
5 - Henderson Lake (Noble)
6 - Lake of the Woods (Marshall)
7 - Lake Manitou (Fulton)
8 - Lake Maxinkuckee (Marshall)
9 - Patoka Reservoir (Crawford, Dubois, Orange)
10 - Lake Shipshewana (LaGrange)
11 - Sylvan Lake (Noble)
12 - Wabee Lake (Kosciusko)
13 - Lake Wawasee (Kosciusko)
14 - Winona Lake (Kosciusko)
15 - Monroe Reservoir (Monroe)
16 - Lake Lemon (Brown, Monroe)
17 - North Twin Lake (Monroe)
18 - Yellowwood Lake (Brown)
19 - King Lake (Fulton)
20 - Palestine Lake (Kosciusko)
21 - Pike Lake (Kosciusko)
22 - Dogwood Lake (Daviess)
23 - Eagle Creek Reservoir (Marion)
24 - Mississinewa Reservoir (Miami, Wabash)
25 - Brookville Reservoir (Franklin, Union)
26 - Lake Shafer (White)
27 - Lake Freeman (Carroll)
28 - Huntington Reservoir (Huntington)
29 - Salamonie Reservoir (Wabash, Huntington)
30 - Cataract Reservoir (Putnam)
31 - Mansfield Reservoir (Parke)
32 - Greensburg Reservoir (Decatur)
33 - Versailles Lake (Ripley)
34 - Hamilton Lake (Steuben)
35 - Wolf Lake (Lake)
36 - Lake George (Lake)
37 - Crooked Lake (Steuben)
38 - Morse Reservoir (Hamilton)
39 - Geist Reservoir (Marion)
40 - Deam Lake (Clark)

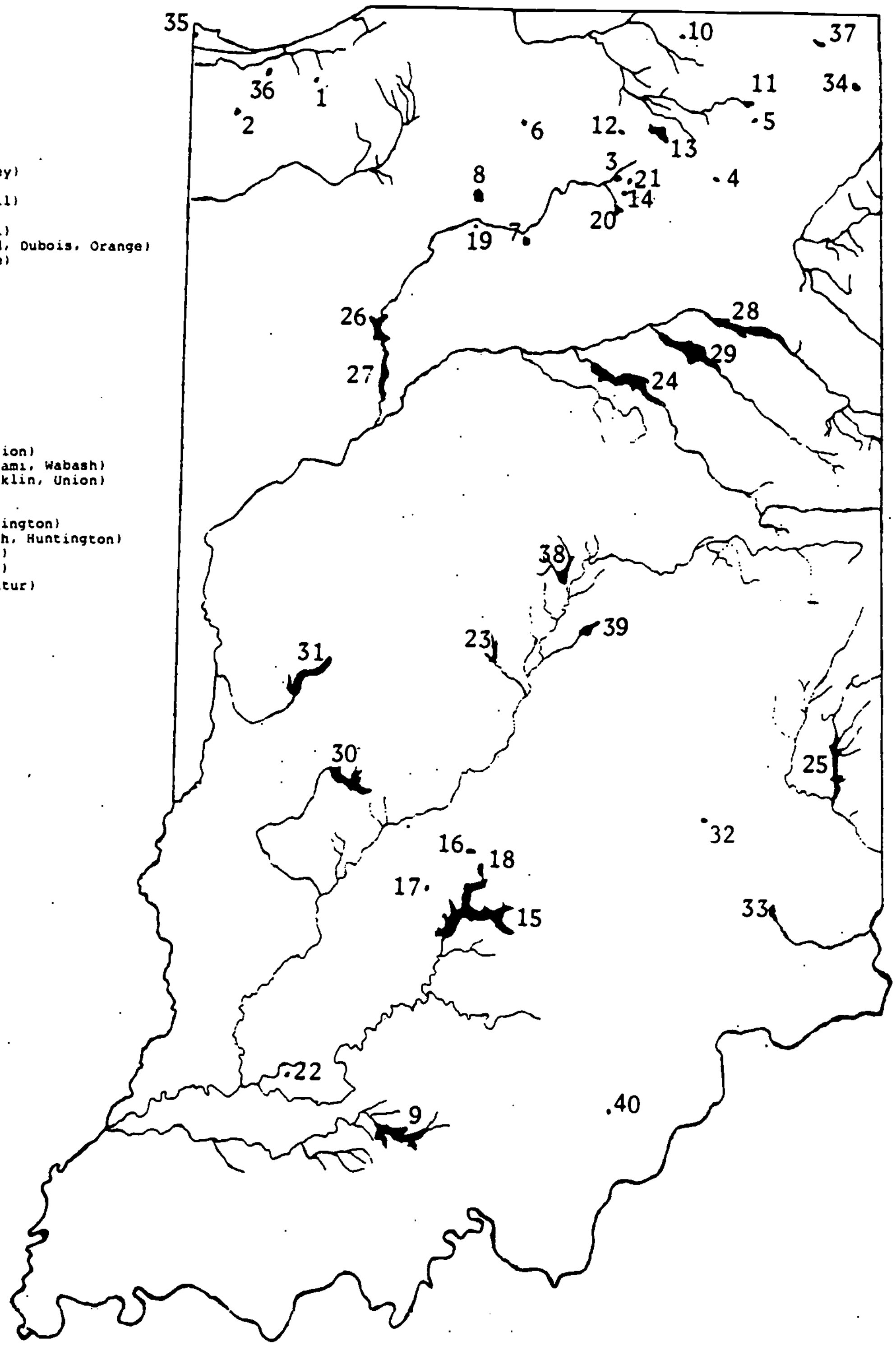


TABLE 20. *PARAMETERS MEASURED IN SEDIMENTS COLLECTED PRIOR TO 1987.*

METALS

Antimony
Arsenic
Beryllium
Cadmium
Chromium
Copper
Cyanide
Lead
Mercury
Nickel
Selenium
Silver
Thallium
Zinc

HALOGENATED VOL. ORGANICS

Methylene Chloride
1,1,-Dichloroethylene
1,1-Dichloroethane
Chloroform
Carbon Tetrachloride
1,2-Dichloropropane
Trichloroethyene
1,1,2-Trichloroethane
Dibromochloromethane
Tetrachloroethylene
Chlorobenzene
Trichlorofluoromethane
Trans-1,2-Dichloroethylene
1,2-Dichloroethane
1,1,1-Trichloroethene
Bromodichloromethane
Trans-1,3-Dichloropropane
Cis-1,3-Dichloropropene
Bromoform
1,1,2,2-Tetrachloroethane

BASE/NEUTRAL FRACTION

Bis(2-Chloroethyl)Ether
1,3-Dichlorobenzene
1,4-Dichlorobenzene
1,2-Dichlorobenzene
n-Nitroso-n-Dipropylamine
Nitrobenzene
Hexachloroethane
Isophorone
Bis (2-Chloroethoxy) Methane
Naphthalene
Hexachlorobutadiene
Hexachlorocyclopentadiene
2-Chloronaphthalene
2,6-Dinitrotoluene
Dimethylphthalate
Acenaphthalene
Acenaphthene
2,4-Dinitrotoluene
Diethylphthlate
Fluorene
N-Nitrosodiphenylamine
4-Bromophenylphenylether
Hexachlorobenzene
Phenanthrene
Anthracene
Di-N-Butylphthlate
Fluoranthene
Pyrene
Butylbenzylphthalate
Benzo(A)anthracene
Chrysene
Bis(2-ethlylhexyl)Phthalate
Di-N-Octylphthalate
Benzo(A)Pyrene
Benzidine
3,3-Dichlorobenzidine
4-Chlorophenylphenylether

PHENOLS

Phenol
2-Chlorophenol
2-Nitrophenol
2,4-Dimethylphenol
2,4-Dichlorophenol
p-Chloro-m-Cresol
2,4,6-Trichlorophenol
4-Nitrophenol
4,6-Dinitro-o-Cresol
2,4-Dinitrophenol
Benzoic Acid
o-Cresol
p-Cresol
2,4,5-Trichlorophenol

ORGANOCHLORINE PESTICIDES

Alpha-BHC
Beta-BHC
Gamma-BHC (Lindane)
Delta-BHC
Heptachlor
Heptachlor Epoxide
Aldrin
Endosulfan I
p,p'(4,4') DDE
p,p'(4,4') DDD
p,p'(4,4') DDT
Dieldrin
Endrin
Endosulfan II
Endosulfan Sulfate
Methoxychlor
Chlordane
Toxaphene
Endrin Aldehyde

TABLE 20. PARAMETERS MEASURED IN SEDIMENTS COLLECTED PRIOR TO 1987. (con't)

HALOGENATED VOL. ORGANICS *(CON'T)*	BASE/NEUTRAL FRACTION *(CON'T)*	
2-Chloro-Ethylvinylether	Bis(2-Chloroisopropyl)Ether	PCBs
	N-Nitrosodimethylamine	
NONHALOGENATED VOL. ORGANICS	Pentachloroanisole	PCB-1221
	Benzo(b)Fluoranthene	PCB-1232
Methyl Ethyl Ketone (MEK)	Benzo(k)Fluoranthene	PCB-1016
Methyl Isobutyl Ketone (MIBK)	Benzo(gni)Perylene	PCB-1242
	Dibenzo(a,h)Anthracene	PCB-1248
AROMATIC VOL. ORGANICS	Indeno(1,2,3-cd)Pyrene	PCB-1254
	Aniline	PCB-1260
Benzene	Benzyl Alcohol	
Toluene	4-Chloroaniline	
Ethyl Benzene	2-Methylnaphthalene	
Xylenes	3-Nitroaniline	
	Dibenzofuran	
	4-Nitroaniline	
	2-Nitroaniline	

Since no criteria for sediment concentrations of priority pollutants have been promulgated by the state or U.S. EPA, the following strategy was adopted to aid in the interpretation of the analytical results. The maximum state sediment background concentration was determined from the analysis of sediment samples from 83 "noncontaminated" sites throughout Indiana (IDEM unpublished manuscript). Each sediment sample was obtained from small streams or lakes at locations upstream of all known point sources of pollution including industrial discharges and combined sewer overflows. Aerial sources of contaminants and contamination from nonpoint urban and agricultural run-off may have impacted these sampling sites. However, since it is unlikely that any areas of the state are free of inputs from these sources, the background levels calculated are considered to represent the best possible estimate of "unpolluted" sediments in the state of Indiana. Table 21 presents the maximum background concentrations of constituents of Indiana stream and lake sediments determined by this study. Sediments containing less than two times the maximum background concentration of these constituents were classified as "uncontaminated."

Lakes and reservoirs or stream sediments were grouped into four levels of concern (High, Medium, Low and Unknown) based upon the presence and concentration of priority pollutants measured. The criteria for grouping are presented in Table 22. If background concentrations of particular contaminants were unknown the waterbody was placed into the "Unknown" category of concern.

It is important to note that the categories of concern do not necessarily reflect priorities for remedial clean-up or amelioration strategies. In areas where sediment samples are grossly contaminated it has been determined that any disturbance, such as dredging, has the potential for adverse ecosystem impact via the release of sediment-bound contaminants into the water column. Therefore, the best management strategy may be to leave the sediment reservoir intact. The primary value of this classification scheme is to identify waterbodies receiving contaminants, to target waterbodies requiring additional sampling efforts, to identify sources of contaminants, and to confirm sites in which fish tissue analyses or toxicity tests indicate potential problems exist.

Along with sediment data, there is sometimes enough complementary information (fish tissue data, biosurveys, water chemistry, etc.) to document that contaminated sediments may have contributed to non-support of uses. Areas where this is true are listed in Table 23. Since use impairment is confirmed, the table represents sites in which sediment contamination is of highest concern.

Table 24 shows other waterbodies with sediment contaminants above background levels classified by degree of concern. No other information is currently available at these sites to indicate nonsupport of uses. Approximately half of the sites sampled in 1985-1987 were classified "Uncontaminated" and are not listed. A summary of all of the priority pollutants detected in sediments from Indiana streams and rivers (1986 and 1987) and lakes and reservoirs (1985, 1986 and 1987) is presented in Table 25.

TABLE 21. *MAXIMUM BACKGROUND CONCENTRATION OF POLLUTANTS IN INDIANA STREAM AND LAKE SEDIMENTS.*

PARAMETER	MAXIMUM BACKGROUND (MG/KG)	PARAMETER	MAXIMUM BACKGROUND (MG/KG)
Aluminum	9400	Silver	<0.5
Antimony	0.49	Strontium	110
Arsenic	29	Thallium	<3.8
Beryllium	0.7	Zinc	130
Boron	8.0	Phenol	<0.2
Cadmium	1.0	Cyanide	<0.1
Chromium	50	PCB (Total)	0.022
Cobalt	20	Chlordane	0.029
Copper	20	Dieldrin	0.033
Iron	57000	DDT (Total)	0.020
Lead	150	BHC (Total)	0.014
Manganese	1700	Pentachlorophenol	0.003
Mercury	0.44	Heptachlor	0.002
Nickel	21	Aldrin	0.0007
Nitrogen (TKN)	1500	HCB	<0.001
Phosphorus	610	Methoxychlor	<0.001
Selenium	0.55	Endrin	<0.001

TABLE 22. *CRITERIA USED FOR GROUPING SEDIMENTS INTO LEVELS OF CONCERN.*

High Concern:	
	Any contaminant present in concentrations greater than 100 times background.
Medium Concern:	
	Any contaminant present in concentrations 10 - 100 times background.
Low Concern:	
	Any contaminant present in concentrations 2 - 10 times background.
Unknown Concern:	
	Contaminants present for which a background concentration has not been established.

TABLE 23. *AREAS WHERE SEDIMENT CONTAMINATION MAY BE CONTRIBUTING TO NON-SUPPORT OF USES.*

WATERBODY	COUNTY	SOURCE OF CONTAMINATION	KNOWN CONTAMINANTS	ESTIMATED AREA (MILES)
* Grand Calumet River	Lake	Multiple sources	Cyanide Metals PCBs PAHs Other organic compounds	15
* Elliot Ditch	Tippecanoe	Alcoa, (Lafayette)	PCBs	3
* Phillips Ditch	Cass	Wm Pfarrer Co. (Walton)	Metals	1
* Wilson Ditch/Stoney Creek	Hamilton	Firestone (Noblesville)	PCBs PAHs	1
Little Mississinewa River	Randolph	Multiple sources	PCBs Metals	10
* Big Blue River	Henry	Allegheny Ludlum Steel Ingersoll Steel (New Castle)	Metals	2
* Pleasant Run	Lawrence	GMC, Central Foundry (Bedford)	PCBs	2
* Stouts Creek	Monroe	Bennett's dump	PCBs Phenols PAH's	3
* Conards Branch/ Richland Creek	Monroe	Neal's landfill	PCBs	2
* Clear Creek/Salt Creek	Monroe Lawrence	Multiple sources	PCBs PAHs	25
Julia Creek	Marion	RSR Quemetco (Indianapolis)	Metals	1
* Maumee River	Allen	Multiple Sources	DDT PCBs Phenol	25
* Springwood Park Lake	Wayne	Dana Corporation	Cyanide	15 (acres)

** = 1985 - 1987 DATA.*

TABLE 24. *OTHER WATERBODIES WITH SEDIMENT CONTAMINANTS ABOVE BACKGROUND LEVELS CLASSIFIED BY DEGREE OF CONCERN.*

	WATERBODY	COUNTY	SOURCE OF CONTAMINANTS (OTHER SOURCES POSSIBLE)	KNOWN CONTAMINANTS	DEGREE OF CONCERN
*	Williamson Ditch/Palestine Lake	Kosciusko	Warsaw Black Oxide (Burket)	Metals	High
	Willow Creek	Allen	GCI (Huntertown)	Metals	High
	Heddy Run	Jackson	Seymour Recycling	Metals Phenols Cyanide Pesticides	High
	Deeds Creek	Kosciusko	Starlight Corp. (Pierceton)	Metals	High
	Cypress Creek	Warrick	Boonville POTW	Chlordane	High
	Brandywine Creek	Hancock	Greenfield POTW	Metals Cyanide	High
*	Lake George (Hammond) North basin	Lake	unknown	Metals	High
*	Henderson Lake	Noble	Kendallville POTW	Metals	Medium
*	Wildcat Creek	Howard	unknown	Aldrin Phthalates Metals PCBs DDT	Medium
*	Center Lake	Kosciusko	unknown	Metals	Medium
	West Fork of White River	Marion	unknown	Metals	Medium
	West Fork of White River	Daviess	unknown	Chlordane	Medium
	Wabash & Erie Canal	Carrol	unknown	Metals	Medium
	Wabash River	Fountain	unknown	PCBs	Medium
	Teutch Ditch	DeKalb	Universal Tool & Stamping (Butler)	Cyanide Metals PCBs	Medium
	Salamonie River	Jay	unknown	PCBs	Medium
	Ravine Branch	Fountain	unknown	PCBs	Medium
	Litttle Center Lake	Steuben	Angola Die Cast (Angola)	Metals	Medium
*	Wolf Lake Channel	Lake	Multiple sources	Cyanide PCBs Metals	Medium
*	Eel River	Whitley/Wabash	Churubusco POTW	PCBs BHC	Medium
*	Cedar Lake	Lake	unknown	Heptachlor	Medium
*	Pike Lake	Kosciukso	unknown	PCBs	Medium
*	Lake George (Hobart)	Lake	unknown	Metals	Low

TABLE 24. *OTHER WATERBODIES WITH SEDIMENT CONTAMINANTS ABOVE BACKGROUND LEVELS CLASSIFIED BY DEGREE OF CONCERN.* (con't)

	WATERBODY	COUNTY	SOURCE OF CONTAMINANTS (OTHER SOURCES POSSIBLE)	KNOWN CONTAMINANTS	DEGREE OF CONCERN
*	Lake George (Hammond) South basin	Lake	unknown	PCBs	Low
*	Judy Creek	St. Joseph	unknown	Metals	Low
	Trail Creek	LaPorte	Michigan City POTW	Phenol Metals	Low
	Pleasant Run	Marion	unknown	Chlordane	Low
	Little Blue River	Rush	The Chrome Shop (Mays)	Metals	Low
	Jasper Swamp	Dubois	Jasper Engine and Transmission (Jasper)	Oil & Grease Metals	Low
	Fall Creek	Marion	unknown	Metals	Low
	Bean Creek	Marion	unknown	Metals	Low
	Cedar Lake	DeKalb	unknown	Metals	Low
*	Geist Reservoir	Hamilton	unknown	PCBs	Low
*	Greensburg Reservoir	Decatur	Greensburg CSO	Metals	Low
*	Flatrock River	Bartholomew	unknown	DDT Chloroform Trichloroethane	Low
*	Flack Ditch	Wabash	unknown	BHC	Low
*	St. Joseph River	St. Joseph	unknown	Silver	Low
*	Greensburg Reservoir	Decatur	Greensburg CSO	Metals	Low
*	West Fork of White River	Delaware Madison	Muncie POTW Anderson POTW	PCBs	Low
*	Flatrock River	Bartholonew	unknown	DDT Chloroform Trichloroethane	Low
*	Flack Ditch	Wabash	unknown	BHC	Low
*	Lake Waubee	Kosciusko	unknown	2-Butanone	Unknown
*	Winona Lake	Kosciusko	Multiple sources	PAHs Metals	Unknown
*	Spy Run	Allen	unknown	PAHs	Unknown
*	Lake Manitou	Fulton	unknown	Phthalates	Unknown

* *Designates 1985 - 1987 data.*

The most commonly detected priority pollutants were PCBs, dieldrin, BHC, DDE, phthalates, and certain metals. None of these were present in more than 15% of all samples.

Waterbodies known to have sediments containing high nutrient concentrations are shown in Table 26. Nutrients in sediments may contribute to undesirable algal blooms. However, the actual effect of nutrient enrichment at these sites is presently unknown.

Lake Information and Assessment

Indiana has approximately 560 public lakes and reservoirs that have a combined surface area of about 104,540 acres. Three of these are reservoirs over 5,000 acres in size with a combined surface area of 24,890 acres. Although all of these water bodies are important and must be protected, Indiana's 404 public, natural lakes are irreplaceable resources and are in need of exceptional protection.

Although scientific investigations of some of Indiana's lakes were begun prior to the turn of the century, probably less than 100 had been studied prior to 1970. At that time the state recognized the need to generate physical, chemical and biological data from all of its public lakes and reservoirs that could be organized into a system that would permit the comparison of one lake to the next and the prioritization of them according to their need for protection and/or renovation.

Although there have been a number of lake classification schemes developed over the years, those most universally used are based on nutrient concentrations and the associated level of productivity. An oligotrophic lake is one with low levels of nutrients and primary production. A eutrophic lake is rich in nutrients and is highly productive. The term mesotrophic has been applied to lakes of moderate productivity.

The level of nutrients (and consequently the level of productivity) can fluctuate to some extent from season to season and from year to year. For this reason there is no sharp line of demarcation between the different classes. In fact, some systems use the terms meso-oligotrophic and meso-eutrophic to describe lakes which are not clearly in one of the three basic classifications.

The Indiana Lake Classification System and Management Plan of the Indiana Department of Environmental Management (1986) describes the system used to classify Indiana lakes and reservoirs and places each in one of seven basic management groups and one of four trophic classes. (Appendix A shows the tropic classification and management group for each lake.) In the classical sense, there are probably no lakes in Indiana which would be considered truly oligotrophic and only about 20% of the lakes and reservoirs would be considered either meso-oligotrophic or mesotrophic. The rest are either meso-eutrophic or eutrophic. Table 27 shows the trophic classification of Indiana public lakes and reservoirs.

TABLE 25. ***METALS EXCEEDING 2X THE MAXIMUM STATE BACKGROUND AND OTHER PRIORITY POLLUTANTS DETECTED IN 1985-87 STREAM AND LAKE SEDIMENT SAMPLES.***

PARAMETER	NUMBER OF SAMPLES	% OF TOTAL	MG/KG DRY WEIGHT	
			Maximum	Minimum
***	38	23	N.A.	N.A.
Copper	26	15	1800	44.7
Selenium	25	15	17	1.3
Alpha-BHC	20	12	0.032	0.001
Silver	15	9	26	0.55
Zinc	15	9	7800	260
PCB-1248	14	8	14	0.16
Antimony	11	7	680	1.9
Dieldrin	11	7	0.008	0.0012
Cadmium	10	6	43	2.1
Lead	9	5	2800	50
Nickel	9	5	140	42
PCB-1254	9	5	4.88	0.08
Bis(2-ethylhexyl)Phthalate	8	5	27	0.0018
Chromium	7	4	1200	130
Beta-BHC	6	4	0.136	0.0022
Di-n-Butylphthalate	6	4	16	2.6
Phenanthrene	6	4	5.4	0.87
pp'(4,4')DDE	6	4	0.017	0.0025
Pyrene	6	4	3300	1.4
Chrysene	5	3	3.2	0.84
Fluoranthene	5	3	6.2	0.1
Fluorene	5	3	160	1.5
PCB-1242	5	3	31	0.4
Benzo(a)Anthracene	4	2	2.2	0.62
Beryllium	4	2	1.34	0.79
Mercury	4	2	6.13	0.99
Naphthalene	4	2	220	2.5
4-Methylphenol	3	2	12	0.99
Lindane	3	2	0.24	0.0028
Aldrin	2	1	0.067	0.0038
Arsenic	2	1	210	58
Benzo(a)Pyrene	2	1	1.5	0.76
Cyanide	2	1	1.15	0.875
Heptachlor	2	1	0.0035	0.0038

TABLE 25. *METALS EXCEEDING 2X THE MAXIMUM STATE BACKGROUND AND OTHER PRIORITY POLLUTANTS DETECTED IN 1985-87 STREAM AND LAKE SEDIMENT SAMPLES.* (con't)

PARAMETER	NUMBER OF SAMPLES	% OF TOTAL	MG/KG DRY WEIGHT	
			Maximum	Minimum
Phenol	2	1	1.1	0.3
pp'(4,4')OOO	2	1	0.016	0.002
1,2-diphenylhydrozine	1	0.6	4.3	4.3
2-Butanone	1	0.6	0.054	0.054
2-Methylnaphthalene	1	0.6	1.2	1.2
4-Chlorophenylphenylether	1	0.6	4.0	4.0
4-nitroanaline	1	0.6	13	13
Acenaphthene	1	0.6	1.4	1.4
Anthracene	1	0.6	0.6	0.6
Chloronaphthalene	1	0.6	6.5	6.5
Oiethylphthalate	1	0.6	5.8	5.8
Oimethylphenol	1	0.6	3.2	3.2
Heptachlor epoxide	1	0.6	0.0048	0.0048
Indenol (1,2,3-cd)Pyrene	1	0.6	1.1	1.1
PC8-1260	1	0.6	0.415	0.415
Pentachlorophenol	1	0.6	17	17
pp'(4,4')OOT	1	0.6	0.048	0.048
p-Cresol	1	0.6	4.5	4.5
TOTAL SAMPLES:	168			

*** *No organic priority pollutants or metals exceeding twice the maximum state background concentration detected in sediment samples.*

TABLE 26. *SEDIMENTS IN WHICH HIGH NUTRIENT CONCENTRATIONS HAVE BEEN FOUND. (HIGH NUTRIENT CONCENTRATIONS WERE CONSIDERED TO BE TOTAL NITROGEN [N] > 3000 MG/KG AND/OR TOTAL PHOSPHORUS [P] > 1200 MG/KG).*

WATERBODY	LOCATION	MILES (ACRES) AFFECTED	ELEVATED NUTRIENTS (mg/kg)
Cypress Creek	Boonville	unknown	P = 4500
West Branch of the Little Calumet River	Highland	unknown	P = 12,000 N = 19,000
Trail Creek	Michigan City	1 mile	P = 5700 N = 5200
Palestine Lake	Kosciusko Co.	232 acres	P = 1150 N = 8600
Sylvan Lake	Noble Co.	630 acres	P = 1290 N = 16,000
Wolf Lake	Lake Co.	385 acres	N = 3400
Wabee Lake	Kosciusko Co.	117 acres	P = 3159
Lake of the Woods	Marshall Co.	416 acres	P = 3363
Lake Charles	Steuben Co.	22 acres	P = 1500

TABLE 27. *TROPHIC CLASSIFICATION OF INDIANA PUBLIC LAKES AND RESERVOIRS.*

NATURAL LAKES

CLASS	NUMBER	PERCENT	ACRES	PERCENT
One	77	19.1	17,398	44.9
Two	145	35.9	12,722	32.9
Three	64	45.8	6,147	15.9
Four	118	29.2	2,448	6.3
	404	100	38,715	100

IMPOUNDMENTS

CLASS	NUMBER	PERCENT	ACRES	PERCENT
One	48	30.8	46,224	70.3
Two	65	41.7	17,167	26.1
Three	43	27.6	2,407	3.7
	156	100.1	65,798	100.1

ALL WATERBODIES

CLASS	NUMBER	PERCENT	ACRES	PERCENT
One	122	21.8	63,662	60.9
Two	209	37.3	29,889	28.6
Three	111	19.8	8,554	8.2
Four	118	21.1	2,448	2.3
	560	100.0	104,513*	100.0

* *Two lakes totaling 27 acres have not yet been classified but were assessed in this report.*

Class One lakes and reservoirs are considered to be Indiana's finest with the highest water quality. They are generally meso-oligotrophic or mesotrophic and rarely support concentrations of algae or rooted plants that interfere with any use. The chemical control of vegetation in these lakes is seldom necessary but may be initiated to eliminate shoreline weeds or shallow water weed beds that may be an inconvenience to a few property owners. Seventy-seven natural lakes (17,398 acres) and 48 artificial lakes or reservoirs (46,224 acres) are included in Class One.

Class Two lakes and reservoirs are moderately productive for Indiana waters. They include waterbodies that would generally be considered meso-eutrophic. They are often noticeably affected by cultural eutrophication but trophic changes are often subtle. Class Two lakes and reservoirs would frequently support moderate growths of weeds and/or algae if not controlled chemically, but seldom to the extent that one or more uses would be threatened. Exceptions would include Class Two lakes and reservoirs that receive or have received direct wastewater discharges. One hundred and forty-five natural lakes (12,722 acres) and 65 artificial lakes or reservoirs (17,167 acres) are included in Class Two.

Class Three lakes and reservoirs are those that are the most productive and have the lowest water quality. They are considered eutrophic or in some cases hypereutrophic. Without chemical control programs many of these waterbodies would support extensive weed and/or algal growth during the summer months. Swimming, boating and fishing may be impaired occasionally but seldom precluded. Nuisance blooms of blue-green algae commonly occur in Class Three lakes and reservoirs and may persist for much of the warm weather months. In the most highly productive of these water bodies, dissolved oxygen depletion may cause fish kills during extended periods of hot weather or winter kills during periods of ice and snow cover. Waterbodies that are presently receiving direct wastewater discharges or those that have received such discharges in the past generally belong to this class. There are 64 natural lakes (6,147 acres) and 43 impoundments (2,407 acres) included in Class Three.

Class Four waterbodies include remnant and oxbow lakes. These include small, shallow, natural water bodies that are in an advanced state of senescence. Therefore, they cannot be realistically compared with other lakes. They are frequently nearly filled with aquatic weeds and organic sediments and are often well on their way to becoming a swamp, bog, or marsh. Although shallow and weedy, many remnant lakes have excellent water quality.

Remnant lakes are often a small open water area surrounded by marsh and other wetlands. Oxbow lakes are shallow, elongate ponds in an old river bed that are formed when a river cuts new channels and leaves them isolated. The water level in an oxbow commonly rises and falls with the level in the main river.

The most common uses of Class Four lakes are fishing, hunting, trapping, and wildlife habitat. Other uses are usually precluded in these lakes by their small size, lack of depth, and inaccessibility. There are 118 class four lakes with a total of 2,448 acres.

As mentioned previously, the excessive growth of weeds in a lake or reservoir can interfere with various designated uses. Aquatic weeds will occupy any open water area of a lake or reservoir that is shallow enough to permit light to reach the bottom at the beginning of the growing season. Since plant remains contribute to the filling process, those lakes and reservoirs with substantial shallow water areas are most vulnerable to filling. Some lake property owners believe that "the only good weed is a dead weed" and tend to initiate unnecessary controls. However, there may be some lake areas where one or more potential uses may be impaired by aquatic weed growth, but these uses may not be important to those using that portion of the lake or reservoir and no weed control is initiated. It is also recognized that a small shoreline area may be treated by an individual owning adjacent property without a permit and a few lake associations may have mechanical weed harvesting equipment. Never-the-less a review of the weed control permits issued by the Indiana Department of Natural Resources (DNR) provides some indication of the extent of aquatic weed problems in the state.

In 1986 and 1987, a total of 139 permits were issued by the DNR for the control of weeds, in 87 different water bodies. The combined surface areas of these waterbodies totaled 23,580 acres. Permits were requested for the control of weeds in only 1405 acres of these in 1986 and in only 1,213 acres in 1987. For the most part, areas to be treated included channels, beach areas, and strips near the shoreline. Lakes over 15 acres with substantial areas that were treated for weeds in 1986 or 1987 included Shafer (40%), Heaton (25%), Bruce (12%), the Barbee Chain (15%), Beaver Dam (30%), Webster (14%), Upper and Lower Fish and Mud Lakes (32%), Lawrence (22%), Long (Noble Co.) (38%), Upper Long (12%), Loomis (73%), Big Turkey (17%), and Hamilton (13%).

In addition to those lakes where chemical control of weeds was initiated by the public, a number of lakes, ponds and reservoirs on state property are treated for weeds by the Indiana Department of Natural Resources to provide better public access. In 1988 the DNR will apply chemicals to control weeds in 517 acres of 58 such waterbodies. Those over 15 acres with substantial areas to be treated include Starve Hollow Lake (35%), Elk Creek Lake (21%), Dogwood Lake (11%), Spring Mill Lake (60%), Reservoir #26 (60%), Bean Blossom Lake (35%), Lincoln Lake (35%), Bass Pit and Ferdinand Lake (42%).

On the basis of this information, it would appear that approximately 2000 acres or about 2% of the total area of Indiana public lakes and reservoirs have weed problems that are serious enough to require chemical treatment in order to permit or enhance various intended uses of the affected waterbodies.

Eighty-three of the 139 permits issued during the two year period included permission for the chemical control of algae. Only the 202 acre Shipshewana Lake had a program for the chemical control of algae alone. Chara, an attached form of algae, was listed on 67 of the permit applications and was the only algae listed on 48 of these. Filamentous algae was listed on 15 applications, and the general term algae was listed on 40. Although the type of vegetation to be treated in lakes on State property was not specified by the DNR, the type of chemicals listed for each would indicate that algae was perceived to be a problem in less that 25 of these.

Based on this information, it would appear that algae is causing less serious impairment of desired water uses than weeds. There is no question that there is less treatment of planktonic algae, statewide, than there was several years ago when multiple applications of copper sulfate were made each year at Cedar Lake (Lake County), Sylvan Lake, Winona Lake, and several other smaller lakes. However, this should not be considered an indication that algae problems do not exist to some extent in many of Indiana lakes and reservoirs where control programs have not been initiated. Neither should it be considered evidence that existing nutrient loading rates for most of these waterbodies are acceptable over the long term.

In 1973 and 1974, 27 Indiana lakes and reservoirs were included in the National Eutrophication Survey conducted by the U.S. EPA in cooperation with the state of Indiana. These lakes were selected as representative of various classes of public lakes and reservoirs in the state. Each basin of each waterbody was sampled on a seasonal basis. In addition, each significant tributary and each wastewater treatment facility in the watershed was sampled monthly.

The survey results (Table 28) indicated that five waterbodies sampled (18.5%) were mesotrophic, one (3.7%) was meso-eutrophic and 21 (77.8%) were eutrophic. The study further indicated that of the five mesotrophic waterbodies included, only two had total phosphorus loading at or below the oligotrophic rate determined by the Vollenweider model, which may or may not be appropriate for a given waterbody. One lake in this group had a mesotrophic phosphorus loading rate and two were being loaded at eutrophic rates.

Of the remaining lakes and reservoirs, all of which were considered to be eutrophic, two had phosphorus loading rates at about the oligotrophic level. The remainder had phosphorus loading rates which ranged from right at the projected eutrophic rate to 20 times the projected eutrophic rate (Table 28).

For the 25 phosphorus limited lakes, phosphorus loading from nonpoint sources ranged from just over 55% to 100% of the total (Table 28). For the two nitrogen limited lakes nonpoint sources of nitrogen made up 75% and 82.8% of the total load, respectively.

Although the 27 lakes and reservoirs studied as part of the National Eutrophication Survey make up only 4.8% of the public lakes and reservoirs in the state, we believe they are a representative sample. Therefore, it is obvious that the most important step to take in reducing the rate of eutrophication is to limit phosphorus and nitrogen inputs to Indiana lakes and reservoirs to the extent possible. An associated benefit would be a reduction in sediment loading rates.

Indiana has developed several programs which work toward reduction of nutrient inputs to lakes and reservoirs. One of the most important of these

TABLE 28. *U. S. EPA NATIONAL EUTROPHICATION SURVEY DATA SUMMARY.*

LAKE NAME	TROPHIC CONDITION	LIMITING NUTRIENT	PHOSPHORUS %		NITROGEN %		TOTAL PHOSPHORUS LOADING (G/M²/YR)		CALCULATED RATE		TOTAL NITROGEN LOADING (G/M²/YR)	
			POINT	NONPOINT	POINT	NONPOINT	TOTAL	ACCUMULATED	EUTROPHIC	OLIGOTROPHIC	TOTAL	ACCUMULATED
Wawasee	Mesotrophic	Phosphorus	19%	81%	10.1%	89.9%	0.11	0.07	0.28	0.14	8.7	5.4
Oliver	Mesotrophic	Phosphorus	6.5%	93.5%	4.7%	95.3%	0.16	0.09	0.44	0.22	15.7	6.9
Lake James	Eutrophic	Phosphorus	.3%	99.7%	.3%	99.7%	1.30	Loss	1.16	0.58	88.8	3.2
Tippecanoe	Mesotrophic	Phosphorus	1.5%	98.5%	1.8%	98.2%	1.10	0.32	1.00	0.50	68.3	13.2
Maxinkuckee	Mesotrophic	Phosphorus	3.5%	96.5%	5.3%	94.7%	0.15	0.13	0.20	0.10	5.6	4.5
Olin	Mesotrophic	Phosphorus	0.0%	100.0%	0.0%	100.0%	0.81	0.64	0.62	0.31	34.6	13.2
Crooked	Meso-Eutrophic	Phosphorus	6.5%	93.5%	16.9%	83.1%	0.24	0.19	0.30	0.15	6.5	3.5
Monroe Reservoir	Eutrophic	Phosphorus	20.9%	79.1%	3.0%	97.0%	0.28	0.12	0.56	0.28	9.0	0.1
Webster	Eutrophic	Phosphorus	11.3%	88.7%	3.7%	97.3%	1.04	0.52	0.78	0.39	52.2	12.5
Dallas	Eutrophic	Phosphorus	17.0%	83.0%	3.3%	96.7%	1.53	0.10	0.98	0.49	62.9	20.5
James Lake	Eutrophic	Phosphorus	.3%	99.7%	.3%	99.7%	1.30	Loss	1.16	0.58	88.8	3.2
Bass	Eutrophic	Phosphorus	23.7%	76.3%	22.5%	77.5%	0.09	0.04	0.14	0.07	3.3	1.4
Westler	Eutrophic	Phosphorus	1.3%	98.7%	2.6%	97.4%	4.39	0.50	1.68	0.84	158.7	Loss
Hamilton	Eutrophic	Phosphorus	5.3%	94.7%	10.1%	89.9%	0.32	0.15	0.36	0.18	12.0	6.3
Witmer	Eutrophic	Phosphorus	9.0%	91.0%	2.9%	97.1%	2.73	0.89	1.12	0.56	79.7	14.9
Winona	Eutrophic	Phosphorus	0.8%	99.2%	1.4%	98.6%	0.80	0.38	0.62	0.31	39.8	9.1
Geist Reservoir	Eutrophic	Phosphorus	32.5%	67.5%	3.5%	96.5%	2.88	1.14	0.92	0.46	91.4	Loss
Sylvan	Eutrophic	Nitrogen	44.3%	55.7%	17.2%	82.8%	1.26	Loss	0.62	0.31	44.6	18.2
Cataract	Eutrophic	Phosphorus	2.0%	98.0%	0.3%	99.7%	5.65	2.44	1.28	0.64	183.1	47.6
Pigeon	Eutrophic	Phosphorus	0.0%	100.0%	0.0%	100.0%	8.32	1.68	1.84	0.92	423.9	53.1
Marsh	Eutrophic	Nitrogen	80.0%	20.0%	22.8%	77.2%	6.09	0.39	1.34	0.67	83.7	Loss
Hovey	Eutrophic	Phosphorus	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Versailles	Eutrophic	Phosphorus	42.9%	57.1%	4.5%	95.5%	44.42	13.56	2.20	1.10	361.5	Loss
Whitewater	Eutrophic	Phosphorus	23.7%	76.3%	4.8%	95.2%	3.28	2.09	0.82	0.41	89.1	21.3
Morse Reservoir	Eutrophic	Phosphorus	32.0%	68.0%	3.1%	96.9%	6.52	3.42	1.16	0.58	157.8	16.7
Long	Eutrophic	Phosphorus	23.5%	76.5%	4.3%	95.7%	29.54	9.84	2.30	1.15	596.7	58.5
Mississinewa Reservoir	Eutrophic	Phosphorus	30.5%	69.5%	12.0%	88.0%	12.59	6.19	1.24	0.62	256.3	67.8

ND = No Data

is the enactment of the Indiana Phosphate Detergent Law (IC 13-1-5.5 as amended) which became fully effective in 1973. This law limits the amount of phosphorus in detergents to that amount incidental to manufacturing (not to exceed 0.5% by weight). Additionally, Regulation 327 IAC 5, governing the issuance of NPDES permits, required phosphorus removal for all discharges containing ten pounds or more of total phosphorus per day if the discharge is located in the Lake Michigan or Lake Erie basins, or on a tributary of a lake or reservoir within 40 miles upstream. A proposed lake discharge policy calls for the installation of phosphorus removal for any discharge of sanitary wastewater if the discharge is directly to a lake or reservoir or within two miles upstream. Advanced treatment for oxygen demanding wastes and ammonia removal would also be required for these discharges.

The Indiana Confined Feeding Control Law (IC 1971,13-1-5.7) and Land Application Regulation (327 IAC 6) contain provisions governing the land application of sludges and animal wastes. These requirements are designed to prevent or reduce runoff of these material to lakes and reservoirs and their tributary streams and thus reduce contributions of nutrients and other materials from these nonpoint sources.

Indiana recognizes the important role that wetlands have in maintaining the water quality of lakes and reservoirs. These wetlands act as nutrient and sediment traps which "filter out" these materials before they reach the open water of a lake or reservoir and cause problems. Substantial effort is made to protect wetlands, especially those contiguous to lakes and reservoirs or their tributaries, through the Section 404 environmental review and Section 401 certification process and the early environmental coordination of proposed construction processes not requiring Section 401 certification. A goal of preventing a net loss in wetland acres has been established by the DEM.

As a result of a soil erosion study by the Governor's Soil Resources Study Commission, the 1986 legislature established a new Division of Soil Conservation in the Indiana Department of Natural Resources and a State Conservation Board to serve as a policy-making body for the Division. Erosion control measures instituted by these bodies will include both agricultural and nonagricultural land and will eventually be part of a regulatory program. A lake enhancement program administered by the Division of Soil Conservation is funded by a portion of a cigarette tax increase. This program supports projects that are generally smaller than those funded under the Federal Clean Lakes program. These, and related programs will help prolong the life of many lakes and reservoirs in the State.

Additionally, representatives of the Indiana Departments of Environmental Management and Natural Resources are co-chairing a committee of professionals who are putting together a nonpoint source assessment and management plans required under Section 319 of the Clean Water Act as amended. The programs developed by the plans should eventually result in the further reduction of nonpoint source contributions of nutrients and other contaminants to Indiana lakes and reservoirs. Nonpoint source problems and control programs are discussed at some length in Section III of this report.

The Indiana Department of Environmental Management will enter into a contract with the School of Public and Environmental Affairs of Indiana University to help manage the Indiana Clean Lakes Program and to work at the local level to encourage the refinement and implementation of the generic management plans for lakes and reservoirs that are contained in the Indiana Lake Classification System and Management Plan.

The state programs that have been in place for the last several years should have resulted in the improvement of some waterbodies and slowed the rate of degradation of a number of others. However, no lake or reservoir has been monitored on a regular basis to assess the effects of these programs.

Some indication of trends might be determined by occasional water column sampling for total phosphorus even though an increase in the detection level used by the State Board of Health laboratory to 0.03 mg/l in recent years makes comparisons difficult or impossible for many lakes. A better indication is provided by a comparison of the calculated trophic index numbers for various lakes and reservoirs.

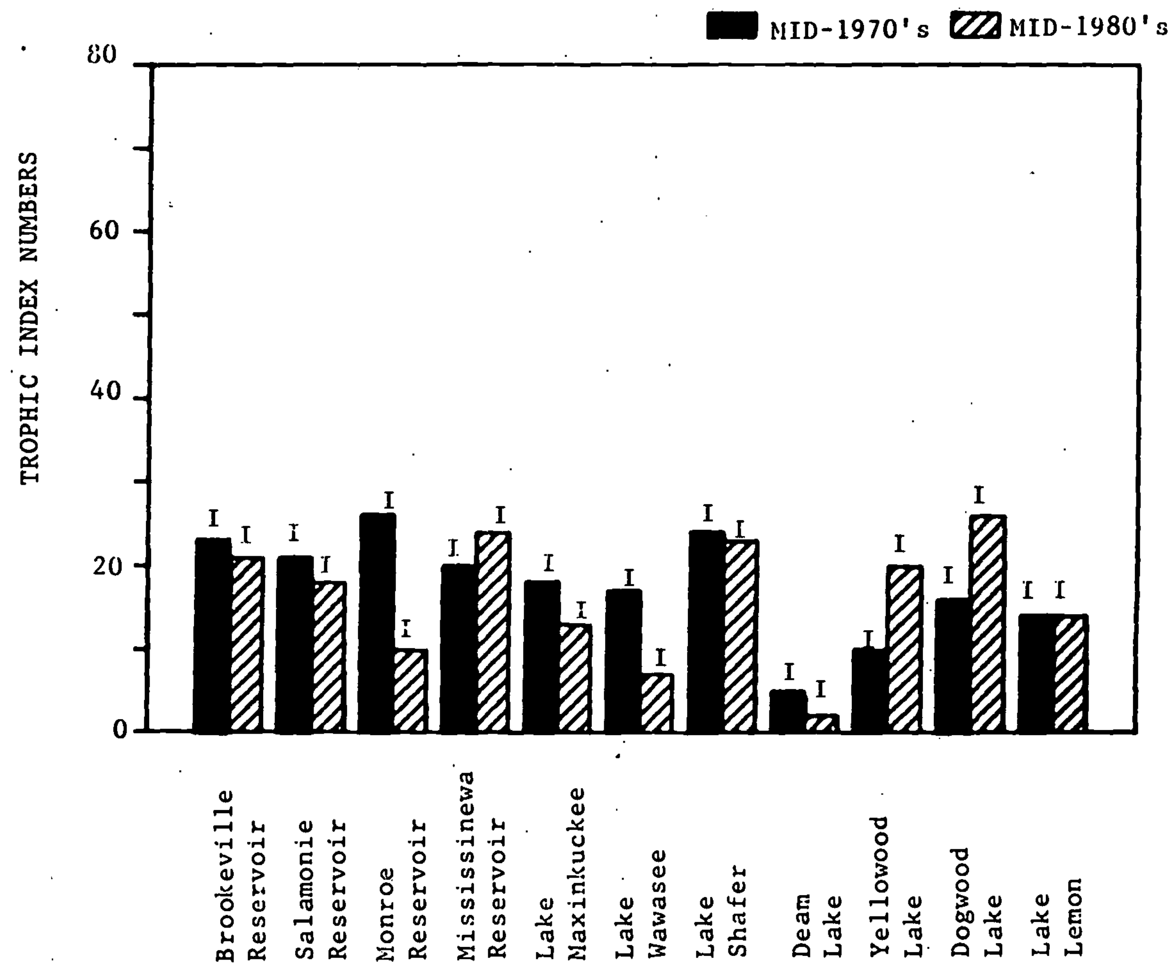
It was pointed out earlier in this discussion that the apparent trophic condition of a lake or reservoir can fluctuate to some extent from year to year and, for that matter, even during a given summer season. Therefore, a change in the trophic index number for a particular lake or reservoir of less than five points from one survey to the next may not always reflect an actual trend. In the same sense, an apparent shift from one trophic class to the next may not indicate a significant or permanent change in trophic condition if the lake or reservoir is near the dividing line between classes.

There are 31 Indiana lakes and reservoirs for which trophic index numbers have been calculated in the mid 1980s. These index numbers were compared to the trophic index numbers and trophic classes for these same waterbodies that were assigned following surveys in the mid 1970s to determine apparent trends (Figure 7). For the most part, the lakes and reservoirs selected for study in the 1980s were chosen because they were considered possible problem lakes since they are downstream from waste fills or wastewater discharges.

Fifteen of the 31 lakes and reservoirs were considered to be in trophic Class I during the mid 1970s. The results of the most recent studies indicated that all of these lakes and reservoirs remained in Class I and that four of these waterbodies actually improved five or more trophic index points from the 1970s (Table 29). The trophic index number for Deam Lake dropped from five index points down to two which was considered to be significant for that lake. The trophic index number for six Class I waterbodies remained the same while the trophic index numbers for the remaining four increased. It appears that changes in land use practices were responsible for the observed increases.

Of the nine resurveyed lakes and reservoirs which were originally placed in Class II, one has apparently improved enough to be placed in Class I while another has slipped into Class III. Four of the nine waterbodies now have

Figure 7. Water quality trends in 31 lakes and reservoirs as shown by trophic index number changes. The number above the bars indicate the trophic class.



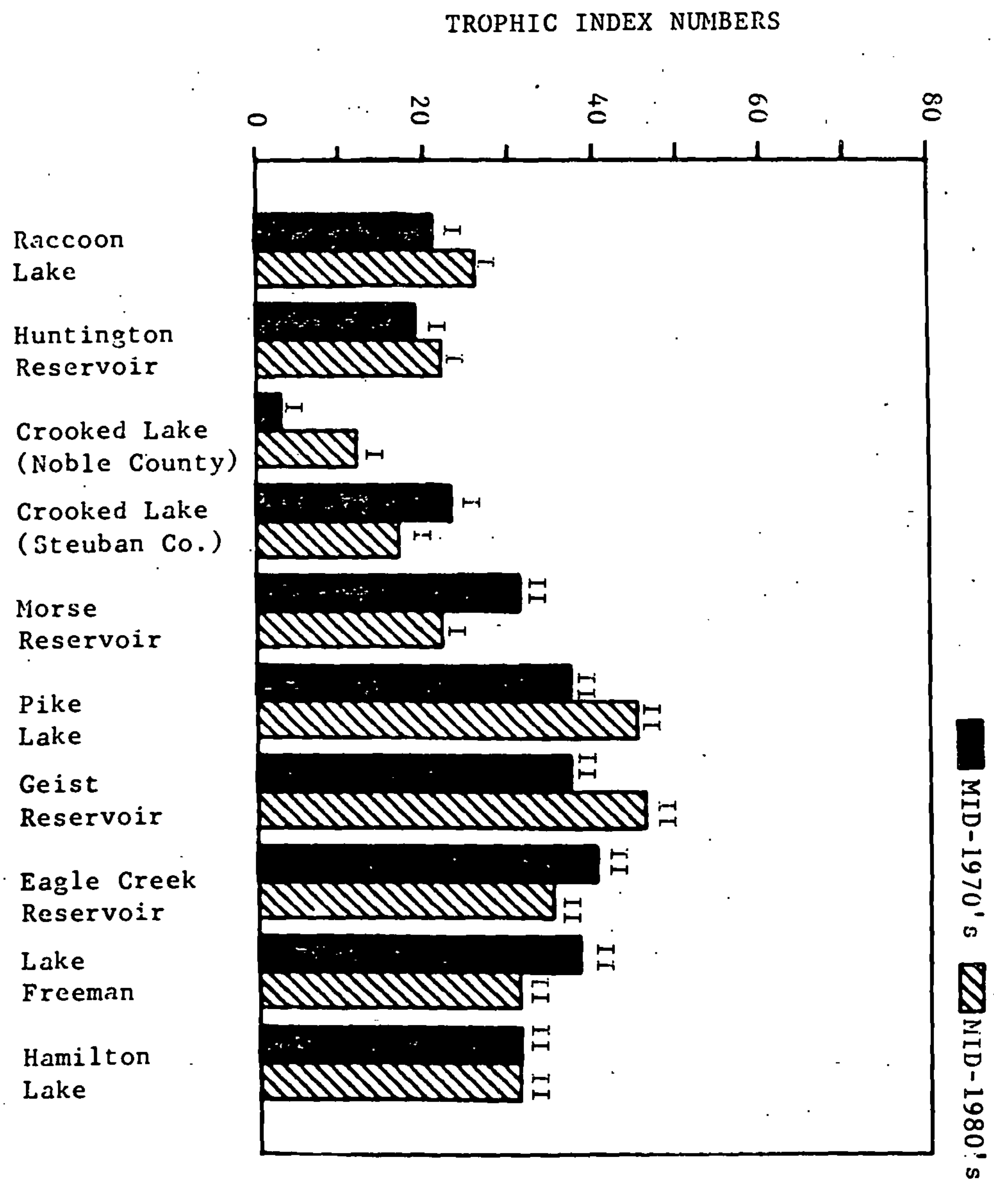


Figure 7. (Con't.)

Figure 7. (Con't.)

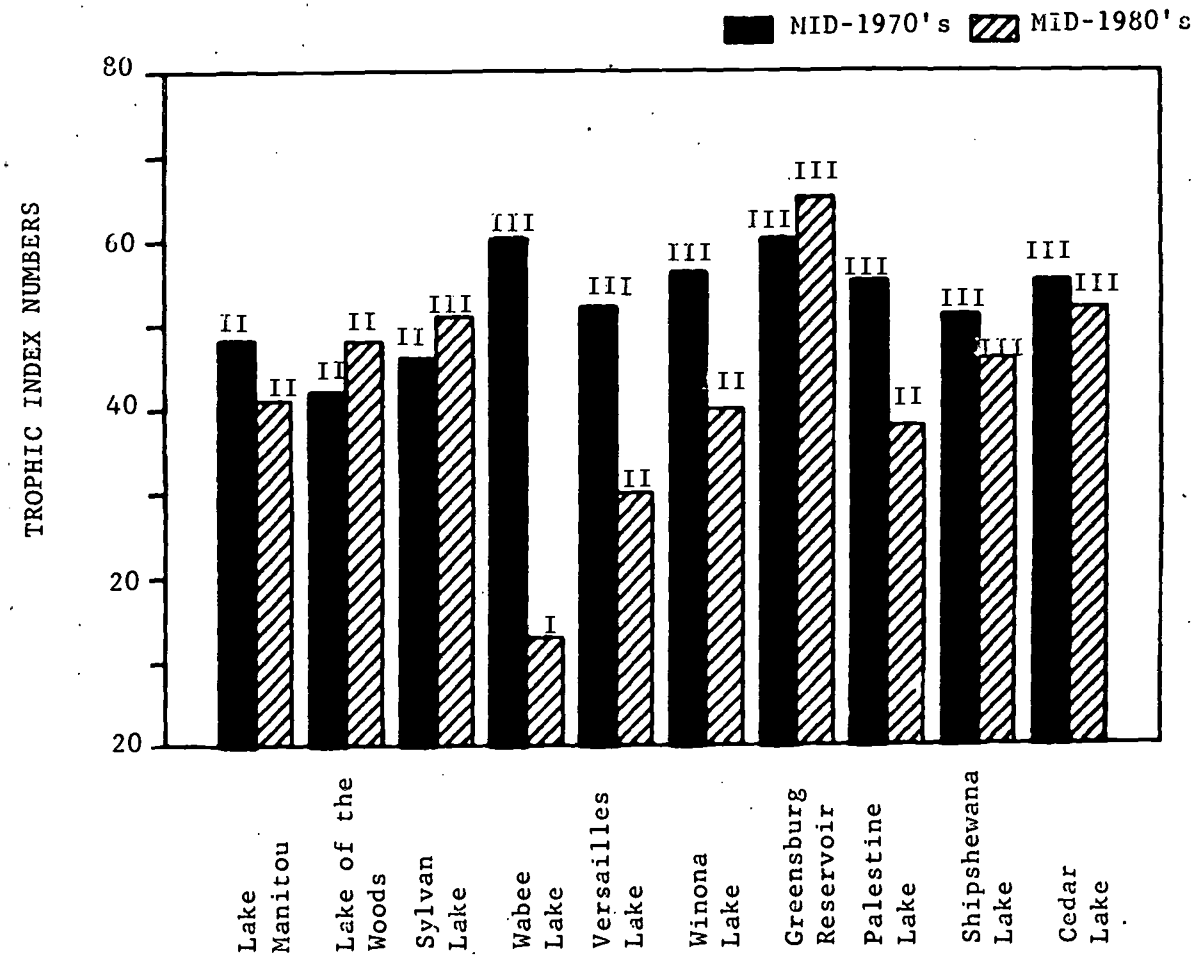


TABLE 29. *SUMMARY OF APPARENT CHANGES IN TROPHIC CONDITIONS FOR 31 LAKES AND RESERVOIRS BETWEEN MID-1970S AND MID-1980S.*

SHIFTS IN TROPHIC CLASS

	ORIGINAL NO.	MOVED TO CLASS I	MOVED TO CLASS II	MOVED TO CLASS III	REMAINED IN CLASS
Class I	15	-	0	0	15
Class II	9	1	-	1	7
Class III	7	1	3	-	3
TOTAL	31	2	3	1	25

TRENDS

TOTAL SURVEYED	MOVED TO BETTER CLASS	MOVED TO WORSE CLASS	REMAINED IN CLASS
31	5 (16.1%)	1 (3.2%)	25 (80.7%)

CHANGES IN TROPHIC INDEX NUMBERS

	NO. SURVEYED	TROPHIC INDEX NO. INCREASED	TROPHIC INDEX NO. DECREASED	NO DEFINITE CHANGE
Class I	15	4 (26.7%)	5 (33.3%)	6 (40%)
Class II	9	4 (44.4%)	4 (44.4%)	1 (11.1%)
Class III	7	1 (14.3%)	5 (71.4%)	1 (14.3%)
TOTAL	31	9 (29.0%)	14 (45.2%)	8 (25.8%)

lower trophic index numbers while an equal number have higher index numbers. The index number for one waterbody remained the same.

Of the seven resurveyed lakes and reservoirs originally included in Class III, one responded dramatically to remedial programs and is now placed in Class I and three improved enough to be placed in Class II. A comparison of trophic index numbers for lakes and reservoirs in this group disclosed that five had improved five or more points, one was worse and one remained about the same.

This trophic assessment was based on surveys of 12.4 % of the Class I, 4.3% of the Class II and 5.9% of the Class III public lakes and reservoir in the state. While this is not a large sample, it does included many of the lakes and reservoirs that were considered to be problems or potential problems in the past. Therefore, this sample should reasonably reflect the extent to which ongoing programs are slowing and/or reversing the rate of eutrophication in the state's major waterbodies. If this is the case, then nearly 30% of Indiana lakes and reservoirs aged at a measurable rate during the last decade. Although this was balanced to some extent by a measurable improvement in 45% of the lakes and reservoirs surveyed, it is still cause for concern and reason enough to continue to implement existing programs and to vigorously work to reduce nutrient contributions from nonpoint sources and combined sewer overflows.

Programs designed to assess the extent of contamination of fish tissue and bottom sediment with toxic and/or bioconcentrating substances are described elsewhere in this report. While concentrations of some contaminants in the bottom sediments of a few lakes and reservoirs are high enough to be of concern, with one exception, there is no evidence that they impair water uses.

Five public lakes and reservoirs totalling 116 acres do not support designated uses because of contaminants entering from either point or nonpoint sources. Each of these is discussed below.

Springwood Lake (15 acres) which is located in a Richmond City Park receives runoff from an industrial park and two industries discharge wastewater to a tributary stream. High cyanide concentrations in the bottom sediments prompted the City Park Department to close the lake to body contact activities and fishing. This problem is presently under investigation and a plan to renovate the lake is under development.

A fish consumption advisory is presently in effect for one small impoundment. An advisory for the 12 acre Decatur County Reservoir near Greensburg is based on high concentrations of contaminants in samples of fish tissue collected from the Muddy Fork of Sand Creek upstream and from Sand Creek downstream. Chlordane, dieldrin and PCBs were present in tissue samples in concentrations exceeding Federal Food and Drug Administration (FDA) action levels.

Pit 29 is a 30 acre strip pit in Green-Sullivan State forest that supports no visible aquatic life due to acid mine drainage from old strip mine workings.

Gilbert Lake is a small, 37 acre, natural lake in Marshall County. It has no tributary streams and receives only runoff from the surrounding terrain and the effluent from the small wastewater treatment plant of Ancilla Domini College. Gilbert Lake has been awarded the maximum possible score of 75 eutrophy points and it has a history of poor water quality and occasional fish kills. Most uses are precluded by the heavy weed and algae growth it supports.

Henderson Lake, which is presently about 22 acres in size, receives the direct discharge from the Kendallville wastewater treatment plant. It also receives untreated wastewater from a treatment plant bypass and combined sewer overflow. As a result, it has a long history of poor water quality and fish kills. A recent attempt to eliminate the large resident carp and bullhead catfish populations and to restock Henderson Lake with game fish was largely unsuccessful. Although a second attempt will be made, there may be little chance for success until better control and treatment of combined sewer overflow is provided. Swimming is precluded by the frequently elevated bacterial concentrations and boating is limited by aesthetic considerations.

There are two small public lakes with a total of 63 acres that are considered to be only partially supporting the designated uses. These are discussed below:

Greensburg Reservoir is a small (23 acre), state owned impoundment that has periodically received overflow from a lift station in the municipal sewer system for several years. It also receives urban runoff and drainage from an industrial area. The lake supports nuisance warm weather blooms of bluegreen algae and there have been several fish kills over the years. The lake supports a fishery of limited value, however, it is still used by the general public to some extent. Swimming potential is limited by aesthetics and the lift station bypass.

Hawks Lake (Lost Lake) (40 acres) receives the discharge from the Culver municipal wastewater treatment plant which provides the only flow into the lake during dry-weather. Although the condition of the lake has improved significantly due to treatment plant improvements, some problems remain.

The remaining lakes and reservoirs in Indiana are all threatened to some degree. Any significant change in watershed land use practices which would result in increased sediment and/or nutrient loading would speed the rate of eutrophication of any of these waterbodies.

Nonpoint Source Assessment

Indiana has completed a nonpoint source assessment and has developed a provisional list of waters which are affected by nonpoint sources of pollution. This assessment and list of waters will be submitted to EPA separately with the state's 304(l) list.

Basin Information and Summaries

Although U.S. EPA has requested the states to utilize the Waterbody System (WBS) in their 1988 305(b) reports, Indiana was unable to comply at this time. All waters of the state are currently being placed in segments to conform to the WBS format, and this task is nearly complete. Information in this 305(b) report will be transferred to the WBS format when the system becomes available.

Lake Michigan Basin

Lake Michigan is located in the northwest corner of the State. Indiana governs approximately 43 miles of shoreline and 241 square miles, about 1% of the total surface area of the lake.

The Lake Michigan drainage basin includes four major waterways in Indiana: The Grand Calumet-Indiana Harbor Ship Canal, the Little Calumet River, Trail Creek and the St. Joseph River. The first three, compose what is referred to as the Lake Michigan Basin - Northwest in this report, empty into Lake Michigan within the boundaries of Indiana (Figure 8). The St. Joseph River and its tributaries, which will be referred to as the Lake Michigan Basin-Northeast in this report (Figure 9). The St. Joseph River flows into Lake Michigan approximately 25 miles north of the state line at the towns of St. Joseph-Benton Harbor.

Five major Indiana municipalities (Michigan City, East Chicago, Gary, Hammond, and Whiting) use Lake Michigan for potable water supply and several return treated municipal wastewater to the lake via a tributary. In addition, a number of industries also use the lake as a raw water source. Lake Michigan and its contiguous harbor areas have been designated for multiple use purposes including recreation, aquatic life, potable water supply, and industrial water supply in regulation 327 IAC 2-7. This regulation outlines the criteria and minimum standards of water quality that must be maintained in the lake.

