Illinois State Water Survey
HYDROLOGY DIVISION

SWS Contract Report 499

KASKASKIA RIVER BASIN STREAMFLOW ASSESSMENT MODEL: HYDROLOGIC ANALYSIS

by

H. Vernon Knapp

Office of Surface Water Resources and Systems Analysis

Prepared for the
Illlinols Department of Transportation,
Division of Water Resources

Champaign, Illinois

November 1990

Illinois Department of Energy end Natural Resources

KASKASKIA RIVER BASIN
STREAMFLOW ASSESSMENT MODEL:
HYDROLOGIC ANALYSIS

by H. Vernon Knapp

Prepared for the
Illinois Department of Transportation,
Division of Water Resources

Illinois State Water Survey
2204 Griffith Drive
Champaign, Illinois 61820-7495

November 1990

CONTENTS

TABLES

FIGURES

KASKASKIA RIVER BASIN STREAMFLOW ASSESSMENT MODEL: HYDROLOGIC ANALYSIS

by H. Vernon Knapp

INTRODUCTION

The Illinois Streamflow Assessment Model *(ILSAM)* is a computer program that produces estimates of the long-term expected magnitude and frequency of streamflow for any location in a watershed. The model is designed to provide basic streamflow information for use in the management and planning of surface water resource projects. *ILSAM* is particularly useful for examining conflicts in the use of streamflow and in evaluating the effects of conflicting water use practices on streamflow quantity. The effects of potential or hypothetical water resource projects (withdrawals, discharges, and reservoirs) on the quantity of water in the present hydrologic regime can also be examined using options available in the model. The effects of a modification to the flow at any one site may then be translated to other locations downstream.

This report describes the development of the hydrologic data for the *ILSAM* model for the Kaskaskia River watershed, located in southwestern Illinois. In addition to this watershed, the model has been developed for three others in Illinois: the Sangamon River, Fox River, and Kankakee River basins. The location of these watersheds is shown in figure 1. Many of the algorithms that estimate the effects of water use practices on streamflow quantity are presented in earlier reports (Knapp et al., 1985; Knapp, 1988). The operation of the model is further described in the *ILSAM User's Guide* (Mills and Knapp, 1989).

ILSAM is available from the Illinois State Water Survey on 5-1/4" floppy diskettes for use on an IBM-PC/AT* or compatible computer having a minimum random access memory (RAM) of 512 K (kilobytes).

* IBM-PC and IBM-AT are trademarks of the International Business Machines Corporation

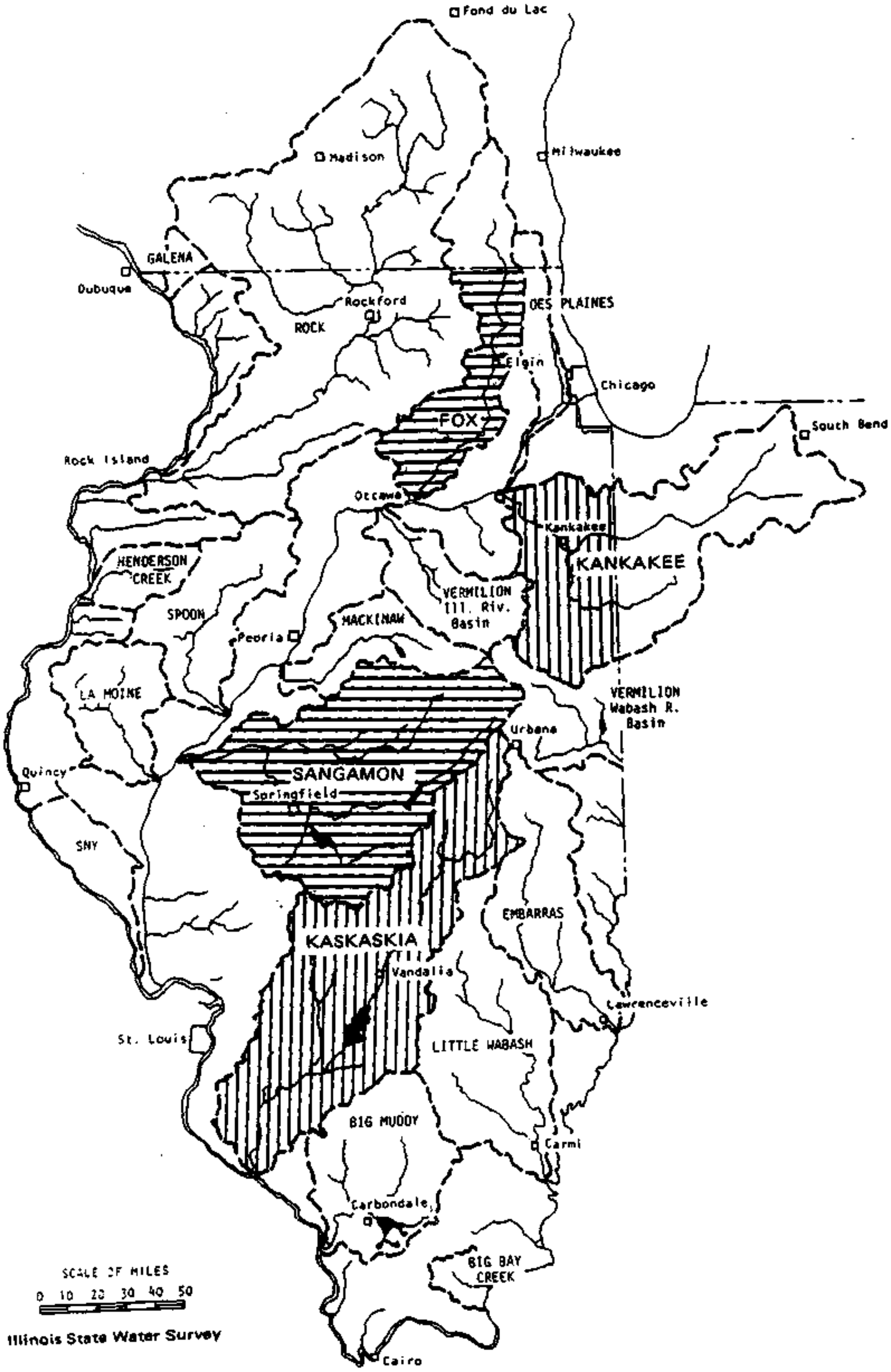

Figure 1. Location of the river basins for which the Illinois Streamflow Assessment Model has been developed

General Products and Use of the Model

ILSAM produces information on 154 selected flow parameters, including flow duration relationships (flow versus percentage of duration) and low flows for various durations and expected return intervals. The 154 flow parameters produced by the model are as follows:

Annual Flow Duration Values (% probability of exceedance,
for example Q02 = the flow exceeded only 2% of the time) —
Qmean (mean flow), Q99, Q98, Q95, Q90, Q85, Q75, Q60, Q50,
Q40, Q25, Q15, Q10, Q05, Q02, Q01

Monthly Flow Duration Values (probability of exceedance for
each month of the year)-
Qmean, Q98, Q90, Q75, Q50, Q25, Q10, Q02

Low Flows (annual series, average flow rate over the given duration) —
Durations: 1-day, 7-day, 15-day, 31-day, 61-day, 91-day
Return intervals: 2 years, 10 years, 25 years, 50 years

Drought Flows (average flow rate) -
Durations: 6-month, 9-month, 12-month, 18-month, 30-month, 54-month
Return intervals: 10 years, 25 years, 50 years

The flow parameters are presented for both present flow conditions and virgin (natural or unaffected) conditions. The virgin flow is an estimate of **what** the streamflow would be without the presence of the major water users and reservoirs in the watershed. The difference between the virgin and present flow therefore describes the impact of the various water resources projects on the flow in the stream.

The model's user may choose to introduce a hypothetical (or potential) withdrawal/discharge and estimate its effect on the specified flow parameters. This introduces a third type of flow, termed "altered flow." Flow conditions may be estimated for any gaged or ungaged site in the watershed with a drainage area of at least 10 square miles.

Acknowledgments

This study was supported by the Illinois Department of Transportation, Division of Water Resources, with Gary Clark as project coordinator. This report was prepared under the general supervision of Richard G. Semonin, Chief of the Illinois State Water Survey; John M. Shafer, Hydrology Division Head; and Krishan P. Singh, Director of the Office of Surface Water Resources and Systems Analysis. Joe Miller and Cheri Chenowith assisted in data analysis and management. John Brother, Linda Riggin, and Cheri Chenowith prepared the illustrations, and Laurie McCarthy Talkington edited the report.

Part I. Background Information

DESCRIPTIO N OF THE KASKASKIA RIVER BASIN

The Kaskaskia River is located in the southwestern portion of Illinois and has a total area of approximately 5,800 square miles. The watershed encompasses portions of 22 counties, as shown in figure 2. The Kaskaskia River originates in Champaign County and flows southwest to its confluence with the Mississippi River in Randolph County (see figure 3). The river starts as a channelized ditch in the flat prairie of central Illinois and through much of its first 60 miles the riverbed remains only slightly entrenched into the surrounding prairie. South of Shelbyville, the topography of the watershed becomes more gently rolling, and in this area the river has developed a broad, flat-bottomed valley (Ekblaw, 1937). The total length of the river is approximately 302 miles. The total range in elevation of the watershed is almost 500 feet, from 855 feet (National Geodetic Vertical Datum) near the headwaters in Champaign County to 368 feet at the Kaskaskia Lock and Dam. The slope of the Kaskaskia River is remarkably consistent over much of its length. Downstream of Shelbyville the river has a slope of approximately 1.0 foot per mile. The slope upstream of Shelbyville is only slightly higher, averaging 1.5 feet per mile until within 6 miles of the headwaters - where the channel elevation rises more than 125 feet. The nine largest tributaries leading into the Kaskaskia River are Shoal Creek, with a drainage area of 916 square miles (mi2), Silver Creek (478 mi2), Crooked Creek (465 mi2), West Okaw River (292 mi2), Richland Creek (248 mi2), Becks Creek (203 mi2), Hurricane Creek (193 mi2), Sugar Creek (176 mi2), and Lake Fork (170 mi2).

Watershed Physiography and Soils

Leighton et al. (1948) defined three physiographic regions within the Kaskaskia River basin: the Bloomington Ridged Plain, the Springfield Plain, and the Mt. Vernon Hill Country (figure 4). The topography of each of these regions was formed by glacial influence, but the age of glaciation differs by region. The Bloomington Ridged Plain, which covers the northeastern 20% of the watershed, was glaciated most recently during the Wisconsin glacial period. The area is generally level except for gently sloping moraines. The drainage patterns in this region are poorly developed, and many of the smaller streams are manmade ditches. This northern region has exceptionally productive farmland, most planted in cash grain crops (corn and soybeans).

The Springfield Plain, which covers the central 65% of the basin, was glaciated in the Illinoisan glacial period. The region has a combination of gently rolling hills and dissected

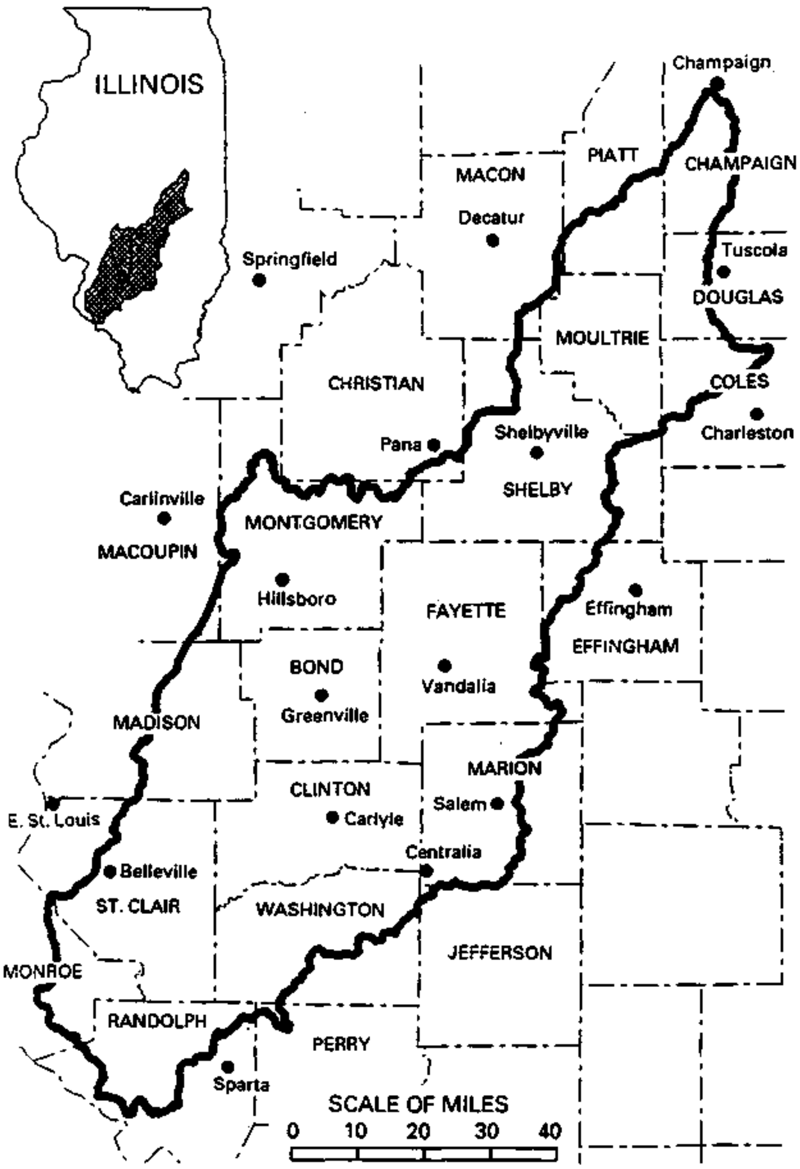

Figure 2. Location of the Kaskaskia River basin in Illinois

plains. The drainage system is more highly developed than in the Bloomington Ridged Plain. Despite the presence of well-defined valleys, the local relief in this region is not great, and some upland areas are poorly drained. The physiography of the Mt. Vernon Hill Country, in Randolph, Monroe, and Washington Counties, is the most removed from its glacial influences. The upland areas in this region are hilly, featuring greater local relief, and the valleys and drainage system are well defined. Sinkholes in Monroe County add to its hilly character. The land use in the two southern regions tends to be mixed, with an assortment of corn and wheat crops, pasture, and small, interspersed woodland areas.

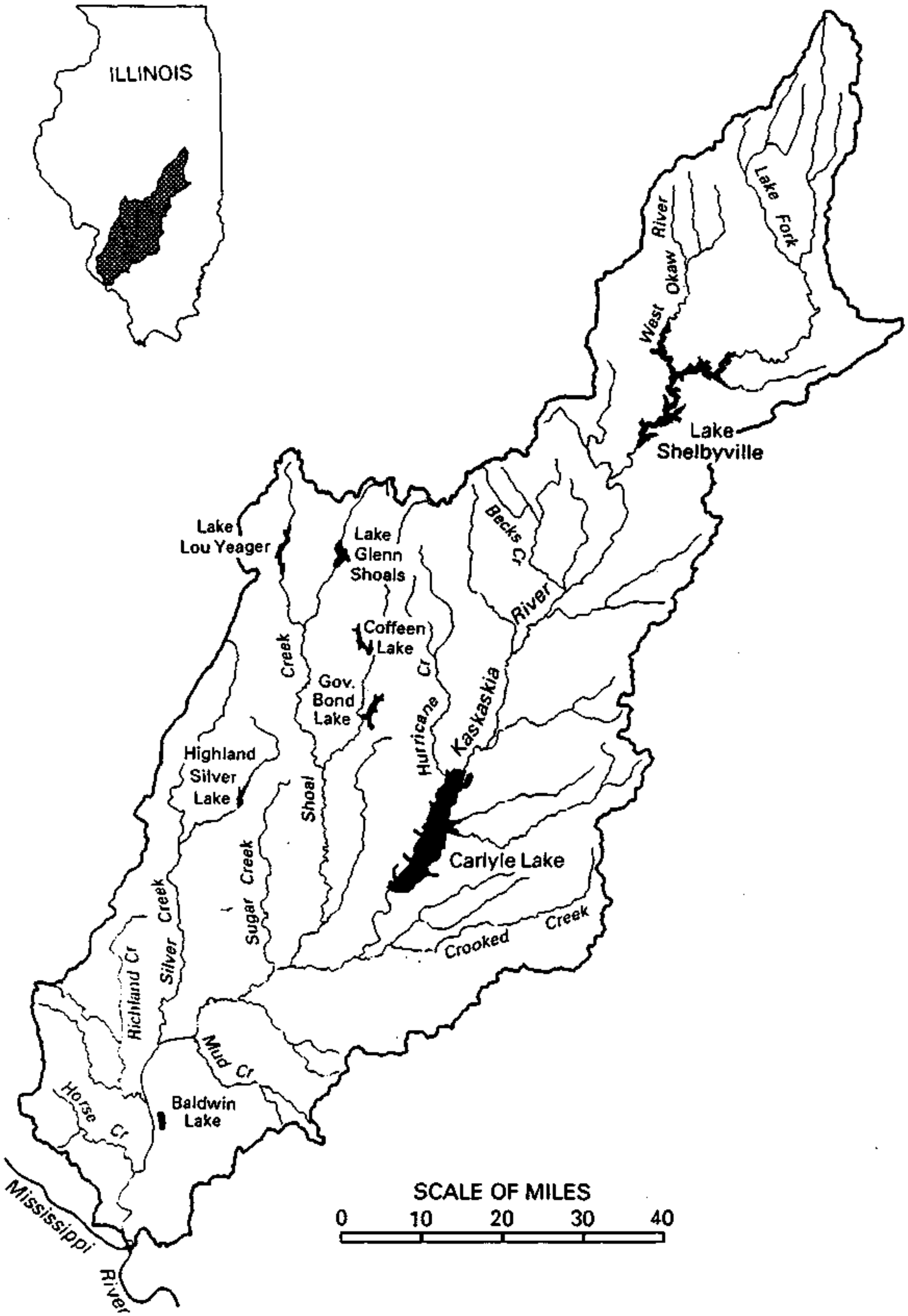

Figure 3. Location of major streams in the Kaskaskia River basin

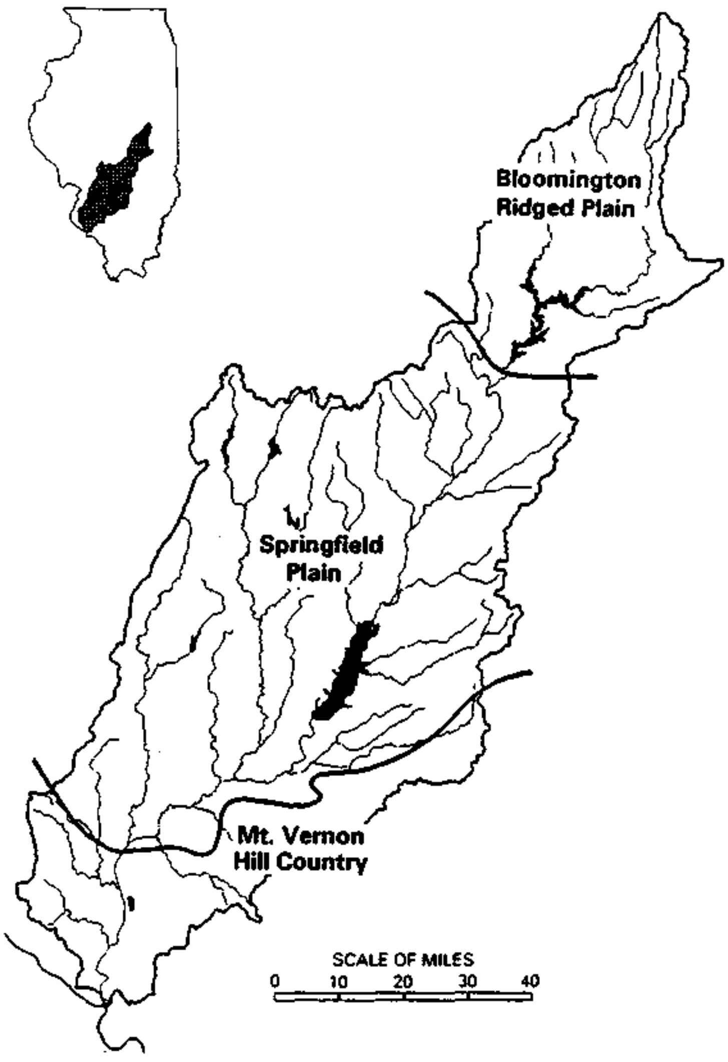

Figure 4. Physiographic regions in the Kaskaskia River basin (adapted from Leighton et al., 1948)

Land Slopes

Table 1 provides the average distribution of overland slopes for the three physiographic regions in the Kaskaskia watershed. The overland slopes listed in this table were estimated from data in Runge et al. (1969). More than three-fourths of the land area in the Bloomington Ridged Plain is level or very gently sloping, having less than a 2% slope; and only 6% of the land in this region has moderate to steep slopes (in excess of 4%). The region typically contains some of the flattest plains in Illinois. The upland area in the Springfield Plain is also relatively flat (58% of the land area in the region has less than a *2%* slope), although the region also contains many gentle to moderate slopes in rolling topography. In contrast, much of the Mt. Vernon Hill Country is sloping to moderately steep. Most of the steeper areas occur along upland slopes.

Table 1. Distribution of Overland Slopes in the Physiographic Regions of the Kaskaskia River Basin

	Percentage of land area		
Overland slope (%)	Bloomington Ridged Plain	Springfield Plain	Mt. Vernon Hill Country
0 - 2	78.	58.	34.
2 - 4	16.	20.	23.
4 - 7	3.3	8.0	14.
7-12	1.3	5.0	12.
12-18	0.5	2.2	8.0
18-30	0.8	6.0	7.0
>30	0.1	0.8	2.0

Channel Slopes

Table 2 provides examples of channel slopes for streams in the Kaskaskia River basin. Streams in the Springfield Plain and the Mt. Vernon Hill Country have similar channel slopes and profiles, typical of many areas in Illinois. The streams and ditches in the Bloomington Ridged Plain, because of the region's level topography, normally have gentle channel slopes.

Soil Types and their Influence on Stream/low Hydrology

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

Table 2. Examples of Channel Slopes in the Kaskaskia River Basin (ft/mi)

Physiographic region	Drainage area of stream		
Stream name	10 mi^2	50 mi^2	150 mi^2
Bloomington Ridged Plain			
Kaskaskia River	3.3	1.5	1.2
Lake Fork	4.0	0.7	1.3
West Okaw River	3.8	3.1	2.0
Springfield Plain			
Richland Creek	6.7	4.0	2.0
Silver Creek	10.0	2.5	1.5
East Fork Shoal Creek	5.6	4.6	3.2
Crooked Creek	5.2	2.3	1.6
Hurricane Creek	9.0	4.7	2.8
Mt. Vernon Hill Country			
Horse Creek	11.3	3.3	----
Mud Creek	6.3	3.0	----

Note: — = not applicable.

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 magnitude of storm runoff. A large portion of the water that infiltrates is usually stored as shallow ground water and may be discharged to the stream later in the year or following years. The presence of sandy material in the subsoil provides for high permeability and consistent baseflow (the flow of shallow ground water to the stream). In contrast, areas whose soils have high clay content usually have greater runoff during storm periods, and less ground water is contributed to streamflow during dry periods.

Typical soils in the Kaskaskia River basin have high silt and clay content. Permeabilities range from moderate (0.6 to 2.0 inches per hour) in the Drummer-Flanagan soils of the Bloomington Ridged Plain to slow (0.06 to 0.2 inch per hour) in the southern portion of the basin. The Flanagan-Drummer soils of the Bloomington Ridged Plain are high in organic matter, with corresponding water-retention capacity and a good amount of available water in the root zone. Major soil associations in the southern portion of the watershed (Cisne-Hoyleton-Huey, Herrick-Virden, Cowden-Oconee, and Hickory-Blair-Bluford) have lower levels of organic matter and available water. The clay content of these soils generally increases with soil depth, resulting in poorer root development and lower subsoil permeability. Although the range of soil permeabilities in the watershed is not extremely large, the combination of permeability with other soil water properties causes a significant difference in both the agricultural productivity and the water yield character of the basin.

Reservoirs in the Kaskaskia River Basin

The Kaskaskia River basin contains ten manmade reservoirs, listed in table 3, that have a storage capacity in excess of 5,000 acre-feet. Lake Shelbyville and Lake Carlyle are the two largest reservoirs in Illinois (based on storage capacity). They were built on the Kaskaskia River for flood control storage. As shown later in this report, these two reservoirs have a significant impact on the flows in the Kaskaskia River. All other major reservoirs listed in table 3 were built for public water supply and cooling water supply. The reservoirs are all shown in figure 3. In addition to the reservoirs listed in table 3, several smaller manmade reservoirs in the watershed provide public water supply. Many of these smaller reservoirs are listed in the section, "Water Use and Water Supply." No major natural lakes exist in the Kaskaskia watershed.

Table 3. Major Reservoirs in the Easkaskia River Basin

Reservoir	County	Major purpose	Surface area (acres)	Storage (acre-ft)
Carlyle Lake	Clinton	Flood Control	24,600	283,000
Lake Shelbyville	Shelby	Flood Control	11,000	210,000
Baldwin Lake	Randolph	Cooling	2,031	26,000
CoffeenLake	Montgomery	Cooling	1,096	22,000
Lake Lou Yeager	Montgomery	P.W.S.	1,410	15,380
Lake Glenn Shoals	Montgomery	P.W.S.	1,140	13,000
Governor Bond Lake	Bond	P.W.S.	900	9,900
Highland Silver Lake	Madison	P.W.S.	600	6,336
Vandalia Lake	Fayette	P.W.S.	660	5,560
Raccoon Lake	Marion	P.W.S.	730	5,524

Note: P.W.S. = Public Water Supply.

Hydrologic Budget

Precipitation

The average annual precipitation for the Kaskaskia River basin varies from approximately 41 inches along the southern edge of the basin to 38.5 inches along the northern edge. The geographical distribution of the annual average precipitation in the basin is shown in figure 5a. This figure is similar to other published values of mean precipitation (Wendland et al., 1985), but the values have been updated to correspond to the period of available streamflow records (1948-1988) and smoothed to provide for greater continuity with estimated values of evapotranspiration and streamflow.

Nine precipitation gages in and near the Kaskaskia watershed have continuous records that date from before 1900 to the present. These precipitation stations and their periods of record are: Carlinville (1891-1988); Charleston (1880-1988); Decatur (1870-1873,1892-1988); Greenville (1883-1988); Hillsboro (1895-1988); Pana (1882-1893,1898-1988); St. Louis, Missouri (1837-1988); Sparta (1887-1988); and Springfield (1879-1988).

Annual precipitation for St. Louis, Greenville, and Charleston is plotted in figure 6 for the years 1890-1940 and in figure 7 for the years 1940-1989. Also plotted in figures 6 and 7 are the 1890-1989 average precipitation for each station and an 11-year moving average of the annual values. These series of annual values indicate the great variability of rainfall, not only year to year but also at different locations within the same region. The moving averages shown in figures 6 and 7 indicate several wet and dry periods. All three locations experienced consistent below-normal precipitation for the period 1952-1965 and consistent above-normal precipitation for the years 1970-1985. The lowest annual precipitation was recorded in 1953, with a basin-wide average of approximately 25 inches (14 inches below normal).

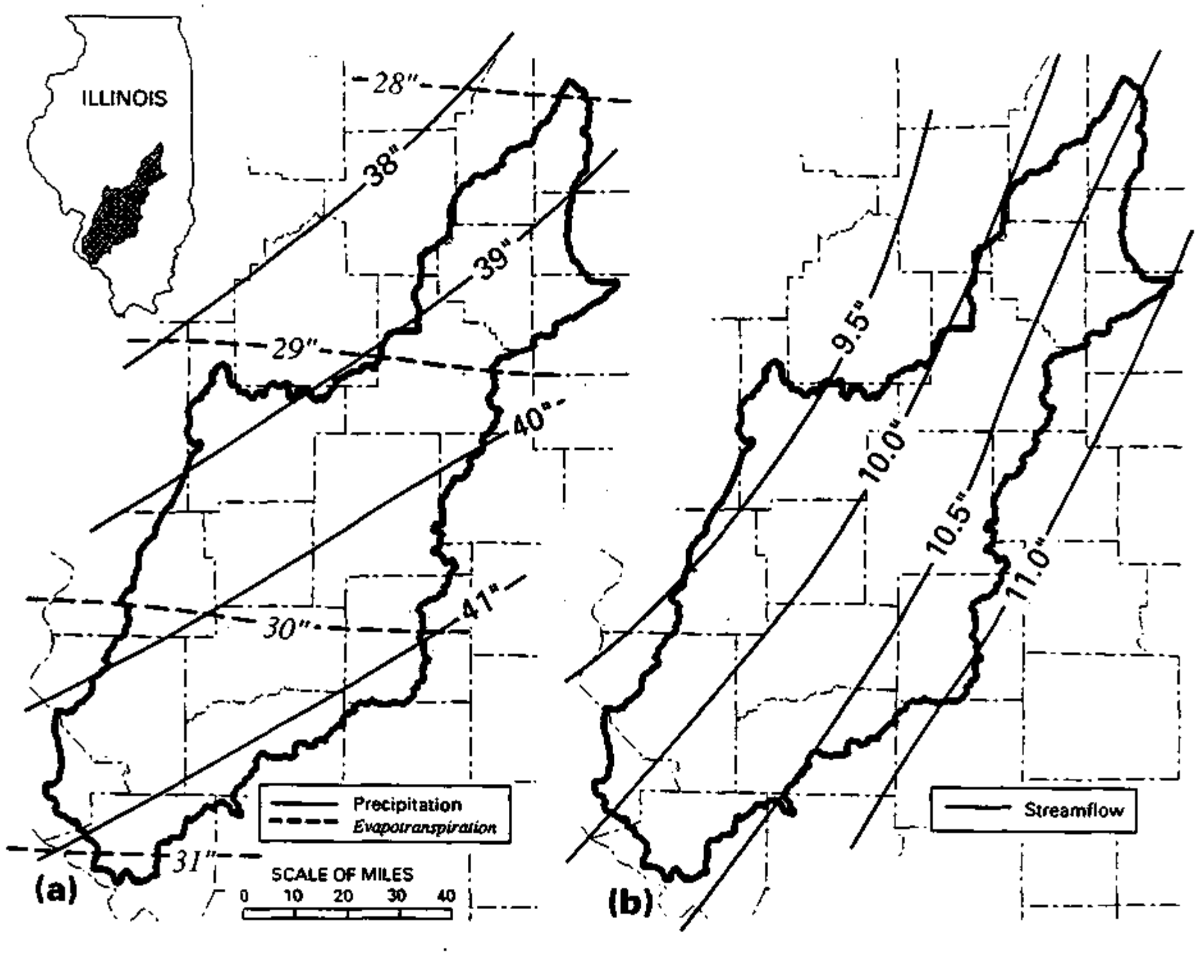

Figure 5. Geographic distribution of a) average annual precipitation **and** evapotranspiration, **and b) streamflow in the Kaskaskia River basin, 1948-1988 (inches/year)**

Table 4 lists the drought periods at the nine precipitation gages that have the greatest cumulative deficit of below-average precipitation. The cumulative precipitation deficit is one of the indicators of a hydrologic drought (a drought that is likely to impact streamflows). Most of the severe hydrologic droughts follow periods in which a precipitation deficit lasted more than a year. The examples in table 4 show that many severe droughts lasted 17 to 32 months and extended over at least two summers. Shorter droughts may also produce significantly low streamflows if the rate of precipitation deficit is particularly intense, but they will not impact water supply reservoirs as severely.

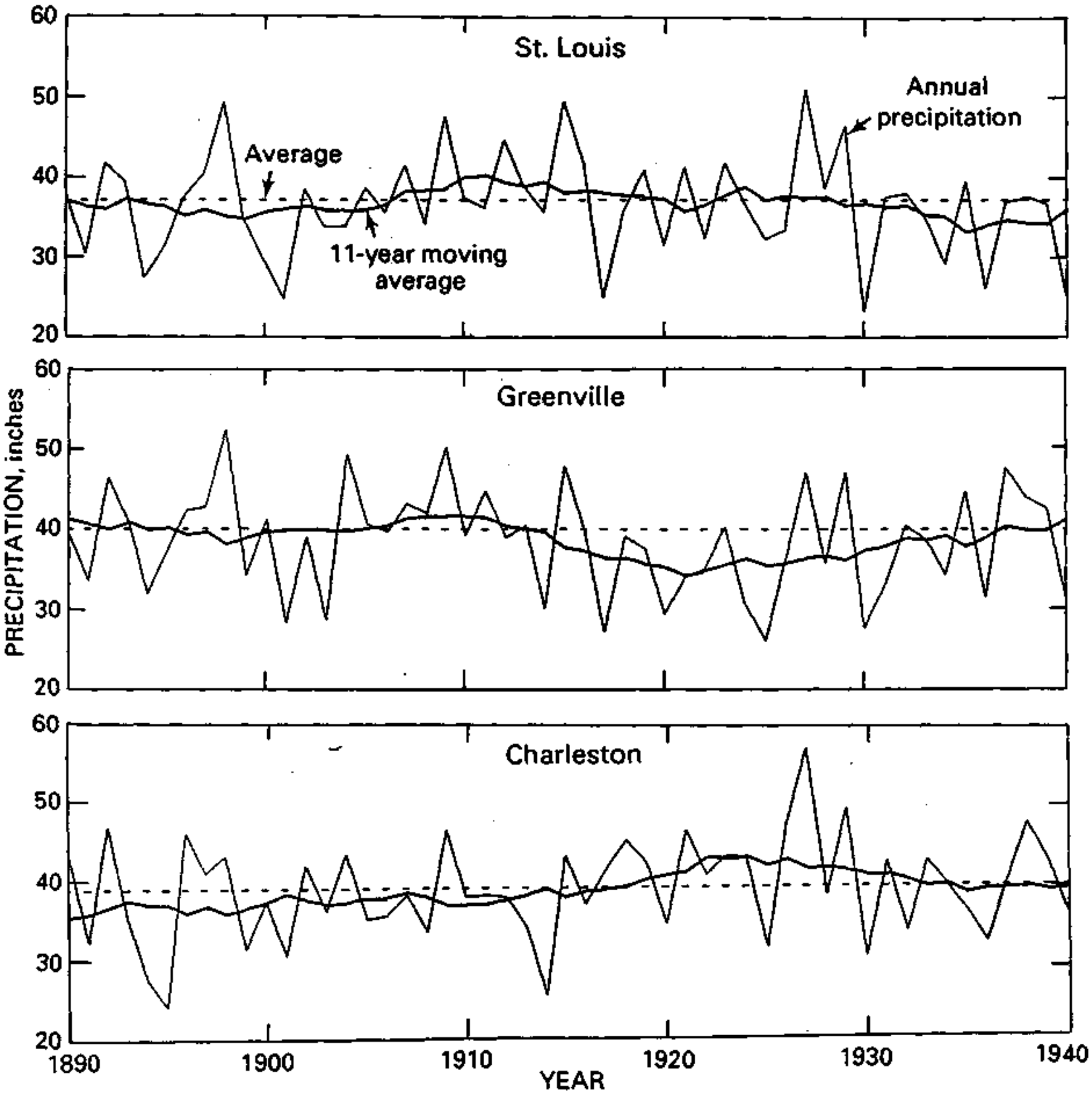

Figure 6. Annual precipitation, 11-year moving average of annual precipitation, and long-term average precipitation: St. Louis, Greenville, and Charleston, 1890-1940

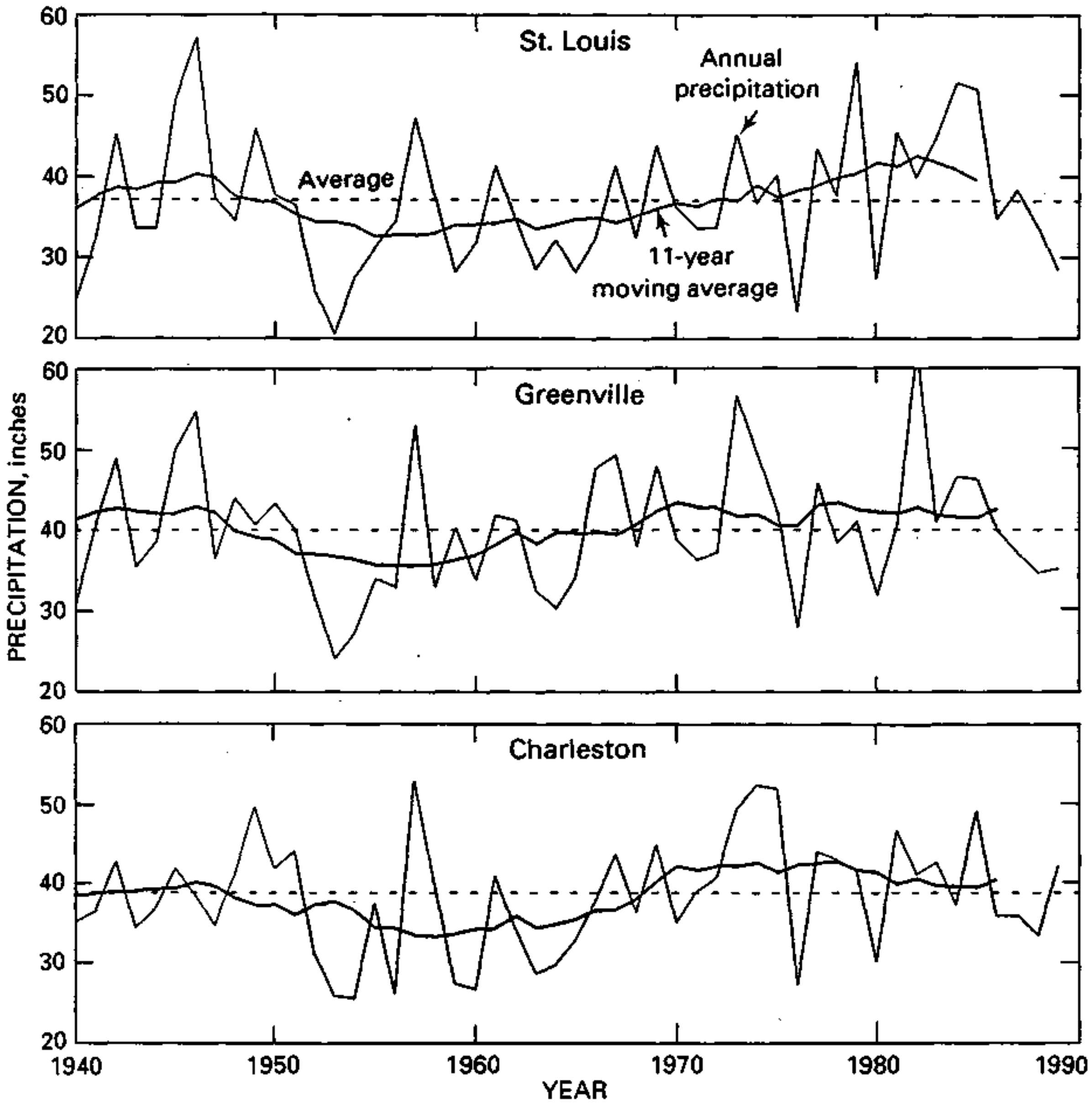

Figure 7. Annual precipitation, 11-year moving average of annual precipitation, and long-term average precipitation: St. Louis, Greenville, and Charleston, 1940-1990

Table 4. Precipitation Deficits (cumulative inches) and Historical Drought Ranking, Easkaskia River Basin, 1837-1988

Locations:
1) Carlinville
2) Charleston
3) Decatur
4) Greenville
5) Hillsboro
6) Pana
7) St. Louis
8) Sparta
9) Springfield

Drought period (duration)	Locations 1	2	3	4	5	6	7	8	9
Jan 1837 - Dec 1838	......	......	......	......	......	......	20.6	......	......
(24 months)									
Feb 1870-Apr 1872	......	......	32.4	......	......	......	33.7	......	......
(27 months)			#2				#1		
Jan 1879 - Oct 1879	......	....	......	......	......	......	15.7	......	......
(10 months)									
Jul 1893-Oct 1895	28.1	33.5	34.0	19.4	......	......	31.0	25.4	25.0
(28 months)	#2	#2	#2	#5			#3	#5	#2
Mar 1900 - Feb 1902	15.7	12.0	12.5	10.8	20.9	16.3	28.6	26.1	16.9
(24 months)					#4	#6	#4	#3	
Dec 1913-Apr 1915	16.2	19.4	17.5	17.1	17.7	20.6	10.2	12.6	17.7
(17 months)		#7		#6*	#5	#4			#4
Mar 1930 - Jul 1931	21.3	21.2	19.3	24.3	26.0	25.5	27.0	28.7	15.9
(17 months)	#3	#4	#4	#2	#3	#2	#5	#2	
Sep 1939-Aug 1941	16.8	17.2	17.9	19.5	26.4	24.3	31.3	25.6	20.2
(24 months)				#4	#2	#3	#2	#4	#3
May 1952-Dec 1954	32.6	34.3	28.3	36.3	36.5	29.8	26.2	26.9	25.4
(32 months)	#2	#2	#3	#2	#1	#2	#6	#2	#2
Sep 1962 - Oct 1964	17.6	25.3	18.7	21.0	16.8	17.6	22.4	17.7	10.0
(26 months)	#4	#3	#5	#4	#6	#5	#7	#6	
Apr 1976-Feb 1977	16.6	12.9	12.5	9.0	14.6	14.8	14.4	11.1	15.0
(11 months)									
Apr 1988-Oct 1988	11.0	10.9	12.0	8.7	13.5	11.7	14.1	6.1	13.1
(7 months)									

Note: Drought Ranks: #1 = the drought with the greatest precipitation deficit at the location, #2 = the drought with the second greatest deficit, etc.

The values in table 4 indicate that the deficit in precipitation, and therefore the total impact of a drought, is not uniform across the watershed. For example, these values help identify the 1952-1954 drought as the most lengthy and geographically extensive drought in this area since 1900. However, in the western part of the watershed (near St. Louis and Sparta) the droughts of 1930-1931 and 1939-1941 were characterized by a greater deficit in precipitation. Two earlier droughts, occurring in 1870-1872 and 1893-1895 were not recorded by all of the precipitation gages, but appear to have been similar in severity to the 1952-1954 drought. The droughts experienced in the last 20 years, in 1976-1977 and 1988, were intense but lacked the duration of the more severe droughts on record.

Evapotranspiration

The spatial distribution of average annual evapotranspiration over the Kaskaskia watershed is also shown in figure 5a. Values range from approximately 31 inches at the southern edge of the watershed to 28 inches near the headwaters of the basin. These values are taken from Knapp (1988) and are estimated as the difference between the 1951-1980 precipitation and the average streamflow from selected gaging stations for the same period. The methodology used is presented in Jones (1966).

Streamflow

The estimated average streamflow over the Kaskaskia River basin is approximately 10.25 inches; and it ranges from less than 9.5 inches on the western edge of the watershed to 11.0 inches on the eastern edge. The geographic distribution of average annual streamflow in the watershed is presented in figure 5b.

Monthly Differences

A typical distribution of precipitation, evapotranspiration, and streamflow over the Kaskaskia watershed for each month of the year is shown in table 5. The evapotranspiration and streamflow do not total the precipitation in any one month due to the effect of subsurface storage of water (soil and ground water). For any one month, the average addition to this subsurface storage (AS) is estimated as the remainder between the precipitation (P), the evapotranspiration (ET), and the streamflow (Q): AS = P - ET - Q. The total streamflow (Q) is the sum of both direct surface runoff and the baseflow that originates from the subsurface storage.

The monthly estimates of evapotranspiration were produced using a soil moisture budget model that was developed at the Water Survey for use in watershed modeling (Durgunoglu et al., 1987). Evapotranspiration is noticeably greater than precipitation during the height of the

Table 5. Typical Monthly Distribution of Precipitation, Evapotranspiration, Streamflow, and Subsurface Storage (inches)

Month	P	ET	Q	ΔS
January	2.0	0.2	1.1	+0.7
February	2.2	0.6	1.6	+0.0
March	3.6	1.2	1.9	+0.5
April	4.0	2.3	1.5	+0.2
May	4.2	3.4	0.8	0.0
June	4.3	4.8	0.7	-1.2
July	4.1	5.9	0.6	-2.4
August	3.6	5.3	0.2	-1.9
September	3.2	3.0	0.1	+0.1
October	2.6	1.7	0.2	+0.7
November	3.0	0.7	0.5	+1.8
December	2.7	0.2	1.0	+1.5
TOTAL	39.5	29.3	10.2	0.0

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

growing season, June through August, when the greatest reduction in subsurface water storage occurs. The lowest streamflow rates are expected near the end of the growing season (August through October), when soil moisture and ground water are at their annual minimums. Average runoff is highest in February, March, and April, when the soil is frequently saturated.

Population

The Kaskaskia River basin is a predominantly rural watershed, with a total population in 1986 of approximately 420,000. The two largest cities in the watershed are Champaign (population 59,180) and Belleville (42,840), although Champaign is not totally contained within the watershed. No other cities exceed a population of 20,000. The watershed is bordered by two metropolitan areas (East St. Louis and Champaign-Urbana), but neither of these urban areas is likely to see sufficient population growth in the next 30 years to significantly affect the population of the Kaskaskia watershed.

The 1986 population for each of the 22 counties partially or wholly contained within the watershed is given in table 6. The 1986 population shows a mild increase of 11.4% from the 1970 population. Population projections using Illinois Bureau of the Budget data show an expected 8.0% increase in population in the basin during the period 1986-2020. Most of this projected population increase is expected in St. Clair and Champaign counties, which contain the major urban areas of the watershed.

Table 6. Population Data for Kaskaskia River Basin Counties
(in thousands)

County	1970	1986	2020*
(population within the Kaskaskia River Basin in parentheses)			
Bond	14 (14)	16 (16)	17 (17)
Champaign	163 (43)	171 (50)	185 (60)
Christian	36 (6)	36 (6)	34 (6)
Clinton	28 (28)	34 (34)	37 (37)
Coles	48 (3)	52 (3)	57 (3)
Douglas	19 (5)	20 (5)	18 (5)
Effingham	25 (1)	32 (1)	32 (1)
Fayette	21 (20)	22 (21)	22 (21)
Jefferson	31 (1)	38 (1)	43 (1)
Macon	125 (0)	127 (0)	127 (0)
Macoupin	45 (2)	49 (2)	48 (2)
Madison	251 (23)	250 (28)	249 (33)
Marion	39 (35)	44 (40)	47 (43)
Monroe	19 (6)	21 (6)	25 (7)
Montgomery	30 (28)	32 (30)	32 (30)
Moultrie	13 (13)	15 (14)	15 (14)
Perry	20 (0)	22 (0)	24 (0)
Piatt	17 (6)	16 (6)	16 (6)
Randolph	31 (12)	35 (13)	36 (13)
St. Clair	285(102)	270(113)	281(128)
Shelby	23 (17)	24 (18)	23 (17)
Washington	14 (11)	15 (12)	15 (12)
TOTAL	1297(376)	1341(419)	1383(456)

* Population projections for counties are from the Illinois Bureau of the Budget (1987).

Note: Estimates of the population of each county within the Kaskaskia watershed are based on data from the 1980 Census of Population (U.S. Bureau of the Census, 1980) and observed trends within the counties since the 1970 census.

WATER USE AND WATER SUPPLY IN THE KASKASKIA RIVER BASIN

An average amount of approximately 36 million gallons per day (mgd) is used for public water supply in the Kaskaskia watershed. This amount has risen significantly since 50 years ago, when total water use was reported as 7.3 mgd (Illinois State Planning Commission, 1938). The increase is related to increased population (+45%), an increase in the percentage of the population using a public water supply system (+100%), and an increase in the per-capita consumption rate (+70%). Average water use per capita over this period has risen from 60 gallons per day to approximately 100 gallons per day. Public water systems currently supply more than 90% of the population in the watershed, including almost all towns with more than 300 people. Changes in total water use in the next 30 years are expected to be most closely tied to population increases. The per-capita use has not changed dramatically since 1970, nor is it expected to change much in the near future.

Surface water sources supply approximately 25 of the 36 mgd used for public water supply. Of this amount approximately 14 mgd is supplied by reservoirs, 2 mgd is supplied by direct withdrawals from the Kaskaskia River and Shoal Creek, and 9 mgd is imported to the basin from the Mississippi River. Ground-water supplies, totalling 11 mgd, are a major source of public water only in Champaign, Piatt, Moultrie, and Shelby Counties. The sources of all of the major public water supply systems in the watershed is given in table 7. Tne effect of these water uses on streamflow conditions is examined in the section, "Estimating Virgin and Present Flow Conditions from Streamflow Records."

Surface water supply also provides cooling for two power plants at Coffeen Lake and Baldwin Lake. The water used from Coffeen Lake is recirculated back into the reservoir, which is not considered a major consumptive use of water. Baldwin Lake is a shallow pond that receives its water by direct withdrawal from the Kaskaskia River. This withdrawal from the Kaskaskia River accounts for an average annual consumption rate of 18 mgd (Durgunoglu and Singh, 1989).

Use of Lake Shelbyville and Carlyle Lake Water

Two major untapped sources of water supply in the Kaskaskia watershed are the major reservoirs, Lake Shelbyville and Carlyle Lake. When these reservoirs were built in 1969 and 1967, respectively, the State of Illinois reserved storage in the reservoirs as a precaution against future water shortages. Several studies (Singh et al., 1972; Singh, 1977) have analyzed the use of these reservoirs as water supply sources. However, up to this point the state has not used the reserve storage —partly due to the lack of demand for this water, but also because using this storage might obligate the state to pay a share of the annual maintenance costs for the lakes.

Table 7. Public Water Supply Systems and Sources

PUBLIC WATER SUPPLY FROM GROUND-WATER SOURCES

Arthur	Ramsey
Atwood	Raymond
Bement	Shelbyville
Champaign	Sullivan
Lovington	Tolono
Pocahontas	Troy

PUBLIC WATER SUPPLY FROM SURFACE WATER SOURCES

Primary sources: C • Channel dam
D - Direct withdrawal from stream
I - Impounding reservoir
S - Side-channel reservoir

County	System name	Major communities served	Primary smime
Bond	Greenville	Donnellson Greenville Mulberry Grove Panama Smithboro	I - Governor Bond Lake
	Sorento	Sorento	I - Sorento Reservoir
Christian	Pana	Pana	I - Lake Pana
Clinton	Breese	Breese	C - Shoal Creek
	Carlyle	Beckmeyer Boulder Carlyle Hoffman Huey Shattuc	D - Kaskaskia River
	Keyesport	Keyesport	I • Lake Carlyle
Douglas	Douglas Water Company	Tuscola Areola Quantum Chemicals (USICC)	S - Kaskaskia River
Fayette	Farina	Farina	I-BorrowPit
	St. Elmo	Brownstown St. Elmo St. Peter	I - Lake Nellie
	Vandalia	Vandalia	I - Vandalia Lake
Madison	Highland	Grantfork Highland Pierron St. Jacob	I - Highland Silver Lake

Table 7. Concluded

County	System name	Major communities served	Primary source
Marion	Centralia	Centralia Hoffman Hoyleton Irvington Rich view Junction City Odin Sandoval Walnut Hill Wamac	I - Raccoon Lake
	Kinmundy	Alma Kinmundy	I - Kinmundy Reservoir
	Patoka	Patoka Vernon	S - North Fork Kaskaskia
	Salem	Salem	I - Salem Reservoir
Montgomery	Hillsboro	Coffeen Hillsboro Schram City Taylor Springs	I - Lake Hillsboro
	Litchfield	Butler Litchfield	I - Lake Lou Yeager
Randolph	Coulterville	Coulterville	I - Coulterville Reservoir
	Evansville	Ellis Grove Evan svi lie	D - Kaskaskia River
St. Clair	Kaskaskia Water Dist.	Lenzburg Marissa New Athens Tilden	D - Kaskaskia River
	SLM Water Comm.	Freeburg Hecker Smithton Lebanon Mascoutah New Baden New Memphis Summerfield Trenton	S - Kaskaskia River
	American Water Company	Belleville OTallon Scott AFB	D - Mississippi River (transfer from outside the watershed)
Washington	Nashville	Hoyleton Nashville New Minden	I - Nashville Reservoir

Source: Major portions of this list are taken from Singh et al. (1988).

