PROJECTED WATER RESOURCE UTILIZATION

Instream Uses

The Great Lakes-St. Lawrence River system carried more than 340 million tons of freight in 1970. This amount is projected to double by the year 2000. The Ohio River navigation system carried more than 170 million tons in 1970.

The ongoing water quality control program is designed to meet water quality standards recognizing the seven day, once in ten year low flow. The projected increase in consumptive use could locally compromise these standards.

Demands for additional water-related outdoor recreational opportunities are expected to increase by about fifty percent by the year 2000. While this is within the theoretical total statewide capability of the resource for boating, waterskiing and canoeing, there will be substantial deficiencies in such activities as fishing, swimming and ice-skating. These two latter demands will undoubtedly be largely met, without any stress on the resource, by artificial pools and skating rinks. It is expected, even on the basis of the total theoretic resource availability, that the existing supply of fishable water will meet only sixty-four percent of the projected demand by the year 2000.

The statewide data concerning the extent of the total resource base for recreational uses is susceptible to misinterpretation with respect to boating, waterskiing and fishing, for a number of reasons. First, with respect to Lake Michigan, it is true that the Indiana portion of the lake comprises some 154,000 acres. All of this is theoretically available for boating and fishing. As a matter of fact, there are severe limitations to general boating because much of the area lies at considerable distances from harbors and because hazardous rough water conditions not only occur frequently, but with little advance warning. With respect to fishing, only about 23 miles of the 45 mile shoreline is generally open to the public access for shoreline fishing. The entire 154,000 acre area is not considered particularly useful general fishing waters primarily due to the difficulties with boating and, with the exception of salmonid species at certain seasons, much of these waters are not particularly productive to the fishermen. Secondly, the resource availability assessment for inland waters was made without regard to the availability of public access. The streams of Indiana, with the exception of those which are navigable under federal or state law or which lie within areas of public ownership, are on private property and available for recreational use only with the permission of the owners. Even for the public fresh water lakes and navigable streams, means of public access must be provided in order to render them useful in the satisfaction of recreational pursuits. Thirdly, the matter of the time or distance which the participant must travel to the resource must be considered in assessing the usefullness of the supply or availability of the resource. In the light of the foregoing, it is considered that there is presently a deficit of opportunity for boating, waterskiing and fishing in certain areas of the state. These are the Fort Wayne area, the western two tiers of counties from Parke County to Lake County, and an extensive portion of the central part of the state. The summary of the supply and demand for boating, skiing, and fishing is presented in Table 2.

TABLE 2

The regional supply and demand summary for boating, waterskiing and fishing.*

REGION	BOATING		SKIING		FISHING	
	1980	2000	1980	2000	1980	2000
1 - A	100+	100+	100+	100+	100+	100+
1 - B	100+	91	100+	100+	83	71
2	100+	100+	100+	100+	100+	100+
3 - A	100+	100+	100+	100+	100+	88
3 - B	4	4	1	1	12	11
4	72	63	82	81	48	45
5	96	100+	100+	100+	54	55
6	5	5	0	0	10	10
7	100+	100+	85	90	77	81
8	16	14	4	4	8	8
9	100+	100+	100+	100+	53	50
10	100+	100+	100+	100+	90	69
11	62	55	60	56	54	46
12	100+	100+	100+	100+	100+	100+
13 - A	100+	100+	80	75	64	60
13 - B	100+	100+	100+	100+	100+	100+
14	100+	100+	100+	100+	100+	100+
15	100+	100+	100+	100+	100+	100+

* The existing supply is expressed as a percentage of projected demand, therefore when the percentage exceeds 100 the supply exceeds demand. This analysis is based only upon the supply within the region and the recreational demands of the residents of that region.

The supply, with respect to natural lakes and miles of stream, is constant. The only prospect for meeting increased demands in these areas is that of providing additional public access to and rights of use on such waters. Since all natural lakes and miles of streams were included in the supply and demand analysis, it is assumed that these waters are accessible. However, many of these waters are not accessible by the general public. Therefore the deficits in supply exceed the estimates presented in Table 2.

The present outlook for the construction of significant new impoundments is almost totally negative. Therefore, absent some new initiatives and directions, the only outlook for those areas of substantial deficiencies is for increasing and perhaps undesirably high pressures on the existing supply, more extensive travel to areas of higher availability or a shift in demand to other pursuits.

Withdrawal Uses

The future demands on the water resource for withdrawal purposes are a function of future populations, economic activity and leisure time activities. In formulating its projections for the future water withdrawal uses, the Commission relied upon a number of recognized projections of future economic activity and a number of specific projections made by the Commission itself.

The Commission's assessment of present and past water withdrawals in Indiana indicates that different types of water uses have markedly different growth characteristics. In some cases, the increase in water consumption is significantly greater than the projected increase in water withdrawals.

Existing federal and state standards virtually assure that future electric generating plants will be equipped with offstream cooling facilities. This means that as new plants are constructed to meet increased demands and to replace aging generating stations, the old once-through cooling methods will be replaced by cooling towers or cooling lakes. These cooling facilities will sharply decrease water withdrawals while substantially increasing water consumption. The Commission's projections, which take into consideration the age of existing generating facilities, forecast a fifty percent decrease in the quantity of water which must be withdrawn by the year 2000 (IWR: AUN, p. 60). However, the amount of water which will be consumed will increase at least four-fold. It is impossible to predict the exact location of new generating facilities. But since the water demands of even new generating plants are still substantial, it is reasonable to assume that newer facilities will be situated along the same major water courses that support the existing facilities.

The economic projections utilized by the Commission in studies of future economic industrial activity forecast a doubling of industrial output by the end of the century. But at the same time, the Commission's studies demonstrate that substantial gains in the efficiency of the use of water within industrial plants can be expected in the same period. While efficiency gains vary from industry to industry, the overall industrial mix in Indiana is such that industrial water withdrawals by the year 2000 should be about one percent less than current withdrawals. More efficient water use, however, results in greater water consumption. Therefore, the Commission's forecast indicates that industrial water consumption will increase by about seventy-four percent.

While the overall industrial water withdrawal in Indiana is expected to be steady, it must be recognized that changes in the local industrial mix can occur at any point in time or at any location in the state. A new industry can have a significant impact on the water resource in its immediate vicinity.