A total of 2,671 analyses conducted on water samples collected from Lake Michigan as part of the Fixed Station Water Quality Monitoring Network during 1986 and 1987 were reviewed for violations of water quality standards established in 327 IAC 2-7. These data showed that less than 1% of these values violated water quality standards. There are occasional violations of standards for mercury, cadmium, chlorides, total chromium, and fecal coliform. However, from this review, these violations are not of sufficient magnitude nor frequency to prevent attainment of designated uses.

Water quality in Lake Michigan does vary in the Indiana portion. Concentrations of mercury and phenols in the near shore zone reflect the effects of wastewater and tributary contributions from the watershed. The highest values consistently appear near the Indiana Harbor Ship Canal. High levels of chlorides in the contiguous harbor, and low dissolved oxygen and high un-ionized ammonia values in Trail Creek, may also be responsible for some of the chemical variability in the lake.

Figure 8. Lake Michigan Basin - Northwest.

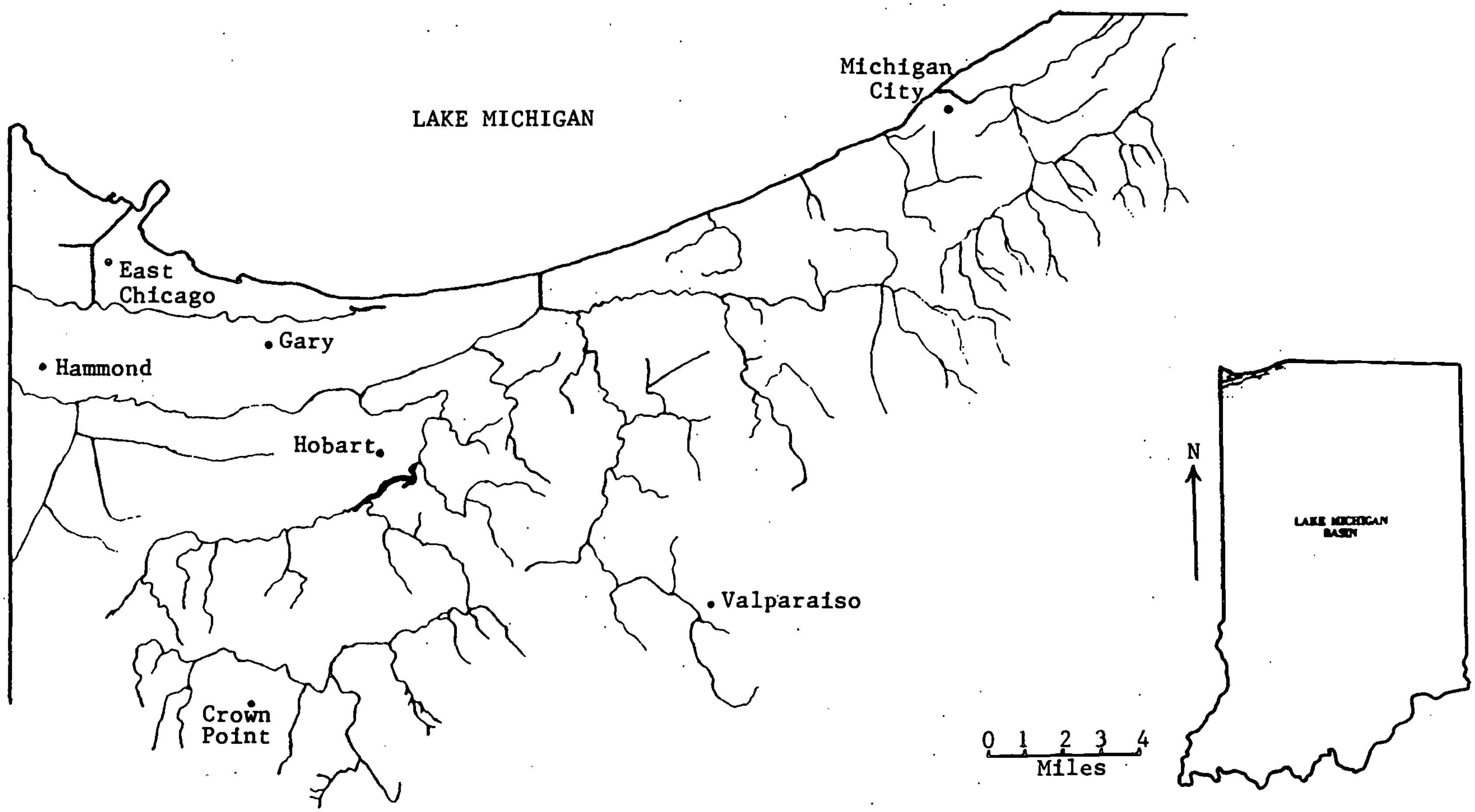
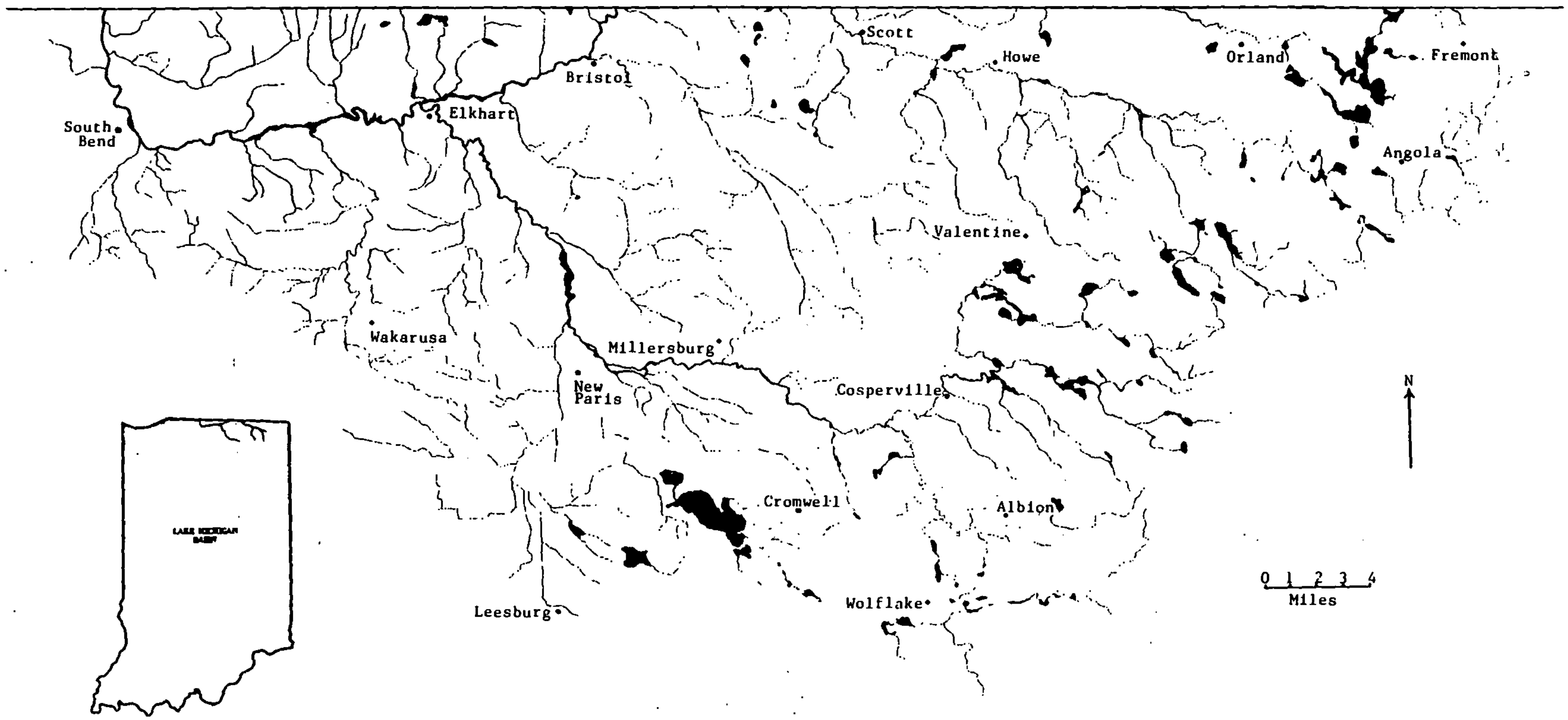


Figure 9. Lake Michigan Basin - Northeast.



Tissue from some species of fish in Lake Michigan have contained concentrations of contaminants in excess of Food and Drug Administration (FDA) action levels since testing began in the early 1970s. Fish are collected for metals, pesticide and PCB analysis in the fall of each year by the Indiana Department of Natural Resources (IDNR) and analyzed by the Indiana State Board of Health (ISBH). PCBs are a problem, with values in excess of the FDA action level of 2.0 ppm. Chlordane, dieldrin, and DDT are also found in excess of their FDA action levels. A revised fish consumption advisory for fishermen and consumers of these fish is issued each spring. The most current advisory is shown in Table 19. Due entirely to this consumption advisory, Lake Michigan is determined to only partially support its designated uses.

Lake Michigan Basin - Northwest

An assessment of designated use support was made for 177 stream miles in this subbasin. The waters assessed, support status, miles affected, and probable causes of impairment are shown in Table 30. Additional information for certain stream reaches are also provided in this table.

Trail Creek is located in LaPorte County in the northwest corner of the state and flows into Lake Michigan at Michigan City. The drainage area is 59.1 square miles, with an approximate average annual flow of 75 cfs. It is Indiana's most noted salmonid stream due to an IDNR stocking program that began in the early 1970s. Since it is a salmonid stream, it is included in Regulation 327 IAC 2-9 (Natural Spawning, Rearing or Imprinting Areas; Migration Routes for Salmonid Fishes) which was revised in late 1985.

Historically, many water quality problems have been associated with this waterway. Inadequately treated sewage, combined sewer overflows, industrial discharges and chemical spills have contributed to its poor condition and resulted in fish kills at different times. In 1986 and 1987, four fish kills occurred due to low dissolved oxygen, high temperature, and/or ammonia.

Because of Trail Creek's designation as a salmonid stream, a more stringent set of water quality standards applies than for general use streams. Dissolved oxygen violations in the lower reaches of the creek occurred nearly 40% of the time according to 1986-1987 Fixed Station Water Quality Monitoring Network data. Fecal coliform bacteria criteria were violated often enough that its designated recreational uses were not supported, and violations of un-ionized ammonia standards occurred. Temperature standards are almost always exceeded in June, July, and August, and violations will continue as these standards appear to be lower than "background" or "ambient" temperatures. Heavy rain causes bypassing of raw and partially treated sewage from the sewage treatment facility as well as from combined sewer overflows to the stream. Bypassing of some flow occurred during construction of sewage treatment plant expansions.

In 1984, Michigan City received a grant award of over 18 million dollars for projects that should eventually eliminate most water quality problems. In 1985, an Order of Compliance was established for interim limits during construction. The Michigan City Sanitary District is currently planning to

TABLE 30. ***WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENTS, AND MILES AFFECTED IN THE LAKE MICHIGAN BASIN - NORTHWEST.***

	WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT[1]	METHOD OF ASSESSMENT[2]	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
1)	Deep River	Lake Station	FS (Threatened)	Evaluated		4	
2)	Coffee Creek and its tributaries	Chesterton	FS	Monitored (b)		10	
3)	Upper Salt Creek	Valparaiso	PS (Aquatic Life)	Monitored (b) (c)		4	
4)	Lower Salt Creek	McCool, Portage	FS (Aquatic Life) NS (Recreational)	Monitored (b) (c)	Sewage from Neighborhood Utilities - Portage	4	City of Portage might take over facility.
5)	Dunes Creek	Tremont	FS (Threatened)	Evaluated	Channelization	5	
6)	Kintzele Ditch and its tributaries	Michigan City	FS (Threatened)	Monitored (b)	Channelization	5	
7)	Upper Trail Creek and its tributaries	Michigan City	FS (Threatened)	Monitored (b)	Agricultural run-off	42	
8)	Galena River and its tributaries	Heston, Lalimere	FS	Monitored (b)		13	
9)	Burns Ditch	Lake Station	PS (Aquatic Life) NS (Recreational)	Monitored (b) (c)	Run-off, D.O.	6	Multiple sources.
10)	L. Calumet River	Porter Chesterton	PS (Aquatic Life) NS (Recreational)	Monitored (c)		6	a)Multiple sources. b) Porter POTW awarded $426,000 in FY86 for advanced treatment, expansion. c)Chesterton POTW awarded $6,200,00 in FY86 for advanced treatment expansion, ammonia removal.
11)	Coffee Creek	Chesterton	PS (Aquatic Life)	Monitored (b)	Urban run-off	2	
12)	L. Calumet River	Gary (Aquatic Life)	PS NS (Recreational)	Monitored (c) Run-off,	Ammonia, D.O., Fecal coliform	7	Multiple sources.

TABLE 30. *WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENTS, AND MILES AFFECTED IN THE LAKE MICHIGAN BASIN - NORTHWEST.* (con't)

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT[1]	METHOD OF ASSESSMENT[2]	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
13) Salt Creek	Valparaiso	PS (Aquatic Life) NS (Recreational)	Monitored (c)	Valparaiso STP CSOs Fecal coliform D.O.	8	Valparaiso POTW permit contains schedule to achieves compliance with final bypass overflow requirements. Municipal Compliance Strategy compiled
14) Deep River	Hobart	PS (Aquatic Life)	Evaluated	Run-off, Hobart POTW, Poor Habitat	4	a) Regionalization of Hobart with Gary is reported to be complete in late 1987. b)Lake Station Sewer Rehabilitation is to be complete in 1988. c) Innovative/ alternative facilities (possible pumping to another municipality) at New Chicago will be complete in early 1989.
15) Turkey Creek	Hobart	PS (Aquatic Life)	Evaluated	Run-off, Channelization	8	
16) Indiana Harbor Canal	Whiting, E. Chicago	NS (Aquatic Life) (Recreational)	Monitored (b)(c)	Metals, Toxics PCBs	4	a) Multiple sources. b) ISBH Consumption Advisory. c)LTV Steel requested 301G variance for proposed limits. Some limits not covered by variance. Consent Decree issued to set construction schedule for some parameters and outfalls.
17) Lake George Branch of Indiana Harbor Canal	E. Chicago,	NS (Aquatic Life) Recreational)	Monitored (b)(c)	Metals, Run-off Oil & Grease, Fecal coliform PCBs	1	a) Multiple sources. b) Fish Consumption Advisory.
18) E. Branch Grand Calumet River	Gary, E. Chicago	NS (Aquatic Life) (Recreational)	Monitored (b) (c)	Oil & Grease, Metals Fecal coliform	10 PCBs	a)Multiple sources. b)Enforcement actions taken for zinc violations at U.S.Steel Outfall 603. Since the public hearing conference held on10/8/85, the company has been in compliance. Dismissal based on successful implemention of compliance plan. c) Fish Consumption Advisory.

TABLE 30. *WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENTS, AND MILES AFFECTED IN THE LAKE MICHIGAN BASIN - NORTHWEST.* (con't)

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT[1]	METHOD OF ASSESSMENT[2]	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
19) W Branch Grand Calumet River	Hammond, E. Chicago	NS (Aquatic Life) (Recreational)	Monitored (b) (c)	Fecal colform, D.O. PCBs	3	a)Hammond POTW fined $500 for violation of permit reporting procedures. Hammond POTW was awarded $5,000,000 in FY87 for advanced treatment, phosphorus removal, expansion , ammonia removal. b) East Chicago POTW was awarded $16,000,000 in FY86 for advanced treatment, expansion, ammonia removal. c)Fish Consumption Advisory.
20) Little Calumet River	Hammond	NS (Aquatic Life) (Recreational)	Monitored (c)	Ammonia D.O. Fecal coliform	10	Multiple sources.
21) Plum Creek	Dyer	NS (Aquatic Life)	Evaluated	Run-off, CSOs, Unknowns	4	
22) Hart Ditch	Munster, Highland	NS (Aquatic Life)	Evaluated	Run-off, CSOs, Unknowns	2	Munster and Highland now discharge to Hammond POTW.
23) Dyer Ditch	Dyer	NS (Aquatic Life)	Evaluated		2	
24) Kaiser Ditch	Lincoln Village	NS (Aquatic Life)	Evaluated	Lincoln Utility STP	1	Lincoln Utilities Consent Decree adopted 10/15/85 with schedule for corrections up to $250,000 but the utility did not get immediate financing,. Public Service Commission Hearing on 6/26/87 on Rate Hike was continued.
25) Beaver Dam Ditch	Crown Point	NS (Aquatic Life)	Monitored (b)	Crown Point POTW Poor Habitat	7	

TABLE 30. *WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENTS, AND MILES AFFECTED IN THE LAKE MICHIGAN BASIN - NORTHWEST.* (con't)

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT[1]	METHOD OF ASSESSMENT[2]	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
26) Burns Ditch	Ogden Dunes	NS (Aquatic Life) (Recreational)	Monitored (b)(c)	PC8s Chlordane Fecal coliform	2	a) Multiple sources. b) PC8s and chlordane in fish tissue.
27) Lower Trail Creek	Michigan City	NS (Aquatic Life) (Recreational)	Monitored (b) (c)	D.O. Oil and Grease Fecal coliform Ammonia	3	a) 2/1/85 Order of Complaince for Michigan City POTW establishes interim limits during construction. Municipal Compliance Strategy and Plan completed. b)Anderson Company visited in September 1987 to establish reasons for noncompliance. Meeting to establish new Consent Decree was held in October 1987. New order is being drafted. c) Enforcment action to establish a compliance schedule for completion of work on Michigan City POTW and require attainment of discharge permit compliance by May 25, 1988.

1 *FS = Fully Supported, PS = Partially Supported, NS = Not Supported. The uses not support are listed. If only one use is listed as not being supported, all other uses are supported.*
2 *b = biological, c = chemical.*

plug CSOs and to build a storage basin for stormwater, which will reduce the amount of raw sewage entering Trail Creek through CSOs. The city is also increasing the capacity of the STP to handle larger volumes of wastewater, which will reduce the frequency of bypassing. Recently, an enforcement action established a compliance schedule for completion of construction and required attainment of discharge permit compliance by May 25, 1988.

In the late fall of 1986, the U.S. Army Corps of Engineers (USACE) dredged the mouth of Trail Creek and Michigan City Harbor to restore the area to design navigational depths.

In 1987, following a great deal of discussion and controversy, USACE dredged bottom sediments from about one mile of Trail Creek to restore the federal navigation channel to its designated depth. The dredged material was determined to be sufficiently contaminated to warrant imposition of disposal limitations. Since the 1987 dredging was viewed as the second phase of an overall project originated in 1978, a confined disposal facility (COF) approved at that time was once again used for disposal of dredged sediment, filling it to capacity.

The CDF was constructed of native materials consisting primarily of sandy soils. Ground water, which flows freely through the lower levels of the CDF and into Trail Creek, has been shown to contain rather high levels of ammonia as well as low levels of barium, mercury, lead, manganese and arsenic. Monitoring conducted by USACE has not revealed any impact on Trail Creek itself.

Biological sampling in Trail Creek has been conducted since 1979. In 1984 and 1986, CORE monitoring surveys found few individuals and species of fish in the lower reach of Trail Creek. Hester-Dendy macroinvertebrate samples collected in 1986 at the Franklin Street Bridge near the stream mouth had two to ten times higher density than in any previous year. Most of the increase was due to greatly increased numbers of the midges *Glyptotendipes* and *Dicrotendipes*. These midge larvae are classic indicators of sewage pollution in slow-moving waters. This station has always been dominated by organisms tolerant to low D.O., but in 1986 the water quality appeared to have declined further, perhaps due to the construction activities at the Michigan City sewage treatment facility. Salmonids attempting to migrate through this area must subject themselves, for short periods, to conditions that are detrimental to this type of fishery. The Lake Michigan Basin provides a sport and commercial fishery worth an estimated 17 million dollars each year to Michigan City. The need to protect this resource, therefore, is readily apparent.

The Little Calumet River flows through Lake and Porter counties in northwest Indiana. This river basin is a highly populated, urban area. The steel industry is the major economic provider in the basin with the large plant of Bethlehem Steel the most visible. Supportive industries and the population base that subsequently developed encompass most of this watershed. Urban runoff, combined sewer overflows, and municipal and industrial wastewater effluents are common, especially in the West Branch of the Little Calumet River.

A portion of the West Branch of the Little Calumet River drains to Lake Michigan via Burns Ditch while a flow divide near Griffith directs a portion of the flow into Illinois, and eventually the Illinois River. The west branch is covered by Regulation 327 IAC 2-1. Deep River is the major tributary to the portion of the west branch that drains to Lake Michigan. The section that flows into Illinois includes Hart Ditch.

Samples from the portion of the Little Calumet River that flows west into Illinois have shown violations of water quality standards for a number of years. Poor treatment at Schererville and Dyer, as well as CSOs from Hammond and Munster were major problems in this reach. Dissolved oxygen values below 4.0 mg/l at fixed water quality station LCR-13 occurred more than 50% of the time from 1984 to 1985. The 1986-1987 data show fewer D.O. violations (23%). Un-ionized ammonia violations also occurred in the 1986-1987 period. Violations of the fecal coliform bacteria standard occurred approximately 75% of the time in 1986-1987.

Schererville, which had previously been denied funding, received a $6,697,800 grant to upgrade and expand its plant from 2.0 mgd to 3.5 mgd and to provide nitrification. This upgrading was completed in 1987. The Dyer sewage treatment facility recently completed the addition of filters to its activated sludge plant. However, compliance with permit limits for total suspended solids has not been consistent due to operational problems. Once these operational problems have been solved, the improved effluents from these plants should greatly alleviate the water quality problems in this stream, although CSOs from Hammond and Munster may still cause periodic problems.

The East Branch of the Little Calumet and its tributaries drain the major cities of Porter, Chesterton and Valparaiso in Porter County. This portion of the east branch of the Little Calumet and Salt Creek are designated by Regulation 327 IAC 2-9 for salmonid migration, or for rearing and imprinting of salmonids.

Salt Creek receives the effluent of the Valparaiso sewage treatment facility. Chronic violations of the facility's NPDES permit in the past have caused poor water quality of this salmonid stream. Advanced waste treatment, including nitrification and dechlorination, was completed in 1985 at the facility, and should have helped to alleviate many problems. Control of combined sewer overflows was also required. In 1986-1987, infrequent dissolved oxygen and no un-ionized ammonia violations were reported at the fixed water quality monitoring stations located on Salt Creek.

The Crown Point sewage treatment facility has been meeting it's NPDES limits for several years. The most recent sampling inspection indicated both low BOD and suspended solids in the effluent. Improved water quality in Beaver Dam Ditch and Deep River is partly attributable to the improvements at this advanced treatment plant. In addition, Hobart received $11,181,675 for regionalization with Gary which should be completed by late 1987. The elimination of this discharge to Deep River is expected to further improve water quality in this stream.

Steel production in the area in the last few years has been reduced, and this has apparently caused a decrease in the volume of wastewater entering the Little Calumet River. Although it is difficult to determine exact cause-effect relationships in this instance, improving water quality may be partly due to this fact.

The East Branch of the Little Calumet River receives effluents from Bethlehem Steel. One of these is a high flow (80-100 mgd) cooling water discharge that enters the river upstream of its confluence with Salt Creek. It appeared that this warmer water was inhibiting salmonid migration in the late summer and fall, possibly diverting some fish up Salt Creek. Bethlehem Steel contracted with a consultant to conduct thermal avoidance studies in 1984 and 1985 in this area. These studies indicated that occasional summer violations of temperatures limits of their cooling water discharge into the Little Calumet River, possibly resulting in thermal avoidance by the salmon, are a direct result of increased lake water intake temperature.

Midwest Steel discharges wastewater to Burns Ditch. Inspection reports and compliance surveys of this facility all indicate that Midwest Steel is meeting its NPDES permit limits and has little or no effect on the water quality in the receiving waters.

Benthic macroinvertebrate samples taken in Burns Ditch have shown improvement in these communities since 1979. The number of genera present has increased steadily from 13 to 21. Water quality appears to be unaffected by toxics, but most of the species present are in the "facultative" group for tolerance to low D.O. An improvement occurred in 1984 and was repeated in 1986 when the "tolerant" midge genera Glyptotendipes and Dicrotendipes were far less abundant than found previously. There also appeared to be much less silt on the samplers in 1986. The relatively low benthic density of tolerant midge larvae indicates that nutrient inputs are not excessive. In general, however, water quality appears to be only moderate.

Carp have been collected from Burns Ditch in 1979, 1980, 1982, 1984 and 1986 for fish flesh analysis for toxic substances. Fish tissue samples from 1986 exceeded FDA action levels for PCBs and chlordane. However, these 1986 samples were of very large carp (8 to 18 pounds, much larger than any previous samples) which may have been Lake Michigan residents which had moved up into Burns Ditch.

The Grand Calumet River (GCR) in Lake County consists of an east and west branch, with the two branches meeting to form the Indiana Harbor Ship Canal. The east portion originates in Gary at the outlet of the Marquette Park Lagoons just upstream from the outfalls of the U.S. Steel Corporation mill. It flows west and empties into Lake Michigan via the Indiana Harbor Ship Canal (IHC). The west portion, like the Little Calumet River, flows both east and west, with the divide located just west of Indianapolis Boulevard. The western flow into Illinois eventually reaches the Illinois River Basin and the Mississippi River.

The Grand Calumet River Basin drainage area is small, but includes some of the most industrialized and populated areas in the entire state. Regulation 327 IAC 2-8, written specifically for this watershed, designates it for industrial water supply, limited aquatic life and recreation on and near the water. The intense industrial and municipal use of this waterway is the reason for this designation. Due to the presence of high concentrations of toxic substances in the sediment and areas of sediment deposition up to 20 feet deep, the state does not wish to encourage full-body contact activities in these areas. The fecal coliform bacteria standard is stringent enough to protect for partial-body contact, however.

The Grand Calumet River-Indiana Harbor Ship Canal has been designated as a Class A Area of Concern (AOC) by the International Joint Commission (IJC). Standards for dissolved oxygen, chlorides, ammonia, and fecal coliform are parameters for which standards are most commonly violated. However, the number and severity of violations have been reduced.

As a result of these water quality problems and the designation of this area as a Class A Area of Concern (AOC) by the IJC, a concerted effort was begun to address these problems. The "Master Plan for improving Water Quality in the Grand Calumet River and Indiana Harbor Canal" was prepared in 1985 by U.S. EPA. The Master Plan calls for programs which will focus U.S. EPA and State of Indiana water quality control efforts on problems related to these streams. These programs include tightening NPDES permit limits, pretreatment program development, and compliance actions (both municipal and industrial) to ensure that permit limits are met. Longer-term investigations to evaluate the effectiveness of existing and new control programs for enhancing water quality conditions in the GCR-IHC system will be conducted. A status report on the implementation of this plan was issued in 1986. Intensive biological and sediment sampling was conducted in 1986 and 1987.

In order to address the more widespread environmental concerns of this area, the Indiana Department of Environmental Management (IDEM) and Region V, U.S. EPA decided to expand the scope of the original "Master Plan" to include air quality and solid and hazardous waste issues as well as water quality. In 1986, a draft "Northwest Indiana Environmental Action Plan" (EAP) was prepared. The final Northwest Indiana Environmental Action Plan was completed in November 1987 through the collaborative efforts of IDEM and U.S. EPA, Region V.

Additionally, as a result of the designation of this area as a Great Lakes AOC, a Remedial Action Plan (RAP) needed to be developed to address the water quality/aquatic habitat/use impairment issues of the nearshore area of Lake Michigan. IDEM's overall goal of the RAP was to define the approach and necessary activities needed to improve water quality in the Grand Calumet River/Indiana Harbor Canal so that the designated uses for Lake Michigan are maintained and/or restored. IDEM established a Remedial Action Plan Work Group, and a draft plan was completed in January 1988. After review and revision, the final RAP is expected to be submitted to the Great Lakes Water Quality Board of the IJC in September 1988.

Three major sewage treatment plants, Gary, Hammond, and East Chicago discharge to the Grand Calumet River. All three municipalities are involved in some type of enforcement action by the State and U.S. EPA. Hammond received $5.0 million in construction grant funding in 1987 for plant expansion and advanced wastewater treatment, including phosphorus removal, and ammonia removal. Construction grant funding for East Chicago in 1986 amounted to $16.0 million for expansion and advanced wastewater treatment, including ammonia removal.

The City of Hammond and the Hammond Sanitary District have been named in an enforcement action by the State of Indiana and U.S. EPA. This action was to address the inadequate sludge disposal methods employed by the Sanitary District. Leaching of material from the District's sludge storage lagoons to the Grand Calumet River was alleged. A $5.8 million dollar sludge dewatering facility has been constructed. Also, a nitrification facility should be in full operation by July 1988.

The City of East Chicago and the East Chicago Sanitary District have entered into a Consent Decree with the State of Indiana, U.S. EPA, and the State of Illinois. The Consent Decree established a fixed date schedule that requires the POTW to be in compliance with new NPDES permit limits by April 1989.

The City of Gary and the Gary Sanitary District have entered into a Consent Decree with the State of Indiana and the U.S. EPA that requires effluent limitations to be met in accordance with the Gary NPDES Permit. Gary was awarded a $8,861,315 construction grant for sludge handling and storage facilities in February 1985. The operation of the new sludge treatment facilities have been delayed by unforseen problems caused by a sinkhole that may affect the operation of these facilities. These problems are currently under investigation.

Recently completed additions to the Gary sewage treatment facility have resulted in water quality improvements in the East Branch of Grand Calumet River. Fixed Station Water Quality Monitoring Network data from 1986 and 1987 indicate that the frequency of fecal coliform violations has decreased from almost 50 percent to approximately 30 percent, and that phosphorus and cyanide violations are now almost non-existent. Ammonia, total phenols and total residual chlorine violations of the Gary NPDES permit still appear to be contributing to water quality problems in the GCR/IHC System.

An additional source of water quality degradation in the subbasin are combined sewer systems. These allow for significant bypassing during wet weather flows. Some dryweather bypassing also contributes to water quality standards violations.

Industrial effects on the GCR/IHC System include discharges from U.S. Steel, (USX) Inland Steel, LTV Steel, DuPont, Vulcan Material, Material Handling, and American Steel. Additional inputs are found along the river, and, although they may not be as great in magnitude as those previously mentioned, they do contribute to the degradation of the waterway. These inputs are not only from point sources, but include ship traffic in the IHC, parking lot runoff, etc.

Although the water quality is far from being desirable, it is showing improvements. Resident fish populations are evident (carp, goldfish, golden shiners, fathead minnow, central mudminnow, black bullhead, pumpkinseed and green sunfish were collected in 1986 and 1987), and even some salmonids are found in the river in autumn. Macroinvertebrates were collected at six sites in the GCR/IHC system in 1986. Five main groups of organisms were present at nearly every site. The most obvious characteristic of this assemblage is the tolerance of each group to moderate organic pollution and reduced dissolved oxygen concentrations. No "intolerant" species were present at any of the sites. However, the presence of many "facultative" organisms (especially odonates, certain midges and snails) indicated that severe oxygen depletions do not occur. Stresses associated with toxic chemicals were indicated by most samples.

Fish flesh sampling for toxics in the GCR/IHC system has been done every other year since 1980. Samples from 1982, 1984, and 1986 exceeded FDA action levels for PCBs. Only one large carp collected in 1982 exceeded the FDA action level for chlordane. A revised fish consumption advisory for 1987 includes the GCR/IHC system (Table 19).

In summary, 177 stream miles were assessed in the Lake Michigan Basin - Northwest. Of these assessed waters, 79 miles (45%) fully supported their designated uses, 18 miles (10%) only partially supported designated uses, and 80 miles (45%) did not support designated uses. Of the 79 miles that fully supported their designated uses 56 miles (71%) are considered threatened. In addition, all 43 shoreline miles (241 square miles) of Lake Michigan are considered to only partially support designated uses due entirely to the consumption advisory on certain species of fish.

Lake Michigan Basin - Northeast

In the Lake Michigan Basin - Northeast (Figure 9), approximately 295 miles were monitored and/or evaluated to determine support of use designations. Table 31 summarizes the waters assessed, support status, miles affected, and probable causes of impairment for the streams in the basin. Additional information on certain stream reaches is also provided in this table.

The St. Joseph River enters the state from Michigan near Bristol in Elkhart County. From there it flows west through Elkhart and South Bend (St. Joseph County) where it bends north and returns to Michigan. Although the St. Joseph River segment in Indiana is less than 40 miles long, the Indiana drainage basin covers 1,778 square miles and six counties. Water quality data from fixed water quality monitoring stations at Bristol, Osceola, and South Bend show almost no violations of water quality standards except for fecal coliform. However, occasional fish kills (400 fish in 1985 at Elkhart) indicate that periodic problems exist.

TABLE 31. *WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE LAKE MICHIGAN BASIN - NORTHEAST.*

	WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT[1]	METHOD OF ASSESSMENT[2]	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
1)	Mud Creek and its tributaries	Helmer	FS	Evaluated		5.5	
2)	Turkey Creek	Helmer Stroh Elmira	FS	Evaluated		14.0	
3)	Unnamed Tributary from Loon Lake to Crooked Lake	Crooked Lake	FS	Evaluated		1.5	
4)	Pigeon River	Scott Ontario How	FS	Monitored (b) (c)		17.0	
5)	Fawn River	Howe	FS	Monitored (b)		4.5	
6)	Fawn River	Scott	FS	Monitored (b)		4.0	
7)	Little Elkhart Creek	Wolcottville	FS	Monitored (b)		3.0	
8)	North Branch Elkhart River	Wolcottville	FS	Monitored (b)		7.0	
9)	Middle Branch Elkhart River	Rome City	FS	Monitored (b)		2.5	
10)	North Branch Elkhart River	Millersburg	FS	Monitored (b)		4.5	
11)	Croft Ditch	Albion	FS (Threatened)	Monitored (b)		7.0	Albion POTW.
12)	Carroll Creek	Wolf Lake	FS	Evaluated		3.0	
13)	Forker Creek	Burr Oak	FS	Evaluated		3.0	
14)	Elkhart River	Ligionier New Paris	FS	Monitored (b)		19.5	
15)	Elkhart River	Goshen Elkhart	FS	Monitored (c)		18.0	
16)	Upper Turkey Creek and Tributaries	Millersburg	FS	Evaluated		9.0	

TABLE 31. WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE LAKE MICHIGAN BASIN - NORTHEAST. (con't)

	WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT[1]	METHOD OF ASSESSMENT[2]	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
17)	Turkey Creek	Syracuse	FS (Threatened)	Evaluated		2.0	Judical Order requires Syracuse POTW to upgrade facilities. Syracuse POTW fined $5000. Municipal Compliance Strategy ordered. Syrcause POTW awarded $3.6 million in FY87 for advanced treatment, disinfection, ammonia removal.
18)	Lower Turkey Creek	Milford New Paris	FS	Evaluated		15.5	
19)	Coppes Ditch	Leesburg Milford	FS	Monitored (b)		6.5	
20)	Little Elkhart River	Bristol Middlesburg	FS	Monitored (b)		10.5	
21)	Baugo Creek	Wakarusa Jamestown	FS	Monitored (b)		11.0	
22)	Christiana Creek	Elkhart	FS	Monitored (b)		4.5	
23)	Cobus Creek	Elkhart	FS	Monitored (b)		5.5	
24)	Gast Ditch	Elkhart	FS	Evaluated		2.0	
25)	St. Joseph River	South Bend	PS (Aquatic Life) NS (Recreational)	Monitored (b)(c)	PCBs and chlordane Fecal coliform	6.0	Fish Consumption Advisory.
26)	St. Joseph River	Mishawaka Elkhart	NS (Recreational)	Monitored (b)(c)	Fecal coliform	18.0	
27)	St. Joseph River	Bristol	FS	Monitored (b)(c)		10.0	
28)	Judy Creek	South Bend	FS	Monitored (b)(c)		7.0	
29)	Fawn River	Orland	FS	Monitored (b)		8.5	
30)	Crooked Creek	Nevada Mills	FS	Monitored (b)		3.0	
31)	Eaton Creek and its Tributaries	Fremont	FS	Monitored (b)		5.5	
32)	Follette Creek	Jamestown	FS	Evaluated		0.5	

TABLE 31. WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PRO8A8LE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE LAKE MICHIGAN 8ASIN - NORTHEAST. (con't)

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT[1]	METHOD OF ASSESSMENT[2]	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
33) Crooked Creek	Jamestown	FS	Monitored (b)		1.5	
34) Pigeon Creek	Angola	FS	Evaluated		9.0	
35) Pigeon Creek	Flint	FS	Evaluated		12.0	
36) Upper Fly Creek	LaGrange	FS	Monitored (b)		6.0	
37) Lower Fly Creek	LaGrange	FS (Threatened)	Monitored (b)	LaGrange POTW	4.5	LaGrange POTW trickling filter plant incapable of meeting ammonia nitrogen limits. Agreed Order filed with complaint in Marion Circuit Court 8/13/87. LaGrange POTW awarded $2.1 million in FY87 for advanced treatment and ammonia removal. Completion of these projects is targeted for late 1989.
38) Pigeon Creek	Pleasant Lake Angola	PS (Aquatic Life)	Monitored (b)		4.0	See Mud Creek.
39) Kohler Ditch	Leesburg	NS (Aquatic Life)	Monitored (b)		0.5	Raw sewage from septic systems.
40) South 8ranch Elkhart River	Albion Kimmel	NS (Aquatic Life)	Monitored (b)	Natural Low D.O.	7.0	
41) Henderson Lake Ditch.	Kendallville	NS (Aquatic Life)	Evaluated		3.5	Kendallville POTW.
42) Mud Creek and Tributary to Angola STP	Angola	NS (Aquatic Life)	Monitored (b)	Angola POTW	3.0	Angola POTW failed to comply with NPDES Permit Final Effluent Limitations. Public Hearing Conference held on 5/28/84. Municipal Compliance Plan approved 6/20/86. Consent Decree signed by Commissioner on 10/86.
42) 8erlin Court Ditch	Nappanee	NS (Aquatic Life)	Monitored (b)	Runoff, Nappanee POTW	4.5	Nappanee POTW capacity and treatment levels are being increased. Project Performance Certification of the recipient is expected in early 1988.

1 *FS = Fully Supported, PS = Partially Supported, NS = Not Supported. The uses not supported are listed. If only one use is listed as not being supported, all other uses are supported.*

2 *b = biological, c = chemical.*

Regulation 327 IAC 2-9 (Salmonid Spawning, Rearing and Imprinting; Migration Routes) was revised in 1985 to include the St. Joseph River from the Twin Branch Dam near Mishawaka to the Indiana-Michigan state line. Through a cooperative effort between Indiana and Michigan, fish ladders are being built at dams in South Bend, Mishawaka and in Michigan. A cold water hatchery is in operation at Mishawaka, Indiana. The salmonid stocking program and the removal of migration barriers will enable trout and salmon to move up the river from Lake Michigan to Mishawaka. The upper part of the river from the Michigan - Indiana state line down to the Twin Branch Dam in Mishawaka is covered by regulations 327 IAC 2-1.

In order to obtain data for modeling, wasteload allocation, permitting, and construction grant purposes due to the new salmonid designation, intensive surveys of the St. Joseph River from Bristol to the State line below South Bend were conducted in 1985 and 1986. Data collected at 40 sites revealed that, for the most part, standards in Regulation 327 IAC 2-9 are supported.

Biological studies indicate diverse macroinvertebrate and fish communities at Bristol and South Bend. Benthic samples indicated no stress from silt, toxics or low D.O. Analysis of fish flesh for toxic substances has shown that some fish violate the FDA action levels for PCBs and chlordane below South Bend. A fish consumption advisory is in effect for certain species below South Bend (Table 19).

The Pigeon River in LaGrange County located in northeastern Indiana enters the St. Joseph River in Michigan. A fixed water quality monitoring station was placed on this put-and-take trout stream at the request of the Indiana Department of Natural Resources. Water quality data from this stream indicate that it is fully supporting aquatic life and recreational uses.

Most streams assessed in this basin fully supported designated uses, and only a few miles were threatened. Approximately 24 miles of the St. Joseph River in the Elkhart, Mishawaka, South Bend area do not fully support recreational uses due to fecal coliform levels. A six mile portion of the river below South Bend does not fully support aquatic life uses because of a fish consumption advisory, but a healthy, diverse fish community exists along the entire length of the St. Joseph River, including this reach.

Several other smaller streams assessed do not fully support aquatic life uses due almost entirely to problems at publicly owned treatment works (POTWs). Pigeon Creek and Mud Creek, Henderson Lake Ditch, and Berlin Court Ditch are impaired by periodic poor treatment and/or bypassing at POTWs in Angola, Kendallville, and Nappanee, respectively. In several of these situations, corrective actions are already underway (Table 31). Kohler Ditch near Leesburg receives raw sewage from inadequate individual septic tank disposal systems.

The South Branch of the Elkhart River does not fully support aquatic life uses in its lower reaches due to natural conditions. This portion of the river flows through extensive wetland areas and is very sluggish and slow moving. Although no point sources have been shown to contribute to the problem, dissolved oxygen levels often fall below the criteria. Fish community diversity does appear to be low in this reach.

In summary, 294.5 stream miles were assessed in the Lake Michigan Basin - Northeast. Of these assessed waters, 248 miles (84%) fully support designated uses, four miles (1.4%) partially supported uses, and 42.5 miles (14.4%) did not support designated uses. Of the 248 miles that fully supported uses, 13.5 miles (5.4%) are considered threatened.

Maumee River Basin

The Maumee River Basin is located in the northeastern portion of Indiana and drains parts of Adams, Allen, DeKalb, Noble and Wells counties (Figure 10). The drainage area in Indiana is approximately 1,216 square miles with the land use approximately 80% agriculture, 10% urban, and the balance forested and other classifications. This region is one of the major livestock and corn producing areas of Indiana. The watershed lies within the Tipton-Till and Lake Moraine geological regions.

Water Quality Standards for the Maumee River Basin are covered under Regulation 327 IAC 2-1 of the Indiana Water Pollution Control Board. In the regulation, the St. Joseph River in Allen County is designated for whole-body contact recreational use, and Cedar Creek is designated as a State Resource water from river mile 13.7 in DeKalb County to its confluence with the St. Joseph River in Allen County. The balance of the basin is designated for warm water aquatic life and partial-body contact recreational use.

The Maumee River Basin comprises three major rivers; the St. Joseph River, the St. Mary's River and the Maumee River. The Maumee River originates in Fort Wayne at the confluence of the St. Joseph and St. Mary's rivers. It then flows east into Ohio where it traverses across the northern portion toward Toledo and empties into Lake Erie. The $Q_{7,10}$ as estimated at New Haven in Allen County is 70 cfs. The St. Mary's River originates near New Bremen, Ohio and flows northwest to Fort Wayne. Approximately 39 river miles are within Indiana, ($Q_{7,10}$ is 9.3 cfs at Decatur). The St. Joseph River originates near Hillsdale, Michigan and enters Indiana from Ohio northeast of Fort Wayne. The St. Joseph River in Indiana covers approximately 41 river miles. The waters assessed, the status of designated use support, probable cause of impairment, and miles affected in the Maumee River Basin are shown in Table 32. Additional comments are also given for certain reaches.

The drainage area for the St. Mary's River is used heavily for agriculture. Although no major cities are located in this area, several small Ohio towns have affected water quality in the past. The Decatur POTW is the only major municipal facility that discharges into the St. Mary's River within Indiana. Lift station failures at this facility have caused problems in the past. However, the facility was recently renovated along with significant combined sewer separation, although CSO's have not been blocked off completely. The facility appears to be well operated and is meeting most of its NPDES permit discharge limits. They have been having trouble meeting ammonia limits.

Figure 10. Maumee River Basin.

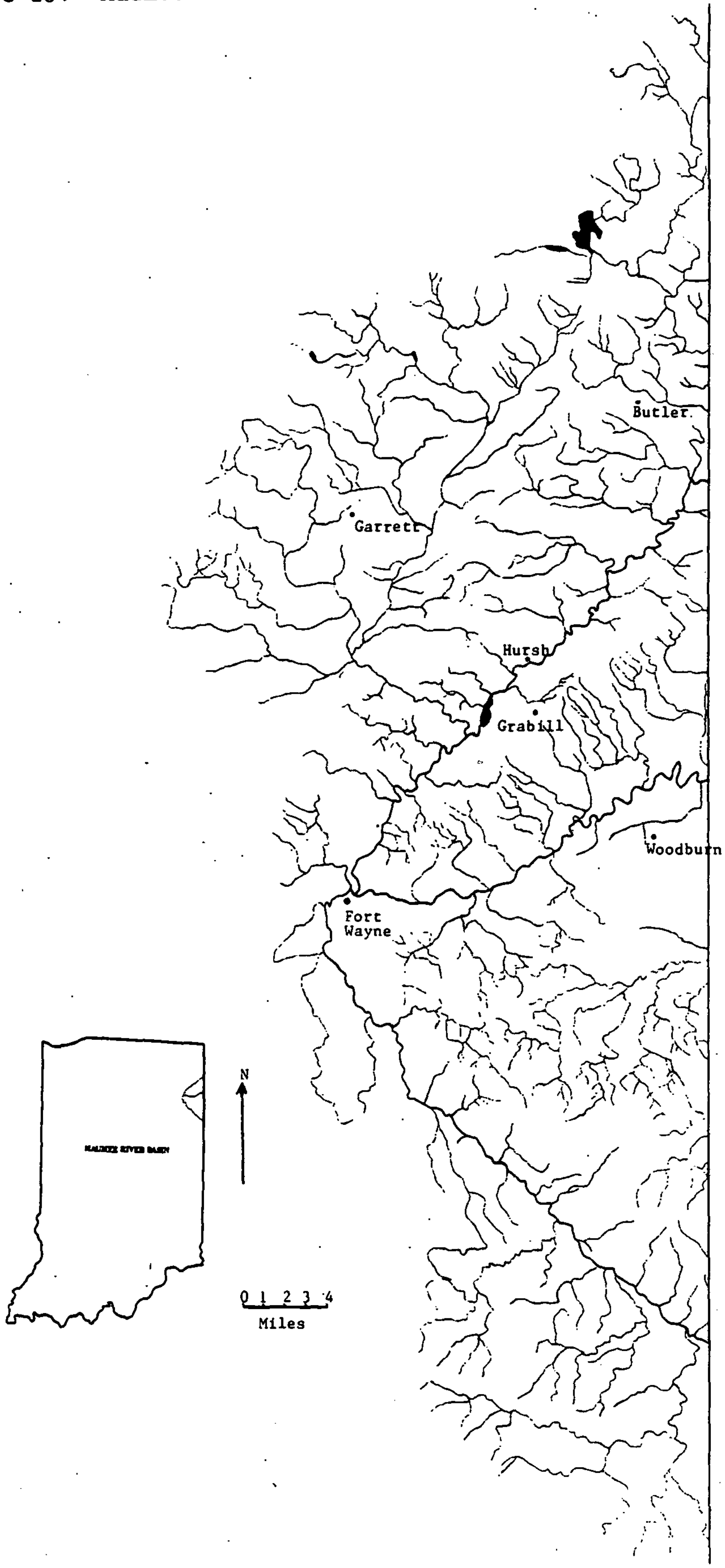


TABLE 32. *WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT AND MILES AFFECTED IN THE MAUMEE RIVER BASIN.*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
1) St. Mary's River	State line to Fort Wayne	PS (Recreational)	Monitored (b)(c)	Nonpoint Fecal Coliform	28	CSO separations in Decatur.
2) St. Mary's River	Fort Wayne	NS (Recreational)	Monitored (b)(c)	Fecal Coliform	11	
3) Yellow Creek	Monroe	FS	Monitored (b)		3	
4) St. Joseph River	State line to Allen County Line	FS	Evaluated		18	
5) St. Joseph River	Allen County line to mouth	PS (Recreational)	Monitored (b)(c)	Fecal Coliform	23	
6) Willow Creek	Huntertown	NS (Aquatic Life)	Monitored (b)(c)	Metals Ammonia Surfactants	1	G.C.I, Inc., is moving discharge from Willow Creek into Fort Wayne sewer system.
7) Cedar Creek	Waterloo	FS (Threatened)	Evaluated	Metals	1	Kitchen Equip. has lowered discharge volume.
8) Cedar Creek	Waterloo to Auburn	FS	Evaluated		6	
9) Cedar Creek	Auburn	PS (Aquatic Life) (Recreational)	Monitored (b)(c)	Ammonia D.O. Fecal Coliform	2	Expansion of Auburn POTW.
10) Cedar Creek	River Mile 13.7 to mouth	FS (Threatened)	Evaluated		14	Upstream industrial and municipal discharges threaten this State Resource Water.
11) Spy Run	Fort Wayne	PS (Aquatic Life)	Monitored (c)	PAH's	1	Unknown source.
12) Teutsch Ditch	8utler	PS (Aquatic Life)	Monitored (c)	Metals Oil and Grease Phenol Chlorine Ammonia	1	
13) 8ig Run Creek	8utler	FS	Evaluated		7	
14) Hilkey Ditch	Auburn	FS	Monitored (b)		1.5	This is a limited use stream.
15) Hindman Ditch	St. Joe	FS	Monitored (b)		0.5	This is a limited use stream.
16) 8ear Creek	St. Joe	FS	Evaluated		1	

TABLE 32. WATER ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT AND MILES AFFECTED IN THE MAUMEE RIVER BASIN. (con't)

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
17) Haifley Ditch	Grabill	FS	Monitored (b)		1	
18) Witmer Ditch	Grabill	FS	Monitored (b)		1	
19) Maumee River	Fort Wayne to State line	PS (Aquatic Life) (Recreational)	Monitored (b)(c)	PCBs Fecal Coliforms Ammonia	25	Fish Consumption Advisory, CSO problems.
20) Harvester Ditch	Fort Wayne	PS (Aquatic Life)	Evaluated	Ammonia Phenols Oil and Grease, Priority Organics	1	
21) Flatrock Creek	Adams County	FS	Evaluated		15	
22) Blue Creek	Adams County	FS	Evaluated		25	

1 PS = Partial Support; NS = Non Support; FS = Full Support. The uses not supported are listed. If only one use is listed as not being supported, all other uses are supported.
2 b = Biological; c = Chemical

Currently, there are three fixed water quality stations for monitoring the St. Mary's River (STM-37, STM-11, and STM-0.2). Station STM-0.2 was added in 1986 to monitor water quality after the impact of CSO's and industry in the Fort Wayne area and is a CORE station.

Phosphorus values in the St. Mary's River continue to be consistently among the highest found in the state. St. Mary's Lake and the Miami/Erie Canal, Ohio are highly eutrophic water bodies contributing high nutrient loads to the upper waters of the river. This, along with the continued absence of a phosphorus detergent ban in Ohio and agricultural pressures has adversely impacted water quality of the St. Mary's River before it enters Indiana. In August 1987, a phytoplankton survey was conducted on the St. Mary's River from Grand Lake, Ohio into Fort Wayne. Results showed a dominance of bluegreen algae (Schizothrix sp. and Spirulina sp.) with an abundance of Euglena sp. indicating high nutrient levels and organics loading. These species persist in the St. Mary's River (although at lower numbers) into Fort Wayne indicating continual nutrient and organics loading. Going downstream from the Grand Lake input,, bluegreen algae lose dominance while diatom numbers increase to a more balanced phytoplankton community. However, Euglena sp. numbers remain rather constant in the river. Euglena has been associated with sewage and high nutrient loads.

Results from fixed station water quality monitoring data in the St. Mary's River reveal high phosphorus and nitrate-nitrite nitrogen levels. Nutrient concentrations increase during the summer months with peak values usually occurring in June. This coincides well with increases in agricultural activity in the basin at this time of year. These values were essentially the same as those found in the 1984-85 period. Violations of the dissolved oxygen and un-ionized ammonia criteria were found no more than once or twice in the St. Mary's River during this two year period. Metals values were rarely above detection limits. Fecal coliform violations at these stations occurred often enough that the river was considered to only partially support its designated recreational use. Comparison with historical data from the St. Mary's River fixed water quality monitoring stations indicate that there have been no significant changes in water quality over the last seven years. Historical records have shown occasional elevated levels of copper and lead over recommended criteria values.

There was a fish kill in Yellow Creek near Monroe on October 24, 1987. Yellow Creek is a tributary of the St. Mary's River with its confluence just upstream of Decatur. The fish kill was attributed to a nitrogen fertilizer spill.

There are several dischargers that can potentially impact the water quality of the St. Mary's River. These include Central Soya (a soybean processor in Decatur), Schmitt Packing (a meat packer), several industries involved in electroplating (B&B Custom Plating in Hoagland, and Fort Wayne Wire and Die, Inc.), and five minor municipal discharges. None have had any documented recent problems in terms of impacting water quality of the St. Mary's River.

Fish and macroinvertebrates were sampled for the first time in 1986 at station STM-0.2, near the mouth of the St. Mary's River. Both fish and macroinvertebrate diversity was low, but no stress due to toxics or low dissolved oxygen was indicated by the species composition. Fish tissue samples collected in 1986 contained no contaminants in concentrations at or above FDA action levels, and concentrations of toxics in sediments were not high enough to be of concern. The St. Mary's River is probably most adversely affected by heavy silt loads from nonpoint sources in the basin. Most macroinvertebrates found were "silt tolerant," and most substrate areas of the stream are covered with layers of silt of various depths.

The St. Joseph River drains an area of largely agricultural usage and contains no major metropolitan areas except Fort Wayne at its mouth. It is dammed north of Fort Wayne in Allen County forming Cedarville Reservoir, a shallow, eutrophic, water supply impoundment.

Cedar Creek is an important tributary of the St. Joseph River entering just below Cedarville Reservoir. Unfortunately, in portions upstream of the area designated as a State Resource Water, some water quality problems exist. The Auburn sewage treatment facility experienced hydraulic overloading and some partial bypassing in 1984. The plant was then expanded to 3.0 mgd capacity. It is being additionally expanded to treat industrial flows which have increased in recent years. Also, the city has begun efforts to separate many CSO's.

A number of industrial dischargers are also found in the Cedar Creek watershed. Kitchen Quip Corporation in Waterloo had a number of NPDES permit limit violations prior to 1981. However, none have been found since then and the most recent inspection reports indicate their plating waste has been reduced, probably in response to lowered plating activity. Their treatment system currently appears to be operating satisfactorily.

G.C.I. Inc., formerly Gridcraft Corporation, in Huntertown has also had a history of wastewater problems. This printed circuit board manufacturer discharges to a branch of Willow Creek, a tributary of Cedar Creek. Past inspections have shown levels of metals in final effluent to be in violation of G.C.I's discharge permit. Sediments immediately downstream of their outfall have had high levels of chromium, copper, iron, lead, tin and silver. The stream bottom was a light blue color indicating the presence of high concentrations of metals. In 1984, a Daphnia magna 48-hour toxicity bioassay on G.C.I.'s final effluent was stopped after seventeen hours because all organisms were killed. Suspected toxics were copper, ammonia and nickel. In a fathead minnow (Pimephales promelas) toxicity bioassay screening all fish died within four hours after being placed in 100% effluent.

A 1986 toxicity bioassay of G.C.I.'s final effluent had an LC_{50} of 35% with ammonia, copper, and surfactants as the identified toxicants. Recent monitoring data for G.C.I. showed regular effluent violations for copper, silver, ammonia and fluoride. Recent Willow Creek sediment testing downstream of G.C.I.'s outfall revealed elevated levels of cyanide and metals.

A Consent Decree between the Stream Pollution Control Board and G.C.I., was signed in October 1984, requiring G.C.I., among other things, to dredge the Willow Creek stream bed 200 feet downstream from the point of discharge to remove the contaminated sediment and to connect to the Huntertown sewer system which is sending its wastewater to the Fort Wayne municipal wastewater treatment plant. Connection with the Huntertown/Fort Wayne interceptor is expected to be completed by March 1988. The elimination of this discharge and removal of the contaminated stream sediment should improve water quality in Willow Creek and Cedar Creek.

Another industry, Rieke Corporation, a manufacturer of plastics and steel closures for drums, pails and other containers, received a Notice of Violation in 1987 for recurring violations of zinc effluent limitations due to defective filter capsules. An April 1987 Compliance Sampling Inspection showed no permit violations.

The only current fixed water quality monitoring station (STJ-0.5) on the St. Joseph River is in Fort Wayne at the Tennessee Avenue bridge just before its confluence with the St. Mary's River. This station is part of the CORE program and is also near a water supply intake point. Chemical data from this station indicates good water quality with almost no violations of established standards. Nutrient levels are also much lower than those in the St. Mary's River. Biological data collected in 1986 also indicate good water quality at this station. Macroinvertebrate and fish samples indicated good diversity with no signs of toxic or dissolved oxygen stress, and analysis of fish tissue samples indicated that no contaminants exceeded FDA action levels. Phytoplankton samples also indicated good water quality.

The St. Joseph River is designated for whole-body contact recreation during the recreational season (April through October). Values for fecal coliform, during the recreational season, exceeded the state standard 36% of the time (5 times) compared to 50% of the time during the previous biennial sampling period. The standard was exceeded only once during the 1987 recreation season.

Sediment sampling at station STJ-0.5 in 1986 revealed that no toxic organics were present in concentrations of concern in the sediment. However, sediment samples taken in tributaries to the St. Joseph River below certain industries revealed some toxics accumulation. Sediment sampling in Spy Run in Fort Wayne showed elevated levels of polyaromatic hydrocarbons (PAH's) of unknown origin. Also a sediment sample from Teutsch Ditch in DeKalb County downstream of Universal Tool and Stamping in Butler had elevated levels of phenols and metals. Teutsch Ditch flows to Big Run Creek which then flows to the St. Joseph River.

Universal Tool and Stamping has had a history of NPDES permit limit violations. Permit violations have included ammonia, BOD_5, cyanide, zinc, hexavalent chromium and total chromium. A 1986 toxicity bioassay performed on Universal Tool and Stamping's final effluent had an LC_{50} of 73% attributed to hexavalent chromium. A November 1987 toxicity bioassay revealed no toxicity, but Universal Tool and Stamping continues to have problems meeting their zinc limit.

There are two industries upstream of Universal Tool and Stamping also discharge into Teutsch Ditch, Bohn Aluminum and Brass Company and DeKalb Plastics. Bohn Aluminum and Brass Company has had problems meeting discharge limits for oil and grease, suspended solids, and total residual chlorine.

Beatrice (County Line) Cheese in Auburn discharges to Hilkey Ditch in south-central DeKalb County. Hilkey Ditch which is a small "limited use" stream for 1.5 miles downstream of the Beatrice discharge, eventually flows into the St. Joseph River. Beatrice Foods has recently installed a new treatment facility.

Another industry with a history of water quality problems in the St. Joseph River basin is Ralph Sechler and Sons, Inc., St. Joe. This is a vegetable pickling firm that discharges seasonally. The receiving stream is Hindman Ditch which connects to Bear Creek, a tributary of the St. Joseph River. Hindman Ditch is a small "limited use" stream, and Sechler supplies most, if not all, of the flow during portions of the year. In 1983-84 the wastewater treatment facility was expanded and aeration capacity increased. Recently, there have been no reports of problems at this facility and no water quality problems have been noted in Bear Creek.

The Maumee River originates in Fort Wayne at the confluence of the St. Joseph and St. Mary's rivers. The Fort Wayne sewage treatment facility, which discharges a short distance downstream of the city has a 60 mgd capacity with advanced treatment, phosphorus removal, and storm water retention ponds. Fort Wayne has an abundance of CSO's all the way to New Haven which have caused serious water quality problems including a fish kill. However, the effluent from the wastewater treatment plant is of good quality and does not appear to be causing significant degradation of the Maumee River.

Fixed water quality station M-129 is located in New Haven at the Linden Road bridge over the Maumee River, six miles downstream from the Fort Wayne sewage treatment facility. In 1986, this station was designated a CORE station and the upstream station (M-135) was dropped from the Fixed Station Water Quality Monitoring Network. Chemical data from the two stations were similar and biological information had usually been collected in the stream reach between these two stations. The other fixed water quality monitoring station on the Maumee River (M-114) is located at the State Road 101 bridge north of Woodburn which is 22 miles downstream of the Fort Wayne sewage treatment plant.

Chemical data from the two Maumee River stations show almost no exceedances of water quality standards over the two year period. Nutrient levels were substantially lower than in the St. Mary's River, which seems to be the source of most of the nutrient loading in the Maumee. Violations of the fecal coliform standards indicate only partial support of the partial body contact designated use, although almost all violations occurred in 1986.

Biological sampling in the Maumee River has included fish, macroinvertebrates and phytoplankton. Fish and macroinvertebrate samples collected in the Maumee River in 1986 indicated a relatively healthy and diverse community. Rock bass, largemouth bass and northern pike were among the fish species collected. However, a limited fish consumption advisory for all species was issued for the Maumee River in 1985 due to PCB levels in whole fish samples which barely exceeded FDA action levels. The advisory states that fish consumed as skinless fillets should be within acceptable limits. The source of the PCB contamination is thought to be an old landfill along the bank which may be leaching substances into the river. This is currently under investigation. Preliminary results from sediment samples collected by the Corps of Engineers in 1985 from a site near this landfill indicate high levels of PCB's (3.3 mg/kg) and DDT (5.8 mg/kg) in the sediments.

The metropolitan Fort Wayne area includes a number of industries that discharge to the Maumee River. The most concentrated area is the east side where an industrial complex is located. A 1986 inspection of the Gladieux Refinery discharge disclosed that the effluent was cloudy and appeared to contain dissolved oil. This company discharges to Harvester Ditch, a tributary to the Maumee River.

Other industries that discharge into Harvester Ditch include ITT-Aerospace/Optical Division, REA Magnet Wire, and Phelps Dodge Magnet Wire. A 1985 inspection of the ITT-Aerospace/Optical Division indicated violations of NPDES permit limitations for ammonia, total copper, total lead and cyanide. In addition, the detection of 1,1,1-trichloroethane and trichloroethylene represented a violation of total toxic organic limitations. A toxicity bioassay on final effluent from Phelps Dodge Magnet Wire Company had an LC_{50} of 63% attributable to phenols. Oil and grease also appear to be a problem in this tributary.

Also included in this watershed segment is Flatrock Creek. It flows into Indiana from Ohio and through southeastern Allen County. It flows northwest to a point just north of Monroeville and then northeast back into Ohio before its confluence with the Maumee River. The only point discharger in the Flatrock Creek drainage basin in the Monroeville POTW. A 1980 Indiana State Board of Health (ISBH) assessment of Flatrock Creek concluded that water quality of the segment was satisfactory.

As a result of the 1978 United States-Canada Great Lakes Water Quality Agreement, three northeast Indiana counties in the Maumee River Basin have been involved in a plan to reduce phosphorus loadings to Lake Erie. As the important point sources in the basin are already discharging phosphorus at levels considerably under their allowed limits, agricultural runoff has been identified as Indiana's primary concern and focal point. Efforts by a variety of federal, state and local interests have helped to promote conservation tillage implementation in the northeastern part of the State over the last several years.

