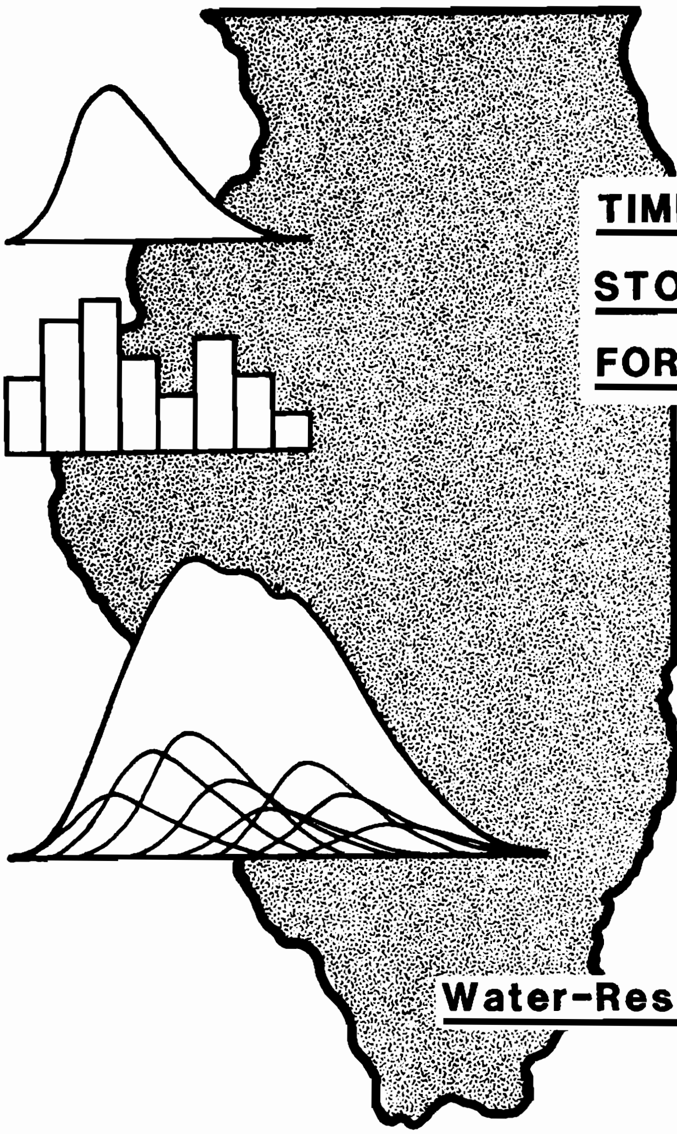
Kevin Oberg

TIME OF CONCENTRATION AND STORAGE COEFFICIENT VALUES FOR ILLINOIS STREAMS



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Values of time of concentration and storage coefficient, two unit hydrograph parameters, are presented for 194 and 120 basins in Illinois, respectively. Tabulated values consist of those computed by previous investigators as well as those computed for 98 basins as part of this investigation. These additional values were computed by calibration of the U.S. Army Corps of Engineers flood hydrograph package (HEC-1). The significance of differences in method used by each investigator to compute these unit hydrograph parameters was evaluated by statistical comparison of four sets of time of concentration values and three sets of storage coefficient values. Because no difference due to method was identified, it is concluded that all of the values tabulated in this report can be used in any application for which time of concentration and storage coefficient are required.

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GLOSSARY OF TECHNICAL TERMS

Discharge. The volume of water, in cubic feet per second, that passes a given point and within a given period of time.

Drainage area. The area, in square miles, measured in a horizontal plane, which is enclosed by a drainage divide.

DLTKR. A HEC-1 loss-rate parameter which is the amount of initial accumulated rainfall loss during which the decrease in loss-rate coefficient is parabolic.

ERAIN. A HEC-1 loss-rate parameter that is the exponent of precipitation in the loss function.

Excess rainfall. Volume of rainfall available for direct runoff.

Gaging station. A particular site on a stream where systematic observations of gage height and discharge are obtained.

Hydrograph. A graph showing stage, discharge, velocity, or other property of water with respect to time.

Inflection point. Point on the recession limb of a hydrograph at which the curvature changes fron concave downward to concave upward.

Instantaneous unit hydrograph. A hydrograph of direct runoff resulting from 1 inch of uniformly-distributed excess rainfall occurring instantaneously over the entire drainage area.

Length. Stream length measured along the channel from the gage to the basin divide.

Loss-rate parameters. Variables which account for the difference between observed rainfall and direct runoff from a basin.

RTIOL. A HEC-1 loss-rate parameter that is the rate of exponential decrease of the loss-rate coefficient with accumulated loss.

Runoff. That part of rainfall that appears in surface streams.

Slope. Main channel slope determined from elevation at points 10 and 85 percent of the distance along the channel from the gaging station to the drainage basin divide, in feet per mile.

Storage. The volume of water naturally detained in a channel.

Storage coefficient. Proportionality constant between storage and discharge at the outflow point of a basin, a time characteristic of a basin indicative of channel storage capacity.

STRKR. A HEC-1 loss-rate parameter which is the value of loss-rate coefficient at the start of rainfall for DLTKR equal to zero.

Time of concentration. The time required for excess rainfall falling on the remotest part of a drainage area to reach the outlet or point of discharge on the stream.

Unit hydrograph. A hydrograph of direct runoff resulting from 1 inch of uniformly-distributed excess rainfall occurring in unit time.

FACTORS FOR CONVERTING INCH-POUND UNITS TO INTERNATIONAL SYSTEM OF METRIC UNITS (SI)

Multiply inch-pound unit	By	To obtain SI unit
Inch (in)	25.40	Millimeter (mm)
	2.54	Centimeter (cm)
	0.0254	Meter (m)
Mile (mi)	1.609	Kilometer (km)
Square mile (mi^2)	2.590	Square kilometer (km^2)
Cubic foot per second (ft^3/s)	0.02832	Cubic meter per second (m^3/s)
Foot per mile (ft/mi)	0.1894	Meter per kilometer (m/km)

TIME OF CONCENTRATION AND STORAGE COEFFICIENT VALUES FOR ILLINOIS STREAMS

By

Julia B. Graf, George Garklavs, and Kevin A. Oberg

ABSTRACT

Values of time of concentration and storage coefficient, two unit hydrograph parameters, are presented for 194 and 120 basins in Illinois, respectively. Tabulated values consist of those computed by previous investigators as well as those computed for 98 basins as part of this investigation. These additional values were computed by calibration of the U.S. Army Corps of Engineers Flood Hydrograph Package (HEC-1). The significance of differences in method used by each investigator to compute these unit hydrograph parameters was evaluated by statistical comparison of four sets of time of concentration values and three sets of storage coefficient values. Because no difference due to method was identified, it is concluded that all of the values in table 1 in this report can be used in any application for which time of concentration and storage coefficient are required.

INTRODUCTION

Time of concentration and storage coefficient are parameters used to model runoff response of a basin to a given rainfall. A discharge hydrograph is required in many design and management applications which, in addition to peak flow, require knowledge of total runoff volume and its time distribution. Before 1978, values of the unit hydrograph parameters had been computed by Mitchell (1948, 1954) and Curtis (1977) for some gaged basins in Illinois. However, the definition of time of concentration and methods used to compute values of the two parameters differed from study to study. Also, storage coefficient had not been computed for all basins studied. For these reasons, and because of a need for time of concentration and storage coefficient for basins not included in previous investigations, a study to compile these values, to compute additional ones, and to evaluate the compatibility of new and previously available data was done in cooperation with the Illinois Department of Transportation, Division of Water Resources.

This report presents a summary of previous work, description of methods used to obtain additional values of time of concentration and storage coefficient, a compilation in tabular format of previously available and new values, and a comparison of values computed by the different investigators.

PREVIOUS WORK

Values of the unit hydrograph parameters have been computed for streams in Illinois as a part of several studies (Mitchell, 1948, 1954, 1972; Curtis, 1977). Mitchell (1948, 1954) computed values of time of concentration for 77 streams with drainage basins ranging in area from 9.81 to 3,090 square miles. Both time of concentration and storage coefficient calculated by Mitchell for 28 additional basins as supporting data for other reports (Mitchell, 1962, 1972) were presented by Curtis (1977). Values for those 28 streams that have drainage areas less than 10.2 square miles are referred to hereafter as Mitchell (1972) data. Curtis (1977) computed storage coefficient and a parameter related to time of concentration for 23 additional streams having drainage areas of less than 10 square miles. Locations of gaging stations used by Mitchell and Curtis are given in figure 1.

For Mitchell (1972) computations, time of concentration is defined as the time between the end of the excess rainfall and the inflection point on the recession limb of the discharge hydrograph. Times of concentration computed earlier by Mitchell (1948, 1954) were taken to be the time difference between the center of mass of excess rainfall and the center of mass of direct runoff. The time parameter computed by Curtis (1977) is the time base of a triangular translation hydrograph (TC). That value is not directly comparable to the time parameter of Mitchell. In this study, Curtis' values were converted to values of time lag (TL) by the relation (Lichty and Liscum, 1978),

$$TL = (TC/2) + KSW, \qquad (1)$$

where KSW is the storage coefficient determined by a U.S. Geological Survey model (Dawdy, Lichty, and Bergmann, 1972). This time lag is the difference in time between the center of mass of excess rainfall and the center of mass of runoff (Wibben, 1976) and therefore is the same as Mitchell's (1948, 1954) time of concentration.

Mitchell's (1972) storage coefficient, k, and Curtis' (1977) storage coefficient, KSW, each represent the relation between storage and outflow for a basin. Clark (1945) defined a storage coefficient, which he called K, as:

$$K = Q_i \,/\, (dQ/dt), \qquad (2)$$

where Q_i is the discharge at the inflection point on the recession limb of the discharge hydrograph and dQ/dt is the rate of change of discharge with time at that point. Equation 2 is derived from the Muskingum routing equations assuming linear storage and solving at the time when inflow is assumed to have ceased. Mitchell's k, Curtis' KSW, and Clark's K are equivalent.

Values of time of concentration and storage coefficient computed by Mitchell and Curtis are given in table 1.

PRESENT STUDY

The Rainfall-Runoff Model

Times of concentration and storage coefficients determined in this study were computed by calibrating the U.S. Army Corps of Engineers Hydrologic Engineering Center (1973) flood hydrograph package (HEC-1). Selection of basins for model calibration was based on the availability of data from suitable runoff events. Basins selected ranged in drainage area from 0.45 to 362 square miles. Location of gaging stations used for calibration of the HEC-1 model are shown in figure 2.

The HEC-1 program uses a lumped-parameter approach to modeling runoff. Model parameters and rainfall data are considered to be averages for each basin. Because the model makes no provision for recovery of soil-moisture capacity and no accounting is made of rainfall losses, the program is appropriate for single event simulation only. The main components of the study program are described below. The reader is referred to the HEC-1 users manual (U.S. Army Corps of Engineers, 1973) for a comprehensive description and explanation of the program.

