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Streamflow Assessment Model for the Little Wabash River Watershed: Hydrologic Analysis

by
H.Vernon Knapp and Michael W. Myers

Prepared for the
Illinois Department of Natural Resources

August 2001

Illinois State Water Survey
Watershed Science Section
Champaign, Illinois

A Division of the Illinois Department of Natural Resources

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Introduction

The flow of water in the rivers and streams of Illinois provides a number of valuable uses. In many locations, it provides for the withdrawal of water for use in public and industrial water supplies. Also of great importance are instream uses of water, i.e., water used or needed within the stream channel, including flows for aquatic habitat and biodiversity, assimilation of wastewaters, water-based recreation, and stream aesthetics, as well as hydropower generation and navigation on the largest rivers. A planning and management goal for surface water resources in a watershed is to maintain sufficient streamflow for both instream needs and withdrawals (i.e., offstream needs). Planning also requires estimates of sustainable yields for streams and lakes to determine whether available resources will satisfy existing and future water needs during drought periods.

Water resource management requires an understanding of the quantity and frequency of streamflow within a river's watershed and the effects of various potential water use practices on the flow characteristics. The impacts of various natural and human factors, such as climate, land and water use, and hydrologic modifications, must also be analyzed as they can greatly affect the quantity, quality, and distribution (both in space and time) of surface waters in a watershed. Estimates of streamflow frequency and climatic and human impacts on streamflows can be useful for:

- Assessing water availability and public water supply system yields.
- Evaluating instream flow levels.
- Providing streamflow estimates for water quality analyses and regulations.
- Classifying Illinois streams by their hydrologic character for use in watershed management.

There are about 5145 miles of rivers and streams in the Little Wabash River basin. Roughly 100 rivers and streams with drainage areas in excess of 10 square miles account for 1640 of these stream miles. The flow character of these rivers and streams is monitored by streamgaging stations, which measure the flow of water over a period of time, providing information on the amount and distribution of surface water passing the station. Because it is not feasible to monitor all streams in a basin, gaging stations are established at selected locations, and the data collected are transferred to other parts of the watershed by applying hydrologic principles. Currently, there are four active streamgages in the basin, and seven locations in the watershed that have been gaged over the past 90 years. This report describes the hydrologic principles used to estimate the flow characteristics at these gages and the remaining ungaged locations within the Little Wabash River basin.

Background Information

The Illinois Streamflow Assessment Model (ILSAM), a watershed management information tool, was designed to provide managers and planners with needed estimates of the streamflow frequencies along major streams within a watershed of interest. For the purposes of this model, major streams are those that have upstream contributing drainage areas that exceed 10 square miles in size. The ILSAM specialized software program was developed for use on a personal computer to provide estimates of the long-term expected magnitude and frequency of streamflow for any stream location. The effects of potential or hypothetical water resource projects on the quantity of water in streams also can be examined using options available in the model. With the completion of this study, the sets of hydrologic data used by the model have been developed for five major watersheds in Illinois: the Sangamon, Fox, Kaskaskia, Kankakee, and Little Wabash River watersheds. Hydrologic data sets are also currently being developed for the Rock River watershed.

Basic ILSAM Hydrologic Concepts

The characteristics of streamflow in any watershed will, over time, vary from earlier conditions because of the cumulative impact of human activities in the region. Like most locations in Illinois, the Little Wabash River basin has experienced considerable land-use modification since European settlement, including cultivation, drainage modification, removal of wetland areas, and deforestation. Most of these modifications occurred in the late 1800s, prior to the introduction of streamgaging activities in the region, and thus the existing gaging records cannot reflect the impact of these changes. Most of the land in the watershed remains in agriculture, much as it did almost 100 years ago. Urbanization has affected only a very minimal percentage of land in the Little Wabash River basin.

For watersheds without major hydrologic modifications, climate variability has the greatest influence on the changes in streamflows. Trend analysis of streamflow records throughout many areas of Illinois suggests that the influence of climate variability is usually large enough to mask the impacts of less obtrusive watershed modifications to river flows, including many contemporary land-use changes other than urbanization. However, modifications to the watershed, such as the construction of reservoirs and channel dams, stormwater detention facilities, water-supply withdrawals, and wastewater discharges to the streams, have had readily definable impacts on the streamflows.

For this analysis, the flow in a stream can be separated into two components: 1) the unaltered or “virgin” flow conditions as influenced primarily by weather and climate phenomena as well as the topography, hydrogeology, and prevailing land-use conditions in the watershed, and 2) modifications to the flow conditions by human activity that produced a quantifiable change in the temporal response of flow from the watershed. Modifications to the flow conditions that can be quantified include direct additions to or subtractions from the flow in the stream, such as from effluent discharges or water-supply withdrawals, or large changes in the water stored within the watershed, such as might be caused by a major reservoir. The evaluation of flow modifications is limited to water resource projects that can be objectively evaluated using existing data, and whose impact on present flow conditions can be differentiated from the expected character of the unaltered flow condition.

Streamflow varies considerably over time, not only displaying day-to-day fluctuations as influenced by weather phenomena, but also by climatic variations that may cause streamflows to remain above or below the long-term expected condition for several decades. The climate during the period for which streamflow records are available also significantly influences our perception and calculation of the expected characteristics of streamflow. Therefore, the estimation of long-term streamflow conditions spanning several decades is necessary to smooth out the impacts of climate variability.

Complete descriptions of the methods used to determine the streamflow characteristics for the ILSAM have been presented in several earlier reports (Knapp, 1988, 1990, 1992), and rather than repeating their descriptions, the reader is referred to these earlier studies. This report focuses on the development of the data used for ILSAM application to the Little Wabash River Basin watershed.

Streamflow Information Produced by ILSAM

The ILSAM produces information on 154 selected streamflow parameters, including flow duration relationships (flow versus probability of exceedence) and low flows for various durations and expected recurrence intervals. All flows are given in units of cubic feet per second (cfs). The 154 flow parameters are described in detail in the following paragraphs. For gaging locations, these flow parameters are computed using daily flow records, which are average flow rates estimated for each individual day within the gage's period of record.

Average Flow Values

Parameters: Average Annual Flow (Q_{mean}) and Average Monthly Flows

Annual Flow-Duration Values

Description: The 2 percent flow (Q_2), for example, is the daily streamflow rate that is exceeded on exactly 2 percent of the days. The 1 percent flow (Q_1) is necessarily a higher flow rate because it is exceeded less frequently.

Parameters: Q_1, Q_2, Q_5, Q_{10}, Q_{15}, Q_{25}, Q_{40}, Q_{50}, Q_{60}, Q_{75}, Q_{85}, Q_{90}, Q_{95}, Q_{98}, and Q_{99}.

Monthly Flow-Duration Values

Description: Monthly flow duration values are defined in the same manner as the annual flow-duration values, except that they are determined using only those daily discharges that fall within a certain month of the year.

Parameters for each calendar month: Q_2, Q_{10}, Q_{25}, Q_{50}, Q_{75}, Q_{90}, and Q_{98}.

Low Flows

Description: Each low-flow parameter is defined by a duration in consecutive days and a recurrence interval in years. A 7-day low flow for a given year is the lowest average flow that occurred within a 7-day consecutive period during that year. The 7-day, 10-year low flow is the 7-day low flow that occurs on average only once in 10 years. A 2-year low flow is the value expected to occur during an "average" year.

Low-Flow Durations: 1, 7, 15, 31, 61, and 91 days

Recurrence Intervals: 2, 10, 25, and 50 years

Drought Flows

Description: Drought flows are similar to low flows, except that the duration of the period is longer and is defined in months instead of days, and the average low flows are developed from monthly records. Drought durations are usually not defined on an annual basis, because a drought period typically encompasses multiple years.

Drought Flow Durations: 6, 9, 12, 18, 30, and 54 months

Recurrence Intervals: 10, 25, and 50 years

Database Used by ILSAM

The ILSAM uses four basic sets of data for computing streamflow characteristics in a watershed.

1) *Estimates of the 154 flow parameters at gaging stations within the watershed.* Streamflow frequency estimates are also computed and entered into the database for other locations in the watershed where such computations are useful to the operation of the model, such as locations downstream of reservoirs or upstream and downstream of major river confluences. Appendix A lists this basic streamflow frequency data for 35 watershed locations.

2) *A data set of all flow modifiers in the watershed (withdrawals, diversions, and effluent discharges).* This includes the estimated impact of that modification on each of the 154 flow parameters produced by the model. Appendix B lists the basic flow data for these modifications.

3) *A table of watershed characteristics for 804 locations in the basin, including stream mileage, drainage area, soils information, and the location of gaging stations, water use projects, reservoirs, and other points of interest in the basin*. Appendix C lists this stream network data.

4) *The set of regional regression equations used to estimate the virgin flow conditions for each of the 154 flow conditions for ungaged sites in the watershed*. Appendix D presents these equations.

In addition to these four basic sets of data, three supplemental data sets provide stream codes that help to identify each stream in the watershed, an index of the stream network in the watershed (which helps the model identify all downstream locations affected by a flow modification), and basic data on the size of each major reservoir in the watershed. All data sets have been imported into a Microsoft Access database for access directly by the ILSAM.

Acknowledgments

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The Illinois Environmental Protection Agency and the U.S. Geological Survey provided wastewater effluent data and streamgaging records, respectively.

Any opinions, findings, and conclusion or recommendations expressed in this report are those of the authors and do not necessarily reflect those of the Office of Water Resources or the Illinois State Water Survey.

Description of the Little Wabash River Watershed

The Little Wabash River watershed is located in the southeastern portion of Illinois and has a total area of approximately 3238 square miles. The watershed is located in portions of 15 counties, as shown in figure 1. The headwaters are located in Coles County southwest of Mattoon, and the river generally flows south to southeast until its confluence with the Wabash River at the southern tip of White County near New Haven, Illinois. The total length of the Little Wabash River is approximately 239 miles. The nine largest tributaries to the Little Wabash River are the Skillet Fork, with a drainage area of 1059 square miles (mi^2), Big Muddy Creek (316 mi^2), Elm River (278 mi^2), Fox River (205 mi^2), Main Outlet (179 mi^2), Horse Creek (104 mi^2), Auxier Creek Drain (101 mi^2), and Salt Creek (94 mi^2). Figure 2 shows the locations of these major streams.

The following sections describe the physical characteristics of the Little Wabash River watershed, which are useful for understanding the surface water hydrology of the watershed. The reader is also referred to a previous study (Barker et al., 1967) for a more comprehensive description of the watershed.

Watershed Physiography and Soils

Most of the Little Wabash River watershed lies within two distinct physiographic regions as identified by Leighton et al. (1948): the Springfield Plain, and the Mt. Vernon Hill Country. Much of the northern third of the Little Wabash River watershed falls within the Springfield Plain covering Effingham and Jasper Counties, the northern half of Clay County, and the southern half of Shelby County. This area was covered by the Kansan Period of glaciation, and is distinguished by its relative flatness and the shallow entrenchment of its drainage. The Mt. Vernon Hill Country covers the southern two-thirds of the watershed, and represents that area covered by the older Illinoian period of glaciation. It is characterized by developed topography and low relief, with a mature drainage system. Most streams have broad valleys with upland areas that have better drainage than the larger valley bottoms. (Leighton et al., 1948).

Less than 3 percent of the watershed falls within the Bloomington Ridged Plain, which covers much of central Illinois, and is associated with land that was covered by the most recent Wisconsin Period of glaciation. The Shelbyville moraine and its outwash plain, which cross the northern tip of the Little Wabash River watershed in Coles and Shelby Counties, represent the southernmost extent of the Bloomington Ridged Plain.

Land Slopes

The elevation of the watershed ranges from a high of approximately 780 feet above the National Geodetic Vertical Datum (NGVD), about 2 miles south-southeast of Mattoon, to a low of approximately 330 feet NGVD where the Little Wabash River meets the Wabash River. Table 1 provides the average distribution of overland slopes for the two major physiographic regions in the Little Wabash River watershed. The overland slopes listed in this table were estimated from data in Runge et al. (1969). Almost two-thirds of the land in the Springfield Plain is nearly level, having less than a 2 percent slope. An additional 20 percent of the land in the region is gently sloping with the remaining 17 percent of the land

Figure 1. Location of the Little Wabash River watershed in southeastern Illinois

Table 1. Distribution of Overland Slopes in Physiographic Regions of the Little Wabash River Watershed

		Percentage of land area	
Overland slope (%)	*Slope description*	*Springfield Plain*	*Mt. Vernon Hill Country*
0 – 2	Nearly level	63.0	56.0
2 – 4	Gently sloping	20.0	20.0
4 – 7	Moderately sloping	4.3	9.7
7 – 12	Strongly sloping	4.1	8.0
12 – 18	Moderately steep	1.5	3.8
18 – 30	Steep	7.1	1.4
> 30		0.0	1.1

Note: Overland slopes were estimated from data in Runge et al., 1969.

being moderately sloped to steep (slopes of 4 to 30 percent). The Mt. Vernon Hill Country is a more mature, rolling topography having both fewer flat areas and fewer steep slopes than the Springfield Plain.

Channel Slopes

The slope of the Little Wabash River increases from downstream to upstream. From the mouth of the Little Wabash River to the town of Golden Gate, River Mile 76, the slope is a mild 0.4 feet per mile. The average slope from Golden Gate to Effingham increases to 1.2 feet per mile. At Effingham the slope is roughly 3 feet per mile, and from Effingham upstream to the headwaters of the Little Wabash, the slope is 7.3 feet per mile. The Little Wabash River valley, which generally coincides with pre-glacial bedrock valleys (Barker et al., 1967), widens from about ½ mile wide near the upstream reach of the watershed to 2 miles wide near the mouth.

Table 2 provides examples of channel slopes for tributaries in the Little Wabash River watershed. The slope for most smaller tributaries is from 6 to 20 feet per mile. As the size of the stream and its drainage area increases, the channel slope decreases to 2-5 feet per mile for most of the larger tributaries in the watershed. These slopes are typical for many streams throughout Illinois.

Soil Types and Their Influence on Streamflow Hydrology

Soils in the Little Wabash River watershed are characterized by generally poor drainage and moderately low permeability. The surface permeability of most soil types is generally less than 2 inches per hour with subsurface permeabilities often less than 0.6 inches per hour. Upland soils, such as the Hoyleton-Cisne soil associations, are on nearly level land and often have the lowest subsurface permeabilities in the region, less than 0.2 inches per hour. Hillslope soils, such as those belonging to the Ava-Bluford-Wynoose soil association, often have subsurface soil permeabilities in the range of 0.2 to 0.6 inches per hour.

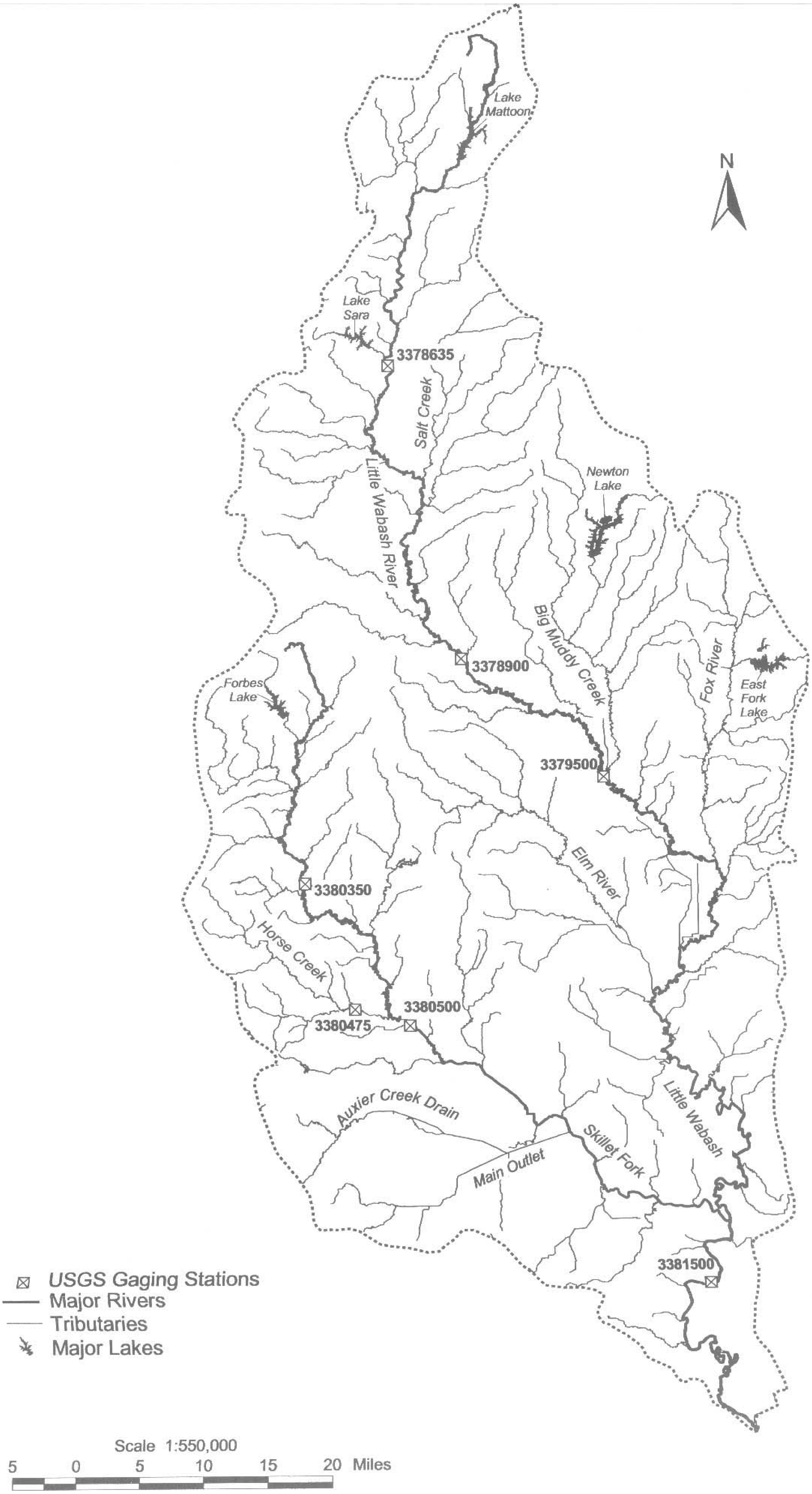

Figure 2. Location of major streams, lakes, and gaging stations in the Little Wabash River watershed

Table 2. Examples of Channel Slopes in the Little Wabash River Watershed (ft/mi)

Streams	*Drainage area*		
	10 mi²	*50 mi²*	*150 mi²*
Springfield Plain			
Little Wabash River	11.1	7.6	8.0
Big Muddy Creek	6.9	6.5	2.6
Mt. Vernon Hill County			
Auxier Creek Drain	22.3	3.7	----
Elm River	6.4	5.2	2.6
Fox River	4.9	2.9	2.4
Horse Creek	7.8	4.8	----
Main Outlet	10.2	5.4	2.5
Salt Creek	5.8	5.5	----
Skillet Fork	13.5	3.5	2.6

Note: ---- = not applicable

Bottomland soils, such as the Belknap-Bonnie-Petrolia association, have somewhat higher subsurface permeabilities in the range of 0.6 to 2.0 inches per hour.

Soil type and permeability are of considerable importance in the evaluation of watershed hydrology because they have a great influence on the rainfall-runoff process and the eventual distribution of flow to the stream. For example, soils with high sand content generally allow a much higher proportion of precipitation to infiltrate the soil. This reduces the amount of water flowing overland directly to the stream and thereby reduces the rate of storm runoff. A large portion of the water that infiltrates is usually stored as shallow groundwater and may be discharged to the stream after the storm, later the same year, and even in following years whenever there is a large accumulation of subsurface moisture. The presence of sandy material in the subsoil and shallow groundwater also provides high permeability and consistent baseflow (the flow of shallow groundwater to the stream). In contrast, areas where soils have high clay content usually have greater runoff during storm periods, and less groundwater is contributed to streamflow during dry periods. Much of the soil in the Little Wabash River basin is representative of this latter group, with low soil permeability producing a large variability in runoff.

The ILSAM uses estimates of the subsoil permeability to compute the streamflow characteristics from a given watershed. County soil surveys provide the most useful information for characterizing the subsoil permeability within the watershed. For each soil type, the permeability of the lowest soil layer is used to estimate the subsoil permeability. If, for example, the permeability of the lowest soil layer is listed in the range of 0.2-0.6 inches per hour, an average value of 0.4 is used as the permeability for the subsoil. Weighted average values are then computed for each soil association in the county.

Five modern (post-1960) county soil surveys are applicable to the Little Wabash River watershed: surveys for Coles, Effingham, Hamilton, and Jasper Counties, and the joint survey for Edwards and Richland Counties. Table 3 gives the subsoil permeability for each

Table 3. Soil Associations and Subsoil Permeability from Post-1960 County Soil Surveys

County	*County soil association*	*County area, percent*	*Average subsoil permeability*	*Permeability Range*
Coles				
	Drummer-Starks-Brooklyn	40	1.11	0.2 – 6.0
	Xenia-Fincastle-Toronto	27	0.48	0.2 – 2.0
	Drummer-Raub-Dana	30	0.82	0.2 – 2.0
	Miami-Russell	03	0.64	0.2 – 2.0
Edwards-Richland				
	Cisne-Hoyleton	27	0.39	0.02 – 0.6
	Patton-Montgomery-Reesville	04	1.29	0.02 – 2.0
	Hosmer-Stoy-Alford	05	1.52	0.06 – 20.0
	Bluford-Ava-Blair	41	0.52	0.06 – 2.0
	Grantsburg-Zaneville	04	0.31	0.06 – 2.0
	Belknap-Bonnie-Petrolia	17	0.61	0.06 – 2.0
Effingham				
	Cisne-Hoyleton-Newberry	50	0.08	0.02 – 0.6
	Bluford-Hickory-Ava	41	0.52	0.02 – 2.0
	Holton-Wirt	09	1.25	0.6 – 2.0
Hamilton				
	Bluford-Hoyleton-Cisne	05	0.15	0.06 – 0.6
	Bluford-Ava	44	0.37	0.06 – 2.0
	Zipp	09	0.36	0.06 – 0.6
	Grantsburg-Zaneville	20	0.82	0.06 – 2.0
	Belknap-Bonnie	22	0.79	0.06 – 2.0
Jasper				
	Cisne-Hoyleton-Darmstadt	45	0.08	0.02 – 0.6
	Bluford-Wynoose-Atlas	38	0.23	0.06 – 2.0
	Wakeland-Petrolia	15	1.21	0.06 – 4.0

soil association within these county surveys. For the remainder of the watershed, the best available coverage of soil characteristics is provided by the statewide soil association map (Agricultural Experiment Station, 1982), which is also available in a geographic informations system (GIS) coverage. State soil associations are generally similar to, but not the same as the county soil associations, which deal more specifically with the soil types within that county. For each state soil association, the subsurface soil permeability is estimated as the regional average of the permeability from similar soil associations within the individual county soil surveys.

Table 4. State Soil Associations and Estimated Subsoil Permeability for Little Wabash River Watershed

State soil association	*Average subsoil permeability*	*Permeability range*
Oconee-Cowden-Piasa	0.21	0.06 – 0.6
Hoyleton-Cisne-Huey	0.16	0.06 – 0.6
Plano-Proctor-Worthen	0.48	0.06 – 12.0
Saybrook-Dana-Drummer	0.93	0.2 – 2.0
Harco-Patton-Montgomery	1.67	0.06 – 2.0
Hosmer-Stoy-Weir	1.52	0.2 – 2.0
Ava-Bluford-Wynoose	0.52	0.2 – 0.6
St. Clair-Camden-Drury	1.46	0.06 – 2.0
Dodge-Russell-Miami	0.64	0.2 – 2.0
Markland-Colp-Del Rey	0.36	0.06 – 0.6
Grantsburg-Zanesville-Wellston	0.82	0.06 – 2.0
Haymond-Petrolia-Karnak	1.09	0.06 – 2.0

Note: Average subsoil permeability for a specific state soil association is estimated using permeability values given in county soil surveys for counties in and near the Little Wabash River watershed. These values are not necessarily representative for that soil association in other regions in the State.

Table 4 lists the computed regional permeability for each of the state soil associations within the Little Wabash River watershed. An alternative method uses the subsurface soil permeabilities that are provided in the State Soil Geographic (STATSGO) data for Illinois, developed by the Natural Resources Conservation Service (NRCS) of the U.S. Department of Agriculture.

Reservoirs in the Little Wabash River Watershed

The Little Wabash River watershed contains 15 artificial reservoirs that have a storage capacity in excess of 300 acre-feet. Table 5 lists these reservoirs, and figure 2 shows the locations of the five largest reservoirs. Newton Lake, the largest lake in the watershed was built as a cooling lake for the Central Illinois Public Service (CIPS) electricity-generating plant near Newton. All but one of the remaining reservoirs in the watershed with a storage capacity of more than 1000 acre-ft are used for public water supply. Some smaller lakes are also used for this purpose, and many others are used for conservation or recreational purposes. All the lakes listed in table 5 were created by the impoundment of streams, with the exception of Goose Pond, which is a natural lake.

Table 5. Major Reservoirs in the Little Wabash River Watershed

Reservoir	*County*	*Major purpose*	*Surface area (acres)*	*Storage (acre-ft)*
Newton Lake	Jasper	Cooling	1650	28500
Lake Mattoon	Shelby	PWS	988	11820
East Fork Lake	Richland	PWS	672	12460
Lake Sara	Effingham	PWS	614	13357
Forbes Lake	Marion	Conservation	542	6793
Lake Paradise	Coles	PWS	138	1241
Borah Lake	Richland	PWS	125	1540
Greendale Lake	Clay	Recreation	93	170
Illinois Central Reservoir	Jefferson	Recreation	91	421
New Altamont Reservoir	Effingham	PWS	57	931
Sam Dale Lake	Wayne	Recreation	44	999
Patterson Lake	Clay	Recreation	41	270
Pauline Lake	Effingham	Recreation	37	350
Vernor Lake	Richland	PWS	35	734
Goose Pond	Wayne	Natural	34	Unknown
CIPS Lake	Effingham	PWS	20	341

Note: PWS = Public Water Supply

Low Channel Dams

Five low channel dams, listed in table 6, have been built in the watershed of the Little Wabash River immediately downstream of public water supply (PWS) intakes. Two of these sites at Carmi and near Olney are no longer used for water supply. The low channel dams are located entirely within the river channel, typically with a height of 8 feet or less, and are used to pool sufficient water so that the pumps can operate during low flow conditions. In some cases, the water stored by these dams may be used as a supplemental supply of water during periods of little or no flow in the river.

Table 6. Low Channel Dams in the Little Wabash River Watershed

Stream Name	*Location*
Little Wabash River	Carmi
Little Wabash River	Effingham PWS intake
Little Wabash River	Flora PWS intake (near Louisville)
Skillet Fork	Wayne City PWS intake
Fox River	Olney PWS intake (inactive)

Note: PWS = Public Water Supply

Hydrologic Budget

Precipitation

Twelve precipitation gages in and around the Little Wabash watershed have continuous records that date from before 1900 to the present. Table 7 lists these stations and their long-term (1895-1999) average annual precipitation. The average annual precipitation for the Little Wabash River watershed is roughly 42 inches, and varies from 44 inches in the southern portion of the watershed to approximately 39 inches along the northern edge. Of the stations listed, the Charleston, Olney, and McLeansboro records are the most complete and were selected to be representative of the northern, central, and southern portions of the watershed, respectively. Annual precipitations for Charleston, McLeansboro, and Olney are plotted for the years 1895-1945 (figure 3) and for the years 1945-1999 (figure 4). Also plotted in figures 3 and 4 are the long-term (1895-1999) average precipitation for each station and an 11-year moving average of the annual values. The 11-year moving average is used to remove a lot of the short-term variation in precipitation amounts, including the potential influence of sunspot activity that has an 11-year cycle. The middle year in the 11-year period is used as the plotting position in both figures.

The annual precipitation values in figures 3 and 4 illustrate the great variability of rainfall, not only year to year but also at different locations within the same watershed. The moving averages shown in figures 3 and 4 indicate several major wet and dry periods. All three locations experienced consistent below-normal precipitation for the period 1952-1965, as compared to the long-term average. The average rainfall for Olney and McLeansboro has been consistently above the long-term average since the early 1980s. Charleston experienced a period of high average rainfall during the 1970s, but since that time the average has fallen closer to the long-term average. The average annual precipitation for the entire watershed fell below 29 inches in four years, 1895, 1914, 1936, and 1953, with 1953 experiencing the lowest annual average precipitation of about 28 inches (14 inches below average). The two wettest years on record occurred in 1927 and 1945, with average annual watershed amounts of 56 inches and 62 inches, respectively.

Table 7. Annual Average Precipitation for Long-Term Gages Located in and around the Little Wabash River Watershed

Location	*Annual average precipitation (inches)*	*Location*	*Annual average precipitation (inches)*
Albion	44.4	Harrisburg	44.0
Casey	39.8	Mattoon	37.9
Charleston	39.1	McLeansboro	42.2
Effingham	39.7	Mt. Carmel	43.7
Fairfield	42.9	Mt. Vernon	41.6
Flora	40.8	Olney	41.9

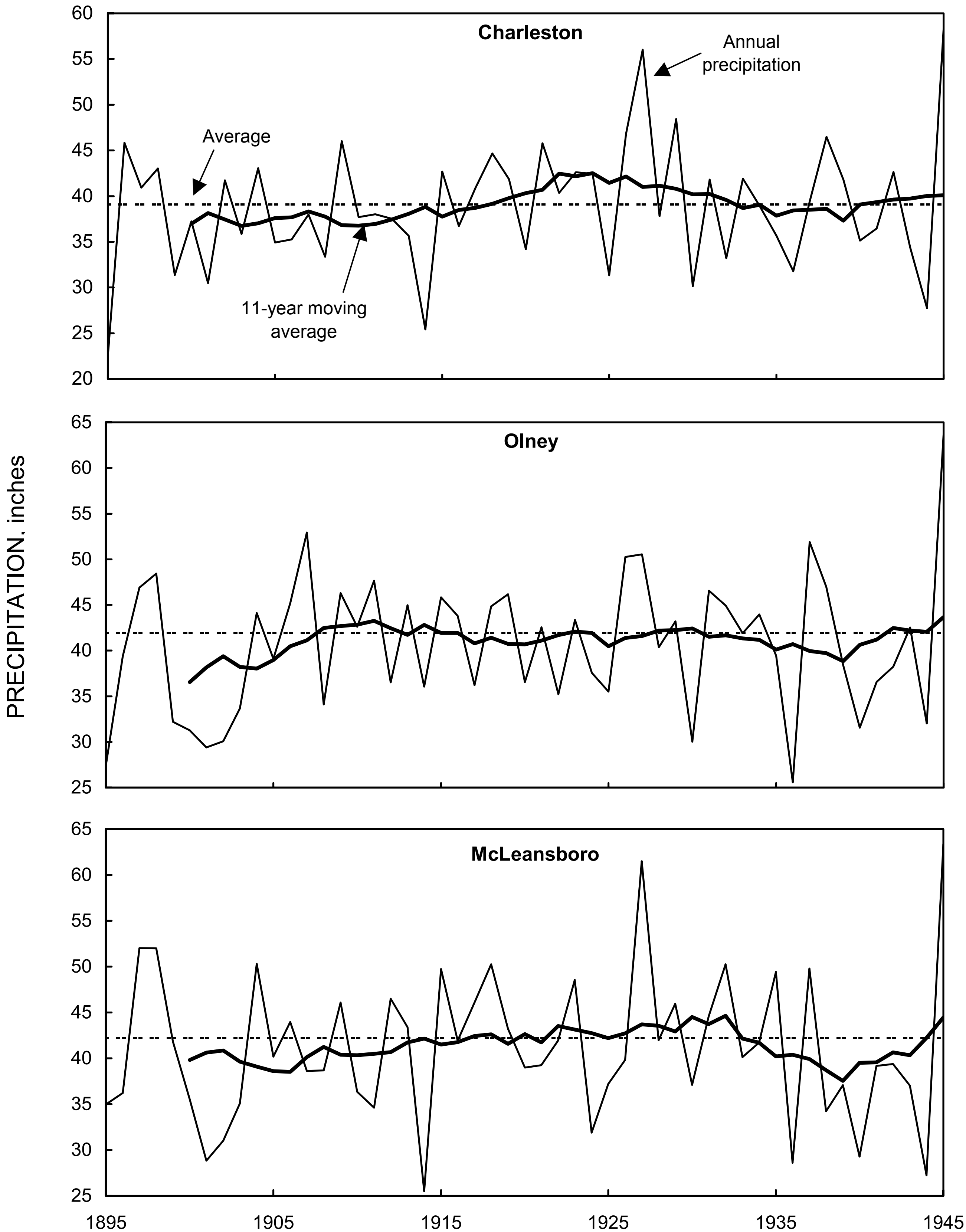

Figure 3. Annual precipitation at Charleston, Olney, and McLeansboro, 1895-1945

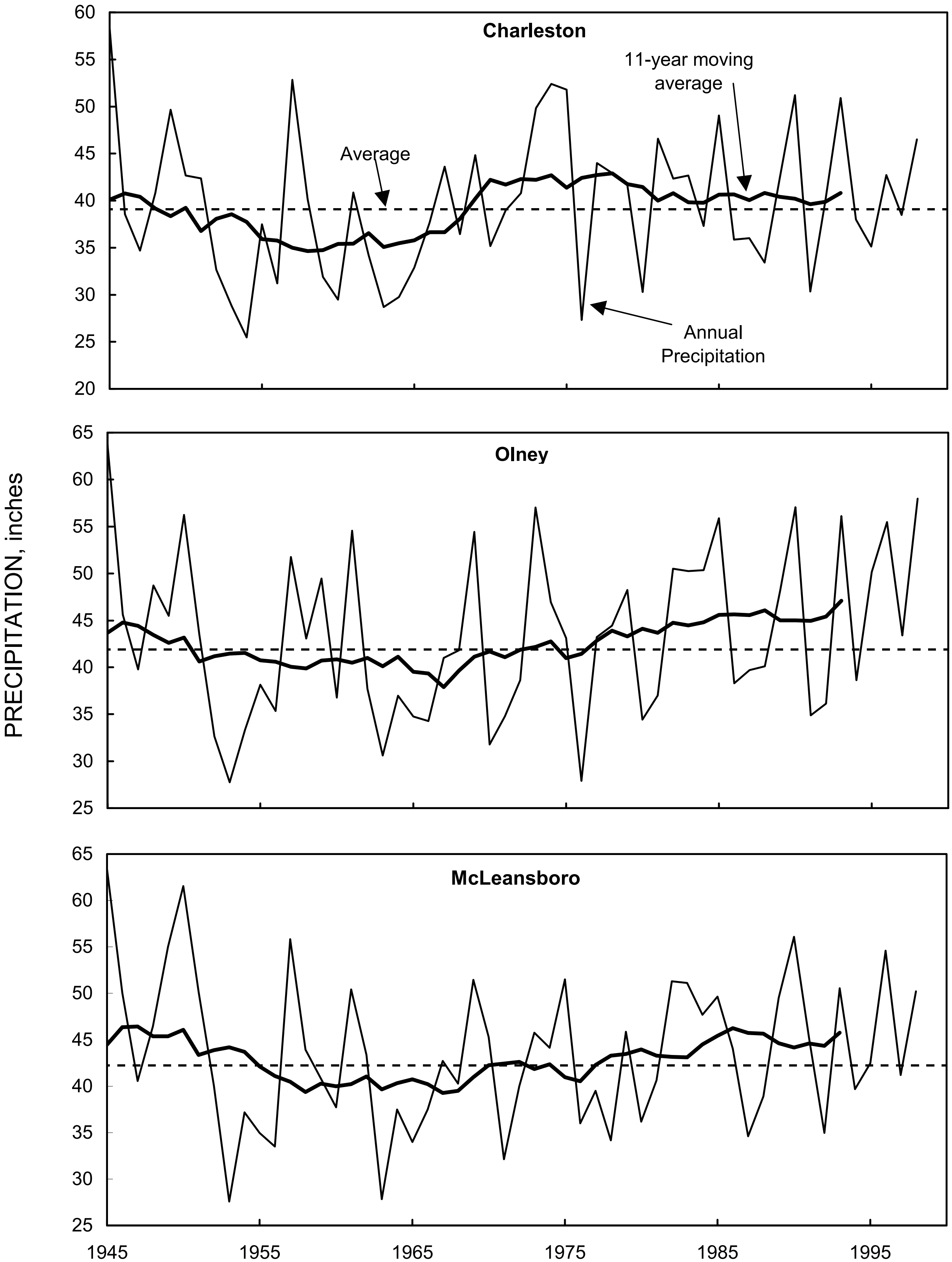

Figure 4. Annual precipitation at Charleston, Olney, and McLeansboro, 1945-1999

Evapotranspiration

A majority of the water that falls as precipitation is stored by the soil and eventually returns to the atmosphere through evapotranspiration (evaporation plus transpiration from plants). The average annual amount of evapotranspiration is roughly 30 inches, and ranges from 29 inches in the northern portion of the region to 31 inches in the southern portion. This average annual evapotranspiration amount, estimated from Knapp (1988), was computed as the difference between long-term average values of regional precipitation and streamflow using the methodology given by Jones (1966). Most of the water not used in evapotranspiration ultimately flows to streams by way of either runoff following precipitation events or from the more gradual seepage of water stored in the soil and shallow groundwater.

Monthly Water Budget

Table 8 shows a typical distribution of precipitation, evapotranspiration, and streamflow over the Little Wabash River watershed for each month of the year. The monthly values of precipitation and streamflow in table 8 are taken from available records, and the general monthly distribution of evapotranspiration was computed using the soil moisture component of a hydrologic model (Durgunoglu et al., 1987), with a slight adjustment to match the average annual evapotranspiration given by Knapp (1988). The sum of the evapotranspiration and streamflow do not equal the precipitation in any one month due to the effect of subsurface storage of water (soil and groundwater). For any one month, the average addition to this subsurface storage (ΔS) is estimated as the remainder between the precipitation (P), the evapotranspiration (ET), and the streamflow (Q): $\Delta S = P - ET - Q$. The

Table 8. Typical Monthly Distribution (inches) of Precipitation, Evapotranspiration, Streamflow, and Subsurface Storage

Month	*P*	*ET*	*Q*	*ΔS*
January	2.9	0.2	1.3	+1.4
February	2.5	0.5	1.6	+0.4
March	4.0	1.6	2.0	+0.4
April	4.1	2.4	2.0	-0.3
May	4.5	3.5	1.6	-0.6
June	4.2	4.8	0.9	-1.5
July	3.5	5.9	0.5	-2.9
August	3.3	5.3	0.3	-2.3
September	3.4	3.1	0.1	+0.2
October	3.1	1.8	0.2	+1.1
November	3.4	0.8	0.5	+2.1
December	3.1	0.3	1.0	+1.8
TOTAL	42.0	30.0	12.0	0.0

Note: P = precipitation, ET = evapotranspiration, Q = streamflow, and ΔS = change in subsurface storage.

total streamflow (Q) is the sum of both direct runoff and the baseflow that originates from the subsurface storage.