The rural water systems that have proliferated in southern Indiana have capacity limitations such that they are not able to supply additional significant quantities of industrial water. Therefore, future water-intensive industrial development in the southern third of Indiana is expected to occur along the major water courses of the region to take advantage of the surface flows or more likely, the valley aquifers.

Water intake for public water supplies is expected to increase by the end of the century, although at a decreased rate of growth. By the year 2000, Indiana public water utilities may be withdrawing about thirty-seven percent more water than at present and consuming thirty-nine percent more. The rural water systems in southern Indiana cannot increase capacity on their existing lines without expanding and developing new systems.

The concentration of water supply demands in the major metropolitan areas of central and north-east Indiana may exceed local water resource availability, thus requiring additional sources of supply beyond the local area. Continued southward

expansion of the suburban areas of Lake, Porter and LaPorte Counties will outstrip the geographical availability of Lake Michigan water as a supply. By federal law, the waters of the Great Lakes may only be used within their immediate drainage basins. Southern Lake, Porter and LaPorte Counties are outside of this area (IWR: AUN, p. 21).

Agricultural irrigation is expected to be the fastest growing use of water in Indiana. Perhaps as much as 145 percent more water will be necessary for application during the growing season by the year 2000. A particularly dry season may require approximately three and one-half times the current average water use rate. This increase is expected to have a particular impact across much of the northern third of Indiana and down the middle reaches of the Wabash River.

Rural water use is expected to increase by approximately twenty-three percent for livestock and fifty percent for residential water. The demand for rural water is sporadic across the state. Except for the generally ground-water poor area of southern Indiana, additional supplies can reasonably be met by individual wells. Some of the anticipated increase in residential water use in southern Indiana will probably be met by expansion of rural water systems.

Table 3 identifies the projected water withdrawals and consumptive use of water by the major use categories by the year 2000. When these figures are compared with the current withdrawal and consumption rates, it will be noted that total withdrawals are projected to decrease by twenty-eight percent, while consumptive use is expected to increase by more than two hundred percent.

TABLE 3

The projected water withdrawal and consumption rates
by the year 2000, in million-gallons-per-day.

Water Use	Withdrawal	Consumption *
Energy Production	5050	386
Industrial Self Supply	3430	257
Public Water Supplies	758	96
Irrigation	452	452
Rural Water Supply	209	209
Total	9899	1400

* Does not include water considered as consumed due to the transfer out of the basin of origin.

EXCESS WATER CONDITIONS

Excess water conditions are caused by the presence of water above or immediately below the surface of normally dry land. Typical excess water conditions include flooding, saturated fields, and ponded water in urban areas. Basically, these are limitations to the use of land caused by the presence of water. The types of economic damage induced by excess water are property damage from floodwaters, interruptions to transportation, crop losses, reduced crop yields, hazards to life, hazards to health, scour and erosion. Conditions of excess water are further aggravated by upland erosion. Soil erosion and consequent stream sedimentation adversely affects both the aquatic habitat and the flow capacity of the stream and can carry land based pollutants into waterways. The excess water conditions of flooding and drainage are discussed separately.

Flooding

All Indiana streams react to excessive precipitation within their watersheds. Heavy precipitation and the resulting rapid diffused surface water contribution to streamflow will occasionally cause all stream levels to raise, spill out of their normal banks and occupy adjacent lands. On infrequent occasions, precipitation may be so intense that the stream spreads out and flows across an entire valley floor.

There are a wide variety of flooding conditions encountered in Indiana. In areas of high relief, the smaller streams are characterized by narrow valleys, rapid rates of rise in water levels, and high flood water velocity. Streams exhibiting these characteristics are located in south-central and south-eastern Indiana. In areas of low relief, such as south-western and northern Indiana, floodplains are generally wide and shallow, rates of stream rise are slow, and floodwater velocities are low. In addition, there are several areas in Indiana where major streams are confined to deep narrow valleys. Examples of these areas include the region north of the White River in Martin County and the Ohio River upstream from Tell City.

The widest floodplains found in Indiana are along the Wabash River below Terre Haute, along the East Fork of the White River above Bedford, the West Fork of the White River below Muncie, the Kankakee River, and the Ohio River below Tell City. Most of these floodplains are used as cropland. Urban areas with particularly notable flood problems are Indianapolis, Fort Wayne, Evansville, and the northwestern Indiana communities in the Little Calumet River valley. Overall, there are some 1,700,000 acres in Indiana considered to be subject to riverine flooding (IWR: AUN, p. 68), with average annual flood damages conservatively estimated at $126.7 million per year. Of this amount, some $83.5 million is classified as rural damages and $43.2 million as urban damages.

Drainage

When excessive precipitation occurs over areas of low topographic relief, the resulting water tends to remain either above the surface of the earth in the form of temporary shallow pools or held high in the soil profile as excess moisture creating

waterlogged soil conditions. Productive soil landscapes subject to these problems are not able to sustain agriculture as it is practiced today without some form of artificial drainage. Approximately two-thirds of the soil associations in Indiana are subject to this problem.

The need for drainage was recognized early in the history of Indiana's development. In order to open vast areas of the state for agricultural use, an extensive system of ditches and drains was constructed. Some shallow lakes in northern Indiana were also drained for agricultural uses. In the fields themselves, field tile is used to carry excess water to surface ditches or to major tile drains. Over its history, Indiana has used a variety of legal mechanisms to construct and maintain these drainage systems. Currently the legal vehicle used for most of this work is the County Drainage Board. It is periodically necessary to remove silt and debris from ditches and other waterways to maintain their drainage potential.

Artificial drainage is paricularly necessary in the Kankakee River Valley, in north-central and in east-central Indiana. To a lesser extent, artificial drainage is necessary across the northern tier of Indiana counties and in the flat river valleys in south-central and west-central Indiana, including the valleys of the Wabash, White, and Eel Rivers. It is also necessary in the Ohio River Valley and along its tributaries west of Tell City.

Table 4 indicates the distribution of soil associations with severe and moderate wetness characteristics where artificial drainage is needed to maintain agricultural productivity.