By establishing 1982 as the base year and using available cropping and soils information, the <u>ANSWERS</u> computer model was used to determine sediment and phosphorus loads from Adams, Allen and DeKalb counties. Increased application of conservation tillage practices in these three counties has resulted in Indiana achieving its 90 ton reduction goal in 1988 according to figures completed by the National Association of Conservation Districts Conservation Technology Information Center. Efforts are now underway to verify these figures.

The State plans a comprehensive review to evaluate the status and progress of conservation tillage in these three counties at the end of crop year 1988. In addition, municipal, industrial, and animal husbandry operations will continue to be monitored for compliance with applicable permits and regulations.

In summary, 187 miles of waterways were assessed in the Maumee River Basin. Of these total miles, 94 miles (50%) support all designated uses, another 81 miles (44%) partially support designated uses, and 12 miles (6%) did not support designated uses. Of the waters assessed, 82% (153 miles) met the aquatic life (fishable) goals of the Clean Water Act. Of the 34 miles (18%) of streams which did not meet this goal, 25 miles (74%) were due only to the limited fish consumption advisory on the Maumee River. Only about 51% of the waters were able to meet the "swimmable" goals of the Clean Water Act. Two miles (1%) of the waters assessed are designated for "limited use" since the Clean Water Act goals are not attainable on these waters due to natural constraints.

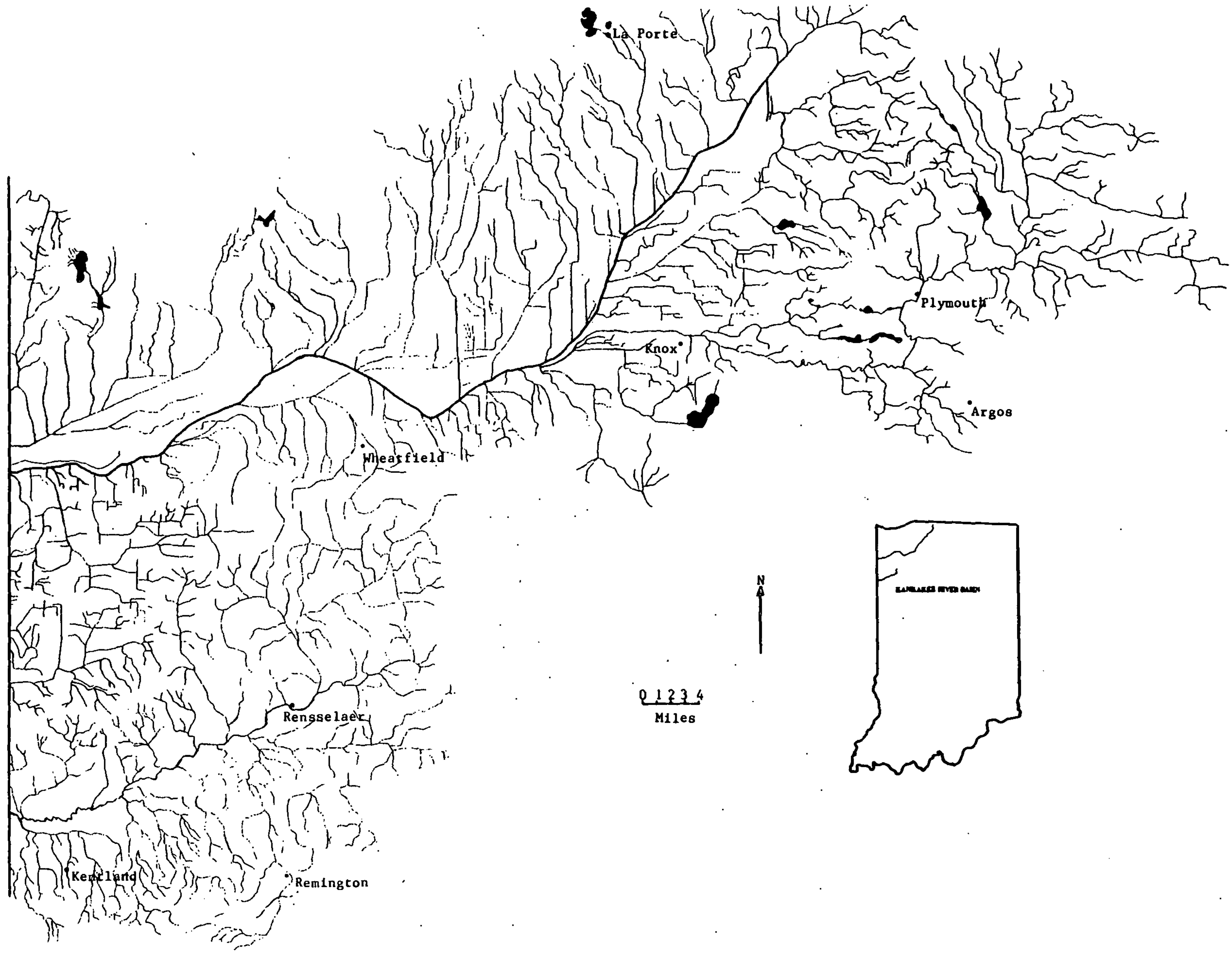
Kankakee River Basin

The Kankakee River Basin (Figure 11) drains about 3,000 square miles of northern Indiana before flowing westward into Illinois. Major tributaries in Indiana include the Iroquois and Yellow rivers. The largest cities in the watershed are LaPorte and Plymouth, and most of the area is extensively farmed. There are relatively few industrial or municipal discharges in the basin, and even at low summer flows only about 3% of the flow in the Kankakee River where it leaves Indiana is composed of treated wastewater.

Many of the present characteristics of the Kankakee Basin are due to the geologic history of the area. Glaciers flattened the region, and moraines formed by the melting ice made the basin lower than surrounding areas. Sand was deposited in this low area by the melting glacier, and much of this lowland became a gigantic marsh. Beginning in the mid-1800s, ditches were dug throughout the basin to improve drainage for farming. Today most of the streams in the basin have been dredged and straightened. The basin is still flood-prone, but nearly all of it is farmed. Most of the streamflow is made up of groundwater, providing a relatively constant discharge of cool water throughout the year.

Despite extensive channelization, the Kankakee Basin still provides some excellent stream fisheries. The state record northern pike was taken from the Yellow River in 1983. Forty-eight species of fish, including a variety of game fish, were collected in the Kankakee River mainstream by the Indiana Department of Natural Resources in 1981. The Kankakee also supports a unique

Figure 11. Kankakee River Basin.



and extremely diverse population of caddisflies, whose larval stage is completely aquatic and is an important fish food. Parts of the river are used frequently for canoeing, and there are two commercial canoe liveries on the Kankakee. Most of the streams in the basin are designated to support warmwater fisheries, although the Little Kankakee (LaPorte County), Crooked Creek (Porter County) and Potato Creek (St. Joseph County) are put-and-take trout streams and designated to support coldwater fisheries. Newly designated limited use streams in the basin include portions of ditches downstream from the Kentland and Lakeville sewage treatment plants. All streams in the Kankakee basin must meet water quality standards for partial-body contact recreation.

Water quality monitoring in the basin during 1986 and 1987 included:

(1) Monthly chemical and bacteriological sampling at two fixed stations (KR-68 and KR-118).

(2) Biological sampling and fish tissue analysis at two CORE stations (KR-68 and KR-118).

(3) Effluent toxicity testing at the Plymouth and LaPorte POTW's and at Roll Coater in Kingsbury.

(4) A fisheries study funded by the Indiana Department of Natural Resources (IDNR) at 89 sites in the basin

(5) Habitat and use attainability studies at New Carlisle, Remington, Kentland, and Wheatfield.

Those waterbodies assessed, the status of designated use support, probable causes of non-support, and miles affected are shown in Table 33. Additional comments concerning certain reaches are also given in this table.

Tissue analysis of fish collected at the two CORE stations revealed that metals, PCBs, and pesticides in fish from the Kankakee remain among the lowest in the state and are well below the concentrations affecting human health. No stream uses are impaired in the Kankakee Basin due to toxics in fish.

Approximately 10 miles of streams in the basin are partially impaired by toxics which do not bioaccumulate in fish. Bioassays of effluents from the LaPorte POTW and Roll Coater, Inc., at Kingsbury, have demonstrated an acute toxicity due to metals and surfactants. Both discharges are to Travis Ditch in LaPorte County.

An additional 54 miles in the Kankakee Basin do not support the aquatic life designation due to inadequately treated sewage. Low dissolved oxygen and high ammonia concentrations completely impair uses in Cedar Creek downstream from Lowell and Lake Dalecarlia. Partial impairment of use occurs in streams below the POTW's at Remington, Hebron, Westville, Plymouth, Knox, LaPorte, and New Carlisle. Partial impairment also occurs because of sewage pollution in Hunter Ditch below Goodland and in Deardurff Ditch and Beaver Creek near

TABLE 33. *WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE KANKAKEE RIVER BASIN.*

	WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT[1]	METHOD OF ASSESSMENT[2]	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
1)	Cedar Creek	Lake Dalecarlia Lowell	NS (Aquatic Life)	Monitored (b)	D.O. Ammonia	5	a) Lowell is bound by a Consent Decree to construct ammonia removal facilities and eliminate bypassing at the POTW by 1988. b) Lake Dalecarlia received a $2.5 million grant to build a new sewage treatment plant. Construction is due for completion in 1989.
2)	Carpenter Creek	Remington	PS (Aquatic Life)	Monitored (b)	D.O. Ammonia	5	Remington placed on the State's Project Priority list for probable future funding of POTW expansion.
3)	Cobb Creek	Hebron	PS (Aquatic Life)	Evaluated	D.O. Ammonia	5	Hebron completed construction in 1986 to replace the rock media in the POTW trickling filter system and decrease BOD.
4)	Travis Ditch	Kingsbury LaPorte	PS (Aquatic Life)	Monitored (b) (c)	D.O. Ammonia Metals	10	a) Completion of a $5.8 million expansion of the LaPorte POTW is due in 1988. b) Roll Coater in Kingsbury received a $9000 fine and is on a compliance schedule to reduce oil and grease and toxicity violations.
5)	Crumpacker Arm/Forbes Ditch/Crooked Creek	Westville	PS (Aquatic Life)	Evaluated	D.O. Ammonia	5	a) Westville POTW received state operator training assistance in 1986 and installed a new filter system. b) Improvements to the Westville Correctional Center Sewage Treatment Plant were completed in 1987.

TABLE 33. WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE KANKAKEE RIVER BASIN. (con't)

	WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
6)	Morrison Ditch	Kentland	PS (Aquatic Life)	Evaluated	Ammonia	3	Capitol Products in Kentland began modifiying their treatment process and additives to reduce ammonia outputs.
7)	Yellow River	Plymouth Knox	PS (Aquatic Life)	Monitored (b)	D.O. Ammonia	25	a) Plymouth received an $8.8 million grant for expansion, advanced treatment and ammonia removal at the POTW. Construction is due for completion in 1988. The State is seeking a $1.3 million fine for recent fish kills cause by unpermitted sewage bypasses. b) Knox received state operator assistance training in 1985. Effluent BOD from the POTW was cut in half.
8)	Neispodziany Ditch	New Carlisle	PS (Aquatic Life)	Monitored (b)	D.O. Ammonia	2	
9)	Hunter Ditch	Goodland	PS (Aquatic Life)	Evaluated	D.O. Ammonia	2	Goodland was placed on the State's Project Priority list for probable future funding of a new POTW.
10)	Deardurff Ditch/Beaver Creek	Morocco	PS (Aquatic Life)	Evaluated	D.O. Ammonia	3	
11)	Upper Kankakee River	Crumstown/ English Lake	PS (Recreational)	Monitored (b)	Fecal coliforms	40	
12)	Iroquois River	Rensselaer	FS	Monitored (b)		20	
13)	Yellow River	Bremen	FS	Monitored (b)		25	
14)	Lower Kankakee River		FS	Monitored (b)(c)		40	
15)	Sugar Creek	Earl Park	FS	Monitored (b)		10	
16)	Wolf Creek	Wheatfield	FS	Monitored (b)		10	
17)	Hoffman Ditch	Lakeville	FS	Monitored (b)		10	
18)	Eagle Creek	Starke County	FS	Monitored (b)		20	
19)	Sloeum Ditch/Reeves Ditch	Wanatah	FS	Monitored (b)		20	

TABLE 33. WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE KANKAKEE RIVER BASIN. (con't)

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
20) Potato Creek	North Liberty	FS	Monitored (b)		5	
21) Mill Creek	Union Mills	FS	Monitored (b)		10	
22) West Creek	Lake County	FS	Monitored (b)		20	
23) Slough Creek	Jasper County	FS	Monitored (b)		10	
24) Beaver Lake Ditch	Newton County	FS	Monitored (b)		10	
25) Singleton Ditch	Lake County	FS	Monitored (b)		10	
26) Brown Ditch	Schneider	FS	Monitored (b)		5	
27) Knight Ditch	Newton County	FS	Monitored (b)		10	
28) Pitner Ditch	LaPorte County	FS	Monitored (b)		10	
29) Little Kankakee River	LaPorte County	FS	Monitored (b)		10	
30) Craigmile Ditch	Starke County	FS	Monitored (b)		10	
31) Kline-Rouch Ditch	St. Joseph County	FS	Monitored (b)		5	
32) Myers Ditch/Wolf Creek	Argos	FS	Monitored (b)		5	
33) Robbins Ditch	Starke County	FS	Monitored (b)		10	
34) Curtis Creek	Jasper County	FS	Monitored (b)		5	
35) Ryan Ditch/Oliver Ditch	Jasper County	FS	Monitored (b)		15	
36) Pine Creek	North Judson	FS	Monitored (b)		5	
37) Yellow Bank Creek	LaPaz	FS	Monitored (b)		5	
38) Pine Creek	Walterton	FS	Monitored (b)		5	
39) Wolf Creek/Sandy Hook Ditch	Lake Eliza	FS	Monitored (b)		10	
40) Geiger Ditch	Porter County	FS	Monitored (b)		5	
41) Lateral 5 Ditch	St. Joseph County	FS	Monitored (b)		5	
42) Evers Ditch	DeMotte	FS	Evaluated		5	
43) Benkie Ditch	Kouts	FS	Evaluated		5	
44) Kent Ditch	Kentland	FS	Monitored (b)		3	
45) Fish Creek	LaPorte County	FS	Monitored (b)		5	

1 *PS = Partial Support; NS = Non Support; FS = Full Support. All uses not supposted are listed. If only one use is listed as not being supported, all other uses are supposted.*

2 *b = biological; c = chemical.*

Morocco. Neither of these towns presently have POTWs. Capitol Products at Kentland is an industrial discharge which partially impairs uses in Montgomery Ditch due to high ammonia concentrations.

Bacteriological sampling at the two fixed stations on the Kankakee River helps estimate the quality of water for recreational uses. All streams in the basin are presently designated for partial-body contact. The upper Kankakee River Station (KR-118) is partially impaired for recreational uses, while the lower station (KR-68) fully meets the bacteriological standards. Therefore, roughly 50% of the Kankakee River mainstream is considered to support recreational uses. The limited amount of data available makes it impossible to determine whether violations of the standard were caused by point sources, CSO's, or runoff from animal feedlots.

Improved water quality at several locations in the basin should occur when additional wastewater treatment facilities are in operation at Lowell, Lake Dalecarlia, LaPorte, and Plymouth. Construction on these projects should be completed in 1988 or 1989. Completion of the expanded plant at Plymouth, which will remove ammonia, provide advanced waste treatment, and eliminate bypassing, should be especially beneficial in improving water quality and preventing frequent fish kills in the lower 25 miles of the Yellow River.

Other recent projects which are expected to enhance water quality in the basin included equipment and operation changes at the Westville, Hebron, and Knox POTWs. Each of these discharges benefitted from the state's Operator Assistance Program, which provided technical expertise to solve equipment malfunctions or provide operator training. Recent changes in the treatment process at Capitol Products in Kentland has apparently helped reduce ammonia problems in that company's discharge. Roll Coater in Kingsbury is on a state imposed compliance schedule to reduce oil and grease and toxicity violations. A possible source of toxicity in the effluent has been identified and alternative treatment methods are being proposed.

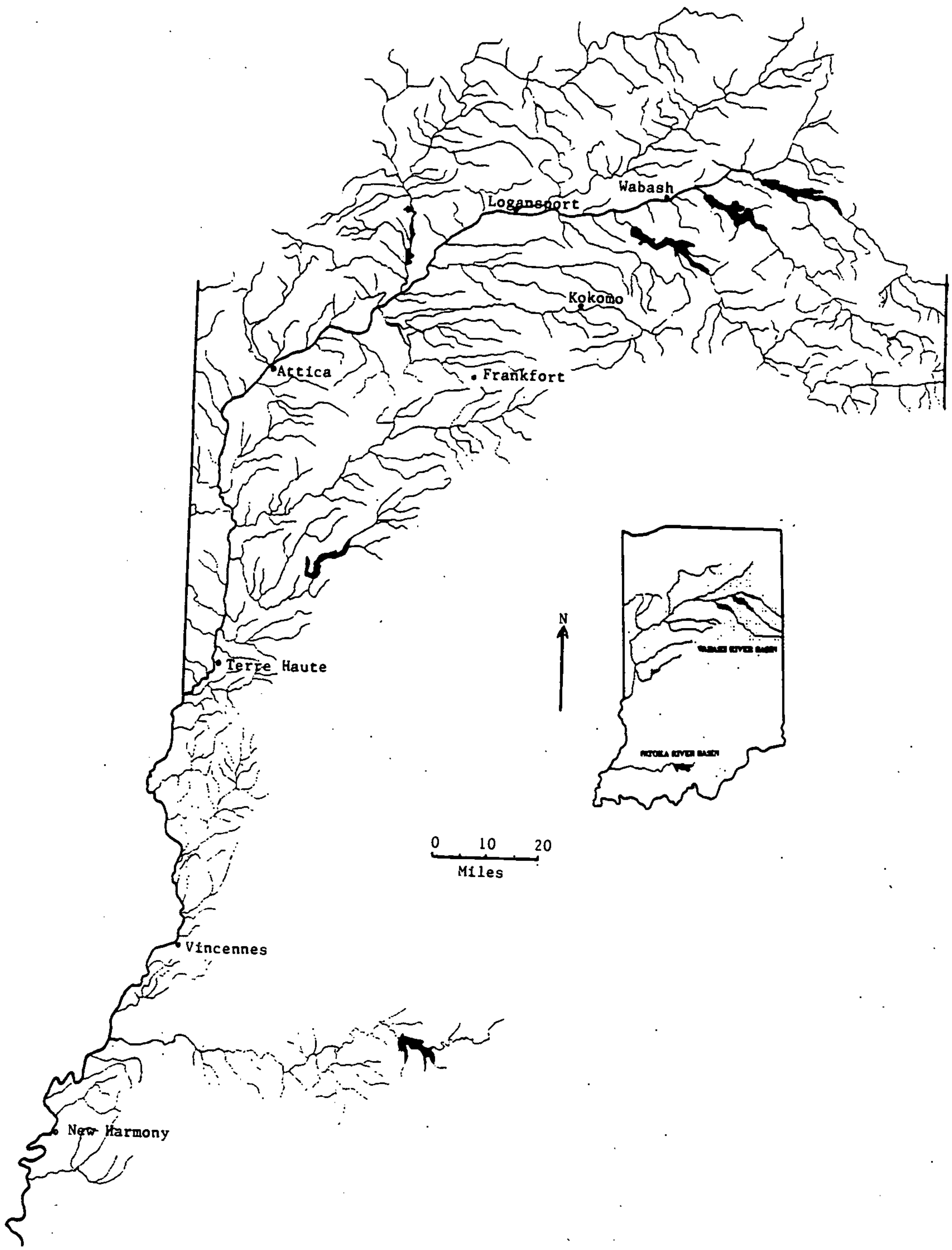
In summary, 464 stream miles were assessed in the Kankakee River Basin in 1986 and 1987. About 78% of those waters assessed fully supported their designated uses, 21% partially supported uses, and 1% did not support designated uses. Sewage-related pollution accounted for the large majority of stream miles not meeting their designated uses. Water quality in the basin was relatively unchanged from the 1984 and 1985 assessment.

Wabash River Basin

The Wabash River Basin provides drainage for approximately 33,000 square miles of the surface area of Indiana, Illinois, and Ohio. The greatest portion of the basin is in Indiana where it drains two-thirds of the state's surface area (Figure 12). The portion of the river system addressed in this section excludes the White River Basin, and is therefore limited to about 21,000 square miles.

There is one large Corps of Engineers (C.O.E.) impoundment on the 450-mile river mainstem and four on its tributaries. Two narrow lakes,

Figure 12. Wabash River Basin (including Patoka River Basin).



Freeman and Shafer, were created on the Tippecanoe River by construction of hydroelectric power facility dams. All of these water bodies provide a variety of uses which require a high degree of protection.

Regulation 327 IAC 2-1 establishes the water quality standards for the Wabash River Basin. In general, the river and its tributaries are designated for partial body contact recreation and maintenance of a warm-water fish community. The lakes and reservoirs are designated for whole-body contact recreation, as is the portion of the Wabash that forms the boundary between Indiana and Illinois. In the Wabash River Basin, stretches of Wildcat Creek and the South Fork of Wildcat Creek are designated as State Resource Waters. These waters are also designated for whole-body contact recreation.

A number of streams within the basin have been designated as exceptional use waters and their quality must be maintained without degradation. Eight of the ten streams which are designated for exceptional use (Table 34) are in the Wabash River Basin.

Limited use streams are those watercourses which because of their shallow depths, lack of flow, and/or lack of habitat cannot support recreational fisheries or whole body contact activities for most of the year. The limited use streams in the Wabash River Basin are listed in Table 35.

Surface water intakes for public water supplies are located on the waters shown in Table 36. These waters are all meeting this designated use.

This basin covers a large portion of the state and is subjected to a wide array of uses, some of which have more adverse impacts on water quality than others. Waters in this basin receive a diversity of wastes from municipal sewage treatment facilities, cropland runoff, chemical manufacturing facilities, coal fired electricity generating stations, steel processing plants, and coal mines.

Water quality monitoring in the basin during 1986 and 1987 included:

1. Monthly or quarterly chemical and bacteriological sampling at 35 fixed monitoring stations.

2. Fish tissue and sediment sampling at six CORE stations.

3. Fish tissue and sediment sampling at six additional stream sites in the basin.

4. Fish tissue and sediment sampling at five reservoirs and three lakes in the basin.

5. Effluent toxicity testing data from fourteen outfalls (industrial and municipal) in the basin.

6. Two DePauw University reports on fish community structure.

TABLE 34. *EXCEPTIONAL USE STREAMS IN WABASH RIVER BASIN.*

STREAM	COUNTY	SPECIFIC PORTION
Big Pine Creek	Warren	Downstream State Road 55 to Wabash River.
Mud Pine Creek	Warren	County Road between Brisco and Ridgeville to confluence with Big Pine Creek.
Fall Creek	Warren	One-half mile downstream from US 41 to confluence with Big Pine Creek.
Indian Creek	Montgomery	From County Road 650 West downstream to confluence with Sugar Creek.
Clifty Creek	Montgomery	Within Pine Hills Nature Preserve..
Bear Creek	Fountain	From County Road 450 North to confluence with Wabash River.
Rattlesnake Creek	Fountain	From County Road 450 North to confluence with Bear Creek.
Unnamed tributary to Bear Creek	Fountain	Within Portland Arch Nature Preserve.

TABLE 35. *LIMITED USE STREAMS IN WABASH RIVER BASIN.*

STREAM	COUNTY	SPECIFIC PORTION
Redkey Run and Halfway Creek	Jay	From Redkey POTW to a point 2 miles downstream.
Kentland POTW Receiving Stream	Newton	Along NYC railroad, upstream from its confluence with Montgomery Ditch.
Buck Creek	Sullivan	From the Sullivan South POTW to 2.25 miles downstream.
Jefferson Ditch	Grant	From the Upland POTW to its confluence with Lake Branch.
Unnamed Stream	Dubois	From Huntingburg City Lake Dam downstream to its confluence with Ell Creek.
Spring Creek	Vigo	From Hercules, Inc., outfall downstream to the Wabash River.
Francis Dutro Ditch	Blackford	From the Blackford Canning Company discharge downstream to its confluence with Prairie Creek.

TABLE 36. *PUBLIC WATER SUPPLY SURFACE WATER INTAKES IN WABASH RIVER BASIN.*

WABASH RIVER BASIN	
Logansport	Eel River
Kokmo	Wildcat Creek (plus wells)
Terre Haute	Wabash River (plus wells)
Turkey Run State Park	Sugar Creek
Warsaw	Center Lake
Montpelier	Salamonie River
PATOKA RIVER BASIN	
Huntingburg	Huntingburg Lake
Jasper	Patoka River
Oakland City	Oakland City Lake
Winslow	Patoka River (plus purchases)

7. Habitat and use attainability studies.

A total of 1,684 miles of waterways including the Patoka River were assessed in the Wabash River Basin. The assessed waters, the status of designated use support, probable cause of impairment, and affected miles are shown in Table 37. Additional information is also provided in this table for certain reaches.

Based on fish data collected prior to 1985, a general fish consumption advisory was issued for a 73-mile reach of the Wabash River from Lafayette downstream to Darwin, Illinois, due to high levels of chlordane, dieldrin, and PCBs. Subsequent fish samples collected in 1985-86 from the Wabash River indicated much reduced levels of these pollutants, and the advisory was revised in 1987 to include only carp (Table 19). Samples from several locations along the river were also collected in 1987, but results of these analyses are not yet available.

Fish tissue samples collected prior to 1986 from Elliott Ditch and Wea Creek in Tippecanoe County also exceeded FDA action levels for PCBs, and these areas are also included in the present fish consumption advisory (Table 19). In these streams a total ban on fish consumption is in effect and this is considered as non-support of the aquatic life use designation. The source of PCB contamination is the Aluminum Company of America (ALCOA) facility which is known to discharge low levels of PCBs to Elliott Ditch. IDEM is currently negotiating a Judicial Order which would require ALCOA to implement corrective measures to eliminate PCB discharge violations by March 1989.

Other streams in the Wabash River Basin which are affected by a total ban on fish consumption include the Little Mississinewa River and two miles of the Mississinewa River near Union City. Fish tissue samples which were collected in late 1984 from these stream areas exceeded FDA action levels for PCBs. The PCBs were discharged from the Union City POTW. The State of Indiana contributed to a clean-up of the POTW in 1986. PCBs entered the Union City POTW from the Westinghouse facility which was leased to Dana Corporation. Westinghouse is currently negotiating with IDEM on a clean-up proposal for a ditch on the Westinghouse property.

Fish and sediment samples were collected from the following Wabash River basin reservoirs during the 1985-87 period: Huntington Reservoir, Salamonie Reservoir, Mississinewa Reservoir, Mansfield Reservoir, and Patoka Reservoir. Lakes Freeman and Shafer on the Tippecanoe River and Palestine Lake in Kosciusko County were also sampled. Although these will be discussed in more detail elsewhere in this report, no contaminants were found in fish tissue at levels which exceeded FDA action levels.

The Wabash River originates in Mercer County, Ohio. It flows westward approximately 15 miles to the Indiana/Ohio state line at river mile 465.6, and then through parts of four Indiana counties until it is dammed to form the 900-acre Huntington Reservoir. Data from fixed water quality monitoring stations at Markle (WB-420) and Geneva (WB-452) show that the portion of the river upstream of the reservoir meets its designated fishable use. The D.O.

TABLE 37. *Waters assessed, status of designated use support, probable causes of impairment, and miles affected in Wabash River Basin (Including Patoka River).*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT 1	METHOD OF ASSESSMENT 2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Wabash River	Geneva	NS(Recreational)	Monitored(b)(c)	Fecal Coliform	16	
Wabash River	Markle	PS(Recreational)	Monitored(b)(c)	Fecal Coliform	3	IDEM recently modified Markle's NPDES permit which will require the city to modify headworks of POTW and monitor CSOs. Markle is making application for construction grant money.
Wabash River	Huntington	FS	Monitored(b)(c)		6	
Wabash River	Andrews	NS(Recreational)	Monitored(b)(c)	Fecal Coliform	16	
Wabash River	Peru	NS(Recreational)	Monitored(b)(c)	Fecal Coliform	28	
Wabash River	Georgetown	PS(Recreational)	Monitored(b)(c)	Fecal Coliform	27	
Wabash River	Upstream Lafayette	NS(Recreational)	Monitored(b)(c)	Fecal Coliform	30	IDEM enforcement action against City of Wabash and Container Corporation of America which caused improved effluent.
Wabash River	Lafayette to Oarwin	PS(Recreational) (Aquatic Life)	Monitored(b)(c)	Fecal Coliform Chlordane, PCB's	73	(1) IDEM is negotiating a Judicial Order that requires ALCOA to implement corrective measures to eliminate PCB violations of NPDES permit by March, 1989. (2) Negotiations between IDEM and ALCOA to remove PCB contaminated sediments in 1988 from Elliott Ditch and Wea Creek. (3) Operator of Clinton POTW entered IDEM's Operator's Assistance Program which resulted in compliance and reduced (dry and) wet weather bypassing.
Wabash River	Oarwin to Mouth	FS(Threatened)	Monitored(b)(c)	Chlordane	185	
Salamonie River	Portland	NS(Recreational)	Monitored(b)(c)	Fecal Coliform	23	
Salamonie River	Upstream Lancaster to Mouth	FS	Monitored(b)(c).		54	
Mississinewa River	Union City	NS(Aquatic Life)	Monitored(b)(c)	PCBs, Chlordane	2	(1) Partially state-funded clean-up of PCB contamination in Union City sewage treatment plant. (2) Negotiations between IDEM and Westinghouse to write clean-up proposal for sediments on Westinghouse property in Union City. (3) IDEM enforcement action on Sheller-Globe resulting in establishment of interim limits and a compliance schedule.

TABLE 37. *Waters assessed, status of designated use support, probable causes of impairment, and miles affected in Wabash River Basin (Including Patoka River). (Con't)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT 1	METHOD OF ASSESSMENT 2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Little Mississinewa River	Union City	NS(Aquatic Life)	Monitored(b)(c)	PCBs, Chlordane Metals	7	(1) Partially state-funded clean-up of PCB contamination in Union City sewage treatment plant. (2) Negotiations between IDEM and Westinghouse to write clean-up proposal for sediments on Westinghouse property in Union City. (3) IDEM enforcement action on Sheller-Globe resulting in establishment of interim limits and a compliance schedule.
Mississinewa River	Downstream Union City to Ridgeville	FS	Monitored(b)(c)		7	
Mississinewa River	Ridgeville	FS(Threatened)	Monitored(b)(c)	DD	5	
Mississinewa River	5 Mile D/S Ridgeville	FS	Monitored(b)(c)		13	
Mississinewa River	Albany	FS(Threatened)	Evaluated	Zinc	5	
Mississinewa River	5 Miles D/S Albany to Marion	FS	Monitored(b)(c)		38	
Mississinewa River	Marion	NS(Recreational)	Monitored(b)(c)	Fecal Coliform	36	
Mississinewa River	Jalapa	PS(Recreational)	Monitored(b)(c)	Fecal Coliform	16	
Mississinewa River	Downstream Jalapa to Mouth	FS	Monitored(b)(c)		21	
Eel River	Headwaters near Churubusco	FS(Threatened)	Monitored(c)	PCBs	5	
Eel River	Near headwaters to upstream South Whitley	FS	Monitored(b)(c)		20	
Eel River	South Whitley	FS(Threatened)	Monitored(b)	Chlorine	2	
Eel River	2 mi D/S South Whitley to Roann	FS	Monitored(b)(c)		24	
Eel River	Roann to Mouth	PS(Recreational)	Monitored(b)(c)	Fecal Coliform	41	

TABLE 37. *Waters assessed, status of designated use support, probable causes of impairment, and miles affected in Wabash River Basin (Including Patoka River). (Con't).*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT 1	METHOD OF ASSESSMENT 2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Williamson Ditch	Upstream Palestine Lake	FS(Threatened)	Evaluated	Metals	2	
Tippecanoe River	Headwater to Rochester	FS	Evaluated		53	
Tippecanoe River	Rochester	NS(Recreational)	Monitored(b)(c)	Fecal Coliform	5	Construction grant awarded to Rochester for POTW expansion and ammonia removal (to be completed 6/88).
Tippecanoe River	Downstream Rochester to Mouth	FS	Monitored(b)(c)		102	
Wildcat Creek	Headwater to Kokomo	FS	Monitored(b)(c)		16	
Wildcat Creek	Below Kokomo	NS(Recreational)	Monitored(b)(c)	Fecal Coliform	29	
Wildcat Creek	Below Kokomo to Mouth	FS	Monitored(b)(c)		37	
South Fork Wildcat Creek	Entire Length	FS	Monitored(b)(c)		41	
Elliott Ditch and Wea Creek	Lafayette	NS(Aquatic Life) (Recreational)	Monitored(b)(c)	PCBs	27	(1) IDEM is negotiating a Judicial Order that requires ALCOA to implement corrective measures to eliminate PCB violations of NPDES permit by March, 1989. (2) Negotiations between IDEM and ALCOA to remove PCB contaminated sediments in 1988 from Elliott Ditch and Wea Creek.
Big Pine Creek	Pine Village	FS	Monitored(b)(c)		77	
Vermillion River	Cayuga	FS	Monitored(b)(c)		8	
Sugar Creek	Entire Length	FS	Monitored(b)(c)		87	
Big Raccoon Creek	Entire Length (except for 1 mile)	FS	Evaluated		82	Based on DePauw University fish population study done in 1983.
Big Raccoon Creek	Coxville	FS(Threatened)	Evaluated	Acid Mine Drainage	1	

TABLE 37. *Waters assessed, status of designated use support, probable causes of impairment, and miles affected in Wabash River Basin (Including Patoka River). (Con't)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT 1	METHOD OF ASSESSMENT 2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Otter Creek (Upper)	Vigo and Clay Counties	FS(Threatened)	Evaluated	Acid Mine Drainage	11	
Otter Creek (Lower)	Vigo County	FS	Monitored(b)		9	
Phillips Ditch	Walton	PS(Aquatic Life)	Monitored(b)(c)	Metals	2	IDEM is investigating the cause of this contamination.
Coal Creek	Vigo County	PS(Aquatic Life)	Evaluated	Acid Mine Drainage, Silt	7	
Blue River	Columbia City	FS(Threatened)	Evaluated	BOD	3	City is contemplating plant expansion.
Flack Ditch	Laketon	FS(Threatened)	Monitored(c)	BOD,COD,TSS, ammonia, sulfide phenolics	1	Enforcement action which was taken by IDEM resulted in an Agreed Order to resolve permit violations.
Brouilletts Creek	Vigo & Vermillion Counties	FS(Threatened)	Evaluated	Acid Mine Drainage	2	
Honey Creek & Tributary	Terre Haute	FS(Threatened)	Evaluated	Acid Mine Drainage	25	Indiana Department of Natural Resources (IDNR) Division of Reclamation has spent $3.5 million reclaiming Victory Mine area; burial of gob and other work completed in 5/86.
Honey Creek	Terre Haute	PS(Aquatic Life)	Evaluated	Acid Mine Drainage	2	IDNR has spent $250,000 in reclaiming 23 acres of gob, project is 15% complete.
Busseron Creek	Sullivan County	PS(Aquatic Life)	Monitored(b)	Acid Mine Drainage	23	
Mud Creek	Sullivan County	NS(Aquatic Life)	Monitored(b)	Acid Mine Drainage	7	
Sulphur Creek	Sullivan County	NS(Aquatic Life)	Monitored(b)	Acid Mine Drainage	7	
Patoka River	Jasper to Mouth	NS(Recreational)	Monitored(b)(c)	Fecal Coliform	86	(1) Construction grant awarded to Oakland City for POTW expansion (to be completed 8/88). (2) City of Jasper is under an Agreed Order to rehabilitate its sewage treatment system which includes a sewer ban. Jasper has also been warned of pretreatment limit and interim discharge limit violations.

TABLE 37. *Waters assessed, status of designated use support, probable causes of impairment, and miles affected in Wabash River Basin (Including Patoka River). (Con't).*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT 1	METHOD OF ASSESSMENT 2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
South Fork of Patoka River and Tributaries	Pike, Warrick and Gibson Counties	FS(Threatened)	Evaluated	Acid Mine Drainage	40	IDNR is spending $2.9 million to reclaim the Blackfoot Area; Burial of gob and slurry and draining of acid lakes began in 1986 and is 93% complete.
South Fork Smalls Creek	Bruceville	NS(Aquatic Life)	Evaluated	Acid Mine Drainage	8	IDNR is spending $2.1 million to reclaim 56 acres of gob and 20 acres of slurry and acid water; 90% complete.
Sugar Creek	Vigo County	NS(Aquatic Life)	Evaluated	Acid Mine Drainage	9	
Turman Creek	Sullivan County	FS(Threatened)	Monitored(b)	Acid Mine Drainage	3	
Big Shawnee Creek	Attica	FS	Evaluated		26	
Little River	Roanoke	FS(Threatened)	Evaluated	Metals in Roanoke Lagoons	21	(1) Criminal prosecution of president and chairman of board for C&M Plating (Roanoke) by IDEM. (2) Clean-up of metals-laden lagoons at Roanoke POTW scheduled.
Humbert Ditch	Fowler	FS	Monitored(b)		2	
Round Prairie Creek	Windfall	FS	Monitored(b)		2	
Townsand Lucas Ditch	Shamrock Lakes	FS	Monitored(b)		6	
Hoagland Ditch	Wolcott	FS	Monitored(b)		12	
Chippewanuk Creek	Akron	FS	Evaluated		2	
Walnut Creek	Warsaw	FS(Threatened)	Evaluated	Metals	5	

TABLE 37. *Waters assessed, status of designated use support, probable causes of impairment, and miles affected in Wabash River Basin (Including Patoka River).(Con't)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT 1	METHOD OF ASSESSMENT 2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Danner Ditch	Etna Green	FS	Evaluated		5	
Little Pipe Creek	Converse	PS(Aquatic Life)	Monitored(b)		2	
Grant Creek	La Fontaine	FS	Monitored(b)		3	
Burnettts Creek	Burnettsville	FS	Monitored(b)		5	
Rock Creek	West Lebanon	FS	Monitored(b)		4	
Mill Creek	Kingman	FS	Monitored(b)		8	
N. Fork Coal Creek	Wingate	FS	Monitored(b)		4	
Roaring Creek	Marshall	FS	Monitored(b)		4	
East Fork Coal Creek	Waynetown	FS	Monitored(b)		10	
Withe Creek	Colfax	FS	Monitored(b)		5	
North Branch Otter Creek	Carbon	FS	Monitored(b)		10	
Little Raccoon Creek	Russellville	FS	Monitored(b)		16	
West Fork Busseron Creek	Farmersburg	FS	Monitored(b)		7	
Bond Ditch	Oaktown	FS	Evaluated		3	
Lost Creek	Francisco	FS	Evaluated		2	
Trimble Creek (Mentone)	Kralis Bros. Poultry (Mentone)	NS(Aquatic Life) (Recreational)	Evaluated	BOD, TSS, Fecal Coliform	4	
Yellow Creek	Provimi Veal	NS(Aquatic Life)	Evaluated	BOD	1	

1. PS = Partial Support; NS = Non Support; FS = Full Support. The uses not supported are listed. If only one use is listed as not being supported, all other uses are supported.

2. b = biological; c = chemical.

levels for these two stations averaged 9.4 and 8.7 ppm, respectively. The recreational use was not supported, however, near Geneva, and only partially supported near Markle due to high fecal coliform levels. Just downstream from Markle, Huntington Reservoir meets its designated uses (fishable and whole-body contact recreation), but is impacted to some extent by nonpoint pollution, specifically soil erosion both upstream of the reservoir and along the reservoir's shoreline.

The Wabash River near Andrews and Peru did not support the recreational use, but aquatic life uses were not impaired. At Georgetown and upstream of Lafayette, fecal coliform levels were present which prevented the mainstem Wabash River from fully meeting its recreational use designation. One problem in this area is the (City of) Wabash POTW. This facility has had permit violations for fecal coliforms and total suspended solids (TSS). One of the two outfalls for the city is a combined waste discharge for the city and Container Corporation of America (CCA). IDEM enforcement action has resulted in an improved effluent.

Problems at the POTWs at Clinton and Terre Haute have resulted in only partial support of the recreational use of this portion of the Wabash River. The operator of the Clinton POTW completed IDEM's Operator Assistance Program in 1987, and this has resulted in compliance and reduced wet-weather bypassing at this plant. Terre Haute is still having solids removal and occasional bypassing problems. Although several industries discharge to the Terre Haute reach of the Wabash River, they do not currently appear to be causing problems.

In the past, low dissolved oxygen levels in the portion of the Wabash River between Cayuga and Montezuma have been found. One major fish kill and several smaller ones occurred in this reach of the river in the late 1970s. Several studies have been done on this portion of the river to try to determine the cause of these problems. It appears that several factors including high algal counts at low flows, naturally sluggish flow in this area, thermal inputs from the Cayuga Generating Station, and possibly, increases sediment oxygen demand may all contribute to the problem. Changes in the operation of the cooling towers at the Cayuga Generating Station in 1984-85 has resulted in reduced thermal inputs to this reach of the river. An NPDES permit issued to this facility in 1987 contains more stringent thermal effluent limits which may require the facility to reduce generation at certain times.

Studies done in recent years by Dr. James Gammon of DePauw University indicate that the fish community has vastly improved in the middle Wabash River since the 1970s, especially in the area between Lafayette and Cayuga. However, due to the consumption advisory for carp on the portion of the river between Lafayette and Darwin, the aquatic life use is considered to be only partially supported in this reach.

The reach of the Wabash River from Darwin, Illinois, to its confluence with the Ohio River appears to fully support its designated uses. It is considered threatened due to the fish consumption advisory which exists in the upstream reach and some low chlordane levels found in fish tissue collected at New Harmony in the early 1980s.

The Little Wabash River is the first major tributary in the upper reach of the Wabash River. It is fully supporting of its designated uses but threatened by metals inputs from the Roanoke POTW lagoons. These metals apparently came from C & M Plating, which discharged to the city sewer system. These lagoons are presently scheduled to be cleaned up, and IDEM has pursued criminal prosecution of C & M Plating. In the past, this firm had numerous violations which eventually resulted in an unprecedented arrest of the firm's president and the chairman of the board who are awaiting trial. C & M Plating is presently not operating.

The Salamonie River in its upper reaches does not fully support its designated uses due to high fecal coliform levels resulting from combined sewer overflows in Portland. The Portland POTW also experiences occasional problems with BOD, TSS, and ammonia limits; but these do not seem to be seriously impacting the river. Low levels of PCBs were detected in river sediments from this area, but the source of these contaminants is not yet known. The portion of the river from Lancaster to its mouth appears to support its designated uses.

The Little Mississinewa River and two miles of the Mississinewa River near Union City, do not support their designated uses due to high levels of PCBs and chlordane found in fish tissue. Sheller Globe in Union City also discharges to the Little Mississinewa River and is having problems meeting its permit limits for nickel. IDEM has taken enforcement action against this facility.

The reach of the Mississinewa River from a point one mile downstream of the confluence of the Little Mississinewa River to Marion supports its designated uses. The river near Ridgeville is considered threatened due to a low dissolved oxygen value recorded at the fixed water quality monitoring station there. The cause of this low value is not known.

Although the Marion POTW complies with its permit limitations in most instances, the Mississinewa River in this reach does not support recreational uses. High fecal coliform levels resulting from combined sewer overflows appear to be causing this problem. High fecal coliform levels in the river near Jalapa occur often enough that this segment of the river only partially supports recreational uses. From below Jalapa to its mouth, the river fully supports its designated uses.

The Eel River fully supports designated uses from its headwaters to Roann. From this point downstream to its mouth, high fecal coliform concentrations occur frequently enough to allow only partial support of the recreational use. This river is threatened in the reach near Churubusco where low levels of PCBs have been found in the sediments of one of its tributaries, Johnson Drain, and in the Eel River near Johnson Drain. The lagoons at the Churubusco POTW were found to contain PCBs. The lagoons were cleaned and some contaminated ditch sediments were removed in 1986. High total residual chlorine levels, at times, also threaten the Eel River near South Whitley.

The Columbia City POTW which discharges to the Blue River, a tributary of the Eel River, meets its NPDES permit limits but dry weather bypassing has occurred. This problem should be corrected with plant expansion which is scheduled to be completed in August 1990.

Problems also exist near Laketon Refining Corporation which discharges to Flack Ditch, a tributary to the Eel River. Permit violations have occurred for BOD, COD, TSS, ammonia, sulfide, and phenolics which threatened the ability of Flack Ditch to support the designated aquatic life use. In response, IDEM initiated an enforcement action in 1985 which resulted in improved operation in 1986. Sediment collected from Flack Ditch in 1986 did not contain any contaminants at levels of concern. A bioassay conducted on effluent from this facility in 1987 produced some toxicity apparently due to cyanide and petroleum.

Sediment analyses have revealed high metals contamination in portions of Phillips Ditch in Walton. The Wm. H. Pfarrer Company is located in this area and discharges to this stream. If the source of this contamination is found to be the Wm. H. Pfarrer Company, IDEM will begin enforcement action. Plans are underway for the county to do routine dredging in this ditch, and IDEM staff are involved in determining whether the dredged materials need special handling and disposal.

In Kosciusko County, Warsaw Black Oxide in Burket discharges to Williamson Ditch, a tributary to Palestine Lake. Sediment samples collected in this ditch and in the West Basin of the lake near the ditch mouth in the past have revealed metals concentrations considerably above background levels. However, sediment samples collected in the West Basin of Palestine Lake in 1987, indicated that concentrations of metals and PCBs were considerably lower. This company has improved its treatment process and its effluent caused no toxicity in an October 1987 Daphnia magna bioassay. In a 1986 bioassay, the LC-50 concentration was 44 percent.

The outlet of Palestine Lake is Trimble Creek which receives the discharge from Kralis Brothers Poultry near Mentone. This is an operation which has had numerous permit violations for BOD, TSS, and fecal coliforms. As a result, four miles of this creek does not support its designated aquatic life use.

Provimi Veal, which discharges to Yellow Creek, another Tippecanoe River tributary, has violated its permit limits for fecal coliform bacteria and BOD regularly. As a result, one mile of stream does not support the aquatic life use. This firm began constructing a new treatment facility in June 1987, which is scheduled to be completed in June 1988.

The Tippecanoe County mainstem is fully supportive of all uses from its upper reaches to a point near Rochester. Fecal coliform levels have been high downstream of the Rochester POTW. This city has received construction grant money to expand its wastewater treatment plant and add ammonia removal. Beyond this area the Tippecanoe River meets all designated uses.

Wildcat Creek is fully supportive of all its designated uses above Kokomo. Bypassing is thought to be the cause of high fecal coliform levels which persist for 29 miles downstream of the city. Fecal coliform levels in this reach are too high to support its designated recreational use. Below this reach, Wildcat Creek fully supports its designated uses as does the entire length of the South Fork of Wildcat Creek.

Many tributary streams of the Wabash River in the Terre Haute area and further south have been impacted by acid mine drainage from coal mines. Considerable amounts of money have been spent by the Department of Natural Resources to reclaim several of these areas. The streams which are affected are listed in Table 37 as is information on the reclamation activities.

The Patoka River has been impacted by acid mine drainage and organic loading from the Jasper and Oakland City POTWs, but aquatic life uses are supported. High fecal coliform levels in the Patoka River prohibit this stream from meeting its recreational use designation. New POTW construction was begun in February 1987, at Oakland City. As a result of IDEM enforcement action, Jasper is under an Agreed Order to rehabilitate and expand its POTW. Jasper presently has problems with CSOs and inflow and infiltration.

In summary, 1,684 miles of streams in the Wabash River Basin were assessed. Of those miles, 1,147 were fully supporting of all designated uses, 196 were partially supporting, and 341 were not supporting. Most of the pollution problems in this basin are caused by fecal coliforms, PCBs, and acid mine drainage. Conditions in this watershed are about the same as in 1984 and 1985.

The West Fork of White River Basin

The West Fork of White River (WF White River) begins near Winchester in Randolph County, Indiana and flows through eleven counties to join the East Fork of White River near Petersburg. The main stem of White River then flows about 48 miles and joins the Wabash River. In total, the West Fork flows about 356 river miles and drains 5,600 square miles of Indiana watershed (Figure 13). Table 38 shows the waters assessed in this basin, the status of their support of designated uses, the probable causes of impairment, and the miles affected. Additional comments on some reaches are also provided.

The 40 mile stretch of the river from Winchester to Muncie has good water quality and supports its designated uses for aquatic life and partial body contact recreation. The fishery collections from this reach have been diverse and representative of a central Indiana river in good condition. A significant smallmouth bass sport fishery exists in Muncie upstream of the publicly owned treatment works (POTW). Only one fecal coliform bacteria concentration exceeding water quality standards was found during 1985, 1986 and 1987 at the fixed water quality monitoring station upstream of the Muncie

Figure 13. West Fork of White River Basin.

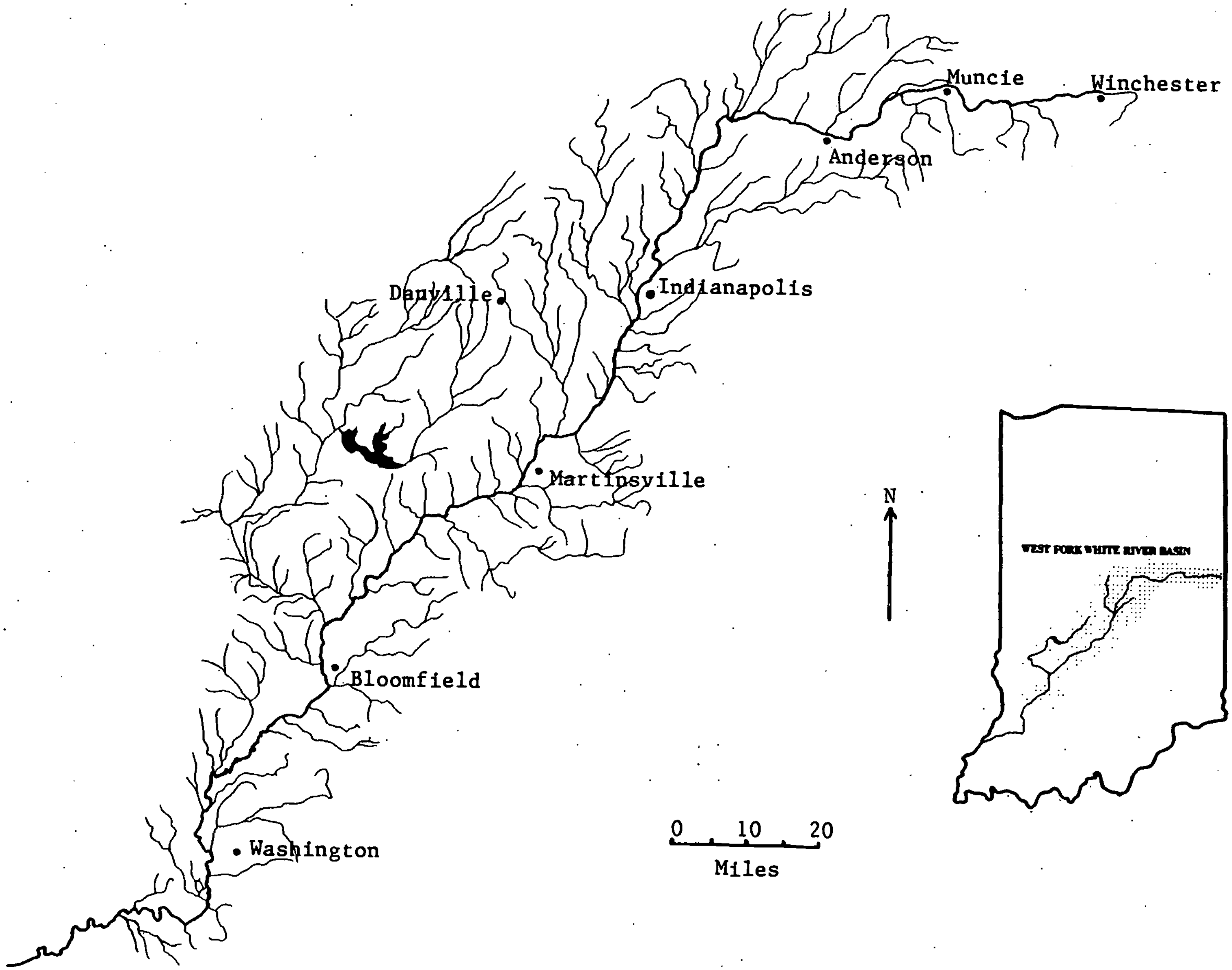


TABLE 38. *WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE WEST FORK OF WHITE RIVER BASIN.*

	WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
1)	WF White River	Muncie to Noblesville	PS (Recreational)	Monitored (b) (c)	Fecal Coliform Nonpoint Municipal Discharges	56	Muncie recently renovated their entire facility, including sludge handling facilities. Since the enforcement action with Muncie was finalized in January of 1986,effluent quality has improved dramatically.
2)	WF White River	Noblesville to Martinsville	NS (Aquatic Life) (Recreational)	Monitored (b) (c)	PCB Chlordane Fecal coliform	71	Firestone Industrial Products of Noblesville, Indiana made arrangements for PCB cleanup of the roof drain and the sludge in the plant #1 drain line manhole. Firestone's consulting engineer prepared a PCB Remedial Action Plan and Site Safety and Health Plan which was accepted as conforming to accepted practice by IDEM, 8/17/87. The company has also completed a sediment survey of that part of Wilson Ditch on their property to determine the location of the PCB contamination. On July 16, 1987, a RCRA Facility Work Plan was submitted by Firestone to EPA. It is expected that this source of PCB contamination will soon be eliminated under a RCRA 3008 H Agreed Order yet to be finalized. Complete Fish Consumption Advisory.
3)	W F White River	Martinsville to confluence of the West Fork of Whte River and the East Fork of White River near Petersburg	PS (Aquatic Life)	Monitored (b) (c)	PCB Chlordane	142	Additional monitoring of the fish and sediments of the WF White River during 1987. Fish Consumption Advisory.

TABLE 38. WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE WEST FORK OF WHITE RIVER BASIN. (con't)

	WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
4)	Lilly Creek	Orestes	NS (Aquatic Life)	Evaluated	Cannery Waste	1	
5)	Duck Creek	Elwood	NS (Aquatic Life) (Recreational)	Monitored (c)	Bypassing, Fecal coliform Ammonia Low D.O.	3	
6)	Fall Creek (The last five miles before joining WF White River)	Indianapolis	PS (Aquatic Life) (Recreational)	Monitored (b) (c)	CSO Spills Metals	5	
7)	Eagle Creek	Indianapolis	PS (Aquatic Life)	Monitored (b) (c)	Speedway POTW Industrial Discharge (Metals) Ammonia Nonpoint Unknowns	4	The U.S. EPA has taken enforcement action against the Town of Speedway for bypassing inadequately treated wastewater at less than average design flow and for violations of effluent quality. In agreement with a 1987 Consent Decree Bridgeport Brass, a brass mill operation, has addressed previous NPDES permit violations by installing adequte pH control in the facilities treatment lagoon.Accumulated copper and zinc sludges in the lagoon were dredged in 1987 and baffler were installed to prevent short circuiting and aid in solids settling. The company has operated in compliance for the second half of 1987.

TABLE 38. WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE WEST FORK OF WHITE RIVER BASIN. (con't)

	WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
8)	East Fork of White Lick Creek for 3 miles downstream of Indianapolis	Indianapolis	PS (Aquatic Life)	Monitored (b) (c)	Urban, Industrial, and Agricultural Nonpoint. Effects of past municipal and industrial discharges and spills. (Metals)	3	The Quemetco Corporation on Morris St. in Indianapolis installed an ion-exchange treatment facility in 1984 that decreased metals concentrations which reached Julia Creek, a tributary of E.F. White Lick Creek. In 1984, defects In the lift station on Bridgeport Road were repaired. This prevented further bypassing of municipal and industrial waste to the East Fork of White Lick Creek. The Avon Railroad Yards installed a more efficient treatment system that treats industrial wastes which enter a tributary of the East Fork of White Lick Creek.
9)	Julia Creek	Indianapolis	NS (Aquatic Life)	Monitored (b) (c)	Heavy Metals from Quemetco Corporation property.	1	
10)	White Lick Creek	Brownsburg	PS (Aquatic Life) (Recreational)	Monitored (b) (c)	Ammonia Low D. O. High BOD Fecal Coliform	2	Brownsburg's STP has been increased in capacity and treatment level. The plant should perform to design by April 1988.
11)	Wilson Ditch and Stoney Creek	Noblesville	NS (Aquatic Life)	Monitored (b) (c)	PCB	1	Complete Fish Consumption Advisory. 1987 Facility Work Plan submitted to IDEM by the Firestone Company for complete cleanup of Wilson Ditch and Stoney Creek. (see WF White River-Noblesville)

TABLE 38. WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE WEST FORK OF WHITE RIVER BASIN. (con't)

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT[1]	METHOD OF ASSESSMENT[2]	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
12) White Lick Creek	Plainfield	PS (Aquatic Life)	Monitored (b) (c)	Ammonia Low D.O. High BOD	2	A construction grant award is providing for expansion and modifications of this facility. Completion is scheduled for summer 1988. The final NPDES effluent limits should be acheivable by 7/1/88.
13) Pleasant Run	Indianapolis	NS (Aquatic Life)	Evaluated	Nonpoint Unknown factors CSO Chlordane	9	
14) Richland Creek	Whitehall, Monroe County to confluence with White River in Greene County	PS (Aquatic Life)	Monitored (b) (c)	PCBs	19	General Fish Consumption Advisory. Neals Landfill has been capped and measures to prevent runoff applied. Additional monitor·ng is occurring.
15) Stouts Creek	Bloomington	NS (Aquatic Life)	Monitored (b) (c)	PCBs	2	Complete Fish Consumption Advisory. Bennets Landfill has been capped and measures to prevent runoff applied. Additional monitoring is occurring.
16) Conards Branch	Monroe County Whitehall	NS (Aquatic Life)	Monitored (b (c)	PCBs	1	Complete Fish Consumption Advisory. Neals Landfill has been capped and measures to prevent runoff applied. Additional monitoring is occurring.
17) Beehunter Ditch	Linton	PS (Aquatic Life)	Monitored (b) (c)	Ammonia Low D.O. Bypassing	4	Linton was reissued its NPDES permit 9/87 based on a wasteload allocation study of Beehunter Ditch. Linton is in noncompliance with the bypass prohibition. A compliance schedule will be established in an Agreed Order

TABLE 38. WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE WEST FORK OF WHITE RIVER BASIN. (con't)

	WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
18)	Indiana Creek	Bicknell	NS (Aquatic Life)	Monitored (b)	Acid Mine Drainage	4	
19)	Hawkins Creek	Washington	NS (Aquatic Life) (Recreation)	Monitored (b)(c)	Low D.O. Ammonia High BOD Fecal coliform CSO	4	A judical complaint has been filed in court against the city because it will not meet the 7/1/88 deadline for compliance with the CWA. The facility is unable to meet its ammonia limitation. A judical order containing a construction schedule for new ammonia facilities is forthcoming. Washington has a serious CSO problem also which is only being partially addressed.
20)	WF White River	Winchester to Muncie	FS	Monitored (b) (c)		40	
21)	White River (Main Stream)	Pertersburg to confluence with Wabash	FS	Evaluated		48	
22)	Pipe Creek	Alexandria	FS	Monitored (b) (c)	Unknown Factors	20	Effluent from several POTWs, nonpoint runoff, currently unkown factors periodically threaten this stream A new Class III facility, consisting of 2 parallel oxidation ditches, secondary clarifiers, and 2 polishing lagoons was put into operation in October 1986.
23)	Eagle Creek	Zionsville, Headwaters to the dam at Eagle Creek Res.	FS	Monitored (b) (c)		25	Increase in capacity and treatment level of Zionsville STP. Should perform to design by September of 1988.
24)	West Fork White Lick Creek	Danville	FS (Threatened)	Monitored (b) (c)	Nonpoint	2	Problems at Danville POTW as well as nonpoint runoff threaten 2 miles of this stream. New plant improvements at Danville POTW will increase capacity and treatment level. The plant should perform to design by July 1988.

TABLE 38. WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE WEST FORK OF WHITE RIVER BASIN. (con't)

	WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
25)	White Lick Creek	Mooresville to Confluence with WF White River	FS	Evaluated		7	Mooresvile's STP routinely meets its discharge limits. There were plant improvements in 1985 because of State enforcement actions.
26)	Jacks Defeat Creek	Elletsville	FS	Monitored (B)		6	
27)	Bean Blossom Creek	Bloomington to confluence with WF White River.	FS (Threatened)	Monitored (b) (c)		12	Low concentrations of PCBs found in fish tissue.
28)	Lattas Creek	Switz City	FS	Monitored (b)		12	
29)	Eel River	Worthington	FS	Evaluated		4	
30)	Four Mile Creek	Lyons	FS	Evaluating		4	
31)	Black Creek	Sandborn	FS	Evaluated		5	
32)	Vertrees Ditch	Elnora	FS	Monitored (b)		3	
33)	Kane Ditch	Odon	FS	Monitored		4	
34)	Smothers Creek	Plainsville	FS	Monitored (b)		4.	
35)	South Fork Prairie Creek	Montgomery	FS	Monitored (b)		5	
36)	Wilson Creek	Monroe City	FS	Monitored (b)		6	
37)	Buck Creek	Yorktown	FS	Evaluated		10	
38)	Bell Creek	Yorktown	FS	Evaluated		10	
39)	Prairie Creek	Muncie	FS	Evaluated		5	
40)	Killbuck Creek	Anderson	FS	Evaluated		20	
41)	Fall Creek (Headwaters through Geist Reservoir)	Pendleton	FS	Monitored (b)		17	
42)	Lick Creek	Ingalls	FS	Evaluated		13	
43)	Mud Creek	Summitville	FS	Evaluated		8	
44)	Duck Creek (lower 8 miles)	Strawtown	FS (Threatened)	Evaluated		8	Periodic bypassing from Elwood POTW threatens this reach of stream.
45)	Cabin Creek	Farmland	FS	Monitored (b)		10	

TABLE 38. WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE WEST FORK OF WHITE RIVER BASIN. (con't)

	WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
46)	Cicero Creek	Cicero	FS (Threatened)	Monitored (b)		7	Occasional problems at the Sheridan and Cicero POTWs as well as nonpoint runoff threaten this stream.
47)	Little Cicero Creek	Cicero	FS	Evaluated		16	
48)	Cool Creek	Westfield	FS	Evaluated		11	
49)	Williams Creek	Indianapolis	FS	Evaluated		6	
50)	Little Eagle Creek	Indianapolis	FS (Threatened)	Evaluated		5	Urban, nonpoint runoff periodically threatens this stream.
51)	Fall Creek	Immediately Downstream Geist Reservoir	FS	Evaluated		6	
52)	Mud Creek	Clayton	FS	Monitored (b)		6	
53)	West Fork White Lick Creek	Pittsboro	FS	Monitored (b)		5	
54)	East Fork Big Walnut Creek	North Salem	FS	Evaluated		8	
55)	West Fork Big Walnut Creek	North Salem	FS	Evaluated		10	
56)	Big Walnut Creek	Roachdale to Reelsville	FS	Monitored (b)		35	
57)	Eel River	Worthington	FS	Evaluated		10	
58)	North Prong Stotts Creek	Centerton	FS	Evaluated		3	
59)	Indian Creek	Morgantown	FS	Monitored (b)		12	
60)	Sycamore Creek	Centerton	FS	Evaluated		7	
61)	Plass Ditch	Decker	FS	Evaluated		5	

1 *PS = Partial Support; NS = Non Support; FS = Full Support. The uses not supported are listed. If only one use is listed as not being supported, all other uses are supported.*

2 *b = biological; c = chemical.*

POTW. All criteria were met at the water quality monitoring station at Winchester.

