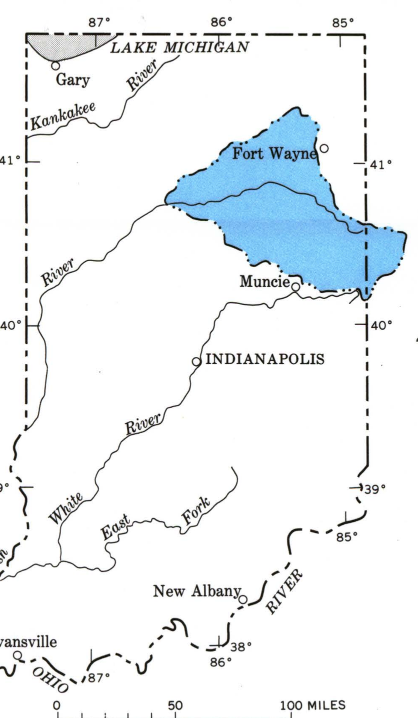
PHYSICAL SETTING

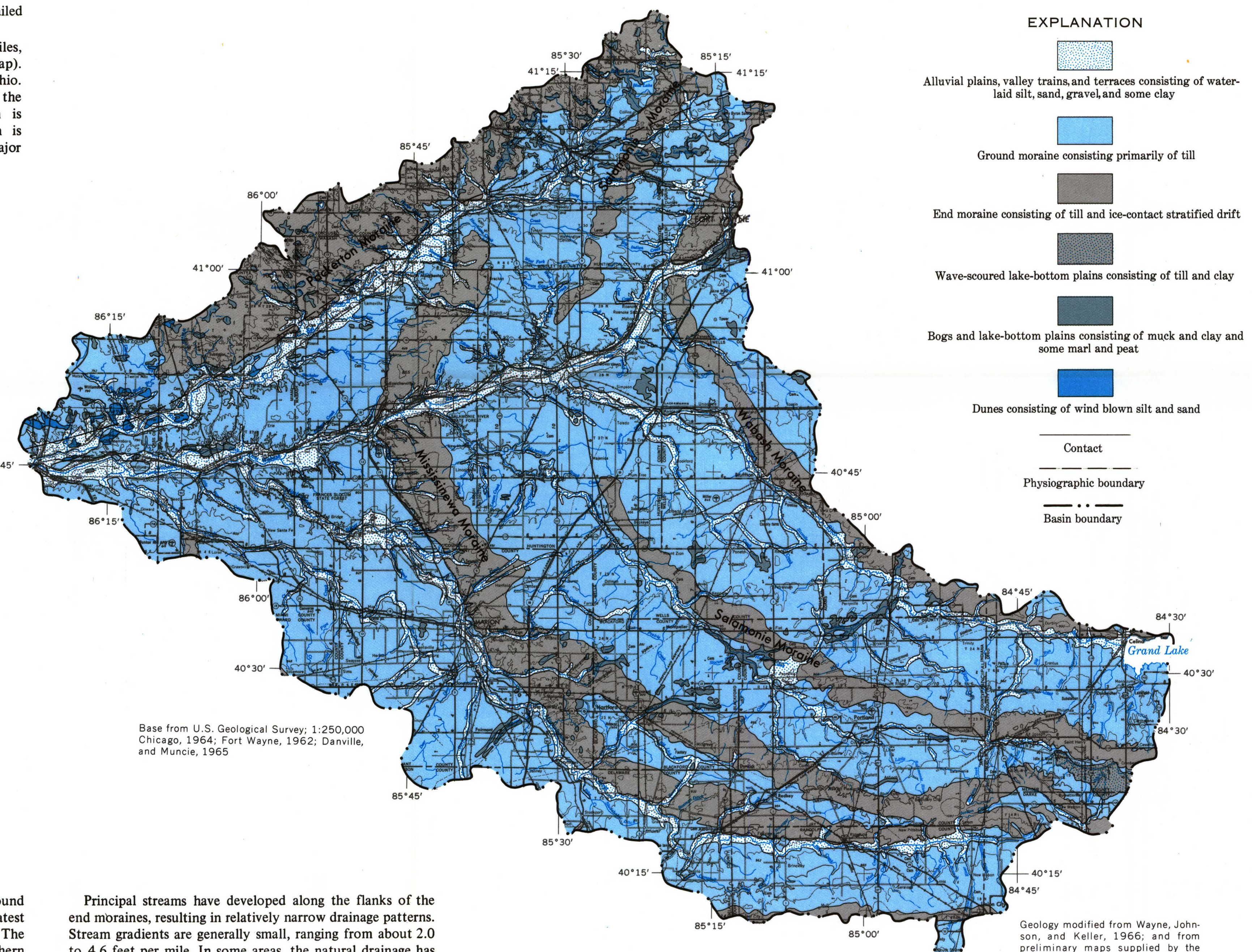
INTRODUCTION

The upper Wabash River basin is one of 18 watersheds established in 1956 by the Indiana Water Resources Study Committee. This report presents general information on streamflow characteristics, ground-water availability and the quality of water in the basin. The presentation is a regional appraisal of the water resources in the basin and is intended to provide a base for planning purposes. Additional detailed data is necessary for design of specific projects.

The upper Wabash River drains 3,779 square miles, primarily in northeastern Indiana (see index map). Approximately 285 square miles are in northwestern Ohio. The investigation was concentrated on the Indiana part of the basin. The population of this part of the basin is approximately 360,000. The economy of the region is primarily agricultural; however, manufacturing is of major importance.



INDEX MAP OF INDIANA
SHOWING LOCATION OF REPORT AREA



SURFICIAL GEOLOGIC MAP

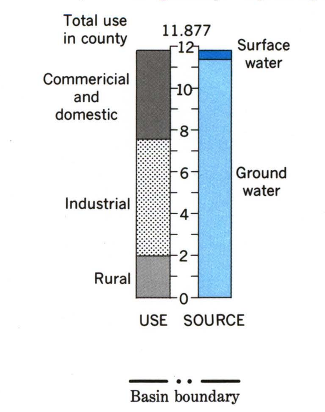
SURFICIAL GEOLOGY AND PHYSIOGRAPHY

The surface of the basin consists predominantly of ground moraine and end moraines deposited during the latest glaciation of Wisconsin age (see surficial geologic map). The area covered by the Packerton Moraine is within the Northern Lake and Moraine region, and the rest of the area is in the Tipton Till Plain (Wayne, 1956). The topography is nearly flat to gently rolling, and has gentle land slopes except near the downstream reach of the Wabash River, where entrenchment of the river valley is greatest. Altitude ranges from about 1,170 feet near Union City in Randolph County to about 570 feet at Logansport.

Principal streams have developed along the flanks of the end moraines, resulting in relatively narrow drainage patterns. Stream gradients are generally small, ranging from about 2.0 to 4.6 feet per mile. In some areas the natural drainage has been improved by ditching.

Numerous lakes of glacial origin are present just north of the Eel River. Blue Lake in Whitley County is the largest lake within the basin with a surface area of about 239 acres. Depths in the lakes do not exceed 75 feet. A few of the larger lakes are used for recreational purposes.

WATER USE



Water supplies in the basin are obtained primarily from ground-water sources, and the use is fairly evenly distributed among three major categories: rural, commercial and domestic, and industrial.

