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1981-1982 Status of
Water Quality Report
for the
State of Indiana *

* This Report has been prepared in accordance with requirements of Section 305 (b) of the Clean Water Act of 1977, as amended.

By
Planning Section
Division of Water Pollution Control
Indiana State Board of Health
June 1982

1330 WEST MICHIGAN STREET
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I. Executive Summary

In accordance with Section 305(b) of the Clean Water Act of 1977, as amended (PL 95-217), the State of Indiana hereby submits its 1981-82 Status of Water Quality Report. The purpose of this report is to show trends in the water quality of Indiana streams over a multiple-year period.

This report assesses water quality by drainage basin. Data from each Fixed Water Quality Monitoring Station along the main stem of primary streams were compiled to demonstrate the aggregate improvement or degradation of each stream. Particular emphasis was placed on locating stream monitors on each side of major cities and towns to determine the impact of each municipality on water quality. Secondary, or tributary streams were also monitored for a five-year period. It should be noted that not every stream had a monitoring station located along its course. This is not to imply that water quality problems are non-existent, but merely to recognize that fewer water quality problems exist in these areas than in urban-industrial environs. Some streams had very limited data available due to either the location of new sampling stations and new parameter monitoring, or to the discontinuance of sampling of parameters found no longer to be critically limiting factors.

The development of this report has been a cooperative effort. A more clear and accurate water quality assessment could be made reliable if other opinions were solicited.

The Indiana Stream Pollution Control Board (SPCB) has been delegated the authority to protect the integrity of all instream water uses, and has promulgated several standards that are intended to accomplish this. These include:

330 IAC 1-1; "Water Quality Standards for All Waters Within the State of Indiana," 1977.

330 IAC 2-1; "Water Quality Standards for Lake Michigan and Contiguous Harbor Areas," 1978.

330 IAC 2-2; "Water Quality Standards for The Grand Calumet River and the Indiana Harbor Ship Canal," 1978.

330 IAC 2-3; "Water Quality Standards for Wolf Lake," 1978.

330 IAC 2-4; "Water Quality Standards for Natural, Spawning, Rearing, or Imprinting Areas, and for Migration Routes for Salmonid Fishes," 1978.

Guidelines On Ammonia Reductions for Protection of Warm Water Fish.

330 IAC 1-1, is a regulation that, in addition to establishing minimum treatment requirements and nondegradation policies applicable to all waters, establishes water quality standards applicable to all waters of the State of Indiana except where otherwise specified by the Stream Pollution Control Board through other standards.

The nondegradation policies of the State are applicable to all waters of the State, especially those designated as an outstanding Natural or State resource, and those streams incorporated by the Indiana Department of Natural Resources into the Natural, Scenic, and Recreational Rivers System. Such designation includes:

1. Blue River from U.S. 150 in Fredricksburg, downstream 45.5 river miles to river mile 11.5. This designated stream flows through portions of Washington, Harrison, and Crawford Counties.

2. Cedar Creek from river mile 13.7 to its confluence with the St. Joseph River. Cedar Creek flows through portions of DeKalb and Allen Counties.

3. The North Fork of Wildcat Creek in Carroll and Tippecanoe Counties, from river mile 43.11 to river mile 4.82. The South Fork of Wildcat Creek in Tippecanoe County, from river mile 10.21 to river mile 0.00.

This designation and related classifications may be waived if the Stream Pollution Control Board, after appropriate consideration to public participation and government coordination, determines that limited degradation is justifiable on the basis of necessary economic or social factors, and will not become injurious or interfere with any beneficial instream uses.

Basically, four uses have been determined by the Stream Pollution Control Board for all waters of the State. These include recreation, aquatic life, industrial/domestic use (as a surface water intake), and agricultural uses. Only the recreational, aquatic life, and water supply criteria, (where applicable) will be assessed in this report.

All lakes and reservoirs, the St. Joseph River in Elkhart and St. Joseph Counties, the St. Joseph River in Allen County, the Wabash River where forming the common boundary with Illinois, the Whitewater River after its confluence with the East Fork of the Whitewater River, the Ohio River, and any stream reach incorporated into the Natural, Scenic, and Recreational River System are designated for whole-body contact recreation. All other streams are classified for partial-body contact recreation.

Whole-body contact recreation is limited to the months of April through October, inclusive. The remainder of the year, these streams will be subject to criteria for partial-body contact recreation. The bacterial quality for whole-body contact at any point outside the mixing zone requires that the fecal coliform content (MPN or MF) shall not exceed 200 organisms per 100 milliliters (200/100 ml.) of water as a geometric mean based on not less than five samples per month, nor 400/100 ml in more than one sample during the month. Conversely, the bacterial quality for partial-body contact outside the mixing zone requires that the fecal coliform bacteria content (MPN or MF) shall not exceed 1000/100 ml as a geometric mean based on not less than five samples per month; nor exceed 2000/100 ml in more than one sample.

Waters of the State designated for aquatic life must be capable of supporting a well-balanced, warm water fish community; except that, all waters, where the natural temperatures will permit, will be capable of supporting put-and-take trout fishing, and, where now possible, the natural reproduction of trout and salmon. The criteria for maintaining a well balanced aquatic community also considers substances that could impart an unpalatable flavor to food fish and offensive odors in the vicinity of the water. Toxic substances are limited to 1/10 of the 96-hour median lethal concentration (LC_{50}). No pH values will be permitted below 6.0 nor above 9.0 except where attributed to photosynthetic activity.

In addition to this general standard, other standards have been established to ensure the maintenance of a well-balanced, warm water fish community, and cold water fish communities. For a warm water fish community, concentrations of dissolved oxygen (DO) shall average at least 5.0 milligrams per liter of water (mg/l) per calendar day and shall not be less than 4.0 mg/l at any time. Water temperature shall not exceed certain maximum limits. For the Ohio River, these temperature constraints range from 10.0^{o} C. in January and February to 31.7^{o} C. in July and August. In the St. Joseph River, a tributary to Lake Michigan, these maximum temperatures range from 10.0^{o} C. from December through February to 29.4^{o} C. from June through September. Other maximum temperatures for Indiana streams range from 10.0^{o} C. in January and February to 32.2^{o} C. from June through September. For specific monthly maximum temperature limits, please consult the standard.

330 IAC 2-1, is a regulation establishing water quality standards for Indiana's portion of Lake Michigan and its Contiguous Harbor Areas, i.e., the Inner Harbor, Gary Harbor, and Burns Harbor. Section 3 of this regulation defines water uses in this area. The uses include: recreation, aquatic life, domestic potable water supplies, and industrial water supplies.

In addition to a toxic substance limitation of 1/10 of the 96-hour median lethal concentration (LC_{50}) for the most ecologically sensitive organism, temperature standards for Lake Michigan and Contiguous Harbor Areas dictate that maximum monthly temperatures not exceed certain prescribed limits. These limits range between 7.0^{o} C. from January through March to 26.5^{o} C. from July through September.

330 IAC 2-2, is another regulation for the Great Lakes Region. Its standards apply to the Grand Calumet River and the Indiana Harbor Ship Canal. Because of the extensive urban-industrial environment, the flow of these two watercourses is comprised predominantly of treated wastewaters and wastewaters of nonpoint source origin, such as stormwater overflow. Due to these factors, the unnatural character of these stream beds, and the recognition that even if all wastewaters discharged into these streams are provided the best available technology for treatment, they may not be capable, at all times, of sustaining a well-balanced fish community, the Stream Pollution Control Board has classified these streams for use as partial-body contact recreation, for limited aquatic life and for use as a industrial water supply.

In addition to limiting toxic substance concentrations to 1/10 of the 96-hour median lethal concentration (LC_{50}) and pH values to a minimum of 6.0 and a maximum of 9.0, the minimum water quality standards for these waterways specify that dissolved oxygen concentrations shall not be less than 4.0 milligrams per liter (mg/l). Water temperature is not to exceed 15.6^{o} C. from December through March, nor exceed 30.6^{o} C. in the summer months of July and August. Recreational criteria for partial-body contact recreation require that the fecal coliform bacteria content (MPN or MF) shall not exceed a geometric mean of 1000 organisms per 100 milliliters of water (1000/100 ml) nor exceed 2000/100 ml in more than 10% of the samples, except during periods of stormwater runoff. The filterable residue or total dissolved solids shall not exceed 500 mg/l at anytime.

The chemical constituents of the Grand Calumet River and the Indiana Harbor Ship Canal should be held to the levels denoted in the following table:

Grand Calumet River/Indiana Harbor Ship Canal
Chemical Concentration Standards

Constituent	Concentration
Total Ammonia-Nitrogen	1.5 mg/l
Cyanide	0.1 mg/l
Fluoride	1.3 mg/l
Iron (dissolved)	0.3 mg/l
Phenol	0.01 mg/l
Total Mercury	0.5 ug/l
PCBs	0.001 ug/l

Two of the remaining parameters, chlorides and sulfates, are limited so as to guarantee the potential for domestic potable water supplies. Specifically, the total chloride content shall not average more than 40 mg/l during any 12-month period nor exceed 125 mg/l at any time. The total sulfate content shall not exceed an annual average of more than 75 mg/l nor exceed 225 mg/l at any time.

The total phosphorus limitation specifies that the phosphorus concentration shall not exceed 0.10 mg/l at any time except in waters flowing westward into Illinois. Oil or similar materials shall not be present in such quantities that they will produce a visible film on the water surface, coat the banks or bottom of the streams or in any way be toxic or harmful to fish and any other aquatic life. To fulfill this criterion, the total oil concentration shall not exceed 10.0 mg/l.

330 IAC 2-3, is a regulation establishing water quality standards for Wolf Lake and Wolf Lake Channel. This standard requires that the water quality of the lake and its channel be designated for whole-body contact recreation and of sufficient quality to support a well-balanced warmwater fish community.

To maintain the recreational potential for whole-body contact recreation, the fecal coliform content (either MPN or MF) shall not exceed 200 organisms per 100 milliliters of water (200/100 ml) as a geometric mean based on not less than five samples; nor exceed 400/100 ml in more than 10% of the samples. In addition to limiting toxic substance concentrations to 1/10 of the 96-hour mean lethal concentration (LC_{50}), the following minimum water quality standards for fish and aquatic life shall apply.

No pH values below 6.5 nor above 8.5 may be tolerated, except for those above 8.5 that are correlated with photosynthetic activity. Oil shall not be present in such quantities that will produce a visible film on the water surface, coat the banks and bottom of the lake or be toxic to fish or aquatic life. Un-ionized ammonia, cyanide and total phosphorus will be limited to daily concentrations not to exceed 0.02 mg/l, 0.01 mg/l, and 0.04 mg/l, respectively. The concentrations of dissolved oxygen shall average at least 5.0 mg/l per day and shall not fall below 4.0 mg/l at any time, except that lower values associated with depth may be tolerated if caused by natural conditions. Temperature standards and criteria have been established for Wolf Lake and Wolf Lake Channel. Generally, the temperature of the waters of Wolf Lake shall not exceed 29.4^{o} C. during the summer nor 15.5^{o} C. during the period from October through March, inclusive. Secondly, at any place in Wolf Lake Channel, the receiving water shall not be more than 2.4^{o} C. above the existing natural water temperature of the lake. The temperature of Wolf Lake Channel at its mouth shall not be more than 1.5^{o} C. above the natural temperature of the lake.

330 IAC 2-4, is a standard established for the protection of the natural salmonid spawning, rearing, and imprinting areas in the State. The standard also provides for the protection of migration routes of salmonid fishes. The Indiana Department of Natural Resources has designated four areas in the State as natural spawning areas or rearing and imprinting areas for salmonid fishes. These include:

1. Trail Creek and tributaries upstream of U.S. Highway 35.

2. Little Calumet River and tributaries upstream (easterly) of the Wagner Road Bridge. The Wagner Road Bridge is located downstream of Chesterton at the southeast corner of the southwest quarter, Section 26, T37N, R6W, in Porter County, Indiana.

3. Kintzele Ditch (Black Ditch) from Beverly Drive downstream to Lake Michigan.

4. Salt Creek above its confluence with the Little Calumet River.

Within these areas, water quality standards are stringent. Specifically, the temperature criterion indicates that <u>no heat shall be added</u> to any part of these stream reaches. In addition, the concentrations of dissolved oxygen (DO) shall not be less than 6.0 at any time or at any place. During the spawning season or during periods of rearing or imprinting, the D.O. shall not fall below 7.0 mg/l at any time or at any place. These critical periods usually occur twice a year; once in the fall and again in the spring. The Department of Natural Resources usually anticipates these times to occur between March 15 through June 30 and again from August 1 through approximately December 1.

Other standards applicable to rearing and imprinting areas indicate that no pH values below 6.0 nor above 8.5 may be tolerated. This excludes any daily fluctuations correlated with photosynthetic activity. Concentrations of toxic substances in these streams are subject to those maximum limits specified in the U.S. EPA Administrator's <u>Quality Criteria for Water 1976</u> for the protection of sensitive aquatic life.

To maintain acceptable recreational standards, the fecal coliform bacteria content (MPN or MF) shall not exceed a geometric mean of 200 organisms per 100 milliliters of water (200/100 ml) nor exceed 400/100 ml in more than 10% of the samples.

Salmon migration routes also exist in two streams within this area; Trail Creek from Highway 35 downstream to Lake Michigan and the Little Calumet River from Wagner Road Bridge downstream to Lake Michigan via Burns Ditch. Migration periods occur twice a year, once in the spring from mid-March through June and again in the fall from the beginning of August through the beginning of December. During these periods, the dissolved oxygen (DO) concentration shall not fall below 6.0 mg/l at any time or any place. At other times during the year, dissolved oxygen must average at least 6.0 mg/l during any 24-hour period and not fall below 5.0 mg/l at any time. The maximum temperature shall not exceed 52.2° C. at any time or any place during migration periods nor exceed 67.26° C. at any time. No pH values below 6.0 nor above 8.5 will be tolerated with an exception for photosynthetic activity.

Another principal concern is the quality of the Ohio River. The Ohio is an interstate river system subject to multi-state jurisdiction. In 1948 an interstate compact, signed by not only Indiana, but also Illinois, Kentucky, Ohio, New York, Pennsylvania, Virginia, and West Virginia, established the Ohio River Valley Water Sanitation Commission (ORSANCO) and committed the signatory states to carry out the policies of the Commission. Article I of the Ohio River Valley Water Sanitation Compact pledges each member state, including Indiana, to place and maintain the waters in the basin "in satisfactory and sanitary condition" available for use as a public and industrial water supply after reasonable treatment, suitable for recreational usage, capable of maintaining fish and other aquatic life, free from unsightly or malodorous nuisances due to flooding solids or sludge deposits, and adaptable to such other uses as may be legitimate.

One such policy of the Commission is the "Stream Quality Criteria and Minimum Conditions for the Main-Stem of the Ohio River." Accordingly, the minimum conditions applicable to all waters at all places and at all times specify that water must be free from: 1) substances that will settle to form putrescent or otherwise objectionable sludge deposits, 2) floating debris, oil, or scum which may be unsightly or deleterious, 3) materials producing color, odor, or other conditions which create a nuisance, and 4) substances which are toxic to human, animal, plant or aquatic life.

Other specifications require that at no time shall the dissolved oxygen concentration be less than 4.0 mg/l any place outside the mixing zone and shall average at least 5.0 mg/l per calendar day.

The Stream Pollution Control Board (SPCB) has also adopted ORSANCO's* recommended instream temperature criteria. As such the maximum temperature shall not exceed 5° F., above the natural temperature. In addition, the allowable maximum temperature during a month shall not exceed:

*All ORSANCO data from ORSANCO Notice of Requirements (Standards Number 1-70 and 2-70) Pertaining to Sewage and Industrial Wastes Discharged to the Ohio River. 414 Walnut Street, Cincinnati, Ohio 45202.

Month	Temperature	Month	Temperature
January	50° F.	July	89° F.
February	50° F.	August	89° F.
March	60° F.	September	87° F.
April	70° F.	October	78° F.
May	80° F.	November	70° F.
June	87° F.	December	57° F.

Some variance is granted from the above table in that temperature shall not exceed these limits during more than 1% of the hours in the 12-month period ending with any month, but at no time shall it exceed those limits by more than 3° F.

In addition, the pH factor shall not fall below 6.0 nor rise above 9.0; except those fluctuations above 9.0 which are correlated with natural photosynthetic activity. In addition to pH, un-ionized ammonia shall be calculated with the corresponding concentration of total ammonia and temperature. At no time should nonionized ammonia exceed 0.05 mg/l.

Although ORSANCO recommends limiting toxic substances to one-tenth of the 96-hour tolerance limit (LC_{50}), it also proposes some additional guidelines for toxic substance control. First, if maximum values, established through verified laboratory tests, are exceeded through natural instream characteristics, then those naturally occurring values shall be the threshold concentration. Second, if synergistic toxic effects can occur as a result of not only a discharge, but also natural occurrences, the limitations for that discharge should be determined using standard bioassay techniques for the effluent and the receiving stream. Last, for those pollutants, such as PCBs, which are known or thought to have potential for bioaccumulation and are at concentrations in the water below quantifiable levels (0.1 ug/l), the total body weight concentration shall be used to determine if there is a need for further action using bioassay monitoring of fish flesh to determine a potential toxic threshold. In the case of PCBs, a body burden level exceeding 2.0 ug/g shall be cause for additional investigation.

ORSANCO has also recommended other maximum concentrations for several other chemicals including:

Constituent	Maximum Limit	Constituent	Max. Limit
Arsenic	0.05 mg/l	Lead (filterable)	0.050.0 ug/l
Barium	1.0 mg/l	Nitrate-N + Nitrate-N	10.0 mg/l
Cadmium	0.01 mg/l	Nitrite-N	1.0 mg/l
Chlorides	250.0 mg/l	Phenols (Phenolic materials)	0.01 ug/l
Chromium (hex)	0.05 mg/l	Selenium	0.01 mg/l
Copper	0.1 X 96 hr. LC_{50}	Silver	0.05 mg/l
Cyanide	0.025 mg/l	Sulfate	250.0 mg/l
Fluoride	1.0 mg/l	Zinc	0.01 mg/l X 96 hr. LC_{50}

Total Mercury - 0.05 ug/gram (total body burden)
Unfiltered Mercury in any water sample - 0.2 ug/l

As fulfillment for whole-body contact recreation the commission recommends that the fecal coliform concentrations (either MPN or MF) shall not exceed 200/100 ml as a monthly geometric mean based on not less than five samples per month; nor exceed 400/100 ml in more than 10% of the samples taken in one month. This recreational standard is applicable only during the designated recreation season of April through October, inclusive. Other coliform standards have been adopted for those municipalities which utilize the Ohio River as a source of water supply. These municipalities include the Cities of Evansville, Mt. Vernon, and New Albany. Therefore, the fecal coliform content (MPN or MF) to maintain a potable water supply, should not exceed 2,000/100 ml as a monthly geometric mean based on not less than five samples per month. In addition, the dissolved solids, as recommended, should not exceed 500 mg/l as a monthly average value nor exceed 750 mg/l at anytime.

The final criteria from the Stream Pollution Control Board are the guidelines it has established on "Ammonia Reduction for the Protection of Warm Water Fish." The staff's recommendation, as approved by the Stream Pollution Control Board, states that the ammonia criterion for the protection of cold water fish should be 0.05 mg/l un-ionized ammonia. This criterion would be equivalent to a total ammonia concentration of 2.8 mg/l at a pH of 7.5 and a temperature of 25° C.

Other parameter criteria used for this water quality assessment have either been taken from the U.S. EPA, Quality Criteria for Water, 1976 and/or from The California State Water Resources Control Board's, Water Quality Criteria, 1963.

Lake Michigan Basin

General Assessment:

The water quality within the Lake Michigan Basin is probably the most difficult to accurately evaluate because of the wide range of land uses that exist throughout the area and the many State and Federal water quality criteria that must be taken into consideration, such as Lake Michigan Standards, Grand Calumet River and the Indiana Harbor Ship Canal Standards, sensitive cold water environments criteria, and the International Joint Commission suggested criteria for the lake.

Generally, the water quality of Lake Michigan is in compliance with applicable water quality standards. Most inland rivers and streams support designated uses, but in some instances, such as within the Grand Calumet River, the influx of toxic waste material significantly reduces the stream's capacity to attain acceptable water quality.

Technical Assessment:

The Lake Michigan Basin lies in extreme northwestern Indiana. Its waters include Lake Michigan, and principal streams such as the Grand Calumet River, the Little Calumet River and Salt Creek. Several other streams also drain directly into Lake Michigan. These tributaries include the Indiana Harbor Ship Canal, Burns Ditch, and Trail Creek. The Basin is composed entirely of "Water Quality Limited" segments because, when classified, it had been anticipated that most segments would not meet water quality standards even after the attainment of applicable effluent limitations.

The water quality of Lake Michigan is determined through water samples taken from several Fixed Stations located at municipal water supply intakes. Cities that utilize Lake Michigan as a potable water supply source include East Chicago, Gary, Hammond, Whiting, and Michigan City.

Collectively, the dissolved oxygen concentrations at each municipal intake are generally well above State standards. Although sporadic violations do occur, sufficient dissolved oxygen is present to support fish and aquatic life.

Concentrations of chemical constituents are low enough to promote the maintenance of a well-balanced lake environment. In 1979 and 1980, the amount of ammonia as a daily maximum was in most cases less than the detectable limit of 0.10 mg/l. Temperature and pH are two of the major variables determining the amount of un-ionized ammonia present. Temperature did not exceed monthly maximum limits and, pH variations were well within high and low limits.