The watershed of the WF White River from Muncie to Noblesville contains the large population centers of Muncie and Anderson plus many small communities. The POTW discharges, periodic combined sewer overflows (CSOs), and urban nonpoint runoff cause a decline in water quality in this area.

There have been several fish kills downstream of Muncie. In 1985, combined sewer overflows (CSOs) in Muncie killed 60,000 fish. This kill included significant numbers of sport fish as well as suckers and carp. Fecal coliform concentrations downstream of Muncie, Yorktown, and Anderson commonly exceed standards although the number of violations was reduced in 1987 at all four fixed water quality stations between Muncie and Noblesville.

No fish kills have been reported since 1985 in the stretch of WF White River between Muncie and Noblesville. Muncie recently renovated their POTW including improving sludge handling facilities. Since an enforcement action with Muncie was finalized in January of 1986, POTW final effluent quality has improved dramatically. Problems with CSOs are also being addressed and water quality in the WF White River has improved in the 56 mile segment between Muncie and Noblesville during the last two years. However, because of periodic violations of the fecal coliform standard, the river in this segment only partially supports its recreational use. Aquatic life use is fully supported.

The 71 mile segment of WF White River between Noblesville and Martinsville is currently under a complete fish consumption advisory (Table 19) due to elevated PCB and chlordane levels in the fish and sediments of the river. The PCBs are coming from the property of the Firestone Company near Noblesville. The PCBs drained to Wilson Ditch, then to Stoney Creek which flows into WF White River. Firestone Industrial Products of Noblesville has made arrangements for a complete cleanup of PCB contamination on their property. Firestone's consulting engineer prepared a PCB Remediation Plan and Site Safety and Health Plan which was accepted by the Indiana Department of Environmental Management (IDEM) in August 1987. The company has also completed a sediment survey of the part of Wilson Ditch on their property to determine the location of the PCB contamination. In July 1987, a RCRA Facility Work Plan was submitted by Firestone to E.P.A. It is expected that the source of PCB contamination will soon be eliminated under a RCRA 3008H Agreed Order yet to be finalized.

The complete fish consumption advisory on WF White River between Noblesville and Martinsville places this 71 mile segment in a status of non support for aquatic life despite the fact that most of the river supports many kinds of fish and a diverse macroinvertebrate community. The fish and sediments of the WF White River were sampled for toxic contaminants again at fifteen location in the summer of 1987, but analyses of these samples are not yet completed.

The part of the WF White River flowing through Indianapolis is of generally good water quality although there are CSO problems and ongoing run-off from the many construction sites. The river supports a good sport fishery, and it is heavily used for boating and partial body contact recreation.

The segment of the WF White River from Indianapolis downstream to Henderson Ford (about 20 miles) is impacted by the two Indianapolis POTWs. Aquatic life is impaired, especially during hot weather, low flow conditions. Fecal coliform counts frequently exceed standards. Water quality conditions have improved during the last two years, however, and fish and other aquatic life show some indications of recovery. The City of Indianapolis has implemented many waste treatment plant renovations in the past two years and has recently received state and federal awards totaling $60,458,162 to further upgrade the two POTWs. The needs addressed with these funds will be additional advanced waste treatment and ammonia removal facilities. Current completion dates are listed as June 1989 and February 1990.

The segment of the WF White River between Martinsville and the West Fork's confluence with the East Fork of White River near Petersburg is under a general fish consumption advisory (Table 19), due to elevated levels of PCBs and chlordane found in fish tissues. Because the PCB and chlordane levels were generally lower in this segment of the river, it has been placed in the partially supporting status for aquatic life rather than in the non supporting status of the previous segment.

This 142 mile length of the WF White River is considered only partially supporting the aquatic life, solely on the basis of the fish consumption advisory. The river supports diverse fish and macroinvertebrate communities and water quality is good. Fish and sediments from this segment of the WF White River were also sampled for toxic contaminants in 1987. The results of these analyses are not yet available.

The lower 48 miles of the WF White River from Petersburg to its confluence with the Wabash River is of generally good quality and supports designated uses. There are two electrical generating stations located at Petersburg just downstream of the confluence of the East and West Forks. Recently issued NPDES permits for these generating stations contain more stringent thermal effluent limitations, including the requirement to reduce generation if necessary to meet water quality standards. There are no other major dischargers on this reach of the river, but some tributaries do receive periodic runoff from oil well operations and both active and abandoned mines.

Fifty-eight of the tributaries (435 stream miles) of the WF White River have been assessed. The smaller streams that receive low volume municipal and industrial discharges have usually been assessed biologically by habitat and use evaluation studies. The larger streams receiving larger discharges have been assessed chemically and biologically during 24 hour compliance surveys.

Nearly all the tributaries receive agricultural nonpoint runoff which results in some degree of siltation, nutrient enrichment, and exposure to pesticides. The streams of the lower part of the WF White River Basin are more severely channelized for drainage than the streams of the upper basin, however, nearly all have undergone some type of habitat alteration. The severely channelized waterways usually support only low diversity aquatic life communities and are not attractive recreation resources.

Wilson Ditch and Stoney Creek near Noblesville do not support their aquatic life uses as a result of a complete fish consumption advisory on these streams (Table 19). The fish are heavily contaminated with PCBs which have come from the Firestone Industrial Products facility which has a discharge to Wilson Ditch. The PCBs appear to come from roof and surface drains which become part of their discharge and not from actual manufacturing processes. The IDEM and Firestone have almost reached agreement on a plan to clean up stream sediments and plant sludges which contain high PCB levels. It is thought that this source has also contributed significantly to the PCB problems in the fish of the WF White River (see earlier discussion on mainstream fish advisory).

Conards Branch in Monroe County (complete advisory) and Richland Creek in Monroe and Greene counties (general advisory) also have problems with PCBs in fish (Table 19). The source of the PCBs in these streams appears to be Neal's Landfill which drains to Conards Branch and then to Richland Creek. Neals Landfill contains PCB contaminated wastes. A two mile reach of Stouts Creek, also in Monroe County, has fish and sediment which contain high levels of PCBs which appear to have leached from Bennetts Landfill. Both Neals Landfill and Bennetts Landfill have now been capped with clay to prevent further leaching until a more complete cleanup can be done.

Several streams in the WF White River basin do not fully support their designated uses due to poor POTW operation, CSOs, and POTW bypassing due to overloaded plants. Streams which fall into this category would include: Duck Creek at Elwood in Madison County; White Lick Creek in Hendricks County downstream of Brownsburg and Plainfield; lower Fall Creek and Pleasant Run Creek in Marion County; Beehunter Ditch near Linton in Greene County, and Hawkins Creek at Washington in Daviess County. Problems in these streams are due to high ammonia, low dissolved oxygen, and high chlorine residual. In many instances, projects are under way or nearly completed at these locations to correct these problems (Table 38).

Of the assessed tributaries to the WF White River which fully support their designated uses, several are threatened. In most cases these streams are threatened due to occasional treatment problems or bypassing at POTWs and/or nonpoint runoff. Streams in the basin which have been assessed and fall in this category would include: Pipe Creek in Madison County, the West Fork of White Lick Creek in Hendricks County, the lower eight miles of Duck Creek in Madison County, Little Eagle Creek in Marion County, and Cicero Creek in Tipton County. In several cases the POTW problems are currently being addressed through upgrading or expansion. Table 38 contains information on these stream reaches and what is currently being done to address these potential problems.

Bean Blossom Creek in Monroe County is threatened due to low levels of PCBs which have been found in the tissue of fish collected from this stream. The source of these PCBs appear to be drainage from Bennetts Landfill which goes to Stouts Creek, a tributary of Bean Blossom Creek. Bennetts Landfill was a disposal site for PCB containing wastes.

Eel River in Putnam and Green counties is another stream which currently supports its designated uses but is threatened. The major threat to this stream is the high volume of nonpoint runoff from the heavily farmed lands in the drainage basin.

Several other assessed streams in the basin do not fully support their designated uses due to problems from various sources. The East Fork of White Lick Creek in Marion County has received periodic bypassing from a lift station, metals contamination from Quemetco Corporation and industrial effluent from the Avon Railroad yards. Urban, industrial, and agricultural nonpoint runoff also periodically affect this stream. The lower four miles of Eagle Creek in Marion County are affected by bypassing and poor effluent quality from the Speedway POTW and several industrial discharges containing high metals concentrations. Flow fluctuations caused by water release and retention schedules at the Eagle Creek Reservoir dam also effect the ability of the stream to maintain a diverse aquatic life community. Several actions taken recently on these streams such as repairs to the defective lift station, enforcement action against the Speedway POTW, and improved treatment at several of the industries should result in improved water quality in these streams.

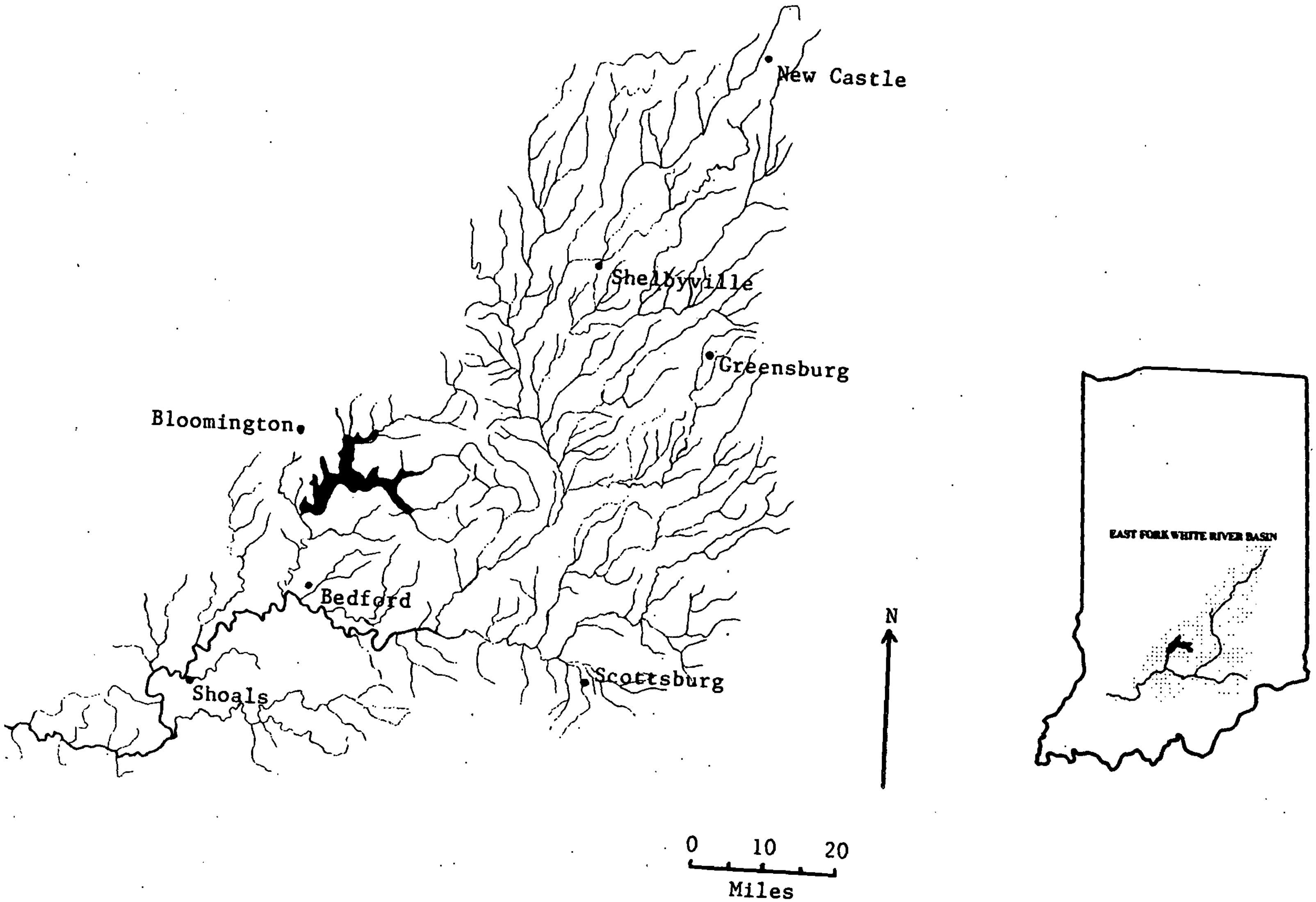
Indian Creek near Bicknell in Knox County does not support aquatic life for about four miles due to acid drainage from abandoned mine land. This stream is already impacted by acid mine drainage before it receives the discharge from the Bicknell POTW. Lilly Creek near Orestes in Madison County receives seasonal discharges from the Red Gold Cannery and several fish kills have occurred there in the past due to excessive discharges of organic oxygen demanding wastes. These discharges do not allow full support of uses for at least one mile downstream of the discharge.

In summary, 794 stream miles were assessed in the WF White River basin. Of these assessed miles 58% fully support their designated uses (10% in this category are considered threatened). Another 30% partially support designated uses, and 12% do not support designated uses. Of the 278 assessed miles that do not fully support aquatic life uses in the basin, approximately 60% are due only to fish consumption advisories. Diverse aquatic life communities exist in all but 41 miles (5%) of the streams assessed in this basin.

East Fork of White River Basin

The East Fork of White River drains about 5,600 square miles of southern Indiana (Figure 14). Roughly 15,000 miles of streams and ditches are included in the basin. Sugar Creek, Big Blue River, Driftwood River, Flatrock River,

Figure 14. East Fork of White River Basin.



the Muscatatuck River, and Salt Creek are the river's major tributaries. The largest cities in the watershed (populations greater than 15,000) are Columbus, Seymour, Bloomington, New Castle, Shelbyville and Bedford.

The topography of this basin ranges from flat to rugged as it crosses seven of southern Indiana's eight physiographic regions. The basin also includes unique underground streams in the karst region of caves and sinkholes in Orange and Lawrence counties. Agriculture is important in the flatter regions, but much of the watershed is forested. The groundwater contribution to stream flow in the basin is low, so flow depends largely on rainfall, and variations can be considerable. Compared to other basins, stream channelization projects in the East Fork of White River Basin have been minimal.

The East Fork of White River system has always supported an important sport fishery. State records for flathead catfish, freshwater drum, rock bass, flier, sucker, and smallmouth bass have all come from this river or one of its tributaries. The reputation of the river to support large fish continues to be justified, as the state records for sucker and smallmouth bass were set in 1984 and 1985. The lower reaches of the river are used as a commercial fishery. An important freshwater mussel fishery also exists in the lower portion of the river. The shells of certain mussels are used in the cultured pearl industry and are commercially valuable.

There are drinking water supply intakes on the East Fork of the White River at Bedford, Mitchell, and Seymour. Surface water supplies for drinking are also found at Paoli, West Baden, Bloomington, Westport, North Vernon, and Scottsburg on various tributaries of the river. Therefore, the water in this basin must meet the raw water standards for potable water supply at the municipal intakes.

The river and several of its tributaries are popular canoeing streams. The 1983 Indiana Canoeing Guide prepared by the Department of Natural Resources lists the Driftwood, Flatrock, and Muscatatuck rivers as especially good for this sport. At least one commercial canoe livery operates within the basin. Like most other Indiana streams, the river is designated for partial-body contact recreation and must meet bacterial standards for this use as well.

The Lost River and many of its tributaries in Orange and Martin counties have recently been designated for exceptional use. This designation should help preserve the exceptional water quality in the watershed and help protect several unusual aquatic animals, including blind cavefish, which inhabit the river. Several streams in the basin have recently been designated for limited use, based on their lack of sufficient habitat to support a diverse fishery. These include Plasterers Creek at Loogootee, portions of Brewer's Ditch at Whiteland, and portions of Ackerman Branch and Mill Creek at Jasper.

Water quality monitoring in the basin during 1986 and 1987 included:

1. Monthly or quarterly chemical and bacteriological sampling at ten fixed stations (EW-1, EW-79, EW-94, EW-168, EW-239, BL-0.7, BL-64, SLT-12, MU-20, and SGR-1).

2. Biological sampling and fish tissue and sediment analysis at one CORE station (EW-79).

3. Biological sampling and fish tissue and sediment analysis at 25 additional sites in the basin (Flatrock River, Big Blue River, Clear Creek, Salt Creek, Pleasant Run, Sugar Creek, Muddy Fork Creek, Sand Creek, and the East Fork of White River).

4. Effluent toxicity testing at POTW's in Greensburg, Bedford, and Bloomington South and at Eli Lilly (Greenfield) and Crane Naval Weapons Support Center (Crane).

5. A fisheries study funded by IDNR at 20 sites on streams draining the Crane Naval Weapons Support Center.

6. Habitat and use attainability studies at Loogootee, Spiceland, Freetown, Lexington, Seymour, Oolitic, and North Vernon.

Those waters assessed, the status of designated use support, the method of assessment, probable causes of non-support, and miles affected are shown in Table 39. Additional comments on certain reaches are also given in this table.

Tissue analysis of fish collected in 1983 from Big Blue River, Sand Creek, Muddy Fork Creek, Clear Creek, Salt Creek, Pleasant Run, and the East Fork of White River indicated a potentially serious PCB and pesticide contamination problem in the streams. Fish consumption advisories were issued for certain reaches in 1987 (Table 19). An advisory recommending a complete ban on fish consumption prevents about 70 miles of streams in the basin from meeting uses for aquatic life. A general advisory allowing limited consumption of fish affects an additional 240 stream miles. These reaches are only partially supporting uses for aquatic life.

The sources of PCBs in Clear Creek, Salt Creek, and Pleasant Run were associated with industrial inputs identified in the 1970's and eliminated through point source controls. Westinghouse Corporation in Bloomington began court-ordered hydrovacuuming of contaminated sediments in Clear Creek and Salt Creek during 1987. This clean-up is expected to help reduce continued PCB contamination of fish in these streams and in the East Fork of White River below Bedford.

Chlordane and/or dieldrin concentrations in fish tissue are the primary cause of fish consumption advisories in the remaining streams. The source of these pesticides (which are no longer used in the U.S. but are highly persistent in the environment) is unknown at present. No point source dischargers of these pesticides have been identified, and nonpoint runoff from previously contaminated upland sites is probably responsible for their

TABLE 39. *WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE EAST FORK OF WHITE RIVER BASIN.*

	WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT[1]	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
1)	Plasterers Creek/ Friends Creek	Loogootee	NS (Aquatic Life)	Evaluated	D.O, Ammonia Minimum conditions	4	Loogootee placed on State's Project Priority List for probable future funding of POTW expansion.
2)	Big Blue River	New Castle	NS (Aquatic Life)	Monitored (b)(c)	Chlordane Metals	10	a) Allegeny-Ludlum Steel (New Castle) received a new permit with lower metals limits. b) Avesta, Inc, (New Castle) will cease discharge and connect to POTW.
3)	Clear Creek/Salt Creek/East Fork White River from Bedford to Williams	Bloomington Bedford Williams	NS (Aquatic Life)	Monitored (b)(c)	PCBs Chlordane D.O.	40	a) Westinghouse began implementing Consent Decree to hydrovaccum PCB contaminated sediments from Clear Creek and Salt Creek. b) Permit limits placed on Bloomington POTW and GM Central Foundry for PCBs.
4)	Pleasant Run	Bedford	NS (Aquatic Life)	Monitored (b)(c)	Chlordane PCBs Heptachlor	4	a) General Motors Corp. Central Foundry near Bedford, signed a Consent Decree for a design plan to lower metals concentrations in effluent; paid $7500 fine for past phenol violations.
5)	Gas Creek/Sand Creek/Muddy Fork	Greensburg	NS (Aquatic Life)	Monitored (b)(c)	Chlordane Dieldrin D.O., Ammonia Metals	15	Greensburg adopted a municipal compliance plan to eliminate bypasses and install ammonia removal by 1990.
6)	Muscatatuck River	Austin Scottsburg	PS (Aquatic Life)	Monitored (c)	D.O. Ammonia	25	Scottsburg received a $1.8 million grant for expansion of their POTW and ammonia removal. Construction is due for completion in 1988.

TABLE 39. WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE EAST FORK OF WHITE RIVER BASIN. (con't)

	WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
7)	Lick Creek	Paoli	PS (Aquatic Life)	Evaluated	D.O. Ammonia	5	Paoli received a $2.2 million grant for advanced waste treatment and ammonia removal. Construction to be completed in 1988.
8)	Underground Lost River	Orleans	PS (Aquatic Life)	Evaluated	D.O. Ammonia	5	Orleans was placed on State's Project Priority List for probable future funding of POTW expansion.
9)	Rock Lick Branch	Mitchell	PS (Aquatic Life)	Evaluated	D.O. Ammonia	4	Mitchell received a $2.3 million grant for POTW expansion, advanced treatment, and ammonia and phosphorus removal. Construction to be completed in 1990.
10)	E. F. White River (Williams to Lawrence County Line)	Williams	PS (Aquatic Life)	Monitored (b)(c)	PCBs Chlordane D.O.	5	
11)	E.F. White River (Columbus to Bedford)	Columbus Seymour Browntown Medora	PS (Aquatic Life)	Monitored (b) (c)	PCBs Chlordane D.O.	145	a)An enforcement action was taken to eliminate an illegal discharge at the Keiffer Paper Company in Brownstown. b) Brownstown completed a $2.5 million expansion of their POTW in 1987. c)United Plastics in Medora paid a $50,000 fine and signed a Consent Decree to build a new treatment facility. d) Medora was placed on the State's Project Priority List for probable future funding of POTW expansion.
12)	Big Blue River	Carthage Shelbyville Edinburg Knightstown	PS (Aquatic Life) (Recreational)	Monitored (b)(c)	Chlordane Fecal coliforms	60	a) Shelbyville signed a Consent Decree to seek funding for expansion of POTW. b) Knightstown is required to complete sewer hook-up to unsewered area presently discharging to Big Blue River.

TABLE 39. WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE EAST FORK OF WHITE RIVER BASIN. (con't)

	WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
13)	Sand Creek	Below Greensburg	PS (Aquatic Life)	Monitored (b)(c)	Chlordane Dieldrin	15	
14)	Leary Ditch/Little Sugar Creek	Greenfield	PS (Aquatic Life)	Monitored(b) (c)	Ammonia	4	
15)	Underground Carters Creek	Campbellsburg	PS (Aquatic Life)	Evaluated	Ammonia D.O.	3	Campbellsburg placed on State's Project Priority List for probable future funding of POTW expansion.
16)	Millstone Creek	Westport	PS (Aquatic Life)	Evaluated	Ammonia D.O.	3	A $1.1 million expansion of the Westport POTW is due for completion in 1988.
17)	Pee Dee Ditch	Wilkinson	PS (Aquatic Life)	Evaluated	Ammonia D.O.	2	Wilkinson has signed a letter of intent to connect a sewage collection facility to the Shirley POTW.
18)	Brock Bezor Ditch	Spiceland	PS (Aquatic Life)	Monitored (b)	Ammonia D.O.	2	
19)	Hominy Ditch	Crothersville	PS (Aquatic Life)	Evaluated	Ammonia D.O.	1	A $2.2 million expansion of POTW, including advanced treatment and ammonia removal due for completion in 1988.
20)	Brewer Ditch	Whiteland	PS (Aquatic Life)	Evaluated	Ammonia	3	Whiteland issued an Order of Complaince to set new interim limits and construction schedule for expansion of POTW.
21)	North Fork of Salt Creek	Nashville	PS (Aquatic Life)	Evaluated	Ammonia D.O.	3	A $1.3 million expansion of POTW is due for completion in 1988.
22)	Heddy Run	Seymour	PS (Aquatic Life)	Evaluated	Metals Pesticides Phenols Cyanide	1	Remedial Plan for Seymour Recycling site has been finalized to clean up soil and groundwater.
23)	Sugar Creek	Edinburg	PS (Recreational)	Monitored (b)	Fecal coliforms	5	
24)	Slate Creek	Alfordsville	PS (Aquatic Life)	Evaluated	Abandoned Mine Drainage (pH, Metals)	7	A $138,000 reclamation project was completed in 1986 under IDNR's Abandoned Mine Lands Program.

TABLE 39. WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE EAST FORK OF WHITE RIVER BASIN. (con't)

	WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
25)	Little Blue River	Mays, Shelbyville	FS - Threatened	Monitored (b) (c)		25	Metals.
26)	Brandywine Creek	Greenfield	FS - Threatened	Monitored (b) (c)		25	Metals, Cyanide.
27)	Clifty Creek	Hartsville	FS - Threatened	Evaluated		10	Pesticides.
28)	Boggs Creek	Martin County	FS - Threatened	Monitored (b)		15	Metals, Cyanide, non-Prority Pollutants. The Crane Naval Weapons Storage Depot is on a compliance schedule to meet, ammonia, cyanide, copper, and pH Limits.
29)	Lost River	Orange and Martin Counties	FS	Monitored (b)		40	
30)	Montgomery Creek	Kennard	FS	Monitored (b)		8	
31)	Little Sugar Creek	Greenfield	FS	Monitored (b) (c)		10	
32)	Six Mile Creek	Shirley	FS	Evaluated		10	
33)	Sulphur Creek	Martin County	FS	Monitored (b)		10	
34)	South Fork Salt Creek	Freetown	FS	Monitored (b)		15	
35)	Town Creek	Lexington	FS			5	
36)	Luther McDonald Ditch	Seymour	FS	Monitored (b)		3	
37)	Goose Creek	Oolitic	FS	Monitored (b)		2	
38)	Six Mile Creek	Jennings County	FS	Monitored (b)		6	
39)	Youngs Creek	Franklin	FS - Threatened	Monitored (b)		10	Pesticides and low D.O. levels. In 1987, Franklin completed a $1.5 million expansion of its POTW.
40)	Cooks Creek/Little Sand Creek	Elizabethtown	FS	Evaluated		5	
41)	Flatrock River	Columbus, Rushville	FS - Threatened	Monitored (b) (c)		40	Pesticides.
42)	Grassy Creek	New Whiteland	FS	Evaluated		3	
43)	Conns Creek	Waldron	FS	Monitored (b)		3	
44)	Little Flatrock River	Milroy	FS	Evaluated		7	

TABLE 39. WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE EAST FORK OF WHITE RIVER BASIN. (con't)

	WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
45)	South Fork Otter Creek	Holton	FS	Evaluated		10	
46)	Haw Creek	Hope	FS - Threatened	Evaluated		10	Pesticides.
47)	Sugar Creek	New Palestine to Edinburgh	FS - Threatened	Monitored (b)		25	Pesticides.
48)	Driftwood River	Edinburg Columbus	PS (Aquatic Life)	Evaluated	Chlordane	15	
49)	E.F. White River (Lawrence County Line to mouth)	Shoals Petersburg	FS	Evaluated		75	
50)	Sand Creek	Brewersburg	FS	Evaluated		10	

1 PS = Partial Support; NS = Non Support, FS = Full Support. All uses not supported are listed. If only one use is listed as not being supported, all other uses are supported.

2 b = biological; c = chemical.

presence in streams. Additional fish and sediment sampling was done in 1987 to help determine if the problem still persists and help locate sources of contaminants. Results of this testing are not yet available.

Approximately 10 miles of the upper Big Blue River near New Castle are not supporting uses for aquatic life due partly to contamination of water and sediments by metals. These metals are believed to originate primarily from two steel mills in New Castle. Previous effluent toxicity tests at Allegheny Ludlum Steel and Avesta, Inc. confirmed the potentially toxic effect of these discharges on aquatic life.

In addition to the stream uses impaired by contaminated fish and sediments, inadequately treated sewage partially impairs an additional 50 miles of streams in the basin. Low dissolved oxygen and high ammonia concentrations adversely affect aquatic communities at Mitchell, Orleans, Greensburg, Campbellsburg, Spiceland, Wilkinson, Crothersville, Whiteland, Westport, and Nashville. Low dissolved oxygen concentrations (some of which may be natural) also, partially impair uses in the lower Muscatatuck River. Sewage related pollution at the Loogootee POTW is even more severe and completely impairs four miles of stream uses in Plasterers Creek and Friends Creek. Seven miles of Slate Creek in Daviess County were partially impaired by drainage from 20 acres of unreclaimed, barren mine spoil.

There were four confirmed fish kills and reports of six others in the basin during 1986 and 1987. All of the confirmed kills were caused by agricultural practices (spills of swine waste and fertilizer). The largest kill occurred in Clifty Creek and involved 10,200 fish in 1.5 miles of stream. No stream uses were considered to be impaired by any of these fish kills because most were relatively minor, isolated incidents.

Bacteriological sampling at ten fixed stations in the basin provides an estimate of how safe the waters are for swimming (recreational use). All streams in the basin are designated for partial body contact. The East Fork of White River mainstem, Salt Creek, and Muscatatuck River fully support this use. These sites account for roughly 80% of all miles monitored in the basin. The remaining 20% of the streams monitored in the basin only partially support recreational uses. Sites on lower Sugar Creek and Big Blue River violated partial body contact standards 10 to 25 percent of the time. It is impossible to determine with the limited data available whether violations were caused by point sources, CSO's or runoff from animal feedlots.

In general, water quality in the East Fork of White River Basin was worse in 1986 and 1987 than it was in 1984 and 1985. During the most recent monitoring period, four of the ten fixed stations in the basin had dissolved oxygen violations. There were no violations at these sites in 1984 and 1985. The recent violations were frequent enough to partially impair uses for aquatic life at one site (the lower Muscatatuck River). No impairment caused by low dissolved oxygen was noted at any of the sites in 1984 and 1985. The suitability of streams in the East Fork of White River basin for partial body contact recreation and as raw water sources for potable water supplies remained essentially unchanged from previous years.

Improvements in water quality should soon be forthcoming because of improved wastewater treatment at several sites. Expanded sewage treatment facilities at Paoli, Westport, Greensburg, Crothersville, Mitchell, Nashville, Franklin, Brownstown and Scottsburg are due for completion during late 1987 through 1990. Also, agreements by Allegheny Ludlum Steel and Avesta, Inc. at New Castle to improve metals treatments or cease direct discharges should help improve water quality in the Big Blue River. Twenty acres of abandoned mine lands in Daviess County were reclaimed in 1986 under IDNR's Abandoned Mine Lands Program and should improve conditions in Slate Creek in Daviess County.

In summary, 761 miles of streams were assessed in the East Fork of White River Basin in 1986 and 1987. About 51 percent of those assessed fully supported designated uses, 39 percent were partially supporting, and 10 percent did not support designated uses. Accumulations of high levels of PCB's and pesticides in fish accounted for most (about 80 percent) of the stream miles not meeting or only partially meeting the designated uses.

The Ohio River Basin

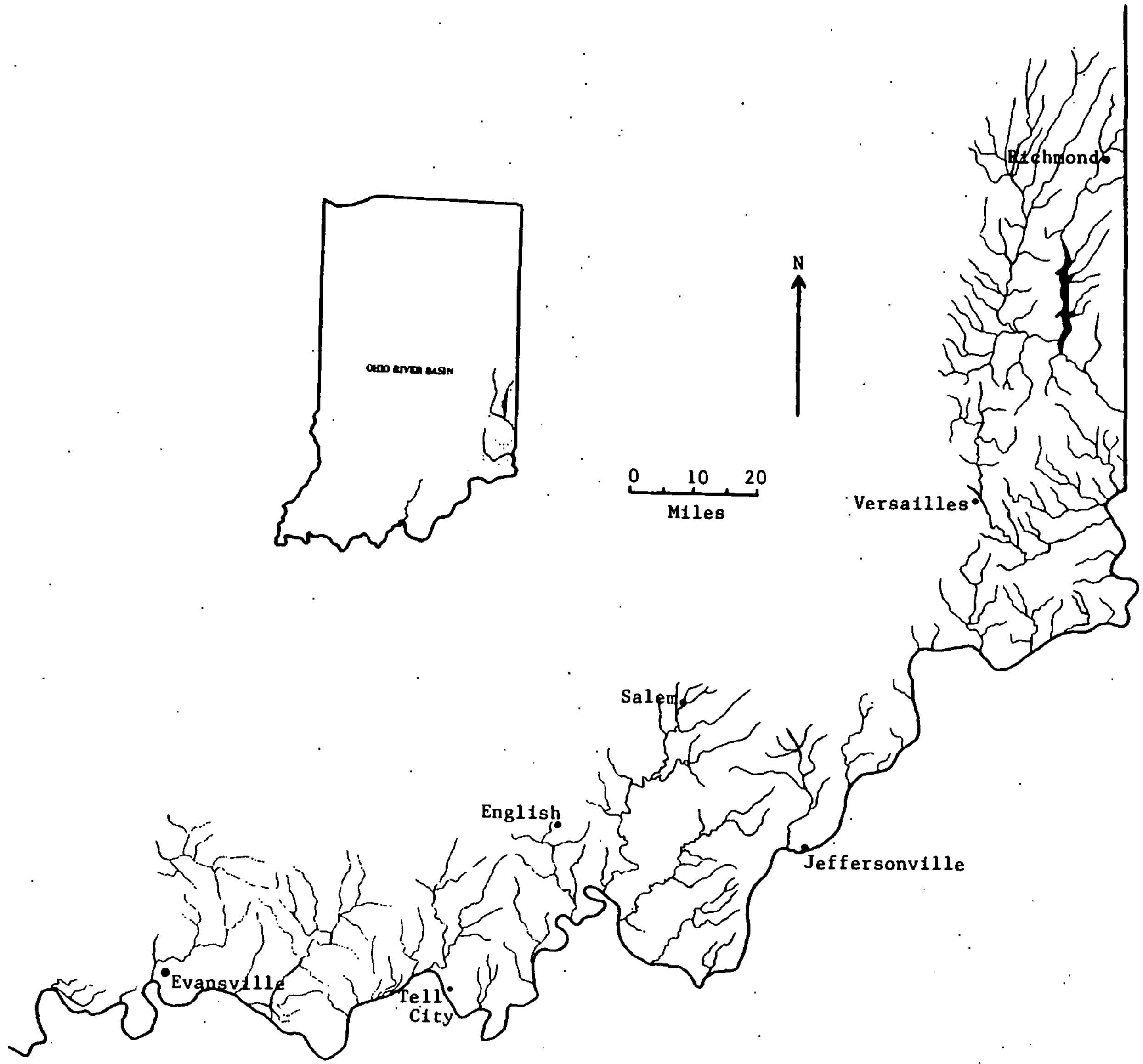
The Ohio River and its Indiana tributaries (excluding the Wabash River) drain approximately 5,800 square miles in Indiana (Figure 15). The major Indiana tributaries in the basin are: the Whitewater River (via the Great Miami River in Ohio), the Blue River, the Little Blue River, the Anderson River, Laughery Creek, Big Indian Creek, and Pigeon Creek. The major land use in the basin is agriculture, but a large portion of the land is hilly and rolling, and much is still heavily forested. Strip mining operations are important in certain portions of the basin.

Water quality monitoring of the Ohio River itself, which forms the southern boundary of 13 Indiana counties from about mile points 492 to 848 (356 miles), is done by the Ohio River Valley Water Sanitation Commission (ORSANCO), a consortium composed of eight states, six of which border the Ohio River mainstem. ORSANCO maintains fixed water quality monitoring stations on the portion of the Ohio River which borders Indiana. The State of Indiana maintains fixed water quality monitoring stations on some of the tributaries, and Department of Environmental Management (DEM) personnel conduct compliance surveys and other water quality monitoring activities on Indiana facilities and water bodies that discharge to the Ohio River.

The U.S. Army Corps of Engineers operates a series of 20 locks and dams on the Ohio River to allow year round navigation. Four of these are located along Indiana's southern boundary, and these dams create slowly moving lakes or pools in the Ohio River.

Indiana Regulation 327 IAC 2-1 disgnates the Ohio River for general uses and whole body contact recreation. The Ohio River has also been designated by the Ohio River Valley Water Sanitation Compact as "available for safe and satisfactory use of public and industrial water supplies after reasonable treatment, suitable for recreational usage, capable of maintaining fish and other aquatic life and adaptable to such other uses as may be legitimate". Such other uses would include navigation and power generation.

Figure 15. Ohio River Basin.



Recreational uses occur all along the river. There are no designated swimming beaches and whole body contact recreation consists mainly of water skiing and swimming from boats. The main stem of the Ohio and especially the tributary embayments created by the dams are extensively used for sport and commercial fishing. These recreational uses have increased in recent years due both to increased demands and leisure time for water based recreation and to improved water quality.

Indiana has 14 municipal water supply intakes on the Ohio River, three of which are greater than two million gallons per day (mgd): Indiana Cities at mile point (MP) 609; Evansville at MP 702.53 and Mount Vernon at MP 829.2. There are 17 municipal discharges and 13 industrial discharges to the Ohio River from Indiana, but only five are two mgd or greater (Jeffersonville, New Albany, Evansville, ALCOA-Warrick, and Newburg). There are three electrical generating stations and 13 Indiana river terminals that handle petroleum products and/or hazardous wastes.

Although most of Indiana's discharges do not appear to be causing problems in the Ohio River, several actions have occurred recently which should enhance water quality. Enforcement action has been initiated against the South Dearborn Region Sewer District to force compliance with the sewer use ordinance in order to prevent plant upsets, and Madison is under a 1987 EPA Administrative Order to correct inflow/infiltration, to reduce wet weather bypassing and maintain permit compliance. New or expanded and upgraded POTWs are completed or scheduled to be completed soon at Charlestown, Clarksville, and Tell City. The cities of Cannelton and Troy will be sending their wastewaters to the Tell City POTW, eliminating these discharges. Some problems still exist at the Rockport and Mount Vernon POTWs, mainly due to operational and maintenance problems.

A brief summary of the information contained in a draft ORSANCO 1986-87 305(b) report assessing water quality conditions in the Ohio River mainstream is provided below. A more detailed discussion of the water quality conditions in the Ohio River mainstem can be found by referring to the 1986-87 ORSANCO 305(b) report.

The ORSANCO report indicates that the entire length of the Ohio River bordering Indiana would only partially support aquatic life and public water supply uses. Approximately 40 miles of the Ohio River downstream of Cincinnati and 23 miles between McAlpine Dam and the Salt River (Kentucky) do not support recreational (whole body contact) uses. The causes for these areas of nonsupport appear to be the Cincinnati and Louisville metropolitan areas and not Indiana sources. The remaining 293 miles of the Ohio River which border Indiana do fully support recreational uses. The ORSANCO report indicates that of the 356 Indiana miles of the Ohio River, all support the "fishable" goal of the Clean Water Act, and 293 miles support the "swimmable" goal.

The main problems relating to less than full support of designated uses of the Ohio River, according to the ORSANCO 305(b) report, are metals, pathogens (fecal coliforms), and priority organics. The metals of most concern were arsenic, mercury and lead, and the priority organics of concern were chloroform and PCBs. Chlordane was detected in many of the fish tissue samples, but only one sample (a carp collected at the Newburg Lock and Dam) exceeded FDA action levels. Other fish samples collected at that site were well below the FDA action level.

Since 1968, ORSANCO has worked with state and federal agencies along the Ohio River to sample fish communities at various lock chambers. A total of 81 species of fish have been identified. Fish were collected at 13 locks in 1985 and 21 locks in 1987. The data collected since 1968 show general improvement in species diversity of the fish community and an increased presence of pollution sensitive species such as sauger. This would indicate general improvement in water quality over this time.

Fifty-one Indiana streams tributary to the Ohio River comprising 818 stream miles have been assessed. Table 40 shows the waters assessed, the status of designated use support, the probable causes of impairment, and the number of miles affected in the Ohio River Basin. Additional comments are also provided for certain reaches.

Most Indiana streams in the Ohio River Basin fully support their designated uses. Those that do not are most often impaired by municipal discharges, hydro/habitat modifications caused by channelization, and strip mining. Nonpoint runoff from agricultural fields and mined areas also impacts many of the streams especially in the western portion of the basin.

Many of the streams in this basin are low gradient watercourses that are often very low or pooled during dry periods and are not capable of assimilating heavy organic loadings. Many waterways drain wetlands or former wetlands and have naturally low dissolved oxygen levels.

Harvey Branch downstream of Oldenburg, Laughery Creek below Versailles, a tributary of Laughery Creek below Osgood, and Little Pigeon Creek downstream of Dale are all relatively small streams which at present do not support designated uses due to impacts resulting from discharges from the POTWs in these towns. Both Dale and Versailles have received grant awards for POTW upgrading and expansion. This should improve water quality in their receiving streams when these improvements are completed.

Cane Run in Clark County does not currently support its designated uses. Cane Run received discharges from both the Clarksville POTW and the Jeffersonville POTW until recently. Cane Run was grossly polluted with organics and a significant sludge bank had formed in the Ohio River at the mouth of this stream. Cane Run enters the Ohio in the section of the river known as the Falls of the Ohio. This is an exceptional natural and historical resource, and steps are currently underway to formally protect this area. A new POTW which discharges directly to the Ohio River has just been completed at Clarksville (October 1987). The old POTW is no longer in use. Jeffersonville currently has POTW improvements under review by the state. One option they are considering is to discharge directly to the Ohio upstream from

TABLE 40. INDIANA TRIBUTARY *WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT AND MILES AFFECTED IN THE OHIO RIVER BASIN.*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
1) E. F. Whitewater River	Connersville	FS	Monitored (b,c)		40	The Connersville POTW has continued to operate within its permit limits with the exception of an occasional heavy metals violation. State pretreatment enforcement actions taken against the city and three of its industries should help prevent future metals violations.
2) W.F. Whitewater River	Richmond	FS	Monitored (b,c)		48	Richmond's state of the art POTW is not being fully used. Many treatment facility units are not needed for normal daily flows. However, Richmond's plant experiences difficulties during wet weather.
3) Nolands Fork	Centerville	FS	Evaluated		20	
4) Greens Fork	Greens Fork	FS	Evaluated		20	
5) Martindale Creek	Germantown	FS	Evaluated		15	
6) Williams Creek	Connersville	FS	Evaluated		10	
7) Salt Creek	Oldenburg	FS	Evaluated		12	
8) Pipe Creek	Brookville	FS	Evaluated		10	
9) Big Cedar Creek	Cedar Gove	FS	Evaluated		4	
10) Village Creek	Alquina	FS	Monitored (b)		6	
11) Richland Creek	Cedar Grove	FS	Monitored (b)		1	
12) Silver Creek	Liberty	FS	Evaluated		12	
13) N. F. Tanner Creek	Lawrenceburg	FS	Monitored (b)		16	Enforcement has been initiated with the South Dearborn Regional Sewer District. Two treatment facilities receive flows from the regional district and two distillers. Poor control by the sanitary district allows violations of the sewer use ordinance. Impact on water quality, although never proven, can be substantial due to high BOD waste generated in the service area.
14) S. F. Tanner Creek	Lawrenceburg	FS	Monitored (b)		4	
15) North Hogan Creek	Aurora	FS	Evaluated		10	

TABLE 40. INDIANA TRIBUTARY WATER ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT AND MILES AFFECTED IN THE OHIO RIVER BASIN. (con't)

	WATERBODY	NEAREST TOWN(S)	STATUS OF DESINGATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
16)	South Hogan Creek	Aurora	FS	Evaluated		10	
17)	Laughrey Creek *	Ripley/Ohio County	FS	Evaluated		30	
18)	Indian Creek	Vevay	FS	Evaluated		5	
19)	Plum Creek	Vevay	FS	Evaluated		1	
20)	Indian Kentuck Creek	Brooksburg	FS	Evaluated		21	
21)	Peter Creek	Dillsboro	FS	Monitored (b)		3	Dillsboro POTW is being increased in capacity and treatment level. The anticipated completion date is July of 1988.
22)	Coles Creek	Tennyson	FS	Monitored (b)		5	
23)	Whitewater River	Brookville	FS	Monitored (b,c)		16	
24)	West Fork Pigeon Creek	Fort Branch	FS	Monitored (b)		5	Fort Branch has received state and federal awards totaling $2,402,824 for advanced treatment, disinfection and ammonia removal. The completion date is listed as October of 1989.
25)	Stollsburg Ditch	Chandler	FS	Monitored (b)		2	Chandler has received state and federal funds totaling $1,433,100 for advanced treatment, expansion, and ammonia removal.
26)	Black River	Griffin	FS	Evaluated		10	
27)	Little Blue River	English	FS	Monitored (b)		20	English is reportedly in range of funding for a new treatment plant.
28)	Stinking Fork	Crawford County	FS	Evaluated		3	
29)	Anderson River	Troy	FS	Evaluated		25	
30)	Middle Fork Anderson River	Troy	FS	Evaluated		12	
31)	Deer Creek	Cannelton	FS	Evaluated		5	
32)	Holey Run	Ferdinand	FS	Monitored (b,c)		2	It is projected that Ferdinand will receive a grant for POTW improvements in FY 1988.
33)	Fourteen Mile Creek	New Market	FS	Evaluated		10	

** WITH THE EXCEPTION OF TWO MILES DOWNSTREAM OF THE VERSAILLES POTW DISCHARGE.*

TABLE 40. INDIANA TRIBUTARY WATER ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT AND MILES AFFECTED IN THE OHIO RIVER BASIN. (con't)

	WATERBODY	NEAREST TOWN(S)	STATUS OF DESINGATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
34)	Silver Creek	Sellersburg/ Clarksville	FS (Threatened)	Monitored (b,c)		20	Sellersburg is currently under a State mandate to allow no more sewer connections. The town faces federal fines if the POTW does not comply with effluent standards.
35)	Muddy Fork	Sellersburg	FS	Evaluated		10	
36)	Little Indian Creek	Lanesville	FS	Evaluated		8	Lanesville in Harrison County has a new POTW under construction. The plant should be completed in May of 1988.
37)	8ig Indian Creek	Corydon	FS (Threatened)	Monitored (b,c)		10	Treatment of the Corydon POTW has significantly improved during 1987, however, stringent ammonia limitations cannot be consistently met. State enforcement against a problem poultry industry should help reduce the nitrogen loading of the plant.
38)	Blue River	Fredericksburg	FS	Monitored (b,c)		40	
39)	Middle Fork Blue River	Salem	FS (Threatened)	Monitored (b)		8	
40)	South Fork Blue River	New Pekin	FS	Monitored (b)		20	The community of New Pekin has expanded its POTW.
41)	Georgetown Creek	Georgetown	FS	Monitored (b)		2	
42)	Harvey Branch	Oldenburg	NS (Aquatic Life/Recreation)	Monitored (b,c)	Municipal (POTW) organics Low D.O. Ammonia Fecal coliform	2	Harvey Branch is too small to support a recreational fishery or swmming.
43)	Laughrey Creek	Versailles	NS (Aquatic Life/Recreation)	Monitored (b,c)	Municipal (POTW) organics Low D.O. Ammonia Fecal coliform	1	A judicial order for failure to meet the July 1, 1988, deadline is forthcoming. Construction to rectify POTW problems will involve closure of one of Versailles POTWs and upgrade and expansion of the remaining facility. Versailles has received initial awards totaling $826,826 for expansion and ammonia removal. The Town of 8atesville also discharges to Laughrey Creek in Ripley County. The new plant was put into operation in May of 1984. It is a Classs II, 1.23 MDG, complete mix activated sludge facility. A June, 1987 performance evaluation conducted by EPA concluded that the plant was performing satisfactory in most areas.

TABLE 40. INDIANA TRIBUTARY WATER ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT AND MILES AFFECTED IN THE OHIO RIVER BASIN. (con't)

WATERBODY		NEAREST TOWN(S)	STATUS OF DESINGATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
44)	Tributary of Laughrey Creek	Osgood	PS (Aquatic Life)	Monitored (b,c)	Municipal (POTW) organics	2	The receiving tributary is too small except for a minnow fishery and partial body contact recreation.
45)	Otter Creek	Boonville	NS (Aquatic Life)	Monitored (b)	Acid Mine	8	
46)	Cypress Creek	8oonville	NS (Aquatic Life/Recreation)	Monitored (b,c)	Municipal (POTW) organics Acid Mine, Chlordane, Fecal coliform	10	8onnville has received $4,392,025 in initial grants for advanced treatment, expansion, and ammonia removal. The town is currently upgrading the existing plant. Construction of a two cell CSO lagoon is also included in the project. Boonville has agreed in a Judical Order to complete construction of the facility by December 31, 1988, and to meet NPDES limits by March 20, 1989.
47)	Pigeon Creek	Evansville Haubstadt	PS (Aquatic Life)	Monitored (b)	Municipal (POTW) organics Habitat alteration, Nonpoint	30	Haubstadt has received federal and State funding for POTW improvements ($1,000,494). The improvements consisting of advanced treatment, disinfection , and ammonia removal are expected to be completed by January of 1990.
48)	Tirbutary of Ripley Creek	Sunman	NS (Aquatic Life)	Monitored (b)	Municipal (POTW) organics Low D.O. Fish Kill ,	2	
49)	Little Pigeon Creek	Dale	NS (Aquatic Life/Recreation)	Monitored (b,c)	Municipal (POTW) organics Low D.O. Ammonia, Fecal coliform	5	Dale has received initial awards totaling $1,775,562 for new sewage treatment facilities. The town may have trouble keeping on a completion schedule.
50)	Oil Creek	Perry County	PS (Aquatic Life)	Monitored (b)	Institutional treatment plant, Organic unkowns.	7	
51)	Cane Run	Clarksville Jeffersonville	NS (Aquatic Life/Recreation)	Monitored (b)	Municipal (POTW) organics Low D.O. Ammonia, Fecal coliform	1	The City of Clarksville started operation of its new POTW in October of 1987. 8oth of the old treatment facilities that used to serve the city have been closed down. The City of Jeffersonville was reissued its NPDES permit in October of 1987 establishing effluent limitations for a new outfall location on the Ohio River. An enforcement action will address permit violation and establish a compliance schedule.

1 PS = Partial Support; NS = Non Support; FS = Full Support. The uses not supported are listed. If only one use is listed as not being supported, all other uses are supported.

2 b = Biological; c = Chemical

the dam. With these changes, water quality should improve in Cane Run and the Falls of the Ohio area.

Pigeon Creek and its tributaries in Vanderburg and Warrick counties receive effluent from POTWs in Elberfield, Haubstadt, Chandler, Fort Branch and Francisco, some of which is inadequately treated. Pigeon Creek has been severely channelized and also receives a large volume of agricultural nonpoint runoff. The combined effects of the channelization, nonpoint runoff, and POTW effluents cause Pigeon Creek to only partially support its designated uses for about 30 miles. Chandler, Haubstadt, and Fort Branch have all received grant awards for POTW improvements, and Francisco is currently being considered for funding.

Approximately 10 miles of Cypress Creek near Boonville in Warrick County does not support designated uses. The Boonville POTW and CSOs severely impact Cypress Creek, and acid mine drainage and agricultural nonpoint runoff also contribute somewhat to degradation of the stream. Elevated chlordane and PCB levels have also been found in stream sediments. Boonville has received a grant award for advanced treatment, plant expansion and ammonia removal.

There have been recent reports of deformed and ulcerated fish in the lower segment of Oil Creek in Perry County. The Branchville Training Camp, operated by the Indiana Department of Corrections, is located on the headwaters of Oil Creek and reportedly discharges inadequately treated sewage to this stream at times. It is not known if this is related to the fish problems.

Silver Creek near Sellersburg, Big Indian Creek near Corydon, and the Middle Fork of Blue River near Salem all fully support their designated uses but are threatened due to POTW problems at these towns. The POTW at Salem has recently been upgraded, and Sellersburg is currently under a state mandated sewer ban and faces federal fines if it does not comply with effluent standards.

The Blue River in Washington, Harrison and Crawford counties is a high quality stream that seldom experiences pollution problems. This river from the confluence of its West and Middle Forks in Washington County downstream to the Ohio River, as well as a portion of the South Fork of Blue River, are designated as "Exceptional Use" streams.

The Blue River is the home of several of Indiana's unique, threatened and/or endangered animal species. This is the only stream system in Indiana in which the hellbender salamander (Cryptobranchus alleganiensis) is found, and it appears that there is a rather large, reproducing population there. Spotted darters (Etheostoma maculatum), variegate darters (E. variatum), rosefin shiners (Notropics ardens), and the cottonmouth water mocassin (Agkistrodon piscivorous) are other unique species which have been found in the Blue River and its environs.

The Little Blue River in Crawford County experiences few water quality problems. The Little Blue River valley is periodically flooded during extended rains and the Town of English, the only community on the Little Blue River, has been nearly destroyed at times. A habitat evaluation of the stream at English in 1981 during extreme low flow revealed no visible degradation from the town although there are probably some localized high fecal coliform concentrations from septic tanks. The water quality of the Little Blue River is generally very good, and the aesthetic qualities of the stream and its forested watershed are quite high. The stream is a unique resource and has been considered for designation as an "Exceptional Use" stream. The Indiana Department of Natural Resources has stated that the Little Blue River may support a remnant population of the endangered Ohio River muskellunge in the lower segment. The Town of English is reportedly eligible for funding for a new treatment facility as it has no facility now.

In summary, 818 miles of Indiana tributaries to the Ohio River were assessed in this report. Of these miles, 750 (92%) fully support designated uses, but 38 of these (5%) are considered threatened. Thirty-nine miles (5%) only partially support uses and 29 (4%) do not support uses. In addition, ORSANCO indicates that the entire 356 miles of the Ohio River bordering Indiana only partially support aquatic life and water supply uses and 63 of these miles do not support recreational uses due to high fecal coliform counts below Cincinnati and Louisville.

III. WATER POLLUTION CONTROL PROGRAM

Point Source Control Program

The point source control program in Indiana primarily involves discharges from municipal or industrial wastewater treatment facilities. In order to meet the goals of the Clean Water Act, federal, state, and local governments, as well as industry, have spent considerable monies to improve the degree of wastewater treatment they provide and, in turn, the water quality of Indiana's lakes, rivers and streams. The concentrations of polluting materials in these discharges are regulated by the National Pollutant Discharge Elimination System (NPDES) permit program. All facilities which discharge to Indiana waters must apply for and receive a NPDES permit. The limits, set in the permit, are designed to protect all designated uses of the river, lake or stream into which the discharge flows.

Municipal Facilities

Table 41 depicts the changes in the degree of wastewater treatment provided by municipal facilities in Indiana in the period from 1972 to 1988. During this time, the percentage of people who are served by municipal treatment plants has not changed appreciably. The degree of treatment has improved considerably, however. There are no more primary treatment plants in the state. The percentage of the population served only by secondary treatment plants has also decreased, whereas, the percentage served by advanced waste treatment facilities of some type has increased dramatically.

In 1972, there were no advanced waste treatment facilities operating in Indiana. In 1988, over half the population was being served by these types of systems. Of the 38 percent of the population not served by municipal wastewater treatment plants, the great majority (about 90 percent) have been determined to have adequate individual septic tank disposal systems or are served by semi-public facilities. The effect of this increased level of wastewater treatment has been an improvement in the water quality of many of Indiana's lakes, rivers and streams.

Table 41. Changes in degree of wastewater treatment provided by municipal facilities to the population of Indiana in the period 1972-1988.

	1972	1982	1985	1988
Population size	5,195,000	5,490,000	5,500,000	5,510,000
No municipal treatment	40%	40%	38%	38%
Primary treatment	6%	0.4%	0.04%	0%
Secondary treatment	54%	41%	17%	11%
Advanced treatment	0%	18%	45%	51%

In order to achieve this increased level of wastewater treatment and resulting improved water quality, large sums of money have been spent by various governmental agencies.

Since 1972, Indiana has received over 1.2 billion dollars in federal construction grants money and has spent over 170 million dollars in state money to construct new wastewater treatment facilities, upgrade and expand existing facilities, construct sewer systems, eliminate combined sewer overflows, etc. In addition, local governmental agencies have spent over 180 million dollars in matching funds for these projects. A summary of state and federal grants awarded from 1986 and 1987 is shown in Table 42.

Industrial Facilities

By July 1, 1977, industrial dischargers were required to meet Best Practicable Control Technology Currently Available (BPT) or achieve water quality standards, whichever was more stringent. Nearly all Indiana industries met BPT by this time. For those which did not comply, enforcement action was initiated and eventually resolved to achieve compliance. However, there was a concern that toxic pollutants which are the primary focus of Best Available Technology Economically Achievable (BAT), were not sufficiently addressed. Many permittees now have installed treatment that can meet BAT, primarily because of an overriding site-specific water quality issue. Applicants for permit reissuance are required to specifically identify toxic substances which are or may be discharged to the waters of the state from their facility. The permit reissuance process involves the detailed review of these applications, and toxic pollutants are limited to safe levels. If there is a question as to the presence of a particular substance in sufficient quantities to be of concern, a monitoring requirement is established in the permit. A final permit limit is based on these additional monitoring data.

Although the total amount of money expended by industry for wastewater treatment has not been reported, it has been considerable. Data from claims

TABLE 42. *STATE AND FEDERAL GRANTS AWARDED IN FISCAL YEARS 1986-87.*

INITIAL AWARD ELIGIBLE PROJECT	INITIAL AWARD STATE AMOUNT	INITIAL AWARD FEDERAL AMOUNT	APPLICANT	EXPECTED COMPLETION DATE	NEEDS ADDRESSED*
$16,014,200	$ 3,202,840	$ 8,807,810	East Chicago	3/88	Adv., exp., ammonia rem.
5,749,9000	1,149,980	3,242,045	Boonville	12/88	Adv., exp., ammonia rem.
6,220,320	1,244,062	4,135,200	Chesterton	12/88	Adv., exp., ammonia rem.
7,874,900	1,574,980	5,233,436	Rochester	6/88	Exp., ammonia rem.
999,400	199,880	626,946	Versailles	11/88	Adv., exp., ammonia rem.
40,583,300	8,116,660	22,320,815	Indianapolis	2/90	Adv., ammonia rem.
426,200	85,240	296,257	Porter	4/88	Adv., exp., ammonia rem.
1,462,000	292,400	1,096,500	Indian Boundary (Porter Co.)	1/89	New plant
5,054,600	1,010,920	2,780,030	Hammond	5/88	Adv., P rem., exp., ammonia rem.
1,023,578	204,716	562,968	Cannelton	11/88	Secondary
3,644,653	728,931	2,130,213	Syracuse	8/89	Adv., P rem., exp., ammonia rem.
1,275,735	255,147	745,347	Haubstadt	1/90	Adv., disin., ammonia rem.
1,783,111	256,622	1,017,749	Scottsburg	12/89	Exp., ammonia rem.
715,358	143,072	508,003	Scott Co. RSD	11/89	New plant
2,173,695	1,023,058	1,432,248	LaGrange	10/89	Adv., ammonia rem.
5,115,293	1,023,058	3,651,333	Turkey Creek RSD	9/90	Adv., P rem., exp., ammonia rem.
2,367,416	473,483	1,302,079	Dale	10/89	Adv., exp., ammonia rem.
2,925,440	585,088	1,817,741	Fort Branch	10/89	Adv., disin., ammonia rem.
1,278,049	255,088	938,537	Carbon	4/90	Adv., disin., exp.
2,273,402	454,680	1,250,371	Mitchell	1/90	Adv., P rem., exp., ammonia rem.
2,513,982	502,796	1,802,437	Lake Dalecarlia	10/89	New plant

* *Adv. = Advanced Treatment; P rem. = Phosphorus removal; Exp. = Expansion; Ammonia rem. = Ammonia removal.*

for tax exemptions for wastewater treatment equipment provide some idea of these expenditures. The number of claims and total amounts claimed for each year from 1978-1987 by Indiana industries are shown in Table 43. This amount has nearly tripled in this time period.

Table 43. The number of tax exemption claims and the total dollars claimed by Indiana industries for wastewater treatment facilities from 1978 to 1987.

Year	Number of Claims	Amount Claimed
1978	102	$ 369,186,717
1979	123	394,712,641
1980	113	400,895,352
1981	124	518,478,055
1982	126	607,093,628
1983	139	633,443,520
1984	145	797,153,029
1985	159	803,676,180
1986	184	867,057,770
1987	176	1,045,182,501

In the past, industrial wastewaters have caused water quality problems even though they were discharged to a municipal sewage treatment facility. These wastes would often "upset" the various treatment processes at the municipal sewage treatment facility to the extent that little or no wastewater treatment would occur. Also, some of these pollutants can pass through a wastewater treatment facility and remain at levels that are still toxic to the aquatic life in the receiving stream. Toxic substances can also accumulate in the municipal sludge at levels which make disposal much more expensive.

To prevent these occurrences, Indiana has developed a pretreatment program that requires industries to reduce concentrations of toxic or harmful substances to "safe" levels before releasing them to the sewer system. Municipalities with sewage treatment facilities which are designed to treat 1.0 mgd or more and have an adequate industrial base are required to work directly with the industries which need pretreatment to develop their own plans for control of these discharges. In general, the state works with the smaller municipalities and their associated industries to develop their pretreatment programs.

Indiana has identified 45 municipalities that need to have direct control of their industrial users (IUs). Approximately 450 IUs are controlled by these 45 municipalities, and their pretreatment programs are audited annually by the state. Also, there are approximately 50 IUs that discharge into smaller municipal sewage plants that are controlled directly by the state.

Compliance and Enforcement

In order to assure compliance with NPDES permit limits for substances in the dischargers' effluent, a variety of data is reviewed. These data would include such things as: self monitoring data submitted on monthly monitoring report forms, data collected during compliance sampling inspections conducted by DEM staff, water quality monitoring survey data, bioassay data and other information which may be available. When NPDES permit or water quality violations are found, appropriate enforcement action is taken. This enforcement action will insure the quickest return to compliance by the permittee and may include such things as Notice of Violation letters, warning letters, prehearing conferences, formal enforcement hearings and, if necessary, judicial proceedings.