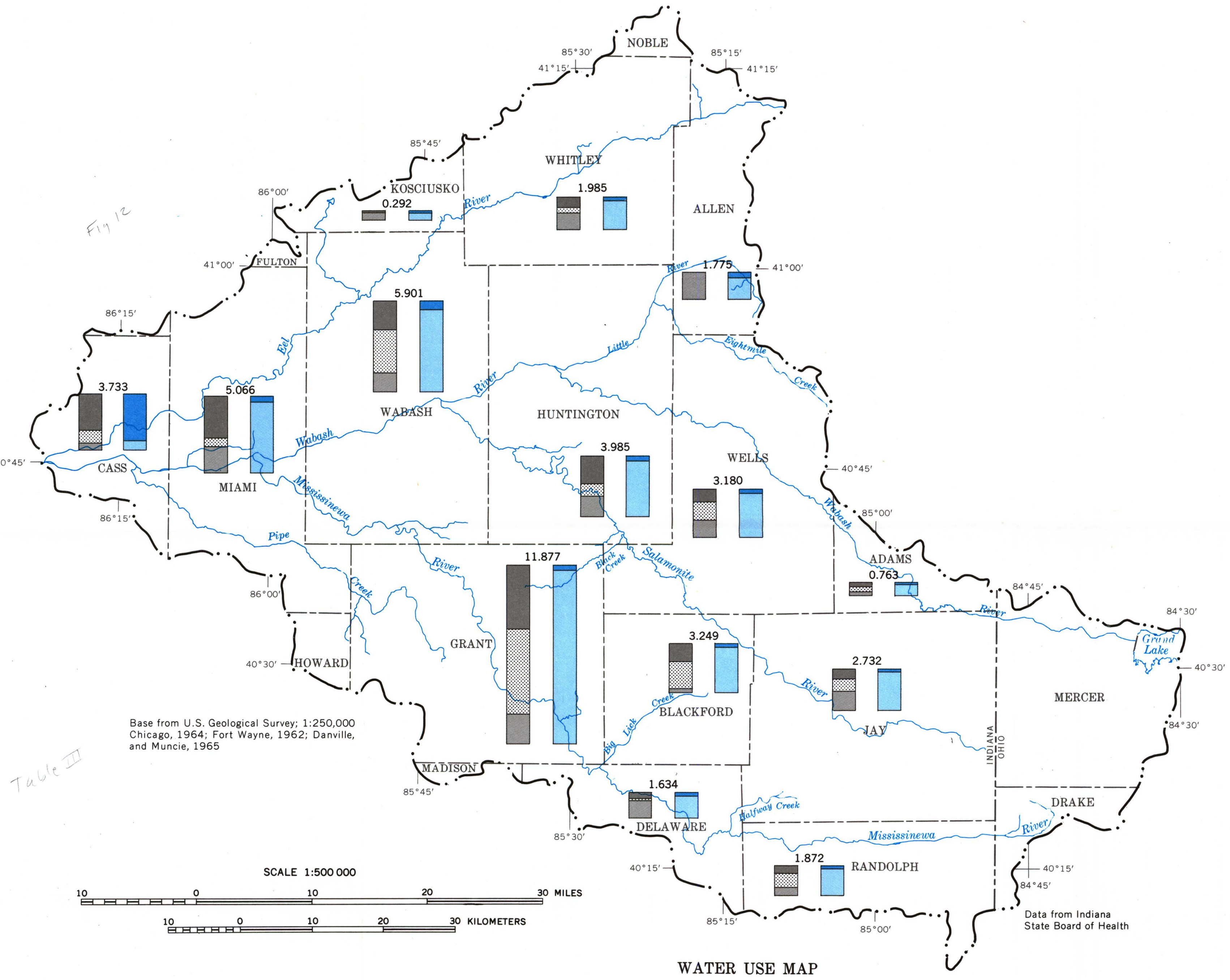
The map indicates the estimated use in Indiana in 1967 by county or parts of counties within the basin, if the use is significant. The use in the basin amounts to approximately 14,000 gpd (gallons per day) per square mile. The use in Grant County, the most highly industrialized area, is 30,400 gpd per square mile.

Water furnished by public water supplies has increased more than 25 percent since 1959, and is a reflection of the growing demand for water. During the same period, the population served has increased less than 5 percent.

