Model Hydrographs

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 2005

Prepared in cooperation with State of Illinois Department of Public Works and Buildings, Division of Highways

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By W. D. MITCHELL

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A discussion of the use of time and areal characteristics of a drainage basin to describe its flood hydrograph

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SYMBOLS

(The following symbols are listed in alphabetical order. Each symbol indicates the basic term usually represented, with no attempt to show the many and unavoidable duplicate uses.)

A Drainage area (square miles).

D Duration of rainfall excess (hours).

H Time from beginning of rainfall excess (hours); also change in elevation between highest point on the drainage divide and channel bed at gage (feet).

I Inflow (sometimes expressed in units of cubic feet per second, but more often in terms of the dimensionless ratio QT/AP_e).

k A coefficient in the relation between storage and outflow (hours).

L Length of a drainage basin (miles).

O Outflow (sometimes expressed in units of cubic feet per second, but more often in terms of the dimensionless ratio QT/AP_e).

P_e The amount of rainfall excess (inches).

Q Rate of discharge (cubic feet per second).

S Basin storage (cubic feet).

T Base length of instantaneous translation hydrograph (hours).

t Increment between successive abscissa of hydrographs (usually dimensionless).

x Exponent in the relation between storage and outflow (dimensionless).

MODEL HYDROGRAPHS

By W. D. Mitchell

ABSTRACT

Model hydrographs are composed of pairs of dimensionless ratios, arrayed in tabular form, which, when modified by the appropriate values of rainfall excess and by the time and areal characteristics of the drainage basin, satisfactorily represent the flood hydrograph for the basin.

Model hydrographs are developed from a dimensionless translation hydrograph, having a time base of T hours and appropriately modified for storm duration by routing through reservoir storage, $S=kO^x$. Models fall into two distinct classes: (1) those for which the value of x is unity and which have all the characteristics of true unit hydrographs and (2) those for which the value of x is other than unity and to which the unit-hydrograph principles of proportionality and superposition do not apply.

Twenty-six families of linear models and eight families of nonlinear models in tabular form form the principal subject of this report. Supplemental discussions describe the development of the models and illustrate their application. Other sections of the report, supplemental to the tables, describe methods of determining the hydrograph characteristics, T, k, and x, both from observed hydrographs and from the physical characteristics of the drainage basin.

Five illustrative examples of use show that the models, when properly converted to incorporate actual rainfall excess and the time and areal characteristics of the drainage basins, do indeed satisfactorily represent the observed flood hydrographs for the basins.

INTRODUCTION

This report presents an array of model hydrographs and explains their development, their use, and their relation to unit hydrographs.

A model hydrograph is a generalized expression for the distribution, with respect to time, of the surface runoff from a drainage area. Although expressed in terms that make it applicable to many areas, it may be readily converted to explicit terms for a particular area. Like the unit hydrograph, it is not concerned with the amount of rainfall excess that may result from a given pattern of rainfall, but only with the time distribution of the excess.

A model hydrograph is distinctive from a unit hydrograph. The latter normally is prepared for a particular drainage area and for a unit amount of rainfall excess in a particular time. These restrictions limit the use of the unit hydrograph to the area from which it is derived. The model hydrograph, on the other hand, is designed to apply to a wide range of sizes and types of drainage areas that have a wide range of conditions of rainfall excess. This application is facilitated by expression of the coordinates of the models in terms of dimensionless ratios.

Another important distinction between the two concepts, as will be shown subsequently, is that the unit-hydrograph principle of proportionality of ordinates limits use of the unit hydrograph to those areas for which the storage effect is linear. Many drainage areas do, indeed, appear to have linear storage—or storage so near to linear that the differences may be disregarded. The widespread success of the customary unit-hydrograph procedures is adequate testimony to this fact. But occasionally an area is found for which storage effects are so far from linear that unit-hydrograph techniques are not applicable. For areas with marked nonlinear storage, ordinates of hydrographs are not in linear proportion to rainfall excess, and the unit-hydrograph techniques of proportionality and superposition cannot be applied. To include these types of areas, the general principles for analysis and synthesis of hydrographs must be expanded. The term "model hydrograph" has been adopted to designate this new and broader concept, under which the unit hydrograph becomes a special, simplified case of the model hydrograph.

The full implications of this more generalized approach to the analysis and synthesis of the hydrograph are not, as yet, completely realized. Some of the techniques which eventually may be of general use, as well as some of those which must be restricted to the special case of the unit hydrograph, have not yet been recognized. Much work remains to be done, especially with regard to the effects of nonuniform distribution of rainfall excess and the effects, for nonlinear models, of high initial inflow from antecedent rainfall. Nevertheless, significant progress has been made, and a record of that progress is the theme of this report.

The basic concepts of this report were developed over a period of several years. Materials and conclusions from other projects within the Illinois District of the Water Resources Division have been appropriated as needed. For example, the adoption of the dimensionless form for the hydrographs resulted from earlier studies (Mitchell, 1948 and, particularly, Mitchell, 1962). Needed impetus for the completion of the project did not develop, however, until intensive analyses were undertaken in connection with a district project intended to determine floodflows from small drainage areas and prosecuted in cooperation with the Illinois Department of Public Works and Buildings, Division of Highways. As it became more apparent that the techinques described in this report were well adapted to analysis of the small-basin flood data and that these projects would clearly benefit from each other, the two projects were closely coordinated. Many of the tables and most of the illustrations which appear in this report have been taken from the work done in connection with the Division of Highways cooperative project.

In the preparation of this report. three other members of the district staff have rendered invaluable assistance. George W. Curtis supervised the long and tedious manual computations for the linear models, a chore which has extended intermittently over a period of about 8 years. Terence E. Harbaugh contributed many valuable suggestions, reviewed the manuscript with great care, made numerous tests of validity, and provided the computations for the nonlinear models. Oscar G. Lara supervised the statistical analyses and contributed suggestions which led to the systematization of the nonlinear models.

ELEMENTS OF THE MODEL HYDROGRAPH

Three principal elements enter into the concept and the use of model hydrographs. These are (1) the concept of the dimensionless, instantaneous translation hydrograph, (2) the effects of storage, and (3) the effects of storm duration.

TRANSLATION HYDROGRAPH

To understand the translation hydrograph, consider a strange, wonderland basin in which there is no such thing as storage. Runoff from such a basin would differ greatly from that to which we are accustomed. As soon as a rainfall excess appeared on any part of a drainage basin, it would flow immediately to the drainage outlet. ("Immediately" is an ambiguous term, but let it suffice for the present.) The result at the outlet would be first, a quick, sharp rise to a peak greatly in excess of present natural occurrence and second, a very rapid recession to a state of no flow.

How quick, how sharp, and to what peak? These questions may be answered by a more deliberate consideration of translation flow, a purely hypothetical type of flow uninfluenced by storage. Let a drainage area, A, be divided into equal, minute parts, dA. Assume a magic carpet whereby rainfall excess accumulating on any dA may be transported to the outlet in an interval of time proportional to the distance it must travel. Now assume that rainfall excess of any depth, P_e, appears instantaneously, simultaneously, and uniformly over the entire basin, A. Then flow at the outlet would occur as follows: During the first instant, flow from the area immediately adjacent to the outlet; during the next instant, flow from those dA's immediately beyond the first; at any time, H, after appearance of rainfall excess, flow would be from those areas removed from the outlet by the distance corresponding to the value of H, and the rate of flow would be proportional to the number of dA's at that particular distance. Flow would increase to a maximum for that particular value of H at which the corresponding distance taps the maximum number of dA's: it would then begin to decrease and would fall to zero after that time, T, when the flow arrives from the most distant dA.

The total volume of flow, V, would equal the product of A and P_e; if V were expressed in cubic feet, with A in square miles and P_e in inches, $V=AP_e\ (5{,}280)^2/12$, or $V=2{,}323{,}200\ AP_e$. Since the entire flow would pass the outlet in the period of T hours, the average rate of flow would be $Q_a=2{,}323{,}200\ AP_e/3{,}600\ T=645.333\ AP_eT$ cubic feet per second.

The preceding considerations define, in a general way, the translation hydrograph for instantaneous rainfall excess. The hydrograph is for a drainage area of A square miles and represents instantaneous rainfall excess of P_e inches; it has a time base of T hours and an average ordinate of $645.333\ AP_e/T$ cubic feet per second. The precise shape of the graph is dependent upon the shape of the drainage area and upon how distances (between the dA's and the outlet) are measured. Should distances be measured by air line? Should they be measured along principal stream channels? Should they be weighted to allow for differences in slope and roughness? Experience with many hydrographs indicates that, in general, these questions are not important. In rare instances, one or another of these considerations may become significant, but these will be dealt with at a later time, perhaps in a subsequent report. For the present, and for the large majority of drainage areas, a sufficiently accurate assumption is that the maximum ordinate of the instantaneous translation hydrograph is twice the average ordinate and occurs at time $H=T/2$ and that the graph is two straight lines connecting this maximum ordinate to the zero ordinate at $H=O$ and at $H=T$. Subsequent manipulations of this graph are so extensive that even appreciable variations from this ideal shape become almost completely obliterated.

One further observation concerning this hydrograph is that its usefulness is greatly enhanced by reducing it to dimensionless terms, QT/AP_e for the ordinate and H/T for the abscissa. Figure 1 presents in dimensionless form the instantaneous translation hydrograph.

STORAGE

The instantaneous translation hydrograph, as shown in figure 1, is only a starting point for further developments toward a model hydro-

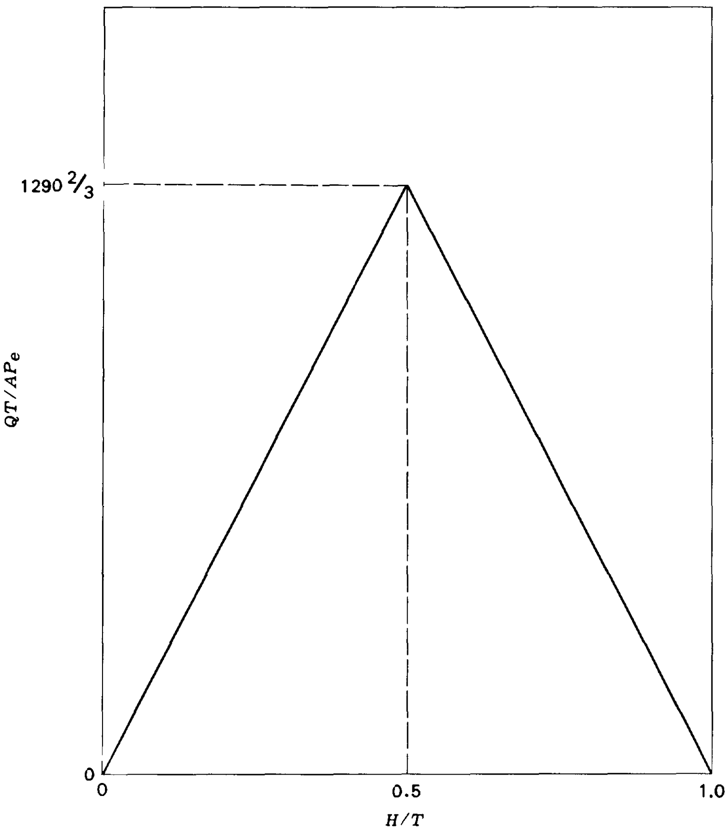

FIGURE 1.—Translation hydrograph, instantaneous.

graph. For natural drainage areas, the runoff hydrograph never appears in this simple form, but is modified by at least two important factors. One of these factors is storage. (The other, duration, will be discussed later.)

The extremely diverse and complicated nature of the actual storage facilities within a drainage basin would appear, at first glance, to preclude any successful effort toward basin-wide evaluation. But experience with many hydrographs indicates that, in general, and for the large majority of drainage areas, the effect of basin storage may be represented as a modification of the translation hydrograph by the techniques of reservoir routing, and that, as will be shown subsequently, to determine the storage relationships needed to make the modification for a particular drainage area is usually feasible.

ROUTING CONSIDERATIONS

The basic relation between inflow, outflow, and storage is expressed by the equation of continuity, which for an incompressible fluid such as water may be written

$$I=O+\Delta S/\Delta t; \tag{1}$$

that is, the inflow, I, is equal to the outflow, O, plus the change of storage, $\Delta S/\Delta t$. If the time increment, $\Delta t=t_2-t_1$, is sufficiently small, the values of I and O may be considered to be the average of their respective values at time t_1 and t_2, or $(I_1+I_2)/2$ and $(O_1+O_2)/2$. Further, ΔS may be expressed as the difference in storage volume at times t_1 and t_2, or $\Delta S=S_2-S_1$. Equation 1 may then be expressed as

$$O_2=(2S_1/\Delta t)-O_1-(2S_2/\Delta t)+(I_1+I_2). \tag{2}$$

Three items of information are required by equation 2. One of these is a starting value, or the value of O_1 at the beginning of the first increment of time, Δt. (For succeeding increments of time, O_1 is the O_2 of the preceding step.) To obtain the initial O_1, simply start the computations at a time for which the outflow is known, as at the beginning of a flood period, when the outflow generally is equal to the inflow. In many cases the initial outflow will be zero, or at least so small as to be of no practical consequence. In fact, for simplicity in the developments immediately following, initial outflow is assumed to be zero.

The second item of information is an inflow hydrograph from which to determine values of I_1 and I_2 for successive times at intervals of Δt. This information is provided by graphs such as figure 1, the instantaneous translation hydrograph.

The third item needed for computation of O_2 is a definitive expression for storage. In reservoir routing, storage is assumed to be a function of outflow and is represented by the generalized expression

$$S=kO^x, \tag{3}$$

in which k is a coefficient of proportionality, O is the outflow, and x is an exponent dependent upon the relative slopes of the stage-discharge and the stage-storage relations.

A special case arises when the value of x is unity. Then, and only then, the storage is said to be linear. Many runoff hydrographs exhibit the characteristics of linear storage. The number of exceptions, however, is so great that nonlinear storage (x other than unity) cannot be ignored. But let us first consider the simple, special case—linear storage, or

$$S=kO. \tag{4}$$

LINEAR ROUTING

In equation 4, S has the dimension of cubic feet, and O has the dimension of cubic feet per second. Therefore, k must have the dimension of time. Routing computations may be greatly simplified by expressing k in dimensionless form, or as a ratio to T. Let $k/T=r$; then $S=rTO$.

In the generalized routing expression, equation 2, Δt also has the dimension of time. Here, again routing computations will be facilitated by expressing Δt as a ratio to T. Let $\Delta t/T=p$. Then

$$2S/\Delta t=2rTO/pT=(2r/p)O.$$

Equation 2 then becomes

$$O_2=(2r/p)O_1-O_2-(2r/p)O_2+(I_1+I_2)$$

or

$$O_2(2r/p+1)=O_1(2r/p-1)+(I_1+I_2). \qquad (5)$$

For any specific problem with linear storage, r will have a fixed specific value, such as $r=k/T=0.20$, and p will have a fixed specific value, such as $p=\Delta t/T=0.02$; hence $2r/p$ will have a specific value, such as $2\times 0.20/0.02=20$, and equation 5 will assume the form

$$O_2=(19O_1+I_1+I_2)/21. \qquad (5a)$$

Note that this simple form of the routing equation is appropriate only when storage is a linear function of outflow and that the constants in the equation will vary with the values of k and Δt. For example, if k becomes $0.5T(r=0.5)$ while Δt remains $0.02T(p=0.02)$, then

$$O_2=(49O_1+I_1+I_2)/51. \qquad (5b)$$

Values of k used in this report cover a considerable range, but the value of Δt has been kept the same for most linear routing computations. As pointed out above, Δt should be small enough that the average values of I and O during the interval will be virtually the same as the average of their respective values at the beginning and end of the interval. For this purpose alone a time increment of $0.1T$ might be sufficiently small; however, in order that there may be no doubt as to the accuracy of the computations and also to provide more accurate data concerning both time and magnitude of peak discharge, the value of Δt has been taken as $0.02T$ for most linear routing computations. (For exceptions, see footnotes to tables at end of report.)

Table 1 presents a section of a typical linear routing computation. In this instance, the storage equation is $S=0.20\ O$, or $k/T=0.20$; the routing equation assumes the specific form of equation 5a. Columns 1 and 2 are a listing of the coordinates of figure 1, the instantaneous translation hydrograph, at intervals of $\Delta t=0.02T$. Any given line in column 3 is the sum of column 2 on that line and column 2 on the preceding line; this process provides the I_1+I_2 terms of the routing equation. Column 4 is the modified, or outflow, instantaneous hydrograph and is obtained by taking a value from column 4, multiplying it by 19, then adding the value of column 3 of the following line, and dividing the sum by 21. (See equation 5a.) The quotient is entered as the value for the second line of column 4. The remaining columns of table 1 will be discussed subsequently.

NONLINEAR ROUTING

Nonlinear routing must take account of problems that are numerous, varied, and of considerable importance. One of these is the adjustments for duration, but this problem must be reserved until the whole subject of duration is considered. Other problems concern the magnitude of flow at the beginning of rainfall excess and the magnitude of rainfall excess. These, too, will be reserved for later discussion. The problem which deserves immediate attention is the solution of the nonlinear routing equation.

When, in equation 3, x assumes any value other than unity, equation 2 cannot be reduced to a simple form such as equation 5a. Except for a few special cases, the routing equation remains so cumbersome that solutions are prohibitively tedious or are rough and unsatisfactory approximations. (This situation is improved by use of an electronic computer, but such equipment became available only near the end of this study.)

Fortunately, there are at least two special cases in which the routing equation may be solved with satisfactory accuracy and reasonable speed on desk calculators which are able to abstract square root. These cases are

$$x=2.0$$

and

$$x=0.5.$$

The first case now appears to have limited practical value in that x for natural drainage basins appears rarely to exceed unity. On the other hand, the second case is quite practical; several small drainage basins have been found to have a value of x near 0.5.

Results of the nonlinear routings will be described as the need arises.

Table 1.--Section of typical model hydrograph (linear) computations

$\frac{H}{T}$ (1)	$\frac{QT}{AP_e}$ (2)	$\frac{QT_1}{AP_e} + \frac{QT_2}{AP_e}$ (3)	Inst hgh (4)	0.02T hgh (5)	Summation 0.02T hgh (6)	Summation lag 0.1T (7)	0.1T hgh (8)	Summation lag 0.2T (9)	0.2T hgh (10)	Summation lag 0.5T (11)	0.5T hgh (12)
0.50	1,290.667	2,529.707	816.689	793.102	7,966.424	4,465.130	700.259	2,076.154	589.027	0	318.657
.52	1,239.040	2,529.707	859.371	838.030	8,804.454	5,073.640	746.163	2,469.672	633.478	1.229	352.129
.54	1,187.413	2,426.453	893.072	876.222	9,680.676	5,727.450	790.645	2,904.382	677.629	7.257	386.937
.56	1,135.787	2,323.200	918.646	905.859	10,586.535	6,427.162	831.875	3,381.276	720.526	22.545	422.560
.58	1,084.160	2,219.947	936.868	927.757	11,514.292	7,173.322	868.194	3,901.254	761.304	51.127	458.527
.60	1,032.533	2,116.693	948.437	942.652	12,456.944	7,966.424	898.104	4,465.130	799.181	96.655	494.412
.62	980.907	2,013.440	953.988	951.212	13,408.156	8,804.454	920.740	5,073.640	833.452	162.431	529.829
.64	929.280	1,910.187	954.093	954.040	14,362.196	9,680.676	936.304	5,727.450	863.475	251.443	564.430
.66	877.653	1,806.933	949.271	951.682	15,313.878	10,586.535	945.469	6,427.162	888.672	366.395	597.899
.68	826.027	1,703.680	939.992	944.632	16,258.510	11,514.292	948.844	7,173.322	908.519	509.735	629.951
.70	774.400	1,600.427	926.680	933.336	17,191.846	12,456.944	946.980	7,966.424	922.542	683.675	660.327
.72	722.773	1,497.173	909.719	918.200	18,110.046	13,408.156	940.378	8,804.454	930.559	890.217	688.793
.74	671.147	1,393.920	889.456	899.588	19,009.634	14,362.196	929.488	9,680.676	932.896	1,131.173	715.138
.76	619.520	1,290.667	866.206	877.831	19,887.465	15,313.878	914.717	10,586.535	930.093	1,408.183	739.171
.78	567.893	1,187.413	840.254	853.230	20,740.695	16,258.510	896.437	11,514.292	922.640	1,722.729	760.719
.80	516.267	1,084.160	811.856	826.055	21,566.750	17,191.846	874.981	12,456.944	910.981	2,076.154	779.624
.82	464.640	980.907	781.246	796.551	22,363.301	18,110.046	850.651	13,408.156	895.514	2,469.672	795.745
.84	413.013	877.653	748.635	764.940	23,128.241	19,009.634	823.721	14,362.196	876.604	2,904.382	808.954
.86	361.387	774.400	714.213	731.424	23,859.665	19,887.465	794.440	15,313.878	854.579	3,381.276	819.136
.88	309.760	671.147	678.152	696.182	24,555.847	20,740.695	763.030	16,258.510	829.734	3,901.254	826.184
.90	258.133	567.893	640.609	659.380	25,215.227	21,566.750	729.695	17,191.846	802.338	4,465.130	830.004
.92	206.507	464.640	601.724	621.166	25,836.393	22,363.301	694.618	18,110.046	772.635	5,073.640	830.510
.94	154.880	361.387	561.626	581.675	26,418.068	23,128.241	657.965	19,009.634	740.843	5,727.450	827.625
.96	103.253	258.133	520.430	541.028	26,959.096	23,859.665	619.886	19,887.465	707.163	6,427.162	821.277
.98	51.627	154.880	478.240	499.335	27,458.431	24,555.847	580.517	20,740.695	671.774	7,173.322	811.404
1.00	0	51.627	435.152	456.696	27,915.127	25,215.227	539.980	21,566.750	634.838	7,966.424	797.948
1.02	0	0	393.709	414.430	28,329.557	25,836.393	498.633	22,363.301	596.626	8,804.454	781.004
1.04	0	0	356.213	374.961	28,704.518	26,418.068	457.290	23,128.241	557.628	9,680.676	760.954
1.06	0	0	322.288	339.250	29,043.768	26,959.096	416.934	23,859.665	518.410	10,586.535	738.289
1.08	0	0	291.594	306.941	29,350.709	27,458.431	378.456	24,555.847	479.486	11,514.292	713.457
1.10	0	0	263.823	277.708	29,628.417	27,915.127	342.658	25,215.227	441.319	12,456.944	686.859

DURATION

The preceding section has shown how the instantaneous translation hydrograph may be modified by reservoir routing to produce hydrographs such as that shown as column 4 of table 1. Some of these begin to resemble actual, natural, hydrographs. But there still is one important difference: duration, or the interval of time during which rainfall excess is generated.

In the development of the initial hydrograph (fig. 1), it was specified that "rainfall excess of any depth, P_e, appears instantaneously, simultaneously, and uniformly over the entire basin, A." Routing a hydrograph does not change its rainfall-excess characteristics. We must recognize, therefore, that the resulting graphs are for rainfall excess that "appears instantaneously, simultaneously, and uniformly over the basin." Because these characteristics are unrealistic, our models must be adjusted to accommodate rainfall excess as it actually occurs. Adjustments for lack of simultaneous and uniform excess must await later consideration, but the adjustment for duration (finite, rather than instantaneous) may be made now.

The duration, D, or time interval during which rainfall excess is generated, obviously has the dimension of time and normally is expressed in hours. In keeping with the dimensionless character of the hydrographs so far developed, however, let duration be expressed by the dimensionless ratio, D/T.

LINEAR MODELS

For linear models, transformations for duration normally are effected, after routing for storage, by means of the summation curve, as follows: Prepare a summation curve for any available hydrograph whose D/T value is z; list a second summation curve identical to first but lagged by a time interval equal to the desired duration, $D/T=y$; subtract the ordinates of the second curve from those of the first and divide the remainders by the value of the ratio y/z. Table 1, beginning with column 6, illustrates the procedure. It is not possible to start the transformations from column 4, since these are the values for instantaneous duration and the ratio y/z would be infinity. Negligible error will result, however, in computing the hydrograph for a finite time of very short duration, such as $\Delta t=0.02T$, merely by averaging the successive ordinates, at intervals of Δt, of the instantaneous hydrograph. This has been done to obtain column 5, the $0.02T$ hydrograph. Column 6 is the summation of column 5. Column 7 is identical to column 6, but has been lagged by an interval of $0.1T$. Column 8 is the differences between columns 6 and 7 divided by $y/z=0.10/0.02=5$ and is the hydrograph for a duration $D/T=0.10$, or the $0.10T$ hydrograph. The remaining columns in table 1 illustrate the computation of other hydrographs, all with k/T values of 0.20 but with succeedingly longer values for D/T.

The question may be raised as to whether the transformations for D/T should be made before, rather than after, the instantaneous translation hydrograph is routed through storage. The answer is that for linear models the choice is only a matter of convenience, for the final results will be the same regardless of the sequence of the computations. Routing computations are more laborious than D/T transformatioms, and fewer routings are required if they are made before, rather than after, the transformations for D/T.

NONLINEAR MODELS

In nonlinear models, an instantaneous translation graph routed through nonlinear storage and then transformed to a particular D/T unfortunately results in a graph different from that obtained from the same instantaneous translation graph transformed to the particular D/T and then routed through the same nonlinear storage. In the sequence of their natural effects, duration is prior to storage; thus it is necessary in nonlinear models to make D/T transformations to the translation graph before routing.

Transformations for the translation hydrograph may be made in a manner identical to the transformation described for linear models. Computations for the transformations to D/T values of 0.1, 0.2, 0.5, 0.7, 1.0, 1.5, and 2.0 are given in table 2. In this table the summation curve is given but once; the reader may obtain the appropriate value of the lagged summation curve by deducting D/T from H/T, and then by reading the value from the indicated line of column 4.

Translation hydrographs for these finite values of D/T are plotted in figure 2. As D/T approaches unity the shape of the graph approaches that of the normal probability curve, and for values greater than unity, the graph approaches a trapezoid. The base of the graph, in all cases, is $(D/T)+1$, and the upper base of the trapezoid is $(D/T)-1$. The maximum ordinate is closely approximated by a simple relationship that changes at the point $D/T=1$. For smaller values of D/T the relations is $Q_m=645.333(2.0-D/T)$; for higher values, $Q_m=645.333/(D/T)$.

For nonlinear storage developments, the appropriate finite translation hydrograph should be used, rather than the instantaneous translation hydrograph.

Table 2.—Transformation of translation hydrograph from instantaneous to finite values of D/T

$\frac{H}{T}$	$\frac{QT}{AP_e}$	0.02T hgh	Summation	Translation Hydrograph D/T = 0.1	D/T = 0.2	D/T = 0.5	D/T = 0.7	D/T = 1.0	D/T = 1.5	D/T = 2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.02	51.627	25.814	25.814	5.163	2.581	1.033	.738	.516	.344	.258
.04	103.253	77.440	103.254	20.651	10.325	4.130	2.950	2.065	1.377	1.033
.06	154.880	129.066	232.320	46.464	23.232	9.293	6.638	4.646	3.098	2.323
.08	206.507	180.694	413.014	82.603	41.301	16.521	11.800	8.260	5.507	4.130
.10	258.133	232.320	645.334	129.067	64.533	25.813	18.438	12.907	8.604	6.453
.12	309.760	283.946	929.280	180.693	92.928	37.171	26.551	18.586	12.390	9.293
.14	361.387	335.574	1,264.854	232.320	126.485	50.594	36.139	25.297	16.865	12.649
.16	413.013	387.200	1,652.054	283.947	165.205	66.082	47.202	33.041	22.027	16.521
.18	464.640	438.826	2,090.880	335.573	209.088	83.635	59.739	41.818	27.878	20.909
.20	516.267	490.454	2,581.334	387.200	258.133	103.253	73.752	51.627	34.418	25.813
.22	567.893	542.080	3,123.414	438.827	309.760	124.937	89.240	62.468	41.646	31.234
.24	619.520	593.706	3,717.120	490.453	361.387	148.685	106.203	74.342	49.562	37.171
.26	671.147	645.334	4,362.454	542.080	413.013	174.498	124.642	87.249	58.166	43.625
.28	722.773	696.960	5,059.414	593.707	464.640	202.377	144.555	101.188	67.459	50.594
.30	774.400	748.586	5,808.000	645.333	516.267	232.320	165.943	116.160	77.440	58.080
.32	826.027	800.214	6,608.214	696.960	567.893	264.329	188.806	132.164	88.110	66.082
.34	877.653	851.840	7,460.054	748.587	619.520	298.402	213.144	149.201	99.467	74.601
.36	929.280	903.466	8,363.520	800.213	671.147	334.541	238.958	167.270	111.514	83.635
.38	980.907	955.094	9,318.614	851.840	722.773	372.745	266.246	186.372	124.248	93.186
.40	1,032.533	1,006.720	10,325.334	903.467	774.400	413.013	295.010	206.507	137.671	103.253
.42	1,084.160	1,058.346	11,383.680	955.093	826.027	455.347	325.248	227.674	151.782	113.837
.44	1,135.787	1,109.974	12,493.654	1,006.720	877.653	499.746	356.962	249.873	166.582	124.937
.46	1,187.413	1,161.600	13,655.254	1,058.347	929.280	546.210	390.150	273.105	182.070	136.553
.48	1,239.040	1,213.226	14,868.480	1,109.973	980.907	594.739	424.813	297.370	198.246	148.685
.50	1,290.667	1,264.854	16,133.334	1,161.600	1,032.533	645.333	460.952	322.667	215.111	161.333
.52	1,239.040	1,264.854	17,398.188	1,202.902	1,078.997	694.895	497.091	347.964	231.976	173.982
.54	1,187.413	1,213.226	18,611.414	1,223.552	1,115.136	740.326	531.755	372.228	248.152	186.114
.56	1,135.787	1,161.600	19,773.014	1,223.552	1,140.949	781.628	564.943	395.460	263.640	197.730
.58	1,084.160	1,109.974	20,882.988	1,202.902	1,156.437	818.799	596.657	417.660	278.440	208.830
.60	1,032.533	1,058.346	21,941.334	1,161.600	1,161.600	851.840	626.895	438.827	292.551	219.413
.62	980.907	1,006.720	22,948.054	1,109.973	1,156.437	880.751	655.659	458.961	305.974	229.480
.64	929.280	955.094	23,903.148	1,058.347	1,140.949	905.532	682.947	478.063	318.709	239.031
.66	877.653	903.466	24,806.614	1,006.720	1,115.136	926.182	708.760	496.132	330.755	248.066
.68	826.027	851.840	25,658.454	955.093	1,078.997	942.703	733.099	513.169	342.113	256.585

Table 2.--Transformation of translation hydrograph from instantaneous to finite values of D/T--Continued

$\frac{H}{T}$	$\frac{QT}{AP_e}$	0.02T hgh	Summation	Translation Hydrograph D/T = 0.1	D/T = 0.2	D/T = 0.5	D/T = 0.7	D/T = 1.0	D/T = 1.5	D/T = 2.0
0.70	774.400	800.214	26,458.668	903.467	1,032.533	955.093	755.962	529.173	352.782	264.587
.72	722.773	748.586	27,207.254	851.840	980.907	963.354	776.613	544.145	362.763	272.073
.74	671.147	696.960	27,904.214	800.213	929.280	967.484	794.313	558.084	372.056	279.042
.76	619.520	645.334	28,549.548	748.587	877.653	967.484	809.064	570.991	380.661	285.495
.78	567.893	593.706	29,143.254	696.960	826.027	963.354	820.864	582.865	388.577	291.433
.80	516.267	542.080	29,685.334	645.333	774.400	955.093	829.714	593.707	395.804	296.853
.82	464.640	490.454	30,175.788	593.707	722.773	942.703	835.614	603.516	402.344	301.758
.84	413.013	438.826	30,614.614	542.080	671.147	926.182	838.565	612.292	408.195	306.146
.86	361.387	387.200	31,001.814	490.453	619.520	905.532	838.565	620.036	413.358	310.018
.88	309.760	335.574	31,337.388	438.827	567.893	880.751	835.614	626.748	417.832	313.374
.90	258.133	283.946	31,621.334	387.200	516.267	851.840	829.714	632.427	421.618	316.213
.92	206.507	232.320	31,853.654	335.573	464.640	818.799	820.864	637.073	424.715	318.537
.94	154.880	180.694	32,034.348	283.947	413.013	781.628	809.064	640.687	427.125	320.343
.96	103.253	129.066	32,163.414	232.320	361.387	740.326	794.313	643.268	428.846	321.634
.98	51.627	77.440	32,240.854	180.693	309.760	694.895	776.613	644.817	429.878	322.409
1.00	0	25.814	32,266.668	129.067	258.133	645.333	755.962	645.333	430.222	322.667
1.02	0	0	32,266.668	82.603	209.088	594.739	733.099	644.817	430.222	322.667
1.04	0	0	32,266.668	46.464	165.205	546.210	708.760	643.268	430.222	322.667
1.06	0	0	32,266.668	20.651	126.485	499.746	682.947	640.687	430.222	322.667
1.08	0	0	32,266.668	5.163	92.928	455.347	655.659	637.073	430.222	322.667
1.10	0	0	32,266.668	0	64.533	413.013	626.895	632.427	430.222	322.667
1.20	0	0	32,266.668	0	0	232.320	460.952	593.707	430.222	322.667
1.30	0	0	32,266.668	0	0	103.253	295.010	529.173	430.222	322.667
1.40	0	0	32,266.668	0	0	25.813	165.943	438.827	430.222	322.667
1.50	0	0	32,266.668	0	0	0	73.752	322.667	430.222	322.667
1.60	0	0	32,266.668	0	0	0	18.438	206.507	421.618	322.667
1.70	0	0	32,266.668	0	0	0	0	116.160	395.804	322.667
1.80	0	0	32,266.668	0	0	0	0	51.627	352.782	322.667
1.90	0	0	32,266.668	0	0	0	0	12.907	292.551	322.667
2.00	0	0	32,266.668	0	0	0	0	0	215.111	322.667
2.10	0	0	32,266.668	0	0	0	0	0	137.671	316.213
2.20	0	0	32,266.668	0	0	0	0	0	77.440	296.853
2.30	0	0	32,266.668	0	0	0	0	0	34.418	264.587
2.40	0	0	32,266.668	0	0	0	0	0	8.604	219.413
2.50	0	0	32,266.668	0	0	0	0	0	0	161.333

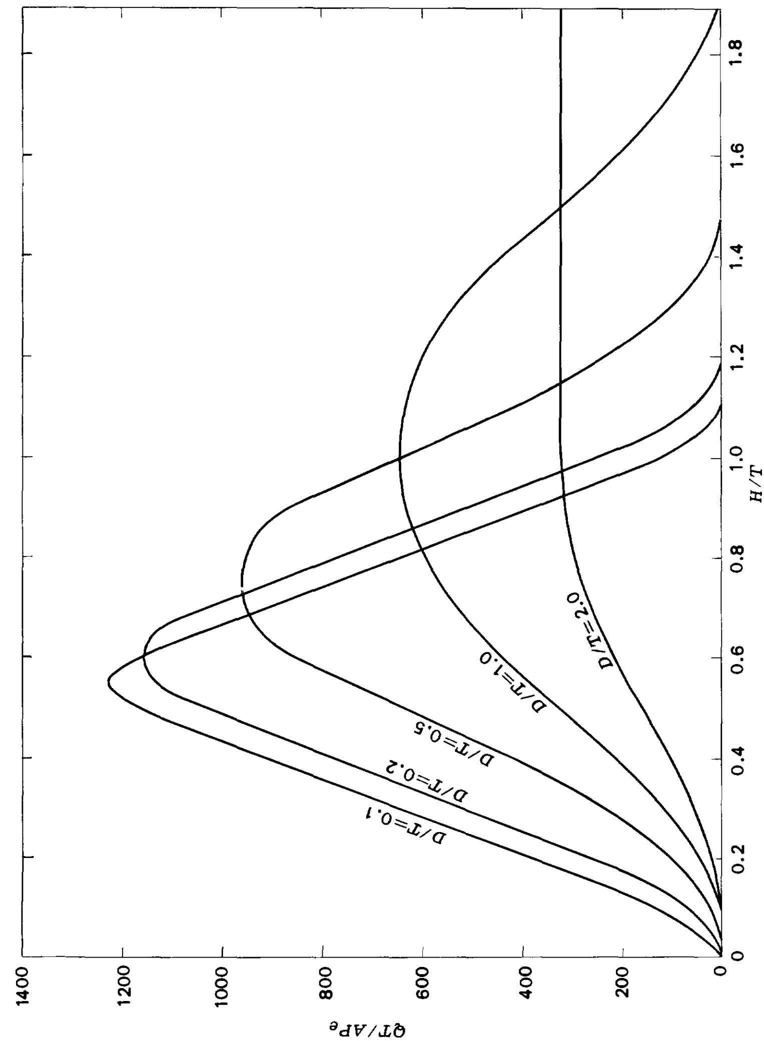

FIGURE 2.—Translation hydrographs, finite values of D/T.