There may be four potential limiting factors preventing Lake Michigan from attaining compliance with water quality standards. From 1974-1978, the concentration of phenols averaged 4.9 ug/l at each water intake location on Lake Michigan. It appears that more violations occurred between 1977-1978 than in earlier years of the survey period. However, in 1979 and 1980, most phenol values were below the minimum detectable level of 0.005 mg/l.

Excessive total phosphorus concentrations also affect the biological quality of Lake Michigan. State water quality criteria for total phosphorus concentrations within Lake Michigan should not exceed a daily maximum of 0.04 mg/l or a monthly average of 0.03 mg/l. In 1979-1980, data indicate this daily maximum limit is generally met with and most samples are at or below the minimum detectable level of 0.03 mg/l.

In the past, cyanide concentrations have been detected that violated State limitations. The Stream Pollution Control Board limits total in-lake cyanide to a maximum of to 0.01 mg/l at anytime. Although violations have been periodically recorded at each location, improvement is indicated. In 1979, most measured values were below the minimum detectable level of 0.005 mg/l. In 1980, all measured values at all stations in Lake Michigan were below the minimum detectable level.

The recreational potential for the open waters of Lake Michigan is very high. In the past, at the Whiting and Michigan City water intakes, coliform bacteria concentrations exceeded State limits. These instances were few and the total effect was not considered detrimental to the lake's recreational potential. Data for 1979 and 1980 show fecal coliform levels well within State criteria for whole-body contact recreation.

The Indiana Harbor Ship Canal, a man-made waterway, connects the Grand Calumet River to Lake Michigan. The heavy industrialization of the area has significantly impaired the water quality of the Indiana Harbor Ship Canal. In at least 44% of the surveys (1974-1978), the dissolved oxygen concentrations were found to be in violation of State standards. The most extreme case was a small western inlet of the Canal that complied with dissolved oxygen standards only 40% of the time. Considering the complex urban-industrial environment and the limited flow of the waterway, it is not surprising that dissolved oxygen concentrations are below standard. Between the upstream and downstream monitoring stations, the Indiana Harbor Ship Canal showed a 1% reduction of available dissolved oxygen between its junction with the Grand Calumet River and the confluence with Lake Michigan. In 1979, average DO levels ranged from 2.5 mg/l at Indianapolis Boulevard Bridge to 5.0 mg/l at Lake Michigan. In 1980, average DO levels ranged from 4.0 mg/l at Dicke Road to 6.2 mg/l at Lake Michigan.

In the past, the two most frequently violated standards in the Indiana Harbor Ship Canal were total ammonia and polychlorinated biphenyls (PCB). At three of the four stations the total ammonia standard was violated in every instance and recorded only a 24% compliance rate at the mouth of the Canal. In addition, the five-year average (1974-1978) was approximately 2.8 mg/l above State standards. The toxic pollutants of greatest concern in the Indiana Harbor Canal are PCBs. Although only limited data are available, every measurement taken between 1974-1976 exceeded State limitations. Specifically, PCB concentrations ranged from less than 0.01 ug/l to 0.04 ug/l at each location surveyed. No PCB data are reported for 1979 and 1980. Total ammonia averaged the highest at 3.71 mg/l at both Dicke Road and Columbus Avenue in 1979, but the highest recorded value was 6.00 mg/l at the Highway 12 bridge. In 1980, the highest average value was 2.62 mg/l at Dicke Road and the lowest average was 1.22 mg/l at the mouth of the Canal.

Cyanide concentrations in 1979 at all four monitoring stations showed levels ranging from below the 0.005 mg/l detectability limits to as high as 0.520 mg/l. Only seven out of 45 samples collected in 1979 were at or below the detectable limit. In 1980, data showed significant improvement in cyanide levels. Concentrations ranged from below the detectable limit to a high of 0.057 mg/l. Fifteen out of 43 samples were at or below the minimum detectable level.

Concentrations of total phosphorus discharged to Lake Michigan from the Indiana Harbor Canal are low. During the five-year period (1974-1978) analyses have shown a 76% compliance with water quality criteria. Measurements of total phosphorus from monitoring stations further upstream averaged a 90% rate of violation for the same period of time. An overall improvement is evident as this stream flows toward Lake Michigan. As an average, a total phosphorus reduction of 1.0 mg/l was measured from 1974-1978. Data for 1979 showed three samples in compliance with State criteria. Concentrations in 1979 ranged from 0.03 mg/l to 0.76 mg/l. In 1980, an improvement was noted. Values ranged from less than 0.03 mg/l to a high of 0.53 mg/l. Six samples were at or below 0.04 mg/l.

Coliform bacteria concentrations indicate very poor recreational potential for the Indiana Harbor Ship Canal. Geometric mean concentrations of fecal coliform in 1979 ranged from 1900/100 ml at the mouth of the Ship Canal to 4,707/100 ml at the Columbus Drive Bridge. Data for 1980 show a geometric mean range from 1,206/100 ml at Indianapolis Boulevard to 15,186/100 ml at Columbus Drive Bridge. An improving trend is noted from 1979 to 1980.

The other two streams draining directly into Lake Michigan are Burns Ditch and Trail Creek. These streams are cold water environments capable of supporting put-and-take trout fishing. These streams serve as migration routes and are also used for the rearing and imprinting of salmonid fishes. Other cold water streams in Indiana include Salt Creek, Kintzele Ditch, and the Little Calumet River from the Wagner Road Bridge downstream to Lake Michigan via Burns Ditch.

Trail Creek (7_Q10=20 cfs), is located in LaPorte County, Indiana, and flows northward to its confluence with Lake Michigan near Michigan City, Indiana. The State of Indiana has located two stream monitoring stations to evaluate water quality; one downstream from the Michigan City Wastewater Treatment Facility and the other prior to its confluence with Lake Michigan.

Data indicate that the annual dissolved oxygen concentrations have complied with State water quality standards 87% of the time (between 1974-1978) prior to discharging to Lake Michigan. But at comparable times during the year, 22% more violations have been recorded at the other station below Michigan City's wastewater treatment plant. In these instances, dissolved oxygen concentrations in Trail Creek fall below 4.0 mg/l, primarily due to poor physical stream flow conditions and the impact of municipal waste. Data for 1979 show annual average DO levels of 8.5 mg/l at Franklin Street and 7.2 mg/l at Highway 12. In 1980, these average values were 6.6 mg/l and 6.5 mg/l, respectively.

Periods of fish migration are the most critical. Sufficient oxygen must be present for salmon and trout. The State Department of Natural Resources anticipates a biannual period for these occurrences; from mid-March through June and again from August through the first of December.

Water quality data indicate that Trail Creek met minimum dissolved oxygen standards only 65% of the time (between 1977-1978) downstream from Michigan City's Wastewater Treatment facility. During designated periods of migration, this point on Trail Creek complied with the minimum requirement of 6.0 mg/l of dissolved oxygen in only 60% of the samples. In the past, better water quality has been sustained at the mouth of Trail Creek where 6.0 mg/l of dissolved oxygen was maintained in approximately 74% of the samples. Dissolved oxygen values at this location complied with the prescribed minimum concentration of 5.0 mg/l 87% of the time. Between 1974 and 1978 annual averge dissolved oxygen in Trail Creek was 7.2 mg/l, but migrational patterns of fish may at times be partially impaired immediately downstream from the Michigan City Wastewater Treatment Facility. The State anticipates that upon completion of the Michigan City advanced waste treatment and ammonia removal facility, water quality problems will be significantly reduced. This will improve potential for salmonid migration in Trail Creek.

Another potential limiting factor in Trail Creek is temperature. At least one sample from each migration period (1974-1978) indicates that temperature exceeded the 21^{o} C. criteria. Although a small temperature increase has been denoted, it is not significant enough to degrade Trail Creek's potential as a cold water environment for salmon and/or trout. Most high temperature violations occurred during summer low-flow periods. Temperature data for 1979 and 1980 is within State criteria.

The most serious documented problem on Trail Creek is cyanide contamination. Prior to its confluence with Lake Michigan, Trail Creek exceeded the 5.0 ug/l cyanide criteria in 33% of the cases as compared to 60% immediately downstream from Michigan City treatment facility during 1977-1978. Total cyanide concentrations were found to average 7.0 ug/l and 11.0 ug/l, respectively, at each monitoring location in those years. In 1979 and 1980, the data looked much better. Sixteen out of 20 samples in 1979 were below the minimum detectable level of 0.005 mg/l. In 1980, 18 out of 20 were below detectable limits.

The U.S. EPA has determined that the un-ionized ammonia concentrations less than 0.02 mg/l are necessary for protection of fish and aquatic life, especially in cold water environments.

Trail Creek is designated for partial-body contact recreation. Instream fecal coliform bacterial concentrations should not exceed 2000 organisms per 100 milliliters of water in any one sample. Mean averages do indicate a more severe problem immediately downstream from Michigan City. Geometric mean fecal coliform bacteria concentrations were 524/100 ml (1976), 1,217/100 ml (1977), and 1,143/100 ml (1978) at the mouth of Trail Creek. In 1979, geometric mean levels of fecal coliform were 657/199 ml at the Franklin Street Bridge, and 1,353/100 ml at Highway 12. In 1980, these levels were 1,555/100 ml and 2,395/100 ml at these same respective locations.

Burns Ditch, part of the salmon migration route, originates in the upper reaches of the Little Calumet River near the Wagner Road Bridge in Porter County. The U.S. Geological Survey has measured a seven-day, once-in-ten-year low flow of 18 cubic feet per second on the Little Calumet River prior to its confluence with Burns Ditch. At Porter, Indiana, data from the State's Fixed Monitoring Station indicate an acceptable environment for fish and aquatic life. Dissolved oxygen has demonstrated 95% compliance with daily minimum standards over the five-year period (1974-1978). The mean dissolved oxygen of the Little Calumet River averaged 9.0 mg/l even during designated migration periods. Data for 1979 at two locations showed annual average DO concentrations ranging from 3.9 mg/l to 8.7 mg/l. In 1980, these averages ranged from 3.5 mg/l to 8.7 mg/l.

The upper reaches of the Little Calumet River are also designated for partial-body contact recreation. Data indicate that instream fecal coliform counts from 1974-1978 have complied with State standards approximately 77% of the time. Data for 1979 show geometric mean fecal coliform levels of 94,201/100 ml at Hohman Avenue and 350/100 ml at SR 149. In 1980, these locations showed levels of 19,350/100 ml and 241/100 ml, respectively.

The Little Calumet River joins Burns Ditch near Lake Station, Indiana, and flows to Lake Michigan. The main channel of Burns Ditch reflects the water quality of the combined flows of its east and west branches. Only the main channel and the east branch of Burns Ditch are subject to standards applicable to cold water streams.

Dissolved oxygen concentrations are usually high in Burns Ditch and have not violated State minimum standards in more than 8% of the samples. Overall dissolved oxygen concentrations averaged 8.5 mg/l for the period 1974-1978. Dissolved oxygen has been present in sufficient quantities during the critical periods of salmonid migration. Data for 1979 at four locations on Burns Ditch showed annual average DO concentrations ranging from 8.2 mg/l to 8.6 mg/l. In 1980, these averages ranged from 7.6 mg/l to 8.4 mg/l. The only major parameter that may have once proved prohibitive to fish and aquatic life is cyanide. Data indicate that total cyanide concentrations have complied with the U.S. EPA criterion only 65% of the time between 1974-1978. Throughout this period, the mean concentrations have averaged 0.009 mg/l. In 1979, most cyanide levels were at or below 0.005 mg/l and in 1980, all samples were at or below the minimum detectable level of 0.005 mg/l, thus indicating vast improvement.

Some areas of Burns Ditch are able to meet instream fecal coliform standards. Past data indicate that recurrent bacterial problems, especially in the main channel of Burns Ditch, are major factors prohibiting attainment of water quality standards. Data for 1979 showed geometric means at four sampling locations ranging from 502/100 ml to 1,731/100 ml. In 1980, these ranges varied from 214/100 ml to 319/100 ml, a significant improvement over the past years.

The remaining cold water stream that needs to be considered in the Lake Michigan Basin is Salt Creek, located in Porter County, Indiana. The headwaters of Salt Creek originate in a marshy area in central Porter County. Its southerly flow, measured at a seven-day, once-in-ten-year low flow of 19 cubic feet per second, joins the Little Calumet River near McCool, Indiana. The only major discharge this stream receives is from the Valparaiso Wastewater Treatment Facility. Other discharges include South Haven WWTF and several package plants.

The water quality of Salt Creek has been evaluated through data compiled from temperature, dissolved oxygen, oil and grease, un-ionized ammonia and fecal coliform bacteria measurements. According to State standards, no heat shall be added. Between 1974-1978 mean annual temperatures increased approximately 28%, the largest gain except for fecal coliform. In 1979, the geometric mean concentration was 2,113/100 ml. This parameter was much lower in 1980 with a geometric mean value of 200/100 ml.

Oil and grease were also found to be potential water quality problems. Prior to mid-1977, oil and grease failed to meet acceptable concentrations 26% of the time. Since that time, however, an overall reduction has been realized. In the last survey year, lower concentrations have been below the minimum detectable level of 10 mg/l except for one at 21 mg/l. There are severly low DO problems downstream of Valparaiso and also significant ammonia problems.

There are two major streams in the Lake Michigan Basin flowing across the Indiana and the Illinois State line. One is the Grand Calumet River. It originates in the eastern portion of Lake County, Indiana, and flows west through one of the largest urban-industrial conmplexes in the United States.

The first monitoring site on the Grand Calumet River is located at the Industrial Highway in Gary, Indiana. No dissolved oxygen measurements made between 1974-1978 violated State requirements. Overall, dissolved oxygen values maintained a five-year mean concentration of 7.6 mg/l. The total ammonia concentration exceeded instream limitations in 98% of the surveys between 1974-1978. Ammonia values in 1979 averaged 7.68 mg/l and 2.87 mg/l at two different stations. In 1980, values averaged 7.15 mg/l and 1.58 mg/l at the same two locations.

The recreational potential is also low. Data revealed fecal coliform violations in 57% of the samples between 1974-1978. The mean coliform concentration during this period was 48,000/100 ml. Data for 1979 show geometric mean concentrations for fecal coliform of 46,679/100 ml and 55,592/100 ml at two locations on the river. Data for 1980 show geometric mean values of 39,731/100 ml and 5,306/100 ml. The latter value shows an improvement since 1979 at the Highway 12 Bridge location.

The most significant reduction is in total cyanide. As the flow of the Grand Calumet River enters Illinois, total cyanide concentrations demonstrate a 91% compliance with Indiana requirements. Specifically, when comparing 1974-1978 mean averages recorded at the Gary and Hammond stations, a 99% reduction of total instream cyanide has been achieved.

The last stream considered in this evaluation is the Little Calumet River. As previously discussed, the upper eastern reaches of this waterway have been designated as a natural spawning and rearing or imprinting area. The western arm of the Little Calumet River is subject to the water quality standards promulgated for all warmwater streams in Indiana.

As the Little Calumet River flows through this region, at an average flow of 16.5 cubic feet per second, several parameters such as phenols, cyanide, and un-ionized ammonia, degrade its water quality. Dissolved oxygen levels were below minimum daily requirements approximately 40% of the time. These violations have not been limited to low flow periods. DO averaged 3.9 mg/l in 1979 and 3.5 mg/l in 1980. At Porter, values were higher. In 1979, they averaged 9.0 mg/l, and in 1980, they were 8.7 mg/l.

Phenol constituents have exceeded the U.S. EPA criterion 86% of the time over the 1974-1978 period. At least 50% of the time, the phenol level exceeded 6.0 micrograms per liter (ug/l), and averaged 7.7 ug/l. Data show averages of 0.007 mg/l at Hammond in 1979 and 0.006 mg/l in 1980.

The potential for partial-body contact recreation is practically nonexistent since coliform bacteria counts are in compliance with State standards less than 20% of the time. The geometric mean in 1979 at Hammond was 94,201/100 ml and 350/100 ml at Porter. In 1980, values at these stations were 19,350/100 ml and 241/100 ml, respectively.

The only lake station within the Lake Michigan Basin, other than those for measuring water quality in Lake Michigan, is located on Wolf Lake in Lake County, Indiana. Specific water quality limitations have been designated for Wolf Lake because it borders the Indiana and Illinois State line. No temperature violations have been recorded. Dissolved oxygen measurements have shown values above required daily limits in 96% of the samples. A limnological survey of Wolf Lake in 1981 revealed high metals concentration in the water column and in bottom sediments.

Total phosphorus samples from Wolf Lake frequently exceeded State standards from 1974-1978. According to State limitations, total phosphorus should not exceed 0.04 mg/l. Data indicate this value was exceeded in 70% of the samples. In 1979 and 1980, total phosphorus values averaged 0.10 mg/l and 0.08 mg/l, respectively.

The Maumee River Basin

General Assessment:

Each major river within the Maumee Basin complies with State Water Quality Standards for fish and aquatic life with respect to dissolved oxygen. Some other parameters may have concentrations detrimental to aquatic life. High concentrations of copper, cyanide, and mercury have in the past been limiting factors within this area. Recent improvement has been demonstrated. In at least two streams, partial-body contact recreation criteria are met. Standards for whole-body contact recreation are not always met in the St. Joseph River.

Technical Assessment:

The Maumee River Basin is located in the northeastern portion of Indiana, and includes the Maumee River, the St. Joseph River, and the St. Mary's River. The latter two join to form the Maumee River at Fort Wayne. The Maumee River, with a 7 day, 10 year low flow of 58 cubic feet per second (cfs) in Indiana, ultimately discharges to Lake Erie at Toledo, Ohio. The State Board of Health has established three Fixed Water Quality Monitoring Stations on the Maumee River at Fort Wayne, New Haven, and Woodburn, Indiana.

Between 1974-1978, the Maumee River at Fort Wayne exhibited high dissolved oxygen levels, averaging 9.9 mg/l during this period. No levels violated either the State's minimum standard or the average daily requirement. The extent to which these standards are violated is somewhat limited downstream from Fort Wayne. Specifically, only 7% of the total samples surveyed indicate that dissolved oxygen declined below the 5.0 mg/l daily average requirement, and were usually associated with periods of summer low flow. At no time did these levels decline below 4.0 mg/l. Adequate dissolved oxygen is present to support a diverse fish and aquatic life community. In 1979, DO levels averaged 10.5 mg/l at Woodburn, 9.9 mg/l at New Haven, and 10.0 mg/l at Fort Wayne. In 1980, DO levels were 9.9 mg/l at both Woodburn and New Haven and 9.7 mg/l at Fort Wayne.

A potential oxygen consuming parameter, ammonia, does not appear to be a significant limiting factor in the Maumee River. The only station showing concentrations near the 0.05 mg/l critical threshold level was in the New Haven area. In 1974, an average concentration of 0.08 mg/l was recorded, but subsequent measurements through 1978 indicate a net 90% reduction has been achieved. This is supported by two facts: first, no concentrations greater than 0.006 mg/l were measured in 1978 on the Maumee River at New Haven, and second, other stations further downstream in the Woodburn area have measured significantly lower concentrations in 1978 than in the previous years of the survey period. Ammonia concentrations in 1979 averaged 0.19 mg/l at Woodburn, 0.21 mg/l at New Haven, and 0.26 mg/l at Fort Wayne. In 1980, averages were 0.31 mg/l, 0.30 mg/l, and 0.16 mg/l at these locations, respectively.

Several parameters do not always meet State/Federal Water Quality criteria. These include: copper, cyanide, mercury, and oil and grease.

For some aquatic species, copper may become a limiting factor at levels greater than 20.0 ug/l. At New Haven, the Maumee River has exceeded this criterion in 48% of the measurements, and averaged 40.0 ug/l between 1977-1978. Some trends towards improvement have been evidenced. In particular, the Maumee River at Woodburn has denoted a 69% compliance rate with this criterion averaging a 20.0 ug/l.

Data for 1979 show copper concentrations at Woodburn, New Haven, and Fort Wayne at or below the detectable limits of 0.020 mg/l. Data for 1980 show the same except for single sample highs of 0.029 mg/l at Woodburn, 0.028 mg/l at Fort Wayne, and 0.029 mg/l at New Haven.

Total cyanide concentrations have in the past exceeded Federal criteria. The highest levels of cyanide between 1974-1978 were found in the Woodburn area. At this point, mean levels averaged near 8.0 ug/l and only complied with the U.S. EPA standards in 55% of the samples. Prior to 1976, it was not uncommon for total cyanide concentrations to range between 5.0 ug/l and 9.0 ug/l. In the remaining two-year period, cyanide averaged only 3.0 ug/l, and exceeded Federal guidelines in 10% of the samples. Present cyanide concentrations are not detrimental to fish and aquatic life. Data for 1979 and 1980 show all concentrations of cyanide at all three stations below detectable limits except for one value in 1979 at Woodburn that was reported at 0.008 mg/l.

In the past, some portions of the Maumee River have had unacceptable mercury concentrations. At Fort Wayne and at Woodburn, mercury levels have only been in compliance with the U.S. EPA criterion in 74% and 66% of the samples, respectively. At each location, violations have come in spurts. At the beginning of each survey period (1974), mercury was not a problem. Then, for unknown reasons, the concentrations began to rise to concentrations ranging between 0.20 ug/l to 0.80 ug/l. Total mercury was again in compliance in mid-1976 through 1977. At both locations during 1978, mercury values have averaged 0.30 ug/l, with concentrations ranging between 0.80 and 1.3 ug/l. Presently, instream surveys completed for the third quarter of 1979 indicate that only in the Fort Wayne area were average mercury concentrations recorded in excess of Federal criteria.