One likely use of this storage is to supplement flows in the Kaskaskia Navigation Channel, which is located in the lowest 36 miles of the river. The navigation channel was originally designed for use by commercial barges, particularly for transporting coal. But at present, its overwhelming use is for recreational boating. The Kaskaskia Lock and Dam, located 0.8 mile upstream of the confluence with the Mississippi River, ordinarily provides for sufficient depth in the channel for navigation purposes. However, during drought conditions low flows in the Kaskaskia River are insufficient to counter losses in the channel due to evaporation and lockages. Analysis by Durgunoglu and Singh (1989) resulted in several alternative actions to relieve low stages in the navigation channel (other than releasing water from Carlyle Lake). These actions include: 1) raising the normal pool level of the navigation channel, 2) partial restrictions in the Baldwin Lake withdrawal from the Kaskaskia River, and 3) pumping water into the channel from the Mississippi River. To date, no course of action concerning the navigation channel has been undertaken.

Part II. Streamflow Assessment

STREAMFLOW RECORDS

Table 8 provides a list of stream gaging records in the Kaskaskia watershed. Gaging records for locations in the Kaskaskia watershed fall into one of four categories:

1) Stations that provide continuous records of discharge.
2) Stations that have continuous records of stage, but inadequate ratings of stage versus discharge.
3) Crest-stage gages.
4) Miscellaneous measurements of discharge.

The United States Geological Survey (USGS) has operated 28 stream gages in the Kaskaskia watershed that provide continuous estimates of daily streamflow. The locations of these gaging stations are provided in figure 8. Table 8 also lists 18 continuous-stage records, 7 crest-stage records, and 12 miscellaneous-discharge measurement sites. Several stream gages in each of the four categories are not listed because the gaging records cover fewer than 5 years.

Applicability of Gaging Records for the Streamflow Assessment Analysis

The estimation of the streamflow parameters used in *ILSAM* requires continuous records of daily discharge over a relatively long period of record. Only 7 of the 28 USGS gaging stations listed in table 8 have operated for periods of more than 25 years. For many of the gages having shorter records, the length of the record may be insufficient to cover a wide range of hydrologic conditions. For example, many of the gages have been operational since only the mid-1960s, which is a period of above-normal rainfall and streamflow. These streamflow records may be inappropriate for estimating long-term conditions because they may contain an excessive proportion of high streamflow events, or they may lack information concerning severe droughts. Estimates of streamflow frequency derived from stations whose records do not span 25 years were either adjusted to reflect expected conditions for the longer period 1948-1988 (see the section, "Estimating Flow at Gaged Sites: Defining Flow Frequency"), or they were not included in the analysis. The stations with continuous records of stage are also of limited use in developing quantitative flow information because stage-discharge ratings for low flows change significantly over time.

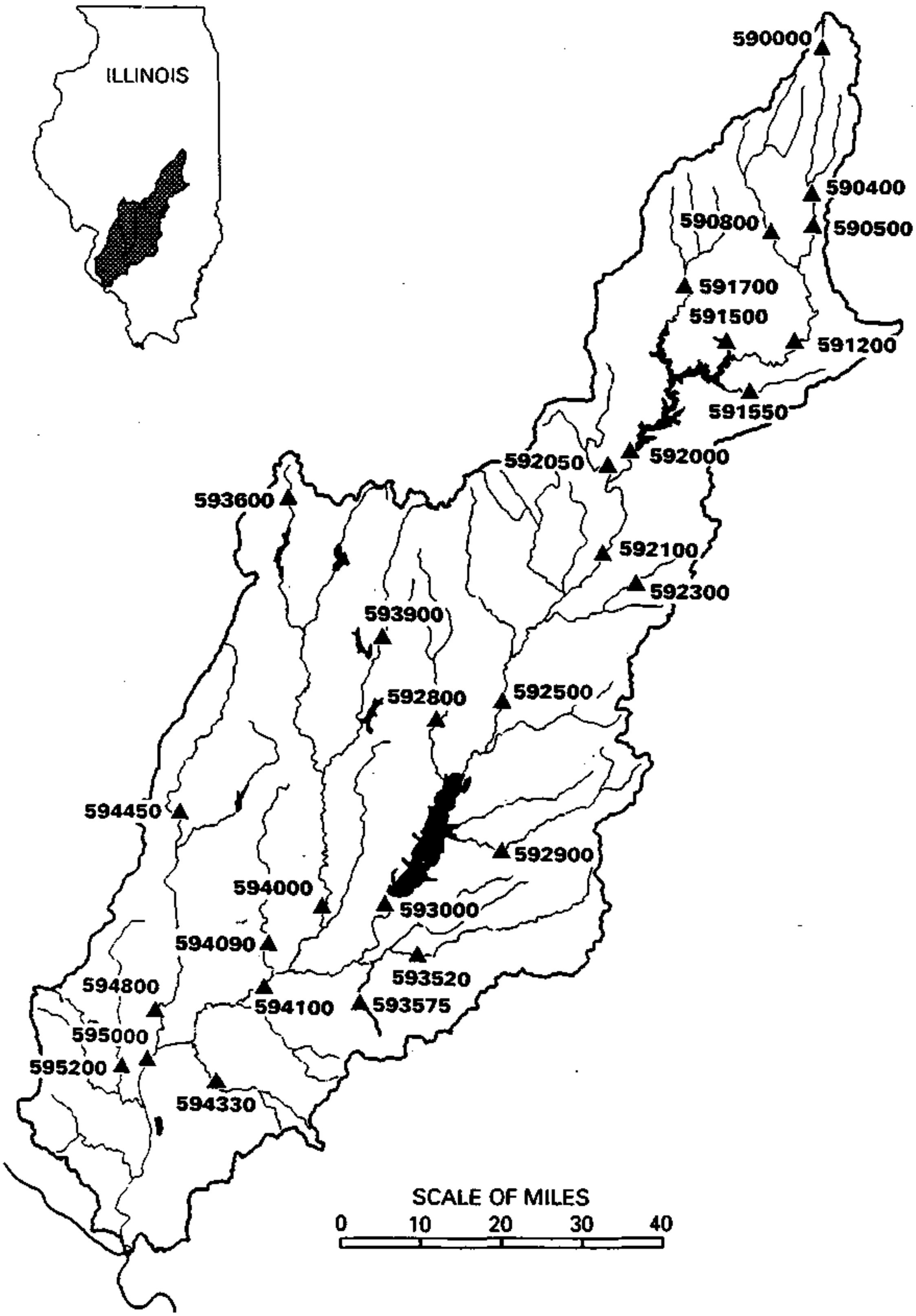

Figure 8. Stream gages in the Kaskaskia River basin that provide continuous records of discharge

Table 8. Selected Stream-Stage and Discharge Records for the Kaskaskia River Basin

1. USGS Gages with daily flow records

Station name	Gage#	Years of record	Drainage area (mi)
Kaskaskia Ditch at Bondville	06-590000	(1948-89)	12.4
Kaskaskia River near Pesotum	05-590400	(1964-79)	109.
Kaskaskia River at Ficklin	05-590500	(1954-64)	127.
Lake Fork at Atwood	05-590800	(1972-89)	149.
Kaskaskia River at Cooks Mills	05-591200	(1970-89)	473.
Asa Creek at Sullivan	05-591500	(1950-82)	8.05
Whitley Creek near Allenville	05-591550	(1980-89)	34.6
West Okaw River near Lovington	05-591700	(1980-89)	112.
Kaskaskia River at Shelbyville	05-592000	(1940-89)	1054.
Robinson Creek near Shelbyville	05-592050	(1979-89)	93.1
Kaskaskia River near Cowden	05-592100	(1970-89)	1330.
Wolf Creek near Beecher City	05-592300	(1958-82)	47.9
Kaskaskia River at Vandalia	05-592500	(1908-12; 1914-89)	1940.
Hurricane Creek near Mulberry Grove	05-592800	(1970-89)	150.
East Fork Kaskaskia River near Sandoval	05-592900	(1979-89)	113.
Kaskaskia River at Carlyle	05-593000	(1933-89)	2719.
Crooked Creek near Hoffman	05-593520	(1974-89)	254.
Little Crooked Creek near New Minden	05-593575	(1967-89)	84.3
Bluegrass Creek near Raymond	05-593600	(1960-82)	17.3
East Fork Shoal Creek near Coffeen	05-593900	(1963-89)	55.5
Shoal Creek near Breese	05-594000	(1945-89)	735.
Sugar Creek near Albers	05-594090	(1972-82)	124.
Kaskaskia River near Venedy Station	05-594100	(1969-89)	4393.
Mud Creek near Marissa	05-594330	(1970-82)	72.4
Silver Creek near Troy	05-594450	(1966 89)	154.
Silver Creek near Freeburg	05-594800	(1970-89)	464.
Kaskaskia River at New Athens	05-595000	(1934-71)	5181.
Richland Creek near Hecker	05-595200	(1969-89)	129.

2. Recording gages with stage records

Station name	Recording agency*	Years of record	Drainage area (mi^2)
Becks Creek near Herrick	SLCOE	(1955-89)	97.
Hickory Creek near Bluff City	SLCOE,USGS	(1955-79)	77.6
Robinson Creek near Shelbyville	SLCOE	(1973-79)	93.1
Silver Creek near Freeburg	SLCOE	(1965-70)	464.
Big Creek near Wrights Corners	SLCOE	(1955-89)	90.
Hurricane Creek near Mulberry Grove	SLCOE	(1955-70)	152.
East Fork Kaskaskia River near Sandoval	SLCOE	(1955-79)	113.
North Fork Kaskaskia River near Patoka	SLCOE	(1955-89)	40.
Kaskaskia River near Chesterville	SLCOE	(1963-89)	363.
West Okaw River near Lovington	SLCOE	(1963-80)	112.
Marrowbone Creek near Bethany	SLCOE	(1963-89)	34.
Whitley Creek near Allenville	SLCOE	(1963-80)	34.6
Jonathan Creek near Sullivan	SLCOE	(1963-89)	56.
Crooked Creek near Hoffman	USGS	(1968-74)	254.
Silver Creek near Lebanon	IDOWR	(1952-61)	284.
Little Silver Creek near Lebanon	IDOWR	(1952-58)	33.0
Richland Creek near Belleville	rDOWR	(1952-61)	12.7
Kaskaskia River at Fayetteville	SLCOE	(1959-69)	4598.

Table 8. Concluded

3. USGS crest-stage measurement sites

Station name	Years of record	Drainage area (mi^2)
Bluegrass Creek near Raymond	1983-89	17.3
Bluegrass Creek tributary near Raymond	1959-71	0.41
Stringtown Branch tributary near Lake City	1961-80	0.70
Hurricane Creek tributary near Witt	1956-80	014
Mud Creek tributary near Tower Hill	1956-76	0.20
Williams Creek near Cordes	1956-72	1.84
Shoal Creek tributary near Old Ripley	1960-69	2.22

4. USGS miscellaneous discharge measurement sites

Station name	Number of measurements	Years of record	Drainage area (mi^2)
West Okaw River near Lovington	33	1971-73	112.
Becks Creek at Herrick	99	1961-63,1980-88	97.0
Hickory Creek near Bluff City	133	1961-63,1978-88	77.6
Crooked Creek near Odin	116	1978-87	89.2
Shoal Creek near Walshville	73	1982-89	281.
Shoal Creek near Panama	59	1978-81	286.
Sugar Creek at Albers	33	1983-89	124.
Loop Creek near Belleville	33	1970-73	7.1
North Fork Kaskaskia River near Patoka	10	1961-63 ---	
East Fork near Sandoval	12	1961-63	---
Ramsey Creek near Ramsey	13	1961-63	---
Big Creek near Wrights Corners	13	1961-63	---

*** SLCOE = St. Louis District, U.S. Army Corps of Engineers.**
IDOWR = Illinois Dept. of Transportation, Division of Water Resources.

ESTIMATING FLOW AT GAGED SITES: DEFINING VIRGIN AND PRESENT FLOW CONDITIONS

The hydrologic evaluations used in the development of the Illinois Streamflow Assessment Model required separating the effects of surface water withdrawals and effluent discharges from the daily streamflow record for each of the stream gages. In order to accomplish this, daily time series were developed for each withdrawal and effluent discharge affecting the flow at the stream gage. The effects of reservoirs on the streamflow were also calculated. Once the effects of each of the different flow modifiers were quantified, they were subtracted from the daily streamflow record to produce the time series of virgin flow. The estimation of the effects of the flow modifiers is described in the following paragraphs.

Discharges to Streams

There are 48 major discharges to streams in the Kaskaskia watershed. The discharges and the variation in the amount of the discharges are listed in appendix B. Forty-six are effluent discharges from public water supply systems. In almost all cases, the public water supply systems have combined sanitary-storm sewers, so the discharges from these systems will be significantly greater following storms and during wet periods of the year. The expected variations in these effluent discharges are analyzed in the following paragraphs.

The remaining two major discharges in the Kaskaskia watershed are: 1) the water supply wells for the Douglas Water Company, which discharge into the Kaskaskia Ditch near Bondville; and 2) the return of cooling water to the Kaskaskia River from Lake Baldwin. Pumping records obtained from Douglas Water Company and the concurrent stream gage record at Bondville were analyzed to estimate the present flow conditions in the Kaskaskia Ditch. This discharge is unique in the watershed, in that the maximum discharge occurs when streamflow is lowest. The return of water from Lake Baldwin was analyzed by Durgunoglu and Singh (1989) in conjunction with withdrawals at that site to produce values of average net consumption (withdrawals minus returns).

Variations in Effluent Discharge

Variations in effluent discharge were examined on three time scales: annual, seasonal, and daily. Annual trends in effluent discharge can be presumed to be proportional to the trends in water use. The evaluation of long-term changes in water use and effluent discharge was accomplished by examining the Illinois State Water Survey's historic records of water use and establishing a trend over the period of record for each stream gage. The seasonal and day-to-day variations in effluent discharge from the average annual value were estimated from selected monthly and daily records of discharge from wastewater treatment plants. These monthly totals of discharge for the period 1982-1988 were obtained from the Illinois Environmental Protection Agency for all of the major wastewater treatment plants in the Kaskaskia River basin. Most of the municipal discharges in the basin are from combined systems, in which the water treatment plant processes both sewage and storm runoff. For this reason, the periods of record with a high rate of effluent discharge usually coincide with periods of high stream runoff. An example of the relationship between monthly average effluent and discharge and streamflow is shown in figure 9 for the Champaign Sanitary Treatment Plant and the flow in the Kaskaskia Ditch at Bondville. The monthly effluent discharge is estimated to be a linear function of the flow in the receiving stream:

$$QEest.1 = a + bQstream \quad ft)$$

where a and b are dependent on location and long-term trends in water use. This relationship can be applied to estimate effluent discharges on a daily basis.

Underlying the linear relationship between effluent discharge and streamflow is a seasonal change in the effluents. When the estimated effluent is subtracted from the observed effluent,

$$QEresidual = Qobs - QEest.l \quad (2)$$

then the residual time series of effluents (Qresidual) displays a seasonal pattern. An example of this seasonal pattern is shown in figure 10. The estimate of the effluent provided in equation 1 can be improved by adding the mean value of the residuals for the month of interest, j:

$$QEest.2 = mean\ (QEresidual)\ j + QEest.1 \quad (3)$$

The estimation of daily effluent amounts is complicated by observed day-to-day variations in effluent discharge. The lowest effluent discharge tends to occur only on certain days (primarily on weekends). This contrasts with days of low flow in streams, which occur consecutively. For this reason, the lowest effluent discharges will not always occur on the days that have the lowest streamflow. An analysis of available daily effluent information (Knapp, 1988) provides a ratio with which to estimate the average expected daily effluent according to a concurrent daily value of streamflow. This effluent discharge ratio, EDR (provided in table 9), is multiplied by the sum in equation 3 to estimate the daily effluent. For cases when the flow at a stream gage is modified only by effluent discharges, the virgin flow can be computed by subtracting the estimates of daily effluent from the observed daily streamflows.

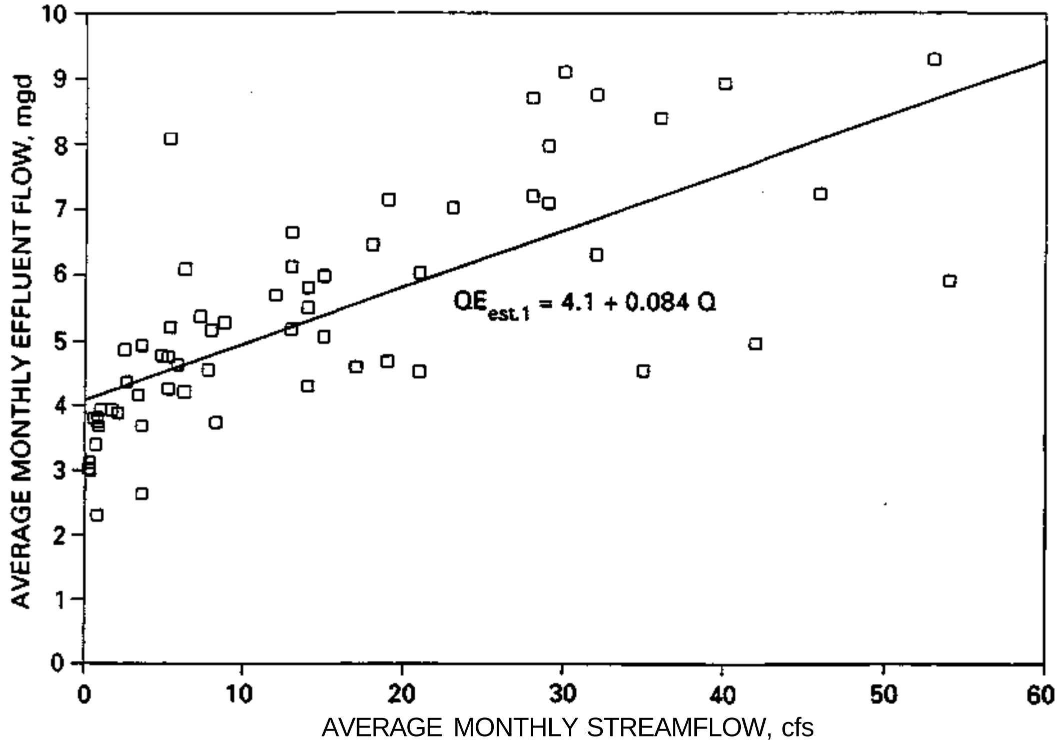

Figure 9. Relationship between the average monthly effluent for Champaign and the average monthly streamflow in the Kaskaskia Ditch near Bondville

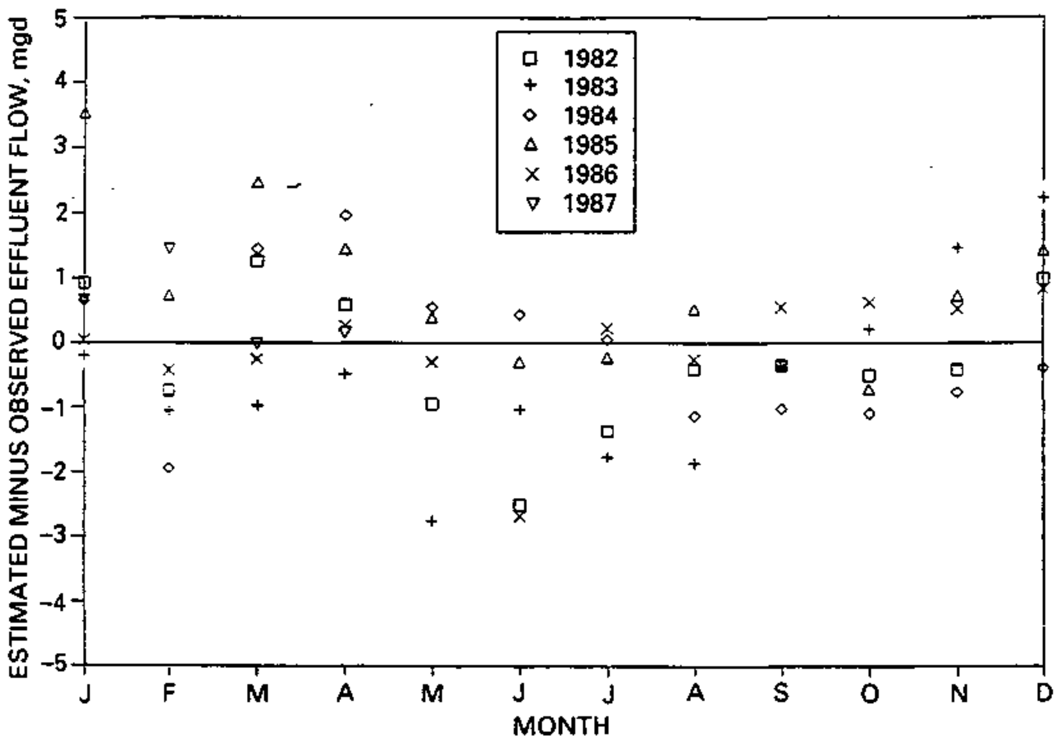

Figure 10. Seasonal pattern of residuals from equation 2

Table 9. Relationship Between the Frequency of Streamflow and the Effluent Discharge Ratio Applied to Equation 3 to Estimate Daily Effluents

Streamflow probability of exceedance (%)	Daily effluent discharge ratio (EDR)
1	0.85
2	0.86
5	0.87
10	0.91
15	0.92
25	0.95
40	1.00
50	1.01
60	1.03
75	1.05
85	1.08
90	1.11
95	1.15
98	1.25
99	1.28
99.5	1.27
99.9	1.12

Effluents Discharged into Dry Streams

When a discharge is made into a stream that is dry (zero flow), the effect of the discharged flow on streamflows downstream will be decreased through evaporation and infiltration into the streambed as the flow progresses downstream. The expected loss is computed by the following equation:

$$\text{Loss (in cfs)} = .00814\ L\ W \quad (4)$$

where L is the length of the stream reach in miles, and W is the width of the stream in feet - estimated from the flow amount, Q (cfs), and the drainage area, A (mi2), by:

$$\log10\ W = .117 \log10\ Q + .508 \log10\ A + .255 \quad (5)$$

Equation 5 is an adaptation of the hydraulic geometry relationships for the Kaskaskia River basin given in Stall and Fok (1968). The calibration of the coefficient in equation 4 was estimated through the examination of six gaging stations in central Illinois that exist downstream of an effluent into a dry stream. The value was judged to be applicable to the Kaskaskia watershed.

The implementation of equations 4 and 5 is usually completed in successive intermediate steps proceeding downstream from the location of the modifier to the site of interest. If the stream becomes wet naturally at one of these intermediate locations, the reduction of the effect of the discharge ceases.

Withdrawals from Streams

Ten major withdrawals in the Kaskaskia watershed were analyzed. The location of these withdrawals and the quantitative estimates of their effects on streamflow are provided in appendix B. The major surface water withdrawals located in the Kaskaskia watershed are from water supply reservoirs. The effects of short-term variations in these withdrawals tend to be buffered by the storage in the lakes, and for this reason they were not studied. Annual variations in withdrawals are primarily related to long-term trends in total water use. The evaluation of long-term changes in water use and withdrawals was accomplished by examining the Water Survey's historic records of water use and establishing a trend over the period of record for each stream gage. Variations in net withdrawals at Lake Baldwin were provided by Durgunoglu and Singh (1989).

Simulating the Effects of Reservoirs on the Kaskaskia River

Of the major reservoirs in the Kaskaskia watershed, only the Shelbyville and Carlyle reservoirs have gaging records that supply a daily record of either inflow or outflow to the reservoir. The relationship between inflow and outflow at these reservoirs was estimated by: 1) creating computer models to simulate the routing of flow through each of these reservoirs (using the modified-Puls routing method); 2) applying streamflow records for the period previous to dam construction (1940-1968) as inflow to the routing models; and 3) comparing the simulated outflow to both the inflow and to a control period (1970-1987) where actual flow records are available for years of normal reservoir operation. The operating policy for each of the reservoirs during the control period was replicated within the model as best possible. These operating policies are described in Singh (1977). Net evaporation rates for the Shelbyville and Carlyle reservoirs were estimated from the evaporation formula given in Roberts and Stall (1967), using climatological data from Urbana and Carbondale, respectively.

Table 10 shows the differences between the simulated outflow and the observed outflow for the different time periods. For both reservoirs, the frequency of medium flows for the simulated period is considerably less than for the observed outflows. However, much of this difference should be expected because the simulated period represents a period of lower reservoir inflows. The established minimum flows for the Shelbyville and Carlyle reservoirs are 10 cubic feet per second (cfs) and 50 cfs, respectively, and they are estimated as such in the simulated outflow. The period of observed flow at each of these reservoirs indicates a number of circumstances in

Table 10. Simulated and Recorded Outflows, Present Flow, and Virgin Flow: Shelbyville and Carlyle Reservoirs

Flow parameter	Simulated outflow (1940-1967)	Recorded outflow (1969-1988)	Estimated present flow (1940-1988)	Estimated virgin flow (1940-1988)
a) Shelbyville reservoir				
Q01	4500.	4740.	4700.	8096.
Q02	4209.	4370.	4250.	5816.
Q05	2564.	3353.	3320.	3658.
Q10	1900.	2352.	2110.	2314.
Q15	1600.	1887.	1775.	1611.
Q25	1120.	1510.	1421.	973.
Q40	485.	908.	736.	502.
Q50	382.	617.	464.	315.
Q60	224.	343.	299.	173.
Q75	46.	66.	68.	41.
Q85	20.	21.	26.	17.
Q90	10.	12.	12.	10.
Q95	10.	8.3	9.6	5.4
Q98	10.	4.1	8.1	1.8
Q99	10.	3.0	7.0	0.84
Qmean	745	961	840	844
b) Carlyle reservoir				
Q01	9195.	9920.	9860.	16493.
Q02	8752.	9426.	9389.	12371.
Q05	8161.	8587.	8456.	8318.
Q10	5326.	5966.	5680.	5712.
Q15	4150.	4753.	4385.	4350.
Q25	2910.	3444.	3232.	2511.
Q40	1410.	2083.	1792.	1215.
Q50	780.	1420.	1053.	805.
Q60	406.	833.	582.	475.
Q75	98.	245.	152.	168.
Q85	55.	59.	57.	88.
Q90	50.	55.	52.	63.
Q95	50.	50.	45.	46.
Q98	50.	44.	41.	32.
Q99	50.	41.	39.	26.
Qmean	1888	2341	2122	2135

which outflows fell below this minimum level. The occurrence of reservoir outflows below the minimum is expected to continue, and this is reflected in the estimates of present flow conditions for the period 1940-1988.

Simulating the Effects of Reservoirs Located on Smaller Streams

Reservoirs create a redistribution of flow downstream, lowering the magnitude of both high flows and low flows. The *ILSAM* model contains a technique for estimating the effect of a reservoir on flow conditions downstream. The development of this method is described in Knapp (1988). In this methodology two effects of reservoirs on streamflow are noted: 1) the detention storage of high flows and the subsequent release of this detained water, and 2) the reduction of low flows through evaporation.

Effect of Detention Storage

The effect of detention storage is estimated using five variables: 1) reservoir surface area (Ar, in mi2); 2) the width of the reservoir spillway (W, in feet); 3) the mean flow entering the reservoir (Qmean, in cfs); 4) the 1% flow duration of inflow (Ql, in cfs); and 5) the 2% flow duration of inflow (Q2, in cfs). The total volume of flow detention, Vdet. expressed as an average flow (cfs) over the entire flow period, is estimated by the empirical formula:

$$V_{det} = (Q1 - Q2)(a\, A_r^{\,b} + c) \qquad (6)$$

in which:

$$a = 5\, W^{-0.5} \,(Q_{mean} + 500\, W^{-0.5})^{-0.8}$$

$$b = 1.08 - 160\,(100 + Q_{mean})^{-1.2}$$

$$c = -Q_{mean} / 1250$$

The flow volume detained during periods of high flow is redistributed throughout the remaining flow record, particularly during medium flows. The changes in the flow duration curve that result from the redistribution of Vdet are given by the following set of equations:

$$
\begin{aligned}
Q01' &= Q01 - 27.0\ Vdet \qquad (7)\\
Q02' &= Q02 - 15.0\ Vdet\\
Q05' &= Q05 - 2.0\ Vdet\\
Q10' &= Q10 + 2.0\ Vdet\\
Q15' &= Q15 + 2.5\ Vdet\\
Q25' &= Q25 + 2.5\ Vdet\\
Q40' &= Q40 + 1.5\ Vdet\\
Q50' &= Q50 + 1.0\ Vdet\\
Q60' &= Q60 + 0.75\ Vdet\\
Q75' &= Q75 + 0.25\ Vdet
\end{aligned}
$$

The effect of detention storage on other flow variables, such as the monthly flow duration, is estimated by transforming these variables from the annual flow duration curve.

Effect of Evaporation

Evaporation will reduce low flows from the reservoir during the summer and fall months. The effect of this reduction on the annual flow duration is estimated using three variables: 1) the reservoir surface area, 2) the mean flow entering the reservoir, and 3) the average subsoil permeability of the watershed, K (in inches per hour). For a particular flow amount, Q (cfs), and its associated frequency of occurrence, f, the total reduction in flow, Qloss (cfs), is estimated as:

$$Qloss = 20\ [\ (s2 + .1\ Moss)^{-5} - s\ ] \qquad (8)$$

where: $Ai_{oss} = [A_r - .6\ Q\ (1\text{-}f)\ ]$

$$s = [1.4 + .0034\ Qmean + In\ (K + 0.4)]\text{-}1$$

Equation 8 is applicable when the reservoir's spillway is very wide. If the reservoir has a narrow spillway (relative to the reservoir size) the greater amount of detention storage will act to augment the low flow during dry periods. For such cases the reduction of the low-flow condition will not be as great as the amount given in equation 8. The modified reduction in flow under the condition of detention storage (Qloss') is described by the empirical equation:

$$Q_{loss}' = Q_{loss}\ (1.0 - e^{-\gamma w}) \qquad (9)$$

in which w is the width of the spillway in feet, and y is a coefficient related to the surface area of the reservoir: $\gamma = .0433125\ A_r$.

Losses due to evaporation will cause the mean flow downstream of the reservoir to be reduced. The mean flow downstream of the reservoir (Qmeand) is computed as a function of the mean inflow (Qmean) and reservoir surface area as follows:

$$Qmeand = Qmean - 0.3\ Ar \qquad (10)$$

ESTIMATING FLOW AT GAGED SITES: DEFINING FLOW FREQUENCY

This section describes the development of flow frequency estimates for the virgin and present flow conditions, which were computed using the methodologies described in the previous section. Two primary considerations in the development of the flow frequency estimates were that these estimates reasonably represent long-term conditions in the watershed and that a consistent relationship was maintained between different locations. The stream gages that were analyzed have records that cover a varying set of years, and the differences in their periods of record affect the frequency estimates for each gage. In order to account for this difference in period of record, one of two adjustments was made in the estimation of frequency. The manner in which this adjustment was made depends on the type of streamflow parameter being estimated.

The streamflow parameters estimated by *ILSAM* can be divided into two broad categories: 1) flow duration statistics that are computed independent of the sequence of daily flow values, and 2) estimates of low-flow frequency that relate average conditions during a sequence of daily flows with an expected frequency of occurrence. For the first category, the flow frequency represents the percent probability that a flow value will be *exceeded on any one day.* For the second category, the frequency of occurrence represents the chance that the average flow value will *not be exceeded in any one year.*

Flow Duration Adjustments for Differences in Period of Record

To maintain consistent frequency estimates between different locations it is necessary to define a set period of years, or "base" period, to which estimates of the annual and monthly flow duration can be related. Considerations in defining this base period are: 1) having a period that includes a representative amount of both low-flow and high-flow conditions, and 2) having a period for which many stations have concurrent records. Using these guidelines, the period 1948-1988 was established as the base period for the analysis of flow duration relationships in the Kaskaskia watershed. The frequency of flow computed from gage records covering a different period were adjusted from their observed values to reflect streamflow conditions during the base period. This adjustment technique involves modifying the frequency with which each particular flow is expected to occur. The adjustment in frequency (or "frequency shift") is determined by comparing the changes in flow frequency that occur for different years at nearby gaging stations that have long-term records. This method is described in greater detail in Knapp (1988).

Defining Recurrence Intervals for Low Flows and Drought Flows

The recurrence interval for a drought or low flow is normally estimated by the formula,

$$RI=n/(N+l) \qquad (11)$$

where N is the number of years of the streamflow record, and n represents the rank of the drought in the flow record (n=l represents the worst drought on record, n=2 is the second worst drought on record, etc.). This estimate of recurrence interval is unbiased and assumes no further knowledge of flow frequency other than what occurs in the N-year record.

Knowledge of drought events, however, extends beyond the 25- to 40-year records that are normally available in the analysis of many stream gages. Though geographic variation occurs with all droughts, the most severe droughts generally affect relatively large regions with similar intensity. An examination of the few available long-term gaging records may therefore provide additional information on the frequency of observed droughts.

Drought frequency was examined for five long-term gaging records: the Sangamon River at Monticello (76 years); the Little Wabash River near Clay City (74 years); the Kaskaskia River at Vandalia (59 years); the Skillet Fork at Wayne City (71 years); and on Macoupin Creek near Kane (62 years). Figure 11 illustrates the frequency relationship for the 18-month drought at the three stations with smaller drainage areas: Monticello, Wayne City, and Kane. The frequencies in figure 11 are estimated using equation 11.

Two observations from figure 11 can provide guidelines for drought and low-flow frequency analysis in the Kaskaskia watershed. First, for all three locations, the 1954 drought is the most severe drought on record, corresponding to a recurrence interval in excess of 75 years. This suggests that in the drought frequency analysis for gages with shorter records, the 1954 drought recurrence should be retained as 75 to 100 years, rather than being estimated using equation 11. Second, the drought flow-versus-frequency plot for all three locations indicates a relatively smooth curve with similar slope. The 18-month drought frequency curve for other comparably sized watersheds in the Kaskaskia River basin should plot roughly parallel to the curves in figure 11. The flow frequency curves for the larger watersheds (the Kaskaskia River at Vandalia and the Little Wabash River near Clay City) have steeper slopes; curves for smaller watersheds are expected to have gentler slopes.

The methodology used to establish low-flow and monthly drought frequencies in this study involved using the above guidelines to determine a graphical fit to the data at each of the gaging stations in the Kaskaskia watershed.

Selected Results from the Analyses

Estimates of the 154 flow parameters were developed for 19 of the gaging stations in the Kaskaskia watershed. A selection of flow parameters for the virgin and present conditions

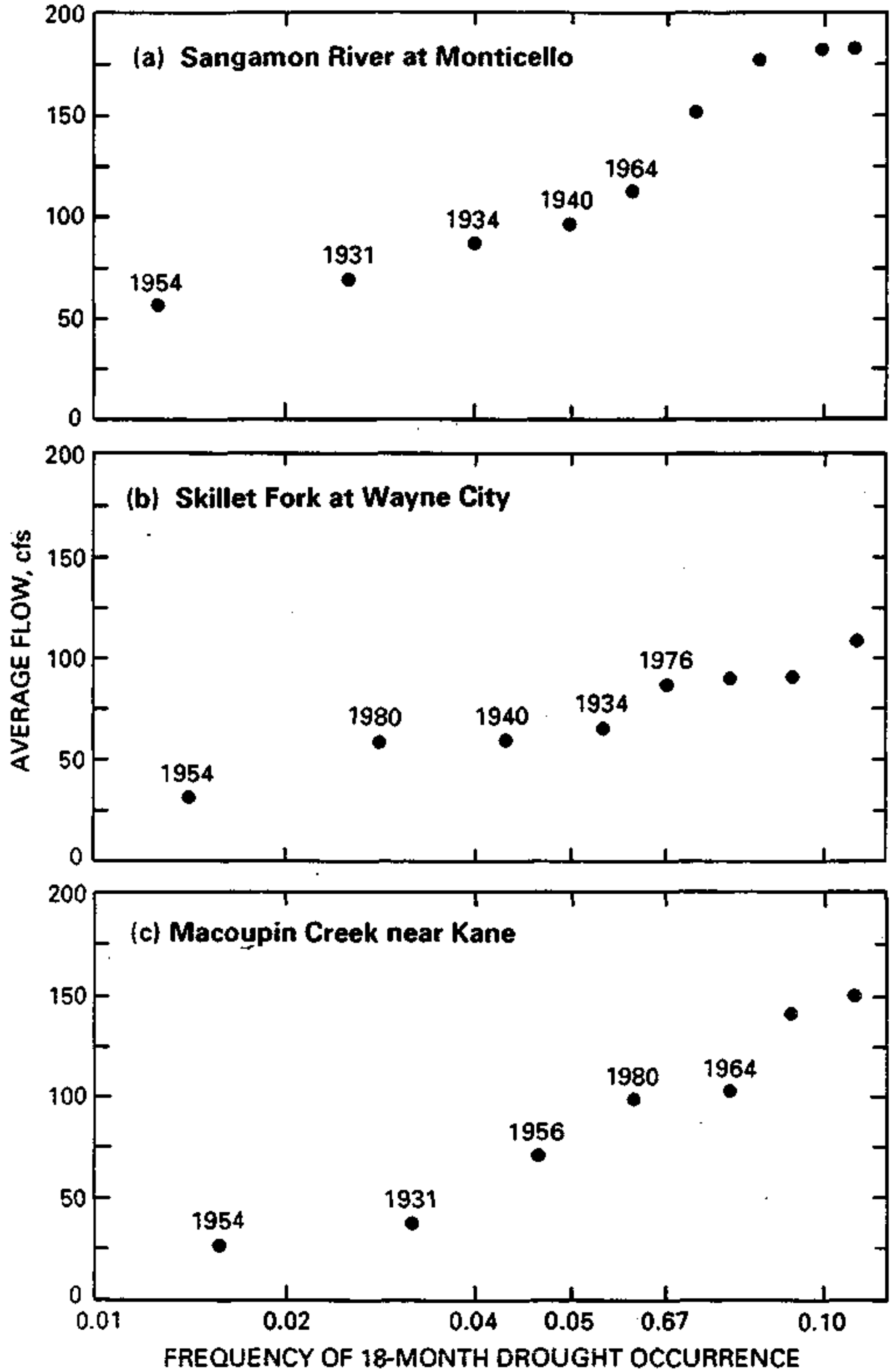

Figure 11. Relationship between the average flow in the 18-month drought and its frequency of occurrence, and years of occurrence for severe droughts

and the period of record are presented for each of these stations in table 11. A complete list of the estimated values for the 154 streamflow parameters for each stream gaging station is given in appendix A. For comparative purposes, table 11 also shows flow statistics computed from the original stream gage record, with no adjustment made for either period of record or for flow modifiers such as withdrawals, discharges, or reservoirs. Significant differences exist between estimated present flow conditions and recorded values on the Kaskaskia River and are explained either by shortness in the period of record at the gage or by the influence on the flow of the Shelbyville and Carlyle reservoirs. For most of the stations located on tributaries to the Kaskaskia River, the gaging record is fairly representative of present flow conditions.

Table 11. Selected Flow Parameters of Virgin Flow, Present Flow, and the Period of Record

Gaging station	Q7,10	Q90	Q75	Qmean	Q01
Kaskaskia River at Cooks Mills					
Record (1970-1988)	3.5	20.	57.	454.	3756.
Virgin	0.25	3.0	17.	380.	3866.
Present	2.7	11.	26.	386.	3878.
Kaskaskia River at Shelbyville					
Record (1940-1988)	0.7	10.	42.	848.	5876.
Virgin	0.6	10.	41.	844.	8096.
Present	6.0	12.	68.	840.	4700.
Kaskaskia River near Cowden					
Record (1970-1988)	7.6	35.	139.	1219.	5525.
Virgin	6.0	27.	95.	1067.	9347.
Present	12.	29.	124.	1064.	5955.
Kaskaskia River at Vandalia					
Record (1914-1988)	17.	49.	139.	1493.	11905.
Virgin	19.	48.	145.	1559.	12595.
Present	26.	52.	176.	1558.	11705.
Kaskaskia River at Carlyle					
Record (1933-1967)	23.	60.	158.	1974.	15472.
Virgin	24.	63.	168.	2135.	16493.
Present	40.	52.	152.	2122.	9860.
Kaskaskia River near Venedy Station					
Record (1969-1988)	70.	136.	508.	3785.	21494.
Virgin	48.	121.	339.	3339.	26089.
Present	65.	115.	330.	3324.	20100.
Kaskaskia River at New Athens					
Record (1924-1969)	61.	167.	385.	3632.	28138.
Virgin	69.	178.	406.	3895.	30626.
Present	89.	178.	404.	3888.	25200.
Silver Creek near Troy					
Record (1966-1988)	0.01	0.6	2.5	121.	1925.
Virgin	0.0	0.08	1.8	106.	1542.
Present	0.01	0.6	2.5	121.	1543.

Table 11. Concluded

Gaging station	Q7,10	Q90	Q75	Qmean	Q01
Wolf Creek near Beecher City					
Record (1959-1982)	0.0	0.02	0.5	37.	727.
Virgin=Present	0.0	0.0	0.6	40.	762.
Asa Creek near Sullivan					
Record (1954-1982)	0.0	0.01	0.08	6.4	81.
Virgin=Present	0.0	0.01	0.08	6.4	81.
Kaskaskia Ditch at Bondville					
Record (1949-1988)	0.06	0.2	0.8	11.	96.
Virgin=Present	0.06	0.2	0.8	11.	96.
Bluegrass Creek near Raymond					
Record (1960-1982)	0.0	0.02	0.2	12.	231.
Virgin=Present	0.0	0.0	0.2	13.	241.
Shoal Creek near Breese					
Record (1943-1988)	0.4	12.	31.	534.	6370.
Virgin	1.4	10.	28.	532.	6917.
Present	0.7	12.	30.	531.	6492.
East Fork Shoal Creek near Coffeen					
Record (1963-1988)	0.0	0.06	0.8	41.	852.
Virgin	0.0	0.07	0.3	39.	757.
Present	0.0	0.07	0.8	39.	758.
Lake Fork at Atwood					
Record (1972-1988)	0.0	0.6	12.	151.	1436.
Virgin	0.0	0.7	4.7	114.	1195.
Present	0.0	0.9	5.0	115.	1195.
Little Crooked Creek near New Minden					
Record (1967-1988)	0.0	0.2	0.9	71.	1252.
Virgin	0.0	0.04	0.9	64.	1141.
Present	0.0	0.07	1.5	65.	1143.
Hurricane Creek near Mulberry Grove					
Record (1970-1988)	0.3	2.4	6.4	144.	2480.
Virgin=Present	0.0	0.3	1.8	111.	1895.
Richland Creek near Hecker					
Record (1969-1988)	5.1	8.2	12.	109.	1776.
Virgin	0.0	0.4	2.5	93.	1616.
Present	4.8	8.5	12.	104.	1634.
Silver Creek near Freeburg					
Record (1970-1988)	1.2	7.7	19.	357.	4392.
Virgin	0.4	3.2	12.	329.	4414.
Present	3.2	9.1	20.	338.	4378.

ESTIMATING FLOW AT UNGAGED SITES

The estimation of virgin flow characteristics at an ungaged location involves two specific steps: 1) the estimation of the virgin flow conditions using equations developed with regression analyses, and 2) adjustment of this estimate when flow statistics are available from records at gaging stations on the same stream. The present flow conditions are estimated from the virgin flow values with an evaluation of the effects of flow modifiers: upstream reservoirs, withdrawals, and effluent discharges. The methodologies for evaluating these flow modifiers were presented in the section, "Defining Virgin and Present Flow Conditions from Streamflow Records."

Virgin Flow Equations

Variations in the virgin flow from one watershed to another are theoretically associated with a number of physical (topographic, geologic, and climatic) characteristics of the basin. In the following analysis, three of these watershed characteristics are used to define differences in streamflow: 1) total drainage area of the stream, 2) average permeability of the subsoil, and 3) annual average excess precipitation (precipitation minus evapotranspiration).

The basic equation used to estimate the flow values for ungaged sites of all 154 streamflow parameters used in the streamflow assessment model is:

$$Qx = \min \{Qmean [a + b K + c DA]^{-0.05} , 0\} \qquad (12)$$

where Qx (cfs) is any flow parameter estimated in the model; Qmean (cfs) is the mean flow at the location; K (inches per hour) is the average subsoil permeability of the watershed; and DA (square miles) is the total drainage area. The mean flow can be determined from estimates of the average annual values for precipitation, P (inches), and evapotranspiration, ET (inches) over the watershed:

$$Qmean = 0.0738 \; DA \; (P-ET) \qquad (13)$$

Two sets of the parameters used in equation 12, a, b, and c, were estimated using a least squares regression procedure. The first set of parameters was developed by including only streamflow data from the gages in the Bloomington Ridged Plain in the regression procedure. The second set of parameters was developed using streamflow data from gages in the Springfield Plain and the Mt. Vernon Hill Country. Fourteen USGS gaging stations were included in the sample population from which the first set of parameters was developed. These stations are listed in table 12. The second set of parameters was developed using 17 gaging stations, also listed in table 12. These stations were selected from a list of all USGS stations located

Table 12. USGS Gaging Stations Used in the Regression Analysis of Virgin Flow

a) Bloomington Ridged Plain

USGS station #	Station name	Drainage area (mi^2)	Subsoil permeability (in/hr)	Mean annual runoff (in)
05-439500	South Br Kickapoo Cr near Fairdale	387.	1.08	9.10
05-525500	Sugar Creek at Milford	446.	1.45	11.00
05-537500	Long Run near Lemont	20.9	0.40	10.80
05-546500	Fox River at Wilmot, WI	868.	3.74	6.95
05-550500	Poplar Creek near Elgin	35.2	1.16	9.10
05-554500	Vermilion River near Pontiac	579.	0.60	9.10
05-566500	East Br Panther Cr near El Paso	28.8	0.60	9.00
05-567500	Mackinaw River near Congerville	675.	0.73	10.20
05-572000	Sangamon River at Monticello	550.	0.71	10.00
05-579500	Lake Fork near Cornland	214.	1.05	9.80
05-580000	Kickapoo Creek near Waynesville	227.	0.77	9.60
05-590000	Kaskaskia Ditch near Bondville	12.4	0.77	10.45
05-591500	Asa Creek near Sullivan	8.0	0.77	10.45
05-592000	Kaskaskia River at Shelbyville	1054.	0.54	10.48

b) Springfield Plain and Mt. Vernon Hill Country

USGS station #	Station name	Drainage area (mi^2)	Subsoil permeability (in/hr)	Mean annual runoff (in)
03-344500	Range Creek near Casey	7.6	0.60	11.00
03-334600	North Fork Embarras River near Oblong	318.	0.65	11.10
03-378635	Little Wabash River near Effingham	240.	0.60	10.80
03-380500	Skillet Fork at Wayne City	464.	0.13	11.90
05-574000	South Fork Sangamon R near Nokomis	11.0	0.40	9.60
05-586800	Otter Creek near Palmyra	61.1	0.40	8.90
05-587000	Macoupin Creek near Kane	868.	0.48	8.43
05-588000	Indian Creek at Wanda	36.7	0.86	9.35
05-592300	Wolf Creek near Beecher City	47.9	0.28	10.65
05-593575	Little Crooked Creek near New Minden	84.3	0.44	10.62
05-593600	Bluegrass Creek near Raymond	17.2	0.40	9.35
05-593900	East Fork Shoal Creek near Coffeen	55.5	0.42	9.72
05-594000	Shoal Creek near Breese	735	0.58	9.66
05-594450	Silver Creek near Troy	154	0.78	9.57
05-595500	Marys River near Sparta	17.8	0.22	10.50
05-597500	Crab Orchard Creek near Marion	31.7	0.12	11.20
05-599000	Beaucoup Creek near Matthews	292.	0.18	10.90

within their respective physiographic regions, and whose period of record included the major portion of the years 1949-1988. The 1949-1988 period was chosen to maximize the number of stations that could be included in the analysis, while still retaining a predominant portion of the total available record. Several other stations, not listed, fit these criteria but were not used in the analysis because their records included significant influence from reservoirs, major effluent discharges, or other anthropogenic influences. Therefore the flows at these stations represent the virgin (or near-virgin) flow conditions of regional streams.

Coefficients for the virgin flow equations developed from regression analysis of values from these gaging stations are listed in table 13. Some of the least-squares estimates of parameters a, b, and c were modified so that a smooth transition might exist between estimates of related parameters. For example, the estimate of the 7-day, 25-year low flow (Q7,25) must always fall between the values of the Q7,10 and Q7,50. In these cases a higher error of estimate was accepted to achieve the proper relationships between parameters. These equations should be used only for watersheds between 10 and 1,000 mi2.