MODEL HYDROGRAPHS

The foregoing sections have presented the concept of the translation hydrograph, both instantaneous and finite, and have shown how these translation hydrographs may be modified by reservoir routing techniques to represent actual runoff hydrographs. It should again be pointed out, and emphasized, that by expressing these hydrographs in terms of dimensionless ratios, rather than absolute values, a comparatively few computations will provide a systematized set of tables, of modest extent, from which an almost limitless number of flood hydrographs readily may be computed. To compute a flood hydrograph, select the appropriate hydrograph from the tables and multiply all the values by appropriate simple constants which are functions of the time and areal characteristics of the specific drainage area. (This conversion process is described in detail in the section "Application to Specific Areas.") The systematized tables from which this final computation is made are presented in tables 3–36 and constitute the model hydrographs.

LINEAR MODELS

Tables 3–28 constitute the linear models. Each table is distinguished from all the others by its unique value of the ratio k/T, which ranges from 0.2 to 3.0. Values of this ratio have been chosen such that by using the table whose value is nearest to the actual k/T ratio for a specific area, the tabular values will be within 5 percent of true values. Each table is similar to all the others in that it provides model hydrographs for various values of the ratio D/T ranging from instantaneous to 2.0. To select the proper linear model, first compute k/T to determine the appropriate table, then compute D/T to determine the appropriate column within the table.

NONLINEAR MODELS

Tables 29–36 are by no means an exhaustive array of all possible nonlinear models, but they do appear to be a representative one. For all these models, the storage equation for the reservoir routing is $S=kO^{1/2}$, which approximates the degree of nonlinearity most common in analyses of actual flood hydrographs. Further experience may demonstrate the need for a more extensive array of nonlinear models, but the present array is sufficient to illustrate the techniques for nonlinear computations and also sufficient to cover most of the problems so far encountered.

Each of the nonlinear models is distinguished from all the others by its unique value of the ratio $k/\sqrt{AP_e/T}$, which ranges from 2.0 to 12.0. Values of this ratio have been chosen such that by using the table whose value is nearest to the actual ratio for a specific area, the tabular values will be within 5 percent of the true values. Each table is similar to all the others in that it provides model hydrographs for various values of the ratio D/T, ranging from instantaneous to 2.0. To select the proper nonlinear model, first compute $k/\sqrt{AP_e/T}$, to determine the appropriate table; then compute D/T to determine the appropriate column within the table.

APPLICATION TO SPECIFIC AREAS

All the model hydrographs, both linear and nonlinear, are expressed in terms of dimensionless ratios. To prepare a flood hydrograph for a specific area, only the proper time and areal dimensions must be incorporated into the appropriate model.

For all models, the abscissa of the hydrograph is expressed in terms of H/T, in which H is hours from beginning of rainfall excess. To obtain the proper time expressions for any flood hydrograph, multiply the values of H/T, as given in column 1 of all the tables, by the value of T for the specific area.

Likewise, for all models, the ordinates of the hydrograph are expressed in terms of QT/AP_e. To obtain the proper discharge, in cubic feet per second, for any flood hydrograph, multiply the values of QT/AP_e by the value of AP_e/T for the specific area.

The following examples, involving both linear and nonlinear models, will illustrate the procedures and indicate the accuracy of results.

EXAMPLE 1

A tributary to Second Creek, at Keptown (Effingham County), Ill., has a drainage area of 1.62 sq mi. As determined by methods subsequently described, the storage is linear, the value of k is 1.03 hr, and the value of T is 1.52 hr. For the storm of July 15, 1957, rainfall excess of 0.87 in. occurred in 0.67 hr, beginning at 1045 hr. Compute the surface-runoff hydrograph from the appropriate model, and compare with the surface runoff from the observed hydrograph.

By using the values just given, k/T=1.03 hr/1.52 hr=0.68; D/T= 0.67 hr/1.52 hr=0.44. The appropriate model is taken from table 12 (k/T=0.7), columns 1 and 6. The value of AP_e/T is (1.62 sq mi×0.87 in.)/1.52 hr=0.927 cfs. The model is converted by multiplying the values from column 1 by 1.52 hr and the values from column 6 by 0.927 cfs.

Four graphs are shown in figure 3. The two light lines show the total observed runoff and the estimate for base flow. The dashed line is the difference between the first two graphs, or the actual surface runoff. This line should be compared with the heavy continuous line which is the converted model hydrograph.

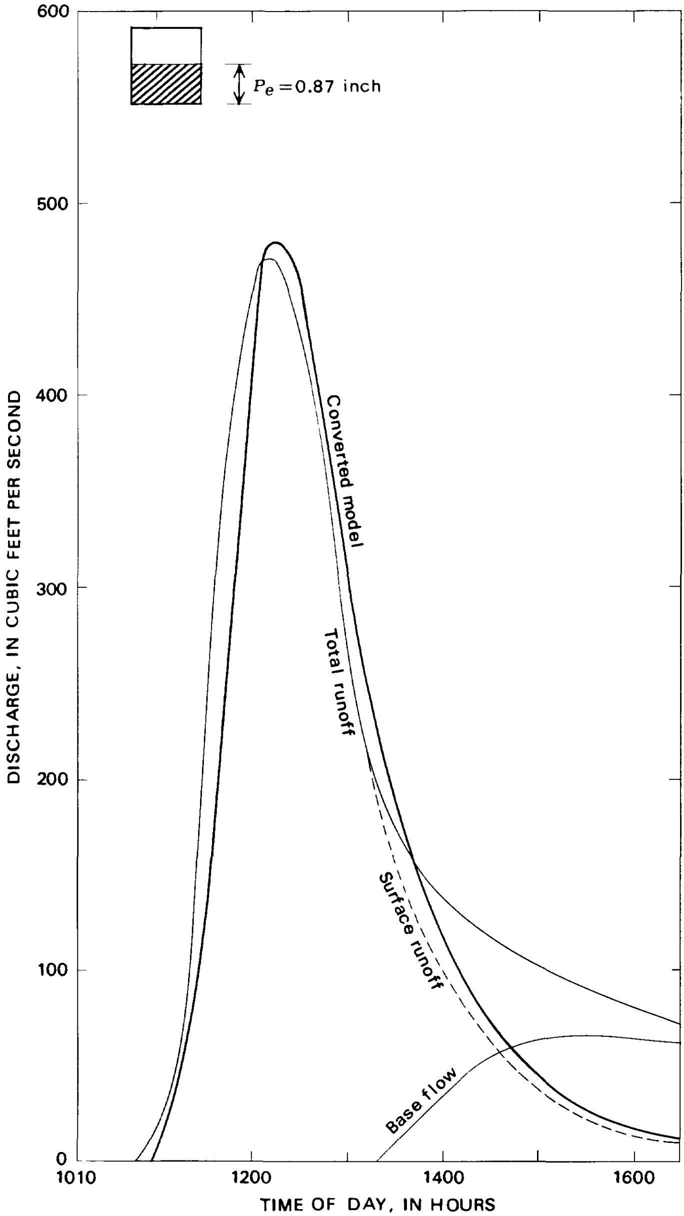

FIGURE 3.—Hydrographs for tributary to Second Creek at Keptown, Ill.

EXAMPLE 2

A tributary to Kankakee River, near Bourbonnais (Kankakee County), Ill., has a drainage area of 0.192 sq mi. As determined by methods subsequently described, the storage is linear, the value of k is 0.405 hr, and the value of T is 0.88 hr. For the storm of July 12, 1957, rainfall excess of 1.90 in. occurred in 0.75 hr, beginning at 1945 hr. Compute the surface-runoff hydrograph from the appropriate model, and compare with the surface runoff from the observed hydrograph.

By using the values just given, $k/T=0.405$ hr/0.88 hr$=0.46$; $D/T=0.75$ hr/0.88 hr$=0.85$. The appropriate model is taken from table 8 ($k/T=0.45$), columns 1 and 10. The value of AP_e/T is 0.192 sq mi$\times$1.90 in./0.88 hr$=0.415$ cfs. The model is converted by multiplying the values from column 1 by 0.88 hr and the values from column 10 by 0.415 cfs.

Four graphs are shown in figure 4. The two light lines show the total observed runoff and the estimate for base flow. The dashed line is the difference between the first two graphs, or the actual surface runoff. This line should be compared with the heavy continuous line, which is the converted model hydrograph.

EXAMPLE 3

Mazon River near Coal City (Grundy County), Ill., has a drainage area of 470 sq mi. As determined by methods subsequently described, the storage is linear, the value of k is 20 hr, and the value of T is 30 hr. For the storm whose peak occurred on May 12, 1943, rainfall excess of 1.79 in. occurred in 20 hr, beginning at 1600 hr on May 10. Compute the surface-runoff hydrograph from the appropriate model, and compare with the surface runoff from the observed hydrograph.

By using the values just given, $k/T=20$ hr/30 hr$=0.67$; $D/T=20$ hr/30 hr$=0.67$. The appropriate model is taken from table 12 ($k/T=0.7$), columns 1 and 9. The value of AP_e/T is 470 sq mi$\times$1.79 in./30 hr$=28.0$ cfs.

Four graphs are shown in figure 5. The two light lines show the total observed runoff and the estimate for base flow. These two graphs are the same as those shown in the report by Mitchell (1948, p. 115). The dashed line is the difference between the first two graphs, or the actual surface runoff. This line should be compared with the heavy continuous line, which is the converted model hydrograph.

EXAMPLE 4

A tributary to Vermilion River, at Lowell (La Salle County), Ill. has a drainage area of 0.126 sq mi. As determined by methods subsequently described, the storage is nonlinear ($x=0.5$), the value of k is

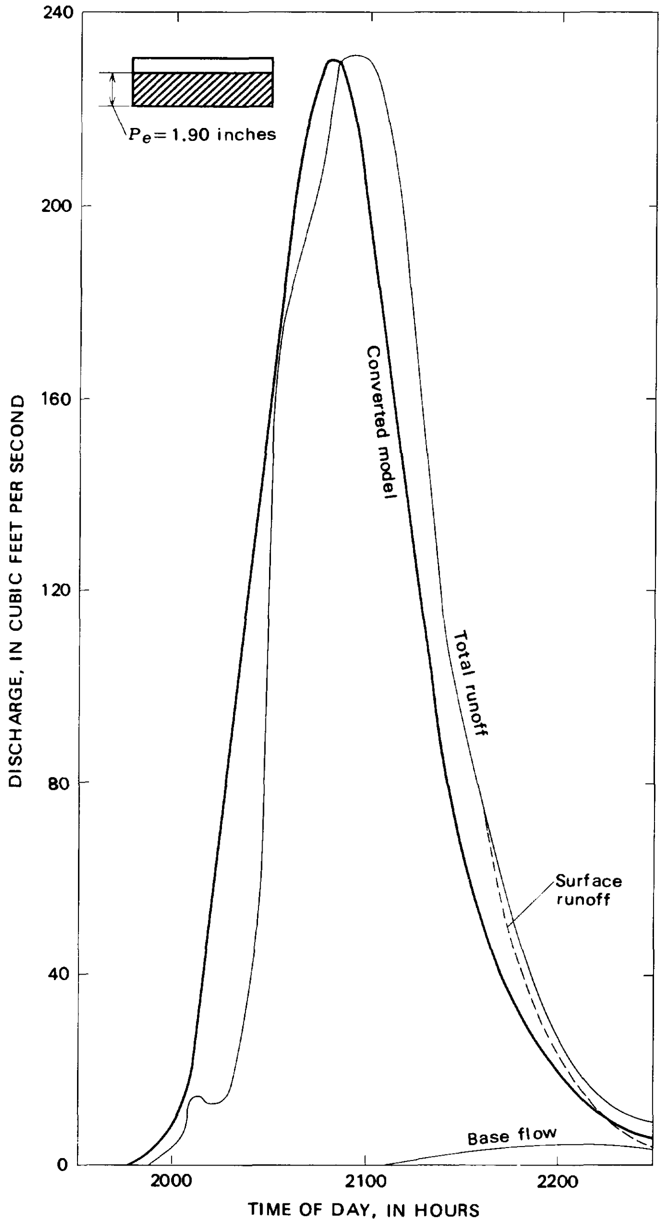

FIGURE 4.—Hydrographs for tributary to Kankakee River near Bourbonnais, Ill.

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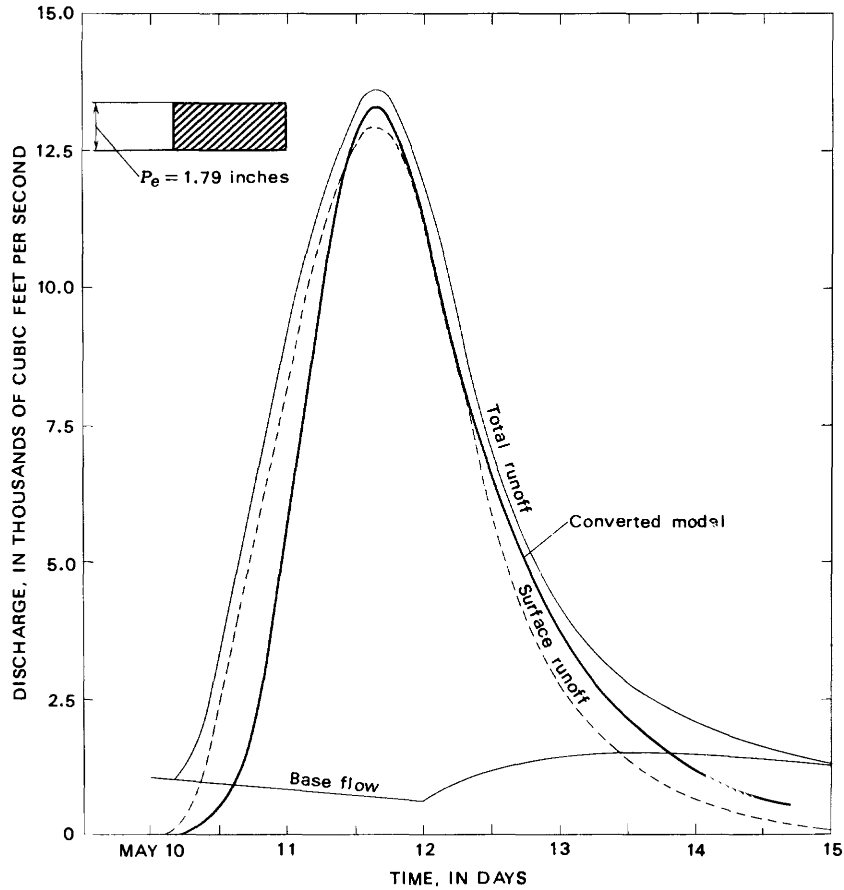

FIGURE 5.—Hydrographs for Mazon River near Coal City, Ill.

1.34 hr, and the value of T is 0.32 hr. For the storm of June 12, 1957, rainfall excess of 0.045 in. occurred in 0.067 hr, beginning at 0625 hr. Compute the surface-runoff hydrograph from the appropriate model, and compare with the surface runoff from the observed hydrograph.

By using the values just given, $k/\sqrt{AP_e/T}=1.34/\sqrt{(0.126\times 0.045)/0.32}=10.1$; $D/T=0.067$ hr/0.32 hr=0.2. The appropriate model is taken from table 34 ($k/\sqrt{AP_e/T}=10.0$), columns 1 and 4. The value of AP_e/T is 0.126 sq mi$\times$0.045 in./0.32 hr=0.018 cfs. The model is converted by multiplying the values from column 1 by 0.32 hr and the values from column 4 by 0.018 cfs.

Four graphs are shown in figure 6. The two light lines show the total observed runoff and the estimate for base flow. The dashed line is the difference between the first two graphs, or the actual surface runoff.

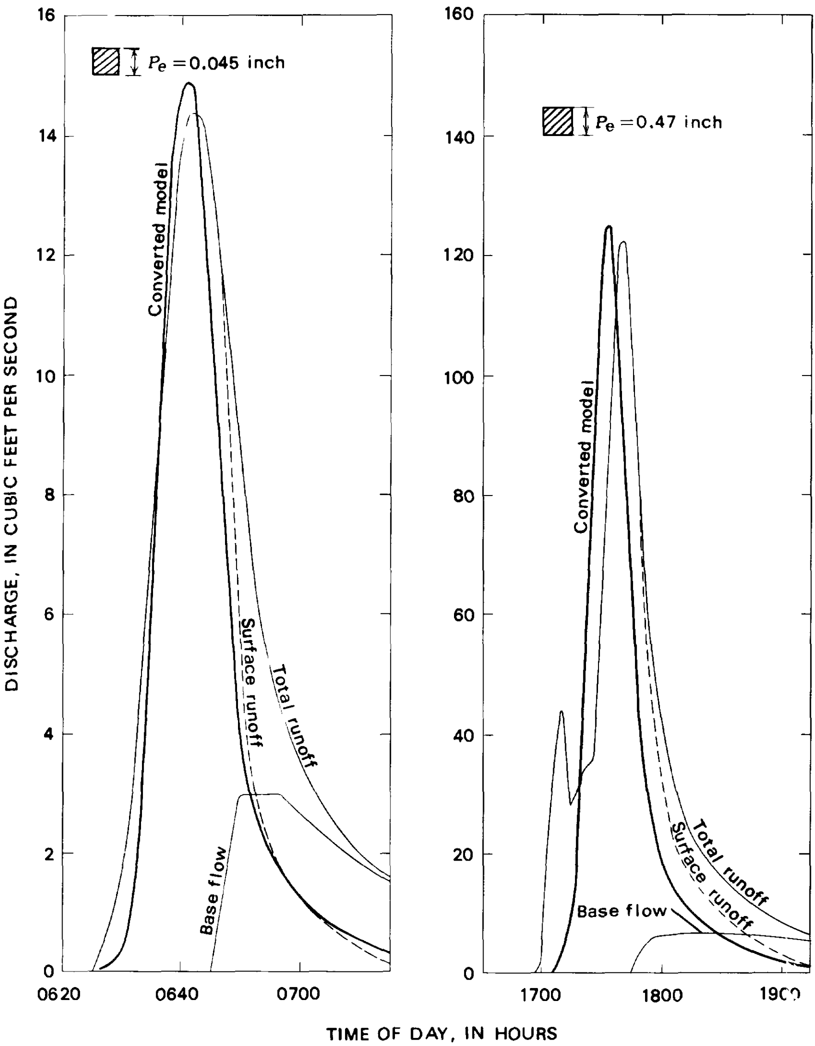

FIGURE 6.—Hydrographs for tributary to Vermilion River at Lowell, Ill. (left) and for tributary to Mud Creek near Tower Hill, Ill., (right).

This line should be compared with the heavy continuous line, which is the converted model hydrograph.

EXAMPLE 5

A tributary to Mud Creek, near Tower Hill (Shelby County), Ill., has a drainage area of 0.204 sq mi. As determined by methods subsequently described, the storage is nonlinear (x=0.5), the value of k is 4.40 hr, and the value of T is 0.58 hr. For the storm of June 19, 1956, rainfall excess of 0.47 in. occurred in 0.25 hr, beginning at 1700 hr. Compute the surface-runoff hydrograph from the appropriate model, and compare with the surface runoff from the observed hydrograph.

By using the values just given, $k/\sqrt{AP_e/T}=4.40/\sqrt{(0.204\times 0.47)/0.58}=10.8$; $D/T=0.25$ hr/0.58 hr$=0.43$. The appropriate model is taken from table 35 ($k/\sqrt{AP_e/T}=11.0$), columns 1 and 6. The value of AP_e/T is 0.204 sq mi$\times$0.47 in./0.58 hr$=$0.165 cfs. The model is converted by multiplying the values from column 1 by 0.58 hr and the values from column 6 by 0.165 cfs.

Four graphs are shown in figure 6. The two light lines show the total observed runoff and the estimate for base flow. The dashed line is the difference between the first two graphs, or the actual surface runoff. This line should be compared with the heavy continous line, which is the converted model hydrograph.

EXAMPLE 6

Assume that for example 5 the rainfall excess had been 1.00 in. and that all other factors were as previously given. After selecting the appropriate model, compute the peak discharge of surface runoff.

By using the values given, $k/\sqrt{AP_e/T}=4.40/\sqrt{(0.204\times 1.00)/0.58}=7.4$; $D/T=0.43$, as before. The appropriate model is taken from table 31 ($k/\sqrt{AP_e/T}=7.0$), columns 1 and 6. The value of AP_e/T is 0.204 sq mi$\times$1.00 in./0.58 hr$=$0.352 cfs. The model indicates that the peak discharge will occur at 0.8×0.58 hr$=$0.46 hr after beginning of rainfall excess and will have a magnitude of 914.0×0.352 cfs$=$322 cfs.

This last example has been included to illustrate the fact that for nonlinear storage peak discharges are not proportional to amount of rainfall excess. A comparison of examples 5 and 6 shows that an increase in rainfall excess of 113 percent (from 0.47 in. to 1.00 in.) produced an increase in peak discharge of 158 percent (from 125 cfs to 322 cfs.)

DETERMINATION OF HYDROGRAPH PARAMETERS

Two types of phenomena combine to produce the flood hydrograph. One of these is the meteorological event—the amount, duration, and distribution of rainfall. The other is the physiographic character of the drainage basin. For the most part, past meteorological events are only a rough and uncertain guide to future intensities and durations. Also, barring the advent of bulldozers (and neglecting the ephemeral effects of temperature and antecedent precipitation), the physiographic character of a drainage basin changes only imperceptibly, from day to day, and from decade to decade. ("Eternal as the hills" is a realistic expression.) Thus, although successive flood hydrographs for a given basin may vary greatly because of the variations in the meteorological events, they will nevertheless have certain invariable characteristics, reflecting the relatively constant, unchanging physiography of the basin. These characteristics, once accurately determined for a basin, may be applied with confidence to a synthesis of other hydrographs for that basin.

The hydrograph does not, of course, provide direct information on discrete elements of the physiography, such as area, slope, or stream density. In fact, for area, the hydrograph provides no information whatsoever; this must be obtained from other sources, such as topographic maps. However, information for the other physiographic factors which influence the hydrograph is available in a total, integrated form as certain constant (or at least nearly constant) hydrograph parameters. These parameters are the characteristic time, T and the storage constants, k and x.

DETERMINATION FROM OBSERVED HYDROGRAPHS

The most direct, and most satisfactory, method of determination of hydrograph parameters is appropriate analysis of observed hydrographs. All three of the significant parameters, T, k, and x, may be determined by such analysis. The principal shortcoming of this method is the lack of observed hydrographs for ungaged areas.

CHARACTERISTIC TIME, T

In the discussion of translation flow (section "Translation Hydrograph"), T was considered to be the time required for flow to arrive at the outlet from the most distant point of the drainage basin. Many hydrologists have assumed, although none has rigorously proved, that this is the time from ending of rainfall excess to the point of inflection on the recession side of the hydrograph. Even in the absence of rigorous proof, experience has demonstrated repeatedly that this lapse of time is a constant for a given basin and adequately serves the purposes for which the concept of T was intended.

The characteristic time, T, for any given basin is determined by subtracting the time of ending of rainfall excess from the time of occurence of the inflection (change of curvature from concave downward to concave upward) on the recession limb of the hydrograph.

STORAGE CONSTANTS, k AND x

In view of the assumption upon which the model hydrographs are developed—that the hydrograph of surface runoff is a translation hydrograph modified by reservoir storage, $S=kO^x$—appropriate analysis of the hydrograph should disclose the values of k and x. For linear storage, the value of x is, of course, unity, and a procedure for determining k already has been published (Mitchell, 1962, p. 23). Briefly, this procedure involves computation of a recession coefficient, r, for any convenient time, Δt, and substitution in the formula

$$k=\Delta t(1+r)/2(1-r).$$

When storage is linear, r has the same value for all points equally spaced in time on a recession curve, but when storage is nonlinear, the value of r will vary with the discharge. Hence, to determine the value of k, as well as x, for nonlinear storage a new procedure is required.

The formula for k, just described, was developed from the flood-routing equation

$$O_2=(2S_1/\Delta t)-O_1-(2S_2/\Delta t)+(I_1+I_2)$$

(see section "Routing Considerations") and the assumption that if beyond the point of inflection on the recession limb of the hydrograph, inflow has been completed, both I_1 and I_2 are zero. Starting with this same assumption, Shen (1962) found that both k and x could be evaluated by the following procedure: On logarithmic coordinates, plot $\Delta Q/\Delta t$ as ordinate and average Q as abscissa, fit a straight line to these points, and determine the slope and the intercept (at $Q=1$); to obtain the value of x, subtract the slope of the line from 2.0, and to obtain k, multiply the intercept by x and take the reciprocal of this product.

Figure 7 shows examples of Shen's procedure. The points plotted there are derived from routed graphs which appear later as figures 11, 12, and 13. Some of the points are from the curves for 1 inch of runoff, others from the curves for 2 inches of runoff; alinement of the points is independent of this variation. One curve is horizontal (zero slope), with an intercept of 50. Hence, the value of x is $2-O=2$, the value of k is $1/(2\times 50)=0.01$, and the storage equation is $S=0.01\ O^2$. For the second line, the slope is 1.0 and the intercept is 5.0; so $x=2-1=1$, $k=1/(1\times 5)=0.20$, and the storage equation is $S=0.2\ O$. For the steepest line, the slope is 1.5 and the intercept is 0.2; so $x=2.0-1.5=0.5$, $k=1/(0.5\times 0.2)=10$, and the storage equation is $S=10.0\ O^{0.5}$.

Shen's method is further illustrated by figure 8. The five sets of data plotted here are for the same five stations that were used to describe the application of model hydrographs to specific areas.

The open circles are for the tributary to Second Creek at Keptown, Ill., and for the storm of July 15, 1957. The values of actual surface runoff (the dashed line of fig. 3) were used to compute these points.

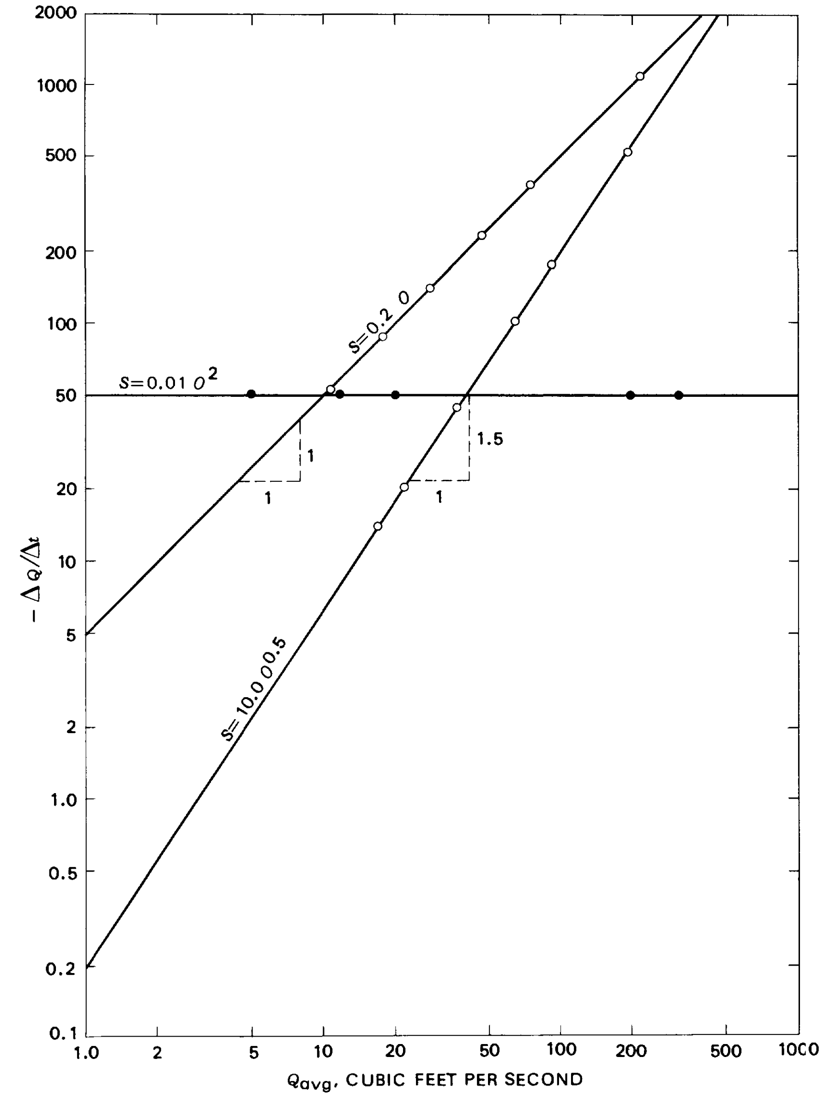

FIGURE 7.—Analyses for storage constants of model hydrographs.

Slope of the line is 1.0, and the intercept is 0.94; thus the constants are $x=1.0$, and $k=1.06$. (Determinations for other storms, not shown here, give an average value for k of 1.03, as used in "Example 1.")

The solid circles are for the tributary to Kankakee River near Bourbonnais, Ill., and for the storm of July 12, 1957. The values of actual surface runoff (the dashed line of fig. 4) were used to compute these points. Slope of the line is 1.0, and the intercept is 2.8; thus the constants are $x=1.0$ and $k=0.357$. (Determinations for other

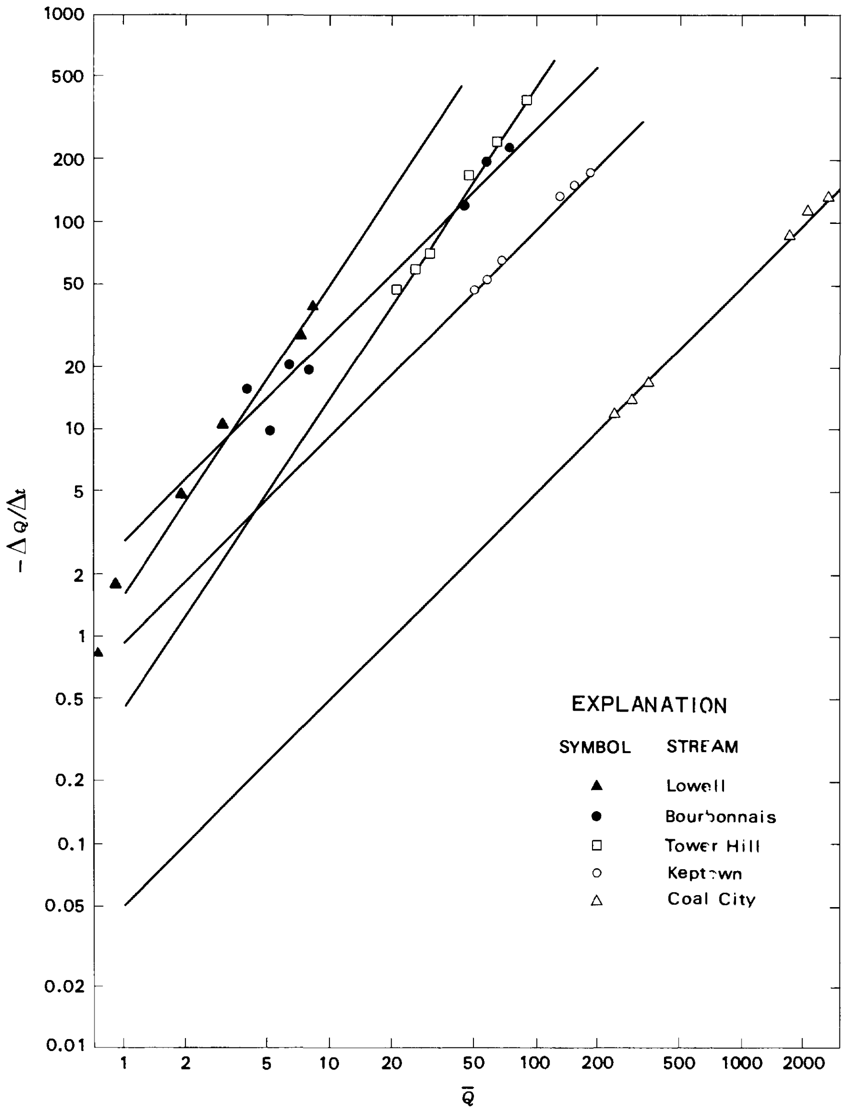

FIGURE 8.—Analyses for storage constants of observed hydrographs.

storms, not shown here, give an average value for k of 0.405, as used in "Example 2.")