Evapotranspiration is noticeably greater than precipitation during the height of the growing season (June through August) when the greatest reduction in subsurface water storage occurs. Lowest streamflow rates are expected near the end of the growing season (August through October) when soil moisture and groundwater are at their annual minimums. Average runoff is highest in February through May when the soil moisture is often near its annual maximum.

Population

The Little Wabash River watershed is a predominantly rural watershed with a total population in 1999 of approximately 122,000. Table 9 gives the 1999 population for the 15 counties either partially or entirely contained within the Little Wabash River watershed. The population of the watershed fell by roughly 2 percent from 1980 to 1999. The Illinois Bureau of the Budget population prediction for 2020 suggests that the population in the watershed will rise approximately 4 percent over the next 20 years. The watershed has no major metropolitan areas. Only Effingham (12,254) and Mattoon (18,441) have populations of more than 10,000 in the watershed; however, Mattoon is only partially within the watershed. Olney (8873), Carmi (5626), Fairfield (5442), Flora (5093), Altamont (2296), and Albion (2116) are the only other cities that have populations of more than 2,000.

Table 9. Population Data for the Little Wabash River Watershed Counties

(in thousands)

County	*1980*	*1999*	*2020**
Clay	15 (15)**	14 (14)	15 (15)
Coles	52 (5)	52 (5)	55 (6)
Cumberland	11 (3)	11 (3)	9 (2)
Edwards	8 (4)	7 (4)	9 (4)
Effingham	31 (30)	34 (33)	32 (31)
Fayette	22 (1)	22 (1)	21 (1)
Hamilton	9 (3)	9 (3)	9 (3)
Jasper	11 (4)	11 (4)	11 (4)
Jefferson	37 (4)	39 (4)	41 (5)
Marion	44 (4)	42 (4)	44 (5)
Moultrie	15 (0)	15 (0)	15 (0)
Richland	18 (16)	17 (15)	18 (16)
Shelby	24 (3)	23 (3)	22 (3)
Wayne	18 (18)	17 (17)	18 (18)
White	18 (14)	16 (12)	18 (14)
TOTAL	318 (124)	315 (122)	322 (127)

Notes:

Estimates of the population of each county within the Little Wabash watershed are based on data from the 1980 Census of the Population (U.S. Bureau of the Census, 2000a) and the Census Bureau's County Population Estimates for 1999 (U.S. Bureau of the Census, 2000b).

* Population projections for counties are from the Illinois Bureau of the Budget (1990).

**Population within the Little Wabash River watershed is given in parentheses.

Water Use and Water Supply

Public and Industrial Water Supply

The average amount of water used for public water supply (PWS) in the Little Wabash watershed varies annually, but in the past 5 years it has usually been in the range of 11.5 to 12 million gallons per day (mgd). Average per-capita water use is approximately 94 gallons a day. Surface water resources supply roughly 80 percent of the total PWS, or about 9.5 mgd. Of this amount, approximately 6 mgd is supplied by reservoirs in the watershed, 3 mgd is supplied by withdrawals from the Little Wabash River and Skillet Fork, and more than 0.3 mgd is imported to the watershed from Rend Lake. The remaining 20 percent of the PWS in the watershed comes from ground-water sources. These water use estimates do not include domestic water use outside of the service areas of the public water supplies, nor do they include water used for livestock. These latter uses are most often supplied from ground-water sources.

Tables 10 and 11 list the major public water supply systems in the watershed. Most of these water supplies have experienced little or no increase in water use over the past 10 years. However, the Effingham PWS has seen water use increase 70 percent over the past 10 years, and Olney experienced a 20-percent growth in water use. A number of communities also have connected to the EJ Water Corporation, which in recent years has experienced significant growth in service population, and thus water use.

Surface water also provides cooling water for the CIPS power plant at Newton Lake. Water used at the power plant is recirculated back into the lake where it is cooled. The heat loading from the plant forces some additional evaporation from the lake surface. The amount of forced evaporation is expected to be roughly 1 percent of the total water withdrawn for cooling use, as estimated for similar cooling lakes in central and northern Illinois.

Table 10. Public Water Supplies Using Groundwater Sources

Albion	Iuka
Burnt Prairie	Jeffersonville (Geff)
Calhoun	Kincade Acres MHP
Carmi	Lakeview Ranch MHP
Cisne	Louisville
Clearwater Corp. – Lake Mattoon WD	Mason
Country Village MHP	Montrose
Crossville	Mount Erie
Dieterich	Sigel
Edgewood	Watson
Iola	

Note: WD = Water District
MHP = Mobile Home Park

Table 11. Public Water Supplies from Surface-Water Sources

System name	*County*	*Communities served*	*Primary source(s)*
Altamont	Effingham	Altamont	Altamont New Reservoir
Clay City	Clay	Clay City	Little Wabash River
Effingham	Effingham	Effingham Heartville WD Lake Sara Water Coop Snake Trail WD Teutopolis	Little Wabash River Lake Sara CIPS Lake
Fairfield	Wayne	Boyleston WD Fairfield Golden Gate New Hope WD	Little Wabash River with side-channel storage
Flora	Clay	Flora Xenia	Little Wabash River
Mattoon	Coles	Humbolt Mattoon	Lake Paradise Lake Mattoon
Neoga	Cumberland	Neoga	Lake Mattoon
Olney	Richland	Noble Olney Parkersburg Watergate Subdivision West Liberty – Dundas	East Fork Lake with emergency supplies: Borah Reservoir, Vernor Lake, and Fox River
Rend Lake Conservation District	Franklin	Bluford – Jefferson Co. Belle Rive – Jefferson Co. Dahlgren – Hamilton Co. Enfield – White Co. Mill Shoals – White Co.	Rend Lake (interwatershed transfer from Big Muddy River watershed, also via Hamilton County WD)
Wayne City	Wayne	Keenes Sims Wayne City Western Wayne WD	Skillet Fork with side-channel storage

Note: WD = Water District

The following paragraphs describe the history and current status of the largest PWS systems in the Little Wabash River watershed and those systems that obtain water from the Little Wabash River or Skillet Fork. Most of this information was taken from files at the Illinois State Water Survey, which contain reports documenting PWS systems since the early 1900s.

Altamont

The Altamont PWS, created in 1913, obtained its water from two wells. Over the next 20 years, additional wells were developed, but the capacity of each well was limited, and they became inadequate to meet the city's PWS needs. In 1935, an impounding reservoir with a storage of 33 million gallons (mg) was built on Second Creek, northeast of the city. During the 1953-1954 drought, the city experienced severe shortages, and water was piped to both Effingham and Altamont from the Embarras River, located 30 miles to the east. In 1973, the New Altamont Reservoir located southeast of the city was created with a capacity of more than 300 mg.

Albion

As early as 1912, there were investigations about establishing a PWS at Albion; however, the development of a nearby groundwater source was considered out of the question because of the high mineral content in the water. Eventually, in 1926, the city began withdrawing water from Bonpas Creek, located 4 miles west of the city. A low channel dam storing 18 mg helped supply the city during dry periods. There were some shortages during the 1953-1954 drought, and the city used a nearby shale pit for supplemental supply. By the late 1950s, the city was experiencing problems with high salinity in Bonpas Creek, and these water quality problems, not quantity, led the city to a new water supply source. In 1963, the city developed and began using 50-foot deep wells in the Wabash River lowlands, located 10 miles to the southeast near Grayville.

Carmi

The Carmi PWS system, established in 1894, obtained water from the Little Wabash River. In 1953, a 4.5-foot channel dam was built to increase the depth of water above the PWS intake. The river never failed to yield sufficient water for the city's use, to the extent that a 1954 newspaper headline proclaimed that "Carmi is an Oasis in the South Illinois Drought." But during low flows, the river water was hard and occasionally had high chloride levels. In 1974, the city changed its water supply to wells located in the Wabash River lowlands, 5 miles east of the city, to save money through reduced water treatment.

Clay City

The Clay City PWS system, established in 1938, obtains water from the Little Wabash River. The river has never failed to yield sufficient water for the city's use, even though shortages were experienced at other locations along the river during the drought of 1953-1954. The current water use of the city is approximately 100,000 gallons per day (gpd).

Effingham

The Effingham PWS was originally established in 1895 using the Little Wabash River as the sole source of water. A channel dam was constructed on the Little Wabash River when the system was established or shortly thereafter. Following the drought of 1930-1931, the CIPS Service Lake was constructed to serve both as a settling pond and side-channel reservoir, providing storage during low flow periods. The CIPS Lake has an estimated capacity of 64 million gallons (Durgunoglu et al., 1990). During the drought of 1953-1954, the Effingham system experienced severe shortages. Water consumption during the drought was reduced by 50 percent of normal, down to 400,000 gpd, and water was pumped to the CIPS Lake from the Embarras River using an oil pipeline from the Newton area. This pipeline also provided water to the city of Altamont. In 1957, Effingham built Lake Sara, located several miles to the west of the city, to provide a supplemental source of water during droughts.

The Effingham PWS system is experiencing the greatest increase in water use in the Little Wabash River watershed, with the annual average water use increasing in the last 10 years from 1.4 million gallons per day (mgd) to 2.4 mgd. According to their water operator, the Little Wabash River supplies about 60 to 70 percent of the water, with Lake Sara supplying the remainder. Detailed pumping records are not kept. A gravity flow release from Lake Sara is used during low flow periods and during wet periods when the lake is overflowing. Lake Sara water is generally of better quality than the river water and is preferred when the release of water from the lake does not cause the lake level to decline.

EJ Water Corporation

Over the last 10 years, a number of communities in Effingham, Jasper, and Clay Counties have connected to water supplied by EJ Water Corporation, which obtains its water primarily from shallow groundwater sources near the Embarras River in Jasper County. Several communities in the Little Wabash River watershed are currently serviced by EJ Water: Dieterich, Edgewood, Louisville, Mason, and Watson. The current water use of the EJ Corporation is roughly 0.5-0.6 mgd

Fairfield

The Fairfield PWS system, established in 1926, obtains water from the Little Wabash River approximately 6 miles east of the city. During the 1954 drought, the city did not experience any water shortages; however, an earthen dam was placed in the river channel to retain as much water as possible. In 1972, a side-channel reservoir was constructed near the existing intake on the Little Wabash River, and now serves as the city's water supply source.

The reported water use of the city has decreased over the past 10 years, from past estimates of almost 1.0 mgd to recent estimates of 0.85 mgd. This reduction in estimated water use may be related in part to improved water metering rather than actual reductions in consumption. The side-channel reservoir has a reported capacity of 90 million gallons, roughly equivalent to a 106-day supply, given an average daily use of 0.85 mgd. There are two pumps at the withdrawal site, each sufficient to withdraw approximately 2000 gpm or almost 3 mgd. The side-channel reservoir is normally refilled daily. Based on the streamflow estimates produced by the ILSAM, it is believed that the low flows on the Little Wabash River combined with the storage in the side-channel reservoir may be able to support a water use of up to 2.5 mgd during a 50-year drought. The Fairfield water supply also services the New Hope Water District and the communities of Boyleston and Golden Gate.

Flora

The Flora PWS system, installed in 1911-1912, obtained its water from a number of wells. Even at that time, the yield of the wells was known to be inadequate for the full needs of the city. In 1933, a raw-water pumping station was built on the Little Wabash River, located 5 miles north of the city, which has served as the city's water supply since that time. Prior to the 1954 drought, the city had an average water use of 0.6 mgd, with consumption rising to almost 1 mgd during summer months. During the summer of 1954, the flow in the river was not sufficient to supply the city, and additional water was obtained by pumping water from various pools located along the river. In the fall of 1954, a channel dam was constructed downstream of the existing pumping station. At the time of construction, the channel dam was reported to have a storage capacity of 50 million gallons.

Flora currently has an average water use of 0.7 mgd. Broeren and Singh (1989) identified the Flora PWS system as having insufficient yield to provide water during a 50-year drought. Data produced by the present ILSAM study indicate that the flow in the Little Wabash River is sufficient during a 50-year drought to supply a withdrawal rate of only 0.5 mgd; however, this does not consider the possible use of water stored behind the channel dam.

Since the present amount of storage behind the channel dam is not known, it is not possible to determine whether the city could provide its current level of water use (0.7 mgd) during a 50-year drought. During the last 20 years, the city had proposed the development of a side-channel reservoir to supplement its supply; however, these plans are no longer being pursued. The city is now proposing to obtain its water from a new water supply system, which reportedly would obtain its water from Carlyle Lake.

Louisville

Louisville established its water works on the Little Wabash River in 1899-1900. Until 1998, the city obtained its water from the river, but it has since shut down its water works and now obtains its water from the EJ Water Corporation. The only water shortage was experienced during the 1953-1954 drought. Flow in the river ceased during that drought, water use was restricted, and a bulldozer was brought in to build an earthen dam in the river and create a pool that provided sufficient water through the remainder of the drought. The average annual water use at Louisville is approximately 100,000 gpd.

Mattoon

Paradise Lake was constructed in 1908 to provide a water supply for the city of Mattoon. Paradise Lake failed to provide sufficient water for the city during the drought of 1953-1954, and the city had to develop wells for a supplemental supply during that drought. A plan for piping water from the Kaskaskia River also was examined during the drought but the plan was never implemented. In 1957, Lake Mattoon was constructed, and, in combination with Lake Paradise, has continued to provide the city's water supply since that time. The current annual average water use of Mattoon is about 2.8 mgd.

Neoga

The Neoga PWS was established in 1915, and for the next 43 years the town obtained its water from two large-diameter shallow wells located in drift material. In 1958, an intake was built into the then newly constructed Lake Mattoon, which was located less than 2 miles northwest of Neoga. The lake has remained the source of water for the town. The current annual average water use is approximately 140,000 gpd.

Olney

Olney first installed a PWS system in the early 1890s, obtaining water from a channel dam on the Fox River located 1.5 miles west of the city. An impounding reservoir, Vernor Lake, was built in 1924 on a small tributary to the Fox River. Severe water shortages were experienced in 1953 and 1954, water use was restricted, and a temporary pipeline was built to pump water from the Embarras River into the Fox River. A second reservoir, Borah Lake, was constructed in 1954 and had just begun filling up when the drought broke later that year. Heavy rainfall severely eroded the spillway of Lake Borah in 1970. Although repairs to the Borah Lake dam were made several year later, the new larger East Fork Lake was constructed in 1972 with a capacity of 300 million gallons, and has since served as the primary water supply for the city.

Wayne City

Wayne City used private wells for its water supply until 1955, when a channel dam was constructed on the Skillet Fork to provide a sustainable source of water for the new PWS. A side-channel reservoir was constructed in 1972 to provide water during low flows and conditions when the river water quality was not desirable. Although the capacity of the side-channel reservoir is not known, information supplied by the system operator suggests a capacity equivalent to 150-180 days of usage for the city, or in the range of 40-50 mg given an average daily use of approximately 0.28 mgd. The side-channel storage is depleted from daily water use and then refilled periodically. Treatment of river water is a concern, particularly when atrazine levels are high. In some cases, when river water is of poor quality, the side-channel reservoir may not be refilled for two months, and may be drawn down as much as 6 feet during this time.

The Wayne City PWS system was identified by Broeren and Singh (1989) as having potential water supply problems during a severe drought; however, the volume of the side-channel reservoir was believed to have been smaller than that indicated by the system's water operator. Thus, volumetric surveys of the side-channel reservoir and the pool behind the channel dam are needed to provide an accurate estimate of the sustainable yield of the Wayne City system during drought conditions. Water use of the Wayne City system has grown over the last 10 years, from 0.2 to 0.28 mgd, as services have been provided to outlying communities. Wayne City currently supplies the communities of Sims and Keenes and the Western Wayne Water District, which services Johnsonville, Orchardville, Berry, and the Sam Dale Lake Conservation Area.

Effluent Discharges to Streams

Most of the public water used is eventually returned to streams through discharges from wastewater treatment facilities, although many smaller communities use wastewater lagoons that release water to streams only during wet conditions. Because water is discharged to streams from communities supplied by both surface- and groundwater sources, the net impact of water use in the watershed is to increase flows in the stream, except during periods of very low flow.

Monthly discharge data were obtained from the Illinois Environmental Protection Agency for all sanitary effluents in the Little Wabash River watershed having an average discharge greater than 50,000 gpd. The frequency of daily discharges for these effluents was estimated using methods described by Knapp (1988, 1990, and 1992). These methods also used data on low flow discharges given in Singh et al. (1988).

Table 12 lists the 23 largest effluent discharges in the Little Wabash River watershed. Appendix B lists the full set of discharge frequency data computed for these 23 discharges and used by the ILSAM.

Table 12. Major Effluent Discharges in the Little Wabash River Watershed

Facility name	*Average discharge (cfs)*	*Facility name*	*Average discharge (cfs)*
Albion	0.47	Effingham	3.82
Altamont (north)	0.31	Enfield	0.04
Altamont (south)	0.16	Fairfield	1.78
Bluford	0.15	Flora	1.42
Carmi	1.90	Louisville	0.18
Cisne	0.11	Neoga	0.45
Clay City	0.20	Noble	0.19
Crossville	0.10	Olney	2.80
Dahlgren	0.09	Roadmaster Corp.	0.12
Dieterich	0.08	Teutopolis	0.51
Edgewood	0.06	Wayne City	0.13
		Xenia	0.11

Characteristics of Observed Streamflows

Streamgaging Records

There are about 5145 miles of rivers and streams in the Little Wabash River watershed. The status of these rivers and streams is monitored by streamgaging stations, which are established at selected locations and measure the flow of water over a period of time. These measurements provide information on the amount and distribution of surface water passing the stations. These streamflow records may be used to evaluate the impacts of changes in climate, land use, water use, and other factors on the water resources of a river basin.

The U.S. Geological Survey (USGS) has operated seven continuous-discharge streamgages in the Little Wabash River watershed. Table 13 lists these stations, and figure 2

Table 13. USGS Streamgages in the Little Wabash River Watershed

USGS ID	*Station name*	*Drainage area (mi^2)*	*RL* (years)*	*Period of record*
	Continuous Discharge Records			
03378635	Little Wabash River near Effingham	240	33	1966-present
03378900	Little Wabash River at Louisville	745	17	1965-1982
03379500	Little Wabash River below Clay City	1131	85	1914-1999
03380350	Skillet Fork near Iuka	208	16	1966-1982
03380475	Horse Creek near Keenes	97	31	1959-1990
03380500	Skillet Fork at Wayne City	464	82	1908-1912, 1914-1921, 1928-1999
03381500	Little Wabash River at Carmi	3102	60	1939-1999
	Continuous Stage Records			
03379000	Little Wabash River near Clay City	801	4	1909-1913
03379600	Little Wabash River at Blood	1387	9	1973-1982
03380000	Little Wabash River near Golden Gate	1792	12	1908-1913, 1973-1980
03381000	Skillet Fork near Mill Shoals	874	7	1909-1913, 1975-1978

Note: * RL = record length

gives their locations. Four of these gages are currently active, and three of the four gages are long-term gages having record lengths in excess of 50 years. In addition to the continuous-discharge gages, the USGS has operated four gages that monitor river stage. These stage gages, also identified in table 13, have short records of 12 years or less. Miscellaneous discharge measurements were collected at several of these stage gages in the 1970s, but these measurements were not sufficient to establish rating curves and discharge records for these gages.

Human Impacts on Streamflows

As indicated earlier, the characteristics of streamflow in any moderately developed watershed will, over time, vary from earlier conditions because of a combination of climate variability and the cumulative effect of human activities in the region. Most of the streamgaging records in this region are less than 60 years old, and thus represent hydrologic conditions related to the agricultural landscape of the region in the 20th Century. Climate variability also influences the changes in streamflows from year to year and decade to decade. The major changes to the climate during this century are assumed to occur from natural climatic variability. However, with recent research focusing on global climate change, it is possible that these changes may be shown also to result from human influences.

For several locations in the Little Wabash River watershed, water use and water resource projects have readily definable impacts on streamflows. Five water supply systems at Effingham, Flora, Clay City, Fairfield, and Wayne City withdraw water directly from the Little Wabash River and Skillet Fork, which has an impact on the low flows in these rivers. Treated wastewater discharges from the larger communities in the watershed also have a significant impact on the low flow in their receiving streams. Thus, the net result of the public water supply (withdrawal and effluent return) on low flows may be positive or negative depending on location. The streamflow immediately downstream of the major reservoirs in the watershed has been altered, as these reservoirs attenuate the magnitude of high flows downstream to varying degrees.

Streamflow Variability

Average Annual Streamflow

The average annual amount of precipitation in the Little Wabash River watershed is approximately 42 inches and ranges from about 39 inches at the northern edge of the region to more than 45 inches at the southern edge. Of this water, about 70 percent eventually returns to the atmosphere through evapotranspiration. Most of the remaining 30 percent ultimately flows to streams by way of runoff after precipitation events or from the more gradual seepage of water stored in the soil and shallow groundwater. The average amount of streamflow during the last half of this century has been approximately 12 inches This represents an average flow rate of approximately 0.9 cubic feet per second (cfs) per square mile of drainage area. The average annual streamflow varies geographically across the region, ranging from 10 inches at the northern edge of the watershed to almost 14 inches at the southern edge.

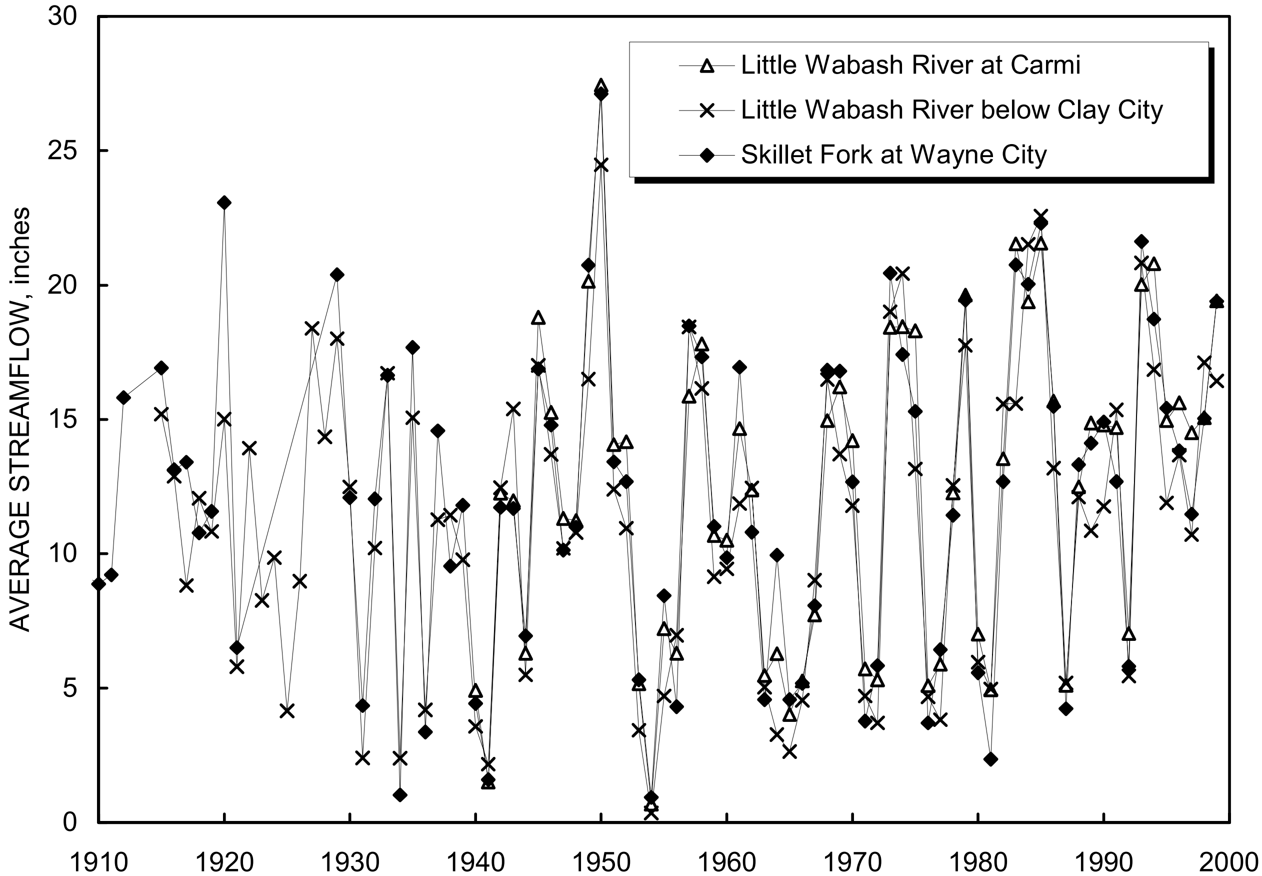

Figure 5. Average annual streamflow for long-term gaging records, Little Wabash River watershed, 1910-2000

Figure 5 shows the annual series of average streamflow for the three longest gaging records in the watershed: Little Wabash River at Carmi, Little Wabash River below Clay City, and Skillet Fork at Wayne City. Flows are presented in units of inches of runoff over each gage's subwatershed. These plots show that average streamflow in the watershed can vary greatly from year to year and between decades. The statistical trends in these flows are examined in the "Streamflow Trends" section of this report.

Figure 5 shows that there is usually a considerable similarity in the total annual flows in the watershed. However, for gages on smaller watershed areas (figure 6), there can be some geographic variability in the average annual flows, which is particularly noticeable in the periods 1963-1970 and 1983-1990. The gage on Horse Creek near Keenes typically shows the highest annual runoff, whereas the Little Wabash River near Effingham typically shows the lowest annual runoff.

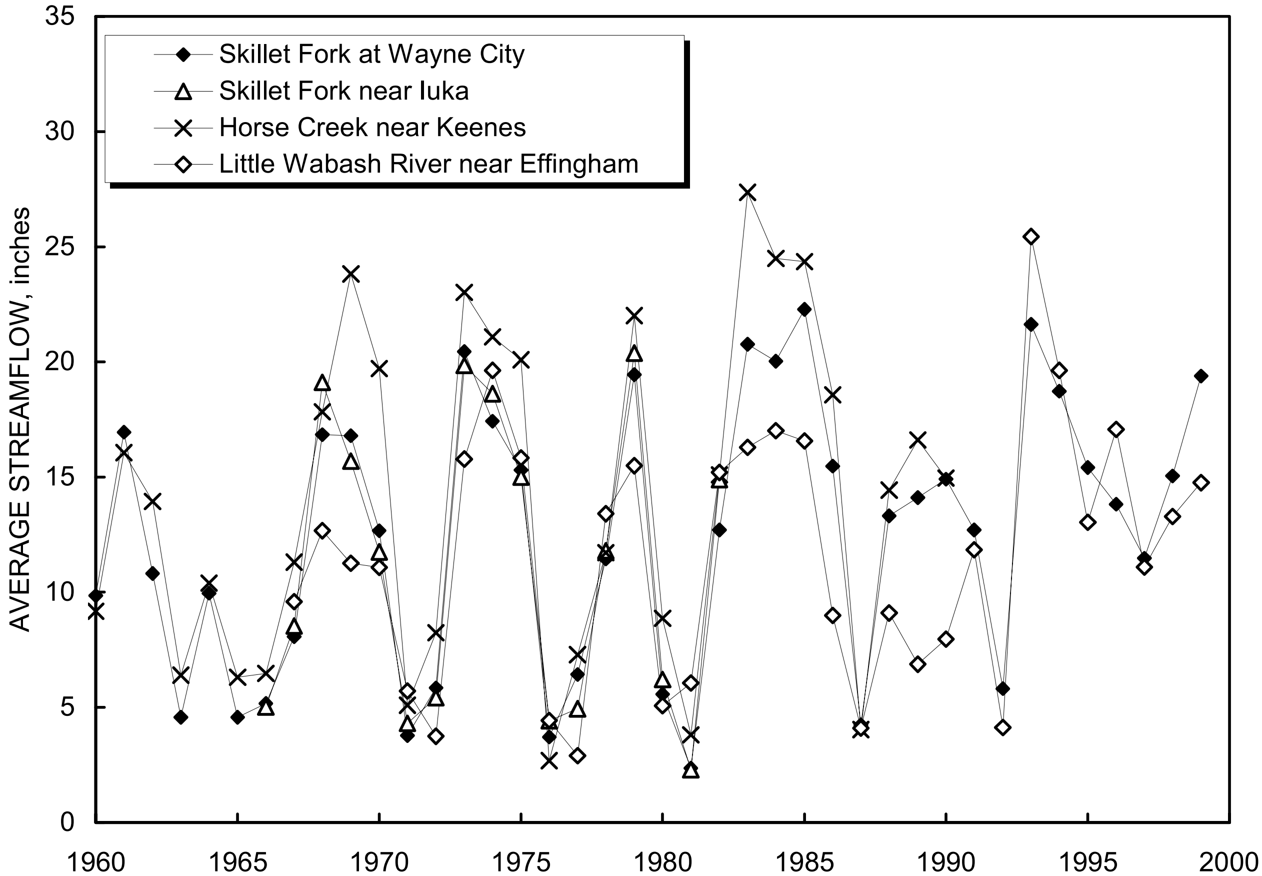

Figure 6. Average annual streamflow for selected watersheds, Little Wabash River watershed, 1960-2000

Monthly Streamflow

As with all other locations in Illinois, streams in the Little Wabash River watershed display a well-defined seasonal cycle. Figure 7 shows the monthly probability of flows for the Little Wabash River below Clay City. Three levels of flow probability are given: 50 percent flow (medium flow), 10 percent flow (high flow), and 90 percent flow (low flow). The 10 percent flow is exceeded only 10 percent of the time during that month. In contrast, the 90 percent flow is exceeded 90 percent of the time, and thus represents the expected low flow conditions in the stream. This figure shows that the average flow in any month can vary considerably from the long-term median condition. For example, the highest 10 percent of the flows can be more than 10 times the median flow for any month. Flows are normally expected to be greatest during the spring months, March-May, and then decline until the lowest flow conditions in or around October.

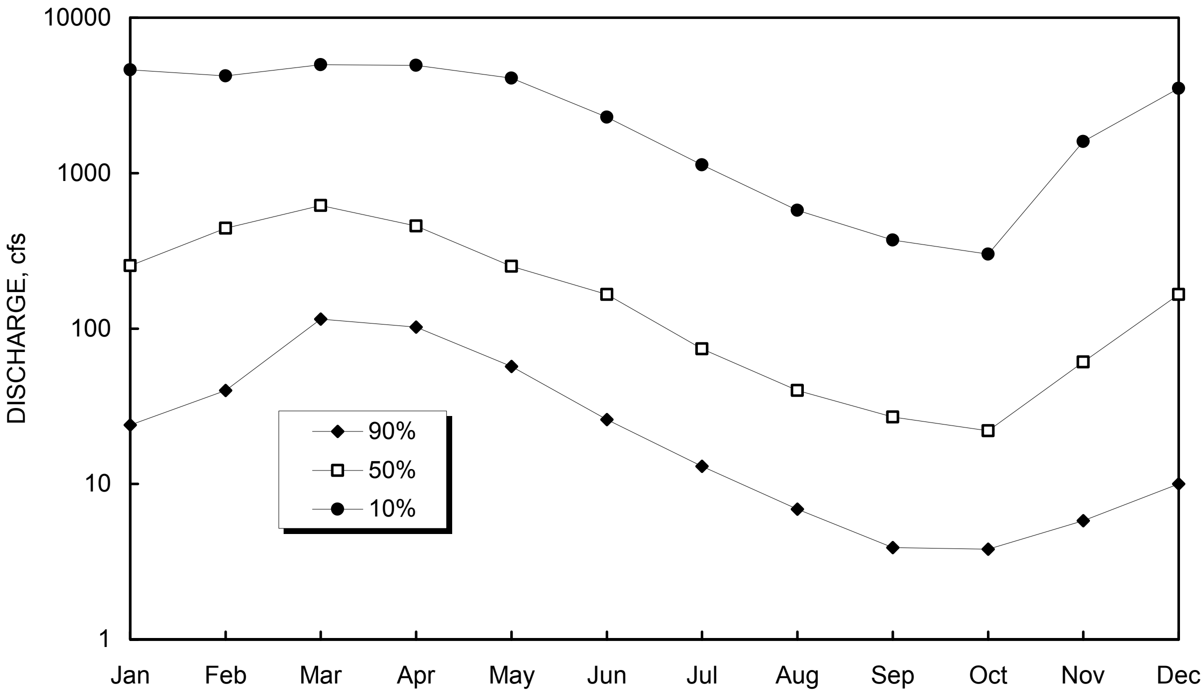

Figure 7. Probability of exceedence for monthly flows, Little Wabash River below Clay City

Variations in Daily Streamflows

Figure 8 plots the flow duration curves for six gaging records in the watershed: Little Wabash River at Carmi, Little Wabash River below Clay City, Skillet Fork at Wayne City, Skillet Fork near Iuka, Horse Creek near Keenes, and Little Wabash River near Effingham. The flow duration curve provides an estimate of the frequency with which the given flows are exceeded. As described earlier, the flow duration represents the percentage of time at which the flow is greater than a given rate; for example, the 90-percent flow is exceeded 90 percent of the time for the period of record, and thus represents the expected low flow conditions in the stream. The magnitude of the flows at each gaging location are different because of varying watershed size. For example, the flows for the Little Wabash River at Carmi convey the runoff for almost the entire Little Wabash River watershed (3102 square miles), and thus flows are much higher than at any of the other gage locations, in particular the Horse Creek gage where the drainage area is only 97 square miles.

Variations in the overall shapes of the flow duration curves often point to either regional differences in the hydrology of the streams or human impacts on streamflows. As can be seen in figure 8, the flow duration curves for most of the gaging records have a very similar shape and plot as nearly parallel lines. The gradient in the flow duration curve is somewhat steeper for smaller streams than for larger rivers, which is typical for any region, and several smaller streams have zero flow during extremely dry periods. The flow duration

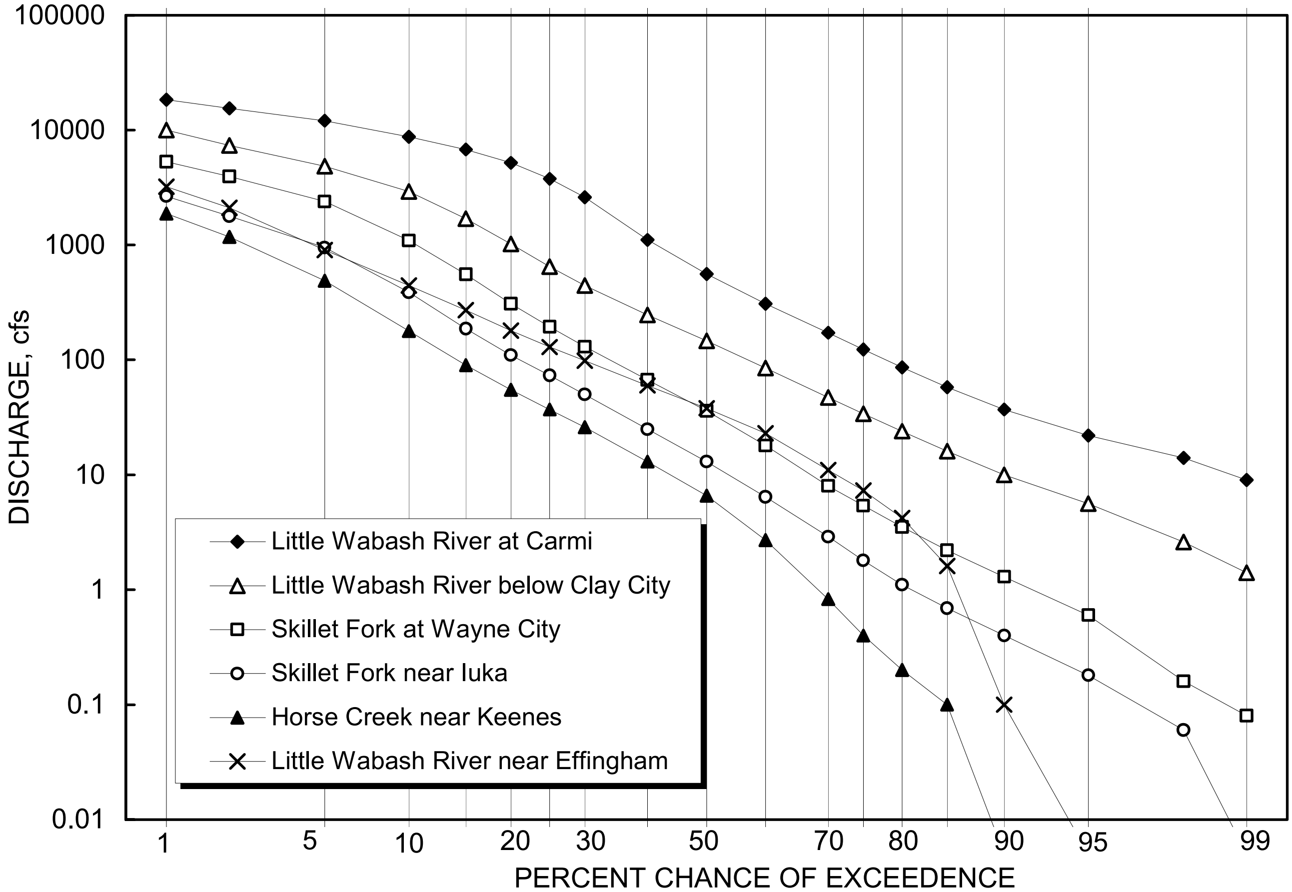

Figure 8. Flow duration probability of daily flows for gaging stations in the Little Wabash River Watershed

curve for the Little Wabash River near Effingham is unique in that it does not act in a similar manner to the other curves. Three factors contribute to the difference in the flow duration curve for the Effingham gage: 1) the northern part of the watershed upstream of Effingham is part of the Bloomington Ridged Plain, a physiographic region that has higher soil permeability and typically has a smaller variability between high and low flow conditions; 2) three PWS reservoirs have an impact on the upstream watershed; and 3) water withdrawn from the Little Wabash River one mile upstream of the gage reduces the magnitude of low flows.