Application of the Regression Equations

The application of the equations is illustrated by the following example. Assume that a watershed exists with the following characteristics:

Drainage area = 62 square miles
Average soil permeability = 0.48 inch per hour
Average annual precipitation = 40.2 inches
Average annual evapotranspiration = 30.0 inches
Physiographic region: Springfield Plain

and that the following estimates of the annual flow duration are desired: Q98, Q90, Q75, Q10, and Q02. The virgin flow coefficients are taken from table 13 and used in the following computations:

Qmean = .0738 (62) (40.2-30.0) = 46.7 cfs

Q98 = min (46.7 [- 0.00174 + 0.0000068 (62) + 0.00190 (0.48)] - 0.05, 0}
= min {- 0.07 , 0} = 0.0 cfs

Q90 = 46.7 [- 0.00180 + 0.0000211 (62) + 0.00338 (0.48)] - 0.05 = 0.03 cfs

Q75 = 46.7 [0.00227 + 0.0000489 (62) + 0.01802 (0.48)] - 0.05 = 0.6 cfs

Q50 = 46.7 [0.03994 + 0.000124 (62) + 0.09961 (0.48)] - 0.05 = 4.4 cfs

Q25 = 46.7 [0.29886 + 0.000381 (62) + 0.20408 (0.48)] - 0.05 = 20 cfs

Q10 = 46.7 [1.80311 + 0.001011 (62) - 0.10537 (0.48)] - 0.05 = 85 cfs

Q02 = 46.7 [11.03862 - 0.00311 (62) - 0.4448 (0.48)] - 0.05 = 496 cfs

Table 13. Regression Coefficients for Virgin Flow Equations (Using Equations 12 and 13)

$$Qmean = 0.0738\ DA\ (P-ET)$$

$$Qx = \min \{ Qmean\ [a + b\ K + c\ DA]\ -0.05\ ,\ 0)$$

	Region 1 (Springfield Plain-Aft. Vernon Hill Country)				Region 2 (Bloomington Ridged Plain)			
	a	b	c	ce (error)	a	b	c	ce (error)
Flow Duration								
Q01	18.42243	-0.00949	0J.720	2.0539	11.37308	-0.00118	-1.44505	0.8389
Q02	11.03862	-0.00311	-0.4448	0.7633	7.78878	-0.00074	-0.80458	0.4752
Q05	4.44878	0.001337	-0.51909	0.5315	4.21772	0.0000246	-0.29777	0.2523
Q10	1.80311	0.001011	-0.10537	0.3623	2.40866	0.000266	-0.08557	0.1349
Q15	0.87690	0.000699	0.09839	0.2258	1.63600	0.000218	0.00803	0.0927
Q25	0.29886	0.000381	0.20408	0J.096	0.90690 .	0.000179	0.05760	0.0645
Q40	0.08930	0.000182	0.14334	0.0508	0.42365	0.000102	0.07891	0.0577
Q50	0.03994	0.000124	0.09961	0.0357	0.23094	0.0000731	0.09085	0.0495
Q60	0.01774	0.0000833	0.05991	0.0235	0.09932	0.0000437	0.09550	0.0398
Q75	0.00227	0.0000489	0.01802	0.0102	-0.00634	0.0000114	0.08830	0.0224
Q85	-0.00128	0.0000291	0.00612	0.0055	-0.02532	0.0000112	0.07129	0.0140
Q90	-0.00180	0.0000211	0.00338	0.0046	-0.02705	0.0000104	0.06112	0.0118
Q95	-0.00179	0.0000127	0.00240	0.0029	-0.02661	0.0000075	0.05094	0.0092
Q98	-0.00174	0.0000068	0.00190	0.0013	-0.02410	0.0000046	0.04183	0.0074
Q99	-0.00167	0.0000042	0.00130	0.0012	-0.02282	0.0000037	0.03685	0.0065
Low Flows								
Ql,2	-0.00120	0.0000161	0.00233	0.0034	-0.02423	0.0000055	0.05223	0.0110
Ql,10	-0.00060	0.0000023	0.00040	0.0008	-0.01993	0.0000042	0.03045	0.0056
Ql,25	-0.00060	0.0000007	0.00008	0.0008	-0.01774	0.0000034	0.02497	0.0045
Ql,50	-0.00060	0.0000007	0.00006	0.0007	-0.01569	0.0000044	0.01910	0.0038
Q7,2	-0.00110	0.0000180	0.00280	0.0037	-0.02511	0.0000039	0.05874	0.0121
Q7,10	-0.00060	0.0000033	0.00050	0.0007	-0.02263	0.0000042	0.03568	0.0065
Q7.25	-0.00060	0.0000010	0.00010	0.0007	-0.01967	0.0000044	0.02810	0.0048
Q7.50	-0.00060	0.0000009	0.00008	0.0007	-0.01712	0.0000052	0.02150	0.0038
Ql5,2	-0.00110	0.0000218	0.00353	0.0043	-0.02619	0.0000034	0.06562	0.0128
QlsilO	-0.00060	0.0000035	0.00064	0.0007	-0.02416	0.0000039	0.04020	0.0078
Ql5,25	-0.00050	0.0000012	0.00020	0.0008	-0.02050	0.0000038	0.03100	0.0058
Ql5,50	-0.00060	0.0000011	0.00016	0.0005	-0.01820	0.0000044	0.02500	0.0042
Q31.2	-0.00021	0.0000300	0.00688	0.0058	-0.02565	0.0000001	0.07326	0.0142
Q31.10	-0.00075	0.0000053	0.00134	0.0009	-0.02420	0.0000025	0.04434	0.0087
Q31.25	-0.00049	0.0000031	0.00038	0.0007	-0.02070	0.0000026	0.03506	0.0067
Q31.50	-0.00062	0.0000016	0.00031	0.0004	-0.01840	0.0000035	0.02800	0.0047

Table 13. Continued

	Region 1				Region 2			
	a	b	c	c_e (error)	a	b	c	c_e (error)
Low Flows								
Q61.2	0.005456	0.0000042	0.01947	0.0085	-0.02273	0.0000002	0.08503	0.0175
Q61.10	-0.00090	0.0000010	0.00248	0.0020	-0.02436	0.0000030	0.04851	0.0090
Q61.25	-0.00007	0.0000056	0.00153	0.0015	-0.02157	0.0000027	0.03834	0.0072
061,50	-0.00077	0.0000033	0.00108	0.0011	-0.01852	0.0000035	0.03072	0.0054
Q91.2	0.012613	0.0000548	0.05235	0.0132	-0.01224	-0.0000064	0.09576	0.0202
Q91.10	-0.00023	0.0000155	0.00302	0.0039	-0.02687	0.0000054	0.05407	0.0102
Q91.25	-0.00057	0.0000083	0.00174	0.0024	-0.02309	0.0000043	0.04221	0.0077
Q91.50	-0.00084	0.0000052	0.00167	0.0018	-0.01836	0.0000043	0.03279	0.0060
Drought Flows								
M6,10	0.00690	0.0000187	0.02686	0.0150	-0.02025	0.0000126	0.06140	0.0269
M6,25	0.00013	0.0000129	0.01242	0.0057	-0.02578	0.0000134	0.05318	0.0199
Me,50	-0.00123	0.0000090	0.00713	0.0036	-0.02708	0.0000112	0.04929	0.0170
M9,10	0.07385	0.0000079	0.05262	0.0390	0.05645	0.000043	0.04913	0.0692
M9,25	0.03346	0.0000041	0.02262	0.0247	0.01053	0.0000042	0.05574	0.0392
Mg,50	0.01957	-0.0000012	0.00546	0.0167	-0.00277	-0.0000013	0.05299	0.0280
M124.0	0.19903	0.0000437	0.00088	0.0533	0.21441	0.0000233	0.05117	01559
Ml 2,25	0.08679	0.0000093	0.02219	0.0366	0.09882	-0.000021	0.06497	0.0945
Ml 2,50	0.04899	-0.0000011	0.02374	0.0315	0.05853	-0.000037	0.06243	0.0674
M18.10	0.25339	0.0000211	0.01573	0.0686	0.30235	0.0000773	0.02324	01973
Ml 8,25	0.12424	0.0000101	0.01173	0.0469	0 J. 3603	0.0000199	0.04706	01129
Ml 8,50	0.07284	-0.0000068	0.01646	0.0385	0.08595	-0.000018	0.05623	0.0858
M30IO	0.42408	0.0000323	0.03910	0.0456	0.57779	0.0000312	0.01697	0.3370
M30.25	0.23584	0.0000206	-0.00989	0.0529	0.28821	0.000074	0.02383	0.1933
M30,50	0.15165	0.0000114	0.00294	0.0504	0.20469	-0.000020	0.04028	0.1382
M54.10	0.70974	-0.000053	019861	0.0931	0.82105	-0.0000035	0.02720	0.4707
M54.25	0.39877	-0.000014	010930	0.1092	0.46537	0.0000271	0.03804	0.2908
M64,50	0.24463	-0.000053	016043	0.1145	0.32438	-0.0000061	0.04610	0.2116
January Flows								
Jan-02	1417886	-0.00525	0.93757	1.6474	8.25623	0.000282	-1.38139	1.2030
Jan-10	2.55000	0.00140	010000	0.9891	2.06431	0.001110	-0.42050	0.3917
Jan-25	0.51089	0.000441	012079	01628	0.72872	0.000597	-0.14009	01719
Jan-50	0.09380	0.000133	0.07468	0.0536	0.22011	0.000232	0.00668	0.0760
Jan-75	0.02084	0.0000331	0.03835	0.0254	0.00531	0.0000419	0.06118	0.0191
Jan-90	0.00141	0.0000194	0.00059	0.0071	-0.02721	0.0000128	0.05269	0.0106
Jan-98	-0.00125	0.0000074	0.00222	0.0032	-0.02804	0.0000083	0.04232	0.0085
JANAVG	1.30080	-0.000086	0.07350	0.1487	0.88842	0.00031	-0.12603	0.1175
February Flows								
Feb-02	17.75254	-0.00708	1.25386	3.9959	9.28448	-0.00074	-1.28014	1.0674
Feb-10	3.54330	0.002811	0.00405	0.8385	2.98910	0.000841	-0.48225	0.4091
Feb-25	0.89520	0.000806	0.09344	0.2400	1.27979	0.000500	-0.20344	0.2485
Feb-50	0.21480	0.000279	013868	0.0761	0.39966	0.000239	-0.02031	0.1236
Feb-75	0.06917	0.000057	0.05541	0.0474	0.09329	0.0000907	0.03700	0.0479
Feb-90	0.01586	0.0000178	0.02119	0.0209	-0.02533	0.0000489	0.05759	0.0139
Feb-98	0.00082	0.0000106	0.00481	0.0047	-0.02987	0.0000156	0.04998	0.0098
FEBAVG	1.69700	0.000139	0.05162	0.2286	1.25872	0.000229	-0.16287	01879

Table 13. Continued

	Region 1 a	Region 1 b	Region 1 c	Region 1 c_e (error)	Region 2 a	Region 2 b	Region 2 c	Region 2 c_e (error)
March Flows								
Mar-02	20.00000	-0.00800	-3.23628	2.9717	1019418	-0.00148	-0.71963	1.3390
Mar-10	4.70000	0.00260	-0.70000	1.2786	3.94080	-0.00034	0.13784	0.5570
Mar-25	1.20000	0.000826	0.20000	0.4104	1.79299	0.000244	0.21239	0.2611
Mar-50	0.42717	0.000318	0.14318	01460	0.80366	0.000162	0.15612	0.1055
Mar-75	016536	0.000136	0.08438	0.0576	0.31649	0.000173	0.08655	0.0721
Mar-90	0.08000	0.000056	0.04000	0.0366	0.12243	0.0000955	0.07008	0.0501
Mar-98	0.01700	-0.0000059	0.00916	0.0232	-0.00969	0.0000468	0.07026	0.0270
MARAVG	1.96200	0.0000963	-0.02263	0.3110	1.72251	-0.00003	0.07040	0.1702
April Flows								
Apr-02	17.50000	-0.00601	-3.60000	2.5266	11.21738	0.001142	-1.82310	1.2877
Apr-10	3.74957	0.00257	-0.84995	1.0453	4.57544	0.000853	-0.53006	0.6603
Apr-25	0.84882	0.001002	0.34495	0.3515	2.35265	0.000548	-012227	0.2950
Apr-50	0.26710	0.000329	0.20292	01354	1.12176	0.000191	0.07607	0.1683
Apr-75	0.10274	0.000138	0.12870	0.0599	0.51502	0.0000397	0.10793	0.0849
Apr-90	0.03715	0.0000958	0.08290	0.0307	0.23084	0.0000814	0.07838	0.0613
Apr-98	0.01531	0.0000244	0.02121	0.0273	0.03372	0.0000406	0.07416	0.0402
APRAVG	1.72232	0.0000882	0.05553	0.2468	2.07532	0.000248	-0.12209	0.2123
May Flows								
May-02	13.27731	-0.00387	-4.08167	3.9642	9.59296	-0.00047	-1.62335	1.4765
May-10	1.63747	0.001674	-0.32906	0.4785	3.18388	0.000928	-0.43881-	0.3242
May-25	0.32784	0.000607	0.23339	01576	1.47506	0.000610	-0.11808	0.1741
May-50	0.09379	0.000216	0.15621	0.0753	0.73953	0.000271	-0.00660	0.1025
May-75	0.03425	0.000107	0.07490	0.0343	0.38646	0.000148	0.02281	0.0633
May-90	0.01219	0.0000758	0.03794	0.0217	0.22235	0.0000858	0.02546	0.0384
May-98	0.00277	0.000023	0.00730	0.0098	0.07839	0.0000291	0.03031	0.0375
MAYAVG	0.99000	0.00009	0.08324	0.2776	1.55688	0.000261	-0.16939	0.0986
June Flows								
Jun-02	8.00000	-0.00247	1.60000	1.7679	10.91530	-0.00161	-1.89561	1.7579
Jun-10	0.80000	0.001363	0.45000	0.5061	3.16795	0.000485	-0.43261	0.4487
Jun-25	0.15000	0.000519	0.21000	0.1509	1.25134	0.000416	-011455	0.1973
Jun-50	0.01141	0.000156	013895	0.0503	0.49775	0.000183	-0.00025	0.0986
Jun-75	0.00108	0.0000826	0.04681	0.0232	0.22252	0.000101	0.02485	0.0590
Jun-90	0.00082	0.0000457	0.01183	0.0117	0.10236	0.0000482	0.03529	0.0420
Jun-98	-0.00216	0.0000224	0.00444	0.0057	0.01802	0.0000220	0.04506	0.0275
JUNAVG	0.79000	0.0000908	0.18700	0.1687	1.47677	0.0000147	-016798	0.2120
July Flows								
Jul-02	5.55417	-0.00014	1.57121	2.2013	5.95937	-0.00090	-0.61420	0.9058
Jul-10	0.35317	0.001166	0.49473	0.2092	1.41917	0.000327	-0.05925	0.2643
Jul-25	0.01908	0.000305	018293	0.0459	0.53224	0.000230	0.02455	0.1362
Jul-50	0.00234	0.000105	0.05401	0.0200	0.18523	0.000138	0.03742	0.0683
Jul-75	-0.00304	0.0000556	0.01755	0.0088	0.05286	0.0000588	0.04572	0.0368
Jul-90	-0.00315	0.0000294	0.00651	0.0059	0.00403	0.0000224	0.04475	0.0205
Jul-98	-0.00195	0.0000058	0.00270	0.0027	-0.00858	0.0000132	0.03148	0.0106
JULAVG	0.47205	0.0000055	0.24078	0.1528	0.73114	0.0000116	-0.01921	0.0948

Table 13. Concluded

	Region 1				Region 2			
	a	b	c	c_e (error)	a	b	c	c_e (error)
August Flows								
Aug-02	2.49621	0.001312	0.08668	0.7351	4.39597	-0.00099	-0.35585	0.9775
Aug-10	0.08939	0.000537	0.30823	0.0692	0.51588	0.0000056	0.18036	0.1606
Aug-25	0.01582	0.000162	0.06025	0.0246	0.08561	0.0000401	0.14258	0.0642
Aug-50	0.00053	0.000071	0.02050	0.0102	0.00366	0.0000234	0.08964	0.0340
Aug-75	-0.00358	0.0000383	0.00810	0.0046	-0.01262	0.0000109	0.05886	0.0180
Aug-90	-0.00292	0.0000197	0.00437	0.0038	-0.01516	0.0000069	0.04372	0.0115
Aug-98	-0.00150	0.0000051	0.00130	0.0020	-0.01444	0.0000040	0.03077	0.0068
AUGAVG	0.25437	0.0000771	012240	01308	0.37171	-0.000074	0.06242	0.0830
September Flows								
Sep-02	2.15558	-0.00024	-016364	0.5518	4.06000	-0.00085	-0.24500	1.5610
Sep-10	0.12855	0.000269	012135	01121	0.44585	-0.000037	0.23617	0.3236
Sep-25	0.01200	0.0000877	0.05000	0.0307	0.01076	0.0000195	0.14930	0.0712
Sep-50	0.00120	0.0000426	0.00746	0.0072	-0.03539	0.0000034	010176	0.0247
Sep-75	-0.00176	0.0000215	0.00297	0.0047	-0.03059	0.0000079	0.06149	0.0127
Sep-90	-0.00130	0.0000092	0.00159	0.0019	-0.02485	0.0000055	0.04283	0.0084
Sep-98	-0.00095	0.0000018	0.00056	0.0004	-0.01945	0.0000040	0.02915	0.0061
SEPAVG	0.19537	-0.000036	0.03143	0.0576	0.33055	-0.000094	0.07743	0.1099
October Flows								
Oct-02	2.38630	0.001345	-0.39068	1.2584	3.74951	-0.00098	-0.13493	0.8482
Oct-10	0.05523	0.000253	0.34084	0.0744	0.76678	0.0000512	0.15624	0.2924
Oct-25	0.00961	0.0000904	0.08963	0.0407	0.11210	0.0000028	0.18260	0.1447
Oct-50	0.00165	0.0000359	0.01540	0.0078	-0.03232	-0.0000021	0.10654	0.0267
Oct-75	-0.00075	0.0000182	0.00202	0.0042	-0.03464	0.0000066	0.06865	0.0124
Oct-90	-0.00135	0.0000094	0.00188	0.0020	-0.02957	0.0000014	0.05162	0.0087
Oct-98	-0.00100	0.0000019	0.00064	0.0002	-0.02461	0.0000009	0.03825	0.0069
OCTAVG	0.25704	-0.0000078	0.03086	0.0984	0.36037	-0.000094	0.08168	0.1237
November Flows								
Nov-02	5.77898	0.0000767	112593	3.3941	3.91240	-0.00071	-0.30011	0.6226
Nov-10	0.62512	0.000486	0.53505	0.4354	1.09762	0.0000194	0.12568	0.3098
Nov-25	0.10052	0.000153	018236	0.0585	0.27637	-0.0000070	0.19316	0.1791
Nov-50	0.00836	0.0000714	0.07110	0.0216	-0.01876	0.0000042	0.15342	0.0523
Nov-75	-0.00064	0.0000279	0.01218	0.0072	-0.04706	0.0000175	0.09212	0.0175
Nov-90	-0.00183	0.0000147	0.00366	0.0041	-0.04239	0.0000111	0.06914	0.0130
Nov-98	-0.00143	0.0000038	0.00213	0.0008	-0.03462	0.0000073	0.05068	0.0104
NOVAVG	0.47819	0.0000413	019734	0.2463	0.35071	-0.0000048	0.10102	0.1065
December Flows								
Dec-02	10.24262	-0.003	110000	4.5048	6.80638	-0.00014	-1.16873	11576
Dec-10	2.33709	0.001164	0.29357	11662	1.79465	-0.0000051	-0.09807	0.3902
Dec-25	0.38615	0.000363	0.22000	0.2372	0.62957	-0.000015	0.06041	0.1730
Dec-50	0.07905	0.0000461	0.13951	0.0736	0.12361	0.0000055	0.10328	0.0990
Dec-75	0.00664	0.0000321	0.05290	0.0296	-0.02192	0.0000081	0.08007	0.0199
Dec-90	0.00124	0.0000193	0.00418	0.0056	-0.03241	0.0000141	0.05693	0.0106
Dec-98	-0.00163	0.0000078	0.00288	0.0026	-0.03051	0.0000111	0.04412	0.0085
DECAVG	1.09399	-0.000062	015380	0.3614	0.74290	-0.000023	-0.00911	0.1270

Error in the Regression Model

The regression relationship between the flow and watershed characteristics explains a high amount of the flow variance that exists between the gaging stations in the sample. The standard error of estimate for the virgin flow equations (se), in cfs, is estimated as the product of the coefficient of error given in table 13 (c_e) and the computed mean flow at the point of interest (Qmean):

$$s_e = c_e \text{ Qmean} \tag{14}$$

Computation of the standard error of estimate for the above application example is provided as follows:

s_e (Q98) = 46.7 * 0.0012 = 0.06 cfs

s_e (Q90) = 46.7 * 0.0046 = 0.22 cfs

s_e (Q75) = 46.7 * 0.0102 = 0.48 cfs

s_e (Q50) = 46.7 * 0.0357 = 1.7 cfs

s_e (Q25) = 46.7 * 0.1096 = 5.1 cfs

s_e (Q10) = 46.7 * 0.3623 = 17 cfs

s_e (Q02) = 46.7 * 0.7633 = 40 cfs

Inclusion of Information from Nearby Gaged Sites

The virgin flows computed at gaged sites will generally not be the same values as those estimated by the virgin flow equations; the computed value is always considered superior to that produced by the equations. For ungaged sites located on the same stream as a gage, the estimates of virgin flow should take advantage of the better information offered at the gage. In these cases the following methodologies are used to modify the virgin flow estimate.

Three different types of adjustments exist, depending upon where the ungaged site is located with respect to the gaged sites on the stream: 1) when a gage exists both upstream and downstream of the site; 2) when a gage exists only on the upstream side of the site; and 3) when a gage exists only on the downstream side of the site. Let the values estimated by the equations at the site of interest, the gage upstream, and the gage downstream be represented by qvi, qvu, and qvd, respectively. Also, let the difference between the virgin flow computed at the gage and the value estimated by the equations be represented by Aqu for the nearest upstream gage and Aqd for the nearest downstream gage. Then the adjustments made to compute the virgin flow, Q, are as follows:

For gages both upstream and downstream:

$$Q = qvi + \Delta qd - (\Delta qd - \Delta qu)(qvd - qvi)/(qvd - qvu) \quad (15)$$

For gages only on the upstream side:

$$Q = qvi + \Delta qu \quad (16)$$

For gages only on the downstream side:

$$Q = qvi\,(1 + \Delta qd/qvd) \quad (17)$$

Verification of the Procedure to Estimate Flow at Ungaged Sites

The validity of applying a regression equation to ungaged sites is related to the ability of the equation to produce good flow estimates for other gaging stations not used in the regression analysis. To evaluate this capability, flow duration values were estimated for four other locations: the Embarras River near Camargo, Spring Creek near Springfield, the Big Muddy River at Plumfield, and North Fork Mauvaise Terre Creek near Jacksonville. Three criteria were used in choosing these stations: 1) location in one of the physiographic regions also in the Kaskaskia watershed; 2) a period of record long enough to be close to the long-term conditions; and 3) a measured flow close to a virgin condition. The values of flow estimated by the virgin flow equations are compared with the flow estimates for records of these stations. For the Embarras River and Spring Creek gages, the equations perform extremely well in estimating the flow conditions at the stations. For the Big Muddy River and North Fork Mauvaise Terre Creek there exist some inconsistencies between the equations and the gaging record. These two gaging stations are located comparatively further away from the Kaskaskia River basin and may have watersheds with slightly different hydrologic or physiographic characteristics. Discretion should be used in applying the virgin flow equations to locations outside of the Kaskaskia watershed.

Table 14. Estimation of Flow Duration Curves for Gaging Stations Outside the Kaskaskia River Basin

	Embarras River near Camargo DA = 186 mi2 K = 0.62 in/hr P-ET = 11.0 in *(Bloomington Ridged Plain)*		Spring Creek near Springfield DA = 107 mi2 K = 0.48 in/hr P-ET = 8.6 in *(Springfield Plain)*	
	Equation	Record	Equation	Record
Qmean	151.	157.	67.1	64.9
Q99	0.0	0.0	0.0	0.0
Q98	0.3	0.0	0.0	0.0
Q95	0.8	0.7	0.0	0.0
Q90	1.8	2.3	0.2	0.0
Q85	3.0	4.5	0.6	0.3
Q75	7.4	14.	2.5	2.5
Q60	25.	37.	10.	11.
Q50	45.	59.	19.	20.
Q40	74.	88.	32.	32.
Q25	147.	162.	64.	60.
Q15	254.	278.	112.	104.
Q10	363.	400.	161.	150.
Q05	610.	624.	274.	260.
Q02	1081.	1015.	491.	485.
Q01	1551.	1507.	708.	705.

	Big Muddy River at Plumfield DA = 794 mi2 K=0.18in/hr P-ET = 11.6 in *(Mt. Vernon Hill Country)*		North Fork Mauvaise Terre Creek near Jacksonville DA = 30.0 mi2 K=0.40in/hr P-ET = 8.4 in *(Springfield Plain)*	
	Equation	Record	Equation	Record
Qmean	672.	691.	18.6	18.4
Q99	1.2	0.2	0.0	0.0
Q98	2.6	0.8	0.0	0.0
Q95	5.7	2.3	0.0	0.0
Q90	10.	4.2	0.0	0.0
Q85	15.	6.1	0.0	0.0
Q75	29.	12.	0.2	0.7
Q60	63.	35.	0.8	3.6
Q50	104.	70.	1.5	6.8
Q40	173.	155.	2.8	11.
Q25	426.	687.	7.2	19.
Q15	970.	1430.	17.	32.
Q10	1732.	2100.	33.	46.
Q05	3632.	3450.	80.	78.
Q02	5724.	5582.	134.	134.
Q01	7395.	7300.	339.	203.

MODEL OPERATION

The Illinois Streamflow Assessment Model has three basic data components: 1) control points (gaging stations and other locations for which a full set of flow statistics is precomputed); 2) virgin flow equations, used to estimate the undisturbed flow at ungaged sites; and 3) flow modifiers (primarily effluent discharges) that are added to the flow. Methods for determining these components have been described in this report. A list of the locations and estimated flow for the control points and flow modifiers is given in appendices A and B. Flow conditions at reservoirs (which would ordinarily be considered flow modifiers) are provided in the list of control points. The location of all of these points and the drainage area and permeability information needed as independent variables in the virgin flow equations are included in a "network" component, the data for which are given in appendix C.

As the model user requests flow information at a particular site, the following series of computations is performed to provide the streamflow estimate:

1. Locate point and collect information on permeability and drainage area (from the network component).
2. Compute the mean flow (equation 13).
3. Compute the virgin flow estimates (equation 12, table 13); search upstream of the point of interest (using the network component) to identify the total area contributing to the low flow and compute subwatersheds independently.
4. Adjust virgin flow estimates using information from gaging stations along the same stream (using equations 15-17).
5. Add all flow modifiers between the point of interest and any upstream control points (add all flow modifiers in the basin if no upstream control points exist).
6. Compute loss of flow when an effluent is discharged into a dry stream (equations 4-5).
7. Add in the effect of user-supplied modifications to produce the altered flow condition.

The preceding steps are duplicated for any additional downstream locations for which the user requests flow information.

Uncertainties of Flow Estimation

Every step in the computation of flow conditions includes some amount of uncertainty. For example, even at the most basic level, using data from stream gaging, some measurement error and uncertainty in the accuracy of the gage's rating curve must be accepted. The error in stream gaging is typically considered to be 10% to 15%. Additional uncertainties are associated with the development of the hydrologic information presented in the streamflow assessment model. At gaged sites, errors may be expected in 1) the adjustment for period of record (a function of the total number of years extended and the correlation between the gage in question and the index station used for adjustment), and 2) the errors in estimating the frequency of low flows. An additional uncertainty is associated with 3) the separation of virgin flow and the flow modifiers. All of these errors differ from station to station. At ungaged sites, errors are associated with 4) the accuracy of the virgin flow equations, and 5) uncertainties in the model's algorithms that concern the effect of flow modifications on downstream sites. In this report, only the fourth error term is addressed (table 13), primarily because it is the only error term that is both quantifiable and universally applicable to all locations within the watershed.

The streamflow statistics represented in this model may occasionally be changed over time. Adjustments in flow values may occur because water-use practices will change, and additional years of gaging may provide additional information concerning long-term streamflow conditions. However, long-term virgin streamflow conditions in the future are expected to be similar to those of the past. Proper verification that the virgin flow in the past 40 years is typical of long-term conditions would require a large number of years of additional stream gage records. The greatest amount of uncertainty in the model output lies with the geographic limitation of the available data. For this reason, future improvement in the model's data is dependent on the procurement of flow data (additional stream gaging, low-flow discharge measurements at additional sites, or measurement of withdrawals and discharges).

CONCLUSION

This report has presented the major analytical steps used to prepare the hydrologic data available for the Kaskaskia River basin for use in the Illinois Streamflow Assessment Model. The three basic steps involved in estimating flow at any site in the basin are: 1) use of the virgin flow regression equations; 2) adjustments in the virgin flow because of the proximity of gaging stations that have more precise information; and 3) the adjustment for the effects of modifications to the flow from effluent discharges, withdrawals, and reservoirs. Streamflow information is supplied in appendices A and B, and the watershed network that describes the relative location of these streamflow elements is provided in appendix C. This information will allow the user to follow these steps to estimate the flow statistics at any location in the basin (with drainage area greater than 10 mi2). However, the user will likely want to use *ILSAM* because the number of computations could be great. Readers are referred to the *Streamflow Assessment Model User's Guide* (Mills and Knapp, 1989) for a detailed description of how the model works. *ILSAM* is available from the Illinois State Water Survey on floppy diskettes for use on an IBM-PC/AT or compatible computer having a minimum random access memory of 512 K

REFERENCES

Durgunoglu, A., H.V. Knapp, and SA. Changnon, Jr. 1987. *PACE Watershed Model (PWM): Volume 1, Model Development.* Illinois State Water Survey Contract Report 437, 90 pp.

Durgunoglu, A., and KP. Singh. 1989. *Optimal Use of the Kaskaskia Navigation Canal: Management Strategies and Guidelines.* Illinois State Water Survey Contract Report 461, 217 pp.

Ekblaw, G.E. 1937. Surficial and Subsurface Geology and Structure, in *Physical, Economic, and Social Aspects of the Valley of the Kaskaskia River in the State of Illinois.* University of Illinois and the State Surveys, Champaign, 298 pp.

Fehrenbacher, J.B., J.D. Alexander, I.J. Jansen, RG. Darmody, R.A. Pope, M.A. Flock, E.E. Voss, J.W. Scott, W.F. Andrews, and L.J. Bushue. 1984. *Soils of Illinois.* University of Illinois Agricultural Experiment Station Bulletin 778.

Illinois Bureau of the Budget. 1987. *Illinois Population Trends from 1980 to 2025.* 282 pp.

Illinois State Planning Commission. 1938. *Report on the Kaskaskia River Basin.* Illinois Department of Public Works and Buildings, Division of Waterways, Springfield, 40 pp.

Jones, D.M.A. 1966. *Variability of Evapotranspiration in Illinois.* Illinois State Water Survey Circular 89, 13 pp.

Knapp, H.V. 1988. *Fox River Basin Streamflow Assessment Model: Hydrologic Analysis.* Illinois State Water Survey Contract Report 454, 109 pp.

Knapp, H.V., M.L. Terstriep, KP. Singh, and D.C. Noel. 1985. *Sangamon River Basin Streamflow Assessment Model: Hydrologic Analysis.* Illinois State Water Survey Contract Report 368, 74 pp.

Leighton, M.M., G.E. Ekblaw, and L. Horberg. 1948. *Physiographic Divisions of Illinois.* Illinois State Geological Survey Report of Investigation 129.

Mills, E.P., and H.V. Knapp. 1989. *The Illinois Streamflow Assessment Model, Version 3.0: User's Guide.* Illinois State Water Survey Miscellaneous Publication 116, 32 pp.

Roberts, W.J., and J.B. Stall. 1967. *Lake Evaporation in Illinois.* Illinois State Water Survey Report of Investigation 57, 44 pp.

Runge, E.C.A., L.E. Taylor, and S.G. Carmer. 1969. *Soil Type Acreages for Illinois; Statewide and County Summaries.* University of Illinois Agricultural Experiment Station, Champaign.

Singh, KP. 1972. *Plans for Meeting Water Requirements in the Kaskaskia River Basin, 1970-2020.* Illinois State Water Survey Report of Investigation 70, 24 pp.

Singh, KP. 1977. *Water Supply from Shelbyville and Carlyle Lakes and Their Optimal Joint Operation.* Illinois State Water Survey Report of Investigation 84, 76 pp.

Singh, K.P., S.M. Broeren, R.B. King, and M.L. Pubentz. 1988. *Future Water Demands of Public Surface Water Supply Systems in Illinois.* Illinois State Water Survey Contract Report 442, 51 pp.

Stall, J.B., and Y.S. Fok. 1968. *Hydraulic Geometry of Illinois Streams.* University of Illinois Water Resources Center, Research Report No. 15.

U.S. Bureau of the Census. 1980. *The 1980 Census of Population.*

Wendland, W.M., J.L. Vogel, and S.A. Changnon, Jr. 1985. *Mean 1951-1980 Temperature and Precipitation for the North Central Region.* Illinois State Water Survey Miscellaneous Publication 84, 32 pp.

Appendix A. Control Points: Location and Estimated Flow

Name of control point	Virgin or present flow	Code	Mile
1)USGS Gage #05590000 Bondville	Vir=Pre	E	297.8
2) Kaskaskia River at Copper Slough	Virgin	E	294.9
3) Kaskaskia River at Copper Slough	Present	E	294.9
4) Kaskaskia River at USICC Withdrawal	Virgin	E	273.1
5) Kaskaskia River at USICC Withdrawal	Present	E	273.1
6) USGS Gage #05591200 Cooks Mills	Virgin	E	244.8
7) USGS Gage #05591200 Cooks Mills	Present	E	244.8
8) USGS Gage #05592000 Shelbyville	Virgin	E	204.7
9) USGS Gage #05592000 Shelbyville	Present	E	204.7
10) USGS Gage #05592100 Cowden	Virgin	E	179.1
11) USGS Gage #05592100 Cowden	Present	E	179.1
12) USGS Gage #05592500 Vandalia	Virgin	E	138.8
13) USGS Gage #05592500 Vandalia	Present	E	138.8
14) USGS Gage #05593000 Carlyle	Virgin	E	95.1
15) USGS Gage #05593000 Carlyle	Present	E	95.1
16) USGS Gage #05594100 Venedy Station	Virgin	E	57.4
17) USGS Gage #05594100 Venedy Station	Present	E	57.4
18) USGS Gage #05595000 New Athens	Virgin	E	28.4
19) USGS Gage #05595000 New Athens	Present	E	28.4
20) Kaskaskia Navigation Lock and Dam	Virgin	E	0.7
21) Kaskaskia Navigation Lock and Dam	Present	E	0.7
22) USGS Gage #05594000 Breese	Virgin	EH	21.3
23) USGS Gage #05594000 Breese	Present	EH	21.3
24) USGS Gage #05592300 Beecher City	Vir=Pre	EP	19.3
25) USGS Gage #05593900 Coffeen	Virgin	EHL	39.4
26) USGS Gage #05593900 Coffeen	Present	EHL	39.4
27) USGS Gage #05594450 Troy	Virgin	ED	45.4
28) USGS Gage #05594450 Troy	Present	ED	45.4
29) USGS Gage #05593600 Raymond	Vir=Pre	EHY	3.2
30) USGS Gage #05593575 New Minden	Virgin	ED3	10.6
31) USGS Gage #05593575 New Minden	Present	ED3	10.6
32) USGS Gage #05591500 Sullivan	Vir=Pre	EU8	3.8
33) Coffeen Dam	Virgin	EHLM	0.3
34) Coffeen Dam	Present	EHLM	0.3
35) Lake Lou Yeager Dam	Virgin	EH	91.6
36) Lake Lou Yeager Dam	Present	EH	91.6
37) Raccoon Lake Dam	Virgin	EIO	1.0
38) Raccoon Lake Dam	Present	EIO	1.0
39) Pana Lake Dam	Virgin	EQV	0.5
40) Pana Lake Dam	Present	EQV	0.5
41) Vandalia Lake Dam	Virgin	EN5	4.2
42) Vandalia Lake Dam	Present	EN5	4.2
43) Lake Centralia Dam	Virgin	EIS	1.1
44) Lake Centralia Dam	Present	EIS	1.1
45) Salem Reservoir Dam	Virgin	EIV	4.1
46) Salem Reservoir Dam	Present	EIV	4.1
47) Governor Bond Lake Dam	Virgin	EHLG	1.3
48) Governor Bond Lake Dam	Present	EHLG	1.3
49) Lake Hillsboro Dam	Virgin	EHTJ	0.2
50) Lake Hillsboro Dam	Present	EHTJ	0.2
51) Glenn Shoals Dam	Virgin	EHT	10.5
52) Glenn Shoals Dam	Present	EHT	10.5
53) Highland Silver Lake Dam	Virgin	EDO	14.5
54) Highland Silver Lake Dam	Present	EDO	14.5

Appendix A. Continued

Flow Type	Location (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Q_{01}	95.00	278.00	294.00	1043.00	1054.00	3866.00	3878.00	8096.00	4700.00	9347.00
Q_{02}	68.00	199.00	212.00	742.00	751.00	2756.00	2767.00	5816.00	4250.00	6646.00
Q_{05}	39.00	114.00	125.00	426.00	433.00	1633.00	1641.00	3658.00	3320.00	4484.00
Q_{10}	24.00	67.20	78.00	250.00	254.00	983.00	988.00	2314.00	2110.00	2962.00
Q_{15}	17.30	47.00	58.00	172.00	176.00	678.00	683.00	1611.00	1775.00	2049.00
Q_{25}	11.20	28.50	46.00	101.00	104.00	400.00	404.00	973.00	1421.00	1170.00
Q_{40}	6.40	15.30	34.00	52.40	54.20	205.00	208.00	502.00	736.00	715.00
Q_{50}	4.20	9.73	28.70	32.60	33.80	127.00	129.00	315.00	464.00	482.00
Q_{60}	2.50	5.60	24.20	18.10	18.60	69.60	70.70	173.00	299.00	261.00
Q_{75}	0.84	1.74	19.10	4.86	13.10	16.80	25.60	41.00	68.00	95.00
Q_{85}	0.36	0.72	16.00	1.75	9.70	5.92	14.40	17.10	25.70	43.00
Q_{90}	0.21	0.42	13.00	0.90	8.30	3.02	10.90	10.50	12.00	26.70
Q_{95}	0.11	0.24	10.80	0.42	6.80	1.23	7.90	5.40	9.60	13.00
Q_{98}	0.08	0.16	9.20	0.18	4.80	0.36	5.00	1.80	8.10	6.50
Q_{99}	0.06	0.12	8.20	0.09	1.00	0.08	1.00	0.84	7.00	5.40
Q_{mean}	11.60	29.00	41.60	102.00	107.00	380.00	386.00	844.00	840.00	1067.00
<u>Low Flows</u>										
$Q_{1,2}$	0.20	0.35	8.30	0.59	3.30	1.35	4.30	4.60	6.40	15.30
$Q_{1,10}$	0.03	0.04	7.50	0.06	0.00	0.20	0.00	0.50	1.70	4.30
$Q_{1,25}$	0.00	0.00	7.40	0.00	0.00	0.00	0.00	0.00	0.00	2.80
$Q_{1,50}$	0.00	0.00	7.30	0.00	0.00	0.00	0.00	0.00	0.00	2.10
$Q_{7,2}$	0.25	0.46	12.80	0.88	8.20	2.09	9.80	5.40	9.40	18.00
$Q_{7,10}$	0.04	0.08	8.20	0.12	2.60	0.25	2.70	0.60	6.00	6.00
$Q_{7,25}$	0.02	0.02	7.90	0.03	0.23	0.05	0.25	0.10	5.50	4.60
$Q_{7,50}$	0.01	0.01	7.80	0.01	0.00	0.01	0.00	0.00	5.00	3.90
$Q_{15;2}$	0.30	0.57	13.40	1.21	8.80	3.07	11.10	7.20	11.80	20.80
$Q_{15,10}$	0.08	0.14	8.70	0.21	3.60	0.40	3.80	0.90	7.80	6.50
$Q_{15,25}$	0.04	0.05	8.10	0.06	0.60	0.10	0.62	0.20	7.00	5.50
$Q_{15,50}$	0.02	0.02	8.00	0.02	0.30	0.02	0.29	0.00	6.40	4.70
$Q_{31,2}$	0.40	0.78	15.70	1.80	9.60	4.63	12.90	9.00	18.00	23.90
$Q_{31,10}$	0.10	0.21	9.10	0.32	4.80	0.68	4.90	1.30	9.30	7.60
$Q_{31,25}$	0.06	0.10	8.40	0.14	1.60	0.30	1.45	0.50	8.00	6.40
$Q_{31,50}$	0.04	0.04	8.20	0.05	0.80	0.10	0.75	0.10	7.00	5.50
$Q_{61,2}$	0.50	1.06	17.00	2.71	10.80	7.82	16.50	16.00	50.00	37.00
$Q_{61,10}$	0.15	0.31	10.10	0.59	6.30	1.31	7.00	3.50	13.70	10.60
$Q_{61,25}$	0.09	0.16	8.80	0.23	2.90	0.76	2.70	1.30	12.00	7.80
$Q_{61,50}$	0.06	0.10	8.40	0.12	1.70	0.20	1.60	0.40	10.00	6.70
$Q_{91,2}$	0.75	1.61	18.70	4.40	12.60	12.90	21.70	24.00	93.00	54.00
$Q_{91,10}$	0.18	0.36	10.90	0.71	7.80	1.89	9.00	5.80	15.60	13.60
$Q_{91,25}$	0.12	0.23	9.30	0.37	5.10	0.80	5.50	3.10	13.50	10.20
$Q_{91,50}$	0.08	0.13	8.90	0.15	3.50	0.40	3.46	1.60	10.00	8.20
<u>Drought Flows</u>										
$Q_{6,10}$	0.36	0.67	16.00	1.57	9.70	5.54	14.20	17.00	71.00	29.00
$Q_{6,25}$	0.25	0.42	12.50	0.81	8.10	3.04	10.70	12.00	18.00	21.00
$Q_{6,50}$	0.21	0.31	11.20	0.42	7.00	1.41	8.00	7.40	12.00	12.20
$Q_{9,10}$	1.20	2.91	20.70	9.98	16.50	41.30	48.50	111.00	170.00	141.00
$Q_{9,25}$	0.70	1.50	18.00	4.44	12.30	15.40	23.80	35.00	62.00	39.00
$Q_{9,50}$	0.56	1.16	16.60	3.22	10.80	10.20	18.20	21.00	15.00	33.00
$Q_{12,10}$	3.30	8.05	26.80	27.60	31.70	104.00	109.00	242.00	212.00	310.00
$Q_{12,25}$	1.60	4.03	21.10	13.50	18.30	46.30	51.70	92.00	118.00	134.00
$Q_{12,50}$	0.90	2.62	20.00	9.00	14.10	28.30	33.90	45.00	78.00	72.00
$Q_{18.10}$	4.20	9.29	28.30	30.90	34.90	122.00	127.00	306.00	333.00	376.00
$Q_{18,25}$	2.10	4.74	23.20	15.50	20.50	58.50	64.20	138.00	189.00	179.00
$Q_{18,50}$	1.20	2.83	21.50	9.04	16.20	30.00	37.70	57.00	121.00	75.00
$Q_{30,10}$	7.20	17.30	36.00	59.20	63.20	223.00	228.00	510.00	564.00	628.00
$Q_{30,25}$	3.70	9.25	28.00	32.70	36.80	131.00	136.00	325.00	337.00	376.00
$Q_{30,50}$	2.30	5.97	24.50	20.80	24.50	74.70	79.00	156.00	212.00	181.00

Appendix A. Continued

Flow Type	Location (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Drought Flows-Cont										
$Q_{54,10}$	9.40	24.10	42.00	85.00	89.60	318.00	323.00	705.00	740.00	905.00
$Q_{54,25}$	5.20	13.50	32.00	48.10	52.00	183.00	188.00	420.00	475.00	524.00
$Q_{54,50}$	3.00	8.64	27.50	31.70	35.80	119.00	124.00	261.00	314.00	316.00
January Flows										
Q_{02}	73.00	188.00	202.00	677.00	687.00	2610.00	2621.00	5951.00	4500.00	6660.00
Q_{10}	22.00	59.90	70.60	229.00	234.00	1014.00	1020.00	2782.00	2516.00	3770.00
Q_{25}	9.60	24.50	43.00	91.90	104.00	422.00	435.00	1218.00	1664.00	1645.00
Q_{50}	4.60	10.00	29.00	34.30	46.10	164.00	167.00	450.00	566.00	781.00
Q_{75}	1.00	2.14	19.60	6.72	16.30	28.20	38.30	81.00	43.00	169.00
Q_{90}	0.26	0.57	13.40	1.52	5.80	5.89	10.60	18.20	12.80	29.30
Q_{98}	0.06	0.18	9.90	0.51	1.00	1.90	2.44	7.00	6.00	10.50
Q_{mean}	10.20	25.70	44.20	93.30	105.00	391.00	404.00	1015.00	993.00	1351.00
February flows										
Q_{02}	105.00	246.00	261.00	839.00	850.00	3047.00	3069.00	6429.00	4700.00	8201.00
Q_{10}	33.00	85.20	96.00	312.00	317.00	1288.00	1294.00	3264.00	4380.00	4065.00
Q_{25}	15.40	40.00	52.00	147.00	153.00	621.00	628.00	1618.00	2356.00	2345.00
Q_{50}	6.80	16.10	35.00	56.80	68.90	241.00	254.00	647.00	795.00	1081.00
0_{75}	2.30	5.33	23.50	18.30	28.80	78.10	89.20	215.00	107.00	273.00
Q_{90}	0.42	1.01	16.80	3.36	10.90	17.10	25.20	60.00	26.00	82.00
Q_{98}	0.06	0.19	11.50	0.44	3.00	2.46	5.06	12.00	9.10	16.40
Q_{mean}	15.30	37.20	49.30	131.00	137.00	522.00	529.00	1269.00	1430.00	1683.00
March Flows										
Q_{02}	71.00	236.00	251.00	916.00	927.00	3369.00	3381.00	6863.00	4800.00	7741.00
Q_{10}	39.00	109.00	121.00	399.00	406.00	1469.00	1477.00	3112.00	3860.00	3630.00
Q_{25}	20.00	54.20	65.00	197.00	202.00	768.00	774.00	1820.00	1877.00	2701.00
Q_{50}	10.70	26.90	45.00	94.20	106.00	369.00	382.00	893.00	873.00	1227.00
Q_{75}	5.50	13.70	32.00	48.30	59.60	200.00	212.00	524.00	432.00	679.00
Q_{90}	3.20	7.04	26.00	23.20	34.70	95.10	107.00	254.00	173.00	369.00
Q_{98}	0.35	0.47	15.00	0.80	7.00	6.35	13.10	34.30	11.20	46.00
Q_{mean}	17.80	49.00	59.60	178.00	183.00	669.00	675.00	1475.00	1374.00	1950.00
April Flows										
Q_{02}	87.00	246.00	261.00	928.00	939.00	3707.00	3719.00	8813.00	4300.00	9506.00
Q_{10}	39.00	114.00	125.00	435.00	441.00	1775.00	1782.00	4362.00	2285.00	5180.00
Q_{25}	23.00	62.50	73.00	232.00	237.00	948.00	954.00	2367.00	1559.00	2859.00
Q_{50}	12.60	29.70	47.00	102.00	113.00	400.00	412.00	973.00	690.00	1196.00
Q_{75}	7.30	16.20	35.00	52.60	64.60	195.00	208.00	449.00	160.00	561.00
Q_{90}	4.00	8.84	28.00	29.00	40.90	114.00	127.00	290.00	33.00	346.00
Q_{98}	1.90	3.73	21.00	11.10	20.30	42.80	52.50	112.00	23.00	136.00
Q_{mean}	20.40	53.80	64.10	195.00	200.00	769.00	775.00	1828.00	966.00	2188.00
May Flows										
Q_{02}	72.00	214.00	229.00	812.00	823.00	3080.00	3092.00	6675.00	3100.00	6367.00
Q_{10}	26.00	75.70	87.00	293.00	299.00	1239.00	1246.00	3200.00	1931.00	3639.00
Q_{25}	14.60	39.20	52.00	147.00	154.00	634.00	641.00	1696.00	1487.00	1807.00
Q_{50}	8.90	19.40	38.00	65.30	77.30	273.00	286.00	729.00	728.00	933.00
Q_{75}	5.30	10.70	29.00	34.10	45.40	141.00	153.00	378.00	211.00	488.00
Q_{90}	3.00	6.39	25.00	20.90	32.20	86.20	98.20	230.00	33.00	285.00
Q_{98}	1.10	2.12	19.00	6.36	15.00	25.50	34.70	69.00	10.00	84.00
Q_{mean}	15.10	38.70	49.00	140.00	144.00	563.00	568.00	1376.00	901.00	1593.00
June Flows										
Q_{02}	83.00	218.00	233.00	784.00	794.00	2798.00	2810.00	5496.00	3280.00	6463.00
Q_{10}	28.00	72.80	84.00	266.00	272.00	1071.00	1077.00	2612.00	2114.00	2903.00
Q_{25}	11.90	29.60	47.00	108.00	119.00	457.00	469.00	1208.00	1510.00	1408.00
Q_{50}	5.80	12.90	32.00	44.00	56.30	184.00	197.00	493.00	742.00	676.00
Q_{75}	3.20	6.33	25.00	19.90	31.30	83.30	95.40	230.00	289.00	306.00
Q_{90}	1.70	3.55	21.70	11.30	21.90	46.20	57.50	124.00	71.00	157.00
Q_{98}	0.90	1.75	17.90	5.08	12.90	19.70	28.10	53.00	9.00	66.00
Q_{mean}	13.50	34.60	45.10	124.00	128.00	472.00	477.00	1057.00	1013.00	1260.00

Appendix A. Continued

Flow Type	Location (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
July Flows										
Q_{02}	69.00	169.00	181.00	581.00	588.00	2070.00	2078.00	4186.00	3380.00	5334.00
Q_{10}	18.40	38.50	53.00	125.00	134.00	496.00	505.00	1247.00	2042.00	1603.00
Q_{25}	8.10	15.70	35.00	49.10	61.70	203.00	217.00	554.00	1536.00	858.00
Q_{50}	3.00	5.69	24.60	17.70	29.50	78.90	91.30	237.00	645.00	531.00
Q_{75}	1.10	1.85	19.60	5.09	15.10	23.50	34.20	78.00	193.00	162.00
Q_{90}	0.60	0.88	16.80	1.88	9.70	7.60	15.90	26.00	29.00	49.00
Q_{98}	0.27	0.36	11.10	0.56	2.40	2.41	4.57	10.70	7.00	29.50
Q_{mean}	9.30	21.00	33.50	69.70	75.60	259.00	265.00	578.00	933.00	810.00
August Flows										
Q_{02}	53.00	109.00	121.00	337.00	344.00	1105.00	1113.00	1975.00	3080.00	2146.00
Q_{10}	8.30	18.00	37.00	56.80	69.40	204.00	217.00	450.00	1905.00	755.00
Q_{25}	2.40	5.43	24.30	17.20	28.80	64.90	77.20	160.00	900.00	476.00
Q_{50}	0.80	1.81	19.50	5.50	15.40	21.00	31.50	56.00	330.00	185.00
Q_{75}	0.35	0.71	16.40	1.82	9.30	6.45	14.50	18.30	42.00	91.00
Q_{90}	0.20	0.38	12.70	0.84	4.60	2.74	6.96	8.50	7.00	28.80
Q_{98}	0.09	0.15	9.20	0.21	0.00	0.41	0.50	2.20	3.00	7.30
Q_{mean}	5.00	11.20	26.20	35.70	43.80	121.00	129.00	231.00	559.00	387.00
September Flows										
Q_{02}	30.00	105.00	116.00	412.00	417.00	1497.00	1504.00	2961.00	2490.00	2960.00
Q_{10}	4.60	17.30	35.00	67.70	78.50	254.00	265.00	548.00	1418.00	644.00
Q_{25}	1.40	4.08	23.00	14.20	25.40	52.90	64.70	125.00	456.00	260.00
Q_{50}	0.60	1.34	17.60	3.63	11.80	11.30	20.00	25.00	70.00	92.00
Q_{75}	0.16	0.37	13.00	0.80	4.90	2.44	7.03	8.10	11.70	24.70
Q_{90}	0.09	0.17	10.60	0.21	1.70	0.34	1.82	2.60	4.50	8.60
Q_{98}	0.07	0.07	8.20	0.05	0.00	0.00	0.00	0.20	2.00	5.70
Q_{mean}	2.80	9.92	27.20	38.20	48.20	135.00	145.00	257.00	331.00	331.00
October Flows										
Q_{02}	33.00	154.00	165.00	651.00	657.00	2452.00	2458.00	5070.00	1914.00	5525.00
Q_{10}	11.90	34.30	50.00	126.00	135.00	484.00	493.00	1102.00	1075.00	1193.00
Q_{25}	4.10	8.87	27.50	27.30	38.50	95.60	108.00	210.00	427.00	259.00
Q_{50}	0.70	1.60	18.10	4.50	12.90	13.80	22.70	28.00	104.00	66.00
Q_{75}	0.20	0.47	13.00	1.08	5.00	3.16	7.59	9.00	11.90	24.90
Q_{90}	0.10	0.25	9.90	0.46	0.90	0.73	1.20	1.60	5.00	8.80
Q_{98}	0.06	0.10	8.00	0.07	0.00	0.09	0.02	0.13	2.20	5.80
Q_{mean}	4.30	16.10	31.90	63.90	72.50	236.00	245.00	484.00	322.00	471.00
November Flows										
Q_{02}	44.00	109.00	120.00	375.00	381.00	1321.00	1328.00	2609.00	2008.00	3285.00
Q_{10}	12.50	37.60	51.00	141.00	148.00	539.00	547.00	1212.00	1463.00	1375.00
Q_{25}	5.40	14.80	33.50	52.40	64.00	193.00	206.00	425.00	619.00	502.00
Q_{50}	1.60	3.68	21.60	11.10	21.30	38.00	48.80	84.00	292.00	177.00
Q_{75}	0.30	0.72	15.80	1.88	8.60	6.96	14.20	22.20	69.00	33.00
Q_{90}	0.11	0.22	10.60	0.19	1.60	0.34	1.17	4.80	10.00	17.60
Q_{98}	0.08	0.10	8.20	0.07	0.00	0.03	0.00	0.20	3.00	4.20
Q_{mean}	5.60	14.20	28.20	48.90	55.70	180.00	188.00	397.00	470.00	514.00
December Flows										
Q_{02}	71.00	162.00	176.00	549.00	558.00	2036.00	2046.00	4458.00	3900.00	5279.00
Q_{10}	25.00	56.60	67.00	189.00	194.00	698.00	703.00	1545.00	1932.00	2484.00
Q_{25}	11.00	26.30	43.00	89.10	99.00	328.00	339.00	721.00	1348.00	924.00
Q_{50}	3.50	8.79	27.20	30.00	40.90	110.00	122.00	247.00	682.00	446.00
Q_{75}	0.70	1.55	17.80	4.49	12.50	15.50	24.10	37.00	112.00	60.00
Q_{90}	0.15	0.32	11.80	0.67	3.40	2.81	5.54	11.90	13.60	20.30
Q_{98}	0.07	0.14	9.00	0.37	0.00	1.31	0.94	6.80	5.00	9.10
Q_{mean}	10.20	23.50	36.20	78.70	84.70	288.00	295.00	628.00	859.00	881.00

