TR-20

COMPUTER PROGRAM

FOR

PROJECT FORMULATION

HYDROLOGY

Revised by

The Hydrology Unit and The Technology Development Support Staff

Soil Conservation Service

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TECHNICAL RELEASE 20
COMPUTER PROGRAM FOR PROJECT FORMULATION
HYDROLOGY

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CHAPTER 1. INTRODUCTION

This chapter describes the Soil Conservation Service (SCS) Computer Program for Project Formulation, Hydrology (TR-20) in terms of the purpose, computer requirements, operation, and availability of the program. The remaining chapters describe in detail: the program methodology, organization, capabilities, limitations, and data structure; input preparation; and output description and use. The appendices contain a sample job showing five progressive levels of complexity, blank input worksheets, and associated utility programs for input and data checking.

1.1 PROGRAM PURPOSE

The TR-20 computer program assists the engineer in hydrologic evaluation of flood events for use in analysis of water resource projects. The program is a physically based event model which computes direct runoff resulting from any synthetic or natural rainstorm. There is no provision for recovery of initial abstraction or infiltration during periods of no rainfall within an event.

The program develops flood hydrographs from runoff and routes the flow through stream channels and reservoirs. Routed hydrographs are combined with those from tributaries. Procedures for hydrograph separation by branching or diversion of flow and for adding baseflow are provided.

The program uses procedures described in the SCS National Engineering Handbook, Section 4, Hydrology (NEH-4) except for the reach flood routing procedure. The reach routing is described in Hydrology Note 2.

Peak discharges, their times of occurrence, water surface elevations and duration of flows can be computed at any desired cross section or structure. Complete discharge hydrographs, as well as discharge hydrograph elevations, can be obtained if requested. The program provides for the analysis of up to nine different rainstorm distributions over a watershed under various combinations of land treatment, floodwater retarding structures, diversions, and channel modifications. Such analysis can be performed on as many as 200 subwatersheds or reaches and 99 structures in any one continuous run.

The program was originally developed by the Hydrology Branch

of the Soil Conservation Service (SCS) in cooperation with the Hydrology Laboratory, Agricultural Research Service (ARS), through a contract with C-E-I-R, Inc. Numerous modifications and additions have been made since by the SCS.

1.2 COMPUTER REQUIREMENTS.

TR-20 is written in FORTRAN 77 computer language for an IBM compatible microcomputer with a PC-DOS or MS-DOS operating system. It was compiled using the Microsoft FORTRAN Compiler to run either with or without a math coprocessor. Use with a math coprocessor is strongly recommended to speed up execution.

The program requires about 320 kilobytes of available memory. Floppy disk systems are adequate for small TR-20 runs, but for larger runs the program and output should be stored on a hard disk. About .5 to 1 megabyte of storage space should be available to load and execute an average run.

1.3 PROGRAM OPERATION

Before operating TR-20 on a microcomputer be sure to read the instructions on setting up and loading the program in the README file. This file is on the program diskette. The file also contains any last minute changes that didn't make this manual. The system error "Too many open files" will occur if not enough files and buffers are opened in your config.sys file upon booting the system. At least 15 files and 15 buffers are recommended.

There are two ways to run TR-20, interactively and by a batch file. The interactive procedure is explained first in the sections below. The alternate batch file procedure that follows can be used when it is desirable to run jobs unattended, such as jobs run back to back overnight.

Initiating a Run

To execute the program, enter TR20 preceded by the proper DOS path, and press return. Once the program is loaded, the organization or individual responsible for support of the program, the program title, version date or number, and a disclaimer will appear on the screen.

Next, you will be asked three questions to be answered with Y (yes) or N (no). The first asks if you want a listing of input as part of the output. The second asks if you want the page of user notes with the output. The user notes contain information for new users and lists important program changes between versions. The third question asks if you want to write all warnings and messages to a separate file rather than have them appear as part of the regular output.

A note on who to contact if you have questions or comments on the program will be displayed following the three questions. The program title and version identification is then repeated.

These screens are shown in Appendix B, pg. B-8 and B-9.

Disk Space

An important disk space warning is displayed next. Sufficient disk space for temporary and output files must be provided for a successful run. The amount of space depends on the amount of input data and the number and type of output files and options selected in the input file.

If TR-20 is loaded and run from a hard disk, the default drive directory you execute the program from will need space (usually 50 to 100 K) for internal temporary files. These files will be automatically erased at the normal termination of a job. If any temporary files remain in the directory from aborted jobs (their names start with ZZ), they should be erased to save disk space. Input files can be entered from any drive and directory, including a floppy disk. The output data, if sent to a file, can be directed to any drive and directory with space available. All other optional output files (which include ECON2, READHD, Messages, and graphics files) can also be written to any drive and directory, so additional space must be available in the location selected.

If TR-20 is loaded and run from a floppy disk, when the space warning appears, the program disk must be replaced with an input data or scratch disk with adequate space for the temporary files. Space must also be provided on the replacement disk for the generated output files. If not replaced, the job usually aborts due to lack of space.

If it is apparent that not enough disk space will be available, the run can be stopped by using the CONTROL-BREAK keys. After adequate space is provided the run can be restarted.

Input File

After the disk space warning, a prompt appears on the screen for the input drive ID and input file name. The response must include the path, the drive and directory needed to access the input file unless the file is on the default drive. If the specified input file does not exist in the given location, the input prompt will reappear.

Output Device or File

The next screen prompt is for the primary output device or file name. The output can be sent directly to an attached printer, the display screen, or to a file.

The recommended choice is to assign a file name, complete with drive and directory (path) as needed. If the uses enters a carriage return, the program will assign a default file name consisting of the path and prefix of the input file, with the extension changed to "out". The program will execute quickly and the output file can be reviewed on the screen or printed if needed later.

The "CON" option will slow the execution somewhat as the output data will scroll past on the screen. Depending on the computer system the scroll may be stopped by the SCROLL LOCK or CONTROL-S keys to review the output, but nothing will be saved. Program status messages sent to the screen during execution will not be displayed with the "CON" option.

The "PRN" option prints the output directly to an attached printer. This usually slows the program execution. Both "CON" and "PRN" are device system names that may vary with the computer system.

Generated Files

The files generated as part of the output are named automatically by the program depending on your answer to the next question. The program asks for the output drive ID and file name prefix for all the generated files. If an output file name has been assigned, the default has the same location and prefix as this. If the user wishes to use a different drive ID and prefix, these must be specified. The question will not be asked, however, if the output data is sent directly to the screen or to the printer. In these cases, the generated files will be automatically assigned to the input file prefix and location.

Table 1-1 lists all temporary and generated files that are used by the program. The generated files use the user's file prefix and an extension assigned by the program. If generated ECON2, READHD, Messages, or graphics files with those names already exist, using the same file prefix from a previous run, the files will be written over.

All the files in Table 1-1 are opened when the program is executed. However, only generated files with the proper input options given are saved at the end of a job. See Table 3-7-1 (p. 30) for required input options to save generated files. All temporary and unused files are deleted at the normal end of the job.

TABLE 1-1. TR-20 PROGRAM FILE DESCRIPTIONS

UNIT	TYPE	NAME 1/ ASSIGNED	RECORD LENGTH	DESCRIPTION
1	temp.	---	67	Temporary storage for Summary Table 2 data.
	or 2/ graphics	"prefix".TS2	67	Condensed REACH output data.
2	temp.	---	80	Current Standard Control data.
3.	ECON2	"prefix".TEC	80	Output data for ECON2 after merge of units 7 & 8.
4	temp.	---	67	Temporary storage for Summary Table 1 data.
	or 2/ graphics	"prefix".TS1	67	Condensed output for Summary Table 1 data.
5	read	---	80	Standard input unit for reading.
6	print	---	80	Standard output unit for printing.
7	temp.	---	80	Temporary flow duration data for ECON2 before merge.
8	temp.	---	80	Temporary peak flow data for ECON2 before merge.
9	READHD	"prefix".TRD	80	Output for saved tabular READHD data.
10	warnings and messages	"prefix".TMG	80	Optional listing of TR-20 warnings and messages.
11	graphics	"prefix".TFD	51	Condensed output for flow duration data.
12	graphics	"prefix".THY	71	Condensed output for hydrograph data.

1/ Automatically uses "prefix" of users choice from input or output filename.
2/ Used as graphics file if GRAPHICS option is on JOB record.

The graphics files are ASCII files containing run identification and preselected detailed output data in condensed tabular format. Separate files can be used to save peak, reach, flow duration and hydrograph information. A separate utility program is needed to plot the information. SCS has developed a prototype plotting program for this purpose that uses proprietary Graphics Kernel System (GKS) software.

Alternate Batch File Procedure

In order to avoid having to enter the above information interactively, a batch processing procedure is available. It requires a data file named AUTOTR20.DAT to be set up in the same directory as the TR-20 program.

The AUTOTR20.DAT data file must contain the answers only to the six items in the following order:

1. Listing of input data desired? Y or N
2. Include the user notes? Y or N
3. Include warnings and messages? Y or N
4. Complete input file path and name.
5. Complete output file path and name or device.
6. Complete output file path & prefix name for all generated files.

Question six does not need to be included if the answer to item five is PRN or CON. Each answer must be on a separate record (line).

If the AUTOTR20.DAT file exists, it will be used automatically. If it doesn't exist, interactive keyboard input is required. When switching from batch to interactive processing, be sure the file is deleted or the answers are deleted.

Run Time Messages

The status of the computations is displayed on the screen when the output is directed to a file or printer. The current cross section or structure number, alternate and storm being processed will flash on the screen until it is completed. This information is displayed in the order of input in the Standard and Executive Controls until the job is terminated and the program returns to the DOS Operating System.

Error or warning messages from the program will not show up on the screen when the output is directed to a file or printer or if the message file has been requested. The user must examine the output and the message file if requested to determine if the job ran correctly. Only operating system errors will be displayed on the screen.

Running Multiple TR-20 Jobs

Sometimes it is desirable to handle more than one job in the same run. This can only accomplished by inserting the complete sets of input data for the jobs back to back under the same input file name. After completing a job or ending it on a fatal error, the program will search for the start of another job. If it doesn't find another job, the run will end. The entire output of all the jobs will be included in the initial output file names given.

1.4 PROGRAM AVAILABILITY

The TR-20 executable program and user manual may be obtained by non-federal users from the National Technical Information Service. The program and associated utility programs are supplied on diskettes.

The program and user manual are available from:

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22161
(703 - 487-4650)

The program is available to Federal Government agencies from:

Engineering Division
Soil Conservation Service
P.O. Box 2890
Washington, D.C. 20013

The program is usually available to state and local public agencies by contacting the SCS State Conservationist in the state where the agency is located.