Instantaneous Unit Hydrograph

The HEC-1 program uses the instantaneous-unit-hydrograph concept and linear-routing scheme described by Clark (1945) to compute a discharge hydrograph from excess rainfall and to route it through the basin. Two basic assumptions of Clark's method are that rainfall is evenly distributed over the basin and that channel storage is linearly related to discharge at the point of basin outflow.

Clark's (1945) time of concentration (T) is defined as the time from the end of excess rainfall to the inflection point of the recession limb of the discharge hydrograph. This is equivalent to the definition of time of concentration (TC) in the HEC-1 model and is intended to represent the time required for a drop of rain falling on the most distant point of a basin to reach the gage. The storage coefficient, R, in the HEC-1 model is equivalent to Clark's storage coefficient, K, defined in equation 2, and is measured in units of time.

In Clark's method, the time of concentration and the storage coefficient are used to construct the unit hydrograph and route it through the basin. A time-area curve provides the means for translating runoff from incremental subareas to the basin outflow point. The time-area curve is developed by dividing each basin into zones separated by lines of equal traveltime to the point of basin outflow. The area of each zone is measured and tabulated cumulatively for each incremental zone from the gage to the basin divide.

Determination of Excess Rainfall

The exponential-loss option of the HEC-1 program was used to obtain excess rainfall from the observed rainfall. A loss function with four adjustable parameters (RTIOL, DLTKR, STRKR, ERAIN) is used to calculate rainfall losses. For a given time interval, losses are computed by multiplying a loss-rate coefficient by the precipitation raised to the ERAIN (dimensionless) power. Excess rainfall is computed as the difference between observed rainfall and computed losses for each time interval. The loss-rate coefficient, which is a maximum at the start of rainfall and decreases with accumulated loss, is dependent upon RTIOL, STRKR, and DLTKR.

Optimization Technique

The HEC-1 program uses a nonlinear optimization algorithm to calculate parameters. The algorithm minimizes an objective function equal to the square root of the weighted squared differences between observed and computed flows. Weightings are computed to give greater importance to higher flows.

Determination of Model Parameters

Event Selection

Daily discharge records were reviewed to select the initial runoff events. The period between November and March was excluded to avoid complications of frozen ground, snowfall, and snowmelt. Temperature records for the fall and spring were examined to ensure that both snow and frozen ground were absent. Because of the assumptions and limitations of the model, discharge hydrographs chosen were isolated events whenever possible. For gaging stations with 10 or more years of stage record, six to eight runoff events were used in the calibration (table 2). A few of the stations included in the study had less than 10 years of record, and four or five runoff events were used.

Rainfall data were obtained from the National Oceanic and Atmospheric Administration publications "Climatological Data" and "Hourly Precipitation Data." Data from USGS (U.S. Geological Survey) rain gages were available at some sites. Rain gages for each basin were chosen to define the spatial and temporal distribution of rainfall. Because temporal distribution of rainfall is an important input to the model, two or three rain gages with hourly data were selected in or near the basin. Two or three additional gages, in or near the basin, for which total storm rainfall is available were selected to better define the spatial distribution.

Model Calibration

The following procedure was used to calibrate the model for each basin. A time-area curve was developed using USGS topographic maps as a base for subdividing the drainage basin. For each runoff event, weightings were assigned to total storm rainfall on the basis of distance of the rain gage from the basin center and areal distribution of rainfall. The weightings are used by the program to compute the total basin-average rainfall (U.S. Army Corps of Engineers, 1973, p. 5). Gages with hourly data were weighted on the basis of spatial and temporal distribution of rainfall, and weighted values for each time interval of rainfall were used by the program to distribute the total storm rainfall in time.

A two-stage procedure was used to obtain optimum basin-average values of the two hydrograph parameters, TC and R. First, optimum values of each of the six parameters (TC, R, ERAIN, RTIOL, STRKR, DLTKR) for each runoff event used in calibration were otained by allowing the values of all parameters to adjust to reach an optimum value of the objective funtion. Results of that initial run were examined for errors in input, for the possibility that values obtained are local rather than global optimum, and for the suitability of rainfall weightings. Second, event-averaged (basin) values of TC and R were obtained. Loss-rate parameters were fixed, in turn, in the following order: ERAIN, RTIOL, STRKR, DLTKR. As each successive parameter was fixed, values of the remaining loss-rate parameters and the hydrograph parameters were allowed to change to reach an optimum value of the objective function. Once fixed values of all loss-rate parameters were determined, both TC and R were fixed at values found by averaging over all events. TC, R, and, in some cases, DLTKR, were given final adjustments to reduce the average difference between observed and computed peak discharges, total runoff volumes, and times of peak discharge as well as to improve the visual fit of the observed and computed hydrographs. Values of TC and R computed in this way for 98 gaging stations are given in table 1. The average errors in peak discharge, runoff volume, and time of peak are given in table 2.

COMPARISON OF DATA SETS

In all studies presented in this report, time of concentration is a measure of the time lag between rainfall and runoff. However, times chosen to represent rainfall and runoff have differed from study to study. Both the HEC-1 and Mitchell (1972) times of concentration are defined as the time difference between the end of excess rainfall and the inflection point on the recession limb of the discharge hydrograph. In Curtis' (1977) work and in Mitchell's (1948, 1954) earlier studies, time of concentration was measured between the center of mass of excess rainfall and the center of mass of the discharge hydrograph. Definitions are shown graphically in figure 3.

Storage coefficients computed in this study, in the Mitchell (1972) work, and by Curtis (1977) are all defined by equation 2, although the symbol used has varied from study to study.

In addition to the differences in definition of time of concentration (described above), each investigator used a different method of computing the unit hydrograph parameters. Mitchell visually inspected each hydrograph and from it selected points used in computing the parameters. In Curtis' work and in the present study, parameters were computed by the optimization techniques of a USGS rainfall-runoff model (Dawdy, Lichty, and Bergmann, 1972) and the HEC-1 model, respectively.

Four sets of time of concentration (Curtis, 1977; Graf and others, this study; Mitchell, 1948, 1954; Mitchell, 1972) and three sets of storage coefficient (Curtis, 1977; Graf and others, this study; Mitchell, 1972) were compared to determine if different computational methods and definitions produced significant differences.

A direct comparison of parameters was not feasible because few sites have values computed by more than one method. An indirect approach based on the relationship of each parameter to basin characteristics was used for the comparison. Length and slope were found from step-backward regression analysis to be the basin characteristics most significantly related to time of concentration and storage coefficient. The relation between each parameter and length and slope was used as the basis for comparing four sets of time of concentration and three sets of storage coefficient. Dummy variables were used to quantify the effect of definition and method on those relations. The model used to compare the time of concentration is given in table 3 and the model for storage coefficient in table 4.

The results show that coefficients b_3 through b_{11} (table 3) and b_3 through b_8 (table 4), when tested at the 5 percent significance level, could not be distinguished from zero under the null hypothesis. Variation within data sets is large enough to obscure any differences between sets caused by method differences. Therefore, all the data sets can be considered to come from the same population, and any of the values listed in table 1 can be used in any application requiring those unit hydrograph parameters.

SUMMARY AND CONCLUSIONS

Unit hydrograph parameters time of concentration and storage coefficient determined by three different investigators are tabulated. Table 1 includes time of concentration for 194 gaging stations, ranging in drainage area from 0.02 to 3,090 square miles, and storage coefficient for 120 gaging stations, ranging in drainage area from 0.02 to 362 square miles.

Values of the two parameters computed with the U.S. Army Corps of Engineers flood hydrograph package (HEC-1) as a part of the present study were compared indirectly with those computed by previous investigators. Analysis of covariance, based on the relationship of each parameter to channel length and slope, showed no significant differences among the four sets of time of concentration or among the three sets of storage coefficient. Therefore, times of concentration and storage coefficients computed by any of the three investigators can be used in any application in Illinois for which values of those hydrograph parameters are needed.

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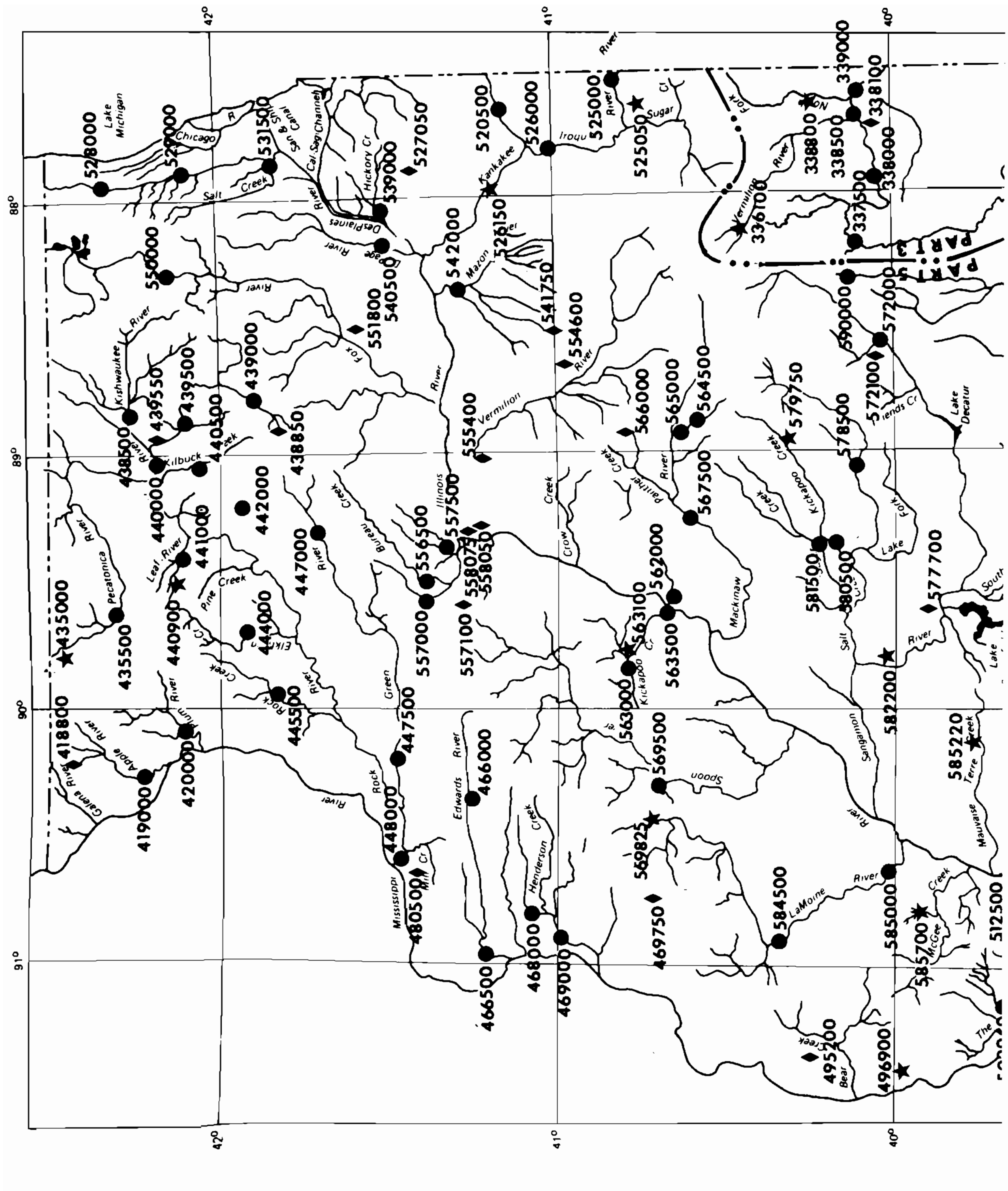
FIGURES 1 to 3; TABLES 1 to 4