Appendix A. Continued

Flow Type	Location (11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Q_{01}	5955.00	12595.00	11705.00	16493.00	9860.00	26089.00	20100.00	30626.00	25200.00	31770.00
Q_{02}	5082.00	9807.00	9045.00	12371.00	9389.00	18691.00	16400.00	22296.00	20491.00	25386.00
Q_{05}	4148.00	6494.00	6160.00	8318.00	8456.00	12300.00	12397.00	14627.00	14734.00	20123.00
Q_{10}	2761.00	4477.00	4278.00	5712.00	5680.00	9286.00	9310.00	10529.00	10568.00	13050.00
Q_{15}	2216.00	3072.00	3041.00	4350.00	4385.00	6865.00	6970.00	7927.00	8048.00	10531.00
Q_{25}	1620.00	1835.00	1987.00	2511.00	3232.00	3728.00	4520.00	4262.00	5068.00	6198.00
Q_{40}	951.00	987.00	1225.00	1215.00	1792.00	1807.00	2420.00	2065.00	2689.00	3832.00
Q_{50}	633.00	672.00	825.00	805.00	1053.00	1285.00	1560.00	1482.00	1767.00	2536.00
Q_{60}	389.00	395.00	525.00	475.00	582.00	775.00	900.00	895.00	1028.00	1599.00
Q_{75}	124.00	145.00	176.00	168.00	152.00	339.00	330.00	406.00	404.00	666.00
Q_{85}	53.00	68.00	80.00	88.00	57.00	179.00	156.00	240.00	224.00	349.00
Q_{90}	29.40	47.80	52.00	63.00	52.00	121.00	115.00	178.00	178.00	201.00
Q_{95}	18.20	33.30	40.00	46.00	45.00	85.00	88.00	121.00	129.00	136.00
Q_{98}	13.40	23.20	31.50	31.60	41.00	63.60	74.00	88.00	102.00	104.10
Q_{99}	12.10	20.40	28.40	25.80	39.00	55.10	68.00	76.30	92.00	92.90
Q_{mean}	1064.00	1559.00	1558.00	2135.00	2122.00	3339.00	3324.00	3895.00	3888.00	3916.00
Low Flows										
$Q_{1,2}$	17.80	39.30	43.00	49.00	44.00	101.00	99.00	145.00	146.00	200.00
$Q_{1,10}$	5.90	16.80	19.50	18.10	36.00	39.30	57.00	62.10	82.00	113.00
$Q_{1,25}$	3.20	12.30	13.70	12.70	31.00	29.70	50.00	45.70	66.00	97.00
$Q_{1,50}$	2.50	10.00	11.40	10.50	28.00	26.50	47.00	37.50	58.00	89.00
$Q_{7,2}$	23.00	46.50	53.00	53.00	49.00	107.00	108.00	152.00	159.00	214.00
$Q_{7,10}$	11.90	19.30	26.50	23.80	40.00	48.10	65.00	69.30	89.00	119.90
$Q_{7,25}$	10.50	13.30	20.50	16.90	35.00	39.50	60.00	57.50	78.00	108.70
$Q_{7,50}$	9.40	11.10	17.80	14.20	32.00	35.80	57.00	50.80	72.00	103.00
$Q_{15,2}$	26.50	51.80	59.00	60.00	53.00	123.00	122.00	163.00	168.00	228.00
$Q_{15,10}$	14.00	21.20	30.00	28.80	42.00	56.00	70.00	74.80	92.00	124.10
$Q_{15,25}$	12.80	16.40	25.00	20.80	37.00	44.60	61.00	63.30	80.00	111.40
$Q_{15,50}$	11.60	12.60	20.80	17.10	34.00	40.80	58.00	56.80	74.00	105.00
$Q_{31,2}$	34.00	63.30	75.00	77.00	74.00	161.00	166.00	202.00	214.00	324.00
$Q_{31,10}$	16.50	23.70	34.00	34.00	44.00	62.00	74.00	85.00	101.00	133.20
$Q_{31,25}$	14.40	19.30	28.60	24.50	39.00	48.80	64.00	71.00	89.00	119.60
$Q_{31,50}$	12.90	15.70	24.40	20.30	36.00	44.20	60.00	63.40	81.00	112.50
$Q_{61,2}$	72.00	105.00	142.00	128.00	172.00	266.00	316.00	300.00	357.00	587.00
$Q_{61,10}$	20.70	28.50	40.00	42.00	46.00	77.70	85.00	105.00	117.00	165.00
$Q_{61,25}$	19.30	20.70	33.50	29.80	42.00	55.80	70.00	78.20	96.00	127.60
$Q_{61,50}$	16.90	17.50	29.00	24.50	39.00	50.80	66.00	67.50	86.00	117.20
$Q_{91,2}$	124.00	158.00	230.00	206.00	323.00	404.00	525.00	491.00	619.00	949.00
$Q_{91,10}$	24.40	34.70	47.00	49.00	57.00	92.00	106.00	122.00	141.00	184.00
$Q_{91,25}$	20.50	24.30	36.00	36.00	46.00	65.00	78.00	90.00	107.00	141.00
$Q_{91,50}$	17.50	20.30	31.00	29.30	42.00	57.20	72.00	75.40	94.00	125.70
Drought Flows										
$Q_{6,10}$	84.00	55.00	112.00	101.00	243.00	161.00	308.00	177.00	331.00	536.00
$Q_{6,25}$	28.00	42.50	51.00	64.00	68.00	146.00	157.00	165.00	182.00	253.00
$Q_{6,50}$	17.80	29.90	37.00	39.00	47.00	102.40	116.00	117.70	137.00	183.00
$Q_{9,10}$	201.00	208.00	270.00	306.00	430.00	368.00	497.00	399.00	535.00	865.00
$Q_{9,25}$	67.00	88.00	118.00	107.00	98.00	189.00	181.00	216.00	214.00	324.00
$Q_{9,50}$	28.10	59.30	56.00	62.00	50.00	129.90	122.00	146.00	145.00	190.00
$Q_{12,10}$	281.00	459.00	432.00	618.00	580.00	842.00	827.00	1121.00	1115.00	1713.00
$Q_{12,25}$	161.00	227.00	256.00	202.00	367.00	297.00	471.00	325.00	506.00	824.00
$Q_{12,50}$	106.00	131.00	167.00	86.00	75.00	172.00	163.00	194.00	191.00	264.00
$Q_{18,10}$	404.00	530.00	560.00	799.00	750.00	1131.00	1114.00	1284.00	1277.00	1805.00
$Q_{18,25}$	231.00	270.00	324.00	338.00	473.00	460.00	610.00	525.00	683.00	1091.00
$Q_{18,50}$	140.00	115.00	182.00	120.00	97.00	262.00	245.00	302.00	292.00	470.00
$Q_{30,10}$	683.00	888.00	945.00	1109.00	1139.00	1612.00	1687.00	1828.00	1914.00	2742.00
$Q_{30,25}$	389.00	488.00	503.00	731.00	640.00	946.00	880.00	1063.00	1006.00	1574.00
$Q_{30,50}$	238.00	235.00	294.00	340.00	327.00	536.00	539.00	627.00	638.00	1016.00

Appendix A. Continued

Location

Flow Type	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Drought Flows-Cont										
$Q_{54,10}$	941.00	1348.00	1386.00	1897.00	1740.00	2837.00	2745.00	3295.00	3217.00	4345.00
$Q_{54,25}$	580.00	753.00	811.00	968.00	957.00	1351.00	1376.00	1537.00	1572.00	2300.00
$Q_{54,50}$	370.00	439.00	495.00	594.00	608.00	832.00	871.00	946.00	995.00	1557.00
January Flows										
Q_{02}	5210.00	11933.00	10485.00	16660.00	9724.00	25682.00	18366.00	31282.00	23946.00	29246.00
Q_{10}	3506.00	4942.00	4680.00	6755.00	8012.00	9005.00	10322.00	9985.00	11317.00	14317.00
Q_{25}	2093.00	2094.00	2544.00	2783.00	4116.00	4387.00	5791.00	4986.00	6404.00	8104.00
Q_{50}	898.00	1018.00	1137.00	764.00	1336.00	1311.00	1907.00	1459.00	2065.00	2865.00
Q_{75}	132.00	195.00	160.00	160.00	157.00	282.00	283.00	312.00	320.00	490.00
Q_{90}	24.90	53.90	51.00	69.00	53.00	111.00	103.00	150.00	148.00	178.00
Q_{98}	10.40	19.70	21.00	42.00	41.00	64.30	66.00	84.70	91.00	93.00
Q_{mean}	1337.00	1897.00	1885.00	2586.00	2493.00	3692.00	3669.00	4292.00	4283.00	4896.00
February flows										
Q_{02}	6474.00	12522.00	10797.00	14772.00	10066.00	22300.00	20038.00	27247.00	24958.00	30258.00
Q_{10}	5183.00	5718.00	6838.00	8491.00	8714.00	13260.00	13486.00	15697.00	15935.00	21235.00
Q_{25}	3075.00	3203.00	3935.00	5311.00	5901.00	7943.00	8606.00	8942.00	9620.00	12120.00
Q_{50}	1230.00	1347.00	1498.00	1640.00	2053.00	2581.00	3036.00	2998.00	3464.00	4564.00
Q_{75}	166.00	433.00	328.00	383.00	358.00	612.00	596.00	647.00	638.00	983.00
Q_{90}	49.00	112.40	81.00	117.00	74.00	196.00	158.00	217.00	186.00	226.00
Q_{98}	14.50	38.40	38.00	76.00	50.00	102.80	84.00	129.00	116.00	120.00
Q_{mean}	1844.00	2421.00	2584.00	3385.00	3366.00	5115.00	5168.00	5981.00	6049.00	6775.00
March Flows										
Q_{02}	5690.00	11847.00	9798.00	13460.00	10140.00	23155.00	19280.00	28455.00	24545.00	29845.00
Q_{10}	4378.00	5626.00	6376.00	7618.00	9062.00	11631.00	13039.00	13771.00	15188.00	20488.00
Q_{25}	2759.00	3878.00	3938.00	4946.00	5601.00	8541.00	9263.00	9562.00	10299.00	12799.00
Q_{50}	1208.00	1582.00	1565.00	2487.00	2857.00	4578.00	5018.00	5149.00	5604.00	8938.00
Q_{75}	588.00	911.00	822.00	1145.00	1151.00	1687.00	1728.00	1838.00	1890.00	2670.00
Q_{90}	289.00	524.00	446.00	584.00	585.00	821.00	839.00	902.00	929.00	1429.00
Q_{98}	22.40	72.00	50.00	69.00	55.00	93.40	84.00	111.80	109.00	115.00
Q_{mean}	1851.00	2733.00	2636.00	3571.00	3890.00	5530.00	5920.00	6538.00	6943.00	7984.00
April Flows										
Q_{02}	4995.00	14323.00	9814.00	16562.00	9718.00	26251.00	18848.00	31451.00	24013.00	29313.00
Q_{10}	3115.00	7686.00	5623.00	8622.00	8178.00	13273.00	12794.00	15543.00	15073.00	20373.00
Q_{25}	2053.00	3980.00	3176.00	4829.00	4580.00	8732.00	8545.00	10091.00	9919.00	12419.00
Q_{50}	914.00	1594.00	1314.00	2117.00	2148.00	4060.00	4163.00	4461.00	4579.00	5679.00
Q_{75}	273.00	839.00	553.00	1075.00	665.00	1729.00	1355.00	1920.00	1557.00	2257.00
Q_{90}	90.00	513.00	259.00	655.00	69.00	1027.00	467.00	1131.00	580.00	910.00
Q_{98}	48.00	192.40	106.00	98.00	47.00	172.00	125.00	180.00	140.00	152.00
Q_{mean}	1327.00	3129.00	2270.00	3694.00	3067.00	5806.00	5248.00	6904.00	6361.00	7124.00
May Flows										
Q_{02}	2807.00	11887.00	8329.00	17172.00	9229.00	28605.00	20230.00	34446.00	26047.00	31347.00
Q_{10}	2372.00	5479.00	4214.00	8542.00	6338.00	12108.00	9910.00	14081.00	11895.00	14895.00
Q_{25}	1599.00	2512.00	2306.00	4126.00	3848.00	5948.00	5742.00	6821.00	6630.00	8430.00
Q_{50}	933.00	1244.00	1246.00	1712.00	1902.00	2768.00	3006.00	3107.00	3357.00	4457.00
Q_{75}	322.00	709.00	545.00	910.00	693.00	1292.00	1109.00	1449.00	1276.00	1876.00
Q_{90}	89.00	449.00	255.00	576.00	55.00	893.00	394.00	1009.00	518.00	818.00
Q_{98}	26.50	176.00	121.00	104.00	42.00	190.00	136.00	226.00	179.00	212.00
Q_{mean}	1119.00	2375.00	1903.00	3478.00	2741.00	5106.00	4440.00	5850.00	5199.00	5823.00
June Flows										
Q_{02}	4249.00	10874.00	8662.00	12556.00	8883.00	19635.00	15656.00	23254.00	19264.00	24564.00
Q_{10}	2407.00	4522.00	4028.00	5374.00	4764.00	8120.00	7569.00	9992.00	9457.00	11957.00
Q_{25}	1711.00	1937.00	2242.00	3358.00	3605.00	4610.00	4928.00	5190.00	5522.00	6822.00
Q_{50}	926.00	966.00	1218.00	1322.00	1700.00	2058.00	2476.00	2278.00	2707.00	3807.00
Q_{75}	366.00	416.00	478.00	646.00	553.00	1071.00	1002.00	1138.00	1077.00	1637.00
Q_{90}	105.00	282.00	232.00	375.00	124.00	649.00	407.00	699.00	465.00	735.00
Q_{98}	23.00	115.40	74.00	124.00	45.00	202.00	129.00	372.00	306.00	466.00
Q_{mean}	1217.00	1913.00	1872.00	2471.00	2342.00	3575.00	3517.00	4124.00	4081.00	4571.00

Appendix A. Continued

Flow Type	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
					Location					
July Flows										
Q_{02}	4430.00	8741.00	7839.00	12690.00	8844.00	17699.00	13682.00	20648.00	16628.00	21928.00
Q_{10}	2400.00	2463.00	3262.00	5061.00	5255.00	7240.00	7506.00	8641.00	8922.00	11422.00
Q_{25}	1745.00	1038.00	1927.00	2260.00	3357.00	3028.00	4172.00	3332.00	4488.00	5588.00
Q_{50}	940.00	685.00	1096.00	837.00	1308.00	1378.00	1874.00	1543.00	2048.00	2898.00
Q_{75}	278.00	273.00	391.00	302.00	299.00	500.00	506.00	545.00	559.00	869.00
Q_{90}	53.50	128.00	134.00	126.00	71.00	249.00	200.00	286.00	244.00	354.00
Q_{98}	26.60	54.40	53.00	37.00	44.00	78.00	86.00	132.00	145.00	160.00
Q_{mean}	1166.00	1101.00	1459.00	1629.00	2065.00	2433.00	2926.00	2838.00	3344.00	3745.00
August Flows										
Q_{02}	3252.00	2506.00	3614.00	8715.00	5884.00	13196.00	10328.00	15216.00	12358.00	15858.00
Q_{10}	2212.00	837.00	2296.00	2303.00	3517.00	2952.00	4231.00	2892.00	4185.00	5285.00
Q_{25}	1217.00	690.00	1433.00	858.00	1531.00	1289.00	1985.00	1557.00	2261.00	3161.00
Q_{50}	460.00	195.00	472.00	281.00	320.00	581.00	628.00	680.00	735.00	935.00
Q_{75}	116.00	131.00	158.00	118.00	75.00	269.00	232.00	320.00	290.00	430.00
Q_{90}	28.20	66.10	67.00	62.00	50.00	131.00	123.00	162.00	160.00	183.00
Q_{98}	8.70	33.20	36.00	27.00	42.00	76.00	91.00	116.00	135.00	145.00
Q_{mean}	716.00	508.00	839.00	1036.00	1133.00	1639.00	1776.00	1935.00	2083.00	2303.00
September Flows										
Q_{02}	2491.00	2960.00	2493.00	3333.00	3758.00	4083.00	4566.00	4676.00	5174.00	6374.00
Q_{10}	1515.00	803.00	1676.00	1082.00	1706.00	1674.00	2336.00	2011.00	2683.00	3783.00
Q_{25}	524.00	311.00	577.00	383.00	472.00	749.00	848.00	876.00	982.00	1502.00
Q_{50}	138.00	179.00	227.00	165.00	117.00	325.00	285.00	386.00	363.00	553.00
Q_{75}	29.40	67.80	74.00	80.00	53.00	159.00	137.00	197.00	181.00	216.00
Q_{90}	11.50	39.60	44.00	49.00	44.00	92.20	90.00	115.00	118.00	123.00
Q_{98}	8.00	23.40	27.00	26.00	39.00	53.90	67.00	76.10	91.00	93.00
Q_{mean}	406.00	414.00	491.00	576.00	525.00	799.00	771.00	907.00	888.00	995.00
October Flows										
Q_{02}	2371.00	6890.00	3738.00	6020.00	3456.00	8314.00	5778.00	9746.00	7222.00	9422.00
Q_{10}	1167.00	1451.00	1427.00	1477.00	1685.00	2062.00	2328.00	2182.00	2460.00	3460.00
Q_{25}	477.00	396.00	616.00	413.00	588.00	651.00	845.00	706.00	907.00	1397.00
Q_{50}	143.00	78.00	157.00	130.00	95.00	264.00	236.00	299.00	278.00	408.00
Q_{75}	28.80	59.60	65.00	58.00	52.00	104.00	104.00	132.00	138.00	150.00
Q_{90}	13.10	30.30	36.00	42.00	43.00	76.30	80.00	92.00	100.00	103.00
Q_{98}	8.40	15.30	19.20	24.00	37.00	50.90	64.00	64.20	79.00	80.00
Q_{mean}	310.00	675.00	516.00	713.00	524.00	936.00	775.00	1052.00	901.00	1009.00
November Flows										
Q_{02}	2686.00	6283.00	5686.00	6865.00	4550.00	11260.00	8926.00	13480.00	11156.00	14356.00
Q_{10}	1627.00	2072.00	2326.00	3305.00	3155.00	4676.00	4596.00	5256.00	5190.00	6390.00
Q_{25}	725.00	839.00	1064.00	1022.00	1228.00	1539.00	1777.00	1553.00	1801.00	2561.00
Q_{50}	386.00	263.00	474.00	239.00	367.00	426.00	562.00	445.00	588.00	908.00
Q_{75}	81.00	97.00	147.00	75.00	57.00	142.00	132.00	161.00	158.00	180.00
Q_{90}	23.80	55.30	63.00	48.00	46.00	80.40	82.00	90.20	97.00	99.00
Q_{98}	7.60	14.70	19.40	26.00	40.00	49.30	64.00	62.20	80.00	81.00
Q_{mean}	588.00	827.00	903.00	982.00	921.00	1423.00	1389.00	1651.00	1627.00	1822.00
December Flows										
Q_{02}	4723.00	9731.00	9177.00	8859.00	9413.00	18720.00	18968.00	23485.00	23719.00	29019.00
Q_{10}	2872.00	3792.00	4182.00	3759.00	4738.00	6865.00	7916.00	8131.00	9197.00	11697.00
Q_{25}	1552.00	1284.00	1914.00	1322.00	3026.00	2420.00	4167.00	2702.00	4460.00	5560.00
Q_{50}	882.00	559.00	997.00	412.00	2231.00	531.00	2364.00	565.00	2406.00	3456.00
Q_{75}	136.00	155.00	233.00	90.00	697.00	293.00	903.00	354.00	970.00	1490.00
Q_{90}	23.00	65.80	70.00	53.00	53.00	101.00	108.00	125.00	138.00	152.00
Q_{98}	8.20	17.20	17.70	30.00	39.00	58.80	70.00	78.90	94.00	96.00
Q_{mean}	1114.00	1366.00	1601.00	1451.00	2321.00	2457.00	3374.00	2967.00	3896.00	4366.00

Appednix A. Continued

Flow Type	Location (21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)
Q_{01}	26745.00	6917.00	6492.00	762.00	757.00	758.00	1542.00	1543.00	241.00	1105.00
Q_{02}	23878.00	4515.00	4280.00	423.00	434.00	435.00	1050.00	1051.00	133.00	712.00
Q_{05}	20226.00	2800.00	2770.00	149.00	152.00	153.00	510.00	511.00	53.00	295.00
Q_{10}	13084.00	1312.00	1360.00	63.00	57.60	58.40	242.00	243.00	25.00	99.00
Q_{15}	10645.00	722.00	781.00	33.00	32.20	33.00	128.00	129.00	13.70	44.30
Q_{25}	6997.00	349.00	407.00	13.00	15.40	16.00	49.10	50.00	5.80	16.40
Q_{40}	4448.00	130.00	166.00	5.20	6.88	7.50	20.70	21.50	2.30	5.70
Q_{50}	2813.00	76.60	100.00	3.40	4.01	4.60	12.30	13.10	1.30	2.86
Q_{60}	1723.00	49.10	63.00	2.00	2.15	2.70	7.15	7.90	0.70	1.40
Q_{75}	650.00	27.70	30.00	0.57	0.33	0.82	1.84	2.50	0.20	0.00
Q_{85}	313.00	13.60	17.00	0.10	0.09	0.20	0.29	0.89	0.02	0.12
Q_{90}	175.00	10.17	12.00	0.00	0.07	0.07	0.08	0.55	0.00	0.09
Q_{95}	118.00	5.79	7.50	0.00	0.00	0.00	0.00	0.29	0.00	0.00
Q_{98}	92.00	4.30	3.60	0.00	0.00	0.00	0.00	0.13	0.00	0.00
Q_{99}	86.00	1.90	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{mean}	3893.00	532.00	531.00	39.70	38.70	39.30	105.80	106.80	13.00	64.00
Low Flows										
$Q_{1,2}$	178.00	6.69	7.50	0.00	0.00	0.00	0.00	0.20	0.00	0.00
$Q_{1,10}$	107.00	1.03	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{1,25}$	89.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{1,50}$	81.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{7,2}$	200.00	7.71	9.50	0.00	0.01	0.01	0.00	0.33	0.00	0.00
$Q_{7,10}$	116.00	1.40	0.70	0.00	0.00	0.00	0.01	0.01	0.00	0.00
$Q_{7,25}$	102.00	0.15	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{7,50}$	96.90	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{15,2}$	212.00	9.85	11.60	0.03	0.06	0.06	0.21	0.68	0.10	0.00
$Q_{15,10}$	118.00	1.70	1.00	0.00	0.00	0.00	0.01	0.03	0.00	0.00
$Q_{15,25}$	101.00	0.52	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{15,50}$	95.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{31,2}$	316.00	14.90	17.90	0.12	0.07	0.18	0.41	1.00	0.10	0.34
$Q_{31,10}$	127.00	1.90	2.30	0.00	0.00	0.00	0.09	0.45	0.00	0.06
$Q_{31,25}$	114.00	1.50	0.80	0.00	0.00	0.00	0.04	0.04	0.00	0.02
$Q_{31,50}$	103.00	0.53	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{61,2}$	624.00	31.20	32.50	0.33	0.54	1.00	1.97	2.60	0.22	1.40
$Q_{61,10}$	155.00	4.31	5.80	0.00	0.00	0.00	0.21	0.60	0.00	0.22
$Q_{61,25}$	123.00	2.72	3.20	0.00	0.00	0.00	0.07	0.40	0.00	0.13
$Q_{61,50}$	113.00	3.00	2.30	0.00	0.00	0.00	0.00	0.16	0.00	0.07
$Q_{91,2}$	1058.00	51.70	52.00	1.30	1.61	2.10	6.92	7.60	0.38	3.27
$Q_{91,10}$	182.00	8.45	9.90	0.01	0.05	0.05	0.42	0.85	0.00	0.26
$Q_{91,25}$	136.00	3.88	5.20	0.00	0.00	0.00	0.14	0.50	0.00	0.27
$Q_{91,50}$	122.00	3.04	3.60	0.00	0.00	0.00	0.00	0.25	0.00	0.18
Drought Flows										
$Q_{6,10}$	665.00	20.00	21.00	0.35	0.56	1.00	3.78	4.40	0.08	1.81
$Q_{6,25}$	244.00	9.32	12.00	0.08	0.00	0.37	1.23	1.80	0.01	0.86
$Q_{6,50}$	176.00	6.09	7.50	0.02	0.20	0.20	0.38	0.90	0.00	0.49
$Q_{9,10}$	982.00	55.30	59.00	6.20	5.39	5.90	15.10	15.80	0.90	4.94
$Q_{9,25}$	302.00	34.50	32.00	3.80	2.53	3.00	7.64	8.30	0.50	2.08
$Q_{9,50}$	169.00	18.10	18.00	2.50	1.46	1.90	2.99	3.60	0.30	1.12
$Q_{12,10}$	1691.00	108.00	127.00	8.70	10.83	11.40	23.30	24.00	2.00	10.50
$Q_{12,25}$	988.00	53.90	61.00	5.30	5.78	6.30	12.80	13.50	1.05	3.73
$Q_{12,50}$	244.00	34.00	33.00	3.70	3.72	4.20	8.02	8.70	0.75	1.67
$Q_{18,10}$	1782.00	124.00	150.00	11.80	13.10	13.70	34.20	35.00	2.70	15.40
$Q_{18,25}$	1232.00	63.90	78.00	7.20	7.65	8.20	16.30	17.00	1.30	5.60
$Q_{18,50}$	443.00	40.30	44.00	5.20	4.89	5.40	9.90	10.60	0.90	2.64
$Q_{30,10}$	2812.00	204.00	242.00	18.00	17.90	18.50	49.20	50.00	4.50	31.50
$Q_{30,25}$	1501.00	82.00	103.00	11.00	10.72	11.30	26.20	27.00	2.20	12.00
$Q_{30,50}$	1010.00	57.10	71.00	7.60	7.85	8.40	16.10	16.80	1.50	7.06

Appednix A. Continued

Flow Type	Location (21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)
Drought Flows-Cont										
$Q_{54,10}$	4252.00	371.00	425.00	29.00	34.30	35.00	93.10	94.00	8.40	55.40
$Q_{54,25}$	2319.00	166.00	196.00	17.10	21.40	22.00	69.20	70.00	4.10	28.50
$Q_{54,50}$	1590.00	102.00	124.00	12.40	15.90	16.40	58.20	59.00	2.70	20.50
January Flows										
Q_{02}	21909.00	5810.00	5521.00	611.00	694.00	695.00	1249.00	1250.00	175.00	849.00
Q_{10}	15643.00	1582.00	1631.00	90.00	79.40	80.40	288.00	289.00	30.00	174.00
Q_{25}	9515.00	439.00	498.00	19.00	17.80	18.50	56.20	57.00	6.00	21.30
Q_{50}	3463.00	97.00	120.00	4.00	5.41	6.00	17.20	18.00	1.20	4.86
Q_{75}	489.00	29.80	30.00	1.70	1.81	2.30	7.32	8.00	0.20	1.77
Q_{90}	165.00	9.94	13.00	0.20	0.52	0.60	0.63	1.10	0.00	0.35
Q_{98}	87.40	5.13	6.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00
Q_{mean}	4880.00	574.00	632.00	54.00	50.40	51.00	124.00	125.00	15.20	75.40
February flows										
Q_{02}	27968.00	7567.00	7199.00	1082.00	845.00	846.00	1998.00	2000.00	196.00	1507.00
Q_{10}	21468.00	3137.00	3140.00	123.00	143.00	144.00	599.00	600.00	36.00	277.00
Q_{25}	12791.00	803.00	862.00	36.00	35.30	36.00	126.00	127.00	11.00	53.30
Q_{50}	5022.00	254.00	289.00	10.00	12.30	13.00	39.20	40.00	2.50	14.40
Q_{75}	965.00	62.90	70.00	4.00	4.68	5.20	14.30	15.00	0.50	4.93
Q_{90}	185.00	16.50	17.00	0.80	1.05	1.50	6.35	7.00	0.10	1.00
Q_{98}	96.10	5.15	8.00	0.00	0.44	0.50	0.00	0.50	0.00	0.18
Q_{mean}	6836.00	951.00	1010.00	78.00	69.30	70.00	219.00	220.00	17.30	128.00
March Flows										
Q_{02}	25933.00	6312.00	5888.00	913.00	799.00	800.00	1805.00	1807.00	288.00	1476.00
Q_{10}	21901.00	2779.00	2751.00	185.00	186.00	187.00	698.00	699.00	50.80	447.00
Q_{25}	13530.00	966.00	1020.00	48.00	44.20	45.00	214.00	215.00	18.00	99.80
Q_{50}	9386.00	363.00	421.00	16.00	17.30	18.00	65.20	66.00	6.60	25.40
Q_{75}	2714.00	140.00	169.00	6.80	8.89	9.50	28.20	29.00	2.40	9.40
Q_{90}	1447.00	70.30	86.00	4.10	4.55	5.10	13.30	14.00	0.90	4.30
Q_{98}	102.00	14.40	14.70	1.90	2.56	3.00	0.98	1.60	0.30	0.01
Q_{mean}	8383.00	928.00	987.00	83.00	79.30	80.00	252.00	253.00	25.90	169.00
April Flows										
Q_{02}	21875.00	6288.00	5862.00	525.00	691.00	692.00	1896.00	1898.00	200.00	1129.00
Q_{10}	19899.00	2888.00	2860.00	105.00	119.00	120.00	575.00	576.00	34.00	302.00
Q_{25}	12241.00	862.00	912.00	29.00	37.20	38.00	198.00	199.00	12.00	48.20
Q_{50}	5791.00	292.00	351.00	11.00	14.20	15.00	44.10	45.00	4.80	13.40
Q_{75}	1886.00	115.00	150.00	5.50	6.18	6.80	21.20	22.00	2.20	6.30
Q_{90}	351.00	64.70	87.00	3.50	3.72	4.30	10.20	11.00	0.70	2.67
Q_{98}	102.00	30.30	30.00	2.30	2.13	2.60	2.86	3.50	0.00	0.00
Q_{mean}	6575.00	917.00	973.00	63.60	70.50	71.20	238.00	239.00	19.30	115.00
May Flows										
Q_{02}	22933.00	4493.00	4164.00	369.00	538.00	539.00	898.00	900.00	179.00	413.00
Q_{10}	12690.00	1423.00	1427.00	42.20	52.60	53.50	183.00	184.00	32.00	60.90
Q_{25}	8217.00	451.00	510.00	14.00	18.30	19.00	52.60	53.50	8.70	13.30
Q_{50}	4685.00	137.00	184.00	5.90	6.55	7.20	18.20	19.00	3.80	3.80
Q_{75}	1680.00	52.60	82.00	3.00	2.69	3.30	7.20	8.00	1.70	1.55
Q_{90}	304.00	31.80	49.00	1.80	0.93	1.50	3.74	4.50	1.00	0.35
Q_{98}	140.00	15.00	18.00	0.50	0.00	0.40	0.19	0.80	0.00	0.00
Q_{mean}	5150.00	521.00	580.00	34.80	40.90	41.70	89.60	90.60	17.80	38.90
June Flows										
Q_{02}	20553.00	3615.00	3382.00	372.00	343.00	344.00	797.00	798.00	95.40	603.00
Q_{10}	11398.00	1272.00	1320.00	33.00	44.10	45.00	249.00	250.00	22.00	57.20
Q_{25}	7128.00	391.00	450.00	9.40	9.80	10.50	55.10	56.00	6.60	8.60
Q_{50}	4208.00	85.00	120.00	2.90	2.48	3.10	12.20	13.00	2.60	1.53
Q_{75}	1548.00	38.40	57.00	1.00	0.32	0.90	2.33	3.10	1.10	0.32
Q_{90}	472.00	22.40	26.00	0.30	0.00	0.14	0.59	1.30	0.50	0.00
Q_{98}	370.00	11.93	14.00	0.00	0.00	0.00	0.00	0.50	0.10	0.08
Q_{mean}	4501.00	461.00	520.00	31.50	31.80	32.60	96.10	97.10	11.20	44.00

Appednix A. Continued

Flow Type	Location (21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)
July Flows										
Q_{02}	17881.00	3034.00	2903.00	271.08	255.60	256.60	735.30	736.30	90.96	733.60
Q_{10}	11671.00	724.00	783.00	20.20	20.20	2L00	106.10	107.00	10.00	42.90
Q_{25}	6712.00	157.00	200.00	3.80	3.56	4.20	16.40	17.20	2.50	5.42
Q_{50}	3370.00	47.90	68.00	1.20	0.61	1.20	3.72	4.50	050	1.17
Q_{75}	849.00	26.60	30.00	0.30	0.00	0.26	0.91	1.60	0.30	0.17
Q_{90}	277.00	1350	16.00	0.00	0.00	0.00	0.13	0.70	0.10	0.00
Q_{98}	137.00	5.60	4.90	0.00	0.00	0.00	0.00	0.40	0.00	0.00
Q_{mean}	4219.00	297.00	344.00	24.80	19.90	20.50	68.80	69.70	8.70	43.60
August Flows										
Q_{02}	12976.00	1876.00	1847.00	87.00	110.00	111.00	166.00	167.00	50.00	107.00
Q_{10}	6551.00	320.00	373.00	8.80	10.35	11.00	42.20	43.00	3.30	14.40
Q_{25}	3837.00	7650	95.00	1.90	2.32	2.90	5.73	6.50	0.70	1.97
Q_{50}	961.00	37.50	40.00	0.60	0.25	0.76	1.42	2.10	0.20	0.34
Q_{75}	370.00	17.20	19.00	0.10	0.06	0.06	0.24	0.85	0.00	0.04
Q_{90}	150.00	9.04	11.00	0.00	0.00	0.00	0.01	0.48	0.00	0.02
Q_{98}	131.00	4.90	4.20	0.00	0.00	0.00	0.00	0.05	0.00	0.00
Q_{mean}	2423.00	151.00	184.00	8.20	8.00	8.60	16.70	17.50	5.30	9.40
September Flows										
Q_{02}	6846.00	723.00	771.00	119.00	108.10	109.00	233.00	234.00	33.60	92.00
Q_{10}	4427.00	170.00	201.00	7.80	8.89	9.50	24.20	25.00	3.70	8.10
Q_{25}	1579.00	57.40	63.00	1.80	2.39	2.90	4.69	5.40	0.77	2.04
Q_{50}	490.00	19.80	23.00	0.20	0.00	0.43	0.34	056	0.10	0.43
Q_{75}	169.00	10.12	12.00	0.00	0.01	0.01	0.03	0.50	0.00	0.23
Q_{90}	94.50	4.49	5.30	0.00	0.00	0.00	0.00	0.35	0.00	0.02
Q_{98}	70.80	1.08	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{mean}	948.00	67.40	86.40	11.60	10.73	11.30	14.10	14.90	3.40	7.90
October Flows										
Q_{02}	6893.00	1343.00	1365.00	48.00	51.10	52.00	434.00	435.00	19.20	277.00
Q_{10}	3731.00	194.00	241.00	4.40	6.35	7.00	41.20	42.00	2.90	17.40
Q_{25}	1590.00	50.90	66.00	1.60	2.34	2.90	7.24	8.00	0.80	2.49
Q_{50}	377.00	19.40	22.00	0.27	0.25	0.72	0.56	1.20	0.14	0.69
Q_{75}	145.00	7.76	9.60	0.00	0.08	0.08	0.03	0.50	0.00	0.24
Q_{90}	99.10	4.54	5.40	0.00	0.00	0.00	0.00	0.25	0.00	0.10
Q_{98}	77.50	0.96	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{mean}	850.00	119.00	142.00	4.20	13.30	13.90	26.50	27.30	4.50	27.30
November Flows										
Q_{02}	12029.00	3280.00	3265.00	83.00	226.00	227.00	918.00	919.00	24.60	971.00
Q_{10}	6316.00	612.00	670.00	15.00	25.30	26.00	207.00	208.00	4.90	78.40
Q_{25}	2801.00	135.00	161.00	4.00	6.71	7.30	32.20	33.00	1.90	12.50
Q_{50}	1042.00	49.80	54.00	1.20	2.09	2.60	7.70	8.40	0.30	1.64
Q_{75}	167.00	18.20	21.00	0.19	0.15	0.48	1.09	1.70	0.08	0.36
Q_{90}	94.30	8.35	10.00	0.00	0.10	0.10	0.32	0.75	0.00	0.20
Q_{98}	86.00	2.00	1.30	0.00	0.00	0.00	0.10	0.40	0.00	0.00
Q_{mean}	1790.00	289.00	312.00	12.70	21.90	22.50	81.90	82.60	3.10	76.40
December Flows										
Q_{02}	29253.00	6381.00	6146.00	378.00	865.00	866.00	2029.00	2030.00	144.00	1307.00
Q_{10}	12757.00	1856.00	1915.00	61.00	89.00	90.00	525.00	526.00	25.00	267.00
Q_{25}	7310.00	438.00	474.00	15.00	19.40	20.00	109.20	110.00	6.00	34.50
Q_{50}	5288.00	82.00	95.00	3.90	8.06	8.60	22.70	23.50	1.00	7.52
Q_{75}	2096.00	30.90	30.00	1.10	1.15	1.60	6.35	7.00	0.10	1.80
Q_{90}	154.00	9.27	12.00	0.20	0.23	0.29	0.24	0.78	0.00	0.44
Q_{98}	98.60	5.11	5.70	0.00	0.00	0.00	0.00	0.30	0.00	0.10
Q_{mean}	5287.00	610.00	650.00	36.80	64.50	65.10	205.00	206.00	14.20	122.70

Appendix A. Continued

Location

Flow Type	(31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)
Q_{01}	1107.00	81.00	236.00	173.00	1390.00	1189.00	704.00	583.00	105.00	88.00
Q_{02}	713.00	52.00	139.00	104.00	748.00	635.00	420.00	350.00	62.00	51.70
Q_{05}	296.00	25.00	54.30	49.60	332.00	315.00	170.00	155.00	24.40	21.40
Q_{10}	100.00	13.60	22.70	27.40	144.00	158.00	71.10	73.90	10.10	9.35
Q_{15}	45.00	9.19	12.00	17.90	76.70	93.60	36.70	41.70	5.18	4.72
Q_{25}	17.00	5.31	5.15	11.00	36.60	53.50	14.70	19.70	2.07	0.00
Q_{40}	6.30	2.63	2.03	5.55	13.90	23.30	5.46	0.00	0.75	0.00
Q_{50}	3.40	1.45	1.11	2.60	7.71	13.40	2.91	0.00	0.38	0.00
Q_{60}	1.90	0.63	0.57	0.89	4.42	7.94	1.50	0.00	0.17	0.00
Q_{75}	0.64	0.08	0.10	0.00	1.40	0.00	0.34	0.00	0.00	0.00
Q_{85}	0.29	0.02	0.00	0.00	0.44	0.00	0.03	0.00	0.00	0.00
Q_{90}	0.12	0.01	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00
Q_{95}	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{99}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{mean}	64.30	6.40	12.80	12.30	75.20	72.80	39.00	33.00	5.66	3.70
Low Flows										
$Q_{1,2}$	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00
$Q_{1,10}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{1,25}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{1,50}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{7,2}$	0.03	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00
$Q_{7,10}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{7,25}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{7,50}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{15,2}$	0.08	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.00
$Q_{15,10}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{15,25}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{15,50}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{31,2}$	0.51	0.01	0.00	0.00	0.58	0.00	0.08	0.00	0.00	0.00
$Q_{31,10}$	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{31,25}$	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{31,50}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{61,2}$	1.80	0.05	0.15	0.00	1.86	0.00	0.47	0.00	0.02	0.00
$Q_{61,10}$	0.22	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00
$Q_{61,25}$	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{61,50}$	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{91,2}$	3.70	0.08	0.45	0.00	3.91	1.33	1.16	0.00	0.13	0.00
$Q_{91,10}$	0.37	0.00	0.00	0.00	0.25	0.00	0.01	0.00	0.00	0.00
$Q_{91,25}$	0.27	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00
$Q_{91,50}$	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Drought Flows										
$Q_{6,10}$	2.20	0.06	0.21	0.00	1.79	0.00	0.57	0.00	0.04	0.00
$Q_{6,25}$	1.10	0.01	0.03	0.00	0.72	0.00	0.13	0.00	0.00	0.00
$Q_{6,50}$	0.60	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00
$Q_{9,10}$	5.40	0.50	1.23	0.35	7.63	6.89	3.47	0.00	0.47	0.00
$Q_{9,25}$	2.50	0.20	0.52	0.00	4.08	0.39	1.53	0.00	0.19	0.00
$Q_{9,50}$	1.50	0.12	0.24	0.00	2.52	0.00	0.78	0.00	0.07	0.00
$Q_{12.10}$	11.00	1.80	2.53	3.43	15.80	20.40	7.82	5.62	1.09	0.00
$Q_{12,25}$	4.20	1.40	1.21	0.67	7.98	8.45	3.62	0.00	0.49	0.00
$Q_{12,50}$	2.10	1.20	0.72	0.00	5.05	2.25	2.12	0.00	0.28	0.00
$Q_{18,10}$	16.00	2.30	3.31	5.20	20.10	26.60	10.10	9.06	1.43	0.00
$Q_{18,25}$	6.10	1.70	1.62	1.77	10.40	13.30	4.96	0.00	0.68	0.00
$Q_{18,50}$	3.10	1.40	0.99	0.11	6.43	5.69	2.98	0.00	0.40	0.00
$Q_{30,10}$	32.00	3.40	5.66	9.41	32.60	42.80	17.00	18.20	2.45	1.42
$Q_{30,25}$	12.50	2.50	2.93	4.18	13.80	19.10	9.09	7.34	1.28	0.00
$Q_{30,50}$	7.60	2.20	1.92	2.07	9.57	12.50	5.93	2.71	0.82	0.00

Appendix A. Continued

Flow Type	Location (31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)
Drought Flows-Cont										
$Q_{54,10}$	56.00	6.00	10.30	15.70	61.50	77.00	29.90	34.00	4.39	3.81
$Q_{54,25}$	29.00	3.70	5.76	8.26	27.70	35.30	16.80	16.40	2.44	1.13
$Q_{54,500}$	21.00	2.90	4.08	5.33	18.70	24.00	11.30	9.54	1.66	0.00
January Flows										
Q_{02}	850.00	50.00	187.00	144.00	1013.00	874.00	555.00	469.00	82.50	70.30
Q_{10}	175.00	13.10	33.70	38.40	175.00	188.00	103.00	106.00	14.80	14.00
Q_{25}	22.00	5.30	7.37	13.20	48.30	66.20	22.20	27.10	3.12	2.66
Q_{50}	5.40	1.10	1.65	3.14	10.50	16.20	4.74	0.00	0.64	0.00
Q_{75}	2.20	0.12	0.46	0.00	2.72	0.14	1.28	0.00	0.14	0.00
Q_{90}	0.50	0.01	0.00	0.00	0.37	0.00	0.05	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{mean}	76.00	5.80	17.10	23.00	92.90	110.00	51.50	56.40	7.52	7.06
February flows										
Q_{02}	1508.00	61.00	235.00	180.00	1352.00	1177.00	695.00	589.00	103.00	89.00
Q_{10}	278.00	16.40	46.20	46.20	306.00	304.00	144.00	138.00	20.30	18.50
Q_{25}	54.00	8.40	12.20	18.10	81.60	98.60	37.60	42.50	5.28	4.82
Q_{50}	15.00	3.00	3.64	7.16	25.70	35.10	10.50	11.20	1.46	0.00
Q_{75}	5.40	0.70	1.20	0.66	7.11	7.58	3.41	0.00	0.46	0.00
Q_{90}	1.40	0.06	0.29	0.00	1.63	0.00	0.85	0.00	0.08	0.00
Q_{98}	0.30	0.00	0.00	0.00	0.37	0.00	0.06	0.00	0.00	0.00
Q_{mean}	129.00	8.10	22.10	28.00	136.00	163.00	67.10	72.10	9.75	9.29
March Flows										
Q_{02}	1477.00	64.00	236.00	173.00	1192.00	991.00	728.00	608.00	108.00	91.00
Q_{10}	448.00	22.10	56.70	52.00	291.00	275.00	180.00	166.00	25.50	22.60
Q_{25}	100.50	9.50	16.80	22.20	105.00	120.00	50.70	54.80	7.23	6.66
Q_{50}	26.00	5.00	6.41	12.30	42.80	59.70	18.90	23.90	2.68	2.22
Q_{75}	10.00	2.50	2.63	5.13	16.90	24.50	7.66	7.28	1.06	0.00
Q_{90}	4.80	0.90	1.24	1.56	8.92	12.40	3.65	0.00	0.49	0.00
Q_{98}	0.40	0.04	0.22	0.00	2.36	0.00	0.71	0.00	0.06	0.00
Q_{mean}	170.00	10.60	25.10	31.00	136.00	153.00	76.50	81.50	11.10	10.70
April Flows										
Q_{02}	1130.00	56.00	202.00	139.00	1136.00	934.00	630.00	509.00	92.60	75.80
Q_{10}	303.00	20.70	43.60	38.90	284.00	268.00	141.00	127.00	19.80	16.90
Q_{25}	49.00	10.90	13.20	18.10	81.90	95.90	39.10	42.30	5.51	4.83
Q_{50}	14.00	5.40	4.72	10.60	32.10	49.00	13.40	18.40	1.88	0.00
Q_{75}	6.90	2.90	2.10	5.62	13.90	23.30	5.73	0.00	0.79	0.00
Q_{90}	3.20	1.50	0.96	2.21	7.01	12.30	2.55	0.00	0.33	0.00
Q_{98}	0.40	0.80	0.28	0.00	2.61	0.00	0.84	0.00	0.08	0.00
Q_{mean}	116.00	10.20	22.50	28.00	133.00	149.00	68.10	72.40	9.90	9.36
May Flows										
Q_{02}	414.00	79.00	145.00	95.90	791.00	633.00	464.00	368.00	67.70	54.10
Q_{10}	61.90	16.80	19.40	19.40	125.00	124.00	63.20	57.50	8.74	6.89
Q_{25}	14.00	7.60	5.75	11.60	40.60	57.60	16.60	21.60	2.30	1.84
Q_{50}	4.40	4.10	2.17	6.86	14.80	28.00	5.85	0.00	0.80	0.00
Q_{75}	2.10	2.50	0.88	3.38	6.16	13.80	2.37	0.00	0.30	0.00
Q_{90}	0.87	1.70	0.36	1.26	3.00	7.63	1.01	0.00	0.10	0.00
Q_{98}	0.15	1.00	0.04	0.00	0.89	0.00	0.19	0.00	0.00	0.00
Q_{mean}	39.50	10.60	13.20	19.10	77.50	94.50	39.80	44.70	5.77	5.31
June Flows										
Q_{02}	604.00	83.00	112.00	76.90	575.00	462.00	327.00	257.00	48.60	38.40
Q_{10}	58.00	20.20	13.30	18.00	107.00	120.00	39.10	41.90	5.45	4.71
Q_{25}	9.30	8.30	3.30	9.16	30.40	47.40	9.25	14.20	1.24	0.00
Q_{50}	2.10	3.30	0.99	4.51	8.02	17.40	2.32	0.00	0.29	0.00
Q_{75}	0.85	1.60	0.27	1.41	2.99	8.05	0.70	0.00	0.05	0.00
Q_{90}	0.35	0.90	0.04	0.00	0.99	0.00	0.21	0.00	0.00	0.00
Q_{98}	0.13	0.50	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00
Q_{mean}	44.70	10.80	11.30	17.20	68.20	85.10	33.20	38.10	4.83	4.37

Appendix A. Continued

Flow Type	Location (31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)
July Flows										
Q_{02}	734.60	49.00	81.10	61.20	409.00	344.00	235.00	193.00	34.70	28.20
Q_{10}	43.60	7.80	7.82	13.70	64.00	70.90	21.80	26.70	2.98	2.52
Q_{25}	6.00	2.20	1.40	5.62	11.60	23.30	3.42	0.00	0.43	0.00
Q_{50}	1.70	0.60	0.34	1.83	3.50	9.22	0.87	0.00	0.07	0.00
Q_{75}	0.52	0.13	0.03	0.00	0.99	0.00	0.14	0.00	0.00	0.00
Q_{90}	0.12	0.02	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{mean}	44.20	4.20	7.52	12.20	46.90	60.10	21.20	24.10	3.11	2.33
August Flows										
Q_{02}	108.00	38.00	32.90	28.20	200.00	184.00	101.00	86.70	14.40	11.50
Q_{10}	15.00	2.30	3.13	8.52	24.10	39.50	8.07	12.20	1.08	0.00
Q_{25}	2.50	0.40	0.56	1.70	5.00	10.10	1.58	0.00	0.16	0.00
Q_{50}	0.80	0.06	0.10	0.00	1.57	0.00	0.35	0.00	0.00	0.00
Q_{75}	0.22	0.01	0.00	0.00	0.37	0.00	0.00	0.00	0.00	0.00
Q_{90}	0.02	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{mean}	10.00	2.60	4.00	7.11	22.10	30.80	11.50	11.70	1.64	0.00
September Flows										
Q_{02}	93.00	42.00	26.60	31.30	119.00	132.00	81.80	84.70	11.90	11.20
Q_{10}	8.70	2.30	2.42	5.33	15.70	24.00	6.90	6.94	0.93	0.00
Q_{25}	2.50	0.20	0.43	0.00	3.90	3.76	1.17	0.00	0.12	0.00
Q_{50}	0.74	0.03	0.02	0.00	0.79	0.00	0.16	0.00	0.00	0.00
Q_{75}	0.23	0.01	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00
Q_{90}	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{mean}	8.50	2.90	2.65	3.55	13.50	18.10	7.88	5.68	1.13	0.00
October Flows										
Q_{02}	278.00	32.70	28.60	30.50	144.00	148.00	91.20	88.80	12.90	11.50
Q_{10}	18.00	4.10	2.83	7.52	19.70	32.90	6.58	9.41	0.94	0.00
Q_{25}	3.00	0.50	0.65	1.20	4.66	8.62	1.55	0.00	0.18	0.00
Q_{50}	1.10	0.06	0.07	0.00	1.07	0.00	0.26	0.00	0.00	0.00
Q_{75}	0.36	0.01	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00
Q_{90}	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{mean}	27.90	3.00	3.45	4.94	20.30	26.00	10.30	8.89	1.48	0.00
November Flows										
Q_{02}	971.00	22.70	81.30	78.50	453.00	442.00	239.00	228.00	35.10	32.60
Q_{10}	79.00	6.60	11.40	17.30	69.50	86.40	31.60	36.50	4.58	4.12
Q_{25}	13.00	1.40	2.41	4.30	14.90	21.40	6.31	5.29	0.88	0.00
Q_{50}	2.10	0.17	0.51	0.00	3.83	3.09	1.25	0.00	0.14	0.00
Q_{75}	0.65	0.03	0.02	0.00	0.87	0.00	0.12	0.00	0.00	0.00
Q_{90}	0.20	0.01	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{mean}	76.90	2.50	7.33	8.82	41.20	46.90	21.00	19.60	3.07	1.55
December Flows										
Q_{02}	1308.00	47.00	138.00	103.00	1050.00	938.00	407.00	338.00	60.40	50.20
Q_{10}	268.00	13.20	32.10	38.00	211.00	228.00	96.90	102.00	13.90	13.50
Q_{25}	35.00	4.80	6.36	9.88	46.10	55.50	18.30	19.00	2.60	1.51
Q_{50}	8.00	1.00	1.84	1.82	10.60	13.00	4.76	0.00	0.67	0.00
Q_{75}	2.20	0.03	0.37	0.00	2.51	0.00	0.89	0.00	0.09	0.00
Q_{90}	0.57	0.00	0.00	0.00	0.46	0.00	0.08	0.00	0.00	0.00
Q_{98}	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{mean}	123.20	5.60	15.00	19.00	94.20	105.00	44.40	45.90	6.49	5.52