TABLE 4

Area distribution of soil associations with severe and moderate wetness characteristics

Area	Percentage of Land Surface
Northern Indiana	84.0
Central Indiana	70.9
Southern Indiana	29.6

PROJECTED EXCESS WATER CONDITIONS

Excess water conditions are closely associated with topography and soil types. Therefore, it can be expected that the majority of land subject to excess water today will continue to be likewise subject in the future.

Flooding

The Commission made no projections of future flood damages. National projections indicate, however, that flood damages are expected to increase in the future. Reasons for this increase are the anticipated increase in the value of crops grown in floodplains and hence subject to flood damage. In a similar manner, as living standards rise, it is anticipated that the value of existing buildings that are located in floodplains and their contents will increase. Future floods, therefore, will cause greater losses than a comparable flood under present conditions. Little additional damage is attributed to new structural development in floodplains. This assumption is predicated on continued implementation of the state's floodplain management program and such nonstructural flood control measures as the National Flood Insurance Program. It will be noted however that some sixty-six percent of existing flood damages are classified as rural in nature and that nonstructural measures will have little impact in reducing such damages.

Drainage

As with flooding, the Commission made no projections of future drainage problems in Indiana. A review of the Commission's data suggests that very little in the way of major new rural drainage projects will be constructed in the last quarter of the 20th century. The major activity in the field of agricultural drainage will be a continuing effort to maintain the existing system of drains and ditches.

Urban drainage is now and will continue to be a major problem in Indiana. One of the problems is that the urban public has increasingly higher expectations as to the capability that an urban drainage system should have. These expectations are even now substantially higher than the basis on which most of the existing systems were designed and installed.

The problem of the older systems is exacerbated not only by deterioration with age, but by the continuing addition of the drainage from newly-developed areas. The rehabilitation and enlargement of old systems is not only disruptive, but is enormously expensive. Although the practice is growing, much more extensive consideration to storm-water drainage needs to be given by planning and zoning authorities to providing new outlets and to on-site retention as a means of alleviating the overloading of old systems.

Managing The Water Resource

Withdrawal and Instream Uses

The Commission adopted the concept that Indiana has in fact a single water resource, composed of the interrelated elements of atmospheric moisture, precipitation, evapotranspiration, soil moisture, surface water, and ground water. A necessary corollary is that utilization or manipulation of some one or more of these phases has impacts on other phases of the resource.

The Commission also concluded that the water resource, on a statewide basis, is adequate to meet current and reasonably foreseeable human, social, and economic needs, *given proper planning and wise management.* The force of this qualification as to the statewide adequacy of the water resource must be emphasized. There is in fact, extensive variability in both time and space in the physical availability and the quality of water within the state. Further, there is in fact, similar variability in the type, amount and point of use and need. Finally, the location of points of need, with few exceptions, is governed by factors and events other than water resource availability. The result is that the resource must be managed in such a way as to make water available where and as needed.

The basic questions are, therefore: Is the system of planning and management (law, policy and programs) that has prevailed in the past, adequate to serve present and foreseeable human, social, and economic needs? Does that system adequately recognize the interrelated nature of the several components of the resource? Does it have the capacity to accomodate existing and foreseeable future uses and needs with equity for all interests?

The Commission addressed these questions through the following process: 1) An identification of the basic types of water resource problems; 2) A general review of the present and projected water use situation in the state, as a basis for determination of the existence of, or potential for, the types of problems identified above; 3) Identification of current and potential problems; 4) Identification of the existing system of planning and management, and review of its adequacy to address current and potential problems; and 5) A discussion of the type of management system required to adequately serve present and foreseeable human, social, and economic needs.

BASIC TYPES OF WATER RESOURCE PROBLEMS

The Commission addressed the natural characteristics and the general availability and quality of the water resource, both on a regional and a statewide basis. It also evaluated existing and projected uses of water, both withdrawal and instream. These uses are identified with respect to general type, amount and geographic location, as reported in *The Indiana Water Resource: Availability, Uses, and Needs.*

Problems Associated With the Characteristics of the Resource

The basic water resource conflicts and problems evident in Indiana are associated either with the characteristics of the resource, the use of that resource, or both. The natural characteristics that relate directly to use problems include the following:

1) The water resource is finite. There are both regional and statewide limits to water availability.

2) Both ground and surface water are in a constant state of motion or flow, although at varying rates. Therefore the impacts of withdrawal uses are not confined to the point of withdrawal, but are reflected as reduced availability at all points downstream from the point of withdrawal. All withdrawal uses, whether from ground or surface sources, have impacts in some degree on the resource and hence on other uses or users.

3) The ground and surface water components of the resource are highly interrelated. Streamflows and lake levels are supported in substantial measure by ground-water discharge. It then follows, and can be demonstrated, that ground-water withdrawals can have adverse effects on streamflows and lake levels. These, in turn, result in reduced availability of surface water for withdrawal uses, in impairment of instream uses, and in damage to wetlands.

4) Ground-water availability varies radically on a regional basis within the state, primarily as a result of differences in regional geologic settings. In large areas, especially southern Indiana, poor ground-water availability results in the necessity for impoundment of surface water or the importation of ground or surface water from other areas to satisfy withdrawal demands.

   In addition, all except the largest streams in southern Indiana have a lack of substantial ground-water contribution to streamflow, and as a consequence, have poor low flow characteristics. These streams cannot, in their natural state, provide a dependable source of water for either withdrawal or instream uses.

5) Both ground and surface water availability is seasonally variable. Periods of drought and excess water are unpredictable in time of occurrence, areal

extent, duration, and severity. Variability is much more pronounced with respect to surface water than ground water.

Under normal conditions, the majority of total annual streamflow occurs during the first five or six months of the year. Streamflow during the remainder of the year is extremely low by comparison. In many cases these low flows can neither supply significant withdrawals with any degree of certainty nor support a desirable range and diversity of instream uses. This problem is intensified by the fact that a number of withdrawal use demands, including water supply, irrigation, and energy generation, reach their peaks during the normal low flow period. The demands placed upon low flows by withdrawal and instream uses are greatly exacerbated during droughts.