The open triangles are for Mazon River near Coal City, Ill. The published unit hydrograph (Mitchell, 1948) was used to compute these points. Slope of the line is 1.0, and the intercept is 0.05; thus the constants are $x=1.0$ and $k=20$, as used in "Example 3."

The solid triangles are for the tributary to Vermilion River at Lowell, Ill., and for the storm of June 12, 1957. The values of actual surface runoff (the dashed line of fig. 6) were used to compute these points. Slope of the line is 1.5, and the intercept is 1.5; thus the constants are $x=0.5$ and $k=1.34$, as used in "Example 4."

The open squares are for the tributary to Mud Creek near Tower Hill, Ill., and for the storm of June 19, 1956. The values of actual surface runoff (the dashed line of fig. 6) were used to compute these points. Slope of the line is 1.5, and the intercept is 0.45; thus the constants are $x=0.5$, and $k=4.40$, as used in "Example 5."

From these examples, which initially were chosen with other objectives in view, it should not be assumed that all observed hydrographs will result in plots for which slope of the lines will be precisely 1.0 or 1.5. Present knowledge concerning nonlinear hydrographs is so meager that slopes cannot be predicted. Our present experience indicates that for most of these plots the slopes will be near to 1.0 and that for the few others the slopes will tend to cluster about 1.5; but any slope appears to be possible. Thus, because a better understanding of nonlinearity is needed and models presently are available only for the two cases cited, the lines for all analyses should be drawn with slopes of either 1.0 (when possible) or 1.5 (when necessary).

DETERMINATION FROM BASIN CHARACTERISTICS

The storage effect results from physiographic influences. Therefore, the expression for a hydrograph may be correlated with the observable physical characteristics of its drainage basin.

Efforts have been made by means of multiple regression analyses to relate T and k for basins having linear storage characteristics to observed values of area (A), length (L), slope between points 10 percent and 85 percent of the distance along the channel from the site to the divide ($S_{10/85}$), soils infiltration index (S_i), a surface-storage index giving percentage of the basin in lakes, ponds, and swamps (S_l), percentage of basin covered by forest (F), rainfall intensity ($I_{24,2}$), and drainage density (D_d). Many of the drainage basins have no forest cover or surface storage; so a constant of 0.5 was added to these two basin characteristics to prevent the computer from stopping when attempting to take logarithms of zero values. Data for 48 stations were used in the regressions for T, and data for 43 stations were used in the regressions for k. The initial array of data followed the general arrangement described by

$$T=f(A, L, S_{10/85}, S_i, S_l, F, I_{24,2}, D_d)$$

and

$$k=f(A, L, S_{10/85}, S_i, S_l, F, I_{24,2}, D_d).$$

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Stepwise multiple regression performed on these data indicated that only three independent variables were significant at either the 1-percent or 5-percent level. The general equations are

$$T_c = C_t L^a S_{10/85}{}^b S_t{}^c$$

and

$$k_c = C_k L^d S_{10/85}{}^e S_t{}^f,$$

where

T_c=computed lag time,
k_c=computed storage time,
C_t, C_k=regression constants,
L=length of stream, in miles,
$S_{10/85}$=slope, in feet per mile,
S_t=surface-storage index+0.5, in percent,
a, b, c, d, e, f=regression coefficients.

The following table gives the regression coefficients, significant at the 1-percent level, to be used in the above equations and also indicates the coefficient of correlation and standard error of each equation:

Regression factors for T_c					
C_t	a	b	c	*Coefficient of correlation*	*Standard error (percent)*
0.837	0.898	----	----	0.885	56.2
5.02	.650	−0.460	----	.929	44.4
5.33	.602	−.448	[1] 0.231	.939	41.9

Regression factors for k_c					
C_k	d	e	f	*Coefficient of correlation*	*Standard error (percent)*
67.2	----	−1.20	----	0.921	48.9
16.5	0.392	−.873	----	.959	35.4
17.6	.339	−.860	0.258	.970	30.6

[1] Significant at 5-percent level.

The equations giving the best estimates of T and k were used to compute T_c and k_c for those stations used in the regression analyses. Figures 9 and 10 show the extent of agreement between the computed and actual values.

Data for more stations are being continually added to those data for stations described in the previous section. It is hoped that continued study based on these additional data and minor refinements to those existing will eventually lead to more accurate correlations.

For nonlinear storage effects, the data are, as yet, too few to warrant any attempt at correlations.

UNIT HYDROGRAPH

Many hydrologists now regard the unit hydrograph as a translation hydrograph modified by some element of reservoir-type storage. Only

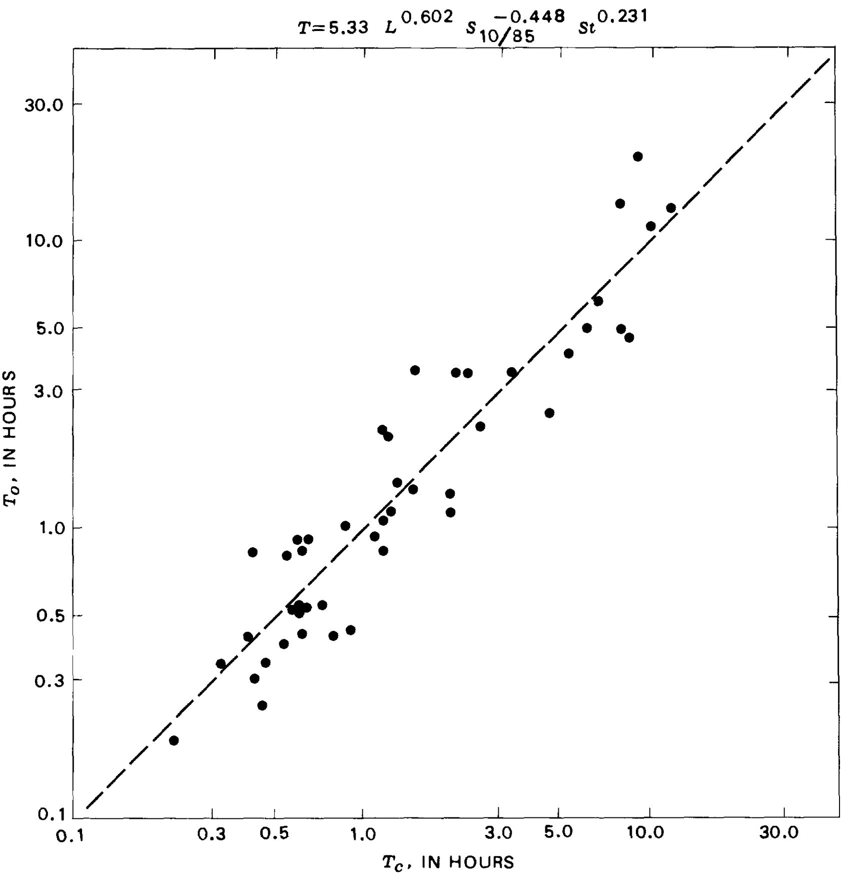

FIGURE 9.—Observed, T_o, versus computed, T_c, values of T.

recently, however, has there been a realization that to define a true unit hydrograph, the reservoir storage must be a particular type, namely linear storage.

A principle of the unit-hydrograph technique is that for rainfall excesses uniformly distributed over a given area and within a given time, the ordinates of the graph of surface runoff are in linear proportion to the amounts of the rainfall excesses. This principle requires that the storage effect be a linear one. A rigorous mathematical development of this statement is not presently available, but a demonstration is quite simple.

In figure 11, the lower curve results from routing the translation hydrograph of figure 1 through linear storage, $S=0.20\ O$. (See table 3, cols. 1, 2.) Suppose now that for figure 1 P_e had been in units of "double inches," of sixths of a foot, rather than twelfths. In that case, the ordinates of figure 1 would all have been doubled. The higher

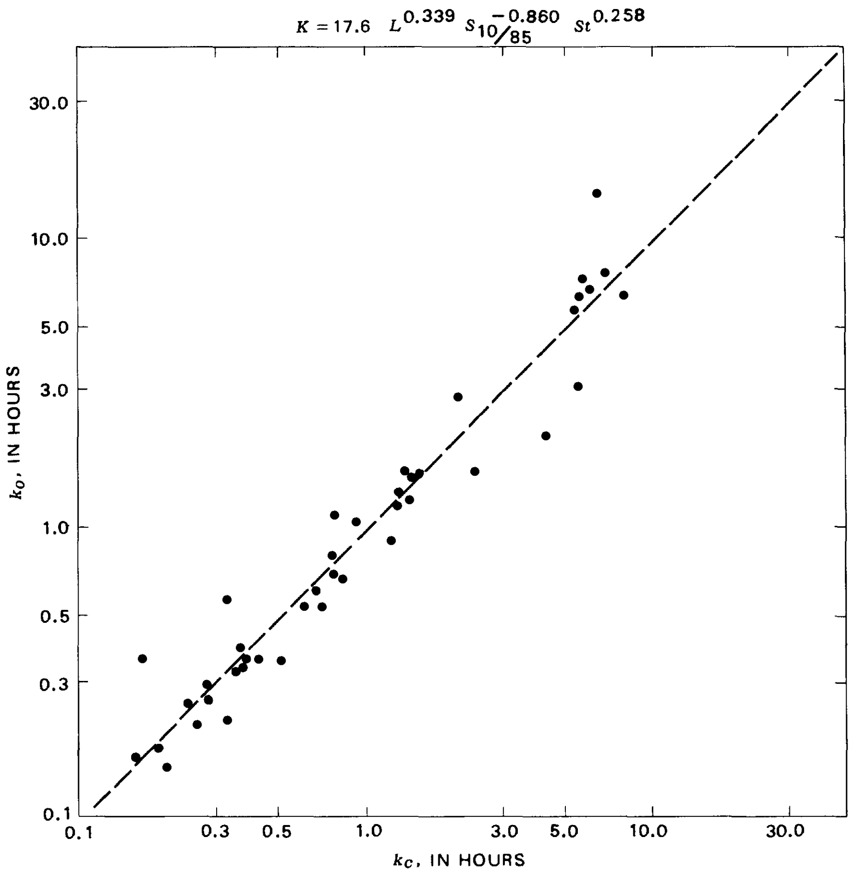

FIGURE 10.—Observed, k_o, versus computed, k_c, values of k.

curve in figure 11 results from routing these doubled ordinates through the same linear storage, $S=0.20\ O$. Comparing the curves of figure 11 shows that all ordinates of the second curve are twice those of the first. This relation meets the requirement of the unit-hydrograph principle that ordinates of the unit hydrograph be in linear proportion to rainfall excess.

In figure 12, the same two translation hydrographs have been routed through nonlinear storage, $S=10\ O^{0.5}$, to obtain the two graphs. Obviously there is no constant of proportionality between the ordinates of these graphs; hence they cannot be true unit hydrographs.

In figure 13, the same translation hydrographs have been routed through nonlinear storage, $S=0.01\ O^2$. Again, the resulting graphs have no constant of proportionality, and thus fail to meet the specifications for true unit hydrographs.

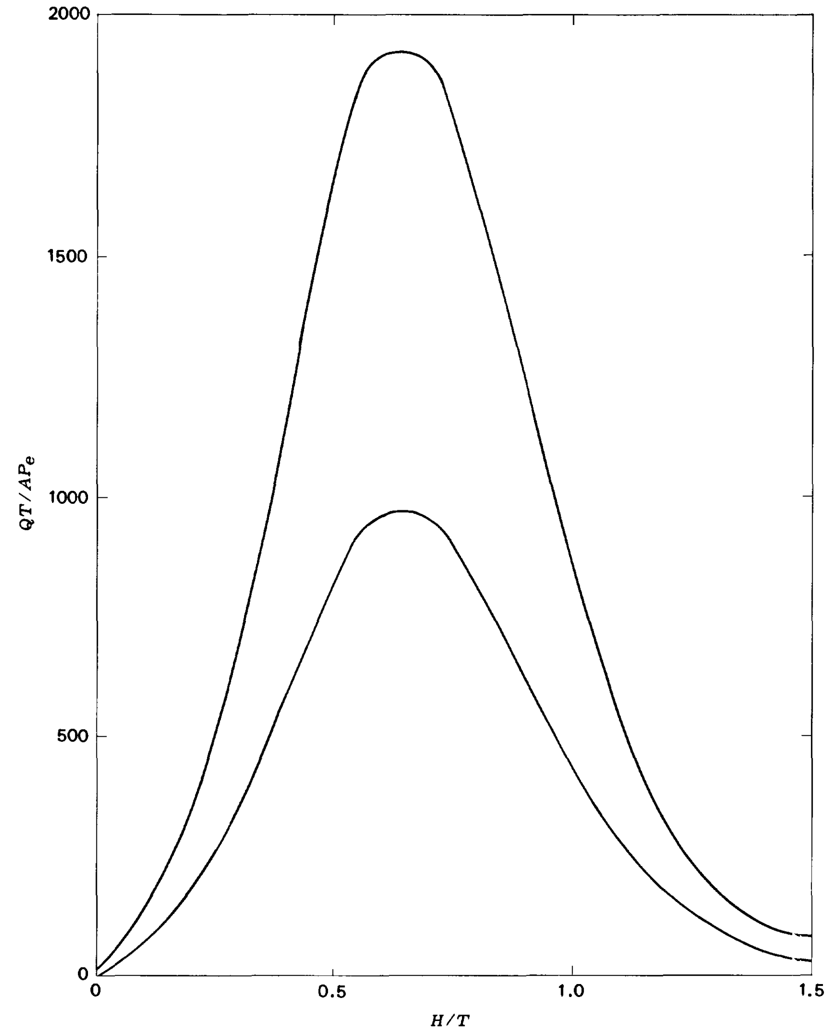

FIGURE 11.—Proportional graphs, resulting from routing through linear stor?ge, $S=0.20\ O$.

A quick method for testing linearity of storage effect in any hydrograph is to plot it semilogarithmically and note the shape of the recession limb. If the value of x is greater than unity, the recession will be concave downward; if less than unity, concave upward. Only when this recession is a straight line is the storage effect linear, and only then is the graph a true unit hydrograph. These statements are illustrated in figure 14, which shows the semilogarithmic plot for the recession limbs of the curves of figures 11, 12, and 13.

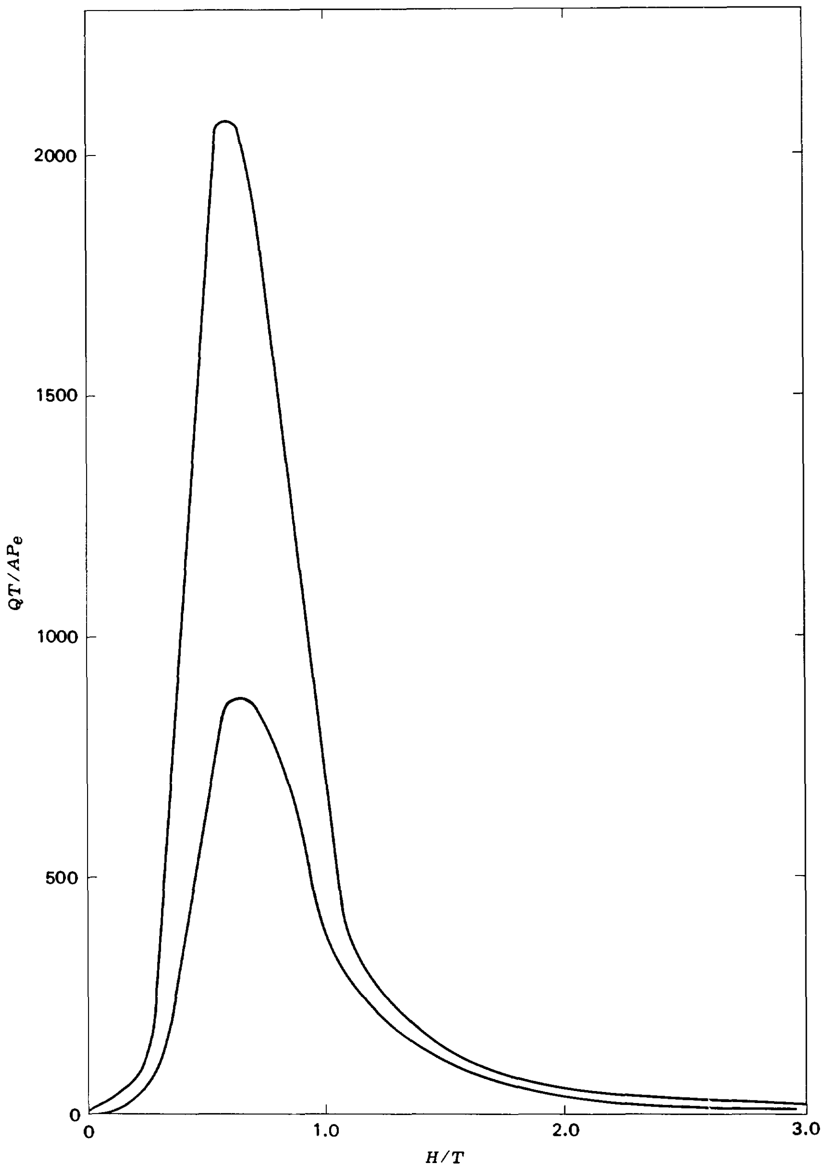

FIGURE 12.—Nonproportional graphs, resulting from routing through nonlinear storage $S=10\ O^{0.5}$.

It is interesting to note the extent to which some of the so-called unit hydrographs in the published literature conform to the criterion of straight-line recession. Figure 15 shows some typical examples (from Mitchell, 1948). Figure 16 shows the hydrograph derived from observed data for Money Creek above Lake Bloomington, Ill.,

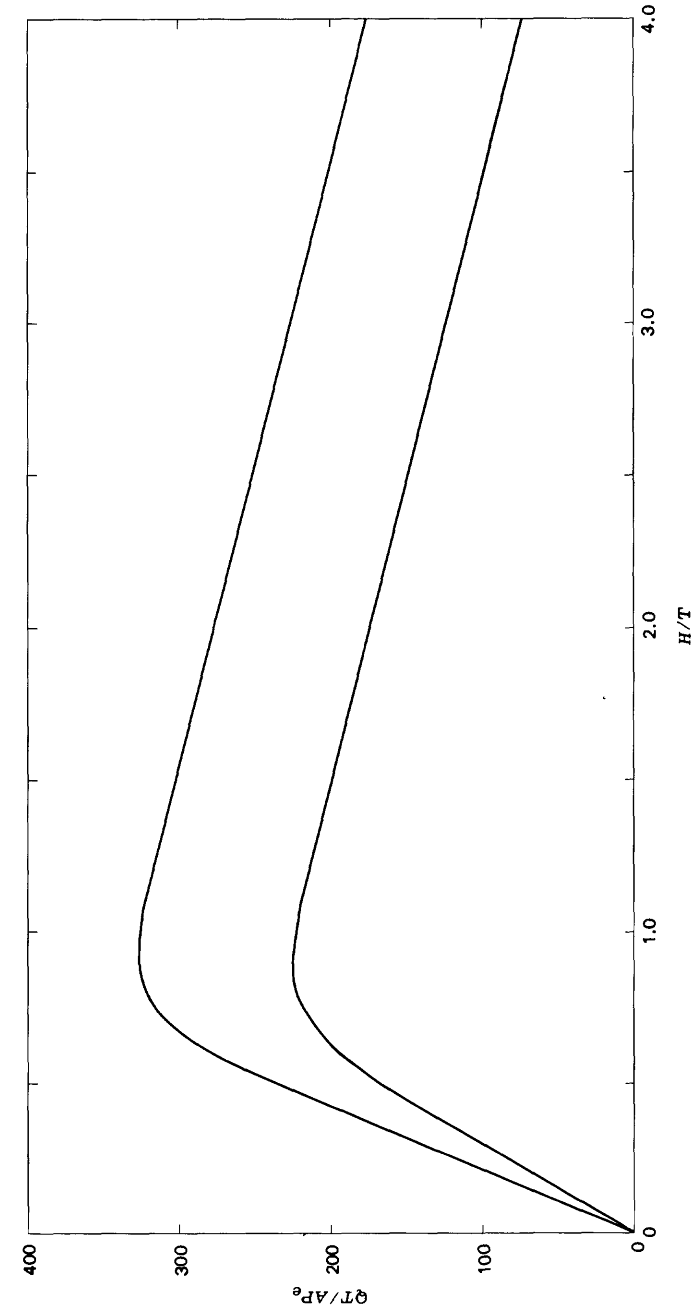

FIGURE 13.—Nonproportional graphs, resulting from routing through nonlinear storage, $S=0.01\ O^2$.

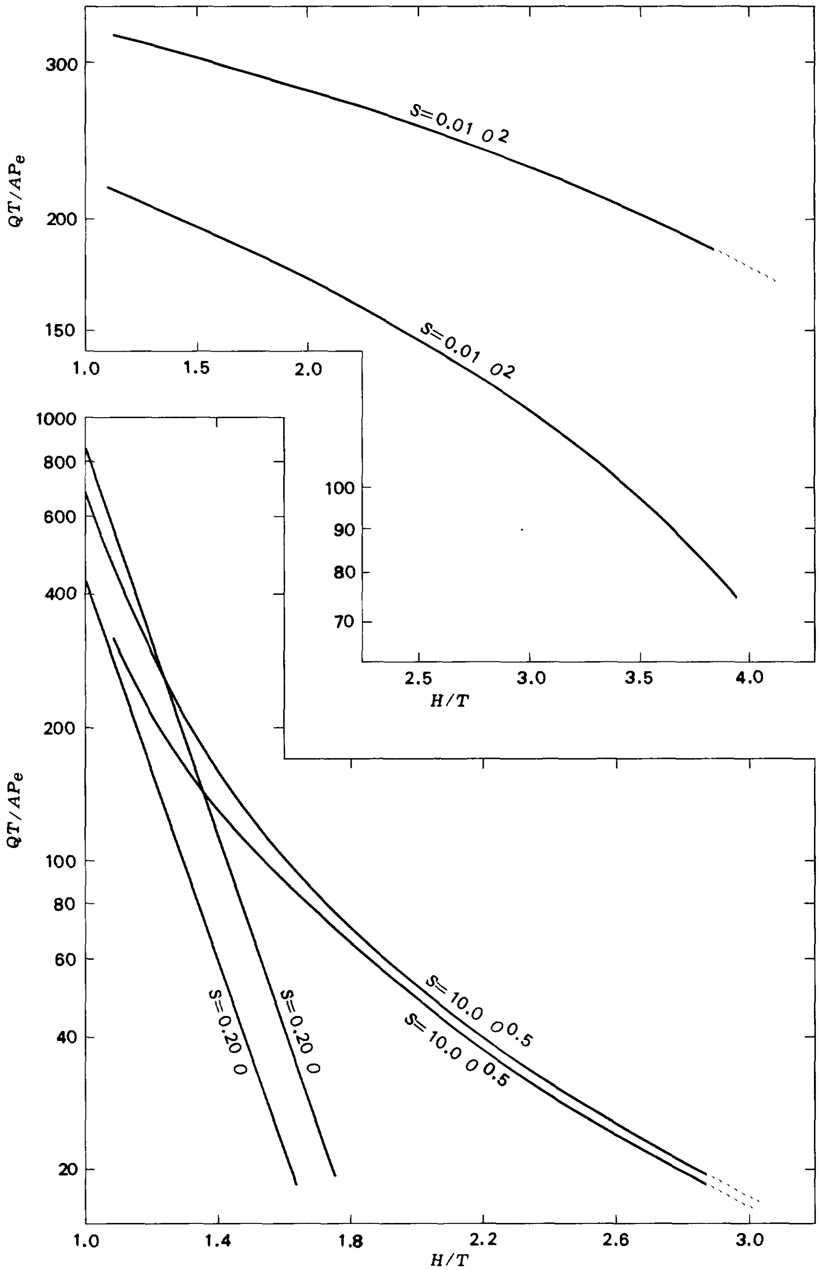

FIGURE 14.—Semilogarithmic plotting, recession limbs of graphs from figures 11, 12, and 13.

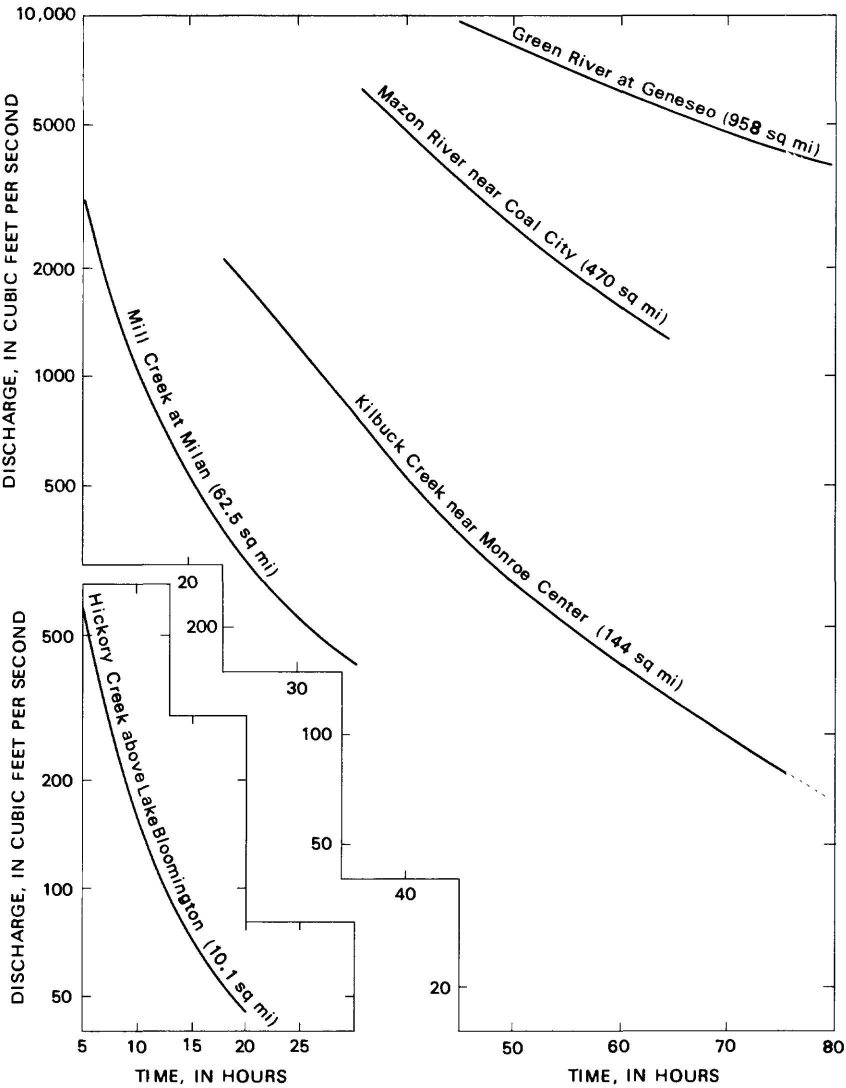

FIGURE 15.—Typical recessions, previously published unit hydrographs.

(Mitchell, 1948) and also the graphs derived by the synthetic methods proposed by Commons (1942), the U.S. Department of Agriculture Soil Conservation Service (1957), and Mitchell (1948). The graph labeled "Mitchell (1962, synthetic)" is the graph derived by methods described earlier in the section "Application to specific areas."

Although some of these last examples have been called unit hydrographs, we should not be swayed by this fact, for the recession lines must be straight in semilogarithmic plots if the storage effect is to be

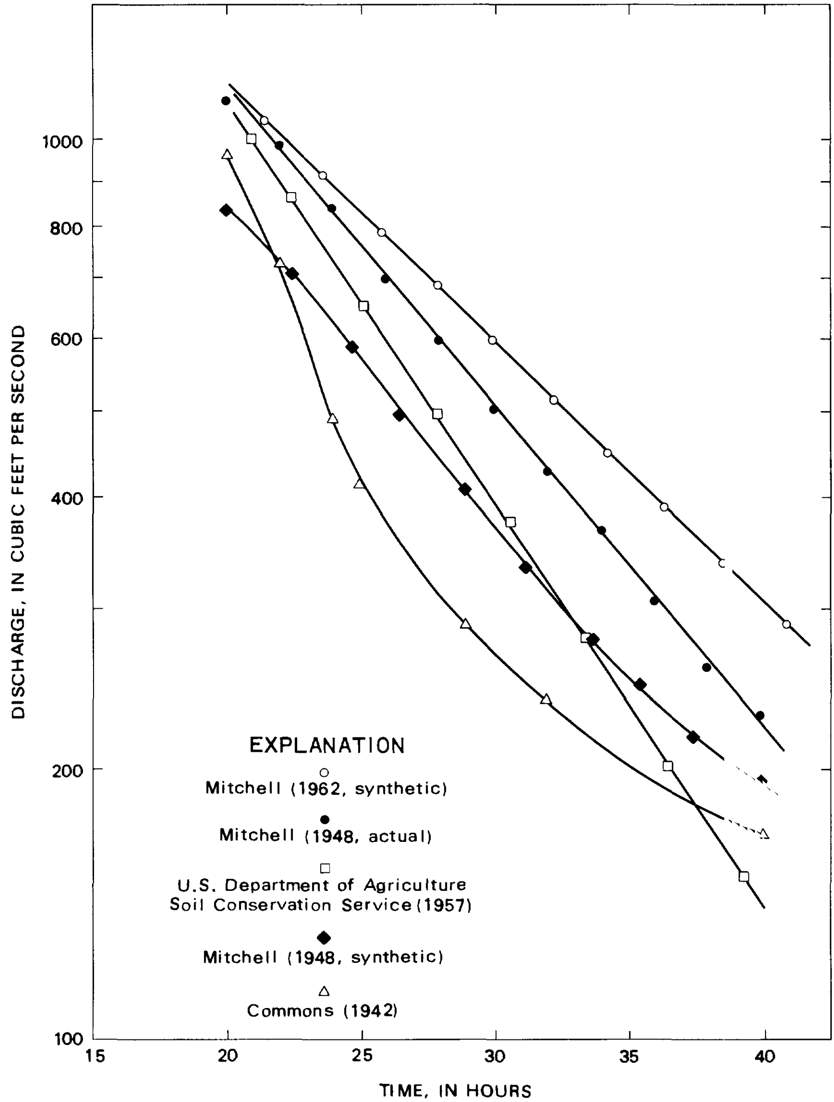

FIGURE 16.—Recession hydrographs, all for Money Creek above Lake Bloomington, Ill., computed by various methods.

considered linear. And the storage effect must be linear if the graphs are to meet the requirement of linear proportionality of ordinates and thus be considered true unit hydrographs.

As mentioned in a foregoing section, areas occasionally are found for which the semilogarithmic plot for the recession limb of the actual hydrograph (even after eliminating base flow) departs significantly from a straight line. True unit hydrographs cannot be developed for these areas. Instead, they must be approached with the broader concepts of the model hydrograph.

The special case of the unit hydrograph is applicable only to those areas for which linear storage effect may be assumed. The model hydrograph with its broader concepts is applicable to those areas for which the storage effect is nonlinear.

SUMMARY AND CONCLUSIONS

Model hydrographs are composed of pairs of dimensionless ratios (H/T, QT/AP_e) arranged in tabular form. Under appropriate conditions these dimensionless models may be converted to flood hydrographs for specific areas. The conversion is accomplished merely by multiplying the abscissas (H/T) by the value of T for the drainage basin and multiplying the ordinates (QT/AP_e) by the appropriate value of AP_e/T.

A dimensionless, isosceles translation hydrograph, for which the time base is T hours, is transformed by summation-curve techniques to a family of hydrographs with storm duration (D/T) ranging from 0.1 to 2.0. Each of these hydrographs is then routed through various single elements of reservoir storage, $S=kO^x$ to provide families of model hydrographs. Twenty-six of the families are linear models ($x=1.0$), with values of k ranging from $0.2T$ to $3.0T$. The remaining eight families are nonlinear models, for which x is 0.5 and for which the value of $k/\sqrt{AP_e/T}$ ranges from 2.0 to 12.0. The linear models are sufficiently extensive to cover most computational needs; the range of nonlinear models may eventually need to be extended, particularly to cover values of x other than 0.5 and conditions of initial inflow other than zero.

For a specific drainage area, the appropriate model is selected by the following procedure:

1. Determine T, in hours, for the basin. If a suitable runoff hydrograph is available, take T as the tlme from ending of rainfall excess to the point of inflection on the recession limb of the hydrograph. If such hydrograph is not available, use the formula

$$T=5.33\ L^{0.602}\ S_{10/85}{}^{-0.448}\ S_t{}^{0.231}.$$

2. Determine values for the storage factors, k and x. (k should be computed in hours; x is a dimensionless number.) If a suitable runoff hydrograph is available, follow the method outlined in the section "Application to Specific Areas" and illustrated by examples 1–5. If such hydrograph is not avallable, assume $x=5.0$, and compute k by formula

$$k=17.6L^{0.339}\ S_{10/85}{}^{-0.860}\ S_t{}^{0.258}.$$

(Techniques are not yet available for computing nonlinear storage factors from measured physiographic characteristics.)

3. Determine the storm characteristics, D, in hours, and P_e, in inches. These are obtained from meteorological data and from estimates of precipitation losses, except that when reproducing an observed hydrograph, P_e is the volume of surface runoff.
4. Determine the appropriate model family (tables 3–36). If the storage is linear ($x=1.0$), the family is identified by the value of the ratio k/T; if the storage is nonlinear ($x=0.5$), the family is identified by the value of the ratio $k/\sqrt{AP_e/T}$
5. Determine the appropriate member of model family (the column of the table containing proper values of the ordinates QT/AP_e). This column is identified by the value of the ratio D/T.