More complete data for 1979 show unusual peaks of mercury up to 6.0 ug/l at Woodburn and 8.0 mg/l at Fort Wayne. In 1980, the highest concentrations were 3.0 ug/l at Woodburn and 5.0 mg/l at Fort Wayne. At both stations, most of the samples were at or below detectable limits.

The Maumee River was suitable for partial-body contact recreation between 75%-85% of the time. Data indicate that for the majority of time within a one-year period, coliform bacteria can be found at concentrations not greater than 2,000 organisms per 100 milliliters of water. A 31% net reduction of bacteria is noted between the Fort Wayne and Woodburn areas during the 1974-1978 period.

The geometric mean concentration of fecal coliform in 1979 was 491/100 ml at Woodburn, 551/100 ml at New Haven, and 798/100 ml at Fort Wayne. In 1980, these stations showed geometric means of 509/100 ml, 646/100 ml, and 814/100 ml, respectively. Note that in both years values decrease with distance downstream of Fort Wayne.

The St. Mary's River is one of two major tributary streams of the Maumee River. Flow records indicate that prior to its discharge to the Maumee River, the St. Mary's River seven-day, once-in-ten-year low flow is 8.1 cubic feet per second.

Water quality data compiled from Fixed Stations at Fort Wayne indicate high dissolved oxygen levels are being attained. Specifically, between 1974-1978, dissolved oxygen maintained 94% to 98% compliance with daily average requirements and with minimum standards. Throughout this period, average concentrations were 9.2 mg/l. In addition, average dissolved oxygen concentrations have increased 11% between 1974-1978. As an oxygen consuming agent, ammonia (NH_3-N) has not handicapped the water quality of the St. Mary's River.

In 1979, dissolved oxygen averaged 9.3 mg/l at Fort Wayne, and 8.3 mg/l at Pleasant Mills. At no time did recorded levels fall below 5.0 mg/l. In 1980, averages were 9.3 mg/l at Fort Wayne, and 8.9 mg/l at Pleasant Mills. The minimum was recorded at Pleasant Mills at 5.5 mg/l.

The bacterial quality of the St. Mary's River from 1974 to 1978 demonstrates an 85% compliance with State recreation standards for partial-body contact. Most values in excess of 2,000 organisms per 100 milliliters of water occurred prior to 1976. Much improvement has been realized in recent years, especially between 1976-1978. During this three-year period, only one sample exceeded State standards. On an annual basis, a 70% reduction of coliform bacteria was recorded for the St. Mary's River at Fort Wayne.

Later data in 1979 showed geometric mean levels of 327/100 ml at Fort Wayne and 669/100 ml at Pleasant Mills. In 1980, geometric mean levels were 489/100 ml at Fort Wayne and 833/100 ml at Pleasant Mills.

The St. Joseph River is a tributary of the Maumee River. It enters Indiana near Newville, in DeKalb County and flows southwest into the Cedarville Reservoir. The seven-day, once-in-ten-year low flow is 23 cubic feet per second. Water quality is very good for fish and aquatic life. The dissolved oxygen concentrations were well above State requirements. During the five-year period, 1974-1978, average dissolved oxygen was 9.9 mg/l and did not fall below the 4.0 mg/l minimum requirement at anytime.

Dissolved oxygen concentrations averaged 10.2 mg/l in 1979 and 10.4 mg/l in 1980.

The only instream parameter with the potential to hinder the recreational potential of the St. Joseph River is fecal coliform bacteria. According to State criteria the St. Joseph River must maintain suitable bacterial quality for whole-body contact recreation between the months of April through October, inclusively. Data indicte that during these designated months, coliform bacteria (fecal) counts meet State standards only 42% of the time. The geometric mean concentration was 298/100 ml in 1979 and 371/100 ml in 1980.

The Wabash River Basin

General Assessment:

The water quality of the Wabash River can generally be described as meeting the State's Water Quality Standards. Dissolved oxygen concentrations are high enough to maintain a well-balanced fish community in most areas of the waterway. Urban discharges within the upper Basin areas sometimes create slight downstream dissolved oxygen sags. The impact of this pollution is not severe enough to inhibit stream recovery. The bacterial quality improves downstream of these.

Tributary streams generally comply with water quality standards. The most severely impacted stream within the Wabash River Basin is Wildcat Creek. As a result of the pollution impact of discharges from the City of Kokomo, Wildcat Creek shows increases in concentration of some toxic parameters. Completion of the City's upgraded wastewater collection system should result in extensive water quality improvement in the stream.

Technical Assessment:

The major drainage area within Indiana is the Wabash River Basin. In conjunction with its associated sub-basin areas of the East Fork and the West Fork of the White River, the Wabash River system drains approximately three-fourths of the land area in the State.

The Wabash River enters Indiana just south of the Maumee River Basin in Jay County, Indiana. Its flow is directed over 400 miles starting from a 40-mile north-northwestern course to Huntington, Indiana, thence in a westerly course of almost 51 miles through Logansport, thence in a south-southwest course for over 80 miles to Covington, and finally in a southerly direction to its confluence with the Ohio River. Flow measurements recorded by the U.S. Geological Survey indicate that the Wabash River flow increases from a seven-day, once-in-ten-year low flow of 1.5 cubic feet per second (cfs) at New Corydon to over 2,170 cubic feet per second at Mt. Carmel, Illinois. The total base flow is augmented by eight major tributary streams including:

1.	Salamonie River	(7Q10 = 20 cfs)
2.	Mississinewa River	(7Q10 = 20 cfs)
3.	Eel River	(7Q10 = 91 cfs)
4.	Tippecanoe River	(7Q10 = 190 cfs)
5.	Wildcat Creek	(7Q10 = 47 cfs)
6.	Sugar Creek	(7Q10 = 21 cfs)
7.	White River (East and West Forks)	(7Q10 = 700 cfs)
8.	Patoka River	(7Q10 = 20 cfs)

The State has designated that the Wabash River maintain sufficient water quality for fish and aquatic life, and for partial-body contact recreation. In that portion where the Wabash River forms the Indiana-Illinois common boundary, water quality is required to meet applicable standards for whole-body contact recreation. The State requires that dissolved oxygen shall not decline lower than 4.0 mg/l at any time, and not decline lower than an average of 5.0 mg/l per calendar day. Overall, very few violations of the State's average standard have been recorded. Noncompliance is generally limited to minimum daily requirements.

In the last 305b report, mercury levels averaging 0.20 mg/l and 0.34 mg/l at Georgetown and Wabash River Generating Station, respectively, were reported. Data for 1979 and 1980 now indicate reductions to annual averages of 0.111 mg/l (1979) and 0.117 mg/l (1980) at Georgetown, and to 0.145 mg/l (1979) and 0.15 mg/l (1980) at Terre Haute.

Data for 1979 and 1980 also show reductions in cyanide at Lafayette and Clinton. Annual averages at Lafayette and Clinton in 1979-1980 were at the detectable limit of 0.005 mg/l with no values higher than 0.006 mg/l at either location in either year.

Indiana requires the Wabash to meet certain bacterial standards that allow partial-body contact recreation. This designation is applicable for the Wabash River upstream of Terre Haute. That portion of the Wabash forming the common boundary with Illinois must meet more stringent conditions so as to sustain whole-body recreation, especially during the period April through October. Portions of the river comply with State recreation standards. Relatively high geometric mean concentrations appeared at Andrews and Peru in 1979, and at Peru and Lafayette (Granville Bridge) in 1980. Trends are down in some areas and up in others, but problems still seem to occur in the stretch from the City of Wabash to Peru and in the vicinity of Lafayette.

In the Vincennes planning area, the river must maintain water quality suitable for whole-body contact recreation. Data indicates these standards are being met.

The Salamonie River is the first major stream to augment the flow of the Wabash River. Its headwaters lie north of Portland, Indiana, and drain northwest to the Salamonie Reservoir. The seven-day, once-in-ten-year low flow at this point is 7.0 cfs. Prior to entering the reservoir, the river maintains an annual average dissolved oxygen concentration upwards of 9.6 mg/l.

Upstream of the reservoir, coliform bacteria counts were found to comply with State standards for partial-body contact 85% of the time between 1974 and 1978. Data for 1979 and 1980, however, show excessive coliform values near Portland, Indiana. In 1979 the geometric mean fecal coliform level at Portland was 16,551/100 ml. In 1980 this value rose to 21,566/100 ml.

Downstream of the Salamonie Reservoir, at the Lagro, Indiana, monitoring station, the river shows no water quality problems, and with respect to ammonia (NH_3-N), a significant improvement is noted. In 1979, NH_3-N levels averaged 0.25 mg/l with a high of 0.60 mg/l in March. In 1980, the annual average was reduced to 0.14 mg/l, but again, a peak valve of 0.60 mg/l, was measured in March.

The Mississinewa River enters Indiana from Parke County, Ohio, and flows to the Wabash River via the Mississinewa Reservoir. Fixed Water Quality Monitoring Stations upstream from the Reservoir indicate fairly good water quality. Dissolved oxygen concentrations have remained well above standards and have averaged 9.0 mg/l for the five-year period (1976-1980) with no recorded levels below 5.0 mg/l.

In the 1978 305b report, the only parameter showing levels higher than water quality criteria for fish and aquatic life during this period was oil and grease. Prior to 1976, oil and grease concentrations were found to exceed 10.0 mg/l in 35 percent of the measurements. During this time, 12 samples from the Mississinewa River were reported to have levels ranging from 11.0 mg/l to 29.0 mg/l. Up to 1978, however, only two samples were found above 9.0 mg/l. Upstream at Jalapa, Indiana, oil and grease levels appear to be diminishing toward more acceptable levels. Data from 1979 and 1980 show significant reductions, however, the margin of error in testing for oil and grease at low concentrations and the error introduced by sampling procedures themselves makes it difficult to identify trends at these low concentration levels.

From 1974-1978, some problems existed upstream from the Mississinewa Reservoir, preventing maintenance of partial-body contact use. At Marion, Indiana, coliform bacteria concentrations failed to comply with State standards in 33% of the samples. This station meets instream requirements on an average of eight months a year. Data collected between 1974-1978 indicate a 35% decrease from 2,517/100 ml to 1,633/100 ml in 1978. Data for 1979 and 1980 show geometric mean average concentrations of 2,538/100 ml and 4,748/100 ml, respectively.

The regulated 20 cubic feet per second flow discharged from the Mississinewa Reservoir is of excellent quality. Indiana's Fixed Station Monitoring site located one-mile upstream from the Wabash River confluence shows no parameters harmful to fish and aquatic life. In 1979, dissolved oxygen concentrations did not fall below 6.5 mg/l, and in 1980, averaged over 11.5 mg/l. The coliform bacteria measurements taken from 1974-1980 produced four samples that exceeded 2,000 organisms per 100 milliliters of water. With this compliance record, the Mississinewa River downstream from the Reservoir meets all applicable standards for partial-body contact recreation.

The next significant stream to contribute flow to the Wabash River is the Eel River. In addition to the designated uses of supporting fish and aquatic life and partial-body contact recreation, Eel River is also utilized as a water supply for the City of Logansport. Data from 1974-1978 indicate that coliform bacteria limitations meet State standards for partial-body contact in 75 percent of the samples taken. In five instances, total coliform bacteria were found at levels exceeding 5,000 organisms per 100 milliliters of water. In all probability, this limits bacteria violations to only those periods associated with summer low flow. Data for 1979 and 1980 showed geometric mean levels of 272/100 ml and 443/100 ml, respectively. The only potential limiting factor in this area is thermal input from the Logansport City Electric Company. The City submitted 316(a) and 316(b) studies to the State which were reviewed by ISBH staff. A determination was made that no problem existed for present operations. Future expansion and a consequent rise in river temperature would be unacceptable.

The most severely impacted stream within the Wabash River Basin is Wildcat Creek. Its headwaters originate in the northeastern portion of Tipton County and flow in a westerly direction through Howard and Carroll Counties to its Wabash River confluence at Lafayette, Indiana. Data indicates that discharges from the City of Kokomo significantly degrade that stretch of Wildcat Creek.

Upstream from Kokomo, Wildcat Creek generally meets with State Water Quality standards. Only two parameters, mercury and oil and grease, show a potential to affect the fish and aquatic life use. Dissolved oxygen has averaged well above State minimum standards, and in only one instance has fallen below average daily requirements. In addition, the annual average total ammonia concentration was 0.01 mg/l in 1976.

As previously mentioned, total mercury concentrations may affect fish and aquatic life in Wildcat Creek. Upstream from Kokomo, Federal criteria have been exceeded in 37 percent of the surveys, with values averaging 0.26 ug/l between 1974-1978. A majority of these violations have been recorded in only two periods, between 1974-1975, and again during 1978. In the interim, total mercury concentrations have averaged 0.10 ug/l with a 92 percent compliance rate. During these periods, total mercury has averaged 0.42 ug/l and 0.32 ug/l, respectively, but subsequent sampling conducted in 1979 indicated no concentration greater than 0.20 ug/l. Data in 1980 shows an annual average of 0.142 mg/l.

Oil and grease concentrations have exhibited similar tendencies, except that no values between mid-1977 and 1979 were recorded greater than 8.2 mg/l. The highest concentrations occurred in 1975, when violations ranged between 12.0 mg/l and 28.0 mg/l and averaged 12.6 mg/l for the year. With a 25 percent annual reduction of oil and grease concentrations, the stream is recovering and meeting the criterion. Data for 1980 show an increase in annual average levels to 11.0 mg/l and a high in July of 27.9 mg/l.

The recreation potential for Wildcat Creek upstream from Kokomo is very good. Bacterial standards for partial-body contact recreation were met in 99 percent of the surveys between 1974-1978. Geometric mean levels were at 205/100 ml in 1979 and to 162/100 ml in 1980. This 1980 value would have been much lower if not for a single high of 1,900/100 ml in June.

Downstream from Kokomo, an entirely different water quality situation exists. Data indicate that dissolved oxygen concentrations from 1974-1976 were in compliance with minimum standards during 81 percent of the surveys. DO concentrations complied with average daily requirements during 71 percent of the surveys. Although dissolved oxygen usually falls below 4.0 mg/l during summer low flow periods, the minimum 5.0 mg/l daily requirement is found to decline below standards on an average of three additional months a year. Annual average dissolved oxygen is consistently lower downstream from Kokomo.

The impact of the City of Kokomo is evident. Between 1974 and 1978 average dissolved oxygen concentrations downstream from Kokomo were 6 to 40% lower than upstream concentrations. In addition, yearly comparisons also indicate a moderate decline of dissolved oxygen at each station during

1978, as compared to the annual concentrations recorded in 1974. Reductions in 1979 and 1980 levels are much less pronounced possibly indicating improved stream conditions.

The dissolved oxygen content of Wildcat Creek is sufficient for fish and aquatic life, but data demonstrate that concentrations of ammonia and oil and grease cause moderate reductions of available dissolved oxygen downstream of urban and industrial dischargers.

Between 1974 and 1980, un-ionized ammonia occasionally exceeded 0.05 mg/l. Although the majority of these critical levels were recorded in 1974, there is strong evidence supporting the fact that occasional high levels of ammonia (NH_3-N) have raised annual concentrations to twice that reported in 1974. Occasionally in 1978, un-ionized ammonia levels increased beyond 0.05 mg/l. In 1979 and 1980, annual average values of total ammonia were 1.30 mg/l and 0.97 mg/l, respectively.

There appear to be increases of oil and grease downstream of Kokomo. Between 1974-1978, oil and grease concentrations exceeded 10.0 mg/l in 28 percent of the samples, but generally these were limited to summer low flow periods. Slightly higher concentrations were recorded during 1975 when annual measurements indicated oil and grease concentrations averaged 13.6 mg/l. In 1979, the annual average was 1.8 mg/l. This value increased to 11.0 mg/l in 1980. All of these values are near the detectability limit of 10 mg/l. The range of sampling and analytic error at these low levels precludes a definitive water quality determination regarding oil and grease.

Other parameters measured in Wildcat Creek, such as cyanide, copper, and mercury, may also reduce its potential for fish and aquatic life. Higher levels of cyanide are consistently reported downstream from Kokomo.

Specifically, violations during this seven-year period were found to exceed Federal standards downstream from Kokomo, with values ranging between 6.0 ug/l and 182.0 ug/l. Even though higher than satisfactory concentrations still exist as a result of discharges at Kokomo, significant reductions have been made over a seven-year period indicating measurable instream improvement.

Mercury levels were also found generally to be declining since 1974. During years prior to 1978, measurements showed an annual 18 percent reduction of total mercury, but in 1978, annual concentrations exceeding 0.13 ug/l upstream and 0.24 ug/l downstream from Kokomo were present. Data for 1979 and 1980 show upstream values of 0.12 ug/l and 0.125 mg/l, respectively, and downstream values of 0.150 mg/l and 0.142 mg/l, respectively.

Significant reductions of total copper in Wildcat Creek were recorded between 1974-1978. Discharges from the area had increased the copper loadings of Wildcat Creek to an annual concentration of 80.0 ug/l. By 1978, a 75 percent reduction had been recorded.

Until 1978, when concentrations declined to acceptable levels, copper was found to be in compliance only 30 percent of the time with violation values ranging from 30.0 ug/l to 210 ug/l. Data for 1979 and 1980 show further reductions especially upstream of Kokomo.

Chemical data generally indicate improving water quality for fish and aquatic life. The potential for partial-body contact recreation is severely limited, especially downstream from the City of Kokomo. At this point, coliform bacteria counts exceeded State standards in 63 percent of the samples between 1974-1978, as compared to a one percent violation rate at a station upstream of Kokomo. A large increase in bacterial counts is produced in the Kokomo area.

Present bacterial conditions below Kokomo preclude using Wildcat Creek for recreational use. Data for 1980 shows no improvement.

The next major tributary to the Wabash is the Tippecanoe River. It originates near Warsaw, Indiana, in Kosciusko County, and flows south-southwest to Lake Shafer in White County. From Lake Shafer, the Tippecanoe River continues its southerly flow to its confluence with the Wabash River near Delphi, Indiana. Water quality monitoring was discontinued at Delphi in 1970, and not resumed until 1976. Consequently, previous data from the State's Fixed Station monitoring records are limited. Since 1976, annual average dissolved oxygen concentrations have remained above 10.0 mg/l and have not declined below 5.0 mg/l at anytime. Fecal coliform data for 1979 and 1980 show geometric mean levels of 52/100 ml and 48/100 ml, respectively.

Sugar Creek is another tributary of the Wabash. The stream originates in southwestern Tipton County and flows in a southerly direction through the City of Crawfordsville to its confluence with the Wabash River in Parke County. Prior to this confluence, Sugar Creek has an estimated seven-day, once-in-ten-year low flow of 21 cubic feet per second. Data obtained from Indiana's Fixed Monitoring Station downstream from Crawfordsville indicate good water quality for fish and aquatic life. Dissolved oxygen levels for 1974-1978 showed a five-year mean concentration of 11.4 mg/l. At no time did levels fall below 5.0 mg/l. In fact, even during summer low flow periods, dissolved oxygen concentrations have been at least 3.0 mg/l above State minimum requirements. Data for 1979 and 1980 show continued high levels. Good water quality is also indicated by the low concentrations of ammonia. No samples taken between 1974-1978 violate the State's 0.05 mg/l threshold level. The highest concentration of ammonia on record (0.02 mg/l) occurred in 1974. Since that time, reductions have been achieved to further enhance water quality for fish and other aquatic life. During each period April through October of 1974 to 1978, coliform bacteria has complied with these standards in 62 percent of the samples, and averaged no more than 975/100 ml. Sugar Creek recorded 93 percent compliance with partial-body contact requirements. The bacterial quality seems fairly good. Data for 1979 and 1980 show geometric mean concentrations of 256/100 ml and 201/100 ml, respectively.

The final major stream to contribute major flow to the Wabash River is the Patoka River. The stream originates in the western portion of Washington County, and flows west to the Patoka Reservoir near Jasper, Indiana. From the Reservoir, the Patoka River continues its westerly flow to its confluence with the Wabash River near Patoka, Indiana.

Indiana has two Fixed Station Water Quality Monitoring Stations on the Patoka River. The first is located immediately downstream from Jasper, Indiana, and the second, 33 miles upstream from the Wabash River near Oakland City in Gibson County. Both stations indicate a five-year average dissolved oxygen concentration of 7.3 mg/l. A reduction of average dissolved oxygen occurred at each station from 1974 to 1978. In 1979 and 1980, levels at Jasper increased, but remained fairly constant at Oakland City.

Cyanide concentrations complied with the Federal criteria in 62 percent of the samples. Prior to discontinuing sampling in 1977, cyanide concentrations averaged 22.0 ug/l with the more severe violations occurring in 1974. Between 1974 and 1977, cyanide concentrations were reduced by over 85 percent. Data for 1979 and 1980 show no problems as levels remain at or below .005 mg/l.

The bacterial quality of the upstream portions of the Patoka River appear to be lower than in other areas. Near Jasper, standards for partial-body contact recreation were met in only 58 percent of the surveys up to 1978. Downstream, near Oakland City, improvement has occurred. Geometric mean values declined in 1979 and in 1980.

As the Patoka River progresses downstream, a reduction of coliform bacteria occurs. The bacterial levels in the vicinity of Jasper still preclude stream uses for partial-body contact recreation much of the time.

In conclusion, some water quality problems exist in the Jasper area, but data indicate that the bacterial quality of the Patoka River improves enough to meet partial-body contact recreational criteria before joining the Wabash River.

The Kankakee River Basin

General Assessment

The water quality of the Kankakee River is good. The river is an excellent habitat for wildlife, fish, and other aquatic life as well as a superior recreational resource. In the past, the only water quality limiting factor within this stream has been an unidentified source of mercury near its headwaters. The extent of this concentration was not severe enough to cause toxic problems. Data for 1979 and 1980 do not indicate that a mercury problem still exists.