42°
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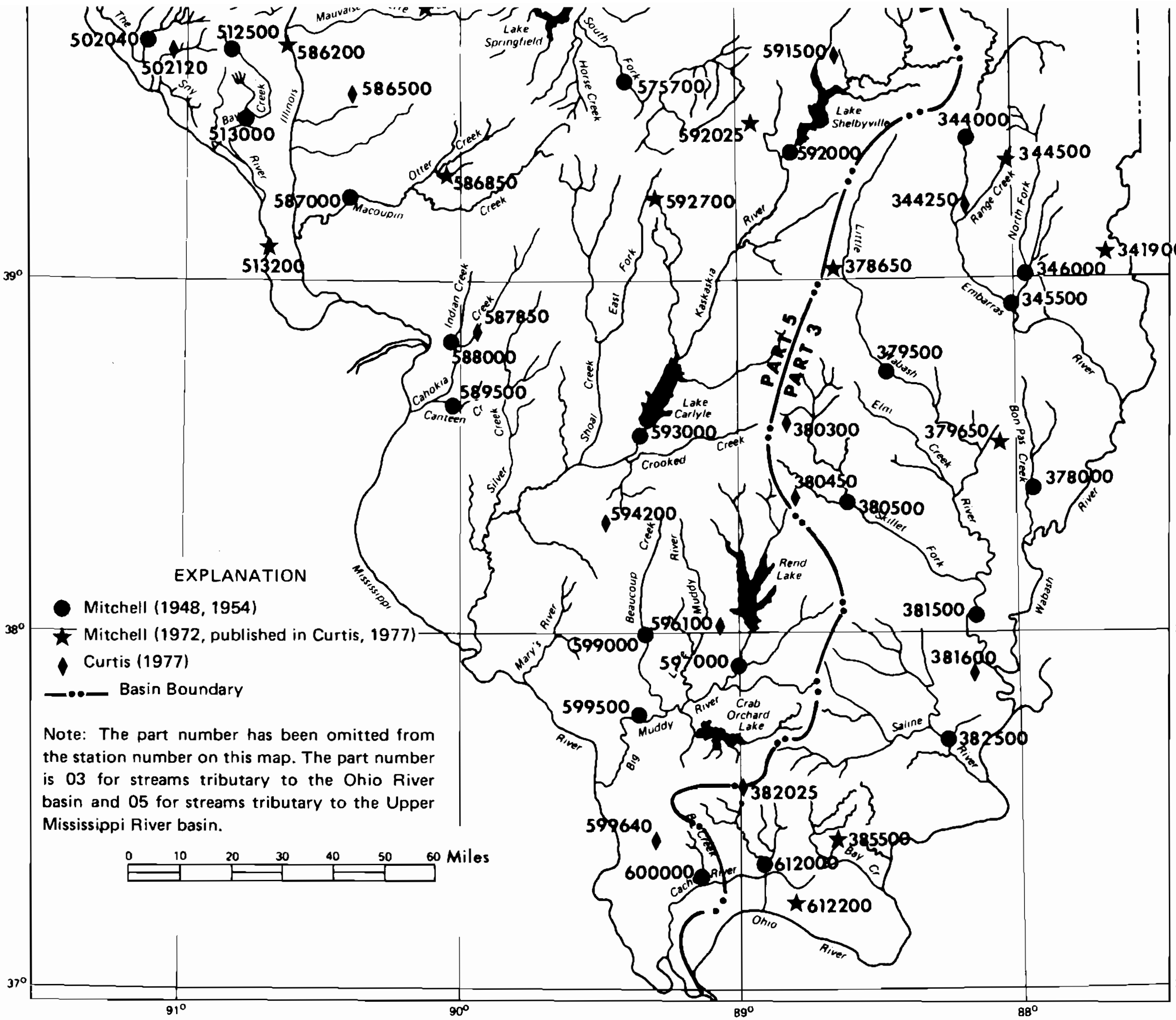
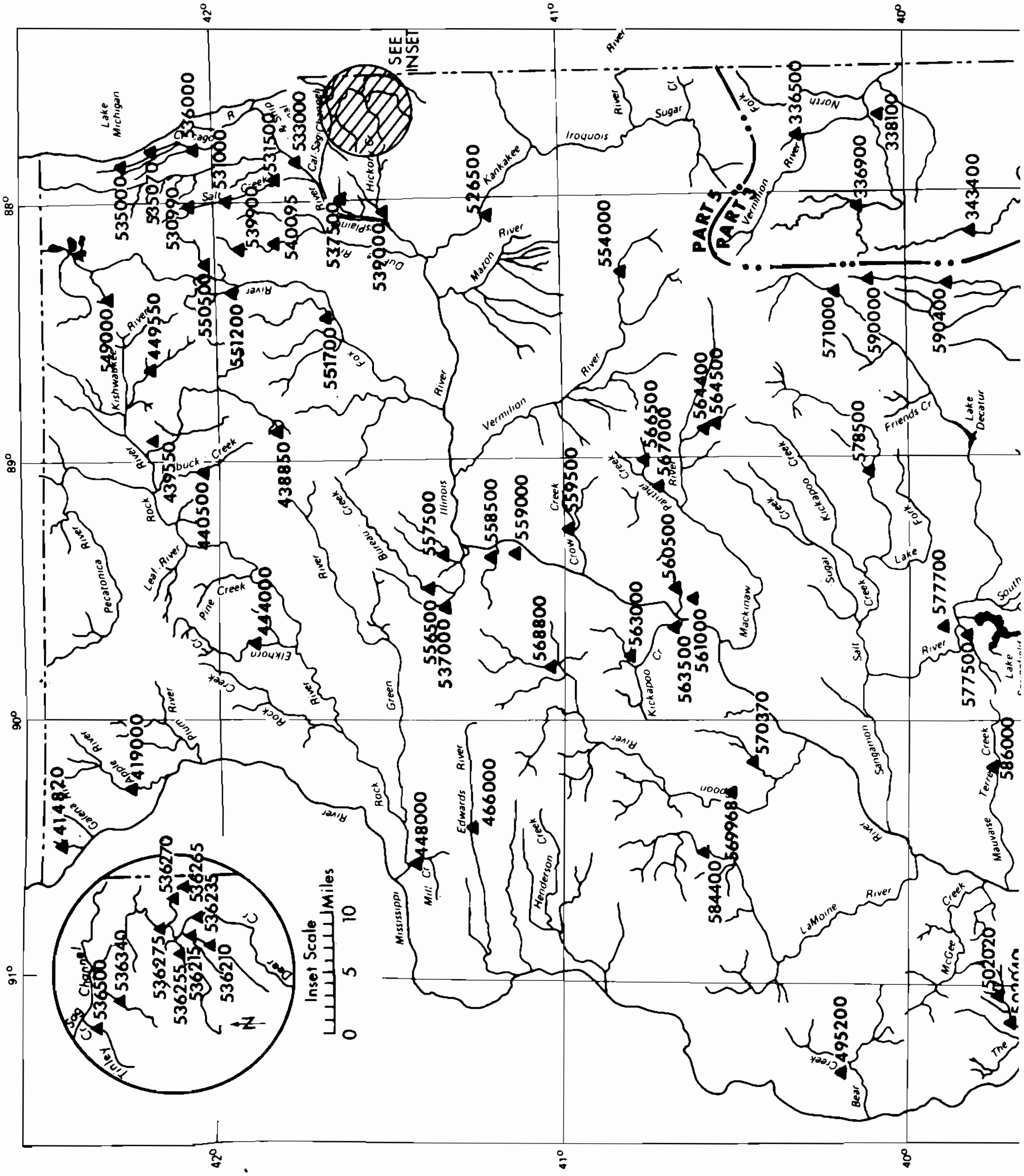


Figure 1.--Location of gaging stations used by Mitchell and Curtis.



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40°
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90°
91°
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Lake Michigan
Chicago
Salt Creek
Cal Sag Channel
Hickory Cr
Des Plaines River
Du Page River
Kankakee
Iroquois
Sugar Cr
North Fork
Vermilion River
PART 5
PART 3
Mazon River
Fox River
Kishwaukee River
Rock River
Kyte River
Leaf River
Pecatonica River
Pine Creek
Elkhorn Creek
Rock Creek
Plum River
Apple River
Galena River
Green River
Rock River
Mississippi
Mill Cr
Edwards River
Henderson Creek
Bureau Creek
Illinois
Vermilion River
Crow Creek
Panther Creek
Kickapoo Cr
Mackinaw River
Spoon River
Sangamon River
LaMoine River
Crooked Creek
McGee Creek
Bear Creek
Kickapoo Creek
Sugar Creek
Salt Creek
Lake Fork
Friends Cr
Lake Decatur
South Fork
Lake Springfield
Mauvaise Terre Creek
The
Tinley Cr
Channel
Deer Cr
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531000
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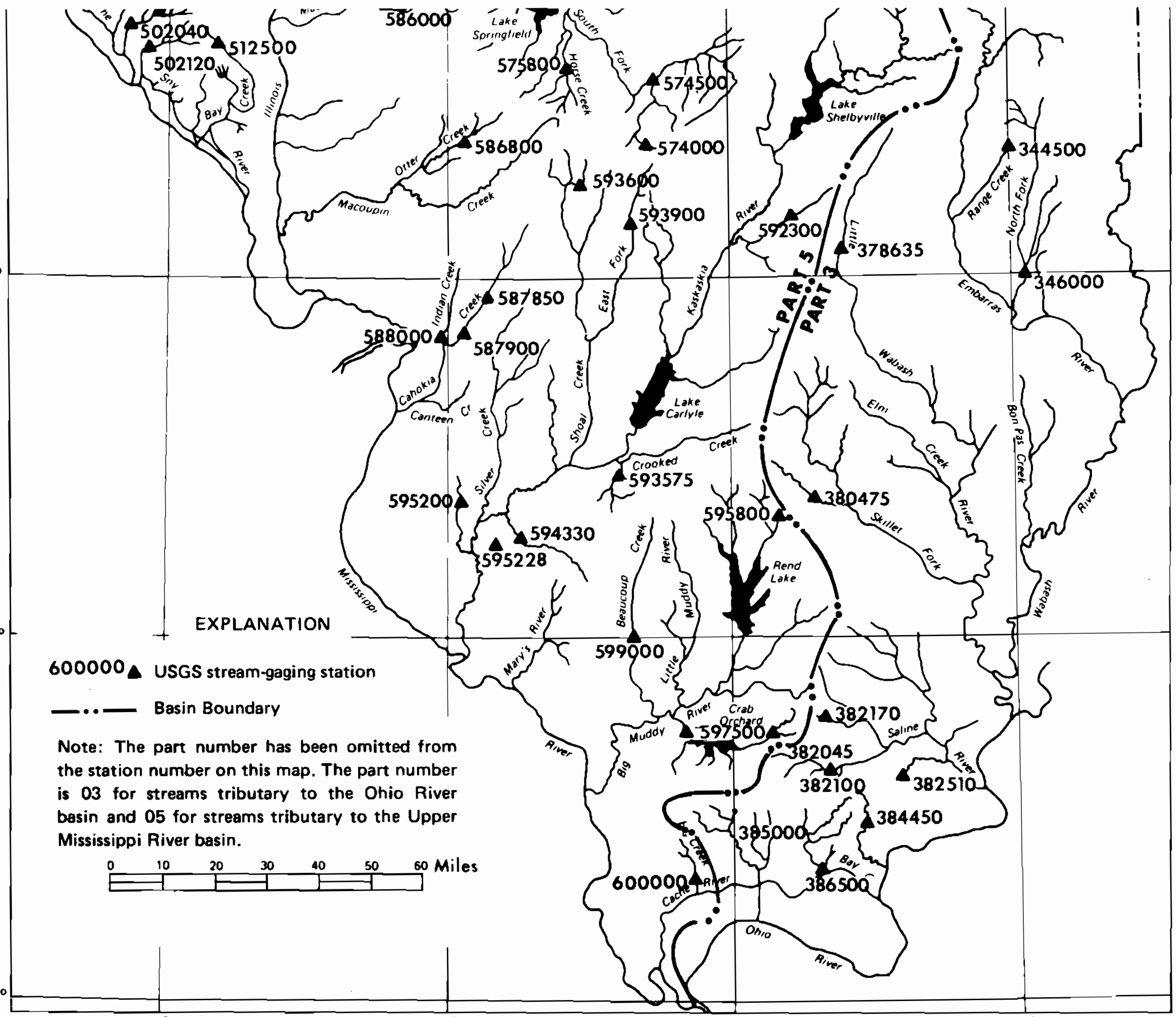

