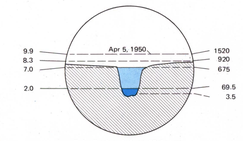
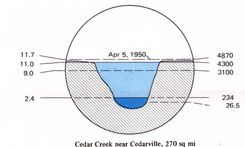
SURFACE WATER

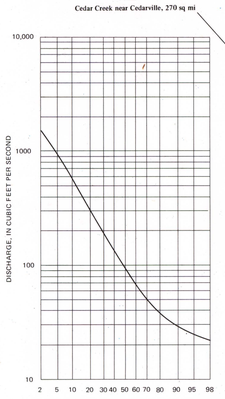
STREAMFLOW



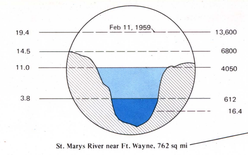
Cedar Creek at Auburn, 87.3 sq mi



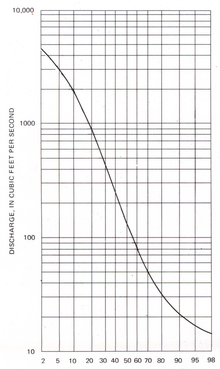
Cedar Creek near Cedarville, 270 sq mi



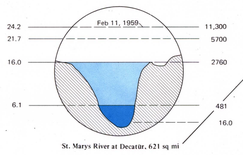
FLOW DURATION CURVE–CEDAR CREEK NEAR CEDARVILLE



St. Marys River near Ft. Wayne, 762 sq mi



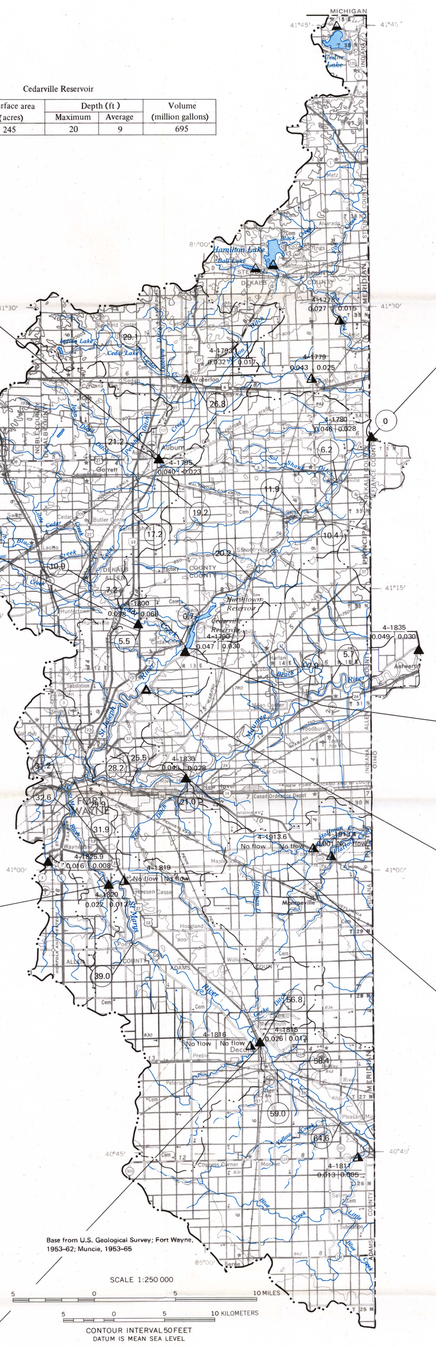
FLOW DURATION CURVE–ST. MARYS RIVER NEAR FT. WAYNE



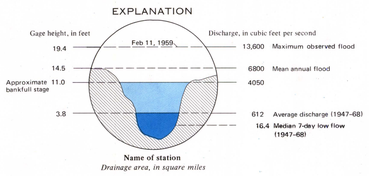
St. Marys River at Decatur, 621 sq mi

Cedarville Reservoir

Drainage area (sq mi)	Surface area (acres)	Depth (ft)		Volume (million gallons)
		Maximum	Average	
762	245	20	9	695



EXPLANATION



Name of station
Drainage area, in square miles

Continuous-recording station

Low-flow partial-record station

Discontinued station

Lake station

Subbasin boundaries for continuous recording stations

Basin boundary

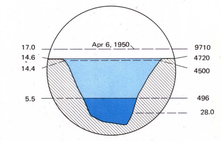
4-1793.1 Station number
Median 7-day low flow index 0.032 | 0.017 7-day, 10-year low-flow index
(Low-flow indices, in cubic feet per second per square mile)

11.9 River miles
(a) above Indiana-Ohio state line for Maumee and St. Marys Rivers
(b) below Indiana-Ohio state line for St. Joseph River
(c) above mouth for all others