Problems Associated With the Characteristics of Withdrawal and Instream Uses

The several withdrawal and instream uses of water have inherent characteristics or requirements that must be recognized in the identification of the basic problems of resource utilization. The characteristics and requirements associated with the major withdrawal and instream uses are listed for each use category. It will be noted that some characteristics are common to many uses.

Public Water Supply 1) Requires a high degree of dependability of supply, even under very adverse conditions; 2) The cost of treatment of public water supplies is influenced substantially by the quality of the raw water supply; 3) Public water supply withdrawals are wholly or partially consumptive in nature with respect to either the resource itself or to other resource users in the following general cases: a) Where withdrawn from ground-water sources, the use is consumptive with respect to the aquifer in that no part of the withdrawn water is normally returned to that aquifer; b) Where withdrawn from surface sources, the use is totally consumptive with respect to the source if return flows are discharged to another stream; c) Totally consumptive with respect to that reach of a stream between the points of intake and discharge if return flows are discharged to the same stream; and d) Partially consumptive with respect to all points downstream of the point of return flow where discharged to the same stream; 4) Withdrawal requirements are seasonally variable, with highest demands during the summer months.

Industrial Self-Supplied Water 1) Most industrial water requires a high degree of dependability of supply, even under adverse conditions; 2) The cost of treatment of industrial water supplies, where required, is influenced substantially by the quality of the raw water supply; 3) Industrial water supply withdrawals exhibit a greater range of diversity than public water supply with respect to consumptive use; 4) In addition to the same general cases described for public water supply, some substantial withdrawals for cooling water are made from surface water and returned to the source very near the point of intake with no significant consumptive use; 5) Many, but not all, withdrawal requirements are seasonally variable, with peak demands during the summer months.

Rural Water Supply 1) Rural water supply is generally considered a totally consumptive use; and 2) Its requirements are seasonally variable with peak needs occuring during the summer months, particularly with respect to livestock.

Irrigation 1) Other than for golf courses and specialty crops, irrigation withdrawals are limited to specific geographic areas having favorable soil conditions; 2) Water quality is not a limiting factor to irrigation in Indiana; 3) The economics of supplemental agricultural irrigation, as practiced in Indiana, are not conducive to the development of central sources of supply or of supplies remote from the point of need; 4) Irrigation is considered to be a totally consumptive use; 5) Withdrawal requirements are highly seasonal, being limited to the growing season, and are highly variable from year to year, depending upon rainfall conditions.

Energy 1) Requires a high degree of dependability of supply, even under adverse conditions; 2) Once-through power plant cooling requires very large volumes of water, although the water is normally returned to the source very near the point of withdrawal. There is little consumptive loss, but the discharge is at elevated temperatures; 3) Where cooling towers or cooling ponds are required to meet thermal standards there are drastic reductions in intake requirements but significant increases in consumptive losses; 4) There is significant potential for the conversion of coal, shale and biomass to more directly useful forms of energy. The conversion requires substantial quantities of water, depending upon the process and the size of plant.

Instream Uses Instream uses are defined as those which are made of surface water in place. They include fishing, boating, swimming, urban and agricultural drainage, the disposal of liquid wastes, navigation, hydroelectric power generation, the passage of flood flows, and general aesthetic enjoyment. In addition, surface water is the natural habitat of aquatic organisms and of riparian vegetation which in turn serves as the natural habitat of a variety of birds and animals. Of these varied uses, aquatic organisms, fishing, swimming and aesthetic enjoyment are directly and immediately related to water quality. Commercial navigation, recreational boating, and hydroelectric power are dependent upon adequate and dependable flows, depths, and surface areas. The waste assimilative capacity of streams is a direct function of the rate of streamflow. Urban and agricultural drainage is a function not only of the capacity of the stream, but of its depth in relationship to the elevation of the lands to be drained. Finally, it is important to note that many instream use demands reach their peak during the natural low flow period for streams.

General Categories of Problems

Simple logic indicates that water resource *problems* are not caused by the resource itself, but by man and the uses that he makes of the resource. Water conflicts or problems are caused by the numerous, sometimes conflicting or incompatible uses that man applies to the resource. These various uses often result in competition for the same water resource. However this competition may be further aggravated by the natural and inherent characteristics of that resource.

The general categories of problems that arise from competition for water are outlined as follows:

1) Competition for surface water

   a) As between multiple withdrawals from the same surface source, whether for the same or different purposes.

   b) As between withdrawal uses and instream uses.

   c) As between different kinds of instream uses.

2) Competition for ground water

   a) As between multiple withdrawals from the same aquifer, whether for the same or different purposes.

   b) As between withdrawal uses and instream uses, by reason of reductions in the ground-water contribution to streamflow.

   c) As between ground-water withdrawals and surface water withdrawals, by reason of reductions in the ground-water contribution to streamflow.

REVIEW OF THE PRESENT AND PROJECTED WATER USE SITUATION

For the purposes of this review, the state has been divided into the three general areas of northern, central, and southern Indiana, as shown in Figure 1. Northern Indiana consists of Planning and Development Regions 1A, 1B, 2, 3A, and 3B and contains 20 counties. Central Indiana consists of Planning and Development Regions 4, 5, 6, 7, 8, and 9, and contains 40 counties. Southern Indiana consists of Planning and Development Regions 10, 11, 12, 13A, 13B, 14, and 15, and contains 32 counties. Each of these three areas is examined qualitatively with respect to existing or potential problems involving public water supply, industrial water supply, rural water supply, irrigation and energy. Current and projected use data is summarized from the more detailed information contained in *The Indiana Water Resource: Availability, Uses, and Needs.*

Northern Indiana

Public Water Supply The major public water supply uses are found in the Calumet region and in and around the cities of Michigan City, South Bend, Mishawaka, Elkhart, and Fort Wayne. The Calumet region and Michigan City are supplied from Lake Michigan. The South Bend-Mishawaka-Elkhart area is served entirely from ground water. South Bend is the largest city in the state that relies exclusively upon ground water for its supply. Fort Wayne is supplied exclusively from the St. Joseph River. New Haven is supplied by Fort Wayne. Bluffton, Huntington and Warsaw are supplied in part from ground water and in part from surface water, with ground water being the major source in each

Figure 1

Map of Indiana showing the location of the northern, central, and southern areas of the state and the eighteen study regions of the Governor's Water Resource Study Commission.

instance. All other public water supplies in northern Indiana are obtained entirely from ground water. Total public water supply withdrawals are projected to increase from 186 million gallons-per-day (mgd) in 1977 to 244 mgd by the year 2000, with consumptive uses increasing from 21.7 mgd to 28.4 mgd.