Figure 2.--Location of gaging stations for which time of concentration and storage coefficients were computed with HEC-1.

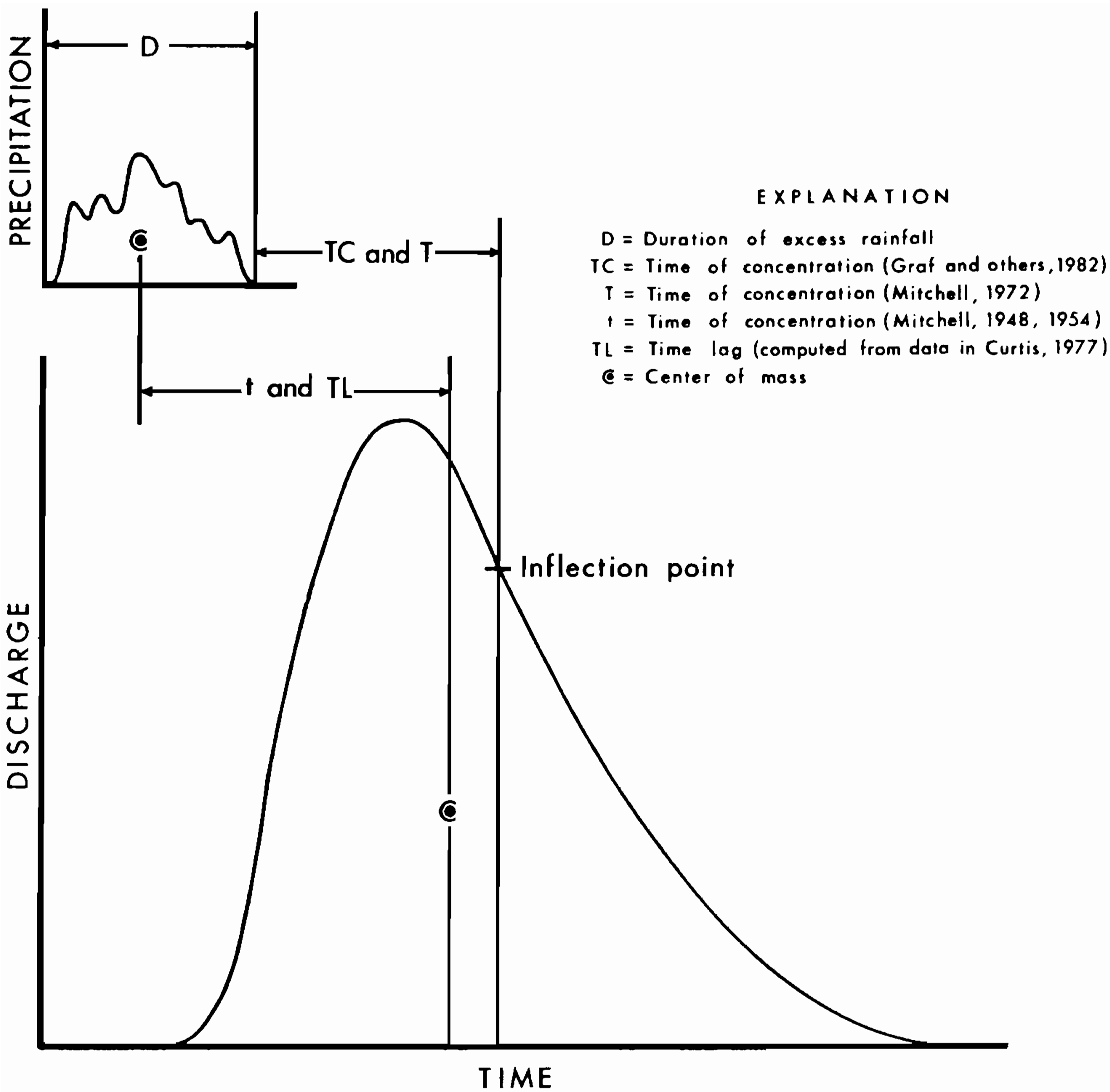

Figure 3.--Definition of times of concentration.

Table 1.--Time of concentration and storage coefficient values for Illinois streams

Values in the table are listed in order of U.S. Geological Survey gaging station number. Station name, drainage area, length, and slope above the gage are also listed to further characterize the basin. Drainage area values were obtained from the published report of each investigator (Mitchell, 1948, 1954; Curtis, 1977) or from Healy (1979a, 1979b) for previously unpublished data. Mitchell (1948) published values of length, and those values are included in the table. All other length values were obtained from Healy (1979a, 1979b). U.S. Geological Survey files were the source of all values of slope.

Gaged basins for which more than one investigator has computed time of concentration or storage coefficient are listed as a single entry except where published values of drainage area or length differ between investigators. Where values differ an entry is made for each investigator. Recomputations of drainage area and length account for the differences.

Symbols used to identify the parameters in the table are those used by the investigators cited. Values in the column labeled TL are Curtis' TC values converted to time lag with equation 1.

t = time of concentration (Mitchell, 1948, 1954)
T = time of concentration (Mitchell, 1972, published in Curtis, 1977)
TL = time lag converted by equation 1 from Curtis (1977)
TC = time of concentration (Graf and others, this paper)
k = storage coefficient (Mitchell, 1972, published in Curtis, 1977)
KSW = storage coefficient (Curtis, 1977)
R = storage coefficient (Graf and others, this paper)

Station No.	Station name	Drainage area (mi^2)	Slope (ft/mi)	Length (mi)	t (h)	T (h)	TL (h)	TC (h)	k (h)	KSW (h)	R (h)
03336100	Big Four Ditch tributary near Paxton, Ill.	1.05	21.01	2.16	-----	3.68	-----	-----	1.35	-----	-----
03336500	Bluegrass Creek at Potomac, Ill.	35.0	6.92	11.80	-----	----	-----	12.00	----	-----	5.50
03336900	Salt Fork near St. Joseph, Ill.	134	5.49	24.30	-----	----	-----	15.38	----	-----	22.00
03337500	Saline Branch at Urbana, Ill.[1]	71.4	2.59	16.80	21.60	----	-----	-----	----	-----	-----
03338000	Salt Fork near Homer, Ill.[2]	344	3.01	45.70	50.90	----	-----	-----	----	-----	-----
03338100	Salt Fork tributary near Catlin, Ill.	2.20	15.81	3.30	-----	----	3.99	2.10	----	2.54	2.11
03338500	Vermilion River near Catlin, Ill.	959	3.12	68.50	56.80	----	-----	-----	----	-----	-----
03338800	North Fork Vermilion River tributary near Danville, Ill.	1.31	33.21	2.21	-----	1.70	-----	-----	1.03	-----	-----

[1] Previously published as West Branch Salt Fork at Urbana, Ill.
[2] Previously published as Salt Fork Vermilion River near Homer, Ill.

Table 1.--Time of concentration and storage coefficient values for Illinois streams--Continued

Station No.	Station name	Drainage area (mi^2)	Slope (ft/mi)	Length (mi)	t (h)	T (h)	TL (h)	TC (h)	k (h)	KSW (h)	R (h)
03339000	Vermilion River near Danville, Ill.	1,280	3.22	78.00	57.60	----	-----	-----	----	-----	-----
03341900	Raccoon Creek tributary near Annapolis, Ill.	0.04	52.80	0.30	-----	0.27	-----	-----	0.25	-----	-----
03343400	Embarras River near Camargo, Ill.	186	2.96	27.50	-----	----	-----	54.00	----	-----	25.00
03344000	Embarras River near Diona, Ill.	903	1.53	73.10	64.20	----	-----	-----	----	-----	-----
03344250	Embarras River tributary near Greenup, Ill.	0.08	10.51	0.38	-----	----	1.86	-----	----	1.66	-----
03344500	Range Creek near Casey, Ill.	7.61	15.73	4.60	-----	----	-----	7.45	----	-----	1.25
	Range Creek near Casey, Ill.	7.61	15.73	4.58*	-----	3.58	-----	-----	2.98	-----	-----
03345500	Embarras River at Ste. Marie, Ill.	1,540	1.58	117.00	68.40	----	-----	-----	----	-----	-----
03346000	North Fork Embarras River near Oblong, Ill.	319	4.33	51.40	-----	----	-----	60.00	----	-----	19.11
	North Fork Embarras River near Oblong, Ill.	304*	4.33	43.70*	37.70	----	-----	-----	----	-----	-----
03378000	Bonpas Creek at Browns, Ill.	235	2.85	32.60	65.70	----	-----	-----	----	-----	-----
03378635	Little Wabash River near Effingham, Ill.	240	5.34	34.80	-----	----	-----	27.88	----	-----	12.00
03378650	Second Creek tributary at Keptown, Ill.	1.62	19.59	2.80	-----	1.52	-----	-----	1.46	-----	-----
03379500	Little Wabash River below Clay City, Ill.[3]	1,130	2.01	108.80	70.60	----	-----	-----	----	-----	-----
03379650	Madden Creek near West Salem, Ill.	1.62	36.06	1.62	-----	2.50	-----	-----	0.75	-----	-----
03380300	Dums Creek tributary near Iuka, Ill.	0.08	98.74	0.40	-----	----	0.46	-----	----	0.09	-----
03380450	White Feather Creek near Marlow, Ill.	0.43	87.65	1.11	-----	----	1.09	-----	----	0.34	-----

* Value subsequently revised as a result of recomputations.
[3] Previously published as Little Wabash River at Wilcox, Ill.