High Flows

Figure 9 shows the annual series of 1-day high flows for the two longest gaging records in the watershed: Little Wabash River below Clay City and Skillet Fork at Wayne City. The 1-day high flow is the highest average flow over one calendar day during each water year, and the high flow amount is similar to but slightly lower than the peak discharge for that day for both gages. Figure 9 shows that the high flow events for all stations had noticeably low magnitudes during the drought periods of the 1930s and 1950s. The greatest flood event for both gages occurred during May 1961. The two highest flows on the Skillet

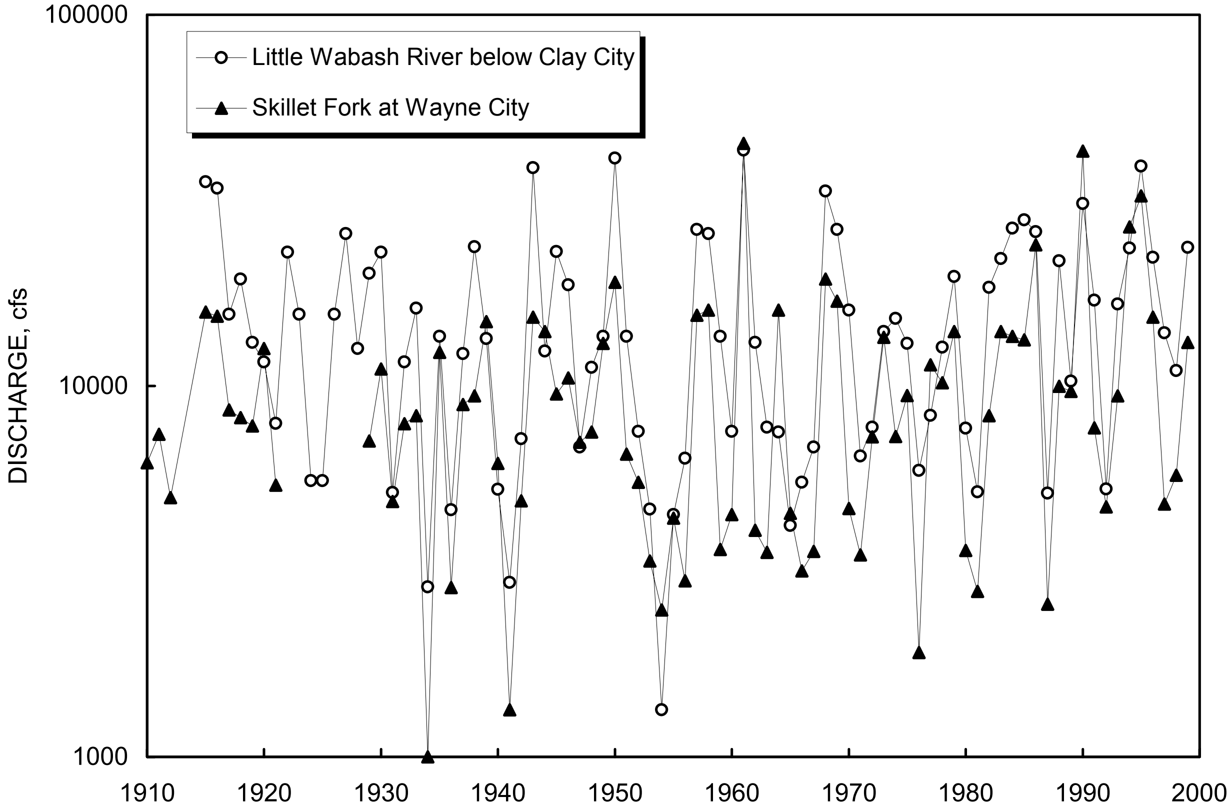

Figure 9. Annual series of 1-day high flows for long-term gaging records in the Little Wabash River watershed, 1910-2000

Fork, 1961 and 1990, are substantially greater any other event in that station's record. Examination of the 1-day high flows for the Little Wabash River below Clay City indicates little change in high flows over that station's 85-year period of record.

Low Flows

Figure 10 shows the annual series of 7-day low flows for the Little Wabash River at Carmi and below Clay City. The low flow values for Clay City do not show any significant long-term change over its 85-year period of record, although low flows are noticeably lower for several periods between 1930 and the early 1960s. The low flows for Carmi have a higher magnitude than the flows at the Clay City gage, but generally follow a similar pattern. The 7-day low flows in the Skillet Fork at Wayne City, not shown, are less than 1 cfs for most years on record. In the past 12 years there has been a noticeable increase in the frequency of occurrence of zero flows at the Skillet Fork gage, which may be related to an increase in withdrawals from the Wayne City PWS located directly upstream of the gage.

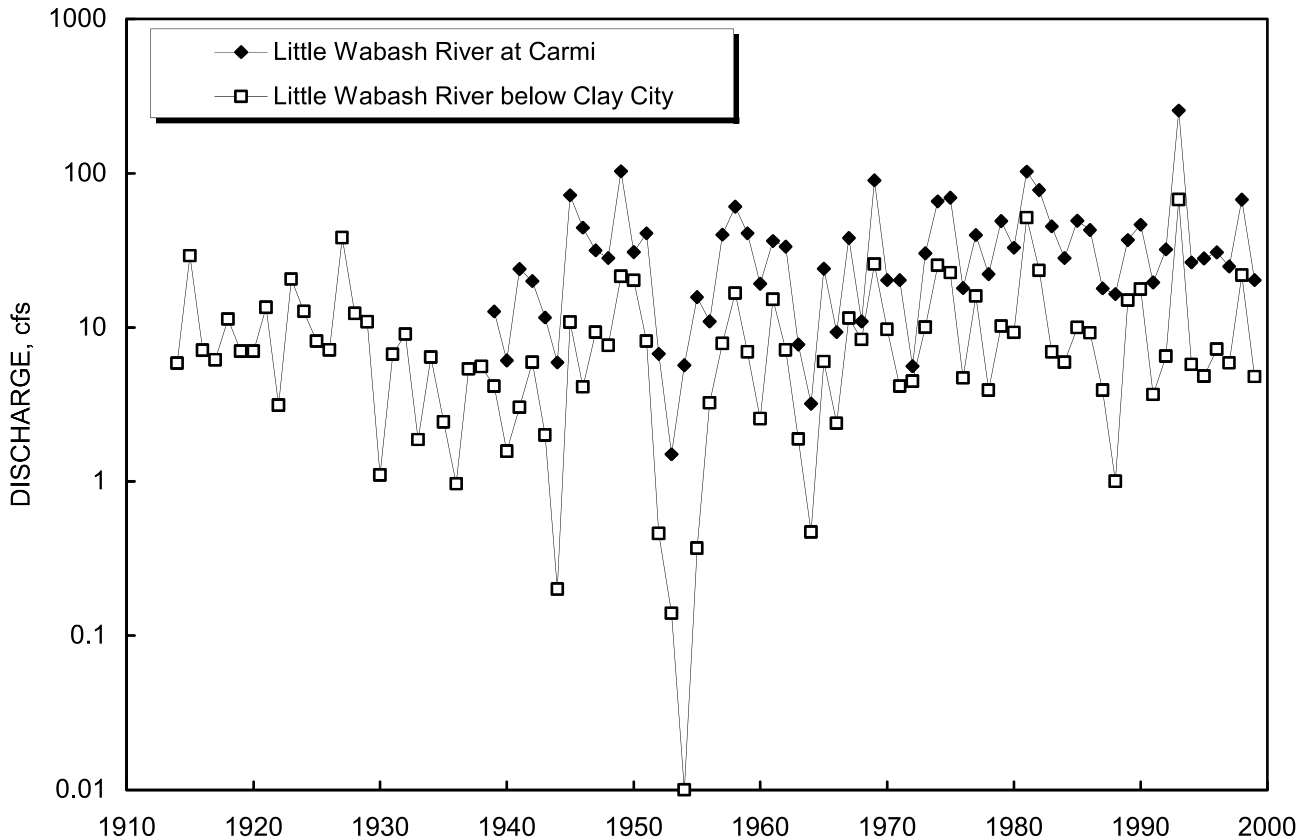

Figure 10. Annual series of 7-day low flows for long-term gaging records in the Little Wabash River watershed, 1910-2000

Streamflow Trends

An examination of figure 5 indicates that the Little Wabash River watershed has experienced stretches of above and below average streamflows. For example, the annual flows during much of the decade of the 1930s and the period 1953-1966 were well below the long-term average of 12 inches. In contrast, flows during 1915-1929 and 1968-1986 were well above the long-term average. During each period, locations in the Little Wabash River watershed have experienced flows in the range of 10 to 25 percent different than their long-term average streamflow. These changes in average streamflow can be attributed to coincident changes in precipitation.

Trend correlation statistics were estimated for the annual flow records of the three gaging stations having long-term records (greater than 50 years): Little Wabash River at Carmi, Little Wabash River below Clay City, and Skillet Fork at Wayne City. Table 14 presents these correlation statistics. The Kendall trend statistic was used to provide an indicator of the increase or decrease in the flow values. A Kendall correlation of 1.0 indicates an absolute increasing trend, with each year having a higher flow than the previous year. A Kendall correlation of -1.0 indicates an absolute decreasing trend, and a Kendall

Table 14. Trend Correlations for Annual Average, High, and Low Flows

Station name analyzed	*Years*	*Kendall trend correlation*		
		Average	*High*	*Low*
Little Wabash River below Clay City	1914-1999	0.087	0.066	0.052
Skillet Fork at Wayne City	1914-1999	0.081	0.071	-0.068
Little Wabash River below Clay City	1939-1999	0.150	0.167	0.196
Skillet Fork at Wayne City	1939-1999	0.140	0.116	-0.030
Little Wabash River at Carmi	1939-1999	0.185	0.194	0.170
Little Wabash River below Clay City	1970-1999	0.122	0.159	-0.103
Skillet Fork at Wayne City	1970-1999	0.094	0.142	-0.251
Little Wabash River at Carmi	1970-1999	0.140	0.147	0.104

correlation of 0.0 indicates no trend. The statistical significance of a trend correlation depends in part on the length of the record being analyzed. With a 50-year record, correlation values greater than 0.16 or less than -0.16 indicate a statistically significant trend, one that can be declared with a 90 percent level of confidence. The level of confidence with which a trend can be declared increases as the absolute value of the correlation increases. To establish statistical significance, shorter records require a higher correlation value, and longer records do not need as high a correlation value.

The trend coefficients in Table 14 were computed for three periods of record: 1914-1999, 1939-1999, and 1970-1999. These different periods were chosen to illustrate the effect that the period of record has on the perception of hydrologic trends, and in part are influenced by the period of record at gages in the watershed. The magnitude of the trend coefficients are generally highest when computed over the period 1939-1999, i.e., a period that starts during dry hydrologic conditions (the droughts of the 1930s-1950s) and ends during the 1990s, a period that represents generally wet hydrologic conditions. When trend coefficients are computed over the shorter period from 1970-1999, the presence of a hydrologic trend is generally less apparent. It is clear, however, that the low flows on the Skillet Fork at Wayne City have decreased during this latter period. Most importantly, there appears to be little trend in streamflows when computed over the long-term conditions from 1914-1999.

Factors in Estimating Flow Frequency at Gaged Sites

The flow observed at a gaging station represents the cumulative effects of 1) the unaltered or "virgin" hydrologic conditions as influenced primarily by weather and climate phenomena as well as the topography, hydrogeology, and prevailing land-use conditions in the watershed, and 2) modifications to the flow conditions by human activity. Changes in the streamflows over time can occur as a result of climatic variability or from human impacts. For this reason, the flow frequency computed directly from a streamgaging record may not always be indicative of the present flow regime on a stream, and it may not be directly comparable to flows measured at different periods of time or at different locations.

Selecting a Representative Period for Estimating Long-Term Conditions

As described earlier, streamflows can show sizable variation, not only between individual years but also between decades. It is possible that a given 10- or 20-year period of gaging primarily may reflect wet or dry conditions within the watershed, and not totally reflect the full range of expected hydrologic conditions over time. Thus, the years included in a streamgage record have a significant impact on the estimation of flow frequency at that gage. A primary consideration in the development of flow estimates for ILSAM is that a consistent relationship be maintained between different locations. For this reason, it is necessary to define a base period, representative of long-term flow conditions, to which frequency estimates can be related. Considerations include both: 1) finding a base period that includes a representative number of dry and wet hydrologic conditions, and 2) finding a period for which many stations have complete records.

In previous studies, estimates of long-term flow frequency have been developed using a general base period from 1948 to the present. The purpose of selecting this range of years was to provide a base period that both includes both a large number of years of record and a large number of active gaging records, in essence trying to maximize the product of the record length and number of gages.

Figure 11 shows the relationship between the number of years of record and the number of coincident gaging years for streamgages in southern Illinois. For example, for the 51 years from 1948 to 1999, there were nine active gages in the region, yielding a coincident set of 459 gaging years. (This estimate does not include five gages on the Big Muddy and Kaskaskia Rivers that experienced significant flow modifications during this period from large flood control reservoirs.) For the 47-year period, 1952-1999, there were 12 active gages yielding 564 coincident years of gaging record, the maximum number for the gages in southern Illinois. The 28-year period (1971-1999), with 20 active gages, has 560 coincident years. In comparing the 1971-1999 and 1952-1999 periods, there is a tradeoff between length of years (time) versus number of gages (spatial coverage). However, the 1971-1999 period does not contain periods of severe drought, which is a weakness for estimating low-flow frequency. The 47-year period is similar to the base period beginning in 1948 used in developing the ILSAM for other regions of the State, and was adopted in this study to maintain continuity with these previous studies.

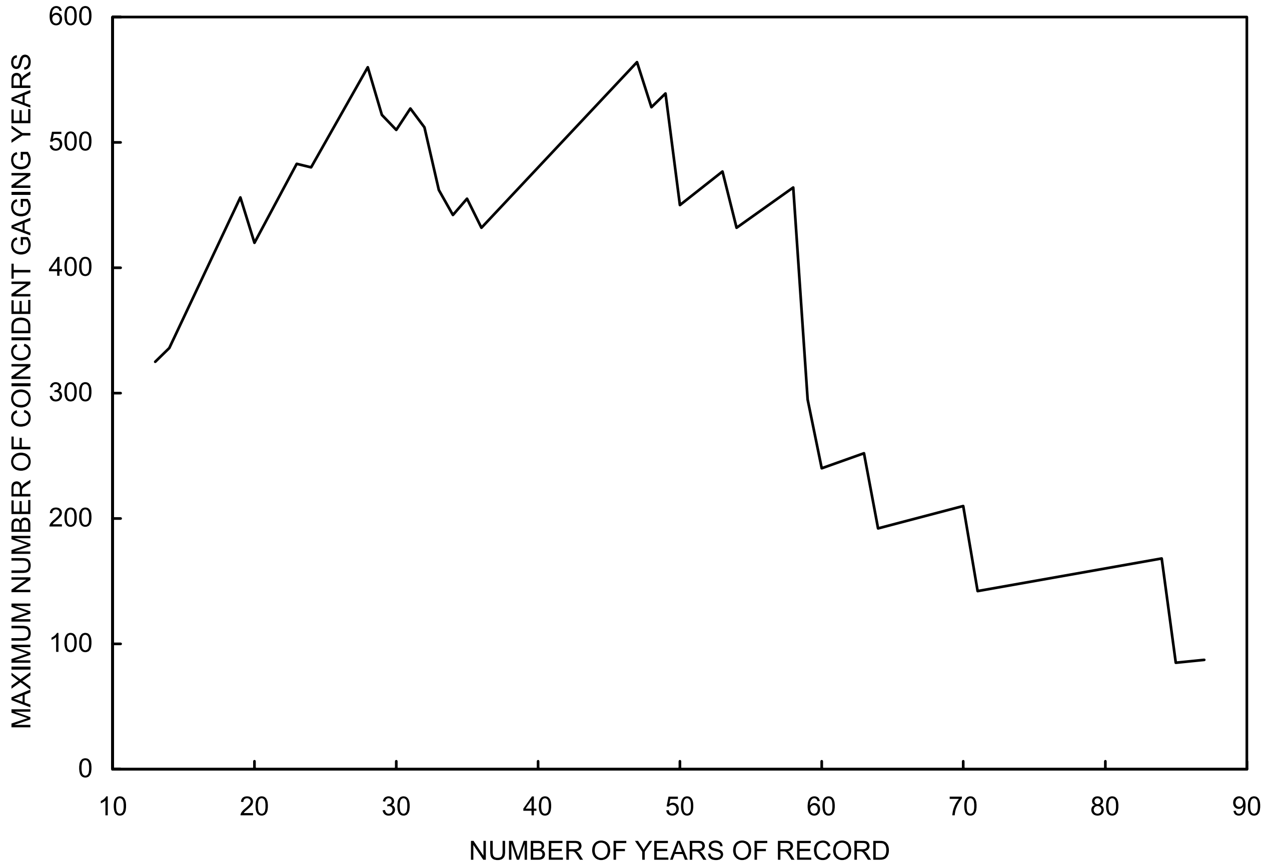

Figure 11. Relationship between period of record and total number of coincident gaging years in southern Illinois

Record Extension Techniques

Many streamgaging stations, particularly those on smaller streams, have periods of record that are shorter than the base period of 1952-1999. To provide consistent flow frequency estimates throughout the Little Wabash River watershed, it was necessary to estimate the long-term flow conditions at short-term gaging records using some type of record-extension technique. In developing flow frequencies in previous ILSAM studies, a process called a frequency adjustment or frequency shift was used to estimate long-term flow frequencies. This method requires the use of a nearby long-term gaging record, called an index station, which is used to related the differences in flow conditions for the short-term versus the longer base period. Details on this method are presented in Knapp (1988, 1990). This frequency adjustment technique has been compared to the MOVE.1 technique (Hirsch, 1982), which is more commonly used for record extension. These comparisons indicate that the frequency shift method generally provides a more accurate estimate of the long-term flow frequency than MOVE.1 when using shorter gaging records in Illinois.

Evaluating Human Modifications to Streamflows

When ILSAM was initially developed, the evaluation of virgin and present flows for a particular gaging record required simulating a time series associated with both the virgin flow and the quantity of flow modification relating to human impacts. When dealing with a reservoir, for example, this included developing a daily flow-routing model of the reservoir, and computing reservoir outflows from either simulated or historical inflows. Under conditions when flow modifications have changed significantly over time, it is sometimes still necessary to follow such an approach. But based on a number of simulations of this type, empirical algorithms were developed for use in ILSAM to estimate the impact of such modifications on flows at ungaged sites. These algorithms, which are coded within ILSAM, have in themselves become useful in estimating the impacts of flow modifications when evaluating virgin and present flows at gaging locations. In this type of procedure, an existing modification located upstream can be input into the model to estimate the downstream impact on streamflows at a gaging location. An iterative process can then be used to compute the virgin and present flow conditions at that site.

The algorithms developed for use in ILSAM to estimate the impacts of flow modifications have been described in several previous reports. The ILSAM reports that are most comprehensive in their discussion of these techniques are Knapp (1988, 1990), and the reader is referred to these studies for details. Examples of these algorithms include methods for estimating: the impacts of reservoirs on downstream flows, variability of effluent discharges during low flow conditions, reduction of low flows when effluents are discharged into dry stream beds, and the impact of seasonal flow modification on the annual flow frequency.

Value of Gaging Data in Defining Flow Conditions in the Watershed

There are four active gages in the Little Wabash River watershed, or roughly one gage for every 800 square miles of drainage area. The southeastern portion of Illinois, including the Little Wabash River watershed, has the lowest density of streamgages in the state, but most of the existing gages have long periods of record that aid in determining long-term flow conditions in the watershed. Withdrawals for water supply have some degree of impact on the streamflows at all existing gages, and provide valuable information for quantifying these impacts. In general, the region would benefit from additional active gages on smaller watersheds so that the regional methods to estimate flow conditions at ungaged sites do not have to rely upon gages on smaller streams located outside the region or on older short-term gaging records that may not accurately reflect present or long-term conditions. In addition, for evaluating the yield of the current water supply, low flow measurements during drought years would be useful on the Little Wabash River near the Fairfield withdrawal, in the vicinity of Golden Gate.

Factors in Estimating Flow Frequency at Ungaged Sites

The ILSAM estimates flow conditions at ungaged sites through the use of three types of information: 1) a set of regional equations to estimate unaltered or "virgin" flow conditions at the ungaged site, 2) data on the extent of flow modification upstream of the site, and 3) a collection of model algorithms used to estimate the impact of flow modifications on downstream locations.

Appendices A and B provide data on the human modifications for use in evaluating impacts on flows at ungaged sites. Among the streamflow information listed in Appendix A are the locations and flow modifications related to the major reservoirs in the watershed. Appendix B provides the quantity of flow modification associated with the effluent discharges and water withdrawals within the watershed. Previous ILSAM reports (Knapp, 1988, 1990) describe the algorithms and techniques used to extend these impacts further downstream. As indicated earlier, the evaluation of flow modifications does not include those major changes to the watershed hydrology in the 1800s and early 1900s caused by cultivation and major drainage modifications. Nor are hydrologic changes from recent drainage or agricultural management practices considered, since there is little data from which to explicitly evaluate these impacts. Thus, the virgin flow, as estimated in this report, essentially reflects the unaltered hydrology associated with the climate and general rural land use conditions that existed in the watershed throughout the mid- and late-1900s.

Most locations in the Little Wabash River watershed, particularly those on minor streams, do not have significant modification to their flows. Thus, the development of an appropriate set of regional equations represents the most dominant factor in estimating flows at ungaged sites. The remainder of this section focuses on the development and application of these equations.

Regional Equations for Estimating Virgin Flow at Ungaged Sites

The regional equations used to estimate unaltered flow conditions are based on a regression analysis of streamgage records within geographic regions that are expected to have similar streamflow characteristics. In previous ILSAM studies, the physiographic divisions established by Leighton et al. (1948) were used to define the geographic areas for which regional equations were developed. Within each region, three watershed characteristics, drainage area, soil permeability, and average annual net precipitation (precipitation minus evapotranspiration), were independent variables used in the regional equations to describe the variation in streamflow characteristics.

To develop and apply the regional flow equations to the Little Wabash River watershed, it was necessary to develop a database of watershed characteristics for all streams within the watershed. A database table, termed the NETWORK table, includes information on drainage area, soil permeability, and average annual net precipitation for approximately 800 stream locations within the watershed. Drainage areas were measured for all locations, data from county soil surveys and statewide soil association maps were used to estimate the average permeability of the soil substrate, and long-term precipitation and streamflow records were used to estimate the net precipitation within the watershed upstream of each location. The resulting NETWORK table is included in the relational database developed for the Little Wabash River ILSAM model, and the values in the table are listed in appendix C.

The two major physiographic divisions of the Little Wabash River watershed are the Springfield Plain and the Mt. Vernon Hill Country. These are also predominant physiographic regions in the Kaskaskia River watershed, which was analyzed in a previous study (Knapp, 1990). During this earlier study, one set of regional flow equations was found to be applicable to both physiographic divisions. For the current study, the equations were updated to take into account 13 years of additional flow data that are available from gaging stations throughout the two physiographic regions, and this equation is considered to be applicable for all stream locations within the Little Wabash River watershed.

A total of 28 streamgaging records from watersheds located within the Springfield Plain and Mt. Vernon Hill Country were examined as potential input for developing the updated set of regional equations. Each gage examined contains a minimum of 22 years of record and flow conditions that have had relatively little or no impact from upstream modification. Five gaging stations in the far northwestern portion of the Springfield Plain, in the vicinity of Macoupin, Greene, Morgan, and Sangamon Counties, were dropped from consideration after it was observed that their flow characteristics were somewhat different than those at the remaining gages, and atypical of flow conditions in the Little Wabash River watershed. Table 15 identifies the remaining 23 gages used in the analysis. The flow at one of the stations, the Little Wabash River near Effingham, which is affected by upstream withdrawals, was not used in developing equations for low flow conditions. Two gaging records for Cahokia Creek at Edwardsville and Hurricane Creek near Mulberry Grove also were not used for evaluating low flow frequency because their period of record did not contain any significant periods of low flow or drought as compared to the other gaging locations.

In the development of the regional equations, the relationship between the streamflow quantity and watershed characteristics follows the following form:

$$Q_x = \max \{ Q_{mean} [a + b K + c DA] - 0.05,\ 0 \} \qquad (1)$$

where Q_x (cfs) is any individual flow parameter estimated by the model; Q_{mean} (cfs) is the annual mean flow at the location of interest; K (inches per hour) is the average subsoil permeability of the watershed; and DA (square miles) is the total drainage area of the watershed. The constant -0.05 is used to interpret very low, nonzero flows as essentially representing dry zero-flow conditions. The annual mean flow is determined from estimates of the average annual values for precipitation (inches) and evapotranspiration (inches) over the watershed:

$$Q_{mean} = 0.0738\ DA\ (P - ET) \qquad (2)$$

The difference between average annual precipitation and evapotranspiration, P - ET, has been computed for all stream locations in the Little Wabash River watershed, and these are included in the NETWORK table of the ILSAM database and listed in appendix D. This difference is termed the average annual excess precipitation.

The form of equation 1 and the independent variables used in that equation were developed in previous ILSAM regional studies for various parts of the State, including the Kaskaskia River watershed bordering the Little Wabash River watershed. Several of these previous studies investigated the use of other watershed factors such as channel slope and land slope for the regional regression equations, but provided little or no improvement in

Table 15. USGS Streamgage Records Used for Developing Regional Equations

USGS ID	*Station name*	*Drainage area (mi^2)*	*RL* (years)*	*Period of record*
03344500	Range Creek near Casey	7.6	32	1950-1982
03346000	North Fork Embarras River near Oblong	319.	52	1947-1999
03378000	Bonpas Creek at Browns	228.	59	1940-1999
03378635	Little Wabash River near Effingham	240.	33	1966-1999
03379500	Little Wabash River below Clay City	1131.	85	1914-1999
03380475	Horse Creek near Keenes	97.2	31	1959-1990
03380500	Skillet Fork at Wayne City	464.	71	1928-1999
05574000	South Fork Sangamon River near Nokomis	11.0	25	1950-1975
05574500	Flat Branch near Taylorville	276.	33	1949-1982
05587900	Cahokia Creek at Edwardsville	212.	30	1969-1999
05588000	Indian Creek near Wanda	36.7	52	1951-1999
05592300	Wolf Creek near Beecher City	47.9	23	1959-1982
05592800	Hurricane Creek near Mulberry Grove	152	29	1970-1999
05593575	Little Crooked Creek near New Minden	84.3	32	1967-1999
05593600	Blue Grass Creek near Raymond	17.3	22	1960-1982
05593900	East Fork Shoal Creek near Coffeen	55.5	36	1963-1999
05594450	Silver Creek at Troy	154	33	1966-1999
05595500	Marys River near Sparta	17.8	22	1949-1971
05595800	Sevenmile Creek near Mt. Vernon	21.1	22	1960-1982
05596000	Big Muddy River near Benton	502.	25	1945-1970
05597000	Big Muddy River at Plumfield	794.	55	1914-1970
05597500	Crab Orchard Creek near Marion	31.7	48	1951-1999
05599000	Beaucoup Creek near Matthews	292.	37	1945-1982

Note: * RL = record length.

the standard error of the regression analysis. No additional attempt was made in the present study to identify other additional watershed characteristics that could be useful as independent variables in equation 1.

For each flow variable, least squares regression was used to compute the values of coefficients a, b, and c in equation 1. The equations developed using this approach, while they produce minimal error, do not always maintain a consistent relationship for each and every combination of watershed characteristics. For example, in some cases it is possible to specify a drainage area and subsoil permeability in which the Q_{99} flow duration estimated by the equations becomes greater than the estimated Q_{98}, thus violating the definitions of these flow values. For this reason, the equations that were developed using the least squares approach were each examined to identify potential situations where the results of the model may produce inconsistent estimates of flow frequency. In cases where a potential inconsistency exists, equation coefficients were adjusted to avoid the inconsistency. This type of adjustment produces an equation that is "not quite least squares," but still has low error while producing flow duration curves and low flow frequency estimates that are consistent, i.e., make sense both hydrologically and statistically.

Appendix D lists the resulting coefficients developed for each of the 154 flow parameters used in the Little Wabash ILSAM. Also shown in appendix D is a coefficient of error associated with these equations. To compute the error of a particular flow parameter in units of cfs, the coefficient of error, c_e, is multiplied by the mean flow rate in cfs at the location of interest. The error in the regional equations is generally in the range of 10 to 25 percent, but it is larger for low flow conditions. An example of the application of the equations is given below. Results are applicable to locations from 10 to 1000 square miles.

Application of Regression Equations

The application of the equations is illustrated by the following example in which various annual flow duration statistics are estimated for the Fox River, a tributary to the Little Wabash River, at a location near the Olney sanitary treatment plant. The watershed for this location has the following characteristics:

Drainage area = 97.6 square miles
Average soil permeability = 0.37 inch per hour
Average annual excess precipitation (P - ET) = 11.89 inches
Physiographic region: Springfield Plain

The following estimates of the annual flow duration are computed: Q_{98}, Q_{90}, Q_{75}, Q_{50}, Q_{25}, Q_{10}, and Q_{02}. The virgin flow coefficients from appendix D are used in the following computations:

$$Q_{mean} = 0.0738\ (97.6)\ (11.89) = 85.6 \text{ cfs}$$

$$Q_{98} = 85.6\ [- 0.00174 + 0.0000068\ (97.6) + 0.00190\ (0.37)] - 0.05, 0\}$$
$$= - 0.08 \text{ cfs, or effectively } 0.0 \text{ cfs}$$

$$Q_{90} = 85.6\ [- 0.00180 + 0.0000211\ (97.6) + 0.00338\ (0.37)] - 0.05 = 0.08 \text{ cfs}$$

Q_{75} = 85.6 [0.00227 + 0.0000489 (97.6) + 0.01802 (0.37)] - 0.05 = 1.12 cfs

Q_{50} = 85.6 [0.03994 + 0.000124 (97.6) + 0.09961 (0.37)] - 0.05 = 7.6 cfs

Q_{25} = 85.6 [0.29886 + 0.000381 (97.6) + 0.20408 (0.37)] - 0.05 = 35 cfs

Q_{10} = 85.6 [1.80311 + 0.001011 (97.6) - 0.10537 (0.37)] - 0.05 = 159 cfs

Q_{02} = 85.6 [11.03862 - 0.00311 (97.6) - 0.4448 (0.37)] - 0.05 = 905 cfs

The virgin flow estimated by the equations for an ungaged site will be adjusted by the ILSAM if there is a gaging station on the same stream at which virgin flow is estimated directly from the gaging record. The technique used in this adjustment is described in previous ILSAM reports (Knapp, 1988, 1990). This adjustment is needed to blend the information at the gage site with the results of the regional equations, and thus maintain a smooth transition between the two types of estimates.

Error in Regression Model

The regression relationship between the flow and watershed characteristics explains a high amount of the flow variance between gaging stations in the sample. However, there still can be considerable variation in flows across the watershed and uncertainties in the flow estimate, particularly for smaller watersheds. The standard error of estimate for the virgin flow equations (s_e), in cfs, is estimated as the product of the coefficient of error given in appendix D (c_e) and the computed mean flow at the point of interest (Q_{mean}):

$$s_e = c_e\ Q_{mean} \qquad (3)$$

This method of estimating the standard error is derived through the form of the regression equation (equation 1), with c_e being a standard term for coefficient of error. The percentage of error can be computed as the standard error of estimate divided by the estimated flow for a given parameter. The standard error in computing Q_{mean} (using equation 2) is 6.8 percent.

Two examples of the computation of the standard error of estimate for the above application example are provided on the following page, along with the range of flow values contained within one standard deviation from the computed estimate of the flow parameter. The first example is for the Fox River near the Olney sanitary treatment plant, and the second example is for Big Muddy Creek at its mouth. The drainage area of the Big Muddy Creek site is over three times larger than that for the Fox River site, and has a mean flow of 271 cfs.

The absolute value of the error increases as the size of the watershed increases and as the flow amount increases, i.e., being greater for high flow conditions than for low flow conditions. However, the percentage error acts in exactly the opposite manner, being smaller for larger watersheds and substantially smaller for high flows than for low flows.

Note that there is typically a large percentage error when the estimated flow approaches 0.0. Thus, in the examples above, this error of estimate exceeds 100 percent for extremely low flow conditions. However, the percentage error of estimate becomes much less for larger flows, and is approximately 10 percent for the Q_{02} flow parameter.

Example 1. Fox River near Olney treatment plant (drainage area = 97.6 square miles)

Flow parameter	*Flow estimate*	*Standard error of estimate*	*Range*
Q_{98}	0.00	s_e = 85.6 * 0.001406 = 0.12 cfs	-0.20 to 0.04 cfs
Q_{90}	0.08	s_e = 85.6 * 0.004322 = 0.37 cfs	-0.29 to 0.45 cfs
Q_{75}	1.12	s_e = 85.6 * 0.01344 = 1.15 cfs	-0.03 to 2.27 cfs
Q_{50}	7.6	s_e = 85.6 * 0.04112 = 3.5 cfs	4.1 to 11.1 cfs
Q_{25}	35.	s_e = 85.6 * 0.1278 = 11 cfs	24 to 46 cfs
Q_{10}	159.	s_e = 85.6 * 0.3893 = 33 cfs	126 to 192 cfs
Q_{02}	905.	s_e = 85.6 * 1.015 = 87 cfs	818 to 992 cfs

Example 2. Big Muddy Creek at mouth (drainage area = 340 square miles)

Flow parameter	*Flow estimate*	*Standard error of estimate*	*Range*
Q_{98}	0.27	s_e = 271 * 0.001406 = 0.12 cfs	-0.11 to 0.65 cfs
Q_{90}	1.63	s_e = 271 * 0.004322 = 1.17 cfs	0.46 to 2.8 cfs
Q_{75}	6.7	s_e = 271 * 0.01344 = 3.6 cfs	3.1 to 10.3 cfs
Q_{50}	32.	s_e = 271 * 0.04112 = 11 cfs	21 to 43 cfs
Q_{25}	136.	s_e = 271 * 0.1278 = 35 cfs	101 to 171 cfs
Q_{10}	564.	s_e = 271 * 0.3893 = 105 cfs	459 to 669 cfs
Q_{02}	2677.	s_e = 271 * 1.015 = 275 cfs	2402 to 2952 cfs

Estimation of Present Flow

The estimation of present flow for a given ungaged site includes both the estimate of virgin flow and an estimate of the cumulative impact of all flow modifications located upstream from that site. All modifications located upstream of any site are represented in the model, either explicitly by way of their location on the stream or through summary statistics that, for specific locations called control points, estimate the cumulative impacts of all upstream modification. The estimation of present flow works in an upstream to downstream direction, starting with the flow modifications that exist most upstream of the site of interest. As indicated earlier, the ILSAM has a collection of algorithms for evaluating present flow conditions, which are used to estimate the downstream impacts of various types of flow modifications. These algorithms are described in several previous reports Knapp (1988, 1990) and have been briefly mentioned in the previous section of this report.

Model Operation

The current version of the ILSAM was developed to operate on a personal computer having a Microsoft Windows 95/98/2000/NT operating system. The model user is expected to identify the stream and location on the stream for which flow statistics are to be computed. Appendix C provides a list of the streams within the Little Wabash River watershed and the locations on these streams identified by river mile. The model can calculate streamflow statistics for existing conditions in the watershed. The model user also may input a description of a potential or hypothetical water resources project to identify the potential impact of such an additional flow modification.

Appendix C also contains a table of watershed characteristics for more than 800 locations in the watershed. The model uses this table to identify the watershed characteristics pertinent to the location selected by the model user. These characteristics are used in a set of regional equations to estimate unaltered flow conditions at any ungaged site in the watershed. These equations are described in the previous section of this report ("Defining Virgin and Present Flow Conditions at Ungaged Sites") and are presented in appendix D.

The model searches for information on streamflow modifications that are located upstream of the point selected by the model user, and then estimates the cumulative impact of these flow modifications. The model supplies two basic data components from which to compute the impact of these flow modifications and the subsequent streamflow quantity. The first data component is a set of computed flows for selected locations (control points) in the watershed, which include the calculated cumulative impacts of all modifications upstream of that site, given in appendix A. The impact of reservoirs on streamflow is presented in this set of data. The second data component is a set of data on effluent discharges and water withdrawals in the watershed, given in appendix B. Additional algorithms are included in the model to estimate downstream impacts from specific types of flow modifications.

Every step in the computation of flow conditions includes some amount of uncertainty. Measurement error in streamgaging, and the resulting estimate of daily flows, is generally considered to be in the range of 5 to 15 percent, depending on the quality of the gaging location. Additional uncertainties are associated in the processing of hydrologic information for the model, including 1) the record extension techniques used for short periods of record, 2) errors in estimating the frequency of infrequent events such as low flows, 3) the separation of the gaging record into virgin flow conditions and the impact of flow modifications, and 4) the algorithms that estimate downstream impacts of the various types of flow modifications. Only the error in the regional flow equations, given in appendix D, is readily quantifiable and generally applicable to all locations within the basin. Because the estimated error in developing these regional equations also encompasses many of the other errors listed above, it is reasonable to accept them as a reasonable comprehensive error for the entire process of flow estimation.

Conclusions

This report describes some of the basic hydrologic analyses used to identify the expected long-term virgin and present flow conditions at gaged and ungaged locations throughout the Little Wabash River watershed. The long-term flow conditions are presented as streamflow frequency statistics that describe either the percent chance that a given flow will be exceeded or the recurrence interval, in years, defining how frequent a specific low flow value is expected to be experienced. A description of the frequency statistics that the model estimates is given in the "Introduction" of this report.

This study has produced data sets of water use quantity, streamflow quantity, and watershed information, which are developed in the form of databases for use with the current Windows-based version of the Illinois Streamflow Assessment Model (ILSAM). Most of the basic data used by ILSAM are included in the appendices.

The proper prediction of expected flow conditions in the future will require additional periodic evaluation to account for flow changes that result from either climatic variability or additional human impacts in the watershed. The ability to perform these periodic evaluations will depend in part upon the continued procurement of flow data from streamgaging, particularly from gaging locations that are located to provide the most useful information on regional hydrology.