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CHAPTER 2. PROGRAM DESCRIPTION

This chapter provides an understanding of the TR-20 computer program organization and features. Terminology and acronyms used solely for this computer program are defined the first time they are used and in the Glossary. Terminology in general use by engineers is not defined.

To use this program effectively, an understanding of the procedures described in SCS National Engineering Handbook, Section 4 (hereafter referred to as NEH-4) is suggested.

2.1 METHODOLOGY FOR HYDROLOGY AND HYDRAULICS

Subwatershed Delineation

The watershed should be divided into as many subwatersheds as required to define hydrologic and alternative structural effects. Hydrologic effects are influenced by entrance of tributaries, watershed shape, valley slope changes, homogeneity of the runoff curve number and existing or proposed water impoundment structures. Each subwatershed is assumed to be hydrologically homogeneous and should not have an area greater than 25 square miles. See Chapter 6, NEH-4.

Rainfall Distribution

Either actual or synthetic cumulative rainfall distributions may be used. Rainfall distributions (time versus cumulative depth) must be representative of the watershed area under study. This could be by individual subwatersheds or the entire watershed.

Runoff Volume

A mass curve of runoff is developed for each subwatershed. The runoff curve number (CN), rainfall volume, and rainfall distribution are the input variables needed to determine this mass curve. Average antecedent runoff condition CN's are determined by the user for each subwatershed based on soil, land use, and hydrologic condition information, as described in Chapters 7, 8, and 9, NEH-4.

The runoff volume (Q) in inches is computed using the SCS runoff equation outlined in Chapter 10, NEH-4. If the user requests, the CN will be adjusted for the low or high antecedent runoff condition (ARC) according to Table 10.1, NEH-4. If the user needs to adjust the runoff volume within

these ARC's, either the CN's or rainfall will need to be adjusted.

Hydrograph Development

An incremental unit hydrograph is developed for each subwatershed similar to the procedure shown in Chapter 16, NEH-4. The unit hydrograph time increment (delta D) is calculated to preserve both the peak discharge and total hydrograph volume if possible. Initially, delta D is set to the smaller of 0.1333 of the time of concentration (Tc), the rainfall time increment, or the main time increment specified by the user. Then to preserve the peak, delta D is adjusted to coincide with the peak time of the unit hydrograph. If the program limit of internal time increments (1200) is exceeded, delta D is further adjusted to preserve the total volume. If the initial delta D is greater than the unit hydrograph peak time, the volume can be truncated.

Coordinates of the incremental unit hydrograph are determined as shown in Example 1, Chapter 16, NEH-4 using delta D, Tc, and the drainage area. The incremental runoff is determined for each delta D. The composite flood hydrograph is computed by summing the incremental hydrograph ordinates as shown in the same example.

After the composite flood hydrograph has been generated at the internal delta D time increments, it is saved at the main time increment starting with the beginning of runoff. A maximum of 400 discharge coordinates at the main time increment can be stored for any composite flood hydrograph. The original hydrograph based on the internal delta D is not saved.

The peak flow value of the composite flood hydrograph is computed by a separate routine that utilizes the Gregory-Newton forward difference formula for fitting a 2nd degree polynomial through the three largest consecutive hydrograph values saved at the main time increment (Wylie, p. 94). In multiple peaked hydrographs up to ten peaks may be computed.

The primary concern when selecting the main time increment is to provide an adequate definition of the hydrograph. The main time increment should be about 0.1 to 0.2 of the shortest subwatershed Tc for the best hydrograph definition. Ratios of 0.3 to 0.5 may be acceptable for occasional subwatersheds with small Tc's within the system of larger subwatersheds. Hydrograph definition decreases when the time increment is larger than this range of values due to the shape of the unit hydrograph and the rainfall time increment.
Generally, the main time increment need not be smaller than 0.05 to 0.1 hour.

Several other factors must be considered by the user when selecting the main time increment. The user must consider the

longest duration hydrograph, with respect to time, that is developed during the analysis of a watershed. For example, if a ten day outflow hydrograph is needed, a main time increment of 0.6 hour would provide the necessary 240 hours (400 coordinates x 0.6 = 240). However, for a small watershed with a time of concentration of 0.25 hour, a main time increment of no more than 0.1 hour is needed to define the composite hydrograph. The user must also consider, when selecting the main time increment, how much of the hydrograph volume at the end of the watershed is needed to develop the peak outflow. The maximum of 400 coordinates applies to all hydrographs that are generated by the operations in the program.

Only one main time increment should normally be used in any one pass through the watershed. The use of multiple time increments in a single pass through a watershed requires some care to ensure that the time increments increase downstream. They may decrease if the calculations begin at the headwaters of a tributary, but should then increase again for downstream subwatersheds.

Reservoir Routing

The composite flood hydrograph is routed through a reservoir using the Storage-Indication method as described in Chapter 17, NEH-4. The working curve is not used; instead the working equation is solved during a process in which interpolations are made in the elevation-discharge-storage data for the structure. The starting elevation for routing or the pool elevation when runoff begins must be specified by the user.

The main time increment is used as the routing time interval. Abrupt changes in the discharge-storage curve may require a smaller main time increment to obtain a satisfactory outflow hydrograph than that needed for hydrograph development.

The outflow hydrograph in cfs and/or elevation can be printed at multiples of the main time increment (subject to the 400 point limit). The peak discharges and associated elevations are determined using the peak flow routine described in the previous Hydrograph Development section.

Reach Routing

The composite flood hydrograph is routed through a valley reach using a Modified Attenuation-Kinematic (Modified Att-Kin) method as described in Hydrology Note 2. The routing time interval is the main time increment. The routing reach length (L) is specified by the user. Separate channel and valley reach lengths are permitted. The main time increment and the reach lengths must be chosen to provide routing parameters within the limits of the procedure to obtain a satisfactory outflow hydrograph.

The routing coefficient is developed from the valley storage-discharge curve ($Q = kS^m$, where Q = discharge, S = valley storage and "k" and "m" are the coefficient and exponent of the relationship) that represents the reach and the maximum inflow hydrograph peak discharge and volume. The user must provide either a cross section rating curve (Q vs. A, where A = cross sectional area) or the "x" and "m" values which describes a rating curve ($Q = xA^m$, where A = S/L).

Flow Duration

When a flood hydrograph is selected for a flow duration analysis, the hydrograph discharge points based on the main time increment are sorted in a temporary array from highest to lowest. The discharge associated with a given duration is then interpolated from this array. This approximate procedure is accurate within discharges associated with one time increment. The advantage of the procedure is that only one interpolation is required for each duration and the hydrograph can contain any number of multiple peaks.

Up to 12 durations are automatically selected by the program to define the flow duration characteristics of the flood hydrograph based on its total duration above baseflow. The durations and associated discharges selected for display are determined by the following:

Maximum hydrograph	Incremental duration
24 hours or less	2 hours
over 24 to 36 hours	3 hours
over 36 to 48 hours	4 hours
over 48 to 72 hours	6 hours
over 72 to 96 hours	8 hours
over 96 to 144 hours	12 hours
over 144 hours	24 hours

The last duration in the display is set by the greater of constant baseflow or zero discharge. Checks are made for shorter, truncated, and still rising hydrographs. If a zero damage elevation is given, the zero damage discharge duration is noted.

If SCS ECON2 Computer Program output is requested for a flood duration damage analysis, three user selected durations can be entered. Discharges associated with these durations are directly interpolated from the temporary sorted hydrograph array at the same time as the automatically selected durations. Checks or limits on the three ECON2 durations include shorter, truncated, and rising hydrographs, as well as baseflow.

2.2 PROGRAM ORGANIZATION

A brief description of the functions of the program and of some of its characteristics will help to better understand the organization of the program operations and the instructions for the preparation of input data. A simplified processing sequence for TR-20 is given in Figure 2-1. It shows the sequence in which the various major functions are performed.

Input data described on input data sheets or in a separate input program can be entered at a computer terminal. Input data can be tabular data (structure data, stream cross section data, cumulative rainfall data, and dimensionless hydrograph data), Standard Control data, and Executive Control data. Briefly, the Standard Control data are used to describe the physical watershed conditions and the Executive Control data are used to describe the meteorological conditions and to control processing.

2.3 CAPABILITIES AND LIMITATIONS

Any one TR-20 job can:

1. Route through up to 99 structures and an unlimited number of variations for each structure.

2. Route through up to 200 stream reaches and an unlimited number of channel modifications for each reach.

3. Develop composite flood hydrographs each based on maximum of 1200 internal (delta D) time increments before conversion to the main time increment.

4. Save flood hydrographs at selected points in a watershed and print out the discharge and elevation for each coordinate. Hydrographs are saved with up to 400 main time increment coordinates, beginning at the start of runoff.

5. Store up to seven computed flood hydrographs at any one time.

6. Do as many as 99 alternates in a watershed, and ten different storms for each alternate with variations in rainfall amounts, rainfall starting times and duration, and antecedent moisture condition.

7. Develop and route the runoff from as many as 9 different rainfall distributions. Storm runoff depths and durations are defined in either dimensionless or actual units.