Technical Assessment:

The Kankakee River Basin lies directly south of the Lake Michigan Basin, southwest of the St. Joseph Basin and drains approximately 3,101 square miles throughout portions of northwestern Indiana. Principal streams located within this basin include the Kankakee River, the Iroquois River, Yellow River, and Cedar Creek. Most of the available water quality data are for the Kankakee River. All other streams have sufficient water quality to support their designated uses.

The headwaters of the Kankakee River originate in a marsh located near South Bend, Indiana. The flow is directed in a south-southwest direction across Indiana into Illinois where it joins the Illinois River. Flow measurements indicate that the annual seven-day, once-in-ten-year low flow is 24 cubic feet per second at LaPorte County, but further downstream at Shelby, Indiana, the flow of the Kankakee River increases to 403 cubic feet per second as an annual seven-day, once-in-ten-year low flow.

Water quality data from the headwaters area of the Kankakee River are very limited. In 1978, the State initiated its continuous sampling program south of the State Fish and Wildlife area near Kingsbury, Indiana. Data as of the last writing were limited to only one calendar year. There appeared to be very few problems in the headwaters region of the Kankakee River. Dissolved oxygen concentrations were well above State standards. Annually, dissolved oxygen averaged greater than 8.0 mg/l in 1978, 1979, and 1980, and at no time declined below 6.4 mg/l. The only significant limiting factor was mercury contamination from an undetermined source. The previous U.S. EPA criterion specified that mercury concentrations should not exceed 0.05 micrograms per liter (ug/l). Data indicate this Federal criterion has been complied with only 30% of the time in 1978. At this location, mercury concentrations averaged 0.26 ug/l with a mean of 0.33 ug/l in 1978. Data for 1979 and 1980 show annual averages of 0.13 mg/l and 0.118 mg/l, respectively, indicating a downward trend since 1978. In 1979, 7 out of 10 samples showed less than detectable levels of mercury. In 1980, 7 out of 11 samples were less than detectable.

Similar water quality conditions appear further downstream on the Kankakee River at Shelby, Indiana. Dissolved oxygen concentrations are well above State minimum standards. From 1978 to 1980 dissolved oxygen was measured at annual averages of greater than 8.3 mg/l, and at no time fell below 6.4 mg/l. The maximum concentration for total ammonia during 1978 was 0.30 mg/l. In 1979, the annual average was 0.11 mg/l, and in 1980, 0.14 mg/l.

Some detectable mercury concentrations also appear at this downstream location. In particular, water quality in the Kankakee River at Shelby complied with the Federal mercury criterion in only 30% of the surveys in 1978. The highest concentration, 1.2 ug/l, was reported during June 1978. Collectively, mercury concentrations averaged 0.41 ug/l during 1978. In 1979 and 1980, concentrations averaged 0.15 ug/l and 0.127 ug/l, respectively.

Coliform bacteria concentrations remained within State standards in 80% of the samples in 1978. In a total of 10 samples, only two were found in excess of 2,000 organisms per 100 milliliter of water. In 1979 and 1980, geometric mean fecal coliform levels were 844/100 ml and 1,726/100 ml, respectively, upstream, and 316/100 ml and 219/100 ml, respectively, downstream at Shelby.

Whitewater River Basin

General Assessment:

Both branches of the Whitewater River support a diversity of fish and other aquatic life. Dissolved oxygen concentrations fell below minimum levels only once in the West Fork of the Whitewater River from 1974 to 1980. No chemical constituent concentrations were recorded that were toxic to fish and aquatic life. The bacterial quality is better in the East Fork than in the West Fork. The West Fork of the Whitewater River does not regularly comply with the bacteriological standards for recreational waters.

Technical Assessment:

The main stem of the Whitewater River is formed by the confluence of its East Fork and West Fork near Brookville, Indiana. From this point, the Whitewater River flows southeast prior to leaving the State in northeastern Dearborn County. At the confluence of the two forks, the Whitewater River has a measured seven-day, once-in-ten-year low flow of 86 cubic feet per second.

The West Fork of the Whitewater River originates in southwestern Randolph County and flows south to its confluence with the East Fork at Brookville, Indiana. Water quality data indicate a very good environment for fish and aquatic life. Over a three-year period (1976-1978), dissolved oxygen concentrations averaged 10.5 mg/l, with only one measurement below minimum State standards. Data for 1979 and 1980 also show high DO levels with averages at 10.6 mg/l in 1979 and 9.9 mg/l in 1980.

Partial-body contact criteria was met in 62% of the samples in (1976-1978). Data for 1979 and 1980 show geometric mean levels of 131/100 ml and 786/100 ml, respecitvely.

The East Fork of the Whitewater River originates north of Richmond, Indiana, and flows south into the Brookville Reservoir. The regulated discharge from this impoundment travels only a short distance until its confluence with the West Fork of the Whitewater River. The data indicate that a very good quality of water is entering Brookville Reservoir. Dissolved oxygen concentrations were at no time below either average daily requirements or minimum State standards. Over a three-year period (1976-1978) dissolved oxygen averaged approximately 10.0 mg/l. In 1979, DO averaged 11.0 mg/l. In 1980, it averaged 9.6 mg/l. Upstream of the reservoir, the East Fork of the Whitewater River is designated for partial-body contact recreation. Data from 1976 to 1978 indicate that the State criteria for coliform organisms is met 87% of the time. The geometric mean concentration was 297/100 ml in 1979 and 269/100 ml in 1980.

The Whitewater River, has sufficient water quality to support its present designated uses.

East Fork White River Basin

General Assessment:

Data since 1974 indicate the water quality of the East Fork White River continues to improve. Sufficient dissolved oxygen is present to support a diverse aquatic community. Several factors create localized pollution problems, but these local problems are being resolved.

Technical Assessment:

The East Fork of White River is located in south central Indiana. It originates at the confluence of the Driftwood and Flatrock Rivers north of Columbus, Indiana. Its 190-mile course takes a southerly direction for about 20 miles to Seymour where it then takes a westerly direction to its confluence with the West Fork of White River near Petersburg, Indiana.

The dissolved oxygen concentrations are high and rarely fall below State minimum standards. At each survey location, an increase of available dissolved oxygen was recorded between 1974-1978. Dissolved oxygen values have averaged approximately 10.0 mg/l over that five-year period.

In 1979, DO concentrations averaged 9.6 mg/l at Williams, 9.7 mg/l at Bedford, and 9.7 mg/l at Seymour. At no time did samples show a value lower than 6.6 mg/l at any of these locations. Data for 1980 showed yearly averages of 10.6 mg/l at Petersburg, 10.1 mg/l at Williams, 10.6 mg/l at Bedford, and 10.0 mg/l at Seymour. At no time did samples show a value lower than 5.2 mg/l. That low was recorded at Williams in August 1980.

The only potential limiting factor for the East Fork White River is the concentration of total copper found upstream of Seymour. Copper concentrations exceeding 20.0 ug/l are critical factor for fish and aquatic life. According to the data, copper concentrations have been less than 20.0 ug/l in 67% of the samples taken between 1974-1978. Although the average five-year concentration measured 197.0 ug/l, an overall 94% reduction was realized during this period to indicate improvement in water quality. Later data in 1979 and 1980 show most samples with levels at or below the 0.020 mg/l detectable limit.

At Williams, total instream cyanide exceeded Federal standards in 31% of the measurements taken between 1974-1978. Average concentrations during this period are reported to be 6.0 ug/l. This is 1.0 ug/l over the U.S. EPA criterion for freshwater aquatic life. Higher concentrations persisted early in the survey period. All samples collected in 1979 and 1980 show values less than the minimum detectable level of 0.005 mg/l.

The bacterial quality of the East Fork of the White River meets State criteria for partial-body contact use most of the time. The coliform bacteria concentrations have never fallen below 75% compliance during any year from 1974 to 1978. Except for a 12% and 10% increase of coliform bacteria between Seymour and Williams in 1978 and 1974, respectively, each year showed reductions of instream bacteria concentrations. The bacterial quality is improving. The highest geometric mean value recorded at any of the monitoring stations in either 1979 or 1980 was 337/100 ml at Williams in 1979.

Three municipalities utilize the East Fork of White River as a potable water supply. State criteria requires that, as a monthly average, total coliform bacteria shall not exceed 5,000/100 ml, nor exceed this number in more than 20% of the samples examined during any month. Data indicate that between each survey point, State criteria were met between 72% to 79% of the time from 1974-1978. During this period mean concentrations of coliform bacteria did not exceed 7,000/100 ml, but rather ranged between 4,477/100 ml to 6,963/100 ml. Data also indicate a marginal reduction of total coliform bacteria in the East Fork of the White River as it flows downstream, and an overall reduction at each survey point throughout this five-year period. Therefore, with respect to fecal coliform, it seems that the East Fork of the White River is an acceptable water supply source for the communities of Seymour, Bedford, and Mitchell.

The Big Blue River, a tributary to the East Fork of White River, originates north of New Castle, Indiana, in Henry County and flows southwest through Rush and Shelby Counties to its confluence with Sugar Creek near Edinburg. At Shelbyville the seven-day, once-in-ten year low flow is measured at 0.5 cubic feet per second.

The State Board of Health has located two Fixed Monitoring Stations along this stream. The first is located near Spiceland, below the City of New Castle. This stream reach was originally designated as a "water quality" segment, suggesting that water quality was not meeting standards, and was not expected to meet standards even after the application of effluent limitations. Data show indicates that the river is a good habitat for fish and other aquatic life. Dissolved oxygen concentrations from 1976 to 1978 met minimum standards in 97% of the measurements while averaging 8.5 mg/l. In only one instance was ammonia found approaching the States critical threshold level. All cyanide levels measured in 1979 and 1980 were at or below the minimum level of 0.005 mg/l.

The bacterial quality of Big Blue River is good. Specifically, the State's standard for partial-body contact recreation was met 84% of the time in a three-year period. Bacterial levels exceeding the State standard of 2,000/100 ml have ranged from 2,800/100 ml to 70,000/100 ml. Minor coliform problems were recorded in 1978 yielding a 30% violation rate. The geometric mean concentrations for 1979 were 483/100 ml at Edinburg and 4,284/100 ml at Spiceland. Levels for 1980 were 1,348/100 ml and 6,292/100 ml at these stations, respectively. Data at Edinburg indicate generally good water quality. Between 1974-1978, dissolved oxygen concentrations have maintained average levels near 10.0 mg/l, and at no time have they declined below State minimum requirements. Although the overall results of bacterial sampling indicate 70% compliance, the majority of the violations occurred early in the survey period. Between 1974-1978, analysis of 20 samples revealed that 56% exeeded the State fecal coliform bacteria criteria limit of 2,000 per 100 milliliters. Since this time, instream conditions have improved enough to meet partial-body contact recreation standards in 88% of the measurements.

Fecal coliform levels appear to have been the only limiting factor in the Big Blue River.

The second tributary to impact and supplement the flow of the East Fork of White River is the Muscatatuck River. It originates in western Jefferson County and flows west to its confluence with the East Fork of White River near the Washington-Lawrence County line. Near Austin, the seven-day, once-in-ten year low flow is estimated to be 0.5 cubic feet per second.

Water quality data collected at this location indicate good water quality for fish and aquatic life and for partial-body contact recreation. Between 1974 and 1978, average dissolved oxygen concentrations maintained levels between 7.4 mg/l to 8.3 mg/l. Although average daily standards (5.0 mg/l) for this parameter were violated about 20% of the time, minimum standards were met in 100% of the samples.

Data for 1979 and 1980 show DO levels averaging 7.0 mg/l and 6.7 mg/l, respectively.

Cyanide concentrations in the Muscatatuck River exceeded U.S. EPA standards in 36% of the samples. Data show a 97% reduction between 1975-1976. Cyanide levels were in compliance with Federal criteria in 1975 and sampling was discontinued.

During the 1974-1978 period, coliform bacteria counts were in compliance with State Water Quality Standards 83% to 88% of the time. The coliform bacteria standard for partial-body contact recreation was generally exceeded in only two months of any given year, with violations limited to summer low-flow periods. Data for 1979 and 1980 show geometric mean levels of 213/100 ml and 384/100 ml, respectively.

Salt Creek is the final stream in this basin where the State Board of Health maintains a Water Quality Monitoring Station. Salt Creek flows into Monroe Reservoir and, continuing its flow below the dam, joins East Fork of White River southwest of Bedford. Near Peerless, Indiana, the U.S. Geological Survey estimates that the annual seven-day, once-in-ten year low flow is 1.3 cubic feet per second.

At Oolitic, data from Salt Creek indicate generally good water quality. In a five-year period (1974-1978), dissolved oxygen concentrations maintained levels well above State minimum standards. This is evidenced through 98% compliance with the State's 4.0 mg/l minimum requirement. A marginal 12% reduction of available dissolved oxygen occurred during this period. In 1974, the annual average was reported to be 9.5 mg/l, and in 1978, the annual average was 8.3 mg/l. Data for 1979 and 1980 show averages of 8.7 mg/l and 8.3 mg/l, respectively.

No recorded pH measurements have fallen below 6.2 or risen above 8.3. No critical levels of nitrate/nitrites, chlorides, or sulfates were recorded that degrade Salt Creek's use as an industrial or public water supply. Dissolved oxygen levels have been sufficient to support aquatic life. No recorded levels of ammonia have exceeded State criteria. In the five-year period (1974-1978), State coliform bacteria standards for partial-body contact were violated in 27% of the measurements. Data for 1979 and 1980 show geometric mean fecal coliform levels of 266/100 ml and 200/100 ml respectively.

The major continuing water quality concern in Salt Creek continues to be levels of PCB in the water column and in the sediment.

West Fork White River Basin

General Assessment:

The general water quality of the West Fork White River is good except for certain reaches downstream of the metropolitan areas of Muncie, Anderson, and Indianapolis. Discharges at Indianapolis affect the water quality to some extent as far downstream as Spencer. A notable decrease in dissolved oxygen concentrations and a corresponding increase of coliform bacteria occur downstream from each of these municipalities. Concentrations of phenols and mercury still indicate water quality problems in some areas of the West Fork of White River.

Technical Assessment:

The West Fork of White River is the second largest drainage area in the State of Indiana. It flows approximately 350 miles through Indiana from the headwaters east of Winchester to its confluence with the East Fork of White River near Petersburg. The flow is west approximately 85 miles through the Muncie-Anderson planning areas. Near Noblesville, the flow turns to a south-southwest course for almost 190 miles through Indianapolis and Martinsville to its confluence with the East Fork of White River south of Washington, Indiana. At Petersburg, Indiana, 48 miles upstream from the Wabash River, the seven-day, once-in-ten-year low flow is estimated at 700 cubic feet per second (cfs).

Only a few Fixed Water Quality Monitoring Stations are located on tributary streams of the West Fork White River. These streams and their seven-day, once-in-ten-year low flows are: Fall Creek (20 cfs), Eagle Creek (20 cfs), Walnut and Mill Creek southwest of Indianapolis (0.5 cfs and 0.8 cfs, respectively) and the Eel River (18 cfs).

A total of thirteen Fixed Water Quality Monitoring Stations are located on the West Fork of White River. Dissolved oxygen concentrations for the period 1976-1980 are adequate to maintain aquatic life. The Muncie-Anderson metropolitan districts and the City of Indianapolis significantly impact and reduce the available dissolved oxygen in White River. Between 1976 and 1980, waste discharges from the City of Indianapolis caused a 2 to 3 mg/l loss of dissolved oxygen in the West Fork of White River. The stream recovers several miles downstream, and in the Spencer area dissolved oxygen concentrations usually remain above 8.0 mg/l.

There is sufficient dissolved oxygen within the stream to support aquatic life except below Indianapolis during certain warm weather periods.

Other instream constituents that may adversely affect fish and other aquatic life are cyanide, mercury, phenols, and un-ionized ammonia. Monitoring stations upstream of Indianapolis show that levels of these constituents are at or below detectable limits.

No significant changes in cyanide concentration appear over time except the reductions from annual average 1976 concentrations at Yorktown and Anderson. Overall, water quality for this parameter is fairly constant.

It appears that the overall cyanide situation in West Fork White River has improved somewhat during a five year period. Each station shows a decrease in cyanide with many samples displaying levels lower than minimum detectable limits.

Mercury levels have shown an increase from 1976 to 1980, with noticeable peaks in 1978. No explanation is available, but it is significant that levels have remained high in 1979 and 1980 relative to pre-1978 data. This warrants further investigation. The higher levels all along the watercourse could reflect a non-point source such as a new or increased use of mercury-containing agricultural chemicals or fungicides perhaps introduced in 1978.

Phenol analyses are incomplete over the five-year period, but those data available show values ranging from .004 mg/l to .018 mg/l. Overall, there appears to be no significant trend upward or downward.

Lead concentrations are fairly stable over time, but a significant reduction is evident in 1980 figures. As a general instream limit, .02 mg/l was exceeded at most stations in 1979, but average values were well below that in 1980.

One designated use for the West Fork of White River is partial-body recreation as defined by State coliform bacterial standards. Throughout the five-year period, fecal coliform levels violate the established standard below Muncie and Indianapolis. Fecal coliform levels were highest in 1979 downstream from Muncie and Indianapolis.

There are only a few major streams augmenting the flow of the West Fork of White River. The first of these streams is Eagle Creek at Indianapolis. The headwaters of Eagle Creek originate in Boone County, and flow in a southerly direction to Eagle Creek Reservoir in Marion County. The regulated discharge from this multi-purpose impoundment continues its flow to White River.

Upstream of the reservoir, there is sufficient dissolved oxygen to support aquatic life. At no time have recorded dissolved oxygen concentrations fallen below either average daily requirements or minimum State standards. Through this survey period, dissolved oxygen maintained an average concentration greater than 10.0 mg/l. Cyanide concentrations show a reduction in time with values at or below the detectable limit of .005 mg/l in 1979 and 1980. The bacterial quality above the reservoir is also very good. Between 1976-1980, fecal coliform bacteria counts complied with standards.

Prior to its confluence with White River, water quality in Eagle Creek declined. Dissolved oxygen, while still maintaining levels above state standards, averaged less than 10.0 mg/l during this five-year period. Presently, the only prohibitive instream constituent is copper. Between 1976-1980, copper values complied with the 20.0 ug/l criterion only in part. Annual average values were 0.32 mg/l in 1979 and .040 mg/l in 1980. Cyanide has been found in the past to be a water quality problem in this area. The EPA Recommended Criterion of 3.5 ug/l has been exceeded in a number of samples taken between 1976-1980. A reduction has been achieved during this period as all values in 1980 were less than 5.0 ug/l.

The water quality with respect to fecal coliform partial-body contact recreational standards is acceptable. Of particular concern are the 1978 measurements that violated instream limitations 64% of the time ranging from 7,300/100 ml. to 540,000/100 ml. Eagle Creek was suitable for partial-body contact recreation below Eagle Creek Reservoir on more occasions in 1980 than in 1979.

Another stream that augments White River's flow within Marion County is Fall Creek. It originates in the southwestern portion of Madison County and flows into Geist Reservoir at the Marion-Hamilton County line. The regulated discharge from this multi-purpose impoundment continues its southerly flow to White River. The quality of water discharged from Geist Reservoir maintains high levels of dissolved oxygen. At no time have concentrations fallen below the minimum 4.0 mg/l limit, and generally levels above 9.0 mg/l have been maintained. As is the case for Eagle Creek, there are several constituents that may inhibit the aquatic life of Fall Creek below Geist Reservoir. Between the latter part of 1974 and early 1978, when sampling was discontinued, phenol concentrations exceeded the U.S. EPA, 1.0 ug/l limit in 75% of the cases. During this period the average phenol concentration was 3.7 ug/l with violations ranging from 2.0 ug/l to 10.0 ug/l. Mercury also appears to be a problem with concentrations ranging from 2.0 ug/l to 10.0 ug/l. Although data for 1978 alone indicated an average mercury concentration of 0.20 ug/l, concentrations as high as 0.50 ug/l have been recorded. Values averaged 0.21 ug/l in 1979 and were reduced to 0.167 ug/l in 1980. Mercury concentrations for this portion of Fall Creek appear high and surveillance should continue.

The Marion County Health Department posted Fall Creek for no swimming, wading, or fishing in 1981 due to high coliform counts. However, ISBH dry weather sampling data indicate that Fall Creek appears to maintain sufficient bacterial quality to support partial-body contact recreation, which <u>is</u> its designated use. Geometric Mean Values for fecal coliform were measured at 1059/100 ml in 1979 and 658/100 ml in 1980.

The remaining stream in the drainage system for which ambient monitoring data are available is Mill Creek in Putnam County. It originates north of Stilesville, Indiana, and flows south-southwest to Cataract Lake. Data from Indiana's Fixed Monitoring Stations at Devore and Stilesville indicate dissolved oxygen concentrations have maintained levels sufficient to support aquatic life. The bacterial quality occasionally does not comply with standards. During most instances violations occurred during summer low-flow periods.

The St. Joseph River Basin

General Assessment:

The St. Joseph River has been designated for two different instream uses; aquatic life and recreation. Dissolved oxygen concentrations are adequate to maintain fish and aquatic life. The once high cyanide levels have been reduced during this survey period. The St. Joseph River does have problems maintaining desirable bacterial levels for full recreational benefits from April through October, inclusive. During the remaining months, when standards for partial-body contact recreation apply, bacterial concentrations demonstrate better instream compliance.

The major tributary stream--the Elkhart River, also maintains sufficient water quality for fish and aquatic life. Like the St. Joseph River, coliform bacteria concentrations periodically rise above State limitations.