Self-Supplied Industrial Water The major industrial water supply requirements are centered around the same three areas as those for public water supply. The Calumet area in Lake and Porter Counties, which represents by far the highest industrial water use area in the state, is supplied from Lake Michigan. In the South Bend-Mishawaka-Elkhart area, most industrial requirements are supplied from ground water, although a few industries use significant amounts from the St. Joseph River. In the Fort Wayne area, most self-supplied use is from ground water. In general, all other industrial water supplies are obtained from ground water.

Self-supplied industrial water withdrawals in northern Indiana are projected to decrease slightly from 3,188 mgd (of which 3,093 mgd is from Lake Michigan) in 1977 to 3,121 mgd by the year 2000. Consumptive use is projected to increase from 103 mgd to 171 mgd. Most of this will be in the Calumet area adjacent to Lake Michigan.

Rural Water Supply Rural water supplies throughout northern Indiana are obtained from ground water by means of individual wells. Such uses are projected to increase from about 43 mgd in 1977 to 71 mgd by the year 2000, and are considered to be totally consumptive.

Irrigation Northern Indiana possesses the majority of the soils in the state with an economic potential for agricultural irrigation. These soils are located in the basins of the Kankakee, Yellow, St. Joseph, Elkhart, Pigeon, and upper Tippecanoe Rivers. The total area possessing high irrigation potential is approximately 513,000 acres.

Approximately 30,840 acres were irrigated in 1977, with a projected increase to 100,000 acres by the year 2000. Average year irrigation withdrawals are expected to increase from some 134 mgd in 1977 to 263 mgd by the year 2000. Approximately 52.5 percent of the 1977 irrigation withdrawals was from ground water. Ground water may supply 66 percent of irrigation water by the year 2000. In addition to the agricultural irrigation, withdrawals for golf course irrigation is projected to increase from about 10 mgd in 1977 to 12.9 mgd by 2000. All irrigation uses are considered to be totally consumptive.

Energy One internal combustion, two hydroelectric, and six fossil-fueled generating plants are located in northern Indiana. Only the fossil-fueled plants have water withdrawal requirements. Of these, four are located on Lake Michigan, with one each on the Kankakee and St. Joseph Rivers. Some of the electrical energy requirements of the area are met by imports from other areas. Withdrawal uses are expected to increase from 588 mgd to 603 mgd by the year 2000, with increases in consumptive use from 21.8 mgd to 28.4 mgd.

Instream Uses Much of the area currently has an adequate supply of water for boating, skiing and fishing (assuming general access to lakes and streams) with the

notable exception of the Fort Wayne area, where opportunity for such activities is almost totally lacking. In addition, the assimilative capacity of the Maumee River is impacted in some degree by water supply withdrawals.

Overview In general, northern Indiana possesses very substantial water resources. With the exception of the southeastern, southwestern, and northwestern corners of the area, ground-water availability ranks as the best in the state. Streamflows generally are reflective of the high ground-water availability, having well sustained low flow characteristics. The area contains the great majority of the natural lakes in the state, as well as the significant wetlands. Lake Michigan affords an ample source of supply for all purposes within the drainage basin of the lake. Most of the future needs for public, industrial, and rural water supply (other than those in the drainage basin of Lake Michigan) will probably be met from ground water.

The area is an importer of electric energy. It appears that because of land use and environmental considerations, additional generating facilities on Lake Michigan may be limited to replacement or modernization of facilities on existing sites, other than the Bailly Nuclear unit now under construction. Elsewhere in the area, there is some potential (at least with respect to water availability) for new sites on the Kankakee and St. Joseph Rivers, although supplemental storage would undoubtedly be necessary.

Agricultural irrigation presents the most rapidly growing demand for water. Not only is irrigation a totally consumptive use, but it occurs during periods when streamflows are in seasonal decline, and at a time when ground-water recharge is normally limited. Irrigation withdrawals place a relatively high demand on the resource per unit area within the irrigated area. Some 513,000 acres, or 801 square miles, of soils have economic potential for agricultural irrigation. Full development of this potential would require on the order of 1,400 mgd during the average growing season.

Ground water is the most probable source of supply for about two-thirds of the projected irrigation. Although the northern area is generally characterized by the best ground-water resources in the state, there is a realistic potential for competition and conflicts between individual irrigators, between the impacts of irrigation withdrawals and those for public, industrial and rural water supply, and between ground-water withdrawals and instream uses.

The potential for conflicts between individual irrigators from ground-water sources exists in northern Indiana. Group enterprise or central source irrigation is not anticipated. As a result, wells will be located to fit individual ownership patterns without adequate regard to well spacings that would prevent or minimize well interference.

The potential for competition or conflicts between public, industrial self-supplied, rural supplies, and irrigation exists because of the potential general lowering of ground-water levels in the heavy ground-water use areas. Such effects will probably be reflected first on the numerous private wells for rural water supply, because these are normally no deeper than necessary to obtain water under existing ground-water level regimes.

The potential for conflicts between ground-water pumpage and instream uses is significant. The levels of the numerous natural lakes in the region are sustained in substantial measure by ground-water discharge, and even small deficiencies in normal levels are a matter of great concern to lake users. In like manner, the generally good low-flow characteristics of the streams of the region, which renders them especially valuable for instream uses, is the result of substantial ground-water contribution to streamflow. The rather extensive wetlands in the region are also heavily dependent upon ground-water levels and ground-water discharge to streamflow. Significant decreases in regional ground-water levels as a result of ground-water pumpage, whether from irrigation or public and industrial uses, would be reflected in decreased streamflows, lowered lake levels and impairment of wetlands.

It should be noted that agricultural irrigation withdrawals from surface water coincide with the normal period of declining streamflows. Depending upon the concentration of withdrawals upon a given stream or stream segment, there could be substantial conflict with other withdrawal uses, with instream uses and, depending upon circumstances, with lake levels and wetlands.