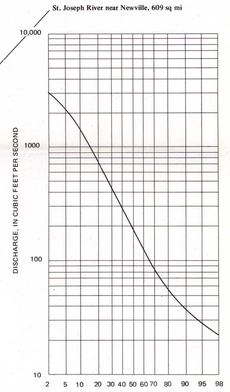
Low-flow partial record stations

Station	Name and location	Drainage area (sq mi)
4–1778.0	Fish Creek near Artic, Ind	95.8
4–1779.0	Big Run at Butler, Ind	16.7
4–1793.1	Cedar Creek at Waterloo, Ind	48.8
4–1811.0	Blue Creek near Pleasant Mills, Ind	78.5
4–1816.0	Holthouse Ditch at Decatur, Ind	34.0
4–1819.0	Houk Ditch near Hessen Cassel, Ind	16.3
4–1913.4	Flatrock Creek near Townley, Ind	47.1
4–1913.6	Hoffman Creek at Townley, Ind	41.7

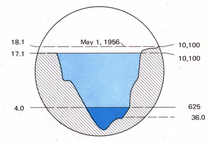
MAP SHOWING LOCATION OF GAGING STATIONS AND SELECTED STREAMFLOW DATA



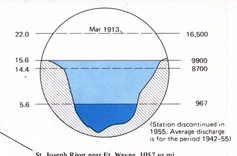
St. Joseph River near Newville, 609 sq mi



FLOW DURATION CURVE–ST. JOSEPH RIVER NEAR NEWVILLE

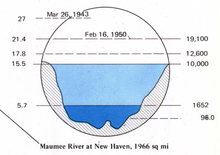


St. Joseph River at Cedarville, 762 sq. mi.

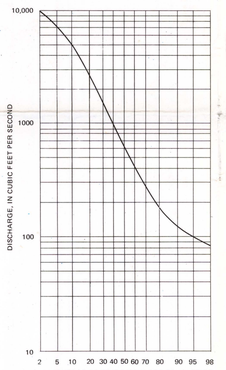


(Station discontinued in 1955. Average discharge is for the period 1942-55)

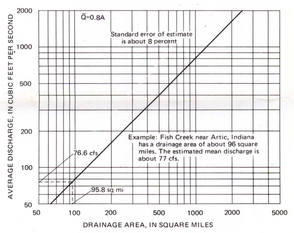
St. Joseph River near Ft. Wayne, 1057 sq mi



Maumee River at New Haven, 1966 sq mi



FLOW DURATION CURVE–MAUMEE RIVER AT NEW HAVEN



GRAPH SHOWING RELATIONSHIP OF DRAINAGE AREA TO AVERAGE DISCHARGE

The magnitude of the average runoff shows a good relationship to the size of drainage area. The relation line gives the ratio of average discharge to drainage area for the 1947–68 period of record. The mathematical expression of this ratio is: $Q = 0.80A$ where Q is the mean annual discharge at any stream location with a known drainage area A.

AREAL VARIATION OF STREAMFLOW

Streamflow records are being collected in the basin at nine continuous-recording gaging stations. In addition, eight low-flow partial-record stations have been in operation since 1968.

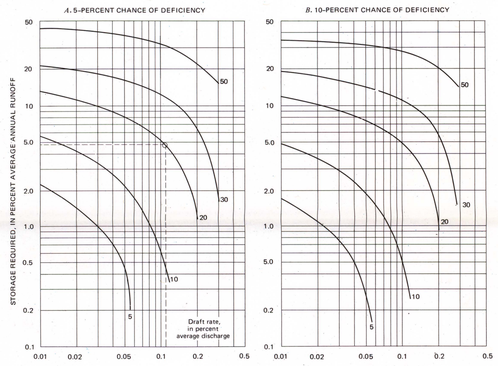
The diagrammatic sections bordering the location map show the approximate channel configuration and limited streamflow characteristics at the gaged sites within the basin. The sections also show the gage heights and discharges at the sites for selected flows. The average discharge given at the continuous-record sites with 6 or more years of record is for the period 1947–68. For the shorter records, the mean for that period was estimated on the basis of correlation with the long-term records.

The median 7-day low flow and the 7-day, 10-year low flow are shown at all sites. These values are based on the 1947–68 period at the long-term continuous-record stations, and estimated on the basis of concurrent 7-day low flows at the short-term continuous-record stations. Values for the low-flow partial-record stations are estimated on the basis of discharge measurements and records for nearby stations. The flow characteristics presented are for essentially natural conditions.