Technical Assessment:

The St. Joseph River Basin is located in the far north and northeastern portion of Indiana. The major streams draining this area include the St. Joseph River, the Elkhart River, and Pigeon Creek in LaGrange County. The largest stream is the St. Joseph River, with a seven-day, once-in-ten-year low-flow of 760 cubic feet per second. Its headwaters originate in the State of Michigan. It flows south, entering Indiana north of Bristol. At South Bend the river turns north and returns to Michigan. The major tributary to this stream is the Elkhart River joining the St. Joseph River near Elkhart, Indiana.

The water quality of the St. Joseph River is monitored at three locations in Indiana. The first Fixed Station is located at Bristol, Indiana, the second at Osceola, and the last, near South Bend, monitor the stream's characteristics prior to its return to Michigan. Data indicate high levels of dissolved oxygen in the St. Joseph River. The stations at Bristol and South Bend, from 1974 to 1978, show a mean dissolved oxygen average of 10.7 mg/l. At no time during that period through 1980 did dissolved oxygen decline below minimum State standards. Another parameter that maintains acceptable levels for a good aquatic environment is un-ionized ammonia. In only one instance, in 1977, was this critical level (0.05 mg/l) surpassed in the South Bend planning area.

Some improvement has been noted for instream concentrations of cyanide. Prior to 1977, cyanide levels near South Bend, Indiana, were reported to exceed the U.S. EPA standards in 59% of the samples. Because of control measures to abate cyanide discharges, cyanide concentrations reached 90% compliance with Federal criteria between 1977 and 1978. During the same time period cyanide levels upstream near Bristol achieved 45% compliance until 1977. Violations have been reduced, and 1978 levels have complied with Federal criteria in more than 80% of the samples. Annual average levels for 1979 were .005 mg/l at South Bend, and in 1980, .005 mg/l at both South Bend and Bristol.

In the period 1974-1978, total mercury at South Bend has been reported to comply with Federal standards in 73% of the samples. Prior to the spring of 1976, mercury averaged only 62% compliance with a mean average concentration of 0.30 mg/l. In 1976, 8 out of 12 samples were less than the minimum detectable level of 0.1 ug/l, instream concentrations having been reduced. In 1978, data again indicated a trend toward noncompliance with Federal criteria as only 2 samples in 10 were less than the minimum detectable level of 0.1 ug/l. Average concentrations were 0.30 ug/l, and compliance with Federal criteria occurred in only 45% of the samples. Similar problems were in evidence upstream, but there was 88% compliance at the Bristol monitoring station. In 1979, mercury averaged 0.39 ug/l at South Bend with only 3 out of 10 samples being less than the .1 ug/l minimum detectable level. Levels were reduced in 1980 to an annual average of 0.11 ug/l at South Bend and 0.12 mg/l at Bristol. At South Bend, in 1980, 7 out of 10 samples were below the minimum detectable level of 0.1 ug/l.

The St. Joseph River has been designated for whole-body contact recreation. State regulations require that fecal coliform concentrations should not exceed a geometric mean of 400 organisms per 100 milliliters in more than one sample per month during the period April through October. For the remainder of the year (January-March and November-December) the fecal coliform concentration should not exceed 2,000/100 ml in more than one sample per month. Data indicate that whole-body contact recreation standards at South Bend have been met in only 15% of the measurements taken from April through October of each year. Upstream at Bristol, coliform bacteria has exhibited a 92% compliance rate during this same period. The general range of coliform bacteria levels not violating State limitations fall between 10/100 ml to 330/100 ml. Even though the St. Joseph River often meets criteria for whole-body contact recreation, the bacterial contamination within the South Bend area continues to warrant attention.

Data for 1980 shows a geometric mean fecal coliform level of 726/100 ml at South Bend, 40/100 ml at Bristol. This is an improvement over 1979 data at South Bend, where levels were at 986/100 ml.

The Elkhart River ($7Q_{10}$ - 76 cfs) is the only major tributary to the St. Joseph River. Its headwaters originate in the glacial outwash areas near Waldron Lake. It flows in a north-northwestern direction to its confluence with the St. Joseph River at Elkhart, Indiana.

The water quality of the Elkhart River generally is very good. Data indicate that no parameter fails to attain standards for fish and aquatic life. The bacterial quality data does show problems in maintaining recreational standards. Specifically, the Elkhart River is required to meet standards applicable for partial-body contact recreation. Data collected prior to its confluence with the St. Joseph River show fecal coliform concentrations are in compliance in 63% of the samples. In 21 measurements, the fecal coliform levels have ranged between 2,100/100 ml to a maximum of 24,000/100 ml. Data for 1979 and 1980 show geometric mean fecal coliform levels of 1,214/100 ml and 1,104/100 ml, respectively.

Ohio River*
Existing Water Quality Conditions

Ohio River Basin Conditions

The Ohio River basin drains an area of 203,900 square miles which includes portions of 14 states. The mainstream Ohio River is formed at Pittsburgh by the confluence of the Allegheny and Monongahela Rivers and flows generally southwest for 981 miles to join the Mississippi River at Cairo, Illinois. The first miles lie within Pennsylvania: for the remainder of its length, the river serves as the state boundary between Ohio, Indiana, and Illinois on the north and West Virginia and Kentucky on the south. Major tributaries, in addition to the Allegheny and the Monongahela, include the Beaver River in Pennsylvania, the Muskingum, Scioto, and Great Miami in Ohio, the Kanawha River in West Virginia, the Big Sandy in West Virginia and Kentucky, the Licking, Green, Cumberland, and Tennessee Rivers in Kentucky, and the Wabash River in Indiana and Illinois. Major population centers along the Ohio include: Pittsburgh, Pennsylvania; Wheeling, Parkersburg, and Huntington, West Virginia; Ashland and Louisville, Kentucky: Portsmouth and Cincinnati, Ohio; and Evansville, Indiana.

A series of 20 locks and dams is operated by U.S. Army Corps of Engineers on the Ohio River to allow navigation year round by barges. The Ohio is a vital link in the inland navigation system of the United States. Materials transported include coal, petroleum products, mineral aggregates, grains, chemical fertilizers, iron ore, and iron and steel. Total tonnage transported on the river has shown steady growth from about 20 million tons in the late 1930's to nearly 140 million tons in the late 1970's. The River also serves as a primary source of potable water for over three million people. A total of 51 entities have water intakes on the River for potable use. Of this number, 34 are operated by public or private water utilities while the balance are operated by industries which use potable water in their plants. Some of these utilities use these intakes as secondary sources, but the larger cities rely almost totally on the river for their supply. In addition, over 100 industries draw water directly from the Ohio for process use. This total includes use by power plants for cooling water. Hydropower facilities are either in place or planned at each of the navigation dams.

Along with the municipal and industrial uses, the Ohio supports a great deal of recreation. Most recreation takes place from power boats, including fishing, water skiing, and swimming. There are no formally designated bathing beaches on the river, but swimming from the shore does take place. The river supports a variety of warm water fish species.

Water Quality Standards

Each of the states along the Ohio River has adopted water quality standards to protect the uses of its streams, lakes, and other waters. These standards include numerical criteria for various physical, chemical,

*From Assessment of Water Quality Conditions Ohio River Mainstream 1980-81. ORSANCO, 1982 and bacterial parameters. A set of recommended criteria has been adopted by the Ohio River Valley Water Sanitation Commission; these have been incorporated to varying degrees by the states in their water quality standards for the Ohio River. For some parameters, one or more of the states have adopted criteria which are more stringent than those recommended by the commission. Some states have also adopted criteria for parameters for which the commission has made no recommendation.

It is one of the goals of the commission that state water quality standards for the Ohio River should be compatible. The following definition of compatibility has been adopted by the commission's Technical Advisory Committee:

A state's water quality standards as they impact this mainstream of the Ohio River will be considered compatible with those of the other states of the ORSANCO Compact when:

1. The standards do not preclude the attainment of any existing or potential use and standards of any reach of the Ohio River within the jurisdiction of another state which has been formally designated by that state,

2. The standards do not require control programs for pollution sources (point and nonpoint) more stringent than those needed to comply with the standards of the state in which the source is located, and

3. The standards meet the intent of specifying criteria consistent with designated uses within the context of coordinating management of water quality.

Water quality standards for the Ohio River are being reviewed by the Criteria Conflicts Committee, a work group of the Technical Advisory Committee, in light of this definition of compatibility. The Criteria Conflicts Committee consists of representatives from each of the member states and the U.S. EPA.

Monitoring Programs

The commission has four distinct monitoring programs viz; electronic monitors, a manual sampling system, water users data and the Organics Detection System. Water quality monitoring in the Ohio River Basin is conducted by numerous federal, state, and local agencies. On the Ohio River itself, the commission serves as a lead agency, conducting a monitoring program to meet the needs of the various agencies. Detailed information on the rationale and makeup of the commission program is contained in the document *Water Quality Monitoring Strategy for the Ohio River and Lower Reaches of Major Tributaries* (revised draft, 1981). The overall program consists of the following components: fixed station monitoring (including continuous and periodic sampling), biological monitoring and intensive surveys.

Fixed Station Monitoring

The fixed station network consists of 36 sites, 22 on the mainstream and 14 on the lower reaches of major tributaries. Of the 36 sampling sites, 21 are in the U.S. EPA National Network. Most of these are sampled monthly and analyzed for 25 parameters (manual system). For some of the 25 parameters, analyses are performed only on a quarterly or seasonal basis. At 21 of these locations, automatic monitors provide hourly analyses of temperature, pH, dissolved oxygen, and specific conductance. Fourteen monitors are operated on the Ohio River and seven on major tributaries. (An eighth tributary monitor, on the Great Miami River at Elizabethtown, was discontinued in 1981.) Daily monitoring by the Organics Detection System for purgeable, halogenated organic compounds takes place at 11 locations (3 tributary, 8 mainstream); four of these locations correspond to fixed stations. Sampling and analytical procedures for these stations are contained in the publication ORSANCO Quality Control Assurance Program (April 1981). Additional data are received from water utilities along the river.

Biological Monitoring

Lock Chamber studies have been conducted at various times since 1957 and annually since 1975 to evaluate fish populations. In addition, both fillets and whole fish have been analyzed for heavy metals, pesticides, and other organics (primarily PCBs). These studies have been cooperative efforts, involving numerous state and federal agencies with commission staff serving in a coordinating role.

Intensive Surveys

The monitoring strategy also calls for intensive surveys on an "as needed" basis. Conduct of such surveys is similar to that of the lock chamber studies, with participation by appropriate state and federal agencies and commission staff serving in a coordinating role. Reconnaissance for a survey was begun in November 1981, to study phenolics levels on the upper river (Mile Point 40.0 to 102.4). Participants included the West Virginia Division of Water Resources, the Ohio Environmental Protection Agency, and the U.S. Environmental Protection Agency, Region III (Wheeling Field Office). This activity will continue into 1982, and will be expanded to include the Pennsylvania portion of the river with participation by the Pennsylvania Department of Environmental Resources.

Stream Flow

Historic records of stream flow at various locations on the Ohio River and its major tributaries indicate a normal pattern of lowest flows in September, followed by monthly increases until highest levels are reached in March, then decreases each month until September. In 1980, Ohio River flow was less than normal in two months (February and December); above normal in five months (April, June through September); and close to normal in five months (January, March, May, October, November). In 1981, flow was below normal in three months (January, March, August); above normal in six months (February, May, June, July, September, October): and close to normal in three months (April, November, December). Overall, stream flow was above normal in both years on the Ohio River.

The term "normal" may be somewhat misleading for Ohio River flows. Because of the size of the basin and variations in topography and local weather, relative flows of the tributaries vary much more than that of the main stem. For example, flow at South Heights on the Ohio River (just below Pittsburgh) was essentially normal in April and August of 1981. In April, flow on the Allegheny River was below normal while in August it was well above normal. The reverse situation must have applied to the Monongahela River, since these two tributaries account for essentially all of the Ohio River flow at South Heights. Since the two rivers have significantly different water quality characteristics, these two situations would have a vastly different influence on water quality at South Heights despite the "normal" flow conditions.

Lake Classification Program

General Assessment

Discussions of lake associated problems traditionally deal with lake degradation resulting from cultural pollution and premature aging. Inputs of organic materials and nutrients from municipal, semi-public, and industrial sources; confined feeding operations; agricultural sedimentation, and septic tanks all have the potential for accelerating the eutrophication process in lakes. Not only have these sources caused primary detrimental effects on lakes, often harming fish and aquatic life and producing conditions sometimes hazardous to public health, but they have also contributed to more long-term problems of eutrophication. Excessive organic loadings result in the reduction of the amount of dissolved oxygen available to fish and other aquatic organisms. Excessive nutrient loadings, especially of phosphorus, stimulate the growth of algae. This often triggers a series of longer biochemical processes that also reduce the dissolved oxygen concentration in lakes. The continuing, accelerated growth, death, decomposition and sedimentation of plant material physically decreases the depth of most lakes. The long-term overproduction of plant life and ultimate reduction of lake volume form the basis of accelerated lake eutrophication.

The State has actively sought pollution control measures for lakes for many years. Point source discharges are being controlled through enforcement of Stream Pollution Control Board Water Quality Standards. Confined feeding operations are being monitored through the Confined Feeding Control Law. Agricultural sedimentation and erosion will be controlled through implementation of the State's Agricultural Nonpoint Source Strategy. The only potential source that appears to lack effective State-wide control is that from lake-side septic systems. Although the nutrient loading may have been somewhat diminished through the phosphate detergent ban, the input from this type of pollutant still occurs at some locations. One possible reason is that enforcement of the State's on-lot disposal regulation, 410 IAC 6-8, is at the local level. Many places cannot meet the requirements of this regulation generally because of soil limitations, lot sizes, and other factors.

Management of Indiana's Lake Program as far as Federal monies are involved was delegated to Ball State University. Lakes proposed or being studied in priority order are: Cedar Lake, Lake Lemon, Waubee, Lake of the Woods, Hamilton Lake, Eagle Creek Reservoir, Webster Lake, and Tippecanoe Lake.

BonHomme's Index

In accordance with Section 314(a)(i) of the Clean Water Act of 1977 as amended, the State, using BonHomme's Index, has completed its trophic classification of all publicly owned fresh water lakes. The BonHomme Index is a unique trophic index classifying lakes using a system of eutrophy points ranging from 0 to 75. Each lake or reservoir is given a total point count. The higher the point count, the more eutrophic the lake. Generally, points were generated from a compilation of various parameters including: total phosphorus, soluble phosphorus, organic nitrogen, dissolved oxygen (percent saturation at five feet and percent of the measured water column with at least 0.1 ppm dissolved oxygen), light penetration and transmission, and total plankton per milliliter. As it stands, the number of known natural lakes (404) and man-made impoundments (150) which have been classified totals 554 with a surface area of approximately 87,533 acres. The new Patoka Reservoir has not been included. In addition, there are several new, small watershed project impoundments constructed under PL 83-566. Because of their number and undetermined locations, many of these have not been surveyed.

Lakes and man-made impoundments will fall into one of four categories. Class I lakes, covering approximately 47,180 acres within the State, <u>rarely</u> support extensive populations of weeds and/or algae and are usually without a chemical control program. Their existing lake uses become significantly impaired only under unusual environmental conditions. These lakes usually exhibit the highest degree of water quality with an index ranging from 0-25 eutrophy points, and are the least eutrophic. Class II lakes, with an index ranging from 26-50 points, demonstrate a medium quality of water and cover about 28,615 acres in Indiana. These lakes, without a chemical control program, <u>frequently</u> support extensive weed and/or algae growth, but seldom to the extent that one or more of the existing lake uses is significantly impaired. Lakes of the lowest quality (Class III), <u>always</u> support extensive populations of weeds and/or algae which frequently impair one or more of the existing lake uses unless chemical waste control programs are utilized. Class III lakes total 9,190 acres and have a point count ranging between 51-75 (advanced eutrophic).

Class IV lakes consist of small remnant lakes and river flood plain lakes. Remnant or marsh lakes have reached an advanced eutrophic state. Because of their small surface area and/or dissimilarity of characteristics, they cannot be realistically ranked with the larger, deeper lakes in Indiana. These marsh lakes are essentially all that remain of the deep basins of large lakes that have gradually filled in through the eutrophication process. River floodplain lakes, oxbows, and washouts are formed when large rivers, such as the White River and the Wabash River, overflow their banks and cut new channels. They are characteristically rich in phosphorus and nitrogen and they often appear very turbid. During warm weather high turbidity is often caused by the rooting behavior of large populations of carp. Plankton blooms also cause the water to be discolored.

Class IV lakes, totalling approximately 2,448 acres in Indiana, demonstrate similarities in that both remnant lakes and floodplain lakes are used by man for hunting, fishing, and trapping, and they often provide wildlife refuge and natural wetlands. To date, the marginal areas of most remnant and floodplain lakes remain largely undeveloped. The marshy characteristics of the shorelines often limit development of more intensive land uses. These lakes <u>always</u> support extensive populations of weeds and/or algae, however, the <u>existing</u> lake uses are not usually impaired. Access to the open waters of these lakes is often difficult because of the marshy littoral areas, but the main lake uses of hunting, fishing, and wildlife habitat remain unimpaired.

Water Quality Management

In the initial planning for Water Quality Management, the State has developed, through contractual arrangements with Ball State University, a Classification and Management Plan for all publicly owned lakes and reservoirs. Based upon a cluster analysis, this plan has identified seven major lake groupings. Each group contains lakes morphometrically and trophically similar to each other. These groupings are different from the four lake classes listed under the BonHommes Index and should be considered separately.

The cluster analysis utlized three variables: a) lake size (acres), b) mean depth (ft.), and c) BonHomme's Index. Each of these variables is interrelated in evaluating a lake and selecting a cost-efficient management strategy. This cluster technique produced groups of lakes having similar characteristics in terms of the three variables used. Since the type of restoration techniques or management strategy will depend on the lake size, depth, and eutrophic condition, certain restoration techniques will be more appropriate for use on certain of the groups than on others. For example, large lakes require different management or restoration strategies than small ones. Deep lakes require different strategies than shallow lakes. More eutrophic ones (nutrient rich) require different strategies than those that are nutrient poor. A list of the lakes in their various clusters is shown in Table A-2 located in the Appendix.

As a result of this clustering concept, Indiana lakes have been classified into seven groupings:

Group I lakes are characterized by their large surface area and relatively good water quality. Although no restoration techniques are recommended, the primary management strategy would be to curb nutrient input from the immediate shoreline, and also from the entire watershed.

Group II lakes have been characterized in three subgroups. Groups IIA and IIB contain some of the best examples of undisturbed natural lakes in the state. The major strategy for these impoundments should be to maintain and protect present water quality. Group IIC, however, differs in that some degradation of water quality has occurred. Strategy for these lakes may encompass management of nutrient inputs and, in some instances, nutrient inactivation and/or selective discharge may be advised.

Group III consists of large shallow bodies of water that exhibit eutrophic characteristics. Although many of these may be naturally eutrophic, the primary concern should be to prevent further degradation by curbing nutrient input. In more severe cases, possible restoration by macrophyte harvesting and sediment consolidation could be instituted.

Group IV probably contains the majority of problem lakes in the state. Most of these impoundments have such severe water quality problems that recreational use is often impaired. Because specific restoration techniques are area and depth dependent, these lakes have been divided into four subgroups. Although restoration is a major priority, the emphasis on nutrient abatement programs will provide an initial step towards long-range improvement.

Group V consists of shallow lakes, both natural and man-made, that demonstrate high water quality. Management should stress maintenance of present conditions. Because of shallow depths, the degree of protection needed should possibly be greater than those for Groups IIA and IIB.

Group VI lakes demonstrate moderate to advanced eutrophication relative to their intermediate size and mean depths. Although the main management strategy will be to limit nutrient inputs, in some cases selected restoration techniques may be applicable.

Group VII lakes are somewhat similar to Group VI but are shallower. Because of their lower mean depths, a wider range of restoration techniques may be considered. Water quality problems are not usually severe enough to warrant any restoration procedures other than management of nutrient inputs.

State Strategy

The ongoing State point source regulatory control programs, and the implementation of the State's Agricultural Nonpoint Source Control Strategy, both provide a mechanism for the continued protection of lakes. During FY 80-84, the State will increase study efforts in the Clean Lakes Program, but the Federal funding for renovation work is being phased out. Two weaknesses in the program exist: (1) the inability to control shoreline septic disposal systems, and (2) the lack of sufficient funding to provide State and/or a local match for large-scale restoration projects. To maintain and restore the integrity of Indiana lakes, the Stream Pollution Control Board will continue its efforts for point source control programs, confined feeding operations and its implementation of the State's Agricultural Nonpoint Source Control Strategy. Also, the State will pursue the utilization of recommended actions for Group IV lakes. Secondly, lake assessment data and the Basic Limnological Primer will be disseminated to lake property owners and other interested groups to advise them of lake problems, restoration techniques and control measures. Implementation of the restoration or control measures will be based on the local level. Any proposed alternative must be found to be cost-effective and environmentally sound. Lastly, the State will make a comprehensive investigation of all studies relative to septic tank alternatives or system improvements such as chemical addition. If found to be cost-effective, these alternatives will be pursued for implementation.