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Appendix A. Control Points: Location and Estimated 1999 Flow Conditions

Control point number and location		Flow condition	Stream Code	Mile
1	Little Wabash River USGS Gage 03381500 at Carmi	Virgin	B	30.5
2	Little Wabash River USGS Gage 03381500 at Carmi	Present	B	30.5
3	Little Wabash River downstream of Skillet Fork	Virgin	B	38.8
4	Little Wabash River downstream of Skillet Fork	Present	B	38.8
5	Little Wabash River upstream of Skillet Fork	Virgin	B	38.81
6	Little Wabash River upstream of Skillet Fork	Present	B	38.81
7	Little Wabash River at Fairfield PWS Intake	Virgin	B	81.7
8	Little Wabash River at Fairfield PWS Intake	Present	B	81.7
9	Little Wabash River USGS Gage 03379500 below Clay City	Virgin	B	128.5
10	Little Wabash River USGS Gage 03379500 below Clay City	Present	B	128.5
11	Little Wabash River upstream of Big Muddy Creek	Virgin	B	128.81
12	Little Wabash River upstream of Big Muddy Creek	Present	B	128.81
13	Little Wabash River at Flora PWS Intake	Virgin	B	155.3
14	Little Wabash River at Flora PWS Intake	Present	B	155.3
15	Little Wabash River at Salt Creek	Virgin	B	186.0
16	Little Wabash River at Salt Creek	Present	B	186.0
17	Little Wabash River USGS Gage 03378635 Effingham	Virgin	B	202.5
18	Little Wabash River USGS Gage 03378635 Effingham	Present	B	202.5
19	Little Wabash River at Mattoon Lake Dam	Virgin	B	222.1
20	Little Wabash River at Mattoon Lake Dam	Present	B	222.1
21	Little Wabash River at Paradise Lake Dam	Virgin	B	230.1
22	Little Wabash River at Paradise Lake Dam	Present	B	230.1
23	Skillet Fork at mouth near Carmi	Virgin	BE	0.0
24	Skillet Fork at mouth near Carmi	Present	BE	0.0
25	Skillet Fork USGS Gage 03380500 at Wayne City	Virgin	BE	42.4
26	Skillet Fork USGS Gage 03380500 at Wayne City	Present	BE	42.4
27	Skillet Fork USGS Gage 03380475 near Keenes	Virgin=Present	BEN	5.2
28	Lost Fork at Forbes Lake	Virgin	BEW	3.4
29	Lost Fork at Forbes Lake	Present	BEW	3.4
30	East Fork at East Fork Lake	Virgin	BMP	1.7
31	East Fork at East Fork Lake	Present	BMP	1.7
32	Weather Creek at Newton Lake Dam	Virgin	BPL	9.6
33	Weather Creek at Newton Lake Dam	Present	BPL	9.6
34	Blue Point Creek at Lake Sara	Virgin	BW8	1.8
35	Blue Point Creek at Lake Sara	Present	BW8	1.8

Notes:

Stream codes are as listed in appendix C
PWS – Public Water Supply

Appendix A. Continued

Flow type	Location									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Q_{01}	18726	18700	18911	18878	18019	17987	16816	16780	10035	10000
Q_{02}	15615	15600	15635	15614	13011	12991	11987	11963	7363	7340
Q_{05}	12400	12400	12212	12206	7309	7304	6550	6542	4857	4850
Q_{10}	8979	8990	8785	8791	4256	4263	3685	3689	2916	2920
Q_{15}	6967	6980	6821	6829	3117	3127	2604	2611	1694	1700
Q_{25}	3908	3920	3832	3840	1696	1705	1363	1370	642	648
Q_{40}	1189	1190	1162	1159	563	561	461	457	250	246
Q_{50}	599	598	583	577	287	282	238	232	154	147
Q_{60}	334	334	325	321	155	152	129	124	91	85
Q_{75}	126	131	127	129	69	72	55	56	34	34
Q_{85}	58	64	62	65	37	41	28.8	31	14.6	16.0
Q_{90}	36	41	39	42	24.0	27.5	18.1	20.4	8.6	10.0
Q_{95}	21.8	26.0	25.1	27.5	16.0	18.7	12.0	13.9	4.4	5.6
Q_{98}	11.7	14.0	13.6	14.7	9.0	10.1	7.0	7.7	2.3	2.6
Q_{99}	9.4	8.8	8.5	6.9	6.0	4.6	4.7	3.1	1.90	1.40
Q_{mean}	2811	2801	2769	2755	1785	1772	1577	1562	945	931
Low Flows										
$Q_{1,2}$	23.7	26	25.2	26.4	16.0	17.5	12.3	13.4	4.9	5.9
$Q_{1,10}$	6.1	5.0	4.9	3.3	4.0	2.4	3.4	1.8	1.9	1.4
$Q_{1,25}$	1.8	1.6	1.6	0.90	1.3	0.20	1.1	0.00	0.42	0.20
$Q_{1,50}$	0.40	0.60	0.60	0.32	0.50	0.10	0.40	0.00	0.16	0.08
$Q_{7,2}$	24.6	30.0	29.0	32	18.0	21.7	13.8	16.3	5.3	7.0
$Q_{7,10}$	7.2	6.8	6.4	4.9	4.8	3.5	4.0	2.5	2.2	1.8
$Q_{7,25}$	3.9	3.5	3.4	2.0	3.0	1.75	1.8	0.34	0.60	0.27
$Q_{7,50}$	1.5	1.8	1.8	1.00	1.6	0.80	1.00	0.00	0.24	0.12
$Q_{15,2}$	33	38	37	40	23.0	26.7	17.6	20.1	6.9	8.5
$Q_{15,10}$	8.1	9.0	8.8	8.6	6.8	6.9	5.5	5.2	2.2	2.0
$Q_{15,25}$	5.4	5.0	4.9	3.4	4.1	2.8	2.4	0.90	0.87	0.50
$Q_{15,50}$	2.6	2.6	2.6	1.5	2.3	1.24	1.3	0.01	0.32	0.16
$Q_{31,2}$	54	60	58	61	36	40	28.4	31	11.7	13.0
$Q_{31,10}$	12.5	15.0	14.7	15.9	11.5	12.7	9.1	9.9	2.1	2.5
$Q_{31,25}$	7.6	7.2	7.0	5.6	4.5	3.3	3.5	2.1	1.3	1.00
$Q_{31,50}$	3.8	3.8	3.7	2.6	2.4	1.23	1.8	0.40	0.57	0.30
$Q_{61,2}$	104	109	106	108	65	68	52	54	24.5	25.0
$Q_{61,10}$	17.2	21.0	20.4	22.6	13.0	15.4	10.1	11.8	4.1	5.2
$Q_{61,25}$	11.2	11.0	10.5	9.2	6.6	5.6	5.0	3.7	3.0	2.8
$Q_{61,50}$	5.5	6.0	5.7	5.1	3.4	2.3	2.4	0.97	1.30	1.00
$Q_{91,2}$	161	164	161	161	105	106	88	87	49	47
$Q_{91,10}$	24.5	29.0	28.0	31	17.0	19.9	13.5	15.3	7.1	8.2
$Q_{91,25}$	13.4	16.0	15.5	16.9	10.0	11.4	7.7	8.7	3.0	3.6
$Q_{91,50}$	9.0	9.0	8.6	7.4	5.5	4.7	4.0	2.8	1.7	1.6

Appendix A. Continued

Flow type	Location									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Drought Flows										
$Q_{6,10}$	100	104	101	103	64	66	53	54	30	30.0
$Q_{6,25}$	50	54	53	55	33	36	27.9	29.2	18.5	19.0
$Q_{6,50}$	21.0	25.0	24.0	26.0	15.0	17.5	12.7	14.1	10.3	11.0
$Q_{9,10}$	310	310	303	300	187	184	161	157	108	103
$Q_{9,25}$	147	150	147	148	94	95	82	82	58	57
$Q_{9,50}$	60	64	62	64	39	41	36	37	35	35
$Q_{12,10}$	790	780	765	752	460	447	400	385	261	247
$Q_{12,25}$	321	320	313	309	195	191	173	167	134	128
$Q_{12,50}$	150	150	146	143	88	85	82	78	85	80
$Q_{18,10}$	932	925	906	895	554	544	509	497	470	459
$Q_{18,25}$	451	450	438	434	270	266	256	250	291	285
$Q_{18,50}$	233	230	223	217	138	132	137	130	188	180
$Q_{30,10}$	1468	1460	1434	1423	886	875	800	787	645	633
$Q_{30,25}$	987	980	959	949	560	550	493	481	386	375
$Q_{30,50}$	666	660	646	636	370	361	324	313	251	240
$Q_{54,10}$	2508	2500	2465	2453	1523	1512	1335	1321	813	800
$Q_{54,25}$	1409	1400	1374	1361	830	818	747	733	604	591
$Q_{54,50}$	1000	990	967	954	560	547	490	475	388	374
January										
Q_{02}	18996	19000	19156	19153	16344	16343	15214	15209	9194	9190
Q_{10}	10705	10700	10426	10416	4579	4570	4157	4145	4631	4620
Q_{25}	5831	5830	5697	5692	2406	2401	1974	1967	1196	1190
Q_{50}	991	988	963	956	440	434	368	360	262	254
Q_{75}	249	247	240	235	119	114	103	96	92	85
Q_{90}	66	70	67	69	38	40	31	32	24.0	24.0
Q_{98}	22.0	25.0	24.0	26.0	15.0	16.8	11.4	12.8	4.3	5.1
Q_{mean}	3719	3711	3666	3654	2400	2388	2126	2112	1374	1360
February										
Q_{02}	16627	16600	16876	16842	16784	16751	15836	15799	9636	9600
Q_{10}	11607	11600	11376	11364	6335	6324	5592	5577	4243	4230
Q_{25}	7130	7130	6972	6968	3139	3135	2625	2619	1705	1700
Q_{50}	2465	2460	2409	2400	1130	1122	924	914	452	443
Q_{75}	430	421	410	397	230	218	200	187	163	149
Q_{90}	124	124	120	116	67	64	56	52	45	40
Q_{98}	37	42	41	44	28.0	31	21.8	24.0	8.6	10.0
Q_{mean}	4369	4353	4313	4293	2814	2794	2506	2484	1510	1489
March										
Q_{02}	17527	17500	17940	17906	18056	18023	16974	16937	8876	8840
Q_{10}	12410	12400	12250	12234	7924	7909	7135	7117	4997	4980
Q_{25}	8331	8330	8141	8135	3821	3816	3285	3277	2527	2520
Q_{50}	4651	4650	4559	4553	2080	2075	1667	1660	624	618
Q_{75}	1014	996	978	956	546	526	464	441	258	236
Q_{90}	405	398	390	380	228	218	197	186	127	115
Q_{98}	56	56	53	50	30.0	27.5	26.6	22.5	34	29.0
Q_{mean}	5503	5479	5444	5415	3671	3643	3259	3229	1779	1750

Appendix A. Continued

Flow type	Location									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
April										
Q_{02}	17812	17800	17825	17806	17548	17530	16265	16243	10621	10600
Q_{10}	12897	12900	12597	12594	6491	6489	5725	5720	4934	4930
Q_{25}	9282	9290	9067	9070	3944	3948	3211	3212	1868	1870
Q_{50}	3837	3840	3760	3758	1714	1713	1355	1352	459	456
Q_{75}	843	841	821	815	437	432	362	355	197	190
Q_{90}	370	369	359	354	192	188	161	154	109	102
Q_{98}	123	122	117	113	68	65	56	51	52	46
Q_{mean}	5447	5435	5360	5344	3412	3396	2968	2950	1684	1667
May										
Q_{02}	25783	25800	25658	25667	19569	19581	17651	17658	10592	10600
Q_{10}	11901	11900	11547	11541	4939	4934	4232	4224	4087	4080
Q_{25}	6065	6080	5934	5944	2478	2489	1985	1994	1052	1060
Q_{50}	1368	1370	1336	1334	629	628	508	504	255	251
Q_{75}	404	407	395	394	198	198	163	161	107	104
Q_{90}	221	224	217	216	102	102	83	82	60	57
Q_{98}	101	106	103	105	61	64	49	50	30	30
Q_{mean}	4345	4339	4262	4252	2619	2609	2264	2252	1406	1395
June										
Q_{02}	13120	13100	13017	12989	10589	10563	9559	9529	5829	5800
Q_{10}	7244	7250	7032	7032	3215	3217	2704	2703	2290	2290
Q_{25}	3198	3210	3122	3130	1367	1376	1094	1100	625	631
Q_{50}	704	706	686	684	329	328	269	265	170	166
Q_{75}	232	236	229	229	107	108	88	87	65	63
Q_{90}	110	118	114	119	68	73	53	56	24	26
Q_{98}	35	41	40	43	25.0	28.7	19.3	21.9	10.4	12.0
Q_{mean}	2393	2385	2356	2344	1608	1597	1409	1396	785	773
July										
Q_{02}	7881	7870	7969	7952	7284	7268	6903	6884	4518	4500
Q_{10}	4314	4330	4210	4222	1738	1750	1436	1446	1120	1130
Q_{25}	1362	1370	1335	1339	588	593	467	470	226	228
Q_{50}	330	334	324	325	147	148	119	118	76	74
Q_{75}	128	134	130	133	72	76	57	59	30.0	31
Q_{90}	54	60	58	61	38	42	28.9	32	11.4	13.0
Q_{98}	17.0	20.0	19.4	20.5	12.0	13.9	9.2	10.3	3.5	4.0
Q_{mean}	1283	1280	1279	1272	939	933	843	835	439	432
August										
Q_{02}	7544	7560	7453	7463	4481	4492	3955	3963	2581	2590
Q_{10}	2249	2250	2186	2183	903	900	743	738	579	575
Q_{25}	497	499	484	482	251	250	204	201	138	134
Q_{50}	142	147	142	144	80	83	64	65	40	40
Q_{75}	58	64	62	65	37	41	29.1	32	14.5	16.0
Q_{90}	25	30	29	32	18.0	20.9	14.0	15.9	5.7	6.8
Q_{98}	15.3	16.0	15.6	14.9	10.0	9.7	7.9	7.2	2.7	2.4
Q_{mean}	786	782	775	768	495	489	450	442	316	309

Appendix A. Continued

Flow type	Location									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
September										
Q_{02}	3202	3190	3137	3119	2896	2880	2760	2741	2628	2610
Q_{10}	1086	1080	1045	1036	431	422	368	357	382	371
Q_{25}	337	337	327	325	143	141	120	116	95	90
Q_{50}	92	98	95	98	57	61	45	48	26.0	27.0
Q_{75}	34	39	38	41	23.0	26.3	18.1	20.4	7.9	9.3
Q_{90}	15.2	18.0	17.5	18.7	11.3	12.8	8.9	9.7	3.7	3.9
Q_{98}	6.1	5.7	5.6	4.1	4.0	2.7	3.3	1.72	1.20	0.80
Q_{mean}	413	404	400	388	248	237	240	228	221	209
October										
Q_{02}	6746	6740	6662	6651	4229	4219	3778	3765	2482	2470
Q_{10}	1223	1220	1177	1170	512	506	402	394	309	301
Q_{25}	223	223	214	210	114	111	92	87	74	68
Q_{50}	61	66	64	66	37	40	30	32	21.5	22.0
Q_{75}	22.9	28.0	27.0	30.0	16.0	19.3	12.8	15.0	6.4	7.8
Q_{90}	11.2	14.0	13.7	15.1	9.0	10.5	7.3	8.4	3.3	3.8
Q_{98}	5.6	5.1	5.0	3.5	3.5	2.2	2.8	1.28	1.00	0.60
Q_{mean}	542	535	531	521	341	332	312	301	213	203
November										
Q_{02}	10629	10600	10453	10418	8499	8465	7721	7683	5586	5550
Q_{10}	4655	4640	4501	4481	2072	2053	1771	1750	1620	1600
Q_{25}	1457	1450	1417	1406	685	675	562	550	302	290
Q_{50}	206	204	199	194	117	113	100	94	68	61
Q_{75}	39	44	43	45	28.0	31	23.4	24.7	13.6	14.0
Q_{90}	15.6	20.0	19.5	22.0	12.0	14.9	9.7	11.7	4.5	5.8
Q_{98}	9.2	9.0	8.8	7.6	6.0	5.1	4.6	3.5	1.40	1.10
Q_{mean}	1548	1532	1502	1482	973	954	856	835	600	580
December										
Q_{02}	16037	16000	15908	15864	14068	14026	12698	12651	7585	7540
Q_{10}	8390	8380	8195	8181	4545	4531	4063	4047	3515	3500
Q_{25}	3898	3890	3804	3792	1723	1712	1409	1396	756	744
Q_{50}	649	643	628	619	342	333	289	278	177	166
Q_{75}	110	110	107	104	61	58	52	48	37	32
Q_{90}	31	36	35	38	22.0	25.1	18.0	20.0	8.8	10.0
Q_{98}	15.7	17.0	16.6	16.7	10.3	10.8	8.1	8.3	3.1	2.9
Q_{mean}	2732	2716	2698	2678	1843	1824	1676	1654	1057	1036

Appendix A. Continued

Flow type	Location									
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Q_{01}	8572	8557	8205	8190	5289	5275	3241	3220	776	696
Q_{02}	6015	6009	5723	5717	3574	3568	2122	2110	503	457
Q_{05}	3431	3429	3192	3190	1727	1726	912	905	200	197
Q_{10}	1890	1891	1736	1737	864	866	447	444	91	92
Q_{15}	1083	1082	994	993	496	496	276	271	55	53
Q_{25}	416	415	385	385	204	204	133	129	27.0	26.4
Q_{40}	177	174	168	165	100	98	66	60	13.9	11.1
Q_{50}	111	107	105	101	65	63	45	38	8.8	5.7
Q_{60}	66	62	63	59	41	38	30.0	23.0	5.3	1.9
Q_{75}	22.3	22.3	20.9	21.1	12.7	13.8	9.8	7.3	1.50	0.00
Q_{85}	8.5	10.0	7.7	9.3	3.6	6.2	2.4	1.60	0.30	0.00
Q_{90}	4.8	6.2	3.9	5.5	1.30	3.8	0.67	0.10	0.17	0.00
Q_{95}	2.7	3.9	1.94	3.3	0.59	2.9	0.32	0.00	0.02	0.00
Q_{98}	1.80	2.1	1.17	1.60	0.47	1.89	0.21	0.00	0.01	0.00
Q_{99}	1.50	1.03	1.00	0.69	0.43	1.13	0.14	0.00	0.00	0.00
Q_{mean}	705	700	663	657	378	373	196	187	48	42
Low Flows										
$Q_{1,2}$	3.5	4.18	2.8	4.0	1.38	3.5	0.96	0.80	0.11	0.00
$Q_{1,10}$	1.50	0.72	1.05	0.73	0.44	1.17	0.03	0.00	0.00	0.00
$Q_{1,25}$	0.30	0.08	0.19	0.00	0.07	0.80	0.00	0.00	0.00	0.00
$Q_{1,50}$	0.12	0.04	0.07	0.00	0.03	0.76	0.00	0.00	0.00	0.00
$Q_{7,2}$	3.6	5.3	2.9	4.8	1.51	4.4	1.22	1.00	0.17	0.00
$Q_{7,10}$	1.70	1.33	1.15	0.94	0.45	1.25	0.04	0.00	0.00	0.00
$Q_{7,25}$	0.43	0.10	0.30	0.05	0.11	0.88	0.00	0.00	0.00	0.00
$Q_{7,50}$	0.17	0.04	0.11	0.00	0.04	0.81	0.00	0.00	0.00	0.00
$Q_{15,2}$	4.5	6.1	3.8	5.6	1.96	4.7	1.60	1.20	0.19	0.00
$Q_{15,10}$	1.80	1.56	1.28	1.20	0.59	1.51	0.17	0.00	0.01	0.00
$Q_{15,25}$	0.70	0.33	0.45	0.24	0.16	0.96	0.00	0.00	0.00	0.00
$Q_{15,50}$	0.26	0.05	0.19	0.00	0.07	0.87	0.00	0.00	0.00	0.00
$Q_{31,2}$	7.4	8.9	6.8	8.4	3.5	6.0	2.2	1.40	0.35	0.00
$Q_{31,10}$	1.90	2.3	1.23	1.82	0.59	2.2	0.28	0.00	0.02	0.00
$Q_{31,25}$	0.90	0.57	0.56	0.39	0.15	0.99	0.00	0.00	0.00	0.00
$Q_{31,50}$	0.40	0.11	0.26	0.05	0.08	0.88	0.00	0.00	0.00	0.00
$Q_{61,2}$	16.1	17.1	14.9	16.1	8.0	10.1	5.0	3.6	0.76	0.00
$Q_{61,10}$	2.4	3.5	2.2	3.4	0.99	3.2	0.67	0.27	0.05	0.00
$Q_{61,25}$	1.40	1.20	1.18	1.14	0.26	1.22	0.04	0.04	0.00	0.00
$Q_{61,50}$	0.52	0.23	0.44	0.31	0.05	0.93	0.00	0.00	0.00	0.00
$Q_{91,2}$	35	34	33	32	19.7	20.2	13.2	10.0	2.2	0.00
$Q_{91,10}$	4.4	5.6	4.0	5.4	2.0	4.4	1.40	0.80	0.12	0.00
$Q_{91,25}$	1.54	2.1	1.36	2.1	0.43	2.2	0.21	0.10	0.01	0.00
$Q_{91,50}$	0.68	0.57	0.57	0.62	0.05	1.09	0.00	0.00	0.00	0.00

Appendix A. Continued

Flow type	Location									
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Drought Flows										
$Q_{6,10}$	21.1	21.4	19.8	20.3	11.4	12.8	7.0	5.0	1.10	0.00
$Q_{6,25}$	12.2	13.0	11.3	12.2	6.0	7.8	3.1	1.80	0.40	0.00
$Q_{6,50}$	6.8	7.5	6.3	7.2	3.5	5.4	2.3	1.20	0.20	0.00
$Q_{9,10}$	78	75	73	71	42	40	22.2	17.0	4.1	0.10
$Q_{9,25}$	41	40	38	38	20.2	21.0	8.7	6.0	1.50	0.00
$Q_{9,50}$	23.8	24.2	22.0	22.6	11.5	13.0	4.9	3.0	0.70	0.00
$Q_{12,10}$	193	186	183	176	110	104	63	53	12.8	4.4
$Q_{12,25}$	100	96	95	91	58	56	34	28.0	6.8	2.6
$Q_{12,50}$	62	59	59	56	37	35	22.8	17.0	4.0	0.00
$Q_{18,10}$	321	319	298	296	155	154	65	60	15.1	12.5
$Q_{18,25}$	193	192	178	177	91	91	39	35	9.2	8.0
$Q_{18,50}$	125	120	116	111	62	57	30.0	22.0	5.3	0.00
$Q_{30,10}$	450	446	418	415	224	221	107	100.0	25.0	21.0
$Q_{30,25}$	258	254	238	234	123	120	63	56	15.0	10.9
$Q_{30,50}$	168	163	155	150	82	78	44	36	8.6	3.5
$Q_{54,10}$	596	591	558	554	312	309	158	150	38	32
$Q_{54,25}$	419	414	389	385	207	204	98	90	23.3	18.2
$Q_{54,50}$	263	256	244	237	130	124	70	60	13.5	6.0
January										
Q_{02}	7463	7474	7065	7076	4304	4316	2495	2500	584	607
Q_{10}	2817	2818	2542	2544	1110	1112	506	503	85	86
Q_{25}	713	712	644	642	285	285	155	150	25.2	23.7
Q_{50}	174	170	161	158	89	86	57	50	10.6	7.4
Q_{75}	65	60	62	57	39	35	28.1	20.0	4.5	0.00
Q_{90}	16.3	16.2	15.4	15.4	9.8	10.8	7.8	5.6	1.20	0.00
Q_{98}	2.0	2.8	1.75	2.7	0.36	2.3	0.08	0.00	0.00	0.00
Q_{mean}	967	961	897	891	480	475	250	241	52	45
February										
Q_{02}	8175	8157	7802	7784	4985	4968	3024	3000	717	624
Q_{10}	2929	2928	2721	2720	1436	1436	745	739	164	161
Q_{25}	1071	1070	977	977	473	473	260	255	49	47
Q_{50}	302	297	280	276	152	148	93	85	18.1	13.8
Q_{75}	122	112	116	106	76	67	53	40	9.4	0.00
Q_{90}	35	30	34	29.6	25.6	22.1	22.0	15.0	3.4	0.00
Q_{98}	5.3	6.7	4.9	6.4	2.6	5.2	2.00	1.50	0.25	0.00
Q_{mean}	1131	1122	1061	1052	611	603	332	319	73	64
March										
Q_{02}	7958	7940	7633	7616	5091	5074	3334	3310	786	692
Q_{10}	3654	3649	3420	3415	1923	1918	1030	1020	233	226
Q_{25}	1614	1607	1477	1471	727	721	384	373	74	66
Q_{50}	417	411	387	382	212	208	145	136	28.3	23.2
Q_{75}	194	181	184	171	115	102	74	57	13.5	0.00
Q_{90}	98	90	94	86	62	55	43	32	7.5	0.00
Q_{98}	28.8	24.1	28.3	23.8	23.4	19.8	21.0	14.0	3.3	0.00
Q_{mean}	1373	1356	1293	1276	765	749	420	400	93	76

Appendix A. Continued

Flow type	Location									
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
April										
Q_{02}	8990	8987	8638	8636	5520	5519	3189	3180	797	765
Q_{10}	3281	3285	3030	3034	1531	1535	776	775	167	170
Q_{25}	1183	1182	1088	1088	552	552	341	336	68	68
Q_{50}	320	318	302	300	181	180	134	128	28.6	26.3
Q_{75}	151	149	145	143	94	93	64	58	14.2	12.2
Q_{90}	85	80	82	77	55	52	39	32	7.9	4.1
Q_{98}	41	35	40	35	30	26.0	25.9	18.0	4.3	0.00
Q_{mean}	1279	1271	1208	1201	714	708	401	390	93	85
May										
Q_{02}	8363	8390	7927	7954	4757	4785	2510	2530	618	700
Q_{10}	2548	2550	2334	2335	1129	1131	609	606	123	123
Q_{25}	641	642	585	586	283	284	179	176	34	34
Q_{50}	179	179	170	169	100	100	66	62	14.6	13.9
Q_{75}	79	78	76	75	48	48	33	29.0	7.1	6.4
Q_{90}	44	42	42	40	27.2	26.2	20.0	15.0	3.6	2.2
Q_{98}	20.1	20.2	18.9	19.1	11.8	12.9	8.9	6.6	1.30	0.00
Q_{mean}	1008	1005	944	941	528	526	287	280	65	61
June										
Q_{02}	4818	4807	4617	4606	2903	2894	1667	1650	412	349
Q_{10}	1490	1494	1381	1386	711	717	383	383	87	90
Q_{25}	405	404	378	377	201	201	121	116	26.5	25.2
Q_{50}	118	117	112	111	65	65	40	35	8.6	7.3
Q_{75}	45	44	42	41	25.2	24.9	16.4	12.0	2.8	2.00
Q_{90}	14.1	16.1	12.9	15.0	6.2	9.2	4.1	3.2	0.60	0.25
Q_{98}	5.2	6.8	4.6	6.3	1.33	4.0	0.46	0.10	0.06	0.00
Q_{mean}	609	605	577	574	340	337	170	163	41	37
July										
Q_{02}	3492	3489	3267	3265	1808	1806	829	821	188	158
Q_{10}	695	702	637	644	311	319	190	193	39	45
Q_{25}	147	148	137	138	73	75	45	42	9.5	10.6
Q_{50}	51	50	48	47	26.4	26.5	16.0	12.0	2.8	2.4
Q_{75}	18.5	19.8	17.1	18.5	8.6	11.0	5.2	3.8	0.80	0.40
Q_{90}	5.9	7.4	5.2	7.0	1.69	4.4	0.78	0.05	0.23	0.00
Q_{98}	1.88	2.4	1.69	2.3	0.65	2.3	0.34	0.00	0.04	0.00
Q_{mean}	343	341	322	321	183	183	85	81	19.1	17.7
August										
Q_{02}	1897	1920	1780	1803	1015	1039	587	605	138	159
Q_{10}	358	359	329	330	162	163	96	93	18.9	20.0
Q_{25}	87	85	80	79	42	41	25.7	21.0	4.4	3.3
Q_{50}	25.3	25.8	23.5	24.2	12.7	14.3	9.0	6.8	1.40	0.24
Q_{75}	8.3	10.0	7.5	9.4	3.2	6.0	1.76	1.10	0.16	0.00
Q_{90}	3.1	4.3	2.8	4.1	1.11	3.4	0.56	0.00	0.07	0.00
Q_{98}	1.62	1.28	1.47	1.29	0.67	1.48	0.27	0.00	0.01	0.00
Q_{mean}	224	223	208	207	111	112	58	54	11.1	9.6

Appendix A. Continued

Flow type	Location									
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
September										
Q_{02}	2056	2050	1961	1956	1245	1240	754	744	182	147
Q_{10}	254	249	237	233	141	137	106	98	20.5	16.4
Q_{25}	64	61	60	57	37	34	27.6	21.0	4.4	1.40
Q_{50}	15.8	17.0	14.4	15.9	7.0	9.4	4.3	3.2	0.60	0.00
Q_{75}	4.3	5.8	3.8	5.5	1.36	3.9	0.55	0.00	0.06	0.00
Q_{90}	1.88	2.1	1.63	1.96	0.45	1.75	0.07	0.00	0.00	0.00
Q_{98}	0.72	0.36	0.64	0.44	0.25	1.06	0.03	0.00	0.00	0.00
Q_{mean}	183	178	176	171	121	117	82	74	18.1	12.6
October										
Q_{02}	1809	1808	1691	1690	949	949	500	495	113	97
Q_{10}	201	200	189	188	114	113	99	94	20.0	18.7
Q_{25}	60	55	59	54	47	43	43	35	8.2	3.9
Q_{50}	14.7	15.5	13.8	14.8	8.3	10.3	6.2	4.7	1.00	0.00
Q_{75}	3.6	5.1	3.3	4.9	1.27	3.8	0.58	0.00	0.08	0.00
Q_{90}	2.1	2.5	1.87	2.5	0.89	2.5	0.41	0.00	0.01	0.00
Q_{98}	0.58	0.16	0.52	0.26	0.19	0.95	0.01	0.00	0.00	0.00
Q_{mean}	164	163	155	154	93	92	54	49	11.5	9
November										
Q_{02}	4542	4519	4361	4338	2805	2782	1698	1670	417	309
Q_{10}	1059	1047	982	970	511	501	287	272	60	49
Q_{25}	209	205	197	192	113	109	70	62	14.2	9.7
Q_{50}	54	49	53	47	37	33	27.3	19.0	4.7	0.00
Q_{75}	10.2	10.9	9.7	10.5	6.2	8.0	4.2	2.6	0.60	0.00
Q_{90}	2.8	4.1	2.5	4.0	1.14	3.6	0.40	0.00	0.10	0.00
Q_{98}	0.69	0.36	0.59	0.42	0.14	0.98	0.00	0.00	0.00	0.00
Q_{mean}	465	454	444	433	280	270	174	160	39	28.2
December										
Q_{02}	6768	6737	6588	6557	4567	4537	3037	3000	753	611
Q_{10}	2352	2349	2171	2168	1102	1100	507	500	110	107
Q_{25}	496	492	460	455	245	242	158	150	31	27.1
Q_{50}	136	130	131	124	87	82	62	53	12.6	6.9
Q_{75}	31	26.7	30	26.2	23.5	20.3	19.7	13.0	3.1	0.00
Q_{90}	6.1	7.4	5.7	7.2	3.3	5.8	2.1	1.50	0.30	0.00
Q_{98}	1.65	1.46	1.45	1.42	0.47	1.43	0.08	0.00	0.00	0.00
Q_{mean}	843	833	801	792	492	483	268	255	63	53

Appendix A. Continued

Flow type	Location									
	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)
Q_{01}	272	262	10692	10692	5300	5300	1890	323	282	182
Q_{02}	174	159	7852	7852	3830	3830	1230	202	179	114
Q_{05}	66	62	5767	5767	2410	2410	540	82	79	47
Q_{10}	28.2	25.6	3473	3473	1170	1170	206	31	34	18.2
Q_{15}	16.4	13.6	2052	2052	606	606	100	15.9	19.7	9.7
Q_{25}	7.8	6.0	867	867	211	211	40	6.5	10.3	4.2
Q_{40}	3.8	1.90	304	304	75	75	15.0	2.2	4.5	1.76
Q_{50}	2.4	0.56	177	177	41	41	7.2	1.14	2.7	0.96
Q_{60}	1.36	0.00	104	103	21.0	20.7	3.0	0.51	1.19	0.48
Q_{75}	0.30	0.00	40	39	6.3	6.0	0.39	0.00	0.00	0.04
Q_{85}	0.04	0.00	19.0	19.0	2.5	2.2	0.07	0.00	0.00	0.00
Q_{90}	0.01	0.00	14.0	13.5	1.50	1.20	0.00	0.00	0.00	0.00
Q_{95}	0.00	0.00	8.6	8.4	0.70	0.40	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	4.6	4.4	0.30	0.00	0.00	0.00	0.00	0.00
Q_{99}	0.00	0.00	2.5	2.4	0.15	0.00	0.00	0.00	0.00	0.00
Q_{mean}	15.5	12.1	987	986	424	424	105	17.6	17.3	10.4
Low Flows										
$Q_{1,2}$	0.00	0.00	8.2	8.0	0.40	0.10	0.00	0.00	0.00	0.00
$Q_{1,10}$	0.00	0.00	0.70	0.72	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{1,25}$	0.00	0.00	0.20	0.20	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{1,50}$	0.00	0.00	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{7,2}$	0.01	0.00	10.0	9.8	0.70	0.40	0.00	0.00	0.00	0.00
$Q_{7,10}$	0.00	0.00	1.50	1.50	0.03	0.00	0.00	0.00	0.00	0.00
$Q_{7,25}$	0.00	0.00	0.30	0.32	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{7,50}$	0.00	0.00	0.15	0.15	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{15,2}$	0.02	0.00	13.0	12.8	1.00	0.70	0.00	0.00	0.00	0.00
$Q_{15,10}$	0.00	0.00	1.90	1.86	0.10	0.00	0.00	0.00	0.00	0.00
$Q_{15,25}$	0.00	0.00	0.75	0.77	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{15,50}$	0.00	0.00	0.22	0.24	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{31,2}$	0.07	0.00	20.0	19.8	1.50	1.20	0.05	0.04	0.00	0.02
$Q_{31,10}$	0.00	0.00	3.0	2.9	0.20	0.00	0.00	0.00	0.00	0.00
$Q_{31,25}$	0.00	0.00	2.4	2.4	0.10	0.00	0.00	0.00	0.00	0.00
$Q_{31,50}$	0.00	0.00	1.2	1.2	0.02	0.00	0.00	0.00	0.00	0.00
$Q_{61,2}$	0.18	0.00	38	38	4.0	3.7	0.40	0.16	0.00	0.11
$Q_{61,10}$	0.00	0.00	7.2	7.0	0.70	0.40	0.02	0.00	0.00	0.00
$Q_{61,25}$	0.00	0.00	3.8	3.7	0.20	0.00	0.00	0.00	0.00	0.00
$Q_{61,50}$	0.00	0.00	2.2	2.2	0.08	0.00	0.00	0.00	0.00	0.00
$Q_{91,2}$	0.61	0.00	51	51	8.7	8.4	3.0	0.52	0.40	0.31
$Q_{91,10}$	0.01	0.00	10.0	9.8	1.10	0.80	0.10	0.01	0.00	0.00
$Q_{91,25}$	0.00	0.00	5.4	5.2	0.36	0.06	0.03	0.00	0.00	0.00
$Q_{91,50}$	0.00	0.00	3.0	2.9	0.15	0.00	0.01	0.00	0.00	0.00

Appendix A. Continued

Flow type	Location									
	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)
Drought Flows										
$Q_{6,10}$	0.30	0.00	34	34	8.0	7.7	1.30	0.23	0.00	0.16
$Q_{6,25}$	0.08	0.00	19.0	18.8	4.0	3.7	0.70	0.07	0.00	0.04
$Q_{6,50}$	0.02	0.00	9.3	9.1	1.20	0.90	0.30	0.00	0.00	0.00
$Q_{9,10}$	1.10	0.20	107	107	35	35	9.0	1.02	0.77	0.74
$Q_{9,25}$	0.40	0.02	51	51	14.0	13.7	4.4	0.38	0.09	0.29
$Q_{9,50}$	0.20	0.00	22.0	21.8	4.0	3.7	2.00	0.15	0.00	0.10
$Q_{12,10}$	3.7	1.40	262	262	90	90	21.0	2.8	2.7	1.99
$Q_{12,25}$	1.90	0.50	115	115	31	31	12.0	1.21	0.92	0.92
$Q_{12,50}$	1.10	0.20	56	56	20.0	19.7	5.0	0.58	0.25	0.44
$Q_{18,10}$	5.4	3.7	344	344	98	98	25.0	3.6	3.5	2.5
$Q_{18,25}$	4.0	1.80	164	164	59	59	15.0	1.77	1.52	1.21
$Q_{18,50}$	2.00	0.50	83	83	36	36	7.0	0.88	0.54	0.62
$Q_{30,10}$	10.2	7.2	542	542	190	190	51	7.7	7.6	4.8
$Q_{30,25}$	7.5	5.3	394	394	128	128	29.0	4.1	3.9	2.4
$Q_{30,50}$	3.6	1.60	269	269	100	100	18.0	2.4	2.1	1.40
$Q_{54,10}$	13.9	10.3	903	903	350	350	86	13.6	13.5	8.3
$Q_{54,25}$	9.6	6.7	538	538	220	220	56	6.8	6.6	4.3
$Q_{54,50}$	4.4	2.00	402	441	162	162	35	4.0	3.7	2.5
January										
Q_{02}	214	198	10087	10087	5300	5300	1140	283	267	152
Q_{10}	30.0	26.5	6184	6184	2370	2370	207	50	50	26.0
Q_{25}	8.1	5.2	1508	1508	399	399	50	11.0	12.5	5.8
Q_{50}	3.0	0.71	309	309	74	74	12.0	2.2	3.7	1.47
Q_{75}	1.15	0.00	92	92	20.0	19.7	4.3	0.42	0.01	0.37
Q_{90}	0.23	0.00	28.0	28.0	5.0	4.7	0.40	0.00	0.00	0.02
Q_{98}	0.00	0.00	8.7	8.5	0.70	0.40	0.00	0.00	0.00	0.00
Q_{mean}	18.2	13.8	1466	1466	656	656	110	25.01	25.27	13.55
February										
Q_{02}	259	245	9610	9610	4860	4860	1960	315	284	173
Q_{10}	52	46	5056	5056	1830	1830	454	63	63	38
Q_{25}	15.2	11.8	1920	1919	472	472	93	17.0	18.5	9.6
Q_{50}	5.4	2.5	521	521	124	124	30.0	4.9	6.5	3.1
Q_{75}	2.6	0.00	161	161	40	40	11.0	1.30	0.84	1.03
Q_{90}	0.84	0.00	49	54	12.0	11.7	3.0	0.12	0.00	0.18
Q_{98}	0.02	0.00	12.0	11.5	1.80	1.50	0.20	0.00	0.00	0.00
Q_{mean}	25	20.1	1499	1498	618	618	176	30	29.7	17.2
March										
Q_{02}	300	276	9215	9215	5010	5010	2040	370	339	196
Q_{10}	77	71	5579	5579	2400	2400	624	92	92	53
Q_{25}	23.0	18.9	2860	2860	861	861	173	25.1	27.4	14.4
Q_{50}	8.7	6.1	842	842	220	220	52	8.6	10.9	5.1
Q_{75}	4.0	1.37	271	270	84	84	22.0	3.5	4.1	2.3
Q_{90}	2.2	0.00	129	129	39	39	12.0	1.65	2.3	1.09
Q_{98}	0.78	0.00	18.0	18.1	7.2	6.9	4.3	0.02	0.00	0.11
Q_{mean}	32	25.8	1773	1773	788	788	243	39	38	22.04