The conditions under which the models may be used are often the same as those usually described for unit hydrographs, but with one restriction. In general, the models may be used only to compute the flood hydrograph from storms for which rainfall excess is evenly distributed with respect to both time and area and unaffected by ice or melting snow. For linear models, the unit-hydrograph techniques of superposition may be used to develop complex hydrographs for storms for which rainfall excess is nonuniform with respect to time. But for nonlinear models superposition techniques are not appropriate. Further, nonlinear models presented here all are predicated on initial flow of zero; more work will be required to determine adjustments necessary when initial flow is substantially greater.

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TABLES 3–36

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Table 3.--Linear Model Hydrographs (S = kO); k/T = 0.20

H/T	QT/AP_e												
	D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	54.867	19.331	9.666	6.444	4.833	3.866	3.222	2.762	2.416	2.148	1.933	1.289	.967
.20	189.765	117.404	68.368	45.578	34.184	27.347	22.789	19.534	17.092	15.193	13.674	9.116	6.837
.30	373.183	278.496	197.950	138.410	103.808	83.046	69.205	59.319	51.904	46.137	41.523	27.682	20.762
.40	586.018	477.795	378.146	291.232	223.256	178.605	148.838	127.575	111.628	99.225	89.303	59.535	44.651
.50	816.689	700.259	589.027	485.517	393.488	318.657	265.547	227.612	199.161	177.032	159.328	106.219	79.664
.60	948.437	898.104	799.181	692.053	588.663	494.412	415.231	355.912	311.424	276.821	249.139	166.093	124.569
.70	926.680	946.980	922.542	848.448	755.785	660.327	569.840	491.195	429.796	382.041	343.837	229.225	171.918
.80	811.856	874.981	910.981	906.688	855.081	779.624	696.102	613.431	539.169	479.261	431.335	287.557	215.668
.90	640.609	729.695	802.338	850.552	862.440	830.004	771.302	700.901	627.964	560.338	504.304	336.203	252.152
1.00	435.152*	539.980	634.838	714.885	772.909	797.948	781.666	738.256	680.786	618.188	558.303	372.202	279.151
1.10	263.823	342.658*	441.319	537.444	621.829	686.859	722.066	718.950	688.807	643.216	590.635	395.045	296.284
1.20	159.950	207.746	275.202*	363.461	455.020	539.012	607.007	648.591	655.050	635.355	599.669	408.895	306.671
1.30	96.974	125.952	166.849	225.452*	304.084	389.206	470.169	538.284	583.262	596.262	584.415	417.292	312.969
1.40	58.793	76.362	101.157	136.687	188.179*	258.540	337.065	413.910	480.544	526.940	544.272	422.383	316.787
1.50	35.645	46.296	61.329	82.870	114.089	159.803*	223.166	295.527	367.959	432.294	478.875	425.469	319.102
1.60	21.611	28.069	37.182	50.242	69.170	96.885	137.847*	195.294	262.095	330.193	391.872	426.052	320.505
1.70	13.103	17.018	22.543	30.461	41.936	58.739	83.574	120.586*	173.010	234.864	298.876	419.359	321.356
1.80	7.944	10.318	13.668	18.468	25.425	35.612	50.669	73.108	106.802*	154.933	212.409	401.481	321.872
1.90	4.817	6.256	8.287	11.197	15.415	21.591	30.720	44.324	64.752	95.630*	140.065	370.045	322.185
2.00	2.920	3.793	5.024	6.789	9.346	13.090	18.625	26.873	39.258	57.979	86.447*	323.614	322.375
2.10	1.770	2.299	3.046	4.116	5.666	7.937	11.292	16.293	23.801	35.151	52.411	263.893	321.523
2.20	1.073	1.394	1.846	2.495	3.435	4.812	6.846	9.878	14.430	21.311	31.776	200.854	315.722
2.30	.650	.845	1.119	1.513	2.083	2.917	4.151	5.989	8.749	12.921	19.265	142.579	301.840
2.40	.394	.511	.678	.917	1.262	1.768	2.516	3.631	5.304	7.834	11.680	93.966	277.976
Peak	954.093	948.844	932.896	906.688	871.625	830.510	785.927	738.853	690.890	644.210	599.781	426.401	322.390
Time	0.64	0.68	0.74	0.80	0.86	0.92	0.96	1.02	1.06	1.12	1.18	1.56	2.02

Summarized from computations at intervals H/T = 0.02. *Recession coefficient 0.60627759 applicable beyond this point.

Table 4.--Linear Model Hydrographs (S = kO); k/T = 0.25

$\frac{H}{T}$	QT/AP$_e$												
	D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	45.288	15.848	7.924	5.283	3.962	3.170	2.641	2.264	1.981	1.761	1.585	1.057	.792
.20	160.777	98.478	57.163	38.109	28.582	22.865	19.054	16.332	14.291	12.703	11.433	7.622	5.716
.30	323.313	238.992	168.735	117.773	88.330	70.664	58.886	50.474	44.165	39.258	35.332	23.555	17.666
.40	517.379	418.301	328.647	251.924	192.905	154.324	128.603	110.231	96.452	85.735	77.162	51.441	38.581
.50	732.576	623.607	520.954	426.967	344.844	279.045	232.538	199.318	174.403	155.025	139.523	93.015	69.761
.60	871.359	814.641	719.124	618.849	523.885	438.804	368.311	315.695	276.233	245.541	220.987	147.324	110.493
.70	879.230	883.787	849.214	774.012	685.084	595.866	512.968	441.951	386.707	343.739	309.365	206.244	154.683
.80	799.366	844.990	864.388	847.806	791.756	717.065	637.386	560.399	492.330	437.627	393.864	262.576	196.932
.90	660.706	733.851	789.420	820.876	819.317	780.175	719.863	651.167	582.081	519.166	467.249	311.500	233.625
1.00	482.641*	574.230	654.040	717.690	759.214	770.300	745.851	699.058	641.550	581.208	524.672	349.782	262.336
1.10	323.455	397.966*	486.098	568.682	637.759	686.965	708.244	696.153	661.421	614.485	562.884	376.313	282.234
1.20	216.772	266.707	332.336*	412.968	493.188	563.549	616.922	645.167	642.472	617.564	579.707	394.093	295.570
1.30	145.276	178.741	222.724	281.138*	354.411	430.299	499.414	554.324	586.864	590.947	573.682	406.009	304.507
1.40	97.361	119.789	149.265	188.412	240.801*	307.486	378.547	445.182	500.008	534.967	543.831	413.995	310.496
1.50	65.250	80.280	100.034	126.270	161.379	208.696*	269.619	335.938	399.569	453.371	489.498	419.347	314.510
1.60	43.729	53.802	67.041	84.624	108.153	139.864	182.881*	238.788	300.671	361.151	413.414	421.877	317.200
1.70	29.306	36.057	44.930	56.713	72.482	93.734	122.563	161.906*	213.446	271.269	328.641	417.716	319.003
1.80	19.640	24.165	30.111	38.008	48.576	62.818	82.139	108.506	144.688*	192.415	246.559	403.394	320.212
1.90	13.162	16.194	20.179	25.472	32.554	42.100	55.048	72.718	96.967	130.411*	174.793	376.587	321.021
2.00	8.821	10.853	13.523	17.070	21.817	28.214	36.892	48.734	64.985	87.399	118.455*	335.737	321.564
2.10	5.911	7.273	9.063	11.440	14.621	18.908	24.724	32.661	43.552	58.573	79.386	281.912	321.135
2.20	3.961	4.874	6.074	7.667	9.798	12.672	16.569	21.888	29.187	39.254	53.203	223.318	316.455
2.30	2.654	3.266	4.070	5.138	6.566	8.492	11.104	14.669	19.560	26.307	35.655	167.203	304.668
2.40	1.779	2.189	2.727	3.443	4.400	5.691	7.441	9.830	13.109	17.630	23.895	118.426	283.863
Peak	879.230	883.787	871.228	850.102	821.017	785.632	745.851	703.969	661.421	619.920	580.367	421.877	321.668
Time	0.70	0.70	0.76	0.82	0.88	0.94	1.00	1.04	1.10	1.16	1.22	1.60	2.04

Summarized from computations at intervals H/T = 0.02. *Recession coefficient 0.67017692 applicable beyond this point.

Table 5.--Linear Model Hydrographs (S = kO); k/T = 0.30

H/T	QT/APe D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	38.547	13.427	6.713	4.476	3.357	2.685	2.238	1.918	1.678	1.492	1.343	.895	.671
.20	139.359	84.764	49.095	32.730	24.548	19.628	16.365	14.027	12.274	10.910	9.819	6.546	4.910
.30	284.780	209.068	146.920	102.419	76.815	61.452	51.210	43.894	38.407	34.140	30.726	20.484	15.363
.40	462.162	371.321	290.195	221.718	169.645	135.716	113.097	96.940	84.823	75.398	67.858	45.239	33.929
.50	662.442	560.762	466.041	380.384	306.479	247.868	206.557	177.049	154.918	137.705	123.934	82.623	61.967
.60	802.033	742.827	651.794	558.303	470.994	393.748	330.361	283.167	247.771	220.241	198.217	132.145	99.108
.70	828.847	823.027	782.927	708.872	624.484	541.401	465.295	400.742	350.649	311.688	280.520	187.013	140.260
.80	774.861	807.290	815.158	791.048	733.476	661.045	585.716	514.151	451.561	401.387	361.248	240.832	180.624
.90	662.988	722.818	765.054	784.378	773.990	731.345	671.341	605.302	540.235	481.700	433.530	289.020	216.765
1.00	509.642*	589.105	655.962	706.405	735.560	737.013	707.638	659.593	603.277	545.665	492.441	328.294	246.220
1.10	365.130	433.538*	511.322	581.821	638.188	675.156	686.434	668.481	631.336	584.417	534.452	357.196	267.897
1.20	261.595	310.606	372.072*	444.416	514.017	572.671	614.397	632.744	623.747	595.699	557.036	377.903	283.428
1.30	187.418	222.531	266.568	322.225*	388.945	455.720	514.315	558.416	581.468	579.167	558.382	392.739	294.554
1.40	134.275	159.432	190.982	230.856	281.527*	343.042	406.338	463.617	508.543	534.575	537.194	403.368	302.526
1.50	96.200	114.224	136.828	165.396	201.698	248.066*	304.906	364.608	419.943	464.730	492.540	410.983	308.237
1.60	68.923	81.835	98.030	118.497	144.506	177.726	220.361*	273.039	329.261	382.376	426.441	415.543	312.329
1.70	49.380	58.631	70.233	84.897	103.530	127.331	157.876	197.257*	246.238	299.191	350.001	413.801	315.260
1.80	35.378	42.006	50.318	60.824	74.174	91.226	113.110	141.324	177.850*	223.545	273.473	402.664	317.361
1.90	25.347	30.096	36.051	43.577	53.142	65.358	81.037	101.251	127.420	161.433*	204.200	379.915	318.865
2.00	18.160	21.562	25.829	31.221	38.074	46.826	58.059	72.541	91.290	115.658	147.446*	343.968	319.943
2.10	13.011	15.448	18.505	22.369	27.278	33.549	41.596	51.972	65.404	82.863	105.637	295.477	320.045
2.20	9.322	11.069	13.259	16.026	19.544	24.036	29.802	37.235	46.859	59.367	75,683	241.346	316.360
2.30	6.679	7.931	9.500	11.483	14.002	17.221	21.352	26.677	33.572	42.534	54.223	188.055	306.303
2.40	4.785	5.682	6.806	8.227	10.032	12.338	15.298	19.113	24.053	30.473	38.848	140.246	288.021
Peak	830.822	826.551	816.189	798.531	773.990	743.283	708.032	670.430	632.635	595.699	560.485	415.813	320.283
Time	0.68	0.72	0.78	0.84	0.90	0.96	1.02	1.06	1.12	1.20	1.26	1.62	2.06

Summarized from computations at intervals H/T = 0.02. *Recession coefficient 0.71644279 applicable beyond this point.

Table 6.--Linear Model Hydrographs (S = kO); k/T = 0.35

$\frac{H}{T}$	QT/APe												
	D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	33.548	11.647	5.823	3.882	2.912	2.329	1.941	1.664	1.456	1.294	1.165	.776	.582
.20	122.923	74.383	43.015	28.677	21.507	17.206	14.338	12.290	10.754	9.559	8.603	5.735	4.301
.30	254.250	185.692	130.037	90.574	67.930	54.344	45.287	38.817	33.965	30.191	27.172	18.115	13.586
.40	417.098	333.498	259.595	197.858	151.305	121.044	100.870	86.460	75.652	67.247	60.522	40.348	30.261
.50	603.631	508.730	421.114	342.640	275.576	222.790	185.658	159.136	139.244	123.772	111.395	74.263	55.698
.60	740.867	681.276	595.003	507.835	427.299	356.716	299.204	256.461	224.403	199.470	179.523	119.682	89.761
.70	779.822	767.128	724.202	652.378	572.658	495.265	425.118	366.051	320.294	284.706	256.235	170.834	128.118
.80	744.926	767.471	767.299	738.625	681.151	611.621	540.633	474.026	416.228	369.981	332.982	221.988	166.491
.90	654.538	703.562	735.517	746.054	729.859	685.634	626.944	563.908	502.718	448.154	403.339	268.892	201.669
1.00	522.450*	591.372	647.467	687.468	707.383	702.162	669.923	621.862	567.341	512.568	462.476	308.317	231.238
1.10	392.578	454.549*	522.960	583.161	629.238	656.816	660.893	639.155	600.948	554.809	506.766	338.620	253.965
1.20	294.991	341.556	398.053*	462.492	522.760	571.702	604.273	615.273	601.956	572.127	533.484	361.391	271.043
1.30	221.662	256.653	299.104	350.919*	411.032	469.538	519.194	554.613	570.446	563.587	540.580	378.501	283.876
1.40	166.561	192.853	224.753	263.687	311.403*	367.397	423.424	472.574	509.393	528.491	526.515	391.358	293.519
1.50	125.158	144.914	168.884	198.140	233.994	278.105*	330.316	383.637	431.616	468.895	490.133	401.019	300.764
1.60	94.046	108.892	126.903	148.886	175.828	208.974	249.903*	298.684	349.294	395.758	432.895	407.502	306.209
1.70	70.668	81.823	95.358	111.876	132.121	157.027	187.782	225.892*	271.576	319.575	364.365	407.998	310.300
1.80	53.101	61.483	71.653	84.066	99.278	117.993	141.103	169.739	205.341*	248.233	293.766	399.717	313.374
1.90	39.902	46.200	53.842	63.169	74.600	88.663	106.028	127.546	154.297	187.658*	228.030	380.564	315.684
2.00	29.983	34.716	40.458	47.467	56.056	66.623	79.672	95.840	115.942	141.010	172.364*	348.963	317.420
2.10	22.530	26.086	30.401	35.667	42.121	50.062	59.867	72.016	87.121	105.958	129.518	305.284	318.142
2.20	16.930	19.602	22.844	26.801	31.651	37.617	44.985	54.115	65.465	79.619	97.322	255.449	315.403
2.30	12.722	14.730	17.166	20.139	23.783	28.267	33.803	40.663	49.192	59.827	73.130	205.266	306.855
2.40	9.560	11.068	12.899	15.133	17.872	21.240	25.400	30.555	36.964	44.956	54.952	159.100	290.733
Peak	779.822	776.199	767.299	752.088	730.900	704.047	672.649	639.155	605.459	572.127	540.810	408.714	318.187
Time	0.70	0.74	0.80	0.86	0.92	0.98	1.04	1.10	1.16	1.20	1.28	1.66	2.08

Summarized from computations at intervals H/T = 0.02. *Recession coefficient 0.75141884 applicable beyond this point.

Table 7.--Linear Model Hydrographs (S = kO); k/T = 0.40

H/T	QT/AP_e												
	D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	29.695	10.283	5.142	3.428	2.571	2.057	1.714	1.469	1.285	1.143	1.028	.686	.514
.20	109.931	66.258	38.271	25.514	19.135	15.308	12.757	10.934	9.568	8.505	7.654	5.103	3.827
.30	229.525	166.959	116.609	81.167	60.875	48.700	40.583	34.786	30.438	27.056	24.350	16.233	12.175
.40	379.769	302.491	234.725	178.570	136.498	109.198	90.999	77.999	68.249	60.666	54.599	36.399	27.300
.50	553.882	465.147	383.819	311.532	250.214	202.228	168.523	144.448	126.392	112.349	101.114	67.409	50.557
.60	687.193	628.359	546.753	465.332	390.739	325.843	273.250	234.214	204.937	182.166	163.950	109.300	81.975
.70	733.901	716.638	672.499	603.381	528.159	455.919	390.976	336.591	294.517	261.793	235.614	157.076	117.807
.80	713.164	728.276	722.457	691.091	634.605	568.182	501.312	439.161	385.552	342.712	308.441	205.627	154.221
.90	639.907	680.230	704.253	708.381	688.376	643.730	586.857	526.871	469.295	418.294	376.464	250.976	188.232
1.00	525.747*	585.704	632.967	664.737	677.712	667.842	634.059	586.692	534.226	482.229	435.035	290.023	217.517
1.10	409.432	465.265*	525.485	577.066	614.869	635.223	634.079	609.946	571.514	526.563	480.533	321.041	240.781
1.20	318.850	362.331	413.798*	471.100	523.383	564.361	589.741	595.258	578.994	548.271	510.140	345.196	258.897
1.30	248.307	282.169	322.250	369.922*	423.867	475.140	517.329	545.802	556.122	546.013	521.661	364.007	273.006
1.40	193.371	219.741	250.955	288.080	332.376*	383.042	432.573	474.817	505.044	518.746	513.386	378.657	283.993
1.50	150.589	171.125	195.433	224.345	258.841	300.126*	347.722	395.223	436.855	467.942	483.984	390.065	292.549
1.60	117.273	133.265	152.195	174.710	201.575	233.726	272.316*	317.086	362.479	403.123	434.474	398.264	299.212
1.70	91.327	103.781	118.523	136.057	156.978	182.016	212.069	248.240*	290.423	333.734	373.189	400.765	304.401
1.80	71.122	80.821	92.301	105.956	122.248	141.746	165.150	193.319	227.312*	267.134	308.443	395.023	308.442
1.90	55.388	62.941	71.881	82.514	95.202	110.386	128.612	150.549	177.022	209.049*	246.714	379.053	311.589
2.00	43.134	49.016	55.978	64.259	74.140	85.965	100.158	117.241	137.858	162.799	193.045*	351.311	314.040
2.10	33.591	38.172	43.594	50.043	57.737	66.946	77.999	91.303	107.358	126.781	150.336	311.965	315.434
2.20	26.159	29.726	33.949	38.971	44.964	52.135	60.743	71.103	83.606	98.732	117.076	266.171	313.608
2.30	20.371	23.150	26.438	30.349	35.016	40.601	47.304	55.372	65.109	76.888	91.174	219.162	306.417
2.40	15.864	18.027	20.588	23.634	27.269	31.618	36.839	43.122	50.704	59.878	71.002	175.016	292.194
Peak	734.617	731.638	723.732	710.291	691.588	667.842	639.880	610.035	579.910	550.308	521.661	400.852	315.434
Time	0.72	0.76	0.82	0.88	0.94	1.00	1.04	1.12	1.18	1.24	1.30	1.68	2.10

Summarized from computations at intervals H/T = 0.02. *Recession coefficient 0.778760205 applicable beyond this point.

Table 8.--Linear Model Hydrographs (S = kO); k/T = 0.45

$\frac{H}{T}$	QT/AP_e												
	D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	26.636	9.205	4.603	3.068	2.301	1.841	1.534	1.315	1.151	1.023	.921	.614	.460
.20	99.407	59.728	34.467	22.978	17.233	13.787	11.489	9.848	8.617	7.659	6.893	4.596	3.447
.30	209.119	151.626	105.677	73.520	55.140	44.112	36.760	31.509	27.570	24.507	22.056	14.704	11.028
.40	348.411	276.654	214.140	162.669	124.303	99.443	82.869	71.031	62.152	55.246	49.721	33.148	24.861
.50	511.387	428.209	352.431	285.496	299.054	185.084	154.237	132.203	115.678	102.825	92.542	61.695	46.271
.60	640.054	582.592	505.400	429.151	359.770	299.762	251.336	215.431	188.502	167.557	150.801	100.534	75.401
.70	691.635	671.347	626.970	560.716	489.700	422.086	361.693	311.337	272.420	242.151	217.936	145.291	108.968
.80	681.494	690.970	681.158	648.303	593.279	529.954	466.900	408.732	358.791	318.926	287.033	191.355	143.517
.90	621.929	655.239	673.105	672.519	650.037	605.671	550.835	493.805	439.546	391.730	352.557	235.038	176.279
1.00	522.791*	575.184	615.212	640.464	648.185	635.067	600.590	554.314	503.978	454.617	410.076	273.384	205.038
1.10	418.604	468.846*	522.015	566.423	597.560	612.317	607.363	581.770	543.630	500.074	456.040	304.640	228.480
1.20	335.180	375.410	422.128*	473.147	518.670	553.130	572.833	574.227	555.975	524.939	487.608	329.667	247.251
1.30	268.382	300.595	338.002	381.617*	430.009	475.055	511.041	533.942	540.023	527.599	502.505	349.707	262.280
1.40	214.896	240.689	270.642	305.564	346.385*	392.145	435.994	472.419	497.285	506.764	498.908	365.753	274.315
1.50	172.069	192.722	216.705	244.6	277.354	315.652*	358.908	401.241	437.457	463.445	475.359	378.601	283.951
1.60	137.777	154.314	173.518	195.908	222.080	252.746	288.763*	329.680	370.375	405.997	432.532	388.275	291.667
1.70	110.319	123.560	138.937	156.865	177.821	202.376	231.215	265.162*	303.915	342.951	377.753	392.530	297.845
1.80	88.334	98.936	111.248	125.603	142.383	162.044	185.136	212.318	244.384*	281.140	318.550	389.018	302.791
1.90	70.729	79.218	89.077	100.572	114.007	129.750	148.240	170.005	195.680	226.032*	260.947	375.855	306.752
2.00	56.634	63.431	71.325	80.529	91.287	103.892	118.697	136.124	156.683	180.986	209.772*	351.537	309.924
2.10	45.348	50.790	57.111	64.480	73.094	83.187	95.042	108.996	125.458	144.917	167.967	316.083	312.003
2.20	36.311	40.669	45.729	51.630	58.527	66.609	76.101	87.274	100.455	116.037	134.492	274.038	311.050
2.30	29.074	32.564	36.616	41.341	46.864	53.335	60.935	69.881	80.435	92.912	107.689	230.145	305.097
2.40	23.280	26.074	29.319	33.102	37.524	42.706	48.791	55.955	64.405	74.395	86.228	188.200	292.568
Peak	594.235	691.871	684.650	672.581	656.175	635.057	609.996	583.074	555.975	529.289	503.374	392.530	312.124
Time	0.74	0.78	0.84	0.88	0.94	1.00	1.06	1.12	1.20	1.26	1.34	1.70	2.12

Summarized from computations at intervals H/T = 0.02. *Recession coefficient 0.80070806 applicable beyond this point.

Table 9.--Linear Model Hydrographs (S = kO); k/T = 0.50

H/T	QT/APe D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	24.147	8.331	4.166	2.777	2.083	1.666	1.389	1.190	1.041	.925	.833	.555	.417
.20	90.714	54.367	31.349	20.899	15.675	12.540	10.450	8.957	7.837	6.966	6.270	4.180	3.135
.30	192.009	138.854	96.610	67.184	50.388	40.310	33.592	28.793	25.194	22.395	20.155	13.437	10.078
.40	321.737	254.820	196.837	149.347	114.093	91.274	76.062	65.196	57.046	50.708	45.637	30.425	22.819
.50	474.744	396.560	325.690	263.411	211.150	170.586	142.155	121.847	106.616	94.770	85.293	56.862	42.647
.60	598.517	542.737	469.649	398.039	333.243	277.468	232.612	199.381	174.459	155.074	139.567	93.045	69.783
.70	653.054	630.785	586.761	523.361	456.226	392.751	336.354	289.493	253.307	225.162	202.645	135.097	101.323
.80	650.906	656.074	643.429	609.865	556.539	496.195	436.638	382.028	335.316	298.059	268.253	178.835	134.126
.90	602.351	629.980	643.027	638.946	614.894	571.227	518.493	464.258	413.022	368.056	331.251	220.834	165.625
1.00	515.800*	561.819	595.900	615.958	619.664	604.279	569.659	524.682	476.454	429.555	387.433	258.288	193.716
1.10	422.291	467.550*	514.685	553.116	578.856	589.242	581.491	555.072	517.541	475.464	433.355	289.458	217.094
1.20	345.733	382.788	425.169*	470.719	510.534	539.642	554.833	553.105	533.537	502.568	466.197	314.978	236.233
1.30	283.055	313.392	348.090	387.910*	431.387	470.106	501.934	520.341	523.141	509.076	483.650	335.870	251.903
1.40	231.739	256.576	284.984	317.585	355.077*	396.425	435.351	466.883	487.371	493.522	483.826	352.976	264.732
1.50	189.727	210.061	233.319	260.010	290.704	326.074*	365.364	403.167	434.780	456.558	465.176	366.980	275.235
1.60	155.331	171.979	191.020	212.872	238.002	266.959	300.391*	337.738	374.268	405.580	428.100	377.889	283.834
1.70	127.170	140.781	156.380	174.274	194.849	213.558	245.930	277.590*	313.118	348.325	379.100	383.650	290.873
1.80	104.115	115.274	128.027	142.678	159.524	178.934	201.344	227.264	257.300*	291.136	325.020	382.078	296.636
1.90	85.240	94.376	104.825	116.810	130.602	146.494	164.841	186.063	210.653	239.197*	271.460	371.382	301.355
2.00	69.786	77.265	85.820	95.638	106.924	119.935	134.956	152.330	172.463	195.832	223.004*	350.096	305.218
2.10	57.135	63.258	70.262	78.300	87.543	98.191	110.489	124.713	141.196	160.329	182.575	318.131	307.964
2.20	46.777	51.790	57.524	64.105	71.672	80.393	90.457	102.103	115.598	131.262	149.475	279.531	307.836
2.30	38.298	42.402	47.096	52.483	58.679	65.818	74.061	83.592	94.641	107.465	122.376	238.619	303.013
2.40	31.355	34.715	38.559	42.969	48.041	53.886	60.634	68.440	77.483	87.982	100.190	198.935	292.008
Peak	658.375	656.074	649.491	638.946	624.020	604.897	582.414	558.218	533.606	509.497	485.935	384.010	308.368
Time	0.74	0.80	0.84	0.90	0.96	1.02	1.08	1.14	1.22	1.28	1.36	1.74	2.14

Summarized from computations at intervals H/T = 0.02. *Recession coefficient 0.31370390 applicable beyond this point.

Table 10.--Linear Model Hydrographs (S = kO); k/T = 0.55

H/T	QT/APe D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	22.084	7.610	3.805	2.537	1.902	1.522	1.268	1.087	.951	.846	.761	.507	.380
.20	83.414	49.887	28.749	19.166	14.374	11.499	9.583	8.214	7.187	6.389	5.750	3.833	2.875
.30	177.465	128.054	88.971	61.850	46.388	37.110	30.925	26.507	23.194	20.617	18.555	12.370	9.278
.40	298.796	236.142	182.098	138.028	105.423	84.339	70.282	60.242	52.712	46.855	42.169	28.113	21.085
.50	442.874	369.177	302.659	244.457	195.815	158.174	131.812	112.981	98.859	87.874	79.087	52.725	39.543
.60	561.748	507.792	438.484	371.037	310.291	258.210	216.444	185.523	162.333	144.296	129.866	86.577	64.933
.70	617.939	594.414	551.103	490.461	426.881	367.116	314.244	270.439	236.634	210.342	189.308	126.205	94.654
.80	621.870	623.715	609.064	575.307	523.774	466.248	409.882	358.454	314.599	279.643	251.679	167.785	125.840
.90	582.229	605.226	614.470	607.785	582.787	540.065	489.411	437.788	389.301	346.891	312.202	208.134	156.101
1.00	506.261*	546.893	576.060	591.945	592.562	575.608	541.203	497.623	451.427	406.811	366.891	244.594	183.445
1.10	422.088	462.950*	504.922	538.356	559.696	566.640	556.832	530.024	493.289	452.707	412.425	275.457	206.593
1.20	351.910	385.978	424.464*	465.274	500.262	524.953	536.529	532.424	512.018	481.365	446.034	301.189	225.892
1.30	293.400	321.805	353.892	390.244*	429.407	464.571	491.095	505.855	506.097	490.883	465.409	322.643	241.982
1.40	244.618	268.300	295.052	325.361	359.758*	397.185	431.859	459.267	476.160	479.675	468.625	340.529	255.397
1.50	203.947	223.692	245.996	271.265	299.944	332.545*	368.270	402.121	429.820	448.108	454.076	355.442	266.582
1.60	170.037	186.499	205.095	226.163	250.074	277.255	308.204*	342.302	375.168	402.784	421.947	367.368	275.907
1.70	141.765	155.490	170.994	188.560	208.495	231.157	256.960	286.388*	318.951	350.759	378.055	374.408	283.681
1.80	118.194	129.637	142.563	157.209	173.829	192.723	214.237	238.771	266.794*	297.916	328.647	374.514	290.163
1.90	98.543	108.083	118.860	131.070	144.927	160.680	178.617	199.072	222.435	249.159*	278.933	365.977	295.567
2.00	82.158	90.113	99.098	109.278	120.831	133.964	148.919	165.973	185.452	207.733	233.255*	347.372	300.073
2.10	68.499	75.130	82.622	91.109	100.741	111.691	124.159	138.378	154.618	173.194	194.473	318.528	303.449
2.20	57.110	62.639	68.885	75.961	83.991	93.121	103.515	115.370	128.910	144.398	162.139	283.077	304.086
2.30	47.614	52.224	57.431	63.331	70.026	77.638	86.304	96.188	107.477	120.390	135.181	244.977	300.295
2.40	39.697	43.540	47.882	52.801	58.383	64.729	71.955	80.195	89.607	100.373	112.705	207.531	293.521
Peak	625.978	623.715	618.020	608.204	594.458	577.195	556.832	535.142	512.850	490.883	469.387	375.420	304.275
Time	0.76	0.80	0.86	0.92	0.96	1.02	1.10	1.16	1.22	1.30	1.36	1.76	2.16

Summarized from computations at intervals H/T = 0.02. *Recession coefficient 0.83373620 applicable beyond this point.

Table 11.--Linear Model Hydrographs (S = kO); k/T = 0.60

H/T	QT/AP_e D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	20.344	7.002	3.501	2.334	1.751	1.400	1.167	1.000	.875	.778	.700	.467	.350
.20	77.197	46.088	26.545	17.697	13.272	10.618	8.848	7.584	6.636	5.898	5.309	3.539	2.654
.30	164.952	118.804	82.446	57.298	42.973	34.379	28.649	24.556	21.487	19.099	17.189	11.460	8.595
.40	278.865	219.986	169.395	128.292	97.970	78.376	65.313	55.983	48.985	43.542	39.188	26.125	19.594
.50	414.921	345.266	282.626	228.019	182.536	147.429	122.858	105.306	92.143	81.905	73.715	49.143	36.857
.60	529.031	476.938	411.102	347.396	290.248	241.416	202.347	173.440	151.760	134.898	121.408	80.939	60.704
.70	585.991	561.711	519.324	461.305	400.975	344.541	294.798	253.685	221.974	197.310	177.579	118.386	88.790
.80	594.574	593.837	577.774	544.161	494.438	439.548	386.090	337.518	296.204	263.292	236.963	157.975	118.482
.90	562.207	581.400	587.618	578.982	553.471	511.830	463.189	413.991	368.004	327.892	295.103	196.735	147.552
1.00	495.178*	531.240	556.320	568.826	567.047	549.025	515.065	472.911	428.648	386.141	348.227	232.151	174.114
1.10	419.153	456.153*	493.696	522.930	540.657	544.868	533.546	506.649	470.816	431.703	393.142	262.561	196.921
1.20	354.800	386.119	421.136*	457.837	488.728	509.750	518.409	512.485	491.583	461.405	427.145	288.302	216.227
1.30	300.327	326.838	356.478	389.703*	425.087	456.350	479.264	491.042	489.279	473.277	447.949	310.092	232.569
1.40	254.216	276.657	301.748	329.871	361.442*	395.401	426.401	450.320	464.244	465.654	453.616	328.535	246.402
1.50	215.186	234.180	255.419	279.225	305.949	335.989*	368.531	398.941	423.303	438.681	442.507	344.147	258.111
1.60	182.148	198.227	216.204	236.355	258.976	284.404	313.029*	344.202	373.852	398.294	414.636	356.895	268.022
1.70	154.182	167.793	183.010	200.066	219.214	240.739	264.969	292.281*	322.151	350.956	375.244	365.009	276.412
1.80	130.511	142.031	154.912	169.350	185.558	203.778	224.287	247.406	273.500*	302.137	330.064	366.557	283.513
1.90	110.473	120.225	131.128	143.349	157.069	172.491	189.852	209.421	231.509	256.469*	283.946	359.904	289.525
2.00	93.513	101.767	110.996	121.341	132.954	146.009	160.704	177.268	195.965	217.093	240.999*	343.673	294.613
2.10	79.157	86.143	93.955	102.712	112.542	123.592	136.031	150.052	165.878	183.762	203.998	317.621	298.570
2.20	67.005	72.919	79.531	86.943	95.264	104.617	115.146	127.015	140.411	155.549	172.678	285.035	299.912
2.30	56.717	61.724	67.322	73.595	80.638	88.556	97.468	107.515	118.854	131.668	146.167	249.560	297.058
2.40	48.008	52.246	56.985	62.296	68.258	74.960	82.504	91.008	100.606	111.453	123.726	214.284	288.671
Peak	596.443	594.679	589.162	580.312	567.893	551.980	533.546	513.620	493.514	473.361	453.776	366.855	299.932
Time	0.76	0.82	0.88	0.92	0.98	1.04	1.10	1.18	1.24	1.32	1.38	1.78	2.18

Summarized from computations at intervals H/T = 0.02. *Recession coefficient 0.84646864 applicable beyond this point.