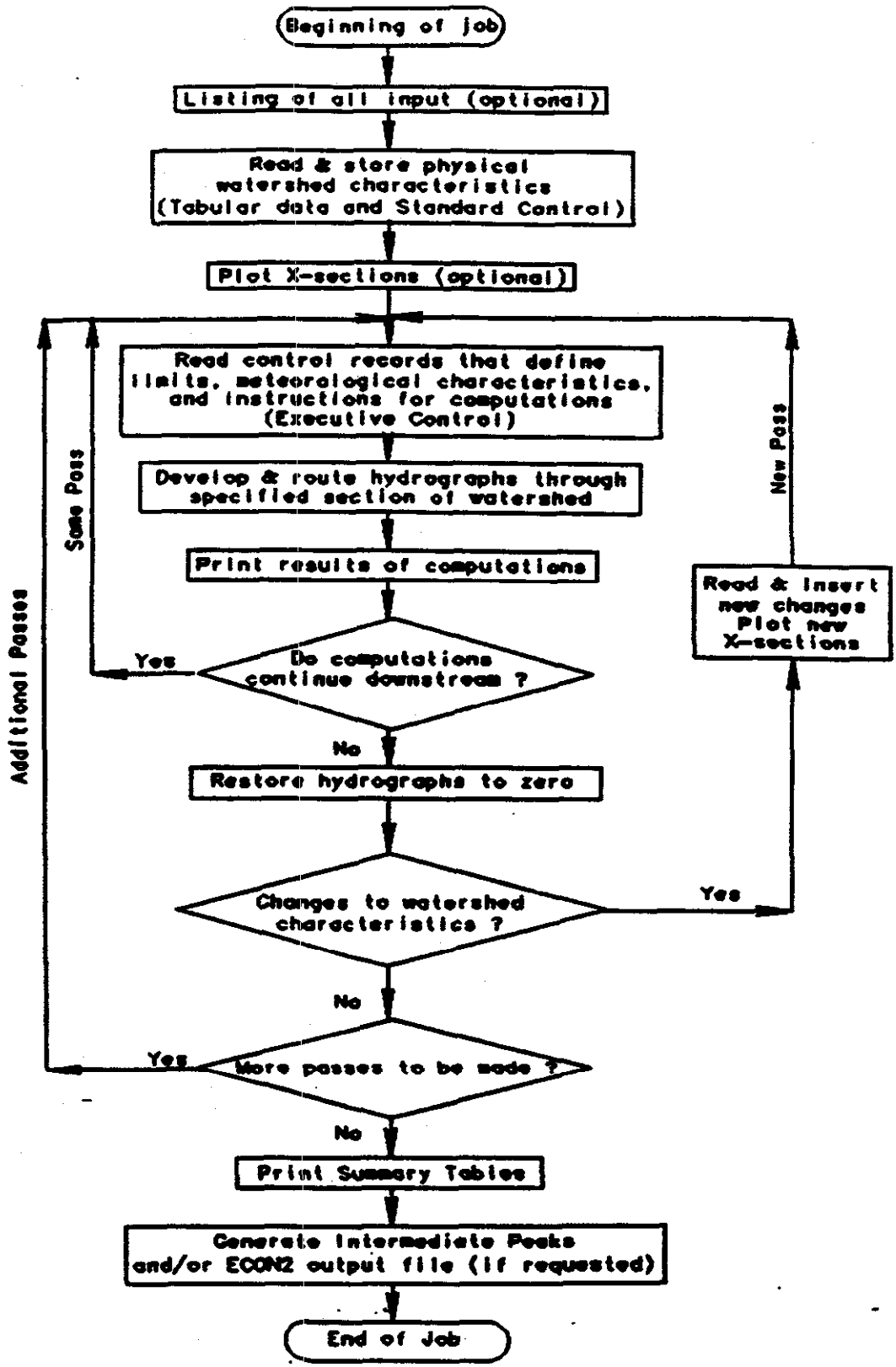

Figure 2-1. Simplified Processing Sequence in TR-20

8. Combine hydrographs from an almost unlimited number of tributaries and reaches (the limitation being the total number of Standard Control operations).

9. Divide flood hydrographs into two separate hydrographs.

10. Enter flood discharge hydrographs and route them through a watershed.

11. Compute up to 12 flow duration values for a flood hydrograph.

The only restriction to those items described as being unlimited is the processing cost and the practicability of dealing with too much output data.

As a limitation the program does not provide for losses of runoff in the transmission of the flood hydrograph due to seepage or other causes of flood water loss.

A further limitation of 600 Standard Control records will be described in Section 3.6. There is also a limit of 24,000 peaks that can be displayed in the Summary Tables. The number of peaks is equal to the product of the number of storms, the number of alternates, and the sum of the number of cross sections and the number of structures: Number of Peaks = (Storms x Alternates x (Cross Sections + Structures)).

The current program has been developed with strict adherence to a policy of having it:

(1) as flexible as possible with a minimum of change in the presentation and use of input data from previous versions;

(2) provide for the maximum use of engineering judgment;

(3) engineer oriented rather than machine oriented; and

(4) written in the FORTRAN 77 language to provide for ease in future extensions, alterations, and recompilation for other computer hardware.

The input data worksheets are in a user oriented format with headings familiar to field engineers. The program output is arranged for ease in reading and is identified with notations consistent with SCS publications. No effort was made to save processing time at the expense of engineer time.

A complete TR-20 run for an average watershed can be processed within 3-4 minutes on a microcomputer. However, the processing time and total cost is increased each time an error in input data has to be searched out, corrected, and the data

returned to the computer. To reduce costs due to errors, the input and data check programs should always be used to enter and check a new or revised set of input data. See Appendix H.

2.4 INPUT DATA STRUCTURE

The input data for a TR-20 run consists of the following six general record types: Job Control, Tabular Data, Standard Control, Executive Control, Modify Standard Control and Intermediate Peaks.

The Job Control records are JOB, up to two titles, and ENDJOB. In a run, the JOB and TITLE records must appear first and the ENDJOB record must appear last.

The Tabular Data, which follows the TITLE records can be subdivided into the following types of data: Flow Duration Increments for ECON2, Structure, Stream Cross Section, Cumulative Rainfall, Dimensionless Hydrograph, and Read Discharge Hydrograph. For example, one of the operations in the program may require a hydrograph to be routed through a specific structure. In order to perform this function, the computer will recall the Structure Data Table as the necessary input for routing through the particular structure.

The Standard Control records describe the hydrologic configuration of the watershed. They prescribe the exact sequence in which hydrographs are to be developed for subwatershed areas, routed through structures and stream reaches and combined at tributary junctions and ends of reaches. The Standard Control thus establishes a series of consecutive steps through which any number of hydrologic events can be routed for analysis. The ENDATA record is used to signify the end of the Standard Control and precedes the Executive Control records.

The Executive Control records: (1) initiate and control the computational process, (2) provide baseflow data, and (3) describe the meteorological characteristics of each situation to be applied to the watershed. This includes rainfall depth, duration and distribution, baseflow, and the portion (all or part) of the watershed to be analyzed, including structures through which the storm is to be routed. The ENDCMP record is used to signify the end of a pass through a watershed or a group of subwatersheds thereby allowing meteorological and tabular conditions to be changed by the user before further processing.

After initial computational passes through the watershed, the Modify Standard Control records may be used to modify the Standard Control. This may be done to describe an alternative watershed situation to be analyzed. This includes changing subwatershed data and the sequence of computation. Executive Control records must then be provided for subsequent analysis.

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CHAPTER 3. INPUT PREPARATION

3.1 MINIMUM DATA REQUIREMENTS

TR-20 can handle complex as well as very simple problems such as developing the hydrograph for one watershed. Analysis of a simple problem can be set up with as few as ten records, including data. An example of the required types of input data for a small watershed is summarized in Table 3-1.

Table 3-1. EXAMPLE INPUT DATA FOR SMALL WATERSHED

Type of Data	Example
For each subwatershed (at least one required):	
drainage area - sq. mi.	1.2 sq. mi.
runoff curve number	75.
time of concentration - hours	0.33 hours
To develop a flood hydrograph:	
rainfall (required)	
antecedent runoff condition	2
rainfall depth - inches	5.2 inches
rain table number (table defined in program)	2
main time increment for hydrograph, etc.	0.1 hours
For each valley reach:	
length of reach (channel and/or valley)	5400. feet
cross section data (elevation, discharge, and end area)	table*
or rating curve coefficients "x" and "m"	0.5, 1.3
For each structure:	
elevation, discharge, and storage	table*

* Where "table" is given, the input is a complete table consisting of at least three lines of data.

3.2 INPUT PREPARATION AND WORKSHEETS

A blank form for listing each type of input data is included in Appendix G. Each 80-column line of data on the form is a record with data fields to be entered at a computer terminal. The 80 columns across the top of the form represent the 80 positions on a record. A data field is a column or group of columns denoting specific data in a record. Different record types perform specific operations. The ordering of the Standard Control records determines the sequence in which the operations are to be performed. There can be up to 600 Standard Control records for each TR-20 job.

The "Data Code" heading (Input forms, Appendix G, Columns 2), indicates the type of data on that record. For example "8" signifies that the line contains tabular data. The data code is a required entry and is preprinted on the tabular worksheets. The TR20INPT program described in Appendix H automatically inserts the appropriate data code.

An "Operation Name" appears in Columns 4 through 9 of all records except those containing tabular data. These names identify for the user the type of operation performed or type of data entered. The digit in column 11 is the "Operation Number" and identifies the type of operation. It must be entered unless it is a blank. The rest of the entry on each line is described in the following sections, except for the optional record identification datafield in Columns 73 to 80 which is on all records.

Great care should be taken to assure that <u>decimal points are included</u> in all of the real number data fields (see Section 3.6). Omission of these decimal points is the most common source of error. Commas must not be used for any reason in numeric data; for example, to signify thousands.

When using the worksheets to enter data, preprinted data must be crossed out on all unused lines. Blank lines are not allowed in the input data. A list of TR-20 input data forms is given in Table 3-2. Brief instructions for the preparation of input data are printed on each form.

Schematic drawings, computer listings of input data, and computer output for five sample jobs are shown in Appendices B through F. The program's initial computer screens and completed input data sheets are only shown for the first sample job in Appendix B.

Table 3-2. LIST OF TR-20 INPUT DATA WORKSHEETS

Form Title - Record Types*	Worksheet Number (SCS-ENG)	Appendix G Page No.
Job and Title - JOB, TITLE	264	G-2
Dimensionless Hydrograph Table - 4 DIMHYD	265**	G-7**
Structure Data - 3 STRUCT	269	G-6
Stream Cross Section Data - 2 XSECTN	270	G-5
Cumulative Rainfall Tables - 5 RAINFL	271**	G-9**
Flow Duration Increment Table - 1 DURINC	272	G-4
Standard Control for Watershed - 6 RUNOFF 1, 6 RESVOR 2, 6 REACH 3, 6 ADDHYD 4, 6 SAVMOV 5, 6 DIVERT 6, ENDATA	273 & 273A	G-16 G-18
Executive Control - 7 LIST, 7 BASFLO 5, 7 INCREM 6, 7 COMPUT 7, ENDCMP 1, ENDJOB 2	274 & 274A	G-19 G-21
Modify Standard Control - 7 INSERT 2, 7 ALTER 3, 7 DELETE 4	275	G-22 G-23
Read Discharge Hydrograph - 7 READHD 8, 7 READHD 9	276	G-24
Intermediate Peaks - IPEAKS, PEAKS	277	G-25

* Record types are identified by their unique data code, operation name, and operation number.

** Standard Tables are preloaded in the program. However, the user may override them by entering another DIMHYD or a RAINFL table with the same number. The preloaded standard tables are listed in Appendix G after the worksheet to which they apply.