Appendix A. Continued

Flow type	Location									
	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)
April										
Q_{02}	253	229	12347	12347	6030	6030	2100	279	248	173
Q_{10}	52	48	6524	6524	2470	2470	492	62	63	38
Q_{25}	19.7	17.5	2547	2547	710	710	122	16.6	19.6	10.7
Q_{50}	8.1	6.0	680	680	172	172	38	5.5	7.9	3.9
Q_{75}	3.9	2.4	247	246	67	67	16.0	2.2	3.7	1.81
Q_{90}	2.1	0.56	138	138	35	35	9.1	0.98	1.59	0.90
Q_{98}	0.99	0.00	49	49	10.0	9.7	4.0	0.00	0.00	0.15
Q_{mean}	29.23	24.84	1948	1948	816	816	200	31	30	19.1
May										
Q_{02}	201	209	10649	10649	5270	5270	1210	223	193	134
Q_{10}	35	30	5434	5434	1730	1730	200	28.4	29.1	19.4
Q_{25}	9.6	8.0	1417	1417	311	311	46	8.4	12.2	5.3
Q_{50}	3.9	2.7	327	326	66	66	12.0	2.2	4.1	1.89
Q_{75}	1.82	0.87	131	131	25.0	24.7	4.6	0.75	1.98	0.77
Q_{90}	0.89	0.10	76	76	13.0	12.7	1.40	0.33	0.00	0.36
Q_{98}	0.26	0.00	39	39	3.2	2.9	0.10	0.00	0.00	0.01
Q_{mean}	20.02	16.63	1643	1643	646	646	122	20.86	20.52	12.99
June										
Q_{02}	129	129	6284	6284	2600	2600	791	141	110	89
Q_{10}	22.9	21.0	2799	2799	693	693	77	13.7	15.2	12.0
Q_{25}	6.7	5.2	752	752	107	107	14.0	2.5	6.3	2.9
Q_{50}	2.1	1.00	184	184	26.0	25.7	3.2	0.65	1.38	0.87
Q_{75}	0.68	0.07	69	69	8.7	8.4	0.60	0.22	0.45	0.28
Q_{90}	0.12	0.00	42	41	3.4	3.1	0.09	0.00	0.00	0.01
Q_{98}	0.00	0.00	14.0	13.6	1.30	1.00	0.00	0.00	0.00	0.00
Q_{mean}	12.33	9.76	748	749	266	266	60	13.6	13.1	8.9
July										
Q_{02}	71	58	4221	4221	2200	2200	600	127	112	68
Q_{10}	11.0	10.2	1464	1464	309	309	41	9.6	12.6	6.2
Q_{25}	2.4	1.63	287	287	45	45	5.8	1.26	3.9	1.21
Q_{50}	0.68	0.08	108	107	12.0	11.7	0.90	0.29	0.69	0.34
Q_{75}	0.17	0.00	47	47	3.9	3.6	0.16	0.00	0.08	0.05
Q_{90}	0.02	0.00	17.0	16.8	1.30	1.00	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	6.9	6.7	0.40	0.10	0.00	0.00	0.00	0.00
Q_{mean}	6.8	5.2	340	340	154	154	40	11.0	10.8	6.1
August										
Q_{02}	45	48	3066	3066	1140	1140	210	52	44	30
Q_{10}	5.1	3.4	710	710	130	130	15.0	3.6	5.2	2.7
Q_{25}	1.12	0.05	158	157	22.0	21.7	2.3	0.67	2.0	0.55
Q_{50}	0.33	0.00	51	51	5.7	5.4	0.21	0.13	0.06	0.13
Q_{75}	0.03	0.00	22.0	21.5	1.60	1.30	0.02	0.03	0.00	0.01
Q_{90}	0.00	0.00	9.8	9.6	0.50	0.20	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	5.0	5.0	0.05	0.00	0.00	0.00	0.00	0.00
Q_{mean}	4.06	2.9	280	280	91	91	11.4	6.1	6.0	3.2

Appendix A. Continued

Flow type	Location									
	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)
September										
Q_{02}	54	42	2356	2356	790	790	145	37	34	25.4
Q_{10}	5.5	2.4	453	453	88	88	9.8	2.4	3.2	1.74
Q_{25}	1.12	0.00	101	101	16.0	15.7	1.30	0.45	0.94	0.35
Q_{50}	0.13	0.00	31	31	3.5	3.2	0.20	0.08	0.00	0.05
Q_{75}	0.00	0.00	14.6	14.3	1.20	0.90	0.00	0.00	0.00	0.00
Q_{90}	0.00	0.00	6.1	5.9	0.50	0.20	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	1.60	1.57	0.05	0.00	0.00	0.00	0.00	0.00
Q_{mean}	5.6	3.3	152	152	73	73	10.9	3.6	3.3	2.4
October										
Q_{02}	38	29.9	2364	2363	906	906	134	44	44	24.9
Q_{10}	5.2	3.7	390	490	61	61	13.0	2.4	3.2	1.96
Q_{25}	2.1	0.25	80	100	11.0	10.7	1.80	0.31	0.57	0.46
Q_{50}	0.22	0.00	24.0	24.1	2.9	2.6	0.17	0.09	0.00	0.07
Q_{75}	0.00	0.00	9.7	9.4	0.90	0.60	0.00	0.00	0.00	0.00
Q_{90}	0.00	0.00	4.6	4.4	0.30	0.00	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	1.40	1.47	0.00	0.00	0.00	0.00	0.00	0.00
Q_{mean}	3.84	2.52	190	190	69	69	20.7	4.6	4.5	2.6
November										
Q_{02}	125	102	6785	6785	3080	3080	1150	103	100	70
Q_{10}	16.5	11.7	2038	2038	570	570	89	11.7	12.5	9.0
Q_{25}	3.9	1.21	356	355	91	91	18.0	2.6	2.9	1.98
Q_{50}	1.22	0.00	60	60	12.0	11.7	3.0	0.43	0.40	0.42
Q_{75}	0.13	0.00	13.4	13.2	2.5	2.2	0.30	0.08	0.00	0.05
Q_{90}	0.00	0.00	7.2	7.0	0.90	0.60	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	2.7	2.5	0.20	0.00	0.00	0.00	0.00	0.00
Q_{mean}	11.4	7.4	529	528	281	281	78	8.5	8.4	6.0
December										
Q_{02}	234	196	8973	8973	3660	3660	1610	205	197	133
Q_{10}	33	30	3653	3653	1250	1250	305	36	36	22.6
Q_{25}	9.3	6.4	969	969	249	249	60	8.4	9.3	5.2
Q_{50}	3.5	0.31	204	203	46	46	13.0	1.64	2.6	1.32
Q_{75}	0.80	0.00	37	37	8.2	7.9	1.60	0.25	0.00	0.22
Q_{90}	0.05	0.00	12.0	11.9	2.1	1.80	0.37	0.03	0.00	0.00
Q_{98}	0.00	0.00	6.2	5.9	0.50	0.20	0.00	0.00	0.00	0.00
Q_{mean}	20.1	15.5	855	855	439	439	141	21.0	20.6	12.9

Appendix A. Continued

Flow type	Location				
	(31)	(32)	(33)	(34)	(35)
Q_{01}	126	730	514	161	128
Q_{02}	80	458	332	101	82
Q_{05}	38	190	163	42	38
Q_{10}	15.9	73	76	16.1	16.7
Q_{15}	8.3	39	45	8.5	9.7
Q_{25}	2.9	16.2	23.1	3.7	4.9
Q_{40}	0.00	5.9	5.3	1.55	0.64
Q_{50}	0.00	3.2	0.00	0.85	0.06
Q_{60}	0.00	1.56	0.00	0.42	0.00
Q_{75}	0.00	0.18	0.00	0.03	0.00
Q_{85}	0.00	0.02	0.00	0.00	0.00
Q_{90}	0.00	0.00	0.00	0.00	0.00
Q_{95}	0.00	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00
Q_{99}	0.00	0.00	0.00	0.00	0.00
Q_{mean}	7.5	41	32	9.2	8.0
Low Flows					
$Q_{1,2}$	0.00	0.00	0.00	0.00	0.00
$Q_{1,10}$	0.00	0.00	0.00	0.00	0.00
$Q_{1,25}$	0.00	0.00	0.00	0.00	0.00
$Q_{1,50}$	0.00	0.00	0.00	0.00	0.00
$Q_{7,2}$	0.00	0.03	0.00	0.00	0.00
$Q_{7,10}$	0.00	0.00	0.00	0.00	0.00
$Q_{7,25}$	0.00	0.00	0.00	0.00	0.00
$Q_{7,50}$	0.00	0.00	0.00	0.00	0.00
$Q_{15,2}$	0.00	0.05	0.00	0.00	0.00
$Q_{15,10}$	0.00	0.00	0.00	0.00	0.00
$Q_{15,25}$	0.00	0.00	0.00	0.00	0.00
$Q_{15,50}$	0.00	0.00	0.00	0.00	0.00
$Q_{31,2}$	0.00	0.19	0.00	0.01	0.00
$Q_{31,10}$	0.00	0.00	0.00	0.00	0.00
$Q_{31,25}$	0.00	0.00	0.00	0.00	0.00
$Q_{31,50}$	0.00	0.00	0.00	0.00	0.00
$Q_{61,2}$	0.00	0.49	0.00	0.09	0.00
$Q_{61,10}$	0.00	0.01	0.00	0.00	0.00
$Q_{61,25}$	0.00	0.00	0.00	0.00	0.00
$Q_{61,50}$	0.00	0.00	0.00	0.00	0.00
$Q_{91,2}$	0.00	1.33	0.00	0.27	0.16
$Q_{91,10}$	0.00	0.10	0.00	0.00	0.00
$Q_{91,25}$	0.00	0.00	0.00	0.00	0.00
$Q_{91,50}$	0.00	0.00	0.00	0.00	0.00

Appendix A. Continued

Flow type	Location				
	(31)	(32)	(33)	(34)	(35)
Drought Flows					
$Q_{6,10}$	0.00	0.68	0.00	0.14	0.00
$Q_{6,25}$	0.00	0.26	0.00	0.03	0.00
$Q_{6,50}$	0.00	0.07	0.00	0.00	0.00
$Q_{9,10}$	0.00	2.7	0.00	0.65	0.42
$Q_{9,25}$	0.00	1.07	0.00	0.25	0.00
$Q_{9,50}$	0.00	0.46	0.00	0.08	0.00
$Q_{12,10}$	0.00	7.1	0.00	1.75	1.49
$Q_{12,25}$	0.00	3.2	0.00	0.81	0.55
$Q_{12,50}$	0.00	1.58	0.00	0.38	0.09
$Q_{18,10}$	0.00	9.1	0.74	2.2	1.91
$Q_{18,25}$	0.00	4.5	0.00	1.06	0.80
$Q_{18,50}$	0.00	2.3	0.00	0.54	0.24
$Q_{30,10}$	2.1	18.4	10.1	4.2	3.8
$Q_{30,25}$	0.00	9.8	2.3	2.2	1.82
$Q_{30,50}$	0.00	5.7	0.00	1.23	0.94
$Q_{54,10}$	5.7	32	23.8	7.3	6.7
$Q_{54,25}$	1.57	16.3	7.8	3.8	3.4
$Q_{54,50}$	0.00	9.7	3.0	2.2	1.84
January					
Q_{02}	128	632	544	135	122
Q_{10}	20.0	115	103	23.0	21.3
Q_{25}	1.67	25.8	21.4	5.1	4.6
Q_{50}	0.00	5.6	1.13	1.29	0.06
Q_{75}	0.00	1.28	0.00	0.32	0.00
Q_{90}	0.00	0.15	0.00	0.02	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00
Q_{mean}	11.71	57	49	12.0	11.4
February					
Q_{02}	130	706	543	153	128
Q_{10}	32	148	136	33	32
Q_{25}	5.4	40	36	8.5	7.9
Q_{50}	0.00	12.0	7.6	2.7	2.2
Q_{75}	0.00	3.5	0.00	0.91	0.00
Q_{90}	0.00	0.55	0.00	0.15	0.00
Q_{98}	0.00	0.04	0.00	0.00	0.00
Q_{mean}	14.1	69	58	15.2	13.5
March					
Q_{02}	153	820	656	173	148
Q_{10}	47	211	199	47	45
Q_{25}	11.2	59	59	12.7	12.7
Q_{50}	1.89	20.5	19.9	4.5	4.5
Q_{75}	0.00	8.6	0.00	2.1	0.49
Q_{90}	0.00	4.1	0.00	0.96	0.00
Q_{98}	0.00	0.29	0.00	0.09	0.00
Q_{mean}	18.54	89	77	19.5	17.3

Appendix A. Continued

Flow type	Location				
	(31)	(32)	(33)	(34)	(35)
April					
Q_{02}	130	650	487	153	128
Q_{10}	33	148	140	34	33
Q_{25}	8.5	41	44	9.5	10.1
Q_{50}	0.68	14.1	13.4	3.4	3.5
Q_{75}	0.00	5.9	1.42	1.60	0.06
Q_{90}	0.00	2.8	0.00	0.79	0.00
Q_{98}	0.00	0.25	0.00	0.13	0.00
Q_{mean}	15.8	73	63	16.9	14.9
May					
Q_{02}	91	517	353	119	94
Q_{10}	14.3	73	64	17.1	16.0
Q_{25}	3.9	21.0	28.0	4.7	5.9
Q_{50}	0.00	6.2	3.3	1.67	0.32
Q_{75}	0.00	2.3	0.00	0.67	0.00
Q_{90}	0.00	1.10	0.00	0.31	0.00
Q_{98}	0.00	0.10	0.00	0.01	0.00
Q_{mean}	9.67	50	42	11.48	9.69
June					
Q_{02}	46	331	168	78	54
Q_{10}	7.8	38	34	10.6	10.0
Q_{25}	0.98	8.4	15.2	2.6	3.0
Q_{50}	0.00	2.3	0.00	0.77	0.06
Q_{75}	0.00	0.83	0.00	0.24	0.00
Q_{90}	0.00	0.10	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00
Q_{mean}	5.1	32	24.6	7.9	6.1
July					
Q_{02}	43	283	195	60	47
Q_{10}	4.0	24.1	27.2	5.5	6.1
Q_{25}	0.00	3.8	5.3	1.07	1.21
Q_{50}	0.00	1.04	0.00	0.30	0.00
Q_{75}	0.00	0.19	0.00	0.04	0.00
Q_{90}	0.00	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00
Q_{mean}	2.7	24.8	18.5	5.4	4.2
August					
Q_{02}	14.9	120	70	26.7	19.3
Q_{10}	0.00	9.7	5.3	2.3	1.15
Q_{25}	0.00	1.97	0.00	0.48	0.41
Q_{50}	0.00	0.50	0.00	0.11	0.00
Q_{75}	0.00	0.18	0.00	0.01	0.00
Q_{90}	0.00	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00
Q_{mean}	0.30	13.7	7.7	2.8	2.1

Appendix A. Concluded

Flow type	Location				
	(31)	(32)	(33)	(34)	(35)
September					
Q_{02}	15.7	90	63	22.5	18.5
Q_{10}	0.00	6.4	0.00	1.53	0.00
Q_{25}	0.00	1.32	0.00	0.30	0.00
Q_{50}	0.00	0.32	0.00	0.04	0.00
Q_{75}	0.00	0.06	0.00	0.00	0.00
Q_{90}	0.00	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00
Q_{mean}	0.40	8.7	1.60	2.1	1.34
October					
Q_{02}	18.9	100	88	22.0	20.3
Q_{10}	0.00	6.8	0.00	1.72	0.00
Q_{25}	0.00	1.22	0.00	0.40	0.00
Q_{50}	0.00	0.34	0.00	0.05	0.00
Q_{75}	0.00	0.07	0.00	0.00	0.00
Q_{90}	0.00	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00
Q_{mean}	0.50	10.7	2.2	2.3	1.77
November					
Q_{02}	61	249	222	62	58
Q_{10}	4.0	31	22.9	8.0	6.9
Q_{25}	0.00	6.8	0.00	1.74	0.00
Q_{50}	0.00	1.31	0.00	0.36	0.00
Q_{75}	0.00	0.28	0.00	0.04	0.00
Q_{90}	0.00	0.01	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00
Q_{mean}	3.5	21.0	11.8	5.3	4.6
December					
Q_{02}	118	486	436	118	110
Q_{10}	16.6	86	74	20.0	18.3
Q_{25}	0.33	20.5	13.0	4.6	3.6
Q_{50}	0.00	4.4	0.00	1.16	0.00
Q_{75}	0.00	0.77	0.00	0.19	0.00
Q_{90}	0.00	0.15	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00
Q_{mean}	10.3	49	38	11.4	10.4

Note: Streamflow values published by the U.S. Geological Survey ordinarily have three significant digits for values greater than or equal to 100 cfs, and two significant digits for values less than 100 cfs. Additional significant digits have been added to some streamflow frequency estimates in this appendix when used by ILSAM to estimate relative differences in flow values, either between virgin and present flow conditions, or between flows at two different locations. The additional digits do not indicate an improvement in the accuracy of the streamflow estimates.

Appendix B. Withdrawals and Effluent Discharges: Location and Estimated 1997 Flow Conditions

Facility	Stream name	Code	Mile
Albion STP	Butter Creek Tributary	BHON	2.8
Altamont South STP	Big Creek	BV8	9.1
Altamont North STP	Coon Creek	BV8K	4.4
Bluford STP	Bear Creek	BENGD	5.0
Carmi WWTP	Little Wabash River	B	33.8
Cisne STP	Deer Creek	BJKC	10.8
Clay City WWTP	Clay City Tributary	BQ	1.7
Crossville STP	Elliot Creek	BF	3.8
Dahlgren STP	Kennedy-Voris Main Drain	BEGJF	9.8
Dieterich STP	Hog Run Creek Tributary	BOW	2.6
Edgewood STP	Edgewood Tributary	BT1	9.9
Effingham STP	Salt Creek	BV	13.5
Enfield East STP	Lost Creek Tributary	BEDJ	2.0
Fairfield STP	Pond Creek Tributary	BIP	2.7
Flora STP	Seminary Creek	BJKQ	5.8
Louisville STP	Little Wabash River	B	157.9
Neoga STP	Copperas Creek	BY3	2.1
Noble WWTP	Hog Run Creek	BO	9.5
Olney STP	Fox River	BM	18.2
Roadmaster Corp.	Big Creek	BMLC	3.6
Teutopolis STP	Salt Creek	BV	18.4
Wayne City South STP	Skillet Fork Tributary	BEM	2.6
Xenia STP	Nickolson Creek	BET	11.2
Effingham PWS Intake	Little Wabash River	B	204.0
Clay City PWS Withdrawal	Little Wabash River	B	141.3
Fairfield PWS Intake	Little Wabash River	B	81.7
Wayne City PWS Intake	Skillet Fork	BE	42.5

Notes:

Stream codes are as listed in appendix C
PWS – Public Water Supply
SD – Sanitary District
STP – Sanitary Treatment Plant
WWTP – Wastewater Treatment Plant

Appendix B. Continued

Flow type	Location									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Q_{01}	0.84	0.60	0.35	0.28	3.41	0.19	0.42	0.92	0.19	0.16
Q_{02}	0.76	0.53	0.30	0.25	3.06	0.17	0.37	0.80	0.17	0.14
Q_{05}	0.66	0.45	0.25	0.22	2.67	0.15	0.31	0.66	0.14	0.12
Q_{10}	0.59	0.40	0.22	0.19	2.41	0.14	0.27	0.57	0.12	0.11
Q_{15}	0.55	0.37	0.20	0.18	2.24	0.13	0.25	0.51	0.11	0.10
Q_{25}	0.51	0.34	0.18	0.16	2.07	0.12	0.22	0.45	0.10	0.09
Q_{40}	0.47	0.31	0.16	0.15	1.90	0.11	0.20	0.40	0.09	0.08
Q_{50}	0.44	0.29	0.14	0.14	1.81	0.11	0.18	0.37	0.08	0.07
Q_{60}	0.42	0.27	0.13	0.13	1.73	0.10	0.17	0.34	0.07	0.07
Q_{75}	0.38	0.24	0.11	0.11	1.56	0.10	0.14	0.28	0.06	0.06
Q_{85}	0.35	0.22	0.10	0.10	1.45	0.09	0.13	0.24	0.05	0.05
Q_{90}	0.32	0.19	0.08	0.09	1.33	0.08	0.11	0.20	0.05	0.05
Q_{95}	0.29	0.17	0.07	0.08	1.22	0.08	0.09	0.16	0.04	0.04
Q_{98}	0.24	0.13	0.04	0.07	1.02	0.07	0.07	0.09	0.02	0.03
Q_{99}	0.20	0.10	0.02	0.05	0.85	0.06	0.04	0.03	0.01	0.02
Q_{mean}	0.97	0.31	0.16	0.15	1.90	0.11	0.20	0.40	0.09	0.08
Low Flows										
$Q_{1,2}$	0.19	0.09	0.01	0.04	0.79	0.06	0.03	0.01	0.01	0.02
$Q_{1,10}$	0.12	0.04	0.00	0.02	0.54	0.04	0.00	0.00	0.00	0.00
$Q_{1,25}$	0.11	0.03	0.00	0.02	0.51	0.04	0.00	0.00	0.00	0.00
$Q_{1,50}$	0.11	0.03	0.00	0.02	0.51	0.04	0.00	0.00	0.00	0.00
$Q_{7,2}$	0.31	0.19	0.08	0.09	1.30	0.08	0.11	0.19	0.04	0.05
$Q_{7,10}$	0.20	0.10	0.02	0.05	0.85	0.06	0.04	0.03	0.01	0.02
$Q_{7,25}$	0.19	0.09	0.01	0.04	0.79	0.06	0.03	0.01	0.01	0.02
$Q_{7,50}$	0.19	0.09	0.01	0.04	0.79	0.06	0.03	0.01	0.01	0.02
$Q_{15,2}$	0.32	0.19	0.08	0.09	1.33	0.08	0.11	0.20	0.05	0.05
$Q_{15,10}$	0.22	0.12	0.03	0.06	0.93	0.06	0.05	0.06	0.02	0.02
$Q_{15,25}$	0.19	0.10	0.02	0.05	0.82	0.06	0.04	0.02	0.01	0.02
$Q_{15,50}$	0.19	0.10	0.02	0.05	0.82	0.06	0.04	0.02	0.01	0.02
$Q_{31,2}$	0.34	0.21	0.09	0.10	1.39	0.09	0.12	0.22	0.05	0.05
$Q_{31,10}$	0.24	0.13	0.04	0.07	1.02	0.07	0.07	0.09	0.02	0.03
$Q_{31,25}$	0.20	0.10	0.02	0.05	0.85	0.06	0.04	0.03	0.01	0.02
$Q_{31,50}$	0.19	0.10	0.02	0.05	0.82	0.06	0.04	0.02	0.01	0.02
$Q_{61,2}$	0.36	0.22	0.10	0.11	1.47	0.09	0.13	0.25	0.06	0.06
$Q_{61,10}$	0.26	0.15	0.05	0.07	1.10	0.07	0.08	0.12	0.03	0.03
$Q_{61,25}$	0.22	0.12	0.03	0.06	0.93	0.06	0.05	0.06	0.02	0.02
$Q_{61,50}$	0.21	0.11	0.02	0.05	0.88	0.06	0.04	0.04	0.01	0.02
$Q_{91,2}$	0.38	0.24	0.11	0.11	1.56	0.10	0.14	0.28	0.06	0.06
$Q_{91,10}$	0.29	0.17	0.07	0.08	1.22	0.08	0.09	0.16	0.04	0.04
$Q_{91,25}$	0.24	0.13	0.04	0.07	1.02	0.07	0.07	0.09	0.02	0.03
$Q_{91,50}$	0.24	0.13	0.04	0.06	0.99	0.07	0.06	0.08	0.02	0.03

Appendix B. Continued

Flow type	Location									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Drought Flows										
$Q_{6,10}$	0.35	0.22	0.10	0.10	1.45	0.09	0.13	0.24	0.05	0.05
$Q_{6,25}$	0.31	0.19	0.08	0.09	1.30	0.08	0.11	0.19	0.04	0.05
$Q_{6,50}$	0.29	0.17	0.07	0.08	1.22	0.08	0.09	0.16	0.04	0.04
$Q_{9,10}$	0.39	0.25	0.12	0.12	1.60	0.10	0.15	0.29	0.06	0.06
$Q_{9,25}$	0.36	0.23	0.10	0.11	1.50	0.09	0.14	0.26	0.06	0.06
$Q_{9,50}$	0.34	0.21	0.09	0.10	1.42	0.09	0.12	0.23	0.05	0.05
$Q_{12,10}$	0.43	0.28	0.14	0.13	1.76	0.11	0.17	0.35	0.08	0.07
$Q_{12,25}$	0.40	0.26	0.12	0.12	1.64	0.10	0.16	0.31	0.07	0.06
$Q_{12,50}$	0.37	0.23	0.11	0.11	1.53	0.09	0.14	0.27	0.06	0.06
$Q_{18,10}$	0.45	0.29	0.15	0.14	1.84	0.11	0.19	0.38	0.08	0.08
$Q_{18,25}$	0.41	0.27	0.13	0.13	1.70	0.10	0.17	0.33	0.07	0.07
$Q_{18,50}$	0.39	0.25	0.12	0.12	1.60	0.10	0.15	0.29	0.06	0.06
$Q_{30,10}$	0.47	0.31	0.16	0.15	1.93	0.11	0.20	0.40	0.09	0.08
$Q_{30,25}$	0.44	0.28	0.14	0.14	1.79	0.11	0.18	0.36	0.08	0.07
$Q_{30,50}$	0.41	0.27	0.13	0.13	1.70	0.10	0.17	0.33	0.07	0.07
$Q_{54,10}$	0.50	0.33	0.17	0.16	2.04	0.12	0.22	0.44	0.09	0.09
$Q_{54,25}$	0.45	0.29	0.15	0.14	1.84	0.11	0.19	0.38	0.08	0.08
$Q_{54,50}$	0.44	0.28	0.14	0.14	1.79	0.11	0.18	0.36	0.08	0.07
January										
Q_{02}	0.78	0.55	0.32	0.26	3.15	0.17	0.38	0.83	0.17	0.15
Q_{10}	0.59	0.40	0.22	0.19	2.41	0.14	0.27	0.57	0.12	0.11
Q_{25}	0.51	0.34	0.18	0.16	2.07	0.12	0.22	0.45	0.10	0.09
Q_{50}	0.44	0.29	0.14	0.14	1.81	0.11	0.18	0.37	0.08	0.07
Q_{75}	0.38	0.24	0.11	0.11	1.56	0.10	0.14	0.28	0.06	0.06
Q_{90}	0.32	0.19	0.08	0.09	1.32	0.08	0.11	0.19	0.04	0.05
Q_{98}	0.26	0.15	0.05	0.07	1.10	0.07	0.08	0.12	0.03	0.03
Q_{mean}	0.49	0.33	0.17	0.16	2.01	0.12	0.21	0.43	0.09	0.09
February										
Q_{02}	0.82	0.58	0.33	0.27	3.29	0.18	0.40	0.88	0.18	0.16
Q_{10}	0.62	0.43	0.24	0.20	2.52	0.14	0.29	0.61	0.13	0.11
Q_{25}	0.54	0.37	0.20	0.17	2.21	0.13	0.24	0.50	0.11	0.10
Q_{50}	0.47	0.31	0.16	0.15	1.90	0.11	0.20	0.40	0.09	0.08
Q_{75}	0.40	0.26	0.12	0.12	1.64	0.10	0.16	0.31	0.07	0.06
Q_{90}	0.36	0.22	0.10	0.11	1.47	0.09	0.13	0.25	0.06	0.06
Q_{98}	0.31	0.18	0.07	0.09	1.28	0.08	0.10	0.18	0.04	0.04
Q_{mean}	0.52	0.34	0.18	0.16	2.10	0.12	0.23	0.47	0.10	0.09
March										
Q_{02}	0.84	0.60	0.35	0.28	3.41	0.19	0.42	0.92	0.19	0.16
Q_{10}	0.66	0.45	0.25	0.22	2.67	0.15	0.31	0.66	0.14	0.12
Q_{25}	0.57	0.39	0.21	0.18	2.33	0.13	0.26	0.54	0.11	0.10
Q_{50}	0.51	0.34	0.18	0.16	2.07	0.12	0.22	0.45	0.10	0.09
Q_{75}	0.45	0.29	0.15	0.14	1.84	0.11	0.19	0.38	0.08	0.08
Q_{90}	0.42	0.27	0.13	0.13	1.73	0.10	0.17	0.34	0.07	0.07
Q_{98}	0.35	0.22	0.10	0.10	1.45	0.09	0.13	0.24	0.05	0.05
Q_{mean}	0.54	0.36	0.19	0.17	2.18	0.13	0.24	0.49	0.10	0.09

Appendix B. Continued

Flow type	Location									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
April										
Q_{02}	0.84	0.60	0.35	0.28	3.41	0.19	0.42	0.92	0.19	0.16
Q_{10}	0.66	0.45	0.25	0.22	2.67	0.15	0.31	0.66	0.14	0.12
Q_{25}	0.59	0.40	0.22	0.19	2.38	0.14	0.27	0.56	0.12	0.11
Q_{50}	0.52	0.35	0.18	0.17	2.13	0.12	0.23	0.47	0.10	0.09
Q_{75}	0.47	0.31	0.16	0.15	1.90	0.11	0.20	0.40	0.09	0.08
Q_{90}	0.44	0.28	0.14	0.14	1.79	0.11	0.18	0.36	0.08	0.07
Q_{98}	0.36	0.23	0.10	0.11	1.50	0.09	0.14	0.26	0.06	0.06
Q_{mean}	0.54	0.36	0.19	0.17	2.18	0.13	0.24	0.49	0.10	0.09
May										
Q_{02}	0.84	0.60	0.35	0.28	3.41	0.19	0.42	0.92	0.19	0.16
Q_{10}	0.62	0.43	0.24	0.20	2.52	0.14	0.29	0.61	0.13	0.11
Q_{25}	0.53	0.36	0.19	0.17	2.18	0.13	0.24	0.49	0.10	0.09
Q_{50}	0.49	0.32	0.17	0.15	1.99	0.12	0.21	0.42	0.09	0.08
Q_{75}	0.45	0.29	0.15	0.14	1.84	0.11	0.19	0.38	0.08	0.08
Q_{90}	0.43	0.28	0.14	0.13	1.76	0.11	0.17	0.35	0.08	0.07
Q_{98}	0.36	0.22	0.10	0.11	1.47	0.09	0.13	0.25	0.06	0.06
Q_{mean}	0.52	0.34	0.18	0.16	2.10	0.12	0.22	0.46	0.10	0.09
June										
Q_{02}	0.84	0.60	0.35	0.28	3.41	0.19	0.42	0.92	0.19	0.16
Q_{10}	0.62	0.43	0.24	0.20	2.52	0.14	0.29	0.61	0.13	0.11
Q_{25}	0.53	0.35	0.19	0.17	2.16	0.12	0.23	0.48	0.10	0.09
Q_{50}	0.47	0.31	0.16	0.15	1.90	0.11	0.20	0.40	0.09	0.08
Q_{75}	0.44	0.28	0.14	0.14	1.79	0.11	0.18	0.36	0.08	0.07
Q_{90}	0.41	0.26	0.13	0.13	1.67	0.10	0.16	0.32	0.07	0.07
Q_{98}	0.35	0.22	0.10	0.10	1.45	0.09	0.13	0.24	0.05	0.05
Q_{mean}	0.47	0.31	0.16	0.15	1.93	0.11	0.20	0.40	0.09	0.08
July										
Q_{02}	0.71	0.49	0.28	0.23	2.87	0.16	0.34	0.73	0.15	0.13
Q_{10}	0.55	0.37	0.20	0.18	2.24	0.13	0.25	0.51	0.11	0.10
Q_{25}	0.48	0.32	0.16	0.15	1.96	0.11	0.20	0.41	0.09	0.08
Q_{50}	0.44	0.29	0.14	0.14	1.81	0.11	0.18	0.37	0.08	0.07
Q_{75}	0.39	0.25	0.12	0.12	1.62	0.10	0.15	0.30	0.07	0.06
Q_{90}	0.36	0.22	0.10	0.11	1.47	0.09	0.13	0.25	0.06	0.06
Q_{98}	0.29	0.17	0.07	0.08	1.22	0.08	0.09	0.16	0.04	0.04
Q_{mean}	0.43	0.28	0.14	0.13	1.76	0.11	0.17	0.35	0.08	0.07
August										
Q_{02}	0.66	0.45	0.25	0.22	2.67	0.15	0.31	0.66	0.14	0.12
Q_{10}	0.50	0.33	0.17	0.16	2.04	0.12	0.22	0.44	0.09	0.09
Q_{25}	0.44	0.28	0.14	0.14	1.79	0.11	0.18	0.36	0.08	0.07
Q_{50}	0.39	0.25	0.12	0.12	1.60	0.10	0.15	0.29	0.06	0.06
Q_{75}	0.36	0.22	0.10	0.11	1.47	0.09	0.13	0.25	0.06	0.06
Q_{90}	0.32	0.19	0.08	0.09	1.32	0.08	0.11	0.19	0.04	0.05
Q_{98}	0.24	0.13	0.04	0.07	1.02	0.07	0.07	0.09	0.02	0.03
Q_{mean}	0.39	0.25	0.12	0.12	1.62	0.10	0.15	0.30	0.07	0.06

Appendix B. Continued

Flow type	Location									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
September										
Q_{02}	0.59	0.40	0.22	0.19	2.41	0.14	0.27	0.57	0.12	0.11
Q_{10}	0.46	0.30	0.15	0.14	1.87	0.11	0.19	0.39	0.08	0.08
Q_{25}	0.39	0.25	0.12	0.12	1.62	0.10	0.15	0.30	0.07	0.06
Q_{50}	0.36	0.22	0.10	0.11	1.47	0.09	0.13	0.25	0.06	0.06
Q_{75}	0.32	0.19	0.08	0.09	1.33	0.08	0.11	0.20	0.05	0.05
Q_{90}	0.29	0.17	0.07	0.08	1.22	0.08	0.09	0.16	0.04	0.04
Q_{98}	0.20	0.10	0.02	0.05	0.85	0.06	0.04	0.03	0.01	0.02
Q_{mean}	0.38	0.24	0.11	0.11	1.55	0.09	0.14	0.27	0.06	0.06
October										
Q_{02}	0.62	0.42	0.23	0.20	2.50	0.14	0.28	0.60	0.13	0.11
Q_{10}	0.49	0.32	0.17	0.15	1.99	0.12	0.21	0.42	0.09	0.08
Q_{25}	0.42	0.27	0.13	0.13	1.73	0.10	0.17	0.34	0.07	0.07
Q_{50}	0.36	0.22	0.10	0.11	1.47	0.09	0.13	0.25	0.06	0.06
Q_{75}	0.32	0.19	0.08	0.09	1.32	0.08	0.11	0.19	0.04	0.05
Q_{90}	0.26	0.15	0.05	0.07	1.10	0.07	0.08	0.12	0.03	0.03
Q_{98}	0.19	0.09	0.01	0.04	0.79	0.06	0.03	0.01	0.01	0.02
Q_{mean}	0.38	0.24	0.11	0.11	1.55	0.09	0.14	0.27	0.06	0.06
November										
Q_{02}	0.64	0.44	0.25	0.21	2.61	0.15	0.30	0.64	0.13	0.12
Q_{10}	0.51	0.34	0.18	0.16	2.07	0.12	0.22	0.45	0.10	0.09
Q_{25}	0.45	0.29	0.15	0.14	1.84	0.11	0.19	0.38	0.08	0.08
Q_{50}	0.39	0.25	0.12	0.12	1.60	0.10	0.15	0.29	0.06	0.06
Q_{75}	0.34	0.21	0.09	0.10	1.42	0.09	0.12	0.23	0.05	0.05
Q_{90}	0.29	0.17	0.07	0.08	1.22	0.08	0.09	0.16	0.04	0.04
Q_{98}	0.20	0.10	0.02	0.05	0.85	0.06	0.04	0.03	0.01	0.02
Q_{mean}	0.44	0.29	0.14	0.14	1.81	0.11	0.18	0.37	0.08	0.07
December										
Q_{02}	0.76	0.53	0.30	0.25	3.06	0.17	0.37	0.80	0.17	0.14
Q_{10}	0.55	0.37	0.20	0.18	2.24	0.13	0.25	0.51	0.11	0.10
Q_{25}	0.47	0.31	0.16	0.15	1.90	0.11	0.20	0.40	0.09	0.08
Q_{50}	0.41	0.27	0.13	0.13	1.70	0.10	0.17	0.33	0.07	0.07
Q_{75}	0.36	0.22	0.10	0.11	1.47	0.09	0.13	0.25	0.06	0.06
Q_{90}	0.31	0.18	0.07	0.09	1.28	0.08	0.10	0.18	0.04	0.04
Q_{98}	0.24	0.13	0.04	0.06	0.99	0.07	0.06	0.08	0.02	0.03
Q_{mean}	0.49	0.33	0.17	0.16	2.01	0.12	0.21	0.43	0.09	0.09

Appendix B. Continued

Flow type	Location									
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Q_{01}	0.15	6.28	0.06	3.34	2.81	0.36	0.88	0.45	4.95	0.22
Q_{02}	0.11	5.72	0.05	2.99	2.49	0.32	0.78	0.39	4.46	0.20
Q_{05}	0.09	5.07	0.05	2.58	2.13	0.27	0.67	0.32	3.90	0.17
Q_{10}	0.08	4.66	0.04	2.31	1.89	0.24	0.60	0.28	3.53	0.15
Q_{15}	0.08	4.38	0.04	2.13	1.73	0.22	0.55	0.25	3.29	0.14
Q_{25}	0.07	4.10	0.04	1.96	1.58	0.20	0.50	0.22	3.04	0.13
Q_{40}	0.06	3.82	0.04	1.78	1.42	0.18	0.45	0.19	2.80	0.12
Q_{50}	0.06	3.68	0.03	1.69	1.34	0.17	0.43	0.17	2.68	0.11
Q_{60}	0.05	3.54	0.03	1.60	1.26	0.16	0.41	0.16	2.56	0.11
Q_{75}	0.05	3.26	0.03	1.43	1.11	0.14	0.36	0.13	2.31	0.09
Q_{85}	0.04	3.08	0.03	1.31	1.00	0.13	0.33	0.11	2.15	0.09
Q_{90}	0.04	2.89	0.03	1.19	0.90	0.12	0.29	0.09	1.99	0.08
Q_{95}	0.03	2.70	0.03	1.07	0.79	0.10	0.26	0.07	1.83	0.07
Q_{98}	0.02	2.38	0.02	0.87	0.61	0.08	0.21	0.03	1.54	0.06
Q_{99}	0.02	2.10	0.02	0.69	0.45	0.06	0.16	0.00	1.30	0.05
Q_{mean}	0.06	3.82	0.04	1.78	1.42	0.18	0.45	0.19	2.80	0.12
Low Flows										
$Q_{1,2}$	0.00	2.01	0.02	0.63	0.40	0.05	0.14	0.00	1.22	0.04
$Q_{1,10}$	0.00	1.89	0.02	0.36	0.16	0.02	0.07	0.00	0.85	0.02
$Q_{1,25}$	0.00	1.84	0.02	0.33	0.14	0.02	0.06	0.00	0.81	0.02
$Q_{1,50}$	0.00	1.84	0.02	0.33	0.14	0.02	0.06	0.00	0.81	0.02
$Q_{7,2}$	0.03	2.84	0.03	1.16	0.87	0.11	0.29	0.08	1.95	0.08
$Q_{7,10}$	0.00	2.10	0.02	0.69	0.45	0.06	0.16	0.00	1.30	0.05
$Q_{7,25}$	0.00	2.01	0.02	0.63	0.40	0.05	0.14	0.00	1.22	0.04
$Q_{7,50}$	0.00	2.01	0.02	0.63	0.40	0.05	0.14	0.00	1.22	0.04
$Q_{15,2}$	0.03	2.89	0.03	1.19	0.90	0.12	0.29	0.09	1.99	0.08
$Q_{15,10}$	0.00	2.24	0.02	0.78	0.53	0.07	0.18	0.02	1.42	0.05
$Q_{15,25}$	0.00	2.05	0.02	0.66	0.43	0.06	0.15	0.00	1.26	0.04
$Q_{15,50}$	0.00	2.05	0.02	0.66	0.43	0.06	0.15	0.00	1.26	0.04
$Q_{31,2}$	0.03	2.98	0.03	1.25	0.95	0.12	0.31	0.10	2.07	0.08
$Q_{31,10}$	0.01	2.38	0.02	0.87	0.61	0.08	0.21	0.03	1.54	0.06
$Q_{31,25}$	0.00	2.10	0.02	0.69	0.45	0.06	0.16	0.00	1.30	0.05
$Q_{31,50}$	0.00	2.05	0.02	0.66	0.43	0.06	0.15	0.00	1.26	0.04
$Q_{61,2}$	0.04	3.12	0.03	1.34	1.03	0.13	0.33	0.11	2.19	0.09
$Q_{61,10}$	0.01	2.52	0.02	0.95	0.69	0.09	0.23	0.05	1.66	0.06
$Q_{61,25}$	0.00	2.24	0.02	0.78	0.53	0.07	0.18	0.02	1.42	0.05
$Q_{61,50}$	0.00	2.15	0.02	0.72	0.48	0.06	0.17	0.01	1.34	0.05
$Q_{91,2}$	0.04	3.26	0.03	1.43	1.11	0.14	0.36	0.13	2.31	0.09
$Q_{91,10}$	0.02	2.70	0.03	1.07	0.79	0.10	0.26	0.07	1.83	0.07
$Q_{91,25}$	0.01	2.38	0.02	0.87	0.61	0.08	0.21	0.03	1.54	0.06
$Q_{91,50}$	0.01	2.33	0.02	0.84	0.58	0.08	0.20	0.03	1.50	0.05