In Indiana, compliance with NPDES requirements is tracked with the assistance of computers. Tracking is performed monthly for each permittee identified on the state compliance monitoring priority list. Once each quarter, a Quarterly Compliance Report is prepared which highlights the status of each permittee and provides a plan for returning noncomplying facilities to compliance. The compliance rate for major dischargers has been about 90% for municipalities and 95% for industries. Minor dischargers experience a somewhat lower compliance rate due to the lower priority assigned this category with regard to state resources. As facilities return to compliance, improvements in water quality are expected, especially since most discharge permits in Indiana are based, at least in part, on water quality considerations.

In addition to compliance tracking, which focuses on significant noncompliance at all types of facilities, the Municipal Compliance Strategy (MCS) has been implemented to achieve maximum municipal compliance by July 1, 1988. This is in accordance with the 1981 amendments to the Clean Water Act and subsequent National Municipal Compliance Strategy. The state is presently working with about 30 municipalities to reach agreements on compliance schedules as part of a court order. The MCS is a plan designed not only to help municipalities achieve and maintain compliance with their permit limits, but also to provide information and guidance to allow the municipality to plan for future expansion, replacement, and operational and maintenance costs independent of outside financial assistance.

Nonpoint Source Control Program

In 1987, in cooperation with other agencies and organizations, IDEM formed a state Nonpoint Source (NPS) Task Force to begin the process of developing a comprehensive NPS program. After several meetings the group generated draft issue papers on the NPS categories which affect Indiana waters. The task force will continue to refine the problem definitions in order to prepare an overall document that will form the basis for the NPS Management Program.

Concurrently, the IDEM staff has prepared a provisional statewide Assessment Report that consists of a list of waters affected by NPS pollution, as well as the NPS categories or sources which contribute to the effects. This assessment (and list of waters) is being submitted separately with the state's 304(l) lists. The other two assessment report items required by Section 319 (the process for identifying Best Management Practices (BMPs) and the description of state/local NPS programs) have not yet been finalized. They will, however, be completed no later than August 4, 1988, in compliance with the statutory deadline. In addition, the Management Program will be completed by the August 4 deadline, and will be submitted to the EPA along with the Assessment Report.

A number of state and/or federally funded programs are currently in place which have helped curtail NPS problems in Indiana. Some of the most widely recognized are implemented by the U.S. Department of Agriculture through the Soil Conservation Service (SCS) and the Agricultural Conservation and Stabilization Services (ASCS). These agencies, working cooperatively with soil and water conservation districts, provide technical and cost-sharing assistance to individual landowners to resolve soil erosion problems which often affect water quality. In addition, these federal activities are supplemented by similar programs implemented by the State Soil Conservation Board and the Department of Natural Resources Soil Conservation Division. The latter group, which was created in response to recommendations made by the Governor's Soil Resources Study Commission in December 1985, has burgeoned with the addition of approximately 50 new employees, made possible by a 3 million dollar budget. As a result, the state "T By 2000" program is now well underway and focuses not only on agricultural erosion, but also addresses urban soil and water problems related to construction and development. A limited "Lake Enhancement" program to address lake sedimentation has been implemented by the division, as well.

The state's 1971 Confined Feeding Control Law has been instrumental in limiting NPS pollution from animal feedlot waste. Anticipation of the rapid evolution of high-volume animal production facilities prompted the enactment of the law to regulate waste disposal, since the waste is generally land applied and poses a potential threat to surface and ground water if it is improperly handled. Although the sheer number of facilities has outstripped IDEM's present ability to inspect all of them regularly, the law has proved to be a valuable regulatory tool.

IDNR's Division of Reclamation, in its administration of the 1977 Federal Surface Mining Control and Reclamation Act, regulates not only point source discharges from mine areas, but also nonpoint sources -- both from active sites and abandoned mine lands. Mine operators are required to utilize accepted management practices for erosion and sedimentation control during active mining as well as during reclamation. Acid drainage from abandoned mine lands is being addressed by IDNR's reclamation program, but limited federal funding will not be sufficient to eliminate all of the state's acid drainage problems, particularly since correction of safety hazards is a higher priority.

Combined sewer overflows (CSOs) share characteristics of both point sources and nonpoint sources. Indiana has explored different methods for evaluating CSOs to determine their effect on water quality, and IDEM is currently pursuing a CSO strategy based on Region V's "NPDES Permit Strategy for Combined Sewer Systems". A CSO task force was created to develop and oversee the program. At the present time, while CSO dischargers are being prioritized on the basis of existing data, all municipalities are being required to minimize CSOs through more effective operation and maintenance. If water quality standards violations attributable to overflows are discovered in the future, remedial action (including sewer separation or treatment plant expansion) will be required to eliminate the problems. Toxic CSO constituents are addressed indirectly and limited, in part, by industrial pretreatment programs and sewer use ordinances.

Indiana's developing ground water protection program has been significantly enhanced by the production of an overall strategy and implementation plan which will provide the guidance necessary to link NPS program elements to the protection of ground water. A number of NPS categories have been identified in the strategy as potential ground water problem sources and have been targeted for further investigation. The state is committed to the development of water quality standards for ground water as soon as possible.

Since pesticide usage has long been recognized as a source of surface and ground water pollutants, different programs have been in place for a number of years to prevent problems from occurring. Use of pesticides is regulated by the Indiana Pesticide Use and Application Law and the Indiana Pesticide Registration Act, as administered by the Office of the State Chemist and the Indiana Pesticide Review Board. The state chemist is responsible for the licensing of applicators and, though the Cooperative Extention Service, has provided applicator training to many thousands of commercial and private (farm) applicators. The overall program reduces indiscriminate use of pesticides, and controls the usage of particularly hazardous substances. IDEM is presently conducting a limited residential well sampling program to identify areas of pesticide contamination.

Indiana's Phosphate Detergent Law, which was enacted in 1971, has been helpful in reducing not only point source, but nonpoint source phosphorus discharges to surface waters as well. Decreased phosphorus contributions to inadequate septic systems and combined sewers have resulted in decreased NPS phosphorus discharges from those systems. While such decreases may appear insignificant for each household involved, the reduced overall mass loadings to downstream lakes and reservoirs can be critical.

Of all the nonpoint source pollution control efforts undertaken in Indiana, the general reduction of phosphorus discharges into lake watersheds has been one with the most readily identifiable benefits. In particular, the phosphorus load reduction in Indiana's portion of the Lake Erie Basin has been the singular endeavor that has provided overwhelming evidence of its success, in a relatively short period of time. Six northeastern Indiana counties, along with counties in Ohio and Michigan, have participated in the Tri-State Tillage project funded through the Great Lakes National Program Office, under Section 108 of the Clean Water Act. The project has been a cooperative effort among federal, state and local agencies to accelerate the rate of adoption of conservation tillage in the target area. These unconventional tillage practices allow crop residues to be retained on the land surface, protecting soil from the erosive forces of wind and rain. By preventing soil particles from being transported off the land, and allowing more water to percolate into the ground, phosphorus is also prevented from being carried to adjacent streams and then to downstream lakes. By promoting conservation tillage, then, the phosphorus load to Lake Erie's western basin has been substantially reduced. This effort, in conjunction with reductions by industrial and municipal point source dischargers, has played an important role in Lake Erie's renewed vitality.

In accordance with Annex 3 of the Great Lakes Water Quality Agreement of 1978, Indiana developed a Phosphorus Reduction Plan for the state's portion of the Lake Erie drainage basin. The principal element of the NPS portion of the plan has been to monitor implementation of conservation tillage in three counties to assure that adoption of the practice increases at predicted rates. The state is presently evaluating a monitoring technique being utilized by other involved states, but existing data indicate that Indiana has already exceeded its phosphorus load reduction goal.

Another nutrient, nitrogen, is applied extensively in different forms as an agricultural fertilizer. Its production, storage and use present widespread potential for nitrate contamination of human and livestock drinking water supplies. Researchers in Indiana are beginning to discover that the magnitude of the problem could be much greater than had previously been realized. A need exists to more thoroughly examine both the cycling of nitrogen following its application and the overall potential for problems to occur throughout the state. It is hoped that an aggressive ground water monitoring program can be developed to identify problem sites and that an extensive fertilizer management education and research program can be established to prevent future problems from occurring.

Evidence has been mounting over the last decade which indicates that atmospheric deposition is a significant source of a variety of pollutants in surface waters. Most of the data have resulted form studies on the Great Lakes or in the northeastern states; little research has been conducted in Indiana which would link water pollution with atmospheric transport. "Acid rain", the best known of the problems, is not a great concern in the state because of the pH buffering capabilities of most of its surface waters. there is evidence, though, of potential for some localized problems which could warrant further investigation. Indiana is now involved in a number of air monitoring efforts, resulting principally from concerns about Great Lakes pollution, which will provide data concerning the relationship between air and water pollution.

On-site sewage disposal systems for individual residences and commercial buildings are widely used throughout Indiana. Unfortunately, though, over 70% of the state's soils are incapable of allowing proper functioning of conventional septic tank/absorption field systems. Many areas are unsuitable because of either slow or rapid permeability, creviced bedrock, or karst geology--areas where surface and ground water protection is most needed. Despite the frequency of problems arising from inadequate systems, new home construction in areas not served by municipal sewage collection and treatment facilities necessitates the continued use of individual systems. Most of the problems related to malfunctions are very localized, resulting only in "ponding" on the property, but can be very significant, if groups of homes all produce discharges to streams--or importantly--to lakes.

Septic tank system design and location, which is regulated by local health departments, is too often dictated by economic and social pressures rather than site capabilities. In many cases, land which is not suitable for sewage disposal systems is selected for residential or commercial development. In such situations, wastewater treatment is generally a lesser concern whose neglect leads to the potential for problems.

The State Board of Health is attempting to improve the ability of local health departments to assess and regulate on-site sewage disposal. Some communities have such widespread problems that they are being required by IDEM to construct centralized sewage collection and treatment systems. It would be beneficial if funding could be provided for further research on and development of septic system technology appropriate to Indiana soils.

Approximately 475 municipal sewage treatment plants, industries and other generators utilize land application to dispose of sludges, waste products and wastewater in a manner subject to state regulations. The wastes typically are high in organic and nutrient content, making them suitable for use as a soil conditioner and a fertilizer on agricultural lands, when appropriately applied. However, the wastes may contain other constituents, such as heavy metals or chlorinated organic compounds which can limit application rates. Land application of the wastes, while beneficial, can pose a threat to surface and ground water if it is not carefully regulated and implemented.

Because of present inadequate staffing for IDEM's land application program and onerous workload imposed by the priority activities of plan review, permit writing, and public noticing, very little routine inspection of permitted land application sites is performed to determine compliance with permits and regulatory criteria. A need therefore exists to increase the number of staff persons to allow for implementation of a routine inspection program.

Urban runoff (in addition to CSOs), is known to transport pollutants into surface waters, but little has been done to evaluate the effects of this runoff on water quality. While Section 402 of the Water Pollution Control Act will begin to address storm sewer discharges from industries and large municipalities, it will be several years before results of studies will enable the state to determine the overall extent of the problem.

Production and harvesting of timber in Indiana have not been known to cause serious NPS problems. The greatest pollution potential arises when trees are removed, exposing land to the erosive effects of rainfall, but proper management can limit erosion to acceptable levels. When problems do occur, the impact is generally localized and subsides as the affected area becomes revegetated. Although there are no regulatory programs for forestry activities in Indiana, the Department of Natural Resources, the U.S. Forest Service and the Purdue University Cooperative Extension Service are all actively involved in education and technology transfer efforts to assure the use of management practices necessary to protect water quality.

Stream channelization, dredging, dam construction, streambank modification, channel relocation, urban development, and road and bridge construction are all activities that typically involve earthmoving and/or excavation work, and removal and destruction of vegetative cover, which can cause locally severe erosion and sedimentation problems.

Construction activities within or adjacent to the state's rivers and streams often involve disturbance of the channel bed and banks. Activities such as channel dredging, clearing and snagging, channel relocation or modification and equipment movement within the stream result in the disturbance of stream bed materials and sediments. Much of this material becomes suspended in the water and can move downstream, carrying contaminants with it. There have been numerous cases of siltation and sedimentation problems in the state's rivers and streams as a result of upstream construction activities. However, it is difficult to assess the amount of material which is dislodged as a result of channel work, and to determine the extent of the problem. There are limited data on the annual number of instream construction projects and the amount of sedimentation which results from them. Many projects which are not under contract to state or federal entities are not monitored for compliance during construction. Few projects are reviewed after construction is completed. Minimal data exist in Indiana which document the impacts of sediment to downstream water quality and aquatic habitat.

Various state and federal agencies have endeavored to control pollution from erosion. Indiana Department of Highways contractors are required to prevent sediments from entering streams. Standard specifications and special provisions address sod, seed, mulched seed, agricultural limestone, pesticides and fertilizers used to re-establish vegetative cover. All federal aid projects must conform to requirements of the National Environmental Policy Act, which involves a systematic assessment of all environmental impacts including water quality. Projects are reviewed by a number of state and federal agencies for potential environmental affects and mitigation measures.

Pursuant to Indiana Code 13-2-22, the Indiana Department of Natural Resources must approve any construction, excavation, or filling within the floodway of any river or stream in the state. As a condition of the approval, the Department of Natural Resources generally requires that disturbed areas be protected from erosion during construction and be suitably revegetated or provided with permanent protection upon completion. In addition, the issue of soil erosion and sedimentation is now being addressed by the state through the "T by 2000" program. Administered by the Department of Natural Resources' Division of Soil Conservation, "T by 2000" provides technical and financial assistance for "lake enhancement" of public lakes and erosion control structural measures on private land where resulting sedimentation is detrimental to the public good.

Regulatory controls over road construction projects which are not under contract to state or federal entities are minimal or non-existent, although portions of such projects located within the floodways of the state's rivers and streams would require approval in accordance with IC 13-2-22. As a part of the IDNR permitting process, erosion control measures could be required as conditions for approval. However, the conditions would be applicable only to certain portions of the project. Any erosion control measures implemented on the remaining portions would be included at the discretion of the contractor performing the work.

IDEM, IDNR, U.S. EPA, and the U.S Fish and Wildlife Service all review stream-related construction projects subject to the Corps of Engineers' Section 404 permitting. The agencies suggest ways in which the projects can be improved to limit erosion and sedimentation. A Section 404 permit cannot be issued unless water quality certification or a waiver thereof is received from the IDEM.

Landfills can represent nonpoint source pollution contributions in a number of different ways. Soils disturbed by the landfill activity can be washed into surrounding waterways. Runoff contaminated by contact with waste materials can flow offsite. Leachate within a landfill can reach the surface either through openings in the cover material or through subsurface formations, and can also affect ground water.

The the hazardous waste program, there are regulatory controls over run-on to disposal sites, as well as runoff. The run-on must be diverted and the runoff must be collected from the active areas of the landfill. Double liners are required for subsurface control, and inspection of closed areas is required to monitor integrity of the cover.

The current solid waste regulation (329 IAC 2) requires that run-on be diverted from landfills, but does not require that runoff be collected or controlled. The regulation, therefore, does not specifically provide for control of siltation and of runoff contaminated by contact with waste, although most of the recently proposed landfills in more heavily populated areas do provide for a sedimentation ponds. the regulation also states that leachate shall not flow "into a stream, lake, river or other surface water, or an aquifer without adequate control measures on operation".

The proposed new sold waste regulation, which was preliminarily adopted by the Solid Waste Management Board in February of 1987, increases the agency's control over nonpoint source problems. The regulation does not require that all landfills collect runoff, but does require that "sedimentation and/or erosion control systems shall be provided and maintained wherever necessary to minimize erosion and the sedimentation of surface water". The regulation also prohibits the surface movement of leachate more than 50 feet outside of the solid waste boundary.

A state law enacted in 1987 requires that the soil and water conservation districts (SWCDs) conduct inspections of landfills twice per year for compliance with state requirements concerning erosion. This may help to coordinate the erosion control experience of the SWCDs with the regulatory programs of the Department of Environmental Management.

In addition to concerns about surface water runoff, solid waste landfills pose a possible threat to ground water. The degree of threat posed and the control measures necessary for sanitary landfills and for landfills dedicated to particular types of wastes is a matter of controversy and no clear consensus appears to exist. The design of current sanitary landfills is primarily based on restricting infiltration into the waste and then relying on clay barriers to limit flow and attenuate pollutant movement from the site. Increased consideration is now being given, in many cases, to designs which allow for collection of at least a portion of the leachate generated at the site.

With the exception of sludge lagoons, which are not specifically addressed by the current solid waste regulations, the various program areas either adequately control nonpoint source contributions from landfills or are in the process of modifying regulatory controls to increase control over nonpoint source problems. It is likely that, through changes in either the state or federal solid waste regulations, solid waste landfills will be required to install runoff collection basins with a discharge that would be regulated by the National Pollutant Discharge Elimination System (NPDES) program.

There are about 95 solid waste disposal landfills in Indiana which were once permitted by the state but are now closed. In addition, there are dozens of older sites, some of them once open dumps, which were closed prior to the permitting of landfills in 1969. Only very few of the closed sites have monitoring wells. Some of these facilities accepted hazardous waste or special wastes which are not allowed at permitted landfills now. Therefore, closed waste disposal sites present a potentially significant but unquantified threat to water quality.

Abandoned waste disposal sites have caused or are suspected of ground and surface water contamination in many locations in the state, affecting public health, public water supplies, private wells, and the natural environment. Many other sites not identified yet as sources of contamination pose a threat of future problems.

The Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA) and its 1986 reauthorization and amendments (SARA), is designed to address liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive or abandoned hazardous waste disposal sites. The law provides authority and funding for government to conduct necessary corrective actions in the absence of responsible parties to perform the work. Sites addressed under the program can be expected to be dealt with in a comprehensive manner over the long term with adequate attention to potential and actual water contamination. The primary deficiencies in the program are the inability of the state to adequately address sites that do not technically qualify for federal attention, and the inordinate amount of time it takes to complete a project.

Cleanup of sites which do not qualify for the Superfund program become the responsibility of the state, without federal assistance. These sites may be addressed though several mechanisms, such as state enforcement action, voluntary cleanup by responsible parties, or state-funded cleanup utilizing the Hazardous Substances Emergency Trust Fund.

Under the authority to the Environmental Management Act, IDEM can regulate some closed landfills, although some past owners have escaped any post-closure responsibility through bankruptcy. State enforcement actions can utilize the Indiana Environmental Management Act (IC 13-7) as amended by Senate Enrolled Act No. 459 of the 1987 Legislature, which contains provisions regarding identification and liability of responsible parties. The threat of potential Superfund liability often encourages responsible parties to work toward satisfactory settlements with the state, but much greater effectiveness can be accomplished with this new more explicit statutory authority.

The cleanup of abandoned waste disposal sites is a an extremely high manpower - and resource-intensive activity. The number of sites known to need attention surpasses the availability of staff and trust fund money to deal with them all expediently. Since the number of sites that can be addressed is directly related to the availability of resources, recent legislation calls for a prioritization to be established by rule, so that sites posing the greatest risk to the public are addressed first.

Several hundred chemicals and generic wastes are termed hazardous by EPA due to their characteristics of toxicity, corrosivity, ignitability or reactivity. In Indiana there are about 1,800 facilities, each of which generates over 1,000 kilograms or more of hazardous waste per month. Annually, nearly 4 million tons of hazardous waste are generated the state. There are about 350 facilities where some 12 million tons per year of hazardous waste are treated, stored or disposed (TSD). The potential for nonpoint source surface or ground water contamination from this many generators and TSD sites is significant.

Indiana has obtained authorization to operate its own hazardous waste management program. Under the authority of the Environmental Management Act, IDEM has adopted regulations for hazardous waste management (329 IAC 2) which are modeled after U.S. EPA rules. EPA is in the process of revising the regulations and it is expected that Indiana will follow the federal lead and modify state regulations to reflect the federal revisions.

Indiana has about 40 hazardous waste management facilities, under interim permit status, that have surface impoundments where wastes are treated, stored, or disposed. These facilities tend to be clustered near major industrial centers located statewide. Ground water monitoring near these impoundments has shown that the majority are causing localized ground water pollution. The state needs to be able to assure that these problems are adequately addressed in order to protect water quality.

All hazardous waste TSD facilities which obtained interim permitted operating status have been required since 1981 to have specific ground water monitoring systems in place. Some 30 percent of these facilities are not in compliance. The inadequacies which have been identified in some existing monitoring programs were related to hydrogeologic studies, well siting and construction, and sampling. TSD facilities seeking final permitted status from IDEM will required to operate adequate ground water monitoring programs in order to obtain permit approval.

Industry can conduct a closure process for waste impoundments which involves IDEM approval of clean up, monitoring and assurance of financial responsibility. In the absence of the closure procedure, though, IDEM still needs to be able to order specific corrective actions for closed impoundments at operating facilities. Facilities that treat, store or dispose of hazardous waste are required to correct pollution problems from waste impoundments closed prior to 1976 in order to receive final permitted status. This provision is currently not part of Indiana's regulations, so future action will be necessary to modify state hazardous waste regulations accordingly.

The accidental or intentional unpermitted discharge of any undesirable substance into public waters constitutes a potential hazard not only to aquatic life and the general vitality of surface and ground waters, but also to organisms dependent on the systems as drinking water sources. Hundreds of such "spills" are reported to IDEM each year, and while many are relatively inconsequential, a great number are capable of causing severe degradation.

During 1986, approximately 800 incidents were reported. these involved a variety of materials including petroleum products, agricultural pesticides and fertilizers, sewage, manure from animal production facilities, and miscellaneous chemicals. Impacts to public waters can vary from being negligible to disastrous, depending on the pollutant involved, its quantity, and the water body's uses. A frequently used subjective indicator of pollution severity in surface waters is the "fish kill" which can result not only from toxicity of a spilled substance, but also from asphyxiation brought on by the introduction of oxygen-depleting discharges.

The Indiana Spill Control Regulation (327 IAC 2-6) requires the responsible party to immediately notify the Office of Environmental Response, IDEM, of all spills of oil, hazardous, and/or objectionable substances that enter or threaten to enter waters of the State. The regulation further requires the spiller to promptly contain and clean up the spilled material. The Office of Environmental Response may provide technical assistance in the containment and recovery of the offending substance. This process provides a mechanism whereby most incidents are resolved before severe damage is incurred. Unfortunately, on many occasions, remedial action cannot be initiated quickly enough to prevent damage from occurring, particularly if the incident is not discovered until the damage is already evident, such as with a fish kill.

Indiana's Wetland Protection Programs

"Wetlands" is a general term describing land which is always or sometimes wet. A more formal definition of wetland is "an area which supports predominantly aquatic vegetation, contains hydric (wet) soils, and/or is permanently or seasonally saturated with water."

Under the U.S. Fish and Wildlife Service National Wetland Inventory Classification System, Indiana contains three major wetland system types: palustrine, lacustrine and riverine. Palustrine systems are usually situated shorewood of lakes, streams, river channels or in isolated depressions and are dominated by trees, shrubs, persistent emergents and emergent mosses or lichens. Lacustrine systems are permanently flooded lakes and reservoirs and intermittent lakes. In Indiana, common names for these areas are: wetland, marsh, fen, bog, swamp, slough, pothole, shallow pond, and remnant lake. Riverine systems includes the wetlands contained within the channel banks except those dominated by trees, shrubs, persistent emergents, emergent mosses and lichens.

Wetlands are important in Indiana because they:

1. help purify water by filtering and trapping toxic chemicals, soil and excess nutrients that would otherwise enter our streams, rivers and lakes;

2. provide habitat and/or spawning grounds for fish and other aquatic life;

3. provide habitat for wildlife such as fur bearers, ducks, and endangered species;

4. act as natural sponges which minimize flood damage by storing and delaying floodwaters;

5. protect banks and shorelines against erosion by acting as buffer areas; and

6. provide areas for recreation, education and scientific research.

In Indiana both the Department of Environmental Management and the Department of Natural Resources have legitimate interests in, and responsibility for, wetland protection. Although each agency's role in the protection of wetlands varies to some extent, there is also some overlap.

Section 404 of the federal Clean Water Act requires an individual to obtain a permit from the U.S. Army Corps of Engineers (COE) for dredging and filling in waterbodies including wetlands. However, the permit cannot be issued until the State provides Section 401 Certification that the disposal of dredged or fill materials will not cause significant degradation of water quality or waives the right to certify the permit. IC 13-7-2, Section 15 designates the Indiana Department of Environmental Management (IDEM) as the water pollution control agency for all purposes of the federal Water Pollution Control Act (Clean Water Act) and, therefore, gives it the responsibility to provide Section 401 Certification of Section 404 permit applications. IC 13-1-3 Section 7(d) specifies that the Commissioner of IDEM may take appropriate steps to prevent any pollution that is determined to be unreasonable and against public interests.

A review of Indiana's environmental laws (IC 13-1-3 Section 4; IC 13-7-1 Section 7, Section 22, Section 26, and Section 27; and IC 13-7-4 Section 1) which became effective July 1, 1986, indicates that wetlands are waters of the state and that the discharge of dredged spoil or fill into wetlands does constitute water pollution.

In making a determination of whether the pollution resulting from a proposed dredge and fill project would be unreasonable and against public interests, the Commissioner or the Commissioner's designee must decide if the pollution would violate sections of Water Pollution Control Board regulations which establish quality standards for various waters of the State. Most wetland fills would violate one or more sections of Indiana's state laws and regulations.

Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material are also used as a guideline for evaluating proposed dredge and fill projects. Few proposed projects that would require fill in a wetland can be approved if these guidelines are applied.

The Indiana Lake Classification System and Management Plan was adopted by the Indiana Stream Pollution Control Board in 1980 as part of its statewide water quality management plan. The protection of all wetland areas contiguous to each lake or reservoir and their tributary streams is part of the generic restoration and management plan for each of the seven lake management groups.

In view of the above, the IDEM is reluctant to approve any wetland fill unless extensive mitigation is provided. Therefore, there is essentially no net loss of wetlands as a result of programs administered by IDEM.

The Indiana Flood Control Act (IC 13-2-22) requires anyone who wishes to construct within the floodway of a river or stream and its adjacent wetlands to obtain a "Construction in the Floodway" permit from the Department of Natural Resources (DNR). Also, the Indiana Lakes Preservation Act (IC 13-2-11.1) requires anyone involved in construction that would effect a public lake to obtain a permit from the DNR for the work. The U.S. Fish and Wildlife Service National Wetland Inventory has been completed for the northern one-half of the State and work is underway to finish the inventory in the southern portion. This inventory will help the State identify important wetlands that need protection.

The Indiana Wetland Conservation Program was established in 1967 by IDNR's Division of Fish and Wildlife. Since that time, the program has protected 16 properties totaling approximately 4,000 acres. These sites have been acquired in a number of ways including land obtained by court order or settlement as mitigation for permit violations, donations, and fee simple purchases. Funding for the program has come through state appropriations, Ducks Unlimited's (DU) MARSH Fund, the IDNR Fish and Wildlife Fund, and the Land and Water Conservation Fund.

In 1986, DU, through its MARSH program, began supporting the state wetland program. Approximately $60,000 a year will be available for wetland acquisition. In addition, the 1987 General Assembly appropriated $150,000 to be used for wetland acquisition and for waterfowl management.

The major deficiency in the State's regulatory programs dealing with wetlands is an inability to prevent the draining of wetlands. Legislation has been introduced in the Indiana General Assembly which would remedy this deficiency but it has not received widespread support to date. There is also some uncertainty about the authority of various state agencies to control the filling of small, isolated wetlands on private property that are not connected to a surface waterway. Proposed legislation would probably clarify this situation.

Monitoring Programs

Fixed Station Water Quality Monitoring Network

In April 1957, the Indiana State Board of Health established 49 stream sites for the biweekly collection of water samples for physical, chemical, and bacteriological analysis. Since 1957, various changes and improvements have been made and several stations have been added. Locations of historical stations for data collection may be found in the annual "Water Quality Monitoring of Rivers and Streams" publication of the Indiana Department of Environmental Management (IDEM).

The Fixed Station Water Quality Monitoring Network was established to provide basic information which would reveal pollution trends and provide water quality data for the many existing and potential users of surface water in Indiana. The monitoring program has these specific objectives:

1. To determine the chemical, physical, bacteriological, and biological characteristics of Indiana's water under changing conditions.

2. To indicate, when possible, the sources of pollution entering a stream.

3. To compile data for future pollution abatement activities.

4. To obtain background data on certain types of wastes, such as sewage, industrial wastes, and radioactive materials, and to detect critical changes.

5. To obtain data useful for municipal, industrial, agricultural, and recreational users.

6. To compile data necessary to support enforcement action intended to preserve streams for all beneficial uses.

In the autumn of 1985, a comprehensive review of the Fixed Station Water Quality Monitoring Network was conducted. Changes in sampling locations, additions, deletions, and parametric coverage were based on the following:

1. Existing and/or recommended water quality standards.

2. Monitoring requirements established by the IDEM or by U.S. EPA.

3. The maintenance of data bases for essential parameters.

4. The ability to obtain representative samples at convenient locations.

5. A review of water quality trends and standards exceedances between 1979 and 1985.

The number of sampling stations for 1986, was increased to 106, monitoring approximately 2,055 stream miles in Indiana. Of the 106 stations, 91 are sampled once each month, and 15 are sampled quarterly. These stations and their descriptions are listed in Table 44 and shown in Figures 16 and 17.

Physical, chemical, and bacteriological analysis are run on samples from all 106 of the stations, but the extensive review of necessary parameter coverage at each station resulted in a 16 percent reduction in water chemistry laboratory workload. The number of stations monitored for phytoplankton was increased from 18 to 41, with emphasis on interstate waters and stations selected to bracket POTW discharges. Radiological analysis remains at the 23 stations that had been sampled in 1985. A list of the parameters for which analysis are run is given in Table 45.

Toxics Monitoring and Control Programs

The state uses a combination of chemical and biological monitoring to identify discharges of toxic pollutants. Chemical methods include toxicants identified by (1) EPA Form 3510-2C for permit applications, (2) effluent sampling in compliance sampling inspections, (3) sludge sampling in land application permits and compliance sampling inspections, and (4) sediment and fish tissue sampling in receiving streams. Biological methods include the use of biosurveys and effluent toxicity tests.

Regular monitoring for toxic substances is conducted by the IDEM through analysis the fish tissue and sediments collected once biennially at the 22 CORE Program stations (Table 44 and Figure 18). These stations are also part of the Fixed Station Water Quality Monitoring Network. The stations are divided into two groups which are sampled on alternate years.

Three sets of fish samples (5 fish each, if possible) are collected at each station. Whole fish samples are submitted to the laboratory for analysis

Figure 16. Locations of Indiana's Fixed Station Water Quality Monitoring Network stations (except Northwest Indiana).

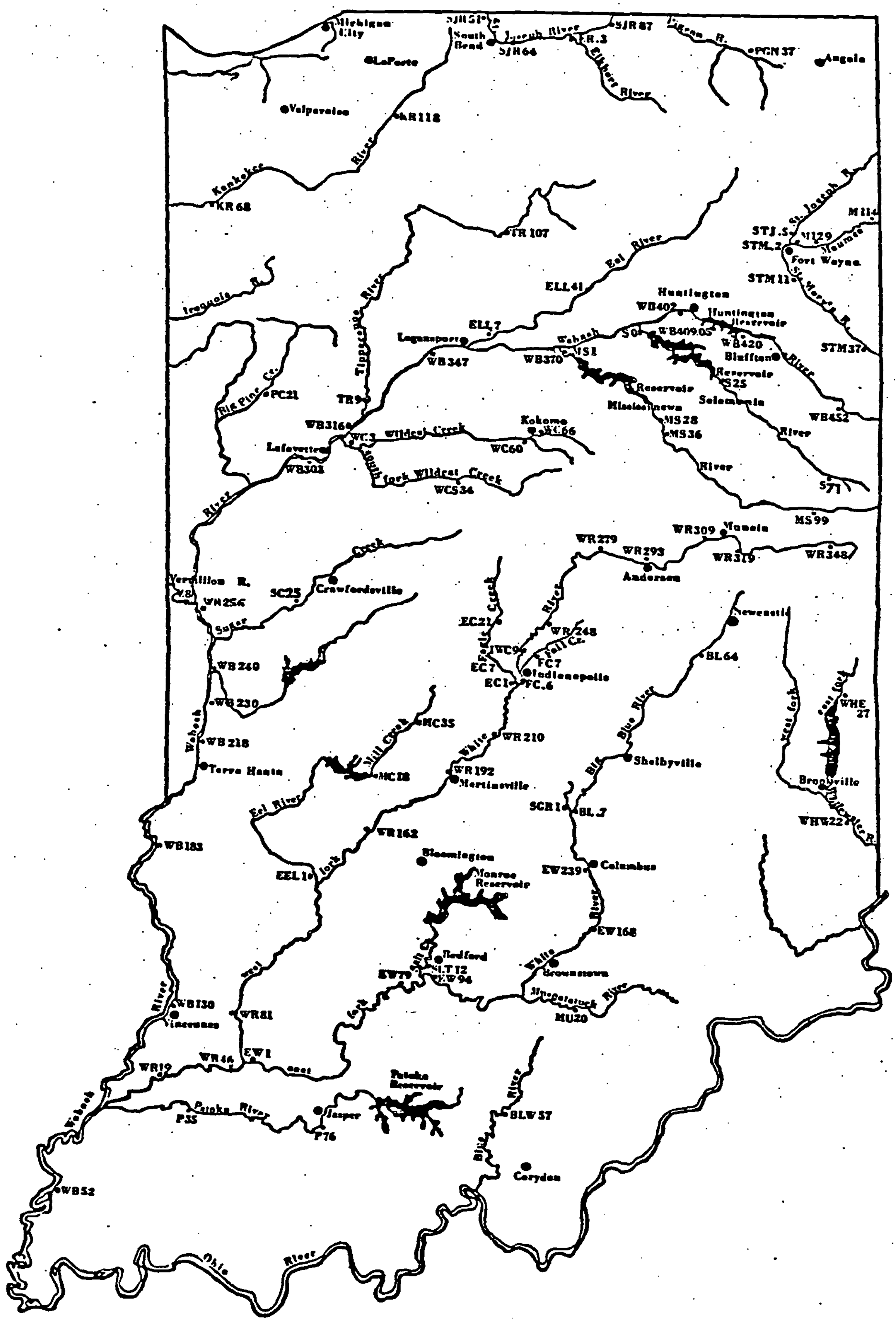


Figure 17. Locations of Indiana's Fixed Station Water Quality Monitoring Network stations in Northwest Indiana.

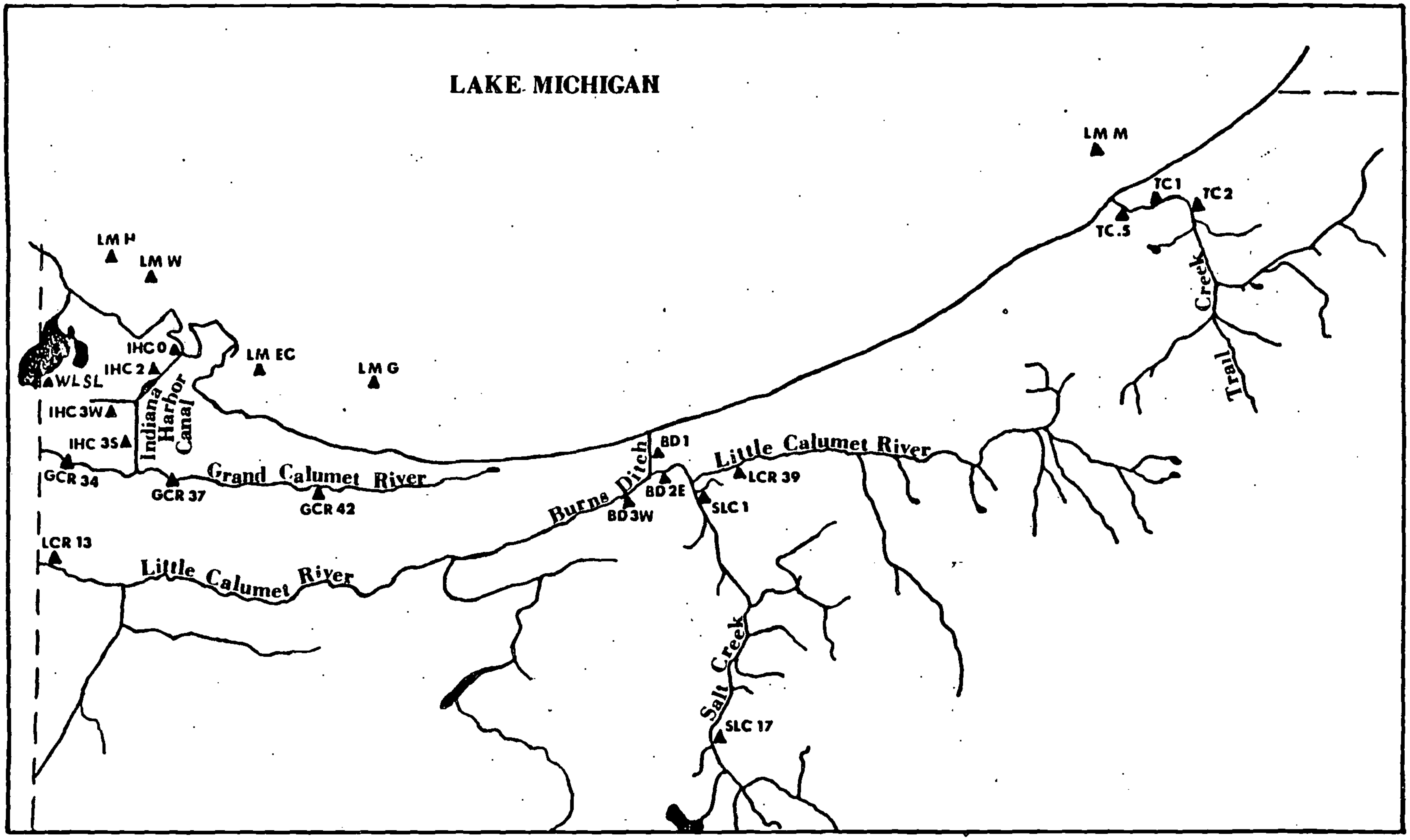


TABLE 44. Indiana's Fixed Station Water Quality Monitoring Network (1986).

STATION	NAME	LAT/LONG	LOCATION
BD-1(C)	Burns Ditch at Portage	41 37 20.5/87 10 34.4	Midwest Steel Truck Bridge, Portage
BD-2E	Burns Ditch at Portage	41 36 45/87 10 25	State Highway 249 Bridge (Chrisman Road)
BD-3W	Burns Ditch at Portage	41 36 9.3/87 11 37	Portage Boat Yard Dock, Portage
BL-.7 (BL-.1)(Q)	Big Blue River at Edinburg	39 21 29/85 59 01	U.S. Highway 31 Bridge, Edinburg
BL-64 (BL-61)(Q)	Big Blue River near Spiceland	39 52 25/85 26 20	County Road 450S Bridge
BLW-57 (BLW-53)(Q)	Blue River, West Fork-Fredericksburg	38 26 02/86 11 31	U.S. Highway 150, Fredericksburg
EC-1	Eagle Creek at Indianapolis	39 44 11/86 11 48	Raymond Street, East of State Hwy. 67
EC-7	Eagle Creek at Speedway	39 46 41/86/15 02	Lynhurst Bridge near W. 10th Street
EC-21	Eagle Creek at Zionsville	39 54 37/86 17 08	State Highway 100, S. of Zionsville
EEL-1(Q)	Eel River at Worthington	39 07 26/86 58 10	S.R. 67 Bridge, Worthington
ELL-7	Eel River near Logansport	40 46 55/86 15 50	C.R. 125N Bridge, NE of Logansport
ELL-41	Eel River near Roann	40 56 53/85 53 28	S.R. 15 NE of Roann
ER-.3	Elkhart River at Elkhart	41 41 16/85 58 18	East Jackson Street Bridge, Elkhart
EW-1	East Fork, White River-Petersburg	38 32 22/87 13 22	S.R. 57 Bridge NE of Petersburg
EW-79 (EW-77)(C)	East Fork, White River-Williams	38 48 07/86 38 44	County Road South of State Highway 450
EW-94	East Fork, White River-Bedford	38 49 33/86 30 47	U.S. Highway 50 Bridge, S. of Bedford
EW-168 (EW-167)	East Fork, White River-Seymour	38 59 12/85 53 56	Seymour Waterworks Intake
EW-239	East Fork, White River-Columbus	39 12 02/85 55 35	S.R. 46 Bridge, Columbus
FC-.6	Fall Creek-Indianapolis	39 46 54/86 10 36	Stadium Drive Bridge, Indianapolis
FC-7	Fall Creek-Indianapolis	39 50 05/86 07 19	Keystone Avenue near Water Intake
CGR-34	Grand Calumet River-Hammond	41 37 12/87 30 31	Hohman Avenue Bridge at Hammond
GCR-37	Grand Calumet River-East Chicago	41 36 50/87 27 41.4	Bridge on Kennedy Avenue, E. Chicago
GCR-42	Grand Calumet-Gary	41 36 33/87 22 20	Bridge Street Bridge, Gary
IHC-0	Indiana Harbor Canal at E. Chicago	41 40 23/87 26 25	At Mouth of Ship Canal
IHC-2 (IHC-1)(C)	Indiana Harbor Canal at E. Chicago	41 39 18/87 27 33	Bridge on Dickey Road, E. Chicago

Table 44. (cont'd)

STATION	NAME	LAT/LONG	LOCATION
IHC-3S	Indiana Harbor Canal at E. Chicago	41 38 22/87 28 16	Bridge on Columbus Drive, E. Chicago
IHC-3W	Indiana Harbor Canal at E. Chicago	41 38 48/87 28 51	Bridge on Indianapolis Blvd., E. Chicago
IWC-9 (IWC-6.6)(C)	Indianapolis Waterway Canal at Indianapolis	39 52 07/86 08 30	Confluence of Canal and White River
KR-68 (KR-65)(C)	Kankakee River at Shelby	41 10 57/87 20 26	S.R. 55 Bridge, 1 Mile South of Shelby
KR-118 (KR-125)(C)	Kankakee River-Kingsbury Wildlife	41 28 39/86 36 16	U.S. 6 Bridge, S. of Kingsbury Wildlife
LCR-13	Little Calumet River at Hammond	41 34 39/87 31 19	Hohman Avenue Bridge, Hammond
LCR-39	Little Calumet River-Porter	41 37 04/87 07 32	S.R. 149, S. of U.S. Hwy. 12, NW of Porter
LM-EC	Lake Michigan at East Chicago	41 39 09/87 26 17	Raw Water, East Chicago Waterworks
LM-G	Lake Michigan at Gary	41 38 58/87 20 32	Raw Water, Gary Waterworks
LM-H	Lake Michigan at Hammond	41 42 00/87 29 00	Raw Water, Hammond Waterworks
LM-M(C)	Lake Michigan at Michigan City	41 44 07/86 54 00	Raw Water, Michigan City Waterworks
LM-W(C)	Lake Michigan at Whiting	41 40 45/87 29 17	Raw Water, Whiting Waterworks
M-114 (M-95)	Maumee River at Woodburn	41 10 11/84 50 57	S.R. 101 Bridge, 3 Miles N. of Woodburn
M-129 (M-110)(C)	Maumee River at New Haven	41 05 06/85 01 14	Landin Road, .5 Mile North of New Haven
MC-18 (MC-17)(Q)	Mill Creek at Devore	39 26 00/86 45 47	U.S. Highway 231 Bridge, Near Devore
MC-35(Q)	Mill Creek at Stilesville	39 38 12/86 38 25	U.S. Highway 40 Bridge at Stilesville
MS-1	Mississinewa River at Peru	40 45 14/86 01 23	State Highway 124, East of Peru
MS-28	Mississinewa River at Jalapa	40 37 32/85 43 52	Izaak Walton Lodge
MS-36 (MS-35)	Mississinewa River at Marion	40 34 34/85 39 34	Highland Avenue Bridge, Marion
MS-99 (MS-100)	Mississinewa River at Ridgeville	40 16 48/84 59 43	County Road 134E, 2 Miles East of City
MU-20 (MU-25)	Muscatatuck River near Austin	38 45 46/85 56 11	S.R. 39 Bridge West of Austin
P-35 (P-33)(Q)	Patoka River near Oakland City	38 22 57/87 20 00	Miller Rd. Bridge, 2 Miles W. of S.R. 57 Bridge
P-76(Q)	Patoka River at Jasper	38 19 40/86 57 59	County Road West of State Highway 45

Table 44. (cont'd)

STATION	NAME	LAT/LONG	LOCATION
PC-21(Q)	Big Pine Creek, Pine Village	40 25 19/87 20 30	S.R. 55 Bridge, Pine Village
PGN-37	Pigeon River, Mongo	41 42 00/85 21 08	S.R. 3 Bridge, Mongo
S-0	Salamonie River-Largo	40 49 46.5/85 43 06	Division Road, near Largo
S-25	Salamonie River-Lancaster	40 43 45/85 30 26	C.R. 300W, S. of Lancaster
S-71	Salamonie River-Portland	40 25 42/85 02 17	106 South Road Bridge, Portland
SC-25 (SC-30)	Sugar Creek at Shades State Park	39 56 46/87 03 33	S.R. 234 Bridge, above Shades State Park
SGR-1(Q)	Sugar Creek at Edinburg	39 21 39/85 59 51	Road to Atterbury from Edinburg
SJR-51 (SJR-46)(C)	St. Joseph River at South Bend	41 44 40/86 16 22	Auten Road Bridge, South Bend
SJR-64	St. Joseph River at Mishawaka	41 40 16.5/86 09 08	Petro Park Bridge, Mishawaka
SJR-87 (SJR-76)(C)	St. Joseph River at Bristol	41 43 20/85 49 03	County Road through Bristol
SLC-1	Salt Creek, Portage	41 35 59/87 08 43	U.S. Hwy. 20 Bridge, Portage
SLC-17 (SLC-12)	Salt Creek near Valparaiso	41 29 56/87 08 29	S.R. 130 Bridge, Below Sewage Treatment Plant
SLT-12 (SLT-11)	Salt Creek near Oolitic	38 53 18/86 30 31	State Highway 37 Bridge
STJ-.5 (STJ-0)(C)	St. Joseph River at Fort Wayne	41 45 21.5/85 07 42	Tennessee Street Bridge
STM-.2(C)	St. Mary's River at Fort Wayne	41 05 01/85 08 07	Spy Run Bridge over St. Mary's
STM-11 (STM-12)	St. Mary's River at Fort Wayne	40 59 17/85 06 01	Anthony Blvd. Bridge, S. of Hwy. 27-33
STM-37 (STM-33)	St. Mary's River at Pleasant Mills	40 46 45/84 50 32	S.R. 101 Bridge, N. of Pleasant Mill
TC-.5 (TC-.3)(C)	Trail Creek at Michigan City	41 43 21/86 54 16	Franklin Street Bridge, Michigan City
TC-1	Trail Creek at Michigan City	41 43 18/86 53 49	U.S. Hwy. 12 Bridge, Michigan City
TC-2	Trail Creek at Michigan City	41 43 21/86 52 32	Bridge Upstream STP at Krueger Park
TR-9 (TR-6)	Tippecanoe River near Delphi	40 35 40/86 46 14	S.R. 18 Bridge, 5 Miles West of Delphi
TR-107	Tippecanoe River near Rochester	41 06 21/86 13 12	U.S. 31 Bridge, North of Rochester
V-.8	Vermillion River at Cayuga	39 57 40/87 27 07	State Highway 63 Bridge, Cayuga
WB-52(C)	Wabash River at New Harmony	38 07 52/85 56 33	U.S. Hwy. 460 Bridge, New Harmony
WB-130 (WB-128)	Wabash River at Vincennes	38 42 26/87 31 09	U.S. Hwy. 50 Bridge, NW Edge of Vincennes

Table 44. (cont'd)

STATION	NAME	LAT/LONG	LOCATION
WB-183 (WB-175)(C)	Wabash River, West of Fairbanks	39 13 39/87 34 21	I&M Breed Generating Station
WB-218 (WB-207)(C)	Wabash River near Terre Haute	39 30 24/87 24 50	Ft. Harrison Boat Club
WB-230 (WC-219)	Wabash River at Clinton	39 39 26/87 23 42	S.R. 163 Bridge at Clinton
WB-240 (WB-228)	Wabash River at Montezuma	39 47 33/87 22 26	U.S. Hwy. 36 Bridge, W. Edge of Montezuma
WB-256 (WB-245)	Wabash River at Cayuga	39 50 08/87 25 11	State Highway 234 Bridge, Cayuga
WB-303 (WB-292)(C)	Wabash River near Lafayette	40 24 43/87 02 11	Granville Bridge, SW of Lafayette on Road 700W
WB-316(C)	Wabash River north of Lafayette	40 25 10/86 53 50	S.R. 225 (East St.) Bridge, Battleground
WB-347 (WB 336)	Wabash River at Georgetown	40 44 19/86 30 10	C.R. 675, West of Georgetown
WB-370 (WB 360)	Wabash River at Peru	40 44 32/86 05 48	Business U.S. Highway 31 Bridge, Peru
WB-402 (WB 390)	Wabash River at Andrews	40 52 08/85 36 06	S.R. 105 Bridge, North of Andrews
WB-409 (WB-399)	Wabash River at Huntington	40 50 19/85 29 53	Huntington Waterworks
WB-420 (WB-409)	Wabash River at Markle	40 49 26/85 20 22	State Highway 3 Bridge
WB-452	Wabash River at Geneva	40 37 00/84 57 15	U.S. 27 Bridge, 1.5 Miles N. of Geneva
WC-3 (WC-1)	Wildcat Creek at Lafayette	40 27 12/86 51 05	S.R. 25 Bridge, NE of Lafayette
WC-60 (WC-63)	Wildcat Creek at Kokomo	40 28 26/86 11 02	County Road 300W, 1 Mile W. of Kokomo
WC-66 (WC-69)	Wildcat Creek at Kokomo	40 29 10/86 06 37	U.S. Highway 31 Bypass Bridge
WCS-34(Q)	Wildcat Creek, South Fork-Frankfort	40 18 59/86 32 48	Hwy. 38-39 Bridge N.W. of Frankfort
WHE-27(Q)	East Fork, Whitewater River-Abington	39 43 57/84 57 35	Abington Pike Rd. Bridge, E. Edge of Abington
WHW-22(Q)	West Fork, Whitewater River, Cedar Grove	39 21 12/85 56 36	S.R. 1 Bridge, Cedar Grove
WLSL	Wolf Lake at Hammond	41 39 42/87 31 30	Culvert, S. Edge of Dike W. of Calumet Ave.
WR-19(Q)	West Fork White River at Hazelton	38 29 24/87 33 00	S.R. 56 Bridge, Hazelton
WR-46 (WR-48)(C)	West Fork White River at Petersburg	38 30 42/87 17 16	State Highway 61 Bridge, Petersburg

Table 44. (cont'd)

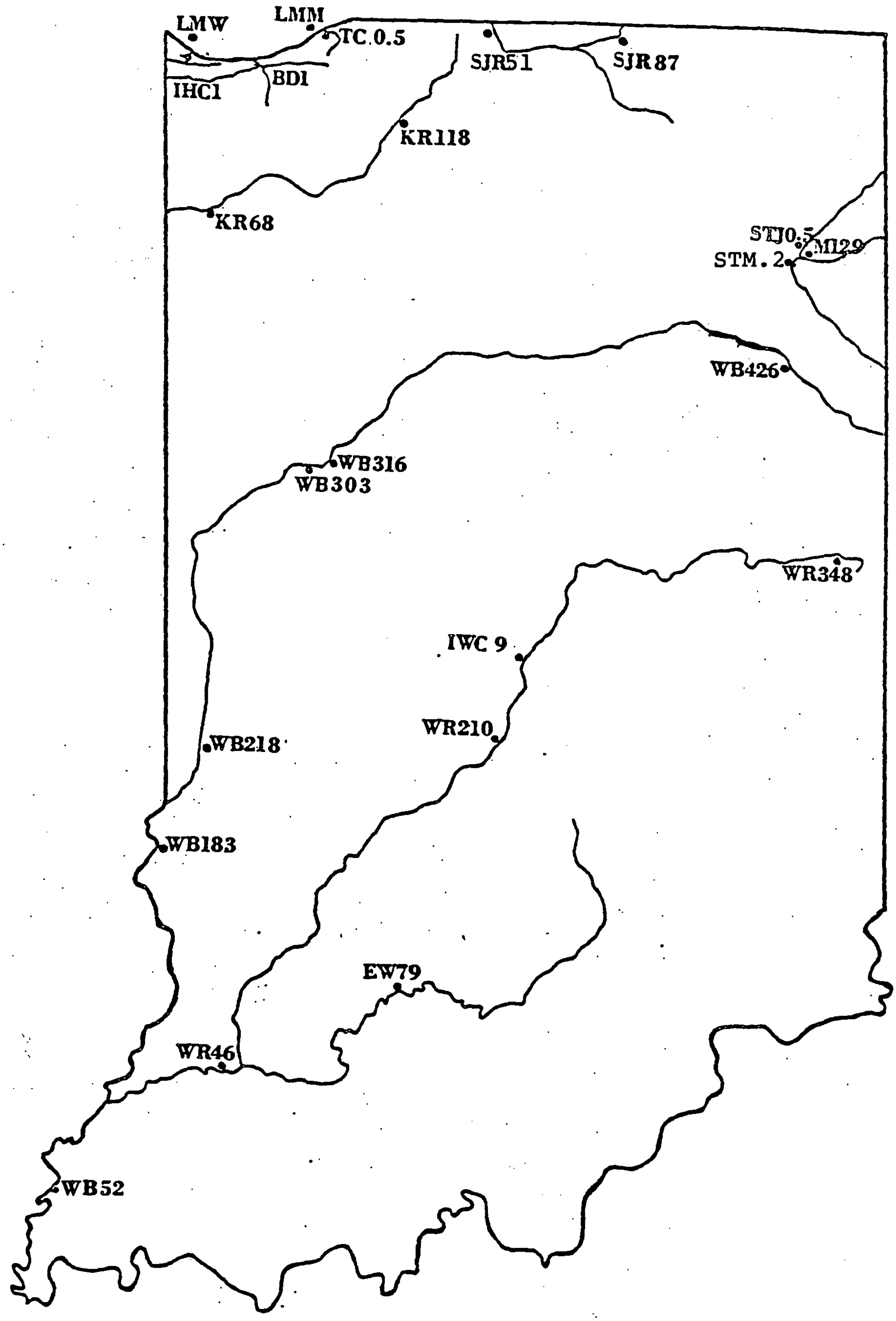
STATION	NAME	LAT/LONG	LOCATION
WR-81 (WR-80)	West Fork White River at Edwardsport	38 42 42/87 14 26	S.R. 358 Bridge, 1 Mile Below PWR Gen. Station
WR-162 (WR-166)	West Fork White River at Spencer	39 17 16/86 44 45	S.R. 43 & 46 Bridge, S. Edge of Spencer
WR-192	West Fork White River, Martinsville	39 26 02/86 26 55	S.R. 39 Bridge West of Martinsville
WR-210(C)	West Fork White River at Waverly	39 33 35/86 16 28	S.R. 144 Bridge, Waverly
WR-248 (WR-249)	West Fork White River at Nora	39 54 35/86 06 19	State Highway 100 Bridge, E. of Nora
WR-279 (WR-280)	West Fork White River, Perkinsville	40 08 30/85 52 48	State Highway 13 Bridge
WR-293 (WR-295)	West Fork White River at Anderson	40 06 22/85 40 22	10th Street at Waterworks
WR-309 (WR-310)	West Fork White River at Yorktown	40 10 42/85 29 40	County Road Bridge, N. of Yorktown H.S.
WR-319	West Fork White River at Muncie	40 10 41/85 20 32	Memorial Drive, East Edge of Muncie
WR-348 (WR-350)(C)	West Fork White River, Winchester	40 10 56/85 58 10	At U.S. 24 Bridge, East of Winchester

(C) CORE Station
(Q) Quarterly Sampling Station

TABLE 45. Analyses conducted at Indiana's Fixed Water Quality Monitoring Stations. (Not all parameters are sampled and analyzed at each station.)

Alkalinity (total)
Ammonia as NH_3-N
Arsenic as As (total)
Biochemical Oxygen Demand (BOD)
Calcium as $CaCO_3$
Chemical Oxygen Demand (COD)
Cadmium as Cd
Chloride as Cl
Chromium as Cr^{+6} (hexavalent)
Chromium as Cr (total)
Coliform fecal (per 100 ml)
Coliform total (per 100 ml)
Copper as Cu (total recoverable)
Cyanide (total) as Cn
Dissolved Iron
Dissolved Oxygen (DO)
Fecal Streptococcus Group
Fluoride as F
Hardness as $CaCO_3$
Iron as Fe (total)
Lead as Pb (total recoverable)
Magnesium as $MgCO_3$
Manganese as Mn (total)
Mercury as Hg
Nickel as Ni (total recoverable)
Nitrate + Nitrite as N
Nitrogen, TKN (total)
Threshold Odor (number)
Oil and Grease
Polychlorinated biphenyls (PCBs)
pH
Phenol
Phosphorus as P (total)
Phthalates
Potassium as K
Selenium
Silica as SiO_2
Silver as Ag
Sodium as Na
Suspended Residue (nonfilterable reside)
Voltile Suspended Matter
Total Residue
Dissolved Residue (filterable residue)
Specific Conductance as micromhos/cm
Sulfate as SO_4
Total Organic Carbon (TOC)
Turbidity as NTU
Zinc as Zn (total recoverable)

Figure 18. Location of Indiana's CORE monitoring stations.



to satisfy the requirement of the U.S. EPA's Basic Water Monitoring Program. In addition, fillet samples have been collected at some stations so comparisons can be made between "edible portion" and "whole fish" samples. A list of the parameters for which the fish samples are analyzed is shown in Table 46. Sediment samples collected are analyzed for 137 pollutants (Table 20).

In addition to the more routine monitoring, special studies of fish, sediment and, in some cases, water are conducted to monitor for toxic substances. Special studies were conducted on portions of the West Fork of the White River, East Fork of the White River Basin, Grand Calumet River/Indiana harbor Canal, Eel River, tributaries to the Wabash River, Judy Creek, and selected lakes and reservoirs during 1986-87 (Tables 47 and 48).

When waterbodies potentially affected by in-place pollutants are identified by sediment and/or fish tissue analysis, the site can be further evaluated by sediment toxicity testing, pollutant transport modelling, sediment criteria, caged fish bioaccumulation studies, or additional sampling. Remedial actions, if appropriate to reduce or remove in-place toxicants, could include additional point source controls, dredging sediments, sealing contaminated sediments or leaking landfills, or construction of sediment traps.

Water quality is routinely sampled for a limited number of toxic parameters (mostly metals) at the fixed water quality monitoring stations. Effluents from discharges known or suspected to contain toxic materials are analyzed for these materials when compliance sampling is conducted at these localities. In addition, 48-hour static bioassays using Daphnia magna as the test organism are conducted on effluents from all major discharges. During 1986-87, 43 static acute bioassays were conducted by IDEM and or U.S. EPA for Indiana wastewater discharges.

The goal of eliminating the discharge of toxic substances in toxic amounts is administered, for the most part, through the NPDES permits program. After a potentially toxic discharge is identified, its toxicity is controlled by issuing water quality-based discharge permits for individual toxicants identified in the effluent. Numerical criteria for 87 toxic substances and procedures for determining criteria for others were included in the state's water quality standards revisions proposed in 1987. When no toxicants have been identified, when a toxicant effect varies in a site specific way or when more than one toxicant may create additive or antagonistic effects, the permit may include a toxicity testing requirement.