Duration curves for the 1947–68 water years are shown for the four principal streams in the basin. Areal variation in the nature of runoff and differences in hydrologic and geologic characteristics within the basin are reflected by the shapes of the curves. Curves for the St. Joseph River and Cedar Creek have rather gentle slopes. These streams drain areas with numerous lakes and ponds and are underlain by relatively thick sand and gravel aquifers. The good surface and ground-water storage capacities in these areas provide for a high rate of sustained flow during dry periods and a low to moderate rate of runoff during wet periods. The duration curve for the St. Marys River is steeper. This area of the basin is characterized by an absence of natural lakes and is underlain by poor water-bearing materials. Surface runoff is rapid, and the rate of flow during dry weather is low. Hydrologic conditions in the northern part of the basin have a greater influence on the integrated flow from the basin, as reflected by the duration curve for the Maumee River. This curve is only slightly steeper than the curve for the St. Joseph River, but is considerably gentler than the curve for the St. Marys River.

Cedarville Reservoir has been in operation since 1956, and is the primary water supply for the city of Fort Wayne. Secondary purposes for the reservoir are recreation and low-flow augmentation.

DRAFT-STORAGE FOR FLOW AUGMENTATION



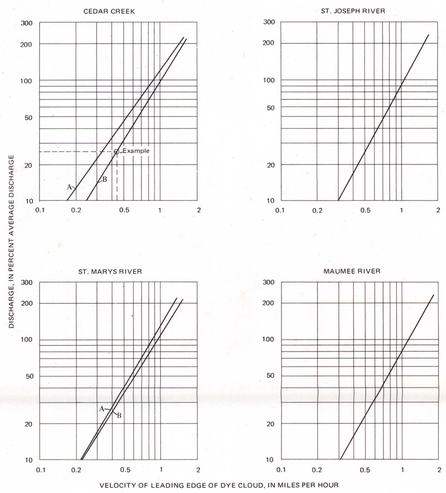
GRAPH SHOWING RELATIONSHIP OF STORAGE REQUIREMENTS AND DRAFT RATES TO MEDIAN 7-DAY LOW FLOW

The demand for water often exceeds the natural flow of streams during low-flow periods, making it necessary to store water during periods of high flow for flow augmentation during drier periods. This storage and subsequent release of water increases the effective utilization of the water supply. A general relationship has been derived from the streamflow records in which required amounts of storage for various draft rates have been determined. Values for average flow and the median 7-day low-flow are necessary to use the draft-storage curves. The average flow at an ungaged site may be estimated on the basis of the drainage area. An estimate of the 7-day low-flow can be determined by correlation of low-flow measurements at the site with the low-flow data for gaging stations.

Figures A and B are regional draft-storage curves for the basin. Given the mean discharge and the median 7-day low-flow, the amount of storage required to maintain a desired draft rate can be estimated for either a 5-percent or a 10-percent chance of deficiency. Allowance for evaporation and seepage losses should be included in the draft rate, or added to the required storage. Because the curves are dimensionless ratios, any units of flow can be used as long as consistency is maintained.

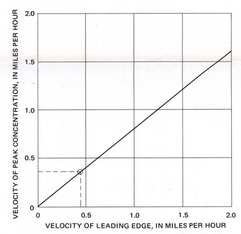
Example: If a dependable flow of 30.0 million gallons per day were desired at Cedar Creek near Cedarville, what is the storage required? The average discharge at the site is 234 cfs, and the estimated median 7-day low flow is 26.5 cfs. The desired draft (46.4 cfs) is about 20 percent of the mean flow. The ratio of the median 7-day low-flow to the average discharge is 0.11. Figure A indicates that a storage of about 4.8 percent of the average annual runoff is required for a 5-percent chance of deficiency. The average annual runoff is 234 cfs x 365 days or 85,400 cfs-days, and 4.8 percent of that is about 4,100 cfs-days, or 2,650 million gallons (8,100 acre-feet). At a 10-percent chance of deficiency, a storage capacity of about 7,200 acre-feet would be required to maintain the desired draft rate.

TIME OF TRAVEL OF WATER



Stream	Reach	Reference gage	River mileage
Cedar Creek	A. Waterloo to County Road 68	4–1795.0	14.6
	B. County Road 68 to State Road 1	4–1800.0	13.1
St. Joseph River	Gage near Newville to Cuba Road	4–1780.0	20.3
St. Marys River	A. State line to Scheiman Bridge	4–1815.0	17.3
	B. Scheiman Bridge to Anthony Blvd. (Gage)	4–1820.0	21.7
Maumee River	Confluence of St. Marys and St. Joseph Rivers to State line	4–1830.0	27.4

GRAPHS FOR DETERMINING THE RATE OF WATER TRAVEL IN STREAMS



GRAPH SHOWING THE RELATIONSHIP OF PEAK CONCENTRATION TO THE LEADING EDGE OF A DYE CLOUD

The rate of travel of water has been investigated for the four principal streams in the basin. From data gathered in these investigations a velocity curve has been developed relating the rate of travel, in miles per hour, to the rate of flow, expressed in percentage of the average discharge, for each stream. Each curve represents the relationship between velocity and discharge for a particular reach of a stream, where the discharge is based on the gaging station indicated for that reach. These relations should serve as a means for planning the operation of water intakes in the event of a contamination of the stream.