Table 1.--Time of concentration and storage coefficient values for Illinois streams--Continued

Station No.	Station name	Drainage area (mi^2)	Slope (ft/mi)	Length (mi)	t (h)	T (h)	TL (h)	TC (h)	k (h)	KSW (h)	R (h)
03380475	Horse Creek near Keenes, Ill.	97.2	4.07	25.40	-----	----	-----	31.50	----	-----	12.60
03380500	Skillet Fork at Wayne City, Ill.	475	1.90	44.60	54.40	----	-----	-----	----	-----	-----
03381500	Little Wabash River at Carmi, Ill.	3,090	1.16	148.00	238.00	----	-----	-----	----	-----	-----
03381600	Little Wabash River tributary near New Haven, Ill.	0.16	89.76	0.62	-----	----	0.60	-----	----	0.21	-----
03382025	Little Saline Creek tributary near Goreville, Ill.	0.52	75.50	1.13	-----	----	1.28	-----	----	0.50	-----
03382045	Little Cana Creek near Creal Springs, Ill.	1.45	41.80	1.60	-----	----	-----	1.10	----	-----	0.60
03382100	South Fork Saline River near Carrier Mills, Ill.	147	4.26	41.60	-----	----	-----	19.90	----	-----	20.00
03382170	Brushy Creek near Harco, Ill.	13.3	12.16	8.80	-----	----	-----	5.42	----	-----	4.85
03382500	Saline River near Junction, Ill.	1,040	3.22	75.40	76.30	----	-----	-----	----	-----	-----
03382510	Eagle Creek near Equality, Ill.	8.51	25.49	5.30	-----	----	-----	7.40	----	-----	5.75
03384450	Lusk Creek near Eddyville, Ill.	42.9	16.23	14.30	-----	----	-----	3.79	----	-----	3.23
03385000	Hayes Creek at Glendale, Ill.	19.1	21.44	12.00	-----	----	-----	10.00	----	-----	7.00
03386500	Sugar Creek near Dixon Springs, Ill.	9.93	25.24	6.20	-----	----	-----	1.20	----	-----	1.90
03612000	Cache River at Forman, Ill.	242	2.69	35.90	55.80	----	-----	-----	----	-----	-----
03612200	Q Ditch tributary near Choat, Ill.	0.27	140.98	0.80	-----	0.85	-----	-----	0.40	-----	-----
05414820	Sinsinawa River near Menominee, Ill.	39.6	18.91	14.50	-----	----	-----	4.50	----	-----	2.00
05418800	Mill Creek tributary near Scales Mound, Ill.	0.86	157.87	1.51	-----	----	1.14	-----	----	0.42	-----
05419000	Apple River near Hanover, Ill.	247	10.93	41.10	-----	----	-----	14.00	----	-----	10.80
	Apple River near Hanover, Ill.	244*	10.93	41.10	15.00	----	-----	-----	----	-----	-----

* Value subsequently revised as a result of recomputations.

Table 1.--Time of concentration and storage coefficient values for Illinois streams--Continued

Station No.	Station name	Drainage area (mi^2)	Slope (ft/mi)	Length (mi)	t (h)	T (h)	TL (h)	TC (h)	k (h)	KSW (h)	R (h)
05420000	Plum River below Carroll Creek near Savanna, Ill.	231	6.55	31.80	22.00	----	-----	-----	----	-----	-----
05435000	Cedar Creek near Winslow, Ill.	1.31	40.90	2.10	-----	1.61	-----	-----	1.34	-----	-----
05435500	Pecatonica River at Freeport, Ill.	1,330	1.61	85.10	72.10	----	-----	-----	----	-----	-----
05438250	Coon Creek at Riley, Ill.	85.1	5.72	16.30	-----	----	-----	17.00	----	-----	28.00
05438500	Kishwaukee River at Belvidere, Ill.	525	4.59	35.00	23.50	----	-----	-----	----	-----	-----
05438850	Middle Branch of South Branch Kishwaukee River near Malta, Ill.	1.67	28.72	2.30	-----	----	1.91	1.02	----	1.45	0.78
05439000	South Branch Kishwaukee River at De Kalb, Ill.	70.0	2.96	18.60	30.00	----	-----	-----	----	-----	-----
05439500	South Branch Kishwaukee River near Fairdale, Ill.	386	2.27	46.20	30.40	----	-----	-----	----	-----	-----
05439550	South Branch Kishwaukee River tributary near Irene, Ill.	1.71	53.75	2.22	-----	----	1.71	1.32	----	0.80	0.74
05440000	Kishwaukee River near Perryville, Ill.	1,090	4.07	47.10	36.80	----	-----	-----	----	-----	-----
05440500	Killbuck Creek near Monroe Center, Ill.	117	6.34	26.30	-----	----	-----	12.05	----	-----	9.18
	Killbuck Creek near Monroe Center, Ill.	114*	6.34	20.60*	21.70	----	-----	-----	----	-----	-----
05440900	Leaf River tributary near Forreston, Ill.	0.15	144.14	0.81	-----	0.33	-----	-----	0.22	-----	-----
05441000	Leaf River at Leaf River, Ill.	102	10.45	21.60	8.40	----	-----	-----	----	-----	-----
05442000	Kyte River near Flagg Center, Ill.	125	5.17	17.00	25.20	----	-----	-----	----	-----	-----
05444000	Elkhorn Creek near Penrose, Ill.	146	4.28	36.20	-----	----	-----	8.20	----	-----	17.35
	Elkhorn Creek near Penrose, Ill.	153*	4.28	34.80*	13.60	----	-----	-----	----	-----	-----
05445500	Rock Creek near Morrison, Ill.	143	3.91	36.10	16.70	----	-----	-----	----	-----	-----

* Value subsequently revised as a result of recomputations.

Table 1.--Time of concentration and storage coefficient values for Illinois streams--Continued

Station No.	Station name	Drainage area (mi^2)	Slope (ft/mi)	Length (mi)	t (h)	T (h)	TL (h)	TC (h)	k (h)	KSW (h)	R (h)
05447000	Green River at Amboy, Ill.	199	3.85	24.60	26.70	----	-----	-----	----	-----	-----
05447500	Green River near Geneseo, Ill.	958	2.53	77.30	60.40	----	-----	-----	----	-----	-----
05448000	Mill Creek at Milan, Ill.	62.4	7.44	21.60	-----	----	-----	7.20	----	-----	3.00
	Mill Creek at Milan, Ill.	62.5*	7.44	19.90*	13.60	----	-----	-----	----	-----	-----
05466000	Edwards River near Orion, Ill.	155	5.07	23.90	-----	----	-----	13.00	----	-----	15.00
	Edwards River near Orion, Ill.	163*	5.07	32.80*	14.50	----	-----	-----	----	-----	-----
05466500	Edwards River near New Boston, Ill.	434	2.69	77.70	38.90	----	-----	-----	----	-----	-----
05468000	North Henderson Creek near Seaton, Ill.	66.4	5.02	27.60	22.00	----	-----	-----	----	-----	-----
05469000	Henderson Creek near Oquawka, Ill.	428	3.96	41.00	43.50	----	-----	-----	----	-----	-----
05469750	Ellison Creek tributary near Roseville, Ill.	0.26	28.78	1.67	-----	----	1.24	-----	----	0.63	-----
05495200	Little Creek near Breckenridge, Ill.	1.45	34.48	1.30	-----	----	1.29	0.33	----	0.72	0.86
05496900	Homan Creek tributary near Quincy, Ill.	0.50	105.60	1.29	-----	0.50	-----	-----	0.30	-----	-----
05502020	Hadley Creek near Barry, Ill.	40.9	19.75	11.30	-----	----	-----	4.07	----	-----	1.87
05502040	Hadley Creek at Kinderhook, Ill.	72.7	15.00	18.10	-----	----	-----	6.80	----	-----	2.12
	Hadley Creek at Kinderhook, Ill.	72.7	15.00	16.80*	5.74	----	-----	-----	----	-----	-----
05502120	Kiser Creek tributary near Barry, Ill.	0.78	78.67	1.20	-----	----	1.06	0.58	----	0.57	0.62
05512500	Bay Creek at Pittsfield, Ill.	39.4	11.25	11.90	-----	----	-----	3.20	----	-----	1.70
	Bay Creek at Pittsfield, Ill.	39.6*	11.25	11.70*	6.31	----	-----	-----	----	-----	-----
05513000	Bay Creek at Nebo, Ill.	162	7.02	35.70	23.50	----	-----	-----	----	-----	-----
05513200	Salt Spring Creek near Gilead, Ill.	1.20	122.50	1.89	-----	0.57	-----	-----	0.29	-----	-----

* Value subsequently revised as a result of recomputations.

Table 1.--Time of concentration and storage coefficient values for Illinois streams--Continued

Station No.	Station name	Drainage area (mi^2)	Slope (ft/mi)	Length (mi)	t (h)	T (h)	TL (h)	TC (h)	k (h)	KSW (h)	R (h)
05520500	Kankakee River at Momence, Ill.	2,340	0.90	89.80	143.00	----	-----	-----	----	-----	-----
05525000	Iroquois River at Iroquois, Ill.	682	1.11	50.40	87.80	----	-----	-----	----	-----	-----
05525050	Eastburn Hollow near Sheldon, Ill.	10.2	8.34	5.25	-----	6.98	-----	-----	7.18	-----	-----
05526000	Iroquois River near Chebanse, Ill.	2,120	0.69	100.26	87.00	----	-----	-----	----	-----	-----
05526150	Kankakee River tributary near Bourbonnais, Ill.	0.19	56.50	0.63	-----	0.88	-----	-----	0.40	-----	-----
05526500	Terry Creek near Custer Park, Ill.	12.1	11.93	6.70	-----	----	-----	6.16	----	-----	10.00
05527050	Prairie Creek near Frankfort, Ill.	0.80	29.67	1.90	-----	----	3.58	-----	----	1.50	-----
05528000	Des Plaines River at Russell, Ill.	215	1.27	38.80	64.00	----	-----	-----	----	-----	-----
05529000	Des Plaines River near Des Plaines, Ill.	374	1.11	63.30	45.90	----	-----	-----	----	-----	-----
05530990	Salt Creek at Rolling Meadows, Ill.	30.5	13.13	10.30	-----	----	-----	1.25	----	-----	6.39
05531000	Salt Creek near Arlington Heights, Ill.	32.1	13.39	11.30	-----	----	-----	2.65	----	-----	15.00
05531500	Salt Creek at Western Springs, Ill.	114	2.85	37.10	-----	----	-----	5.73	----	-----	8.60
	Salt Creek at Western Springs, Ill.	122*	2.85	37.10	42.00	----	-----	-----	----	-----	-----
05533000	Flag Creek near Willow Springs, Ill.	16.5	14.04	6.60	-----	----	-----	2.40	----	-----	7.00
05535000	Skokie River at Lake Forest, Ill.	13.0	5.58	10.80	-----	----	-----	3.40	----	-----	14.50
05535070	Skokie River near Highland Park, Ill.	21.1	5.29	16.60	-----	----	-----	5.63	----	-----	9.91
05536000	North Branch Chicago River at Niles, Ill.	100	2.94	26.80	-----	----	-----	13.28	----	-----	25.30
05536210	Thorn Creek near Chicago Heights, Ill.	17.2	17.51	8.70	-----	----	-----	4.08	----	-----	10.11
05536215	Thorn Creek at Glenwood, Ill.	24.7	15.68	10.30	-----	----	-----	7.30	----	-----	12.60
05536235	Deer Creek near Chicago Heights, Ill.	23.1	9.72	14.70	-----	----	-----	15.50	----	-----	25.75

* Value subsequently revised as a result of recomputations.