Central Indiana

Public Water Supply The major public water supply uses are found in and around Indianapolis, Lafayette, West Lafayette, Kokomo, Richmond, Anderson, Muncie, Marion, and Terre Haute. The range of supply sources is indicative of the somewhat "mixed bag" of relative availability of surface and ground water. Lafayette, West Lafayette, Anderson, and Marion are supplied entirely from ground water. The Indianapolis service area is supplied almost entirely from surface water. Richmond utilizes substantial supplies from both surface and ground-water sources, with surface water being slightly predominant. Terre Haute uses both ground and surface sources, with ground water providing the major share. Speedway uses both ground and surface sources. Oldenburg and Batesville are supplied entirely from surface water, while all others in the region use ground water exclusively.

As would be expected, due to the pattern of reduced ground-water availability from north to south, rural water systems occur in these ground-water poor areas of the southern portion of central Indiana.

Self-Supplied Industrial Water The majority of self-supplied industrial water requirements are centered around the same major areas as those for public water supplies. Most of the supply is from ground water. About 43 percent of the total 1977 withdrawals of 215 mgd occured in the Indianapolis area. Total withdrawals are expected to increase to about 244 mgd by the year 2000. Consumptive uses are estimated to increase from 35 mgd to 67 mgd.

Rural Water Supply Rural water supplies are generally obtained from individual wells, although ponds and cisterns are important for watering livestock in some areas. Rural water supply use is projected to increase from 63 mgd in 1977 to 95 mgd by the year 2000. Rural water supply withdrawals are considered to be totally consumptive.

Irrigation Central Indiana ranks a distant second among the three general areas in the amount of agricultural lands possessing economic potential for irrigation. The areas with irrigation potential generally lie in long, relatively narrow strips paralleling the major water courses, and total about 261,000 acres.

Approximately 5,900 acres were irrigated in 1977, with a projected increase to 41,000 acres by 2000. Irrigation withdrawals are projected to increase by 16 mgd to about 111 mgd. Approximately 57 percent of the 1977 irrigation withdrawals were from ground water. It is estimated that ground water will supply about 58 percent by the year 2000. In addition to the agricultural irrigation usage, withdrawals for irrigation of golf courses is expected to increase from about 13 mgd in 1977 to 18 mgd by 2000.

Energy There are a total of fourteen electric generating plants in central Indiana, including one in an advanced construction stage. Two are hydroelectric, located on Tippecanoe River, and the remainder are fossil-fueled. Of these, four are municipally owned (Crawfordsville, Logansport, Peru and Richmond). Four large plants located along the Wabash River and four along the West Fork of the White River utilize those streams for cooling water. The fourteen plants have a combined nameplate rating of 5,234 megawatts. Combined withdrawals during 1977 were approximately 2,788 mgd, with an estimated consumptive use of 8 mgd. Withdrawals are projected to decrease to 1,862 mgd, accompanied by an increase in consumptive use to 28 mgd.

Instream Uses Very substantial deficits in supply for boating, waterskiing and fishing currently exist in most of central Indiana. It is expected that these shortages will intensify and extend to all parts of central Indiana by the year 2000.

Overview The ground-water resource in central Indiana is in the transition zone from the generally excellent resource in northern Indiana to the generally poor conditions in southern Indiana. In the central, north-central and easterly portions of the area, ground-water availability is generally in the range of 200 to 400 gpm. Elsewhere, availability decreases very significantly and is in the general range of 50 to 100 gpm, with some extensive areas in the southeast and southwest limited to potential yields on the order of 10 gpm. The potential high yield areas are limited to the alluvial valleys of the Wabash, East and West Forks of the White, and Whitewater Rivers.

Only the Wabash River is an interregional stream. Central Indiana is the headwater area for the East and West Forks of the White River and the East and West Forks of the Whitewater. The Salamonie and Mississinewa Rivers, Sugar Creek, Eel River, and lower Tippecanoe River are the other major streams in the region.

Central Indiana has very few natural lakes, but does have a number of artificial reservoirs, of which the most significant are Lakes Shafer and Freeman, and the Salamonie, Mississinewa, Mansfield, Brookville, Morse, Geist and Eagle Creek Reservoirs.

When considered in light of water resource availability and of the rather concentrated areas of the major demands, it becomes apparent that projected

water requirements will require careful planning. Planning is necessary to determine the source of supply to be utilized in the particular case and to give adequate consideration to impacts on other uses, both withdrawal and instream. In much of the area, even relatively modest ground-water developments can have impacts on ground-water levels over considerable distances. Many communities will find it necessary to go further afield to find new sources of supply. Instream needs, especially for recreation and waste assimilation capacity, are substantial on a number of streams, especially Wildcat Creek and the West Fork of the White River. Particular attention needs to be given to the maintenance of the low flow regimes of significant streams, and to the improvement of low flows in those streams where substantial impacts already exist.

It is noted that, although agricultural irrigation was rather modest in 1977, the projected acreage by the year 2000 is significant. Since the irrigable areas generally lie along stream valleys, irrigation water withdrawals pose the potential for conflicts with instream uses, whether withdrawn from streams or from aquifers located in stream valleys.

There is potential, insofar as water availability is concerned, for new electrical generating plants along the West Fork of the White and Wabash Rivers. Such construction would however, necessitate supplemental storage for use during periods of low flow.

Southern Indiana

Public Water Supply Fifty-five percent of the total public water supply withdrawals in southern Indiana in 1977 were accounted for by Bloomington, Columbus, Bedford, Vincennes, Evansville, Clarksville, and New Albany. Evansville accounted for 50 percent of the combined usage of these seven cities, and about 27.5 percent of the total regional withdrawals for 1977. Of these major cities, Evansville, Bloomington, Bedford, and New Albany are supplied from surface water, while Clarksville, Columbus, and Vincennes utilize ground water.

Southern Indiana has by far the largest number of surface water supply sources of the three statewide areas; a reflection of extensive areas of poor ground-water availability. Southern Indiana is also characterized by very extensive rural water supply systems for the same reason. Only Decatur, Orange, and Posey Counties have limited rural systems. The public water supply withdrawals are projected to increase from 108.8 mgd in 1977 to 160.5 mgd by 2000, with consumptive uses increasing from 19.8 mgd to 30.0 mgd.