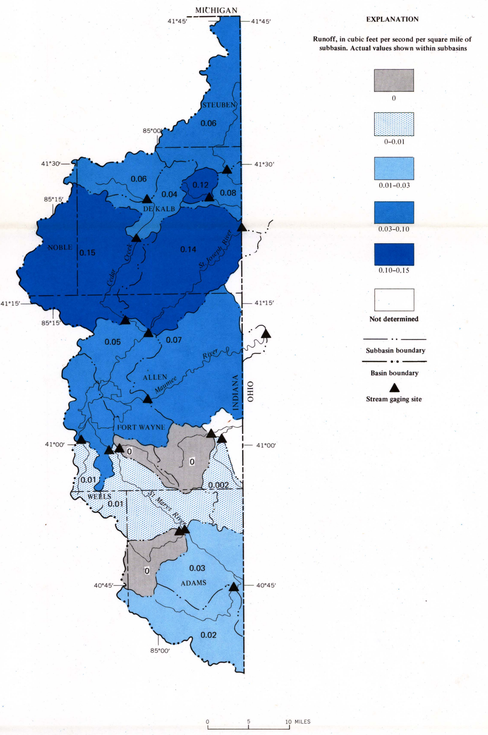
Example: If a spill of a harmful contaminant occurred on Cedar Creek at Interstate 69 near Cedarville, Indiana, when the discharge there was 60 cfs, when would the leading edge and peak concentration of the contaminant reach the St. Joseph River? A discharge of 60 cfs is approximately 26 percent of the average. From the velocity curve for the reach of Cedar Creek where the discharge is based on the gage near Cedarville, the velocity at 26 percent average discharge is 0.45 miles per hour. The distance from Interstate 69 to the St. Joseph River is about 7.2 miles; therefore, the travel time for the leading edge of the contaminant would be– –

$$\frac{7.2 \text{ miles}}{0.45 \text{ mph}} \text{ or 16 hours.}$$

The travel time for the peak concentration can be determined from the curve relating the velocity of the peak concentration to the velocity of the leading edge of a dye cloud at any rate of flow. In this example, the velocity of the peak concentration is 0.36 mph; therefore, the travel time would be– –

$$\frac{7.2 \text{ miles}}{0.36 \text{ mph}} \text{ or 20 hours.}$$

LOW FLOW



MAP SHOWING RUNOFF PATTERN DURING LOW FLOW, SEPTEMBER 3–4, 1969

Variations in the rate of low flow occur between subbasins within the Maumee basin. These variations are caused by a combination of factors: differences in precipitation amounts, soil cover, type and thickness of overburden, geology, rates of evapotranspiration, and percentage of area in lakes and marshes. In addition to the above natural factors, other factors induced by man, such as variations in land use and the rate of ground-water withdrawal, may affect the rate of flow.

The average streamflow for the basin during the low-flow period of September 3–4, 1969, was about 0.06 cubic feet per second per square mile. This flow rate varied between the measured subbasins as shown on the map. Runoff values shown are valid only at the gaged sites, and for the period in which they were determined.

Summary of natural factors affecting dry weather streamflow

Subbasins	Flow rate range (cfsm)	Lakes and marshes	Primary land forms	Principal aquifers	Average thickness of overburden (ft)
North of the Maumee River	0.04 to 0.15	Abundant	End moraine and kettle moraine	Unconsolidated sand and gravel	200–500
South of the Maumee River	0 to 0.03	Few	Mostly till plain	Bedrock	50–100

LAKES

Hydrologic data for selected lakes

Name	Drainage area (sq mi)	Surface area (acres)[1]	Depth (feet)[2]		Volume (million gallons)
			Maximum	Average	
Ball	11.6	87	66	40	1,147
Cedar	23.4	28	25	8	75
Clear	6.86	800	107	31	8,142
Hamilton	16.5	802	70	21	5,408
Indian	3.76	56	38	22	398
Long	2.80	154	36	12	601
Round	7.25	30	25	11	111

[1] Lakes smaller than 25 acres in area are not shown.
[2] Depth contour maps are available for the above lakes.

There are numerous lakes of glacial origin in the northern part of the basin. The larger lakes are used primarily for recreation. Some hydrologic data for the larger lakes are given in the table above. A few of the smaller lakes in the basin have been mapped and data on them are available in the files of the U.S. Geological Survey's district office in Indianapolis.

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1973—W72463

WATER RESOURCES OF THE MAUMEE RIVER BASIN, NORTHEASTERN INDIANA

By
R. A. Pettijohn and L. G. Davis

1973