Table 1.--Time of concentration and storage coefficient values for Illinois streams--Continued

Station No.	Station name	Drainage area (mi^2)	Slope (ft/mi)	Length (mi)	t (h)	T (h)	TL (h)	TC (h)	k (h)	KSW (h)	R (h)
05536255	Butterfield Creek at Flossmoor, Ill.	23.5	6.34	14.60	-----	----	-----	5.80	----	-----	14.91
05536265	Lansing Ditch near Lansing, Ill.	8.84	8.71	7.05	-----	----	-----	12.30	----	-----	26.05
05536270	North Creek near Lansing, Ill.	16.8	6.34	9.70	-----	----	-----	9.58	----	-----	28.24
05536275	Thorn Creek at Thornton, Ill.	104	10.82	15.30	-----	----	-----	24.30	----	-----	25.85
05536340	Midlothian Creek at Oak Forest, Ill.	12.6	8.33	8.80	-----	----	-----	15.00	----	-----	23.24
05536500	Tinley Creek near Palos Park, Ill.	11.2	11.46	9.20	-----	----	-----	10.00	----	-----	11.00
05537500	Long Run near Lemont, Ill.	20.9	7.81	9.20	-----	----	-----	4.06	----	-----	8.33
05539000	Hickory Creek at Joliet, Ill.	107	7.55	23.40	21.60	----	-----	12.50	----	-----	14.00
05539900	West Branch Du Page River near West Chicago, Ill.	28.5	6.58	13.90	-----	----	-----	18.80	----	-----	25.00
05540095	West Branch Du Page River near Warrenville, Ill.	90.4	4.97	24.20	-----	----	-----	37.30	----	-----	18.00
05540500	Du Page River at Shorewood, Ill.[4]	325	4.38	43.20	32.80	----	-----	-----	----	-----	-----
05541750	Mazon River tributary near Gardner, Ill.	4.52	6.55	4.89	-----	----	21.77	-----	----	19.00	-----
05542000	Mazon River near Coal City, Ill.	470	4.33	32.40	33.00	----	-----	-----	----	-----	-----
05549000	Boone Creek near McHenry, Ill.	15.5	7.34	8.80	-----	----	-----	8.30	----	-----	10.00
05550000	Fox River at Algonquin, Ill.	1,364	0.90	96.00	84.80	----	-----	-----	----	-----	-----
05550500	Poplar Creek at Elgin, Ill.	35.2	9.08	15.30	-----	----	-----	11.60	----	-----	40.00
05551200	Ferson Creek near St. Charles, Ill.	51.7	13.31	12.70	-----	----	-----	16.75	----	-----	27.00
05551700	Blackberry Creek near Yorkville, Ill.	70.2	5.60	31.30	-----	----	-----	60.30	----	-----	30.00
05551800	Fox River tributary No. 2 near Fox, Ill.	0.45	87.12	1.02	-----	----	1.63	-----	----	0.69	-----

[4] Previously published as Du Page River at Troy, Ill.

Table 1.--Time of concentration and storage coefficient values for Illinois streams--Continued

Station No.	Station name	Drainage area (mi^2)	Slope (ft/mi)	Length (mi)	t (h)	T (h)	TL (h)	TC (h)	k (h)	KSW (h)	R (h)
05554000	North Fork Vermilion River near Charlotte, Ill.	186	5.39	23.00	-----	----	-----	13.25	----	-----	22.00
05554500	Vermilion River at Pontiac, Ill.	568	1.11	54.40	80.20	----	-----	-----	----	-----	-----
05554600	Mud Creek tributary near Odell, Ill.	0.16	60.72	0.79	-----	----	1.23	-----	----	0.82	-----
05555400	Vermilion River tributary at Lowell, Ill.	0.14	50.37	0.90	-----	----	0.47	-----	----	0.34	-----
05556500	Big Bureau Creek at Princeton, Ill.	196	6.07	54.10	-----	----	-----	7.43	----	-----	18.35
	Big Bureau Creek at Princeton, Ill.[5]	186*	6.07	47.90*	23.20	----	-----	-----	----	-----	-----
05557000	West Bureau Creek at Wyanet, Ill.	86.7	9.03	16.70	-----	----	-----	3.70	----	-----	4.87
	West Bureau Creek at Wyanet, Ill.	86.3*	9.03	19.60*	11.20	----	-----	-----	----	-----	-----
05557100	West Bureau Creek tributary near Wyanet, Ill.	0.33	97.15	1.60	-----	----	0.64	-----	----	0.36	-----
05557500	East Bureau Creek near Bureau, Ill.	99.0	12.72	24.70	-----	----	-----	1.89	----	-----	5.09
	East Bureau Creek near Bureau, Ill.	101*	12.72	23.30*	12.10	----	-----	-----	----	-----	-----
05558050	Coffee Creek tributary near Florid, Ill.	0.03	228.62	0.30	-----	----	0.30	-----	----	0.10	-----
05558075	Coffee Creek tributary near Hennepin, Ill.	0.22	139.39	0.85	-----	----	0.64	-----	----	0.11	-----
05558500	Crow Creek (West) near Henry, Ill.	56.2	10.24	24.30	-----	----	-----	9.61	----	-----	5.65
05559000	Gimlet Creek at Sparland, Ill.	5.66	53.86	4.81	-----	----	-----	1.55	----	-----	1.12
05559500	Crow Creek near Washburn, Ill.	115	6.07	27.60	-----	----	-----	5.00	----	-----	9.00
	Crow Creek near Washburn, Ill.	123*	6.07	27.60	21.20	----	-----	-----	----	-----	-----
05560500	Farm Creek at Farmdale, Ill.	27.4	17.10	14.10	-----	----	-----	5.50	----	-----	4.96

* Value subsequently revised as a result of recomputations.
[5] Previously published as Bureau Creek at Princeton, Ill.

Table 1.--Time of concentration and storage coefficient values for Illinois streams--Continued

Station No.	Station name	Drainage area (mi^2)	Slope (ft/mi)	Length (mi)	t (h)	T (h)	TL (h)	TC (h)	k (h)	KSW (h)	R (h)
05561000	Ackerman Creek at Farmdale, Ill.	11.2	39.86	7.30	-----	----	-----	2.00	----	-----	2.12
05562000	Farm Creek at East Peoria, Ill.	60.9	18.90	17.30	4.07	----	-----	-----	----	-----	-----
05563000	Kickapoo Creek near Kickapoo, Ill.	119	10.93	23.90	-----	----	-----	5.00	----	-----	3.00
	Kickapoo Creek near Kickapoo, Ill.	120*	10.93	21.60*	13.30	----	-----	-----	----	-----	-----
05563100	Kickapoo Creek tributary near Kickapoo, Ill.	0.07	76.03	0.45	-----	0.47	-----	-----	0.28	-----	-----
05563500	Kickapoo Creek at Peoria, Ill.	297	7.50	40.80	-----	----	-----	20.50	----	-----	9.50
	Kickapoo Creek at Peoria, Ill.	296*	7.50	37.40*	24.40	----	-----	-----	----	-----	-----
05564400	Money Creek near Towanda, Ill.	49.0	5.25	26.40	-----	----	-----	26.25	----	-----	5.60
05564500	Money Creek above Lake Bloomington, Ill.	53.1	4.91	28.40	-----	----	-----	16.90	----	-----	11.85
	Money Creek above Lake Bloomington, Ill.	51.9*	4.91	23.80*	22.30	----	-----	-----	----	-----	-----
05556500	Hickory Creek above Lake Bloomington, Ill.	10.1	11.88	4.90	6.10	----	-----	-----	----	-----	-----
05566000	East Branch Panther Creek near Gridley, Ill.	6.30	11.14	2.90	-----	----	9.21	-----	----	7.50	-----
05566500	East Branch Panther Creek at El Paso, Ill.	30.5	4.54	8.60	-----	----	-----	5.80	----	-----	15.00
05567000	Panther Creek near El Paso, Ill.	93.9	4.22	13.80	-----	----	-----	9.85	----	-----	13.50
05567500	Mackinaw River near Congerville, Ill.	764	2.27	57.40	43.70	----	-----	-----	----	-----	-----
05568800	Indian Creek near Wyoming, Ill.	62.7	6.44	24.20	-----	----	-----	18.60	----	-----	11.00
05569500	Spoon River at London Mills, Ill.	1,070	2.27	78.50	45.40	----	-----	-----	----	-----	-----
05569825	Cedar Creek tributary at St. Augustine, Ill.	4.06	24.39	3.98	-----	3.35	-----	-----	1.70	-----	-----

* Value subsequently revised as a result of recomputations.