Grouping of Indiana Lakes by Cluster Analysis

ID No.	Lake	Area	Mean Depth	Index
Group I				
442.	Brookville Reservoir	5260.0	7.4	23
397.	Wawasee (South Basin)	3060.0	22.0	15
379.	Wawasee (Mid-E Basin)	3060.0	22.0	16
380.	Wawasee (SE Basin)	3060.0	22.0	18
197.	Mississinewa Res.	3180.0	17.5	20
198.	Mississinewa Res.	3180.0	17.5	20
199.	Mississinewa Res.	3180.0	17.5	20
202.	Mississinewa Res.	3180.0	17.5	20
201.	Mississinewa Res.	3180.0	17.5	20
200.	Mississinewa Res.	3180.0	17.5	20
205.	Mississinewa Res.	3180.0	17.5	20
204.	Mississinewa Res.	3180.0	17.5	20
203.	Mississinewa Res.	3180.0	17.5	20
219.	Mississinewa Res.	3180.0	17.5	20
218.	Mississinewa Res.	3180.0	17.5	20
196.	Mississinewa Res.	3180.0	17.5	16
Group II	Subgroup A			
55.	Beaver Dam	146.0	22.5	16
444.	New	50.0	17.6	7
209.	Stone	125.0	19.9	6
315.	George	488.0	25.0	9
178.	Saugany	74.0	29.6	1
151.	South Twin	116.0	31.0	8
447.	Cedar (Tri-Lake)	131.0	30.0	8
330.	Gage	327.0	30.6	8
314.	Gage	332.0	30.5	8
32.	Indiana	122.0	27.9	11
	Subgroup B			
103.	Tippecanoe	768.0	37.0	12
104.	Tippecanoe	768.0	37.0	12
339.	James (Upper Basin)	1034.0	32.5	16
341.	James (Lower Basin)	1034.0	32.5	17
340.	James (Middle Basin)	1034.0	32.5	22
308.	Clear	800.0	31.2	25
454.	Shriner	111.0	45.0	19
257.	Crooked	206.0	43.9	3
258.	Crooked	206.0	43.9	3
259.	Crooked	206.0	43.9	3
138.	Olin	103.0	38.0	10
139.	Olin	103.0	38.0	10
143.	Oliver	362.0	40.0	10

ID No.	Lake	Area	Mean Depth	Index
144.	Oliver	362.0	40.0	10
142.	Oliver	362.0	40.0	10
141.	Oliver	362.0	40.0	10
140.	Oliver	362.0	40.0	10
127.	Lake of the Woods	136.0	40.2	18
96.	Shoe	40.0	40.0	14
	Subgroup C			
95.	Shock	37.0	32.7	28
159.	Witmer	204.0	34.5	27
160.	Witmer	204.0	34.5	27
119.	Dallas	283.0	35.2	28
118.	Dallas	283.0	35.2	28
391.	McClish	35.0	34.6	18
129.	Martin	26.0	34.2	35
130.	Martin	26.0	34.2	35
456.	Martin	26.0	34.2	35
255.	Bowen	30.0	36.0	41
247.	Knapp	88.0	34.5	41
122.	Fish	100.0	40.5	39
123.	Fish	100.0	40.5	39
286.	Ball	87.0	40.5	34
112.	Big Long	388.0	40.5	33
Group III				
189.	Maxinkuckee	1864.0	24.5	18
190.	Maxinkuckee	1864.0	24.5	18
18.	Dogwood	1300.0	18.0	16
446.	Shafer Dam	1291.0	10.2	23
41.	Manitou	1156.0	8.8	48
240.	J.C. Murphy	1515.0	5.0	47
210.	Eagle Creek Res.	1500.0	12.5	34
212.	Eagle Creek Res.	1500.0	12.5	34
280.	Bass	1400.0	10.0	36
281.	Bass	1400.0	10.0	39
213.	Eagle Creek Res.	1500.0	12.5	42
211.	Eagle Creek Res.	1500.0	12.5	38
214.	Geist Res.	1800.0	12.0	35
68.	Morse Res.	1375.0	15.4	40
9.	Freeman	1547.0	16.8	38
Group IV	Subgroup A			
3.	Cedarville Res.	245	4.0	61
170.	Wolf (Main Ind. Basin)	385	5.0	58
206.	Wolf (Illinois Basin)	385	5.0	59
169.	George (Hobart)	282	5.0	55
50.	Starve Hollow	145	6.8	58
191.	Mill Pond	136	6.1	58
440.	Kunkel	25	6.0	59

ID No.	Lake	Area	Mean Depth	Index
98.	Silver	102	14.9	51
97.	Silver	102	14.9	51
44.	Nyona (S. Basin)	104	12.9	54
313.	Fish	59	12.7	54
242.	Bougher	32	12.2	54
321.	Wible	49	13.3	55
83.	Little Barbee	74	13.0	56
87.	McClures	32	12.8	51
70.	Diamond	79	16.2	60
420.	Loomis	62	15.0	56
356.	Pigeon	61	15.2	57
22.	Story	77	13.2	60
	Subgroup C			
306.	Charles	150	5.0	75
317.	Sylvan	575	14.0	62
161.	Cedar	781	8.6	70
162.	Cedar	781	8.6	70
163.	Cedar	781	8.6	70
164.	Cedar	781	8.6	70
165.	Cedar	781	8.6	70
69.	Kokomo Res. #2	484	7.0	66
	Subgroup D			
109.	Yellow Creek	151	31.1	67
117.	Cotton	31	30.0	66
107.	Winona (Central Basin)	562	29.7	56
136.	Navoo	38	25.0	50
333.	Big Otter	69	25.8	52
451.	Loon	222	25.8	46
105.	Wabee	187	25.4	60
449.	Goose	84	25.9	61
455.	Troy-Cedar	93	27.3	60
91.	Ridinger	136	21.0	58
342.	Little Otter	34	21.8	58
54.	Beaver Dam	146	22.5	55
Group V				
6.	Yellow Wood	133	14.2	11
137.	North Twin	135	15.7	13
82.	Kuhn	137	9.4	15
273.	Bass	88	10.0	17
174.	Fishtrap	102	10.0	18
155.	Wall	141	11.6	13
407.	Elk Creek	47	12.5	13
114.	Brokesha	36	10.0	11
419.	Lime	30	11.	10
418.	Lime	30	11.	10
63.	Crystal	76	12.2	10

ID No.	Lake	Area	Mean Depth	Index
37.	Bruce	245	7.3	61
375.	Kelly Bayoe	40	3.0	64
460.	Maria	50	5.0	62
335.	Howard	27	4.8	64
43.	Mt. Zion Mill Pond	38	5.0	65
167.	George (N. Basin)	78	3.0	55
168.	George (S. Basin)	78	3.0	55
459.	Long Pond	38	4.0	58
173.	Horseshoe	35	3.0	60
171.	Crane	58	3.0	50
327.	Chamberlain	51	3.5	50
278.	Sously	40	4.0	50
279.	South Clear	51	2.0	50
275.	Mud 7101	197	2.0	50
441.	Moser	26	6.0	55
462.	Sandborn Old Bed Lake	30	6.0	54
463.	White Oak	30	5.0	55
458.	Halfmoon Bed Pond	38	5.0	55
150.	Shipshewana	202	6.7	51
166.	Dalecarlia	193	6.0	51
348.	Loon	163	4.6	53
274.	Czmanda	90	5.0	50
284.	Langenbaum	48	5.4	51
364.	Shallow	65	5.0	51
124.	Green	62	5.0	51
	Subgroup B			
46.	South Mud	94	10.9	66
291.	Big Bower	25	11.2	66
292.	Big Center	46	8.5	71
293.	Golden (SE Basin)	119	15.2	66
295.	Golden (Middle Basin)	119	15.2	66
438.	Salinda	70	15.0	63
294.	Golden (NW Basin)	119	15.2	71
346.	Long A (Near Pleasant)	92	16.7	74
183.	Gilbert	37	13.2	75
350.	Marsh	56	20.0	57
24.	Ferdinand	42	10.5	55
235.	High	123	10.1	53
325.	Hogback (NE Basin)	146	10.1	57
334.	Hogback (NE Basin)	146	10.1	57
51.	Brushcreek Res.	167	10.0	55
324.	Hogback (SW Basin)	146	10.1	60
337.	Hogback (NE Basin)	146	10.1	59
45.	Rock	56	11.1	61
436.	Scales	66	7.9	50
390.	Mink	35	10.0	50
71.	Flatbelly	326	13.3	54
61.	Carr	79	17.0	50
343.	Long A (Near Pleasant)	92	16.7	53
86.	Loon	40	16.8	52

ID No.	Lake	Area	Mean Depth	Index
33.	Simonton	282	5.5	6
377.	Merom Gravel Pit	55	6.0	5
176.	Lower Fish	134	6.5	8
115.	Cedar	120	8.5	9
30.	Heaton	87	7.4	10
154.	Stone	116	14.7	2
102.	Syracuse	414	12.9	4
11.	Deam	195	12.5	5
Group VI	Subgroup A			
72.	Goose	27	20.0	15
296.	Gooseneck	25	20.0	15
394.	Pleasant (Steuben Co.)	53	22.5	20
416.	Kickapoo			
192.	Myers	96	20.8	21
153.	Still	30	20.7	19
121.	Eve	31	21.6	18
188.	Lawrence	69	22.9	13
366.	Snow	421	19.0	20
367.	Snow (S. Basin)	421	19.0	18
101.	Stanton	32	15.0	20
113.	Blackman	67	18.1	20
77.	Hoffman	180	17.6	23
131.	Messick	68	21.3	34
271.	Smalley	69	22.0	34
268.	Sacarider	33	22.4	35
236.	Latta	42	21.4	36
443.	Lukens	46	22.	30
331.	Upper Long	86	22.1	32
442.	Blue	239	21.	30
316.	Stienbarger	73	21.8	39
260.	Diamond	105	24.6	21
269.	Sand (Chain O'Lakes)	47	27.0	23
110.	Adams	308	25.0	28
146.	Pretty	184	25.7	25
453.	Round (Tri-Lake)	125	25.	30
264.	Little Long	71	24.6	32
132.	Messick	68	21.3	26
267.	Round	99	21.6	24
388.	Flint	86	20.0	25
158.	Westler	88	20.1	25
157.	Westler	88	20.1	25
194.	Pretty	97	22.1	28
329.	Fox	142	22.2	27
148.	Royer	69	23.6	26
149.	Royer	69	23.6	26
94.	Sechrist	105	23.7	24
	Subgroup B			
244.	Big	288	24.7	38
80.	James	282	26.9	39
79.	James	282	26.9	39

ID No.	Lake	Area	Mean Depth	Index
	Subgroup C			
301.	Hamilton	802	20.7	31
Group VII	Subgroup A			
106.	Webster	774	7.0	37
31.	Hunter	99	11.3	20
172.	Hog	59	11.7	21
184.	Holem	40	9.8	23
360.	Round B (Steuben)	30	11.3	23
371.	Walters	53	10.4	26
347.	Long B (Steuben)	154	11.9	24
84.	Little Chapman	177	11.2	25
230.	Engle	48	14.0	26
290.	Bell	38	13.4	24
283.	Hartz	28	13.2	23
365.	Silver	238	10.7	28
125.	Hackenberg	42	12.1	29
111.	Appleman	52	11.3	30
180.	Upper Fish	139	7.5	22
85.	Little Pike	25	5.6	31
370.	Tamarack	47	5.0	30
18.	Flat	26	8.1	35
207.	Clear	106	7.2	30
288.	Bass	61	7.4	31
277.	Riddles	77	8.3	30
389.	Long (Porter)	65	8.0	33
179.	Swede	33	8.0	32
40.	Lake 16	27	8.1	32
310.	Crooked (Middle Basin)	828	12.8	23
177.	Pine	282	13.0	22
336.	Jimmerson	434	10.1	22
208.	Hudson	432	11.7	23
414.	Quick Creek (Hardy)	705	12.5	19
58.	Big Chapman (W. Basin)	581	10.5	18
57.	Big Chapman (N. Basin)	581	10.5	18
	Subgroup B			
38.	Fletcher	45	19.6	46
452.	Old	32	19.4	48
120.	Emma	42	16.7	44
318.	Tamarack	50	17.6	42
59.	Caldwell	45	17.8	46
243.	Bear	32	12.2	54
231.	Gordy	31	21.9	43
64.	Dewart (SE Basin)	551	16.3	36
65.	Bewart (SW Basin)	551	16.3	36
66.	Dewart (NW Basin)	551	16.3	36
303.	Big Turkey	450	16.2	44
187.	Lake of the Woods	416	16.4	42

ID No.	Lake	Area	Mean Depth	Index
195.	Boggs Creek	600	12.5	45
62.	Center	120	17.2	31
145.	Pigeon	61	19.0	27
328.	Pleasant (St. Joseph)	29	18.0	29
262.	Gilbert	28	17.5	28
76.	Hill	67	19.4	31
237.	Millers	28	14.6	35
265.	Long (Chain O'Lakes)	40	15.8	33
249.	Long (At Laketon)	48	16.0	30
287.	Barton	94	14.3	32
439.	Salinda	70	15.0	31
216.	Dixon	33	14.5	30
89.	Pike	203	13.9	37
215.	Cook	93	17.7	40
254.	Bixler	120	17.4	38
245.	Cree	58	15.7	39
373.	West Otter	118	16.6	35
56.	Big Barbee	304	18.6	38
	Subgroup C			
78.	Irish	182	12.8	45
270.	Skinner	125	14.0	45
320.	Waldron	216	14.4	43
256.	Crane	28	12.9	45
238.	Muncie	47	12.3	46
185.	Koontz	346	9.2	42
395.	Lake Pleasant	424	8.2	40
20.	Cedar	28	8.2	40
412.	Spectacle	62	8.7	40
307.	Cheeseboro	27	10.0	40
88.	Muskelonge	32	9.4	40
221.	Griffey Res.	130	10.0	40
434.	Round (At Laketon)	48	11.2	43
152.	Star Mill Dam	38	10.0	43
345.	Lime-Kiln	25	10.0	42
60.	Boner	40	9.2	43
128.	Little Turkey	135	11.5	36
396.	Shakamak	56	10.9	38
241.	Bartley	34	12.6	35
93.	Sawmill	36	10.3	33
29.	Fish	34	10.0	35
272.	Sparta	31	5.5	40
2.	Rainbow	45	6.0	41

A Summary of the Lake Groupings from Cluster Analysis

	Area	Mean Depth	Index
Group I	3060-3180	17.5-22.0	16-20
Group II			
A	50-48	17.6-31.0	1-16
B	40-1034	31.2-45.0	3-25
C	37-388	32.7-40.5	18-41
Group III	1291-1864	5.0-24.5	23-48
Group IV			
A	26-385	2.0-7.3	50-65
B	25-326	7.9-20.0	50-75
C	150-575	5.0-14.0	62-75
D	31-562	21.0-31.1	46-67
Group V	30-414	5.5-15.7	2-18
Group VI			
A	25-421	15.0-27.0	13-39
B	228-282	24.7-26.9	38-39
C	802	20.7	31
Group VII			
A	25-828	5.0-13.2	18-37
B	28-551	12.2-19.6	27-54
C	25-424	5.5-14.4	33-46

Nonpoint Source Pollution

Nonpoint source pollution (NPS) differs from point source pollution in two distinct ways: it does not occur from a definable source such as a pipe, ditch, or outfall, and it is most severe at those times of the year when seasonal rains may carry pollutants to water courses. Point sources are more critical during low flow stream conditions.

Nonpoint source pollution in Indiana occurs from a variety of sources and in varying degrees. In the State's Five Year Strategy (FY 80-84) for Water Quality Management Planning, the Stream Pollution Control Board identified agricultural and residual waste as priority NPS problems. No direct effort will be focused on mining, forestry, or construction NPS by the SPCB since existing programs, including those administered by the Department of Natural Resources appear to be working adequately.

Agricultural Nonpoint Source

Indiana is primarily an agricultural state and therefore, the potential for nonpoint source pollution generated from agricultural activities is great. Generally, potential pollutants considered are sediment, sediment-bound phosphorus, nutrients, organic matter, pesticides, herbicides, and pathogenic bacteria from animals.

In an effort to curb sediment delivery to streams, many farmers have already instituted soil conservation practices. For example, certain types of tillage practices around the contour of the land constitute a basic "best management practice" (BMP). The accepted definition of BMP is:

> "An alternative combination of land use conservation practices and management techniques, which, when applied to a unit of land, will result in the opportunity for reasonable and economic return with an acceptable environmental standard."

Agricultural Conservation Program (ACP)

To aid local land owner in instituting best management practices to control agricultural nonpoint source pollution funds are made available through the Federal ACP.

Under the Soil Conservation Domestic Allotment Act of 1934, Title X of the Agricultural Consumer Protection Act of 1973, provisions were made to cost-share, through the ACP, with farmers to install conservation practices on their land. Conservation practices are classified yearly in regard to effectiveness and need with funding levels up to 65 percent for the highest priority practices. This determination is made from a coordinated effort by the State ACP Development Group. Although the ACP is limited to agricultural producers, it is very flexible in its options by offering annual agreements, three to five year long term agreements, pooling agreements with multiple producers, and special projects developed at the local levels and funded through the state reserve.

The ACP continues to be extremely successful. For fiscal year 1981 $4,885,882 was spent for cost shares, with 4,424 participating farms. Although no attempts have been made to quantify the reduction in soil loss, it is apparent that such a wide scale program can improve water quality.

Model Implementation Project

The Model Implementation Project (MIP) was completed in 1981 by the Indiana Heartland Coordinating Commission. This important nonpoint source demonstration project, a joint venture between IHCC, USDA, USEPA, ISBH, and four state Universities, assessed the impact of best management practices on water quality. To provide an incentive for local land owners, the cost share rates were greater than the regular ACP levels. During the three-year project period more than $1,000,000 was used for BMP installation. In-sights gained during the MIP will aid in producing the greatest statewide water quality improvement for the least cost.

Regional Erosion Estimates
Potential and Gross

Region 1B

	Soil Association	Potential (tons/acre/yr.)	P-Rating	Gross (tons/acre/yr.)	G-Rating
B1	Houghton-Adrian	2.0	Low	.5	Low
B2	Maumee-Gilford-Sebewa	6.0	Low	1.2	Low
C1	Rensselaer-Darroch-Whitaker	12.0	Low	2.8	Low
E3	Oshtemo-Fox	21.0	Low	4.2	Low
F2	Plainfield-Maumee-Oshtemo	11.0	Low	1.7	Low
J1	Brookston-Ordell-Corwin	11.0	Low	3.9	Low
J2	Crosier-Brookston	24.0	Low	6.1	Medium
L1	Parr-Brookston	22.0	Low	5.1	Medium
L3	Miami-Crosier-Brookston-Riddles	33.0	Medium	6.6	Medium

Region 2

	Soil Association	Potential (tons/acre/yr.)	P-Rating	Gross (tons/acre/yr.)	G-Rating
A2	Fox-Genesee-Eel	27.0	Low	4.0	Low
B1	Houghton-Adrian	2.0	Low	.7	Low
C1	Rensselaer-Darroch-Whitaker	12.0	Low	3.7	Low
C2	Sebewa-Gilford-Homer	10.0	Low	3.4	Low
D1	Milford-Bono-Rensselaer	8.0	Low	2.0	Low
E2	Elston-Shipshe-Warsaw	16.0	Low	4.8	Low
E3	Oshtemo-Fox	21.0	Low	3.6	Low
J2	Crosier-Brookston	24.6	Low	5.3	Medium
L3	Miami-Crosier-Brookston-Riddles	33.0	Medium	3.2	Low

Region 3A

	Soil Association	Potential (tons/acre/yr.)	P-Rating	Gross (tons/acre/yr.)	G-Rating
A2	Fox-Genesee-Eel	27.0	Low	4.8	Low
B1	Houghton-Adrian	2.0	Low	.7	Low
C2	Sebewa-Gilford-Homer	10.0	Low	4.6	Low
E2	Elston-Shipshe-Warsaw	16.0	Low	3.2	Low
E3	Oshtemo-Fox	21.0	Low	3.2	Low
F2	Plainfield-Maumee-Oshtemo	11.0	Low	.5	Low
K1	Blount-Pewamo	19.0	Low	5.7	Medium
L3	Miami-Crosier-Brookston-Riddles	33.0	Medium	5.1	Medium
M2	Morely-Blount-Pewamo	49.0	Medium	9.1	Medium

Region 3B

	Soil Association	Potential (tons/acre/yr.)	P-Rating	Gross (tons/acre/yr.)	G-Rating
A2	Fox-Genessee-Eel	27.0	Low	7.2	Medium
B1	Houghton-Adrian	2.0	Low	.7	Low
C1	Rensselaer-Darroch-Whitaker	12.0	Low	2.8	Low
D1	Milford-Bono-Rensselaer	8.0	Low	1.9	Low
K1	Blount-Pewamo	19.0	Low	4.9	Low
K2	Hoytville-Nappanee	9.0	Low	2.6	Low
L3	Miami-Grosier-Brookston-Riddles	33.0	Medium	6.6	Medium
M2	Morley-Bount-Pewamo	49.0	Medium	7.3	Medium

Region 4

	Soil Association	Potential (tons/acre/yr.)	P-Rating	Gross (tons/acre/yr.)	G-Rating
A1	Genesee-Eel-Shoals	16.0	Low	2.9	Low
B2	Maumee-Gilford-Sebewa	6.0	Low	1.2	Low
C1	Rensselaer-Darroch-Whitaker	12.0	Low	3.0	Low
E2	Elston-Shipshe-Warsaw	16.0	Low	3.3	Low
E3	Oshtemo-Fox	21.0	Low	3.8	Low
E4	Fox-Ockley-Westland	37.0	Medium	5.3	Medium
F2	Plainfield-Maumee-Oshtemo	11.0	Low	4.7	Low
I1	Ragsdale-Raub	14.0	Low	4.3	Low
I2	Sable-Ipava	14.0	Low	4.1	Low
I3	Fincastle-Ragsdale	20.0	Low	5.4	Medium
I4	Reesville-Ragsdale	26.0	Low	6.6	Medium
J1	Brookston-Ordell-Corwin	11.0	Low	3.4	Low
J2	Crosier-Brookston	24.0	Low	4.5	Low
J3	Crosby-Brookston	18.0	Low	3.7	Low
L1	Parr-Brookston	22.0	Low	5.6	Medium
L3	Miami-Crosier-Brookston-Riddles	33.0	Medium	4.4	Low
L4	Miami-Crosby-Brookston	62.0	Medium	7.6	Medium
L5	Miami-Hennepin-Crosby	161.0	High	9.2	Medium
L6	Miami-Russell-Fincastle-Ragsdale	103.0	High	9.0	Medium
L7	Russell-Hennepin-Fincastle	235.0	High	4.3	Low