Currently, there are seven discharges in Indiana with a toxicity testing requirement, and at least six others are expected to have such a requirement in the next year. Although none of these dischargers has a specific effluent toxicity limit, such a limit will be set if there is repeated effluent toxicity appearing in required tests. The state also plans to require toxicity reduction evaluations (TRE's) in these cases. A TRE is used to determine what measures are necessary to control effluent toxicity. This

TABLE 46. *List of parameters for which CORE fish flesh samples are analyzed*

PCB (total)	DDE, o, p'
BHC (alpha)	DDD, p, p'
BHC (beta)	DDD, o, p'
BHC (delta)	DDT, p, p'
BHC (gamma)	DDT, p, p'
Bexachlorobenzene	Methoxychlor, p, p'
Pentachloroanisole	Dieldrin
Heptachlor	Endrin
Heptachlor Epoxide	Mercury
Trans-Nonachlor	Chromium
Cis-Chlordane	Cadmium
Oxychlordane	Copper
Aldrin	Lead
DDE, p, p'	% Lipid Content

TABLE 47. *River and Stream Fish and Sediment Collection Sites in 1986-1987.*

RIVER or STREAM	STATION LOCATION	COUNTY
West Fork White River	U/S Winchester	Randolph
West Fork White River	U/S Muncie Water Co. Dam	Delaware
West Fork White River	D/S Muncie S.T.P.	Delaware
West Fork White River	U/S Anderson, Mounds S.P.	Madison
West Fork White River	D/S Anderson S.T.P.	Madison
West Fork White River	Riverwood (U/S Noblesville)	Hamilton
West Fork White River	D/S Noblesville S.T.P.	Hamilton
Stoney Creek	D/S Firestone Company (S.R. 37A)	Hamilton
West Fork White River	Broad Ripple@ Water Canal (c)	Marion
West Fork White River	Indianapolis Michigan Street Bridge	Marion
West Fork White River	Henderson Ford Bridge (c)	Morgan
West Fork White River	Paragon	Morgan
West Fork White River	D/S Spencer S.T.P.	Owen
West Fork White River	D/S Worthington S.T.P.	Greene
Richland Creek	U/S Neal's Landfill	Monroe
Richland Creek	D/S Neal's Landfill, Whitehall	Owen
Stouts Creek	Acuff Road Bridge, Bloomington	Monroe
West Fork White River	Elnora C.R. 400E	Daviess
West Fork White River	U/S Washington	Daviess
West Fork White River	D/S Washington	Daviess
West Fork White River	D/S Petersburg (c)	Pike
Big Blue	D/S New Castle	Henry
Big Blue	Carthage	Rush
Big Blue	D/S Shelbyville S.T.P.	Shelby
Big Blue	U/S Edinburgh, County line	Johnson
Flatrock	D/S Rushville	Rush
Flatrock	U/S Geneva	Shelby
Sugar Creek	D/S New Palestine	Shelby
Sugar Creek	Camp Atterbury, Edinburgh	Johnson

Table 47. (Con't)

Sand Creek	U/S Greensburg	Decatur
Sand Creek	D/S Greensburg	Decatur
Sand Creek	Westport	Decatur
Sand Creek	Scipio	Decatur
Muddy Fork Sand Creek	U/S Delta Faucet, Greensburg	Decatur
Muddy Fork Sand Creek	D/S Delta Faucet, near Harris City	Decatur
East Fork White River	D/S Brownstown	Jackson
East Fork White River	D/S Williams Dam (c)	Lawrence
East Fork White River	U/S Shoals	Martin
Clear Creek	County Club Road, Bloomington	Monroe
Clear Creek	Fluckmill Road, Bloomington	Monroe
Clear Creek	Harrodsburg	Monroe
Pleasant Run Creek	U/S Central Foundry, Bedford	Lawrence
Pleasant Run Creek	D/S Central Foundry, Bedford	Lawrence
Salt Creek	Guthrie	Lawrence
Salt Creek	D/S Old S.R. 450, Bedford	Lawrence
1,2 Grand Calumet River East Branch	Virginia St. Bridge (Gary)	Lake
2 Grand Calumet River East Branch	Bridge St. Bridge (Gary)	Lake
2 Grand Calumet River East Branch	Cline Avenue Bridge (East Chicago)	Lake
2 Grand Calumet River East Branch	Kennedy Avenue Bridge (East Chicago)	Lake
1,2 Grand Calumet River Confluence of East and West Branches	(East Chicago)	Lake
Indiana Harbor Canal	Dickey Road Bridge (East Chicago)	Lake
Grand Calumet River West Branch	Indianapolis Blvd. Bridge (East Chicago)	Lake
1,2 Grand Calumet River West Branch	Hohman Ave. Bridge (Hammond)	Lake

Table 47. (Con't)

Eel River	U/S Johnson Drain	Allen
Johnson Drain	U/S Confluence Eel River	Allen
Eel Rivr	D/S Johnson Drain	Allen/Whitley
Eel River	U/S Blue River, Columbia City	Whitley
Blue River	U/S Wayne Recycling, Columbia City	Whitley
Blue River	D/S Wayne Recycling, Columbia City	Whitley
Eel River	D/S Blue R Washington Road	Whitley
Eel River	U/S South Whitley	Whitley
Eel River	D/S South Whitley, Collamer Dam	Whitley
Eel River	U/S North Manchester	Wabash
Eel River	D/S North Manchester	Wabash
Eel River	U/S Laketon	Wabash
Round Lake Outlet to Eel River	Laketon	Wabash
Eel River	D/S Laketon	Wabash
Eel River	Denver	Miami
Eel River	Adamsboro	Cass
Eel River	U/S Logansport	Cass
Eel River	U/S Confluence	Cass
Little Calumet River	Burns Ditch (c)	Porter
Grand Calumet River	Indiana Harbor Canal (c)	Lake
Kankakee River	Shelby (c)	Lake
Kankakee River	Kingsbury Fish & Wildlife Area (c)	La Porte
Maumee River	D/S Fort Wayne S.T.P. (c)	Allen
St. Mary's River	Fort Wayne (c)	Allen
St. Joseph River	U/S Fort Wayne (c)	Allen
St. Joseph River	U/S Bristol (c)	Elkhart
St. Joseph River	D/S South Bend S.T.P. (c)	St. Joseph

Table 47. (Con't)

Trail Creek	D/S Michigan City S.T.P. (c)	La Porte
Judy Creek	Ironwood Road South Bend	St. Joseph
Judy Creek	Bittersweet Road South Bend	St. Joseph
Judy Creek	Kenilworth Road South Bend	St. Joseph
Wabash River	U/S Bluffton (c)	Wells
Wabash River	U/S Lafayette (c)	Tippecanoe
Wabash River	D/S Lafayette (c)	Tippecanoe
Wabash River	U/S Terre Haute (c)	Vigo
Wabash River	D/S Terre Haute (c)	Vigo
Wabash River	New Harmony (c)	Posey
Little Sugar Creek	U/S Old Mallory Plant	Montgomery
Little Sugar Creek	D/S Old Mallory Plant	Montgomery
Sugar Creek	U/S Crawfordsville	Montgomery
Sugar Creek	D/S Crawfordsville S.T.P.	Montgomery
Wildcat Creek	U/S Kokomo	Howard
Wildcat Creek	D/S Kokomo S.T.P.	Howard

U/S = Upstream
D/S = Downstream
C = CORE Program Station
1 = No fish sample collected.
2 = Suspended sediment also sampled.

TABLE 48. *Lake and reservoir fish and sediment collection sites in 1986-1987.**

LAKE or RESERVOIR	COUNTY	STATION LOCATION
Cataract	Owen/Putnam	U/S Cunot Public Ramp
Crooked	Steuben	First and third basins
Deam	Clark	Stone branch
Dogwood	Daviess	N. E. fork
Dogwood	Daviess	S. E. fork
Freeman	White/Carroll	S. R. 421 Bridge
Freeman	White/Carroll	Dam
Hamilton	Steuben	North end
Huntington	Huntington	West basin
Huntington	Huntington	East basin
Lake George	Lake (Hammond)	South basin
Lake George	Lake (Hammond)	North basin
Lemon	Brown/Monroe	Along South Shore Road
Mansfield	Parke	U.S. 36 Bridge
Round	Wabash	East end
Shafer	White	U/S Main basin
Shafer	White	Big Monon Creek
Wolf	Lake	West basin
Wolf	Lake	Channel
Wolf	Lake	East basin
Yellowood	Brown	West Shore

Table 48. (Con't)

LAKE or RESERVOIR	COUNTY	STATION LOCATION
Carlson Pond	Porter	Inlet end
Cedar	Lake	Main basin
Center	Kosciusko	Main basin
Crooked	Noble/Whitley	Main basin
Henderson	Noble	Main basin
Lake of the Woods	Marshall	Main basin
Manitou	Fulton	Main basin
Maxinkuckee	Marshall	Main basin
Patoka	Crawford/Dubois/Orange	Painters Creek inlet
Patoka	Crawford/Dubois/Orange	Wall's Lake branch
Patoka	Crawford/Dubois/Orange	South Fork Lick Creek
Shipshewana	Lagrange	Main basin
Sylvan	Noble	Main basin
Wabee	Kosciusko	Main basin
Wawasee	Kosciusko	Conklin Bay
Wawasee	Kosciusko	Mouth Turkey Creek
Winona	Kosciusko	Main basin

* - In addition, fish were collected from Lake Michigan by Indiana Department of Natural Resources personnel and submitted for analysis.

U/S - Upstream

could include bench scale treatability studies, spill control procedures, or process modifications in which the identification of specific toxicants is not necessary.

Biological Monitoring Program

Biological monitoring involves sampling for fish, aquatic invertebrates, plankton, bacteria, and conducting bioassay work. Some of these programs were discussed in the Toxic Monitoring Programs Section and will not be discussed further here.

In addition to those fish collected and analyzed for toxic substances, data as to number and kinds of all fish observed are recorded during sampling. This provides qualitative information as to the composition of the fish community at these stations. These data can be compared to data obtained in previous years or from other studies to give some indication of how the fish community is reacting to changes in water quality.

Monitoring for aquatic macroinvertebrates also is done at the CORE Program stations. Approximately 4-6 weeks before the fish and sediment sampling occurs, three Hester-Dendy macroinvertebrate samplers are set at each station to be sampled that year. At the time of the fish sampling, these samplers are retrieved, and the organisms collected, preserved, and identified to the lowest taxon possible and counted. Differences in kinds and/or number of organisms between samples set upstream and downstream of major discharge areas indicate the nature of water quality problems originating in these areas.

Routine monitoring of fecal coliform bacteria is done at all fixed water quality monitoring stations. Very high numbers of these organisms usually indicate inadequate sewage treatment, feedlot contamination, or areas where combined sewer overflows (CSO's) may be causing problems upstream. Bacteriological samples are also collected as part of surveys or inspections at wastewater treatment facilities.

Primary productivity studies are also part of the biological monitoring program. These are not done on a routine basis, but are used to provide information for full scale models and wasteload allocations when needed and in conjunction with special lake studies. These studies provide information on the rates of algal photosynthesis and respiration in the river, lake, or stream.

Each year Habitat and Use Attainability Studies are conducted to determine the existing and/or potential uses that various stream reaches will support. During the study, a checklist which includes detailed information regarding the physical, chemical, and biological nature of the stream, as well as a description of the riparian land use, is completed. This information is used to prepare a habitat evaluation report which describes the existing and potential uses of the stream.

Some streams are incapable of supporting diverse communities of fish and other aquatic life during much of the year simply because there is not enough water, food, or suitable habitat present to support them, no matter how high the water quality might be. The state has established a "Limited Use" designation for some of these streams. Waters which provide unusual aquatic habitat, which are an integral feature of an area of exceptional natural beauty or character, or support unique assemblages of aquatic organisms may be classified for "Exceptional Use".

If the habitat evaluation study indicates that the use designation for a particular stream or stream reach should be changed, the report is presented to the Water Pollution Control Board to support a recommended change in the official stream use designation. The report will also be made part of the official record of the public hearing that is held to consider changing the official use designation in the water quality standards. In 1986-87, Habitat and Use Attainability Studies were conducted on 31 streams. However, many of these were re-checks of streams previously designated for "Limited Use", and no new stream reaches are currently being proposed for this designation. At present, 34 streams reaches (77 stream miles) are designated for "Limited Use" and 11 are designated for "Exceptional Use" (181 stream miles).

IV. GROUND WATER QUALITY IN INDIANA

Part I. The Ground Water Resource

Ground water in Indiana occurs in both unconsolidated and bedrock aquifer systems that can yield potable water in sufficient quantity to serve as a source of supply. The most productive aquifers are associated with glacially derived outwash sand and gravel deposits that occur in the major river valleys. Large diameter wells in these areas can produce up to 2,000 gallons per minute. Other good unconsolidated aquifers are found in the thick, inter-till sand and gravel deposits of central and northern Indiana. The withdrawal potential for properly constructed wells there ranges from 400 to 2,000 gpm. The major bedrock aquifers include the Pennsylvanian age sandstones of southwest Indiana, Mississippian age limestones in the south central area, Devonian age limestone and dolomite units across the northern and mid-sections, and Silurian age limestones and dolomites in the north and central portions of the state. Well yields of the important bedrock aquifers can vary from 20 to 600 gpm.

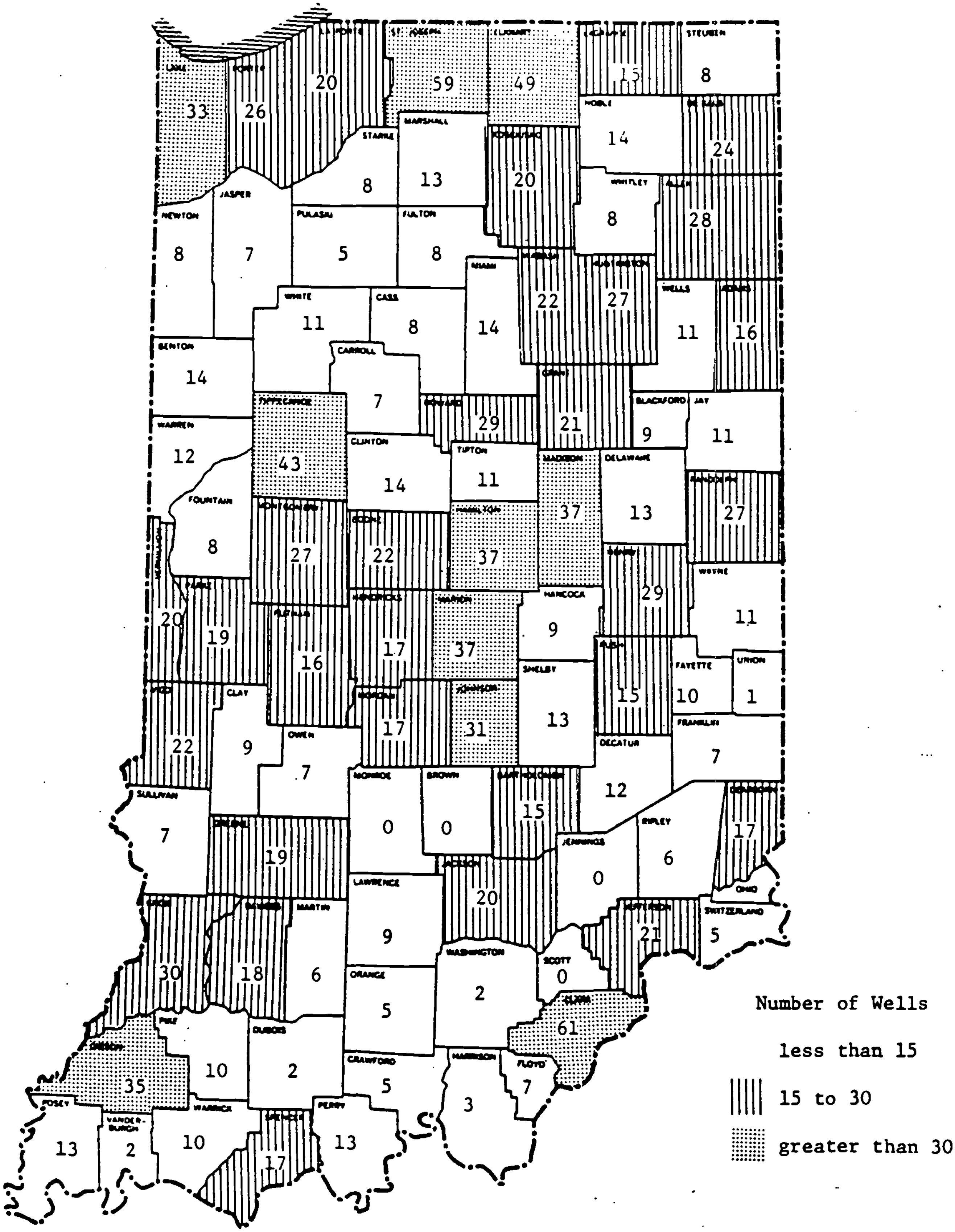
The ambient ground water quality throughout Indiana is variable and dependent on the aquifer system, geologic setting, and depth of the formation. On a general basis, the incidence of mineralized or even saline ground water increases rapidly at bedrock depths below 300 feet. The chemical quality of the potable water is adequate to meet the basic needs for household, municipal, industrial, and irrigation uses. However, the waters are normally very hard, exceeding 180 parts per million (ppm) hardness in a range from 100 ppm to over 600 ppm across the state. Other constituents of importance to natural water quality are iron, manganese, sulfate, fluoride and hydrogen-sulfide. Most of Indiana's ground water contains over the 0.3 ppm aesthetic threshold for iron. Manganese concentrations are often a nuisance associated with iron, but are lowest along the Wabash and Whitewater Rivers and in Mississippian age limestone aquifers. Sulfate levels are dependent on the geologic deposits. Concentrations exceeding 600 ppm have been noted in northeastern Indiana, and Harrison, Orange, Vermillion and Lake counties. Hydrogen-sulfide is present in the ground water of sizeable areas in the northwestern region underlain by limestone bedrock. Even small concentrations can be objectionable to domestic water users.

Nearly 59% of the state's population uses ground water for drinking water purposes. There are 426 public water systems, utilizing some 1,775 individual waterwells, that are directly dependent on ground water for their supplies. About half of the population served by public water supplies use ground water. The distribution of public water supply wells by county is depicted in Figure 19. There are 2,975 non-community water systems in Indiana utilizing 3,439 waterwells. These systems service a transient (non-residential) population of at least 25 persons per day for 60 or more days per year. The distribution of these wells by county is shown in Figure 20. Approximately a half-million homes have private wells for their water supply and their number may increase by as much as 44% by the year 2000. The 1980 census data for private wells per county is shown in Figure 21. Ground water also services the needs of Indiana's economy. Industry uses an average 190 million gallons per day, irrigation consumes 200 million gallons per day during the growing season, and livestock depends on an average of 45 million gallons per day.

Indiana's Ground Water Programs

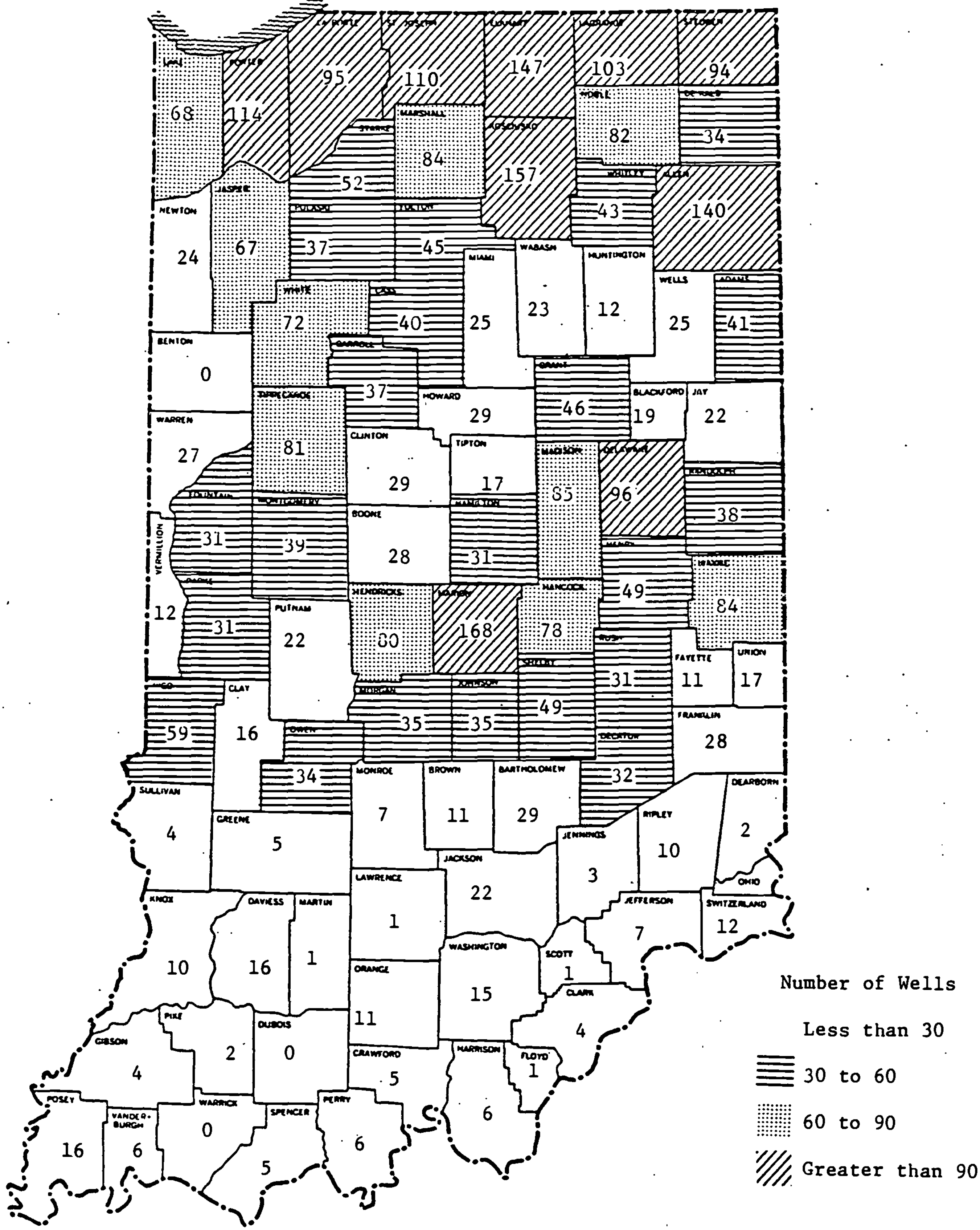
Indiana's primary ground water management and protection efforts reside within three state agencies. The Department of Environmental Management administers applicable state and federal laws through regulatory programs to protect the quality of ground water and drinking water supplies from potential pollution sources such as solid and hazardous waste, wastewater, underground storage tanks, and hazardous materials spills. The Department of Natural Resources has authority for management of oil, gas and mining activities, water well drilling, ground water information, and aspects of water quantity. The State Board of Health's ground water function is through administration of regulations for on-site sewage disposal systems. The role of the federal government is to establish laws, rules, policies, and to provide research and technical guidance for the State to use in administering programs for ground water protection. Typically, federal support includes grant assistance. In Indiana, the federal government directly regulates activities which affect ground water, such as public water supply supervision and underground injection control under the Safe Drinking Water Act. On the local level, Indiana counties, townships, and municipalities have powers to protect public health, safety, and welfare, by adopting land use restrictions and pollution control ordinances, and by properly managing water supply, sewage treatment and solid waste disposal facilities.

Figure 19. Community Water Supply Wells.



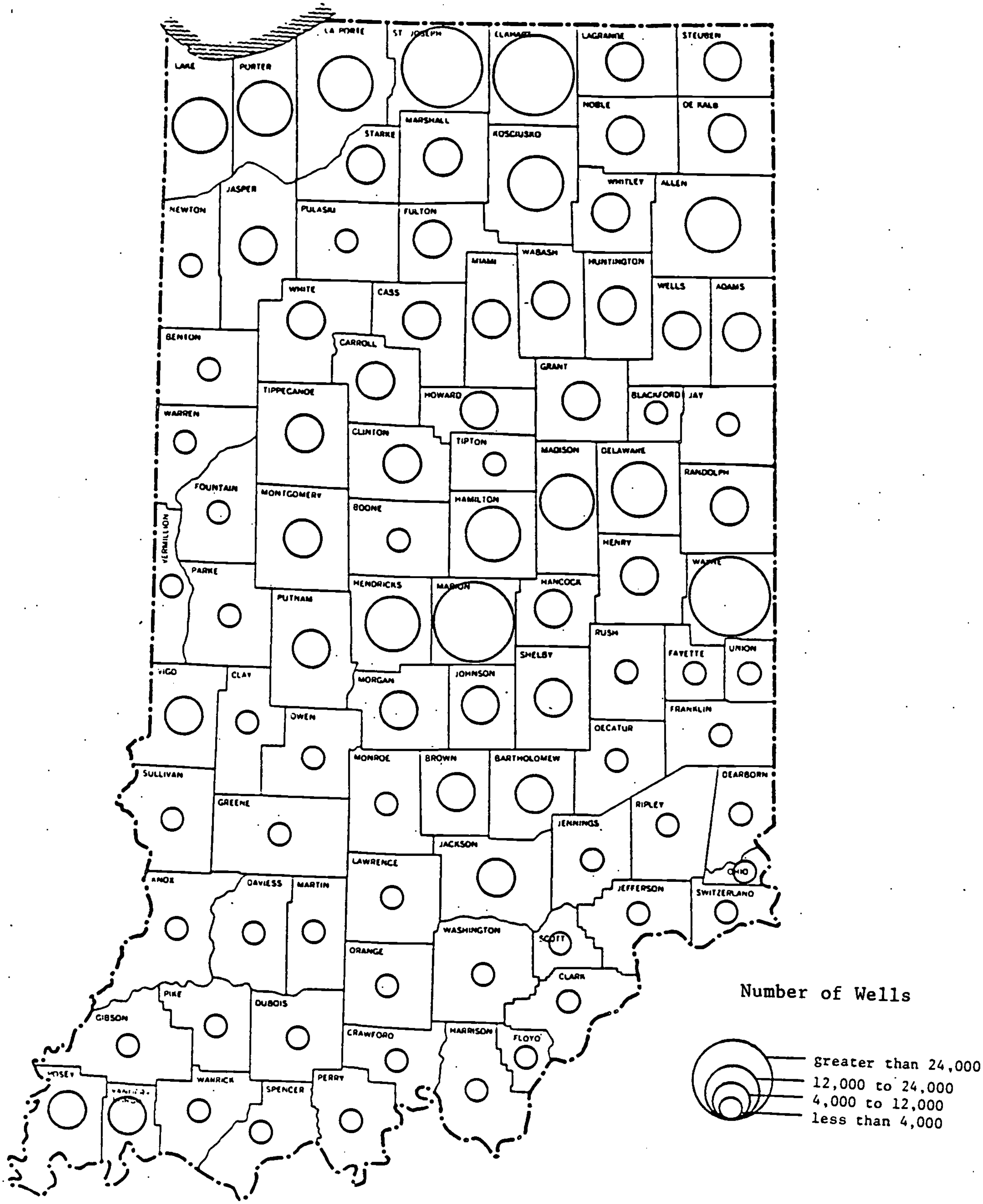
Source: IDEM Public Water Supply Section

Figure 20. Non-Community Water Supply Wells.



Information Obtained from A Survey of Non-Community Water Supplies in the State of Indiana, Hunger et al, 1986, Indiana University.

Figure 21. Private Water Supply Wells.



Information taken from
1980 Census on Population
and Housing for Indiana,
U.S. Dept. of Commerce.
listing number of drilled and
dug wells per county

Indiana's Ground Water Policy

This policy has been adopted to coordinate the activities and authority of those agencies currently involved in ground water protection and management:

> "A state-wide action plan will be implemented that will prevent ground water from being depleted and contaminated and which will correct or properly manage known or suspected problems."

These goals will be addressed within the context of a comprehensive ground water protection and management strategy:

- Coordination of the efforts of all state and local agencies which have ground water management responsibilities.
- Development and implementation of an information system for all programs involved with ground water that provides better access to existing and needed data.
- Development of a comprehensive understanding of Indiana's ground water environment and its relationship to current and potential threats.
- Establishment of adequate statutory and regulatory authority to accomplish the ground water protection and management tasks of the strategy.
- Promotion of local initiatives to safeguard public well water supplies and aquifers of critical concern.

The Indiana Ground Water Strategy

Indiana has a single water resource, composed of interrelated elements which include ground water. How ground water is treated or managed will ultimately affect Indiana's overall water resource.

Ground water is part of nearly all human, social, and economic activity. Because of this quality, no single law, agency or level of government can reasonably provide all the safeguards, research and guidance needed for ground water. In fact, at least 14 programs in five state agencies administer provisions of nine federal laws and 12 state statutes, which affect ground water in some way.

A plan was needed which would address a large number of issues, to serve as a common reference for state agencies, governments, businesses, and citizens as they work toward the shared goal of ground water protection.

In early 1986, an Inter-Agency Ground Water Task Force was formed at the state level, with representatives of the Department of Environmental Management, Department of Natural Resources, State Board of Health, State

Chemist's Office, and State Fire Marshal's Office. This committee developed a ground water policy and list of issues which were presented at six state-wide meetings. With that public input, a draft planning document was issued in mid-1986, as a discussion tool for six more public meetings and a written comment period. This analysis of ground water issues, alternative solutions, and recommended actions was then revised by the Task Force, based on this public participation.

The Indiana Inter-Agency Ground Water Task Force adopted a final version of the State Ground Water Protection Strategy and Draft Implementation Plan in early 1987. This document addresses 43 separate issues involving wells, ground water quality and water quantity, and makes 160 recommendations for improved safeguards and management of the resource. The plan calls for new and revised laws and rules, new as well as modified agency programs, research and information management, coordination efforts within and among all levels of government, and continued public participation. Implementation of the plan is targeted for at least a five-year phase-in, affecting many state agency programs, along with the involvement of local government, the U.S. Environmental Protection Agency, the State Legislature, universities, and others.

The Indiana Strategy is an agenda for state action to prevent, detect, and correct contamination and depletion of ground water. The implementation plan identifies key steps, schedules, responsibilities, resources, outputs, and contingencies to accomplish the objectives of the strategy. This plan is to be adaptable to new federal requirements, responsive to emerging issues and priorities, and subject to revision based on experience.

The Inter-Agency Ground Water Task Force, with an expanded membership, will continue to serve as a group for coordination and review of strategy implementation. Some of the priority actions for each of the agencies include the following:

- Department of Environmental Management: Obtain primacy for supervision of the public water supply and underground injection control programs. Implement a state program for cleanup of abandoned hazardous waste sites. Develop a program of protection zones for public water supply wells.

- Department of Natural Resources: Complete an Indiana Ground Water Atlas which maps and describes major aquifers. Implement a program for well driller certification and well construction standards.

- State Board of Health: Provide assistance to local health departments to improve ground water protection activities.

- Office of State Chemist: Implement a spill control and containment program for bulk fertilizer storage.

- Office of State Fire Marshal: Coordinate the response to leaking underground storage tanks and releases of hazardous materials.

Part II. Ground Water Quality

Ground Water Contamination Case Histories

The IDEM Ground Water Section developed and maintains a data base for details from case histories of chemical contamination of ground water in Indiana. This registry is compiled from file records of state and county environmental or health agencies and updated as new information is acquired. Contamination is defined as the concentration of a chemical in the ground water in excess of a U.S. EPA public drinking water standard, proposed standard, or health advisory guidance level. Documentation such as laboratory analyses or site investigation reports must exist in order for a case history to be included in the data base. Information is recorded separately for each contamination incident, which typically involves more than one well. Therefore, the registry is basically a listing of sites where evidence indicated the ground water was and/or is contaminated. It is not a library of ground water quality monitoring data. This summary of information in the registry forms the basis for a status report on Indiana's ground water quality problems.

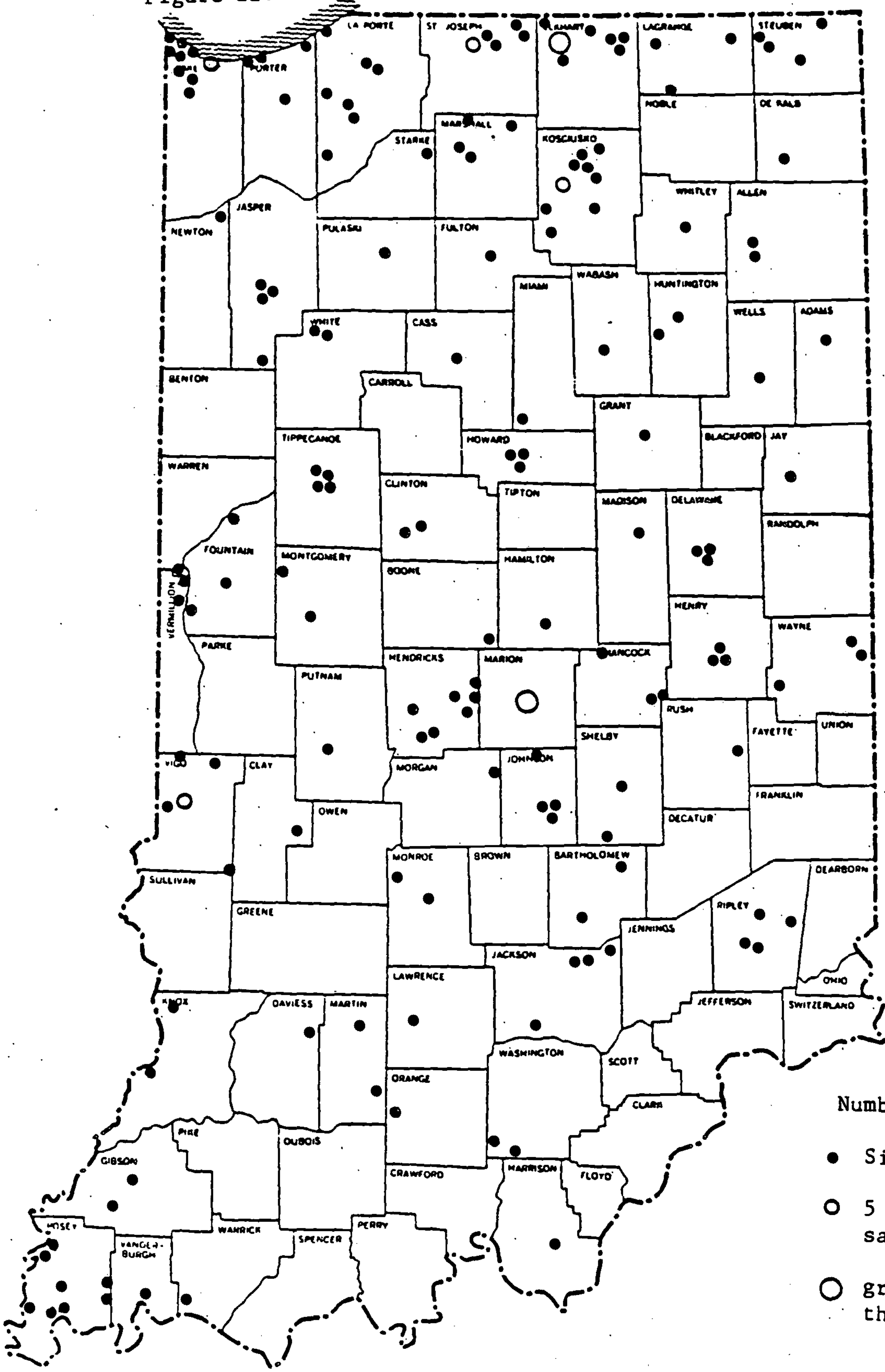
At the time of this report, there were 228 sites of ground water contamination recorded. Their location is displayed in Figure 22. Information sources for these case histories appear in Table 49. The greatest number of sites are found in the following counties: Elkhart, Lake, Vigo, Marion, Kosciusko, and St. Joseph. The cases were documented between 1954 and 1987, with the majority after 1977. Figure 23 shows a trend of increased detections of contamination over the past four years.

Table 49. Case History Information Source

Source of Information	Number of Cases
Ground Water Section - DEM	123
County Health Department	25
CERCLA (Superfund Cleanup Program) - DEM	21
CERCLIS (Superfund Site Investigation Program) - DEM	13
RCRA (Hazardous Waste Management Program) - DEM	21
Public Water Supply Section - DEM	19
Department of Natural Resources	6

For all of the case histories, about 900 of the over 1,900 wells sampled were shown to be contaminated. Fifty of the sites involved monitoring wells only, but nearly 80% had drinking water wells affected. About 775 of the 1,700 water supply wells sampled were contaminated, and approximately 60% of these served single residences. At 16% of the ground water contamination sites in the state, a public water supply well was involved, affecting on the average a year-round residential population of nearly 20,000 persons. Figure 24 describes the types of wells affected by ground water pollution. Figure 25 shows the location of 179 sites where drinking water supply wells were contaminated.

Figure 22. Sites of Documented Ground Water Contamination.



Number of Sites

- ● Sites of contamination
- o 5 to 10 sites in the same city of location
- O greater than 10 sites in the same city or location

Source: IDEM Ground Water Section (1987)

Figure 23. Documented Ground Water Contamination.

(Number of Cases Per Year)

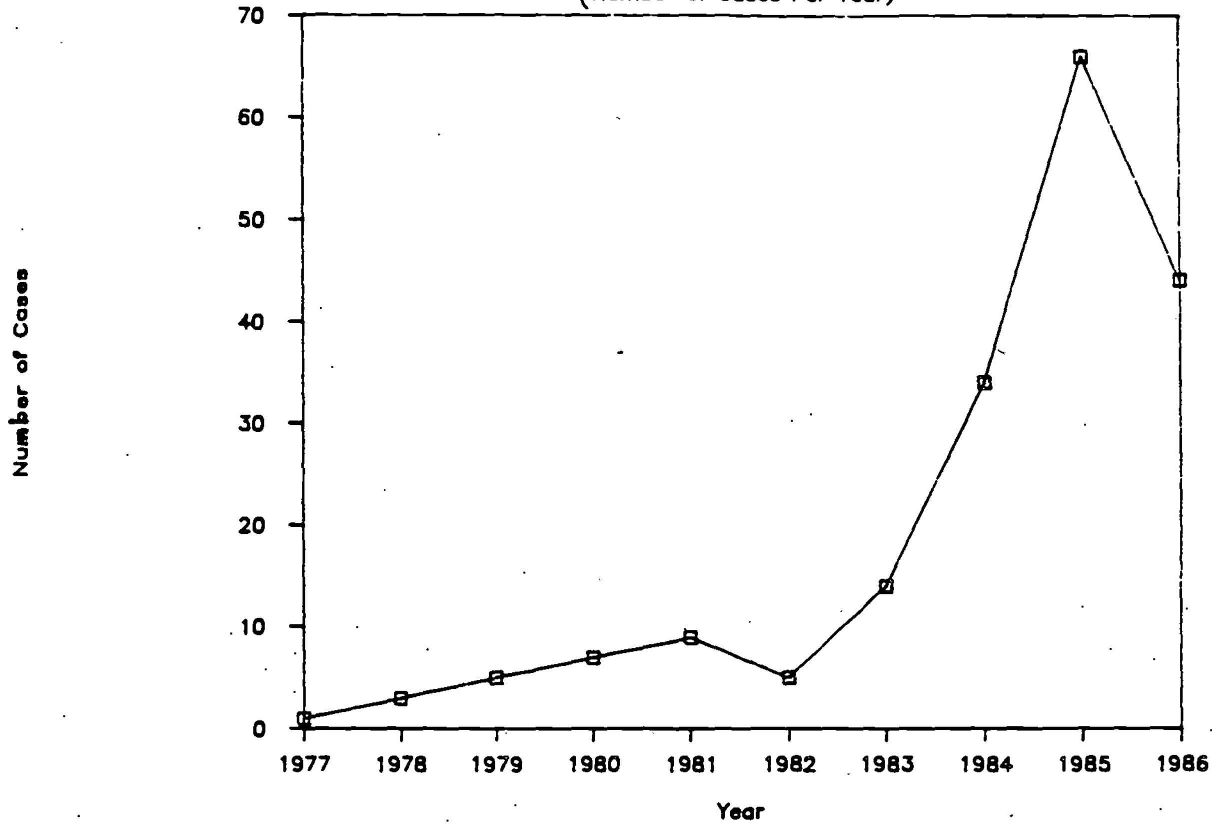
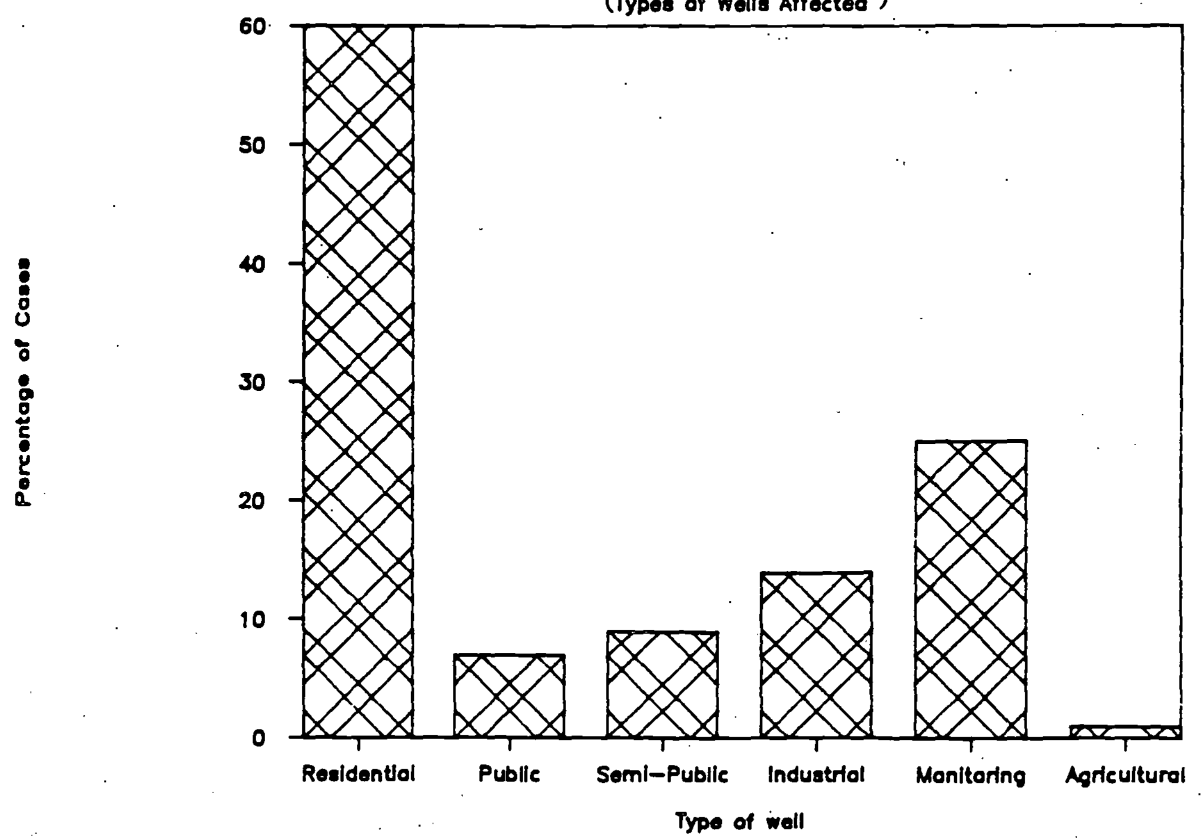


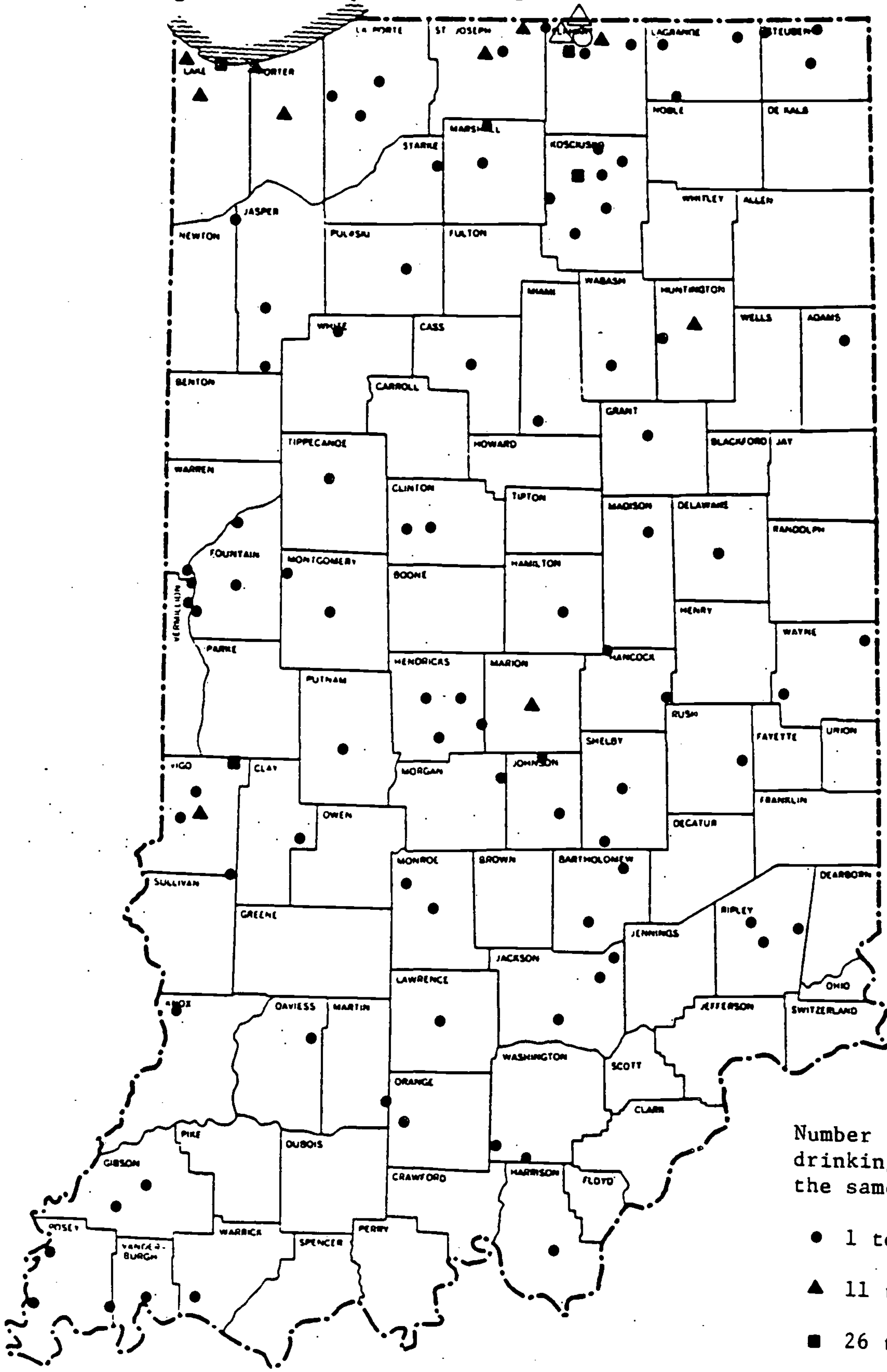
Figure 24. Documented Ground Water Contamination.

(Types of Wells Affected)



Source: IDEM Ground Water Section (1987)

Figure 25. Sites of Drinking Water Well Contaminations.



Number of contaminated drinking water wells in the same city or location

- ● 1 to 10
- ▲ 11 to 25
- ■ 26 to 50
- △ 51 to 100
- ○ greater than 100

Source: IDEM Ground Water Section (1987)

The case histories for chemical contamination of ground water suggest that the drinking water supply wells affected were very close to the source of pollution. The average distance ranged from approximately 450 to 1,400 feet between these wells and the facility, site, event, or activity which released the chemicals to the ground water. The data also indicates that relatively shallow wells, averaging in depth from 50 to 85 feet are most often impacted. Typically, they are located outside of municipal water and sewer service areas.

Investigations into drinking water well contamination were initiated because of complaints of taste or odor in the water for about a third of the cases in the registry. Similarly, concerns over pollution sources resulted in pollutants being documented in nearly a fourth of the cases. But at over a third of the sites, contaminants were detected only as a result of sample analysis not based on a complaint response action by a government agency. Compared to the 228 cases where ground water was affected, there have been nearly a hundred incidents where water samples were collected and no contamination was detected as part of a complaint response investigation. For recorded cases of drinking water well impacts, the remedies which were applied include bottled water, point of use water treatment, connection to a public supply, or well replacement. Actual cleanup of the ground water or corrective action for the contaminant source was only reported for a small number of the incidents. See Table 50 for a summary of ground water monitoring actions which documented contamination and Table 51 for a summary of remedial actions. (Percent totals may exceed 100 due to multiple actions for some cases.)

Table 50. Ground Water Monitoring Actions Which Documented Contamination

Action	Percent Frequency for 228 cases *	Percent Frequency for 179 cases **
Water sample analysis	27	35
Complaint response for:		
objectionable taste	26	33
objectionable odor	22	28
color or sediment	5	6
health concern	6	8
Pollution source investigation:		
known source	11	14
suspected source	6	8
Required monitoring	22	0

*includes monitoring wells
**drinking water wells only

Table 51. Remedial Actions for Water Well Contamination

Action	Percent Frequency for 179 Cases
Bottled Water Use	33
Point of Use Treatment	21
Public Water Connection	18
Contaminant Cleanup	17
Long Term Monitoring	18
Well Abandonment	16
Well Replacement	14

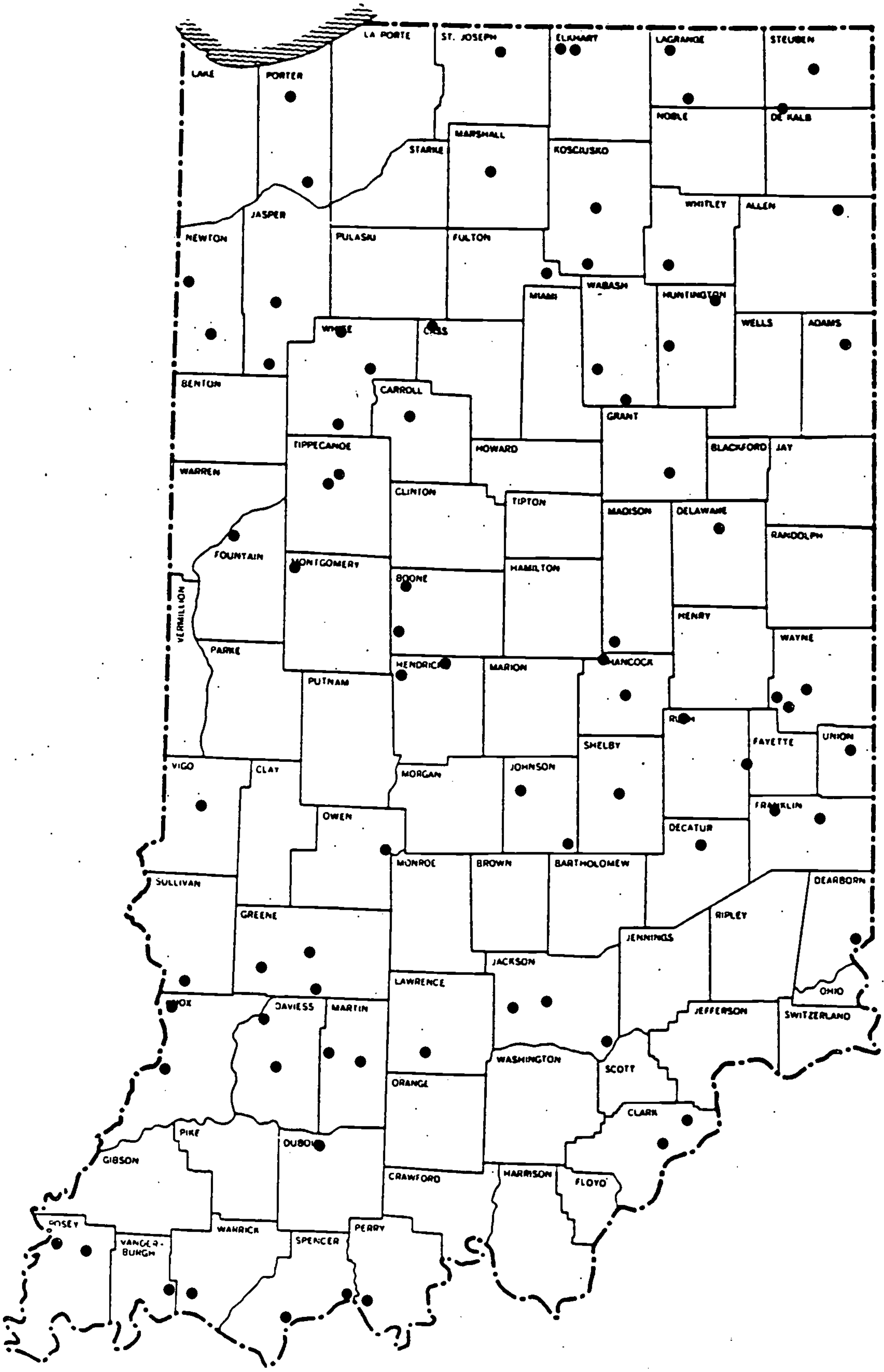
Public Water Supply Monitoring

Since 1981, the U.S. EPA, Region V Drinking Water Section has been conducting a survey for the presence of 26 synthetic volatile organic chemicals in the ground water supplies of over 400 community water systems in Indiana serving more than 25 persons year-round. This survey is essentially complete and EPA has reported results for 1,267 of the 1,774 community water supply wells in the state that had been sampled as of late 1986. Detectable levels of at least one chemical occurred in 140 wells, with locations shown in Figure 26. In 19 of the wells, the identified chemicals posed an increased lifetime cancer risk. As of September 30, 1986, 16 of these public wells had been permanently or temporarily abandoned due to contamination detected by the survey. Three water supplies were using treatment systems to remove the contaminants, and one of the affected wellfields was being addressed by the Superfund program. For the remaining wells, the water utilities were advised to continue monitoring the water quality. In a number of cases, blending the water from several wells has produced a finished water for the customers with non-detectable chemical contaminants.

Community water supplies in Indiana which utilize ground water are required to monitor the quality of the water delivered to their customers at least once every 3 years for 10 inorganic parameters (8 metals, nitrate, and fluoride). Although it is not required, some systems also test for five pesticides regulated for public supplies using surface water. Records indicate that only five systems, serving a total of 8,923 people, exceeded the maximum contaminant level (drinking water standard) for these chemicals. Nitrates were found to be high for two systems. Barium was reported above the standard for two other city supplies and the fluoride maximum was exceeded in one system. No public water supply wells were shown to contain any of the five pesticides when tested.

The Indiana University School of Public and Environmental Affairs recently completed the first phase of an EPA-funded study of non-community water supply systems in Indiana. These are public supplies serving 25 or more persons on a semi-permanent or transient basis, 60 or more days per year. It was reported that out of 2,929 systems in the state, 67 using ground water contained levels of nitrate in excess of the drinking water standard

Figure 26. Public Water Supply Wells with Detectable Organic Chemicals



Source: U.S. EPA, Region V
Drinking Water Section

(Figure 27). Analysis for other chemical parameters is planned for the second phase of the study.

Sources of Ground Water Contamination

Information regarding sites and sources of ground water contamination is based principally on analysis of samples collected by agency staff from public or private waterwells or from monitoring wells. Claims related to responsible sources are not yet possible for sites where ground water data has not been reported to the state.

Documenting the source for a particular incident of ground water contamination is not always possible. In about 30% of the case histories recorded at IDEM, the source was unknown or unconfirmed. There are a wide variety of activities, events, structures, or facilities which have been shown to pollute ground water in Indiana, as evidenced in Table 52. The most prevalent appear to be hazardous materials spills, losses from underground storage tank systems, and waste disposal activities.

Table 52. Sources of Ground Water Contamination

Type of Contaminant Source Affecting Water Wells	Percent Frequency For 228 Cases*	Percent Frequency For 179 Cases**
Unknown/Not Confirmed	33.3	30.7
Underground Storage Tank System	19.7	19.6
Hazardous Materials Spill	18.4	17.3
Solid Waste Disposal Facility	10.5	4.5
Hazardous Waste Disposal	10.5	10.1
Above Ground Storage Tank System	6.6	5.6
Leaking Sewer	7.0	8.4
Pit, Pond, or Lagoon	5.3	3.9
Pesticide Application	6.1	7.8
Salt Storage/Handling Facility	3.5	8.4
Improperly Abandoned Hole/Well (all associated with oil and gas)	3.1	8.4
Septic System	2.2	2.8
Wastewater Disposal into a Dry Well	1.8	2.2
Oil and Gas Production Operation	1.8	2.2
Injection Well (for brine disposal)	1.3	1.7

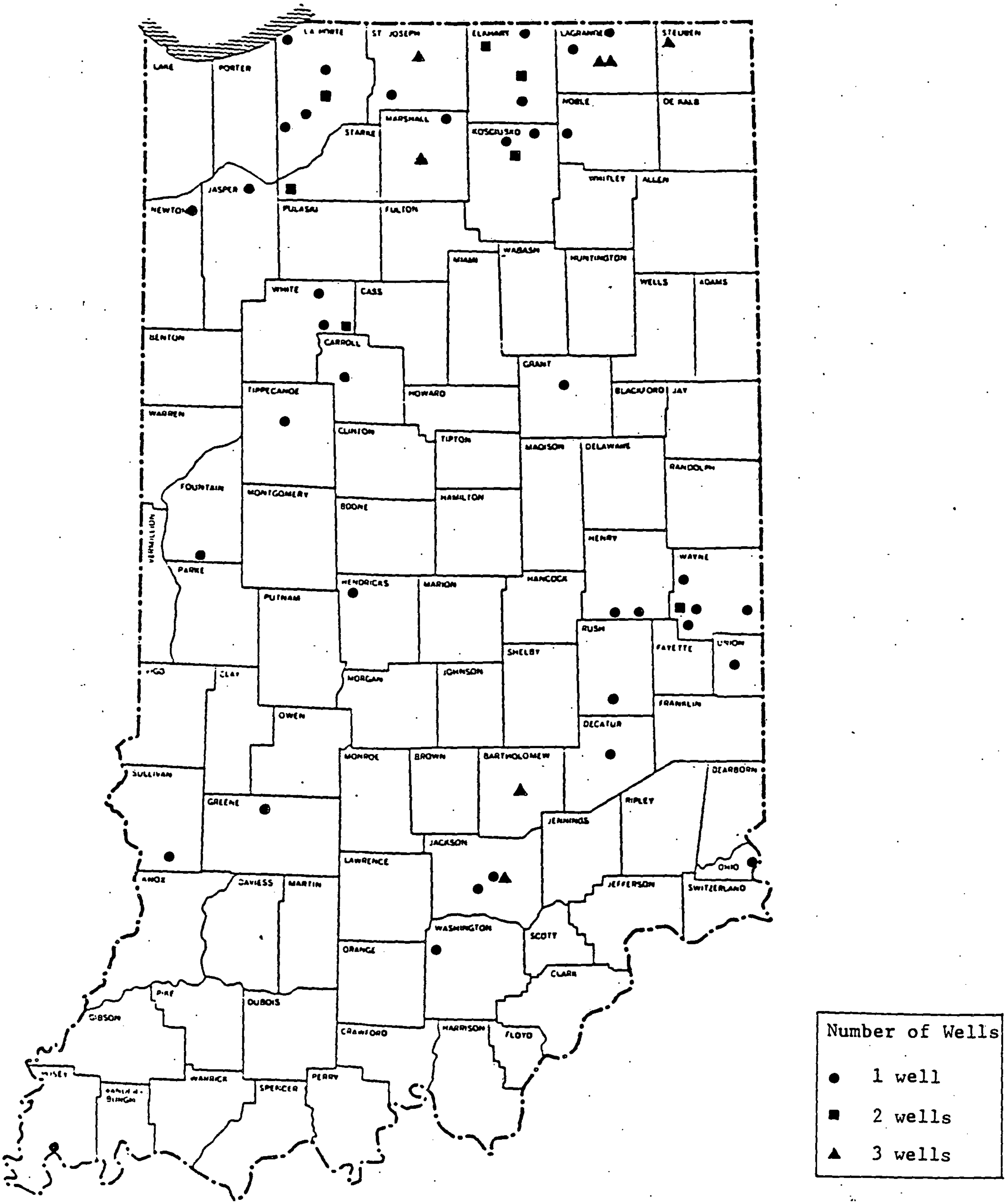
* includes monitoring wells
** drinking water wells only

(Percent totals will exceed 100 due to multiple sources for some cases.)

Hazardous Materials Spills

In general, it is reported that nearly half of the volume of hazardous materials lost to the environment each year is not recovered. Some of this is

Figure 27. Noncommunity water supply wells with over 10 parts per million nitrate nitrogen.



Source: A survey of noncommunity water supplies in Indiana (1986) Indiana University School of Public and Environmental Affairs due to volatilization, dilution, or adsorption of the chemicals which inhibit the feasibility of recovery. Yet where large volume spills are not sufficiently contained or cleaned up, or where chronic small losses go unreported and unaddressed, these events have been shown to be one of the most common causes of ground water pollution in Indiana.

In 1986, there were about 800 hazardous materials spills reported to the IDEM Office of Environmental Emergency Response. The largest number occurred in heavily industrialized areas such as Marion County (150 spills) and Lake County (60 spills). The statewide distribution of these events is shown in Figure 28. As shown in Figure 29, the types of materials released most often have also been found to be common ground water contaminants. These are petroleum products, plus industrial and agricultural chemicals. Such materials are more frequently spilled at industrial, commercial, or agricultural sites when they impact ground water. Details for 1986 spills are in Figure 30. The circumstances which cause these events most often are equipment failure and employee error (Figure 31). This reinforces the need for spill prevention and containment engineering and training as a means of protecting ground water and the environment.

Underground Storage Tank Systems

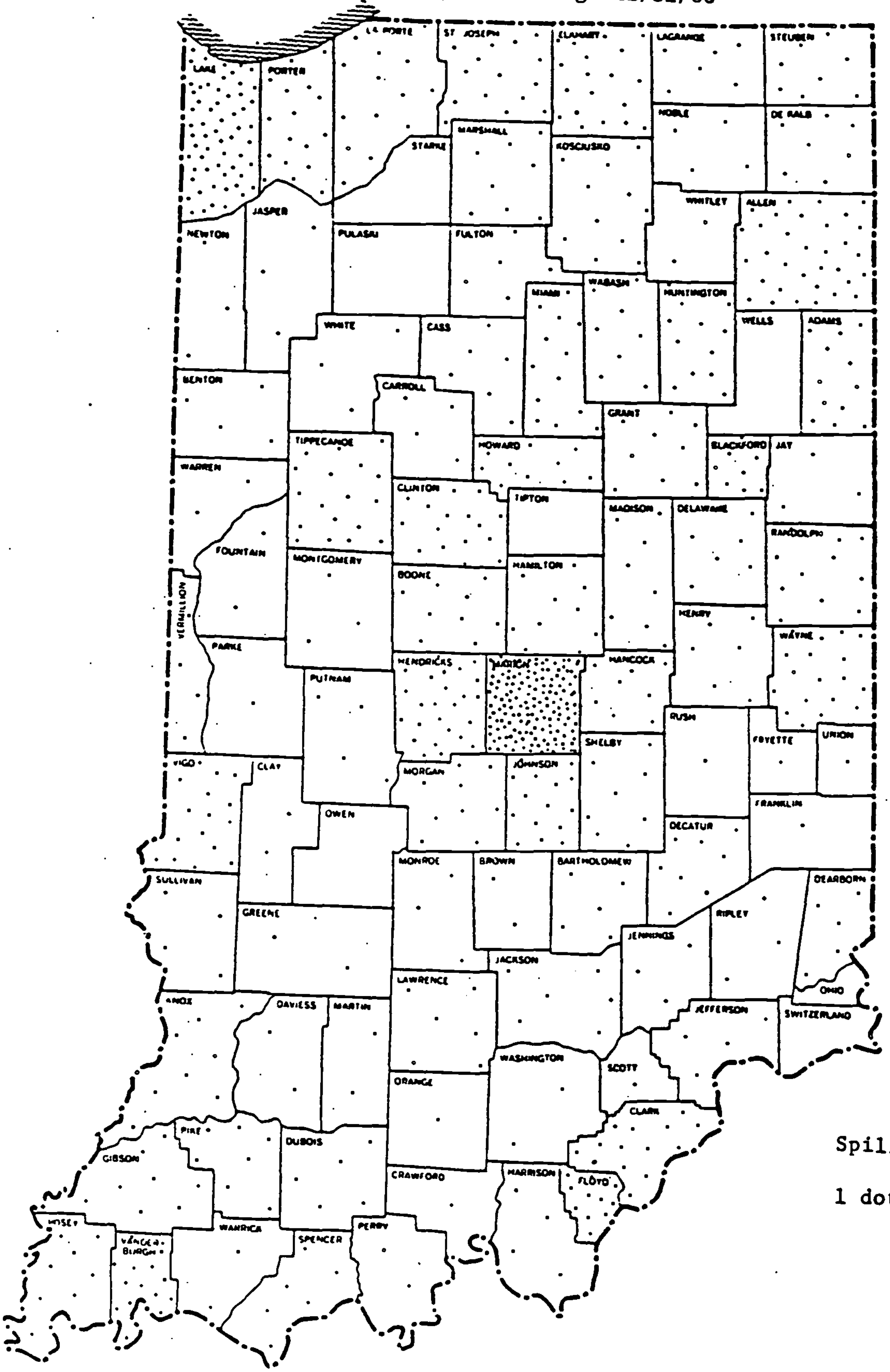
Chronic leaks and sudden releases from buried storage tanks and their associating piping have resulted in the contamination of ground water and water supply wells at some 50 sites in the state. Since IDEM began keeping records, approximately 180 other leaks from underground storage tanks systems were reported between January 1986, and September 1987. Remedial actions at half of these are in progress with about 15% requiring extensive treatment of polluted ground water.