Table 1.--Time of concentration and storage coefficient values for Illinois streams--Continued

Station No.	Station name	Drainage area (mi^2)	Slope (ft/mi)	Length (mi)	t (h)	T (h)	TL (h)	TC (h)	k (h)	KSW (h)	R (h)
05569968	Turkey Creek near Fiatt, Ill.	11.5	22.90	8.00	-----	----	-----	4.80	----	-----	2.50
05570370	Big Creek near Bryant, Ill.	40.3	9.95	21.70	-----	----	-----	17.20	----	-----	12.00
05571000	Sangamon River at Mahomet, Ill.	362	3.59	55.20	-----	----	-----	47.50	----	-----	37.02
05572000	Sangamon River at Monticello, Ill.	550	2.75	78.70	62.00	----	-----	-----	----	-----	-----
05572100	Wildcat Creek tributary near Monticello, Ill.	0.10	34.11	0.37	-----	----	0.72	-----	----	0.43	-----
05574000	South Fork Sangamon River near Nokomis, Ill.	11.0	18.80	5.60	-----	----	-----	2.50	----	-----	2.50
05574500	Flat Branch near Taylorville, Ill.	276	2.01	35.20	-----	----	-----	41.62	----	-----	51.30
05575500	South Fork Sangamon River at Kincaid, Ill.	510	2.01	49.80	60.30	----	-----	-----	----	-----	-----
05575800	Horse Creek at Pawnee, Ill.	52.2	5.59	15.00	-----	----	-----	17.70	----	-----	8.47
05577500	Spring Creek at Springfield, Ill.	107	5.39	30.20	-----	----	-----	17.31	----	-----	15.96
05577700	Sangamon River tributary at Andrew, Ill.	1.50	40.13	1.36	-----	----	1.99	1.17	----	1.44	0.75
05578500	Salt Creek near Rowell, Ill.	335	2.59	52.30	-----	----	-----	65.97	----	-----	70.00
	Salt Creek near Rowell, Ill.	334*	2.59	42.80*	40.00	----	-----	-----	----	-----	-----
05579750	Kickapoo Creek tributary at Heyworth, Ill.	3.06	21.75	4.17	-----	2.52	-----	-----	1.78	-----	-----
05580500	Kickapoo Creek near Lincoln, Ill.	306	5.12	43.50	38.50	----	-----	-----	----	-----	-----
05581500	Sugar Creek near Hartsburg, Ill.	335	5.76	35.70	37.50	----	-----	-----	----	-----	-----
05582200	Cabiness Creek tributary near Petersburg, Ill.	0.94	23.76	1.57	-----	1.38	-----	-----	1.10	-----	-----
05584400	Drowning Fork at Bushnell, Ill.	26.3	5.76	13.30	-----	----	-----	17.30	----	-----	16.50

* Value subsequently revised as a result of recomputations.

Table 1.--Time of concentration and storage coefficient values for Illinois streams--Continued

Station No.	Station name	Drainage area (mi^2)	Slope (ft/mi)	Length (mi)	t (h)	T (h)	TL (h)	TC (h)	k (h)	KSW (h)	R (h)
05584500	La Moine River at Colmar, Ill.	655	3.70	57.50	47.40	----	-----	-----	----	-----	-----
05585000	La Moine River at Ripley, Ill.	1,310	1.85	106.00	68.10	----	-----	-----	----	-----	-----
05585220	Indian Creek tributary near Sinclair, Ill.	3.58	27.24	2.69	-----	1.67	-----	-----	0.94	-----	-----
05585700	Dry Fork tributary near Mount Sterling, Ill.	0.15	48.58	0.49	-----	0.36	-----	-----	0.39	-----	-----
05586000	North Fork Mauvaise Terre Creek near Jacksonville, Ill.	29.1	9.03	9.20	-----	----	-----	12.10	----	-----	6.60
05586200	Illinois River tributary at Florence, Ill.	0.49	131.47	1.11	-----	0.51	-----	-----	0.17	-----	-----
05586500	Hurricane Creek near Roodhouse, Ill.	2.30	24.29	3.00	-----	----	2.23	-----	----	1.45	-----
05586800	Otter Creek near Palmyra, Ill.	61.1	11.30	16.50	-----	----	-----	20.57	----	-----	11.00
05586850	Bear Creek tributary near Reeders, Ill.	0.02	63.36	0.17	-----	0.21	-----	-----	0.58	-----	-----
05587000	Macoupin Creek near Kane, Ill.	875	2.32	76.50	50.30	----	-----	-----	----	-----	-----
05587850	Cahokia Creek tributary No. 2 near Carpenter, Ill.	0.45	42.50	0.92	-----	----	-----	0.64	----	-----	0.79
05587900	Cahokia Creek at Edwardsville, Ill.	212	5.12	42.30	-----	----	-----	7.20	----	-----	8.64
05588000	Indian Creek at Wanda, Ill.	36.7	7.92	20.10	-----	----	-----	18.00	----	-----	3.50
	Indian Creek at Wanda, Ill.	37.0*	7.92	18.80*	12.20	----	-----	-----	----	-----	-----
05589500	Canteen Creek at Caseyville, Ill.	22.5	11.09	10.10	5.02	----	-----	-----	----	-----	-----
05590000	Kaskaskia Ditch at Bondville, Ill.	12.4	17.16	5.50	-----	----	-----	2.50	----	-----	4.00
	Kaskaskia Ditch at Bondville, Ill.[6]	12.3*	17.16	5.50	16.10	----	-----	-----	----	-----	-----
05590400	Kaskaskia River near Pesotum, Ill.	109	2.46	23.70	-----	----	-----	13.60	----	-----	11.50

* Value subsequently revised as a result of recomputations.
[6] Previously published as Kaskaskia River at Bondville, Ill.

Table 1.--Time of concentration and storage coefficient values for Illinois streams--Continued

Station No.	Station name	Drainage area (mi^2)	Slope (ft/mi)	Length (mi)	t (h)	T (h)	TL (h)	TC (h)	k (h)	KSW (h)	R (h)
05591500	Asa Creek at Sullivan, Ill.	8.05	5.23	4.20	-----	----	20.30	-----	----	17.30	-----
05592000	Kaskaskia River at Shelbyville, Ill.	1,030	1.43	92.40	71.50	----	-----	-----	----	-----	-----
05592025	Mud Creek tributary near Tower Hill, Ill.	0.20	63.89	0.85	-----	0.58	-----	-----	0.46	-----	-----
05592300	Wolf Creek near Beecher City, Ill.	47.9	6.60	13.20	-----	----	-----	25.50	----	-----	3.50
05592700	Hurricane Creek tributary near Witt, Ill.	0.14	27.09	0.44	-----	0.89	-----	-----	0.56	-----	-----
05593000	Kaskaskia River at Carlyle, Ill.	2,680	1.27	167.00	146.00	----	-----	-----	----	-----	-----
05593575	Little Crooked Creek near New Minden,	84.3	4.42	17.70	-----	----	-----	21.00	----	-----	11.92
05593600	Blue Grass Creek near Raymond, Ill.	17.1	4.28	6.60	-----	----	-----	7.50	----	-----	6.70
05593900	East Fork Shoal Creek near Coffeen, Ill.	55.5	5.54	21.00	-----	----	-----	11.30	----	-----	13.00
05594200	Williams Creek near Cordes, Ill.	1.90	17.16	3.00	-----	----	3.14	-----	----	1.62	-----
05594330	Mud Creek near Marissa, Ill.	72.4	5.72	23.70	-----	----	-----	24.30	----	-----	10.00
05595200	Richland Creek near Hecker, Ill.	129	6.43	22.40	-----	----	-----	11.00	----	-----	9.50
05595228	South Branch Doza Creek near Lenzburg, Ill.	8.00	11.30	4.70	-----	----	-----	6.70	----	-----	5.30
05595800	Sevenmile Creek near Mt. Vernon, Ill.	21.1	14.52	7.40	-----	----	-----	8.85	----	-----	3.70
05596100	Andy Creek tributary at Valier, Ill.	1.03	39.02	1.78	-----	----	2.19	-----	----	0.50	-----
05597000	Big Muddy River at Plumfield, Ill.	753	1.53	67.60	110.00	----	-----	-----	----	-----	-----
05597500	Crab Orchard Creek near Marion, Ill.	31.7	8.08	11.60	-----	----	-----	15.66	----	-----	11.80
05599000	Beaucoup Creek near Matthews, Ill.	292	2.64	47.60	-----	----	-----	77.50	----	-----	30.00
	Beaucoup Creek near Matthews, Ill.	291*	2.64	47.60	54.60	----	-----	-----	----	-----	-----

* Value subsequently revised as a result of recomputations.

Table 1.--Time of concentration and storage coefficient values for Illinois streams--Continued

Station No.	Station name	Drainage area (mi^2)	Slope (ft/mi)	Length (mi)	t (h)	T (h)	TL (h)	TC (h)	k (h)	KSW (h)	R (h)
05599500	Big Muddy River at Murphysboro, Ill.	2,170	1.00	86.40	134.00	----	-----	-----	----	-----	-----
05599640	Green Creek tributary near Jonesboro, Ill.	0.43	111.94	1.19	-----	----	0.45	-----	----	0.32	-----
05600000	Big Creek near Wetaug, Ill.	32.2	11.30	15.70	-----	----	-----	7.19	----	-----	4.28
	Big Creek near Wetaug, Ill.	32.2	11.30	15.60*	12.90	----	-----	-----	----	-----	-----

* Value subsequently revised as a result of recomputations.

Table 2.--Accuracy of HEC-1 model calibration expressed as the difference between observed and computed runoff volume, peak discharge, and time of peak discharge for individual gaging stations

The accuracy of computed runoff volume was calculated as follows:

$$\Delta V = \Sigma(V_o - V_c)/\Sigma V_o$$

where ΔV is the average difference between observed and computed runoff volume, V_o is the observed runoff volume, V_c is the computed runoff volume, the sums computed over all events modeled for a given gaging station.

The accuracy of computed peak discharge was calculated as follows:

$$\Delta Q = \Sigma(Q_o - Q_c)/\Sigma Q_o$$

where ΔQ is the average difference between observed and computed peak discharge, Q_o is the observed peak discharge, Q_c is the computed peak discharge, the sums computed over all events modeled for a given gaging station.

The accuracy of computed time of peak discharge was calculated as follows:

$$\Delta T = \Sigma(T_o - T_c)$$

where ΔT is the absolute difference between observed and computed time of peak discharge, T_o is the observed time of peak discharge, T_c is the computed time of peak discharge, the sum computed over all events modeled for a given gaging station.