Region 5

	Soil Association	Potential (tons/acre/yr.)	P-Rating	Gross (tons/acre/yr.)	G-Rating
A1	Genesee-Eel-Shoals	16.0	Low	2.8	Low
A2	Fox-Genesee-Eel	27.0	Low	4.7	Low
B2	Maumee-Gilford-Sebewa	6.0	Low	1.6	Low
C1	Rensselaer-Darroch-Whitaker	12.0	Low	3.1	Low
E3	Oshtemo-Fox	21.0	Low	3.1	Low
E4	Fox-Ockley-Westland	37.0	Medium	5.1	Medium
F2	Plainfield-Maumee-Oshtemo	11.0	Low	1.6	Low
I3	Fincastle-Ragsdale	20.0	Low	4.9	Low
J2	Crosier-Brookston	24.0	Low	4.6	Low
J3	Crosby-Brookston	18.0	Low	4.7	Low
K1	Bount-Pewamo	19.0	Low	3.7	Low
L3	Miami-Crosier-Brookston-Riddles	33.0	Medium	5.1	Medium
L4	Miami-Crosby-Brookston	62.0	Medium	9.2	Medium
L6	Miami-Russell-Fincastle-Ragsdale	103.0	High	9.7	Medium
M2	Morley-Blount-Pewamo	49.0	Medium	7.3	Medium

Region 6

	Soil Association	Potential (tons/acre/yr.)	P-Rating	Gross (tons/acre/yr.)	G-Rating
A2	Fox-Genesee-Eel	27.0	Low	3.7	Low
C1	Rensselaer-Darroch-Whitaker	12.0	Low	2.8	Low
J3	Crosby-Brookston	18.0	Low	3.6	Low
K1	Blount-Pewamo	19.0	Low	4.4	Low
L4	Miami-Crosby-Brookston	62.0	Medium	5.8	Medium
M2	Morley-Blount-Pewamo	49.0	Medium	6.7	Medium

Region 8

	Soil Association	Potential (tons/acre/yr.)	P-Rating	Gross (tons/acre/yr.)	G-Rating
A1	Genesee-Eel-Shoals	16.0	Low	2.9	Low
A2	Fox-Genesee-Eel	27.0	Low	5.5	Medium
C1	Rensselaer-Darroch-Whitaker	12.0	Low	2.9	Low
D2	Patton-Lyles-Henshaw	15.0	Low	3.8	Low
E4	Fox-Ockley-Westland	37.0	Medium	5.5	Medium
E5	Parke-Negley	464.0	Very High	7.2	Medium
G	Princeton-Bloomfield-Whitaker	76.0	Medium	5.1	Medium
I3	Fincastle-Ragsdale	20.0	Low	4.7	Low
J3	Crosby-Brookston	18.0	Low	3.9	Low
L4	Miami-Crosby-Brookston	62.0	Medium	6.3	Medium
L5	Miami-Hennepin-Crosby	161.0	High	6.7	Medium
L6	Miami-Russell-Fincastle-Ragsdale	103.0	High	7.9	Medium
N1	Bartle-Peoga-Dubois	70.0	Medium	7.9	Medium
O3	Cincinnati-Vigo-Ava	279.0	High	11.5	High
Q2	Crider-Hagerstown-Bedford	213.0	High	9.9	Medium
R1	Berks-Gilpin-Weikert	569.0	Very High	8.8	Medium

Region 9

	Soil Association	Potential (tons/acre/yr.)	P-Rating	Gross (tons/acre/yr.)	G-Rating
A2	Fox-Genesee-Eel	27.0	Low	4.5	Low
E4	Fox-Ockley-Westland	37.0	Medium	5.5	Medium
I3	Fincastle-Ragsdale	20.0	Low	5.1	Medium
J3	Crosby-Brookston	18.0	Low	3.3	Low
L4	Miami-Crosby-Brookston	62.0	Medium	4.8	Low
L5	Miami-Hennepin-Crosby	161.0	High	4.1	Low
L6	Miami-Russell-Fincastle-Ragsdale	103.0	High	9.3	Medium
N3	Avonburg-Clermont	32.0	Low	4.5	Low
O4	Cincinnati-Rossmoyne	275.0	High	13.5	High
R3	Edin-Switzerland	741.0	Very High	40.5	Very High

Region 10

	Soil Association	Potential (tons/acre/yr.)	P-Rating	Gross (tons/acre/yr.)	G-Rating
A1	Genesee-Eel-Shoals	16.0	Low	3.0	Low
A4	Stendal-Haymond-Wakeland-Nolan	26.0	Low	3.6	Low
E5	Parke-Negley	464.0	Very High	5.7	Medium
N1	Bartle-Peoga-Dubois	70.0	Medium	6.3	Medium
03	Cincinnati-Vigo-Ava	279.0	High	6.7	Medium
P	Wellston-Zanesville-Berks	457.0	Very High	7.7	Medium
Q2	Crider-Hagerstown-Bedford	213.0	High	8.8	Medium
R1	Berks-Gilpin-Weikert	469.0	Very High	5.2	Medium
R2	Corydon-Weikert-Berks	669.0	Very High	7.8	Medium

Region 11

	Soil Association	Potential (tons/acre/yr.)	P-Rating	Gross (tons/acre/yr.)	G-Rating
A1	Genesee-Eel-Shoals	16.0	Low	2.2	Low
A4	Stendal-Haymond-Wakeland-Nolan	26.0	Low	2.5	Low
E4	Fox-Ockley-Westland	37.0	Medium	5.7	Medium
E5	Parke-Negly	464.0	Very High	4.5	Low
G	Princeton-Bloomfield-Ayshine	76.0	Medium	5.0	Medium
I3	Fincastle-Ragsdale	20.0	Low	5.4	Medium
J3	Crosby-Brookston	18.0	Low	3.9	Low
L4	Miami-Crosby-Brookston	62.0	Medium	7.8	Medium
L5	Miami-Hennepin-Crosby	161.0	High	9.6	High
L6	Miami-Russell-Fincastle-Ragsdale	103.0	High	12.5	High
N1	Bartle-Peoga-Dubois	70.0	Medium	4.6	Medium
N3	Avonburg-Clermont	32.0	Medium	4.6	Low
03	Cincinnati-Vigo-Ava	269.0	High	5.7	Medium
04	Cincinnati-Rossmoyne	275.0	High	10.4	High
P	Wellston-Zanesville-Berks	457.0	Very High	12.5	High
Q2	Crider-Hagerstown-Bedford	213.0	High	10.3	High
R1	Berks-Gilpin-Weikert	469.0	Very High	5.3	Medium

Region 12

	Soil Association	Potential (tons/acre/yr.)	P-Rating	Gross (tons/acre/yr.)	G-Rating
A1	Genesee-Eel-Shoals	16.0	Low	3.8	Low
A4	Stendal-Haymond-Wakeland-Nolan	26.0	Low	2.6	Low
N3	Avonburg-Clermont	32.2	Medium	3.9	Low
04	Cincinnati-Rossmoyne	275.0	High	15.7	Very High
R3	Edin-Switzerland	741.0	Very High	24.9	Very High

Region 13A

	Soil Association	Potential (tons/acre/yr.)	P-Rating	Gross (tons/acre/yr.)	G-Rating
A3	Sloan-Ross-Vincennes-Zipp	14.0	Low	4.5	Low
A4	Stendal-Haymond-Wakeland-Nolin	26.0	Low	3.7	Low
C3	Lyles-Ayrshine-Princeton	12.0	Low	4.1	Low
D2	Patton-Lyles-Henshaw	15.0	Low	3.5	Low
E2	Elston-Shipshe-Warsaw	16.0	Low	4.8	Low
G	Princeton-Bloomfield-Ayrshine	76.0	Medium	6.7	Medium
H	Alford	169.0	High	10.8	High
I4	Reesville-Ragsdale	26.0	Low	5.7	Medium
I5	Ava-Vigo	28.0	Low	5.2	Medium
N1	Bartle-Peoga-Dubois	70.0	Medium	6.1	Medium
O1	Hosmer	143.0	High	12.9	Medium
O3	Cincinnati-Vigo-Ava	279.0	High	10.5	Medium
P	Wellston-Zanesville-Berks	457.0	Very High	12.1	Medium
Q1	Crider-Bedford-Lawrence	181.0	High	11.9	Medium
Q2	Crider-Hagerstown-Bedford	213.0	High	13.0	Medium
Q3	Crider-Baxter-Corydon	235.0	High	14.5	Medium
R1	Berks-Gilpen-Weikert	469.0	Very High	4.6	Low
R2	Corydon-Weikert-Berks	669.0	Very High	12.5	Medium

Region 13B

	Soil Association	Potential (tons/acre/yr.)	P-Rating	Gross (tons/acre/yr.)	G-Rating
A3	Sloan-Ross-Vincennes-Zipp	14.0	Low	3.8	Low
A4	Stendal-Haymond-Wakeland-Nolin	26.0	Low	3.4	Low
D2	Patton-Lyles-Henshaw	15.0	Low	5.0	Medium
D3	Zipp-Markland-McGary	50.0	Medium	5.8	Medium
G	Princeton-Bloomfield-Ayrshine	76.0	Medium	9.1	Medium
H	Alford	169.0	High	16.9	Very High
I4	Reesville-Ragsdale	26.0	Low	6.4	Medium
N1	Bartle-Peoga-Dubois	70.0	Medium	10.9	High
N2	Weinbach-Wheeling	32.0	Medium	7.7	Medium
O1	Hosmer	143.0	High	10.7	High
O2	Zanesville-Wellston-Tilsit	307.0	High	11.3	High

Region 14

	Soil Association	Potential (tons/acre/yr.)	P-Rating	Gross (tons/acre/yr.)	G-Rating
A4	Stendal-Haymond-Wakeland-Nolin	26.0	Low	3.2	Low
N3	Avonburg-Clermont	32.0	Medium	4.7	Low
04	Cincinnati-Rossmoyne	275.0	High	9.5	Medium
P	Wellston-Zanesville-Berks	457.0	Very High	15.3	Very High
Q1	Crider-Bedford-Lawrence	181.0	High	13.5	High
Q2	Crider-Hagerstown-Bedford	213.0	High	9.1	Medium
Q3	Crider-Baxter-Corydon	235.0	High	14.5	High
R1	Berks-Gilpen-Weikert	469.0	Very High	5.6	Medium
R2	Corydon-Weikert-Berks	669.0	Very High	4.2	Low
R3	Edin-Switzerland	741.0	Very High	6.2	Medium

Region 15

	Soil Association	Potential (tons/acre/yr.)	P-Rating	Gross (tons/acre/yr.)	G-Rating
A4	Stendal-Haymond-Wakeland-Nolin	26.0	Low	2.9	Low
D3	Zipp-Markland-McGay	50.0	Medium	6.1	Medium
H	Alford	169.0	High	16.8	Very High
N1	Bartle-Peoga-Dubois	70.0	Medium	6.8	Medium
N2	Weinbach-Wheeling	32.0	Low	6.5	Medium
01	Hosmer	143.0	High	11.9	High
02	Zanesville-Wellston-Tilsit	307.0	High	10.7	High
P	Wellston-Zanesville-Berks	457.0	Very High	8.4	Medium
Q1	Crider-Bedford-Lawrence	181.0	High	7.7	Medium
Q2	Crider-Hagerstown-Bedford	213.0	High	6.6	Medium
Q3	Crider-Baxter-Corydon	235.0	High	8.4	Medium

*Developed by Soil and Water Conservation Committee (SWCC).

Solid Waste Disposal

The practice of solid waste disposal has for many years been regarded as only an urban problem spilling over into the rural community. As a result, an evolved philosophy of out-of-sight, out-of-mind became justification for the ultimate disposal of solid waste. This precept is no longer prevalent because waste disposal has, in some instances, been improperly handled, poorly managed, and subsequently is back in the public mind. Therefore, the purpose of this assessment is not to address the solid waste problem relative to amounts of a total waste tonnage generated, but rather to determine which activities may adversely impact the State's water resources.

The integrity of water resources may be threatened by poorly located or mismanaged conventional sanitary landfill operations as well as by unacceptable hazardous waste disposal methods. Landfill operations may potentially impact not only groundwater resources, but also surface water by contamination from leachate transmitted through local groundwater aquifers.

Generally, there are three ways in which water resources may become degraded from poorly located solid waste facilities. These impacts include: depositing refuse directly into saturated soil or surface water, precipitation infiltrating into the refuse, and surface water runoff. The latter occurrence usually stems from poor grading and seeding to the inadequate application of cover. The former two, however, are very dependent on not only the soil cover, but also on the soil's permeability which collectively determine the rate of infiltration and attenuation. Permeable soils will permit rapid movement of leachate and generally will allow the contaminants to filter into the water table. Less permeable soils, such as clay will retard leachate migration and often restrict it to the immediate disposal area. Generally, when disposed refuse comes into contact with the water table, a lateral movement of leachate will occur paralleling the slope of the water table. The gradient of the water table is usually reflected by the slope of the land surface tilting to the stream valley where the groundwater is ultimately discharged as supplemental surface flow.

Within Indiana there are approximately 134 permitted sanitary landfills. Of this toal, 89 percent (119) meet State geologic criteria; 81 percent (96) of this total must conform to additional specific management and operation practices prescribed by the Stream Pollution Control Board. As listed in Table I, a total of seven percent (10) do not meet State criteria and therefore, are unacceptable sanitary landfill operations. Table II lists non-permitted, unacceptable disposal sites identified in the State.

TABLE I
Unacceptable Permitted Sanitary Landfill Operations
Under Phase-Out Plan
*In Litigation

Disposal Sites	County	Region
1. Franklin County Landfill	Franklin	9
2. Fulton County Landfill	Fulton	5

*3. Lawrence County Landfill	Lawrence	13A
4. A-1 Landfill	Marshall	2
5. Montgomery-Crawfordsville Landfill	Montgomery	4
6. Pulaski County Landfill	Pulaski	1B
7. Warren County Landfill	Warren	4
8. Richmond Landfill	Wayne	9
9. Segal Landfill	White	4
*10. United Refuse Landfill	Allen	3B

TABLE II
Unacceptable Non-Permitted Disposal Sites
*In Litigation

Disposal Sites	County	Region
*1. Midwest Industrial Disposal Company (Midco I & II)	Lake	1A
*2. Seymour Recycling	Jackson	11
*3. Industrial Disposal	Lake	1A
*4. Dis-Pos-All	LaPorte	2
*5. Gary Dump	Lake	1A
*6. Lake Station Dump	Lake	1A
*7. Neal's Landfill	Monroe	10
*8. Neal's Dump	Owen	10
9. Lemon Lane Landfill	Monroe	10

Region 1A

One of the more landfill dense areas of the State is Lake County in Region 1A. Currently, five disposal areas have been classified as geologically unsuitable. The non-permitted Lake Station Dump is one that is presumed to be contributing leachate to Deep River and may be an immediate threat to local groundwater and surface water resources. In its proximity to the Deep River, this landfill is located on the north bank and because of highly permeable cover material, leachate generation is probable. In addition, a swamp located on the site has been used for refuse disposal. Based upon staff observation, it is presumed that this swamp is hydraulically linked to Deep River. In several instances, leachate laden waste was noticed welling up from the river floor adjacent to the landfill property. This reinforces the conclusion that a good portion of this operation is linked hydraulically to the Deep River. This site is scheduled to close April 1, 1982.

The Gary Dump is geologically unsuitable for waste disposal because of its threat to groundwater resources in its vicinity. The disposal area is currently dewatered. When dewatering ceases, the water table will rise to former levels resulting in saturation of the refuse and generation of large volumes of leachate. Water quality information from monitoring wells around the site indicate that a leachate plume is moving toward the north-northwest with the groundwater. There is a lack of cover material available on-site and silt material must be hauled in. This site is under litigation at this time.

The Industrial Disposal Landfill is located along the Grand Calumet River. Because of soil characteristics and its geologic environment, this site has also been classified as an unacceptable landfill. Types of waste which had been accepted at this site include foundry sand, wood, plastic, and steel slag, which not being totally innocuous to the environment, have produced leachate when coming into contact with the shallow groundwater resources. In addition, as a totally unacceptable cover agent, sand had been used as a cover material in the past. This operational practice greatly accentuates the possibility of leachate generation since sand is characteristically a good conductor for lateral movement. Although this site is closed at this time, it remains of concern to the State and litigation proceedings are continuing.

The Midwest Industrial Disposal Company, Inc., (Midco I) in Gary, Indiana, began operations in April 1975, as an industrial waste disposal and solvent reclamation facility that stored bulk liquids and drums from firms in the Chicago and northern Indiana area. Operations there ceased on December 21, 1976, when a fire destroyed some 14,000 drums of waste material. According to EPA officials, this site has been and continues to be a threat to human health and the environment through hazardous waste runoff from the site and public exposure. After several years of both State and federal litigation concerning Midco I and a sister site, Midco II, located across from the Gary Municipal Airport, the U.S. EPA announced in January 27, 1982, the award of a $350,000 contract for removal of hazardous waste materials from this site. This contract is the first planned removal action taken at a hazardous waste site under the National Superfund Program. Waste removal actions will include sorting, crushing, and removing 55-gallon drums burned in a fire at the site; sampling, staging, bulking, and removing intact drums that contain wastes; excavation and removal of wastes in a sludge disposal pit, removal of contaminated soil, and the capping of the site with clay.

Region 2

LaPorte County serves as the present location of the Dis-Pos-All Dump. In addition to its unfavorable geologic setting, other alleged violations have occurred including the acceptance of unauthorized hazardous waste, general poor operation of the facility, and lack of adequate cover material. Inspections of the site have revealed the use of foundry sand, a highly permeable material as a covering agent. This could promote rapid leachate generation and movement which could impact the quality of Trail Creek which is located adjacent to the landfill. Although this site has been ordered to be closed and covered, litigation concerning it continues.

A-1 Disposal Landfill in Marshall County is rated as geologically unsuitable for waste disposal because of the threat it poses to local groundwater resources. The absence of a well-developed surface drainage system indicates the presence of surficial materials characterized by high hydraulic conductivities. This occurrence, in addition to the use of sand and gravel as daily cover, will promote the generation and movement of leachate. The water table occurs five to eight feet below the bottom of the pit into which metals and other leachable materials are placed. This site is scheduled for closure in the near future.

Region 3B

The northeastern portion of the State has one sanitary landfill which may adversely affect the environment.

United Refuse is located in Allen County, Indiana. Because this landfill is sited within the 100-year flood elevation of the St. Mary's, Maumee, and St. Joseph Rivers, it has been classified as located within an unacceptable geologic environment. On April 18, 1978, the Stream Pollution Control Board (SPCB) denied renewal of its operating permit for not only failure to submit required well monitoring reports, but also for alleged filling within an unapproved area. Because of the flood area location, any area which is proposed to be used for refuse disposal must receive approval from the Department of Natural Resources and concurrence from the State Board of Health. This site remains in litigation.

Region 4

The Runyon Landfill in Carroll County was classified as an unacceptable operation because of thick permeable granular zones beneath the site and the possibility of direct hydraulic contact with local water systems. In addition, generation of excessive leachate may occur as the result of the poor characteristics of sand, sandy-silt, and gravel used as a cover material. Any leachate which is produced may eventually be discharged to the Wabash River via Burnett's Creek. This site was closed under the Phase-Out Plan, however, litigation concerning this site remains in progress.

Segal Landfill in White County is located in a poor geologic setting because of the high water table and the highly pervious materials at the surface. Aquifers in this area may be in danger of leachate pollution. This site is included in the Phase-Out Plan.

The Montgomery County Landfill is also listed as a site in the Phase-Out Plan. This site is geologically unacceptable for waste disposal due to the threat of groundwater contamination that it poses. The highly permeable, coarsely granular deposits into which wastes are placed are readily capable of transmitting leachate with eventual discharge into local streams and swamps.

Scheduled for closure in 1983 is the Warren County Landfill. Unacceptable conditions exist which create limiting factors for this area to be used for disposal purposes. Specifically, the high permeability of weathered material overlying gray till in conjunction with high groundwater tables allow water to infiltrate the refuse and possibly flow through the trenches unchecked.

Region 5

The Fulton County Landfill was rated geologically unacceptable for waste disposal because of the threat of groundwater pollution that exists in its vicinity. Surface water degradation is also possible through discharge to adjacent swampy areas.

Region 9

Two landfills in Region 9 have been identified as unacceptable for waste disposal. The Franklin County Landfill is unacceptable due to saturated zones of granular material located close to the surface. In addition, water cannot run off and is forced to percolate into the refuse. The thin layer of silty-clay used to separate groundwater from the refuse is not sufficient to retard leachate, therefore, possible groundwater contamination was suspected. Monitoring wells were recently installed and initial sample results did not indicate that any serious groundwater contamination has occurred at this site. This landfill will be allowed to operate for a short time to reach contours which will facilitate proper closure.