Federal and state legislation requires owners of underground storage tanks used for commercial or industrial purposes to notify the IDEM of the tank's existence. (Tanks less than 1,100 gallons capacity, those containing heating oil, and those for residential and on farm use are exempt). Between May 1986, and September 1987, 34,500 tanks had been reported to IDEM. The statewide distribution is shown in Figure 32. In 1987, 19 counties were contracted to verify the tank notifications received by the state. These counties increased their tank inventories by about 65%. If the statewide reporting averages about 50%, then there are probably 65,000 underground storage tank systems in Indiana subject to regulation.

A large majority of the existing buried storage tanks in the state are over ten years old and of steel construction (Figure 33). Most of these older tanks do not have corrosion protection or leak detection features, although requirements for these are expected in the near future. Over 90% of these tanks contain petroleum products (Figure 34). Gasoline is the substance most often detected in ground water due to leaks from underground storage, although heating fuel and chlorinated solvents have also been found. The health risks associated with these dissolved chemicals in well water used for drinking can be significant.

Figure 28. Reported spills of hazardous materials.

1/1/86 through 12/31/86



Spills Per County

1 dot = 1 reported spill

Source: IDEM Emergency Response Section (1986)

Figure 29. Types of Materials Spilled

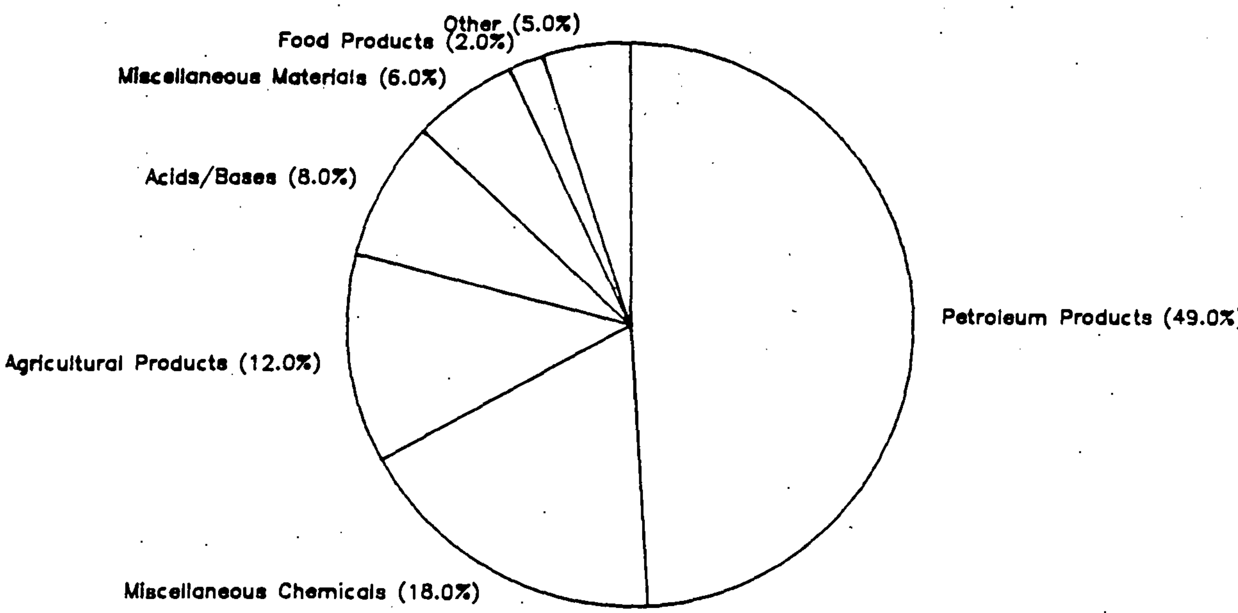


Figure 30. Sources of Materials Spilled

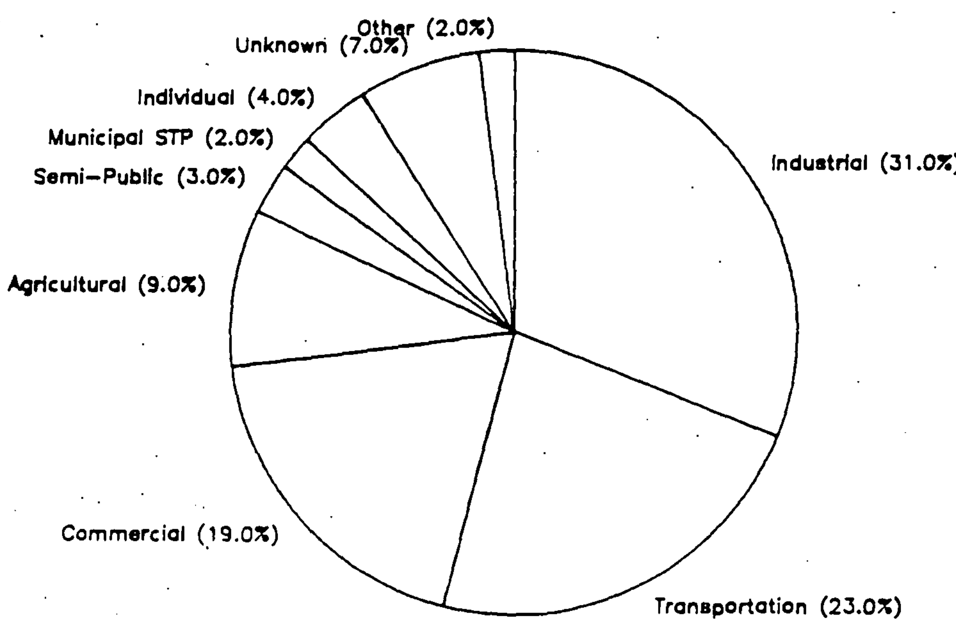
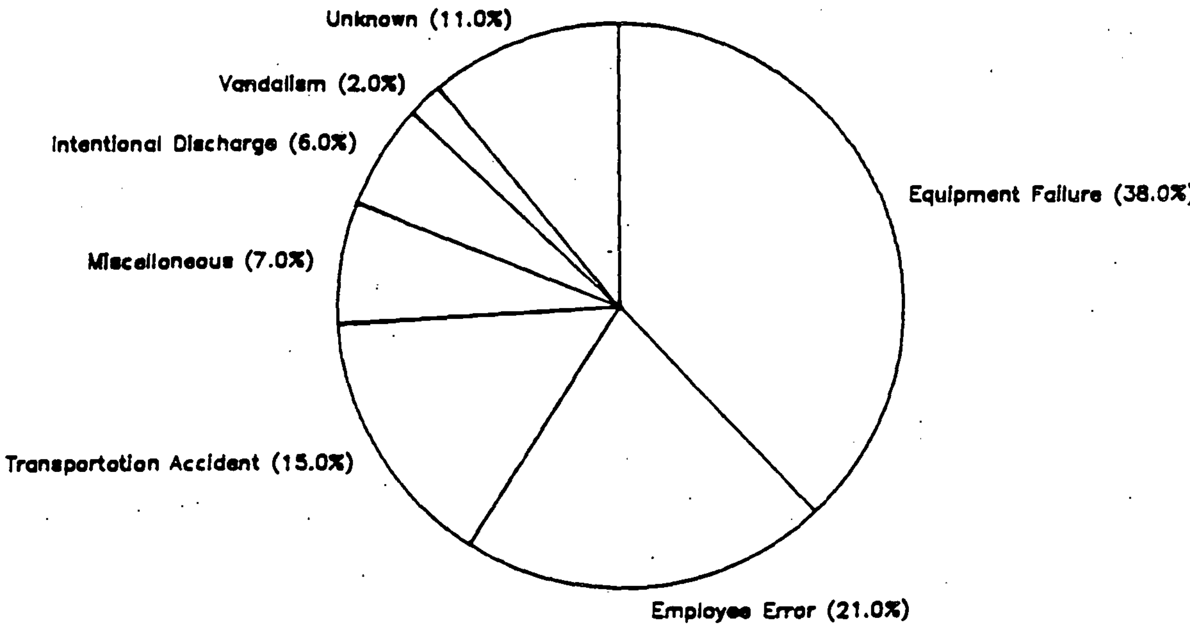
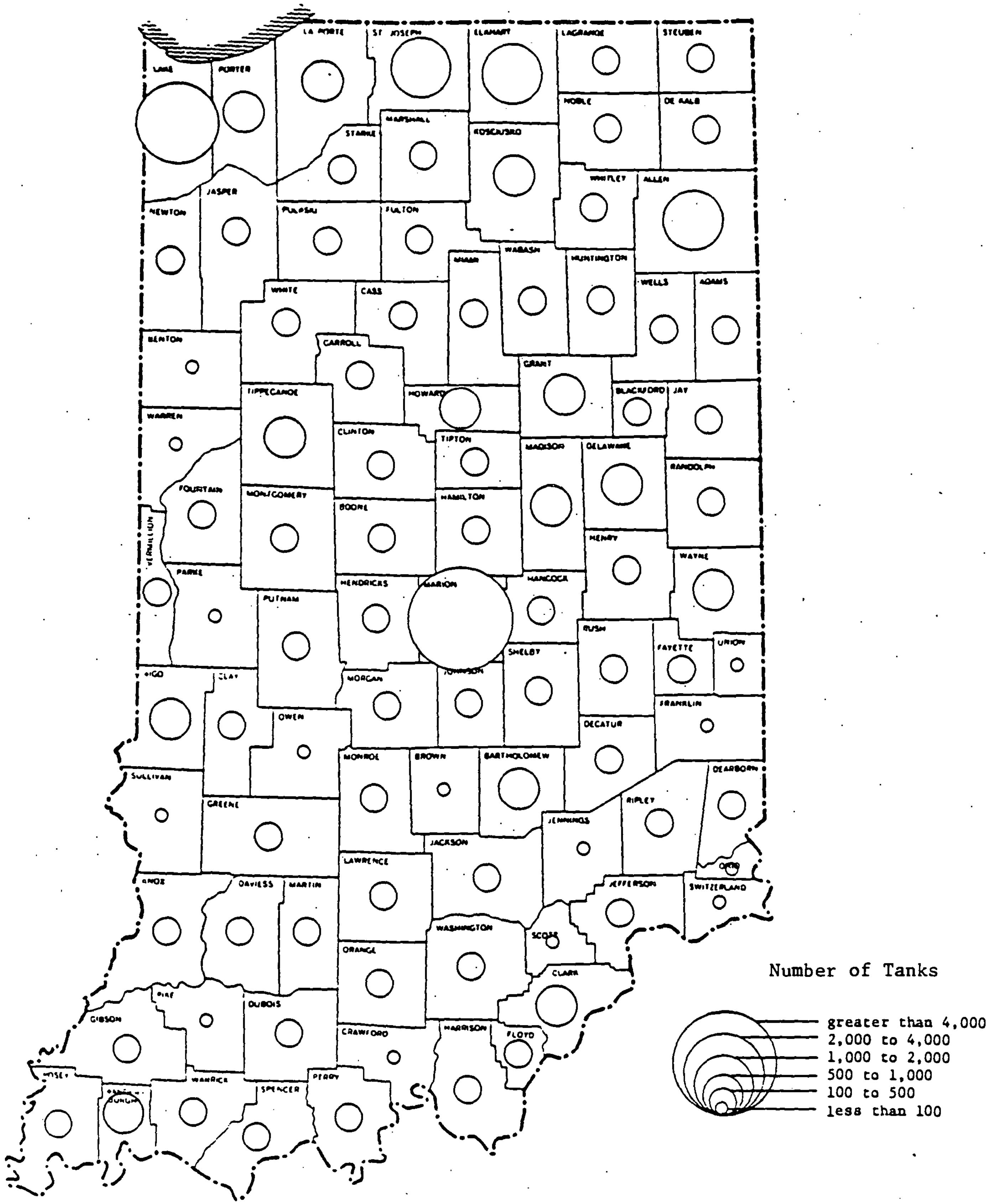


Figure 31. Circumstances of Materials Spilled



Source: IDEM Emergency Response Section (1986)

Figure 32. Underground Storage Tanks



Source: IDEM Underground Storage Tank Section (1987)

Figure 33. Underground Storage Tanks

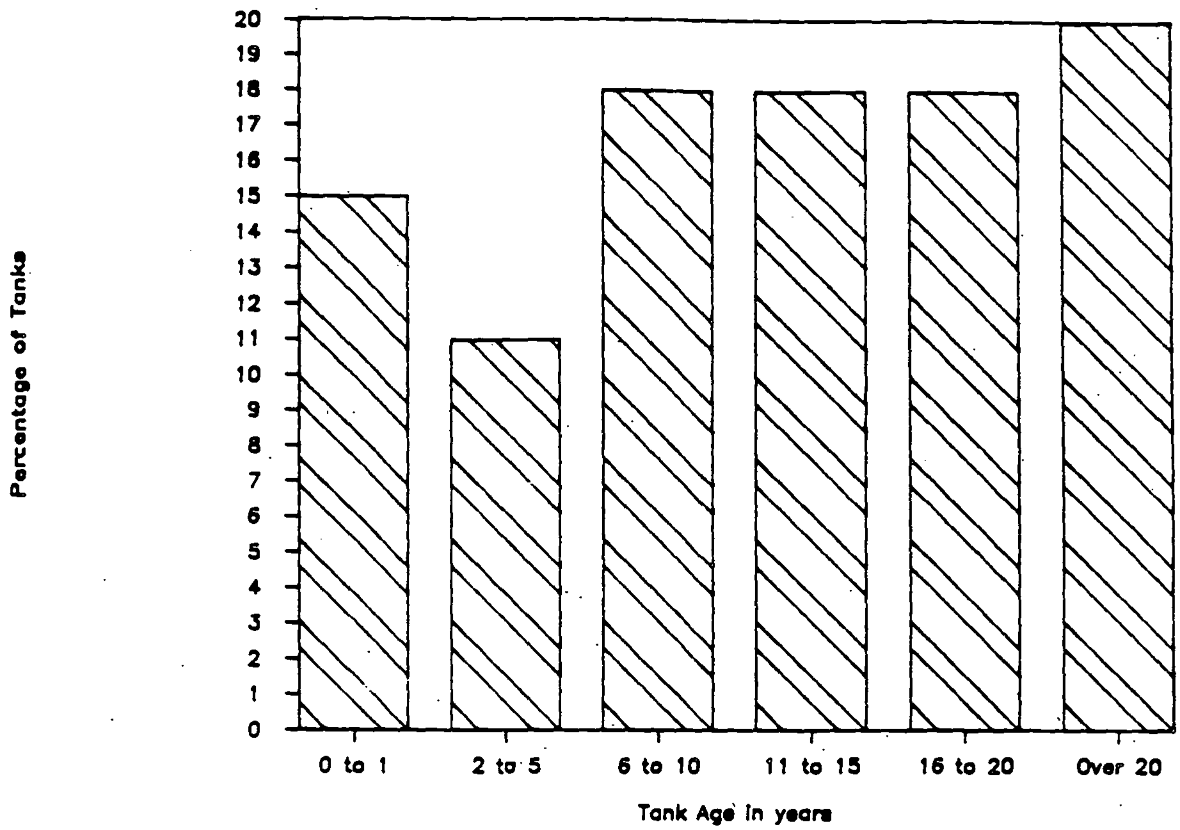
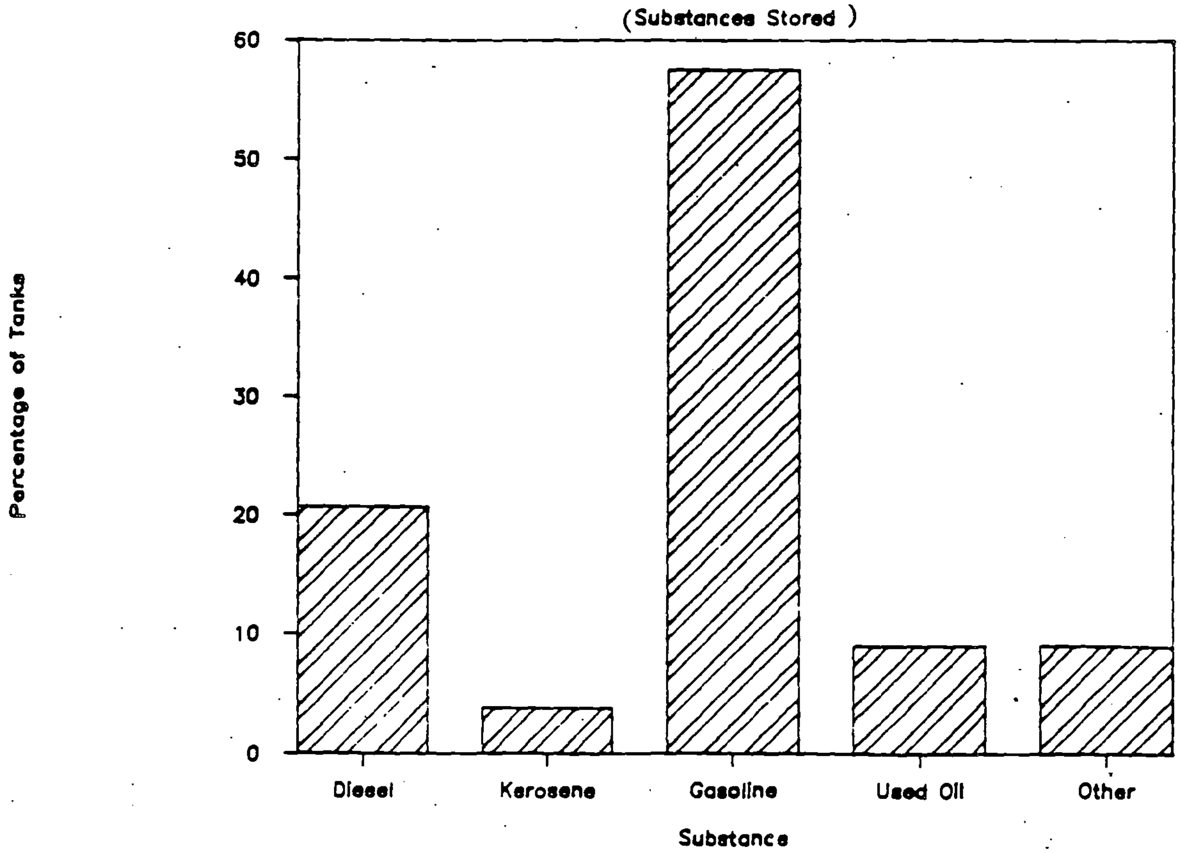


Figure 34. Petroleum Tanks

(Substances Stored)



Source: IDEM Underground Storag_ Tank Section (1987)

Solid and Hazardous Waste Disposal

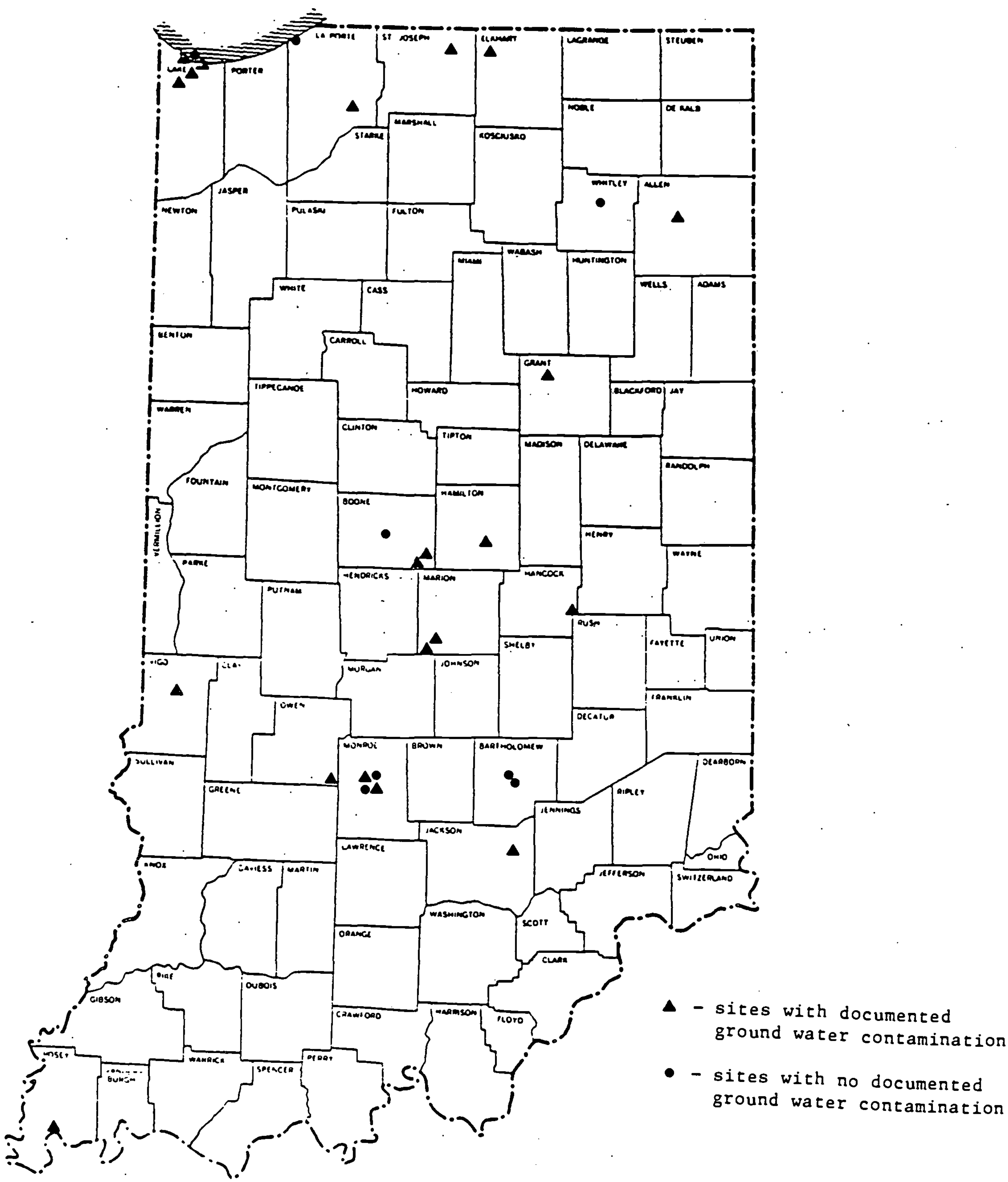
Activities related to the disposal of solid and hazardous wastes have contributed to the pollution of ground water at over 50 sites in Indiana. At 21 of the 29 sites in the state on the U.S. EPA's Superfund National Priorities List, contamination of the ground water has been documented (Figure 35). Improper and unregulated hazardous waste disposal practices at these locations and at nine others resulted in impacts on the ground water that are being addressed by state or federally funded corrective actions or oversight of cleanups conducted by responsible parties. There are some 1,200 sites in Indiana that have been placed on an inventory of potential Superfund or State-lead cleanup candidates. Investigations and assessments of the environmental hazards at these locations are still in progress, but additional ground water problems due to poor waste disposal practices in the past are expected to be discovered. See Figure 36 for the distribution of these potential ground water pollution sites across the state.

There are about 1,500 operations in the state which generate hazardous wastes and over 250 facilities which treat, store, or dispose of these wastes. The distribution of hazardous waste facilities statewide is shown in Figure 37. Two million tons of hazardous waste are managed in the state each year. Stringent regulation of these activities includes monitoring of ground water quality at hazardous waste disposal facilities. Results of monitoring at these sites by IDEM staff indicate that impacts on ground water quality are occurring at 20 of them. Insufficiencies in the design, construction or operation of the waste management units at these sites are likely to have resulted in the ground water pollution recorded. Similar deficiencies in the management of solid wastes at six of the over 80 sanitary landfills in the state have also contributed to the ground water contamination documented through monitoring by IDEM staff.

Substances Contaminating Ground Water

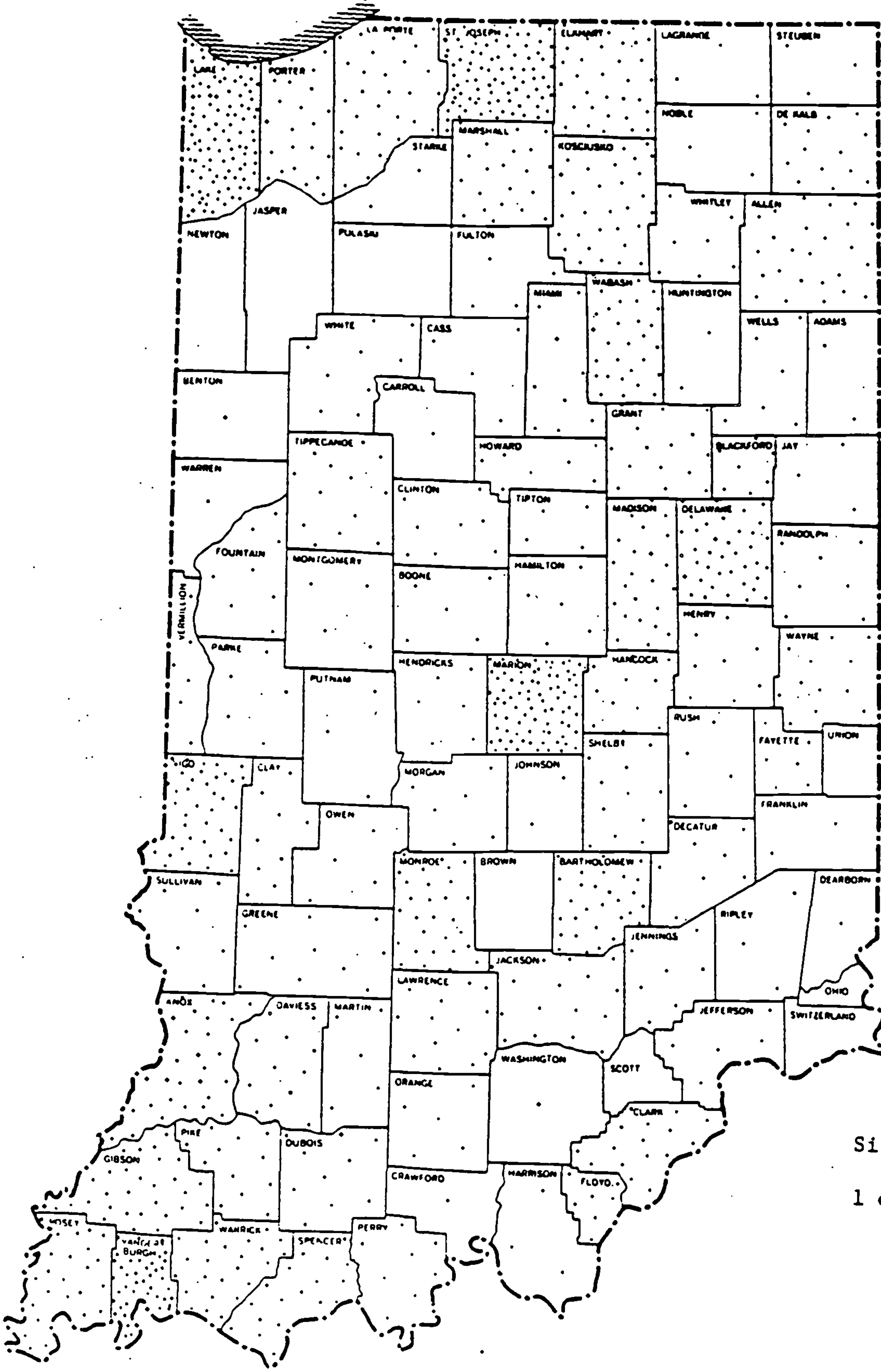
Various chemicals have been detected through analysis of water samples from public or private waterwells, or monitoring wells, at the sites of ground water contamination previously discussed. Where the concentration of a chemical exceeds a U.S. EPA primary or secondary public drinking water standard, proposed standard, or health protection guidance for drinking water, contamination was considered to be present. In summarizing the information from available state agency records, the following categories of contaminants were documented for the sites already mentioned. A statistical cross tabulation between sources and contaminants was not performed, but their frequency of detection is presented in Table 53. The substances which have been documented to contaminate ground water at the most sites in Indiana are chlorinated solvents or degreasers and dissolved or undissolved petroleum products. Nitrates are also frequently found as contaminants of drinking water supply wells. Inorganic parameters, usually metals are often found in monitoring wells at levels of significance.

Figure 35. Superfund sites.



Source: IDEM Site Management Section (1987)

Figure 36. Abandoned waste disposal sites.
(Distribution per county)

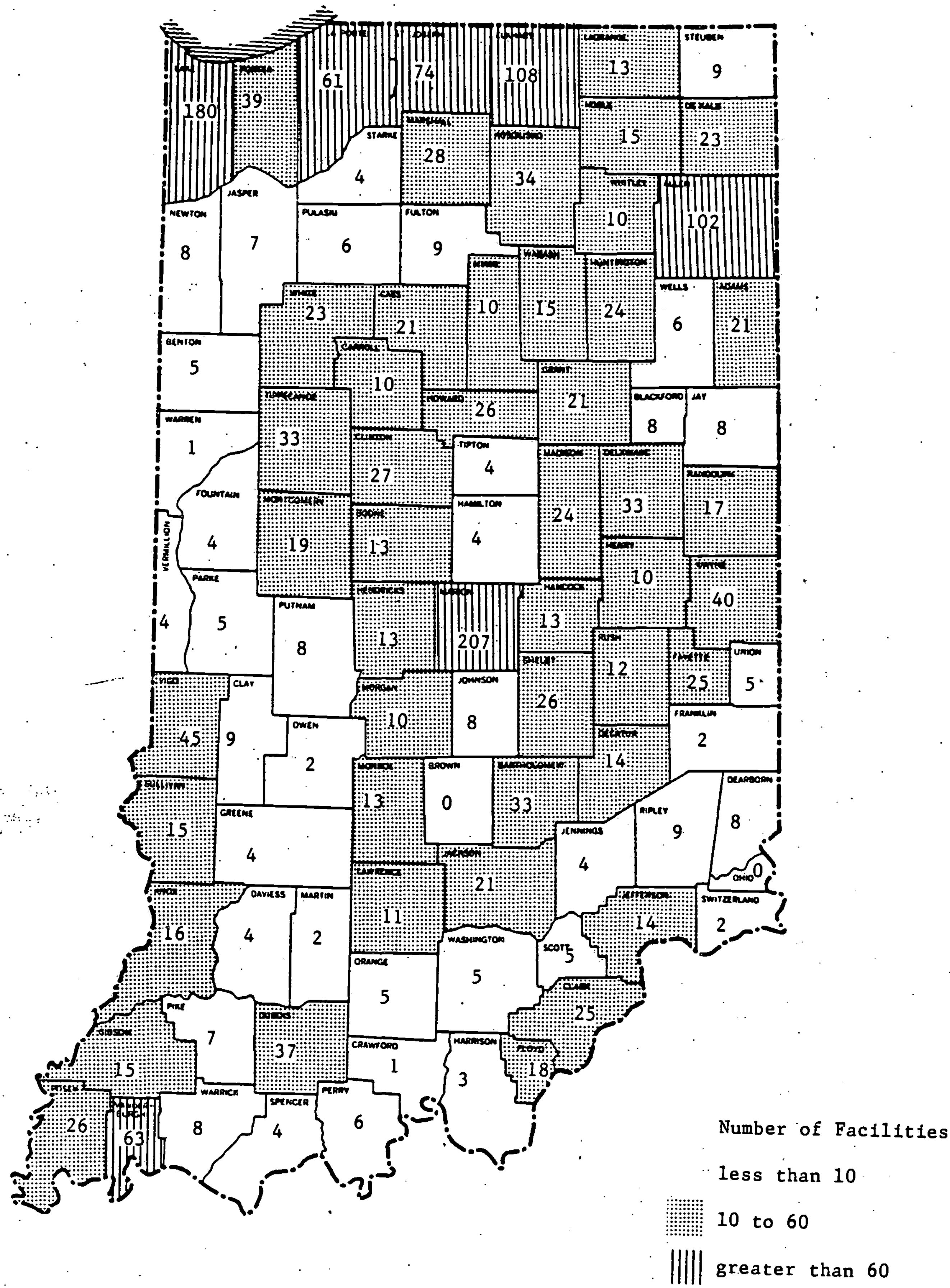


Sites Per County

1 dot = 1 site

Source: IDEM Site Investigation Section (11/87 CERCLIS Superfund Site Inventory)

Figure 37. Hazardous waste facilities.
(Generators and treatment - storage - disposal sites)



Source: IDEM Hazardous Waste Management Branch (1985)

Table 53. Substances Contaminating Ground Water

Type of Contaminant	Percent Frequency For 228 Cases*	Percent Frequency For 179 Cases**
Chlorinated Organic Chemicals	32.0	34.6
Other Metals/Inorganics	19.3	13.4
Aromatic Organic Chemicals	16.7	17.9
Nitrates	14.9	19.0
Heavy Metals	14.5	8.4
Petroleum/Petroleum Products	11.8	11.7
Chlorides/Salts	10.1	11.7
Pesticides	6.1	7.3
Other Volatile Organic Chemicals	3.9	3.9
All other Organic Chemicals	3.9	5.0
Coliform Bacteria	1.2	1.2

* includes monitoring wells
** drinking water wells only

Volatile Organic Compounds

Chlorinated, non-halogenated, and aromatic volatile organic compounds (VOCs) are the most common ground water contaminants. At 73 sites, chlorinated VOCs were present, most notably trichloroethylene at 37 sites, and 1,1,1-trichloroethane at 23 sites. Concentrations ranged to 19.4 parts per million for these substances. Tetrachloroethylene, carbon tetrachloride, 1,1- dichloroethylene, 1,1- dichloroethane, and tetrahydrofuran have also been detected. At 38 of the locations, aromatic VOCs were reported, typically benzene and toluene. In most of these instances, dissolved motor fuels were considered to be the source of the chemicals. Other compounds often associated with the dissolved fuels include ethyl benzene, xylenes, methyl isobutyl ketone, methyl ethyl ketone, methyl tertiary butyl ether and 1,2-dichloroethane. The chlorinated VOCs were associated with waste disposal sites, hazardous materials spills, and most of the cases where the source is unconfirmed or not identified. The aromatic VOCs were linked to leaking underground storage tank systems and petroleum fuel spills. In only a few cases were the aromatics traced to improper disposal or spills of solvents.

Petroleum and Petroleum Products

Besides dissolved petroleum products, undissolved petroleum and its refined products are frequently detected ground water pollutants. This category includes crude oil, gasoline, fuel oil, diesel fuel, and petroleum distillate solvents such as naphtha. Of 27 sites contaminated with petroleum, 12 involved underground storage tanks leaking motor fuel, heating oil or petroleum based solvents. Three other sites involved crude oil present in private water wells near oil and gas drilling operations. The remaining locations can be attributed to spills from storage, handling, or transportation accidents. Fire and explosion hazards in addition to drinking water risks result from ground water pollution involving these fuels and solvents.

Metals and Inorganics

Typical inorganic analytical parameters for ground water monitoring at hazardous waste treatment, storage, and disposal facilities, and at sites under investigation through Superfund, include metals for which there are primary or secondary public drinking water standards, such as arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, iron, manganese, copper, and zinc. Arsenic, lead or chromium exceed drinking water standards in monitoring wells at 30 RCRA and Superfund sites, with iron and manganese greatly elevated at 21 of these sites. Eight sites, which involve private wells only, have high levels of manganese, iron, arsenic or barium, and are probably affected by natural water quality conditions associated with highly mineralized waters or outcrops of black shale bedrock.

Chlorides and Salts

Concentrations of chlorides in excess of the secondary public drinking water standard of 250 parts per million can exhibit objectionable taste in drinking water, particularly at levels of about 500 parts per million or greater. Because cases of naturally high amounts of chlorides in ground water are not included in this report, the 22 cases of public or private waterwells impacted by chlorides were due to man's activities. Elevated levels of sodium in excess of 150 parts per million are typically found in conjunction with elevated chlorides. The majority of the problems resulted from uncovered storage piles of road deicing salt. Most of the other sites are associated with crude oil exploration and production activities through brine disposal pits, brine disposal wells, and improperly abandoned testholes.

Nitrates

Nitrates have exceeded the ten parts per million standard at 32 documented sites affecting 155 private wells in Indiana. In 25 of the cases, the source is assumed to be nonpoint in nature, such as infiltration of chemical fertilizer applied to farm fields in areas of highly permeable soils. Seven of the sites were contaminated by above ground storage tank spills of liquid nitrogen fertilizer which were not fully cleaned up. Most of the remaining incidents are believed to involve nitrates contributed by septic systems near the wells. In one case, a hazardous waste disposal site contaminated 18 residential wells with nitrates as well as heavy metals and organic compounds. Nitrates and pesticides are also discussed in the section on nonpoint source pollution of ground water.

Other Contaminants

Incidents involving pesticides detected in water supply wells were nearly all due to spills or applications of these chemicals near the well. Chlordane is most often detected as a result of treatment for termites. Pesticides are discussed further in the section on nonpoint source pollution.

Total coliform bacteria counts are routinely used as indicators of bacterial contamination of well water samples. Such tests are also useful as an index for the integrity of well construction. Although thousands of such samples are analyzed each year, with some yielding unsatisfactory results, these have not been included in this report. Two historical incidents where multiple private wells in separate housing developments were apparently impacted by neighboring septic systems were documented by coliform bacteria tests.

Part III. Nonpoint Source Impacts

Nonpoint source pollution of ground water is caused by diffuse inputs that are area wide in extent. It does not result from a discharge of contaminants to the subsurface from a specific single location. Nonpoint source impacts on ground water are typically associated with agricultural activities. Forestry, landscape maintenance, lawn care, and urban runoff also have a potential as nonpoint ground water pollution sources.

The information available to assess nonpoint source impacts on ground water is fragmented and diverse. It includes studies, monitoring, investigations, and research by government agencies and universities. There is ongoing and expanding scientific inquiry into these issues in the state that will add to this knowledge.

The lack of a consistent and comprehensive data base makes it difficult to establish direct links between nonpoint source activities and ground water contamination events. Evidence suggests a significant number of wells have been affected, but this has not been conclusively proven. Rigidly designed and controlled research into nonpoint pollution of Indiana's ground water has not yet occurred.

Some areas of the state have a serious potential for nonpoint source pollution of ground water supplies. Extensive agricultural activity occurs in Indiana. Nearly 90 percent of the rural self-supplied water and about 20 percent of community systems using wells are in rural locations. Geologic settings of permeable, fluvial deposits of mostly sand, gravel or thin, unconsolidated materials over bedrock can allow agricultural chemicals to more readily enter and move in ground water. It is in these areas that most nonpoint source problems affecting well water have been documented.

Nitrates in Ground Water

Very low concentrations of nitrate are naturally present in the major aquifer systems in Indiana. A median value can be used for comparing nitrate data sets. In a rank ordered data list, half the values are greater and half are less than the median. The U.S. Geological Survey reports a range of median values for nitrate concentration in Indiana's major aquifers from .1-1.4 parts per million (ppm), based on over 750 samples. An Indiana Department of Natural Resources data set of 795 samples has an estimated median value for nitrate nitrogen at less than 2 ppm. A survey of 3,282 non-community water supply wells in Indiana in 1985-86 also reports a median nitrate value at less than 2 ppm.

Data on nitrate contamination of drinking water wells from nonpoint sources is based on samples with over 10 ppm nitrate-nitrogen. Where nearby point sources of nitrogen are not recorded for these wells, nonpoint source impacts are assumed to be present. (Point sources are, for example, feed lots, septic tanks, liquid fertilizer storage, handling, or spills within at least 50 feet of the well.) (This definition differs from that in the surface water programs where point sources are defined, for the most part, as discharges that have NPDES permits.)

For over 5,000 nitrate samples statewide, about 300 (6%) contained nitrate above 10 ppm. This includes 2.2% of the non-community wells samples and about 10% of the private water wells tested. (By comparison, only two of the 436 community water systems using ground water have been recorded to have over 10 ppm nitrate.) In one rural county, over 40% of the private wells sampled had excessive nitrate while less than .5% of the private wells in an urban county exceeded 10 ppm. There were nearly 700 samples in these two counties. Nitrate values in all the contaminanted wells ranged up to 120 ppm with a median value of about 15 ppm.

Pesticides in Ground Water

There is not a great amount of data on pesticides in ground water in Indiana. The IDEM registry of chemical contamination of water wells has information on 13 case histories involving pesticides, Four of the incidents are believed to have originated from nonpoint sources. Three farm wells were affected by 1-3 parts per billion (ppb) atrazine and alachlor while another home well was found to contain up to 200 ppb dicamba.

Two small scale surveys by IDEM and IDNR in 1986, examined 32 wells in two separate aquifer systems for over 30 different pesticides. Only one well was confirmed to be affected by low levels of alachlor.

Public water supply wells have been monitored in the past for six, persistent organo chlorine pesticides, but none have been detected. In 1987, IDEM, with support from EPA, sampled 131 randomly selected community and non-community supply wells in Indiana for analysis of 70 pesticides, predominantly those in current use. Preliminary, unconfirmed results of this survey indicate positive detections in less than four percent of the samples.

Findings

Nitrate from nonpoint sources has not been shown to be a significant contaminant of public water supply wells, although elevated levels have been detected in wells in rural locations. Private wells in vulnerable geologic settings in agricultural areas have a greater potential for nitrate contamination.

There is insufficient evidence yet in Indiana to determine if nonpoint source pollution of ground water is occurring due to normal pesticide use. Consequently, additional sampling of water supply wells, and ground water research into nonpoint source impacts is needed.

Part IV. Geographic Areas of Concern

Areas Vulnerable to Ground Water Contamination

There are some areas of the state where the geologic setting makes the ground water more vulnerable to contamination than others. In this approach, vulnerability is considered as the relative ease for downward migration of a pollutant from a release at the surface. This is dependent in part on the permeability and thickness of the material overlying the ground water, which can be inferred from geologic maps. There are two conditions that can be considered to represent relatively high vulnerability to contamination: permeable deposits of mostly sand and gravel (and to a lesser extent, silt), and unconsolidated material less than 50 feet thick. These areas are shown in Figure 38.

Highly vulnerable areas of permeable geologic materials include: alluvium; valley-train and outwash plain sediments; muck, peat and marl paludal; eskers, kames, and kame complexes; eolian sand and silt; beach and shoreline deposits; sandy lacustrine sediments; and valley-train sand and gravel overlain by thin lacustrine or alluvial deposits.

Where the unconsolidated deposits are of a shallow depth, conditions of high vulnerability to ground water contamination also exist. This is because there is relatively less material to slow contaminant migration into bedrock and bedrock aquifers or into ground water in the non-bedrock material. Since the smallest contour interval on maps of the thickness of unconsolidated deposits statewide is 50 feet, areas with less than 50 feet of this material are considered highly vulnerable.

An area of the state whose bedrock conditions are uniquely vulnerable to contamination of ground water is that with karst or sinkhole topography. The limestone bedrock appears close to the surface and typically contains sinkholes, caves, solution channels, and cave streams. Surface contaminants can rapidly enter and move in this ground water environment. The area of karst topography in Indiana is shown in Figure 39.

A soil survey report is now available for every county in Indiana. The information available in these references is very detailed compared to

Figure 38. Areas Susceptible to Ground Water Contamination

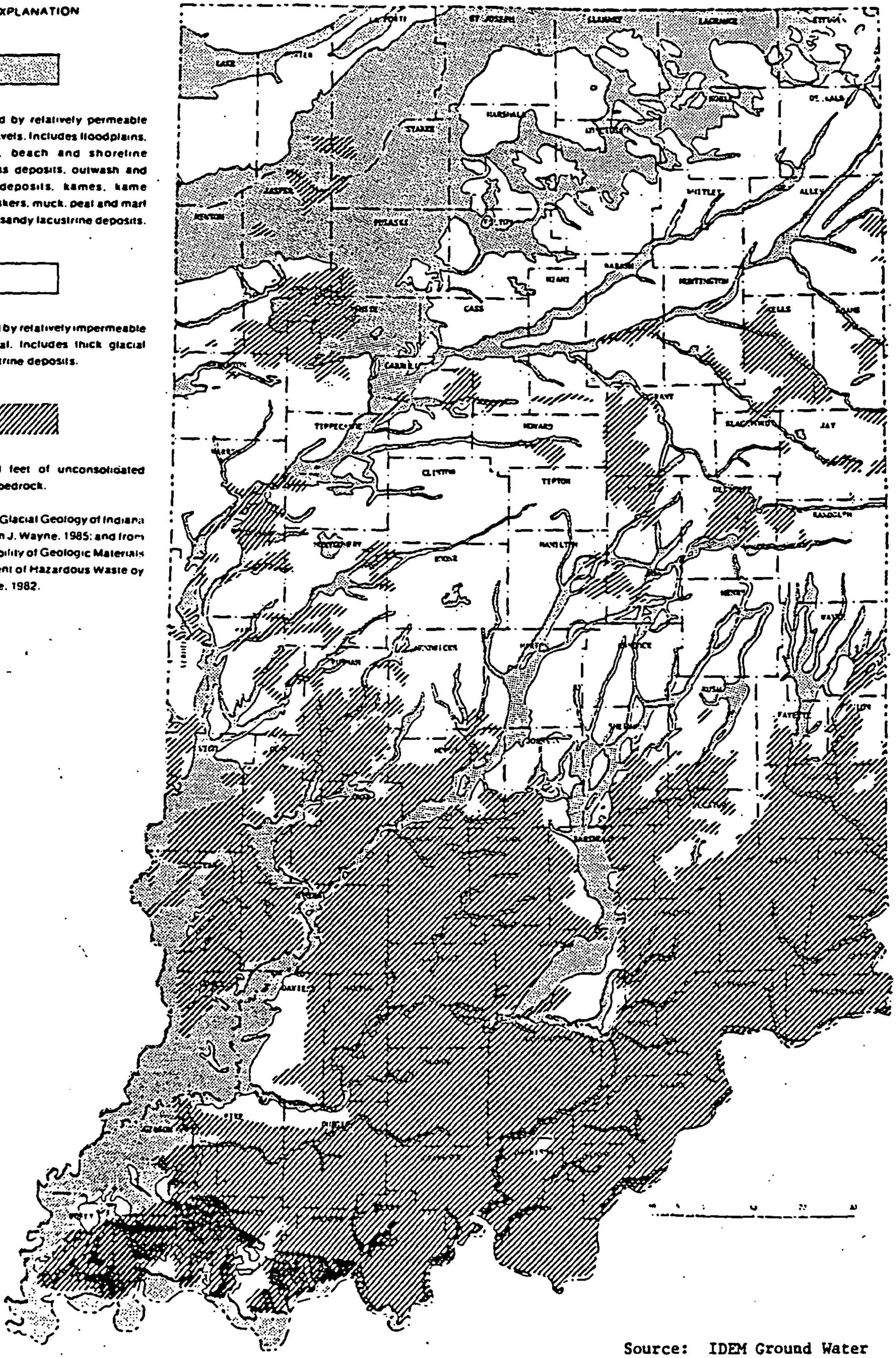
EXPLANATION

Areas covered by relatively permeable sands and gravels. Includes floodplains, dune sands, beach and shoreline deposits, loess deposits, outwash and valley-train deposits, kames, kame complexes, eskers, muck, peat and marl deposits, and sandy lacustrine deposits.

Areas covered by relatively impermeable clayey material. Includes thick glacial tills and lacustrine deposits.

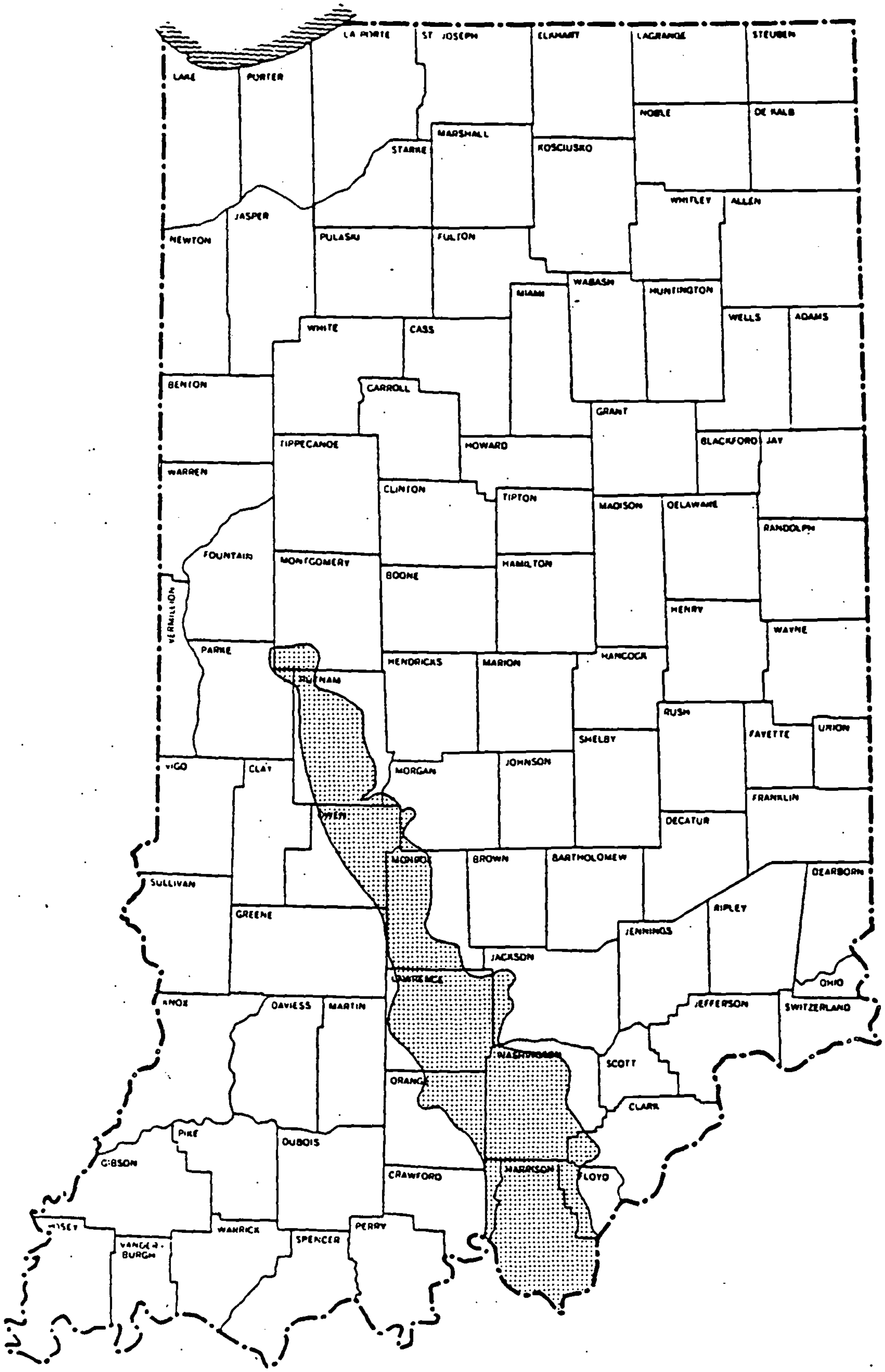
Less than 50 feet of unconsolidated material over bedrock.

Modified from Glacial Geology of Indiana map by William J. Wayne, 1985; and from Relative Suitability of Geologic Materials for Confinement of Hazardous Waste by Hill and Hartke, 1982.



Source: IDEM Ground Water Section

Figure 39. Areas of exposed Karst geology.



Source: IDEM Ground Water Section

statewide geologic and ground water data. Knowledge of soil permeability, parent material, drainage, limitations on use, depth to water table, and other factors can be obtained from a soil survey. For site specific planning to identify conditions where the ground water is vulnerable to contamination, the soil surveys and assistance from soil scientists can be very useful. By contrast, the areas vulnerable to contamination based only on geologic information should be interpreted on a broader scale and not for site specific decisions.

Priority Ground Water Counties

Where a broad spectrum of potential ground water protection, monitoring, management, and regulatory activities needs to be implemented on a statewide basis with limited staff and fiscal resources, a means of organizing and setting priorities is necessary. The concept of prioritizing water bodies for surface water management (i.e. wastewater treatment facility construction and discharge permit processing) has been in use for several years. Priority ground water areas are somewhat analogous to this.

There are a number of actions that can be accomplished first in priority ground water areas. The objective is to select geographic locations where benefits can be maximized in terms of public health protection and environmental improvement. These activities can include:

- °development of local ground water protection plans,
- °establishment of well-head protection zones for public water supplies,
- °monitoring of ground water quality,
- °assessment and correction of known or suspected sites of ground water contamination,
- °management and integration of ground water data.

The use of a priority ranking system to focus on geographic areas of concern is not meant to place less importance on specific problems or needs in other locales, but merely to indicate where ground water protection may be most essential and beneficial, at least in the short term.

The concept that some areas are relatively more susceptible to ground water contamination than others, based on their geologic setting, provides a first order screening of geographic areas of concern. The current and potential ground water use, the location of known sites of contamination and the presence of potential sources of contamination are additional screening criteria. The use of county boundaries is an artificial demarcation when compared to the natural boundaries of a ground water basin or aquifer system. However, basin or aquifer boundaries may not be clearly defined. Conversely, much currently available information is most easily sorted on a county basis. The governmental units through which local ground water protection efforts can be channeled also follow county lines. These include health departments, planning commissions, and zoning boards. Therefore, a concept of priority ground water counties is used here.

A sum of weighted factor scores method is used as a priority ranking system for Indiana's 92 counties. Eleven different screening factors are included and are evaluated as low, low-medium, medium, medium-high, or high in their importance or significance for ground water. The respective scores for these evaluative measures are 10, 20, 30, 40, and 50. When each weighted factor is scored, a sum is totalled for each county. A rank order of the counties is thus listed, with some relative comparison possible based on total scores. The evaluative criteria are discussed below:

(1) Geologic Susceptibility to Contamination:

The approximate percentage of county area is figured that is covered by relatively permeable unconsolidated deposits and/or less than 50 feet of unconsolidated material over bedrock. These permeable materials are primarily glacial outwash valleys and plains, dunes, eskers, kames, and beach deposits composed mostly of sands and gravels. Typically, the vertical and horizontal migration of contaminants from surface or shallow buried sources is less attenuated in such settings. See Figure 38 for the state-wide distribution of these areas.

(2) County Population:

This is derived from 1980 census figures.

(3) Number of Public Water Wells:

This information was obtained from water utilities, from records of the IDEM Public Water Supply Section, and from Bulletin PWS-3 (1984) "Data on Indiana Public Water Supplies". See Figure 19 for this data.

(4) Number of Private Water Wells:

The 1980 census differentiates the households dependent upon public water supplies versus drilled, driven, and dug wells. A total of all these residential wells is used here. Although all wells constructed after 1959 have been required to be recorded with the Indiana Department of Natural Resources, a comparison of the total number of well records per county with the census data always showed a higher total in the census. This is not unexpected, but it is recognized that the number of industrial, commercial, and agricultural wells is not included in the census. However these county totals are assumed to be representative, particularly for comparing counties. The data is shown in Figure 21.

(5) Number of Non-community Water Wells:

This is derived from a survey of non-community water supplies by the School of Public and Environmental Affairs at Indiana University for the U.S. EPA. Figure 20 displays this information.

(6) Number of Ground Water Contamination Sites:

This was taken from the Ground Water Section's registry of case histories of chemical contamination of ground water in Indiana. See Figures 22 and 23.

The leading sources of ground water contamination are hazardous material spills, underground storage tank systems, and solid and hazardous waste disposal facilities, as seen in Table 24. Based on this evaluation, the remaining criteria were selected.

(7) Number of Hazardous Material Spills:

This was taken from computer logs of reported hazardous material spills for the year 1986, as recorded by the IDEM Office of Emergency Response, and shown in Figure 28 for Indiana's counties.

(8) Number of Underground Storage Tanks:

The number of tanks was compiled from the data base of the IDEM Underground Storage Tank Section updated to September, 1987. See Figure 29 for the county distributions.

(9) Number of Hazardous Waste Facilities:

This includes generators of over 1,000 kilograms per month, and interim-permitted treatment, storage, and disposal facilities. A 1985 roster of facilities from the IDEM Office of Solid and Hazardous Waste Management was used as the source of information.

(10) Number of Sanitary Landfills:

A January, 1986 list of active facilities from the IDEM Office of Solid and Hazardous Waste Management was used as the source of information.

(11) Number of Abandoned Waste Sites:

The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) list contains all the reported sites in Indiana where improper disposal of solid or hazardous waste is suspected that may pose a threat to human health and the environment. CERCLIS is authorized under Section 3012 of CERCLA (the Superfund Law). The current 1987 CERCLIS list used here has 1,210 sites (Figure 36).

The factor weighting scheme is presented in Table 54 and the complete scoring matrix for 16 representative counties is shown in Table 55.

TABLE 54. *FACTOR WEIGHTING SCHEME.*

RATING	SCORE	PUBLIC WELLS	SEMI-PUBLIC WATERWELLS	PUBLIC WELLS (THOUSAND)	GROUND WATER CONTAMI-NATION SITES	HAZARDOUS MATERIAL SPILLS	UNDERGROUND STORAGE TANKS	HAZARDOUS WASTE FACILITIES	ABANDONED WASTE SITES	SANITARY LANDFILLS	PERCENT SUSCEPTIBLE GEOLOGY	POPULATION (THOUSAND)
LOW	10	0-9	0-34	0-10	0-4	0-24	0-299	0-34	0-19	1	0-19	0-50
LOW MEDIUM	20	10-19	35-69	10-15	5-9	25-49	300-599	35-69	20-39	2	20-39	50-100
MEDIUM	30	20-29	70-104	15-20	10-14	50-74	600-899	70-104	40-59	3	40-59	100-150
MEDIUM-HIGH	40	30-39	105-139	20-25	15-19	75-99	900-1199	105-139	60-79	4	60-79	150-200
HIGH	50	40 +	140 +	25 +	20 +	100 +	1200 +	140 +	80 +	5	80 +	200 +
ASSIGNED WEIGHT		5	3	4	2	5	4	1	3	1	2	2

TABLE 55. *REPRESENTATIVE SCORING MATRIX*

COUNTY	PUBLIC WATERWELLS		SEMI-PUBLIC WATERWELLS		PRIVATE WATERWELLS (In Thousands)		GROUND WATER CONTAMINATION SITES		HAZARDOUS MATERIAL SPILLS		UNDERGROUND STORAGE TANKS		ABANDONED WASTE SITES		HAZARDOUS WASTE FACILITIES		SANITARY LANDFILLS		SUSCEPTIBLE GEOLOGY		POPULATION (In Thousands)	
	#	Score	#	Score	#	Score	#	Score	#	Score	#	Score	#	Score	#	Score	#	Score	#	Score	#	Score
LAKE	33	MH	68	LM	17.2	M	18	MH	60	H	2492	H	126	H	180	H	7	H	50	M	522.9	H
MARION	37	MH	168	H	33.8	MH	11	M	150	H	4897	H	80	H	207	H	7	H	25	LM	765.2	H
ST. JOSEPH	59	H	110	MH	24.7	MH	10	M	15	LM	1531	H	87	H	74	M	1	L	60	MH	241.6	H
ELKHART	49	H	147	H	24.3	MH	33	H	19	LM	1263	H	32	LM	108	MH	3	M	50	M	137.3	M
ALLEN	28	M	140	H	18.7	M	2	L	33	M	1877	H	25	M	102	M	2	LM	20	LM	294.3	H
MADISON	37	MH	85	M	15.6	M	1	L	8	L	757	M	23	LM	24	L	4	MH	50	M	139.3	M
VIGO	22	M	59	LM	11.8	LM	13	M	16	LM	652	M	39	LM	45	LM	3	M	75	MH	112.3	M
LAPORTE	20	M	95	M	14.1	LM	7	LM	14	L	704	M	30	LM	61	LM	1	L	90	H	108.6	M
TIPPECANOE	43	H	81	M	9.3	L	4	L	18	LM	609	M	13	L	33	LM	1	L	30	LM	121.7	M
PORTER	26	M	114	MH	13.2	LM	4	L	17	LM	826	M	23	LM	39	LM	2	LM	50	M	119.8	M
CLARK	61	H	4	L	1.6	L	0	L	14	L	545	LM	16	L	25	L	3	M	100	H	88.8	LM
WAYNE	11	LM	84	M	28.4	H	3	L	18	LM	582	LM	12	L	40	LM	2	LM	50	M	76.0	LM
VANDERBURGH	2	L	6	L	6.0	L	1	L	14	L	935	MH	42	M	63	LM	3	M	90	H	167.5	MH
KOSCIUSKO	20	M	159	H	16.8	M	13	M	11	L	509	LM	31	LM	34	L	3	M	40	M	59.5	LM
JOHNSON	31	MH	35	LM	5.5	L	4	L	15	LM	440	LM	2	L	8	L	2	LM	50	M	77.2	LM
DELAWARE	13	LM	96	M	14.7	LM	3	L	6	L	721	M	38	LM	33	L	1	L	40	M	128.6	M

A list of the top priority ground water counties for Indiana is presented, based on the application of the ranking system method. The sum of weighted factor scores matrix is presented in Table 56. The counties are listed in descending order with their total score adjusted for comparative purposes, to the 1-5, low to high rating scale.

Table 56. Priority Ground Water Counties in Indiana

County	Total Score	Adjusted Total Score	Rating
Lake	128	4.0	Medium High
Marion	128	4.0	Medium High
St. Joseph	114	3.6	Medium High
Elkhart	106	3.3	Medium
Allen	89	2.8	Medium
Madison	83	2.6	Medium
Vigo	76	2.4	Low Medium
LaPorte	69	2.2	Low Medium
Tippecanoe	69	2.2	Low Medium
Porter	69	2.2	Low Medium
Clark	68	2.2	Low Medium
Wayne	67	2.1	Low Medium
Vanderburgh	67	2.1	Low Medium
Kosciusko	66	2.1	Low Medium
Johnson	66	2.1	Low Medium
Delaware	66	2.1	Low Medium

Priority Sites for Wellhead Protection in Indiana

The federal Safe Drinking Water Act Amendments of 1986 established a program for protection of of public water supply system wellhead areas from contamination. States shall prepare program plans describing the delineation and management of wellhead protection zones, in order to receive federal financial assistance for these efforts. Protection of public water supply well fields is also a prime initiative in the Indiana Ground Water Strategy.