Appendix A. Continued

Flow Type	Location (41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)	(50)
Q_{01}	339.00	277.00	105.00	89.90	53.10	46.10	466.00	364.00	88.80	79.10
Q_{02}	202.00	168.00	62.10	53.70	31.30	26.70	278.00	220.00	52.10	46.40
Q_{05}	80.80	76.20	24.60	23.50	12.30	7.22	112.00	103.00	20.30	18.90
Q_{10}	33.40	38.00	10.10	11.20	5.05	1.75	46.40	52.70	8.45	8.28
Q_{15}	17.10	22.80	5.15	6.56	2.58	0.00	23.90	32.00	4.41	4.40
Q_{25}	6.67	12.40	2.01	3.42	1.02	0.00	9.55	17.70	1.83	1.82
Q_{40}	2.39	5.84	0.70	0.00	0.35	0.00	3.51	7.90	0.69	0.00
Q_{50}	1.23	3.53	0.35	0.00	0.17	0.00	1.86	4.29	0.36	0.00
Q_{60}	0.61	0.00	0.15	0.00	0.06	0.00	0.94	0.00	0.17	0.00
Q_{75}	0.10	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00
Q_{85}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{90}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{95}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{99}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{mean}	18.50	18.20	5.66	5.53	2.83	1.41	25.70	24.00	4.77	3.90
Low Flows										
$Q_{1,2}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{1,10}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{1,25}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{1,50}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{7,2}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{7,10}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{7,25}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{7,50}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{15,2}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{15,10}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{15,25}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{15,50}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{31,2}$	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
$Q_{31.10}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{31,25}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{31,50}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{61,2}$	0.16	0.00	0.02	0.00	0.00	0.00	0.28	0.00	0.02	0.00
$Q_{61,10}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{61,25}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{61,50}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{91,2}$	0.46	0.09	0.11	0.00	0.04	0.00	0.73	0.00	0.12	0.00
$Q_{91,10}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{91,25}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{91,50}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Drought Flows										
$Q_{6,10}$	0.22	0.00	0.03	0.00	0.00	0.00	0.35	0.00	0.04	0.00
$Q_{6,25}$	0.02	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00
$Q_{6,50}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Q_{9,10}$	1.58	1.70	0.46	0.27	0.22	0.00	2.26	1.35	0.42	0.00
$Q_{9,25}$	0.68	0.00	0.18	0.00	0.07	0.00	0.99	0.00	0.16	0.00
$Q_{9,50}$	0.34	0.00	0.07	0.00	0.01	0.00	0.49	0.00	0.06	0.00
$Q_{12,10}$	3.67	5.44	1.09	1.32	0.53	0.00	5.11	6.72	0.91	0.16
$Q_{12,25}$	1.68	2.12	0.48	0.37	0.22	0.00	2.36	1.94	0.42	0.00
$Q_{12,50}$	0.97	0.54	0.27	0.00	0.12	0.00	1.38	0.00	0.24	0.00
$Q_{18,10}$	4.75	7.28	1.42	1.89	0.70	0.00	6.60	9.42	1.20	0.67
$Q_{18,25}$	2.32	3.40	0.68	0.73	0.32	0.00	3.24	3.79	0.57	0.00
$Q_{18,50}$	1.38	1.50	0.39	0.20	0.18	0.00	1.94	1.03	0.34	0.00
$Q_{30,10}$	8.04	11.70	2.44	3.35	1.21	0.00	11.20	15.90	2.08	1.78
$Q_{30,25}$	4.30	6.39	1.28	1.59	0.62	0.00	5.96	8.06	1.07	0.47
$Q_{30,50}$	2.79	3.87	6.82	0.87	0.39	0.00	3.88	4.43	0.69	0.00

Appendix A. Continued

Flow Type	Location (41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)	(50)
Drought Flows-Cont										
$Q_{54,10}$	14.10	9.40	4.33	5.63	2.20	0.96	19.70	27.10	3.79	3.72
$Q_{54,25}$	7.89	10.80	2.41	3.02	1.21	0.00	11.00	14.40	2.10	1.65
$Q_{54,50}$	5.25	7.34	1.61	1.92	0.82	0.00	7.43	9.53	1.47	0.87
January Flows										
Q_{02}	266.00	223.00	82.30	71.90	41.70	36.40	367.00	297.00	70.10	63.20
Q_{10}	48.50	53.10	14.70	15.80	7.42	6.12	67.50	73.80	12.50	12.40
Q_{25}	10.20	15.90	3.09	4.50	1.55	0.00	14.40	22.50	2.68	2.67
Q_{50}	2.12	4.42	0.61	0.98	0.30	0.00	3.06	5.49	0.56	0.00
Q_{75}	0.54	0.17	0.13	0.00	0.05	0.00	0.81	0.00	0.13	0.00
Q_{90}	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{mean}	24.50	30.20	7.50	8.91	3.77	2.57	33.90	42.00	6.37	6.36
February flows										
Q_{02}	333.00	279.00	103.00	89.90	52.30	46.00	460.00	371.00	87.90	79.50
Q_{10}	67.10	67.10	20.30	20.30	10.20	8.51	93.60	92.40	17.10	16.30
Q_{25}	17.40	23.10	5.25	6.66	2.63	1.43	24.40	32.50	4.49	4.48
Q_{50}	4.74	8.19	1.42	2.27	0.71	0.00	6.79	11.20	1.29	0.92
Q_{75}	1.53	1.97	0.44	0.33	0.21	0.00	2.21	1.79	0.40	0.00
Q_{90}	0.36	0.00	0.08	0.00	0.02	0.00	0.54	0.00	0.07	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
Q_{mean}	31.80	37.50	9.73	11.10	4.90	3.70	44.10	52.20	8.24	8.23
March Flows										
Q_{02}	352.00	290.00	108.00	92.90	54.30	47.30	482.00	380.00	89.20	79.60
Q_{10}	85.10	80.50	25.70	24.60	12.80	10.70	118.00	109.00	21.20	19.80
Q_{25}	23.60	28.90	7.17	8.47	3.62	2.38	33.10	40.50	6.18	6.11
Q_{50}	8.73	14.50	2.64	4.05	1.33	0.00	12.30	20.40	2.32	2.31
Q_{75}	3.49	6.37	1.04	1.65	0.51	0.00	4.97	8.38	0.93	0.20
Q_{90}	1.66	2.90	0.48	0.57	0.22	0.00	2.37	3.16	0.42	0.00
Q_{98}	0.31	0.00	0.06	0.00	0.01	0.00	0.45	0.00	0.05	0.00
Q_{mean}	36.40	42.10	11.10	12.50	5.58	4.38	50.30	58.40	9.36	9.35
April Flows										
Q_{02}	305.00	243.00	93.70	78.60	46.70	39.70	417.00	314.00	76.40	66.80
Q_{10}	66.70	62.10	20.10	19.00	9.93	7.85	92.10	83.50	16.30	14.90
Q_{25}	17.90	22.70	5.41	6.60	2.76	1.48	25.30	31.90	4.80	4.66
Q_{50}	6.05	11.80	1.82	3.23	0.93	0.00	8.68	16.80	1.68	1.67
Q_{75}	2.55	6.00	0.76	1.61	0.38	0.00	3.71	8.10	0.72	0.00
Q_{90}	1.09	3.18	0.30	0.61	0.14	0.00	1.63	3.73	0.31	0.00
Q_{98}	0.35	0.00	0.07	0.00	0.02	0.00	0.53	0.00	0.07	0.00
Q_{mean}	32.30	37.70	9.88	11.20	4.97	3.74	44.70	52.30	8.37	8.31
May Flows										
Q_{02}	225.00	177.00	68.90	57.10	34.10	28.30	306.00	227.00	55.10	47.50
Q_{10}	29.60	29.60	8.83	8.84	4.36	2.67	41.00	39.80	7.20	6.38
Q_{25}	7.45	13.20	2.23	3.64	1.14	0.00	10.70	18.80	2.04	2.03
Q_{50}	2.55	7.15	0.75	1.88	0.38	0.00	3.76	10.00	0.74	0.00
Q_{75}	1.00	3.88	0.27	0.88	0.13	0.00	1.50	4.91	0.28	0.00
Q_{90}	0.39	2.16	0.09	0.32	0.02	0.00	0.62	0.00	0.09	0.00
Q_{98}	0.05	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00
Q_{mean}	18.80	24.50	5.75	7.16	2.89	1.69	26.10	34.20	4.90	4.89
June Flows										
Q_{02}	155.00	121.00	48.20	39.80	24.60	20.00	216.00	159.00	41.80	36.10
Q_{10}	17.60	22.20	5.32	6.45	2.72	1.42	25.20	31.50	4.80	4.63
Q_{25}	3.99	9.73	1.18	2.59	0.60	0.00	5.89	14.00	1.13	0.60
Q_{50}	0.91	4.36	0.25	1.10	0.12	0.00	1.45	5.84	0.30	0.00
Q_{75}	0.23	1.84	0.04	0.00	0.00	0.00	0.41	0.00	0.06	0.00
Q_{90}	0.04	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{mean}	15.60	21.30	4.78	6.19	2.42	1.22	21.80	29.90	4.16	4.15

Appendix A. Continued

Flow Type	Location (41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)	(50)
July Flows										
Q_{02}	111.00	91.50	34.30	29.50	17.50	14.10	155.00	122.00	30.00	26.50
Q_{10}	9.44	15.20	2.83	4.24	1.48	0.00	13.90	22.00	2.74	2.73
Q_{25}	1.33	5.47	0.37	1.39	0.19	0.00	2.12	7.63	0.44	0.00
Q_{50}	0.30	2.40	0.06	0.00	0.01	0.00	0.52	0.00	0.08	0.00
Q_{75}	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00
Q_{90}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{mean}	9.89	14.50	3.05	4.18	1.55	0.86	13.90	20.20	2.73	2.56
August Flows										
Q_{02}	47.40	42.80	14.40	13.30	7.25	5.17	66.00	57.30	12.20	10.80
Q_{10}	3.35	8.63	0.99	2.29	0.52	0.00	5.11	12.50	1.05	0.44
Q_{25}	0.61	2.60	0.15	0.44	0.06	0.00	0.97	0.00	0.16	0.00
Q_{50}	0.09	0.21	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00
Q_{75}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{90}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{mean}	5.31	8.53	1.61	2.37	0.81	0.44	7.50	11.50	1.44	1.06
September Flows										
Q_{02}	39.10	43.70	12.00	13.10	6.00	4.70	53.90	60.20	9.98	9.81
Q_{10}	3.05	6.16	0.90	1.61	0.45	0.00	4.43	8.23	0.84	0.02
Q_{25}	0.46	0.74	0.10	0.00	0.04	0.00	0.72	0.00	0.12	0.00
Q_{50}	0.03	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00
Q_{75}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{90}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{mean}	3.72	5.49	1.12	1.35	0.54	0.24	5.18	6.79	0.96	0.26
October Flows										
Q_{02}	43.00	44.80	13.00	13.50	6.45	4.92	59.50	61.30	10.70	10.10
Q_{10}	2.74	7.34	0.84	1.97	0.46	0.00	4.22	10.50	0.95	0.24
Q_{25}	0.60	2.06	0.16	0.30	0.07	0.00	0.97	0.00	0.19	0.00
Q_{50}	0.07	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00
Q_{75}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{90}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{mean}	4.87	7.17	1.47	1.84	0.72	0.29	6.79	9.22	1.25	0.67
November Flows										
Q_{02}	113.00	110.00	34.80	34.10	17.70	15.80	157.00	152.00	30.20	29.00
Q_{10}	14.40	20.10	4.43	5.84	2.30	1.10	20.60	28.70	4.11	4.10
Q_{25}	2.77	5.30	0.83	1.30	0.43	0.00	4.08	6.90	0.83	0.00
Q_{50}	0.48	0.60	0.12	0.00	0.05	0.00	0.78	0.00	0.14	0.00
Q_{75}	0.01	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00
Q_{90}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{mean}	9.81	12.10	3.01	3.38	1.53	0.64	13.80	16.20	2.67	2.09
December Flows										
Q_{02}	194.00	160.00	60.10	51.70	30.60	26.00	269.00	212.00	51.50	45.80
Q_{10}	45.40	51.10	13.80	15.20	7.00	5.80	63.30	71.40	11.90	11.80
Q_{25}	8.36	11.80	2.53	3.38	1.29	0.00	11.90	16.30	2.29	1.96
Q_{50}	2.12	3.04	0.63	0.64	0.32	0.00	3.10	3.40	0.63	0.00
Q_{75}	0.34	0.00	0.08	0.00	0.02	0.00	0.56	0.00	0.10	0.00
Q_{90}	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q_{mean}	21.00	24.90	6.45	7.41	3.26	1.89	29.20	34.30	5.54	5.27

Appendix A. Continued

Flow Type	Location (51)	(52)	(53)	(54)
Q_{01}	946.00	714.00	617.00	563.00
Q_{02}	562.00	432.00	365.00	335.00
Q_{05}	227.00	209.00	146.00	141.00
Q_{10}	96.90	113.00	61.60	63.70
Q_{15}	52.10	72.70	32.50	35.70
Q_{25}	23.10	43.70	13.80	17.00
Q_{40}	9.46	21.50	5.45	6.59
Q_{50}	5.38	13.10	3.01	3.18
Q_{60}	2.91	8.52	1.59	0.00
Q_{75}	0.77	0.00	0.38	0.00
Q_{85}	0.17	0.00	0.05	0.00
Q_{90}	0.03	0.00	0.00	0.00
Q_{95}	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00
Q_{99}	0.00	0.00	0.00	0.00
Q_{mean}	53.10	51.80	34.10	32.20
Low Flows				
$Q_{1,2}$	0.02	0.00	0.00	0.00
$Q_{1,10}$	0.00	0.00	0.00	0.00
$Q_{1,25}$	0.00	0.00	0.00	0.00
$Q_{1,50}$	0.00	0.00	0.00	0.00
$Q_{7,2}$	0.04	0.00	0.00	0.00
$Q_{7,10}$	0.00	0.00	0.00	0.00
$Q_{7,25}$	0.00	0.00	0.00	0.00
$Q_{7,50}$	0.00	0.00	0.00	0.00
$Q_{15,2}$	0.08	0.00	0.00	0.00
$Q_{15,10}$	0.00	0.00	0.00	0.00
$Q_{15,25}$	0.00	0.00	0.00	0.00
$Q_{15,50}$	0.00	0.00	0.00	0.00
$Q_{31,2}$	0.25	0.00	0.09	0.00
$Q_{31,10}$	0.00	0.00	0.00	0.00
$Q_{31,25}$	0.00	0.00	0.00	0.00
$Q_{31,50}$	0.00	0.00	0.00	0.00
$Q_{61,2}$	0.96	0.00	0.50	0.00
$Q_{61,10}$	0.01	0.00	0.00	0.00
$Q_{61,25}$	0.00	0.00	0.00	0.00
$Q_{61,50}$	0.00	0.00	0.00	0.00
$Q_{91,2}$	2.31	1.59	1.26	0.00
$Q_{91,10}$	0.08	0.00	0.01	0.00
$Q_{91,25}$	0.00	0.00	0.00	0.00
$Q_{91,50}$	0.00	0.00	0.00	0.00
Drought Flows				
$Q_{6,10}$	1.15	0.00	0.62	0.00
$Q_{6,25}$	0.36	0.00	0.16	0.00
$Q_{6,50}$	0.12	0.00	0.03	0.00
$Q_{9,10}$	5.39	6.57	3.28	2.02
$Q_{9,25}$	2.38	0.39	1.44	0.00
$Q_{9,50}$	1.14	0.00	0.70	0.00
$Q_{12,10}$	10.70	17.40	6.84	6.75
$Q_{12,25}$	5.23	7.67	3.26	2.26
$Q_{12,50}$	3.18	2.21	1.96	0.26
$Q_{18,10}$	13.90	22.50	8.88	9.24
$Q_{18,25}$	6.93	11.90	4.39	3.91
$Q_{18,50}$	4.26	5.44	2.68	1.42
$Q_{30,10}$	23.70	36.60	15.10	16.40
$Q_{30,25}$	12.30	19.60	7.90	7.96
$Q_{30,50}$	8.14	13.10	5.20	4.72

Appendix A. Continued

Location

Flow Type	(51)	(52)	(53)	(54)
Drought Flows-Cont				
$Q_{54,10}$	43.10	6130	27.10	2930
$Q_{54,25}$	24.20	34.00	15.20	1530
$Q_{54,50}$	17.30	2430	10.60	10.70
January Flows				
Q_{02}	759.00	599.00	490.00	452.00
Q_{10}	144.00	160.00	9030	93.00
Q_{25}	32.30	52.80	1930	23.10
Q_{50}	7.57	1530	4.49	4.66
Q_{75}	2.27	1.55	1.29	0.00
Q_{90}	0.12	0.00	0.04	0.00
Q_{98}	0.00	0.00	0.00	0.00
Q_{mean}	70.80	91.40	45.40	48.50
February flows				
Q_{02}	951.00	750.00	614.00	567.00
Q_{10}	200.00	199.00	126.00	124.00
Q_{25}	53.40	74.00	3330	36.40
Q_{50}	16.40	28.50	9.83	11.00
Q_{75}	5.42	7.86	3.24	2.24
Q_{90}	1.46	0.00	0.84	0.00
Q_{98}	0.17	0.00	0.07	0.00
Q_{mean}	92.20	113.00	5830	62.10
March Flows				
Q_{02}	940.00	708.00	622.00	568.00
Q_{10}	241.00	223.00	154.00	148.00
Q_{25}	72.70	91.60	4530	48.00
Q_{50}	28.00	4830	17.20	2030
Q_{75}	11.70	21.50	7.09	7.74
Q_{90}	5.55	1130	3.38	3.03
Q_{98}	1.09	0.00	0.66	0.00
Q_{mean}	104.00	124.00	6630	69.90
April Flows				
Q_{02}	805.00	573.00	534.00	480.00
Q_{10}	186.00	168.00	119.00	114.00
Q_{25}	58.80	76.00	3530	38.10
Q_{50}	21.20	4130	12.70	1530
Q_{75}	9.59	21.60	5.62	6.76
Q_{90}	4.64	12.00	2.62	2.68
Q_{98}	1.46	0.00	0.83	0.00
Q_{mean}	93.40	113.00	59.80	62.60
May Flows				
Q_{02}	575.00	395.00	386.00	343.00
Q_{10}	84.40	83.60	53.70	51.90
Q_{25}	26.40	47.00	15.60	1830
Q_{50}	10.20	26.50	5.85	7.96
Q_{75}	4.31	14.20	2.42	3.07
Q_{90}	1.97	8.65	1.06	0.00
Q_{98}	0.39	0.00	0.19	0.00
Q_{mean}	55.30	75.90	35.20	38.30
June Flows				
Q_{02}	460.00	331.00	293.00	263.00
Q_{10}	60.60	76.90	36.30	38.40
Q_{25}	15.90	36.50	9.08	12.20
Q_{50}	5.10	17.10	2.68	3.82
Q_{75}	1.66	8.77	0.82	0.00
Q_{90}	0.51	0.00	0.23	0.00
Q_{98}	0.05	0.00	0.00	0.00
Q_{mean}	47.60	68.20	29.90	33.00

Appendix A. Concluded

Flow Type	Location (51)	(52)	(53)	(54)
July Flows				
Q_{02}	339.00	265.00	213.00	195.00
Q_{10}	37.30	57.90	21.30	24.50
Q_{25}	7.34	21.90	3.85	5.57
Q_{50}	2.02	9.77	1.01	0.00
Q_{75}	0.51	0.00	0.20	0.00
Q_{90}	0.08	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00
Q_{mean}	31.90	48.10	19.70	21.80
August Flows				
Q_{02}	140.00	122.00	88.70	83.00
Q_{10}	15.50	34.40	8.51	11.20
Q_{25}	3.14	10.10	1.66	0.00
Q_{50}	0.84	0.16	0.39	0.00
Q_{75}	0.14	0.00	0.01	0.00
Q_{90}	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00
Q_{mean}	17.20	28.40	10.60	11.60
September Flows				
Q_{02}	109.00	125.00	70.80	72.90
Q_{10}	11.30	22.00	6.60	7.45
Q_{25}	2.35	4.16	1.25	0.00
Q_{50}	0.39	0.00	0.17	0.00
Q_{75}	0.03	0.00	0.00	0.00
Q_{90}	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00
Q_{mean}	11.10	17.70	7.04	6.95
October Flows				
Q_{02}	121.00	127.00	77.80	77.60
Q_{10}	13.50	29.80	7.37	9.48
Q_{25}	3.35	9.38	1.77	0.00
Q_{50}	0.62	0.00	0.30	0.00
Q_{75}	0.04	0.00	0.00	0.00
Q_{90}	0.00	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00
Q_{mean}	14.50	22.20	9.19	9.36
November Flows				
Q_{02}	339.00	328.00	215.00	211.00
Q_{10}	50.20	70.80	30.10	33.30
Q_{25}	11.00	19.60	6.38	6.74
Q_{50}	2.68	3.86	1.42	0.00
Q_{75}	0.37	0.00	0.16	0.00
Q_{90}	0.01	0.00	0.00	0.00
Q_{98}	0.00	0.00	0.00	0.00
Q_{mean}	31.10	38.90	19.30	19.40
December Flows				
Q_{02}	564.00	434.00	362.00	331.00
Q_{10}	137.00	157.00	86.10	89.20
Q_{25}	28.10	40.20	17.00	18.20
Q_{50}	8.27	12.60	4.82	4.21
Q_{75}	1.92	0.00	1.02	0.00
Q_{90}	0.21	0.00	0.09	0.00
Q_{98}	0.00	0.00	0.00	0.00
Q_{mean}	62.20	76.00	39.60	41.10

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

Name of withdrawal or discharge	Stream name	Code	Mile
1) Arthur discharge		EW5	7.7
2) Atwood discharge	Lake Fork	EX	81
3) Bement discharge		EXU	11
4) Bethany discharge	Marrowbone Creek	EUF	3.4
5) Lovington discharge		EUN8	0.6
6) Sullivan discharge	Asa Creek	ETJ8	3.0
7) Windsor discharge		ET4L	3.2
8) Nokomis discharge	East Fork Shoal Creek	EHL	54.7
9) Pana discharge	Coal Creek	EQOG	6.5
10) Belleville discharge	Richland Creek	EC	30.1
11) Breese discharge		EHE	1.8
12) Centralia discharge	Sewer Creek	EIJG	3.4
13) Champaign-Urbana discharge	Copper Slough	EZ	11
14) Farina discharge	East Fork Kaskaskia River	EK	47.1
15) Freeburg (West) discharge		ECO	4.3
16) Germantown discharge	Shoal Creek	EH	8.2
17) Greenville discharge	East Fork Shoal Creek	EHL	8.5
18) Highland discharge		EGS	1.7
19) Hillsboro discharge	Middle Fork Shoal Creek	EHT	9.1
20) Lebanon discharge	Little Silver Creek	EDJ	3.4
21) Litchfield discharge		EHV5	2.5
22) Mascoutah discharge		EDF	2.8
23) Millstadt discharge		ECPU	1.3
24) Nashville discharge	Little Crooked Creek	EIB	21.7
25) New Baden discharge	Rayhill Slough	EE4	10.7
26) OTallon discharge	Engle Creek	EDK	5.4
27) Red Bud discharge		ECEH	3.2
28) Salem discharge	Town Creek	EIV	1.9
29) St. Elmo discharge	Brickyard Branch	EPBP	3.0
30) Sandoval discharge	Prairie Creek	EIEG	12.7
31) Scott AFB discharge	Silver Creek	ED	251
32) Shelbyville discharge		ESB	2.5
33) Smithton discharge	Douglas Creek	ECP	1.2
34) Trenton discharge		EGL	2.8
35) Troy discharge		EDPF	2.1
36) Vandalia discharge	Kaskaskia River	E	139.9
37) Raymond discharge	Shoal Creek	EH	1031
38) Witt discharge	East Fork Shoal Creek	EHL	51.1
39) Caseyville discharge	Ogles Creek	EDL	8.7
40) Central City discharge	Raccoon Creek	EIO	0.3
41) Freeburg (east) discharge	Jacks Run	EDD	1.7
42) Marissa discharge	Doza Creek	EB8	16.8
43) New Athens discharge	Kaskaskia River	E	28.2
44) Odin discharge	Turkey Creek	EIN6	7.1
45) Okawville discharge	Plum Creek	EH2	6.0
46) Litchfield withdrawal	Shoal Creek	EH	91.6
47) Highland withdrawal	Silver Creek	EDO	14.5
48) Centralia withdrawal	Raccoon Creek	EIO	1.0
49) Pana withdrawal		EQV	0.5
50) Douglas Water Company withdrawal	Kaskaskia River	E	297.3
51) Salem withdrawal	Town Creek	EIV	41
52) Greenville withdrawal	Kingsbury Branch	EHLG	1.3
53) Hillsboro withdrawal (Glenn Shoals Dam)	Middle Fork Shoal Creek	EHT	10.5
54) Hillsboro withdrawal (Lake Hillsboro)	Lake Hillsboro Creek	EHTJ	0.2
55) Breese withdrawal	Shoal Creek	EH	21.3
56) Swansea discharge	Richland Creek	EC	32.4
57) Baldwin Lake net withdrawal	Kaskaskia River	E	20.2

Appendix B. Continued

Flow Type	Location (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Q_{01}	1.20	0.78	0.74	0.74	0.75	3.45	0.55	0.82	1.61	13.13
Q_{02}	1.08	0.69	0.65	0.65	0.66	3.03	0.49	0.73	1.44	12.10
Q_{05}	0.94	0.58	0.55	0.55	0.56	2.55	0.42	0.62	1.25	10.90
Q_{10}	0.86	0.51	0.50	0.49	0.50	2.28	0.37	0.56	1.14	10.22
Q_{15}	0.80	0.47	0.46	0.45	0.46	2.07	0.34	0.51	1.06	9.71
Q_{25}	0.74	0.42	0.41	0.40	0.42	1.86	0.31	0.46	0.98	9.19
Q_{40}	0.68	0.37	0.37	0.36	0.37	1.66	0.28	0.42	0.90	8.68
Q_{50}	0.65	0.35	0.35	0.33	0.35	1.56	0.26	0.40	0.86	8.42
Q_{60}	0.62	0.32	0.33	0.31	0.33	1.45	0.25	0.37	0.82	8.17
Q_{75}	0.56	0.28	0.29	0.27	0.28	1.25	0.22	0.33	0.74	7.65
Q_{85}	0.52	0.25	0.26	0.24	0.26	1.11	0.19	0.29	0.68	7.31
Q_{90}	0.48	0.22	0.23	0.21	0.23	0.97	0.17	0.26	0.63	6.97
Q_{95}	0.44	0.18	0.20	0.18	0.20	0.83	0.15	0.23	0.57	6.63
Q_{98}	0.38	0.14	0.16	0.13	0.15	0.63	0.12	0.19	0.49	6.31
Q_{99}	0.32	0.09	0.12	0.09	0.11	0.42	0.09	0.14	0.41	6.00
Q_{mean}	0.68	0.37	0.37	0.36	0.37	1.66	0.28	0.42	0.90	8.68
Low Flows										
$Q_{1,2}$	0.31	0.09	0.11	0.09	0.11	0.40	0.09	0.13	0.39	5.76
$Q_{1,10}$	0.27	0.07	0.10	0.07	0.09	0.35	0.07	0.12	0.34	5.04
$Q_{1,25}$	0.26	0.07	0.10	0.07	0.09	0.34	0.07	0.11	0.33	4.93
$Q_{1,50}$	0.26	0.07	0.10	0.07	0.09	0.34	0.07	0.11	0.33	4.88
$Q_{7,2}$	0.47	0.21	0.23	0.20	0.22	0.94	0.17	0.26	0.62	6.90
$Q_{7,10}$	0.32	0.09	0.12	0.09	0.11	0.42	0.09	0.14	0.41	6.00
$Q_{7,25}$	0.31	0.09	0.12	0.09	0.11	0.41	0.09	0.14	0.40	5.83
$Q_{7,50}$	0.31	0.09	0.11	0.09	0.11	0.40	0.09	0.13	0.39	5.76
$Q_{15,2}$	0.49	0.22	0.24	0.21	0.23	1.00	0.18	0.27	0.64	7.04
$Q_{15,10}$	0.35	0.11	0.14	0.11	0.13	0.52	0.11	0.16	0.45	6.16
$Q_{15,25}$	0.32	0.09	1.12	0.09	0.11	0.41	0.09	0.14	0.40	5.93
$Q_{15,50}$	0.31	0.09	0.12	0.09	0.11	0.41	0.09	0.14	0.40	5.86
$Q_{31,2}$	0.51	0.24	0.25	0.23	0.25	1.07	0.19	0.29	0.67	7.21
$Q_{31,10}$	0.37	0.13	0.16	0.13	0.15	0.61	0.12	0.18	0.48	6.26
$Q_{31,25}$	0.32	0.09	0.12	0.09	0.11	0.42	0.09	0.14	0.41	6.00
$Q_{31,50}$	0.32	0.09	0.12	0.09	0.11	0.41	0.09	0.14	0.40	5.93
$Q_{61,2}$	0.53	0.26	0.27	0.25	0.26	1.15	0.20	0.30	0.70	7.41
$Q_{61,10}$	0.41	0.16	0.18	0.16	0.18	0.73	0.14	0.21	0.53	6.47
$Q_{61,25}$	0.35	0.11	0.14	0.11	0.13	0.52	0.11	0.16	0.45	6.16
$Q_{61,50}$	0.33	0.10	0.13	0.10	0.12	0.46	0.10	0.15	0.43	6.00
$Q_{91,2}$	0.56	0.28	0.29	0.27	0.28	1.25	0.22	0.33	0.74	7.65
$Q_{91,10}$	0.44	0.18	0.20	0.18	0.20	0.83	0.15	0.23	0.57	6.63
$Q_{91,25}$	0.38	0.14	0.16	0.13	0.15	0.63	0.12	0.19	0.49	6.11
$Q_{91,50}$	0.36	0.12	0.15	0.12	0.14	0.56	0.11	0.17	0.47	6.20
Drought Flows										
$Q_{6,10}$	0.52	0.25	0.26	0.24	0.26	1.11	0.19	0.29	0.68	7.31
$Q_{6,25}$	0.47	0.21	0.23	0.20	0.22	0.94	0.17	0.26	0.62	6.90
$Q_{6,50}$	0.45	0.19	0.21	0.18	0.20	0.86	0.16	0.24	0.58	6.70
$Q_{9,10}$	0.58	0.29	0.30	0.28	0.30	1.31	0.23	0.34	0.76	7.81
$Q_{9,25}$	0.54	0.26	0.27	0.25	0.27	1.18	0.21	0.31	0.71	7.48
$Q_{9,50}$	0.51	0.24	0.25	0.23	0.25	1.08	0.19	0.29	0.67	7.24
$Q_{12,10}$	0.64	0.34	0.34	0.32	0.34	1.50	0.26	0.38	0.84	8.30
$Q_{12,25}$	0.59	0.30	0.31	0.29	0.31	1.35	0.23	0.35	0.78	7.91
$Q_{12,50}$	0.56	0.27	0.29	0.26	0.28	1.23	0.21	0.32	0.73	7.62
$Q_{18,10}$	0.66	0.35	0.36	0.34	0.35	1.58	0.27	0.40	0.87	8.47
$Q_{18,25}$	0.62	0.32	0.33	0.31	0.32	1.43	0.24	0.37	0.81	8.12
$Q_{18,50}$	0.58	0.29	0.30	0.28	0.30	1.31	0.23	0.34	0.76	7.81
$Q_{30,10}$	0.69	0.38	0.38	0.36	0.38	1.68	0.28	0.42	0.91	8.73
$Q_{30,25}$	0.65	0.34	0.35	0.33	0.35	1.53	0.26	0.39	0.85	8.37
$Q_{30,50}$	0.62	0.32	0.33	0.31	0.32	1.43	0.24	0.37	0.81	8.12

Appendix B. Continued

Flow Type	Location (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Drought Flows-Cont										
$Q_{54,10}$	0.73	0.41	0.41	0.39	0.41	132	0.30	0.46	0.96	9.09
$Q_{54,25}$	0.67	0.36	0.36	0.35	0.36	1.61	0.27	0.41	0.88	8.55
$Q_{54,50}$	0.65	0.34	0.35	0.33	0.35	1.53	0.26	0.39	0.85	8.37
Q_{02}	1.12	0.71	0.68	0.68	0.69	3.16	0.51	0.76	1.49	12.41
Q_{10}	0.86	0.51	0.50	0.49	0.50	2.28	0.37	0.56	1.14	10.22
Q_{25}	0.74	0.42	0.41	0.40	0.42	136	031	0.46	0.98	9.19
Q_{50}	0.65	0.35	0.35	0.33	0.35	1.56	0.26	0.40	036	8.42
Q_{75}	0.56	0.28	0.29	0.27	0.28	1.25	0.22	033	0.74	7.65
Q_{90}	0.48	0.22	0.23	0.21	0.23	037	0.17	0.26	0.63	6.97
Q_{98}	0.41	0.16	0.18	0.16	0.18	0.73	0.14	0.21	0.53	6.37
Q_{mean}	0.74	0.42	0.41	0.40	0.42	136	031	0.46	0.98	9.19
February flows										
Q_{02}	1.17	0.75	0.71	0.71	0.72	332	0.53	0.79	1.56	12.82
Q_{10}	0.90	0.54	0.53	0.52	0.53	2.42	0.39	0.59	1.20	10.56
Q_{25}	0.79	0.46	0.45	0.44	0.45	2.03	0.34	0.50	1.05	9.60
Q_{50}	0.68	0.37	0.37	0.36	0.37	1.66	0.28	0.42	0.90	8.68
Q_{75}	0.59	0.30	0.31	0.29	031	1.35	0.23	0.35	0.78	7.91
Q_{90}	0.53	0.25	0.27	0.24	0.26	1.14	0.20	0.30	0.69	7.38
Q_{98}	0.46	0.20	0.22	0.20	0.21	0.92	0.17	0.25	0.61	6.83
Q_{mean}	0.77	0.44	0.44	0.42	0.44	1.97	0.33	0.49	1.02	9.45
March Flows										
Q_{02}	1.20	0.78	0.74	0.74	0.75	3.45	0.55	032	1.61	13.13
Q_{10}	0.94	0.58	0.55	0.55	0.56	2.55	0.42	0.62	1.25	10.90
Q_{25}	0.83	0.48	0.47	0.46	0.48	2.15	035	0.53	1.09	9.91
Q_{50}	0.74	0.42	0.41	0.40	0.42	136	0.31	0.46	0.98	9.19
Q_{75}	0.67	0.36	0.36	0.35	0.36	1.61	0.27	0.41	038	8.55
Q_{90}	0.62	0.32	0.33	0.31	0.33	1.45	0.25	037	032	8.17
Q_{98}	0.52	0.25	0.26	0.24	0.26	1.11	0.19	0.29	0.68	7.31
Q_{mean}	0.80	0.47	0.46	0.45	0.46	2.07	0.34	0.51	1.06	9.71
April Flows										
Q_{02}	1.20	0.78	0.74	0.74	0.75	3.45	0.55	0.82	1.61	13.13
Q_{10}	0.94	0.58	0.55	0.55	0.56	2.55	0.42	0.62	1.25	10.90
Q_{25}	0.85	0.50	0.49	0.48	0.49	2.24	037	0.55	1.13	10.12
Q_{50}	0.76	0.43	0.43	0.41	0.43	1.93	032	0.48	1.00	9.35
Q_{75}	0.68	0.37	0.37	0.36	0.37	1.66	0.28	0.42	0.90	8.68
Q_{90}	0.65	0.34	0.35	0.33	0.35	1.53	0.26	0.39	035	8.37
Q_{98}	0.54	0.26	0.27	0.25	0.27	1.18	0.21	0.31	0.71	7.48
Q_{mean}	0.82	0.48	0.47	0.46	0.47	2.13	0.35	0.53	1.09	9.86
May Flows										
Q_{02}	1.20	0.78	0.74	0.74	0.76	3.45	0.55	0.82	1.61	13.13
Q_{10}	0.90	0.54	0.53	0.52	0.53	2.42	0.39	0.59	1.20	10.56
Q_{25}	0.78	0.45	0.44	0.43	0.44	1.99	0.33	0.49	1.03	9.50
Q_{50}	0.71	0.40	0.39	0.38	0.39	1.76	0.29	0.44	0.94	8.94
Q_{75}	0.67	0.36	0.36	0.35	0.36	1.61	0.27	0.41	0.88	8.55
Q_{90}	0.64	0.34	0.34	0.32	0.34	1.50	0.26	0.38	0.84	8.30
Q_{98}	0.53	0.25	0.27	0.24	0.26	1.14	0.20	0.30	0.69	7.38
Q_{mean}	0.78	0.45	0.44	0.43	0.45	2.01	0.33	0.50	1.04	9.55
June Flows										
Q_{02}	1.20	0.78	0.74	0.74	0.75	3.45	0.55	032	1.61	13.13
Q_{10}	0.90	0.54	0.53	0.52	0.53	2.42	039	0.59	1.20	10.56
Q_{25}	0.77	0.44	0.43	0.42	0.43	1.95	0.32	0.48	1.01	9.40
Q_{50}	0.68	0.37	0.37	0.36	0.37	1.66	0.28	0.42	0.90	8.68
Q_{75}	0.64	0.34	0.34	0.33	0.34	1.52	0.26	0.39	035	8.35
Q_{90}	0.60	0.31	0.32	0.30	0.32	1.39	0.24	0.36	0.79	8.01
Q_{98}	0.52	0.25	0.26	0.24	0.26	1.11	0.19	0.29	0.68	7.31
Q_{mean}	0.76	0.43	0.43	0.41	0.43	1.93	0.32	0.48	1.00	9.35

Appendix B. Continued

Flow Type	Location (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
July Flows										
Q_{02}	1.01	0.63	0.60	0.60	0.61	2.79	0.45	0.67	1.35	11.50
Q_{10}	0.80	0.47	0.46	0.45	0.46	2.07	0.34	0.51	1.06	9.71
Q_{25}	0.70	0.39	0.38	0.37	0.39	1.72	0.29	0.43	0.92	8.83
Q_{50}	0.65	0.35	0.35	0.33	0.35	1.56	0.26	0.40	0.86	8.42
Q_{75}	0.59	0.30	0.30	0.29	0.30	1.33	0.23	0.34	0.77	7.86
Q_{90}	0.54	0.26	0.27	0.25	0.27	1.16	0.20	0.31	0.70	7.45
Q_{98}	0.44	0.18	0.20	0.18	0.20	0.83	0.15	0.23	0.57	6.63
Q_{mean}	0.71	0.40	0.39	0.38	0.39	1.76	0.29	0.44	0.94	8.94
August Flows										
Q_{02}	0.94	0.58	0.55	0.55	0.56	2.55	0.42	0.62	1.25	10.90
Q_{10}	0.73	0.41	0.41	0.39	0.41	1.82	0.30	0.46	0.96	9.09
Q_{25}	0.64	0.34	0.34	0.33	0.34	1.52	0.26	0.39	0.85	8.35
Q_{50}	0.58	0.29	0.30	0.28	0.30	1.31	0.23	0.34	0.76	7.81
Q_{75}	0.53	0.26	0.27	0.25	0.26	1.15	0.20	0.30	0.70	7.41
Q_{90}	0.48	0.22	0.23	0.21	0.23	0.97	0.17	0.26	0.63	6.97
Q_{98}	0.38	0.14	0.16	0.13	0.15	0.63	0.12	0.19	0.49	6.11
Q_{mean}	0.68	0.37	0.37	0.35	0.37	1.64	0.28	0.41	0.89	8.63
September Flows										
Q_{02}	0.86	0.51	0.50	0.49	0.50	2.28	0.37	0.56	1.14	10.22
Q_{10}	0.67	0.36	0.37	0.35	0.37	1.63	0.27	0.41	0.89	8.60
Q_{25}	0.59	0.30	0.30	0.29	0.30	1.33	0.23	0.34	0.77	7.86
Q_{50}	0.54	0.26	0.27	0.25	0.27	1.16	0.20	0.31	0.70	7.45
Q_{75}	0.49	0.22	0.24	0.21	0.23	1.00	0.18	0.27	0.64	7.04
Q_{90}	0.44	0.18	0.20	0.18	0.20	0.83	0.15	0.23	0.57	6.63
Q_{98}	0.32	0.09	0.12	0.09	0.11	0.42	0.09	0.14	0.41	5.90
Q_{mean}	0.64	0.34	0.34	0.32	0.34	1.50	0.26	0.38	0.84	8.30
October Flows										
Q_{02}	0.89	0.53	0.51	0.51	0.52	2.36	0.39	0.58	1.18	10.43
Q_{10}	0.71	0.40	0.39	0.38	0.39	1.76	0.29	0.44	0.94	8.94
Q_{25}	0.63	0.33	0.33	0.32	0.33	1.47	0.25	0.38	0.83	8.22
Q_{50}	0.54	0.26	0.27	0.25	0.27	1.16	0.20	0.31	0.70	7.45
Q_{75}	0.48	0.22	0.23	0.21	0.23	0.97	0.17	0.26	0.63	6.97
Q_{80}	0.41	0.16	0.18	0.16	0.18	0.73	0.14	0.21	0.53	6.37
Q_{98}	0.31	0.09	0.11	0.09	0.11	0.40	0.09	0.13	0.39	5.76
Q_{mean}	0.65	0.35	0.35	0.33	0.35	1.56	0.26	0.40	0.86	8.42
November Flows										
Q_{02}	0.93	0.56	0.54	0.54	0.55	2.50	0.41	0.61	1.23	10.77
Q_{10}	0.74	0.42	0.41	0.40	0.42	1.86	0.31	0.46	0.98	9.19
Q_{25}	0.66	0.35	0.36	0.34	0.35	1.58	0.27	0.40	0.87	8.47
Q_{50}	0.58	0.29	0.30	0.28	0.30	1.31	0.23	0.34	0.76	7.81
Q_{75}	0.51	0.24	0.25	0.23	0.25	1.08	0.19	0.29	0.67	7.24
Q_{90}	0.44	0.18	0.20	0.18	0.20	0.83	0.15	0.23	0.57	6.63
Q_{98}	0.32	0.09	0.12	0.09	0.11	0.42	0.09	0.14	0.41	5.90
Q_{mean}	0.65	0.35	0.35	0.33	0.35	1.56	0.26	0.40	0.86	8.42
December Flows										
Q_{02}	1.08	0.69	0.65	0.65	0.66	3.03	0.49	0.73	1.44	12.10
Q_{10}	0.80	0.47	0.46	0.45	0.46	2.07	0.34	0.51	1.06	9.71
Q_{25}	0.68	0.37	0.37	0.36	0.37	1.66	0.28	0.42	0.90	8.68
Q_{50}	0.61	0.32	0.32	0.30	0.32	1.41	0.24	0.36	0.80	8.06
Q_{75}	0.53	0.25	0.27	0.24	0.26	1.14	0.20	0.30	0.69	7.38
Q_{90}	0.46	0.20	0.22	0.19	0.21	0.90	0.16	0.25	0.60	6.80
Q_{98}	0.37	0.13	0.15	0.13	0.14	0.59	0.12	0.18	0.48	6.01
Q_{mean}	0.69	0.38	0.38	0.37	0.38	1.70	0.29	0.43	0.92	8.78

Appendix B. Continued

Flow Type	Location (11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Q_{01}	1.55	5.02	15.24	0.41	0.86	0.45	1.91	2.70	1.90	1.48
Q_{02}	1.39	4.59	13.63	0.36	0.76	0.40	1.72	2.46	1.74	1.31
Q_{05}	1.20	4.09	11.74	0.30	0.65	0.34	1.51	2.18	1.55	1.12
Q_{10}	1.09	3.81	10.67	0.26	0.58	0.31	1.38	2.02	1.45	1.01
Q_{15}	1.01	3.60	9.86	0.24	0.53	0.28	1.29	1.90	1.37	0.93
Q_{25}	0.93	3.39	9.05	0.21	0.48	0.26	1.19	1.78	1.29	0.84
Q_{40}	0.85	3.17	8.24	0.19	0.43	0.23	1.10	1.66	1.21	0.76
Q_{50}	0.81	3.07	7.84	0.17	0.41	0.22	1.05	1.60	1.17	0.72
Q_{60}	0.77	2.96	7.44	0.16	0.39	0.21	1.01	1.54	1.13	0.68
Q_{75}	0.69	2.75	6.63	0.13	0.34	0.18	0.91	1.42	1.05	0.59
Q_{85}	0.64	2.61	6.09	0.12	0.30	0.16	0.85	1.34	1.00	0.54
Q_{90}	0.58	2.47	5.55	0.10	0.27	0.15	0.79	1.26	0.94	0.48
Q_{95}	0.53	2.32	5.01	0.08	0.24	0.13	0.73	1.18	0.89	0.43
Q_{98}	0.45	2.11	4.21	0.06	0.19	0.11	0.63	1.06	0.81	0.34
Q_{99}	0.37	1.90	3.40	0.03	0.14	0.08	0.54	0.94	0.73	0.26
Q_{mean}	0.85	3.17	8.24	0.19	0.43	0.23	1.10	1.66	1.21	0.76
<u>Low Flows</u>										
$Q_{1,2}$	0.35	1.82	3.26	0.03	0.13	0.08	0.52	0.90	0.70	0.25
$Q_{1,10}$	0.31	1.57	2.82	0.02	0.12	0.07	0.45	0.78	0.60	0.22
$Q_{1,25}$	0.30	1.54	2.75	0.02	0.11	0.06	0.44	0.76	0.59	0.21
$Q_{1,50}$	0.30	1.52	2.72	0.02	0.11	0.06	0.43	0.75	0.58	0.21
$Q_{7,2}$	0.57	2.44	5.45	0.10	0.26	0.14	0.78	1.24	0.93	0.47
$Q_{7,10}$	0.37	1.90	3.40	0.03	0.14	0.08	0.54	0.94	0.73	0.26
$Q_{7,25}$	0.36	1.84	3.30	0.03	0.14	0.08	0.52	0.91	0.71	0.25
$Q_{7,50}$	0.35	1.82	3.26	0.03	0.13	0.08	0.52	0.90	0.70	0.25
$Q_{15,2}$	0.60	2.49	5.66	0.10	0.28	0.15	0.80	1.28	0.9?	0.49
$Q_{15,10}$	0.41	2.01	3.80	0.04	0.16	0.09	0.59	1.00	0.77	0.30
$Q_{15,25}$	0.37	1.88	3.36	0.03	0.14	0.08	0.53	0.93	0.72	0.26
$Q_{15,50}$	0.36	1.85	3.31	0.03	0.14	0.08	0.53	0.92	0.7l	0.25
$Q_{31,2}$	0.62	2.57	5.93	0.11	0.29	0.16	0.83	1.32	0.98	0.52
$Q_{31,10}$	0.44	2.09	4.13	0.05	0.18	0.10	0.62	1.05	0.80	0.33
$Q_{31,25}$	0.37	1.90	3.40	0.03	0.14	0.08	0.54	0.94	0.73	0.26
$Q_{31,50}$	0.37	1.88	3.36	0.03	0.14	0.08	0.53	0.93	0.72	0.26
$Q_{61,2}$	0.65	2.65	6.25	0.12	0.31	0.17	0.87	1.36	1.01	0.55
$Q_{61,10}$	0.49	2.22	4.61	0.07	0.21	0.12	0.68	1.12	0.85	0.38
$Q_{61,25}$	0.41	2.01	3.80	0.04	0.16	0.09	0.59	1.00	0.77	0.30
$Q_{61,50}$	0.39	1.94	3.56	0.04	0.15	0.09	0.56	0.96	0.75	0.28
$Q_{91,2}$	0.69	2.75	6.63	0.13	0.34	0.18	0.91	1.42	1.05	0.59
$Q_{91,10}$	0.53	2.32	5.01	0.08	0.24	0.13	0.73	1.18	0.89	0.43
$Q_{91,25}$	0.45	2.11	4.21	0.06	0.19	0.11	0.63	1.06	0.81	0.34
$Q_{91,50}$	0.43	2.05	3.97	0.05	0.17	0.10	0.61	1.02	0.79	0.32
<u>Drought Flows</u>										
$Q_{6,10}$	0.64	2.61	6.09	0.12	0.30	0.16	0.85	1.34	1.00	0.54
$Q_{6,25}$	0.57	2.44	5.45	0.10	0.26	0.14	0.78	1.24	0.93	0.47
$Q_{6,50}$	0.54	2.35	5.12	0.09	0.24	0.13	0.74	1.20	0.90	0.44
$Q_{9,10}$	0.72	2.81	6.87	0.14	0.35	0.19	0.94	1.45	1.07	0.62
$Q_{9,25}$	0.66	2.68	6.36	0.13	0.32	0.17	0.88	1.38	1.02	0.57
$Q_{9,50}$	0.63	2.58	5.98	0.11	0.30	0.16	0.84	1.32	0.99	0.53
$Q_{12,10}$	0.79	3.02	7.64	0.17	0.40	0.21	1.03	1.57	1.15	0.70
$Q_{12,25}$	0.73	2.86	7.03	0.15	0.36	0.19	0.96	1.48	1.09	0.63
$Q_{12,50}$	0.69	2.74	6.58	0.13	0.33	0.18	0.91	1.41	1.04	0.59
$Q_{18,10}$	0.82	3.09	7.92	0.18	0.41	0.22	1.06	1.61	1.18	0.73
$Q_{18,25}$	0.76	2.94	7.36	0.16	0.38	0.20	1.00	1.53	1.12	0.67
$Q_{18,50}$	0.72	2.81	6.87	0.14	0.35	0.19	0.94	1.45	1.07	0.62
$Q_{30,10}$	0.86	3.20	8.33	0.19	0.44	0.24	1.11	1.67	1.22	0.77
$Q_{30,25}$	0.80	3.05	7.76	0.17	0.40	0.22	1.04	1.59	1.16	0.71
$Q_{30,50}$	0.76	2.94	7.36	0.16	0.38	0.20	1.00	1.53	1.12	0.67