Preparation of input data prior to filling out worksheets can be divided into the following requirements and functions:

1. Prepare a schematic drawing (section 3.5) for the watershed that conveniently identifies the subwatershed locations, drainage areas, CN's, Tc's, and reach lengths. It should display all alternate structural systems together with the routing and evaluation reaches through which they are to be analyzed.

2. Establish a Standard Control list for the watershed.

3. Compile the tabular data to support the requirements of the Standard Control list. This may consist of structural data, stream cross section data, cumulative rainfall data, read discharge hydrograph data, and the dimensionless hydrograph tables.

4. Establish the Executive Control records that describe each storm and alternative situation that is to be analyzed through the Standard Control list.

5. Determine the job and output options needed to display and evaluate the correctness of results.

A simple example of these types of input data are shown in Sample Job #1 in Appendix B.

3.3 INPUT DATA SEQUENCE

A number of the various kinds of input records are required to be in a particular order for the TR-20 program to run. The narrative in this section will concentrate on the required general order and purpose of certain records. Table 3.3 summarizes the preferred order of input for all the various record types in detail. Further sections of this chapter will describe the exact input needed for the individual records.

The JOB record is required to initiate and identify each job. It must be the first record in the data set. Various options are available on the JOB record for program output for use with other SCS programs and for the amount of detail to be output with the run.

The TITLE record, or records, must follow the JOB record. One TITLE record is mandatory; there can be two TITLE records if desired. These are often used to give descriptive information on the job, such as the watershed location and conditions and/or project and user documentation. Whatever is in the TITLE records appears on top of each page of output.

The various kinds of tabular data (DURINC, DIMHYD, RAINFL, XSECTN, STRUCT) come after these introductory records. Tabular data may come in any order as long as they are in front of the Executive Control that uses them. Many times a job will not need all the different kinds of tabular data that can be used. Each table of tabular data must end with an ENDTBL record.

The Standard Control instructions for the watershed normally follow the tabular data. These records (RUNOFF, REACH, RESVOR, ADDHYD, SAVMOV, DIVERT) describe the way that the user wishes the hydrographs to be developed, combined and routed within the system of subwatersheds that make up the watershed under study. The records must be set up in the same order that one wants these developments, combinations and routings to occur. The data in the

various records describe the physical conditions of the watershed: the size of the drainage areas, the length of reaches and so on. The Standard Control must be in front of the Executive Control that uses it and the last Standard Control record must be followed by an ENDATA record.

The Executive Control records (LIST, INCREM, BASFLO, COMPUT, ENDCMP) come next. These records set the meteorological conditions for the watershed and define over how much of it they extend. For example, the COMPUT record designates where to begin and end calculations, how much rain to use and the rainfall's duration, which raintable is applicable and which antecedent runoff condition to use. READHD tabular data, LIST, INCREM and BASFLO must precede the COMPUT record in which they are used. The ENDCMP record marks the end of a pass through the watershed.

Most data sets will end at this point with an ENDJOB record. However, if the user wishes to incorporate modifications within the watershed in the same run, instead of making separate runs, they can leave out the ENDJOB record and add any changes to the tabular data and Modify Standard Control instead. A new set of Executive Control instructions must be supplied to run these changes. This can be followed by any number of combinations of changes to the tabular data and Standard Control and new sets of Executive Control records. The ENDJOB record must follow the last set of Executive Control records unless Intermediate Peaks are to be calculated.

When using the IPEAKS and PEAKS records to obtain peak discharges at intermediate points within subwatersheds, one must place these records after the last ENDCMP at the end of the program. An ENDJOB record must follow them.

The "Record Identification" space in columns 73 through 80 on all records can be filled in if desired when all input data for a watershed have been completed and put in order. The numbering in the sample jobs starts with 10 on the first line and increments by 10. The numbers are right justified. The remaining columns in the 73 - 80 Record Identification field can be used for abbreviated words, letters, etc. to assist in identifying the data in the output.

TABLE 3.3. PREFERRED INPUT SEQUENCE

Type Input/RECORD	Description
JOB	Job identification for TR20. Includes options for data output. Required for job to run, must be first record.
TITLE	Identifying and/or descriptive data for job. One TITLE record is required; two may be used. TITLE records must follow the JOB record.
Tabular Data	Provides tables for input data as needed. May or may not be required depending on job. Each table must end with ENDTBL record.
1 DURINC	Flow Duration Increments Table. Used with ECON option in JOB record. Only one DURINC table is allowed in a job. Table must end with ENDTBL.
4 DIMHYD	Dimensionless Hydrograph Table. Standard SCS hydrograph (Peak factor = 484) is preloaded into program and need not be entered as part of data. To use any other dimensionless hydrograph, one must enter it as a DIMHYD table. Table must end with ENDTBL.
5 RAINFL	Cumulative Rainfall Table. Six standard SCS rainfall distributions are preloaded into program and need not be entered. Actual storm rainfall and nonstandard distributions must be entered as a mass curve in a RAINFL table. Table must end with ENDTBL.
2 XSECTN	Stream Cross Section Data Table. Required if program will perform a reach routing without given coefficients. Lists elevation, discharge and end-area data for a given cross section. Table must end with ENDTBL.

TABLE 3.3. PREFERRED INPUT SEQUENCE (Cont'd.)

3 STRUCT	Structure Data or Reservoir Table. Required if program will perform routing through an existing or proposed structure. Provides elevation, discharge, and storage data for the reservoir. Table must end with ENDTBL.
Standard Control	Describes physical characteristics of watershed and defines order in which hydrographs are generated, routed, and combined. Standard Control records of the types shown below must be ahead of Executive Control in which they are used. At least one Standard Control record must be present (the most likely one is RUNOFF). The complete list of Standard Controls must be followed by ENDATA.
6 RUNOFF 1	Generates a hydrograph for an area, given the size of the drainage area, the runoff curve number, and the time of concentration. Various output options can be specified.
6 REACH 3	Routes a hydrograph through a stream reach. User must either provide a XSECTN table in the Tabular Data for the reach, or specify "x" and "m" on the REACH record. Reach length is necessary. Various output options can be specified.
6 RESVOR 2	Routes hydrograph through a reservoir structure. STRUCT table with outlet data must be part of Tabular data (unless structure is a Null Structure, see Section 3.8.1 in text). Elevation at which routing starts if necessary. A blank in this entry will start routing at the lowest elevation given in the structural data table. Various output options can be specified.
6 ADDHYD 4	Adds two hydrographs together. Various output options can be specified.

TABLE 3.3. PREFERRED INPUT SEQUENCE (Cont'd.)

6 DIVERT 6	Splits flow into two hydrographs to account for diversion or division of flow. Various output options can be specified.
6 SAVMOV 5	Allows user to move hydrographs into or out of storage locations if necessary.
ENDATA	Must follow last Standard Control record.
7 READHD	Used to introduce a given hydrograph into the current run. Must follow ENDATA and precede the COMPUT record that uses it. Can introduce a hydrograph generated by another program or source, or one generated by another TR-20 run.
Executive Control	Needed to define hydrologic conditions of the watershed and to control processing of storms within the watershed. All input data used by these records must be ahead of the Executive Control.
7 LIST	Will list portions or all of the current input data to the program.
7 INCREM 6	Specifies the main time increment used in storing, routing, adding, and displaying hydrographs. Must precede COMPUT record(s) that use it.
7 BASFLO 5	Used to introduce or change a baseflow. Must precede COMPUT record(s) that use it.
7 COMPUT 7	Designates beginning and ending points of a run, the rainfall amount and duration to use, the rainfall table number, and antecedent moisture condition. Specifies alternate and storm numbers for each pass. At least one COMPUT is required for output.
ENDCMP 1	Signals the end of a set of computations (pass) and resets program to start of Standard Control. Follows COMPUT record(s).

TABLE 3.3. PREFERRED INPUT SEQUENCE (Cont'd.)

Modified Tabular Data	New tabular data tables for describing changes in the job. Must precede the Executive Control that use the new tables.
Modify Standard Control	Changes data in previous Standard Control records. Records must be in the order that the Standard Control list is modified. Must precede the Executive Control that uses it.
7 ALTER 3	Changes the designated Standard Control records as shown.
7 DELETE 4	Deletes the designated Standard Control records.
7 INSERT 2	Places one or more new lines in the Standard Control following the designated location.
New Executive Control	As needed to make alternate runs with changed conditions specified by rest of modified data.
IPEAKS	Indicates Intermediate Peak data are requested. Required to recognize intermediate peaks. Must follow the last ENDCMP record.
PEAKS	Sets locations at which Intermediate Peak data are computed based on given drainage areas. Must follow IPEAKS record.
ENDJOB 2	Ends all processing on job. Required to end job.

3.4 WATERSHED SUBDIVISIONS

A watershed is subdivided into hydrologically homogeneous subwatersheds. A flood hydrograph is developed for each of these subwatersheds. The attenuation and translation of these hydrographs, due to structures and to floodplain storage and hydraulics, are determined by flood routing.

Section 2.1 briefly describes these procedures and gives specific references to the applicable portions of NEH-4. The major considerations in defining subwatersheds are also described in Section 2.1 under subwatershed delineation.

The sizes of the subwatersheds should be relatively uniform. Unless a hydrograph is needed for a subwatershed that is very small in comparison to the other subwatersheds, there is usually little advantage to include it as a separate subwatershed.

The difficulty comes from defining the hydrographs with the main time increment. This is discussed under Hydrograph Development in Section 2.1. For example, a hydrograph developed by combining hydrographs from draining areas of 0.1, 2.1, and 15.2 square miles is only as accurate as the hydrograph from the larger area since it has a much larger drainage area and time of concentration than the smallest drainage area. Therefore, unless there is a need for the hydrographs for the two smaller subwatersheds (e.g., a potential structure site), only one hydrograph should be developed for the total drainage area of 17.4 square miles or the large area should be broken into smaller, more uniformly sized areas.

Another consideration in subdividing watersheds is the reach length used in routing. A cross section is generally used to represent the stream or valley reach through which hydrographs will be flood routed using the Modified Att-Kin routing procedure. The reaches should be as long as practical when considering the detail for which the watershed hydrology is analyzed. In general, each reach will extend from one tributary to another. The Intermediate Peak procedure will allow the development of peak discharges for points within a reach (subwatershed) where such information is needed.

Any analysis of existing and with project conditions should use the same watershed subdivisions to obtain comparable results.

3.5 SCHEMATIC DRAWING

A schematic drawing is a flow diagram that shows subwatershed delineation and the relationships of subwatersheds, structures, and reaches. The schematic drawing for the watershed is an important aid in compiling input data and is especially important to those checking and handling the data through processing and documentation. A sample schematic drawing including a legend showing suggested symbols is shown in front of each sample job in the appendices. The schematic drawing discussed in this section is from Appendix D, page D-2, but is reflected here as Figure 3-1 for convenience.