Table 12.--Linear Model Hydrographs (S = kO); k/T = 0.70

H/T	QT/APe												
	D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	17.575	6.039	3.020	2.013	1.510	1.208	1.006	.863	.755	.671	.604	.403	.302
.20	67.175	39.992	23.016	15.344	11.508	9.206	7.672	6.576	5.754	5.115	4.603	3.069	2.302
.30	144.539	103.791	71.892	49.941	37.456	29.964	24.970	21.403	18.728	16.647	14.982	9.988	7.491
.40	245.969	193.464	148.628	112.416	85.822	68.657	57.214	49.041	42.911	38.143	34.329	22.886	17.164
.50	368.260	305.563	249.513	200.939	160.702	129.770	108.141	92.693	81.106	72.094	64.885	43.257	32.442
.60	473.485	425.024	365.293	308.017	256.960	213.567	178.979	153.410	134.234	119.319	107.387	71.591	53.694
.70	530.337	505.510	465.267	412.032	357.390	306.670	262.224	225.626	197.423	175.487	157.938	105.292	78.969
.80	545.254	540.915	523.212	490.483	444.253	394.095	345.711	302.037	265.037	235.589	212.030	141.353	106.015
.90	523.819	537.241	539.078	527.889	502.172	462.850	417.953	373.072	331.437	295.282	265.754	177.169	132.877
1.00	470.873*	499.690	518.466	525.949	520.839	501.676	468.990	429.629	388.900	350.132	315.723	210.482	157.861
1.10	408.187	438.814*	469.252	491.915	504.165	504.434	491.199	464.679	430.777	394.446	359.000	239.736	179.802
1.20	353.845	380.395	409.604*	439.633	464.035	479.411	483.761	475.370	454.144	425.179	393.041	265.096	198.822
1.30	306.737	329.753	355.074	382.987*	412.163	437.179	454.468	461.760	457.168	440.323	415.637	287.079	215.310
1.40	265.900	285.852	307.802	332.000	358.703*	386.901	411.957	430.380	439.771	438.132	424.876	306.136	229.602
1.50	230.501	247.796	266.824	287.800	310.949	336.522*	363.717	388.506	407.557	418.441	419.099	322.656	241.992
1.60	199.814	214.807	231.302	249.485	269.552	291.721	316.236*	342.444	366.793	386.140	398.077	336.574	252.732
1.70	173.212	186.209	200.508	216.271	233.666	252.883	274.135	297.661*	322.914	346.728	366.147	346.322	262.043
1.80	150.153	161.419	173.814	187.478	202.558	219.217	237.639	258.033	280.631*	304.971	328.198	350.163	270.114
1.90	130.162	139.929	150.674	162.519	175.590	190.032	206.002	223.681	243.270	264.997*	288.466	346.594	277.110
2.00	112.833	121.299	130.614	140.882	152.214	164.733	178.576	193.902	210.883	229.718	250.627*	334.310	283.175
2.10	97.812	105.151	113.225	122.126	131.949	142.801	154.802	168.087	182.808	199.135	217.261	312.985	288.131
2.20	84.790	91.152	98.152	105.867	114.383	123.790	134.193	145.709	158.470	172.624	188.337	285.361	290.689
2.30	73.502	79.018	85.085	91.774	99.155	107.310	116.328	126.311	137.373	149.642	163.263	254.568	289.450
2.40	63.718	68.498	73.758	79.556	85.955	93.024	100.841	109.495	119.084	129.720	141.528	223.319	283.202
Peak	545.346	543.827	539.078	531.524	520.839	507.308	491.917	475.370	458.506	441.616	424.970	350.163	290.785
Time	0.78	0.84	0.90	0.94	1.00	1.06	1.12	1.20	1.26	1.34	1.42	1.80	2.22

Summarized from computations at intervals H/T = 0.02. *Recession coefficient 0.86686944 applicable beyond this point.

Table 13.--Linear Model Hydrographs (S = kO); k/T = 0.80

H/T	QT/AP_e D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	15.469	5.308	2.654	1.769	1.327	1.062	.885	.758	.664	.590	.531	.354	.265
.20	59.454	35.320	20.314	13.543	10.157	8.126	6.771	5.804	5.078	4.514	4.063	2.708	2.031
.30	128.603	92.139	63.730	44.256	33.192	26.553	22.128	18.967	16.596	14.752	13.277	8.851	6.638
.40	219.959	172.614	132.376	100.024	76.345	61.076	50.897	43.626	38.173	33.931	30.538	20.359	15.269
.50	330.914	273.965	223.289	179.573	143.510	115.869	96.558	82.764	72.418	64.372	57.935	38.623	28.967
.60	428.223	383.122	328.544	276.567	230.460	191.432	160.411	137.496	120.308	106.941	96.247	64.164	48.123
.70	483.764	459.130	421.126	372.072	322.208	276.194	236.048	203.085	177.700	157.955	142.160	94.773	71.080
.80	502.447	495.873	477.502	446.042	403.023	356.941	312.807	273.166	239.684	213.052	191.747	127.831	95.874
.90	488.601	497.966	496.920	484.323	459.023	422.011	380.445	339.258	301.266	268.382	241.544	161.029	120.772
1.00	446.050*	469.481	483.724	487.774	480.612	461.114	429.923	393.164	355.536	319.957	288.492	192.328	144.246
1.10	393.635	419.318*	444.400	462.255	470.660	468.354	454.148	428.408	396.434	362.623	329.893	220.282	165.212
1.20	347.381	370.046	394.682*	419.615	439.203	450.537	451.969	442.134	421.113	393.502	363.365	244.952	183.714
1.30	306.560	326.562	348.304	371.975*	396.352	416.675	429.874	434.054	427.687	410.607	386.808	266.723	200.042
1.40	270.537	288.189	307.375	328.265	351.029*	374.719	395.260	409.634	415.821	412.187	398.365	285.936	214.452
1.50	238.747	254.324	271.256	289.692	309.780	331.688*	354.653	375.126	390.220	397.876	396.401	302.890	227.168
1.60	210.693	224.440	239.382	255.651	273.379	292.712	313.813*	336.051	356.291	371.800	380.533	317.499	238.390
1.70	185.935	198.066	211.253	225.610	241.255	258.316	276.938	297.278*	318.803	338.710	354.426	328.349	248.293
1.80	164.086	174.792	186.429	199.099	212.906	227.962	244.396	262.346	281.967*	302.802	322.318	333.859	257.033
1.90	144.804	154.252	164.522	175.703	187.888	201.175	215.677	231.518	248.834	267.776*	287.947	332.635	264.745
2.00	127.789	136.126	145.189	155.057	165.809	177.535	190.334	204.313	219.594	236.311	254.612*	323.446	271.552
2.10	112.774	120.132	128.129	136.837	146.326	156.674	167.968	180.305	193.790	208.543	224.693	305.913	277.293
2.20	99.521	106.015	113.073	120.758	129.131	138.263	148.230	159.118	171.018	184.037	198.290	282.372	280.828
2.30	87.827	93.557	99.786	106.568	113.957	122.016	130.812	140.420	150.922	162.412	174.989	255.551	280.898
2.40	77.506	82.563	88.060	94.045	100.566	107.678	115.441	123.920	133.188	143.327	154.427	227.858	276.396
Peak	502.447	501.015	496.920	490.300	480.871	469.219	456.179	442.152	427.904	413.522	399.287	334.250	281.360
Time	0.80	0.86	0.90	0.96	1.02	1.08	1.14	1.22	1.28	1.36	1.44	1.84	2.26

Summarized from computations at intervals H/T = 0.02. *Recession coefficient 0.88249115 applicable beyond this point.

Table 14.--Linear Model Hydrographs (S = kO); k/T = 0.90

H/T	QT/APe D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	13.814	4.736	2.368	1.579	1.184	.947	.789	.677	.592	.526	.474	.316	.237
.20	53.322	31.625	18.180	12.120	9.090	7.272	6.060	5.194	4.545	4.040	3.636	2.424	1.818
.30	115.821	82.833	57.229	39.731	29.798	23.839	19.866	17.028	14.899	13.244	11.919	7.946	5.960
.40	198.895	155.803	119.318	90.087	68.749	54.999	45.833	39.285	34.375	30.555	27.500	18.333	13.750
.50	300.379	248.245	202.024	162.293	129.626	104.648	87.207	74.749	65.405	58.138	52.324	34.883	26.162
.60	390.707	348.640	298.442	250.896	208.880	173.429	145.314	124.554	108.985	96.876	87.188	58.125	43.594
.70	444.391	420.320	384.480	339.068	293.252	251.168	214.578	184.600	161.525	143.578	129.220	86.147	64.610
.80	465.283	457.317	438.818	408.759	368.630	326.065	285.256	249.255	218.690	194.391	174.952	116.635	87.476
.90	456.830	463.275	460.296	446.971	422.388	387.559	348.933	310.919	276.007	245.866	221.279	147.520	110.640
1.00	422.120*	441.461	452.368	454.018	445.593	426.203	396.543	362.152	327.237	294.391	265.425	176.950	132.713
1.10	377.729	399.530*	420.496	434.755	440.396	436.381	421.757	396.970	366.824	335.269	304.905	203.586	152.689
1.20	338.005	357.514	378.522*	399.502	415.445	423.819	423.236	412.580	392.038	365.789	337.494	227.420	170.565
1.30	302.458	319.916	338.715	358.987*	379.605	396.339	406.502	408.476	400.997	384.024	361.202	248.748	186.561
1.40	270.651	286.272	303.094	321.234	340.808*	360.939	377.995	389.326	393.201	388.249	374.249	267.832	200.874
1.50	242.188	256.166	271.219	287.451	304.967	323.880*	343.476	360.591	372.681	377.974	375.041	284.910	213.683
1.60	216.718	229.227	242.696	257.222	272.895	289.819	308.104*	327.155	344.170	356.742	363.100	299.876	225.144
1.70	193.927	205.120	217.173	230.171	244.196	259.340	275.702	293.392*	311.901	328.720	341.580	311.443	235.400
1.80	173.533	183.549	194.334	205.965	218.515	232.067	246.708	262.538	279.662*	297.639	314.203	318.157	244.577
1.90	155.283	164.246	173.897	184.305	195.535	207.662	220.763	234.928	250.251	266.838*	284.300	318.720	252.790
2.00	138.952	146.973	155.609	164.922	174.972	185.823	197.547	210.222	223.933	238.776	254.851*	311.968	260.138
2.10	124.339	131.515	139.244	147.578	156.571	166.281	176.772	188.114	200.383	213.665	228.050	297.493	266.477
2.20	111.263	117.684	124.600	132.057	140.105	148.793	158.181	168.331	179.310	191.195	204.067	277.318	270.780
2.30	99.562	105.308	111.496	118.169	125.370	133.145	141.546	150.628	160.453	171.088	182.606	253.850	271.904
2.40	89.092	94.234	99.771	105.742	112.186	119.143	126.660	134.787	143.579	153.095	163.402	229.248	268.826
Peak	465.836	464.405	460.959	454.939	446.594	436.430	425.215	413.246	400.997	388.602	376.290	319.310	271.984
Time	0.82	0.88	0.92	0.98	1.02	1.08	1.16	1.22	1.30	1.38	1.46	1.86	2.28

Summarized from computations at intervals H/T = 0.02. *Recession coefficient 0.89483523 is applicable beyond this point.

Table 15.--Linear Model Hydrographs (S = kO); k/T = 1.00

H/T	QT/AP_e												
	D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	12.478	4.274	2.137	1.425	1.069	.855	.712	.611	.534	.475	.427	.285	.214
.20	48.335	28.629	16.451	10.968	8.226	6.580	5.484	4.700	4.113	3.656	3.290	2.194	1.645
.30	105.345	75.231	51.930	36.045	27.034	21.627	18.022	15.448	13.517	12.015	10.813	7.209	5.407
.40	181.496	141.965	108.598	81.942	62.525	50.020	41.683	35.728	31.262	27.789	25.010	16.673	12.505
.50	274.965	226.913	184.439	148.036	118.185	95.402	79.502	68.145	59.627	53.001	47.701	31.801	23.851
.60	359.146	319.794	273.353	229.557	190.976	158.506	132.801	113.829	99.601	88.534	79.681	53.120	39.840
.70	410.750	387.425	353.610	311.377	269.024	230.266	196.660	169.176	148.029	131.581	118.423	78.949	59.212
.80	432.878	424.056	405.741	377.092	339.547	300.031	262.564	229.145	201.036	178.699	160.829	107.219	80.414
.90	428.334	432.634	428.345	414.705	390.977	358.164	322.131	286.860	254.581	226.769	204.092	136.061	102.046
1.00	399.658*	415.832	424.233	424.174	414.987	395.948	367.776	335.517	302.981	272.498	245.675	163.784	122.838
1.10	361.624	380.337*	398.084	409.601	413.215	408.057	393.346	369.570	341.120	311.576	283.282	189.139	141.855
1.20	327.210	344.142	362.395*	380.104	393.236	399.400	397.404	386.317	366.392	341.455	314.833	212.082	159.062
1.30	296.072	311.391	327.766	345.290*	362.925	376.867	384.732	385.117	376.951	360.280	338.449	232.842	174.631
1.40	267.896	281.757	296.574	312.430	329.407*	346.692	361.015	370.021	372.197	366.374	352.428	251.625	188.719
1.50	242.401	254.944	268.350	282.697	298.058	314.514*	331.400	345.862	355.637	359.169	355.231	268.622	201.466
1.60	219.333	230.683	242.814	255.795	269.694	284.583	300.542*	317.012	331.465	341.753	346.320	283.716	213.000
1.70	198.461	208.730	219.707	231.452	244.028	257.501	271.941	287.426*	303.477	317.828	328.451	295.722	223.437
1.80	179.574	188.866	198.798	209.426	220.806	232.996	246.062	260.073	275.106*	290.742	304.932	303.298	232.880
1.90	162.485	170.892	179.879	189.496	199.793	210.823	222.645	235.323	248.926	263.527*	278.757	305.226	241.425
2.00	147.022	154.629	162.761	171.463	180.779	190.760	201.457	212.929	225.236	238.448	252.637*	300.407	249.156
2.10	133.031	139.914	147.272	155.144	163.575	172.606	182.285	192.665	203.802	215.756	228.595	288.415	255.938
2.20	120.371	126.599	133.257	140.382	148.008	156.180	164.938	174.330	184.407	195.223	206.840	271.027	260.837
2.30	108.916	114.551	120.576	127.022	133.922	141.316	149.241	157.740	166.857	176.645	187.156	250.393	262.802
2.40	98.551	103.650	109.101	114.934	121.177	127.868	135.038	142.728	150.978	159.834	169.345	228.461	260.887
Peak	434.113	433.031	429.758	424.399	417.000	408.057	398.127	387.834	377.161	366.374	355.634	305.347	262.802
Time	0.84	0.88	0.94	0.98	1.04	1.10	1.16	1.24	1.32	1.40	1.48	1.88	2.30

Summarized from computations at intervals H/T = 0.02. *Recession coefficient 0.90483436 applicable beyond this point.

Table 16.--*Linear* Model Hydrographs (S = kO); k/T = 1.10

H/T	QT/APe D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	11.379	3.895	1.947	1.298	.974	.779	.649	.556	.487	.433	.389	.260	.195
.20	44.201	26.151	15.023	10.015	7.512	6.009	5.008	4.292	3.756	3.338	3.005	2.003	1.502
.30	96.603	68.906	47.529	32.984	24.738	19.790	16.492	14.136	12.369	10.995	9.895	6.597	4.948
.40	166.884	130.357	99.632	75.138	57.327	45.862	38.218	32.759	28.664	25.479	22.931	15.287	11.465
.50	253.488	208.959	169.658	136.074	108.593	87.654	73.045	62.610	54.784	48.696	43.827	29.218	21.913
.60	332.241	295.314	252.137	211.544	175.884	145.938	122.264	104.798	91.698	81.509	73.358	48.906	36.679
.70	381.719	359.217	327.266	287.830	248.462	212.551	181.484	156.114	136.600	121.422	109.280	72.853	54.640
.80	404.465	395.134	377.176	349.889	314.656	277.796	242.981	212.006	185.992	165.326	148.793	99.196	74.397
.90	402.800	405.498	400.316	386.616	363.791	332.824	299.080	266.198	236.192	210.381	189.343	126.229	94.672
1.00	378.848*	392.527	399.012	397.720	388.094	369.538	342.775	312.429	281.989	253.563	228.596	152.397	114.298
1.10	345.926	362.148*	377.337	386.724	388.827	382.905	368.306	345.542	318.644	290.896	264.421	176.540	132.405
1.20	315.864	330.676	346.412*	361.784	372.712	377.197	374.200	362.931	343.684	319.981	294.874	198.586	148.939
1.30	288.415	301.940	316.308	331.588*	346.823	358.558	364.654	363.877	355.307	339.046	318.177	218.715	164.036
1.40	263.351	275.701	288.820	302.772	317.616*	332.598	344.748	351.946	352.855	346.462	332.711	237.095	177.821
1.50	240.465	251.741	263.721	276.461	290.015	304.441*	319.122	331.461	339.420	341.620	336.990	253.878	190.408
1.60	219.567	229.864	240.803	252.435	264.811	277.984	292.012*	306.371	318.762	327.248	330.445	268.942	201.901
1.70	200.486	209.888	219.876	230.498	241.798	253.827	266.635	280.280*	294.311	306.665	315.512	281.191	212.396
1.80	183.064	191.649	200.768	210.467	220.786	231.769	243.464	255.923	269.201*	282.904	295.163	289.374	221.978
1.90	167.156	174.994	183.322	192.177	201.599	211.627	222.306	233.682	245.807	258.733*	272.113	292.350	230.728
2.00	152.629	159.787	167.391	175.477	184.079	193.236	202.987	213.375	224.445	236.249	248.839*	289.072	238.717
2.10	139.365	145.900	152.844	160.227	168.083	176.444	185.347	194.832	204.940	215.718	227.214	279.111	245.818
2.20	127.254	133.222	139.561	146.303	153.476	161.110	169.240	177.901	187.131	196.972	207.469	264.045	251.171
2.30	116.195	121.644	127.433	133.589	140.138	147.109	154.533	162.441	170.868	179.854	189.439	245.812	253.808
2.40	106.096	111.072	116.358	121.979	127.960	134.325	141.103	148.324	156.020	164.224	172.976	226.184	252.844
Peak	406.605	405.498	402.604	397.720	390.973	383.084	374.427	365.299	355.899	346.462	337.020	292.350	253.930
Time	0.84	0.90	0.94	1.00	1.06	1.12	1.18	1.26	1.34	1.40	1.48	1.90	2.32

Summarized from computations at intervals H/T = 0.02. *Recession coefficient 0.91309842 applicable beyond this point.

Table 17.--Linear Model Hydrographs (S = kO); k/T = 1.20

$\frac{H}{T}$	QT/APe												
	D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	10.458	3.578	1.789	1.193	.895	.716	.596	.511	.447	.398	.358	.239	.179
.20	40.719	24.069	13.824	9.216	6.912	5.530	4.608	3.950	3.456	3.072	2.765	1.843	1.382
.30	89.200	63.562	43.816	30.403	22.802	18.242	15.202	13.030	11.401	10.134	9.121	6.081	4.560
.40	154.444	120.536	92.049	69.389	52.936	42.349	35.291	30.249	26.468	23.527	21.175	14.116	10.587
.50	235.112	193.595	157.066	125.898	100.441	81.068	67.557	57.906	50.668	45.038	40.534	27.023	20.267
.60	309.054	274.297	233.946	196.143	162.998	135.212	113.273	97.091	84.955	75.515	67.964	45.309	33.982
.70	356.444	334.786	304.541	267.559	230.803	197.355	168.474	144.918	126.803	112.714	101.442	67.628	50.721
.80	379.406	369.799	352.292	326.294	293.119	258.603	226.096	197.235	173.028	153.802	138.422	92.281	69.211
.90	379.891	381.373	375.586	361.986	340.064	310.770	279.064	248.278	220.252	196.177	176.559	117.706	88.280
1.00	359.698*	371.381	376.377	374.184	364.335	346.327	320.872	292.252	263.666	237.044	213.698	142.465	106.849
1.10	330.938	345.127*	358.254	365.960	366.920	360.493	346.127	324.337	298.862	272.717	247.852	165.473	124.105
1.20	304.477	317.531	331.329*	344.680	353.853	357.042	353.333	342.042	323.486	300.936	277.199	186.642	139.982
1.30	280.131	292.141	304.836	318.266*	331.545	341.510	346.225	344.591	335.804	320.003	300.056	206.118	154.589
1.40	257.733	268.783	280.462	292.818	305.895*	318.993	329.389	335.162	335.115	328.357	314.881	224.037	168.028
1.50	237.126	247.292	258.037	269.405	281.437	294.175*	307.042	317.661	324.178	325.357	320.251	240.523	180.392
1.60	218.166	227.520	237.406	247.865	258.934	270.653	283.066*	295.682	306.393	313.438	315.573	255.453	191.768
1.70	200.722	209.328	218.424	228.047	238.231	249.013	260.432	272.532*	284.888	295.608	303.027	267.803	202.235
1.80	184.672	192.590	200.959	209.813	219.182	229.102	239.609	250.741	262.539*	274.632	285.306	276.405	211.864
1.90	169.906	177.191	184.890	193.036	201.657	210.784	220.451	230.692	241.547	253.056*	264.888	280.182	220.724
2.00	156.322	163.023	170.107	177.601	185.533	193.930	202.824	212.247	222.233	232.822	244.053*	278.144	228.875
2.10	143.823	149.989	156.506	163.401	170.698	178.424	186.607	195.276	204.464	214.206	224.539	269.857	236.196
2.20	132.324	137.997	143.993	150.336	157.050	164.158	171.686	179.663	188.116	197.079	206.585	256.738	241.892
2.30	121.744	126.963	132.480	138.316	144.493	151.033	157.959	165.297	173.075	181.321	190.068	240.549	245.062
2.40	112.010	116.812	121.888	127.257	132.940	138.957	145.329	152.081	159.237	166.824	174.871	222.911	244.876
Peak	382.276	381.373	378.642	374.184	368.141	361.028	353.333	345.239	336.988	328.624	320.251	280.270	245.435
Time	0.86	0.90	0.96	1.00	1.06	1.12	1.20	1.26	1.34	1.42	1.50	1.92	2.34

Summarized from computations at intervals H/T = 0.02. *Recession coefficient 0.92004262 applicable beyond this point.

Table 18.--Linear Model Hydrographs (S = kO); k/T = 1.30

$\frac{H}{T}$	QT/AP_e												
	D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	9.560	4.780	2.390	1.593	1.195	.956	.797	.683	.598	.531	.478	.319	.239
.20	37.534	23.547	14.164	9.442	7.082	5.665	4.721	4.047	3.541	3.148	2.833	1.888	1.416
.30	82.556	60.045	41.796	29.457	22.093	17.674	14.729	12.625	11.046	9.819	8.837	5.891	4.419
.40	143.364	112.960	86.502	65.517	50.333	40.266	33.555	28.762	25.166	22.370	20.133	13.422	10.067
.50	218.789	181.077	147.018	118.027	94.407	76.482	63.735	54.630	47.801	42.490	38.241	25.494	19.120
.60	288.627	253.708	217.392	182.582	151.947	126.267	106.020	90.874	79.515	70.680	63.612	42.408	31.806
.70	334.171	311.399	282.553	248.728	214.786	183.838	157.123	135.359	118.439	105.280	94.752	63.168	47.376
.80	357.220	345.695	328.547	303.601	272.970	240.968	210.814	184.061	161.651	143.690	129.321	86.214	64.660
.90	359.440	358.330	352.013	338.475	317.283	290.042	260.528	231.888	205.845	183.505	165.154	110.103	82.577
1.00	342.376*	350.908	354.619	351.644	341.583	324.008	300.186	273.439	247.765	221.963	200.245	133.496	100.122
1.10	317.015	329.695*	340.302	346.311	346.157	339.205	324.956	304.402	280.471	255.980	232.736	155.476	116.607
1.20	293.532	305.273	317.484*	328.626	336.052	337.980	333.550	322.144	304.511	283.227	260.909	175.828	131.871
1.30	271.789	282.660	293.967	305.876*	317.134	325.373	328.760	326.280	317.209	302.083	283.171	194.672	146.004
1.40	251.656	261.722	272.191	283.219	294.838*	306.052	314.765	319.184	318.210	311.043	298.047	212.120	159.090
1.50	233.015	242.336	252.029	262.240	272.998	284.337*	295.433	304.418	309.577	309.780	304.173	228.276	171.207
1.60	215.755	224.385	233.360	242.814	252.776	263.275	274.345*	285.283	294.414	300.112	301.241	242.916	182.426
1.70	199.773	207.764	216.074	224.828	234.052	243.773	254.023	264.834*	275.593	284.786	290.877	255.197	192.814
1.80	184.975	192.374	200.069	208.174	216.715	225.716	235.207	245.216	255.776*	266.346	275.545	264.019	202.433
1.90	171.273	178.124	185.249	192.754	200.662	208.996	217.784	227.052	236.830	247.148*	257.524	268.363	211.339
2.00	158.586	164.930	171.527	178.476	185.798	193.515	201.652	210.234	219.287	228.841	238.927*	267.287	219.586
2.10	146.839	152.713	158.821	165.255	172.035	179.181	186.715	194.661	203.043	211.890	221.228	260.554	226.982
2.20	135.962	141.401	147.057	153.014	159.292	165.908	172.884	180.241	188.003	196.194	204.841	249.221	232.875
2.30	125.891	130.927	136.164	141.680	147.492	153.619	160.078	166.890	174.077	181.661	189.668	234.903	236.419
2.40	116.566	121.228	126.077	131.185	136.567	142.239	148.220	154.528	161.182	168.205	175.618	219.096	236.833
Peak	360.9	358.4	355.9	351.8	346.2	340.2	333.6	326.5	319.0	311.6	304.3	268.7	237.1
Time	0.86	0.92	0.96	1.02	1.08	1.14	1.20	1.28	1.36	1.44	1.52	1.94	2.36

Electronically computed at intervals H/T = 0.10, and expanded manually to obtain peak value. *Recession coefficient 0.925925923 applicable beyond this point.

Table 19.--Linear Model Hydrographs (S = kO); k/T = 1.40

$\frac{H}{T}$	QT/APe D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	8.901	4.451	2.225	1.484	1.113	.890	.742	.636	.556	.495	.445	.297	.223
.20	34.991	21.946	13.198	8.799	6.599	5.279	4.399	3.771	3.300	2.932	2.640	1.760	1.320
.30	77.083	56.037	38.991	27.478	20.608	16.487	13.739	11.776	10.304	9.159	8.243	5.496	4.122
.40	134.075	105.579	80.808	61.187	47.003	37.603	31.335	26.859	23.502	20.890	18.801	12.534	9.401
.50	204.939	169.507	137.543	110.374	88.267	71.504	59.587	51.074	44.690	39.725	35.752	23.835	17.876
.60	270.916	237.927	203.717	171.005	142.263	118.199	99.241	85.064	74.431	66.161	59.545	39.696	29.772
.70	314.540	292.728	265.328	233.387	201.435	172.356	147.287	126.882	111.022	98.686	88.818	59.212	44.409
.80	337.353	325.947	309.337	285.534	256.527	226.338	197.954	172.810	151.765	134.902	121.412	80.941	60.706
.90	340.791	339.072	332.509	319.249	298.918	273.036	245.127	218.114	193.593	172.577	155.319	103.546	77.660
1.00	326.189*	333.490	336.281	332.836	322.809	305.833	283.112	257.750	232.536	209.137	188.668	125.779	94.334
1.10	303.693	314.941*	324.216	329.168	328.363	321.235	307.351	287.659	264.899	241.692	219.718	146.775	110.081
1.20	282.749	293.221	304.081*	313.884	320.181	321.334	316.567	305.332	288.354	268.046	246.845	166.323	124.742
1.30	263.249	272.999	283.110	293.721*	303.663	310.744	313.278	310.343	301.291	286.648	268.541	184.523	138.392
1.40	245.094	254.172	263.585	273.464	283.833*	293.765	301.316	304.835	303.321	296.055	283.401	201.468	151.101
1.50	228.191	236.643	245.407	254.604	264.259	274.395*	284.244	292.077	296.310	295.912	290.114	217.244	162.933
1.60	212.454	220.322	228.482	237.046	246.034	255.471	265.383*	275.113	283.107	287.867	288.354	231.635	173.949
1.70	197.802	205.128	212.725	220.698	229.066	237.853	247.081	256.775*	266.364	274.443	279.594	243.847	184.206
1.80	184.160	190.981	198.054	205.477	213.268	221.449	230.041	239.066	248.551*	257.989	266.097	252.844	193.755
1.90	171.460	177.810	184.395	191.306	198.560	206.177	214.176	222.579	231.409	240.691*	249.971	257.659	202.645
2.00	159.635	165.547	171.678	178.113	184.866	191.957	199.405	207.229	215.450	224.091	233.177*	257.395	210.922
2.10	148.625	154.130	159.839	165.829	172.117	178.719	185.653	192.937	200.591	208.637	217.095	251.809	218.406
2.20	138.375	143.500	148.815	154.392	160.247	166.394	172.849	179.631	186.758	194.248	202.123	241.860	224.484
2.30	128.832	133.604	138.552	143.745	149.195	154.918	160.929	167.243	173.878	180.852	188.184	229.037	228.363
2.40	119.947	124.390	128.997	133.831	138.906	144.234	149.830	155.709	161.886	168.379	175.206	214.725	229.303
2.50	111.675	115.811	120.100	124.602	129.326	134.287	139.497	144.970	150.722	156.767	163.122	200.213*	226.618
2.60	103.973	107.824	111.818	116.008	120.407	125.026	129.877	134.972	140.327	145.955	151.873	186.405	220.113
2.70	96.803	100.388	104.106	108.008	112.103	116.403	120.920	125.664	130.649	135.889	141.399	173.550	210.496
2.80	90.127	93.465	96.926	100.559	104.372	108.376	112.580	116.997	121.639	126.518	131.647	161.581	198.872
2.90	83.911	87.019	90.242	93.624	97.174	100.901	104.816	108.929	113.250	117.792	122.568	150.437	186.269
Peak	341.6	339.4	336.9	333.3	328.6	322.7	316.8	310.3	303.6	297.0	290.4	258.2	229.4
Time	0.86	0.92	0.96	1.02	1.08	1.14	1.22	1.30	1.36	1.44	1.52	1.94	2.38

Electronically computed at intervals H/T = 0.10, and expanded manually to obtain peak value. *Recession coefficient 0.931034483 applicable beyond this point.

Table 20.--Linear Model Hydrographs (S = kO); k/T = 1.50

H/T	QT/APe D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	8.412	2.874	1.437	.958	.719	.575	.479	.411	.359	.319	.287	.192	.144
.20	32.930	19.425	11.150	7.433	5.575	4.460	3.717	3.186	2.787	2.478	2.230	1.487	1.115
.30	72.516	51.557	35.491	24.619	18.464	14.771	12.310	10.551	9.232	8.207	7.386	4.924	3.693
.40	126.196	98.265	74.911	56.416	43.030	34.424	28.687	24.589	21.515	19.125	17.212	11.475	8.606
.50	193.062	158.609	128.437	102.811	81.964	66.146	55.122	47.247	41.341	36.748	33.073	22.049	16.537
.60	255.438	225.960	192.284	160.945	133.598	110.763	92.782	79.527	69.586	61.854	55.669	37.113	27.835
.70	297.143	277.889	251.924	220.819	190.181	162.456	138.618	119.226	104.322	92.731	83.458	55.639	41.729
.80	319.511	309.822	293.856	271.224	243.070	214.109	187.017	163.075	143.050	127.156	114.440	76.293	57.220
.90	323.787	323.048	316.435	303.587	284.180	259.066	232.266	206.450	183.072	163.050	146.745	97.830	73.373
1.00	311.141*	318.773	320.911	317.215	307.383	291.099	269.017	244.624	220.491	198.150	178.622	119.082	89.311
1.10	291.075	301.001*	309.887	314.274	313.161	306.107	292.749	273.586	251.671	229.436	208.435	139.148	104.361
1.20	272.303	281.589	291.295*	300.454	306.103	306.847	302.021	291.155	274.586	254.995	234.651	157.921	118.441
1.30	254.741	263.428	272.508	282.006*	291.198	297.568	299.610	296.507	287.689	273.347	255.838	175.483	131.612
1.40	238.312	246.439	254.934	263.819	273.114*	282.246	289.046	292.014	290.249	283.106	270.656	191.912	143.934
1.50	222.942	230.545	238.492	246.804	255.500	264.600*	273.629	280.689	284.331	283.615	277.850	207.282	155.461
1.60	208.563	215.676	223.111	230.887	239.022	247.535	256.446*	265.350	272.562	276.702	276.821	221.469	166.245
1.70	195.112	201.766	208.721	215.996	223.607	231.571	239.907	248.635*	257.402	264.696	269.209	233.625	176.333
1.80	182.529	188.753	195.260	202.065	209.185	216.636	224.435	232.600	241.150*	249.775	257.102	242.771	185.771
1.90	170.756	176.580	182.666	189.033	195.694	202.664	209.960	217.598	225.597	233.975*	242.455	247.992	194.600
2.00	159.743	165.191	170.885	176.841	183.072	189.593	196.418	203.564	211.047	218.885	227.097*	248.431	202.860
2.10	149.440	154.536	159.864	165.436	171.265	177.365	183.750	190.435	197.436	204.768	212.450	243.669	210.443
2.20	139.802	144.570	149.553	154.766	160.219	165.926	171.899	178.153	184.702	191.562	198.748	234.781	216.700
2.30	130.785	135.245	139.908	144.784	149.886	155.224	160.812	166.663	172.790	179.207	185.930	223.143	220.884
2.40	122.351	126.523	130.884	135.446	140.219	145.213	150.441	155.914	161.645	167.649	173.939	210.041	222.297
Peak	324.322	323.556	321.407	317.311	313.198	307.935	302.357	296.507	290.502	284.438	278.368	248.882	222.297
Time	0.88	0.92	0.98	1.02	1.08	1.16	1.22	1.30	1.38	1.46	1.54	1.96	2.40

Summarized from computations at intervals H/T = 0.02. *Recession coefficient 0.93550603 applicable beyond this point.