Self-Supplied Industrial Water Southern Indiana is not characterized by large water-using industries. The 1977 withdrawals of 52.9 mgd and projections to 65 mgd by the year 2000, are modest in comparison to those in northern and central Indiana. Consumptive uses are expected to increase from 8.8 mgd to 18.1 mgd. Ground water is the principal source of supply for self-supplied industrial water in southern Indiana.

Rural Water Supply Rural water supply withdrawals of 5.6 mgd in 1977 are projected to increase to 44.4 mgd by the year 2000. This is considerably less than

that for northern and central Indiana, although one important factor is the significant rural usage supplied by rural water companies, which is accounted for under public water supply. Sources of supply vary widely, from individual wells where possible, to farm ponds, strip mine lakes, cisterns, and supplies transported by truck.

Irrigation Approximately 7,860 acres were irrigated in 1977, with withdrawals of 20.6 mgd, of which almost all was from surface water. The irrigated acreage is expected to increase to about 16,100 acres by the year 2000, with projected withdrawals of 42.6 mgd. About 80 percent of this usage may be supplied from ground water. The major expansion in irrigation is expected in Green, Knox, Daviess, Bartholomew, and Jackson Counties, along the valleys of the Wabash and the East and West Forks of the White River. There are about 45,300 acres in southern Indiana that have some potential for irrigation. In addition to agricultural irrigation requirements, 1977 withdrawals for golf courses was 3.5 mgd and is expected to increase to 4.6 mgd by the year 2000. All irrigation uses are considered to be totally consumptive.

Energy As might be anticipated because of the availability of water in the Ohio, White and Wabash Rivers, southern Indiana contains a number of large electrical generating plants. There is one hydroelectric and six fossil-fueled plants along the Ohio River in Indiana, with one nuclear and two fossil-fueled plants under construction and one fossil-fueled plant in advanced planning along the same stream. Of the remaining plants, one is on the Wabash River, two are on the White River, one is on the West Fork of the White River, and one is on the Patoka River.

Gross nameplate capacity in 1977 was 6,890 megawatts. It is significant that announced expansion at existing and new sites totals about 10,680 megawatts. These will occur on the White, Wabash, and Ohio Rivers. 1977 withdrawals of 4,800 mgd with a consumptive use of 21 mgd are projected to change to 2,245 mgd and 170 mgd, respectively, by the year 2000.

Instream Uses The supply for boating, waterskiing, and fishing is adequate to meet current demands in all areas of southern Indiana except the general notheastern section. By the year 2000, substantial deficits will extend to the northwestern quarter as well.

Overview Significant ground-water availability is limited to the alluvial valleys of the Ohio, Wabash, White, East Fork of the White, West Fork of the White and Eel Rivers. These same streams, plus the Patoka, Muscatatuck, Driftwood, Flatrock, and Blue Rivers, are the major streams in southern Indiana. The major reservoirs are Cagles Mill, Monroe and Patoka. Both Monroe and Patoka Reservoirs have large water supply storages owned by the state. Each is already supplying substantial amounts of water, either directly to cities in the case of Monroe or to a large regional water district in the case of Patoka. Very substantial reserve capacity is available in both projects.

The major water supply problems of southern Indiana relate to those municipalities and rural areas which are at some distance from the major river valleys and the economic zone of influence of the Monroe, Patoka and Brookville Reservoirs. The rural water systems are generally at or approaching the limits of

reasonable distance from their source of supply and lack the distribution capacity to serve substantial uses. Numerous small communities are struggling with supply developments that are only marginally adequate for present needs and have little or no capacity to serve population growth or economic development. The development of regional sources of supply would appear to be both necessary and desirable in several areas.

It appears that there are substantial rural areas where supplies are extremely limited, but which, due to costs and sparsity of the population, may not be served by rural water companies. The projected growth in irrigation has the potential for conflicts between individual irrigators, other stream withdrawal uses, and instream uses.

General Conclusions

In summary, the current withdrawal and instream uses, and the availability of the water resource, have led to past and present water resource management practices, namely:

1) Indiana water users have utilized the most readily available sources of supply. Where available in sufficient supply, ground water is the preferred source because of lower costs of development and treatment.

2) Creativity has been employed in a number of cases in the development of supplies. Examples include off-channel storage reservoirs, regional sources of supply, and rural distribution systems.

3) Development of supply sources has, in the general case, occured without consideration to the effects of such development on other users or uses, including instream uses in particular. There are a number of cases where instream uses, including fish and wildlife, recreational uses, and waste assimilative capacity, have been adversly affected.

4) The location of a number of the points of need for water is not coincident with local water availability. Hence there already exists the practice of the importation of water from both ground and surface sources which are distant from the point of use.

5) Agricultural irrigation, from both ground and surface sources of supply, is a rapidly growing practice in some areas of the state.

6) The consumptive use of water, resulting primarily from water recycling efforts by industry, from the thermal limitations on power plant cooling water, and from irrigation, is increasing at substantial rates.

7) There are now substantial regional deficits for water-related recreation.

In looking to the future, the following patterns emerge:

1) Withdrawal uses of all types, except for electrical energy and self-supplied industrial water, will increase substantially.

2) The consumptive use of water is expected to increase by about 22 percent to some 1,400 mgd by the year 2000.

3) There will be an intensification of demand for such instream uses as boating, waterskiing, and fish and wildlife, and a much heavier usage of the existing supply. No major new supplies of surface water for boating and waterskiing are expected.

4) Withdrawal uses, whether from ground or surface sources, can adversely affect instream uses, both with respect to recreational uses and the waste assimilative capacity of streams. Impairment of waste assimilative capacity can have severe water quality impacts and may impose requirements for additional treatment.

5) There will be increasing competition between withdrawal users, both from ground and surface sources.

6) The continuing and expanded need for developing supply sources at points distant from the point of use will develop substantial conflicts between those seeking such supplies and actual or potential users in the region of proposed development.

7) The as yet unknown, but clearly prospective, development of energy-conversion facilities will present situations which have clear potential for problems in the development of needed water supplies in harmony with other uses and needs.

8) The largely untapped flood runoff of Indiana streams has significant potential for development in connection with many supply problems, including instream uses.