A schematic drawing should be completed before preparing the input data. The location of all potential structures to be considered should be shown together with all cross sections that represent reaches and junctions. The structures and cross sections should be numbered in the sequence in which they will be routed. This sequence facilitates setting up the job, checking and verifying. The drainage area above each structure and the area of local drainage to each reach are inserted as shown on Figure 3-1. The reach length, runoff curve number, and time of concentration should also be included for ready reference.

A cross section representing a rating section for a reach should be shown at the downstream end of the reach, even though the surveyed section may be at another location. The rating section gives the average cross-sectional flow and end area of a routing reach. If more than one rating is available for a reach, the ratings may be averaged by the user. Cross sections can also be a means of denoting reference locations in the system. This is illustrated on Figure 3-1, where 1 and 2 represent rating sections while 4 merely denotes a reference location or an expedient for designating a location. The use of reference locations can aid greatly in describing the Standard Control for the watershed.

The sample schematic drawing shows that a hydrograph is to be developed for the area of structure 1 with a drainage area of 1.20 square miles, a runoff curve number of 75, and a time of concentration of 0.33 hours. This hydrograph is to be routed through structure 1 and then through reach 1 using a stream cross section rating table for a reach length of 5400 feet. Each reach is referred to by the number of the cross section at the downstream end of the reach on the schematic. Another runoff hydrograph is to be developed for the intervening area (0.46 sq. mi.) between structure 1 and cross section 1 and added to the reach routed hydrograph at the downstream end of reach 1. This combined hydrograph is to be reach routed through reach 2 with a reach length of 3000 feet.

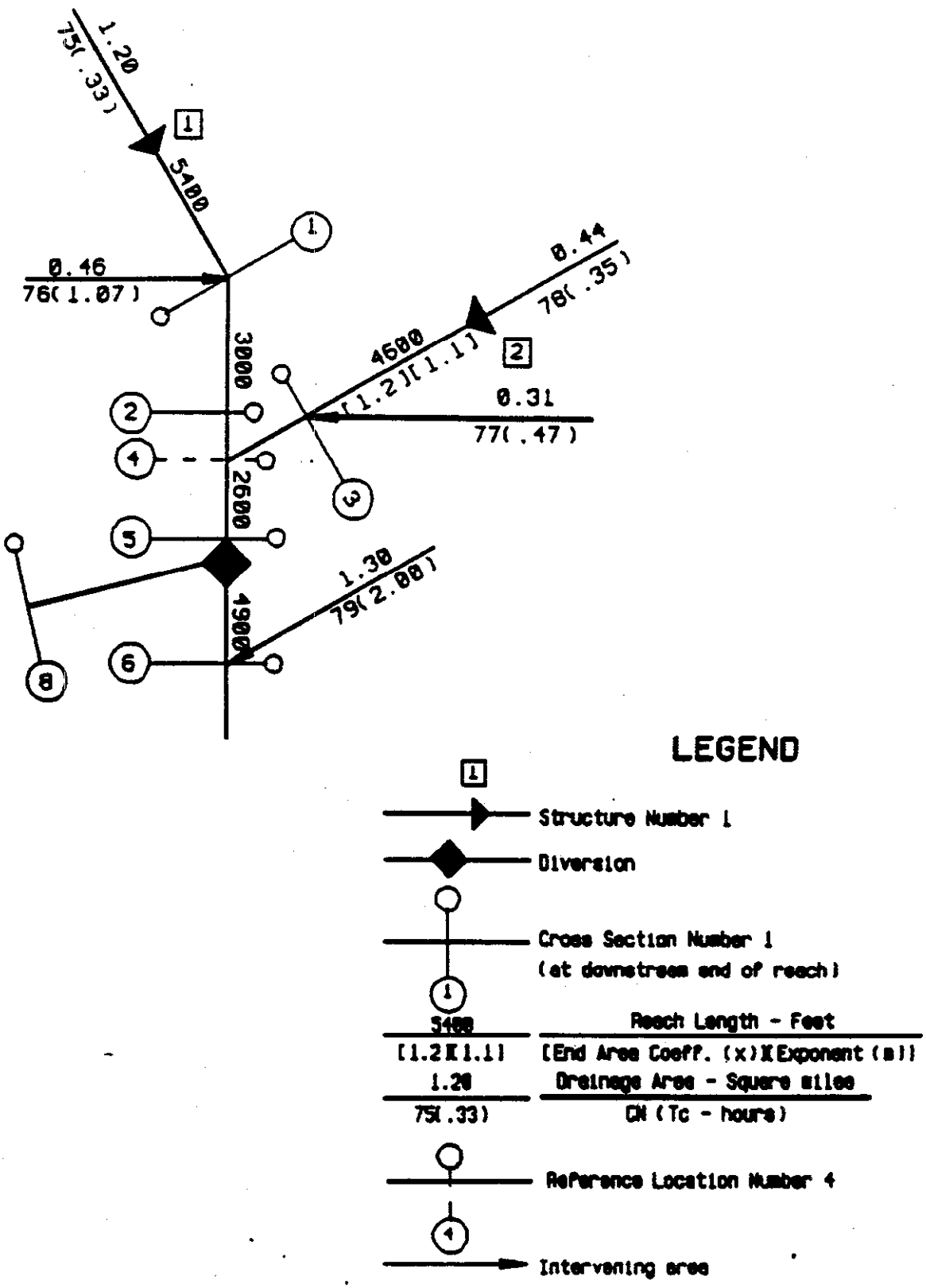


Figure 3-1 Sample Schematic Drawing

Another runoff hydrograph is to be developed upstream of structure 2 (D.A.=0.44 sq. mi.), routed through structure 2, and then through reach 3 using given "x" and "m" values. A runoff hydrograph for the intervening area (D.A.=0.31 sq. mi.) is to be developed and combined with the hydrograph routed through reach 3. The hydrographs at sections 2 and 3 are then to be combined at location number 4, shown on the schematic drawing as a dashed line. The hydrograph at location 4 is to be routed through reach 5.

A diversion structure is located at the downstream end of reach 5 that will divert part of the hydrograph to section 8 out of the watershed. The remaining portion of the hydrograph is to be routed through reach 6 and combined with a runoff hydrograph for the intervening area (D.A.=1.30 sq. mi.).

This schematic drawing would normally be used for all alternatives, even those not including structures 1 and 2 and the diversion structure at section 5. In cases where structures are not to be included in an alternative, they would be shown in the input data as null structures (see p. 42 for discussion of null structures). Separate schematic drawings are shown for each alternate in Sample Job 5 (Appendix F, page F-2) to give a better understanding of the complexity of the example.

3.6 INPUT RECORD FORMAT CONVENTIONS

This section describes the input record format conventions used in this manual. The detailed instructions that follow for the individual records give the purpose, use, relation to other records, and data field requirements for columns 1 to 72.

The data fields are designated by columns, value to be entered, and type of characters to be used. The type of characters in a data field are indicated by the following convention:

A = Alphanumeric, (letters or numeric) data which can appear in any location within specified columns.

N = Numeric, numbers which can appear in any location within specified columns and must include decimal points, and plus or minus signs.

I = Integer, numbers (no decimal points) which can occur in any location within specified columns.

Ix= Integer, numbers (no decimal points) which occur in a fixed position and must be right justified.

e = Essential data for use of record. Error message will be printed and job execution is normally terminated if this data is omitted.

(-) = Negative data is allowed.

The Record Identification field, in columns 73 through 80 is not included in the detailed instructions that follow. Alphanumeric data is permitted in all columns of the field. See section 3.3 for suggested uses for this field in ordering input and identifying output.

The designations are combined as necessary to describe a particular type of data entry; for instance "Ae" means essential alphanumeric data, and "-Ne" means essential numeric data which may be negative.

3.7 JOB CONTROL RECORD SPECIFICATIONS

There are three types of Job Control records, all of which are required for a job to run. These are the JOB, TITLE, and ENDJOB records.

3.7.1 DISCUSSION OF INPUT

<u>Job Record</u> (see also pp. 34-35 and Worksheet SCS-ENG-264, Page G-2)

The input data begins with the JOB record. The JOB record is required for each job. The letters "JOB" in columns 1-3 is the only required entry. There are seven additional fields for processing options. Up to seven output files may be generated by TR-20 (two transport files, four graphic files and one warning and message file). To obtain some of the optional transport and graphic files, selection of options on both the JOB record and Standard Control records are required. Table 3-7-1 lists the options both in the JOB record and in the Standard Control records that are used to generate various files.

The processing options in the JOB record remain in effect through all alternates and storms until reset by another JOB record at the beginning of another TR-20 job. The JOB record options are discussed below. The Standard Control Options are discussed in section 3.9.1.

TABLE 3-7-1. INPUT OPTIONS TO OBTAIN GENERATED FILES

TYPE DATA	NAME 1/ PREFIX.EXT	REQUIRED OPTIONS JOB 2/	SC 3/	FILE DESCRIPTION
		Transport Files		
READHD	"prefix".TRD	---	FILE	Hydrographs in READHD format.
ECON2	"prefix".TEC	ECON & SUMMARY or and	SUM DUR	Output data for ECON2: Peak flow data only; With Flow duration data (DURINC Table required).
		Graphic Files		
Summary	"prefix".TS1	GRAPHICS & SUMMARY or	SUM	Summary Table 1 data.
Summary	"prefix".TS2	GRAPHICS	--	Summary Table 2 (REACH) data.
Duration	"prefix".TFD	GRAPHICS	DUR	All flow duration data.
Hydrograph	"prefix".THY	GRAPHICS	FILE	Hydrograph data (compressed). Also writes READHD file).
		Other Files		
Warnings and messages	"prefix".TMG	-4-		Optional listing of all warning and messages.

1/ Uses "prefix" from input or output file name, or users choice.
2/ JOB = JOB record required option.
3/ SC = Standard Control record required option, see section 3.9.1 for selection instructions.
4/ Requires Yes answer to third question when initiating a run, see section 1.3 for discussion.

WATERSHED IDENTIFICATION (col. 11-18) -- Alphanumeric Watershed identifier (maximum 8 characters) for output.

ECON OPTION (Col. 21-24) -- The SCS computer programs, ECON2 and URB1, require percent chance versus discharge data. A peak discharge and flow duration file can be created by the TR-20 program with the ECON option. The peak discharge and flow durations can be related to runoff volumes and percent chance.