Summary of water use in 1967, in million gallons per day

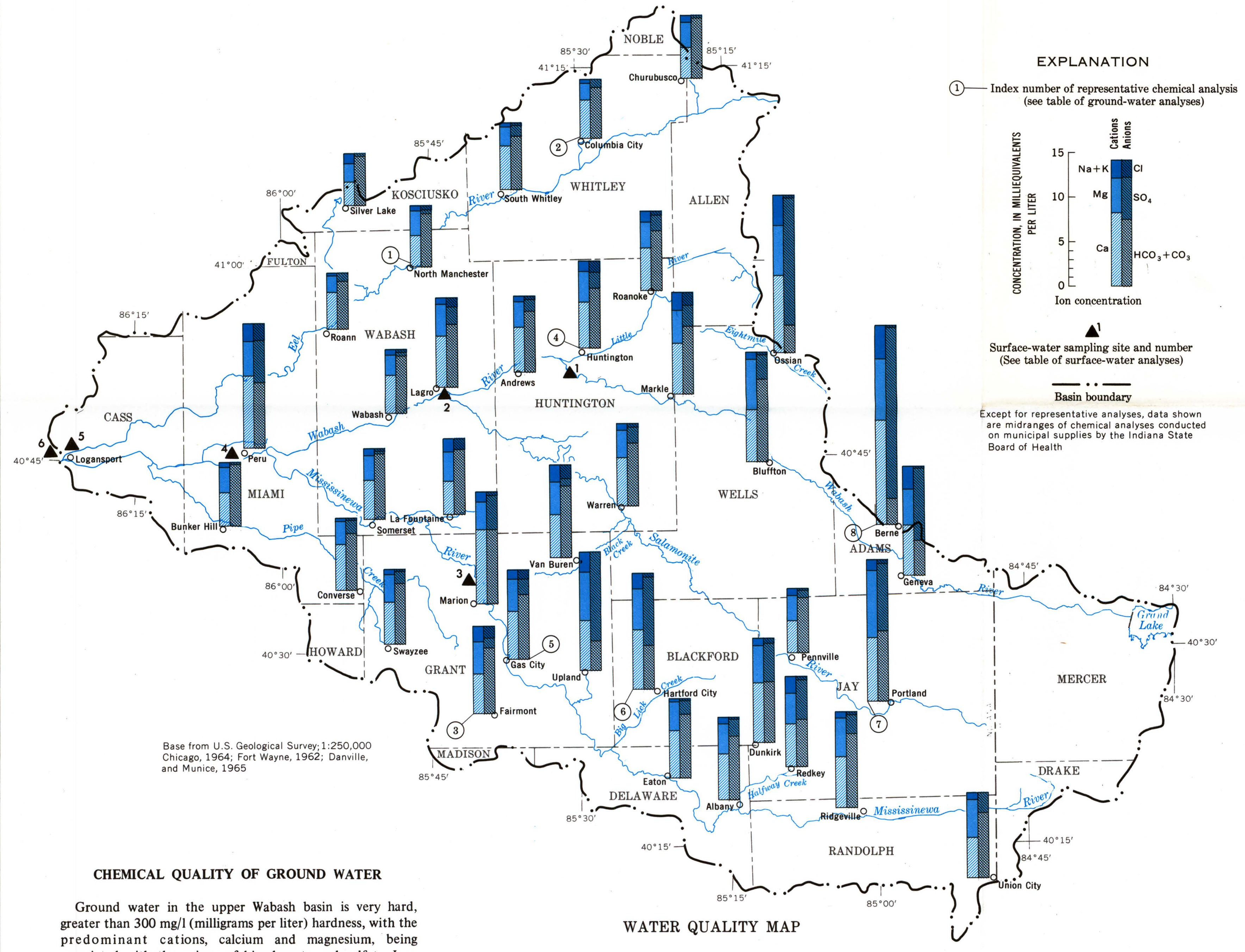
Source	Rural[1]	Public Water Supply		Industrial self-supply	Total
		Commercial and domestic	Industrial		
Ground Water.....	11.55	15.33	8.63	6.46	41.97
Surface Water......	2.93	2.24	.85	.34	6.36
Total.............	14.48	17.57	9.48	6.80	48.33

[1]Estimated on basis of 1965 State average per capita rural usage (Murray, 1968) and includes water for livestock.



WATER USE MAP

QUALITY OF WATER



WATER QUALITY MAP

CHEMICAL QUALITY OF GROUND WATER

Ground water in the upper Wabash basin is very hard, greater than 300 mg/l (milligrams per liter) hardness, with the predominant cations, calcium and magnesium, being associated with the anions of bicarbonate and sulfate. Iron concentrations commonly exceed the maximum of 0.3 mg/l recommended by the U.S. Public Health Service. Fluoride concentrations in some of the more mineralized ground waters commonly exceed the recommended maximum of 1.3 mg/l for this area.

A significant regional variation of ground-water quality is evidenced by higher dissolved solids and increased percentage of sulfate in water supplies in the southeastern part of the basin (see map). This increase causes these waters to be harder and can result in problems of potability and utility.

The available information indicates no significant correlation between the ground-water quality and the different aquifer units; however, experience in other parts of Indiana indicates that, in general, water will be more mineralized at greater depths.