The Richmond Landfill in Wayne County was rated as unacceptable for waste disposal due to the serious leachate generation problems at the site and the erodibility of daily cover. Numerous seeps have been noted. A stream flowing through tiles beneath the fill area has been polluted by leachate seeps at the northern end of the landfill. Leachate enters the tiles and the stream leaves the southern end of the property polluted, eventually flowing into the East Fork of the Whitewater River. This site was originally slated for closure, but the city plans to correct the problems and closure requirements may be lifted.

Region 10

Three inactive dump sites that were used for disposal of wastes during the fifties, sixties, and early seventies are located in Region 10. Neal Dump in Owen County and Lemon Lane and Neal's Landfills in Monroe County were used for the disposal of unknown quantities of discarded PCB capacitors. The capacitors at all three locations were found to be exposed, broken open, and leaking their contents onto the soil. The contaminated soil around the capacitors at these sites was found to contain high levels of PCBs. Tributaries of Richland Creek draining Neal's Landfill were found to contain significant levels of PCB contamination. Neal's Landfill was listed by EPA on the list of 115 priority sites for remedial action. The Lemon Lane Landfill is being considered by EPA as a possible removal action site for clean-up under the Superfund.

Region 11

The Seymour Recycling Corporation has been identified by the State as Indiana's number one priority hazardous waste site for clean-up and has been listed by the EPA as one of the 115 priority sites in the nation for remedial action under the Comprehensive Environmental Response Compensation and Liability Act of 1980 (Superfund). It is estimated that there are 60,000 drums containing hazardous waste on the site. Materials involved include such substances as reclaimable solvents, acid and caustic wastes, cyanide, laboratory chemicals, pesticides, still bottoms, enamels, and a vague category of waste classified as "set-ups." In addition, the soil on the site has been contaminated as a result of ruptured barrels and miscellaneous spillage pooling on the surface of the site. The high water table and the Ayrshire soil prevalent in the area which is characterized by slow to rapid conductivities, add to the possibility of groundwater contamination.

A study to determine the extent of possible groundwater contamination was conducted in the summer of 1981. To facilitate this study, monitoring wells were installed around the perimeter of the site. Preliminary results from this study indicate that groundwater contamination has occurred and a plume of contaminated groundwater is migrating off-site toward the northwest. This study also indicates that seasonal or future contamination of residential wells near the Seymour site is possible.

Clean-up efforts at this site to date include the removal and incineration of hazardous wastes from above ground storage tanks, the construction of dikes around the facility, and the installation of a drainage collection system which routes run-off to a charcoal filter prior to discharge into the city sewage system.

Further clean-up efforts are awaiting the outcome of litigation. EPA has designated Seymour as a 50 percent funding site which means that the State must assume 50 percent of the cost for clean-up to qualify for Superfund awards. Efforts are presently underway to collect funds for clean-up of waste from generators whose waste was improperly disposed of at this facility.

Region 13A

Geologically, possibly the poorest landfill site is the Lawrence County Landfill in Region 13A. The highly permeable material into which the refuse is placed allows water to percolate freely through the refuse, generate leachate, and flow downward to enter the groundwater system within the bedrock. Some leachate, however, may be diverted westward in the surficial cover by the influence of the tight residual clay zone. Because groundwater in Karst systems moves rapidly, pollutants may become dispersed over a wider area in a shorter or period of time than if other geologic conditions prevailed, and filtration and attentuation may be neglible. It may, however, be argued that the dilution of leachate may occur much more efficiently in such a system as described in Lawrence County.

State Strategy

Pursuant to the goals of protecting the public health and the environmental quality of the State as well as obtaining EPA authorization to assume responsibility for the hazardous waste management provisions of RCRA, the Indiana State Board of Health has initiated an extensive effort to reorganize and increase in number the staff administering and enforcing the solid and hazardous waste management programs in Indiana. In early FY 82, the Division of Land Pollution Control was formed out of the Solid Waste Management Section.

The Division of Land Pollution Control has continued to implement the Phase-Out Plan for landfills that have been found to be geologically unacceptable. This program has been quite successful to this date. As listed in Table III, 14 sites have been closed under the Phase-Out Plan and efforts are continuing to close the remaining Phase-Out sites.

TABLE III
Unacceptable Sanitary Landfill Operations Closed
Under Phase-Out Plan
*In Litigation

	Disposal Sites	County	Region
1.	Petersville Solid Fill	Bartholomew	11
2.	Lawrenceburg City Landfill	Dearborn	12
3.	New Paris Landfill	Elkhart	2
4.	Franklin City Landfill	Johnson	8
5.	Knox County Landfill	Knox	13A
6.	Scott Landfill	Kosciusko	2
7.	Superior Landfill	St. Joseph	2
8.	Warsaw City Landfill	Kosciusko	2
9.	Spidel Landfill	LaGrange	3A
10.	Lane Restoration	Marion	8
11.	A-1 Landfill (Burr Oak)	Marshall	2
12.	Breman Glass	Marshall	2
13.	Miller Landfill	White	4
*14.	Runyon Landfill	Carroll	4

The State of Indiana has submitted to EPA its application for Phase I Interim Authorization for the implementation and administration of a hazardous waste management program substantially equivalent in force and effect to the federal program. The Indiana Environmental Management Board has acted to fulfill the statutory responsibilities by adopting hazardous waste management rules substantially equivalent to the federal regulations found at 40 CFR Parts 260-263 and 265 (May 19, 1980, to January 16, 1981), implementing Subtitle C of the Resource Conservation and Recovery Act of 1976 (RCRA) as amended. These regulations provide for strict regulation over the generation, storage, transportation, treatment, recycling, and disposal of hazardous wastes in the State.

Staff of the Division of Land Pollution Control regulate non-hazardous solid waste disposal by the permitting of facilities and enforcement of regulations. Staff duties include in part, the inspection and monitoring of solid waste facilities, water and stream sampling, evaluation of approved plans to ensure continual compliance of site development, and closure of illegal disposal sites. Staff have been conducting an open dump inventory of unacceptably operated licensed landfills and non-permitted disposal sites.

In addition to the above-mentioned responsibilities, staff of the Resource Recovery and Planning Section are investigating and researching potential problems from abandoned or closed hazardous waste disposal sites.

Investigations of Spills of Oil, Hazardous, and Objectionable Materials

Summary of Materials Spilled

During 1980-1981, 621 recorded spill incidents resulted in the discharge of more than 5.4 million gallons. On several occasions more than one kind of material was lost during a spill incident. The materials spilled were grouped into six (6) categories and then summarized according to: the number of spills within that category; the percentage of that category of the total materials spilled; the amount of liquid material spilled (if determined); and that percentage of the total volume of material spilled.

Petroleum products accounted for 268 spill incidents or 43% of the total number of spills in 1980-1981. The volume of this spillage exceeded 2.2 million gallons or 41% of the estimated 5.4 million total gallons reported spilled. Gasoline accounted for not only the greatest number of spills, but also represented the largest volume of petroleum products spilled.

With 155 reported incidents, agricultural-related materials accounted for 25% of the materials spilled and totalled approximately 755,000 gallons. This represented 14% of the total gallons reported spilled and the second largest volume of material spilled. The largest volume of material identified in this category was fertilizer, although the loss of animal waste also represented a large volume of the agricultural-related material spilled. However, the difficulty of determining the volume of animal waste spilled precluded recording of volume figures.

The miscellaneous chemicals category included an array of organic and inorganic compounds spilled during 1980-1981. A total of 93 materials were spilled, representing 15% of the total number of spills recorded during the year. The miscellaneous chemical category accounted for the fifth largest volume of material spilled, approximately 590,000 gallons or 11% of the total volume. Several of the materials spilled involved very toxic or reactive materials.

Acids and bases accounted for 33 recorded spills or 5% of the total. Included in this category were several significant spills involving toxic and very reactive material. Acids and bases by volume account for 12.5% of the total volume spilled or 680,000 gallons.

The remaining two categories were food products and miscellaneous materials. Together they accounted for 3% of the materials spilled.

Sources of Materials Spilled

Spills investigated in Indiana during 1980-81 were divided into five classifications according to source. This classification was enlarged during 1978 to better identify the source of materials spilled. The new fifth classification identifies spills originating from commercial enterprises.

Before 1978, spills originating from commercial sources were included with the other four categories.

Transportation-related spills accounted for 179 of the 621 reported spills or 29% of the spills occurring in Indiana during 1980-81. Transportation-related spills were divided into four categories:

Trucks	Pipelines
Railroads	Ships and Barges

This division differs slightly over previous years with the inclusion of pipelines as a transportation-related spill source instead of being identified as a separate source. Transportation-related spills were those spills originating from sources involved in the transportation of materials and people. The spilled substance may have been the material transported or the fuel powering that mode of transportation. These spills may have resulted from accidents, equipment malfunctions, vandalism, employee error, and other reasons, but involved the discharge of material from a mode of transportation or the discharge of material from the maintenance or storage area serving the mode of transportation.

Industrial-related spills accounted for 143 (23%) of the 621 of the spills occurring in Indiana during 1980-81. Spills identified as industrial-related spills were those incidents in which materials were lost from sources involved in the manufacturing or mining of materials. These materials may have involved raw products awaiting processing or finished products ready for distribution to industrial or wholesale users. Spills involving both a transportation mode and industrial mode were classified according to where the material originated and what mode had control. For example, if a material was lost while loading a transport truck from an industrial source, it was identified as an industrial-related spill. If the material was lost while being unloaded at an industrial source, it was identified as a transportation-related spill. However, if it was determined that while loading, the transportation mode was obviously responsible, the spill was then identified as a transportation-related spill. Likewise, if it was determined that while unloading, the industrial mode was obviously responsible, the spill was then identified as an industrial-related spill.

Agricultural-related spills accounted for 130 of the 621 spills recorded during 1980-81. Agricultural spills were identified as those spills which occurred from sources involved in the actual production of agricultural products from commonly identified farms.

Spills from commercial sources accounted for 74 (12%) of the 621 spills during 1980-81. Most spill incidents currently identified as commercially-related spills were grouped with miscellaneous and unknown spills during earlier years, or in some cases, identified with the three other categories. Commercially-related spills were so identified when the material lost originated from businesses involved with the wholesale or retail handling of a product.

Miscellaneous and unknown spills accounted for 74 incidents during 1980-81. These incidents were grouped in the final category when they could not be identified as belonging to the other four categories.

Circumstance of Spills

During 1980-81, 621 spills of oil, hazardous, or objectionable substances were recorded in Indiana. Each spill incident was identified according to source and then grouped into five categories. In addition, each spill incident was examined as to the circumstances or reason the spill occurred. In many cases, the spills resulted from several different factors, but an attempt was made to determine the one significant factor as the major circumstance for the spill's occurrence. Seven separate categories were identified as factors responsible for the recorded spills during the year:

- Equipment Malfunctions
- Employee Error
- Transportation Accidents
- Vandalism
- Intentional Discharge
- Miscellaneous Circumstances
- Unknowns

Equipment malfunction accounted for the greatest number of recorded spills during 1980-81. Thirty eight percent, or 234 spills attributed to equipment malfunctions, resulted when equipment failed to operate as intended. The failures may have been attributed to poor design or construction, improper maintenance, equipment damage not attributable to vandalism, employee error, or transportation-related accidents.

One hundred twenty nine incidents, or 21% of the spills in 1980-81, were identified as resulting from employee error. Such spills were identified when persons, employed or authorized by a responsible party, made an erroneous decision that precipitated the spill. A bad decision may have been made when a person did not perform a task as directed, performed a task without proper explanation, or just exercised bad judgment while utilizing existing information. Employee error may have also contributed to spills that have been identified as equipment malfunction or transportation accidents.

Transportation accidents accounted for 88 incidents, or 14%, of the recorded spills for the year. These spills included incidents involving railroads, trucks, ships, and barges when these vehicles collided with another vehicle, object, or otherwise deviated from their intended path of transit.

Nineteen spills resulting from vandalism accounted for 3% of the spills during 1980-81. These spills occurred when unauthorized person(s) inflicted damage to equipment, or altered equipment such that material was lost.

Intentional acts of discharging materials to the waters of the State accounted for 7% of the spills in 1979. On 41 occasions, person(s) were identified as knowingly discharging material that subsequently entered or threatened to enter the waters of the State.

On twenty occasions, spill incidents could not be grouped with any of the preceding classifications. Consequently, these twenty incidents, 3% of all spills, were grouped as miscellaneous spills.

On 90 occasions, the circumstances for the spill incidents could not be identified due to lack of information. This represented 14% of the spills recorded in 1980-81.

Response to Oil and Hazardous Materials Spills--1980-81

Indiana Administrative Code 330 IAC 1-6 requires the notification to the Stream Pollution Control Board or its representatives of all spills of oil, hazardous and/or objectionable substances that enter or threaten to enter the waters of the State. Prompt containment, recovery and neutralization of the threatening substance is also required by this Rule. The Rule further requires that the organization or persons responsibile for the spill make the notification. This obligation to report is not deemed fulfilled if the report was made to some other State, local, or Federal agency.

During 1980-81, 621 spills of oil, hazardous and/or objectionable substances were recorded. Of these, 335 incidents, or 54% of the total, were properly reported. The remaining 286 incidents were not reported by the responsible party, but were reported to the Board by representatives of other governmental agencies and/or private citizens. A modest state-wide education program has been launched to familiarize State and local governmental agencies, industries, businesses, appropriate associations, and interested citizens with the provisions of the Rule. It is anticipated that this program will result in improved compliance.

The term "contain," as defined by this Rule, is to dam, bury, block, restrain, or, as may be otherwise necessary, affirmatively act so as to most effectively prevent spilled substances from entering the waters of the State. The term "cleanup" is defined as action taken to neutralize, remove, collect, gather, pump, separate, cover, or, as may be otherwise necessary, affirmatively act so as to most effectively prevent, minimize, or mitigate damage or threatened damage to the public health, safety and welfare, and to aquatic biota, animal life, plant life, or recreational, domestic, commercial, industrial, or agricultural water uses.

Spill cleanup success depends on several critical factors, including the nature of the material involved, the time elapsed between the spill event and cleanup initiation, the expertise of the cleanup personnel, methodology employed, topographical characteristics of the spill site, and climatic conditions. When immediate action is taken to contain and clean up a spill, it greatly increases the chance of a successful operation. Experience has demonstrated that, if hours or even minutes are lost, the operation will be more costly and there will be a more limited chance of success. If oil is contained at the spill site, it is normally much easier and less costly to clean up than if it were spread over miles of stream. Immediate action taken to remove a pool of toxic substance from the ground is much less expensive and safer for the environment and the public than delayed action taken to recover the material from the groundwater.

Many caustic solutions in water may be neutralized. Nonsoluble, lighter than water materials may be skimmed from the water surface. Nonsoluble, heavier than water materials may be pumped up from the stream bed, but materials like liquid fertilizer, soluble organics or various toxic materials may require the use of extraordinary recovery methods that might include activated carbon filters, chemical treatment, aeration or other such measures.

During 1980-81, 264 successful or partially successful cleanup operations were initiated. On several occasions, the lack of knowledge of appropriate cleanup techniques prevented the responsible party from initiating a successful operation. Such situations clearly demonstrate the necessity of the spill reporting requirements. If the responsible party is not aware of appropriate containment and cleanup methods, assistance can be provided by the staff.

The environmental impact of a spill is significantly influenced by the speed and success of cleanup operations. During 1980-81, water quality violations resulted from 132 of the incidents cited. Ninety-eight of these resulted in significant fish kills. One hundred eighty incidents resulted in no water quality violations being detected. Most of these latter incidents involved spills where the material lost did not enter the waters of the State, but were confined to the spill site and immediately cleaned up. Due to a lack of adequate information, no determinations of the extent of water quality violations could be made for the remaining incidents.

Fish Kill Investigation

A diverse healthy fish population is considered an indication of good water quality. Bodies of fresh water exhibiting such quality are utilized by society to serve its needs for public water supplies, water sources for domestic animals, areas for recreational activities, and sources of water for industrial use. The sudden appearance of many dead and dying fish resulting from the poisoning or degradation of an aquatic environment can arouse serious public concern. The sudden appearance of dead and dying fish can quickly signal the temporary or possible long-term loss of the use of the affected waters.

Fish kills can result from the accidental or intentional discharge of toxic or oxygen-demanding materials into an aquatic environment. Fish kills can also occur downstream of continuous industrial and municipal discharges when unusual circumstances such as equipment failure or spillage of toxic or oxygen-demanding materials may cause the facility to discharge a lethal effluent. It might be noted that fish kills in waters of continuous poor water quality may go unnoticed since these areas do not normally support a significant fish population or serve as a recreation site.

It has been noted that climatic conditions often influence the number of fish kills that occur each year. A relationship appears to exist between the amount of rainfall and fish kills. Figure 1 graphically presents the number of fish kills that have occurred in the past 27 years. As an example, the number of documented fish kills was low for the years 1957, 1968 and 1974. These were years of high rainfall.

Conversely, the number of fish kills was significantly higher during the low precipitation years of 1956, 1964, 1971, 1976, and 1977.

During 1979 through 1981, the number of investigated fish kills was unusually high. This may be due to increased awareness of the regulatory requirement to report fish kills to the Indiana State Board of Health. Figure 2 points out that fish kills occur most often during summer and fall months of the year. These months normally have the least amount of rainfall. Fish kills resulting from suffocation due to ice cover were not included. Such instances are not normally related to pollution problems.

Sewage and industrial sources accounted for a significant percentage of the documented fish kills in earlier years while kills resulting from identified agricultural sources accounted for an increasing, percentage of the incidents. The increase of agriculture related fish kills corresponds to an increase in the use of agri-chemicals and confined feeding lots. Fish kills often occurred as a result of a sudden discharge of toxic or oxygen-demanding materials normally associated with agri-chemicals and animal waste.

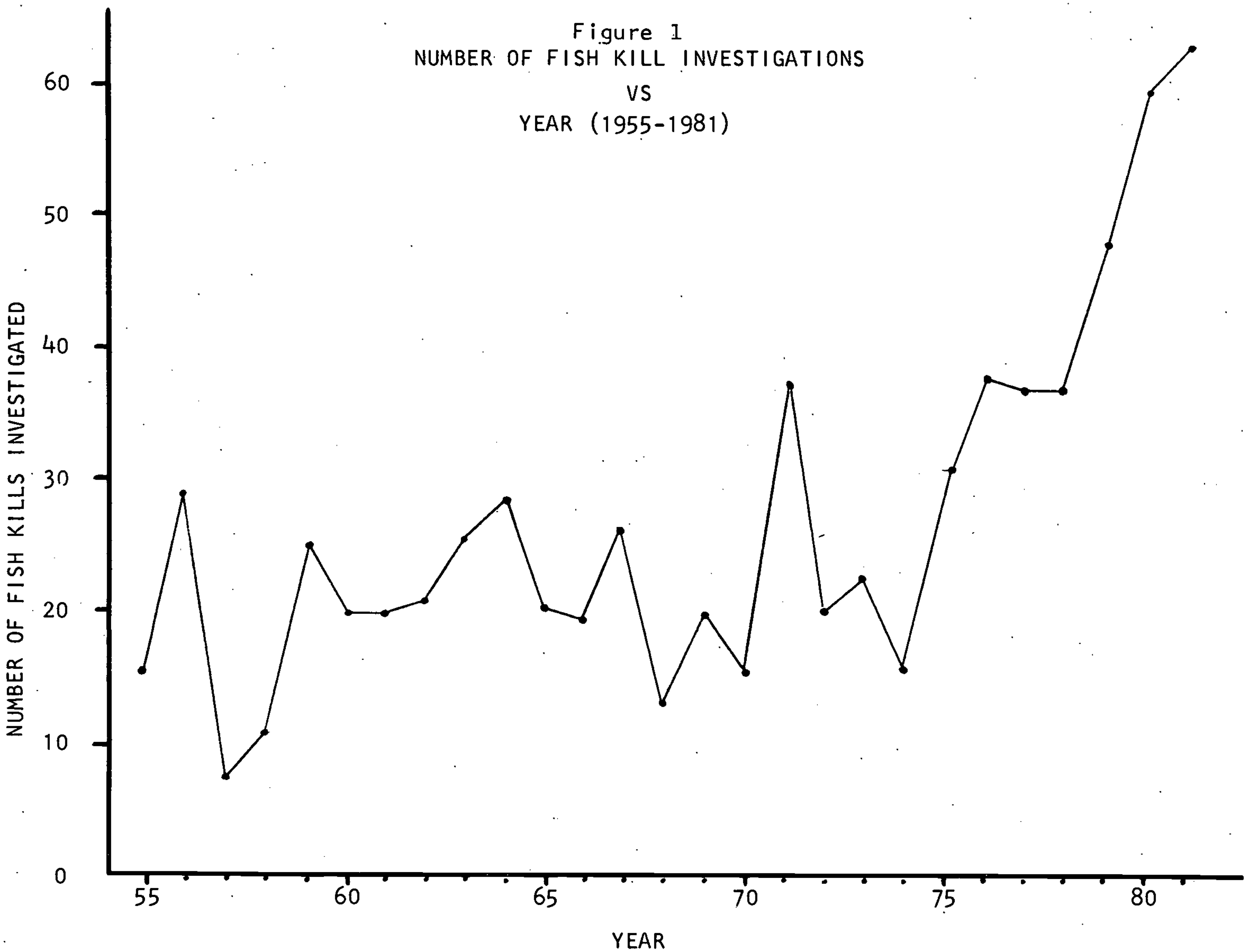

Figure 1
NUMBER OF FISH KILL INVESTIGATIONS
VS
YEAR (1955-1981)

Figure 2
CUMULATIVE MONTHLY DISTRIBUTION
OF FISH KILLS 1960-1981