The IDEM Ground Water Section identified priority sites in Indiana for Wellhead Protection (WHP) to be used for phasing in the delineation and management of WHP zones during program implementation. The criteria used in selecting the sites include vulnerability to contamination, threats of contamination, extent of contamination, and population served. The selection process involved the evaluation of geologic conditions and over 1,500 well records for wellfields of 436 public water supply systems. Based on geologic conditions alone, 218 systems in the state were rated highly vulnerable to contamination (Figure 40). When the other factors were considered, statewide priority sites were identified (Figure 41). The priority sites are the vulnerable wellfields serving over 15,000 people in counties with numerous potential sources of ground water contamination. They are: Elkhart, Indianapolis, Lafayette, Lake Station, LaPorte, Mishawaka, Richmond, South Bend, and Terre Haute.

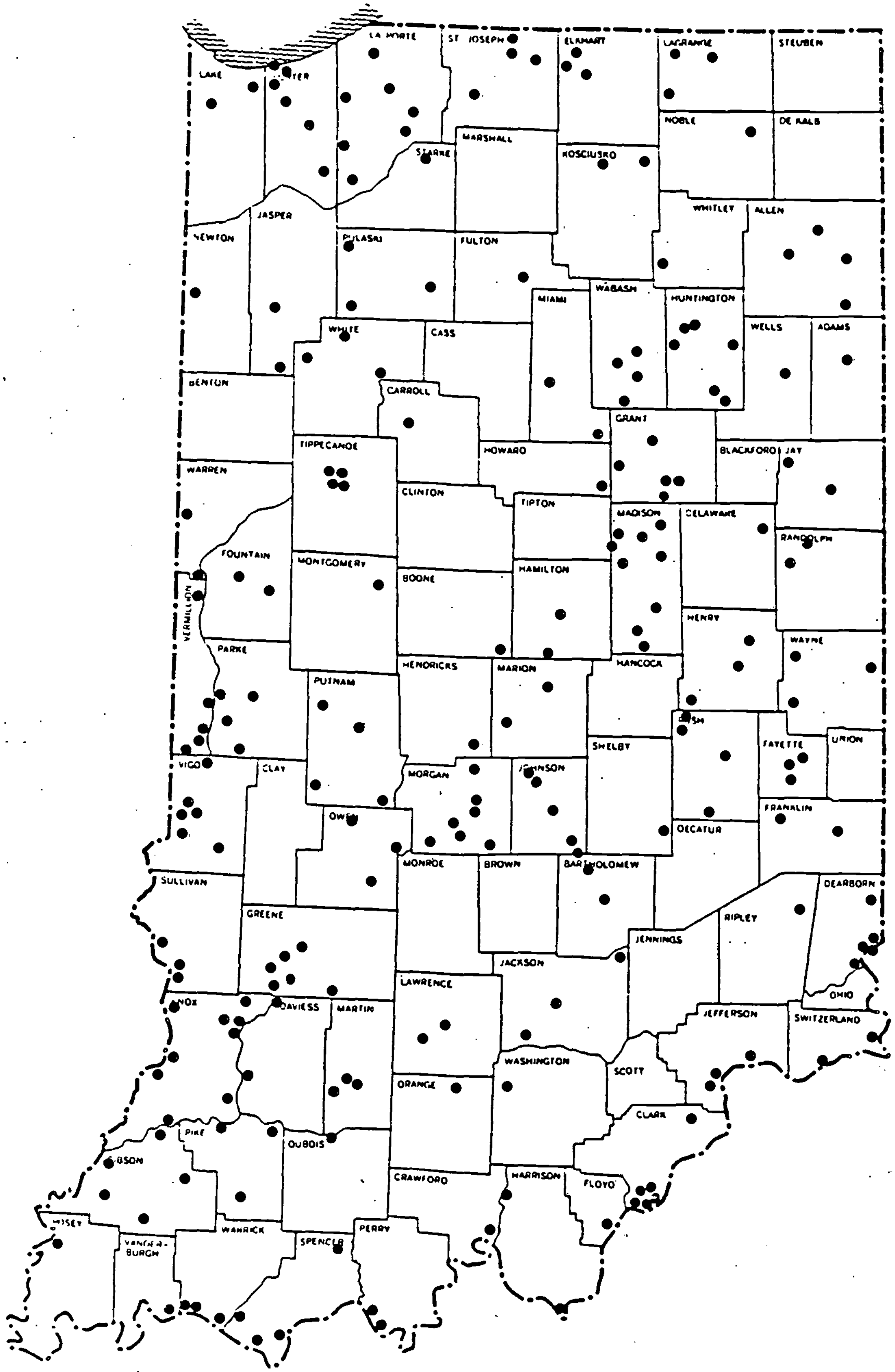
Inventory of Potential Sole Source Aquifers in Indiana

The federal Safe Drinking Water Act established a program for formal designation and protection by EPA of sole source aquifers in the U.S. Formal designation by EPA of a sole source aquifer means that all federally financially assisted projects above the aquifer receive an evaluation for their potential to cause significant pollution. Adverse impacts that could result must be corrected in order for the federal funding to be allowed.

The IDEM Ground Water Section has prepared a statewide inventory of potential sole source aquifers. Conceptually, hydrogeologic environments were sought where one aquifer is thought to exist that serves nearly all (50% or more) the water needs of nearby residents. The areas identified possess natural boundaries for use in prioritizing parts of the state for ground water protection and management activities. An approach of priority ground water counties has also been used, because criteria available for ranking priority areas was most easily available on a county basis. The incorporation of the sole source aquifer inventory should be useful for ground water activities in the state conducted on a regional basis. The inventory can provide a starting point for petitioning EPA for formal designation of some of Indiana's sole source aquifers. If any of these aquifers receive designated status, they could be eligible for EPA grants for demonstration projects within critical protection areas in the aquifer.

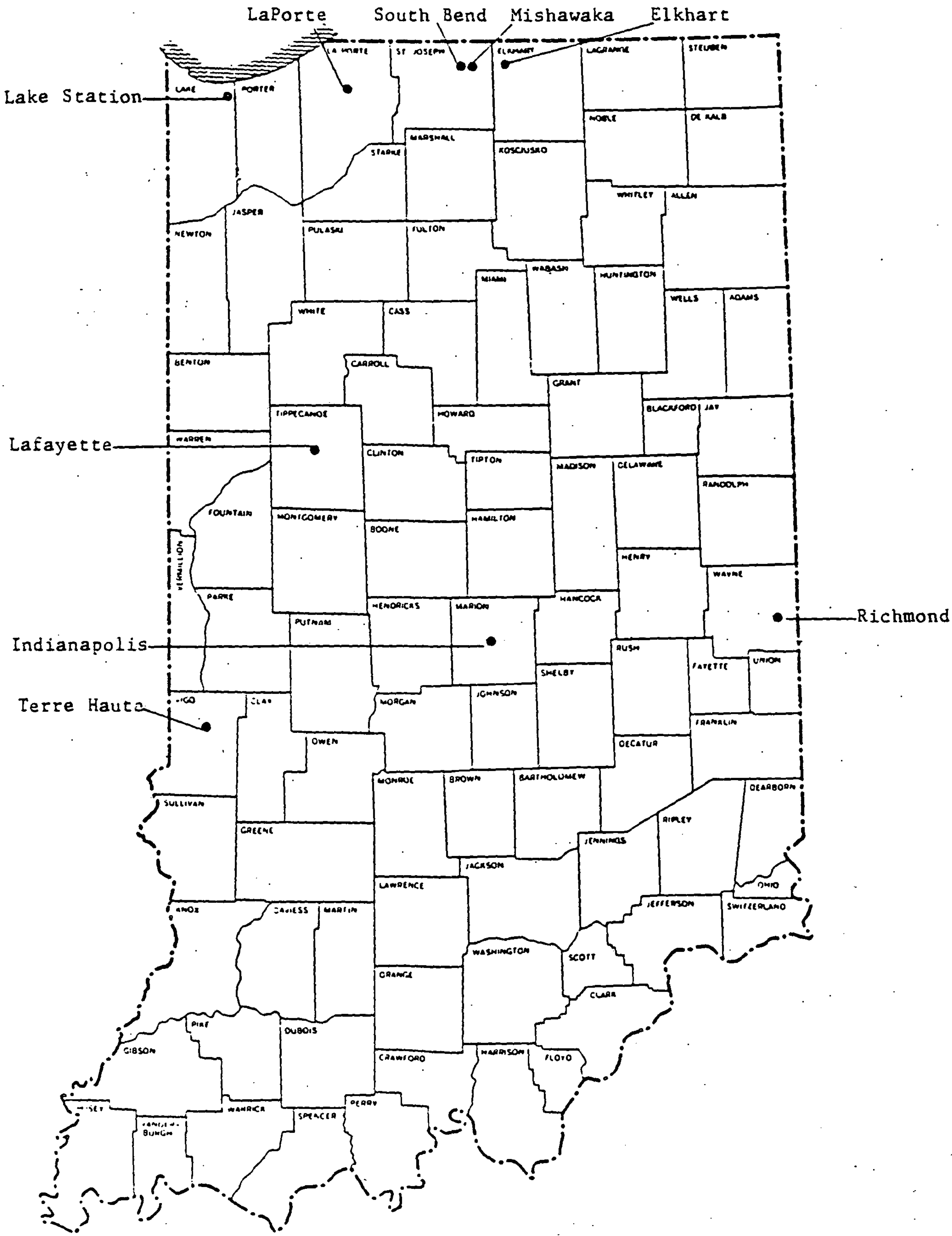
Three generic geologic environments were examined for sole source aquifer potential. They include thick, glacial, valley train and sluiceway deposits, sand and gravel-filled river valleys, and sandstones formed from ancient

Figure 40. Wellfields vunerable to contamination.



Source: IDEM Ground Water Section

Figure 41. Priority sites for well head protection.



Source: IDEM Ground Water Section

shorelines. In northern Indiana, there is a glacio-fluvial aquifer encompassing much of the St. Joseph River Valley from Bristol in Elkhart County southwest to the LaPorte County Line. This body of outwash valley train is underlain by shale and limestone not used as potable aquifers. A formal sole source designation for this aquifer is being discussed with EPA as a petition from the City of Elkhart and Elkhart County. In central and southern Indiana, there are several sand and gravel-filled valleys following some of the state's major surface water drainages, including the Wabash River, East Fork White River, West Fork White River, the Ohio River, and the Whitewater River. Last, in southwestern Indiana, some Pennsylvanian System sandstones, limestones and coals yield the only water available to private well users in the upland areas. This is in contrast to the other potential sole source aquifer environments where public water systems supply the majority of the residents, with private wells comprising only a small portion of the water use. See Figure 42 for the location of Indiana's potential sole source aquifers and Table 57 for a summary of their use. The precise boundaries and hydrologic features of these aquifers will require detailed descriptions from a technical perspective. From a policy viewpoint, the inventory intends only to suggest that aquifer environments which satisfy the federal "sole source" criteria do exist in Indiana.

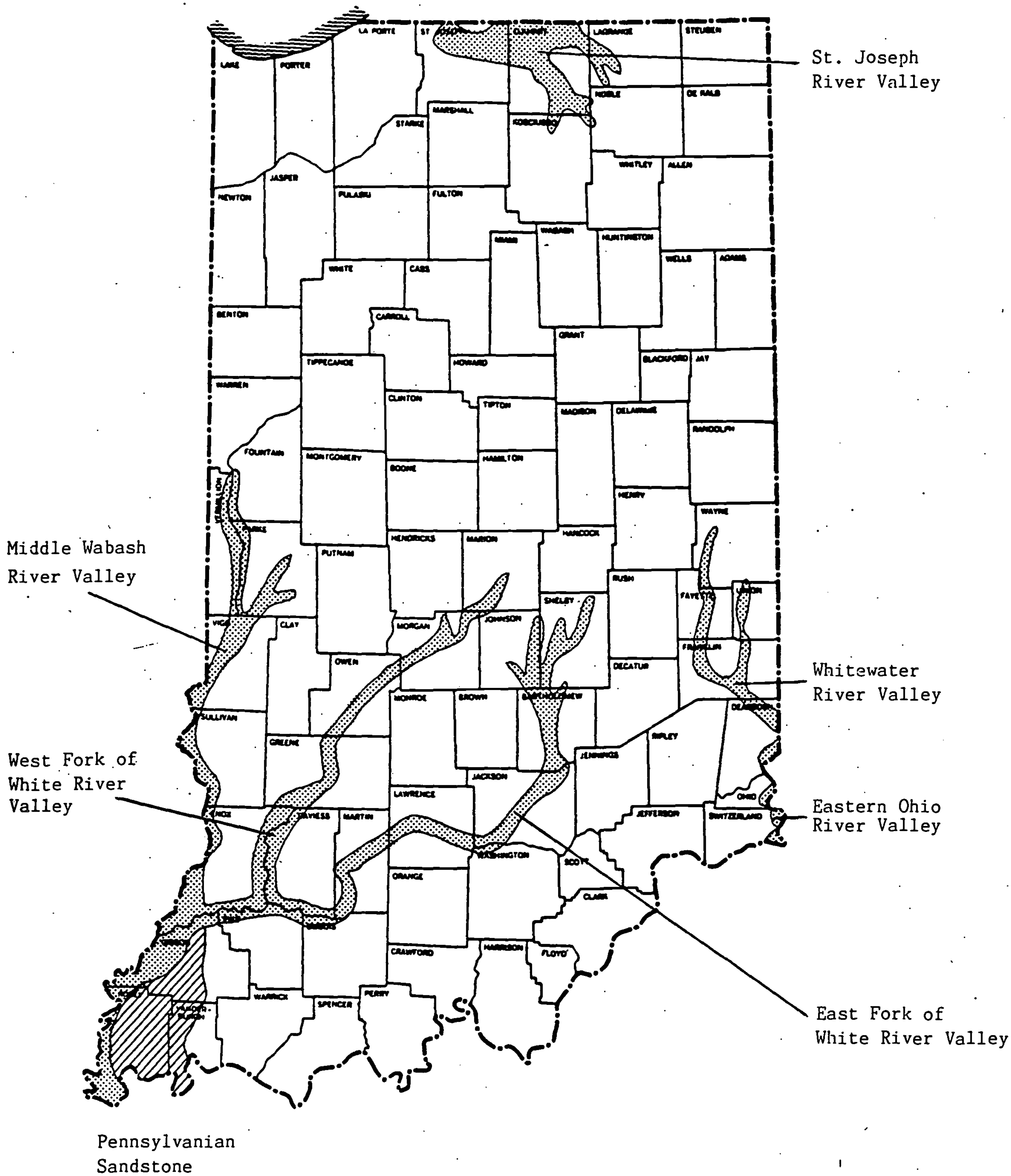
It is expected that the inventory or formal designation by EPA will allow for sole source aquifer areas to be incorporated into a number of ground water programs and projects in Indiana needing priority zones in which to focus activities. Some of these programs include: wellhead protection, underground tank management, spill response, remedial action initiation and oversight, and local initiatives for ground water protection.

Table 57. Ground Water Use in Indiana's Sole Source Aquifers

Aquifer Name	Number of Public Water Supplies	Population Served	Maximum Daily Ground Water Use (MGD)
1. St. Joseph River Valley	10	231,767	81.356
2. East Fork White River Valley	12	84,487	25.936
3. West Fork White River Valley	17	79,012	16.501
4. Whitewater River Valley	10	33,008	9.961
5. Wabash River Valley	17	31,271	6.127
6. Eastern Ohio River Valley	7	41,062	7.434
7. Pennsylvanian Sandstone	0	3,000	.200
Total	73	503,607	146.315

MGD = Million Gallons Per Day

Figure 42. Potential Sole Source Aquifers in Indiana



Source: IDEM Ground Water Section

V. SPECIAL STATE CONCERNS AND RECOMMENDATIONS

Although the discharge of inadequately treated "conventional" pollutants (BOD, ammonia, solids, etc.) in the past often resulted in highly visible evidence of water pollution, much has been done in the last 10-15 years to greatly reduce or eliminate these problems. This includes the construction of an increasing number of advanced wastewater treatment plants; implementation of the Municipal Compliance Strategy (MCS) which will require all municipalities to be in compliance with water quality standards by 1988 regardless of the availability of construction grant funding; and the implementation of an operator training and assistance program to help assure better operation of these wastewater treatment facilities. However, other problems or concerns continue, and new ones arise. Some of these concerns will be briefly discussed below.

About two thirds of the municipal sewer systems in Indiana are used to transport stormwater as well as domestic and industrial wastes. Overflows from these systems when they become overloaded during storm events or snow melt usually cause violations of water quality standards and may impair one or more designated uses of the receiving waters. When combined sewer overflows (CSOs) occur during low stream flow, damage to aquatic life may be severe. There have been several documented cases of fish kills caused by CSO events during dry periods.

A municipality may be able to reduce the frequency and/or duration of combined sewer overflows by insuring that the storage capacity of their sewer system is utilized to the fullest extent possible. NPDES permits are now being written requiring continued maintenance of combined sewers to eliminate overflows caused by restricted or blocked sewers, among other things. The DEM is working with several municipalities to help them accomplish this.

CSOs can be eliminated by the separation of the storm and sanitary sewer systems. This involves the installation of a second sewer system, which may require the tearing up of streets, alleys, and yards, in addition to the expenditure of many millions of dollars. Another way to minimize the effects of combined sewer overflows is to provide retention basins where the "first flush" can be stored until it can be pumped back into the sewer system after the rainflow has subsided. For many cities, however, the required capacity of the storage ponds would be very large and they would probably occupy land that is considered prime for development.

In the past, construction of facilities needed to eliminate combined sewer overflows was not eligible for construction grant funding. However, these projects may qualify for revolving loans. In any event, in instances where serious water quality standard violations are caused by CSO events, corrective actions will be required. An agency task force has been formed to determine how best to assess the effects of combined sewer overflows on the receiving waters and determine when to require corrective actions.

Evidence also indicates that storm water runoff from both residential and rural areas sometimes carries contaminants in concentrations high enough to be of concern. In the past there has been some confusion concerning the extent to which stormwater should be regulated as a point source.

Although there may be hundreds of storm sewer outfalls in some major Indiana cities, the Water Quality Act of 1987 required EPA to develop regulations within two years for industrial stormwater discharges and for municipal storm sewer systems serving more than 250,000 residents. Within four years regulations were required for municipal systems serving a population of between 100,000 and 250,000 people. At this point, it appears that this requirement may affect decisions for some of the larger communities regarding the justification for sewer separation projects since treatment may be required for storm water in any event. Further discussions need to occur within IDEM and between IDEM and EPA on this subject.

Increased monitoring of fish tissue and sediments for toxic and bioconcentrating materials has occurred in Indiana over the last two years, and a considerable amount of data has been collected. Other than FDA action levels, which are available for relatively few toxic pollutants, little guidance is available to aid the state in interpreting this fish tissue and sediment data as to health effects and potential environmental impacts. U.S. EPA needs to take the lead in developing sediment and fish tissue criteria or action levels for a larger number of these toxic substances than are currently available. Most states, including Indiana, do not have the staff nor resources to do this on their own.

Another special state concern is the revision of Indiana's water quality standards. The general water quality standards for most of Indiana's waters (327 IAC 2-1) are being revised to include numerical criteria for many toxic substances, to designate all waters under this rule for full body contact recreation, and to provide criteria for these waters based on E. coli as the indicator organism instead of fecal coliform. Revision of the water quality standards governing Lake Michigan, the Grand Calumet River/Indiana Harbor Ship Canal, and the Salmonid streams (327 IAC 2-7, 327 IAC 2-8 and 327 IAC 2-9, respectively) will begin during 1988. This is likely to be a lengthy process which will generate considerable controversy and require considerable staff time and resources to complete. The state and EPA will need to work together closely on these revisions to insure that this is accomplished as smoothly and quickly as possible.

Indiana is currently in the beginning stages of the development of water quality standards for ground water. It is anticipated that an advisory committee composed of representatives from various interest groups will be formed to help with this task. This may be a long and difficult process and will require considerable cooperation and input from state, local and federal agencies.

Another state concern is the uncertainty and apprehension in the state regarding the implications of the various 304(I) lists the states were required to generate. Although the requirements associated with the development of the "short list" are rather clear, the requirements that may arise regarding waters on the other two lists are more uncertain. U.S. EPA needs to be aware of the limited resources, monies and personnel which Indiana has available to work on these problems. Continued cooperation and understanding between U.S. EPA and the states on these issues will be needed.

With the continuing emphasis on toxics control and the probable revision of all of Indiana's water quality standards to include numerical criteria for more toxic substances, there will be an increased demand for laboratory services. It is anticipated that surface water monitoring for toxics will increase, that ground water monitoring will increase, that fish tissue and sediment monitoring for toxics will continue and that drinking water monitoring programs will also increase. Although the Indiana State Board of Health laboratory is currently able to handle the sample loads because IDEM is utilizing outside contract laboratories for a large number of toxic programs, this may change in the future. The state and EPA need to be aware of the potential problem of laboratory support for the toxic programs both from a monetary and personnel viewpoint. In addition, the state currently has a very limited capacity to do bioassays and whole effluent toxicity studies. Laboratory facilities needed to do these studies have been built, but the necessary equipment has not yet arrived. The state is currently attempting to hire a toxicologist to provide assistance in the various toxic programs, but we have not been successful to date.

The control of nonpoint source (NPS) pollution poses another concern for the state. With the limited resources available, it will be difficult to gather the data on the sources and effects of NPS pollution necessary to develop a meaningful NPS pollution control program. The DEM is proposing a cooperative approach utilizing resources from a variety of state and federal agencies in order to assess NPS problems. However, the main focus of many of these agencies is on the agricultural aspects (erosion control, etc.) of NPS pollution which leaves other areas inadequately assessed or monitored. In addition, the ability to control NPS pollution through enforcement actions is extremely limited, so for many NPS categories the state relies mainly on educational programs and economic incentives (cost-sharing, tax credits, etc.) to implement nonpoint source controls. We are uncertain if these types of programs will be effective in controlling NPS problems or if we will need other means of controlling these problems.

There are some geographical areas of the state which are of special concern for the prevention, detection and correction of ground water quality problems. These include areas geologically vulnerable to contamination, priority public supply well fields, and potential sole source aquifers. Special attention should be focused in these areas through expanded ground water protection efforts. In addition, Indiana completed a Comprehensive Ground Water Protection Strategy in 1987 which addresses many of the problems documented in this report. Implementation of the 160 recommendations in this plan over the next five years is an important goal for increased effort to safeguard the ground water resource in Indiana.

One area of special concern in Indiana includes the Grand Calumet River, Indiana Harbor Ship Canal (GCR/IHC) and the nearshore area of Lake Michigan in Northwest Indiana. The GCR/IHC is an International Joint Commission designated "Area of Concern" and considerable time and resources have been and will continue to be focused on this area by both the federal government and the state to implement recommendations of the Master Plan for Improving Water Quality in the Grand Calumet River/Indiana Harbor Canal, the Northwest Indiana Environmental Action Plan (EAP), and the Remedial Action Plan (RAP) for the GCR/IHC for this area as well as the Lake Michigan Toxic Reduction/Control Strategy and other Lake Michigan monitoring programs. During 1986-87, the DEM was involved in many activities related to the implementation of the monitoring programs specified in these various plans.

One of the first activities conducted during 1986 was an evaluation of the habitat provided by the Grand Calumet River and Indiana Harbor Ship Canal and an assessment of both the existing and potential uses that can be made of these streams when water quality is improved to the extent possible. Biologists making the assessment covered both the open water portions of the system and, to the extent possible, the bordering wetlands. These system will be re-evaluated periodically.

Both suspended and inplace sediment samples were collected from each of five permanent stations located on the Grand Calumet River and Indiana Harbor Ship Canal during 1986 and again in 1987. Analyses for priority pollutants will indicate how much and what kinds of contaminated material is being transported downstream and if the inplace sediment is more or less contaminated than that being transported. It is expected that sediment samples will pinpoint both existing and past sources of contamination. Results of these analyses are not yet available.

Electrofishing was conducted at the five permanent stations during the spring, summer and fall of both 1986 and 1987 to provide information regarding seasonal differences in fish community structure. During the summer sampling periods, fish tissue samples were collected for analysis for toxic pollutants.

An attempt was made to collect crayfish from each of the five permanent stations during both 1986 and 1987. These macroinvertebrates live closely associated with the bottom sediments and would be expected to bioconcentrate contaminants from them. Because crayfish are important food items for some fishes and wildlife, they could play an important role in the bioaccumulation of contaminants at the upper end of some food chains. Results of both the fish and crayfish tissue analyses are not yet available.

During the summer periods, macroinvertebrate samples were collected using Hester-Dendy plate samplers placed at the five permanent stations. These samples will show which stream areas are most severely polluted and provide an indication of the types of pollutants present. An evaluation of community structure will provide baseline data needed to indicate if a change in ambient water quality results in a corresponding change in the number and type of invertebrates found.

Monthly samples were collected from the nearshore zone of Lake Michigan at the water supply intakes for Hammond, Whiting, East Chicago, and Gary. The Indiana Harbor Ship Canal was sampled at four locations and the Grand Calumet

River at three stations each month. These stations are part of the statewide, Fixed Station Water Quality Monitoring Network that has been ongoing for several years. Samples collected at each station are analyzed for a number of physical, chemical, and bacteriological parameters.

Major dischargers to the Grand Calumet River and Indiana Harbor Ship Canal are sampled in accordance with established schedules to determine the extent of compliance with NPDES permit limits and conditions. Permit limits have been set low enough to permit downstream water quality standards to be met.

The state and U.S. EPA will continue to plan and undertake studies of water, air and land pollution problems in the GCR/IHC watershed. These problems are very complex, and it will require considerable cooperation between various federal, state and local agencies and organizations to resolve them.

APPENDIX A

Appendix A. Morphometric and trophic characteristics of Indiana Lakes

The Eutrophication Index is derived from the parameters listed on pages 36 and 37 in the Indiana Lake Classification System and Management Plan.

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
Adams Co.								
Rainbow	Two	45	16.0	6.0	0.07	1.5	41	VII C
Saddle	Two	24	10.	10.0	0.04	2.0	41	VII C
Allen Co.								
Cedarville Res.	Three	245	20.0	4.0	0.12	1.5	61	IV A
Bartholomew Co.								
Grouse Ridge	Two	20	25.0	10.0	0.10	4.0	25	VII A
Brown Co.								
Bear Creek	One	7	27.0	10.0	0.03	5.0	7	V
Crooked Creek	One	13	27.0	10.0	0.03	5.0	7	V
Ogle	One	20	24.0	12.5	0.03	5.0	8	V
Strahl	One	6	23.0	9.0	0.05	5.0	10	V
Yellowood (1986)	One	133	30.0	14.2	0.04	17.0	20	V
Carrol Co.								
Freeman (1986)	Two	1,547	44.0	16.	0.067	1.5	31	III

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
Clark Co.								
Bowen	One	7	22.0	6.0	0.05			V
Deam (1986)	One	195	33.0	12.	0.03	14.0	2	V
Franke	Two	9	18.0	7.8	0.05	4.0	35	V
Oak	One	3.5	13.0	8.0	0.03	8.0	8	V
Pine	Three	1.5	11.0	6.0	0.05	4.0	55	IV A
Schlamm	One	19	24.0	8.9	0.03	8.0	10	V
Clay Co.								
Brazil Water-works Pond	Three	15	15.0	6.0	0.52	1.0	67	IV B
Crawford Co.								
Sulphur	Two	1	10.0	5.0	0.03	5.0	26	VII A
Daviess Co.								
Dogwood (1986)	One	1,300	40.0	18.0	0.07	9.5	26	III
Indian Rock	Two	100	20.0	10.0	0.06	10.5	37	VII A
Decatur Co.								
Greensburg State Fishing Area Lake (1975)	Three	23	14.0	6.0	0.23	2.5	60	IV A
Surface only (1985)		--	--	--	0.17	8 in.	65	IV A

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
Dekalb Co.								
Cedar	Three	28	30.0	8.2	0.08	2.5	40	VII C
Lintz	Three	19	35.0	15.0	0.11	4.0	53	IV B
Story	Three	77	32.0	13.2	0.33	2.0	60	IV B
Delaware Co.								
Prairie Creek Reservoir	Two	1,216	30.0	15.0	0.05	5.5	36	III
Dubois Co.								
Ferdinand (Ferdinand State Forest)	Three	42	23.0	10.5	0.04	5.0	55	IV B
Ferdinand 1	One	16	17.0	10.0	0.03	--	20	VII A
Holland 1	Two	17	12.0	10.0	--	0.6	27	VII A
Holland 2	Two	20	14.0	10.0	--	7.0	25	VII A
Huntingburg City	Two	102	30.0	12.0	0.03	5.0	18	V
Elkhart Co.								
Fish	Three	34	30.0	10.0	0.11	6.5	35	VIIA
Heaton	One	87	22.0	7.4	0.02	10.0	10	V
Hunter	One	99	29.0	11.3	0.06	6.5	20	VII A
Indiana	One	122	29.0	27.9	0.02	9.5	11	II A
Simonton	One	282	40.0	5.5	0.02	5.0	6	II A
Yellow Creek	Three	16	20.0	4.0	0.34	1.3	58	IV A

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
Franklin Co.								
Brookville Res. 1979 (Dam)		5,260	120.0	25.0	0.02	4.0	23	I
Brookville Res. 1985 (Dam)		--	--	--	0.03	3.8	21	
Fulton Co.								
Anderson	Two	14	25.0	5.0	0.04	5.0	31	VII A
Barr	Two	5	48.0	12.0	0.06	5.0	35	VI A
Bruce	Three	245	18.0	14.0	0.12	2.5	61	IV B
Fletcher	Two	45	60.0	15.0	0.14	6.8	45	VII B
King 1976 Estimate (Low)	Two	18	35.0	10.0	--	5.0	35	IV B
King 1985	Three	--	--	--	0.046	2.0	56	VII A
Lake 16	Two	27	30.0	8.1	0.10	6.0	32	VII A
Manitou (1987)	Two	713	35.0	8.	0.28	3.8	41	III
Millark Pond	Four	15	6.0	5.0	0.06	5.0	65	IV A
Mt. Zion Mill Pond	Four	28	6.0	5.0	0.05	5.0	65	IV A
Nyona (S. Bas.)	Three	104	32.0	12.9	0.12	5.0	54	IV B
Rock	Three	56	16.0	11.0	0.07	2.5	61	IV B
South Mud	Three	94	20.0	10.9	0.25	1.0	66	IV B
Town	Three	22	16.0	9.6	0.21	4.0	64	IV B
Upper Summit	Two	6	40.0	15.0	0.04	6.0	42	VII B
Zink	Two	19	40.0	12.0	0.04	6.0	28	VII A
Hamilton Co.								
Morse Res. 1975	Two	1,375	40.0	15.4	0.10	4.5	31	III
Morse Res. 1985	Two	1,375	40.0	15.4	0.036	4.0	22	

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
Howard Co.								
Kokomo Res. 2	Three	484	22.0	7.0	0.18	1.5	66	IV C
Huntington Co.								
Salamonie Res. (1975 Dam)	Two	2,800	60.0	16.6	0.04	2.5	21	I
Salamonie Res. (1985 Dam)	Two	2,800	60.0	16.6	0.03	4.3	18	
Huntington Res. (1985 Dam)	One	900	36.0	17.0	0.21	0.5	22	III
Jackson Co.								
Cypress	Two	200	20.0	5.0	0.10	2.5	49	V
Starve Hollow	Two	145	17.0	6.8	0.03	9.0 (Atypical)	58	VII A
Jennings Co.								
Brush Creek Res.	Two	167	32.0	10.0	0.07	4.0	55	VII B
Knox Co.								
Brodie	Four	19	12.0	4.0	0.36	1.0	64	V
Halfmoon Bed Pond	Four	38	8.0	5.0	0.19	1.0	55	V
Long Ponds	Four	38	8.0	4.0	0.29	1.0	58	V
Mariah Pond	Four	50	10.0	5.0	0.31	1.3	62	V
Oaktown Bed	Four	15	10.0	3.0	0.13	1.5	48	V

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
Sandborn Old Bed	Four	30	8.0	6.0	0.35	1.0	54	V
White Oak	Three	30	15.0	5.0	0.12	1.5	55	IV A
Kosciusko Co.								
Barrell	Four	7	50.0	35.0	0.08	5.0	46	V
Beaver Dam	Three	146	61.0	22.5	0.85	4.0	55	IV D
Big Barbee	Two	304	49.0	18.6	0.05	5.0	38	VI A
Big Chapman (W. Bas.)	One	581(total)	35.0	10.5	0.01	10.0	18	VII A
Big Chapman (N. Bas.)	--	--	30.0	10.5	0.01	10.0	19	VII A
Boner	Two	40	60.0	9.2	0.35	7.5	43	VII C
Caldwell	Two	45	42.0	17.8	0.12	6.0	46	VII B
Carr	Three	79	35.0	17.0	0.14	3.5	50	VII B
Center 1987	Two	120	42.0	17.	0.035	8.5	5	VII B
Crystal	One	76	41.0	12.2	0.03	6.0	10	V
Daniels	Four	8	25.0	25.0	0.03	6.0	18	V
Dewart (NW Bas.)	Two	551(total)	70.0	16.3	0.03	5.5	36	VII B
Dewart (SE Bas.)	Two	--	--	--	0.03	6.0	36	VII B
Dewart (SW Bas.)	Two	--	--	--	0.03/0.03	6.0	36	VII B
Flatbelly	Three	326	49.0	13.3	0.02	8.0	54	IV B
Goose	One	27	61.0	20.0	0.03	9.0	15	VI A
Heron	Two	22	30.0	12.0	0.03	5.0	22	VII A
Hill	Two	66	35.0	19.4	0.12	12.0	31	VI A
Hoffman	Two	180	34.0	17.6	0.02	8.5	23	VI A
Irish	Two	182	35.0	12.8	0.05	7.0	45	VII C
James	Two	282	63.0	26.9	0.04	6.5	39	VI B
Kuhn	Two	137	27.0	9.4	0.01	9.8	15	V

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
Little Barbee	Three	74	26.0	13.0	0.08	5.0	56	VII B
Little Chapman	Two	177	30.0	11.2	0.03	7.0	25	VII A
Little Pike	Two	25	30.0	5.6	0.09	2.5	31	VII A
Loon	Three	40	30.0	16.8	0.05	2.5	52	IV B
McClures	Two	32	30.0	12.8	0.05	2.5	51	VII B
Muskelonge	Two	32	21.0	9.4	0.14	1.8	40	VII C
North Little	Three	12	26.0	10.0	0.12	2.5	52	VI B
Oswego	Two	41	36.0	20.0	0.04	5.5	33	VI A
Palestine (East Basin)(1985)	Three	232(total)	25.0	8.0	0.91	0.5	41	IV B
Palestine (West Basin)(1985)	Three	--	--	--	0.48	0.5	36	IV B
Pike 1975	Two	203	35.0	13.9	0.09	3.0	37	IV B
Pike 1985	Two	--	--	--	0.12	3.0	45	IV B
Price	Three	12	40.0	20.0	0.10	8.0	50	V
Ridinger	Two	136	42.0	21.0	0.05	3.5	58	VII B
Sawmill	Two	36	26.0	10.3	0.01	5.5	33	VII A
Sechrist	One	105	26.0	23.7	0.02	9.0	24	VI A
Shock	Two	37	59.0	32.7	0.23	9.0	28	II C
Shoe	Two	40	60.0	40.0	0.04	8.5	14	II C
Silver	Three	102	33.0	14.9	0.34/0.19	2.8/2.5	51	IV B
Spear	Two	18	34.0	25.0	0.19	9.0	36	VI A
Stanton	Two	32	30.0	15.0	0.01	12.0	20	VI A
Syracuse	One	414	35.0	12.9	0.01	13.0	4	V
Tippecanoe	One	768	123.0	37.0	0.05/0.04	7.0/6.5	12	II B
Wabee (1987)	One	187	51.0	25.4	0.035	8.5	13	IVD/ VI A
Wawasee (S.Bas.)	One 1987	3,060	77.0	22.0	0.04	8.0	7	I
Wawasee (SE Bas.)	One 1976	--	--	--	0.03	7.5	18	I
Webster	Two	774	45.0	7.0	0.06	3.0	37	VII A

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
Winona (Central Bas.)(5/27/87)	Two	562	80.0	29.	0.03	6.5	40 (Atypical)	IV D
Yellow Creek	Three	151	60.0	31.3	0.09	2.5	67	IV D
LaGrange Co.								
Adams	One	308	91.0	25.0 (Atypical)	0.14	10.0	28	VI A
Appleman	Two	52	26.0	11.3	0.035	6.0	30	VII A
Big Long	Two	388	82.0	40.0	0.06	11.0	33	II C
Blackman	Two	67	60.0	18.1	0.05	9.0	20	VI A
Brokesha	One	36	40.0	10.0	0.03	8.0	11	V
Cedar	One	120	30.0	8.5	0.03	10.0	9	V
Cline	Four	20	31.0	17.5	0.03	6.0	9	V
Cotton	Three	31	25.0	30.0	0.11	3.5	66	IV D
Dallas	Two	283	96.0	35.2	0.33/0.05	9.0/6.5	28	II C
Emma	Two	42	34.0	16.7	0.04	4.0	44	VII B
Eve	Two	31	42.0	21.6	0.03	8.0	18	VI A
Fish	Two	100	78.0	40.5	0.04	6.0/5.0	39	II C
Green (Rawles)	Four	62	10.0	5.0	Ill.Res	5.0	51	V
Hackenberg	Two	42	38.0	12.1	0.07	6.5	29	VII A
Hayward	Two	6	20.0	15.0	Ill.Res.	6.0	43	V
Lake of the Woods	One	136	84.0	40.2	0.03	9.5	18	II C
Little Turkey	Two	135	30.0	11.5	0.16	7.0	36	VII A
Martin	One	26	56.0	34.2	0.33/0.04	10.5/6.0/5.5	35	II C
Meteer	One	18	18.0	8.3	0.03	12.5	17	V
Meesick	Two	68	55.0/54.0	21.3	0.10/0.13	8.5/6.5	34/26	VI A
Mongo Res.	Three	24	15.0	15.0	0.08	2.5	54	V
Nasby Mill Pond	Two	35	15.0	10.0	0.05	2.5	41	V
Nauvoo	Three	38	40.0	25.0	0.05	3.0	50	VI A
North Twin	One	135	30.0	15.7	0.03	5.8	13	V

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
Olin	One	103	82.0	38.0	0.01/0.03	9.0/7.0	10	II B
Oliver	One	362	91.0	40.0	0.01/0.03	12.0/10.0	10	II B
Pigeon (North)	Two	61	35.0	19.0	0.065	8.0	27	VII B
Pretty	One	184	84.0	25.7	0.08	10.0	25	VI A
Rainbow	Two	16	40.0	15.6	0.03	2.6	31	VII B
Royer	Two	69	59.0/56.0	23.6	0.16	8.0/6.2	26	VI A
Shipshewana	Three	202	14.0	6.7	0.045	3.0	51	IV A
South Twin	One	116	52.0	31.0	Ill.Res.	8.0	8	II A
Spectacle Pond	Three	6	20.0	7.5	Ill.Res.	8.0	52	V
Star Mill Pond	Four	38	10.0	10.0	0.03	4.0	43	V
Still	One	30	58.0	20.7	0.03	8.0	19	VI A
Stone	One	116	58.0	14.7	0.03	10.0	2	V
Wall	One	141	34.0	11.0	0.03	9.5	13	V
Weir	Four	6	19	12	0.03	9.0	10	V
Westler	Two	88	38.0	20.1	0.03	7.0/4.0	25	VI A
Witmer	Two	204	54.0	34.5	0.09	6.5	27	II C
Lake Co.								
Cedar (1987)	Three	781	16.0	8.	0.16	1.0	57+	IV C
Dalecarlia	Three	193	--	6.0	0.30	1.0	51	IV A
George (North Basin)(1986)	Four	78(total)	12.0	3.0	0.03	5.0	11(Atypical)	IV A
Marquette Park Lagoons								
East (1986)	Four	100	10.0	7.0	0.035	5.5	22	VII A
Middle	Four	100	10.0	7.0	0.05	6.0	17	VII A
West	Four	100	10.0	6.0	0.10	1.5	33	VII C
George (South Basin)	Four		12.0	3.0	0.04	3.0	26(Atypical)	IV A
George (Hobart)	Three	282	14.0	5.0	0.19	1.0	55	IV A

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
Wolf (Ill. Basin)	Three	385(total)	8.0	5.0	0.04	3.0	59	IV A
Wolf (Main Ind. Basin	--	--	15.0	5.0	0.09	3.0	58	IV A
LaPorte Co.								
Clear	Two	106	12.0	7.2	0.02	7.0	30	VII A
Crane	Three	58	12.0	3.0	0.02	3.0	50	VII C
Fishtrap	One	102	37.0	10.0	0.03	5.0	18	V
Hog	One	59	52.0	11.7	0.02	13.0	21	VII A
Horseshoe	Three	35	10.0	3.0	0.09	5.0	60	V
Hudson	Two	432	42.0	11.7	0.02	5.5	23	VII A
Lily	Four	16	22.0	8.0	0.11	5.0	55	V
Lower Fish	One	134	16.0	6.5	0.02	6.0	8	V
Pine	One	282	71.0	13.0	0.03	10.0	22	VII A
Saugany(Atypical)	One	74	66.0	29.6	0.01	31.8 (Atypical)	1 (Atypical)	II A
Stone	One	125	36.0	19.9	0.02	13.5	6	V
Swede	Two	33	15.0	8.0	0.04	4.5	32	VII A
Upper Fish	Two	139	24.0	7.5	0.03	7.5	22	VII A
Marion Co.								
Eagle Creek Res. (1975)	Two	1,500	35.0	12.5	0.19/ 0.10/0.06	4/5/4.0/2.0	42/44/34	III
Eagle Creek Res. (1985)	Two	--	--	--	0.45	3.0	35	--
Geist Res. (1973)	Two	1,800	22.0	12.0	0.14/0.06	2.5	37	III

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
Geist Res. (1985)	Two	--	--	--	0.12	3.0	42	--
Marshall Co.								
Cook	Two	93	64.0	17.7	0.18	9.0	40	VII B
Dixon	Two	33	48.0	14.5	0.26	7.0	30	VII B
Eddy	Two	16	49.0	25.0	0.09	5.0	42	VI A
Flat	Two	26	24.0	8.1	0.16	6.0	35	VII A
Gilbert	Three	37	41.0	13.2	0.43	1.0	75	IV B
Holem	One	30	74.0	9.8	0.03	8.5	23	VII A
Hawks (Lost)	Three	40	9.0	4.0	0.10	5.0	65	IV B
Koontz	Two	346	31.0	9.2	0.05	3.5	42	VII C
Kreighbaum	Two	20	28.0	20.0	0.07	11.0	32	VII A
Lake of the Woods (1987)	Two	416	48.0	16.	0.04	2.5	48	VII B
Lawrence	One	69	63.0	22.9	0.02	13.0	13	II A
Maxinkuckee (1987)	One	1,864	88.0	24.5	0.034	8.0	13	III
Meyers	One	96	59.0	20.8	0.06	11.8	21	VI A
Mill Pond	Four	136	36.0	6.1	0.08	5.0	58	IV A
Pretty	One	97	40.0	22.1	0.04	14.5	28	IV A
Thomas	Three	16	58.0	27.0	0.06	4.5	51	V D
Martin Co.								
Boggs Creek	Two	600	30.0	12.5	0.04	3.0	45	VII B
Trinity Springs	Three	10	7.0	2.0	0.18	2.0	60	IV A

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
Miami Co.								
Mississinewa Res. Dam 1975	One	3,180	45.0	17.5	0.02/0.03	6.5	20/16	I
Mississinewa Res. Dam 1985	One	--	--	--	0.081	5.0	24	I
Monroe Co.								
Cherry	One	4	30.0	12.0	0.01	8.0	15	V
Bryants Creek Lake	One	9	23.0	10.0	0.02	6.0	15	V
Griffey Res.	Two	130	30.0	10.0	0.30	7.5	40	VII C
Lemon (1986)	One	1,650	28.0	10.0	0.056	2.0	14(Atypical)	III
Monroe Res. Dam 1976	One	10,750	38.0	15.0-20.0	0.03	12.0	25	I
Monroe Res. Dam 1985	--	--	--	--	0.03	7.0	3	
Monroe Res. (Causeway)	--	--	--	--	0.04	6.0	34	I
Monroe Res. (Moores C.)	--	--	--	--	0.04	8.0	25	I
Monroe Res. (N. Salt C.)	--	--	--	--	0.03	8.0	29	I
Monroe Res. (N. Salt Cr.) 1985	--	--	--	--	0.04	2.0	19	I
Monroe Res. (Paynetown) 1976	--	--	--	--	0.03	8.0	27	I

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
Monroe Res. (Paynetown) 1985	--	--	--	--	0.03	3.3	15	I
Montgomery Co.								
Waveland (1978)	Two	360	27.0	10.0	0.03	5.0	20(Atypical)	VII A
Newton Co.								
J.C. Murphy	Three	1,515	8.0	5.0	0.045	1.5	47(Atypical)	III
Noble Co.								
Bartley	Two	34	34.0	12.6	0.07	7.2	35	VII A
Baugher	Three	32	36.0	12.2	0.08	3.0	54	IV B
Bear	Two	136	59.0	22.3	0.22	4.5	46	VI B
Big	Two	228	70.0	24.7	0.17	3.0	38	VI B
Bixler	Two	120	43.0	17.4	0.09	8.0	38	VII B
Bowen	Two	30	36.0	15.0	0.04	7.0	41	VII B
Crane	Two	28	26.0	12.9	0.04	9.0	45	VII B
Cree	Two	58	26.0	15.7	0.07	5.3	39	VII B
Crooked 1987	One	206	108.0	43	0.065	10.0	12	
Diamond	Two	105	81.0	14.0	0.03	6.0	21	VII A
Dock	Two	16	40.0	16.6	0.05	7.0	38	VII B
Duely	Four	21	19.0	8.6	0.09	5.0	42	V
Engle	Two	48	29.0	14.0	0.03	8.0	26	VII A
Gilbert	Two	28	36.0	17.5	0.03	7.0	28	VII B
Gordy	Two	31	35.0	21.9	0.11	7.5	43	VII B
Hall	One	10	35.0	18.0	0.03	8.0	16	V
Harper	Three	11	25.0	14.5	0.03	5.1	60	VII B

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
Henderson	Three	22	35.0	15.0	1.00	1.0	73	IV B
High	Two	123	25.0	10.1	0.07	4.0	53	VII B
Hindman	Four	13	20.0	10.8	0.42	7.0	52	V
Horseshoe	Two	18	28.0	13.9	0.40	6.5	40	VII C
Indian (Village)	Four	12	22.0	13.3	0.06	5.1	59	V
Knapp	Two	88	59.0	25.0	0.23	11.0	43	VII A
Latta	Two	42	38.0	21.4	0.05	5.0	36	VI A
Little Long	Two	71	32.0	24.6	0.04	5.0	32	VI A
Long (Chain of Lakes)	Two	40	32.0	15.8	0.04	7.0	33	VII B
Millers	Two	28	34.0	14.6	0.05	8.0	35	VII B
Moss	Four	9	19.0	8.9	0.24	8.0	51	V
Muncie	Two	47	37.0	12.3	0.09	3.0	46	VII C
Norman	Three	14	46.0	20.0	0.18	11.0	39	VI A
Pleasant	Two	20	67.0	27.0/22.5	0.21	8.0	29	VI A
Port Mitchell	Two	15	31.0	12.0	0.19	8.0	30	VII A
Rider	Four	5	15.0	6.0	0.07	7.5	55	V
Rivir (Chain of Lakes)	Three	24	32.0	15.8	0.07	6.0	38	VII B
Round	Two	99	66.0	21.6	0.05	5.0	24	VI A
Sacarider	Two	33	60.0	22.4	0.25	9.0	35	VI A
Sand (Chain of Lakes)	Two	47	51.0	27.0	0.05	9.0	23	VI A
Shockopee	Two	21	26.0	13.3	0.04	5.0	30	VII A
Skinner	Three	125	32.0	14.0	0.04	4.0	45	VII C
Smalley	Two	69	49.0	22.0	0.05	7.0	34	VI A
Sparta	Two	31	10.0	5.5	0.04	6.0	40	VII C
Stienbarger	Two	73	39.0	21.8	0.09	6.0	39	VI A
Sylvan 1987	Three	575	36.0	14.0	0.25	2.5	51	IV C
Tamarak	Two	50	37.0	17.6	0.23	5.2	42	VII A
Upper Long	Two	86	54.0	22.1	0.17	7.0	32	VI A

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
Waldron	Two	216	45.0	14.4	0.24	3.2	43	VII C
Wible	Three	49	27.0	13.3	0.08	4.0	55	IV B
Wolf	Four	25	14.0	8.0	0.33	5.0	43	IV B
<u>Orange Co.</u>								
Springs Valley	One	141	26.0	8.0	0.03	6.0	20	VII A
Patoka (1987)	One	8000+	50 (est.)					I
Main Basin East					0.032	14.0	3	
East Basin					0.042	14.0	3	
164 Basin					0.047	13.0	14	
Intake Basin					0.038	15.0	12	
<u>Parke Co.</u>								
Raccoon (1986) (Mansfield)	One	2,060	60.0	15.0	0.07	4.5	26	III
Rockville	Three	100	30.0	15.0	0.31	5.0	47	VII B
<u>Perry Co.</u>								
Celina	One	164	38.0	15.0/20.0	0.03	8.0	10	V
Fenn Haven	Three	20	10.0	4.0	0.03	2.0	55	IV A
Oriole	Two	1	8.0	5.0	0.08	4.0	39	VII C
Indian	One	149	25.0	15.0	0.03	9.0	20	VI A
Saddle	Two	41	20.0	15.0	0.03	6.0	36	VI A
Tipsaw	One	131	15.0	15.0	0.03	8.0	19	VI A

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
Pike Co.								
West Lake	Two	15	25.0	10.0	0.03	7.0	7	V
Prides Creek	Two	90	20.0	10.0	0.80	4.0	33	VII A
Porter Co.								
Billington	Two	11	10.0	10.0	0.13	5.0	35	V
Canada	Two	10	36.0	10.0	0.08	5.0	39	V
Clear	One	17	30.0	15.0	0.03	8.0	22	VI A
Deep	Two	7	7.0	10.0	0.03	5.0	28	
Eliza	Three	45	35.0	15.0	0.08	3.8	42	VII B
Flint	One	86	67.0	20.0	0.03	18.0	25	VI A
Long	Two	65	27.0	8.0	0.04	4.0	33	VII A
Loomis	Three	62	30.0	15.0	0.04	4.0	56	IV B
Mink	Three	35	24.0	10.0	0.06	2.0	50	VII C
Morgan	Two	12	15.0	15.0	0.04	5.0	28	VII C
Moss	Two	9	20.0	9.0	0.03	7.0	24	VII A
Spectacle	Two	62	30.0	8.7	0.09	5.0	40	VII C
Wahob	Two	21	48.0	35.0	0.11	7.0	31	II C
Posey Co.								
Hovey	Four	242	51.0	4.0	0.06	0.7/1.5	60	V
Putnam Co.								
Cataract (Lieber) (1986)	Three	1,400	36.0	20.0	0.063	4.0	37	III

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
Ripley Co.								
Bischoff	Three	200	27.0	15.0	0.12	2.5	63	VII B
Feller	Three	6	8.0	4.0	0.28	3.0	64	IV A
Hahn	Two	8	12.0	6.0	0.04	5.0	46	VII A
Liberty Park	Two	11	18.0	7.0	0.06	5.0	26	VI A
Mollenkramer	Three	93	10.0	5.0	0.10	4.0	59	V
Oser	Two	12	18.0	9.0	0.16	5.0	34	VII A
Versailles (1975)	Three	230	20.0	5.0	0.11	1.5	52	VII A
Versailles (1985)	Two	--	--	--	0.13	2.0	30(Atypical)	--
St. Joseph Co.								
Bass	One	88	37.0	10.0	0.01	10.7	17	V
Chamberlain	Four	51	27.0	3.5	0.03	5.0	50	IV A
Czmanda	Four	90	9.0	5.0	0.06	5.0	50	IV A
Mud	Four	197	8.0	2.0	--	5.0	50	IV A
Pleasant	Two	29	39.0	18.0	0.11	3.4	29	VII B
Potato Creek Res.	Two	300	--	15.0	0.03	6.5	25	VII A
Quarry	Two	43	64.0	15.0	0.04	6.0	30	VI A
Riddles	Two	77	20.0	8.3	0.02	4.0	30	VII A
Sously	Two	40	19.0	4.0	0.04	4.0	50	IV A
South Clear	Three	51	15.0	2.0	0.08	5.0	50	IV A
Scott Co.								
Hardy	Two	705	40.0	12.0	0.02	5.0	19	VII A
Scottburg Res.	Three	83	16.0	4.0	0.11	1.0	63	IV A

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
Spencer Co.								
Lincoln	Two	58	24.0	12.0	0.03	4.5	29	VII A
Starke Co.								
Bass	Two	1,400	30.0	10.0	0.70/0.02	2.5	39/36	III
Eagle	Two	24	12.0	6.7	0.04	5.0	40	VII C
Hartz	One	28	40.0	13.2	0.05	9.0	23	VII A
Langenbaum	Three	48	19.0	5.4	0.03	7.0	41	VII C
Steuben Co.								
Ball	One	87	66.0	40.5	0.04	6.0	34	II C
Barton	Two	94	44.0	14.3	0.12	8.0	32	VII B
Bass	Two	61	20.0	7.4	0.06	11.0	34/31	VII A
Beaver Dam	Two	11	26.0	15.0	Illogical Results	10.0	27	V
Bell	Two	38	24.0	13.4	0.05	10.0	24	VII A
Big Bower	Three	25	22.0	11.2	0.16/0.09	3.0/3.0	66	IV B
Big Center	Three	46	19.0	8.5	0.33	1.5	71	IV B
Big Otter	Two	69	38.0	25.8	0.14	8.0	52	IV D
Big Turkey	Two	450	65.0	16.2	0.07	5.0	44	VII B
Black	Two	18	35.0	15.0	0.03	5.0	36	VII B
Booth	Four	10	40.0	14.0	0.04	5.0	55	IV B
Buck	Four	20	57.0	15.0	Illogical Results	5.0	30	VI A
Charles	Three	150	10.0	5.0	0.14	1.3	75	IV C
Cheesboro	Two	27	16.0	10.0	0.05	5.0	40	VII C
Clear	One	800	107.0	31.2	0.17	7.5	25.	II B
Crockett	Four	5	15.0	15.0	0.05	5.0	49	VII B
Crooked (Middle Bas.)(1986)	One	828	77.0	12.	0.03	6.0	17	VII A

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
Deep	Four	12	28.0	10.0	0.06	5.0	51	V
Failing	One	23	35.0	8.0	0.01	15.0	20	V
Fish	Three	59	34.0	12.7	0.14	4.5	54	IV B
Fox	Two	142	55.0	22.2	0.07	9.0	27	IV A
Gage	One	332	70.0	30.6	0.03	12.0/8.0	8	II B
George		488	71.0	25.0	0.03	6.0	9	II B
Golden (Middle Bas.)	Three	119(total)	15.0	15.2	0.06	3.0	66	IV B
Golden (NW Bas.)	Three	--	15.0	15.2	0.12	3.5	71	IV B
Golden (SE Bas.)	Three	--	31.00	15.2	0.06	3.0	66	IV B
Gooseneck	One	25	28.0	20.0	0.03	7.0	15	VI A
Grass	Four	20	25.0	10.0	0.03	5.0	24	V
Gravel	One	12	89.0	10.0	0.05	5.0	19	VII A
Gravel Pit	One	28	29.0	15.0	0.03	9.0	12	VI A
Green	One	24	27.0	10.0	0.02	9.5	15	VII A
Hamilton (E. Basin 1986)	Two	802	70.0	20.	0.04	4.0	31	VI C
Handy	Four	16	41.0	18.1	0.04	10.0	35	V
Henry	Four	20	25.0	15.0	0.32	5.0	38	VII B
Hogback (NE. Bas.)	Three	146	26.0	10.1	0.28/0.04	4.6/2.5/4.0	59/57	IV B
Hogback SW. Bas.)	Three	--	--	10.1	0.07/0.04	4.0	60	IV B
Howard	Four	27	12.0	4.8	Illogical Result	5.0	64	IV A
James (Upper Bas.)	One	1,034(total)	--	--	0.03	12.0	16	II B
James (Middle Bas.)	One	--	86.0	32.5	0.03	12.0	22	II B

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
James (Lower Bas.)	One	--	--	--	0.03	12.0	17	II B
Jimmerson	One	346	56.0	36.0	0.04	13.0	22	II B
Johnson	Four	17	39.0	15.0	0.045	5.0	30	VI A
Lake Anne (Unique)	One	17	31.0	16.5	0.10	9.0	38	VI A
Lake Pleasant	Two	424	52.0	40.0	0.12	8.0	40	II C
Little Otter	Three	34	37.0	21.8	0.28	5.5	58	IV D
Lime	Four	30	29.0	11.0	0.03	10.0	10	V
Lime-Kiln	Two	25	22.0	10.0	0.04	5.0	42	VII C
Long A (Near Pleasant)	Three	92	33.0	16.7	0.40/0.12	2.5	75/53	IV B
Long B	Two	154	36.0	11.9	0.03	7.3	24	VII A
Loon	Four	138	18.0	4.6	0.05	5.0	53	V
Marsh	Three	56	38.0/35.0	20.0	0.60/0.50 /0.39	6.0/5.5/4.5	67/65/64	IV B
McClish	One	35	57.0	34.6	0.03	9.0	18	II C
Meserve	One	16	25.0	14.0	0.03	10.0	22	VII A
Middle Center	Three	15	20.0	5.0	0.50	5.0	62	IV A
Mirror	Four	9	60.0	13.3	0.03	10.0	25/12	VII A
Mud B	Four	16	40.0	18.0	0.05	5.0	59	VII B
Mud C	Four	20	32.0	6.0	0.25	5.0	48	VII C
Perch	Four	12	36.0	18.0	0.04	5.0	30	VII B
Pigeon (Big Bas.)	Three	61	38.0	15.2	0.18	5.0	57	IV B
Pigeon (Little Bas.)	Three	--	20.0	10.0	0.29	5.0	60	IV B
Pleasant	One	53	44.0	30.0	0.09	13.0	20	II A
Round A	Two	30	60.0	35.0	0.06	6.0	25	II C
Round B	Two	30	25.0	11.3	0.03	8.0	23	VII A

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
Round C	Two	12	30.0	10.0	0.05	7.0	38	VII A
Seven Sisters	Four	22	40.0	14.0	0.03	5.0	27	V
Shallow	Four	65	16.0	5.0	0.05	5.0	51	V
Silver	Two	238	38.0	10.7	0.03	9.5	28	VII A
Snow	One	421	84.0	30.0	0.03	10.5	20	II B
Snow (S. Bas.)	One	--	--	19.0	0.03	10.5	18	II B
Stayner	Four	5	10.0	7.0	0.03	7.0	51	V
Tamarak	Two	47	14.0	5.0	0.04	7.0	30	VII A
Walters	Four	53	29.0	10.4	0.03	8.0	26	V
Warner	Four	17	25.0	15.0	0.04	7.0	30	V
West Otter	Two	118	31.0	16.6	0.04	5.0	35	VII B
Sullivan Co.								
County Line Pit	Four	5	6.0	4.0	0.06	0.0	61	IV A
Jonay Res.	Three	11	18.0	6.0	0.07	6.0	32	VII C
Kelly Bayou	Four	40	6.0	3.0	0.19	1.5	64	IV A
Kickapoo	Two	30	40.0	23.0	0.02	6.0	21	VI A
Lake 29 (Acid)		--	--	--	0.10	--	--	--
Lake Sullivan	Two	507	25.0	10.0	0.80	5.0	39	VII A
Merom Gravel Pits	One	55	50.0	6.0	0.03	10.0	5	V
Shakamak	Two	56	26.0	10.9	0.13	6.5	38	VII C
Union Co.								
Whitewater Lake	Two	199	46.0	15.0	0.06	8.5	29	VII B
Vigo Co.								
Fowler Park	Two	50	40.0	15.0	0.14	10.0	50	VII B
Greenfield Bayou	Four	61	12.0	5.0	0.11	5.0	52	V

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
Green Valley	Two	50	--	--	0.04	5.0	36	VII A
Hartman	Two	21	18.0	12.0	0.05	5.0	37	VII A
Izaak Walton	Two	83	60.0	25.0	0.07	5.0	40	VI B
Wabash Co.								
Hominy Ridge	Three	11	20.0	8.0	0.32	2.5	59	IV A
Long (at Laketon)	Two	48	39.0	16.0	0.04	7.0	30	VII B
Lukens	Two	46	41.0	22.0	0.09	10.0	30	VI A
Round (at Laketon)	Two	48	25.0	11.2	0.03	2.0	43	VII B
Twin Lakes	Two	81	16.0	10.6	0.05	4.5	50	IV B
Warrick Co.								
Scales	Two	66	20.0	7.0	0.04	15.0	50	VII C
Washington Co.								
Elk Creek	Two	47	32.0	12.5	0.04	17.0	13	V
John Hay	Two		40.0	15.0	0.03	8.0	13	VI A
Salinda	Three	70	20.0	15.0	0.36/0.03	11.0/4.5	63/31	IV B
Wayne Co.								
Middle Fork Res.	One	277	30.0	15.0	0.03	8.0	18	V
Wells Co.								
Kunkel	Three	25	19.0	6.0	0.06	1.5	59	IV A
Moser	Three	26	12.0	6.0	0.19	3.0	55	IV A

Lake Name	Trophic Class	Size (Acres)	Maximum Depth (ft)	Mean Depth	Total Phosphorus (mg/l)	Secchi Disc (ft)	Eutrophication Index	Lake Management Group
White Co.								
Shaffer Dam (1986)	Two	1,291	30.0	10.0	0.08	3.5	23	III
Whitley Co.								
Blue	Two	239	49.0	21.0	0.15	10.5	35	VI A
Cedar (Tri-Lake)	One	131	75.0	30.0	0.04	21.0	8	II A
Dollar	Four	10	59.0	15.0	0.10	18.0	29	V
Goose	Three	84	69.0	25.9	0.04	3.5	61	IV D
Little Crooked	Two	15	50.0	20.0	0.04	9.0	32	VI A
Loon	Two	222	96.0	25.8	0.05	9.5	46	IV D
New	One	50	44.0	17.6	0.03	12.0	7	II A
Old	Two	32	42.0	19.4	0.15	9.5	48	VII B
Round (Tri-Lake)	Three	125	63.0	25.0	0.06	10.0	30	VI A
Scott	Two	18	22.0	5.0	0.05	5.0	23	VII A
Shriner (Tri-Lake)	One	111	61.0	45.0	0.05	16.0	19	II B
Troy-Cedar	Three	93	88.0	27.3	0.08	4.5	60	IV D