Table 21.--Linear Model Hydrographs (S = kO); k/T = 1.60

H/T	QT/APe												
	D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	7.822	3.911	1.956	1.304	.978	.782	.652	.559	.489	.435	.391	.261	.196
.20	30.815	19.319	11.615	7.743	5.807	4.646	3.872	3.319	2.904	2.581	2.323	1.549	1.161
.30	68.058	49.437	34.378	24.222	18.167	14.533	12.111	10.381	9.083	8.074	7.267	4.844	3.633
.40	118.689	93.374	71.405	54.043	41.510	33.208	27.673	23.720	20.755	18.449	16.604	11.069	8.302
.50	181.896	150.292	121.833	97.701	78.105	63.266	52.722	45.190	39.542	35.148	31.633	21.089	15.817
.60	241.272	211.584	180.938	151.750	126.171	104.801	87.986	75.417	65.989	58.657	52.792	35.194	26.396
.70	281.405	261.338	236.461	207.738	179.147	153.205	130.891	112.751	98.657	87.695	78.926	52.617	39.463
.80	303.461	292.433	276.886	255.118	228.912	201.804	176.410	153.968	135.211	120.188	108.169	72.112	54.084
.90	308.536	305.999	299.216	286.590	267.838	244.329	219.170	194.922	172.972	154.187	138.769	92.512	69.384
1.00	297.659*	303.098	304.548	300.510	290.717	274.890	254.124	231.160	208.444	187.430	169.079	112.719	84.539
1.10	279.619	288.639*	295.868	299.245	297.542	290.301	277.182	259.055	238.345	217.355	197.551	131.962	98.971
1.20	262.672	271.146	279.893*	287.628	292.220	292.263	287.109	276.320	260.566	241.989	222.734	150.038	112.528
1.30	246.753	254.713	262.929	271.499*	279.399	284.719	286.005	282.481	273.619	259.916	243.262	167.019	125.264
1.40	231.798	239.276	246.994	255.045	263.444*	271.374	277.145	279.329	277.080	269.803	257.852	182.070	137.228
1.50	217.750	224.774	232.025	239.588	247.477	255.710*	263.608	269.664	272.510	271.268	265.300	197.955	148.467
1.60	204.553	211.152	217.963	225.067	232.479	240.212	248.283*	256.114	262.349	165.692	265.257	211.771	159.024
1.70	192.156	198.354	204.753	211.427	218.389	225.654	233.236	241.151*	248.894	255.239	258.959	223.707	168.942
1.80	180.510	186.333	192.344	198.613	205.153	211.978	219.100	226.535	234.298*	241.943	248.349	232.834	178.259
1.90	169.570	175.040	180.686	186.576	192.720	199.131	205.822	212.806	220.098	227.714*	235.253	238.278	187.011
2.00	159.293	164.432	169.736	175.268	181.040	187.062	193.348	199.909	206.759	213.913	221.386*	239.221	195.232
2.10	149.639	154.466	159.449	164.646	170.068	175.725	181.629	187.793	194.228	200.949	207.969	235.413	202.760
2.20	140.570	145.104	149.785	154.667	159.761	165.075	170.622	176.412	182.457	188.770	195.365	227.664	209.049
2.30	132.051	136.310	140.707	145.294	150.078	155.070	160.281	165.720	171.399	177.330	183.524	217.256	213.393
2.40	124.048	128.049	132.180	136.488	140.982	145.672	150.567	155.676	161.011	166.582	172.402	205.392	215.127
2.50	116.529	120.288	124.169	128.216	132.438	136.844	141.442	146.241	151.253	156.486	161.953	193.205*	213.627
2.60	109.467	112.998	116.643	120.445	124.412	128.550	132.869	137.378	142.086	147.002	152.138	181.496	208.697
2.70	102.833	106.150	109.574	113.146	116.871	120.759	124.817	129.052	133.475	138.093	142.917	170.496	200.938
2.80	96.600	99.717	102.933	106.288	109.788	113.440	117.252	121.231	125.385	129.724	134.256	160.163	191.302
2.90	90.746	93.673	96.695	99.847	103.135	106.565	110.146	113.884	117.786	121.862	126.119	150.456	180.686
Peak	308.8	306.7	304.7	301.4	297.5	292.6	288.0	282.5	277.1	271.5	266.1	239.5	215.1
Time	0.88	0.94	0.98	1.04	1.10	1.16	1.26	1.30	1.40	1.46	1.54	1.98	2.40

Electronically computed at intervals H/T = 0.10, and expanded manually to obtain peak value. *Recession coefficient 0.939393939 applicable beyond this point.

Table 22.--Linear Model Hydrographs (S = kO); k/T = 1.80

H/T	QT/APe D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	6.977	3.488	1.744	1.163	.872	.698	.581	.498	.436	.388	.349	.233	.174
.20	27.529	17.253	10.371	6.914	5.185	4.148	3.457	2.963	2.593	2.305	2.074	1.383	1.037
.30	60.924	44.227	30.740	21.656	16.242	12.994	10.828	9.281	8.121	7.219	6.497	4.331	3.248
.40	106.467	83.695	63.961	48.392	37.166	29.733	24.777	21.238	18.583	16.518	14.866	9.911	7.433
.50	163.501	134.984	109.340	87.635	70.040	56.729	47.275	40.521	35.456	31.516	28.365	18.910	14.182
.60	217.452	190.477	162.730	136.385	113.346	94.127	79.021	67.732	59.265	52.680	47.412	31.608	23.706
.70	254.534	235.993	213.235	187.151	161.287	137.875	117.771	101.445	88.765	78.902	71.012	47.341	35.506
.80	275.658	265.096	250.545	230.522	206.638	182.049	159.079	138.818	121.902	108.357	97.521	65.014	48.761
.90	281.688	278.673	271.885	259.921	242.560	221.045	198.153	176.164	156.300	139.321	125.389	83.592	62.694
1.00	273.438*	277.563	278.118	273.777	264.331	249.560	230.464	209.497	188.838	169.773	153.145	102.097	76.572
1.10	258.658	266.048*	271.805	274.095	271.845	264.675	252.308	235.548	216.566	197.417	179.401	119.833	89.875
1.20	244.676	251.667	258.857*	265.093	268.488	267.809	262.507	252.217	237.563	220.466	202.842	136.611	102.458
1.30	231.450	238.063	244.865	251.926*	258.335	262.403	262.852	259.015	250.447	237.618	222.226	152.482	114.361
1.40	218.940	225.195	231.629	238.308	245.243*	251.707	256.201	257.472	254.787	247.642	236.376	167.495	125.621
1.50	207.105	213.022	219.109	225.427	231.987	238.799*	245.260	250.033	251.916	250.147	244.180	181.696	136.272
1.60	195.910	201.508	207.265	213.242	219.447	225.891	232.584*	239.009	243.967	246.315	245.283	194.898	146.348
1.70	185.320	190.615	196.061	201.715	207.585	213.680	220.012	226.588*	232.960	238.039	240.745	206.455	155.878
1.80	175.303	180.312	185.463	190.812	196.364	202.130	208.119	214.340	220.804*	227.110	232.267	215.527	164.894
1.90	165.827	170.565	175.438	180.497	185.750	191.204	196.869	202.754	208.868	215.222*	221.456	221.319	173.422
2.00	156.864	161.345	165.955	170.741	175.709	180.869	186.228	191.795	197.578	203.588	209.834*	223.076	181.490
2.10	148.384	152.624	156.985	161.512	166.212	171.092	176.161	181.427	186.898	192.583	198.492	220.553	188.946
2.20	140.364	144.374	148.499	152.781	157.227	161.844	166.639	171.620	176.796	182.173	187.762	214.445	195.302
2.30	132.776	136.570	140.472	144.523	148.728	153.096	157.632	162.344	167.239	172.326	177.613	205.876	199.920
2.40	125.599	129.188	132.879	136.711	140.689	144.820	149.111	153.568	158.199	163.011	168.012	195.910	202.194
2.50	118.810	122.205	125.696	129.321	133.084	136.992	141.051	145.267	149.648	154.200	158.931	185.553*	201.555
2.60	112.388	115.599	118.902	122.331	125.890	129.587	133.427	137.415	141.559	145.865	150.340	175.523	197.811
2.70	106.313	109.351	112.475	115.718	119.086	122.582	126.214	129.987	133.906	137.980	142.213	166.035	191.479
2.80	100.566	103.440	106.395	109.463	112.649	115.956	119.392	122.961	126.669	130.522	134.526	157.061	183.396
2.90	95.130	97.848	100.644	103.546	106.559	109.688	112.938	116.314	119.822	123.467	127.254	148.571	174.355
Peak	281.7	279.9	278.1	275.2	271.8	267.8	263.8	259.3	254.8	250.1	245.5	223.1	202.3
Time	0.90	0.94	1.00	1.04	1.10	1.20	1.28	1.32	1.40	1.50	1.56	2.00	2.44

Electronically computed at intervals H/T = 0.10, and expanded manually to obtain peak value. *Recession coefficient 0.945945945 applicable beyond this point.

Table 23.--Linear Model Hydrographs ($S = kO$); $k/T = 2.00$

$\frac{H}{T}$	QT/AP_e D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	6.345	2.165	1.083	.722	.541	.433	.361	.309	.271	.241	.217	.144	.108
.20	24.969	14.699	8.432	5.621	4.216	3.373	2.811	2.409	2.108	1.874	1.686	1.124	.843
.30	55.275	39.211	26.955	18.692	14.019	11.215	9.346	8.011	7.009	6.231	5.608	3.738	2.804
.40	96.692	75.116	57.164	43.009	32.798	26.238	21.865	18.742	16.399	14.577	13.119	8.746	6.560
.50	148.680	121.861	98.489	78.729	62.722	50.611	42.175	36.150	31.632	28.117	25.305	16.870	12.653
.60	198.030	174.585	148.223	123.854	102.693	85.094	71.273	61.091	53.455	47.515	42.764	28.509	21.382
.70	232.385	216.378	195.481	170.941	146.985	125.430	106.975	92.002	80.502	71.557	64.402	42.934	32.201
.80	252.475	243.543	229.960	211.502	189.092	166.297	145.116	126.485	110.945	98.618	88.756	59.171	44.378
.90	258.996	256.794	250.168	238.905	222.825	202.632	181.379	161.070	142.773	127.150	114.435	76.290	57.218
1.00	252.611*	256.811	256.802	252.382	243.381	229.622	211.662	192.155	173.037	155.444	140.116	93.411	70.058
1.10	240.290	246.401*	251.606	253.335	250.887	243.985	232.418	216.625	198.936	181.189	164.540	109.838	82.378
1.20	228.571	234.384	240.392*	245.865	248.597	247.586	242.385	232.699	218.844	202.875	186.508	125.463	94.097
1.30	217.424	222.953	228.668	234.579*	240.137	243.468	243.481	239.609	231.481	219.301	204.882	140.327	105.245
1.40	206.820	212.080	217.516	223.139	228.954*	234.525	238.237	238.995	236.168	229.325	218.579	154.465	115.849
1.50	196.734	201.737	206.908	212.256	217.788	223.511*	229.060	233.023	234.338	232.342	226.566	167.914	125.936
1.60	187.138	191.897	196.817	201.905	207.167	212.610	218.242*	223.752	227.882	229.622	228.298	180.563	135.531
1.70	178.011	182.538	187.218	192.057	197.063	202.241	207.598	213.141*	218.600	222.844	224.914	191.752	144.658
1.80	169.329	173.635	178.087	182.690	187.452	192.377	197.473	202.746	208.203*	213.604	217.923	200.714	153.339
1.90	161.070	165.166	169.401	173.780	178.309	182.995	187.842	192.858	198.049	203.421*	208.760	206.717	161.598
2.00	153.214	157.110	161.138	165.304	169.613	174.070	178.681	183.452	188.390	193.500	198.790*	209.067	169.453
2.10	145.742	149.448	153.279	157.242	161.340	165.580	169.966	174.505	179.202	184.063	189.095	207.392	176.817
2.20	138.635	142.160	145.804	149.573	153.471	157.504	161.676	165.994	170.462	175.086	179.872	202.444	183.190
2.30	131.874	135.227	138.694	142.278	145.986	149.822	153.791	157.898	162.148	166.547	171.100	195.223	187.991
2.40	125.443	128.633	131.930	135.340	138.867	142.516	146.291	150.197	154.240	158.424	162.755	186.679	190.667
2.50	119.326	122.360	125.496	128.740	132.095	135.566	139.156	142.872	146.718	150.698	154.818	177.715*	190.692
2.60	113.506	116.393	119.376	122.462	125.653	128.955	132.370	135.904	139.562	143.348	147.267	169.048	187.782
2.70	107.971	110.717	113.555	116.490	119.525	122.666	125.915	129.277	132.756	136.357	140.085	160.804	182.499
2.80	102.705	105.317	108.017	110.809	113.696	116.684	119.774	122.972	126.282	129.707	133.253	152.961	175.588
2.90	97.695	100.180	102.748	105.405	108.151	110.993	113.933	116.975	120.123	123.381	126.754	145.501	167.757

Table 23.--Linear Model Hydrographs (S = kO); k/T = 2.00--Continued

H/T	QT/APe												
	D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
3.00	92.931	95.294	97.737	100.264	102.877	105.580	108.377	111.270	114.265	117.364	120.573	138.405	159.681*
3.10	88.400	90.647	92.970	95.374	97.859	100.431	103.091	105.844	108.692	111.641	114.693	131.655	151.894
3.20	84.088	86.226	88.437	90.722	93.086	95.533	98.063	100.682	103.392	106.196	109.099	125.234	144.486
3.30	79.987	82.021	84.124	86.298	88.546	90.874	93.281	95.772	98.349	101.017	103.779	119.127	137.439
3.40	76.086	78.021	80.021	82.089	84.228	86.442	88.731	91.101	93.553	96.090	98.718	113.317	130.736
3.50	72.375	74.216	76.118	78.086	80.121	82.226	84.404	86.658	88.990	91.404	93.903	107.791	124.360
3.60	68.845	70.596	72.406	74.277	76.212	78.216	80.288	82.431	84.650	86.946	89.323	102.534	118.295
3.70	65.487	67.153	68.874	70.655	72.496	74.401	76.372	78.411	80.522	82.706	84.967	97.533	112.526
3.80	62.293	63.877	65.515	67.208	68.960	70.772	72.647	74.587	76.594	78.672	80.823	92.777	107.038
3.90	59.255	60.761	62.319	63.930	65.597	67.320	69.104	70.949	72.859	74.835	76.881	88.252	101.818
4.00	56.365	57.798	59.280	60.812	62.397	64.037	65.733	67.489	69.305	71.185	73.132	83.948	96.852
4.10	53.616	54.979	56.389	57.846	59.354	60.914	62.527	64.197	65.925	67.713	69.565	79.853	92.129
4.20	51.001	52.299	53.639	55.025	56.459	57.943	59.478	61.066	62.710	64.411	66.172	75.959	87.636
4.30	48.514	49.748	51.024	52.342	53.705	55.117	56.577	58.088	59.651	61.270	62.945	72.254	83.362
4.40	46.148	47.321	48.535	49.789	51.086	52.429	53.818	55.255	56.742	58.281	59.875	68.730	79.296
4.50	43.897	45.014	46.167	47.361	48.595	49.872	51.193	52.560	53.975	55.439	56.955	65.378	75.429
4.60	41.756	42.818	43.916	45.051	46.225	47.440	48.696	49.997	51.343	52.735	54.177	62.190	71.750
4.70	39.720	40.730	41.774	42.854	43.970	45.126	46.322	47.559	48.839	50.163	51.535	59.157	68.251
4.80	37.783	38.744	39.737	40.764	41.826	42.925	44.063	45.239	46.457	47.717	49.021	56.272	64.922
4.90	35.940	36.854	37.799	38.776	39.786	40.832	41.914	43.033	44.191	45.390	46.631	53.527	61.756
5.00	34.187	35.056	35.955	36.885	37.846	38.840	39.869	40.934	42.036	43.176	44.356	50.917	58.744
Peak	258.996	258.352	256.802	254.231	251.094	247.586	243.942	240.142	236.261	232.342	228.410	209.067	191.033
Time	0.90	0.94	1.00	1.06	1.12	1.20	1.26	1.34	1.42	1.50	1.58	2.00	2.46

Summarized from computations at intervals H/T = 0.02. *Recession coefficient 0.95122903 applicable beyond this point.

Table 24.--Linear Model Hydrographs (S = kO); k/T = 2.20

H/T	QT/APe D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	5.736	2.868	1.434	.956	.717	.574	.478	.410	.359	.319	.287	.191	.143
.20	22.690	14.213	8.541	5.694	4.270	3.416	2.847	2.440	2.135	1.898	1.708	1.139	.854
.30	50.363	36.527	25.370	17.869	13.402	10.722	8.935	7.658	6.701	5.956	5.361	3.574	2.680
.40	88.279	69.321	52.924	40.020	30.732	24.586	20.488	17.561	15.366	13.659	12.293	8.195	6.146
.50	135.982	112.131	90.728	72.659	58.048	47.012	39.177	33.580	29.382	26.118	23.506	15.671	11.753
.60	181.565	158.774	135.452	113.408	94.188	78.193	65.639	56.262	49.229	43.759	39.383	26.256	19.692
.70	213.650	197.607	178.190	156.171	134.458	114.872	98.095	84.492	73.930	65.716	59.144	39.429	29.572
.80	232.836	223.243	210.425	193.208	172.939	152.215	132.934	115.974	101.835	90.520	81.468	54.312	40.734
.90	239.696	236.266	229.754	219.039	203.972	185.604	166.224	147.695	131.010	116.772	105.095	70.063	52.547
1.00	234.779*	237.238	236.752	232.249	223.588	210.625	194.210	176.368	158.888	142.813	128.819	85.879	64.409
1.10	224.345	229.562*	233.399	234.355	231.577	224.783	213.782	199.260	183.018	166.741	151.488	101.183	75.887
1.20	214.374	219.359	224.461*	228.720	230.606	229.133	223.879	214.578	201.772	187.056	172.003	115.807	86.855
1.30	204.846	209.610	214.485	219.510*	223.942	226.407	225.880	221.841	213.957	202.643	189.311	129.781	97.336
1.40	195.742	200.294	204.952	209.754	214.706*	219.213	222.055	222.224	219.147	212.439	202.408	143.134	107.351
1.50	187.042	191.392	195.843	200.432	205.164	210.043*	214.576	217.674	218.370	216.063	210.335	155.894	116.920
1.60	178.729	182.886	187.139	191.524	196.046	200.708	205.517*	210.049	213.326	214.428	212.746	167.895	126.065
1.70	170.786	174.758	178.822	183.012	187.332	191.788	196.383	201.123*	205.637	209.040	210.461	178.598	134.802
1.80	163.195	166.991	170.874	174.878	179.007	183.264	187.655	192.184	196.856*	201.343	204.836	187.295	143.152
1.90	155.942	159.569	163.280	167.106	171.051	175.118	179.315	183.643	188.107	192.713*	197.166	193.312	151.130
2.00	149.011	152.477	156.023	159.679	163.448	167.336	171.345	175.481	179.747	184.148	188.690*	196.002	158.754
2.10	142.389	145.700	149.088	152.582	156.184	159.899	163.730	167.682	171.758	175.964	180.304	195.130	165.896
2.20	136.060	139.224	142.462	145.800	149.243	152.792	156.453	160.229	164.124	168.143	172.290	191.238	172.146
2.30	130.013	133.037	136.131	139.320	142.610	146.001	149.499	153.108	156.830	160.670	164.633	185.224	176.972
2.40	124.235	127.124	130.080	133.128	136.271	139.512	142.855	146.303	149.860	153.529	157.316	177.948	179.862
2.50	118.713	121.474	124.299	127.212	130.215	133.312	136.506	139.801	143.199	146.706	150.324	170.230*	180.329
2.60	113.437	116.075	118.775	121.558	124.428	127.387	130.439	133.587	136.835	140.186	143.643	162.664	178.194
2.70	108.395	110.916	113.496	116.155	118.897	121.725	124.642	127.650	130.753	133.955	137.259	155.435	173.860
2.80	103.578	105.987	108.451	110.993	113.613	116.315	119.102	121.977	124.942	128.002	131.158	148.527	167.997
2.90	98.974	101.276	103.631	106.060	108.564	111.146	113.809	116.056	119.389	122.313	125.329	141.926	161.247
Peak	239.7	238.2	236.8	234.5	232.0	229.1	226.0	222.7	219.4	216.1	212.7	196.1	180.5
Time	0.90	0.96	1.02	1.06	1.14	1.20	1.28	1.36	1.44	1.52	1.60	2.02	2.46

Electronically computed at intervals H/T =0.10, and expanded manually to obtain peak value. *Recession coefficient 0.955555556 applicable beyond this point.

Table 25.--Linear Model Hydrographs (S = kO); k/T = 2.40

H/T	QT/APe D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	5.268	2.634	1.317	.878	.659	.527	.439	.376	.329	.293	.263	.176	.132
.20	20.857	13.063	7.848	5.232	3.924	3.139	2.616	2.242	1.962	1.744	1.570	1.046	.785
.30	46.346	33.602	23.332	16.433	12.325	9.860	8.216	7.043	6.162	5.478	4.930	3.287	2.465
.40	81.330	63.838	48.720	36.834	28.284	22.627	18.856	16.162	14.142	12.571	11.314	7.542	5.657
.50	125.423	103.377	83.607	66.939	53.470	43.303	36.085	30.930	27.064	24.057	21.651	14.434	10.826
.60	167.716	146.570	124.973	104.595	86.847	72.090	60.514	51.869	45.385	40.343	36.308	24.205	18.154
.70	197.747	182.731	164.650	144.226	124.129	106.023	90.530	77.973	68.227	60.646	54.581	36.388	27.291
.80	216.015	206.881	194.806	178.727	159.890	140.679	122.833	107.152	94.087	83.633	75.270	50.180	37.635
.90	223.003	219.509	213.195	203.041	188.923	171.813	153.818	136.644	121.196	108.023	97.220	64.814	48.610
1.00	219.168*	221.086	220.297	215.825	207.552	195.355	180.026	163.427	147.199	132.295	119.329	79.553	59.664
1.10	210.223	214.696*	217.891	218.430	215.543	208.980	198.579	184.978	169.836	154.699	140.535	93.866	70.399
1.20	201.642	205.933	210.314*	213.905	215.306	213.621	208.473	199.629	187.598	173.847	159.822	107.594	80.696
1.30	193.412	197.527	201.730	206.052*	209.810	211.750	210.939	206.909	199.366	188.701	176.215	120.762	90.572
1.40	185.518	189.465	193.496	197.642	201.905*	205.741	208.036	207.871	204.728	198.266	188.777	133.394	100.045
1.50	177.946	181.732	185.598	189.575	193.664	197.870*	201.740	204.278	204.603	202.173	196.613	145.509	109.132
1.60	170.682	174.314	178.023	181.837	185.759	189.794	193.944*	197.822	200.532	201.238	199.387	156.955	117.848
1.70	163.716	167.199	170.756	174.415	178.177	182.047	186.028	190.124*	193.994	196.829	197.834	167.230	126.208
1.80	157.034	160.375	163.787	167.296	170.905	174.617	178.435	182.363	186.405*	190.258	193.184	175.682	134.227
1.90	150.624	153.829	157.102	160.466	163.929	167.490	171.152	174.920	178.797	182.785*	186.615	181.681	141.918
2.00	144.476	147.550	150.689	153.918	157.238	160.653	164.166	167.780	171.499	175.325	179.262*	184.626	149.295
2.10	138.579	141.528	144.539	147.635	150.820	154.096	157.466	160.932	164.499	168.169	171.945	184.290	156.240
2.20	132.923	135.751	138.639	141.610	144.664	147.806	151.039	154.364	157.785	161.305	164.924	181.158	162.375
2.30	127.497	130.210	132.980	135.830	138.760	141.773	144.874	148.063	151.344	154.721	158.195	176.047	167.205
2.40	122.293	124.895	127.553	130.286	133.096	135.987	138.960	142.020	145.167	148.406	151.738	169.739	170.258
2.50	117.302	119.798	122.346	124.968	127.664	130.436	133.289	136.223	139.242	142.348	145.545	162.987*	171.079
2.60	112.514	114.908	117.353	119.867	122.453	125.112	127.848	130.663	133.558	136.538	139.604	156.334	169.496
2.70	107.922	110.218	112.563	114.974	117.455	120.006	122.630	125.330	128.107	130.965	133.906	149.953	165.870
2.80	103.517	105.719	107.968	110.282	112.661	115.108	117.625	120.214	122.878	125.620	128.441	143.833	160.812
2.90	99.291	101.404	103.562	105.780	108.062	110.409	112.824	115.307	117.863	120.492	123.198	137.962	154.907
Peak	223.1	221.7	220.4	218.5	216.2	213.7	211.0	208.0	205.2	202.3	199.4	184.9	171.1
Time	0.92	0.96	1.02	1.08	1.14	1.22	1.28	1.36	1.44	1.52	1.60	2.04	2.48

Electronically computed at intervals H/T = 0.10, and expanded manually to obtain peak value. *Recession coefficient 0.959183673 applicable beyond this point.

Table 26.--Linear Model Hydrographs (S = kO); k/T = 2.60

H/T	QT/APe D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	4.870	2.435	1.218	.812	.609	.487	.406	.348	.304	.271	.244	.162	.122
.20	19.298	12.084	7.260	4.840	3.630	2.904	2.420	2.074	1.815	1.613	1.452	.968	.726
.30	42.922	31.110	21.597	15.210	11.407	9.126	7.605	6.518	5.704	5.070	4.563	3.042	2.281
.40	75.395	59.159	45.134	34.118	26.197	20.958	17.465	14.970	13.098	11.643	10.479	6.986	5.239
.50	116.384	95.890	77.524	62.053	49.561	40.136	33.446	28.668	25.085	22.298	20.068	13.379	10.034
.60	155.826	136.105	115.997	97.051	80.566	66.870	56.131	48.112	42.098	37.420	33.678	22.452	16.839
.70	184.039	169.933	153.019	133.976	115.272	98.439	84.047	72.388	63.339	56.302	50.672	33.781	25.336
.80	201.446	192.743	181.338	166.260	148.668	130.766	114.157	99.575	87.432	77.718	69.946	46.631	34.973
.90	208.456	204.951	198.847	189.209	175.933	159.924	143.130	127.127	112.747	100.490	90.441	60.294	45.220
1.00	205.460*	206.958	205.955	201.551	193.646	182.138	167.763	152.248	137.106	123.215	111.137	74.091	55.568
1.10	197.707	201.584*	204.271	204.498	201.559	195.234	185.379	172.595	158.415	144.270	131.052	87.530	65.648
1.20	190.246	193.977	197.780*	200.840	201.867	200.042	195.024	186.607	175.267	162.367	149.241	100.462	75.346
1.30	183.067	186.657	190.317	194.072*	197.294	198.825	197.812	193.829	186.613	176.533	164.796	112.906	84.679
1.40	176.159	179.613	183.135	186.749	190.458*	193.758	195.623	195.212	192.052	185.836	176.841	124.880	93.660
1.50	169.512	172.835	176.224	179.702	183.271	186.933*	190.271	192.368	192.415	189.917	184.536	136.402	102.302
1.60	163.115	166.313	169.574	172.921	176.355	179.879	183.496*	186.848	189.111	189.515	187.556	147.327	110.617
1.70	156.960	160.037	163.175	166.395	169.700	173.091	176.572	180.145*	183.497	185.881	186.567	157.191	118.619
1.80	151.037	153.998	157.018	160.116	163.296	166.559	169.909	173.347	176.877*	180.219	182.692	165.383	126.320
1.90	145.337	148.187	151.092	154.074	157.134	160.274	163.497	166.806	170.202	173.689*	177.016	171.319	133.728
2.00	139.853	142.595	145.391	148.260	151.204	154.226	157.328	160.511	163.779	167.135	170.580*	174.432	140.858
2.10	134.575	137.214	139.904	142.665	145.499	148.406	151.391	154.454	157.599	160.828	164.143	174.506	147.597
2.20	129.497	132.036	134.625	137.282	140.008	142.806	145.678	148.626	151.652	154.759	157.949	171.980	153.595
2.30	124.610	127.054	129.545	132.101	134.725	137.417	140.181	143.017	145.929	148.919	151.988	167.601	158.392
2.40	119.908	122.259	124.656	127.116	129.641	132.231	134.891	137.620	140.422	143.299	146.253	162.088	161.547
2.50	115.383	117.646	119.952	122.319	124.749	127.242	129.801	132.427	135.123	137.892	140.734	156.134*	162.635
2.60	111.029	113.206	115.426	117.704	120.041	122.440	124.902	127.430	130.024	132.688	135.423	150.242	161.490
2.70	106.839	108.934	111.070	113.262	115.511	117.820	120.189	122.621	125.118	127.681	130.313	144.572	158.440
2.80	102.808	104.823	106.879	108.988	111.152	113.374	115.654	117.994	120.396	122.863	125.395	139.117	154.044
2.90	98.928	100.868	102.846	104.875	106.958	109.095	111.289	113.541	115.853	118.227	120.664	133.867	148.840
Peak	208.6	207.3	206.2	204.6	202.4	200.2	197.8	195.3	192.7	190.2	187.6	174.8	162.6
Time	0.92	0.96	1.02	1.08	1.14	1.22	1.30	1.38	1.46	1.54	1.62	2.04	2.50

Electronically computed at intervals H/T = 0.10, and expanded manually to obtain peak value. *Recession coefficient 0.962264151 applicable beyond this point.

Table 27.--Linear Model Hydrographs (S = kO); k/T = 2.80

$\frac{H}{T}$	QT/AP_e												
	D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	4.554	1.553	.776	.518	.388	.311	.259	.222	.194	.173	.155	.104	.078
.20	18.005	10.580	6.066	4.044	3.033	2.427	2.022	1.733	1.517	1.348	1.213	.809	.607
.30	40.039	28.348	19.464	13.493	10.120	8.096	6.747	5.783	5.060	4.498	4.048	2.699	2.024
.40	70.356	54.546	41.447	31.158	23.757	19.005	15.838	13.575	11.878	10.559	9.503	6.335	4.751
.50	108.667	88.883	71.715	57.259	45.589	36.782	30.652	26.273	22.989	20.434	18.391	12.261	9.196
.60	145.582	127.968	108.426	90.466	74.936	62.065	51.980	44.554	38.985	34.653	31.188	20.792	15.594
.70	172.146	159.677	143.822	125.509	107.769	91.884	78.334	67.365	58.944	52.395	47.156	31.437	23.578
.80	188.721	181.219	170.448	156.288	139.437	122.459	106.773	93.032	81.597	72.530	65.277	43.518	32.639
.90	195.660	192.948	187.083	177.948	165.453	150.139	134.207	119.084	105.521	93.969	84.572	56.381	42.286
1.00	193.298*	195.210	194.079	189.792	182.263	171.404	157.651	142.921	128.600	115.486	104.093	69.395	52.047
1.10	186.516	189.887*	192.549	192.682	189.816	183.788	174.475	162.256	148.792	135.409	122.927	82.054	61.541
1.20	179.973	183.226	186.556*	189.441	190.318	188.498	183.694	175.733	164.877	152.618	140.191	94.269	70.702
1.30	173.658	176.797	180.011	183.303*	186.280	187.614	186.548	182.709	175.866	166.202	155.036	106.056	79.542
1.40	167.566	170.594	173.696	176.872	180.126*	183.143	184.777	184.269	181.195	175.280	166.641	117.429	88.072
1.50	161.687	164.610	167.602	170.667	173.807	177.023*	180.054	181.896	181.811	179.352	174.214	128.403	96.302
1.60	156.015	158.834	161.722	164.679	167.709	170.812	173.991*	177.022	179.013	179.258	177.300	138.888	104.244
1.70	150.542	153.263	156.049	158.902	161.825	164.820	167.887	171.030*	174.053	176.152	176.659	148.400	111.907
1.80	145.261	147.886	150.575	153.328	156.148	159.038	161.997	165.030	168.137*	171.145	173.326	156.370	119.301
1.90	140.165	142.699	145.293	147.949	150.671	153.458	156.314	159.240	162.239	165.311*	168.301	162.246	126.436
2.00	135.249	137.693	140.196	142.759	145.385	148.075	150.831	153.654	156.547	159.511	162.549*	165.500	133.321
2.10	130.504	132.863	135.278	137.751	140.285	142.881	145.540	148.264	151.055	153.915	156.847	165.827	139.887
2.20	125.925	128.201	130.532	132.919	135.364	137.868	140.434	143.063	145.756	148.516	151.344	163.728	145.768
2.30	121.508	123.704	125.953	128.256	130.615	133.032	135.508	138.044	140.643	143.306	146.035	159.894	150.535
2.40	117.245	119.364	121.534	123.756	126.033	128.365	130.754	133.201	135.709	138.279	140.912	154.988	153.776
2.50	113.132	115.177	117.271	119.415	121.612	123.862	126.167	128.529	130.948	133.428	135.969	149.653*	155.091
2.60	109.164	111.137	113.157	115.226	117.346	119.517	121.741	124.020	126.355	128.747	131.199	144.403	154.250
2.70	105.335	107.239	109.188	111.184	113.229	115.324	117.470	119.669	121.922	124.231	126.596	139.337	151.628
2.80	101.639	103.477	105.358	107.284	109.257	111.279	113.350	115.471	117.645	119.873	122.155	134.449	147.740
2.90	98.074	99.847	101.662	103.521	105.425	107.375	109.373	111.421	113.518	115.668	117.870	129.733	143.085

Table 27.--Linear Model Hydrographs (S = kO); k/T = 2.80--Continued

H/T	QT/AP_e D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
3.00	94.634	96.344	98.096	99.889	101.727	103.609	105.537	107.512	109.536	111.610	113.735	125.182	138.142*
3.10	91.313	92.964	94.654	96.385	98.158	99.974	101.835	103.741	105.694	107.695	109.746	120.791	133.296
3.20	88.109	89.702	91.333	93.003	94.714	96.467	98.262	100.101	101.986	103.917	105.896	116.553	128.620
3.30	85.018	86.555	88.128	89.740	91.391	93.082	94.815	96.590	98.408	100.271	102.181	112.464	124.108
3.40	82.035	83.518	85.036	86.591	88.185	89.817	91.488	93.201	94.956	96.754	98.596	108.519	119.754
3.50	79.157	80.588	82.053	83.553	85.090	86.665	88.278	89.931	91.624	93.359	95.137	104.712	115.553
3.60	76.381	77.761	79.174	80.622	82.105	83.625	85.181	86.776	88.410	90.084	91.799	101.038	111.499
3.70	73.701	75.033	76.397	77.794	79.225	80.690	82.193	83.731	85.308	86.923	88.579	97.494	107.588
3.80	71.115	72.401	73.717	75.065	76.446	77.860	79.309	80.794	82.315	83.874	87.471	94.074	103.813
3.90	68.620	69.861	71.130	72.431	73.764	75.129	76.527	77.959	79.427	80.931	82.473	90.773	100.171
4.00	66.213	67.410	68.635	69.890	71.176	72.493	73.842	75.224	76.641	78.092	79.579	87.589	96.657
4.10	63.890	65.045	66.227	67.438	68.679	69.950	71.252	72.585	73.952	75.352	76.787	84.516	93.266
4.20	61.649	62.763	63.904	65.072	66.270	67.496	68.752	70.039	71.358	72.709	74.093	81.551	89.994
4.30	59.486	60.561	61.662	62.790	63.945	65.128	66.340	67.582	68.854	70.158	71.494	78.690	86.838
4.40	57.401	58.436	59.499	60.587	61.702	62.843	64.013	65.211	66.439	67.697	68.986	75.929	83.791
4.50	55.386	56.386	57.412	58.462	59.537	60.639	61.767	62.923	64.108	65.322	66.566	73.266	80.851
4.60	53.443	54.408	55.398	56.411	57.449	58.511	59.600	60.716	61.859	63.030	64.231	70.695	78.015
4.70	51.568	52.499	53.455	54.432	55.433	56.459	57.510	58.586	59.689	60.819	61.977	68.215	75.278
4.80	49.759	50.657	51.580	52.523	53.489	54.478	55.492	56.531	57.595	58.686	59.803	65.822	72.637
4.90	48.013	48.880	49.770	50.680	51.612	52.567	53.546	54.548	55.575	56.627	57.705	63.513	70.089
5.00	46.329	47.165	48.024	48.902	49.802	50.723	51.667	52.634	53.625	54.640	55.681	61.285	67.630
Peak	195.921	195.499	194.360	192.700	190.800	188.703	186.548	184.318	182.046	179.749	177.437	166.027	155.091
Time	0.92	0.98	1.02	1.08	1.16	1.22	1.32	1.38	1.46	1.54	1.62	2.06	2.50

Summarized from computations at intervals H/T = 0.02. *Recession coefficient 0.96491580 applicable beyond this point.