Appendix B. Continued

Flow Type	Location (11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Drought Flows-Cont										
$Q_{54,10}$	0.92	3.34	8.89	0.21	0.47	0.25	1.18	1.75	1.27	0.83
$Q_{54,25}$	0.83	3.12	8.04	0.18	0.42	0.23	1.08	1.63	1.19	0.74
$Q_{54,50}$	0.80	3.05	7.76	0.17	0.40	0.22	1.04	1.59	1.16	0.71
January Flows										
Q_{02}	1.44	4.72	14.11	0.37	0.79	0.42	1.78	2.53	1.79	1.36
Q_{10}	1.09	3.81	10.67	0.26	0.58	0.31	1.38	2.02	1.45	1.01
Q_{25}	0.93	3.39	9.05	0.21	0.48	0.26	1.19	1.78	1.29	0.84
Q_{50}	0.81	3.07	7.84	0.17	0.41	0.22	1.05	1.60	1.17	0.72
Q_{75}	0.69	2.75	6.63	0.13	0.34	0.18	0.91	1.42	1.05	0.59
Q_{90}	0.58	2.47	5.55	0.10	0.27	0.15	0.79	1.26	0.94	0.48
Q_{98}	0.49	2.22	4.61	0.07	0.21	0.12	0.68	1.12	0.85	0.38
Q_{mean}	0.93	3.39	9.05	0.21	0.48	0.26	1.19	1.78	1.29	0.84
February flows										
Q_{02}	1.50	4.89	14.76	0.40	0.83	0.44	1.85	2.62	1.85	1.43
Q_{10}	1.15	3.95	11.20	0.28	0.61	0.33	1.44	2.10	1.50	1.06
Q_{25}	1.00	3.56	9.70	0.23	0.52	0.28	1.27	1.87	1.35	0.91
Q_{50}	0.85	3.17	8.24	0.19	0.43	0.23	1.10	1.66	1.21	0.76
Q_{75}	0.73	2.86	7.03	0.15	0.36	0.19	0.96	1.48	1.09	0.63
Q_{90}	0.65	2.64	6.20	0.12	0.31	0.17	0.86	1.36	1.01	0.55
Q_{98}	0.56	2.41	5.34	0.09	0.26	0.14	0.76	1.23	0.92	0.46
Q_{mean}	0.97	3.49	9.46	0.22	0.51	0.27	1.24	1.84	1.33	0.88
March Flows										
Q_{02}	1.55	5.02	15.24	0.41	0.86	0.45	1.91	2.70	1.90	1.48
Q_{10}	1.20	4.09	11.74	0.30	0.65	0.34	1.51	2.18	1.55	1.12
Q_{25}	1.05	3.68	10.18	0.25	0.55	0.29	1.32	1.95	1.40	0.96
Q_{50}	0.93	3.39	9.05	0.21	0.48	0.26	1.19	1.78	1.29	0.84
Q_{75}	0.83	3.12	8.04	0.18	0.42	0.23	1.08	1.63	1.19	0.74
Q_{90}	0.77	2.96	7.44	0.16	0.39	0.21	1.01	1.54	1.13	0.68
Q_{98}	0.64	2.61	6.09	0.12	0.30	0.16	0.85	1.34	1.00	0.54
Q_{mean}	1.01	3.60	9.86	0.24	0.53	0.28	1.29	1.90	1.37	0.93
April Flows										
Q_{02}	1.55	5.02	15.24	0.41	0.86	0.45	1.91	2.70	1.90	1.48
Q_{10}	1.20	4.09	11.74	0.30	0.65	0.34	1.51	2.18	1.55	1.12
Q_{25}	1.08	3.77	10.51	0.26	0.57	0.30	1.36	1.99	1.43	0.99
Q_{50}	0.96	3.45	9.29	0.22	0.50	0.27	1.22	1.81	1.31	0.87
Q_{75}	0.85	3.17	8.24	0.19	0.43	0.23	1.10	1.66	1.21	0.76
Q_{90}	0.80	3.05	7.76	0.17	0.40	0.22	1.04	1.59	1.16	0.71
Q_{98}	0.66	2.68	6.36	0.13	0.32	0.17	0.88	1.38	1.02	0.57
Q_{mean}	1.04	3.66	10.10	0.25	0.55	0.29	1.32	1.93	1.39	0.95
May Flows										
Q_{02}	1.55	5.02	15.24	0.41	0.86	0.45	1.91	2.70	1.90	1.48
Q_{10}	1.15	3.95	11.20	0.28	0.61	0.33	1.44	2.10	1.50	1.06
Q_{25}	0.98	3.51	9.54	0.23	0.51	0.27	1.25	1.85	1.34	0.89
Q_{50}	0.89	3.28	8.65	0.20	0.46	0.25	1.15	1.72	1.25	0.80
Q_{75}	0.83	3.12	8.04	0.18	0.42	0.23	1.08	1.63	1.19	0.74
Q_{90}	0.79	3.02	7.64	0.17	0.40	0.21	1.03	1.57	1.15	0.70
Q_{98}	0.65	2.64	6.20	0.12	0.31	0.17	0.86	1.36	1.01	0.55
Q_{mean}	0.99	3.54	9.62	0.23	0.52	0.28	1.26	1.86	1.34	0.90
June Flows										
Q_{02}	1.55	5.02	15.24	0.41	0.86	0.45	1.91	2.70	1.90	1.48
Q_{10}	1.15	3.95	11.20	0.28	0.61	0.33	1.44	2.10	1.50	1.06
Q_{25}	0.97	3.47	9.37	0.22	0.50	0.27	1.23	1.83	1.32	0.88
Q_{50}	0.85	3.17	8.24	0.19	0.43	0.23	1.10	1.66	1.21	0.76
Q_{75}	0.80	3.04	7.72	0.17	0.40	0.22	1.04	1.58	1.16	0.71
Q_{90}	0.75	2.90	7.19	0.15	0.37	0.20	0.98	1.50	1.11	0.65
Q_{98}	0.64	2.61	6.09	0.12	0.30	0.16	0.85	1.34	1.00	0.54
Q_{mean}	0.96	3.45	9.29	0.22	0.50	0.27	1.22	1.81	1.31	0.87

Appendix B. Continued

Flow Type	Location (11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
July Flows										
Q_{02}	1.29	4.34	12.69	0.33	0.70	0.37	1.61	2.32	1.65	1.22
Q_{10}	1.01	3.60	9.86	0.24	0.53	0.28	1.29	1.90	1.37	0.93
Q_{25}	0.88	3.24	8.49	0.19	0.45	0.24	1.13	1.69	1.23	0.78
Q_{50}	0.81	3.07	7.84	0.17	0.41	0.22	1.05	1.60	1.17	0.72
Q_{75}	0.72	2.83	6.95	0.14	0.36	0.19	0.95	1.47	1.08	0.63
Q_{90}	0.66	2.66	6.31	0.12	0.32	0.17	0.88	1.37	1.02	0.56
Q_{98}	0.53	2.32	5.01	0.08	0.24	0.13	0.73	1.18	0.89	0.43
Q_{mean}	0.89	3.28	8.65	0.20	0.46	0.25	1.15	1.72	1.25	0.80
August Flows										
Q_{02}	1.20	4.09	11.74	0.30	0.65	0.34	1.51	2.18	1.55	1.12
Q_{10}	0.92	3.34	8.89	0.21	0.47	0.25	1.18	1.75	1.27	0.83
Q_{25}	0.80	3.04	7.72	0.17	0.40	0.22	1.04	1.58	1.16	0.71
Q_{50}	.0.72	2.81	6.87	0.14	0.35	0.19	0.94	1.45	1.07	0.62
Q_{75}	0.65	2.65	6.25	0.12	0.31	0.17	0.87	1.36	1.01	0.55
Q_{90}	0.58	2.47	5.55	0.10	0.27	0.15	0.79	1.26	0.94	0.48
Q_{98}	0.45	2.11	4.21	0.06	0.19	0.11	0.63	1.06	0.81	0.34
Q_{mean}	0.84	3.15	8.16	0.18	0.43	0.23	1.09	1.65	1.20	0.75
September Flows										
Q_{02}	1.09	3.81	10.67	0.26	0.58	0.31	1.38	2.02	1.45	1.01
Q_{10}	0.84	3.14	8.12	0.18	0.43	0.23	1.09	1.64	1.20	0.75
Q_{25}	0.72	2.83	6.95	0.14	0.36	0.19	0.95	1.47	1.08	0.63
Q_{50}	0.66	2.66	6.31	0.12	0.32	0.17	0.88	1.37	1.02	0.56
Q_{75}	0.60	2.49	5.66	0.10	0.28	0.15	0.80	1.28	0.95	0.49
Q_{90}	0.53	2.32	5.01	0.08	0.24	0.13	0.73	1.18	0.89	0.43
Q_{98}	0.37	1.90	3.40	0.03	0.14	0.08	0.54	0.94	0.73	0.26
Q_{mean}	0.79	3.02	7.64	0.17	0.40	0.21	1.03	1.57	1.15	0.70
October Flows										
Q_{02}	1.13	3.90	10.99	0.27	0.60	0.32	1.42	2.07	1.48	1.04
Q_{10}	0.89	3.28	8.65	0.20	0.46	0.25	1.15	1.72	1.25	0.80
Q_{25}	0.78	2.98	7.52	0.16	0.39	0.21	1.02	1.55	1.14	0.68
Q_{50}	0.66	2.66	6.31	0.12	0.32	0.17	0.88	1.37	1.02	0.56
Q_{75}	0.58	2.47	5.55	0.10	0.27	0.15	0.79	1.26	0.94	0.48
Q_{90}	0.49	2.22	4.61	0.07	0.21	0.12	0.68	1.12	0.85	0.38
Q_{98}	0.35	1.82	3.26	0.03	0.13	0.08	0.52	0.90	0.70	0.25
Q_{mean}	0.81	3.07	7.84	0.17	0.41	0.22	1.05	1.60	1.17	0.72
November Flows										
Q_{02}	1.18	4.04	11.53	0.29	0.63	0.34	1.48	2.15	1.53	1.10
Q_{10}	0.93	3.39	9.05	0.21	0.48	0.26	1.19	1.78	1.29	0.84
Q_{25}	0.82	3.09	7.92	0.18	0.41	0.22	1.06	1.61	1.18	0.73
Q_{50}	0.72	2.81	6.87	0.14	0.35	0.19	0.94	1.45	1.07	0.62
Q_{75}	0.63	2.58	5.98	0.11	0.30	0.16	0.84	1.32	0.99	0.53
Q_{90}	0.53	2.32	5.01	0.08	0.24	0.13	0.73	1.18	0.89	0.43
Q_{98}	0.37	1.90	3.40	0.03	0.14	0.08	0.54	0.94	0.73	0.26
Q_{mean}	0.81	3.07	7.84	0.17	0.41	0.22	1.05	1.60	1.17	0.72
December Flows										
Q_{02}	1.39	4.59	13.63	0.36	0.76	0.40	1.72	2.46	1.74	1.31
Q_{10}	1.01	3.60	9.86	0.24	0.53	0.28	1.29	1.90	1.37	0.93
Q_{25}	0.85	3.17	8.24	0.19	0.43	0.23	1.10	1.66	1.21	0.76
Q_{50}	0.76	2.92	7.28	0.15	0.38	0.20	0.99	1.51	1.11	0.66
Q_{75}	0.65	2.64	6.20	0.12	0.31	0.17	0.86	1.36	1.01	0.55
Q_{90}	0.56	2.40	5.28	0.09	0.25	0.14	0.76	1.22	0.92	0.45
Q_{98}	0.43	2.07	4.05	0.05	0.18	0.10	0.61	1.04	0.79	0.33
Q_{mean}	0.87	3.22	8.41	0.19	0.44	0.24	1.12	1.68	1.22	0.78

Appendix B. Continued

Flow Type	Location (21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)
Q_{01}	5.61	1.62	1.29	1.13	1.32	6.19	1.46	3.31	0.55	0.37
Q_{02}	4.98	1.44	1.15	1.00	1.15	5.42	1.32	2.99	0.51	0.35
Q_{05}	4.25	1.24	0.99	0.84	0.96	4.53	1.16	2.61	0.46	0.32
Q_{10}	3.83	1.12	0.89	0.76	0.84	4.02	1.06	2.39	0.42	0.30
Q_{15}	3.51	1.03	0.82	0.69	0.76	3.64	0.99	2.23	0.40	0.29
Q_{25}	3.20	0.94	0.75	0.63	0.67	3.25	0.92	2.07	0.38	0.28
Q_{40}	2.88	0.85	0.68	0.56	0.59	2.87	0.85	1.90	0.36	0.26
Q_{50}	2.73	0.81	0.65	0.54	0.55	2.68	0.82	1.82	0.35	0.26
Q_{60}	2.57	0.76	0.61	0.50	0.50	2.49	0.78	1.74	0.33	0.25
Q_{75}	2.26	0.68	0.54	0.67	0.42	2.10	0.71	1.58	0.31	0.24
Q_{85}	2.05	0.62	0.49	0.38	0.36	1.85	0.66	1.47	0.30	0.23
Q_{90}	1.84	0.56	0.45	0.35	0.31	1.59	0.62	1.36	0.28	0.22
Q_{95}	1.63	0.50	0.40	0.30	0.25	1.34	0.57	1.25	0.27	0.21
Q_{98}	1.31	0.41	0.33	0.23	0.16	0.95	0.50	1.09	0.24	0.20
Q_{99}	1.00	0.32	0.26	0.15	0.08	0.57	0.43	0.93	0.22	0.19
Q_{mean}	2.88	0.85	0.68	0.37	0.59	2.87	0.85	1.90	0.36	0.26
Low Flows										
$Q_{1,2}$	0.96	0.31	0.25	0.14	0.08	0.55	0.41	0.89	0.21	0.18
$Q_{1,10}$	0.83	0.27	0.22	0.12	0.07	0.47	0.36	0.77	0.18	0.16
$Q_{1,25}$	0.81	0.26	0.21	0.12	0.06	0.46	0.35	0.75	0.18	0.15
$Q_{1,50}$	0.80	0.26	0.21	0.12	0.06	0.46	0.34	0.74	0.18	0.15
$Q_{7,2}$	1.80	0.54	0.44	0.34	0.29	1.54	0.61	1.34	0.28	0.22
$Q_{7,10}$	1.00	0.32	0.26	0.15	0.08	0.57	0.43	0.93	0.22	0.19
$Q_{7,25}$	0.97	0.31	0.25	0.15	0.08	0.55	0.42	0.90	0.21	0.18
$Q_{7,50}$	0.96	0.31	0.25	0.14	0.08	0.55	0.41	0.89	0.21	0.18
$Q_{15,2}$	1.88	0.57	0.46	0.35	0.32	1.64	0.63	1.38	0.28	0.22
$Q_{15,10}$	1.16	0.36	0.30	0.22	0.12	0.76	0.47	1.01	0.23	0.20
$Q_{15,25}$	0.99	0.32	0.26	0.15	0.08	0.56	0.42	0.92	0.22	0.19
$Q_{15,50}$	0.97	0.31	0.25	0.15	0.08	0.56	0.42	0.91	0.21	0.19
$Q_{31,2}$	1.98	0.60	0.48	0.38	0.35	1.77	0.65	1.44	0.29	0.23
$Q_{31,10}$	1.28	0.40	0.32	0.23	0.16	0.91	0.49	1.08	0.24	0.20
$Q_{31,25}$	1.00	0.32	0.26	0.15	0.08	0.57	0.43	0.93	0.22	0.19
$Q_{31,50}$	0.99	0.32	0.26	0.15	0.08	0.56	0.42	0.92	0.22	0.19
$Q_{61,2}$	2.11	0.63	0.51	0.40	0.38	1.92	0.68	1.50	0.30	0.23
$Q_{61,10}$	1.47	0.45	0.37	0.27	0.21	1.14	0.54	1.17	0.25	0.21
$Q_{61,25}$	1.16	0.36	0.30	0.22	0.12	0.76	0.47	1.01	0.23	0.20
$Q_{61,50}$	1.06	0.34	0.27	0.18	0.10	0.65	0.44	0.96	0.22	0.19
$Q_{91,2}$	2.26	0.68	0.54	0.43	0.42	2.10	0.71	1.58	0.31	0.24
$Q_{91,10}$	1.63	0.50	0.40	0.31	0.25	1.34	0.57	1.25	0.27	0.21
$Q_{91,25}$	1.31	0.41	0.33	0.24	0.16	0.95	0.50	1.09	0.24	0.20
$Q_{91,50}$	1.22	0.38	0.31	0.22	0.14	0.84	0.48	1.04	0.24	0.20
Drought Flows										
$Q_{6,10}$	2.05	0.62	0.49	0.39	0.36	1.85	0.66	1.47	0.30	0.23
$Q_{6,25}$	1.80	0.54	0.44	0.34	0.29	1.54	0.61	1.34	0.28	0.22
$Q_{6,50}$	1.67	0.51	0.41	0.31	0.26	1.39	0.58	1.28	0.27	0.22
$Q_{9,10}$	2.35	0.70	0.56	0.46	0.44	2.22	0.73	1.63	0.32	0.24
$Q_{9,25}$	2.15	0.65	0.52	0.42	0.39	1.97	0.69	1.53	0.30	0.23
$Q_{9,50}$	2.01	0.60	0.49	0.38	0.35	1.80	0.66	1.45	0.29	0.23
$Q_{12,10}$	2.65	0.79	0.63	0.52	0.53	2.58	0.80	1.78	0.34	0.25
$Q_{12,25}$	2.41	0.72	0.58	0.47	0.46	2.29	0.75	1.66	0.32	0.25
$Q_{12,50}$	2.24	0.67	0.54	0.43	0.41	2.08	0.71	1.57	0.31	0.24
$Q_{18,10}$	2.76	0.82	0.65	0.54	0.56	2.72	0.82	1.84	0.35	0.26
$Q_{18,25}$	2.54	0.75	0.60	0.50	0.50	2.45	0.78	1.73	0.33	0.25
$Q_{18,50}$	2.35	0.70	0.56	0.46	0.44	2.22	0.73	1.63	0.32	0.24
$Q_{30,10}$	2.92	0.86	0.69	0.57	0.60	2.91	0.86	1.92	0.36	0.26
$Q_{30,25}$	2.70	0.80	0.64	0.53	0.54	2.64	0.81	1.81	0.34	0.26
$Q_{30,50}$	2.54	0.75	0.60	0.50	0.50	2.45	0.78	1.73	0.33	0.25

Appendix B. Continued

Flow Type	Location (21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)
Drought Flows-Cont										
$Q_{54,10}$	3.14	0.92	0.74	0.62	0.66	3.18	0.91	2.03	0.37	0.27
$Q_{54,25}$	2.81	0.83	0.66	0.55	0.57	2.77	0.83	1.86	0.35	0.26
$Q_{54,50}$	2.70	0.80	0.64	0.52	0.54	2.64	0.81	1.81	0.34	0.26
January Flows										
Q_{02}	5.17	1.50	1.19	1.03	1.21	5.65	1.36	3.09	0.52	0.35
Q_{10}	3.83	1.12	0.89	0.76	0.84	4.02	1.06	2.39	0.42	0.30
Q_{25}	3.20	0.94	0.75	0.63	0.67	3.25	0.92	2.07	0.38	0.28
Q_{50}	2.73	0.81	0.65	0.54	0.55	2.68	0.82	1.82	0.35	0.26
Q_{75}	2.26	0.68	0.54	0.43	0.42	2.10	0.71	1.58	0.31	0.24
Q_{90}	1.84	0.56	0.45	0.35	0.31	1.59	0.62	1.36	0.28	0.22
Q_{98}	1.47	0.45	0.37	0.27	0.21	1.14	0.54	1.17	0.25	0.21
Q_{mean}	3.20	0.94	0.75	0.63	0.67	3.25	0.92	2.07	0.38	0.28
February flows										
Q_{02}	5.42	1.57	1.25	1.09	1.27	5.96	1.42	3.22	0.54	0.36
Q_{10}	4.04	1.18	0.94	0.80	0.90	4.27	1.11	2.50	0.44	0.31
Q_{25}	3.45	1.01	0.81	0.68	0.74	3.56	0.98	2.20	0.40	0.29
Q_{50}	2.88	0.85	0.68	0.56	0.59	2.87	0.85	1.90	0.36	0.26
Q_{75}	2.41	0.72	0.58	0.47	0.46	2.29	0.75	1.66	0.32	0.25
Q_{90}	2.09	0.63	0.50	0.40	0.37	1.90	0.67	1.49	0.30	0.23
Q_{98}	1.75	0.53	0.43	0.33	0.28	1.49	0.60	1.32	0.27	0.22
Q_{mean}	3.36	0.99	0.79	0.66	0.72	3.44	0.96	2.15	0.39	0.28
March Flows										
Q_{02}	5.61	1.62	1.29	1.13	1.32	6.19	1.46	3.31	0.55	0.37
Q_{10}	4.25	1.24	0.99	0.85	0.96	4.53	1.16	2.61	0.46	0.32
Q_{25}	3.64	1.07	0.85	0.72	0.79	3.79	1.02	2.29	0.41	0.29
Q_{50}	3.20	0.94	t>.75	0.63	0.67	3.25	0.92	2.07	0.38	0.28
Q_{75}	2.81	0.83	0.66	0.55	0.57	2.77	0.83	1.86	0.35	0.26
Q_{90}	2.57	0.76	0.61	0.50	0.50	2.49	0.78	1.74	0.33	0.25
Q_{98}	2.05	0.62	0.49	0.39	0.36	1.85	0.66	1.47	0.30	0.23
Q_{mean}	3.51	1.03	0.82	0.69	0.76	3.64	0.99	2.23	0.40	0.29
April Flows										
Q_{02}	5.61	1.62	1.29	1.13	1.32	6.19	1.46	3.31	0.55	0.37
Q_{10}	4.25	1.24	0.99	0.85	0.96	4.53	1.16	2.61	0.46	0.32
Q_{25}	3.76	1.10	0.88	0.75	0.83	3.94	1.05	2.36	0.42	0.30
Q_{50}	3.29	0.97	0.77	0.65	0.70	3.37	0.94	2.12	0.39	0.28
Q_{75}	2.88	0.85	0.68	0.57	0.59	2.87	0.85	1.90	0.36	0.26
Q_{90}	2.70	0.80	0.64	0.53	0.54	2.64	0.81	1.81	0.34	0.26
Q_{98}	2.15	0.65	0.52	0.42	0.39	1.97	0.69	1.53	0.30	0.23
Q_{mean}	3.61	1.06	0.84	0.72	0.78	3.75	1.01	2.28	0.41	0.29
May Flows										
Q_{02}	5.61	1.62	1.29	1.13	1.32	6.19	1.46	3.31	0.55	0.37
Q_{10}	4.04	1.18	0.94	0.81	0.90	4.27	1.11	2.50	0.44	0.31
Q_{25}	3.39	0.99	0.79	0.67	0.72	3.48	0.97	2.16	0.39	0.28
Q_{50}	3.04	0.90	0.72	0.60	0.63	3.06	0.89	1.99	0.37	0.27
Q_{75}	2.81	0.83	0.66	0.55	0.57	2.77	0.83	1.86	0.35	0.26
Q_{90}	2.65	0.79	0.63	0.52	0.53	2.58	0.80	1.78	0.34	0.25
Q_{98}	2.09	0.63	0.50	0.40	0.37	1.90	0.67	1.49	0.30	0.23
Q_{mean}	3.42	1.00	0.80	0.68	0.73	3.52	0.97	2.18	0.40	0.28
June Flows										
Q_{02}	5.61	1.62	1.29	1.13	1.32	6.19	1.46	3.31	0.55	0.37
Q_{10}	4.04	1.18	0.94	0.81	0.90	4.27	1.11	2.50	0.44	0.31
Q_{25}	3.32	0.98	0.78	0.66	0.71	3.41	0.95	2.13	0.39	0.28
Q_{50}	2.88	0.85	0.68	0.57	0.59	2.87	0.85	1.90	0.36	0.26
Q_{75}	2.68	0.79	0.64	0.53	0.53	2.62	0.81	1.80	0.34	0.26
Q_{90}	2.48	0.74	0.59	0.48	0.48	2.37	0.76	1.69	0.33	0.25
Q_{98}	2.05	0.62	0.49	0.39	0.36	1.85	0.66	1.47	0.30	0.23
Q_{mean}	3.29	0.97	0.77	0.65	0.70	3.37	0.94	2.12	0.39	0.28

Appendix B. Continued

Flow Type	Location (21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)
July Flows										
Q_{02}	4.61	1.34	1.07	0.94	1.06	4.98	1.24	2.80	0.48	0.33
Q_{10}	3.51	1.03	0.82	0.70	0.76	3.64	0.99	2.23	0.40	0.29
Q_{25}	2.98	0.88	0.70	0.58	0.61	2.98	0.87	1.95	0.36	0.27
Q_{50}	2.73	0.81	0.65	0.53	0.55	2.68	0.82	1.82	0.35	0.26
Q_{75}	2.38	0.71	0.57	0.46	0.45	2.26	0.74	1.64	0.32	0.24
Q_{90}	2.13	0.64	0.51	0.41	0.39	1.95	0.68	1.51	0.30	0.23
Q_{98}	1.63	0.50	0.40	0.31	0.25	1.34	0.57	1.25	0.27	0.21
Q_{mean}	3.04	0.90	0.72	0.60	0.63	3.06	0.89	1.99	0.37	0.27
August Flows										
Q_{02}	4.25	1.24	0.99	0.85	0.96	4.53	1.16	2.61	0.46	0.32
Q_{10}	3.14	0.92	0.74	0.62	0.66	3.18	0.91	2.03	0.37	0.27
Q_{25}	2.68	0.79	0.64	0.53	0.53	2.62	0.81	1.80	0.34	0.26
Q_{50}	2.35	0.70	0.56	0.46	0.44	2.22	0.73	1.63	0.32	0.24
Q_{75}	2.11	0.63	0.51	0.41	0.38	1.92	0.68	1.50	0.30	0.23
Q_{90}	1.84	0.56	0.45	0.35	0.31	1.59	0.62	1.36	0.28	0.22
Q_{98}	1.31	0.41	0.33	0.24	0.16	0.95	0.50	1.09	0.24	0.20
Q_{mean}	2.85	0.84	0.67	0.56	0.58	2.83	0.85	1.89	0.35	0.26
September Flows										
Q_{02}	3.83	1.12	0.89	0.76	0.84	4.02	1.06	2.39	0.42	0.30
Q_{10}	2.84	0.84	0.67	0.56	0.58	2.81	0.84	1.88	0.35	0.26
Q_{25}	2.38	0.71	0.57	0.46	0.45	2.26	0.74	1.64	0.32	0.24
Q_{50}	2.13	0.64	0.51	0.41	0.39	1.95	0.68	1.51	0.30	0.23
Q_{75}	1.88	0.57	0.46	0.36	0.32	1.64	0.63	1.38	0.28	0.22
Q_{90}	1.63	0.50	0.40	0.31	0.25	1.34	0.57	1.25	0.27	0.21
Q_{98}	1.00	0.32	0.26	0.15	0.08	0.57	0.43	0.93	0.22	0.19
Q_{mean}	2.65	0.79	0.63	0.52	0.53	2.58	0.80	1.78	0.34	0.25
October Flows										
Q_{02}	3.95	1.15	0.92	0.79	0.88	4.17	1.09	2.46	0.43	0.31
Q_{10}	3.04	0.90	0.72	0.60	0.63	3.06	0.89	1.99	0.37	0.27
Q_{25}	2.60	0.77	0.62	0.51	0.51	2.52	0.79	1.76	0.34	0.25
Q_{50}	2.13	0.64	0.51	0.41	0.39	1.95	0.68	1.51	0.30	0.23
Q_{75}	1.84	0.56	0.45	0.35	0.31	1.59	0.62	1.36	0.28	0.22
Q_{90}	1.47	0.45	0.37	0.27	0.21	1.14	0.54	1.17	0.25	0.21
Q_{98}	0.96	0.31	0.25	0.14	0.08	0.55	0.41	0.89	0.21	0.18
Q_{mean}	2.73	0.81	0.65	0.53	0.55	2.68	0.82	1.82	0.35	0.26
November Flows										
Q_{02}	4.16	1.21	0.97	0.83	0.93	4.43	1.14	2.57	0.45	0.31
Q_{10}	3.20	0.94	0.75	0.63	0.67	3.25	0.92	2.07	0.38	0.28
Q_{25}	2.76	0.82	0.65	0.54	0.56	2.72	0.82	1.84	0.35	0.26
Q_{50}	2.35	0.70	0.56	0.46	0.44	2.22	0.73	1.63	0.32	0.24
Q_{75}	2.01	0.60	0.49	0.39	0.35	1.80	0.66	1.45	0.29	0.23
Q_{90}	1.63	0.50	0.40	0.31	0.25	1.34	0.57	1.25	0.27	0.21
Q_{98}	1.00	0.32	0.26	0.15	0.08	0.57	0.43	0.93	0.22	0.19
Q_{mean}	2.73	0.81	0.65	0.53	0.55	2.68	0.82	1.82	0.35	0.26
December Flows										
Q_{02}	4.98	1.44	1.15	1.00	1.15	5.42	1.32	2.99	0.51	0.35
Q_{10}	3.51	1.03	0.82	0.70	0.76	3.64	0.99	2.23	0.40	0.29
Q_{25}	2.88	0.85	0.68	0.56	0.59	2.87	0.85	1.90	0.36	0.26
Q_{50}	2.51	0.75	0.60	0.48	0.49	2.41	0.77	1.71	0.33	0.25
Q_{75}	2.09	0.63	0.50	0.40	0.37	1.90	0.67	1.49	0.30	0.23
Q_{90}	1.73	0.53	0.42	0.33	0.28	1.46	0.59	1.31	0.27	0.22
Q_{98}	1.25	0.39	0.32	0.22	0.15	0.88	0.49	1.06	0.24	0.20
Q_{mean}	2.95	0.87	0.70	0.58	0.61	2.95	0.87	1.94	0.36	0.27

Appendix B. Continued

Flow Type	Location (31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)
Q_{01}	3.74	2.25	0.35	0.59	1.36	2.45	0.51	0.36	4.46	0.49
Q_{02}	3.44	2.05	0.32	0.53	1.23	2.30	0.45	0.33	3.97	0.43
Q_{05}	3.08	1.82	0.29	0.46	1.08	2.11	0.38	0.28	3.40	0.37
Q_{10}	2.88	1.69	0.27	0.43	1.00	2.01	0.34	0.26	3.07	0.33
Q_{15}	2.72	1.59	0.26	0.40	0.94	1.93	0.31	0.24	2.82	0.30
Q_{25}	2.57	1.49	0.25	0.37	0.87	1.85	0.28	0.22	2.57	0.28
Q_{40}	2.42	1.39	0.23	0.34	0.81	1.77	0.25	0.20	2.33	0.25
Q_{50}	2.34	1.34	0.23	0.33	0.78	1.73	0.23	0.19	2.20	0.23
Q_{60}	2.26	1.29	0.22	0.31	0.75	1.69	0.22	0.18	2.08	0.22
Q_{75}	2.11	1.19	0.21	0.28	0.68	1.61	0.19	0.16	1.84	0.19
Q_{85}	2.01	1.12	0.20	0.26	0.64	1.56	0.17	0.15	1.67	0.17
Q_{90}	1.91	1.06	0.19	0.25	0.60	1.51	0.15	0.14	1.51	0.15
Q_{95}	1.81	0.99	0.18	0.23	0.56	1.46	0.13	0.13	1.34	0.14
Q_{98}	1.65	0.89	0.16	0.20	0.49	1.38	0.10	0.11	1.10	0.11
Q_{99}	1.50	0.79	0.15	0.17	0.43	1.30	0.07	0.09	0.85	0.08
Q_{mean}	2.42	1.39	0.23	0.34	0.81	1.77	0.25	0.20	2.33	0.25
LOW Flows										
$Q_{1,2}$	1.44	0.76	0.14	0.16	0.41	1.25	0.07	0.09	0.81	0.08
$Q_{1,10}$	1.24	0.65	0.12	0.14	0.36	1.08	0.06	0.07	0.70	0.07
$Q_{1,25}$	1.21	0.64	0.12	0.14	0.35	1.05	0.06	0.07	0.69	0.06
$Q_{1,50}$	1.20	0.63	0.12	0.14	0.34	1.04	0.06	0.07	0.68	0.06
$Q_{7,2}$	1.89	1.04	0.18	0.24	0.59	1.50	0.15	0.14	1.47	0.15
$Q_{7,10}$	1.50	0.79	0.15	0.17	0.43	1.30	0.07	0.09	0.85	0.08
$Q_{7,25}$	1.46	0.77	0.15	0.16	0.42	1.26	0.07	0.09	0.82	0.08
$Q_{7,50}$	1.44	0.76	0.14	0.16	0.41	1.25	0.07	0.09	0.81	0.08
$Q_{15,2}$	1.93	1.07	0.19	0.25	0.61	1.52	0.15	0.14	1.54	0.16
$Q_{15,10}$	1.58	0.84	0.16	0.18	0.46	1.34	0.08	0.10	0.97	0.09
$Q_{15,25}$	1.48	0.78	0.15	0.17	0.42	1.28	0.07	0.09	0.84	0.08
$Q_{15,50}$	1.46	0.77	0.15	0.17	0.42	1.27	0.07	0.09	0.83	0.08
$Q_{31,2}$	1.98	1.10	0.19	0.26	0.63	1.55	0.16	0.15	1.62	0.17
$Q_{31,10}$	1.64	0.88	0.16	0.20	0.49	1.37	0.10	0.11	1.07	0.11
$Q_{31,25}$	1.50	0.79	0.15	0.17	0.43	1.30	0.07	0.09	0.85	0.08
$Q_{31,50}$	1.48	0.78	0.15	0.17	0.42	1.28	0.07	0.09	0.84	0.08
$Q_{61,2}$	2.04	1.14	0.20	0.27	0.65	1.58	0.17	0.16	1.72	0.18
$Q_{61,10}$	1.73	0.94	0.17	0.21	0.52	1.42	0.11	0.12	1.22	0.12
$Q_{61,25}$	1.58	0.84	0.16	0.18	0.46	1.34	0.08	0.10	0.97	0.09
$Q_{61,50}$	1.53	0.81	0.15	0.18	0.44	1.32	0.08	0.09	0.90	0.09
$Q_{91,2}$	2.11	1.19	0.21	0.28	0.68	1.61	0.19	0.16	1.84	0.19
$Q_{91,10}$	1.81	0.99	0.18	0.23	0.56	1.46	0.13	0.13	1.34	0.14
$Q_{91,25}$	1.65	0.89	0.16	0.20	0.49	1.38	0.10	0.11	1.10	0.11
$Q_{91,50}$	1.61	0.86	0.16	0.19	0.47	1.36	0.09	0.10	1.02	0.10
Drought Flows										
$Q_{6,10}$	2.01	1.12	0.20	0.26	0.64	1.56	0.17	0.15	1.67	0.17
$Q_{6,25}$	1.89	1.04	0.18	0.24	0.59	1.50	0.15	0.14	1.47	0.15
$Q_{6,50}$	1.83	1.00	0.18	0.23	0.56	1.47	0.13	0.13	1.38	0.14
$Q_{9,10}$	2.16	1.22	0.21	0.29	0.70	1.64	0.20	0.17	1.91	0.20
$Q_{9,25}$	2.06	1.16	0.20	0.27	0.66	1.59	0.18	0.16	1.75	0.18
$Q_{9,50}$	1.99	1.11	0.19	0.26	0.63	1.55	0.16	0.15	1.64	0.17
$Q_{12,10}$	2.30	1.31	0.22	0.32	0.76	1.71	0.23	0.19	2.14	0.23
$Q_{12,25}$	2.19	1.24	0.21	0.30	0.71	1.65	0.20	0.17	1.96	0.21
$Q_{12,50}$	2.10	1.18	0.20	0.28	0.68	1.61	0.19	0.16	1.82	0.19
$Q_{18,10}$	2.36	1.35	0.23	0.33	0.78	1.74	0.24	0.19	2.23	0.24
$Q_{18,25}$	2.25	1.28	0.22	0.31	0.74	1.69	0.22	0.18	2.06	0.22
$Q_{18,50}$	2.16	1.22	0.21	0.29	0.70	1.64	0.20	0.17	1.91	0.20
$Q_{30,10}$	2.43	1.40	0.23	0.34	0.82	1.78	0.25	0.20	2.35	0.25
$Q_{30,25}$	2.33	1.33	0.22	0.32	0.77	1.72	0.23	0.19	2.18	0.23
$Q_{30,50}$	2.25	1.28	0.22	0.31	0.74	1.69	0.22	0.18	2.06	0.22

Appendix B. Continued

Flow Type	Location (31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)
Drought Flows-Cont										
$Q_{54,10}$	2.54	1.47	0.24	0.36	0.86	1.83	0.27	0.22	2.53	0.27
$Q_{54,25}$	2.38	1.36	0.23	0.33	0.79	1.75	0.24	0.20	2.27	0.24
$Q_{54,50}$	2.33	1.33	0.22	0.32	0.77	1.72	0.23	0.19	2.18	0.23
January Flows										
Q_{02}	3.53	2.11	0.33	0.55	1.27	2.34	0.46	0.34	4.12	0.45
Q_{10}	2.88	1.69	0.27	0.43	1.00	2.01	0.34	0.26	3.07	0.33
Q_{25}	2.57	1.49	0.25	0.37	0.87	1.85	0.28	0.22	2.57	0.28
Q_{50}	2.34	1.34	0.23	0.33	0.78	1.73	0.23	0.19	2.20	0.23
Q_{75}	2.11	1.19	0.21	0.28	0.68	1.61	0.19	0.16	1.84	0.19
Q_{90}	1.91	1.06	0.19	0.25	0.60	1.51	0.15	0.14	1.51	0.15
Q_{98}	1.73	0.94	0.17	0.21	0.52	1.42	0.11	0.12	1.22	0.12
Q_{mean}	2.57	1.49	0.25	0.37	0.87	1.85	0.28	0.22	2.57	0.28
February flows										
Q_{02}	3.65	2.19	0.34	0.57	1.32	2.41	0.49	0.35	4.32	0.47
Q_{10}	2.98	1.75	0.28	0.45	1.04	2.06	0.36	0.27	3.23	0.35
Q_{25}	2.69	1.57	0.26	0.39	0.92	1.91	0.30	0.23	2.77	0.30
Q_{50}	2.42	1.39	0.23	0.34	0.81	1.77	0.25	0.20	2.33	0.25
Q_{75}	2.19	1.24	0.21	0.30	0.71	1.65	0.20	0.17	1.96	0.21
Q_{90}	2.03	1.14	0.20	0.27	0.65	1.57	0.17	0.15	1.70	0.18
Q_{98}	1.87	1.03	0.18	0.24	0.58	1.49	0.14	0.13	1.44	0.15
Q_{mean}	2.66	1.54	0.25	0.38	0.90	1.89	0.29	0.23	2.70	0.29
March Flows										
Q_{02}	3.74	2.25	0.35	0.59	1.36	2.45	0.51	0.36	4.46	0.49
Q_{10}	3.08	1.82	0.29	0.46	1.08	2.11	0.38	0.28	3.40	0.37
Q_{25}	2.79	1.63	0.27	0.41	0.96	1.96	0.32	0.25	2.92	0.32
Q_{50}	2.57	1.49	0.25	0.37	0.87	1.85	0.28	0.22	2.57	0.28
Q_{75}	2.38	1.36	0.23	0.33	0.79	1.75	0.24	0.20	2.27	0.24
Q_{90}	2.26	1.29	0.22	0.31	0.75	1.69	0.22	0.18	2.08	0.22
Q_{98}	2.01	1.12	0.20	0.26	0.64	1.56	0.17	0.15	1.67	0.17
Q_{mean}	2.72	1.59	0.26	0.40	0.94	1.93	0.31	0.24	2.82	0.30
April Flows										
Q_{02}	3.74	2.25	0.35	0.59	1.36	2.45	0.51	0.36	4.46	0.49
Q_{10}	3.08	1.82	0.29	0.46	1.08	2.11	0.38	0.28	3.40	0.37
Q_{25}	2.85	1.67	0.27	0.42	0.99	1.99	0.33	0.25	3.02	0.33
Q_{50}	2.62	1.52	0.25	0.38	0.89	1.87	0.29	0.23	2.65	0.28
Q_{75}	2.42	1.39	0.23	0.34	0.81	1.77	0.25	0.20	2.33	0.25
Q_{90}	2.33	1.33	0.22	0.32	0.77	1.72	0.23	0.19	2.18	0.23
Q_{98}	2.06	1.16	0.20	0.27	0.66	1.59	0.18	0.16	1.75	0.18
Q_{mean}	2.77	1.62	0.26	0.41	0.95	1.95	0.32	0.24	2.89	0.31
May Flows										
Q_{02}	3.74	2.25	0.35	0.59	1.36	2.45	0.51	0.36	4.46	0.49
Q_{10}	2.98	1.75	0.28	0.45	1.04	2.06	0.36	0.27	3.23	0.35
Q_{25}	2.66	1.55	0.25	0.39	0.91	1.90	0.30	0.23	2.72	0.29
Q_{50}	2.49	1.44	0.24	0.36	0.84	1.81	0.26	0.21	2.45	0.26
Q_{75}	2.38	1.36	0.23	0.33	0.79	1.75	0.24	0.20	2.27	0.24
Q_{90}	2.30	1.31	0.22	0.32	0.76	1.71	0.23	0.19	2.14	0.23
Q_{98}	2.03	1.14	0.20	0.27	0.65	1.57	0.17	0.15	1.70	0.18
Q_{mean}	2.68	1.56	0.26	0.39	0.92	1.91	0.30	0.23	2.75	0.30
June Flows										
Q_{02}	3.74	2.25	0.35	0.59	1.36	2.45	0.51	0.36	4.46	0.49
Q_{10}	2.98	1.75	0.28	0.45	1.04	2.06	0.36	0.27	3.23	0.35
Q_{25}	2.63	1.53	0.25	0.38	0.90	1.88	0.29	0.23	2.67	0.29
Q_{50}	2.42	1.39	0.23	0.34	0.81	1.77	0.25	0.20	2.33	0.25
Q_{75}	2.32	1.32	0.22	0.32	0.77	1.72	0.23	0.19	2.17	0.23
Q_{90}	2.22	1.26	0.21	0.30	0.73	1.67	0.21	0.18	2.01	0.21
Q_{98}	2.01	1.12	0.20	0.26	0.64	1.56	0.17	0.15	1.67	0.17
Q_{mean}	2.62	1.52	0.25	0.38	0.89	1.87	0.29	0.23	2.65	0.28

Appendix B. Continued

Flow Type	Location (31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)
July Flows										
Q_{02}	3.26	1.94	0.31	0.50	1.16	2.20	0.41	0.30	3.68	0.40
Q_{10}	2.72	1.59	0.26	0.40	0.94	1.93	0.31	0.24	232	0.30
Q_{25}	2.46	1.42	0.24	0.35	0.83	1.80	0.26	0.21	2.40	0.26
Q_{50}	2.34	1.34	0.23	0.33	0.78	1.73	0.23	0.19	2.20	0.23
Q_{75}	2.17	1.23	0.21	0.30	0.71	1.65	0.20	0.17	1.93	0.20
Q_{90}	2.05	1.15	0.20	0.27	0.66	1.58	0.18	0.16	1.74	0.18
Q_{98}	1.81	0.99	0.18	0.23	0.56	1.46	0.13	0.13	1.34	0.14
Q_{mean}	2.49	1.44	0.24	0.36	0.84	1.81	0.26	0.21	2.45	0.26
August Flows										
Q_{02}	3.08	1.82	0.29	0.46	1.08	2.11	038	0.28	3.40	0.37
Q_{10}	2.54	1.47	0.24	0.36	0.86	1.83	0.27	0.22	2.53	0.27
Q_{25}	2.32	1.32	0.22	0.32	0.77	1.72	0.23	0.19	2.17	0.23
Q_{50}	2.16	1.22	0.21	0.29	0.70	1.64	0.20	0.17	1.91	0.20
Q_{75}	2.04	1.14	0.20	0.27	0.65	1.58	0.17	0.16	1.72	0.18
Q_{90}	1.91	1.06	0.19	0.25	0.60	1.51	0.15	0.14	1.51	0.15
Q_{98}	1.65	039	0.16	0.20	0.49	1.38	0.10	0.11	1.10	0.11
Q_{mean}	2.40	1.38	0.23	0.34	0.80	1.76	0.25	0.20	2.30	0.25
September Flows										
Q_{02}	2.88	1.69	0.27	0.43	1.00	2.01	0.34	0.26	3.07	0.33
Q_{10}	2.40	1.37	0.23	0.34	030	1.76	0.24	0.20	2.29	0.24
Q_{25}	2.17	1.23	0.21	0.30	0.71	1.65	0.20	0.17	1.93	0.20
Q_{50}	2.05	1.15	0.20	0.27	0.66	1.58	0.18	0.16	1.74	0.18
Q_{75}	1.93	1.07	0.19	0.25	0.61	1.52	0.15	0.14	1.54	0.16
Q_{90}	1.81	0.99	0.18	0.23	0.56	1.46	0.13	0.13	1.34	0.14
Q_{98}	1.50	0.79	0.15	0.17	0.43	1.30	0.07	0.09	035	0.08
Q_{mean}	2.30	1.31	0.22	0.32	0.76	1.71	0.23	0.19	2.14	0.23
October Flows										
Q_{02}	2.94	1.73	0.28	0.44	1.02	2.04	0.35	0.26	3.17	0.34
Q_{10}	2.49	1.44	0.24	0.36	0.84	131	0.26	0.21	2.45	0.26
Q_{25}	2.28	1.30	0.22	0.32	0.75	1.70	0.22	0.18	2.11	0.22
Q_{50}	2.05	1.15	0.20	0.27	0.66	1.58	0.18	0.16	1.74	0.18
Q_{75}	1.91	1.06	0.19	0.25	0.60	1.51	0.15	0.14	1.51	0.15
Q_{90}	1.73	0.94	0.17	0.21	0.52	1.42	0.11	0.12	1.22	0.12
Q_{98}	1.44	0.76	0.14	0.16	0.41	1.25	0.07	0.09	031	0.08
Q_{mean}	2.34	1.34	0.23	0.33	0.78	1.73	0.23	0.19	2.20	0.23
November Flows										
Q_{02}	3.04	1.79	0.29	0.46	1.07	2.09	0.37	0.28	3.33	0.36
Q_{10}	2.57	1.49	0.25	0.37	0.87	135	0.28	0.22	2.57	0.28
Q_{25}	2.36	1.35	0.23	0.33	0.78	1.74	0.24	0.19	2.23	0.24
Q_{50}	2.16	1.22	0.21	0.29	0.70	1.64	0.20	0.17	1.91	0.20
Q_{75}	1.99	1.11	0.19	0.26	0.63	1.55	0.16	0.15	1.64	0.17
Q_{90}	131	0.99	0.18	0.23	0.56	1.46	0.13	0.13	1.34	0.14
Q_{98}	1.50	0.79	0.15	0.17	0.43	1.30	0.07	0.09	0.85	0.08
Q_{mean}	2.34	1.34	0.23	0.33	0.78	1.73	0.23	0.19	2.20	0.23
December Flows										
Q_{02}	3.44	2.05	0.32	0.53	1.23	2.30	0.45	0.33	3.97	0.43
Q_{10}	2.72	1.59	0.26	0.40	0.94	1.93	0.31	0.24	232	0.30
Q_{25}	2.42	1.39	0.23	0.34	0.81	1.77	0.25	0.20	2.33	0.25
Q_{50}	2.23	1.27	0.22	0.31	0.73	1.68	0.21	0.18	2.03	0.21
Q_{75}	2.03	1.14	0.20	0.27	0.65	1.57	0.17	0.15	1.70	0.18
Q_{90}	1.86	1.02	0.18	0.24	0.58	1.48	0.14	0.13	1.42	0.15
Q_{98}	1.62	0.87	0.16	0.19	0.48	1.36	0.09	0.10	1.05	0.10
Q_{mean}	2.45	1.41	0.24	0.35	0.82	1.79	0.25	0.21	2.38	0.25