Station No.	Station name	Number of events	Accuracy measures		
			ΔV (percent)	ΔQ (percent)	ΔT (hours)
03336500	Bluegrass Creek at Potomac, Ill.	6	+6.0	-5.0	0
03336900	Salt Fork near St. Joseph, Ill.	6	+6.2	-6.0	0
03338100	Salt Fork tributary near Catlin, Ill.	6	+3.1	+0.5	0
03343400	Embarras River near Camargo, Ill.	6	+5.0	-4.0	0
03344500	Range Creek near Casey, Ill.	6	-9.1	+9.8	0
03346000	North Fork Embarras River near Oblong, Ill.	7	-5.1	+5.5	-2.0
03378635	Little Wabash River near Effingham, Ill.	6	+8.0	-7.4	0

Table 2.--Accuracy of HEC-1 model calibration expressed as the difference between observed and computed runoff volume, peak discharge, and time of peak discharge for individual gaging stations--Continued

Station No.	Station name	Number of events	Accuracy measures		
			ΔV (percent)	ΔQ (percent)	ΔT (hours)
03380475	Horse Creek near Keenes, Ill.	7	0	+0.3	0
03382045	Little Cana Creek near Creal Springs, Ill.	7	-9.5	+11.0	0
03382100	South Fork Saline River near Carrier Mills, Ill.	7	+7.6	-7.9	0
03382170	Brushy Creek near Harco, Ill.	6	-1.4	+3.7	0
03382510	Eagle Creek near Equality, Ill.	7	+6.8	-4.2	0
03384450	Lusk Creek near Eddyville, Ill.	6	+4.9	-5.0	0
03385000	Hayes Creek at Glendale, Ill.	6	-4.1	+2.8	0
03386500	Sugar Creek near Dixon Springs, Ill.	7	+2.3	-2.1	0
05414820	Sinsinawa River near Menominee, Ill.	7	-6.3	+5.5	0
05419000	Apple River near Hanover, Ill.	7	+0.9	-8.0	0
05438250	Coon Creek at Riley, Ill.	7	+4.8	+2.7	0
05438850	Middle Branch of South Branch Kishwaukee River near Malta, Ill.	6	-0.3	+1.3	-0.2
05439550	South Branch Kishwaukee River tributary near Irene, Ill.	7	+0.5	+3.0	0
05440500	Killbuck Creek near Monroe Center, Ill.	7	+4.0	+4.0	0
05444000	Elkhorn Creek near Penrose, Ill.	6	+0.1	+1.6	0
05448000	Mill Creek at Milan, Ill.	5	+4.9	-1.0	0
05466000	Edwards River near Orion, Ill.	6	+7.0	-6.0	0
05495200	Little Creek near Breckenridge, Ill.	6	-2.0	-1.0	+0.1
05502020	Hadley Creek near Barry, Ill.	7	+2.0	-1.6	0

Table 2.--Accuracy of HEC-1 model calibration expressed as the difference between observed and computed runoff volume, peak discharge, and time of peak discharge for individual gaging stations--Continued

Station No.	Station name	Number of events	Accuracy measures ΔV (percent)	ΔQ (percent)	ΔT (hours)
05502040	Hadley Creek at Kinderhook, Ill.	7	-1.9	-1.3	0
05502120	Kiser Creek tributary near Barry, Ill.	7	-5.6	+5.7	0
05512500	Bay Creek at Pittsfield, Ill.	7	+2.0	-2.0	0
05526500	Terry Creek near Custer Park, Ill.	6	+4.4	+1.8	0
05530990	Salt Creek at Rolling Meadows, Ill.	6	+3.3	-3.5	0
05531000	Salt Creek near Arlington Heights, Ill.	6	+4.7	+0.4	+1.0
05531500	Salt Creek at Western Springs, Ill.	7	+6.3	-6.1	0
05533000	Flag Creek near Willow Springs, Ill.	7	+3.2	-2.9	0
05535000	Skokie River at Lake Forest, Ill.	6	+17.3	-18.5	0
05535070	Skokie River near Highland Park, Ill.	7	-0.3	-0.8	0
05536000	North Branch Chicago River at Niles, Ill.	6	+13.8	-9.8	0
05536210	Thorn Creek near Chicago Heights, Ill.	6	-6.0	+6.0	0
05536215	Thorn Creek at Glenwood, Ill.	6	+7.0	-8.0	0
05536235	Deer Creek near Chicago Heights, Ill.	7	+3.5	-4.0	0
05536255	Butterfield Creek at Flossmoor, Ill.	7	+3.8	-4.0	0
05536265	Lansing Ditch near Lansing, Ill.	6	+6.7	-7.0	0
05536270	North Creek near Lansing, Ill.	7	+13.0	-13.0	0
05536275	Thorn Creek at Thornton, Ill.	7	+1.5	-3.0	0
05536340	Midlothian Creek at Oak Forest, Ill.	6	+6.0	-4.0	0
05536500	Tinley Creek near Palos Park, Ill.	6	+4.8	-0.3	0

Table 2.--Accuracy of HEC-1 model calibration expressed as the difference between observed and computed runoff volume, peak discharge, and time of peak discharge for individual gaging stations--Continued

Station No.	Station name	Number of events	Accuracy measures ΔV (per-cent)	ΔQ (per-cent)	ΔT (hours)
05537500	Long Run near Lemont, Ill.	7	+8.5	-7.6	0
05539000	Hickory Creek at Joliet, Ill.	7	+8.5	-6.1	0
05539900	West Branch Du Page River near West Chicago, Ill.	7	-4.9	+3.4	0
05540095	West Branch Du Page River near Warrenville, Ill.	6	+12.4	-12.4	0
05549000	Boone Creek near McHenry, Ill.	7	+17.0	-17.0	-2.0
05550500	Poplar Creek at Elgin, Ill.	6	+3.3	-6.4	0
05551200	Ferson Creek near St. Charles, Ill.	7	+0.5	+5.5	0
05551700	Blackberry Creek near Yorkville, Ill.	7	+3.3	+3.6	0
05554000	North Fork Vermilion River near Charlotte, Ill.	7	+4.2	-4.9	+1.0
05556500	Big Bureau Creek at Princeton, Ill.	6	+1.0	+0.3	0
05557000	West Bureau Creek at Wyanet, Ill.	5	+4.2	-5.2	0
05557500	East Bureau Creek near Bureau, Ill.	4	-2.3	+0.3	0
05558500	Crow Creek (West) near Henry, Ill.	7	+3.5	-1.4	0
05559000	Gimlet Creek at Sparland, Ill.	6	+1.9	+3.9	0
05559500	Crow Creek near Washburn, Ill.	6	+8.6	-6.6	0
05560500	Farm Creek at Farmdale, Ill.	6	+9.6	-8.3	0
05561000	Ackerman Creek at Farmdale, Ill.	7	+3.2	+1.4	-1.0
05563000	Kickapoo Creek near Kickapoo, Ill.	7	+2.6	+3.1	0
05563500	Kickapoo Creek at Peoria, Ill.	6	+6.1	-6.1	0

Table 2.--Accuracy of HEC-1 model calibration expressed as the difference between observed and computed runoff volume, peak discharge, and time of peak discharge for individual gaging stations--Continued

Station No.	Station name	Number of events	Accuracy measures		
			ΔV (percent)	ΔQ (percent)	ΔT (hours)
05564400	Money Creek near Towanda, Ill.	7	+3.6	-2.3	0
05564500	Money Creek above Lake Bloomington, Ill.	6	+3.6	-2.1	0
05566500	East Branch Panther Creek at El Paso, Ill.	7	+7.1	-5.4	0
05567000	Panther Creek near El Paso, Ill.	6	+6.6	-0.4	0
05568800	Indian Creek near Wyoming, Ill.	5	+1.8	-4.4	0
05569968	Turkey Creek near Fiatt, Ill.	4	+0.4	+0.4	0
05570370	Big Creek near Bryant, Ill.	6	+0.1	-1.2	0
05571000	Sangamon River at Mahomet, Ill.	7	+2.7	-2.4	+10.0
05574000	South Fork Sangamon River near Nokomis, Ill.	7	+0.6	+5.1	0
05574500	Flat Branch near Taylorville, Ill.	6	+0.3	+4.0	-2.0
05575800	Horse Creek at Pawnee, Ill.	7	-6.1	+7.0	0
05577500	Spring Creek at Springfield, Ill.	6	-4.1	+3.3	0
05577700	Sangamon River tributary at Andrew, Ill.	6	+0.1	-3.3	-0.1
05578500	Salt Creek near Rowell, Ill.	6	+2.3	+0.3	0
05584400	Drowning Fork near Bushnell, Ill.	6	-4.9	+0.8	0
05586000	North Fork Mauvaise Terre Creek near Jacksonville, Ill.	7	+7.6	-7.2	0
05586800	Otter Creek near Palmyra, Ill.	7	-14.0	-15.0	0
05587850	Cahokia Creek tributary No. 2 near Carpenter, Ill.	4	-2.7	0	0
05587900	Cahokia Creek at Edwardsville, Ill.	6	-3.0	+0.6	0

Table 2.--Accuracy of HEC-1 model calibration expressed as the difference between observed and computed runoff volume, peak discharge, and time of peak discharge for individual gaging stations--Continued

Station No.	Station name	Number of events	Accuracy measures		
			ΔV (percent)	ΔQ (percent)	ΔT (hours)
05588000	Indian Creek at Wanda, Ill.	7	-5.1	+4.8	+6.0
05599000	Kaskaskia Ditch at Bondville, Ill.	4	+3.5	-0.4	0
05590400	Kaskaskia River near Pesotum, Ill.	7	+4.6	-0.2	0
05592300	Wolf Creek near Beecher City, Ill.	7	-12.0	+11.5	0
05593575	Little Crooked Creek near New Minden, Ill.	6	+5.0	-4.5	0
05593600	Blue Grass Creek near Raymond, Ill.	6	+0.1	+3.0	0
05593900	East Fork Shoal Creek near Coffeen, Ill.	6	-4.0	-2.5	0
05594330	Mud Creek near Marissa, Ill.	7	+7.0	-7.0	0
05595200	Richland Creek near Hecker, Ill.	7	+3.7	-3.3	0
05595228	South Branch Doza Creek near Lenzburg, Ill.	5	+9.5	-9.7	0
05595800	Sevenmile Creek near Mt. Vernon, Ill.	7	+5.9	-4.8	0
05597500	Crab Orchard Creek near Marion, Ill.	7	+1.6	+1.1	0
05599000	Beaucoup Creek near Matthews, Ill.	6	+1.9	-3.7	0
05600000	Big Creek near Wetaug, Ill.	7	+3.8	-4.5	0

Table 3.--Analysis of covariance of time of concentration (TC) values from four data sets

[The number of values is 222. Residual mean square is 0.0485.]

Model: $$y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_1x_5 + b_7x_1x_4 + b_8x_1x_3 + b_9x_2x_3 + b_{10}x_2x_4 + b_{11}x_2x_5$$

Where: $y = \log(TC)$, $x_1 = \log(\text{length})$, $x_2 = \log(\text{slope})$, and x_3, x_4, x_5 are dummy variables with the values:

	x_3	x_4	x_5
HEC-1 (this paper)	1	0	0
Mitchell (1972)	0	1	0
Mitchell (1948, 1954)	0	0	1
Curtis (1977)	0	0	0

Coefficient	Mean square	F
b_3	0.0315	0.65
b_4	.0498	1.03
b_5	.0002	.00
b_6	.0090	.18
b_7	.0004	.01
b_8	.0276	.57
b_9	.0001	.00
b_{10}	.0171	.35
b_{11}	.0007	.01

Table 4.--Analysis of covariance of storage coefficient values from three data sets

[The number of values is 148. Residual mean square is 0.0642.]

Model: $y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_1x_3 + b_6x_1x_4 + b_7x_2x_3 + b_8x_2x_4$

Where: $y = \log(R)$, $x_1 = \log(\text{length})$, $x_2 = \log(\text{slope})$, and x_3, x_4 are dummy variables with the values:

	x_3	x_4
HEC-1 (this paper)	1	0
Mitchell (1972)	0	1
Curtis (1977)	0	0

Coefficient	Mean square	F
b_3	0.0006	0.01
b_4	.0100	.16
b_5	.1499	2.33
b_6	.0886	1.38
b_7	.0125	.19
b_8	.0107	.17

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