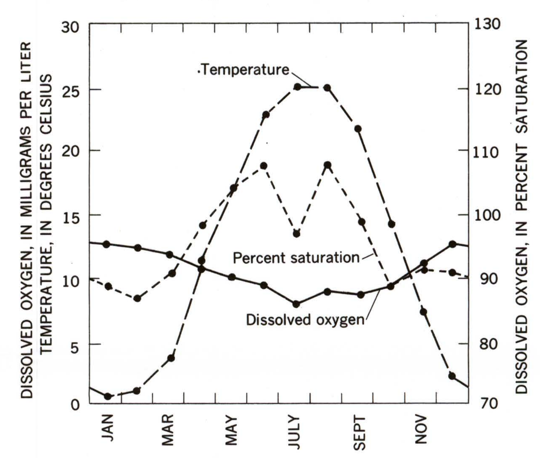
Representative chemical analyses of ground water
(Analyses by U.S. Geological Survey, 1950–55)

Location	(1) North Manchester	(2) Columbia City	(3) Fairmont	(4) Huntington	(5) Gas City	(6) Hartford City	(7) Portland	(8) Berne
Water-bearing unit.........	Gravel	Limestone	Limestone	Limestone	Sand and gravel	Sand and gravel	Limestone	Gravel
Producing interval (ft)...	95–105	321–457	153–183	7–300	108–140	94–124	47–195	118–128
pH........	8.2	8.0	7.5	7.5	7.3	7.9	7.5	7.5
Concentrations, in milligrams per liter								
SiO_2..............	20	15	14	12	16	18	20	11
Fe..................	3.5	1.4	.79	.14	1.5	.79	3.8	5.0
Mn.................	.0	.0	.0	.12	.0	.08	.03	....
Ca..................	72	89	89	104	109	137	142	233
Mg..................	31	24	44	41	43	55	91	84
Na+K..............	17	49	37	26	25	44	34	88
HCO_3.............	374	340	444	400	440	314	469	160
CO_3...............	10	0	0	0	0	0	0	0
SO_4...............	10	43	51	84	77	360	344	930
Cl...................	2.0	3.2	32	34	30	6.8	8.0	10
F....................	.9	.2	.6	.1	.3	1.4	1.5	1.8
NO_3...............	1.4	.9	9.1	11	1.0	1.2	1.1	.0
Dissolved solids.............	352	350	496	518	519	804	919	1,590
Hardness, in milligrams per liter								
Carbonate......................	306	322	406	428	447	570	730	927
Noncarbonate................	0	42	42	100	86	313	346	....
Specific conductance, in micromhos per centimeter at 25°C								
	578	572	831	857	858	1,100	1,260	1,810

CHEMICAL QUALITY OF STREAMFLOW

Surface water in the upper Wabash River basin is generally similar in chemical composition to that of ground water but tends to be less mineralized and more variable. The listing of chemical parameters for each of the Indiana State Board of Health surveillance stations indicates that the waters are predominately basic (pH greater than 7) and are very hard.

The monthly variations of dissolved oxygen, percent saturation of dissolved oxygen, and water temperature for the Wabash River at Huntington (1957–67) illustrate the influence of several factors upon the dissolved oxygen levels in the upper Wabash River basin (see graph showing dissolved oxygen). The inverse relationship between temperature and dissolved oxygen is apparent. Values of percent saturation,



GRAPH SHOWING MONTHLY VARIATIONS OF DISSOLVED OXYGEN, PERCENT SATURATION OF DISSOLVED OXYGEN, AND TEMPERATURE FOR THE WABASH RIVER AT HUNTINGTON (1957–67).

which during the winter months indicate a mild organic loading, commonly exceed 100 percent during the daylight hours of the growing season due to the photosynthetic activity of aquatic plant life. During July, a period of high temperature and low streamflow, the organic loading will become most critical and the lowest dissolved oxygen values will usually occur during this period. Although dissolved oxygen values for the six surveillance stations maintained by the Indiana State Board of Health seldom fall below 5 mg/l, it should be noted that these data may not indicate the influence of the effluent from sewage treatment facilities.

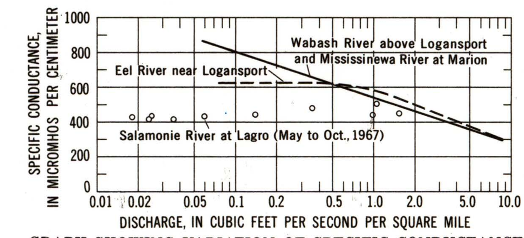
Although the waters draining from the different parts of the basin are essentially of the same type, there are significant variations of quality, both with time and location. These variations are the result of natural phenomena as well as man's activities.