The ECON option is invoked by entering ECON in the data field. The user can select cross sections and structures that are to be included for peak discharges in this data by placing "1" in the SUM column (71) of the output options on the Standard Control records. The SUMMARY option (Col. 51-57) on the job record will also provide the peak discharge data but at every cross section and structure.

Peak discharges for each alternate and each storm will be provided. Summary Tables 3 and 4 and a separate output file will contain the peak discharge information prepared for the ECON option.

Cross sections and structures selected for flow duration data are included in the ECON file by placing a "1" in the DUR column (67) of the output options on the standard control records. The DURINC table (Section 3.8.2.) must also be entered. This provides time flow data for each alternate and storm that uses that standard control record. Summary Table 3A contains both the peak discharge and flow duration information developed for the ECON option.

The ECON output file is automatically named by the program with the user's choice as to file prefix and the extension TEC ("prefix".TEC).

PRINT OPTION (Col. 31-39) -- The Print option field is columns 31-39 of the JOB record. The default option, called NOPRINT, provides a reduced printing of output if the field is left blank. To obtain the FULLPRINT option, enter FULLPRINT in the data field.

The FULLPRINT option will generate considerable output that can effectively conceal pertinent data. However, Standard Control or other input errors may be overlooked without checking the FULLPRINT data at least once on every job. It is suggested that the first pass through a watershed be made using FULLPRINT. The bulk of the output is the step-by-step list of each Standard Control instruction, related basic data, and warning messages printed as the operations are executed. This detailed printout including multiple peaks is suppressed unless individual options on the Standard Control records are selected.

With NOPRINT, all changes to tabular data and Executive Control records are printed as before. No step-by-step output information will be printed unless the individual Standard Control output options are selected. Exceptions are warning messages and divert option hydrographs which are automatic.

Summary Tables are not affected by the Print options. An example of the default Noprint output is shown in Appendix C. An example of FULLPRINT output is shown in Appendix B. The Standard Control output options are discussed in Section 3.9.1.

PASS OPTION (Col. 41-48) -- Generally, a pass is the processing one time through a complete watershed. A pass is usually represented by the results of a particular set of conditions within a watershed such as a specific storm rainfall over the watershed for a certain alternative. The pass number is incremented by one when a ENDCMP Executive Control Record is encountered.

The default value for the initial pass number is 1 for each TR-20 job. The user may change the initial pass number with the PASS option by placing PASS=XXX in the data field. The XXX is a right justified integer.

SUMMARY OPTION (Col. 51-57) -- By placing SUMMARY in this field the user will not have to enter individual SUM options on the Standard Control operations to obtain the summary tables described in Section 4.1.6. All operations (except SAVMOV for all alternates and storms) will be included in Summary Tables 1 and 3. If the user wants to control what operations are displayed, this field should be left blank and the user must specify the desired individual SUM options described in Section 3.9.1.

If both the SUMMARY and all the SUM options are left blank no Summary Tables 1 or 3 or Intermediate Peaks output will be provided. Combined with the no-print option and no other Standard Control options selected, this will result in a run with no computational results printed out.

PLOT OPTION (Col. 61-68) -- The plot option can be used to obtain line plots of discharge vs. end area for cross sections having tabular data or to generate output files for use with SCS graphic software. These are obtained by control word options placed in the data field. There are four options when using plot. These are:

1. PLOTS - Provides a discharge-end area line plot for each cross section before the results of routings are processed and printed. Accompanying each plot is a tabulation of elevation vs. exponent "m." It is good practice to obtain the plots at least once with the output to facilitate checking of the results.

2. GRAPHICS - Saves output data in files for use with SCS graphics software.

3. ENDPLOT - Obtains plots of XSECTN data without any other processing. The listing of input data and the plots will be printed, but routings will not be done nor any other output printed. The ENDPLOT option can be used to check the cross section data separately prior to processing.

4. BLANK - No plots or graphics data are generated during the processing of the data when the data field is left blank.

<u>Title Records</u> (See also p. 36 and Worksheet SCS-ENG-264 Page G-2)

One or two TITLE records follow the JOB record providing a one or two line description that is printed at the top of each page of output. The word "TITLE" is the only required entry in these records. The descriptions are entered in columns 11-72. At least one TITLE record is required for a job to run.

<u>End job record</u> (See also p. 37 and Worksheet SCS-ENG-274, Page G-19)

An ENDJOB record is required at the end of a TR-20 job. It can follow the last ENDCMP record or the last PEAKS record. For a discussion on the ENDCMP and PEAKS records, see Section 3.10.1 and Section 3.12.1.

When an IPEAKS record is encountered a check is made to see if a PEAKS record follows. If there is none, the job is ended. Any PEAKS records found are processed until a ENDJOB record is found. Then the TR-20 job is ended.

After an ENDJOB record is encountered a check is made to see if there is another JOB record to initiate another TR-20 job. If there is none, control returns to the computer operating system.

JOB

3.7.2 JOB Record

Table 3-7-2. JOB record

JOB - record indicates the beginning of a job. All variables and coefficients are set to program default values and all hydrograph storage arrays are initialized to zero. Seven data fields provide identification and processing options for the program. For discussion see page 29.

Data Field (Columns)	Value	Type	Description
1-3	JOB	Ae	Required data code signifying a TR-20 job follows.
5-9	TR-20	A	Program identifier.
11-18	WATERSHED ID	A	Watershed identification.
21-24	ECON	A	Used to request that a peak discharge, flow duration data file be created for SCS ECON2/URB1 computer programs.
31-39	FULLPRINT	A	Used to request FULLPRINT option. Leave blank for Noprint option.
41-48	PASS=XXX	I	Used to assign a pass number other than 1. XXX is a three digit integer, right justified.
51-57	SUMMARY	A	Use only if Summary Tables 1 and 3 or 3A are to include all Standard Control operations (except SAVMOV).
61-68			Four options as follows:
	PLOTS	A	1. Provides plotted discharge-end area plots for cross section tables with regular output.
	GRAPHICS	A	2. Data files for use with SCS graphics programs are generated.
	ENDPLOT	A	3. Request cross section discharge-end area plots only. Routings through watershed will not be done.

JOB

--- 4. Leave blank if no plots or graphics data files are desired.

Figure 3-7-2. JOB record example

1 - 12	13 - 24	25 - 36	37 - 48	49 - 60	61 - 72	73 - 80
Operation Name	Watershed ID	ECON Option	FULLPRINT Option	Starting Pass No.	SUMMARY Option	PLOTS, GRAPHICS Options / ENDPLOT.	Record Identification
JOB TR-20			PASS			
JOB TR-20	ROCKCR	ECON	FULLPRINT	004	SUMMARY		10

This record causes a TR-20 job to be initiated. The Watershed Identification is ROCKCR. A data set containing peak discharge data will be created for later input to the SCS ECON2 or URB1 program. The FULLPRINT option for the output will be invoked. The pass number is four, indicating that three other passes were made previously. The summary tables will include all Standard Control operations encountered. No plots of any stream cross section data or graphics data files will be made. The record identification number is 10.

TITLE

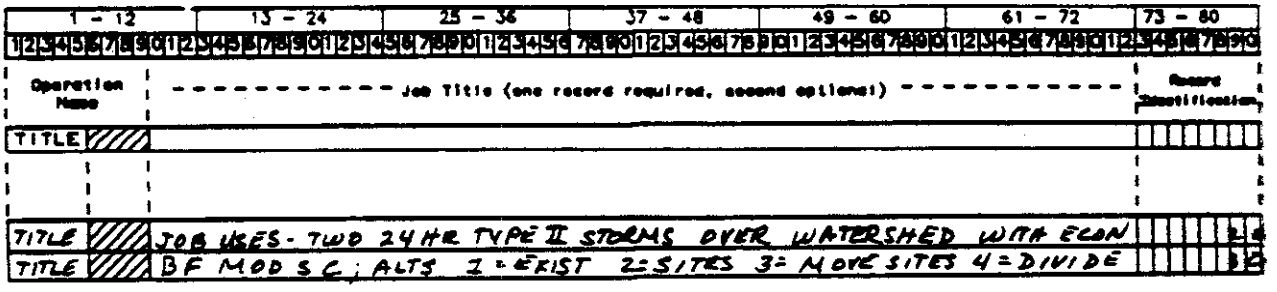
3.7.3 TITLE Records

Table 3-7-3. TITLE records

TITLE -- record provides a line of descriptive text to be printed at top of each page. Two TITLE records are allowed, one is required per job. For discussion, see page 33.

Data Field (Columns)	Value	Type	Description
1-5	TITLE	Ae	Required data code signifying a TITLE record.
11-72	TEXT	A	Optional descriptive text in alphanumeric characters to be listed at the top of each output page.

Figure 3-7-3. TITLE record example



Both lines of the job title will appear at the top of each page of output. The record numbers, 20 and 30, will not appear as part of the title.

ENDJOB

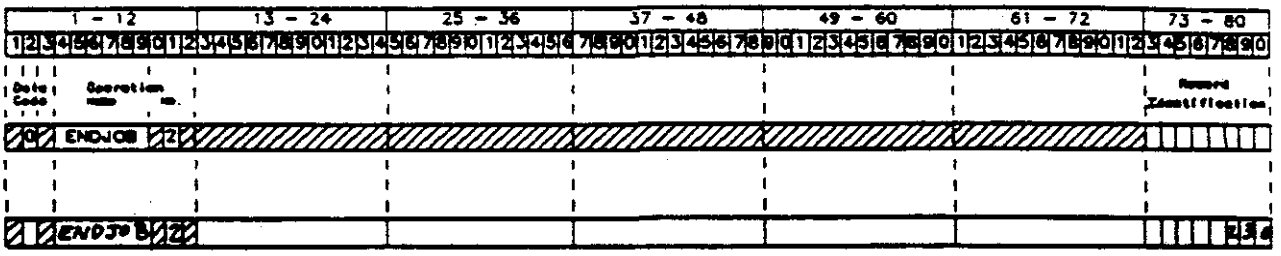
3.7.4 ENDJOB Record

Table 3-7-4. ENDJOB record

ENDJOB -- indicates the end of a job. For discussion, see page 33.

Data Field (Columns)	Value	Type	Description
2	-	I	Data Code, blank or zero.
4-9	ENDJOB	A	Operation name.
11	2	Ie	Operation number.

Figure 3-7-4. ENDJOB record example



The ENDJOB record is required at the end of each TR20 job in a TR-20 run. If intermediate peak records are used at the end of a TR-20 job, the ENDJOB record must follow the last PEAKS record.