Table 28.--Linear Model Hydrographs (S = kO); k/T = 3.00

H/T	QT/APe D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	4.254	1.450	.725	.483	.362	.290	.242	.207	.181	.161	.145	.097	.072
.20	16.831	9.887	5.669	3.791	2.834	2.267	1.890	1.620	1.417	1.260	1.134	.756	.567
.30	37.459	26.511	18.199	12.616	9.462	7.570	6.308	5.407	4.731	4.205	3.785	2.523	1.892
.40	65.872	51.053	38.782	29.151	22.225	17.780	14.817	12.700	11.113	9.878	8.890	5.927	4.445
.50	101.818	83.253	67.153	53.606	42.676	34.431	28.692	24.593	21.519	19.128	17.215	11.477	8.608
.60	136.540	119.960	101.606	84.755	70.192	58.133	48.686	41.731	36.514	32.457	29.211	19.474	14.606
.70	161.660	149.855	134.908	117.689	101.030	86.126	73.420	63.138	55.246	49.108	44.197	29.465	22.098
.80	177.494	170.308	160.081	146.707	130.844	114.886	100.156	87.261	76.535	68.031	61.228	40.818	30.614
.90	184.346	181.627	175.967	167.263	155.437	141.000	126.009	111.795	99.057	88.211	79.390	52.927	39.695
1.00	182.512*	184.113	182.870	178.682	171.476	161.172	148.186	134.309	120.835	108.507	97.802	65.201	48.901
1.10	176.527	179.504*	181.808	181.747	178.888	173.081	164.227	152.660	139.959	127.353	115.607	77.168	57.876
1.20	170.740	173.618	176.561*	179.078	179.715	177.834	173.170	165.569	155.280	143.699	131.980	88.742	66.557
1.30	165.141	167.926	170.772	173.682*	176.290	177.357	176.182	172.421	165.864	156.684	146.121	99.937	74.953
1.40	159.727	162.419	165.173	167.987	170.867*	173.516	174.867	174.216	171.171	165.481	157.258	110.765	83.074
1.50	154.492	157.095	159.757	162.480	165.265	168.112*	170.779	172.329	172.076	169.607	164.642	121.238	90.929
1.60	149.426	151.945	154.520	157.153	159.846	162.601	165.418*	168.088	169.781	169.839	167.841	131.271	98.526
1.70	144.527	146.963	149.454	152.001	154.606	157.270	159.994	162.781*	165.448	167.245	167.552	140.410	105.874
1.80	139.789	142.145	144.554	147.018	149.537	152.114	154.749	157.444	160.202*	162.859	164.735	148.118	112.982
1.90	135.206	137.485	139.815	142.198	144.635	147.127	149.675	152.283	154.950	157.678*	160.321	153.881	119.856
2.00	130.773	132.978	135.231	137.536	139.893	142.303	144.768	147.290	149.870	152.508	155.208*	157.196	126.505
2.10	126.486	128.618	130.798	133.027	135.306	137.638	140.022	142.461	144.956	147.508	150.119	157.773	132.863
2.20	122.340	124.402	126.510	128.666	130.870	133.125	135.432	137.791	140.204	142.672	145.198	156.076	138.589
2.30	118.328	120.323	122.363	124.448	126.580	128.761	130.992	133.273	135.607	137.995	140.437	152.744	143.279
2.40	114.448	116.378	118.351	120.368	122.430	124.540	126.697	128.904	131.162	133.471	135.833	148.394	146.546
2.50	110.697	112.562	114.470	116.421	118.416	120.457	122.543	124.678	126.861	129.095	131.380	143.624*	148.011
2.60	107.067	108.872	110.717	112.604	114.534	116.508	118.526	120.590	122.702	124.862	127.073	138.915	147.457
2.70	103.557	105.303	107.088	108.912	110.779	112.688	114.640	116.637	118.680	120.769	122.907	134.361	145.229
2.80	100.161	101.850	103.576	105.342	107.147	108.993	110.881	112.813	114.789	116.809	118.877	129.956	141.806
2.90	96.877	98.510	100.180	101.887	103.634	105.419	107.246	109.114	111.025	112.980	114.980	125.695	137.650

Table 28.--Linear Model Hydrographs (S = kO); k/T = 3.00--Continued

H/T	QT/AP_e												
	D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
3.00	93.701	95.281	96.895	98.547	100.236	101.963	103.730	105.537	107.385	109.276	111.210	121.574	133.209*
3.10	90.629	92.156	93.718	95.316	96.949	98.620	100.329	102.076	103.864	105.692	107.564	117.588	128.842
3.20	87.659	89.136	90.646	92.191	93.771	95.387	97.039	98.730	100.459	102.228	104.037	113.733	124.617
3.30	84.785	86.214	87.675	89.169	90.697	92.259	93.858	95.493	97.165	98.876	100.626	110.005	120.532
3.40	82.005	83.388	84.801	86.246	87.724	89.235	90.781	92.362	93.980	95.634	97.327	106.398	116.580
3.50	79.316	80.654	82.021	83.419	84.848	86.310	87.805	89.334	90.899	92.499	94.136	102.910	112.758
3.60	76.715	78.008	79.331	80.683	82.066	83.480	84.926	86.405	87.918	89.466	91.050	99.536	109.061
3.70	74.200	75.451	76.730	78.038	79.375	80.743	82.142	83.573	85.036	86.533	88.065	96.272	105.486
3.80	71.767	72.977	74.214	75.479	76.772	78.096	79.449	80.833	82.248	83.696	85.178	93.116	102.027
3.90	69.414	70.584	71.780	73.004	74.255	75.535	76.844	78.182	79.552	80.952	82.385	90.063	98.682
4.00	67.139	68.271	69.427	70.611	71.821	73.058	74.324	75.619	76.943	78.298	79.684	87.110	95.447
4.10	64.939	66.033	67.152	68.296	69.466	70.663	71.887	73.140	74.421	75.731	77.072	84.254	92.318
4.20	62.809	63.868	64.950	66.057	67.189	68.347	69.531	70.742	71.981	73.248	74.545	81.492	89.291
4.30	60.750	61.774	62.821	63.892	64.986	66.106	67.251	68.422	69.621	70.847	72.101	78.820	86.364
4.40	58.758	59.749	60.761	61.797	62.856	63.939	65.046	66.179	67.338	68.524	69.737	76.236	83.532
4.50	56.832	57.790	58.769	59.771	60.795	61.843	62.914	64.010	65.131	66.277	67.450	73.737	80.793
4.60	54.968	55.895	56.842	57.811	58.802	59.815	60.851	61.911	62.995	64.104	65.239	71.319	78.145
4.70	53.166	54.063	54.979	55.916	56.874	57.854	58.856	59.882	60.930	62.003	63.100	68.981	75.583
4.80	51.423	52.290	53.176	54.083	55.009	55.957	56.927	57.918	58.933	59.970	61.032	66.720	73.105
4.90	49.737	50.576	51.433	52.310	53.206	54.123	55.060	56.019	57.000	58.004	59.031	64.532	70.708
5.00	48.106	48.917	49.747	50.594	51.462	52.348	53.255	54.183	55.132	56.102	57.095	62.416	68.390
Peak	184.665	184.308	183.233	181.747	180.023	178.165	176.215	174.216	172.189	170.144	168.089	157.860	148.058
Time	0.92	0.98	1.04	1.10	1.16	1.24	1.32	1.40	1.48	1.56	1.64	2.08	2.52

Summarized from computations at intervals H/T = 0.02. *Recession coefficient 0.96721598 applicable beyond this point.

Table 29.--Nonlinear Model Hydrographs ($S = kO^x$); $x = 0.5$; $k/\sqrt{AP_e/T} = 2.0$

$\frac{H}{T}$	QT/AP_e												
	D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	52.753	15.992	4.507	2.096	1.207	.784	.550	.407	.313	.248	.202	.091	.051
.20	325.189	174.881	82.152	42.302	25.907	17.534	12.675	9.594	7.517	6.050	4.975	2.319	1.337
.30	662.143	502.000	338.550	213.809	141.207	101.066	76.251	59.736	48.147	39.680	33.293	16.611	9.963
.40	945.126	807.767	662.499	508.507	374.691	282.365	222.353	180.627	150.193	127.184	109.292	59.479	37.702
.50	1214.258	1080.045	945.075	807.273	662.899	530.121	429.811	358.566	305.483	264.502	231.987	136.950	92.007
.60	1147.690	1182.331	1132.659	1026.775	905.938	775.179	649.878	549.787	474.849	416.681	370.199	231.449	162.994
.70	848.583	995.787	1088.176	1087.179	1020.662	927.406	817.898	707.364	615.039	543.290	485.926	313.953	228.003
.80	614.870	732.288	862.963	966.903	995.636	960.949	893.994	806.346	712.722	631.525	566.612	371.974	274.622
.90	375.086	493.302	612.286	738.399	845.649	891.573	879.591	833.865	765.202	687.361	617.608	408.484	303.954
1.00	154.361	261.554	375.355	492.418	615.391	723.723	780.804	785.683	757.161	704.807	641.282	426.105	318.470
1.10	50.611	102.778	180.750	281.417	391.171	508.247	614.376	677.320	693.622	677.976	638.600	430.292	322.434
1.20	26.616	41.501	73.664	135.634	221.799	321.003	429.455	530.241	594.506	617.330	610.235	430.221	322.654
1.30	16.580	23.132	34.107	60.096	111.123	185.243	274.050	373.342	467.549	530.624	556.847	430.222	322.666
1.40	11.359	14.855	20.027	29.907	52.020	95.445	160.174	239.957	330.800	418.460	479.305	430.222	322.667
1.50	8.281	10.375	13.242	18.135	27.125	46.517	84.415	141.816	214.033	297.437	379.015	430.222	322.667
1.60	6.310	7.665	9.427	12.222	16.825	25.092	42.456	76.164	127.738	193.611	270.538	425.847	322.667
1.70	4.971	5.899	7.060	8.811	11.496	15.835	23.515	39.302	69.722	116.564	177.080	408.531	322.667
1.80	4.018	4.682	5.488	6.660	8.367	10.938	15.049	22.237	36.760	64.527	107.458	374.478	322.667
1.90	3.316	3.807	4.390	5.213	6.367	8.020	10.487	14.398	21.172	34.658	60.234	324.423	322.667
2.00	2.783	3.157	3.593	4.193	5.010	6.136	7.736	10.109	13.846	20.268	32.877	259.383	322.667
2.10	2.370	2.661	2.995	3.446	4.046	4.849	5.946	7.496	9.785	13.370	19.483	188.349	319.617
2.20	2.042	2.274	2.535	2.883	3.337	3.929	4.715	5.785	7.290	9.503	12.952	126.086	307.330
2.30	1.778	1.965	2.174	2.448	2.800	3.249	3.832	4.601	5.645	7.109	9.253	78.931	282.742
2.40	1.562	1.715	1.885	2.105	2.382	2.732	3.176	3.748	4.502	5.522	6.947	46.372	246.205
2.50	1.384	1.511	1.650	1.829	2.052	2.329	2.675	3.113	3.675	4.414	5.411	26.833	198.514
2.60	1.234	1.340	1.456	1.604	1.786	2.010	2.285	2.627	3.058	3.610	4.335	16.684	146.037
2.70	1.107	1.197	1.295	1.418	1.569	1.752	1.974	2.246	2.584	3.008	3.552	11.417	99.435
2.80	.999	1.076	1.159	1.263	1.389	1.541	1.723	1.943	2.212	2.546	2.964	8.318	63.672
2.90	.906	.973	1.044	1.132	1.239	1.366	1.517	1.698	1.916	2.182	2.511	6.335	38.630

Table 29.--Nonlinear Model Hydrographs ($S = kO^x$); $x = 0.5$; $k/\sqrt{AP_e/T} = 2.0$ -- Continued

H/T	QT/APe D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
3.00	0.826	0.883	0.944	1.020	1.111	1.219	1.346	1.496	1.675	1.891	2.155	4.987	23.226
3.10	.755	.806	.859	.924	1.003	1.094	1.202	1.328	1.477	1.655	1.869	4.030	14.903
3.20	.694	.738	.784	.841	.909	.988	1.080	1.187	1.313	1.461	1.637	3.325	10.402
3.30	.639	.678	.719	.769	.828	.897	.976	1.067	1.174	1.299	1.446	2.790	7.683
3.40	.591	.626	.662	.706	.758	.817	.886	.965	1.056	1.162	1.286	2.375	5.910
3.50	.548	.579	.611	.650	.696	.748	.808	.877	.955	1.046	1.152	2.046	4.690
3.60	.510	.537	.566	.601	.641	.687	.740	.800	.868	.947	1.037	1.782	3.813
3.70	.475	.500	.526	.557	.593	.634	.680	.733	.793	.861	.939	1.565	3.162
3.80	.444	.466	.489	.517	.549	.586	.627	.674	.726	.786	.854	1.386	2.665
3.90	.416	.436	.457	.482	.511	.543	.580	.622	.668	.721	.780	1.236	2.276
4.00	.390	.408	.427	.450	.476	.505	.538	.575	.617	.663	.715	1.109	1.967
4.10	.367	.384	.401	.421	.445	.471	.501	.534	.571	.612	.659	1.001	1.717
4.20	.346	.361	.377	.395	.417	.441	.467	.497	.530	.567	.608	.907	1.512
4.30	.326	.340	.354	.371	.391	.413	.437	.464	.493	.527	.563	.827	1.342
4.40	.308	.321	.334	.350	.368	.387	.409	.434	.461	.490	.523	.756	1.199
4.50	.292	.304	.316	.330	.346	.364	.384	.406	.431	.458	.487	.694	1.077
4.60	.277	.288	.299	.312	.327	.343	.362	.382	.404	.428	.455	.640	.973
4.70	.263	.273	.283	.295	.309	.324	.341	.359	.379	.401	.426	.592	.884
4.80	.250	.259	.269	.280	.292	.306	.322	.339	.357	.377	.399	.549	.806
4.90	.238	.246	.255	.265	.277	.290	.304	.320	.337	.355	.375	.510	.738
5.00	.226	.235	.243	.252	.263	.275	.288	.302	.318	.335	.353	.475	.679

Table 30.—Nonlinear Model Hydrographs ($S = kO^x$); $x = 0.5$; $k/\sqrt{AP_e/T} = 5.0$

H/T	QT/APe D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	12.116	3.172	.813	.364	.206	.132	.092	.068	.052	.041	.033	.015	.008
.20	115.385	51.380	20.468	9.460	5.431	3.521	2.466	1.823	1.402	1.112	.903	.405	.229
.30	366.450	229.464	128.357	69.913	41.518	27.503	19.558	14.621	11.344	9.058	7.399	3.377	1.925
.40	706.420	535.945	377.882	250.143	163.294	111.958	81.666	62.235	49.023	39.626	32.700	15.407	8.936
.50	1044.820	880.965	712.460	549.683	406.600	297.604	224.113	175.193	140.919	115.886	97.035	47.988	28.606
.60	1137.741	1097.696	996.206	854.362	704.253	561.932	443.803	356.493	293.441	246.135	209.664	110.139	68.101
.70	953.715	1046.126	1075.202	1022.426	919.135	795.913	669.570	557.081	468.375	400.398	346.919	194.248	125.243
.80	727.338	839.363	941.785	996.848	981.019	913.357	819.535	715.171	616.732	535.320	470.430	278.963	187.447
.90	501.848	613.039	724.763	829.258	897.551	905.914	865.390	796.441	713.044	630.311	559.484	346.771	241.394
1.00	289.655	393.227	501.178	610.630	714.843	790.115	814.401	793.843	744.759	679.323	611.266	390.692	279.481
1.10	156.416	222.478	306.340	404.977	508.628	609.529	687.085	721.122	714.627	680.600	629.632	413.322	301.438
1.20	98.770	129.215	176.406	247.158	334.606	429.840	524.699	600.777	639.581	642.032	618.594	423.134	312.456
1.30	68.246	84.907	108.428	148.123	208.701	285.974	372.446	460.242	532.801	573.184	581.010	427.273	317.806
1.40	50.050	60.190	73.676	94.636	129.239	182.210	251.034	329.533	410.419	478.766	519.064	428.999	320.365
1.50	38.304	44.942	53.414	65.877	84.919	115.771	162.889	224.781	296.328	370.888	434.964	429.716	321.579
1.60	30.272	34.859	40.534	48.560	60.197	77.712	105.645	148.123	204.289	269.846	338.760	427.493	322.153
1.70	24.534	27.838	31.828	37.306	44.947	55.876	72.126	97.706	136.413	187.797	248.196	416.554	322.424
1.80	20.290	22.749	25.663	29.571	34.863	42.149	52.460	67.639	91.271	126.854	174.197	392.309	322.552
1.90	17.061	18.942	21.135	24.022	27.840	32.945	39.905	49.670	63.929	85.921	118.871	353.504	322.613
2.00	14.548	16.019	17.711	19.905	22.751	26.468	31.390	38.050	47.329	60.790	81.380	300.557	322.641
2.10	12.553	13.725	15.058	16.764	18.943	21.735	25.346	30.094	36.478	45.328	58.087	239.145	320.951
2.20	10.942	11.891	12.961	14.314	16.020	18.170	20.899	24.404	28.986	35.122	43.586	180.048	313.378
2.30	9.623	10.403	11.273	12.365	13.725	15.417	17.530	20.192	23.594	28.025	33.933	130.525	296.471
2.40	8.530	9.178	9.896	10.790	11.892	13.247	14.916	16.986	19.582	22.887	27.176	92.508	269.054
2.50	7.613	8.157	8.757	9.497	10.403	11.505	12.847	14.489	16.515	19.047	22.260	65.856	231.241
2.60	6.836	7.298	7.804	8.425	9.178	10.087	11.181	12.505	14.117	16.100	18.571	48.547	186.852
2.70	6.172	6.568	6.999	7.524	8.157	8.915	9.820	10.904	12.207	13.789	15.730	37.297	143.428
2.80	5.601	5.942	6.312	6.760	7.298	7.937	8.694	9.592	10.661	11.943	13.495	29.565	106.347
2.90	5.106	5.402	5.721	6.108	6.568	7.111	7.751	8.503	9.391	10.445	11.706	24.018	77.329

Table 30.--Nonlinear Model Hydrographs ($S = kO^x$); x = 0.5; $k/\sqrt{AP_e/T}$ = 5.0 -- Continued

$\frac{H}{T}$	QT/AP_e												
	D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
3.00	4.673	4.932	5.210	5.545	5.942	6.408	6.953	7.590	8.336	9.213	10.251	19.901	56.492
3.10	4.293	4.521	4.765	5.057	5.402	5.805	6.273	6.817	7.449	8.186	9.052	16.762	42.550
3.20	3.958	4.159	4.374	4.630	4.932	5.283	5.688	6.156	6.697	7.323	8.052	14.312	33.222
3.30	3.661	3.839	4.029	4.256	4.521	4.828	5.181	5.587	6.053	6.589	7.209	12.364	26.667
3.40	3.396	3.555	3.724	3.925	4.159	4.430	4.739	5.093	5.498	5.960	6.492	10.788	21.883
3.50	3.158	3.301	3.452	3.631	3.839	4.079	4.352	4.662	5.015	5.417	5.876	9.496	18.283
3.60	2.945	3.073	3.209	3.369	3.555	3.768	4.010	4.284	4.594	4.946	5.345	8.424	15.505
3.70	2.753	2.868	2.991	3.134	3.301	3.491	3.707	3.950	4.224	4.533	4.882	7.523	13.317
3.80	2.579	2.683	2.794	2.924	3.073	3.244	3.437	3.653	3.897	4.170	4.477	6.760	11.562
3.90	2.420	2.516	2.616	2.733	2.868	3.022	3.195	3.389	3.606	3.849	4.121	6.107	10.133
4.00	2.276	2.363	2.454	2.561	2.683	2.822	2.978	3.152	3.347	3.563	3.805	5.545	8.954
4.10	2.145	2.224	2.307	2.404	2.516	2.642	2.782	2.940	3.114	3.308	3.524	5.056	7.969
4.20	2.025	2.097	2.173	2.262	2.363	2.478	2.606	2.748	2.905	3.080	3.274	4.630	7.139
4.30	1.914	1.981	2.050	2.132	2.224	2.329	2.445	2.574	2.717	2.875	3.049	4.255	6.432
4.40	1.812	1.874	1.938	2.012	2.097	2.193	2.299	2.416	2.546	2.689	2.846	3.924	5.825
4.50	1.718	1.775	1.834	1.903	1.981	2.068	2.165	2.273	2.391	2.521	2.663	3.631	5.300
4.60	1.632	1.684	1.739	1.802	1.874	1.954	2.043	2.142	2.250	2.368	2.498	3.369	4.843
4.70	1.551	1.600	1.650	1.709	1.775	1.849	1.931	2.021	2.120	2.228	2.347	3.134	4.443
4.80	1.477	1.522	1.569	1.623	1.684	1.753	1.828	1.911	2.002	2.101	2.209	2.923	4.090
4.90	1.408	1.449	1.493	1.543	1.600	1.663	1.733	1.810	1.893	1.984	2.083	2.733	3.778
5.00	1.343	1.382	1.423	1.469	1.522	1.581	1.645	1.716	1.793	1.877	1.968	2.561	3.501

Table 31.--Nonlinear Model Hydrographs ($S = kO^x$); x = 0.5; $k/\sqrt{AP_e/T} = 7.0$

H/T	QT/APe D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	6.467	1.658	.420	.187	.106	.068	.047	.035	.026	.021	.017	.008	.004
.20	67.213	28.693	11.069	5.028	2.860	1.842	1.285	.947	.727	.576	.467	.208	.118
.30	241.453	142.513	75.781	39.817	23.107	15.077	10.613	7.872	6.071	4.824	3.925	1.769	1.002
.40	531.789	379.432	251.837	158.434	99.637	66.504	47.556	35.695	27.781	22.237	18.203	8.356	4.779
.50	878.163	705.489	540.328	394.933	278.838	196.811	144.077	110.109	86.925	70.385	58.167	27.527	16.003
.60	1052.419	972.442	844.532	691.992	545.080	417.815	319.274	249.593	200.704	165.020	138.144	68.233	40.634
.70	959.526	1009.727	997.271	912.982	790.541	659.674	536.721	434.221	356.350	298.126	253.345	131.850	81.002
.80	773.497	866.468	939.534	959.540	913.988	825.214	718.694	610.741	515.045	438.267	378.086	207.962	132.356
.90	564.993	667.887	766.310	848.285	888.306	871.200	811.158	728.955	639.334	555.609	485.662	281.275	185.519
1.00	360.090	460.279	562.243	661.121	747.359	799.536	802.356	764.833	703.592	631.550	561.144	339.441	231.311
1.10	219.245	288.853	373.008	467.791	563.108	649.361	707.773	723.663	702.607	657.977	600.971	378.105	264.871
1.20	148.120	184.746	236.945	309.479	394.780	483.557	566.359	626.356	649.729	639.754	607.258	401.033	287.042
1.30	106.966	128.693	157.741	202.347	265.334	341.525	422.898	500.559	559.374	586.459	583.572	414.102	301.063
1.40	80.942	94.910	112.793	138.721	177.929	233.503	301.855	376.181	448.340	504.692	533.309	421.388	309.695
1.50	63.419	72.940	84.743	101.185	124.739	159.866	209.590	271.349	339.358	406.229	459.637	425.402	314.925
1.60	51.047	57.832	66.038	77.129	92.409	114.068	145.965	190.962	247.163	309.638	371.646	425.638	318.062
1.70	41.983	46.991	52.929	60.770	71.256	85.569	105.649	134.904	175.996	227.513	285.141	417.959	319.934
1.80	35.141	38.943	43.381	49.131	56.643	66.605	80.077	98.812	125.853	163.682	211.191	398.398	321.047
1.90	29.848	32.804	36.208	40.551	46.120	53.335	62.820	75.551	93.116	118.287	153.335	365.342	321.707
2.00	25.670	28.013	30.682	34.043	38.286	43.681	50.615	59.666	71.733	88.289	111.839	318.742	322.099
2.10	22.312	24.202	26.333	28.988	32.296	36.437	41.660	48.329	56.980	68.462	84.124	262.968	321.014
2.20	19.574	21.120	22.849	24.983	27.612	30.860	34.894	39.950	46.367	54.661	65.613	207.121	315.134
2.30	17.312	18.592	20.015	21.755	23.879	26.475	29.655	33.580	38.473	44.661	52.625	158.183	301.332
2.40	15.420	16.493	17.677	19.116	20.857	22.963	25.516	28.624	32.440	37.182	43.155	118.836	278.121
2.50	13.823	14.731	15.727	16.930	18.375	20.108	22.187	24.692	27.726	31.439	36.036	89.672	245.185
2.60	12.461	13.237	14.083	15.099	16.312	17.755	19.472	21.518	23.971	26.934	30.548	69.403	205.323
2.70	11.292	11.959	12.684	13.550	14.578	15.792	17.226	18.921	20.932	23.334	26.226	55.330	164.757
2.80	10.280	10.858	11.484	12.228	13.106	14.138	15.348	16.768	18.437	20.412	22.763	45.154	128.530
2.90	9.398	9.902	10.447	11.090	11.847	12.732	13.762	14.962	16.364	18.007	19.944	37.555	98.815

Table 31.--Nonlinear Model Hydrographs ($S = kO^x$); x = 0.5; $k/\sqrt{AP_e/T}$ = 7.0 -- Continued

$\frac{H}{T}$	QT/APe												
	D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D.T=2.0
3.00	8.625	9.068	9.544	10.105	10.761	11.525	12.409	13.434	14.621	16.003	17.619	31.730	76.272
3.10	7.944	8.334	8.753	9.245	9.818	10.482	11.247	12.128	13.144	14.317	15.678	27.164	60.171
3.20	7.340	7.686	8.057	8.490	8.994	9.574	10.241	11.004	11.879	12.884	14.041	23.519	48.696
3.30	6.803	7.111	7.440	7.825	8.269	8.780	9.364	10.030	10.789	11.656	12.649	20.563	40.225
3.40	6.322	6.599	6.892	7.234	7.629	8.081	8.595	9.179	9.842	10.595	11.454	18.132	33.792
3.50	5.891	6,139	6.403	6.708	7.060	7.462	7.917	8.433	9.015	9.674	10.420	16.108	28.791
3.60	5.503	5.726	5.963	6.238	6.553	6.911	7.316	7.773	8.288	8.867	9.521	14.406	24.825
3.70	5.151	5.354	5.568	5.815	6.098	6.419	6.782	7.189	7.645	8.157	8.733	12.959	21.627
3.80	4.833	5.016	5.210	5.434	5.689	5.978	6.303	6.668	7.075	7.530	8.039	11.721	19.011
3.90	4.542	4.710	4.886	5.089	5.320	5.581	5.874	6.201	6.566	6.972	7.424	10.652	16.842
4.00	4.278	4.431	4.591	4.776	4.986	5.223	5.487	5.782	6.110	6.474	6.878	9.723	15.025
4.10	4.036	4.176	4.322	4.491	4.682	4.897	5.137	5.404	5.700	6.027	6.390	8.910	13.487
4.20	3.813	3.942	4.076	4.231	4.405	4.602	4.820	5.062	5.330	5.625	5.952	8.195	12.174
4.30	3.609	3.727	3.851	3.992	4.152	4.332	4.531	4.751	4.995	5.262	5.557	7.563	11.044
4.40	3.421	3.530	3.644	3.774	3.921	4.085	4.267	4.469	4.690	4.933	5.201	7.002	10.064
4.50	3.247	3.348	3.453	3.573	3.708	3.859	4.026	4.210	4.413	4.634	4.878	6.501	9.209
4.60	3.086	3.179	3.276	3.387	3.512	3.651	3.805	3.974	4.159	4.362	4.584	6.051	8.459
4.70	2.937	3.023	3.113	3.216	3.331	3.459	3.601	3.757	3.927	4.113	4.315	5.647	7.797
4.80	2.798	2.878	2.962	3.057	3.164	3.283	3.413	3.557	3.713	3.884	4.070	5.282	7.210
4.90	2.669	2.744	2.821	2.910	3.009	3.119	3.240	3.372	3.517	3.674	3.845	4.951	6.686
5.00	2.548	2.618	2.691	2.773	2.865	2.967	3.079	3.202	3.336	3.481	3.638	4.651	6.218

Table 32.--Nonlinear Model Hydrographs ($S = kO^x$); $x = 0.5$; $k/\sqrt{AP_e/T} = 8.0$

$\frac{H}{T}$	QT/APe D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	5.009	1.277	.322	.144	.081	.052	.036	.027	.020	.016	.013	.006	.003
.20	53.345	22.496	8.607	3.890	2.207	1.420	.989	.729	.559	.442	.359	.160	.090
.30	199.107	115.306	60.381	31.389	18.098	11.764	8.254	6.110	4.704	3.733	3.035	1.363	.771
.40	459.552	320.609	208.434	129.005	80.151	53.070	37.722	28.190	21.865	17.454	14.255	6.498	3.703
.50	794.213	624.811	468.279	335.509	233.036	162.415	117.780	89.358	70.134	56.520	46.524	21.736	12.548
.60	994.125	900.292	766.267	615.646	476.218	359.328	271.194	209.917	167.427	136.719	113.787	55.106	32.455
.70	943.340	973.484	943.337	848.053	721.737	592.490	475.304	380.103	308.922	256.284	216.195	109.624	66.289
.80	783.238	864.073	921.311	924.788	866.856	770.921	662.031	555.798	463.907	391.253	334.837	178.694	111.497
.90	587.903	684.550	774.032	843.289	869.194	840.345	772.344	685.899	595.424	513.001	444.982	249.848	161.177
1.00	389.248	486.500	583.933	675.702	751.682	792.053	784.532	739.415	673.400	599.379	528.819	310.789	207.075
1.10	247.304	317.392	400.437	491.930	581.677	659.599	708.186	715.222	687.367	638.189	578.855	355.143	243.600
1.20	171.540	210.264	263.822	336.058	419.126	503.505	579.496	631.325	647.159	631.308	594.760	384.241	269.989
1.30	126.144	149.860	180.923	226.994	290.146	364.767	442.618	514.631	566.546	587.198	579.271	402.512	288.190
1.40	96.730	112.329	131.997	159.766	200.426	256.372	323.561	395.008	462.365	512.788	535.845	413.686	300.366
1.50	76.565	87.381	100.632	118.688	143.943	180.448	230.629	291.510	357.074	419.774	467.993	420.412	308.352
1.60	62.127	69.938	79.297	91.710	108.488	131.702	164.887	210.384	265.895	326.224	384.540	422.662	313.522
1.70	51.431	57.258	64.116	73.021	84.743	100.436	121.941	152.411	194.011	244.941	300.656	416.973	316.844
1.80	43.283	47.747	52.924	59.531	68.049	79.160	93.908	113.975	142.149	180.451	227.457	399.759	318.966
1.90	36.933	40.428	44.433	49.472	55.857	64.017	74.576	88.505	107.317	133.516	169.025	369.403	320.318
2.00	31.887	34.675	37.837	41.768	46.680	52.849	60.673	70.742	83.936	101.638	126.152	325.724	321.177
2.10	27.810	30.070	32.611	35.737	39.596	44.376	50.335	57.852	67.469	79.999	96.736	272.630	320.542
2.20	24.469	26.328	28.399	30.926	34.014	37.792	42.437	48.198	55.426	64.625	76.569	218.549	315.435
2.30	21.697	23.243	24.955	27.028	29.536	32.575	36.265	40.780	46.350	53.305	62.130	170.273	302.924
2.40	19.371	20.671	22.102	23.823	25.890	28.369	31.351	34.954	39.339	44.726	51.433	130.712	281.471
2.50	17.400	18.504	19.712	21.157	22.880	24.931	27.373	30.295	33.809	38.067	43.285	100.742	250.618
2.60	15.716	16.661	17.690	18.915	20.366	22.082	24.109	26.512	29.370	32.794	36.934	79.374	212.789
2.70	14.265	15.080	15.964	17.011	18.246	19.695	21.396	23.396	25.754	28.548	31.888	64.171	173.671
2.80	13.006	13.715	14.480	15.382	16.440	17.676	19.117	20.799	22.767	25.077	27.811	52.965	138.104
2.90	11.907	12.526	13.193	13.976	14.890	15.952	17.184	18.612	20.271	22.204	24.470	44.465	108.376