Appendix B. Continued

Flow type	Location									
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Drought Flows										
$Q_{6,10}$	0.03	3.08	0.03	1.31	1.00	0.13	0.33	0.11	2.15	0.09
$Q_{6,25}$	0.03	2.84	0.03	1.16	0.87	0.11	0.29	0.08	1.95	0.08
$Q_{6,50}$	0.02	2.70	0.03	1.07	0.79	0.10	0.26	0.07	1.83	0.07
$Q_{9,10}$	0.04	3.33	0.03	1.47	1.15	0.15	0.37	0.13	2.37	0.10
$Q_{9,25}$	0.04	3.17	0.03	1.37	1.05	0.14	0.34	0.12	2.23	0.09
$Q_{9,50}$	0.03	3.03	0.03	1.28	0.98	0.13	0.32	0.10	2.11	0.08
$Q_{12,10}$	0.05	3.59	0.03	1.63	1.29	0.17	0.41	0.16	2.60	0.11
$Q_{12,25}$	0.05	3.40	0.03	1.51	1.18	0.15	0.38	0.14	2.43	0.10
$Q_{12,50}$	0.04	3.22	0.03	1.40	1.08	0.14	0.35	0.12	2.27	0.09
$Q_{18,10}$	0.06	3.73	0.04	1.72	1.37	0.18	0.44	0.18	2.72	0.11
$Q_{18,25}$	0.05	3.49	0.03	1.57	1.24	0.16	0.40	0.15	2.52	0.10
$Q_{18,50}$	0.04	3.33	0.03	1.47	1.15	0.15	0.37	0.13	2.37	0.10
$Q_{30,10}$	0.06	3.87	0.04	1.81	1.45	0.19	0.46	0.19	2.84	0.12
$Q_{30,25}$	0.05	3.63	0.03	1.66	1.32	0.17	0.42	0.17	2.64	0.11
$Q_{30,50}$	0.05	3.49	0.03	1.57	1.24	0.16	0.40	0.15	2.52	0.10
$Q_{54,10}$	0.07	4.05	0.04	1.93	1.55	0.20	0.49	0.21	3.00	0.13
$Q_{54,25}$	0.06	3.73	0.04	1.72	1.37	0.18	0.44	0.18	2.72	0.11
$Q_{54,50}$	0.05	3.63	0.03	1.66	1.32	0.17	0.42	0.17	2.64	0.11
January										
Q_{02}	0.13	5.86	0.05	3.08	2.57	0.33	0.80	0.41	4.58	0.20
Q_{10}	0.09	4.66	0.04	2.31	1.89	0.24	0.60	0.28	3.53	0.15
Q_{25}	0.07	4.10	0.04	1.96	1.58	0.20	0.50	0.22	3.04	0.13
Q_{50}	0.06	3.68	0.03	1.69	1.34	0.17	0.43	0.17	2.68	0.11
Q_{75}	0.04	3.26	0.03	1.43	1.11	0.14	0.36	0.13	2.31	0.09
Q_{90}	0.03	2.87	0.03	1.18	0.88	0.11	0.29	0.08	1.97	0.08
Q_{98}	0.01	2.52	0.02	0.95	0.69	0.09	0.23	0.05	1.66	0.06
Q_{mean}	0.07	4.01	0.04	1.90	1.52	0.20	0.49	0.21	2.96	0.13
February										
Q_{02}	0.14	6.10	0.06	3.23	2.70	0.35	0.84	0.43	4.79	0.21
Q_{10}	0.10	4.84	0.05	2.43	2.00	0.26	0.63	0.30	3.69	0.16
Q_{25}	0.08	4.33	0.04	2.10	1.71	0.22	0.54	0.24	3.25	0.14
Q_{50}	0.06	3.82	0.04	1.78	1.42	0.18	0.45	0.19	2.80	0.12
Q_{75}	0.05	3.40	0.03	1.51	1.18	0.15	0.38	0.14	2.43	0.10
Q_{90}	0.04	3.12	0.03	1.34	1.03	0.13	0.33	0.11	2.19	0.09
Q_{98}	0.02	2.80	0.03	1.13	0.84	0.11	0.28	0.08	1.91	0.07
Q_{mean}	0.07	4.15	0.04	1.99	1.61	0.21	0.51	0.22	3.09	0.13
March										
Q_{02}	0.15	6.28	0.06	3.34	2.81	0.36	0.88	0.45	4.95	0.22
Q_{10}	0.10	5.07	0.05	2.58	2.13	0.27	0.67	0.32	3.90	0.17
Q_{25}	0.08	4.52	0.04	2.22	1.81	0.23	0.57	0.26	3.41	0.15
Q_{50}	0.07	4.10	0.04	1.96	1.58	0.20	0.50	0.22	3.04	0.13
Q_{75}	0.06	3.73	0.04	1.72	1.37	0.18	0.44	0.18	2.72	0.11
Q_{90}	0.05	3.54	0.03	1.60	1.26	0.16	0.41	0.16	2.56	0.11
Q_{98}	0.03	3.08	0.03	1.31	1.00	0.13	0.33	0.11	2.15	0.09
Q_{mean}	0.08	4.28	0.04	2.07	1.68	0.22	0.53	0.24	3.20	0.14

Appendix B. Continued

Flow type	Location									
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
April										
Q_{02}	0.15	6.28	0.06	3.34	2.81	0.36	0.88	0.45	4.95	0.22
Q_{10}	0.10	5.07	0.05	2.58	2.13	0.27	0.67	0.32	3.90	0.17
Q_{25}	0.09	4.61	0.04	2.28	1.86	0.24	0.59	0.27	3.49	0.15
Q_{50}	0.07	4.19	0.04	2.02	1.63	0.21	0.52	0.23	3.12	0.13
Q_{75}	0.06	3.82	0.04	1.78	1.42	0.18	0.45	0.19	2.80	0.12
Q_{90}	0.05	3.63	0.03	1.66	1.32	0.17	0.42	0.17	2.64	0.11
Q_{98}	0.04	3.17	0.03	1.37	1.05	0.14	0.34	0.12	2.23	0.09
Q_{mean}	0.08	4.28	0.04	2.07	1.68	0.22	0.53	0.24	3.20	0.14
May										
Q_{02}	0.15	6.28	0.06	3.34	2.81	0.36	0.88	0.45	4.95	0.22
Q_{10}	0.10	4.84	0.05	2.43	2.00	0.26	0.63	0.30	3.69	0.16
Q_{25}	0.08	4.27	0.04	2.07	1.67	0.22	0.53	0.23	3.19	0.14
Q_{50}	0.06	3.96	0.04	1.87	1.50	0.19	0.48	0.20	2.92	0.12
Q_{75}	0.06	3.73	0.04	1.72	1.37	0.18	0.44	0.18	2.72	0.11
Q_{90}	0.05	3.59	0.03	1.63	1.29	0.17	0.41	0.16	2.60	0.11
Q_{98}	0.04	3.12	0.03	1.34	1.03	0.13	0.33	0.11	2.19	0.09
Q_{mean}	0.07	4.15	0.04	1.99	1.60	0.21	0.51	0.22	3.08	0.13
June										
Q_{02}	0.15	6.28	0.06	3.34	2.81	0.36	0.88	0.45	4.95	0.22
Q_{10}	0.10	4.84	0.05	2.43	2.00	0.26	0.63	0.30	3.69	0.16
Q_{25}	0.07	4.24	0.04	2.05	1.66	0.21	0.53	0.23	3.17	0.14
Q_{50}	0.06	3.82	0.04	1.78	1.42	0.18	0.45	0.19	2.80	0.12
Q_{75}	0.05	3.63	0.03	1.66	1.32	0.17	0.42	0.17	2.64	0.11
Q_{90}	0.05	3.45	0.03	1.54	1.21	0.16	0.39	0.15	2.48	0.10
Q_{98}	0.03	3.08	0.03	1.31	1.00	0.13	0.33	0.11	2.15	0.09
Q_{mean}	0.06	3.86	0.04	1.81	1.44	0.19	0.46	0.19	2.84	0.12
July										
Q_{02}	0.12	5.40	0.05	2.78	2.31	0.30	0.72	0.36	4.18	0.19
Q_{10}	0.08	4.38	0.04	2.13	1.73	0.22	0.55	0.25	3.29	0.14
Q_{25}	0.06	3.91	0.04	1.84	1.47	0.19	0.47	0.20	2.88	0.12
Q_{50}	0.06	3.68	0.03	1.69	1.34	0.17	0.43	0.17	2.68	0.11
Q_{75}	0.04	3.36	0.03	1.49	1.16	0.15	0.37	0.14	2.39	0.10
Q_{90}	0.04	3.12	0.03	1.34	1.03	0.13	0.33	0.11	2.19	0.09
Q_{98}	0.02	2.70	0.03	1.07	0.79	0.10	0.26	0.07	1.83	0.07
Q_{mean}	0.05	3.59	0.03	1.63	1.29	0.17	0.41	0.16	2.60	0.11
August										
Q_{02}	0.10	5.07	0.05	2.58	2.13	0.27	0.67	0.32	3.90	0.17
Q_{10}	0.07	4.05	0.04	1.93	1.55	0.20	0.49	0.21	3.00	0.13
Q_{25}	0.05	3.63	0.03	1.66	1.32	0.17	0.42	0.17	2.64	0.11
Q_{50}	0.04	3.33	0.03	1.47	1.15	0.15	0.37	0.13	2.37	0.10
Q_{75}	0.04	3.12	0.03	1.34	1.03	0.13	0.33	0.11	2.19	0.09
Q_{90}	0.03	2.87	0.03	1.18	0.88	0.11	0.29	0.08	1.97	0.08
Q_{98}	0.01	2.38	0.02	0.87	0.61	0.08	0.21	0.03	1.54	0.06
Q_{mean}	0.04	3.36	0.03	1.49	1.16	0.15	0.37	0.14	2.39	0.10

Appendix B. Continued

Flow type	Location									
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
September										
Q_{02}	0.09	4.66	0.04	2.31	1.89	0.24	0.60	0.28	3.53	0.15
Q_{10}	0.06	3.77	0.04	1.75	1.39	0.18	0.45	0.18	2.76	0.12
Q_{25}	0.04	3.36	0.03	1.49	1.16	0.15	0.37	0.14	2.39	0.10
Q_{50}	0.04	3.12	0.03	1.34	1.03	0.13	0.33	0.11	2.19	0.09
Q_{75}	0.03	2.89	0.03	1.19	0.90	0.12	0.29	0.09	1.99	0.08
Q_{90}	0.02	2.70	0.03	1.07	0.79	0.10	0.26	0.07	1.83	0.07
Q_{98}	0.00	2.10	0.02	0.69	0.45	0.06	0.16	0.00	1.30	0.05
Q_{mean}	0.04	3.25	0.03	1.42	1.10	0.14	0.36	0.12	2.31	0.09
October										
Q_{02}	0.09	4.80	0.04	2.40	1.97	0.25	0.62	0.29	3.65	0.16
Q_{10}	0.06	3.96	0.04	1.87	1.50	0.19	0.48	0.20	2.92	0.12
Q_{25}	0.05	3.54	0.03	1.60	1.26	0.16	0.41	0.16	2.56	0.11
Q_{50}	0.04	3.12	0.03	1.34	1.03	0.13	0.33	0.11	2.19	0.09
Q_{75}	0.03	2.87	0.03	1.18	0.88	0.11	0.29	0.08	1.97	0.08
Q_{90}	0.01	2.52	0.02	0.95	0.69	0.09	0.23	0.05	1.66	0.06
Q_{98}	0.00	2.01	0.02	0.63	0.40	0.05	0.14	0.00	1.22	0.04
Q_{mean}	0.04	3.24	0.03	1.41	1.10	0.14	0.36	0.12	2.30	0.09
November										
Q_{02}	0.10	4.98	0.05	2.52	2.07	0.27	0.65	0.31	3.81	0.17
Q_{10}	0.07	4.10	0.04	1.96	1.58	0.20	0.50	0.22	3.04	0.13
Q_{25}	0.06	3.73	0.04	1.72	1.37	0.18	0.44	0.18	2.72	0.11
Q_{50}	0.04	3.33	0.03	1.47	1.15	0.15	0.37	0.13	2.37	0.10
Q_{75}	0.03	3.03	0.03	1.28	0.98	0.13	0.32	0.10	2.11	0.08
Q_{90}	0.02	2.70	0.03	1.07	0.79	0.10	0.26	0.07	1.83	0.07
Q_{98}	0.00	2.10	0.02	0.69	0.45	0.06	0.16	0.00	1.30	0.05
Q_{mean}	0.06	3.68	0.03	1.69	1.34	0.17	0.43	0.17	2.68	0.11
December										
Q_{02}	0.13	5.72	0.05	2.99	2.49	0.32	0.78	0.39	4.46	0.20
Q_{10}	0.08	4.38	0.04	2.13	1.73	0.22	0.55	0.25	3.29	0.14
Q_{25}	0.06	3.82	0.04	1.78	1.42	0.18	0.45	0.19	2.80	0.12
Q_{50}	0.05	3.49	0.03	1.57	1.24	0.16	0.40	0.15	2.52	0.10
Q_{75}	0.04	3.12	0.03	1.34	1.03	0.13	0.33	0.11	2.19	0.09
Q_{90}	0.02	2.80	0.03	1.13	0.84	0.11	0.28	0.08	1.91	0.07
Q_{98}	0.01	2.33	0.02	0.84	0.58	0.08	0.20	0.03	1.50	0.05
Q_{mean}	0.07	4.00	0.04	1.89	1.52	0.20	0.48	0.21	2.95	0.13

Appendix B. Continued

Flow type	Location						
	(21)	(22)	(23)	(24)	(25)	(26)	(27)
Q_{01}	1.03	0.18	0.27	-3.60	-0.16	-1.13	-0.30
Q_{02}	0.91	0.17	0.24	-3.60	-0.16	-1.13	-0.30
Q_{05}	0.78	0.15	0.20	-3.60	-0.16	-1.13	-0.30
Q_{10}	0.69	0.15	0.17	-3.60	-0.16	-1.13	-0.30
Q_{15}	0.63	0.14	0.15	-3.60	-0.16	-1.13	-0.30
Q_{25}	0.57	0.13	0.13	-3.60	-0.16	-1.13	-0.30
Q_{40}	0.51	0.13	0.11	-3.60	-0.16	-1.13	-0.30
Q_{50}	0.48	0.12	0.10	-3.60	-0.16	-1.13	-0.30
Q_{60}	0.45	0.12	0.09	-3.60	-0.16	-1.13	-0.30
Q_{75}	0.39	0.11	0.08	-1.00	-0.16	-1.13	-0.30
Q_{85}	0.36	0.11	0.06	-0.50	-0.16	-1.13	-0.30
Q_{90}	0.32	0.11	0.05	-0.40	-0.16	-1.13	-0.30
Q_{95}	0.28	0.10	0.04	-0.30	-0.16	-1.13	-0.30
Q_{98}	0.21	0.10	0.02	-0.20	-0.16	-1.13	-0.30
Q_{99}	0.15	0.09	0.00	-0.14	-0.16	-1.13	-0.30
Q_{mean}	0.51	0.13	0.11	-2.75	-0.16	-1.13	-0.30
Low Flows							
$Q_{1,2}$	0.13	0.09	0.00	-0.05	-0.16	-1.13	-0.30
$Q_{1,10}$	0.04	0.08	0.00	-0.05	-0.16	-1.13	-0.30
$Q_{1,25}$	0.03	0.08	0.00	-0.05	-0.16	-1.13	-0.30
$Q_{1,50}$	0.03	0.08	0.00	-0.05	-0.16	-1.13	-0.30
$Q_{7,2}$	0.31	0.11	0.05	-0.05	-0.16	-1.13	-0.30
$Q_{7,10}$	0.15	0.09	0.00	-0.05	-0.16	-1.13	-0.30
$Q_{7,25}$	0.13	0.09	0.00	-0.05	-0.16	-1.13	-0.30
$Q_{7,50}$	0.13	0.09	0.00	-0.05	-0.16	-1.13	-0.30
$Q_{15,2}$	0.32	0.11	0.05	-0.20	-0.16	-1.13	-0.30
$Q_{15,10}$	0.18	0.09	0.01	-0.16	-0.16	-1.13	-0.30
$Q_{15,25}$	0.14	0.09	0.00	-0.05	-0.16	-1.13	-0.30
$Q_{15,50}$	0.14	0.09	0.00	-0.05	-0.16	-1.13	-0.30
$Q_{31,2}$	0.34	0.11	0.06	-0.40	-0.16	-1.13	-0.30
$Q_{31,10}$	0.21	0.10	0.02	-0.26	-0.16	-1.13	-0.30
$Q_{31,25}$	0.15	0.09	0.00	-0.10	-0.16	-1.13	-0.30
$Q_{31,50}$	0.14	0.09	0.00	-0.10	-0.16	-1.13	-0.30
$Q_{61,2}$	0.37	0.11	0.07	-0.60	-0.16	-1.13	-0.30
$Q_{61,10}$	0.24	0.10	0.03	-0.40	-0.16	-1.13	-0.30
$Q_{61,25}$	0.18	0.09	0.01	-0.10	-0.16	-1.13	-0.30
$Q_{61,50}$	0.16	0.09	0.00	-0.10	-0.16	-1.13	-0.30
$Q_{91,2}$	0.39	0.11	0.08	-1.00	-0.16	-1.13	-0.30
$Q_{91,10}$	0.28	0.10	0.04	-0.50	-0.16	-1.13	-0.30
$Q_{91,25}$	0.21	0.10	0.02	-0.10	-0.16	-1.13	-0.30
$Q_{91,50}$	0.20	0.09	0.02	-0.10	-0.16	-1.13	-0.30

Appendix B. Continued

Flow type	Location						
	(21)	(22)	(23)	(24)	(25)	(26)	(27)
Drought Flows							
$Q_{6,10}$	0.36	0.11	0.06	-0.90	-0.16	-1.13	-0.30
$Q_{6,25}$	0.31	0.11	0.05	-0.90	-0.16	-1.13	-0.30
$Q_{6,50}$	0.28	0.10	0.04	-0.90	-0.16	-1.13	-0.30
$Q_{9,10}$	0.41	0.12	0.08	-1.20	-0.16	-1.13	-0.30
$Q_{9,25}$	0.38	0.11	0.07	-1.20	-0.16	-1.13	-0.30
$Q_{9,50}$	0.35	0.11	0.06	-1.20	-0.16	-1.13	-0.30
$Q_{12,10}$	0.46	0.12	0.10	-1.80	-0.16	-1.13	-0.30
$Q_{12,25}$	0.42	0.12	0.09	-1.80	-0.16	-1.13	-0.30
$Q_{12,50}$	0.38	0.11	0.07	-1.80	-0.16	-1.13	-0.30
$Q_{18,10}$	0.49	0.12	0.11	-2.75	-0.16	-1.13	-0.30
$Q_{18,25}$	0.44	0.12	0.09	-2.75	-0.16	-1.13	-0.30
$Q_{18,50}$	0.41	0.12	0.08	-2.75	-0.16	-1.13	-0.30
$Q_{30,10}$	0.52	0.13	0.12	-2.75	-0.16	-1.13	-0.30
$Q_{30,25}$	0.47	0.12	0.10	-2.75	-0.16	-1.13	-0.30
$Q_{30,50}$	0.44	0.12	0.09	-2.75	-0.16	-1.13	-0.30
$Q_{54,10}$	0.56	0.13	0.13	-2.75	-0.16	-1.13	-0.30
$Q_{54,25}$	0.49	0.12	0.11	-2.75	-0.16	-1.13	-0.30
$Q_{54,50}$	0.47	0.12	0.10	-2.75	-0.16	-1.13	-0.30
January							
Q_{02}	0.94	0.17	0.25	-3.60	-0.16	-1.13	-0.30
Q_{10}	0.69	0.15	0.17	-3.60	-0.16	-1.13	-0.30
Q_{25}	0.57	0.13	0.13	-3.60	-0.16	-1.13	-0.30
Q_{50}	0.48	0.12	0.10	-3.60	-0.16	-1.13	-0.30
Q_{75}	0.39	0.11	0.08	-3.60	-0.16	-1.13	-0.30
Q_{90}	0.31	0.11	0.05	-1.00	-0.16	-1.13	-0.30
Q_{98}	0.24	0.10	0.03	-0.10	-0.16	-1.13	-0.30
Q_{mean}	0.55	0.13	0.13	-2.75	-0.16	-1.13	-0.30
February							
Q_{02}	0.99	0.18	0.26	-3.60	-0.16	-1.13	-0.30
Q_{10}	0.73	0.15	0.18	-3.60	-0.16	-1.13	-0.30
Q_{25}	0.62	0.14	0.15	-3.60	-0.16	-1.13	-0.30
Q_{50}	0.51	0.13	0.11	-3.60	-0.16	-1.13	-0.30
Q_{75}	0.42	0.12	0.09	-3.60	-0.16	-1.13	-0.30
Q_{90}	0.37	0.11	0.07	-3.60	-0.16	-1.13	-0.30
Q_{98}	0.30	0.10	0.05	-0.30	-0.16	-1.13	-0.30
Q_{mean}	0.58	0.13	0.13	-3.30	-0.16	-1.13	-0.30
March							
Q_{02}	1.03	0.18	0.27	-3.60	-0.16	-1.13	-0.30
Q_{10}	0.78	0.15	0.20	-3.60	-0.16	-1.13	-0.30
Q_{25}	0.66	0.14	0.16	-3.60	-0.16	-1.13	-0.30
Q_{50}	0.57	0.13	0.13	-3.60	-0.16	-1.13	-0.30
Q_{75}	0.49	0.12	0.11	-3.60	-0.16	-1.13	-0.30
Q_{90}	0.45	0.12	0.09	-3.60	-0.16	-1.13	-0.30
Q_{98}	0.36	0.11	0.06	-3.60	-0.16	-1.13	-0.30
Q_{mean}	0.61	0.14	0.14	-3.60	-0.16	-1.13	-0.30

Appendix B. Continued

Flow type	Location						
	(21)	(22)	(23)	(24)	(25)	(26)	(27)
April							
Q_{02}	1.03	0.18	0.27	-3.60	-0.16	-1.13	-0.30
Q_{10}	0.78	0.15	0.20	-3.60	-0.16	-1.13	-0.30
Q_{25}	0.68	0.14	0.16	-3.60	-0.16	-1.13	-0.30
Q_{50}	0.59	0.14	0.14	-3.60	-0.16	-1.13	-0.30
Q_{75}	0.51	0.13	0.11	-3.60	-0.16	-1.13	-0.30
Q_{90}	0.47	0.12	0.10	-3.60	-0.16	-1.13	-0.30
Q_{98}	0.38	0.11	0.07	-3.60	-0.16	-1.13	-0.30
Q_{mean}	0.61	0.14	0.14	-3.60	-0.16	-1.13	-0.30
May							
Q_{02}	1.03	0.18	0.27	-3.60	-0.16	-1.13	-0.30
Q_{10}	0.73	0.15	0.18	-3.60	-0.16	-1.13	-0.30
Q_{25}	0.61	0.14	0.14	-3.60	-0.16	-1.13	-0.30
Q_{50}	0.54	0.13	0.12	-3.60	-0.16	-1.13	-0.30
Q_{75}	0.49	0.12	0.11	-3.60	-0.16	-1.13	-0.30
Q_{90}	0.46	0.12	0.10	-3.60	-0.16	-1.13	-0.30
Q_{98}	0.37	0.11	0.07	-1.00	-0.16	-1.13	-0.30
Q_{mean}	0.58	0.13	0.13	-3.30	-0.16	-1.13	-0.30
June							
Q_{02}	1.03	0.18	0.27	-3.60	-0.16	-1.13	-0.30
Q_{10}	0.73	0.15	0.18	-3.60	-0.16	-1.13	-0.30
Q_{25}	0.60	0.14	0.14	-3.60	-0.16	-1.13	-0.30
Q_{50}	0.51	0.13	0.11	-3.60	-0.16	-1.13	-0.30
Q_{75}	0.47	0.12	0.10	-3.60	-0.16	-1.13	-0.30
Q_{90}	0.43	0.12	0.09	-0.50	-0.16	-1.13	-0.30
Q_{98}	0.36	0.11	0.06	-0.30	-0.16	-1.13	-0.30
Q_{mean}	0.52	0.13	0.12	-3.00	-0.16	-1.13	-0.30
July							
Q_{02}	0.84	0.16	0.22	-3.60	-0.16	-1.13	-0.30
Q_{10}	0.63	0.14	0.15	-3.60	-0.16	-1.13	-0.30
Q_{25}	0.53	0.13	0.12	-3.60	-0.16	-1.13	-0.30
Q_{50}	0.48	0.12	0.10	-3.60	-0.16	-1.13	-0.30
Q_{75}	0.41	0.12	0.08	-1.00	-0.16	-1.13	-0.30
Q_{90}	0.37	0.11	0.07	-0.50	-0.16	-1.13	-0.30
Q_{98}	0.28	0.10	0.04	-0.30	-0.16	-1.13	-0.30
Q_{mean}	0.46	0.12	0.10	-2.75	-0.16	-1.13	-0.30
August							
Q_{02}	0.78	0.15	0.20	-3.60	-0.16	-1.13	-0.30
Q_{10}	0.56	0.13	0.13	-3.60	-0.16	-1.13	-0.30
Q_{25}	0.47	0.12	0.10	-3.60	-0.16	-1.13	-0.30
Q_{50}	0.41	0.12	0.08	-1.00	-0.16	-1.13	-0.30
Q_{75}	0.37	0.11	0.07	-0.50	-0.16	-1.13	-0.30
Q_{90}	0.31	0.11	0.05	-0.50	-0.16	-1.13	-0.30
Q_{98}	0.21	0.10	0.02	-0.30	-0.16	-1.13	-0.30
Q_{mean}	0.41	0.12	0.08	-1.80	-0.16	-1.13	-0.30

Appendix B. Concluded

Flow type	Location						
	(21)	(22)	(23)	(24)	(25)	(26)	(27)
September							
Q_{02}	0.69	0.15	0.17	-3.60	-0.16	-1.13	-0.30
Q_{10}	0.50	0.13	0.11	-3.60	-0.16	-1.13	-0.30
Q_{25}	0.41	0.12	0.08	-3.60	-0.16	-1.13	-0.30
Q_{50}	0.37	0.11	0.07	-0.50	-0.16	-1.13	-0.30
Q_{75}	0.32	0.11	0.05	-0.50	-0.16	-1.13	-0.30
Q_{90}	0.28	0.10	0.04	-0.10	-0.16	-1.13	-0.30
Q_{98}	0.15	0.09	0.00	-0.10	-0.16	-1.13	-0.30
Q_{mean}	0.39	0.11	0.08	-1.80	-0.16	-1.13	-0.30
October							
Q_{02}	0.72	0.15	0.18	-3.60	-0.16	-1.13	-0.30
Q_{10}	0.54	0.13	0.12	-3.60	-0.16	-1.13	-0.30
Q_{25}	0.45	0.12	0.09	-3.60	-0.16	-1.13	-0.30
Q_{50}	0.37	0.11	0.07	-0.50	-0.16	-1.13	-0.30
Q_{75}	0.31	0.11	0.05	-0.50	-0.16	-1.13	-0.30
Q_{90}	0.24	0.10	0.03	-0.40	-0.16	-1.13	-0.30
Q_{98}	0.13	0.09	0.00	-0.10	-0.16	-1.13	-0.30
Q_{mean}	0.39	0.11	0.08	-1.80	-0.16	-1.13	-0.30
November							
Q_{02}	0.76	0.15	0.19	-3.60	-0.16	-1.13	-0.30
Q_{10}	0.57	0.13	0.13	-3.60	-0.16	-1.13	-0.30
Q_{25}	0.49	0.12	0.11	-3.60	-0.16	-1.13	-0.30
Q_{50}	0.41	0.12	0.08	-3.60	-0.16	-1.13	-0.30
Q_{75}	0.35	0.11	0.06	-1.00	-0.16	-1.13	-0.30
Q_{90}	0.28	0.10	0.04	-0.30	-0.16	-1.13	-0.30
Q_{98}	0.15	0.09	0.00	-0.10	-0.16	-1.13	-0.30
Q_{mean}	0.48	0.12	0.10	-2.70	-0.16	-1.13	-0.30
December							
Q_{02}	0.91	0.17	0.24	-3.60	-0.16	-1.13	-0.30
Q_{10}	0.63	0.14	0.15	-3.60	-0.16	-1.13	-0.30
Q_{25}	0.51	0.13	0.11	-3.60	-0.16	-1.13	-0.30
Q_{50}	0.44	0.12	0.09	-3.60	-0.16	-1.13	-0.30
Q_{75}	0.37	0.11	0.07	-3.60	-0.16	-1.13	-0.30
Q_{90}	0.30	0.10	0.05	-0.30	-0.16	-1.13	-0.30
Q_{98}	0.20	0.09	0.02	-0.10	-0.16	-1.13	-0.30
Q_{mean}	0.55	0.13	0.12	-2.70	-0.16	-1.13	-0.30

Appendix C. NETWORK File Describing the Location of Streams, Control Points, Withdrawals, and Discharges in the Little Wabash River Basin

List of Stream Names and Associated Codes

Stream name	Code
Auxier Creek Drain	BEJG
Bear Creek	BENGD
Bear Creek	BJKPG
Beaver Creek	BEE
Big Creek	BH
Big Creek	BMLC
Big Creek	BV8
Big Mound Drainage Ditch	BEH
Big Muddy Creek	BP
Big Muddy Diversion Ditch	BPA
Bills Creek	BYIE
Bishop Creek	BU
Blue Point Creek	BW8
Briar Branch	BI4
Brush Creek	BEP
Brush Creek	BYI
Buck Creek	BR
Bush Creek	BZ
Butter Creek	BHO
Clay City tributary	BQ
Clear Creek	BZ1
Coal Bank Creek	BENO
Conners Branch	BEV2
Coon Creek	BV8K
Copperas Creek	BY3
Crooked Creek	BS2
Deer Creek	BJKC
Deer Creek Drainage Ditch	BJK
Dietrich Creek	BUP
Dismal Creek	BS9
Drake Creek	BYF
Dry Fork	BEK
Dums Creek	BEV
East Branch Green Creek	BXJ
East Fork	BMP
Edgewood tributary	BT1
Elliot Creek	BF
Elm River Drainage Ditch	BJ
Emma Ditch	BA2
Endslay Creek	BJKI
Flanders Creek	BC7
Fourmile Creek	BEL

Stream name	Code
Fox River	BM
Fulfer Creek	BV6
Fulton Creek	BEU
Gentry Creek	BMD
Green Creek	BX
Grindstone Creek	BC4
Harper Creek	BHM
Haw Creek	BEG8
Henry Creek	BXK
Hog Run Creek	BO
Horse Creek	BEN
Hurricane Creek	BPI
Kennedy-Voris Main Drain	BEGJF
Lick Creek	BC
Lily Creek	BW2
Limekiln Creek	BEB
Limestone Creek	BPP
Limestone Creek	BV6J
Little Bishop Creek	BUG
Little Dry Fork	BEKN
Little Fox Creek	BML
Little Muddy Creek	BPAK
Little Pond Creek	BH9
Little Salt Creek	BVG
Little Wabash	B
Livergood Creek	BEJ
Long Branch	BMS
Lost Creek	BED
Lost Fork	BEW
Lucas Creek	BT
Madden Creek	BL7J
Main Outlet	BEG
Martin Creek	BJKCB
Nickolson Creek	BET
North Mount Erie tributary	BN
Opossum Creek	BEGT
Paddy Creek	BEO6
Paintrock Creek	BES
Panther Creek	BS
Pond Creek	BI
Poplar Creek	BES2
Prairie Creek	BEE8

Appendix C. Continued

Stream Names and Associated Codes Continued

Stream name	Code	Stream name	Code
Puncheon Creek	BENG	Sugar Creek	BPG
Raccoon Creek	BJKP	Sutton Creek	BEX
Ramsey Creek	BUA	Turkey Creek	BMG
Randolf Drainage Ditch	BE6	Unnamed tributary of Big Muddy Creek	BPW
Rock Branch	BEGJP	Unnamed tributary of Butter Creek	BHON
Salt Creek	BV	Unnamed tributary of Lost Creek	BEDJ
Sandy Creek	BPLK	Unnamed tributary of Pond Creek	BIP
Second Creek	BW	Unnamed tributary of Salt Creek	BVB
Second Creek tributary	BWG	Unnamed tributary of Skillet Fork	BEM
Second Salt Creek	BVS	Village Creek	BK
Seminary Creek	BJKQ	Watson Creek	BEG6
Seven Mile Creek	BEC	Weather Creek	BPL
Sexson Branch	BYM	West Branch	BY
Skillet Fork	BE	West Fork Wet Weather Creek	BPJK
Skillet Fork Lagoon	BEI	West Village Creek	BKLJ
South Fork Beaver Creek	BEEL	Westside Diversion Ditch	BK3
Southern Outlet	BEF	Wet Weather Creek	BPJ
Sugar Creek	BL7	White Feather Creek	BENGO
Sugar Creek	BMJ		

Note: Each stream has a unique code. Along the course of a stream it is possible for the stream name to change, but the stream code will not change. To differentiate between two streams that share the same name, use the location descriptions presented in the remainder of this appendix.