Table of means and extremes of selected quality parameters[1] of streamflow

Parameter	Station	1. Wabash River at Huntington	2. Salamonie River at Lagro	3. Mississinewa River at Marion	4. Wabash River at Peru	5. Eel River near Logansport	6. Wabash River at Logansport
Hardness[2] (mg/l)	max.	632	500	460	492	454	452
	min.	56	60	68	56	106	88
	mean	300	291	308	294	319	295
Alkalinity (mg/l)	max.	384	362	333	380	540	504
	min.	34	34	40	40	28	52
	mean	190	202	226	203	226	205
Chloride (mg/l)	max.	100	36	78	61	32	81
	min.	3	3	4	4	2	3
	mean	29	15	29	26	12	22
Nitrate as N (mg/l)	max.	10.0	10.0	7.3	8.4	8.8	7.0
	min.	.0	.0	.0	.0	.0	.0
	mean	2.1	1.7	1.8	2.0	2.2	1.9
Phosphates (mg/l)	max.	7.0	3.0	6.0	6.5	6.5	9.5
	min.	.0	.0	.2	.1	.0	.0
	mean	.7	.5	1.6	1.1	.5	.8
B.O.D. (mg/l)	max.	17.0	17.0	18.0	18.0	24.0	30.0
	min.	.7	.6	.8	1.0	.3	.9
	mean	4.1	3.1	4.8	5.2	2.6	4.3
pH	max.	8.8	9.7	9.4	8.9	8.7	8.9
	min.	6.6	6.8	6.6	6.8	6.8	6.8
	mean	8.0	8.0	8.0	8.0	8.1	8.1
Color (Platinum-Cobalt units)	max.	80	70	70	60	80	50
	min.	5	5	5	5	5	5
	mean	20	20	20	20	20	20
Turbidity (Candle units)	max.	1500	1500	3000	1000	400	950
	min.	5	0	5	5	0	0
	mean	87	96	82	79	36	82

[1]Based on twice monthly sampling by Indiana State Board of Health (1957–67).
[2]as $CaCO_3$.

Mixing of waters from surface runoff of low conductance and from ground waters of higher conductance results in an inverse relationship between specific conductance and streamflow. The relationship, shown as a solid line on the graph below, is derived from data for the main stem of the Wabash River above Logansport and for the Mississinewa River at Marion. This indicates that similar geohydrologic conditions control the chemical variations of streamflow from these parts of the basin.

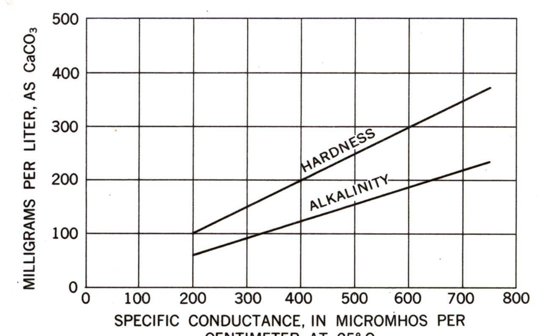


GRAPH SHOWING VARIATION OF SPECIFIC CONDUCTANCE WITH WATER DISCHARGE

For those streams affected by either natural or manmade storage of surface runoff during high flow periods the relation is different. The water in the Eel River, for example, exhibits the contributing influence of natural storage of low conductance surface runoff which is released during low flow periods.

The chemical mineralization of the water released from the Salamonie Reservoir during the summer of 1967 was nearly constant and approximated the average conductance (weighted with discharge) of the water which filled the reservoir during the spring floods.

Specific conductance may be used to estimate hardness and alkalinity of surface water in the upper Wabash basin on the basis of the empirical curve if the conductance is less than 750 micromhos per centimeter (see graph below). For values greater than 750 micromhos per centimeter the relationship is not linear and has not been adequately defined. This change indicates a corresponding change in the chemical composition of the water and may be due to the increased effect of man's activities on the water quality of streamflow during low flow periods.



GRAPH SHOWING THAT SPECIFIC CONDUCTANCE IS AN INDICATOR OF HARDNESS AND ALKALINITY

Suspended sediment samples collected periodically at several sites are used to estimate the average annual sediment yield for streams in the upper Wabash River basin.

Suspended sediment

Sampling stations	Period of record	Estimated yield (tons per yr per sq mi)	Maximum observed concen. (mg/l)
Wabash River at Bluffton.......	7–68 to 7–69	180	365
Salamonie River near Warren..	7–63 to 7–69	230	448
Eel River near Logansport......	7–68 to 7–69	90	298

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By
C. H. Tate, L. G. Davis, L. E. Johnson, and R. A. Pettijohn

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