3.8 TABULAR DATA SPECIFICATIONS

3.8.1 Discussion of Input

There are six tabular data formats to support the Standard Control records. The tabular data formats are: (1) Flow Duration Increment, (2) Stream Cross Section, (3) Structure, (4) Dimensionless Hydrograph, (5) Cumulative Rainfall, and (6) Read Discharge Hydrograph.

Each tabular data set has a header line specifying the type of data that is entered before the actual tabular data lines. Each line of the tabular data has an "8" in column 2 and five 12-column numeric data fields. Decimal points must accompany all figures in the numeric data fields. Commas must not be used with figures to denote thousands. If the worksheets are used, all unused lines must be crossed out and not entered.

Each tabular data set must be followed by a 9 ENDTBL record. One of the most common errors in preparing input data is to omit the 9 ENDTBL line.

<u>Flow Duration Increment Table (1 DURINC)</u> (See also p. 48 and Worksheet SCS-ENG-272, Page G-4)

TIME-FLOW records are generated in the ECON2 output file for a user selected hydrograph at the flow duration increments entered in the 1 DURINC Table. The SCS ECON2 computer program uses the TIME-FLOW records for a flood duration damage analysis.

In addition to the 1 DURINC Table, the ECON option on the JOB record and the DUR option on the selected Standard Control records, must be activated in the input to obtain the TIME-FLOW records in the ECON2 file. Only one 1 DURINC Table is recognized in a TR-20 job, subsequent ones following a Executive Control will be ignored.

Three durations in increasing order of magnitude can be entered in the numeric data fields of the 1 DURINC Table. The durations can be in hours or days. The program will convert days to hours for the output. The maximum discharges in cfs associated with the durations are computed from each flood hydrograph selected in the Standard Control. The computed flows consider only the peak portion of multiple peaked flood hydrographs and do not consider the time between peaks as part of the flow duration time. See Figure 3.2 for an illustration of a flood hydrograph with 6, 12, and 24 hr flow durations identified.

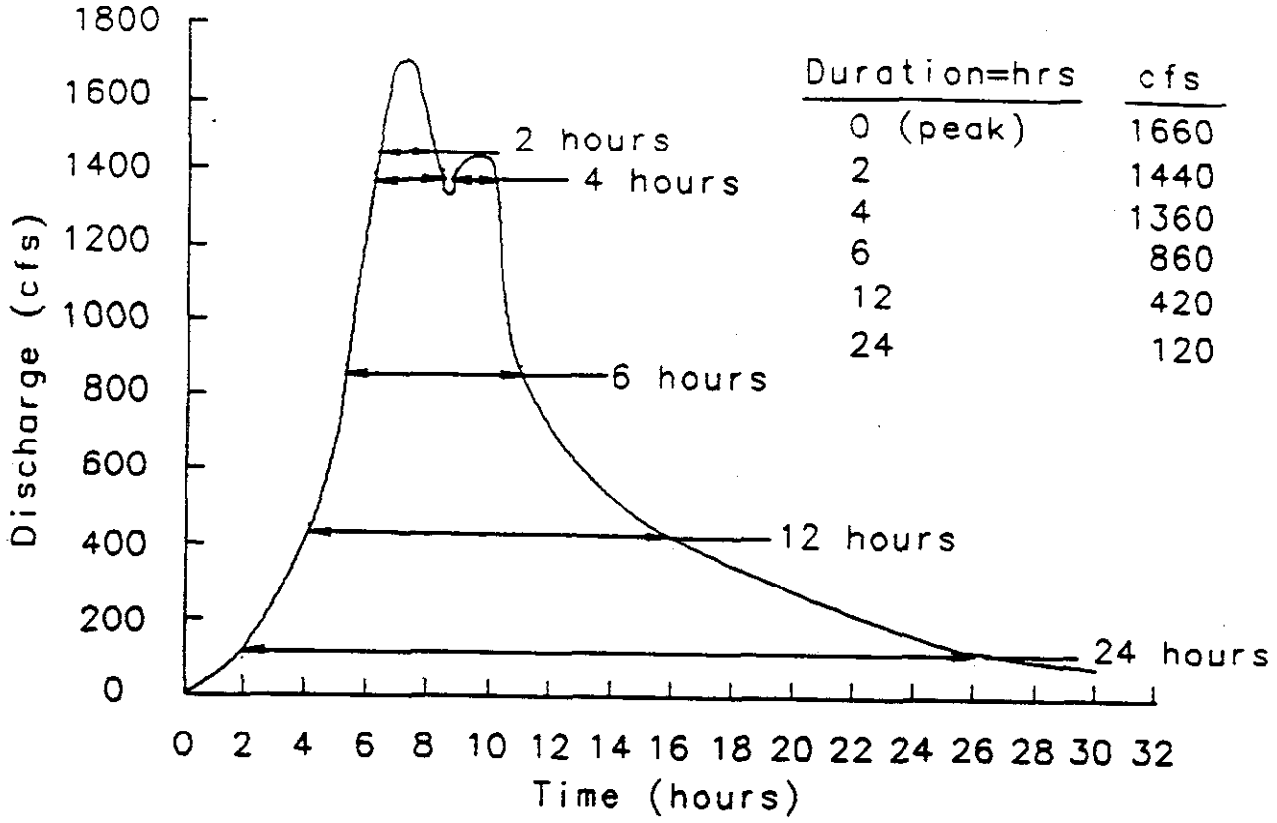


Figure 3-8-1. Flood hydrograph with flow duration identified

If the 1 DURINC table is omitted from a job with or without the ECON option on, TIME-FLOW records will not be generated. The standard flood hydrograph flow duration analysis, however, will still be performed for up to 12 durations when the DUR option is activated on the Standard Control (See pp. 48-49).

Stream Cross Section Data Table (2 XSECTN) (See also p. 50 and Worksheet SCS-ENG-270, Page G-5

The stream cross section table relates the water surface elevation to discharge in cubic feet per second per square mile (csm) or cubic feet per second (cfs) and to the cross-sectional end area in square feet. These data may be from 1) water surface profiles, 2) a user weighted average of flow and end area at two or more cross sections or 3) solution of Manning's equation assuming uniform flow.

The important consideration is that the cross section data should represent the hydraulic conditions for the reach through which reach routing is to be performed. It is necessary that the user enter flow and end area data for elevations below bankfull as well as data for flows up to or larger than those expected to be routed in order to define the complete rating curve accurately.

The number of the cross section on the 2 XSECTN record must correspond with the cross section number of the REACH record. The cross section ID number must be between 1 and 200, inclusive. If discharge is given in csm the total drainage area above the cross section must be shown in columns 25-36 on the 2 XSECTN record. The figure shown in this space is multiplied by the discharge in csm in order to convert to cfs. Usually the discharge in columns 37-48 of cross section input data is given in cfs and a figure of 1.0 is put in the drainage area field of the 2 XSECTN record. The number of data entries describing each cross section cannot exceed 20.

The optional bankfull elevation in columns 37-48 of the 2 XSECTN record is shown on the discharge-end area plot and is used to trigger a warning message if less than two cross section data points are below bankfull.

The optional zero damage elevation in columns 49-60 of the 2 XSECTN record is used with the flow duration analysis to flag results at this elevation.

The low ground elevation or the lowest floodplain elevation in a cross-section (columns 61-72 of the 2 XSECTN record) is required if separate channel and flood plain lengths are given on the REACH Standard Control record. The modified Att-Kin routing procedure accounts for differences in channel and valley storage based on changes in reach length at the low ground elevation. The low ground elevation must not be higher than the bankfull elevation for the interpolation routine to work.

The discharge-end area data in columns 25-36 and 37-48 are used to compute the discharge-storage equation representative of the reach. (See section 3.9.1. under 6 REACH 3.) The first data point must be at zero discharge and zero end area. All other data points (minimum of 2) must be greater than zero and increase in magnitude with elevation.

The SCS water surface profile program (WSP2) can be used to generate rating tables for use in TR-20. Columns 61-72 of these tables may contain data on acres flooded in addition to the elevation, discharge, and end area data. The acres flooded columns are not read by TR-20 and do not cause an error.

If the channel represented by a cross section is to be modified as an alternative consideration, a new cross section data table is made up for the modified cross section and inserted ahead of the Executive Control records for the alternate. Any number of alternative channel conditions for any one section or sections can be compared by inserting each new cross section data table ahead of the respective Executive Control records. If two cross sections are entered with the same cross section number, the last one entered will be used.

The numbering of cross sections need not be in consecutive order. Similarly, the cross section data tables can be in any order when inserted in the runstream. However, chances of error will be minimized if they are numbered and placed in the runstream in the order in which they appear in the Standard Control routing sequence and follow a natural sequence in the watershed. The elevations, discharges, and end areas in columns 25 through 60 must increase between successive lines of data; however, they need not increase by a constant increment. Linear interpolation is used between data for the elevations and discharges shown. Also, a linear extension through the last two values of elevation and discharge is used to extrapolate discharge beyond the highest elevation given in the table when the cross section has insufficient capacity.

Structure Data Table (3 STRUCT) (See also p. 52 and Worksheet SCS-ENG-269, Page G-6)

Structure data tables relate the water-surface elevation to spillway discharge and reservoir storage. The structure ID number must be between 1 and 99, inclusive. The numbering of structures must correspond with the structure number on the RESVOR Standard Control record. Structure numbering need not be consecutive, and the data table preceding each respective set of Executive Control records can be inserted into the runstream in any order. However, chances of error will be minimized if the structures are numbered and placed in the runstream in the order in which they appear in the Standard Control routing sequence.

The first data record in columns 25-36 should always begin with zero discharge. This usually corresponds to the crest elevation of the low stage outlet in the principal spillway. See the explanation of "Starting Elevation," columns 25-36, of the Standard Control RESVOR record, Section 3.9.1, if routing begins above or below the crest elevation of the low stage outlet.

The elevation, discharges, and volumes in columns 25-60 must increase between successive lines of data; however, they need not increase by a constant increment. A linear interpolation is used between data for the elevations shown. If needed, an extrapolation of data above the highest elevation is performed by extending a line linearly through the last two data entries.

The Storage Indication method of reservoir routing requires that the main time increment (in the Executive Control), the discharge, and storage (from the structure data table) must be such that the following inequality holds true (See chapter 17, NEH-4):

$$\frac{O}{2} < \frac{S}{\text{delta } t}$$

where: O = the outflow in cfs at a line in the table,

S = the storage in cfs-hours (acre-feet x 12.1) at the same line in the table,

delta t = the main time increment in hours

If this inequality is not true, oscillations will occur in the descending limb of the hydrograph and may include negative discharges, peak outflow greater than peak inflow, and/or outflow volume greater than inflow volume. A warning message in the output alerts the user to the problem. The usual need is to decrease the delta t or make smaller elevation increments in the structure table, especially near significant changes in flow conditions.