Table 32.--Nonlinear Model Hydrographs ($S = kO^x$); $x = 0.5$; $k/\sqrt{AP_e/T} = 8.0$ -- Continued

$\frac{H}{T}$	QT/APe												
	D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
3.00	10.941	11.486	12.070	12.754	13.549	14.469	15.530	16.753	18.165	19.798	21.698	37.862	85.337
3.10	10.089	10.570	11.085	11.686	12.382	13.184	14.104	15.160	16.371	17.763	19.371	32.631	68.475
3.20	9.332	9.760	10.216	10.747	11.359	12.062	12.866	13.783	14.831	16.027	17.400	28.415	56.174
3.30	8.658	9.040	9.446	9.916	10.459	11.078	11.784	12.586	13.498	14.534	15.716	24.968	46.921
3.40	8.054	8.396	8.759	9.179	9.661	10.210	10.833	11.539	12.337	13.240	14.265	22.113	39.785
3.50	7.511	7.819	8.145	8.521	8.951	9.440	9.993	10.617	11.320	12.112	13.006	19.721	34.164
3.60	7.021	7.299	7.593	7.931	8.317	8.754	9.247	9.801	10.424	11.122	11.907	17.698	29.657
3.70	6.578	6.830	7.095	7.400	7.747	8.140	8.581	9.076	9.630	10.248	10.941	15.971	25.989
3.80	6.175	6.404	6.645	6.921	7.235	7.589	7.985	8.429	8.923	9.474	10.089	14.486	22.962
3.90	5.808	6.017	6.236	6.487	6.771	7.091	7.449	7.848	8.292	8.784	9.332	13.198	20.435
4.00	5.473	5.664	5.864	6.093	6.351	6.642	6.966	7.326	7.725	8.167	8.658	12.075	18.304
4.10	5.167	5.341	5.524	5.733	5.969	6.233	6.527	6.854	7.215	7.613	8.054	11.089	16.490
4.20	4.885	5.045	5.213	5.404	5.620	5.861	6.129	6.426	6.753	7.114	7.511	10.220	14.933
4.30	4.626	4.773	4.928	5.103	5.301	5.522	5.767	6.037	6.335	6.662	7.021	9.449	13.587
4.40	4.386	4.523	4.665	4.827	5.008	5.211	5.435	5.682	5.954	6.251	6.578	8.762	12.415
4.50	4.165	4.292	4.423	4.572	4.739	4.926	5.132	5.358	5.606	5.878	6.175	8.147	11.388
4.60	3.961	4.077	4.199	4.337	4.491	4.663	4.853	5.061	5.288	5.537	5.809	7.595	10.484
4.70	3.771	3.879	3.992	4.120	4.263	4.421	4.596	4.788	4.997	5.225	5.474	7.097	9.683
4.80	3.594	3.695	3.800	3.918	4.051	4.197	4.359	4.536	4.729	4.939	5.167	6.647	8.971
4.90	3.429	3.523	3.621	3.731	3.854	3.990	4.140	4.304	4.482	4.675	4.885	6.238	8.335
5.00	3.276	3.364	3.455	3.557	3.672	3.798	3.937	4.089	4.253	4.432	4.626	5.866	7.764

Table 33.--Nonlinear Model Hydrographs ($S = kO^x$); $x = 0.5$; $k/\sqrt{AP_e/T} = 9.0$

$\frac{H}{T}$	QT/AP_e D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	3.990	1.013	.255	.114	.064	.041	.029	.021	.016	.013	.010	.005	.003
.20	43.244	18.073	6.872	3.095	1.753	1.127	.784	.577	.443	.350	.284	.127	.071
.30	166.127	94.818	49.084	25.319	14.535	9.417	6.594	4.873	3.748	2.972	2.414	1.082	.611
.40	398.005	272.728	174.394	106.572	65.630	43.184	30.563	22.767	17.615	14.033	11.443	5.190	2.950
.50	715.142	552.540	406.525	286.541	196.440	135.563	97.596	73.635	57.540	46.206	37.922	17.552	10.082
.60	930.955	827.759	691.815	546.347	416.124	309.939	231.561	177.816	140.908	114.448	94.821	45.248	26.421
.70	917.075	929.210	884.514	781.950	655.081	530.087	420.084	332.633	268.140	220.941	185.269	92.011	54.954
.80	784.060	852.106	893.947	882.706	814.892	714.536	605.801	502.976	415.982	348.114	295.856	153.935	94.518
.90	604.305	693.589	773.175	829.560	842.183	803.077	728.977	640.119	550.342	470.346	405.077	221.234	140.061
1.00	413.794	507.192	599.136	682.909	748.253	777.144	760.123	708.511	638.996	564.083	494.239	282.600	184.540
1.10	272.534	342.243	423.331	510.703	594.057	663.229	702.113	700.730	666.773	613.825	552.873	330.688	222.330
1.20	193.493	233.662	287.848	359.028	439.063	518.384	587.193	630.856	639.451	618.147	578.035	364.856	251.636
1.30	144.634	169.955	202.532	249.445	312.067	384.448	458.226	524.267	569.290	583.738	571.055	388.043	273.309
1.40	112.277	129.280	150.424	179.619	221.177	276.902	342.392	410.456	472.763	517.287	534.983	403.314	288.811
1.50	89.720	101.697	116.212	135.634	162.201	199.607	249.748	309.264	371.964	430.309	473.395	413.181	299.651
1.60	73.357	82.116	92.517	106.102	124.129	148.556	182.626	228.155	282.551	340.398	394.887	417.886	307.115
1.70	61.106	67.707	75.418	85.296	98.099	114.946	137.597	168.875	210.576	260.552	314.072	414.496	312.202
1.80	51.693	56.793	62.669	70.079	79.502	91.619	107.455	128.566	157.514	195.948	242.101	399.770	315.645
1.90	44.304	48.325	52.906	58.609	65.748	74.757	86.269	101.200	120.992	147.929	183.556	372.138	317.963
2.00	38.395	41.622	45.264	49.747	55.286	62.168	70.802	81.756	95.895	114.520	139.709	331.338	319.520
2.10	33.597	36.226	39.168	42.757	47.141	52.518	59.161	67.438	77.894	91.316	108.907	280.900	319.494
2.20	29.646	31.817	34.229	37.145	40.675	44.957	50.178	56.586	64.538	74.534	87.310	228.674	315.211
2.30	26.354	28.167	30.169	32.572	35.456	38.921	43.100	48.162	54.353	61.999	71.575	181.256	303.930
2.40	23.581	25.112	26.792	28.796	31.183	34.027	37.423	41.493	46.406	52.387	59.750	141.723	284.107
2.50	21.225	22.528	23.952	25.640	27.639	30.002	32.800	36.120	40.086	44.853	50.638	111.194	255.182
2.60	19.205	20.324	21.541	22.977	24.667	26.652	28.985	31.730	34.976	38.838	43.465	88.946	219.269
2.70	17.461	18.429	19.477	20.709	22.150	23.834	25.799	28.095	30.787	33.959	37.718	72.786	181.590
2.80	15.944	16.787	17.696	18.760	20.000	21.440	23.112	25.051	27.308	29.946	33.043	60.672	146.782
2.90	14.616	15.355	16.149	17.075	18.149	19.390	20.824	22.477	24.388	26.605	29.186	51.356	117.201

Table 33.—Nonlinear Model Hydrographs ($S = kO^x$); $x = 0.5$; $k/\sqrt{AP_e/T} = 9.0$ — Continued

H/T	QT/APe												
	D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
3.00	13.448	14.099	14.796	15.607	16.543	17.621	18.860	20.280	21.913	23.794	25.968	44.036	93.847
3.10	12.415	12.991	13.607	14.320	15.142	16.084	17.161	18.391	19.796	21.406	23.255	38.179	76.394
3.20	11.496	12.009	12.555	13.187	13.911	14.739	15.682	16.754	17.973	19.361	20.947	33.420	63.407
3.30	10.676	11.134	11.621	12.183	12.825	13.556	14.387	15.326	16.390	17.596	18.965	29.499	53.478
3.40	9.940	10.351	10.788	11.289	11.861	12.511	13.245	14.073	15.008	16.061	17.253	26.231	45.716
3.50	9.278	9.649	10.041	10.490	11.002	11.581	12.235	12.968	13.793	14.720	15.762	23.477	39.532
3.60	8.680	9.015	9.369	9.774	10.233	10.752	11.335	11.989	12.720	13.539	14.457	21.136	34.526
3.70	8.138	8.442	8.762	9.128	9.542	10.009	10.532	11.116	11.768	12.495	13.307	19.129	30.415
3.80	7.645	7.922	8.213	8.544	8.919	9.340	9.811	10.335	10.919	11.568	12.290	17.394	26.997
3.90	7.196	7.448	7.713	8.015	8.355	8.736	9.162	9.634	10.159	10.740	11.385	15.886	24.126
4.00	6.785	7.016	7.258	7.533	7.843	8.189	8.575	9.002	9.475	9.998	10.576	14.566	21.689
4.10	6.409	6.620	6.842	7.093	7.376	7.692	8.042	8.430	8.858	9.330	9.851	13.403	19.604
4.20	6.063	6.257	6.461	6.691	6.950	7.238	7.558	7.911	8.300	8.727	9.197	12.375	17.806
4.30	5.744	5.923	6.110	6.322	6.560	6.824	7.116	7.438	7.792	8.181	8.607	11.460	16.245
4.40	5.449	5.615	5.788	5.983	6.201	6.444	6.712	7.007	7.330	7.684	8.072	10.644	14.881
4.50	5.177	5.331	5.490	5.670	5.872	6.095	6.342	6.612	6.908	7.232	7.585	9.912	13.681
4.60	4.925	5.067	5.215	5.382	5.568	5.774	6.001	6.250	6.521	6.818	7.141	9.252	12.621
4.70	4.691	4.823	4.960	5.115	5.287	5.477	5.687	5.916	6.166	6.439	6.735	8.657	11.680
4.80	4.473	4.596	4.723	4.867	5.027	5.203	5.397	5.609	5.839	6.090	6.362	8.117	10.840
4.90	4.270	4.384	4.503	4.637	4.785	4.949	5.129	5.325	5.538	5.769	6.020	7.626	10.088
5.00	4.080	4.187	4.298	4.422	4.561	4.713	4.880	5.062	5.259	5.473	5.704	7.178	9.411

Table 34.--Nonlinear Model Hydrographs ($S = kO^x$); $x = 0.5$; $k/\sqrt{AP_e/T} = 10.0$

$\frac{H}{T}$	QT/AP_e D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	3.251	.823	.207	.092	.052	.033	.023	.017	.013	.010	.008	.004	.002
.20	35.696	14.819	5.609	2.520	1.425	.915	.637	.469	.359	.284	.230	.103	.058
.30	140.235	79.121	40.600	20.829	11.911	7.700	5.384	3.975	3.054	2.420	1.965	.879	.496
.40	346.124	233.677	147.491	89.254	54.578	35.745	25.216	18.739	14.472	11.512	9.376	4.237	2.403
.50	642.752	488.833	354.176	246.402	167.105	114.425	81.911	61.536	47.924	38.380	31.429	14.445	8.266
.60	866.340	757.622	623.118	484.976	364.485	268.581	199.006	151.837	119.700	96.811	79.924	37.702	21.876
.70	883.290	879.946	824.024	717.565	592.713	473.651	372.453	291.712	233.556	191.317	159.643	77.980	46.130
.80	776.840	832.163	859.759	836.113	760.980	658.687	552.037	453.903	372.385	309.486	261.461	133.192	80.734
.90	614.202	695.362	764.644	808.610	809.231	761.698	683.380	593.881	506.082	429.303	367.371	195.832	122.044
1.00	433.493	522.278	607.929	683.179	737.899	756.034	730.657	673.902	602.186	527.427	459.103	255.951	164.221
1.10	294.582	363.140	441.465	523.990	600.377	660.674	690.218	681.142	641.960	586.134	524.349	305.985	201.989
1.20	213.582	254.582	308.686	378.095	454.446	528.158	589.578	625.279	627.088	600.901	557.836	343.931	233.008
1.30	162.088	188.597	222.195	269.348	330.817	400.376	469.586	529.458	567.710	576.253	559.214	371.380	257.283
1.40	127.278	145.425	167.739	197.925	239.868	294.809	358.087	422.366	479.455	518.157	530.744	390.601	275.635
1.50	102.627	115.602	131.190	151.694	179.197	217.039	266.662	324.379	383.878	437.724	475.778	403.770	289.169
1.60	84.523	94.125	105.448	120.021	139.047	164.362	198.900	244.074	296.951	352.028	402.596	411.211	298.977
1.70	70.830	78.137	86.624	97.357	111.074	128.855	152.346	184.111	225.531	274.199	325.289	410.369	305.997
1.80	60.222	65.912	72.438	80.574	90.792	103.766	120.478	142.389	171.795	210.007	255.016	398.289	310.978
1.90	51.834	56.352	61.480	67.794	75.613	85.372	97.691	113.451	133.982	161.352	196.800	373.455	314.491
2.00	45.087	48.734	52.837	57.837	63.954	71.481	80.824	92.544	107.453	126.767	152.365	335.548	316.958
2.10	39.579	42.567	45.899	49.927	54.803	60.731	67.988	76.941	88.114	102.258	120.492	287.785	317.708
2.20	35.023	37.502	40.247	43.537	47.487	52.240	57.989	64.985	73.575	84.247	97.701	237.514	314.335
2.30	31.212	33.290	35.578	38.303	41.548	45.416	50.049	55.619	62.367	70.619	80.832	191.135	304.280
2.40	27.991	29.751	31.679	33.960	36.658	39.850	43.637	48.145	53.543	60.056	67.993	151.850	286.017
2.50	25.244	26.748	28.387	30.316	32.584	35.249	38.385	42.086	46.470	51.702	57.994	120.986	258.916
2.60	22.883	24.178	25.583	27.229	29.154	31.401	34.028	37.104	40.715	44.979	50.052	98.061	224.832
2.70	20.839	21.962	23.176	24.591	26.239	28.152	30.374	32.957	35.967	39.491	43.639	81.103	188.589
2.80	19.057	20.037	21.093	22.319	23.740	25.382	27.278	29.470	32.005	34.950	38.387	68.202	154.619
2.90	17.494	18.355	19.279	20.348	21.583	23.002	24.634	26.508	28.664	31.150	34.030	58.158	125.316

Table 34.--Nonlinear Model Hydrographs ($S = kQ^x$); $x = 0.5$; $k/\sqrt{AP_e/T} = 10.0$ -- Continued

H/T	QT/AP$_e$ D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
3.00	16.116	16.876	17.689	18.628	19.707	20.942	22.356	23.972	25.821	27.938	30.375	50.184	101.800
3.10	14.895	15.569	16.289	17.116	18.065	19.147	20.380	21.783	23.380	25.199	27.280	43.747	83.905
3.20	13.807	14.408	15.048	15.782	16.620	17.573	18.655	19.881	21.270	22.844	24.635	38.476	70.357
3.30	12.835	13.373	13.944	14.598	15.342	16.186	17.141	18.218	19.434	20.805	22.357	34.104	59.850
3.40	11.962	12.445	12.957	13.542	14.206	14.957	15.804	16.756	17.825	19.027	20.381	30.438	51.538
3.50	11.175	11.611	12.072	12.597	13.192	13.863	14.617	15.462	16.409	17.468	18.656	27.333	44.846
3.60	10.463	10.857	11.274	11.748	12.283	12.885	13.559	14.313	15.155	16.093	17.142	24.680	39.381
3.70	9.817	10.175	10.553	10.981	11.464	12.006	12.612	13.288	14.039	14.875	15.804	22.396	34.859
3.80	9.229	9.555	9.899	10.288	10.725	11.215	11.761	12.369	13.043	13.789	14.618	20.415	31.073
3.90	8.692	8.991	9.304	9.658	10.055	10.499	10.994	11.542	12.148	12.819	13.560	18.686	27.873
4.00	8.201	8.474	8.761	9.084	9.446	9.850	10.299	10.795	11.343	11.947	12.613	17.168	25.144
4.10	7.751	8.001	8.264	8.560	8.891	9.259	9.668	10.119	10.615	11.161	11.762	15.828	22.796
4.20	7.336	7.567	7.808	8.080	8.383	8.720	9.093	9.504	9.956	10.451	10.994	14.638	20.763
4.30	6.954	7.167	7.389	7.639	7.918	8.227	8.568	8.944	9.355	9.806	10.299	13.578	18.991
4.40	6.601	6.798	7.003	7.233	7.490	7.774	8.088	8.431	8.808	9.219	9.668	12.629	17.436
4.50	6.275	6.457	6.646	6.859	7.096	7.358	7.646	7.962	8.307	8.683	9.093	11.777	16.065
4.60	5.971	6.140	6.316	6.513	6.732	6.974	7.240	7.531	7.848	8.193	8.569	11.008	14.849
4.70	5.690	5.847	6.010	6.193	6.396	6.620	6.865	7.134	7.426	7.743	8.088	10.311	13.767
4.80	5.428	5.574	5.726	5.896	6.084	6.292	6.519	6.767	7.037	7.329	7.646	9.679	12.798
4.90	5.183	5.320	5.461	5.619	5.795	5.987	6.198	6.428	6.678	6.948	7.240	9.104	11.929
5.00	4.955	5.082	5.215	5.362	5.525	5.705	5.901	6.114	6.345	6.595	6.865	8.578	11.145

Table 35.--Nonlinear Model Hydrographs ($S = kO^x$); x = 0.5; $k/\sqrt{AP_e/T}$ = 11.0

H/T	QT/APe D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	2.699	.682	.171	.076	.043	.027	.019	.014	.011	.008	.007	.003	.002
.20	29.925	12.359	4.662	2.091	1.182	.758	.528	.388	.297	.235	.191	.085	.048
.30	119.617	66.890	34.090	17.411	9.930	6.409	4.476	3.302	2.536	2.008	1.630	.729	.411
.40	302.460	201.749	126.015	75.662	46.016	30.029	21.131	15.674	12.088	9.605	7.816	3.522	1.995
.50	577.581	433.380	309.987	213.317	143.434	97.606	69.558	52.079	40.453	32.328	26.428	12.081	6.894
.60	802.711	691.696	560.953	431.087	320.421	234.018	172.222	130.715	102.621	82.717	68.111	31.834	18.381
.70	844.408	828.297	764.248	656.533	535.647	423.438	329.170	256.655	204.317	166.572	138.453	66.724	39.175
.80	762.824	806.064	820.992	787.261	707.312	605.183	502.021	409.217	333.375	275.437	231.533	115.878	69.508
.90	617.969	690.630	749.661	782.040	772.293	718.248	637.499	548.754	463.890	390.928	332.604	173.616	106.785
1.00	448.329	531.878	610.721	677.244	721.757	730.175	697.764	637.234	564.511	490.868	424.667	231.409	146.229
1.10	313.234	379.941	454.815	531.956	601.074	652.617	673.471	657.597	614.155	556.404	494.545	281.958	183.090
1.20	231.491	272.752	326.123	393.120	465.271	533.019	587.083	615.185	610.792	580.425	535.081	322.424	214.816
1.30	178.182	205.507	239.623	286.452	346.199	412.455	476.775	530.410	562.124	565.186	544.274	353.292	240.840
1.40	141.446	160.492	183.639	214.388	256.224	309.929	370.543	430.725	482.514	515.590	523.350	376.053	261.449
1.50	115.039	128.852	145.287	166.582	194.668	232.558	281.220	336.732	392.758	442.052	475.196	392.441	277.348
1.60	95.413	105.751	117.847	133.212	152.994	178.900	213.542	257.951	308.971	361.058	407.646	402.716	289.378
1.70	80.424	88.365	97.528	108.982	123.446	141.952	166.005	197.908	238.708	285.781	334.242	404.568	298.355
1.80	68.716	74.949	82.057	90.826	101.725	115.410	132.799	155.243	184.809	222.503	266.107	395.255	304.986
1.90	59.394	64.377	70.004	76.866	85.285	95.693	108.677	125.072	146.109	173.647	208.645	373.295	309.848
2.00	51.852	55.898	60.428	65.900	72.539	80.640	90.594	102.939	118.446	138.238	164.001	338.321	313.393
2.10	45.663	48.993	52.694	57.128	62.457	68.887	76.686	86.215	97.979	112.686	131.367	293.278	315.072
2.20	40.520	43.295	46.358	50.002	54.342	59.532	65.757	73.268	82.405	93.635	107.617	245.067	312.703
2.30	36.200	38.537	41.100	44.132	47.716	51.964	57.013	63.038	70.277	79.047	89.787	199.897	303.898
2.40	32.537	34.523	36.690	39.239	42.232	45.755	49.907	54.814	60.647	67.628	76.058	161.065	287.164
2.50	29.403	31.105	32.954	35.117	37.644	40.597	44.053	48.103	52.872	58.520	65.258	130.074	261.824
2.60	26.702	28.171	29.761	31.613	33.765	36.266	39.173	42.555	46.505	51.140	56.610	106.659	229.521
2.70	24.356	25.634	27.011	28.609	30.456	32.593	35.061	37.915	41.223	45.074	49.577	89.057	194.712
2.80	22.307	23.425	24.626	26.014	27.612	29.451	31.566	33.995	36.794	40.028	43.780	75.489	161.648
2.90	20.506	21.490	22.543	23.756	25.148	26.743	28.568	30.654	33.042	35.785	38.944	64.806	132.737

Table 35.—Nonlinear Model Hydrographs ($S = kO^x$); x = 0.5; $k/\sqrt{AP_e/T}$ = 11.0 — Continued

$\frac{H}{T}$	QT/AP_e												
	D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
3.00	18.915	19.785	20.714	21.781	23.000	24.392	25.978	27.782	29.837	32.182	34.867	56.245	109.192
3.10	17.502	18.275	19.099	20.042	21.116	22.339	23.725	25.296	27.077	29.098	31.400	49.278	90.986
3.20	16.242	16.932	17.666	18.503	19.455	20.534	21.754	23.130	24.683	26.438	28.425	43.531	76.990
3.30	15.113	15.732	16.388	17.136	17.982	18.939	20.018	21.230	22.593	24.126	25.855	38.735	65.999
3.40	14.098	14.655	15.244	15.914	16.671	17.524	18.482	19.556	20.758	22.105	23.618	34.691	57.208
3.50	13.182	13.685	14.216	14.819	15.498	16.261	17.117	18.072	19.138	20.328	21.659	31.249	50.067
3.60	12.352	12.808	13.289	13.833	14.444	15.131	15.897	16.751	17.700	18.757	19.934	28.296	44.186
3.70	11.599	12.013	12.449	12.942	13.495	14.114	14.803	15.569	16.419	17.362	18.408	25.742	39.284
3.80	10.912	11.290	11.687	12.135	12.636	13.196	13.819	14.509	15.272	16.116	17.050	23.519	35.155
3.90	10.285	10.630	10.993	11.401	11.857	12.365	12.930	13.553	14.241	15.000	15.838	21.573	31.646
4.00	9.710	10.027	10.358	10.731	11.147	11.610	12.123	12.689	13.311	13.996	14.750	19.858	28.637
4.10	9.182	9.473	9.777	10.119	10.500	10.923	11.390	11.905	12.470	13.090	13.771	18.340	26.038
4.20	8.696	8.964	9.244	9.558	9.907	10.294	10.722	11.191	11.706	12.269	12.886	16.990	23.778
4.30	8.247	8.495	8.753	9.042	9.363	9.719	10.110	10.540	11.010	11.523	12.084	15.784	21.800
4.40	7.833	8.062	8.300	8.567	8.863	9.190	9.550	9.944	10.374	10.843	11.354	14.702	20.058
4.50	7.449	7.661	7.882	8.128	8.402	8.704	9.035	9.397	9.792	10.221	10.689	13.727	18.518
4.60	7.092	7.289	7.494	7.723	7.976	8.255	8.560	8.894	9.257	9.652	10.080	12.846	17.149
4.70	6.761	6.944	7.134	7.347	7.581	7.839	8.122	8.430	8.765	9.128	9.522	12.048	15.926
4.80	6.452	6.623	6.800	6.997	7.215	7.455	7.717	8.002	8.311	8.647	9.009	11.322	14.829
4.90	6.164	6.323	6.489	6.672	6.875	7.098	7.341	7.606	7.892	8.202	8.537	10.659	13.842
5.00	5.895	6.044	6.198	6.370	6.559	6.766	6.992	7.238	7.504	7.791	8.101	10.053	12.951
5.10	5.643	5.782	5.927	6.087	6.263	6.457	6.668	6.896	7.143	7.410	7.697	9.497	12.142
5.20	5.407	5.537	5.673	5.823	5.988	6.168	6.365	6.578	6.808	7.056	7.323	8.986	11.408
5.30	5.185	5.308	5.435	5.575	5.730	5.899	6.083	6.282	6.496	6.727	6.975	8.516	10.738
5.40	4.977	5.092	5.211	5.343	5.488	5.647	5.819	6.005	6.205	6.421	6.652	8.081	10.125
5.50	4.781	4.889	5.001	5.125	5.262	5.410	5.572	5.746	5.933	6.135	6.350	7.679	9.563
5.60	4.596	4.698	4.804	4.921	5.049	5.188	5.340	5.503	5.679	5.867	6.069	7.306	9.047
5.70	4.422	4.519	4.618	4.728	4.849	4.980	5.122	5.276	5.441	5.617	5.806	6.959	8.572
5.80	4.258	4.349	4.443	4.546	4.660	4.784	4.918	5.062	5.217	5.382	5.559	6.637	8.133
5.90	4.102	4.188	4.277	4.375	4.482	4.599	4.725	4.861	5.007	5.162	5.328	6.337	7.727
6.00	3.955	4.037	4.121	4.213	4.315	4.425	4.544	4.672	4.809	4.955	5.112	6.056	7.350

Table 36.—Nonlinear Model Hydrographs ($S = kO^x$); x = 0.5; $k/\sqrt{AP_e/T}$ = 12.0

H/T	QT/AP_e D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.10	2.274	.574	.144	.064	.036	.023	.016	.012	.009	.007	.006	.003	.001
.20	25.422	10.459	3.934	1.762	.995	.638	.444	.327	.250	.198	.160	.071	.040
.30	103.028	57.227	28.998	14.759	8.400	5.414	3.778	2.785	2.138	1.693	1.373	.613	.346
.40	265.714	175.517	108.688	64.850	39.271	25.554	17.947	13.293	10.240	8.130	6.611	2.973	1.682
.50	519.651	385.407	272.690	185.965	124.172	84.073	59.698	44.577	34.553	27.568	22.506	10.245	5.833
.60	741.847	630.885	505.380	384.179	282.901	205.088	150.086	113.427	88.749	71.355	58.611	27.198	15.643
.70	802.629	776.297	706.779	599.890	484.171	379.187	292.545	226.739	179.640	145.894	120.851	57.611	33.621
.80	743.450	775.582	779.600	738.058	655.397	554.963	456.217	369.097	298.866	245.699	205.630	101.409	60.312
.90	616.265	680.389	729.578	751.525	733.096	674.303	592.656	505.802	424.562	355.662	301.054	154.335	93.885
1.00	458.485	536.390	608.163	666.088	701.072	700.948	662.866	599.853	527.222	455.390	391.766	209.184	130.471
1.10	328.415	392.699	463.628	535.011	596.796	639.974	652.903	631.235	584.556	525.754	464.448	259.180	165.868
1.20	247.055	288.042	340.135	404.223	471.759	533.390	580.240	601.302	591.429	557.618	510.646	301.051	197.537
1.30	192.708	220.463	254.645	300.659	358.231	420.784	479.994	527.501	553.036	551.110	526.853	334.462	224.556
1.40	154.570	174.250	197.909	228.850	270.161	322.172	379.757	435.658	482.191	509.865	513.170	306.209	246.816
1.50	126.763	141.230	158.292	180.112	208.454	245.986	293.298	346.300	398.674	443.405	471.832	379.553	264.657
1.60	105.856	116.804	129.519	145.489	165.789	191.973	226.373	269.688	318.577	367.494	410.102	392.602	278.669
1.70	89.737	98.224	107.955	119.998	135.041	154.043	178.385	210.129	250.013	295.238	340.927	397.179	289.508
1.80	77.045	83.758	91.372	100.680	112.141	126.372	144.236	166.974	196.432	233.338	275.323	390.684	297.795
1.90	66.871	72.273	78.343	85.688	94.621	105.558	119.060	135.911	157.237	184.698	219.010	371.647	304.078
2.00	58.592	63.002	67.920	73.817	80.917	89.505	99.960	112.798	128.739	148.807	174.515	339.645	308.811
2.10	51.762	55.410	59.451	64.257	69.993	76.860	85.122	95.130	107.361	122.476	141.422	297.380	311.532
2.20	46.061	49.114	52.475	56.444	61.146	66.722	73.365	81.319	90.910	102.581	116.949	251.333	310.251
2.30	41.254	43.834	46.659	49.976	53.878	58.469	63.890	70.316	77.977	87.177	98.335	207.531	302.732
2.40	37.163	39.362	41.760	44.560	47.834	51.660	56.142	61.409	67.624	75.006	83.845	169.340	287.520
2.50	33.651	35.542	37.595	39.980	42.753	45.976	49.724	54.096	59.209	65.221	72.343	138.414	263.902
2.60	30.615	32.253	34.023	36.072	38.441	41.181	44.348	48.016	52.274	57.238	63.059	114.686	233.337
2.70	27.972	29.400	30.938	32.710	34.751	37.100	39.799	42.907	46.490	50.636	55.457	96.590	199.976
2.80	25.658	26.910	28.254	29.798	31.569	33.597	35.917	38.573	41.617	45.116	49.153	82.471	167.883
2.90	23.619	24.723	25.905	27.258	28.804	30.568	32.577	34.865	37.473	40.452	43.867	71.241	139.465

Table 36.--Nonlinear Model Hydrographs ($S = kO^x$); x = 0.5; $k/\sqrt{AP_e/T}$ = 12.0 -- Continued

$\frac{H}{T}$	QT/APe D=Inst.	D/T=0.1	D/T=0.2	D/T=0.3	D/T=0.4	D/T=0.5	D/T=0.6	D/T=0.7	D/T=0.8	D/T=0.9	D/T=1.0	D/T=1.5	D/T=2.0
3.00	21.814	22.793	23.838	25.030	26.388	27.931	29.682	31.667	33.918	36.476	39.390	62.162	116.011
3.10	20.209	21.080	22.008	23.064	24.263	25.622	27.157	28.890	30.847	33.059	35.566	54.717	97.612
3.20	18.775	19.554	20.382	21.322	22.386	23.587	24.941	26.463	28.175	30.101	32.274	48.535	83.276
3.30	17.488	18.187	18.929	19.769	20.718	21.786	22.985	24.330	25.836	27.523	29.418	43.346	71.887
3.40	16.329	16.959	17.627	18.381	19.230	20.184	21.251	22.444	23.776	25.263	26.926	38.947	62.687
3.50	15.281	15.852	16.454	17.133	17.897	18.752	19.707	20.770	21.954	23.270	24.737	35.186	55.151
3.60	14.332	14.849	15.395	16.009	16.698	17.467	18.324	19.277	20.333	21.505	22.806	31.944	48.898
3.70	13.468	13.939	14.435	14.992	15.615	16.310	17.083	17.939	18.886	19.933	21.091	29.132	43.652
3.80	12.680	13.110	13.562	14.068	14.635	15.265	15.963	16.735	17.588	18.527	19.564	26.675	39.207
3.90	11.959	12.353	12.765	13.228	13.744	14.317	14.950	15.649	16.419	17.265	18.196	24.516	35.409
4.00	11.298	11.659	12.037	12.461	12.932	13.454	14.031	14.666	15.363	16.128	16.967	22.610	32.138
4.10	10.690	11.023	11.370	11.758	12.190	12.667	13.194	13.772	14.406	15.099	15.859	20.917	29.300
4.20	10.130	10.437	10.757	11.113	11.510	11.948	12.429	12.957	13.535	14.166	14.856	19.408	26.822
4.30	9.613	9.896	10.192	10.520	10.885	11.287	11.729	12.213	12.741	13.317	13.945	18.057	24.646
4.40	9.135	9.397	9.670	9.974	10.310	10.681	11.087	11.531	12.015	12.542	13.115	16.842	22.725
4.50	8.691	8.934	9.187	9.468	9.779	10.121	10.496	10.905	11.350	11.833	12.358	15.745	21.020
4.60	8.279	8.505	8.740	9.001	9.289	9.605	9.951	10.328	10.738	11.182	11.664	14.753	19.500
4.70	7.896	8.106	8.324	8.567	8.834	9.127	9.448	9.796	10.174	10.584	11.027	13.851	18.139
4.80	7.539	7.735	7.938	8.163	8.412	8.684	8.981	9.304	9.654	10.032	10.441	13.030	16.916
4.90	7.205	7.388	7.578	7.788	8.019	8.273	8.549	8.848	9.173	9.522	9.900	12.279	15.812
5.00	6.893	7.064	7.242	7.438	7.654	7.890	8.147	8.425	8.726	9.051	9.400	11.592	14.813
5.10	6.601	6.761	6.927	7.111	7.312	7.533	7.772	8.032	8.312	8.613	8.937	10.961	13.906
5.20	6.327	6.477	6.633	6.805	6.993	7.200	7.423	7.665	7.926	8.207	8.508	10.380	13.080
5.30	6.070	6.211	6.357	6.518	6.695	6.888	7.097	7.323	7.567	7.828	8.109	9.844	12.325
5.40	5.828	5.961	6.098	6.249	6.415	6.596	6.792	7.004	7.231	7.475	7.737	9.348	11.634
5.50	5.600	5.725	5.854	5.997	6.153	6.322	6.506	6.705	6.918	7.146	7.390	8.889	11.000
5.60	5.385	5.503	5.625	5.759	5.906	6.065	6.238	6.424	6.624	6.838	7.066	8.463	10.415
5.70	5.183	5.294	5.409	5.535	5.674	5.824	5.986	6.161	6.349	6.549	6.763	8.067	9.877
5.80	4.992	5.097	5.205	5.325	5.455	5.596	5.749	5.914	6.090	6.278	6.479	7.698	9.379
5.90	4.811	4.910	5.013	5.125	5.248	5.382	5.526	5.681	5.847	6.024	6.213	7.354	8.918
6.00	4.640	4.734	4.831	4.937	5.054	5.180	5.316	5.462	5.618	5.785	5.962	7.032	8.489

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