Appendix C. Continued

Watershed Characteristics at Locations of Interest in the Little Wabash River Basin

DA(u) = Drainage area upstream of location (sq mi)
DA(d) = Drainage area downstream of location (sq mi)
K = Average subsoil permeability (inches/hr)
P-ET = Net excess precipitation for the watershed (inches), defined as average annual precipitation (P) minus evapotranspiration (ET)

ID = 0 Basic watershed information
= 1 Tributary inflow
= 2 Effluent discharge
= 3 Water supply withdrawal
= 6 Control point (full set of flow information)
= 9 Reservoir

Region = 1 Bloomington Ridged Plain
= 2 Springfield Plain

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Little Wabash	239.00	0.0	0.0	0.78	10.70	0	1	Topographic Divide
River	234.30	4.7	4.7	0.78	10.70	0	1	Road@Sec. 28 13N 6E
(B)	232.80	13.3	13.3	0.78	10.70	0	1	Road@Sec. 33 13N 6E
	230.10	18.7	18.7	0.78	10.70	9	1	Lake Paradise Dam
	226.31	22.3	22.3	0.78	10.70	0	1	
	226.30	22.3	29.3	0.82	10.72	1	1	at Clear Creek (BZ1)
	225.51	30.4	30.4	0.83	10.73	0	1	
	225.50	30.4	54.0	0.93	10.76	1	1	at Brush Creek (BZ)
	222.10	57.0	57.0	0.97	10.76	9	1	Lake Mattoon
	220.31	60.9	60.9	0.97	10.76	0	1	
	220.30	60.9	71.8	1.01	10.77	2	1	at Copperas Creek (BY3)
	218.91	74.7	74.7	1.02	10.77	0	1	
	218.90	74.7	140.3	1.10	10.70	1	1	at West Branch Little Wabash River (BY)
	215.40	148.2	148.2	1.08	10.71	0	1	above Hog Creek
	213.60	153.8	153.8	1.07	10.71	0	1	above Rattle Snake Creek
	212.80	157.9	157.9	1.06	10.71	0	1	Effingham-Shelby County Line
	209.20	163.0	163.0	1.05	10.71	0	1	above Shoal Creek
	206.41	176.6	176.6	1.03	10.72	0	1	
	206.40	176.6	219.3	0.92	10.73	1	1	at Green Creek (BX)
	204.00	227.2	227.2	0.90	10.73	3	1	Effingham PWS Intake
	203.51	228.8	228.8	0.90	10.73	0	1	
	203.50	228.8	242.5	0.88	10.73	2	1	at Blue Point Creek (BW8)
	202.50	243.2	243.2	0.88	10.73	6	1	USGS Gage 03378635 near Effingham
	197.41	253.3	253.3	0.86	10.73	0	1	
	197.40	253.3	263.9	0.85	10.74	1	1	at Lily Creek (BW2)
	194.61	268.1	268.1	0.85	10.74	0	1	
	194.60	268.1	289.0	0.83	10.74	1	1	at Second Creek (BW)
	192.21	291.0	291.0	0.83	10.74	0	1	
	192.20	291.0	312.7	0.80	10.75	1	1	at Big Creek (BV8)
	189.71	316.8	316.8	0.80	10.75	0	1	
	189.70	316.8	369.7	0.74	10.76	1	1	at Fulfer Creek (BV6)
	186.01	367.8	367.8	0.74	10.76	0	1	
	186.00	367.8	462.1	0.70	10.80	6	1	at Salt Creek (BV)
	183.51	464.4	464.4	0.70	10.80	0	1	
	183.50	464.4	530.2	0.66	10.85	1	1	Bishop Creek (BU)
	182.00	536.9	536.9	0.66	10.85	0	1	Road@Sec. 29 16N 6E
	179.40	541.4	541.4	0.66	10.85	0	1	Clay-Effingham County Line

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Little Wabash	172.71	546.2	546.2	0.66	10.85	0	1	
River	172.70	546.2	567.2	0.66	10.86	1	1	at Second Creek (BT1)
(B)	171.31	568.6	568.6	0.66	10.86	0	1	
	171.30	568.6	587.4	0.64	10.87	1	1	at Lucas Creek (BT)
	165.51	592.4	592.4	0.65	10.87	0	1	
	165.50	592.4	644.2	0.62	10.88	1	1	at Dismal Creek (BS9)
	162.41	650.4	650.4	0.62	10.89	0	1	
	162.40	650.4	698.2	0.59	10.91	1	1	at Crooked Creek (BS2)
	159.31	701.5	701.5	0.60	10.91	0	1	
	159.30	701.5	733.6	0.58	10.93	1	1	at Panther Creek (BS)
	159.00	733.8	733.8	0.58	10.93	0	1	USGS Gage 03378900 at Louisville/STP
	157.90	750.6	750.6	0.58	10.93	2	1	Louisville STP
	155.30	748.3	748.3	0.58	10.93	6	1	Flora Water Supply Intake
	153.30	747.8	747.8	0.57	10.94	0	1	Road@Sec. 5 3N 7E
	145.91	751.6	751.6	0.57	10.95	0	1	
	145.90	751.6	780.3	0.56	10.97	1	1	at Buck Creek (BR)
	141.30	782.4	782.4	0.56	10.97	3	1	Clay City PWS Intake
	138.01	783.9	783.9	0.56	10.97	0	1	
	138.00	783.9	791.2	0.56	10.98	1	1	at Clay City trib. (BQ)
	128.81	802.9	802.9	0.56	10.99	6	1	Upstream of Big Muddy Creek
	128.80	802.9	1113.9	0.52	11.17	1	1	at Big Muddy Creek (BP)
	128.50	1114.2	1114.2	0.52	11.17	6	1	USGS Gage 03379500 at Clay City
	122.11	1125.4	1125.4	0.52	11.18	0	1	
	122.10	1125.4	1140.0	0.52	11.19	1	1	at Hog Run Creek (BO)
	118.30	1150.9	1150.9	0.52	11.20	0	1	Road@Sec. 20 2N 9E
	112.61	1156.5	1156.5	0.52	11.21	0	1	
	112.60	1156.5	1168.9	0.52	11.22	1	1	at North Mount Erie trib. (BN)
	106.81	1177.9	1177.9	0.52	11.22	0	1	
	106.80	1177.9	1382.9	0.52	11.33	2	1	at Fox River (BM)
	104.51	1391.5	1391.5	0.52	11.34	0	1	
	104.50	1391.5	1429.3	0.52	11.36	1	1	at Sugar Creek (BL7)
	100.10	1438.7	1438.7	0.52	11.37	0	1	
	96.50	1442.7	1442.7	0.52	11.37	0	1	
	92.21	1452.8	1452.8	0.53	11.38	0	1	
	92.20	1452.8	1470.9	0.53	11.39	1	1	at Westside Diversion Ditch (BK3)
	89.31	1474.8	1474.8	0.53	11.39	0	1	
	89.30	1474.8	1507.1	0.53	11.42	1	1	at Village Creek (BK)
	83.81	1513.6	1513.6	0.53	11.42	0	1	
	83.80	1513.6	1791.3	0.51	11.51	2	1	at Elm River Drainage Ditch (BJ)
	81.70	1800.9	1800.9	0.51	11.52	6	1	Fairfield PWS Intake
	80.00	1808.1	1808.1	0.51	11.52	0	1	USGS Gage 03380030 at Golden Gate
	76.31	1815.8	1815.8	0.51	11.53	0	1	
	76.30	1815.8	1835.3	0.51	11.54	1	1	at Briar Branch (BI4)
	73.71	1845.4	1845.4	0.52	11.54	0	1	
	73.70	1845.4	1884.4	0.52	11.57	2	1	at Pond Creek (BI)
	73.41	1884.5	1884.5	0.52	11.57	0	1	
	73.40	1884.5	1935.2	0.52	11.60	1	1	at Little Pond Creek (BH9)
	70.40	1940.9	1940.9	0.53	11.60	0	1	
	65.11	1949.6	1949.6	0.53	11.61	0	1	
	65.10	1949.6	1986.5	0.53	11.63	1	1	at Big Creek (BH)
	57.90	1958.8	1958.8	0.52	11.61	0	1	White-Edwards County Line
	56.50	1965.8	1965.8	0.53	11.61	0	1	Hwy 64
	52.90	1978.8	1978.8	0.53	11.62	0	1	Hanks Ferry Bridge
	49.71	1980.9	1980.9	0.53	11.62	0	1	
	49.70	1980.9	1994.8	0.54	11.64	2	1	at Elliot Creek (BF)
	47.80	1997.0	1997.0	0.54	11.64	0	1	
	45.01	2007.3	2007.3	0.54	11.64	0	1	
	45.00	2007.3	2025.5	0.55	11.66	1	1	at Randolf Drainage Ditch (BE6)

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Little Wabash	41.80	2009.2	2009.2	0.54	11.64	0	1	
River	38.81	2015.9	2015.9	0.54	11.65	6	1	upstream of Skillet Fork
(B)	38.80	2015.9	3074.6	0.58	11.84	6	1	at Skillet Fork (BE)
	35.60	3081.8	3081.8	0.58	11.85	0	1	Lowe Bridge
	33.80	3089.4	3089.4	0.59	11.85	2	1	Route 1-Carmi WWTP
	30.50	3105.1	3105.1	0.59	11.86	6	1	USGS Gage 03381500
	28.21	3111.7	3111.7	0.60	11.86	0	1	
	28.20	3111.7	3115.0	0.60	11.86	1	1	at Flanders Creek (BC7)
	25.11	3119.1	3119.1	0.60	11.86	0	1	
	25.10	3119.1	3126.8	0.60	11.87	1	1	at Grindstone Creek (BC4)
	21.81	3137.7	3137.7	0.60	11.87	0	1	
	21.80	3137.7	3156.9	0.60	11.88	1	1	at Lick Creek (BC)
	12.80	3172.5	3172.5	0.61	11.89	0	1	above unnamed trib. NW 29 6S 10E
	9.80	3180.0	3180.0	0.62	11.90	0	1	Road@Sec. 32 6S 10E
	5.60	3184.0	3184.0	0.62	11.90	0	1	above The Bayou
	2.91	3188.8	3188.8	0.63	11.90	0	1	
	2.90	3188.8	3204.1	0.63	11.91	1	1	Emma Ditch (BA2)
	0.00	3206.1	3206.1	0.64	11.91	0	1	Mouth near New Haven
Emma Ditch	12.40	0.0	0.0	2.59	13.90	0	1	
(BA2)	6.80	5.1	5.1	2.59	13.90	0	1	Road@Sec. 27 6S 15W
	3.50	11.2	11.2	2.59	13.90	0	1	Route 141
	0.00	15.3	15.3	2.59	13.90	0	1	
Lick Creek	10.10	0.0	0.0	0.90	13.50	0	1	Topograpahic Divide
(BC)	7.80	3.0	3.0	0.90	13.50	0	1	Penn Central RR
	5.00	11.1	11.1	0.90	13.50	0	1	Road@Sec. 17 6S 9E
	0.00	19.2	19.2	0.90	13.50	0	1	
Grindstone Creek	4.60	0.0	0.0	1.40	13.50	0	1	
(BC4)	2.00	3.4	3.4	1.40	13.50	0	1	Road@Sec. 5 6S 9E
	0.00	7.7	7.7	1.40	13.50	0	1	
Flanders Creek	2.80	0.0	0.0	1.50	13.40	0	1	
(BC7)	1.20	1.0	1.0	1.50	13.40	0	1	Penn Central RR
	0.00	3.2	3.2	1.50	13.40	0	1	
Skillet Fork	102.20	0.0	0.0	0.29	11.20	0	1	Topographic Divide
(BE)	99.00	5.4	5.4	0.29	11.20	0	1	Road@Sec. 25 4N 4E
	94.71	13.0	13.0	0.29	11.20	0	1	
	94.70	13.0	35.4	0.26	11.26	1	1	Sutton Creek (BEX)
	89.61	40.8	40.8	0.29	11.27	0	1	
	89.60	40.8	68.4	0.27	11.24	1	1	Lost Fork (BEW)
	84.41	79.6	79.6	0.29	11.25	0	1	
	84.40	79.6	93.8	0.30	11.27	1	1	Conners Branch (BEV2)
	83.51	94.2	94.2	0.31	11.27	0	1	
	83.50	94.2	146.1	0.40	11.28	1	1	Dums Creek (BEV)
	81.20	150.9	150.9	0.41	11.29	0	1	Road@Sec. 22 2N 4E
	77.21	158.1	158.1	0.41	11.30	0	1	
	77.20	158.1	177.6	0.41	11.31	1	1	Fulton Creek (BEU)
	73.41	184.9	184.9	0.43	11.32	0	1	
	73.40	184.9	203.7	0.41	11.35	1	1	Nickolson Creek (BET)
	70.30	207.2	207.2	0.42	11.35	0	1	USGS Gage 03380350 near Iuka
	69.71	207.5	207.5	0.42	11.35	0	1	
	69.70	207.5	217.7	0.42	11.37	1	1	Poplar Creek (BES2)
	69.11	218.2	218.2	0.42	11.37	0	1	
	69.10	218.2	236.0	0.43	11.39	1	1	Paintrock Creek (BES)
	65.40	245.0	245.0	0.43	11.40	0	1	Illinois Central Gulf RR
	57.00	252.7	252.7	0.44	11.41	0	1	above Turner Creek

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Skillet Fork	56.91	261.9	261.9	0.45	11.42	0	1	
(BE)	56.90	261.9	314.6	0.45	11.50	1	1	Brush Creek (BEP)
	54.81	316.5	316.5	0.46	11.51	0	1	
	54.80	316.5	325.1	0.46	11.52	1	1	Paddy Creek (BEO6)
	50.80	333.0	333.0	0.46	11.53	0	1	Road@Sec. 26 1S 5E
	47.50	342.7	342.7	0.47	11.55	0	1	Road@Sec. 2 2S 5E
	44.71	347.7	347.7	0.47	11.56	0	1	
	44.70	347.7	451.1	0.49	11.64	1	1	Horse Creek (BEN)
	42.50	455.4	455.4	0.49	11.65	3	1	Wayne City PWS Intake
	42.40	455.4	455.4	0.49	11.65	6	1	USGS Gage 03380500 Wayne City
	40.90	464.6	464.6	0.49	11.66	1	1	Southern RR
	38.50	474.4	474.4	0.49	11.67	1	1	Road@Sec. 20 2S 6E
	37.01	475.3	475.3	0.49	11.67	0	1	
	37.00	475.3	478.4	0.50	11.67	2	1	at Skillet Fork trib. (BEM)
	35.61	481.2	481.2	0.50	11.68	0	1	
	35.60	481.2	516.3	0.50	11.72	1	1	Fourmile Creek (BEL)
	29.51	517.8	517.8	0.51	11.72	0	1	
	29.50	517.8	587.0	0.50	11.78	1	1	Dry Fork (BEK)
	28.51	587.8	587.8	0.50	11.78	0	1	
	28.50	587.8	599.0	0.50	11.79	1	1	Livergood Creek (BEJ)
	23.71	604.5	604.5	0.51	11.80	0	1	
	23.70	604.5	625.1	0.52	11.83	1	1	Skillet Fork Lagoon (BEI)
	21.51	627.2	627.2	0.52	11.83	0	1	
	21.50	627.2	653.6	0.54	11.86	1	1	Big Mound Drainage Ditch (BEH)
	21.01	654.3	654.3	0.54	11.86	0	1	
	21.00	654.3	668.4	0.54	11.88	1	1	Haw Creek (BEG8)
	20.51	670.7	670.7	0.54	11.88	0	1	
	20.50	670.7	687.4	0.54	11.90	1	1	Watson Creek (BEG6)
	19.01	692.8	692.8	0.55	11.91	0	1	
	19.00	692.8	872.0	0.53	12.04	1	1	Main Outlet (BEG)
	16.61	879.1	879.1	0.53	12.04	0	1	
	16.60	879.1	908.8	0.53	12.07	1	1	Southern Outlet (BEF)
	15.51	909.8	909.8	0.53	12.07	0	1	
	15.50	909.8	923.4	0.54	12.08	1	1	Prarie Creek (BEE8)
	14.11	925.8	925.8	0.54	12.08	0	1	
	14.10	925.8	951.1	0.54	12.11	1	1	Beaver Creek (BEE)
	13.11	952.1	952.1	0.54	12.11	0	1	
	13.10	952.1	952.1	0.54	12.11	1	1	Lost Creek (BED)
	7.61	992.9	992.9	0.61	12.15	0	1	
	7.60	1040.3	1040.3	0.63	12.20	1	1	Seven Mile Creek (BEC)
	7.60	1040.3	1040.3	0.63	12.20	1	1	Limekiln Creek (BEB)
	4.50	1047.9	1047.9	0.64	12.20	0	1	above Wilson Creek
	3.40	1055.0	1055.0	0.65	12.21	0	1	Winter Bridge
	0.00	1058.7	1058.7	0.65	12.21	6	1	Mouth near Carmi
Limekiln Creek	6.10	0.0	0.0	1.60	13.00	0	1	Topographic Divide
(BEB)	3.60	6.7	6.7	1.60	13.00	0	1	Road@Sec. 8 4S 9E
	0.00	12.3	12.3	1.60	13.00	0	1	
Seven Mile Creek	17.00	0.0	0.0	1.18	13.20	0	1	Topographic Divide
(BEC)	10.80	5.1	5.1	1.18	13.20	0	1	Route 14
	10.70	15.0	15.0	1.18	13.20	0	1	Road@Sec. 13 5S 9E
	9.10	23.4	23.4	1.18	13.20	0	1	Road@Sec. 18 5S 9E
	7.20	27.9	27.9	1.18	13.20	0	1	Road@Sec. 6 5S 9E
	0.00	35.1	35.1	1.18	13.20	0	1	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Lost Creek	12.00	0.0	0.0	0.72	13.10	0	1	Topographic Divide
(BED)	7.30	8.7	8.7	0.72	13.10	0	1	White-Hamilton County Line
	5.90	14.6	14.6	0.72	13.10	0	1	Baltimore and Ohio RR
	4.31	17.2	17.2	0.72	13.10	0	1	
	4.30	17.2	20.6	0.72	13.10	1	1	at Lost Creek trib. (BEDJ)
	3.30	22.2	22.2	0.72	13.10	0	1	Road@Sec. 28 4S 8E
	0.00	31.0	31.0	0.72	13.10	0	1	
Lost Creek	3.30	0.0	0.0	0.72	13.10	0	1	
Tributary	2.00	0.8	0.8	0.72	13.10	2	1	Enfield East STP
(BEDJ)	0.00	3.4	3.4	0.72	13.10	0	1	
Beaver Creek	9.80	0.0	0.0	0.40	12.90	0	1	Topographic Divide
(BEE)	4.31	6.8	6.8	0.40	12.90	0	1	
	4.30	6.8	17.6	0.47	12.90	1	1	South Fork Beaver Creek (BEEL)
	0.00	25.4	25.4	0.67	12.90	0	1	
South Fork	7.00	0.0	0.0	0.52	12.90	0	1	Topographic Divide
Beaver Creek	4.20	6.3	6.3	0.52	12.90	0	1	Road@Sec. 35 4S 7E
(BEEL)	0.00	10.9	10.9	0.52	12.90	0	1	
Prairie Creek	7.40	0.0	0.0	1.01	12.90	0	1	Topographic Divide
(BEE8)	4.00	5.6	5.6	1.01	12.90	0	1	Road@Sec. 36 4S 8E
	0.00	13.5	13.5	1.01	12.90	0	1	
Southern Outlet	11.00	0.0	0.0	0.51	12.80	0	1	Topographic Divide
(BEF)	7.40	9.5	9.5	0.51	12.80	0	1	Road@Sec. 8 4S 7E
	3.90	20.1	20.1	0.51	12.80	0	1	Road@Sec. 2 4S 7E
	0.00	29.9	29.9	0.51	12.80	0	1	
Main Outlet	19.30	0.0	0.0	0.50	12.70	0	1	Topographic Divide
(BEG)	17.20	5.9	5.9	0.50	12.70	0	1	Road@Sec. 21 4S 5E
	14.60	11.9	11.9	0.50	12.70	0	1	Road@Sec. 23 4S 5E
	13.60	17.2	17.2	0.50	12.70	0	1	Louisville and Nashville RR
	12.50	25.2	25.2	0.50	12.70	0	1	Road@Sec. 24 4S 5E
	10.81	28.3	28.3	0.50	12.70	0	1	
	10.80	28.3	40.0	0.49	12.73	1	1	at Opposum Creek (BEGT)
	10.70	52.7	52.7	0.50	12.72	0	1	Route 142
	9.70	57.2	57.2	0.50	12.72	0	1	Road@Sec.114S 8E
	5.31	74.0	74.0	0.50	12.72	0	1	
	5.30	74.0	175.1	0.44	12.54	1	1	at Auxier Creek Drain (BEGJ)
	0.00	179.2	179.2	0.44	12.55	0	1	
Auxier Creek	28.90	0.0	0.0	0.26	12.30	0	1	Topographic Divide
Drain	23.70	7.0	7.0	0.26	12.30	0	1	Road@Sec. 15 3S 4E
(BEGJ)	23.00	14.6	14.6	0.26	12.30	0	1	Road@Sec. 22 3S 5E
	21.80	18.6	18.6	0.26	12.30	0	1	Illinois Central Gulf RR
	17.11	26.6	26.6	0.26	12.30	0	1	
	17.10	26.6	46.8	0.26	12.34	1	1	at Rocky Branch (BEGJP)
	13.50	54.1	54.1	0.29	12.35	0	1	Road@Sec. 21 3S 5E
	10.40	61.8	61.8	0.31	12.36	0	1	Road@Sec. 14 3S 5E
	8.60	65.5	65.5	0.32	12.36	0	1	Hamilton-Wayne County Line
	5.31	68.6	68.6	0.33	12.36	0	1	
	5.30	68.6	88.0	0.36	12.39	1	1	at Shelton Creek (BEGJF)
	4.20	96.2	96.2	0.38	12.41	0	1	Road@Sec. 26 3S 6E
	0.00	101.2	101.2	0.39	12.42	0	1	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Kennedy-Voris	9.90	0.0	0.0	0.48	12.50	0	1	Topographic Divide
Main Drain	9.80	0.5	0.5	0.48	12.50	2	1	Dahlgren STP
(BEGJF)	6.40	5.8	5.8	0.48	12.50	0	1	Road@Sec. 27 3S 5E
	4.20	10.0	10.0	0.48	12.50	0	1	Road@Sec. 25 3S 5E
	0.00	19.4	19.4	0.48	12.50	0	1	
Rock Branch	8.40	0.0	0.0	0.26	12.40	0	1	Topographic Divide
(BEGJP)	8.20	3.8	3.8	0.26	12.40	2	1	Dahlgren STP
	3.70	4.4	4.4	0.26	12.40	0	1	Road@Sec. 1 4S 4E
	1.80	17.3	17.3	0.26	12.40	0	1	Louisville and Nashville RR
	0.00	20.2	20.2	0.26	12.40	0	1	
Opossum Creek	7.30	0.0	0.0	0.56	12.80	0	1	Topographic Divide
(BEGT)	2.20	6.7	6.7	0.56	12.80	0	1	Louisville and Nashville RR
	0.00	11.8	11.8	0.56	12.80	0	1	
Watson Creek	7.40	0.0	0.0	0.64	12.70	0	1	Topographic Divide
(BEG6)	1.90	7.9	7.9	0.64	12.70	0	1	above Boyd Creek
	0.00	16.7	16.7	0.64	12.70	0	1	
Haw Creek	8.50	0.0	0.0	0.42	12.70	0	1	Topographic Divide
(BEG8)	4.80	5.3	5.3	0.42	12.70	0	1	Road@Sec. 28 3S 7E
	0.00	14.1	14.1	0.42	12.70	0	1	
Big Mound	12.10	0.0	0.0	0.95	12.50	0	1	Topographic Divide
Drainage Ditch	6.60	7.0	7.0	0.95	12.50	0	1	Road@Sec. 22 2S 7E
(BEH)	5.90	15.1	15.1	0.95	12.50	0	1	Road@Sec. 22 2S 7E
	3.80	24.6	24.6	0.95	12.50	0	1	Road@Sec. 34 2S 7E
	0.00	26.4	26.4	0.95	12.50	0	1	
Skillet Fork	16.00	0.0	0.0	0.84	12.60	0	1	Topographic Divide
Lagoon	13.20	5.1	5.1	0.84	12.60	0	1	Road@Sec. 23 3S 6E
(BEI)	6.40	15.4	15.4	0.84	12.60	0	1	Hwy 64
	0.00	20.6	20.6	0.84	12.60	0	1	
Livergood Creek	6.60	0.0	0.0	0.39	12.50	0	1	Topographic Divide
(BEJ)	3.80	3.9	3.9	0.39	12.50	0	1	Southern RR
	0.00	11.2	11.2	0.39	12.50	0	1	
Dry Fork	24.50	0.0	0.0	0.43	12.10	0	1	Topogaphic Divide
(BEK)	22.10	62.0	6.2	0.43	12.10	0	1	Road@Sec. 14 1N 6E
	18.50	12.1	12.1	0.43	12.10	0	1	Road@Sec. 26 1N 6E
	16.80	17.2	17.2	0.43	12.10	0	1	Road@Sec. 2 1N 6E
	11.91	24.3	24.3	0.43	12.10	0	1	
	11.90	24.3	38.4	0.41	12.10	1	1	at Little Dry Fork (BEKN)
	9.20	48.9	48.9	0.44	12.14	0	1	Road@Sec. 35 1S 6E
	6.80	55.3	55.3	0.46	12.16	0	1	above Walton Creek
	6.20	62.0	62.0	0.47	12.18	0	1	Route 15
	0.00	69.2	69.2	0.48	12.19	0	1	
Little Dry Fork	10.60	0.0	0.0	0.37	12.10	0	1	Topographic Divide
(BEKN)	4.80	5.8	5.8	0.37	12.10	0	1	Road@Sec. 17 1S 6E
	0.00	14.1	14.1	0.37	12.10	0	1	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Fourmile Creek	18.80	0.0	0.0	0.62	12.30	0	1	Topographic Divide
(BEL)	13.10	7.5	7.5	0.62	12.30	0	1	Jefferson-Wayne County Line
	9.80	18.1	18.1	0.62	12.30	0	1	Road@Sec. 27 2S 5E
	3.80	25.8	25.8	0.62	12.30	0	1	Route 142
	0.00	35.2	35.2	0.62	12.30	0	1	
Skillet Fork	3.60	0.0	0.0	0.50	11.67	0	1	
Tributary	2.60	0.8	0.8	0.50	11.67	2	1	Wayne City South STP
(BEM)	0.00	3.1	3.1	0.50	11.67	0	1	
Horse Creek	30.60	0.0	0.0	0.50	11.70	0	1	Topographic Divide
(BEN)	29.60	1.0	1.0	0.50	11.70	0	1	Road@Sec. 21 1N 3E
	25.80	9.6	9.6	0.50	11.70	0	1	Road@Sec. 35 1N 3E
	22.50	14.7	14.7	0.50	11.70	0	1	above Panther Creek
	19.60	25.2	25.2	0.50	11.70	0	1	Road@Sec. 8 2S 4E
	17.10	29.3	29.3	0.50	11.70	0	1	
	17.00	29.3	39.4	0.50	11.73	1	1	at Coal Bank Creek (BENO)
	11.60	52.4	52.4	0.51	11.79	0	1	
	7.21	60.4	60.4	0.52	11.82	0	1	
	7.20	60.4	93.4	0.53	11.90	1	1	at Puncheon Creek (BENG)
	5.20	100.4	100.4	0.53	11.92	4	1	USGS Gage 03380475 near Keenes
	0.00	103.5	103.5	0.54	11.93	0	1	mouth near Wayne City
Puncheon Creek	12.50	0.0	0.0	0.51	12.10	0	1	Topoographic Divide
(BENG)	6.91	8.5	8.5	0.51	12.10	0	1	
	6.90	8.5	12.3	0.46	12.10	1	1	at White Feather Creek (BENGO)
	4.31	12.9	12.9	0.51	12.07	0	1	
	4.30	12.9	19.6	0.51	12.07	1	1	Bear Creek (BENGD)
	3.40	25.7	25.7	0.54	12.05	0	1	Illinois Central Gulf RR
	0.00	33.0	33.0	0.56	12.04	0	1	
Bear Creek	1.80	0.0	0.0	0.51	12.07	0	1	
(BENGD)	5.00	3.3	3.3	0.51	12.07	2	1	Bluford STP
	0.00	6.7	6.7	0.51	12.07	0	1	
White Feather	3.40	0.0	0.0	0.34	12.10	0	1	Topographic Divide
Creek	2.50	3.7	3.7	0.34	12.10	0	1	Route 15
(BENGO)	0.00	3.9	3.9	0.34	12.10	0	1	
Coal Bank	4.80	0.0	0.0	0.49	11.80	0	1	Topographic Divide
Creek	1.60	5.2	5.2	0.49	11.80	0	1	Road@Sec. 19 1S 4E
(BENO)	0.00	10.1	10.1	0.49	11.80	0	1	
Paddy Creek	7.00	0.0	0.0	0.59	12.00	0	1	Topographic Divide
(BEO6)	5.10	3.2	3.2	0.59	12.00	0	1	Wayne-Jefferson County Line
	0.00	8.6	8.6	0.59	12.00	0	1	
Brush Creek	22.00	0.0	0.0	0.49	11.90	0	1	Topographic Divide
(BEP)	15.40	8.1	8.1	0.49	11.90	0	1	Wayne-Clay County Line
	13.10	13.7	13.7	0.49	11.90	0	1	Road@Sec. 36 2N 5E
	10.10	20.2	20.2	0.49	11.90	0	1	above Gum Branch
	9.10	24.9	24.9	0.49	11.90	0	1	above Rattlesnake Branch
	8.50	28.2	28.2	0.49	11.90	0	1	above Boh Branch
	7.80	36.8	36.8	0.49	11.90	0	1	Road@Sec. 14 1N 5E
	2.50	42.5	42.5	0.49	11.90	0	1	above Johnson Creek
	1.30	48.9	48.9	0.49	11.90	0	1	Marion-Wayne County Line
	0.00	52.7	52.7	0.49	11.90	0	1	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Paintrock Creek	10.40	0.0	0.0	0.46	11.70	0	1	Topographic Divide
(BES)	6.80	4.8	4.8	0.46	11.70	0	1	Road@Sec. 18 7N 4E
	4.50	10.4	10.4	0.46	11.70	0	1	above Brewer Branch
	0.00	17.9	17.9	0.46	11.70	0	1	
Poplar Creek	8.40	0.0	0.0	0.42	11.70	0	1	Topographic Divide
(BES2)	2.90	6.7	6.7	0.42	11.70	0	1	Marion-Wayne County Line
	0.00	10.3	10.3	0.42	11.70	0	1	
Nickolson Creek	12.60	0.0	0.0	0.31	11.60	0	1	Topographic Divide
(BET)	11.20	1.7	1.7	0.31	11.60	2	1	Xenia STP
	7.50	7.7	7.7	0.31	11.60	0	1	Wayne-Clay County Line
	3.10	14.1	14.1	0.31	11.60	0	1	Illinois Central RR
	0.00	18.8	18.8	0.31	11.60	0	1	
Fulton Creek	8.50	0.0	0.0	0.43	11.40	0	1	Topographic Divide
(BEU)	4.90	4.6	4.6	0.43	11.40	0	1	above Old Camp Creek
	2.20	13.9	13.9	0.43	11.40	0	1	Road@Sec. 32 2N 4E
	0.00	19.5	19.5	0.43	11.40	0	1	
Dums Creek	26.90	0.0	0.0	0.58	11.30	0	1	Topographic Divide
(BEV)	19.00	10.6	10.6	0.58	11.30	0	1	Road@Sec. 23 3N 3E
	14.20	17.5	17.5	0.58	11.30	0	1	Road@Sec. 3 2N 3E
	10.50	22.5	22.5	0.58	11.30	0	1	Route 50
	6.10	28.5	28.5	0.58	11.30	0	1	above Bee Branch
	5.90	38.5	38.5	0.58	11.30	0	1	Road@Sec. 32 3N 4E
	0.60	47.2	47.2	0.58	11.30	0	1	Route 50
	0.00	51.9	51.9	0.58	11.30	0	1	
Conners Branch	10.30	0.0	0.0	0.38	11.40	0	1	Topographic Divide
(BEV2)	4.80	6.7	6.7	0.38	11.40	0	1	Road@Sec. 30 3N 5E
	0.00	14.1	14.1	0.38	11.40	0	1	
Lost Fork	11.40	0.0	0.0	0.24	11.20	0	1	Topographic Divide
(BEW)	7.40	5.0	5.0	0.24	11.20	0	1	Road@Sec. 29 4N 4E
	5.40	13.3	13.3	0.24	11.20	0	1	above Rocky Branch
	3.40	21.3	21.3	0.24	11.20	0	1	Forbes Lake Dam
	0.00	27.7	27.7	0.24	11.20	0	1	
Sutton Creek	7.60	0.0	0.0	0.25	11.30	0	1	Topographic Divide
(BEX)	4.60	2.8	2.8	0.25	11.30	0	1	Road@Sec. 28 4N 5E
	3.50	11.2	11.2	0.25	11.30	0	1	Road@Sec. 32 4N 5E
	0.70	13.5	13.5	0.25	11.30	0	1	above Pickle Creek
	0.00	22.4	22.4	0.25	11.30	0	1	
Randolf Drainage	7.60	0.0	0.0	1.41	13.00	0	1	Topographic Divide
Ditch	5.50	6.6	6.6	1.41	13.00	0	1	I-64
(BE6)	3.40	11.3	11.3	1.41	13.00	0	1	Road@Sec. 4S 10E
	0.00	18.2	18.2	1.41	13.00	0	1	
Elliot Creek	6.70	0.0	0.0	1.32	13.20	0	1	Topographic Divide
(BF)	3.80	4.2	4.2	1.32	13.20	2	1	Crossville STP
	3.60	5.1	5.1	1.32	13.20	0	1	Road@Sec. 15 4S 10E
	0.00	13.9	13.9	1.32	13.20	0	1	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Big Creek	11.80	0.0	0.0	0.75	12.70	0	1	Topographic Divide
(BH)	6.51	7.0	7.0	0.75	12.70	0	1	
	6.50	7.0	16.7	0.66	12.70	2	1	at Butter Creek (BHO)
	5.31	19.2	19.2	0.67	12.70	0	1	
	5.30	19.2	28.9	0.72	12.73	1	1	at Harper Creek (BHM)
	0.00	36.9	36.9	0.79	12.75	0	1	
Harper Creek	4.60	0.0	0.0	0.83	12.80	0	1	Topographic Divide
(BHM)	2.50	3.2	3.2	0.83	12.80	0	1	Road@Sec. 27 2S 10E
	0.00	9.7	9.7	0.83	12.80	0	1	
Butter Creek	4.90	0.0	0.0	0.60	12.70	0	1	Topographic Divide
(BHO)	2.60	2.5	2.5	0.60	12.70	0	1	Road@Sec. 15 2S 10E
	2.51	3.8	3.8	0.60	12.70	0	1	
	2.50	3.8	7.2	0.60	12.70	2	1	at Butter Creek trib. (BHON)
	0.00	9.7	9.7	0.60	12.70	0	1	
Butter Creek	3.80	0.0	0.0	0.60	12.70	0	1	
Tributary	2.80	0.6	0.6	0.60	12.70	2	1	Albion STP
(BHON)	0.00	3.4	3.4	0.60	12.70	0	1	
Little Pond Creek	9.70	0.0	0.0	0.64	12.80	0	1	Topographic Divide
(BH9)	5.60	5.8	5.8	0.64	12.80	0	1	above Freds Creek
	4.60	10.5	10.5	0.64	12.80	0	1	Road@Sec. 8 3S 9E
	0.00	14.7	14.7	0.64	12.80	0	1	
Pond Creek	12.00	0.0	0.0	0.70	12.60	0	1	Topographic Divide
(BI)	7.10	5.9	5.9	0.70	12.60	0	1	
	7.00	5.9	13.5	0.70	12.60	2	1	at Pond Creek trib. (BIP)
	5.80	17.4	17.4	0.70	12.60	0	1	Road@Sec. 23 2N 8E
	3.90	27.6	27.6	0.70	12.60	0	1	Road@Sec. 25 2N 8E
	0.00	38.9	38.9	0.70	12.60	0	1	
Pond Creek	5.00	0.0	0.0	0.70	12.60	0	1	
Tributary	2.70	2.8	2.8	0.70	12.60	2	1	Fairfield STP
(BIP)	0.00	7.6	7.6	0.70	12.60	0	1	
Briar Branch	9.40	0.0	0.0	0.67	12.60	0	1	Topographic Divide
(BI4)	6.50	7.1	7.1	0.67	12.60	0	1	Wayne-Edwards County Line
	2.80	13.9	13.9	0.67	12.60	0	1	Southern RR
	0.00	19.5	19.5	0.67	12.60	0	1	
Elm River	11.10	0.0	0.0	0.48	12.30	0	1	Topographic Divide
Drainage Ditch	6.60	6.6	6.6	0.48	12.30	0	1	above Emmons Creek
(BJ)	5.90	14.9	14.9	0.48	12.30	0	1	Road@Sec. 2 1S 8E
	4.31	17.4	17.4	0.48	12.30	0	1	
	4.30	17.4	254.6	0.36	11.96	2	1	at Deer Creek Drainage Ditch (BJK)
	3.30	259.8	259.8	0.36	11.96	0	1	above Lick Creek Lateral
	2.90	263.8	263.8	0.37	11.97	0	1	above Bail Creek
	1.70	275.8	275.8	0.37	11.99	0	1	Road@Sec. 29 1S 9E
	0.00	277.8	277.8	0.37	11.99	0	1	mouth near Golden Gate