CURRENT AND POTENTIAL PROBLEMS

It is concluded that each of the general problem categories previously identified already exists in Indiana in varying degrees. However, with a few exceptions, none of them are presently at an acute stage. When the water use projections are analyzed, a scenario emerges whereby competition for the water resource intensifies and conflicts between water uses and users become inevitable.

This is not to say that either the same types or degrees of conflicts will necessarily occur on a statewide basis. It is safe to say that no part of the state is entirely free of either present or future conflict situations of some type.

In summary, the major focus of the water resource situation is centered around the issue of water rights and managment, not that of adapting to a very scarce resource. *The central problem is:*

> *managing a resource that must serve a diversity of uses and needs that are not usually mutually compatible in such a way as to minimize conflicts, to promote equity as between various uses and users, to provide a reasonable degree of certainty as to rights to use, to promote efficiency in utilization, and to enable water to be supplied to the areas of need while ensuring reasonable protection for areas of origin.*

Managing the water resource must be done with full recognition of the variability of the resource in time and space, of the variability in the relative occurence of ground and surface water, and of the interrelated nature of ground and surface water.

THE EXISTING WATER RESOURCE MANAGEMENT SYSTEM

The major elements of the existing management system (law, policy and programs) have been assembled in a condensed form and are contained in the appendix to this report. The Commission has examined this existing program in the light of its analysis of the present and projected water use situation, and of its conclusions with respect to the basic problem, that of water rights and management. The following general conclusions are drawn from a review of the existing water program outlined in the appendix and treated in expanded fashion in *The Indiana Water Resource: Availability, Uses, and Needs (pages 91-124 and 493-502).*

1) The General Assembly over the years has addressd many aspects of the water resource through a substantial number of legislative enactments. Interestingly, although probably not from any conscious recognition of the hydrologic cycle and its interrelated components, it has addressed all of those elements in some measure.

2) The vast bulk of the existing program is concentrated in two major areas, enabling acts and regulatory acts. *Enabling acts* are designed to provide the authority and institutions at state and local levels to provide for public water supply, drainage, water quality, recreation, fish and wildlife, and flood control. *Regulatory acts* are designed to protect and promote the public health and safety, primarily in the area of water quality, public water supply and floodplain management.

3) Two major program elements, rights to use and management of use, have been addressed by the General Assembly in a very limited degree. The only significant legislation relating to these elements is found in I.C. 13-2-1 and I.C. 13-2-2, dealing with surface water and ground water, respectively. It then remains that, subject to the limited impacts of these two statutes, the matter of water rights rests with the common law of the state. That law essentially vests water rights in the riparian owner in the case of surface water and in the overlying land owner in the case of ground water.

4) In summary, the existing water program consists of a substantial body of enabling legislation for implementing many water resource objectives, together with a similar body of law and programs designed to protect the public health, safety and welfare.

   The existing program does not provide in any substantial degree for the mitigation or resolution of conflicts over the actual taking of water from its source, over impacts of such takings on other uses and interests, or over competing or conflicting uses, save only to the courts.

CONCLUSIONS

The Commission therefore concludes that:

1) The primary issue is management of the water resource to achieve the following objectives:

   a) minimize conflicts between a diversity of uses and needs;

   b) promote equity between various uses and users;

   c) preserve and protect the public interest;

   d) provide a reasonable degree of certainty as to rights of use;

   e) ensure reasonable provision for present and future uses in the watershed of origin, before water is transferred out of the basin for other uses;

   f) promote economic and efficient utilization; and,

   g) provide a procedure whereby questions of use may be resolved on a timely basis, while giving adequate recognition to all interests involved and the characteristics of the resource itself.

2) The existing law of water rights in Indiana is inadequate to provide that legal basis and management framework within which human, social and economic water needs may be satisfied in a timely and equitable manner. This conclusion is based upon the finding that:

   a) The existing common law is directly concerned only with withdrawal uses by riparian owners in the case of surface water and by overlying land owners in the case of ground water;

   b) It provides no basis in law for uses on non-riparian and non-overlying lands, which in many cases is the major use and need and is a widely prevalent practice throughout the state;

   c) It provides no certainty of rights to use, regardless of the type of use or the investments made to take and utilize the water;

   d) It provides no recognition for legitimate and necessary instream uses and needs;

   e) It provides no basis for recognition of the interrelated nature of the various components of the water resource and of the relative impacts of uses of the various components;

   f) The only recourse for conflict resolution is to the courts, where the constraints of the present law and the narrow issues of a particular case preclude consideration of the full range of relevant factors.

3) There is need for legislation to create a water rights and use management statute for Indiana.

4) The General Assembly has established certain public policy that provides a substantial basis for the development of a water rights and use management statute, to wit:

> I.C. 13-2-1. "Water in any natural stream, natural lake or other natural body of water in the State of Indiana which may be applied to any useful and beneficial purpose is hereby declared to be a natural resource and public water of the State of Indiana and subject to control and/or regulation for the public welfare as hereinafter determined by the General Assembly of the State of Indiana."
>
> I.C. 13-2-2. "It is hereby declared a public policy of this state in the interest of the economy, health, and welfare of the state and its citizens, to conserve and protect the ground-water resources of the state, and for that purpose to provide reasonable regulations for its most beneficial use and disposition."

ALTERNATE MANAGEMENT STRATEGIES

The Commission has considered possible alternatives to its conclusion as to the need for a water rights and use management statute. The management alternatives included: 1) maintaining the status quo; 2) legislative clarification of vague terms in the existing common law; 3) providing the courts with *amicus curiae* technical advisors from qualified state agencies, while retaining the existing law; and 4) providing administrative mediation of water rights disputes and conflicts by a qualified state agency, with opportunity for final recourse to the courts, while retaining the existing law.

While some one, or a combination, of these possible causes of action might be helpful to a degree, none of them offers any substantial assistance to the solution of the basic problem. These management strategies are rejected because the fundamental problem has its basis in the law itself. No modification of strategy based upon these laws would be adequate. Current Indiana water law was developed primarily during or before the eighteenth century in an era that bears little or no resemblance to modern uses and needs for the water resource. Furthermore, the current body of law is inadequate in its concepts and doctrines to serve the needs of the future.