Appendix B. Continued

Flow Type	Location (41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)	(50)
Q_{01}	0.70	1.23	0.62	0.48	0.28	-1.94	-1.78	-5.74	-136	0.00
Q_{02}	0.62	1.09	0.57	0.42	0.25	-1.94	-1.78	-5.74	-1.86	0.00
Q_{05}	0.53	0.92	0.51	0.36	0.22	-1.94	-1.78	-5.74	-1.86	0.00
Q_{10}	0.47	0.83	0.48	0.33	0.20	-1.94	-1.78	-5.74	-1.86	0.00
Q_{15}	0.44	0.76	0.45	0.30	0.18	-1.94	-1.78	-5.74	-1.86	0.50
Q_{25}	0.40	0.69	0.43	0.27	0.17	-1.94	-1.78	-5.74	-1.86	2.50
Q_{40}	0.36	0.62	0.40	0.25	0.16	-1.94	-1.78	-5.74	-1.86	3.70
Q_{50}	0.34	0.59	0.39	0.23	0.15	-1.94	-1.78	-5.74	-1.86	4.30
Q_{60}	0.32	0.55	0.38	0.22	0.14	-1.94	-1.78	-5.74	-1.86	4.50
Q_{75}	0.28	0.48	0.35	0.20	0.13	-1.94	-1.78	-5.74	-1.86	4.06
Q_{85}	0.25	0.43	0.33	0.18	0.12	-1.94	-1.78	-5.74	-1.86	3.44
Q_{90}	0.23	0.39	0.32	0.16	0.11	-1.94	-1.78	-5.74	-1.86	2.79
Q_{95}	0.20	0.34	0.30	0.14	0.10	-1.94	-1.78	-5.74	-1.86	2.09
Q_{98}	0.16	0.27	0.28	0.12	0.08	-1.94	-1.78	-5.74	-1.86	1.42
Q_{99}	0.12	0.20	0.25	0.09	0.07	-1.94	-1.78	-5.74	-1.86	0.79
Q_{mean}	0.36	0.62	0.40	0.25	0.16	-1.94	-1.78	-5.74	-1.86	4.00
<u>Low Flows</u>										
$Q_{1,2}$	0.11	0.19	0.24	0.09	0.07	-1.94	-1.78	-5.74	-1.86	2.10
$Q_{1,10}$	0.10	0.17	0.21	0.07	0.06	-1.94	-1.78	-5.74	-1.86	0.57
$Q_{1,25}$	0.10	0.16	0.20	0.07	0.06	-1.94	-1.78	-5.74	-1.86	0.30
$Q_{1,50}$	0.10	0.16	0.20	0.07	0.06	-1.94	-1.78	-5.74	-1.86	0.21
$Q_{7,2}$	0.22	0.38	0.31	0.16	0.11	-1.94	-1.78	-5.74	-1.86	2.85
$Q_{7,10}$	0.12	0.20	0.25	0.09	0.07	-1.94	-1.78	-5.74	-1.86	0.96
$Q_{7,25}$	0.12	0.19	0.24	0.09	0.07	-1.94	-1.78	-5.74	-1.86	0.48
$Q_{7,50}$	0.11	0.19	0.24	0.09	0.07	-1.94	-1.78	-5.74	-1.86	0.29
$Q_{15,2}$	0.23	0.40	0.32	0.16	0.11	-1.94	-1.78	-5.74	-1.86	3.30
$Q_{15,10}$	0.14	0.24	0.26	0.10	0.08	-1.94	-1.78	-5.74	-1.86	1.12
$Q_{15,25}$	0.12	0.20	0.25	0.09	0.07	-1.94	-1.78	-5.74	-1.86	0.76
$Q_{15,50}$	0.12	0.19	0.24	0.09	0.07	-1.94	-1.78	-5.74	-1.86	0.58
$Q_{31,2}$	0.24	0.42	0.33	0.17	0.11	-1.94	-1.78	-5.74	-1.86	3.70
$Q_{31,10}$	0.16	0.26	0.27	0.11	0.08	-1.94	-1.78	-5.74	-1.86	1.40
$Q_{31,25}$	0.12	0.20	0.25	0.09	0.07	-1.94	-1.78	-5.74	-1.86	1.04
$Q_{31,50}$	0.12	0.20	0.25	0.09	0.07	-1.94	-1.78	-5.74	-1.86	0.86
$Q_{61,2}$	0.26	0.45	0.34	0.18	0.12	-1.94	-1.78	-5.74	-1.86	5.50
$Q_{61,10}$	0.18	0.31	0.29	0.13	0.09	-1.94	-1.78	-5.74	-1.86	2.45
$Q_{61,25}$	0.14	0.24	0.26	0.10	0.08	-1.94	-1.78	-5.74	-1.86	1.00
$Q_{61,50}$	0.13	0.21	0.26	0.10	0.07	-1.94	-1.78	-5.74	-1.86	1.44
$Q_{91,2}$	0.28	0.48	0.35	0.20	0.13	-1.94	-1.78	-6.74	-1.86	6.95
$Q_{91,10}$	0.20	0.34	0.30	0.14	0.10	-1.94	-1.78	-5.74	-1.86	3.62
$Q_{91,25}$	0.16	0.27	0.28	0.12	0.08	-1.94	-1.78	-5.74	-1.86	2.88
$Q_{91,50}$	0.15	0.25	0.27	0.11	0.08	-1.94	-1.78	-5.74	-1.86	2.32
<u>Drought Flows</u>										
$Q_{6,10}$	0.25	0.43	0.33	0.18	0.12	-1.94	-1.78	-5.74	-1.86	5.44
$Q_{6,25}$	0.22	0.38	0.31	0.16	0.11	-1.94	-1.78	-5.74	-1.86	4.45
$Q_{6,50}$	0.20	0.35	0.30	0.15	0.10	-1.94	-1.78	-5.74	-1.86	3.49
$Q_{9,10}$	0.29	0.50	0.36	0.20	0.13	-1.94	-1.78	-5.74	-1.86	5.60
$Q_{9,25}$	0.26	0.46	0.34	0.19	0.12	-1.94	-1.78	-5.74	-1.86	4.60
$Q_{9,50}$	0.25	0.42	0.33	0.17	0.12	-1.94	-1.78	-5.74	-1.86	3.64
$Q_{12,10}$	0.33	0.57	0.38	0.23	0.14	-1.94	-1.78	-5.74	-1.86	5.10
$Q_{12,25}$	0.30	0.52	0.36	0.21	0.13	-1.94	-1.78	-5.74	-1.86	4.70
$Q_{12,50}$	0.28	0.48	0.35	0.19	0.13	-1.94	-1.78	-5.74	-1.86	4.00
$Q_{18,10}$	0.34	0.59	0.39	0.24	0.15	-1.94	-1.78	-5.74	-1.86	5.40
$Q_{18,25}$	0.31	0.54	0.37	0.22	0.14	-1.94	-1.78	-5.74	-1.86	5.30
$Q_{18.50}$	0.29	0.50	0.36	0.20	0.13	-1.94	-1.78	-5.74	-1.86	4.80
$Q_{30,10}$	0.36	0.63	0.41	0.25	0.16	-1.94	-1.78	-5.74	-1.86	4.60
$Q_{30,25}$	0.33	0.58	0.39	0.23	0.15	-1.94	-1.78	-5.74	-1.86	5.60
$Q_{30,50}$	0.31	0.54	0.37	0.22	0.14	-1.94	-1.78	-5.74	-1.86	5.00

Appendix B. Continued

Flow Type	Location (41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)	(50)
Drought Flows-Cont										
$Q_{54,10}$	0.39	0.68	0.42	0.27	0.17	-1.94	-1.78	-5.74	-1.86	5.20
$Q_{54,25}$	0.35	0.60	0.40	0.24	0.15	-1.94	-1.78	-5.74	-1.86	6.10
$Q_{54,50}$	0.33	0.58	0.39	0.23	0.15	-1.94	-1.78	-5.74	-1.86	5.00
January Flows										
Q_{02}	0.64	1.13	0.59	0.44	0.26	-1.94	-1.78	-5.74	-1.86	0.00
Q_{10}	0.47	0.83	0.48	0.33	0.20	-1.94	-1.78	-5.74	-136	0.00
Q_{25}	0.40	0.69	0.43	0.27	0.17	-1.94	-1.78	-5.74	-1.86	3.20
Q_{50}	0.34	0.59	0.39	0.23	0.15	-1.94	-1.78	-5.74	-1.86	4.40
Q_{75}	0.28	0.48	0.35	0.20	0.13	-1.94	-1.78	-5.74	-1.86	4.70
Q_{90}	0.23	0.39	0.32	0.16	0.11	-1.94	-1.78	-5.74	-1.86	3.54
Q_{98}	0.18	0.31	0.29	0.13	0.09	-1.94	-1.78	-5.74	-1.86	1.34
Q_{mean}	0.40	0.69	0.43	0.27	0.17	-1.94	-1.78	-5.74	-1.86	3.50
February flows										
Q_{02}	0.67	1.18	0.61	0.46	0.27	-1.94	-1.78	-5.74	-1.86	0.00
Q_{10}	0.50	0.88	0.50	0.34	0.21	-1.94	-1.78	-5.74	-1.86	0.00
Q_{25}	0.43	0.75	0.45	0.30	0.18	-1.94	-1.78	-5.74	-1.86	2.20
Q_{50}	0.36	0.62	0.40	0.25	0.16	-1.94	-1.78	-5.74	-1.86	4.70
Q_{75}	0.30	0.52	0.36	0.21	0.13	-1.94	-1.78	-5.74	-1.86	5.30
Q_{90}	0.26	0.44	0.34	0.18	0.12	-1.94	-1.78	-5.74	-1.86	3.98
Q_{98}	0.21	0.37	0.31	0.15	0.10	-1.94	-1.78	-5.74	-136	2.24
Q_{mean}	0.42	0.73	0.44	0.29	0.18	-1.94	-1.78	-5.74	-136	2.60
March Flows										
Q_{02}	0.70	1.23	0.62	0.48	0.28	-1.94	-1.78	-5.74	-136	0.00
Q_{10}	0.53	0.92	0.51	0.36	0.22	-1.94	-1.78	-5.74	-136	0.00
Q_{25}	0.45	0.79	0.46	0.31	0.19	-1.94	-1.78	-5.74	-136	0.00
Q_{50}	0.40	0.69	0.43	0.27	0.17	-1.94	-1.78	-5.74	-136	0.00
Q_{75}	0.35	0.60	0.40	0.24	0.15	-1.94	-1.78	-5.74	-136	0.90
Q_{90}	0.32	0.55	0.38	0.22	0.14	-1.94	-1.78	-5.74	-1.86	0.80
Q_{98}	0.25	0.43	0.33	0.18	0.12	-1.94	-1.78	-5.74	-1.86	1.45
Q_{mean}	0.44	0.76	0.45	0.30	0.18	-1.94	-1.78	-5.74	-1.86	0.60
April Flows										
Q_{02}	0.70	1.23	0.62	0.48	0.28	-1.94	-1.78	-5.74	-136	0.00
Q_{10}	0.53	0.92	0.51	0.36	0.22	-1.94	-1.78	-5.74	-1.86	0.00
Q_{25}	0.47	0.82	0.47	0.32	0.19	-1.94	-1.78	-5.74	-1.86	0.00
Q_{50}	0.41	0.71	0.44	0.28	0.17	-1.94	-1.78	-5.74	-136	0.20
Q_{75}	0.36	0.62	0.40	0.25	0.16	-1.94	-1.78	-5.74	-136	0.30
Q_{90}	0.33	0.58	0.39	0.23	0.15	-1.94	-1.78	-5.74	-1.86	0.40
Q_{98}	0.26	0.46	0.34	0.19	0.12	-1.94	-1.78	-5.74	-136	0.50
Q_{mean}	0.45	0.78	0.46	0.31	0.19	-1.94	-1.78	-5.74	-136	0.20
May Flows										
Q_{02}	0.70	1.23	0.62	0.48	0.28	-1.94	-1.78	-5.74	-136	0.00
Q_{10}	0.50	0.88	0.50	0.34	0.21	-1.94	-1.78	-5.74	-136	0.00
Q_{25}	0.42	0.73	0.44	0.29	0.18	-1.94	-1.78	-5.74	-1.86	0.40
Q_{50}	0.38	0.65	0.42	0.26	0.16	-1.94	-1.78	-5.74	-1.86	0.60
Q_{75}	0.35	0.60	0.40	0.24	0.15	-1.94	-1.78	-5.74	-1.86	0.60
Q_{90}	0.33	0.57	0.38	0.23	0.14	-1.94	-1.78	-5.74	-1.86	0.80
Q_{98}	0.26	0.44	0.34	0.18	0.12	-1.94	-1.78	-5.74	-1.86	0.90
Q_{mean}	0.42	0.74	0.45	0.29	0.18	-1.94	-1.78	-5.74	-1.86	0.50
June Flows										
Q_{02}	0.70	1.23	0.62	0.48	0.28	-1.94	-1.78	-5.74	-1.86	0.00
Q_{10}	0.50	0.88	0.50	0.34	0.21	-1.94	-1.78	-5.74	-1.86	0.00
Q_{25}	0.41	0.72	0.44	0.28	0.17	-1.94	-1.78	-5.74	-136	1.30
Q_{50}	0.36	0.62	0.40	0.25	0.16	-1.94	-1.78	-5.74	-1.86	2.80
Q_{75}	0.33	0.57	0.39	0.23	0.15	-1.94	-1.78	-5.74	-1.86	2.60
Q_{90}	0.31	0.53	0.37	0.21	0.14	-1.94	-1.78	-5.74	-1.86	2.00
Q_{98}	0.25	0.43	0.33	0.18	0.12	-1.94	-1.78	-5.74	-136	1.10
Q_{mean}	0.41	0.71	0.44	0.28	0.17	-1.94	-1.78	-5.74	-1.86	1.20

Appendix B. Continued

Flow Type	Location (41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)	(50)
July Flows										
Q_{02}	0.57	1.01	0.54	0.39	0.23	-1.94	-1.78	-5.74	-1.86	0.00
Q_{10}	0.44	0.76	0.45	0.30	0.18	-1.94	-1.78	-5.74	-1.86	1.80
Q_{25}	0.37	0.64	0.41	0.26	0.16	-1.94	-1.78	-5.74	-136	4.00
Q_{50}	0.34	0.59	0.39	0.23	0.15	-1.94	-1.78	-5.74	-136	5.40
Q_{75}	0.29	0.51	0.36	0.21	0.13	-1.94	-1.78	-5.74	-136	4.60
Q_{90}	0.26	0.45	0.34	0.18	0.12	-1.94	-1.78	-5.74	-1.86	3.40
Q_{98}	0.20	0.34	030	0.14	0.10	-1.94	-1.78	-5.74	-136	1.73
Q_{mean}	0.38	0.65	0.42	0.26	0.16	-1.94	-1.78	-5.74	-1.86	3.90
August Flows										
Q_{02}	0.53	0.92	0.51	0.36	0.22	-1.94	-1.78	-5.74	-1.86	0.00
Q_{10}	0.39	0.68	0.42	0.27	0.17	-1.94	-1.78	-5.74	-1.86	9.70
Q_{25}	0.33	0.57	0.39	0.23	0.15	-1.94	-1.78	-5.74	-1.86	10.10
Q_{50}	0.29	0.50	0.36	0.20	0.13	-1.94	-1.78	-5.74	-1.86	7.10
O_{75}	0.26	0.45	0.34	0.18	0.12	-1.94	-1.78	-5.74	-1.86	5.25
Q_{90}	0.23	0.39	0.32	0.16	0.11	-1.94	-1.78	-5.74	-1.86	3.60
Q_{98}	0.16	0.27	0.28	0.12	0.08	-1.94	-1.78	-5.74	-1.86	1.71
Q_{mean}	0.35	0.61	0.40	0.25	0.15	-1.94	-1.78	-5.74	-1.86	6.90
September Flows										
Q_{02}	0.47	0.83	0.48	0.33	0.20	-1.94	-1.78	-5.74	-1.86	0.00
Q_{10}	0.35	0.61	0.40	0.24	0.15	-1.94	-1.78	-5.74	-1.86	12.40
Q_{25}	0.29	0.51	0.36	0.21	0.13	-1.94	-1.78	-5.74	-1.86	1230
Q_{50}	0.26	0.45	0.34	0.18	0.12	-1.94	-1.78	-5.74	-1.86	11.60
Q_{75}	0.23	0.40	0.32	0.16	0.11	-1.94	-1.78	-5.74	-1.86	834
Q_{90}	0.20	0.34	0.30	0.14	0.10	-1.94	-1.78	-5.74	-1.86	4.71
Q_{98}	0.12	0.20	0.25	0.09	0.07	-1.94	-1.78	-5.74	-1.86	1.63
Q_{mean}	0.33	0.57	0.38	0.23	0.14	-1.94	-1.78	-5.74	-1.86	9.60
October Flows										
Q_{02}	0.49	0.86	0.49	0.34	0.20	-1.94	-1.78	-5.74	-1.86	0.00
Q_{10}	0.38	0.65	0.42	0.26	0.16	-1.94	-1.78	-5.74	-1.86	5.10
Q_{25}	0.32	0.56	0.38	0.22	0.14	-1.94	-1.78	-5.74	-1.86	9.90
Q_{50}	0.26	0.45	0.34	0.18	0.12	-1.94	-1.78	-5.74	-1.86	11.10
Q_{75}	0.23	0.39	0.32	0.16	0.11	-1.94	-1.78	-5.74	-1.86	9.20
Q_{90}	0.18	0.31	0.29	0.13	0.09	-1.94	-1.78	-5.74	-1.86	5.20
Q_{98}	0.11	0.19	0.24	0.09	0.07	-1.94	-1.78	-5.74	-1.86	1.54
Q_{mean}	0.34	0.59	0.39	0.23	0.15	-1.94	-1.78	-5.74	-1.86	7.90
November Flows										
Q_{02}	0.52	0.90	0.51	0.36	0.21	-1.94	-1.78	-5.74	-1.86	0.00
Q_{10}	0.40	0.69	0.43	0.27	0.17	-1.94	-1.78	-5.74	-1.86	4.50
Q_{25}	0.34	0.59	0.39	0.24	0.15	-1.94	-1.78	-5.74	-1.86	8.60
Q_{50}	0.29	0.50	0.36	0.20	0.13	-1.94	-1.78	-5.74	-1.86	9.40
Q_{75}	0.25	0.42	0.33	0.17	0.12	-1.94	-1.78	-5.74	-1.86	6.10
Q_{90}	0.20	0.34	0.30	0.14	0.10	-1.94	-1.78	-5.74	-1.86	4.09
Q_{98}	0.12	0.20	0.25	0.09	0.07	-1.94	-1.78	-5.74	-1.86	1.42
Q_{mean}	0.34	0.59	0.39	0.23	0.15	-1.94	-1.78	-5.74	-1.86	6.10
December Flows										
Q_{02}	0.62	1.09	0.57	0.42	0.25	-1.94	-1.78	-5.74	-1.86	0.00
Q_{10}	0.44	0.76	0.45	0.30	0.18	-1.94	-1.78	-5.74	-1.86	0.00
Q_{25}	0.36	0.62	.0.40	0.25	0.16	-1.94	-1.78	-5.74	-1.86	4.30
Q_{50}	0.31	0.54	0.37	0.22	0.14	-1.94	-1.78	-5.74	-1.86	6.60
Q_{75}	0.26	0.44	0.34	0.18	0.12	-1.94	-1.78	-5.74	-1.86	4.90
Q_{90}	0.21	0.36	0.31	0.15	0.10	-1.94	-1.78	-5.74	-1.86	2.45
Q_{98}	0.15	0.26	0.27	0.11	0.08	-1.94	-1.78	-5.74	-1.86	1.33
Q_{mean}	0.36	0.63	0.41	0.25	0.16	-1.94	-1.78	-5.74	-1.86	4.30

Appendix B. Continued

Flow Type	Location (51)	(52)	(53)	(54)	(55)	(56)
Q_{01}	-1-21	-0.83	-0.83	-0.70	1.91	-20.0
Q_{02}	-1.21	-0.83	-0.83	-0.70	1.72	-20.0
Q_{05}	-1.21	-0.83	-0.83	-0.70	1.51	-20.0
Q_{10}	-1.21	-0.83	-0.83	-0.70	1.38	-20.0
Q_{15}	-1.21	-0.83	-0.83	-0.70	1.29	-20.0
Q_{25}	-1.21	-0.83	-0.83	-0.70	1.19	-20.0
Q_{40}	-1.21	-0.83	-0.83	-0.70	1.10	-20.0
Q_{50}	-1.21	-0.83	-0.83	-0.70	1.05	-20.0
Q_{60}	-1.21	-0.83	-0.83	-0.70	1.01	-20.0
Q_{75}	-1.21	-0.83	-0.83	-0.70	0.91	-25.0
Q_{85}	-1.21	-0.83	-0.83	-0.70	0.85	-30.0
Q_{90}	-1.21	-0.83	-0.83	-0.70	0.79	-35.0
Q_{95}	-1.21	-0.83	-0.83	-0.70	0.71	-35.0
Q_{98}	-1.21	-0.83	-0.83	-0.70	0.60	-34.0
Q_{99}	-1.21	-0.83	-0.83	-0.70	0.50	-29.0
Q_{mean}	-1.21	-0.83	-0.83	-0.70	1.27	-28.0
Low Flows						
$Q_{1,2}$	-1.21	-0.83	-0.83	-0.70	0.52	-30.0
$Q_{1,10}$	-1.21	-0.83	-0.83	-0.70	0.45	-30.0
$Q_{1,25}$	-1.21	-0.83	-0.83	-0.70	0.44	-30.0
$Q_{1,50}$	-1.21	-0.83	-0.83	-0.70	0.43	-30.0
$Q_{7,2}$	-1.21	-0.83	-0.83	-0.70	0.78	-30.0
$Q_{7,10}$	-1.21	-0.83	-0.83	-0.70	0.50	-30.0
$Q_{7,25}$	-1.21	-0.83	-0.83	-0.70	0.48	-30.0
$Q_{7,50}$	-1.21	-0.83	-0.83	-0.70	0.48	-30.0
$Q_{15,2}$	-1.21	-0.83	-0.83	-0.70	0.80	-30.0
$Q_{15,10}$	-1.21	-0.83	-0.83	-0.70	0.59	-30.0
$Q_{15,25}$	-1.21	-0.83	-0.83	-0.70	0.53	-30.0
$Q_{15,50}$	-1.21	-0.83	-0.83	-0.70	0.53	-30.0
$Q_{31,2}$	-1.21	-0.83	-0.83	-0.70	0.83	-30.0
$Q_{31,10}$	-1.21	-0.83	-0.83	-0.70	0.62	-30.0
$Q_{31,25}$	-1.21	-0.83	-0.83	-0.70	0.54	-30.0
$Q_{31,50}$	-1.21	-0.83	-0.83	-0.70	0.53	-30.0
$Q_{61,2}$	-1.21	-0.83	-0.83	-0.70	0.87	-30.0
$Q_{61,10}$	-1.21	-0.83	-0.83	-0.70	0.68	-30.0
$Q_{61,25}$	-1.21	-0.83	-0.83	-0.70	0.59	-30.0
$Q_{61,50}$	-1.21	-0.83	-0.83	-0.70	0.56	-30.0
$Q_{91,2}$	-1.21	-0.83	-0.83	-0.70	0.91	-30.0
$Q_{91,10}$	-1.21	-0.83	-0.83	-0.70	0.73	-30.0
$Q_{91,25}$	-1.21	-0.83	-0.83	-0.70	0.63	-30.0
$Q_{91,50}$	-1.21	-0.83	-0.83	-0.70	0.61	-30.0
Drought Flows						
$Q_{6,10}$	-1.21	-0.83	-0.83	-0.70	0.85	-35.0
$Q_{6,25}$	-1.21	-0.83	-0.83	-0.70	0.78	-35.0
$Q_{6,50}$	-1.21	-0.83	-0.83	-0.70	0.74	-35.0
$Q_{9,10}$	-1.21	-0.83	-0.83	-0.70	0.94	-30.0
$Q_{9,25}$	-1.21	-0.83	-0.83	-0.70	0.88	-30.0
$Q_{9,50}$	-1.21	-0.83	-0.83	-0.70	0.84	-30.0
$Q_{12,10}$	-1.21	-0.83	-0.83	-0.70	1.03	-28.0
$Q_{12,25}$	-1.21	-083	-0.83	-0.70	0.96	-28.0
$Q_{12,50}$	-1.21	-0.83	-0.83	-0.70	0.91	-28.0
$Q_{18,10}$	-1.21	-0.83	-0.83	-0.70	1.06	-28.0
$Q_{18,25}$	-1.21	-0.83	-0.83	-0.70	1.00	-28.0
$Q_{18,50}$	-1.21	-0.83	-0.83	-0.70	0.94	-28.0
$Q_{30,10}$	-1.21	-0.83	-0.83	-0.70	1.11	-28.0
$Q_{30,25}$	-1.21	-0.83	-0.83	-0.70	1.04	-28.0
$Q_{30,50}$	-1.21	-0.83	-0.83	-0.70	1.00	-28.0

Appendix B. Continued

Flow Type	Location (51)	(52)	(53)	(54)	(55)	(56)
Drought Flows-Cont						
$Q_{54,10}$	-1.21	-0.83	-0.83	-0.70	1.18	-28.0
$Q_{54,25}$	-1.21	-0.83	-0.83	-0.70	1.08	-28.0
$Q_{54,50}$	-1.21	-0.83	-0.83	-0.70	1.04	-28.0
January Flows						
Q_{02}	-1.21	-0.83	-0.83	-0.70	1.78	-20.0
Q_{10}	-1.21	-0.83	-0.83	-0.70	1.38	-20.0
Q_{25}	-1.21	-0.83	-0.83	-0.70	1.19	-20.0
Q_{50}	-1.21	-0.83	-0.83	-0.70	1.05	-20.0
Q_{75}	-1.21	-0.83	-0.83	-0.70	0.91	-20.0
Q_{90}	-1.21	-0.83	-0.83	-0.70	0.79	-20.0
Q_{98}	-1.21	-0.83	-0.83	-0.70	0.68	-20.0
Q_{mean}	-1.21	-0.83	-0.83	-0.70	1.29	-20.0
February flows						
Q_{02}	-1.21	-0.83	-0.83	-0.70	1.85	-20.0
Q_{10}	-1.21	-0.83	-0.83	-0.70	1.44	-20.0
Q_{25}	-1.21	-0.83	-0.83	-0.70	1.27	-20 0
Q_{50}	-1.21	-0.83	-0.83	-0.70	1.10	-20.0
Q_{75}	-1.21	-0.83	-0.83	-0.70	0.96	-20.0
Q_{90}	-1.21	-0.83	-0.83	-0.70	0.86	-20.0
Q_{98}	-1.21	-0.83	-0.83	-0.70	0.76	-20.0
Q_{mean}	-1.21	-0.83	-0.83	-0.70	1.34	-20.0
March Flows						
Q_{02}	-1.21	-0.83	-0.83	-0.70	1.91	-20.0
Q_{10}	-1.21	-0.83	-0.83	-0.70	1.51	-20.0
Q_{25}	-1.21	-0.83	-0.83	-0.70	1.32	-20.0
Q_{50}	-1.21	-0.83	-0.83	-0.70	1.19	-20.0
Q_{75}	-1.21	-0.83	-0.83	-0.70	1.08	-20.0
Q_{90}	-1.21	-0.83	-0.83	-0.70	1.01	-20.0
Q_{98}	-1.21	-0.83	-0.83	-0.70	0.85	-20 0
Q_{mean}	-1-21	-0.83	-0.83	-0.70	1.39	-20.0
April Flows						
Q_{02}	-1.21	-0.83	-0.83	-0.70	1.91	-20.0
Q_{10}	-1.21	-0.83	-0.83	-0.70	1.51	-20.0
Q_{25}	-1.21	-0.83	-0.83	-0.70	1.36	-20.0
Q_{50}	-1.21	-0.83	-0.83	-0.70	1.22	-20.0
Q_{75}	-1-21	-0.83	-0.83	-0.70	1.10	-20.0
Q_{90}	-1.21	-0.83	-0.83	-0.70	1.04	-20.0
Q_{98}	-1.21	-0.83	-0.83	-0.70	0.88	-20.0
Q_{mean}	-1.21	-0.83	-0.83	-0.70	1.42	-20.0
May Flows						
Q_{02}	-1.21	-0.83	-0.83	-0.70	1.91	-35.0
Q_{10}	-1.21	-0.83	-0.83	-0.70	1.44	-35.0
Q_{25}	-1.21	-0.83	-0.83	-0.70	1.25	-35.0
Q_{50}	-1.21	-0.83	-0.83	-0.70	1.15	-35.0
Q_{75}	-1.21	-0.83	-0.83	-0.70	1.08	-35.0
Q_{90}	-1.21	-0.83	-0.83	-0.70	1.03	-35.0
Q_{98}	-1.21	-0.83	-0.83	-0.70	0.86	-35.0
Q_{mean}	-121	-0.83	-0.83	-0.70	1.36	-35.0
June Flows						
Q_{02}	-1.21	-0.83	-0.83	-0.70	1.91	-40.0
Q_{10}	-1.21	-0.83	-0.83	-0.70	1.44	-40.0
Q_{25}	-1.21	-0.83	-0.83	-0.70	1.23	-40.0
Q_{50}	-1.21	-0.83	-0.83	-0.70	1.10	-40.0
Q_{75}	-1.21	-0.83	-0.83	-0.70	1.04	-40.0
Q_{90}	-1.21	-0.83	-0.83	-0.70	0.98	-40.0
Q_{98}	-1.21	-0.83	-0.83	-0.70	0.85	-40.0
Q_{mean}	-1.21	-0.83	-0.83	-0.70	1.32	-40.0

Appendix B. Concluded

Flow Type	Location (51)	(52)	(53)	(54)	(55)	(56)
July Flows						
Q_{02}	-1.21	-0.83	-0.83	-0.70	1.61	-45.0
Q_{10}	-1.21	-0.83	-0.83	-0.70	1.29	-45.0
Q_{25}	-1.21	-0.83	-0.83	-0.70	1.13	-45.0
Q_{50}	-1.21	-0.83	-0.83	-0.70	1.05	-45.0
Q_{75}	-1.21	-0.83	-0.83	-0.70	0.95	-45.0
Q_{90}	-1.21	-0.83	-0.83	-0.70	0.88	-45.0
Q_{98}	-1.21	-0.83	-0.83	-0.70	0.73	-45.0
Q_{mean}	-1.21	-0.83	-0.83	-0.70	1.27	-45.0
August Flows						
Q_{02}	-1.21	-0.83	-0.83	-0.70	1.51	-40.0
Q_{10}	-1.21	-0.83	-0.83	-0.70	1.18	-40.0
Q_{25}	-1.21	-0.83	-0.83	-0.70	1.04	-40.0
Q_{50}	-1.21	-0.83	-0.83	-0.70	0.94	-40.0
Q_{75}	-1.21	-0.83	-0.83	-0.70	0.87	-40.0
Q_{90}	-1.21	-0.83	-0.83	-0.70	0.79	-40.0
Q_{98}	-1.21	-0.83	-0.83	-0.70	0.63	-40.0
Q_{mean}	-1.21	-0.83	-0.83	-0.70	1.19	-40.0
September Flows						
Q_{02}	-1.21	-0.83	-0.83	-0.70	1.38	-40.0
Q_{10}	-1.21	-0.83	-0.83	-0.70	1.09	-40.0
Q_{25}	-1.21	-0.83	-0.83	-0.70	0.95	-40.0
Q_{50}	-1.21	-0.83	-0.83	-0.70	0.88	-40.0
Q_{75}	-1.21	-0.83	-0.83	-0.70	0.80	-40.0
Q_{90}	-1.21	-0.83	-0.83	-0.70	0.73	-40.0
Q_{98}	-1.21	-0.83	-0.83	-0.70	0.54	-40.0
Q_{mean}	-1.21	-0.83	-0.83	-0.70	1.13	-40.0
October Flows						
Q_{02}	-1.21	-0.83	-0.83	-0.70	1.42	-20.0
Q_{10}	-1.21	-0.83	-0.83	-0.70	1.15	-20.0
Q_{25}	-1.21	-0.83	-0.83	-0.70	1.02	-20.0
Q_{50}	-1.21	-0.83	-0.83	-0.70	0.88	-20.0
Q_{75}	-1.21	-0.83	-0.83	-0.70	0.79	-20.0
Q_{90}	-1.21	-0.83	-0.83	-0.70	0.68	-20.0
Q_{98}	-1.21	-0.83	-0.83	-0.70	0.52	-20.0
Q_{mean}	-1.21	-0.83	-0.83	-0.70	1.15	-20.0
November Flows						
Q_{02}	-1.21	-0.83	-0.83	-0.70	1.48	-20.0
Q_{10}	-1.21	-0.83	-0.83	-0.70	1.19	-20.0
Q_{25}	-1.21	-0.83	-0.83	-0.70	1.06	-20.0
Q_{50}	-1.21	-0.83	-0.83	-0.70	0.94	-20.0
Q_{75}	-1.21	-0.83	-0.83	-0.70	0.84	-20.0
Q_{90}	-1.21	-0.83	-0.83	-0.70	0.73	-20.0
Q_{98}	-1.21	-0.83	-0.83	-0.70	0.54	-20.0
Q_{mean}	-1.21	-0.83	-0.83	-0.70	1.15	-20.0
December Flows						
Q_{02}	-1.21	-0.83	-0.83	-0.70	1.72	-20.0
Q_{10}	-1.21	-0.83	-0.83	-0.70	1.29	-20.0
Q_{25}	-1.21	-0.83	-0.83	-0.70	1.10	-20.0
Q_{50}	-1.21	-0.83	-0.83	-0.70	0.99	-20.0
Q_{75}	-1.21	-0.83	-0.83	-0.70	0.86	-20.0
Q_{90}	-1.21	-0.83	-0.83	-0.70	0.76	-20.0
Q_{98}	-1.21	-0.83	-0.83	-0.70	0.61	-20.0
Q_{mean}	-1.21	-0.83	-0.83	-0.70	1.22	-20.0

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

DA(u) = Drainage area upstream of location (sq mi)
DA(d) = Drainage area downstream of location (sq mi)
K = Average subsoil permeability (in/hr)
P-ET = Net excess precipitation for the watershed (in)

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/Mt. Vernon Hill Country

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Kaskaskia River	300.80	2.9	2.9	0.77	10.45	0	1	
(E)	297.80	13.7	13.7	0.77	10.45	6	1	USGS Gage 05590000 Bondville
	297.30	13.7	13.7	0.77	10.45	2	1	Douglas Water Co. Supply Wells
	294.90	19.7	35.2	0.73	10.49	6	1	Copper Slough (EZ)
	292.30	38.5	46.0	0.72	10.50	0	1	
	286.40	59.1	59.1	0.71	10.51	0	1	At Sadorus
	283.20	64.2	64.2	0.70	10.51	0	1	
	279.70	71.3	107.5	0.65	10.55	1	1	Twomile Slough (EY)
	276.00	119.8	119.8	0.64	10.56	0	1	
	273.10	124.0	124.0	0.63	10.56	6	1	Douglas Water Co. Withdrawal
	272.20	125.8	125.8	0.63	10.56	0	1	US HWY 36 (near Tuscola)
	267.20	135.0	155.6	0.61	10.57	1	1	Dry Fork (EX2)
	265.20	155.6	325.2	0.57	10.50	1	1	Lake Fork (EX)
	264.80	326.6	344.6	0.57	10.50	1	1	West Fork (EW9)
	262.40	353.3	353.3	0.57	10.50	0	1	ILRT 133 at Chesterville
	258.00	368.0	395.1	0.56	10.52	1	1	Kaskaskia Tributary EW5
	250.10	410.8	410.8	0.56	10.53	0	1	
	248.50	412.0	454.0	0.56	10.54	1	1	Flat Branch (EW)
	244.80	466.3	466.3	0.56	10.55	6	1	USGS Gage 05591200 Cooks Mills
	241.80	477.3	477.3	0.56	10.55	0	1	
	234.60	493.1	493.1	0.56	10.56	0	1	
	231.10	497.7	497.7	0.56	10.56	0	1	IL RT 121 at Allenville
	229.30	506.8	563.9	0.56	10.56	1	1	Jonathon Creek (EV)
	226.90	566.9	582.5	0.56	10.56	1	1	Asa Creek (EU8)
	223.50	588.2	642.9	0.55	10.58	1	1	Whitley Creek (EU5)
	21711	665.6	665.6	0.55	10.58	0	1	Above West Okaw River
	217.10	665.6	953.4	0.54	10.48	1	1	West Okaw River (EU)
	214.90	963.4	972.6	0.54	10.48	0	1	At Wolf Creek
	210.90	981.7	1013.1	0.54	10.48	1	1	Sand Creek (ET4)
	206.50	1032.4	1040.3	0.54	10.48	0	1	
	205.10	1043.4	1043.4	0.54	10.48	9	1	Shelbyville Reservoir
	204.70	1043.4	1043.4	0.54	10.48	6	2	USGS Gage 05592000 Shelbyville
	196.20	1052.6	1175.0	0.55	10.45	1	2	Robinson Creek (ES)
	189.40	1182.7	1208.1	0.55	10.45	1	2	Jordan Creek (ER6)
	186.90	1212.7	1219.0	0.55	10.45	0	2	
	179.80	1230.2	1315.3	0.55	10.46	1	2	Richland Creek (ER)
	179.10	1315.7	1315.7	0.55	10.46	6	2	USGS Gage 05592100 Cowden
	168.60	1333.8	1342.9	0.55	10.46	1	2	At Hog Creek
	165.60	1347.6	1547.9	0.54	10.42	1	2	Becks Creek (EQ)
	159.70	1557.9	1696.5	0.54	10.44	1	2	Big Creek-Wolf Creek (EP)
	157.10	1703.0	1707.5	0.54	10.44	0	2	At Peppermill Ditch
	155.60	1707.9	1737.7	0.54	10.43	1	2	Ash Creek (E06)
	153.20	1739.1	1752.8	0.54	10.43	1	2	Suck Creek (E04)
	150.70	1761.5	1761.5	0.54	10.43	0	2	
	148.40	1767.8	1871.6	0.54	10.41	1	2	Ramsey Creek (EO)
	146.10	1872.7	1884.9	0.54	10.41	1	2	Hoffman Creek (EN8)
	140.70	1888.6	1918.6	0.54	10.41	1	2	Bear Creek (EN5)
	139.90	1918.8	1918.8	0.54	10.41	2	2	Vandalia Discharge
	138.80	1921.0	1921.0	0.54	10.41	6	2	USGS Gage 05592500 Vandalia

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Kaskaskia River	132.80	1921.2	2066.6	0.53	10.42	1	2	Hickory Creek (EN)
	132.00	2066.6	2081.2	0.53	10.42	1	2	Richland Creek (EM9)
	125.70	21021	2102.1	0.53	10.42	0	2	
	117.00	2105.6	2155.1	0.53	10.42	1	2	Wildcat Ditch (EL4)
	11310	2160.6	2356.9	0.52	10.42	1	2	Hurricane Creek (EL)
	106.90	2369.5	2382.6	0.52	10.42	1	2	Spring Branch (EK1)
	106.80	2382.6	2584.9	0.51	10.44	1	2	East Fork Kaskaskia River (EK)
	105.60	2604.0	2604.0	0.51	10.44	0	2	Burlington Northern RR
	104.00	2620.5	2620.5	0.51	10.44	0	2	
	99.90	2651.5	2668.7	0.50	10.44	1	2	Coles Creek (EJ5)
	95.20	2690.7	2690.7	0.50	10.44	9	2	Cariyle Reservoir
	95.10	2690.7	2690.7	0.50	10.44	6	2	USGS Gage 05593000 Carlyle
	94.30	2693.4	2693.4	0.50	10.44	2	2	Cariyle Discharge
	88.80	2703.5	2703.5	0.50	10.44	0	2	ILRT 127
	84.90	2712.7	2712.7	0.50	10.44	0	2	IL RT 161 near Posey
	77.31	2726.5	2726.5	0.50	10.44	0	2	Above Crooked Creek
	77.30	2726.5	3194.8	0.49	10.45	1	2	Crooked Creek (EI)
	64.90	3227.6	3242.6	0.49	10.48	1	2	Plum Creek (EH2)
	62.41	3245.0	3245.0	0.49	10.48	0	2	Above Shoal Creek
	62.40	3245.0	4151.5	0.50	10.32	1	2	Shoal Creek (EH)
	60.00	4154.7	4330.2	0.50	10.31	1	2	Sugar Creek (EG)
	57.40	4331.4	4331.4	0.50	10.31	6	2	USGS Gage 0559410 Venedy Station
	5410	4350.6	4350.6	0.50	10.31	0	2	
	48.40	4367.3	4454.4	0.50	10.31	1	2	Elkhorn Creek (EF)
	39.40	4470.8	4495.8	0.50	10.31	1	2	Jackson Slough-Rayhill Slough (EE4)
	34.20	4501.8	4632.7	0.51	10.31	1	2	Mud Creek (EE)
	31.40	4653.0	4653.0	0.51	10.31	0	2	
	29.80	4654.5	5125.5	0.54	10.26	1	2	Silver Creek (ED)
	28.40	5126.0	5126.0	0.54	10.26	6	2	USGS Gage 0559500 New Athens
	28.20	5126.0	5126.0	0.54	10.26	2	2	New Athens Discharge
	22.00	5155.7	5400.2	0.55	10.25	1	2	Richland Creek (EC)
	20.60	5401.6	5444.5	0.55	10.25	1	2	Doza Creek (EB8)
	20.20	5444.6	5444.6	0.55	10.25	2	2	Baldwin Lake (net withdrawal)
	18.60	5453.6	5453.6	0.55	10.25	0	2	ILRT13
	1310	5468.9	5557.9	0.56	10.25	1	2	Plum Creek (EB2)
	11.60	5561.8	56541	0.56	10.25	1	2	Horse Creek (EB)
	9.00	5659.7	5671.9	0.56	10.25	1	2	Camp Creek (EA8)
	4.60	5680.0	57241	0.56	10.25	1	2	Ninemile Creek (EA4)
	0.70	5738.0	5738.0	0.56	10.25	6	2	Kaskaskia Lock and Dam
	0.00	5738.0	5738.0	0.56	10.25	0	2	At mouth
Ninemile Creek	12.20	5.9	9.1	1.01	10.45	0	2	
(EA4)	10.00	12.8	16.2	1.03	10.45	0	2	
	5.50	23.5	32.2	1.07	10.42	0	2	
	4.50	32.5	39.7	1.09	10.42	0	2	ILRT 3
	0.00	44.1	441	1.09	10.41	0	2	At mouth near Ellis Grove
Camp Creek	4.70	5.7	5.7	1.05	10.25	0	2	
(EA8)	0.00	12.2	12.2	1.05	10.25	0	2	At mouth near Evansville
Horse Creek	27.00	9.4	9.4	0.94	10.05	0	2	
(EB)	20.80	18.9	18.9	0.94	10.05	0	2	
	19.71	22.7	22.7	0.94	10.05	0	2	
	19.70	22.7	46.9	1.01	10.08	1	2	Dry Fork (EBR)
	12.10	54.7	60.5	0.99	1011	0	2	
	9.80	66.0	66.0	0.98	10.12	0	2	IL RT 3
	7.80	72.5	72.5	0.97	1012	0	2	
	6.10	73.4	82.7	0.95	1014	0	2	
	0.00	92.3	92.3	0.93	1015	0	2	At mouth at Evansville
Dry Fork	0.30	18.8	24.1	1.08	1011	0	2	
(EBR)	0.00	24.2	24.2	1.08	1011	0	2	
Plum Creek	28.10	4.3	5.6	0.79	10.45	0	2	
(EB2)	27.60	5.7	12.3	0.79	10.45	0	2	
	26.20	13.0	13.0	0.79	10.45	0	2	IL RT 4 (north of Sparta)
	24.40	19.4	19.4	0.79	10.45	0	2	
	20.40	29.8	38.2	0.79	10.45	0	2	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Plum Creek	19.70	38.7	38.7	0.79	10.45	0	2	IL RT 154 (west of Sparta)
	18.00	42.2	42.2	0.79	10.45	0	2	
	14.30	45.9	54.6	0.78	10.43	0	2	
	11.10	61.3	61.3	0.77	10.42	0	2	
	4.90	64.7	82.6	0.77	10.41	1	2	Little Plum Creek (EB2E)
	0.00	89.0	89.0	0.77	10.41	0	2	At mouth near Evansville
Little Plum Creek	2.70	8.5	13.5	0.74	10.40	0	2	
(EB2E)	0.00	17.9	17.9	0.74	10.40	0	2	
Doza Creek	16.80	6.7	6.7	0.41	10.30	2	2	Marissa Discharge
(EB8)	13.00	11.8	17.3	0.41	10.30	0	2	Illinois Central RR
	11.30	18.9	26.6	0.41	10.30	0	2	
	11.00	26.8	36.3	0.41	10.30	0	2	
	8.80	37.1	371	0.41	10.30	0	2	USGS Gage 05595230
	0.00	42.9	42.9	0.41	10.29	0	2	At mouth near Lake Baldwin
Richland Creek	36.30	7.9	7.9	1.20	9.85	0	2	
(EC)	32.40	16.2	18.2	1.20	9.85	2	2	Swansea Discharge
	31.30	18.6	18.6	1.20	9.86	0	2	
	30.70	19.8	19.8	1.20	9.86	0	2	ILRT 159
	30.10	26.2	26.2	1.19	9.87	2	2	Belleville Discharge #1
	29.40	26.5	26.5	1.19	9.87	0	2	US HWY 460
	27.20	37.2	37.2	1.17	9.88	0	2	
	22.60	55.3	74.7	1.12	9.90	1	2	Douglas Creek (ECP)
	2210	74.8	80.0	1.12	9.91	1	2	Richland Creek Tributary ECO
	18.31	94.3	94.3	1.10	9.93	0	2	
	18.30	94.3	121.2	1.07	9.93	1	2	West Fork Richland Creek (ECM)
	17.30	126.6	126.6	1.05	9.94	0	2	USGS Gage 05595200 Hecker
	8.90	140.4	218.9	0.99	9.98	1	2	Prairie DuLong Cr (ECG)
	7.00	220.4	240.0	0.96	9.99	1	2	Black Creek (ECE)
	0.00	244.5	244.5	0.96	9.99	0	2	
Black Creek	2.10	5.3	11.3	0.68	10.15	0	2	
(ECE)	2.00	11.3	17.6	0.68	10.15	1	2	Black Creek tributary ECEH
	0.00	19.6	19.6	0.68	10.15	0	2	
Black Creek tributary	3.20	0.5	0.5	0.68	10.15	2	2	Red Bud Discharge
(ECEH)	0.00	6.3	6.3	0.68	1015	0	2	
Prairie DuLong Cr	21.50	8.5	8.5	1.15	9.95	0	2	
(ECG)	14.50	16.2	361	114	9.95	1	2	Gerhardt Creek (ECGP)
	12.90	39.1	42.5	1.10	9.97	0	2	
	7.61	50.4	50.4	1.05	9.98	0	2	IL RT 156
	7.60	50.4	65.0	1.00	10.00	1	2	Rockhouse Creek (ECGI)
	0.00	78.5	78.5	0.95	10.02	0	2	At mouth near Hecker
Rockhouse Creek	7.90	3.0	3.0	0.82	10.05	0	2	IL RT 3
(ECGI)	1.90	10.6	10.6	0.82	10.05	0	2	
	0.00	14.6	14.6	0.82	10.05	0	2	
Gerhardt Creek	2.00	9.5	12.9	113	9.95	0	2	
(ECGP)	0.50	141	19.6	1.13	9.95	0	2	
	0.00	19.9	19.9	1.13	9.95	0	2	
West Fk Richland Cr	14.70	6.1	61	1.08	9.90	0	2	
(ECM)	11.70	8.5	8.5	1.08	9.90	0	2	ILRT 163
	10.60	8.9	12.0	1.08	9.90	0	2	
	8.40	15.7	15.7	1.08	9.90	0	2	USGS Gage 05595190 Floraville
	0.00	26.9	26.9	0.98	9.94	0	2	At mouth near Hecker
Richland Cr tributary	4.30	0.6	0.6	0.71	10.05	2	2	Freeburg (West) Discharge
(ECO)	0.00	5.2	5.2	0.71	10.05	0	2	
Douglas Creek	9.90	1.5	2.7	1.10	9.90	1	2	Douglas Cr Tributary ECPU
(ECP)	5.80	9.4	10.4	1.10	9.90	0	2	
	1.20	18.9	18.9	1.10	9.90	2	2	Smithton Discharge
	0.00	19.4	19.4	1.10	9.90	0	2	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Douglas Cr tributary	1.30	0.2	0.2	1.10	9.90	2	2	Millstadt Discharge
(ECPU)	0.00	1.2	1.2	1.10	9.90	0	2	
Silver Creek	82.40	3.4	81	0.66	9.45	0	2	
(ED)	81.20	10.1	101	0.66	9.45	0	2	Madison-Macoupin County Line
	78.30	15.5	19.8	0.66	9.45	0	2	
	76.50	22.2	32.3	0.64	9.45	1	2	Silver Cr Tributary EDX
	69.60	44.0	55.9	0.67	9.47	1	2	Silver Cr Tributary EDV
	68.70	61.0	61.0	0.67	9.48	0	2	IL RT 140
	65.90	66.2	75.1	0.67	9.50	0	2	
	61.20	85.0	94.4	0.67	9.51	0	2	
	5610	112.1	112.1	0.69	9.53	0	2	IL RT 143
	49.80	117.7	126.6	0.72	9.55	1	2	Silver Cr Tributary EDQ
	47.30	132.8	146.9	0.75	9.57	1	2	Wendell Branch (EDP)
	45.40	150.4	150.4	0.77	9.57	9	2	USGS Gage 05594450 Troy
	43.40	154.0	250.7	0.72	9.64	1	2	East Fork (EDO)
	41.10	2541	264.0	0.73	9.65	1	2	Lake Fork (EDN)
	39.30	267.0	278.8	0.75	9.65	1	2	Mill Creek (EDM)
	38.70	279.0	279.0	0.75	9.65	0	2	St. Clair-Madison County Line
	37.70	281.0	297.0	0.78	9.66	1	2	Ogles Creek (EDL)
	34.00	307.4	318.9	0.80	9.68	1	2	Engle Creek (EDK)
	33.40	319.3	319.3	0.80	9.68	0	2	US HWY 50 at Lebanon
	29.30	323.7	373.6	0.80	9.72	1	2	Little Silver Creek (EDJ)
	25.10	380.0	380.0	0.80	9.72	2	2	Scott AFB Discharge
	20.80	397.5	397.5	0.81	9.73	0	2	IL RT 177 near Mascoutah
	18.40	4011	434.7	0.83	9.75	1	2	Loop Creek (EDG)
	15.90	436.2	442.6	0.83	9.76	1	2	Silver Cr Tributary EDF
	11.90	445.6	451.5	0.84	9.77	0	2	At Heberers Branch
	9.40	453.0	456.6	0.84	9.77	1	2	Jacks Run (EDD)
	8.70	457.4	457.4	0.84	9.77	0	2	USGS Gage 05594800 Freeburg
	0.00	471.0	471.0	0.85	9.78	0	2	At mouth near New Athens
Jack Run	1.70	2.8	2.8	0.85	9.90	2	2	Freeburg (East) Discharge
(EDD)	0.00	3.6	3.6	0.85	9.90	0	2	
Silver Cr Tributary	2.80	1.3	1.3	0.89	10.05	2	2	Mascoutah Discharge
(EDF)	0.00	6.4	6.4	0.89	10.05	0	2	
Loop Creek	8.00	4.5	4.5	1.17	9.95	0	2	IL RT 158
(EDG)	4.70	10.0	161	1.17	9.95	0	2	
	2.70	18.1	181	1.17	9.95	0	2	
	0.60	26.8	33.5	1.13	9.97	0	2	
	0.00	33.6	33.6	1.13	9.97	0	2	
Little Silver Creek	9.70	5.5	7.8	0.81	9.90	0	2	
(EDJ)	5.21	17.9	17.9	0.81	9.90	0	2	
	5.20	17.9	30.5	0.76	9.94	1	2	East Branch (EDJJ)
	3.40	32.7	32.7	0.76	9.96	2	2	Lebanon Discharge
	1.80	35.4	35.4	0.76	9.96	0	2	IL RT 4
	1.60	35.4	43.3	0.77	9.96	0	2	
	0.00	49.9	49.9	0.77	9.97	0	2	At mouth near Lebanon
East Branch	3.10	6.6	9.9	0.69	10.00	0	2	
(EDJJ)	0.00	12.6	12.6	0.69	10.00	0	2	At mouth at Lebanon
Engle Creek	5.40	1.4	1.4	119	9.85	2	2	OTallon Discharge
(EDK)	0.90	7.3	11.2	1.19	9.85	0	2	
	0.00	11.5	11.5	1.19	9.85	0	2	
Ogles Creek	8.70	2.8	2.8	1.18	9.80	2	2	Caseyville Discharge
(EDL)	4.90	9.5	9.5	1.18	9.80	0	2	
	0.00	16.0	16.0	1.18	9.80	0	2	
Mill Creek	4.10	4.5	7.1	1.19	9.75	0	2	
(EDM)	1.70	8.7	10.9	1.19	9.75	0	2	
	0.00	11.8	11.8	1.19	9.75	0	2	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Lake Fork	1.90	5.6	8.7	0.81	9.85	0	2	
(EDN)	0.00	9.9	9.9	0.81	9.85	0	2	
East Fork	26.90	2.0	2.0	0.32	9.75	0	2	IL RT 140
(EDO)	22.61	9.2	9.2	0.32	9.75	0	2	
	22.60	9.2	29.4	0.35	9.75	1	2	Little Silver Creek (EDOU)
	19.60	39.2	39.2	0.40	9.76	0	2	IL RT 160 at Grantfork
	14.51	47.4	47.4	0.44	9.77	3	2	Highland Withdrawal
	14.50	47.4	47.4	0.44	9.77	9	2	Highland Silver Lake Dam
	8.11	57.4	57.4	0.51	9.78	0	2	
	810	57.4	87.8	0.56	9.77	1	2	Sugar Creek (EDOH)
	3.20	93.4	93.4	0.59	9.77	0	2	US HWY 40
	0.00	96.6	96.6	0.61	9.77	0	2	
Sugar Creek	12.70	61	61	0.66	9.75	0	2	
(EDOH)	9.60	10.4	10.4	0.66	9.75	0	2	
	7.20	14.0	21.4	0.66	9.75	0	2	
	510	26.2	26.2	0.66	9.75	0	2	IL RT 143
	0.00	30.4	30.4	0.66	9.75	0	2	
Little Silver Creek	9.50	2.6	2.6	0.36	9.75	0	2	
(EDOU)	4.90	7.6	7.6	0.36	9.75	0	2	IL RT 140
	4.30	7.8	10.6	0.36	9.75	0	2	
	2.50	14.9	14.9	0.36	9.75	0	2	
	0.00	20.2	20.2	0.36	9.75	0	2	
Wendell Branch	4.00	6.3	6.3	1.20	9.70	0	2	
(EDP)	1.90	8.3	12.8	1.20	9.70	1	2	Wendell Br Tributary EDPF
	0.00	14.1	141	1.20	9.70	0	2	
Wendell Br Tributary	2.10	1.7	1.7	1.20	9.70	2	2	Troy Discharge
(EDPF)	0.00	5.3	5.3	1.20	9.70	0	2	
Silver Cr Tributary	3.30	2.2	2.2	0.88	9.75	2	2	Marine Discharge
(EDQ)	0.00	8.9	8.9	0.88	9.75	0	2	
Silver Cr Tributary	5.20	31	3.1	0.69	9.45	2	2	Livingston Discharge
(EDV)	1.70	8.8	8.8	0.69	9.45	0	2	
	0.00	11.9	11.9	0.69	9.45	0	2	
Silver Cr Tributary	1.50	5.6	9.3	0.59	9.45	0	2	
(EDX)	0.00	101	101	0.59	9.45	0	2	
Mud Creek	32.90	3.6	3.6	0.65	10.55	0	2	
(EE)	30.30	9.7	9.7	0.65	10.55	0	2	
	26.70	15.0	15.0	0.65	10.55	0	2	
	24.50	18.2	18.2	0.66	10.54	0	2	IL RT 153 near Coulterville
	23.20	191	28.8	0.72	10.50	0	2	
	20.80	33.2	45.6	0.74	10.49	1	2	South Fork (EEP)
	15.70	60.2	60.2	0.76	10.48	0	2	St Clair-Washington County Line
	13.30	70.6	70.6	0.75	10.47	0	2	USGS Gage 05594330 Marissa
	8.90	81.6	81.6	0.74	10.45	0	2	
	0.40	93.5	130.8	0.60	10.39	1	2	Little Mud Cr (EEA)
	0.00	130.9	130.9	0.60	10.39	0	2	
Little Mud Creek	12.20	4.9	4.9	0.39	10.35	0	2	
(EEA)	9.90	11.5	11.5	0.39	10.35	0	2	
	6.80	18.6	18.6	0.39	10.35	0	2	IL RT 4
	4.00	21.2	28.6	0.44	10.32	0	2	
	0.00	37.3	37.3	0.49	10.30	0	2	At mouth near Fayetteville
South Fork	5.50	6.6	6.6	0.64	10.50	0	2	IL RT 153
(EEP)	0.00	12.4	12.4	0.64	10.50	0	2	
Jackson Slough-	10.70	3.7	3.7	0.64	1015	2	2	New Baden Discharge
Rayhill Slough	7.10	7.7	7.7	0.64	1015	0	2	IL RT 15
(EE4)	4.00	12.4	21.5	0.64	1015	0	2	
	0.00	25.0	25.0	0.64	1015	0	2	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Elkhora Creek	27.20	3.9	3.9	0.33	10.55	0	2	
(EF)	24.80	11.8	11.8	0.33	10.55	0	2	
	19.80	20.6	20.6	0.48	10.53	0	2	
	16.60	27.7	43.4	0.61	10.51	1	2	Williams Creek (EFO)
	12.70	54.2	54.2	0.61	10.50	0	2	IL RT 15
	12.00	62.1	67.4	0.62	10.49	0	2	
	6.80	77.9	77.9	0.62	10.48	0	2	
	0.00	87.1	87.1	0.62	10.46	0	2	
Williams Creek	9.10	1.9	1.9	0.64	10.50	0	2	
(EFO)	4.00	7.1	13.2	0.64	10.50	0	2	
	0.00	15.7	15.7	0.64	10.50	0	2	
Sugar Creek	38.20	6.0	6.0	0.59	9.90	0	2	Interstate HWY 70
(EG)	36.50	10.1	101	0.59	9.90	0	2	IL RT 143
	33.80	14.0	24.8	0.62	9.88	1	2	Sugar Cr Tributary EGV
	29.40	33.6	40.6	0.62	9.91	1	2	Sugar Cr Tributary EGS
	28.80	41.2	49.5	0.62	9.92	0	2	At Buckeye Branch
	23.80	59.0	76.3	0.60	9.95	1	2	Spanker Branch (EGP)
	21.00	79.7	90.1	0.61	9.96	1	2	Sugar Cr Tributary EGN
	18.90	94.5	94.5	0.61	9.96	0	2	US HWY 50
	16.80	96.4	104.3	0.62	9.98	1	2	Sugar Cr Tributary EGL
	10.30	111.6	123.4	0.61	10.00	0	2	
	9.20	124.0	124.0	0.61	10.00	0	2	USGS Gage 05594090 Albers
	8.90	124.0	146.3	0.59	10.02	1	2	Lake Branch (EGG)
	7.80	146.6	159.8	0.58	10.04	1	2	Grassy Branch (EGF)
	0.90	168.8	174.4	0.60	10.05	0	2	At Sycamore Drainage Ditch
	0.00	175.5	175.5	0.60	10.05	0	2	
Grassy Branch	4.00	6.8	6.8	0.44	10.20	0	2	
(EGF)	2.60	9.3	9.3	0.44	10.20	0	2	IL RT 161
	1.10	11.5	11.5	0.44	10.20	0	2	Albers Discharge (not included)
	0.00	13.2	13.2	0.44	10.20	0	2	
Lake Branch	9.10	8.1	81	0.38	10.15	0	2	
(EGG)	7.30	11.1	11.1	0.38	10.15	0	2	US HWY 50
	6.20	15.7	15.7	0.44	1015	0	2	Aviston Dicharge (not included)
	0.00	22.3	22.3	0.48	1015	0	2	
Sugar Cr Tributary	2.80	2.8	2.8	0.68	10.10	2	2	Trenton Discharge
(EGL)	0.00	7.9	7.9	0.68	1010	0	2	
Sugar Cr Tributary	4.50	4.5	4.5	0.62	10.00	0	2	IL RT 160
(EGN)	0.00	10.4	10.4	0.62	10.00	0	2	
Spanker Branch	410	6.5	8.8	0.51	10.05	0	2	
(EGP)	0.00	17.3	17.3	0.51	10.05	0	2	
Sugar Cr Tributary	1.70	5.7	5.7	0.62	9.95	2	2	Highland Discharge
(EGS)	0.00	7.0	7.0	0.62	9.95	0	2	
Sugar Cr Tributary	3.10	5.9	5.9	0.65	9.85	0	2	
(EGV)	0.00	10.8	10.8	0.65	9.85	0	2	
Shoal Creek-	105.40	5.5	5.5	0.40	9.10	0	2	
West Fk Shoal Cr	104.80	10.8	10.8	0.40	9.10	0	2	
(EH)	103.10	16.3	16.3	0.42	9.12	2	2	Raymond Discharge
	100.70	20.5	28.5	0.45	9.16	0	2	
	98.81	30.3	30.3	0.46	9.16	0	2	
	98.80	30.3	53.6	0.43	9.24	1	2	Bluegrass Creek (EHY)
	97.21	55.7	55.7	0.43	9.24	0	2	
	97.20	55.7	93.2	0.48	9.20	1	2	Threemile Branch (EHX)
	91.61	109.0	109.0	0.50	9.21	3	2	Litchfield Withdrawal
	91.60	109.0	109.0	0.50	9.21	9	2	Lake Lou Yaeger Dam
	89.60	110.8	116.1	0.52	9.22	1	2	West Fk Tributary EHV5
	86.90	120.6	139.2	0.53	9.25	1	2	Brush Creek (EHV)
	85.90	139.8	149.7	0.54	9.26	0	2	At Walton Lake outlet
	81.01	157.7	157.7	0.56	9.27	0	2	Above Middle Fork