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Deer Creek	39.50	0.0	0.0	0.22	11.70	0	1	Topographic Divide
Drainage Ditch	36.10	9.7	9.7	0.22	11.70	0	1	Baltimore and Ohio RR
(BJK)	29.50	17.2	17.2	0.22	11.70	0	1	Road@Sec. 34 3N 7E
	26.80	25.5	25.5	0.22	11.70	0	1	Road@Sec. 3 2N 7E
	25.01	30.3	30.3	0.22	11.70	0	1	
	25.00	30.3	39.6	0.25	11.70	2	1	at Seminary Creek (BJKQ)
	23.41	40.9	40.9	0.27	11.70	0	1	
	23.40	40.9	114.1	0.33	11.71	1	1	at Raccoon Creek (BJKP)
	19.50	119.1	119.1	0.33	11.72	0	1	above Sycamore Creek
	17.90	126.9	126.9	0.33	11.73	0	1	Road@Sec. 25 2N 7E
	15.80	135.7	135.7	0.33	11.74	0	1	Road@Sec. 6 1N 7E
	12.81	139.9	139.9	0.34	11.74	0	1	
	12.80	139.9	158.0	0.33	11.77	1	1	at Endsley Creek (BJKI)
	10.30	161.9	161.9	0.32	11.78	0	1	Road@Sec. 8 1N 8E
	8.10	172.3	172.3	0.32	11.81	0	1	Road@Sec. 21 1N 8E
	2.91	177.4	177.4	0.32	11.82	0	1	
	2.90	177.4	233.6	0.34	11.92	1	1	at Deer Creek (BJKC)
	0.00	237.2	237.2	0.35	11.93	0	1	
Deer Creek	14.60	0.0	0.0	0.48	12.20	0	1	Topographic Divide
(BJKC)	10.80	4.7	4.7	0.48	12.20	2	1	Cisne STP
	8.80	8.8	8.8	0.48	12.20	0	1	above South Fork
	7.50	15.5	15.5	0.48	12.20	0	1	Route 45
	4.70	22.1	22.1	0.48	12.20	0	1	Road@Sec. 31 1N 8E
	0.71	25.8	25.8	0.48	12.20	0	1	
	0.70	25.8	55.8	0.40	12.25	1	1	at Little Elm Lateral (BJKCB)
	0.00	56.2	56.2	0.40	12.25	0	1	
Martin Creek	12.40	0.0	0.0	0.33	12.30	0	1	Topographic Divide
(BJKCB)	7.70	7.3	7.3	0.33	12.30	0	1	Route 45
	4.50	12.0	12.0	0.33	12.30	0	1	Road@Sec. 12 1S 7E
	2.20	22.3	22.3	0.33	12.30	0	1	Road@Sec. 5 1S 8E
	0.00	30.0	30.0	0.33	12.30	0	1	
Endslay Creek	9.80	0.0	0.0	0.25	12.00	0	1	Topographic Divide
(BJKI)	6.10	3.8	3.8	0.25	12.00	0	1	Route 45
	2.10	10.7	10.7	0.25	12.00	0	1	Road@Sec. 1 1N 7E
	0.00	18.1	18.1	0.25	12.00	0	1	
Raccoon Creek	23.10	0.0	0.0	0.39	11.60	0	1	Topographic Divide
(BJKP)	19.60	6.7	6.7	0.39	11.60	0	1	Road@Sec. 18 3N 6E
	16.90	14.8	14.8	0.39	11.60	0	1	Road@Sec. 30 3N 6E
	13.50	23.6	23.6	0.39	11.60	0	1	Baltimore and Ohio RR
	5.71	34.3	34.3	0.39	11.60	0	1	
	5.70	34.3	59.5	0.37	11.68	1	1	at Bear Creek (BJKPG)
	2.95	62.0	62.0	0.37	11.69	0	1	above Camel Creek
	2.70	70.3	70.3	0.36	11.70	0	1	IL Route 45
	0.00	73.2	73.2	0.36	11.71	0	1	
Bear Creek	13.50	0.0	0.0	0.34	11.80	0	1	Topographic Divide
(BJKPG)	10.00	3.6	3.6	0.34	11.80	0	1	Road@Sec. 8 2N 6E
	7.20	10.1	10.1	0.34	11.80	0	1	Road@Sec. 16 2N 6E
	3.30	13.5	13.5	0.34	11.80	0	1	above Willow Branch
	2.00	23.9	23.9	0.34	11.80	0	1	Road@Sec. 24 2N 6E
	0.00	25.2	25.2	0.34	11.80	0	1	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Seminary Creek	7.70	0.0	0.0	0.34	11.70	0	1	Topographic Divide
(BJKQ)	6.00	1.8	1.8	0.34	11.70	0	1	Baltimore and Ohio RR
	5.80	2.2	2.2	0.34	11.70	2	1	Flora STP
	0.00	9.4	9.4	0.34	11.70	0	1	
Village Creek	14.30	0.0	0.0	0.58	12.60	0	1	Topographic Divide
(BK)	10.50	4.8	4.8	0.58	12.60	0	1	Road@Sec. 22 1S 10E
	9.30	11.4	11.4	0.58	12.60	0	1	Road@Sec. 21 1S 10E
	6.31	15.9	15.9	0.58	12.60	0	1	
	6.30	15.9	27.5	0.60	12.56	1	1	at West Village Creek (BKLJ)
	0.00	32.3	32.3	0.64	12.55	0	1	
West Village	7.90	0.0	0.0	0.62	12.50	0	1	Topographic Divide
Creek	4.50	5.7	5.7	0.62	12.50	0	1	Road@Sec. 3 1S 10E
(BKLJ)	0.00	11.7	11.7	0.62	12.50	0	1	
	8.20	0.0	0.0	0.63	12.40	0	1	Topographic Divide
Westside	5.90	6.0	6.0	0.63	12.40	0	1	Road@Sec. 14 1N 9E
Diversion Ditch	3.70	12.7	12.7	0.63	12.40	0	1	Road@Sec. 23 1N 9E
(BK3)	0.00	18.1	18.1	0.63	12.40	0	1	
Sugar Creek	14.20	0.0	0.0	0.58	12.30	0	1	Topographic Divide
(BL7)	9.90	9.0	9.0	0.58	12.30	0	1	Illinois Central RR
	5.11	16.0	16.0	0.58	12.30	0	1	
	5.10	16.0	27.9	0.54	12.30	1	1	at Madden Creek (BL7J)
	0.00	37.8	37.8	0.55	12.33	0	1	
Madden Creek	5.00	0.0	0.0	0.49	12.30	0	1	Topographic Divide
(BL7J)	3.30	1.6	1.6	0.49	12.30	0	1	IL Route 30
	0.00	11.9	11.9	0.49	12.30	0	1	
Fox River	45.80	0.0	0.0	0.29	11.80	0	1	Topographic Divide
(BM)	44.30	4.6	4.6	0.29	11.80	0	1	Rt 130
	40.60	9.4	9.4	0.29	11.80	0	1	Road@Sec. 5 5N 10E
	38.10	15.3	15.3	0.29	11.80	0	1	above Richland Creek
	35.70	24.9	24.9	0.29	11.80	0	1	Richland-Jasper County Line
	32.70	32.8	32.8	0.29	11.80	0	1	above Coon Creek
	30.51	44.0	44.0	0.29	11.80	0	1	
	30.50	44.0	54.7	0.34	11.82	1	1	at Long Branch (BMS)
	25.91	62.3	62.3	0.35	11.83	0	1	
	25.90	62.3	79.7	0.37	11.87	2	1	at East Fork (BMP)
	24.60	87.6	87.6	0.37	11.88	0	1	Road@Sec. 33 4N 10E
	22.10	93.8	93.8	0.37	11.89	0	1	Baltimore and Ohio RR
	18.20	97.6	97.6	0.37	11.89	2	1	Olney STP
	17.81	100.1	100.1	0.38	11.89	0	1	
	17.80	100.1	128.4	0.39	11.91	1	1	at Little Fox Creek (BML)
	15.11	131.6	131.6	0.40	11.91	0	1	
	15.10	131.6	157.1	0.43	11.91	1	1	at Sugar Creek (BMJ)
	11.11	163.6	163.6	0.43	11.91	0	1	
	11.10	163.6	174.3	0.43	11.92	1	1	at Turkey Creek (BMG)
	8.90	180.2	180.2	0.43	11.93	0	1	above Jones Ditch
	5.91	185.0	185.0	0.43	11.93	0	1	
	5.90	185.0	193.5	0.43	11.93	1	1	at Gentry Creek (BMD)
	0.00	205.0	205.0	0.44	11.95	0	1	mouth near Mount Erie
Gentry Creek	8.60	0.0	0.0	0.31	11.90	0	1	Topographic Divide
(BMD)	2.90	1.9	1.9	0.31	11.90	0	1	Road@Sec. 17 2N 10E
	0.00	8.4	8.4	0.31	11.90	0	1	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Turkey Creek	8.10	0.0	0.0	0.50	12.00	0	1	Topographic Divide
(BMG)	3.20	2.8	2.8	0.50	12.00	0	1	Road@Sec. 32 3N 10E
	0.00	10.7	10.7	0.50	12.00	0	1	
Sugar Creek	10.70	0.0	0.0	0.53	11.90	0	1	Topographic Divide
(BMJ)	7.10	4.5	4.5	0.53	11.90	0	1	Road@Sec. 35 4N 9E
	4.40	9.1	9.1	0.53	11.90	0	1	Hwy 50
	3.80	13.9	13.9	0.53	11.90	0	1	Road@Sec. 13 3N 10E
	2.50	24.1	24.1	0.53	11.90	0	1	Road@Sec. 24 3N 9E
	0.00	25.5	25.5	0.53	11.90	0	1	
Little Fox Creek	9.70	0.0	0.0	0.51	11.90	0	1	Topographic Divide
(BML)	5.00	5.8	5.8	0.51	11.90	0	1	Road@Sec. 23 3N 10E
	0.91	8.8	8.8	0.51	11.90	0	1	
	0.90	8.8	27.9	0.52	11.97	1	1	at Big Creek (BMLC)
	0.00	28.3	28.3	0.52	11.97	0	1	
Big Creek	11.80	0.0	0.0	0.53	12.00	0	1	Topographic Divide
(BMLC)	7.60	3.1	3.1	0.53	12.00	0	1	
	6.50	9.1	9.1	0.53	12.00	0	1	Road@Sec. 18 3N 11E
	3.60	15.8	15.8	0.53	12.00	2	1	Roadmaster Corp.
	0.00	19.1	19.1	0.53	12.00	0	1	
East Fork	8.30	0.0	0.0	0.45	12.00	0	1	Topographic Divide
(BMP)	4.70	4.8	4.8	0.45	12.00	0	1	Road@Sec. 24 4N 10E
	1.70	11.8	11.8	0.45	12.00	9	1	East Fork Lake
	0.00	17.4	17.4	0.45	12.00	0	1	
Long Branch	6.30	0.0	0.0	0.58	11.90	0	1	Topographic Divide
(BMS)	2.40	5.6	5.6	0.58	11.90	0	1	Illinois Central RR
	0.00	10.7	10.7	0.58	11.90	0	1	
North Mount	8.00	0.0	0.0	0.60	12.10	0	1	Topographic Divide
Erie Tributary	2.70	8.8	8.8	0.60	12.10	0	1	Road@Sec. 29 2N 9E
(BN)	0.00	12.4	12.4	0.60	12.10	0	1	
Hog Run Creek	9.70	0.0	0.0	0.47	12.00	0	1	Topographic Divide
(BO)	9.50	0.7	0.7	0.47	12.00	2	1	Noble WWTP
	4.30	7.2	7.2	0.47	12.00	0	1	above Brown Creek
	0.00	14.7	14.7	0.47	12.00	0	1	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Big Muddy Creek	50.60	0.0	0.0	0.22	11.40	0	1	Topographic Divide
(BP)	45.90	7.7	7.7	0.22	11.40	0	1	USGS Gage 03379100 at Wheeler
	44.30	11.9	11.9	0.22	11.40	0	1	Road@Sec. 28 7N 8E
	43.81	12.2	12.2	0.22	11.40	0	1	
	43.80	12.2	20.6	0.22	11.40	1	1	at Big Muddy Creek Trib (BPW)
	43.70	20.7	20.7	0.22	11.40	0	1	Road@Sec. 29 7N 8E
	39.00	28.5	28.5	0.22	11.40	0	1	Road@Sec. 9 6N 8E
	36.50	38.0	38.0	0.22	11.40	0	1	Road@Sec. 21 6N 8E
	34.00	41.8	41.8	0.22	11.40	0	1	Road@Sec. 32 6N 8E
	28.61	49.4	49.4	0.22	11.40	0	1	
	28.60	49.4	59.3	0.22	11.42	1	1	Limestone Creek (BPP)
	25.80	62.8	62.8	0.25	11.43	0	1	
	24.00	70.3	70.3	0.30	11.45	0	1	
	21.51	74.2	74.2	0.32	11.45	0	1	
	21.50	74.2	141.5	0.36	11.49	2	1	Weather Creek (BPL)
	17.81	145.3	145.3	0.37	11.50	0	1	
	17.80	145.3	177.0	0.39	11.53	1	1	East Fork Wet Weather Creek (BPJ)
	15.01	179.0	179.0	0.40	11.53	0	1	
	15.00	179.0	204.4	0.41	11.56	1	1	Hurricane Creek (BPI)
	11.71	206.0	206.0	0.41	11.56	0	1	
	11.70	206.0	226.7	0.43	11.59	1	1	Sugar Creek (BPG)
	6.20	238.2	238.2	0.43	11.60	0	1	
	0.41	243.9	243.9	0.43	11.61	0	1	
	0.40	243.9	315.4	0.40	11.63	1	1	Big Muddy Diversion Ditch (BPA)
	0.00	315.7	315.7	0.40	11.63	0	1	mouth near Clay Ditch
Big Muddy Creek	8.60	0.0	0.0	0.65	11.80	0	1	Topographic Divide
Diversion Ditch	3.30	7.6	69.8	0.29	11.70	1	1	Little Muddy Creek (BPAK)
(BPA)	0.00	71.5	71.5	0.31	11.70	0	1	
Little Muddy	30.80	0.0	0.0	0.29	11.70	0	1	Topographic Divide
Creek	26.10	5.5	5.5	0.29	11.70	0	1	Clay-Effingham County Line
(BPAK)	20.60	15.0	15.0	0.29	11.70	0	1	above Georgetown Creek
	20.40	23.2	23.2	0.29	11.70	0	1	Road@Sec. 28 5N 6E
	17.30	29.8	29.8	0.29	11.70	0	1	Road@Sec. 3 4N 7E
	15.70	34.7	34.7	0.29	11.70	0	1	Road@Sec. 11 4N 7E
	11.60	42.1	42.1	0.29	11.70	0	1	Road@Sec. 25 4N 7E
	4.40	48.3	48.3	0.29	11.70	0	1	above Flat Branch
	3.30	57.6	57.6	0.29	11.70	0	1	above Indian Creek
	2.80	62.2	62.2	0.29	11.70	0	1	Road@Sec. 6 3N 7E
	0.00	69.4	69.4	0.29	11.70	0	1	
Sugar Creek	12.20	0.0	0.0	0.57	11.80	0	1	Topographic Divide
(BPG)	8.40	6.0	6.0	0.57	11.80	0	1	above Jesse Creek
	2.40	15.3	15.3	0.57	11.80	0	1	Clay-Richland County Line
	0.00	20.7	20.7	0.57	11.80	0	1	
Hurricane Creek	17.80	0.0	0.0	0.48	11.80	0	1	Topographic Divide
(BPI)	11.10	8.0	8.0	0.48	11.80	0	1	Richland-Jasper County Line
	7.40	14.0	14.0	0.48	11.80	0	1	Road@Sec. 5 4N 9E
	3.90	19.9	19.9	0.48	11.80	0	1	Clay-Richland County Line
	0.00	25.4	25.4	0.48	11.80	0	1	
Wet Weather	17.00	0.0	0.0	0.33	11.70	0	1	Topographic Divide
Creek	10.00	6.5	6.5	0.33	11.70	0	1	Road@Sec. 20 5N 9E
(BPJ)	6.61	12.5	12.5	0.33	11.70	0	1	
	6.60	12.5	20.6	0.34	11.66	1	1	West Fork Wet Weather Creek (BPJK)
	2.40	28.7	28.7	0.45	11.67	0	1	Road@Sec. 14 4N 8E
	0.00	31.7	31.7	0.48	11.67	0	1	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
West Fork Wet	8.20	0.0	0.0	0.36	11.60	0	1	Topographic Divide
Weather Creek	4.20	2.5	2.5	0.36	11.60	0	1	Road@Sec. 7 5N 9E
(BPJK)	0.00	8.1	8.1	0.36	11.60	0	1	
Weather Creek	26.40	0.0	0.0	0.28	11.50	0	1	Topographic Divide
(BPL)	20.60	6.7	6.7	0.28	11.50	0	1	Road@Sec. 5 6N 9E
	16.90	16.9	16.9	0.28	11.50	0	1	above Long Branch
	9.81	28.7	28.7	0.28	11.50	0	1	
	9.80	28.7	45.0	0.29	11.50	1	1	at Sandy Creek (BPLK)/Newton Lake
	9.60	48.0	48.0	0.31	11.51	9	1	Newton Lake Dam
	6.00	49.1	49.1	0.32	11.51	0	1	above Wolf Creek
	5.90	58.9	58.9	0.37	11.52	0	1	Clay-Jasper County Line
	0.00	67.3	67.3	0.40	11.53	0	1	
Sandy Creek	11.30	0.0	0.0	0.31	11.50	0	1	Topographic Divide
(BPLK)	6.10	9.4	9.4	0.31	11.50	0	1	Road@Sec. 15 6N 8E
	0.00	16.4	16.4	0.31	11.50	0	1	
Limestone Creek	9.80	0.0	0.0	0.19	11.50	0	1	Topographic Divide
(BPP)	4.50	4.5	4.5	0.19	11.50	0	1	Clay-Effingham County Line
	0.00	9.8	9.8	0.19	11.50	0	1	
Big Muddy	5.80	0.0	0.0	0.22	11.40	0	1	
Creek Tributary	2.60	2.9	2.9	0.22	11.40	1	1	Dieterich STP
(BPW)	0.00	8.4	8.4	0.22	11.40	0	1	
Clay City	5.00	0.0	0.0	0.48	11.80	0	1	Topographic Divide
Tributary	2.50	2.1	2.1	0.48	11.80	0	1	Baltimore and Ohio RR
(BQ)	1.70	4.6	4.6	0.48	11.80	1	1	Clay City WWTP
	0.00	7.3	7.3	0.48	11.80	0	1	
Buck Creek	20.20	0.0	0.0	0.23	11.60	0	1	Topographic Divide
(BR)	16.50	6.0	6.0	0.23	11.60	0	1	Road@Sec. 32 4N 6E
	12.20	12.0	12.0	0.23	11.60	0	1	Road@Sec. 10 3N 6E
	5.50	21.1	21.1	0.23	11.60	0	1	Road@Sec. 17 3N 7E
	0.00	28.7	28.7	0.23	11.60	0	1	
Panther Creek	13.30	0.0	0.0	0.26	11.40	0	1	Topographic Divide
(BS)	8.50	9.4	9.4	0.26	11.40	0	1	Road@Sec. 23 5N 6E
	3.10	18.4	18.4	0.26	11.40	0	1	Road@Sec. 12 4N 6E
	2.10	29.3	29.3	0.26	11.40	0	1	Road@Sec. 13 4N 6E
	0.00	32.0	32.0	0.26	11.40	0	1	
Crooked Creek	20.80	0.0	0.0	0.22	11.20	0	1	Topographic Divide
(BS2)	16.70	6.7	6.7	0.22	11.20	0	1	Fayette-Marion County Line
	13.30	14.1	14.1	0.22	11.20	0	1	Illinois Central RR
	12.20	19.7	19.7	0.22	11.20	0	1	Road@Sec. 32 5N 5E
	10.00	28.1	28.1	0.22	11.20	0	1	Road@Sec. 3 4N 5E
	8.60	35.3	35.3	0.22	11.20	0	1	Road@Sec. 11 4N 5E
	3.70	42.8	42.8	0.22	11.20	0	1	Road@Sec. 17 4N 6E
	0.00	47.9	47.9	0.22	11.20	0	1	
Dismal Creek	24.30	0.0	0.0	0.35	11.00	0	1	Topographic Divide
(BS9)	18.80	6.7	6.7	0.35	11.00	0	1	Road@Sec. 9 5N 4E
	14.50	17.7	17.7	0.35	11.00	0	1	Southbound Lane US 57
	9.20	26.3	26.3	0.35	11.00	0	1	Baltimore and Ohio RR
	6.10	37.8	37.8	0.35	11.00	0	1	Road@Sec. 20 5N 5E
	4.10	45.3	45.3	0.35	11.00	0	1	Road@Sec. 36 5N 5E
	0.00	51.8	51.8	0.35	11.00	0	1	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Lucas Creek	13.40	0.0	0.0	0.24	11.20	0	1	Topographic Divide
(BT)	6.20	10.4	10.4	0.24	11.20	0	1	Clay-Effingham County Line
	0.00	18.8	18.8	0.24	11.20	0	1	
Edgewood	10.20	0.0	0.0	0.57	11.10	0	1	Topographic Divide
Tributary	4.70	8.1	8.1	0.57	11.10	0	1	Clay-Effingham County Line
(BT1)	2.20	14.5	14.5	0.57	11.10	0	1	Road@Sec. 12 5N 6E
	0.00	21.1	21.1	0.57	11.10	0	1	
Bishop Creek	19.70	0.0	0.0	0.24	11.10	0	1	Topographic Divide
(BU)	14.00	6.7	6.7	0.24	11.10	0	1	Road@Sec. 17 7N 7E
	11.10	13.7	13.7	0.24	11.10	0	1	
	11.00	13.7	24.7	0.31	11.14	1	1	at Dieterich Creek (BUP)
	4.71	34.7	34.7	0.42	11.13	0	1	
	4.70	34.7	47.0	0.41	11.15	1	1	at Little Bishop Creek (BUG)
	0.31	51.2	51.2	0.44	11.15	0	1	
	0.30	51.2	65.7	0.42	11.16	1	1	at Ramsey Creek (BUA)
	0.00	65.9	65.9	0.42	11.16	0	1	
Ramsey Creek	11.40	0.0	0.0	0.34	11.20	0	1	Topographic Divide
(BUA)	4.70	7.0	7.0	0.34	11.20	0	1	Road@Sec. 13 6N 6E
	0.00	14.5	14.5	0.34	11.20	0	1	
Little Bishop	9.50	0.0	0.0	0.38	11.20	0	1	Topographic Divide
Creek	5.30	7.8	7.8	0.38	11.20	0	1	Road@Sec. 6 6N 7E
(BUG)	0.00	12.2	12.2	0.38	11.20	0	1	
Dietrich Creek	9.60	0.0	0.0	0.39	11.20	0	1	Topographic Divide
(BUP)	3.70	5.4	5.4	0.39	11.20	0	1	Road@Sec. 23 7N 7E
	0.00	11.0	11.0	0.39	11.20	0	1	
Salt Creek	25.00	0.0	0.0	0.28	11.00	0	1	Topographic Divide
(BV)	20.30	5.1	5.1	0.28	11.00	0	1	Road@Sec. 17 8N 7E
	18.40	11.2	11.2	0.28	11.00	2	1	Teutopolis STP
	17.61	12.0	12.0	0.28	11.00	0	1	
	17.60	12.0	22.3	0.39	10.95	1	1	at Second Salt Creek (BVS)
	15.20	31.5	31.5	0.49	10.94	0	1	Route 40
	13.50	36.7	36.7	0.52	10.93	2	1	Effingham STP
	10.00	47.1	47.1	0.57	10.93	0	1	Road@Sec. 10 7N 6E
	5.41	54.0	54.0	0.59	10.92	0	1	
	5.40	54.0	78.6	0.54	10.95	1	1	at Little Salt Creek (BVG)
	1.41	81.7	81.7	0.55	10.95	0	1	
	1.40	81.7	93.6	0.54	10.94	1	1	at Unnamed trib. (BVB) SW 9 6N 6E
	0.00	94.3	94.3	0.54	10.94	0	1	mouth near Watson
Salt Creek	9.00	0.0	0.0	0.44	10.90	0	1	
Tributary	2.90	7.4	7.4	0.44	10.90	0	1	Road@Sec. 29 7N 6E
(BVB)	0.00	11.9	11.9	0.44	10.90	0	1	
Little Salt Creek	15.30	0.0	0.0	0.42	11.00	0	1	Topographic Divide
(BVG)	12.00	5.5	5.5	0.42	11.00	0	1	Road@Sec. 21 8N 7E
	8.00	12.1	12.1	0.42	11.00	0	1	Route 33
	5.70	18.0	18.0	0.42	11.00	0	1	Road@Sec. 1 7N 6E
	0.00	24.6	24.6	0.42	11.00	0	1	
Second Salt	7.20	0.0	0.0	0.52	10.90	0	1	Topographic Divide
Creek	1.50	9.2	9.2	0.52	10.90	6	1	USGS Gage 03378750 near Teutopolis
(BVS)	0.00	10.3	10.3	0.52	10.90	0	1	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Fulfer Creek	17.80	0.0	0.0	0.21	10.80	0	1	Topographic Divide
(BV6)	13.50	4.1	4.1	0.21	10.80	0	1	Road@Sec. 21 6N 4E
	11.20	12.3	12.3	0.21	10.80	0	1	Road@Sec. 10 6N 4E
	10.00	21.3	21.3	0.21	10.80	0	1	Road@Sec. 11 6N 4E
	6.11	26.2	26.2	0.21	10.80	0	1	
	6.10	26.2	40.5	0.21	10.82	1	1	at Limestone Creek(BV6J)
	2.80	49.2	49.2	0.30	10.84	0	1	Road@Sec. 3 6N 5E
	0.00	52.9	52.9	0.33	10.84	0	1	
Limestone Creek	7.80	0.0	0.0	0.21	10.90	0	1	Topographic Divide
(BV6J)	2.90	6.5	6.5	0.21	10.90	0	1	Baltimore and Ohio RR
	0.00	14.3	14.3	0.21	10.90	0	1	
Big Creek	12.30	0.0	0.0	0.50	10.80	0	1	Topographic Divide
(BV8)	9.70	4.2	4.2	0.50	10.80	0	1	Baltimore and Ohio RR
	9.10	4.8	4.8	0.50	10.80	2	1	Altamont South STP
	5.11	10.1	10.1	0.50	10.80	0	1	
	5.10	10.1	15.4	0.50	10.80	2	1	at Coon Creek (BV8K)
	3.20	17.6	17.6	0.50	10.80	0	1	above Brockett Creek
	0.00	21.7	21.7	0.50	10.80	0	1	
Coon Creek	6.40	0.0	0.0	0.50	10.80	0	1	
(BV8K)	4.40	1.5	1.5	0.50	10.80	2	1	Altamont STP
	0.00	5.3	5.3	0.50	10.80	0	1	
Second Creek	11.30	0.0	0.0	0.53	10.80	0	1	Topographic Divide
(BW)	9.90	1.2	1.2	0.53	10.80	2	1	Edgewood STP
	7.30	6.5	6.5	0.53	10.80	0	1	Route 40
	2.71	11.4	11.4	0.53	10.80	0	1	
	2.70	11.4	17.7	0.57	10.80	1	1	at Second Creek trib. (BWG)
	0.00	20.9	20.9	0.59	10.80	0	1	
Second Creek	5.40	0.0	0.0	0.64	10.80	0	1	Topographic Divide
Tributary	1.80	2.5	2.5	0.64	10.80	0	1	I-70
(BWG)	0.00	6.3	6.3	0.64	10.80	0	1	
Lily Creek	7.80	0.0	0.0	0.52	10.80	0	1	Topographic Divide
(BW2)	3.30	6.5	6.5	0.52	10.80	0	1	Pennsylvania RR
	0.00	10.6	10.6	0.52	10.80	0	1	
Blue Point Creek	8.40	0.0	0.0	0.45	10.70	0	1	Topographic Divide
(BW8)	5.20	2.3	2.3	0.45	10.70	0	1	Road@Sec. 17 8N 5E
	1.80	11.7	11.7	0.45	10.70	9	1	Lake Sara
	0.00	13.6	13.6	0.45	10.70	0	1	
Green Creek	12.60	0.0	0.0	0.41	10.80	0	1	Topographic Divide
(BX)	9.90	4.0	4.0	0.41	10.80	0	1	Road@Sec. 4 9N 6E
	4.81	9.2	9.2	0.41	10.80	0	1	
	4.80	9.2	23.4	0.41	10.74	1	1	at Henry Creek (BXK)
	4.31	23.8	23.8	0.42	10.74	0	1	
	4.30	23.8	35.1	0.44	10.76	1	1	at East Branch Green Creek (BXJ)
	0.00	42.8	42.8	0.47	10.77	0	1	
East Branch	9.00	0.0	0.0	0.47	10.80	0	1	Topographic Divide
Green Creek	4.50	4.5	4.5	0.47	10.80	0	1	Effingham-Shelby County Line
(BXJ)	0.00	11.3	11.3	0.47	10.80	0	1	

Appendix C. Concluded

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Henry Creek	7.60	0.0	0.0	0.41	10.70	0	1	Topographic Divide
(BXK)	4.10	8.8	8.8	0.41	10.70	0	1	Road@Sec. 11 9N 6E
	0.00	14.2	14.2	0.41	10.70	0	1	
West Branch	11.50	0.0	0.0	0.87	10.70	0	1	Topographic Divide
(BY)	8.30	5.0	5.0	0.87	10.60	0	1	
	5.21	11.5	11.5	0.87	10.60	0	1	
	5.20	11.5	29.5	0.87	10.60	1	1	at Sexson Branch (BYM)
	3.31	30.7	30.7	0.90	10.60	0	1	
	3.33	30.7	52.6	1.16	10.60	1	1	at Brush Creek (BYI)
	2.41	53.3	53.3	1.16	10.60	0	1	
	2.40	53.3	62.9	1.17	10.62	1	1	at Drake Creek (BYF)
	0.00	65.6	65.6	1.18	10.62	0	1	
Drake Creek	4.90	0.0	0.0	1.23	10.70	0	1	Topographic Divide
(BYF)	3.20	1.8	1.8	1.23	10.70	0	1	Road@Sec. 34 11N 6E
	0.00	9.6	9.6	1.23	10.70	0	1	
Brush Creek	5.60	0.0	0.0	1.19	10.60	0	1	Topographic Divide
(BYI)	1.80	6.8	6.8	1.19	10.60	0	1	Road@Sec. 7 10N 6E
	0.91	11.4	11.4	1.19	10.60	0	1	
	0.90	11.4	21.1	1.07	10.60	1	1	at Bills Creek (BYIE)
	0.00	21.8	21.8	1.08	10.60	0	1	
Bills Creek	6.90	0.0	0.0	0.92	10.60	0	1	Topographic Divide
(BYIE)	3.20	5.5	5.5	0.92	10.60	0	1	Road@Sec. 36 11N 6E
	0.00	9.7	9.7	0.92	10.60	0	1	
Sexson Branch	8.10	0.0	0.0	0.87	10.60	0	1	Topographic Divide
(BYM)	2.95	10.2	10.2	0.87	10.60	0	1	above Flat Branch
	0.00	18.0	18.0	0.87	10.60	0	1	
Copperas Creek	5.60	0.0	0.0	1.25	10.80	0	1	Topographic Divide
(BY3)	2.20	2.6	2.6	1.25	10.80	0	1	Shelby-Cumberland County Line
	2.10	2.7	2.7	1.25	10.80	2	1	Neoga STP
	0.00	11.0	11.0	1.25	10.80	0	1	
Bush Creek	11.00	0.0	0.0	1.06	10.80	0	1	Topographic Divide
(BZ)	6.70	6.2	6.2	1.06	10.80	0	1	at Buttermilk Ditch
	4.30	10.4	10.4	1.06	10.80	0	1	I-57
	0.80	18.0	18.0	1.06	10.80	0	1	above Brush Creek
	0.00	23.6	23.6	1.06	10.80	0	1	
Clear Creek	5.60	0.0	0.0	0.93	10.70	0	1	Topographic Divide
(BZ1)	2.50	2.2	2.2	0.93	10.70	0	1	Road@Sec. 12 11N 6E
	0.00	7.0	7.0	0.93	10.70	0	1	

Notes:

PWS – Public Water Supply
Sec. – Section
STP – Sanitary Treatment Plant
trib. – Tributary
WWTP – Wastewater Treatment Plant

Appendix D. Coefficients for Virgin Flow Equations

The mean flow for a stream location (Q_{mean}) is computed as: $Q_{mean} = 0.0738$ DA (P-ET), where the drainage area (DA) and net excess precipitation (P-ET) are included in the NETWORK file, listed in appendix C.

The flow values for the remaining flow parameters, designated by Q_x, are computed using the following equation:

$$Q_x = \min \{ Q_{mean} [a + b\, DA + c\, K] - 0.05, 0\}$$

where K is the average soil permeability for the watershed, also included in the NETWORK file (see appendix C), and the coefficients a, b, and c are defined in the following table.

Flow type	Springfield Plain and Mt. Vernon Hill Country			
	(a)	(b)	(c)	Error(c_e)
Q_{01}	19.615347	-0.00429499	-4.830000	2.652
Q_{02}	12.151146	-0.00200676	-2.670000	1.015
Q_{05}	4.797264	0.00112204	-0.640000	0.5524
Q_{10}	1.687191	0.00158367	0.087300	0.3893
Q_{15}	0.842755	0.00108333	0.165000	0.2613
Q_{25}	0.311007	0.00047252	0.206000	0.1278
Q_{40}	0.075119	0.00011470	0.214000	0.05553
Q_{50}	0.031294	0.00006880	0.144000	0.04112
Q_{60}	0.009641	0.00004678	0.089300	0.02965
Q_{75}	-0.004000	0.00002900	0.026800	0.01344
Q_{85}	-0.002500	0.00001610	0.011000	0.005962
Q_{90}	-0.003104	0.00001216	0.009000	0.004322
Q_{95}	-0.001768	0.00000673	0.005000	0.002593
Q_{98}	-0.000159	0.00000234	0.001500	0.001406
Q_{99}	-0.001206	0.00000150	0.002100	0.000692
Low Flows				
$Q_{1,2}$	-0.000890	0.00000581	0.004900	0.002966
$Q_{1,10}$	0.000000	0.00000051	0.000130	0.000169
$Q_{1,25}$	-0.000023	0.00000019	0.000030	0.000054
$Q_{1,50}$	0.000056	0.00000004	0.000030	0.000026
$Q_{7,2}$	-0.000211	0.00000652	0.005800	0.003464
$Q_{7,10}$	-0.000278	0.00000116	0.000440	0.000310
$Q_{7,25}$	0.000160	0.00000011	0.000001	0.000067
$Q_{7,50}$	0.000010	0.00000011	0.000030	0.000037
$Q_{15,2}$	-0.000150	0.00000862	0.007000	0.004217
$Q_{15,10}$	0.000133	0.00000110	0.000380	0.000632
$Q_{15,25}$	0.000030	0.00000045	0.000100	0.000121
$Q_{15,50}$	0.000161	0.00000002	0.000050	0.000049
$Q_{31,2}$	0.003004	0.00000946	0.007500	0.006065
$Q_{31,10}$	0.001016	0.00000116	0.000250	0.001449
$Q_{31,25}$	-0.000550	0.00000157	0.000800	0.000791
$Q_{31,50}$	-0.000550	0.00000062	0.001000	0.000290
$Q_{61,2}$	0.007304	0.00001678	0.016600	0.008679
$Q_{61,10}$	0.000971	0.00000452	0.001270	0.002793
$Q_{61,25}$	-0.001644	0.00000452	0.001650	0.001995
$Q_{61,50}$	-0.001900	0.00000260	0.002400	0.001309
$Q_{91,2}$	0.029716	0.00001954	0.010000	0.013190
$Q_{91,10}$	0.002391	0.00000659	0.002800	0.003799
$Q_{91,25}$	-0.000009	0.00000408	0.001680	0.002611
$Q_{91,50}$	-0.001500	0.00000338	0.002000	0.002000

Appendix D. Continued

Flow type	Springfield Plain and Mt. Vernon Hill Country			
	(a)	(b)	(c)	Error (c_e)
Drought Flows				
$Q_{6,10}$	0.011052	0.00001354	0.020000	0.001504
$Q_{6,25}$	0.004841	0.00000871	0.007340	0.005259
$Q_{6,50}$	0.001542	0.00000673	0.003830	0.003369
$Q_{9,10}$	0.043342	0.00002079	0.071600	0.02501
$Q_{9,25}$	0.015086	0.00001087	0.038400	0.01406
$Q_{9,50}$	0.007023	0.00000900	0.016500	0.008833
$Q_{12,10}$	0.126937	0.00003220	0.150000	0.04176
$Q_{12,25}$	0.046527	0.00001740	0.103000	0.02894
$Q_{12,50}$	0.023190	0.00001722	0.051700	0.01850
$Q_{18,10}$	0.162451	0.00010486	0.181000	0.05638
$Q_{18,25}$	0.080258	0.00009937	0.087200	0.04351
$Q_{18,50}$	0.037742	0.00006894	0.055800	0.02916
$Q_{30,10}$	0.412286	0.00013771	0.106000	0.05103
$Q_{30,25}$	0.232314	0.00015910	0.007600	0.05842
$Q_{30,50}$	0.132334	0.00010882	0.010500	0.03672
$Q_{54,10}$	0.749958	0.00005460	0.107000	0.04789
$Q_{54,25}$	0.354065	0.00013823	0.126000	0.06256
$Q_{54,50}$	0.205164	0.00015874	0.082000	0.05552
January				
Q_{02}	17.823006	-0.00264160	-7.100000	2.277
Q_{10}	3.132433	0.00324013	-1.500000	0.8623
Q_{25}	0.666800	0.00101612	-0.260000	0.2261
Q_{50}	0.099080	0.00016453	0.099000	0.04611
Q_{75}	0.009310	0.00004495	0.068000	0.02085
Q_{90}	-0.002564	0.00001886	0.021000	0.004897
Q_{98}	0.000179	0.00000650	0.001200	0.002493
Q_{mean}	1.554024	0.00029511	-0.570000	0.1536
February				
Q_{02}	19.579158	-0.00411625	-6.630000	3.728
Q_{10}	3.456354	0.00137649	0.320000	0.6437
Q_{25}	0.984793	0.00116200	-0.170000	0.2736
Q_{50}	0.251195	0.00025399	0.105000	0.07929
Q_{75}	0.044352	0.00004896	0.130000	0.03813
Q_{90}	-0.004485	0.00002349	0.058000	0.01056
Q_{98}	0.000100	0.00000896	0.005600	0.002969
Q_{mean}	1.816476	0.00000314	-0.380000	0.1600
March				
Q_{02}	23.830691	-0.00529361	-11.200000	4.011
Q_{10}	5.329827	0.00051124	-0.570000	0.7657
Q_{25}	1.431732	0.00151058	-0.146000	0.3828
Q_{50}	0.477710	0.00041266	0.024000	0.1551
Q_{75}	0.172980	0.00004447	0.122000	0.07312
Q_{90}	0.080837	0.00002090	0.063000	0.03820
Q_{98}	-0.009262	0.00001290	0.055000	0.01586
Q_{mean}	2.381576	-0.00020940	-0.590000	0.2077

Appendix D. Continued

Flow type	Springfield Plain and Mt. Vernon Hill Country			
	(a)	(b)	(c)	Error (c_e)
April				
Q_{02}	15.126938	-0.00433369	3.300000	3.259
Q_{10}	3.286005	0.00226567	0.750000	0.9252
Q_{25}	0.795183	0.00141913	0.490000	0.3289
Q_{50}	0.239285	0.00029419	0.300000	0.1305
Q_{75}	0.065266	0.00004314	0.250000	0.06525
Q_{90}	0.020414	0.00002963	0.156000	0.04091
Q_{98}	-0.022848	0.00002633	0.093000	0.01945
Q_{mean}	1.668239	0.00001269	0.360000	0.1639
May				
Q_{02}	12.566714	-0.00239704	0.710000	1.926
Q_{10}	1.241662	0.00294960	1.290000	0.6459
Q_{25}	0.405759	0.00094621	0.213000	0.2250
Q_{50}	0.061479	0.00013109	0.273000	0.09191
Q_{75}	0.006803	0.00004161	0.158000	0.05495
Q_{90}	0.000030	0.00003129	0.086000	0.03930
Q_{98}	-0.004717	0.00002222	0.023500	0.01259
Q_{mean}	1.109662	0.00029373	0.300000	0.1438
June				
Q_{02}	7.536454	-0.00177952	2.160000	2.437
Q_{10}	0.314624	0.00138255	1.820000	0.5425
Q_{25}	-0.025362	0.00044289	0.680000	0.2287
Q_{50}	-0.019107	0.00008049	0.237000	0.08895
Q_{75}	-0.004310	0.00003558	0.078000	0.03791
Q_{90}	-0.004439	0.00002563	0.022000	0.02145
Q_{98}	-0.001474	0.00001383	0.004200	0.00681
Q_{mean}	0.686401	-0.00013344	0.380000	0.3350
July				
Q_{02}	8.125950	-0.00119622	-3.630000	1.557
Q_{10}	0.451857	0.00092342	0.310000	0.3233
Q_{25}	0.015901	0.00016240	0.229000	0.1020
Q_{50}	-0.003345	0.00004683	0.090000	0.04189
Q_{75}	-0.005611	0.00002634	0.033000	0.01565
Q_{90}	-0.003308	0.00001557	0.010900	0.00772
Q_{98}	-0.001512	0.00000442	0.003900	0.00266
Q_{mean}	0.681707	-0.00012955	-0.210000	0.1594
August				
Q_{02}	3.003057	0.00041331	-0.250000	1.033
Q_{10}	0.136644	0.00047268	0.258000	0.1920
Q_{25}	0.018913	0.00010794	0.082000	0.05624
Q_{50}	0.000838	0.00003616	0.035000	0.01824
Q_{75}	0.002813	0.00001521	0.006800	0.00763
Q_{90}	-0.000963	0.00000642	0.003500	0.00396
Q_{98}	-0.000853	0.00000192	0.002000	0.00212
Q_{mean}	0.389390	0.00005270	-0.180000	0.1285

Appendix D. Concluded

Flow type	Springfield Plain and Mt. Vernon Hill Country			
	(a)	(b)	(c)	Error (c_e)
September				
Q_{02}	1.707011	-0.00011024	1.630000	0.7226
Q_{10}	0.094214	0.00029137	0.163000	0.08789
Q_{25}	0.014633	0.00006604	0.051000	0.02488
Q_{50}	0.003895	0.00002372	0.012800	0.009831
Q_{75}	0.002172	0.00000843	0.000300	0.005569
Q_{90}	-0.000005	0.00000433	0.000000	0.003484
Q_{98}	0.000104	0.00000056	0.000000	0.000504
Q_{mean}	0.184051	-0.00003389	0.105000	0.06406
October				
Q_{02}	2.567582	0.00022733	-0.410000	1.0839
Q_{10}	0.068757	0.00033300	0.265000	0.1212
Q_{25}	-0.012797	0.00004600	0.135000	0.04512
Q_{50}	0.004307	0.00001516	0.015000	0.009588
Q_{75}	0.002479	0.00000625	0.000400	0.004359
Q_{90}	0.000864	0.00000200	0.000350	0.002207
Q_{98}	-0.000081	0.00000058	0.000250	0.000281
Q_{mean}	0.276009	-0.00001239	-0.042000	0.09889
November				
Q_{02}	4.889324	-0.00096280	4.100000	2.849
Q_{10}	0.408449	0.00097359	1.000000	0.3794
Q_{25}	0.093011	0.00014136	0.221000	0.04938
Q_{50}	0.006861	0.00000972	0.084000	0.02812
Q_{75}	0.004092	0.00000389	0.012500	0.01141
Q_{90}	0.000630	0.00000254	0.002000	0.006558
Q_{98}	-0.000013	0.00000175	0.000020	0.001602
Q_{mean}	0.374917	0.00002873	0.450000	0.1908
December				
Q_{02}	10.521850	-0.00330148	5.000000	2.967
Q_{10}	1.831899	0.00127968	0.720000	0.5625
Q_{25}	0.439319	0.00050214	0.130000	0.1491
Q_{50}	0.055047	0.00004181	0.168000	0.03987
Q_{75}	0.006471	0.00000789	0.043000	0.01757
Q_{90}	0.003600	0.00000432	0.003400	0.007535
Q_{98}	0.000051	0.00000306	0.000200	0.004779
Q_{mean}	1.152659	-0.00025698	0.190000	0.1324