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
	81.00	157.7	272.7	0.57	9.40	1	2	Middle Fork Shoal Cr (EHT)
	77.00	285.3	330.7	0.57	9.41	1	2	Lake Fork (EHS)
	75.70	332.0	332.0	0.57	9.41	0	2	Bond-Montgomery County Line
	74.20	333.6	353.2	0.58	9.43	1	2	Bearcat Creek (EHR4)
	72.10	355.5	365.8	0.58	9.44	1	2	Yankee Creek (EHR)
	66.10	370.9	370.9	0.58	9.44	0	2	
	61.90	374.8	420.6	0.59	9.47	1	2	Dry Fork (EHP)
	58.40	425.2	439.7	0.59	9.49	1	2	Dorris Creek (EHO)
	56.71	448.1	448.1	0.59	9.50	0	2	IL RT 140
	56.70	448.1	460.2	0.60	9.51	1	2	Indian Creek (EHN)
	50.10	471.8	471.8	0.60	9.52	0	2	US HWY 40 near Pocahontas
	49.50	472.0	654.7	0.58	9.61	1	2	East Fork Shoal Cr (EHL)
	43.00	672.1	672.1	0.58	9.62	0	2	IL RT 143
	39.10	676.9	694.1	0.58	9.63	1	2	Locust Fork (EHJ)
	32.70	707.2	707.2	0.58	9.64	0	2	
	26.40	721.0	721.0	0.58	9.65	0	2	
	21.31	733.1	733.1	0.58	9.66	3	2	Breese Withdrawal
	21.30	733.1	733.1	0.58	9.66	6	2	USGS Gage 05594000 Breese
	18.70	736.4	739.8	0.58	9.67	1	2	Shoal Cr Tributary EHE
	13.31	741.2	741.2	0.58	9.67	0	2	Above Beaver Creek
	13.30	741.2	885.2	0.55	9.76	1	2	Beaver Creek (EHD)
	10.40	888.3	888.3	0.55	9.76	0	2	IL RT 161
	8.20	891.6	891.6	0.55	9.76	2	2	Germantown Discharge
	6.90	893.1	893.1	0.55	9.76	0	2	
	0.00	906.5	906.5	0.55	9.77	0	2	
Beaver Creek	40.40	1.6	5.4	0.23	10.05	0	2	
(EHD)	38.50	10.6	10.6	0.23	10.05	0	2	
	34.20	16.5	16.5	0.23	10.05	0	2	
	28.01	32.0	32.0	0.32	10.05	0	2	Above Little Beaver Creek
	28.00	32.0	45.2	0.32	10.08	1	2	Little Beaver Creek (EHDR)
	25.80	47.6	47.6	0.32	10.08	0	2	IL RT 143
	2210	54.6	54.6	0.32	10.08	0	2	Clinton-Bond County Line
	20.60	60.0	69.0	0.32	10.08	0	2	
	15.91	74.4	74.4	0.35	10.11	0	2	Above Flat Branch
	15.90	74.4	99.4	0.32	10.15	1	2	Flat Branch (EHDK)
	13.30	109.6	109.6	0.32	1016	0	2	
	8.40	122.7	122.7	0.33	1017	0	2	
	6.50	129.7	129.7	0.33	1018	0	2	US HWY 50 near Beckemeyer
	0.00	144.0	144.0	0.34	10.20	0	2	
Flat Branch	8.20	5.8	5.8	0.23	10.25	0	2	
(EHDK)	4.10	13.1	131	0.23	10.25	0	2	IL RT 127
	1.40	16.1	21.6	0.23	10.25	0	2	
	0.00	25.0	25.0	0.23	10.25	0	2	
Little Beaver Creek	6.00	3.1	31	0.31	1015	0	2	
(EHDR)	0.00	13.2	13.2	0.31	1015	0	2	
Shoal Cr Tributary	1.80	0.6	0.6	0.76	10.25	2	2	Breese Discharge
(EHE)	0.00	3.4	3.4	0.76	10.25	0	2	
Locust Fork	5.00	5.5	5.5	0.32	10.00	0	2	
(EHJ)	2.30	10.8	15.9	0.32	10.00	0	2	
	0.00	17.2	17.2	0.32	10.00	0	2	
East Fork Shoal Cr	5710	3.8	3.8	0.34	9.70	0	2	
(EHL)	54.70	10.3	10.3	0.34	9.70	2	2	Nokomis Discharge
	5310	16.5	16.5	0.34	9.70	0	2	
	51.10	22.2	22.2	0.35	9.70	2	2	Witt Discharge
	45.80	36.4	36.4	0.37	9.70	0	2	
	39.40	56.0	56.0	0.42	9.72	6	2	USGS Gage 05593900 Cofleen
	33.71	62.4	62.4	0.46	9.73	0	2	
	33.70	62.4	70.8	0.45	9.75	0	2	
	31.90	78.5	78.5	0.48	9.76	2	2	Coffeen Discharge
	27.50	83.3	101.1	0.50	9.78	1	2	McDavid Branch (EHLM)
	22.30	112.6	112.6	0.51	9.79	0	2	
	16.40	119.2	130.0	0.52	9.80	0	2	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
East Fork Shoal Cr	14.61	131.1	131.1	0.52	9.80	0	2	
	14.60	131.1	166.7	0.48	9.84	1	2	Kingsbury Branch (EHLG)
	8.50	170.3	170.3	0.48	9.84	2	2	Greenville Discharge
	0.00	182.7	182.7	0.51	9.85	0	2	
Kingsbury Branch	5.90	7.3	7.3	0.28	10.05	0	2	
(EHLG)	4.21	14.3	14.3	0.28	10.05	0	2	
	4.20	14.3	26.8	0.30	10.00	1	2	Dry Branch (EHLGJ)
	1.31	34.8	34.8	0.30	10.01	3	2	Greenville Withdrawal
	1.30	34.8	34.8	0.30	10.01	9	2	Governor Bond Lake Dam
	0.00	35.6	35.6	0.30	10.01	0	2	
Dry Branch	4.80	5.3	5.3	0.33	9.95	0	2	
(EHLGJ)	0.00	12.5	12.5	0.33	9.95	0	2	
McDavid Branch	5.60	4.8	4.8	0.48	9.80	0	2	
(EHLM)	3.30	9.8	9.8	0.48	9.80	0	2	
	0.30	17.8	17.8	0.48	9.80	9	2	Coffeen Dam
	0.00	17.8	17.8	0.48	9.80	0	2	
Indian Creek	3.60	5.5	5.5	0.68	9.90	0	2	
(EHN)	0.00	12.1	12.1	0.68	9.90	0	2	
Dorris Creek	5.30	8.3	8.3	0.63	9.85	0	2	
(EHO)	0.00	14.5	14.5	0.63	9.85	0	2	
Dry Fork	13.00	2.8	2.8	0.45	9.50	0	2	
(EHP)	9.80	5.4	12.6	0.45	9.50	0	2	
	5.60	19.4	22.9	0.55	9.57	0	2	
	0.80	29.9	45.6	0.56	9.63	1	2	Little Dry Fork (EHPB)
	0.00	45.8	45.8	0.56	9.63	0	2	
Little Dry Fork	6.40	4.3	4.3	0.55	9.70	0	2	
(EHPB)	0.00	15.7	15.7	0.55	9.70	0	2	
Yankee Creek	3.00	3.6	3.6	0.61	9.75	0	2	
(EHR)	0.00	10.3	10.3	0.61	9.75	0	2	
Bearcat Creek	7.40	5.1	51	0.59	9.70	0	2	
(EHR4)	4.90	9.6	13.4	0.59	9.70	0	2	
	0.00	19.6	19.6	0.59	9.70	0	2	
Lake Fork	8.40	6.7	16.0	0.53	9.41	0	2	
(EHS)	5.20	19.1	23.5	0.55	9.44	0	2	
	4.01	25.9	25.9	0.57	9.44	0	2	
	4.00	25.9	41.6	0.53	9.44	1	2	Grove Branch (EHSH)
	0.00	45.4	45.4	0.54	9.45	0	2	
Grove Branch	6.70	6.3	6.3	0.46	9.45	0	2	
(EHSH)	0.00	15.7	15.7	0.46	9.45	0	2	
Middle Fk Shoal Cr	25.20	7.6	7.6	0.40	9.55	0	2	
(EHT)	20.90	16.9	16.9	0.40	9.55	0	2	
	16.70	28.1	28.1	0.50	9.53	0	2	
	14.50	33.3	48.5	0.53	9.55	1	2	Fawn Creek (EHTN)
	12.30	52.4	73.0	0.53	9.58	1	2	Little Creek (EHTL)
	10.51	75.2	75.2	0.53	9.58	3	2	Hillsboro Withdrawal
	10.50	75.2	75.2	0.53	9.58	9	2	Glenn Shoals Dam
	10.10	75.4	82.2	0.53	9.58	1	2	Lake Hillsboro Cr (EHTJ)
	9.10	87.4	87.4	0.54	9.58	2	2	Hillsboro Discharge
	8.20	87.7	97.7	0.54	9.57	1	2	Cress Creek (EHTH)
	0.00	115.0	115.0	0.59	9.57	0	2	
Cress Creek	3.10	3.9	7.6	0.57	9.45	0	2	
(EHTH)	0.00	10.0	10.0	0.57	9.45	0	2	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Lake Hillsboro Cr	1.60	4.6	4.6	0.44	9.60	0	2	
(EHTJ)	0.21	6.8	6.8	0.44	9.60	3	2	Hillsboro Withdrawal
	0.20	6.8	6.8	0.44	9.60	9	2	Lake Hillsboro Dam
	0.00	6.8	6.8	0.44	9.60	0	2	
Little Creek	6.60	4.3	4.3	0.50	9.65	0	2	
(EHTL)	2.80	91	16.8	0.50	9.65	0	2	
	0.00	20.6	20.6	0.50	9.65	0	2	
Fawn Creek	2.70	3.8	3.8	0.53	9.60	0	2	
(EHTN)	0.00	15.2	15.2	0.53	9.60	0	2	
Brush Creek	4.40	9.0	9.0	0.52	9.40	0	2	
(EHV)	0.00	18.6	18.6	0.52	9.40	0	2	
West Fk Tributary	2.50	1.3	1.3	0.69	9.40	2	2	Litchfield Discharge
(EHV5)	0.00	5.3	5.3	0.69	9.40	0	2	
Threemile Branch	2.31	91	9.1	0.60	9.20	0	2	
(EHX)	2.30	91	35.3	0.54	915	1	2	Shop Creek (EHXG)
	0.00	37.5	37.5	0.55	9.15	0	2	
Shop Creek	7.10	5.2	5.2	0.55	915	0	2	
(EHXG)	1.81	12.9	12.9	0.55	915	0	2	
	1.80	12.9	24.5	0.52	9.13	0	2	
	0.00	26.2	26.2	0.52	9.13	0	2	
Bluegrass Creek	4.90	7.5	7.5	0.40	9.35	0	2	
(EHY)	3.20	19.5	19.5	0.40	9.35	6	2	USGS Gage 05593600 Raymond
	0.00	23.3	23.3	0.40	9.35	0	2	
Plum Creek	8.60	4.0	4.0	0.41	10.45	0	2	
(EH2)	6.00	15.0	15.0	0.41	10.45	2	2	Okawville Discharge
	0.00	23.3	23.3	0.48	10.41	0	2	
Crooked Creek	69.70	8.8	8.8	0.31	10.90	0	2	
(ED	62.60	11.2	26.2	0.30	10.93	0	2	
	60.01	30.4	30.4	0.28	10.93	0	2	
	60.00	30.4	41.9	0.30	10.91	1	2	Town Creek (EIV)
	59.50	42.1	57.1	0.30	10.93	1	2	South Creek (EIU)
	51.51	76.9	76.9	0.31	10.92	0	2	
	51.50	76.9	84.3	0.31	10.92	1	2	At Martin Branch
	41.81	92.2	92.2	0.33	10.91	6	2	Above Raccoon Creek
	41.80	92.2	144.4	0.32	10.92	1	2	Raccoon Creek (EIO)
	40.50	144.8	166.0	0.32	10.90	1	2	Turkey Creek (EIN)
	24.91	1831	183.1	0.34	10.88	6	2	
	24.90	183.1	248.3	0.35	10.85	1	2	Grand Point Creek (EIJ)
	22.00	251.9	251.9	0.35	10.85	0	2	USGS Gage 05593520 Hoffman
	11.00	262.9	340.4	0.34	10.79	1	2	Lost Creek (EIE)
	10.50	340.6	340.6	0.34	10.79	0	2	
	3.20	344.8	457.2	0.37	10.74	1	2	Little Crooked Creek (ED3)
	0.00	459.5	459.5	0.37	10.74	0	2	
Little Crooked Creek	21.70	8.9	8.9	0.43	10.65	2	2	Nashville Discharge
(ED3)	16.51	17.5	17.5	0.43	10.65	0	2	
	16.50	17.5	37.6	0.47	10.67	1	2	Middle Creek (EDBQ)
	16.00	37.6	55.5	0.46	10.66	1	2	North Creek (EDBP)
	14.10	55.5	65.9	0.43	10.64	1	2	Willow Creek (EIBN)
	12.50	69.9	80.4	0.43	10.62	1	2	Beaver Pond Creek (EIBL)
	10.60	82.2	82.2	0.44	10.62	6	2	USGS Gage 05593575 New Minden
	7.10	86.4	93.3	0.44	10.61	0	2	
	2.50	96.0	109.1	0.44	10.60	1	2	Coon Creek (ED3C)
	0.00	112.4	112.4	0.44	10.60	0	2	
Coon Creek	3.30	5.9	10.9	0.32	10.60	0	2	
(ED3C)	0.00	13.1	13.1	0.32	10.60	0	2	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Beaver Pond Creek	2.40	6.8	6.8	0.43	10.50	0	2	
(EIBL)	0.00	10.5	10.5	0.43	10.50	0	2	
Willow Creek	3.10	5.6	5.6	0.25	10.55	0	2	
(EIBN)	0.00	10.4	10.4	0.25	10.55	0	2	
North Creek	7.00	6.1	9.8	0.28	10.65	0	2	
(EIBP)	0.00	17.9	17.9	0.45	10.63	0	2	
Middle Creek	12.10	5.7	5.7	0.41	10.70	0	2	
(EIBQ)	6.90	12.7	12.7	0.41	10.70	0	2	
	0.00	20.1	201	0.51	10.68	0	2	
Lost Creek	21.00	6.5	6.5	0.20	10.65	0	2	
(EIE)	15.40	13.5	13.5	0.20	10.65	0	2	
	6.90	24.3	24.3	0.22	10.61	0	2	
	5.61	38.1	381	0.24	10.59	0	2	
	5.60	38.1	68.5	0.24	10.62	1	2	Prairie Creek (EJEG)
	0.00	77.5	77.5	0.27	10.61	0	2	
Prairie Creek	12.70	81	8.1	0.27	10.70	2	2	Sandoval Discharge
(EIEG)	8.50	15.1	151	0.20	10.70	0	2	
	1.50	21.8	28.9	0.23	10.65	0	2	
	0.00	30.4	30.4	0.23	10.65	0	2	
Grand Point Creek	12.80	6.2	10.6	0.39	10.75	0	2	
(ELJ)	8.40	16.2	21.9	0.39	10.75	0	2	
	6.81	22.9	22.9	0.39	10.75	0	2	
	6.80	22.9	32.4	0.35	10.75	0	2	
	410	34.2	56.5	0.38	10.76	1	2	Sewer Creek (EIJG)
	4.09	56.5	56.5	0.38	10.76	6	2	
	0.00	65.2	65.2	0.38	10.75	0	2	
Sewer Creek	3.40	2.9	2.9	0.31	10.75	2	2	Centralia Discharge
(ELJG)	2.30	3.6	9.1	0.31	10.75	0	2	
	0.71	10.7	10.7	0.31	10.75	0	2	
	0.70	10.7	221	0.35	10.78	1	2	Webster Creek (ELJGD)
	0.00	22.3	22.3	0.35	10.78	0	2	
Webster Creek	4.60	5.8	5.8	0.41	10.80	0	2	
(EIJGD)	0.00	11.4	11.4	0.41	10.80	0	2	
Turkey Creek	9.00	2.8	7.3	0.30	10.80	0	2	
(EIN6)	7.10	9.3	10.5	0.30	10.80	2	2	Odin Discharge
	6.60	11.2	11.2	0.30	10.80	0	2	
	3.00	15.0	18.8	0.30	10.78	0	2	
	0.00	21.2	21.2	0.30	10.78	0	2	
Raccoon Creek	16.20	4.6	8.1	0.34	11.00	0	2	
(EIO)	12.50	151	151	0.34	11.00	0	2	
	7.60	27.6	27.6	0.33	10.98	0	2	
	510	34.8	34.8	0.32	10.97	0	2	
	1.01	48.4	48.4	0.30	10.94	3	2	Centralia Withdrawal
	1.00	48.4	48.4	0.30	10.94	9	2	Raccoon Lake Dam
	0.30	52.1	521	0.30	10.93	2	2	Central City Discharge
	0.00	52.2	52.2	0.30	10.93	0	2	
South Creek	4.90	5.1	7.8	0.31	11.00	0	2	
(EIU)	0.00	15.0	15.0	0.31	11.00	0	2	
Town Creek	4.11	3.6	3.6	0.35	10.85	3	2	Salem Withdrawal
(EIV)	410	3.6	3.6	0.35	10.85	9	2	Salem Reservoir Dam
	1.90	5.7	5.7	0.35	10.85	2	2	Salem Discharge
	1.60	5.8	10.8	0.35	10.85	0	2	
	0.00	11.5	11.5	0.35	10.85	0	2	
Coles Creek	5.30	8.5	8.5	0.22	10.55	0	2	
(EJ5)	0.00	17.2	17.2	0.22	10.55	0	2	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
East Fk Kaskaskia R	4710	1.5	1.5	0.22	10.90	2	2	Farina Discharge
(EK)	46.20	4.6	9.1	0.22	10.90	0	2	
	44.20	12.1	18.4	0.22	10.90	0	2	At Schneider Springs Branch
	40.81	23.4	23.4	0.25	10.90	0	2	
	40.80	23.4	41.5	0.25	10.86	1	2	Lone Grove Branch (EKU)
	36.60	49.6	54.8	0.28	10.86	0	2	
	34.10	57.2	57.2	0.29	10.86	0	2	
	29.60	681	68.1	0.31	10.85	0	2	
	2211	76.4	76.4	0.31	10.83	0	2	
	2210	76.4	87.9	0.32	10.82	1	2	Jims Creek (EKK)
	16.31	93.4	93.4	0.35	10.81	0	2	
	16.30	93.4	109.8	0.35	10.79	1	2	Davidson Creek (EKG)
	16.20	109.8	109.8	0.35	10.79	0	2	USGS Gage 05592900 Sandoval
	12.30	115.2	115.2	0.35	10.78	0	2	
	0.60	125.0	202.2	0.35	10.71	1	2	North Fork Kaskaskia River (EKA)
	0.00	202.3	202.3	0.36	10.71	0	2	
North Fk Kaskaskia	26.40	6.9	8.9	0.26	10.75	0	2	
(EKA)	25.30	11.5	11.5	0.26	10.75	0	2	
	21.20	16.3	16.3	0.27	10.72	0	2	
	17.80	24.5	24.5	0.30	10.70	0	2	
	15.20	27.8	35.0	0.33	10.69	0	2	
	11.50	39.9	39.9	0.35	10.69	0	2	
	9.70	42.8	48.6	0.35	10.66	0	2	
	7.20	54.4	54.4	0.35	10.65	0	2	
	1.90	58.5	75.5	0.36	10.63	1	2	Louse Run (EKAB)
	0.00	77.2	77.2	0.36	10.63	0	2	
Louse Run	5.00	7.8	12.9	0.26	10.60	0	2	
(EKAB)	0.00	17.0	17.0	0.26	10.60	0	2	
Davidson Creek	3.50	9.2	12.5	0.30	10.70	0	2	
(EKG)	0.00	16.4	16.4	0.30	10.70	0	2	
Jims Creek	3.10	5.4	8.2	0.38	10.75	0	2	
(EKK)	0.00	11.5	11.5	0.38	10.75	0	2	
Lone Grove Branch	5.20	4.7	11.6	0.26	10.80	0	2	
(EKU)	4.10	13.0	13.0	0.26	10.80	0	2	
	0.00	18.1	181	0.26	10.80	0	2	
Spring Branch	3.20	4.9	4.9	0.36	10.25	0	2	
(EK1)	0.00	13.1	131	0.36	10.25	0	2	
Hurricane Creek	41.70	6.6	10.4	0.51	9.85	0	2	
(EL)	37.90	19.6	19.6	0.51	9.90	0	2	
	3510	27.6	27.6	0.50	9.91	0	2	
	32.70	33.2	37.2	0.46	9.95	0	2	
	27.21	47.9	47.9	0.43	9.97	0	2	
	27.20	47.9	80.4	0.43	9.96	1	2	Dry Fork (ELO)
	23.20	85.6	101.8	0.42	9.96	1	2	Gilham Creek (ELM)
	18.60	111.0	120.0	0.41	9.99	0	2	
	14.80	122.6	130.4	0.41	10.00	0	2	
	14.60	130.5	149.9	0.41	10.03	1	2	Raccoon Creek (ELI)
	14.40	150.0	150.0	0.41	10.03	0	2	Gage 05592800 Mulberry Grove
	8.50	176.3	176.3	0.41	10.06	0	2	
	0.00	196.3	196.3	0.36	10.08	0	2	
Raccoon Creek	6.00	5.8	5.8	0.36	10.30	0	2	
(ELI)	3.40	11.7	11.7	0.36	10.30	0	2	
	0.00	19.4	19.4	0.36	10.30	0	2	
Gilham Creek	5.10	61	6.1	0.32	10.05	0	2	
(ELM)	0.00	16.2	16.2	0.32	10.05	0	2	
Dry Fork	11.70	4.9	4.9	0.36	9.90	0	2	
(ELO)	6.80	16.0	16.0	0.36	9.90	0	2	
	0.00	32.5	32.5	0.34	9.95	0	2	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Wadcat Ditch	7.50	6.8	6.8	0.42	10.45	0	2	
(EL4)	3.30	16.5	16.5	0.42	10.45	0	2	
	2.40	16.5	40.0	0.38	10.53	1	2	Flat Creek (EL4E)
	0.00	49.5	49.5	0.38	10.51	0	2	
Flat Creek	13.80	5.8	5.8	0.25	10.65	0	2	
(EL4E)	10.20	11.9	11.9	0.25	10.65	0	2	
	6.61	14.2	14.2	0.27	10.63	0	2	
	6.60	14.2	18.4	0.29	10.60	0	2	
	0.00	23.5	23.5	0.33	10.58	0	2	
Richland Creek	6.00	6.6	6.6	0.35	10.50	0	2	
(EM9)	0.00	14.6	14.6	0.35	10.50	0	2	
Hickory Creek	20.70	61	8.2	0.29	10.65	0	2	
(EN)	16.71	13.6	13.6	0.29	10.65	0	2	
	16.70	18.9	18.9	0.29	10.65	0	2	
	13.61	29.1	29.1	0.34	10.65	0	2	
	13.60	29.1	42.3	0.34	10.67	1	2	Little Hickory Creek (ENO)
	7.70	49.2	741	0.34	10.65	1	2	Little Hickory Creek (END
	1.00	83.4	145.2	0.41	10.55	1	2	Vandalia Drainage Ditch (ENB)
	0.00	145.4	145.4	0.42	10.55	0	2	
Vandalia Drainage D	7.90	2.3	7.0	0.45	10.35	0	2	
(ENB)	5.50	12.5	32.6	0.45	10.44	1	2	Camp Creek (ENBM)
	310	36.5	54.5	0.44	10.45	1	2	Sandy Run Ditch (ENBH)
	0.00	61.8	61.8	0.48	10.44	0	2	
Sandy Run	3.20	9.0	14.4	0.36	10.50	0	2	
(ENBH)	0.00	18.0	18.0	0.36	10.50	0	2	
Camp Creek	6.20	9.6	9.6	0.28	10.50	0	2	
(ENBM)	0.00	201	20.1	0.28	10.50	0	2	
Little Hickory Creek	4.50	8.5	8.5	0.32	10.65	0	2	
(END	3.50	9.1	15.7	0.32	10.65	0	2	
	0.00	24.9	24.9	0.32	10.65	0	2	
Little Hickory Creek	5.80	6.7	6.7	0.37	10.70	0	2	
(ENO)	0.00	13.2	13.2	0.37	10.70	0	2	
Bear Creek	7.70	3.8	7.6	0.26	10.20	0	2	
(EN5)	7.30	8.2	101	0.26	10.20	0	2	
	6.30	10.9	18.0	0.26	10.20	0	2	
	4.21	24.7	24.7	0.26	10.20	0	2	
	4.20	24.7	24.7	0.26	10.20	9	2	Vandalia Lake Dam
	0.00	30.0	30.0	0.33	10.22	0	2	
Hoffman Creek	4.90	4.5	4.5	0.35	10.20	0	2	
(EN8)	1.70	10.9	10.9	0.35	10.20	0	2	US HWY 51
	0.00	12.2	12.2	0.35	10.20	0	2	
Ramsey Creek	27.40	7.4	7.4	0.37	9.90	0	2	
(EO)	24.70	12.2	12.2	0.37	9.90	0	2	
	23.70	17.0	21.7	0.43	9.92	0	2	
	19.51	29.9	29.9	0.48	9.93	0	2	
	19.50	29.9	44.6	0.53	9.92	1	2	Elliot Creek (EOR)
	18.60	45.3	52.1	0.53	9.93	0	2	
	16.20	54.8	68.2	0.54	9.93	1	2	Caesar Creek (EOO)
	13.80	73.3	79.6	0.59	9.94	0	2	
	13.30	80.1	80.1	0.60	9.94	0	2	
	8.90	90.1	90.1	0.61	9.96	0	2	Ramsey Discharge (not included)
	5.50	95.4	95.4	0.61	9.97	0	2	US HWY 51
	0.00	103.8	103.8	0.62	9.99	0	2	
Caesar Creek	5.00	8.8	8.8	0.57	9.90	0	2	
(EOO)	0.00	13.4	13.4	0.57	9.90	0	2	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Elliott Creek	1.30	8.7	13.5	0.63	9.90	0	2	
(EOR)	0.00	14.7	14.7	0.63	9.90	0	2	
Suck Creek	5.40	6.3	8.6	0.36	10.50	0	2	
(E04)	0.00	13.7	13.7	0.36	10.50	0	2	
Ash Creek	8.20	6.8	6.8	0.66	1015	0	2	US HWY 51
(E06)	6.90	9.0	9.0	0.65	1015	0	2	
	610	9.3	12.7	0.64	10.15	0	2	
	0.20	19.3	29.8	0.59	1019	1	2	Bolt Creek (EO6A)
	0.00	29.8	29.8	0.61	1019	0	2	
Bolt Creek	4.40	6.3	6.3	0.55	10.25	0	2	
(E06A)	0.00	10.5	10.5	0.55	10.25	0	2	
Big Creek-								
Wolf Creek	32.50	5.6	5.6	0.26	10.70	0	2	
(EP)	31.00	121	121	0.26	10.70	0	2	
	27.30	17.2	23.7	0.26	10.70	0	2	
	26.90	261	26.1	0.26	10.70	0	2	
	24.00	29.9	35.2	0.27	10.67	0	2	
	21.90	44.0	44.0	0.28	10.66	0	2	
	19.30	47.9	47.9	0.28	10.65	6	2	USGS Gage 05592300 Beecher City
	14.21	54.0	54.0	0.28	10.64	0	2	
	14.20	54.0	87.3	0.30	10.64	1	2	Moccasin Creek (EPK)
	11.20	90.0	91.1	0.34	10.64	0	2	
	0.81	101.9	101.9	0.34	10.62	0	2	
	0.80	101.9	137.3	0.37	10.61	1	2	South Fork-Sugar Creek (EPB)
	0.00	138.6	138.6	0.37	10.61	0	2	
South Fork-	10.30	8.2	11.0	0.30	10.65	0	2	
Sugar Creek	8.80	11.8	14.2	0.30	10.65	0	2	At Watson Creek
(EPB)	8.50	14.2	21.5	0.29	10.65	1	2	Brickyard Branch (EPBP)
	4.71	25.1	251	0.31	10.63	0	2	
	4.70	25.1	31.4	0.34	10.60	0	2	At Little Creek
	0.00	35.4	35.4	0.36	10.59	0	2	
Brickyard Branch	3.00	4.7	4.7	0.27	10.65	2	2	St. Elmo Discharge
(EPBP)	0.00	7.3	7.3	0.27	10.65	0 2		
Moccasin Creek	7.80	4.3	7.3	0.28	10.65	0	2	
(EPK)	2.31	11.3	11.3	0.28	10.65	0	2	
	2.30	11.3	22.0	0.29	10.65	0	2	
	1.11	24.7	24.7	0.29	10.65	0	2	
	1.10	24.7	32.3	0.31	10.65	0	2	
	0.00	33.3	33.3	0.31	10.65	0	2	
Becks Creek	24.91	81	81	0.34	10.05	0	2	
(EQ)	24.90	8.1	16.0	0.34	10.05	1	2	Pana Lake Outlet (EQV)
	22.21	17.9	17.9	0.34	10.05	0	2	
	22.20	17.9	32.8	0.38	10.07	1	2	Becks Cr Tributary EQT
	16.61	43.6	43.6	0.47	10.09	0	2	
	16.60	43.6	87.5	0.52	10.04	1	2	Opossum Creek (EQO)
	9.41	100.8	100.8	0.55	10.05	0	2	
	9.40	100.8	114.3	0.55	10.06	1	2	Little Creek (EQI)
	110	127.3	199.8	0.55	1015	1	2	Mitchell Creek (EQB)
	0.00	200.3	200.3	0.55	1015	0	2	
Mitchell Creek	16.50	5.9	10.0	0.42	10.25	0	2	
(EQB)	15.60	10.6	10.6	0.42	10.25	0	2	
	13.60	12.8	18.0	0.42	10.25	0	2	
	10.20	24.7	24.7	0.42	10.25	0	2	
	6.70	37.0	37.0	0.43	10.28	0	2	
	6.60	39.4	50.6	0.45	10.28	1	2	Mitchell Cr Tributary EQBI
	6.00	52.3	52.3	0.45	10.28	0	2	
	2.40	57.4	69.7	0.48	10.28	1	2	Section Creek (EQBD)
	0.00	72.5	72.5	0.51	10.28	0	2	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Section Creek	1.80	6.5	9.1	0.68	10.25	0	2	
(EQBD)	0.00	12.3	12.3	0.58	10.25	0	2	
Mitchell Cr Tributary	1.80	8.3	8.3	0.45	10.25	0	2	
(EQBD	0.00	11.2	11.2	0.45	10.25	0	2	
Little Creek	2.70	6.2	11.1	0.50	10.10	0	2	
(EQD	0.00	13.5	13.5	0.50	10.10	0	2	
Opossum Creek	10.60	5.7	5.7	0.40	9.95	0	2	
(EQO)	7.60	10.4	10.4	0.40	9.95	0	2	
	5.30	13.0	20.4	0.44	9.99	0	2	
	3.11	24.7	24.7	0.46	10.00	0	2	
	3.10	24.7	38.5	0.53	10.00	1	2	Coal Creek (EQOG)
	0.00	43.9	43.9	0.56	10.00	0	2	
Coal Creek	6.50	3.7	3.7	0.51	10.05	2	2	Pana Discharge
(EQOG)	3.90	8.9	8.9	0.51	10.05	0	2	
	0.00	13.8	13.8	0.51	10.05	0	2	
Becks Cr Tributary	1.90	6.6	10.5	0.51	1010	0	2	
(EQT)	0.00	14.9	14.9	0.43	10.10	0	2	
Pana Lake outlet	0.51	7.7	7.7	0.34	10.05	3	2	Pana Withdrawal
(EQV)	0.50	7.7	7.7	0.34	10.05	9	2	Pana Lake Dam
	0.00	7.9	7.9	0.34	10.05	0	2	
Richland Creek	22.00	5.2	5.2	0.56	10.55	0	2	
(ER)	17.30	11.5	11.5	0.56	10.55	0	2	
	17.20	11.5	20.4	0.56	10.59	0	2	
	14.00	27.2	31.5	0.56	10.60	0	2	
	8.20	42.2	42.2	0.57	10.60	0	2	
	3.61	49.2	49.2	0.57	10.59	0	2	
	3.60	49.2	77.3	0.60	10.60	1	2	Brush Creek (ERE)
	0.00	85.1	85.1	0.61	10.59	0	2	
Brush Creek	8.70	7.9	7.9	0.45	10.65	0	2	
(ERE)	4.61	12.9	12.9	0.45	10.65	0	2	
	4.60	12.9	20.8	0.47	10.63	0	2	
	0.00	281	28.1	0.58	10.61	0	2	
Jordan Creek	5.50	8.0	8.0	0.60	10.45	0	2	
(ER6)	3.21	13.3	13.3	0.60	10.45	0	2	
	3.20	13.3	17.5	0.61	10.45	0	2	
	0.00	25.4	25.4	0.64	10.46	0	2	
Robinson Creek	24.80	6.5	19.9	0.53	10.22	1	2	Robinson Cr Tributary ESV
(ES)	22.30	28.4	28.4	0.53	10.20	0	2	
	19.10	39.6	39.6	0.53	10.21	0	2	
	8.90	49.6	86.9	0.68	10.16	1	2	Mud Creek (ESI)
	8.80	91.6	91.6	0.62	10.16	0	2	USGS Gage 05592050 Shelbyville
	5.50	100.2	100.2	0.62	1017	0	2	
	3.70	109.4	109.4	0.63	10.18	0	2	
	1.50	118.1	121.1	0.65	1019	1	2	Robinson Cr Tributary ESB
	0.00	122.4	122.4	0.65	10.19	0	2	
Robinson Cr Trib.	2.50	1.6	1.6	0.82	10.20	2	2	Shelbyville Discharge
(ESB)	0.00	3.0	3.0	0.82	10.20	0	2	
Mud Creek	7.20	71	71	0.50	10.05	0	2	
(ESD	6.60	10.2	10.2	0.50	10.05	0	2	
	3.51	23.9	23.9	0.53	10.08	0	2	
	3.50	23.9	27.7	0.54	10.08	0	2	
	0.00	37.3	37.3	0.62	10.10	0	2	
Robinson Cr Trib.	1.70	6.2	6.2	0.51	10.25	0	2	
(ESV)	0.00	13.4	13.4	0.51	10.25	0	2	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Sand Creek	6.51	9.4	9.4	0.52	10.65	0	1	
(ET4)	6.50	9.4	14.3	0.52	10.65	0	1	Sand Cr Tributary ET4L
	1.20	25.8	30.4	0.52	10.60	0	1	
	0.00	31.4	31.4	0.52	10.60	0	1	
Sand Cr Tributary	3.20	0.8	0.8	0.52	10.65	2	1	Windsor Discharge
(ET4L)	0.00	4.9	4.9	0.52	10.65	0	1	
West Okaw River	39.90	5.4	9.3	0.50	10.20	0	1	
(EU)	37.60	11.9	11.9	0.50	10.20	0	1	
	32.00	24.3	35.1	0.50	10.25	1	1	Ditch No. 4 (EOT)
	29.60	38.0	69.6	0.50	10.28	1	1	Hammond Mutual Ditch (EUS)
	26.90	75.1	112.2	0.50	10.25	1	1	West Okaw R Tributary EUQ
	26.70	112.5	112.5	0.50	10.25	0	1	USGS Gage 05591700 Lovington
	25.00	113.8	132.8	0.50	10.24	1	1	Stringtown Branch (EUO)
	24.50	132.9	136.4	0.50	10.24	1	1	West Okaw R Tributary (EUN8)
	21.60	142.2	152.8	0.51	10.25	1	1	Jonathan Branch (EUM)
	18.10	157.2	163.0	0.51	10.25	0	1	
	9.20	172.8	181.5	0.51	10.26	0	1	
	8.90	181.5	236.4	0.51	10.23	1	1	Marrowbone Creek (EUF)
	4.60	247.4	279.4	0.51	10.23	1	1	Wilborn Creek (EUD)
	0.00	287.8	287.8	0.51	10.23	0	1	
Wilburn Creek	8.30	3.5	3.5	0.51	10.20	0	1	
(EUD)	1.91	13.7	13.7	0.51	10.20	0	1	
	1.90	13.7	26.4	0.50	10.20	1	1	Wilborn Cr Tributary EUDD
	0.00	32.0	32.0	0.50	10.20	0	1	
WUburn Cr Tributary	4.20	8.6	8.6	0.51	10.20	0	1	
(EUDD)	0.00	12.7	12.7	0.51	10.20	0	1	
Marrowbone Creek	12.40	4.9	11.1	0.50	1015	0	1	
(EUF)	8.00	18.6	321	0.50	10.13	1	1	Marrowbone Cr Tributary EUFM
	5.20	35.1	47.4	0.50	1014	1	1	Brush Creek (EUFD
	3.40	52.6	52.6	0.50	1015	2	1	Bethany Discharge
	0.00	54.9	54.9	0.50	1015	0	1	
Brush Creek	5.50	6.8	6.8	0.50	1015	0	1	
(EUFI)	0.00	12.3	12.3	0.50	10.15	0	1	
Marrowbone Cr Trib.	4.00	5.4	8.9	0.50	10.10	0	1	
(EUFM)	0.00	13.5	13.5	0.50	1010	0	1	
Jonathon Creek	3.90	3.2	3.2	0.51	10.40	0	1	
(EUM)	0.00	10.6	10.6	0.51	10.40	0	1	
West Okaw R Trib.	0.60	31	3.1	0.52	10.35	2	1	Lovington Discharge
(EUN8)	0.00	3.5	3.5	0.52	10.35	0	1	
Stringtown Branch	3.10	6.5	10.1	0.50	10.20	0	1	
(EUO)	2.10	12.3	17.4	0.50	10.20	0	1	
	0.00	19.0	19.0	0.50	10.20	0	1	
West Okaw R Trib.	10.60	4.5	13.4	0.50	10.15	0	1	
(EUQ)	8.00	20.7	20.7	0.50	1015	0	1	
	4.30	32.8	32.8	0.51	1017	0	1	
	0.00	37.1	371	0.51	1017	0	1	
Hammond Mutual D	12.00	6.0	6.0	0.50	10.30	0	1	
(EUS)	8.40	12.5	12.5	0.50	10.30	0	1	
	5.60	19.4	19.4	0.50	10.30	0	1	Hammond Discharge (not included)
	2.50	25.4	25.4	0.50	10.31	0	1	
	0.00	31.6	31.6	0.50	10.32	0	1	
Ditch No. 4	4.10	4.5	4.5	0.50	10.30	0	1	
(EUT)	0.00	10.8	10.8	0.50	10.30	0	1	

Appendix C. Continued

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Whitley Creek	10.20	6.2	10.2	0.59	10.80	0	1	
(EU5)	8.30	17 .1	33.7	0.55	10.80	1	1	Crabapple Creek (EU50)
	6.60	34.6	34.6	0.55	10.80	0	1	USGS Gage 05591550 Allenville
	5.50	36.3	45.6	0.54	10.77	0	1	
	0.00	54.7	54.7	0.54	10.75	0	1	
Crabapple Creek	7.30	6.6	6.6	0.51	10.80	0	1	
(EU50)	0.00	16.6	16.6	0.51	10.80	0	1	
Asa Creek	5.30	8.0	8.0	0.51	10.45	6	1	USGS Gage 05591500 Sullivan
(EU8)	3.80	10.3	10.3	0.51	10.45	0	1	
	3.00	10.6	10.6	0.51	10.45	2	1	Sullivan Discharge
	0.00	15.6	15.6	0.51	10.45	0	1	
Jonathon Creek	15.20	7.0	7.0	0.50	10.45	0	1	
(EV)	13.20	10.9	10.9	0.50	10.45	0	1	
	8.70	16.1	16.1	0.51	10.48	0	1	
	4.50	21.8	39.9	0.51	10.57	1	1	Bolin Branch (EVG)
	4.10	39.9	53.7	0.52	10.54	1	1	Twomile Branch (EVF)
	0.00	57.1	571	0.52	10.54	0	1	
Twomile Branch	3.70	7.7	10.8	0.51	10.45	0	1	
(EVF)	0.00	13.8	13.8	0.51	10.45	0	1	
Bolin Branch	4.90	4.7	4.7	0.51	10.65	0	1	
(EVG)	0.30	10.9	17.9	0.51	10.65	0	1	
	0.00	18.1	181	0.51	10.65	0	1	
Flat Branch	10.80	4.3	4.3	0.51	11.00	0	1	
(EW)	7.40	12.7	12.7	0.51	11.00	0	1	
	4.60	18.5	24.7	0.51	10.95	0	1	
	4.10	24.9	34.9	0.51	10.95	0	1	
	0.00	42.0	42.0	0.51	10.94	0	1	
Kaskaskia R Trib.	7.70	6.3	6.3	0.50	10.55	2	1	Arthur Discharge
(EW5)	6.80	6.6	14.1	0.50	10.55	0	1	
	3.50	20.7	20.7	0.50	10.58	0	1	
	0.00	27.1	271	0.50	10.60	0	1	
West Fork	5.00	7.6	131	0.50	10.55	0	1	
(EW9)	0.00	18.0	18.0	0.50	10.55	0	1	
Lake Fork	24.30	4.5	4.5	0.51	10.30	0	1	
(EX)	20.50	11.9	11.9	0.51	10.30	0	1	
	19.30	13.8	18.1	0.51	10.30	1	1	Lake Fk Tributary EXU
	17.41	26.7	26.7	0.51	10.30	0	1	
	17.40	26.7	96.8	0.53	10.39	1	1	East Lake Fork (EXS)
	16.90	971	105.4	0.52	10.39	0	1	
	15.80	112.8	112.8	0.52	10.39	0	1	
	13.30	1221	131.7	0.52	10.40	0	1	
	12.00	132.9	145.2	0.52	10.40	1	1	Lake Fk Tributary EXM
	9.20	149.0	149.0	0.52	10.40	0	1	USGS Gage 05590800 Atwood
	810	151.8	151.8	0.52	10.40	2	1	Atwood Discharge
	1.01	1621	162.1	0.51	10.41	0	1	
	1.00	1621	168.5	0.51	10.42	0	1	
	0.00	169.6	169.6	0.51	10.42	0	1	
Lake Fork Tributary	4.00	6.2	6.2	0.51	10.45	0	1	
(EXM)	0.00	12.3	12.3	0.51	10.45	0	1	
East Lake Fork	16.70	5.6	5.6	0.64	10.45	0	1	
(EXS)	13.60	14.4	14.4	0.64	10.45	0	1	
	10.30	22.3	22.3	0.60	10.47	0	1	
	5.21	29.5	29.5	0.57	10.48	0	1	
	5.20	29.5	58.9	0.54	10.45	1	1	Kankakee Drainage Ditch (EXSH)
	0.00	70.1	70.1	0.53	10.43	0	1	

Appendix C. Concluded

Stream (code)	Mileage	DA(u)	DA(d)	K	P-ET	ID	Region	Location description
Kankakee Drainage D	8.30	5.2	5.2	0.53	10.45	o	l	
(EXSH)	5.20	12.2	12.2	0.53	10.45	0	1	
	2.20	19.5	19.5	0.52	10.43	0	1	
	0.10	26.2	29.4	0.50	10.42	0	1	
	0.00	29.4	29.4	0.50	10.42	0	1	
Lake Fork Tributary	1.10	3.9	3.9	0.51	10.30	2	1	Bement Discharge
(EXU)	0.00	4.3	4.3	0.51	10.30	0	1	
Dry Fork	8.20	7.4	7.4	0.50	10.55	0	1	
(EX2)	5.30	13.4	13.4	0.50	10.55	0	1	
	0.00	20.6	20.6	0.50	10.55	0	1	
Twomile Slough	9.60	4.3	11.9	0.63	10.60	0	1	
(EY)	8.10	14.3	14.3	0.63	10.60	0	1	
	6.01	18.3	18.3	0.62	10.61	0	1	
	6.00	18.3	23.6	0.61	10.62	0	1	
	0.00	36.3	36.3	0.59	10.63	0	1	
Copper Slough	5.30	4.2	4.2	0.67	10.55	0	1	Kraft Discharge
(EZ)	2.10	8.7	14.4	0.67	10.55	0	1	At Phinney Branch
	1.10	15.1	15.1	0.67	10.55	2	1	Champaign-Urbana Discharge
	0.00	15.5	15.5	0.67	10.55	0	1	