There are usually two structure conditions described for each site. One is the Null structure, and the other is for the existing structure or as it would be designed or constructed. The Null

structure condition represents the present condition in a watershed where a structure is proposed to be located. The Null structure is used to avoid having to modify the Standard Control sequence between processing for "present" and for "with project" conditions. This can also be done using Modify Standard Control statements (section 3.11).

A Null structure is indicated by one of two methods. The first method is placing a 3 STRUCT record followed by a 9 ENDTBL record without any intervening "8" data records. A second method is leaving out all structure table records referring to a structure. To use the Null structure by the first method, the two records (3 STRUCT and 9 ENDTBL) are inserted into the runstream with Tabular data prior to the Executive Control records to which they pertain (See appendix F, sample Job 5, for the use of Null structures).

When a new structure table with the same ID number is entered, the new structure table replaces any previous data for the table. When a structure table, including a null table (first method), is entered, it remains in effect until replaced. When only 2 records for a Null structure are found (or no structure data as in the second method) the RESVOR inflow hydrograph is moved into the RESVOR outflow hydrograph storage location without any routing. For "with project" conditions, the complete structure data table is inserted ahead of the Executive Control records to which it pertains. Any number of structure conditions can be processed for each numbered site with each structure data table inserted ahead of the appropriate Executive Control records.

Each structure data table must have a structure number and a 9 ENDTBL record. The number of data records describing a structure cannot exceed 20.

<u>Dimensionless Hydrograph Table (4 DIMHYD)</u> (See also p. 54 and Worksheet SCS-ENG-265, Page G-7)

The dimensionless unit hydrograph is used in the RUNOFF operation for developing flood hydrographs from subwatersheds. The standard SCS dimensionless unit hydrograph with a peak rate factor of 484 is contained in the program and is not required in the input. The standard SCS dimensionless hydrograph is shown in Appendix G, page G-8. It is also described in Chapter 16, NEH 4.

This input table is required only if another dimensionless unit hydrograph is used. The data records contain the ratio of discharge to peak discharge for each increment of the dimensionless time scale. The number of entries must not exceed 105. The product of the number of non-zero entries plus one and the dimensionless time increment (column 25-36 of the 4 DIMHYD record) must equal 1.0.

The peak rate factor is not an input item. It is calculated by the program and displayed when the DIMHYD table is entered.

Cumulative Rainfall Table (5 RAINFL) (See also p. 56 and Worksheet SCS-ENG-271, Page G-9)

TR-20 was designed to allow almost complete freedom for input of storm rainfall and its time distribution. There are four methods to input cumulative rainfall distributions. They differ in the specifications of the rainfall volume and duration with both actual and dimensionless values available for use. The four methods are:

1. cumulative rainfall in inches - time increment in hours.

2. cumulative rainfall in inches - dimensionless time increments.

3. cumulative dimensionless rainfall - time increment in hours.

4. cumulative dimensionless rainfall - dimensionless time increment.

Up to a total of nine actual or synthetic rainfall distributions can be used in any run. They can be input using the Cumulative-Rainfall Table. RAINFL Table 7, in Appendix D (p. D-3), shows how an actual storm rainfall can be described. The values from left to right in the five data fields are accumulated rainfall depths, in inches, for 1-hour time increments. Any time increment can be selected to describe an actual storm, but the smaller the increment, the better the hydrograph definition. The time increment is specified in column 25-36 of the 5 RAINFL record.

The number of records in the body of the format cannot exceed 60 (300 entries). This means that if a 1-hour time increment is specified, storms up to 299 hours duration can be used. All five data fields must be completed on each line or the entire line crossed out. Note that 12.16 inches, at 42 hours, in columns 37-48 of the last data record in RAINFL Table 7, Appendix D is the end of rainfall, however, the value of 12.16 inches is repeated in data 8columns 49-72 to complete the line. The 9 ENDTBL record must follow each RAINFL table.

Each cumulative rainfall table must be labeled with a separate table number between 1 and 9, inclusive, for its identification. The actual storm in Appendix D, is identified as Table Number 7 on the header record in column 11. When it is desired to route this storm through the watershed, Rainfall Table Number 7 is specified in the Executive Control COMPUT record. Note further that a 1.0 appears under both the rainfall depth and rainfall duration data fields in the Executive Control because Table 7 contains the cumulative rainfall depth in inches and time increment in hours.

The SCS has six standard synthetic rainfall distributions. The standard distributions are listed as in Tables 1 through 6 on pages

G-10 to G-15 in Appendix G. Each standard table has been designed to be used for a distinct purpose and has certain limitations. The standard tables are designed to adapt the rainfall distributions over a wide range of drainage areas and times of concentration. The user is offered a choice of the six standard distributions due to the variation of climatic and watershed conditions. If none of the standard distributions are suitable the user may choose to enter other distributions.

The six standard rainfall distributions as shown in RAINFL Tables 1 through 6 in Appendix G have been preloaded into TR-20. The user does not need to enter these tables, but needs only to use the proper rain table number on the COMPUT record. The user may override any of these tables by entering a new RAINFL table of the same table number.

The 24-hour type I distribution (Table 1), which is shown on page G-10, is used in the Pacific maritime climate area of Central and Southern California and is accepted in some other areas because it approximates peaks resulting from less severe short duration intensities. The time increment used for this distribution is 0.1 hour.

The 24-hour type II distribution (Table 2), which is shown on page G-11, is generally used in the summer thunderstorm area of the United States east of the Cascade and Sierra-Nevada Mountains. The time increment of 0.1 hour gives good definition of the resulting hydrograph for the short duration intensities.

The 24-hour type IA distribution (Table 3), which is shown on page G-12, is recommended for watersheds subject to low intensity storms normally associated with frontal storms such as on the coastal side of the Cascade Mountains in Oregon, Washington and Northern California. The time increment used for this distribution is 0.1 hour.

The 24-hour type III distribution (Table 4) which is shown on page G-13, is generally used along the coastal areas of the eastern and southeastern United States. It reflects the influence of hurricane type rains in these areas. The time increment used for the distribution is 0.1 hour.

The 48-hour type II storm distribution, (Table 5), which is shown on page G-14, is similar in maximum intensities to the Type II 24-hour storm. The time increment used for this distribution is 0.5 hour. The 48-hour distribution can be used in watersheds where times of concentration for the entire watershed exceed 24 hours. The storm distribution used should most nearly match the precipitation pattern. The 48-hour distribution should be evaluated by the user for applicability, especially in relation to peaks and runoff volume.

Note that these standard 24- and 48- hour distribution tables are dimensionless rainfall vs. time increment (0.1 or 0.5) in hours tables. Each entry in the table is the ratio of the storm accumulation to total storm depth.

When any of these five standard 24- and 48- hour distribution tables are specified in the COMPUT Executive Control record, a storm rainfall depth in inches must be shown in columns 37-48 of the COMPUT record because these units are dimensionless, and a 1.0 for duration in columns 49-60 because time increment is hours. There is no limit to the number of storm rainfall depths that can be routed through the watershed when these tables are used. (There is a limit of ten storms if the output data is to be used in ECON2.)

The cumulative rainfall table for the SCS standard emergency spillway and freeboard hydrograph distribution (Table 6) is shown on page G-15. This table is a dimensionless rainfall vs. dimensionless time table used primarily within SCS for structural design. Both depth and duration must be supplied in columns 37-48 and 49-60, respectively, on the COMPUT record when this rainfall table is specified. It is the same as the design storm distribution in Figure 2-6, TR-60. There is no limit to the number of storm depths and durations that can be routed when specifying this rainfall table. Storm duration or areal corrections to design rainfall amounts must be made before data are entered. This distribution is undesirable for peak flow frequency studies since with dimensionless time, as the duration increases, the rainfall intensities decrease.

Runoff option. -- The runoff option, invoked by placing a one in column 17 of the 5 RAINFL record, is used only when the data to be entered are for a cumulative runoff table. When the Rainfall (Runoff) Table Number is requested on the COMPUT operation, the program will use a Runoff Curve Number of 100 for all hydrograph development in that pass in place of the curve numbers entered in the Standard Control. Use of a different rainfall table with a blank in column 17 will revert the curve numbers back to their original values. This can also be accomplished with same rainfall table by leaving column 17 blank on the 5 RAINFL record, followed by the 9 ENDTBL record without any data records.

The runoff option will allow the user to change all the curve numbers in the Standard Control at once within a job without using Modify Standard Control operations. It should be used with caution, however, since the runoff distribution will be used for development of all hydrographs specified within the FROM/THRU fields on the COMPUT operation.

The runoff option can be activated for a preloaded rainfall table by entering the 5 RAINFL X record with a 1 in column 17, followed by a 9 ENDTBL record. A user-entered rainfall table with a 1 in column 17 of the 5 RAINFL X record will also use the runoff option. To turn the option off with a user-entered rainfall table, enter the 5 RAINFL X record with a blank in column 17, and follow it immediately with a 9 ENDTBL record.

Read Discharge Hydrograph Data Table (7 READHD) (See also p. 58 and Worksheet SCS-ENG-276, Page G-24)

The Read Discharge Hydrograph table provides a means of introducing hydrographs at any desired point in the watershed. Time must be in hours and discharge in cfs. The table enables the user to insert stream-gage or known hydrograph data where appropriate. The table also makes it possible to break the processing of large watersheds into two or more parts for easier handling. The table further enables the user to reprocess a lower portion of the watershed with outflow hydrographs from the upper portion of a previous run. The two latter cases require subsequent TR-20 jobs to be run.

Although the 7 READHD is a table and is discussed here with the other tables, it is in the Executive Control series as denoted by the 7 data code and must be placed after the ENDATA record and before the COMPUT record in which the hydrograph will be used.

The Read Discharge Hydrograph data differ from other tabular data in two respects. First, they are actual hydrographs that go directly into one of the seven hydrograph storage locations described in Section 3.9.1. Second, each table is inserted into the runstream ahead of the COMPUT record that will require the data.

For example, a "6" in column 17 of the 7 READHD 8 record would place the hydrograph in storage location 6. The hydrograph would then be used the next time storage location 6 was called in the Standard Control.

The 7 READHD 9 record, the second line on the Read Discharge Hydrograph format provides appropriate spaces for entering any of the following: (1) the time in hours at which the zero time of rainfall is related to the first point of the hydrograph; (2) the time increment between data points in hours; (3) the drainage area in square miles associated with the hydrograph; and (4) the baseflow in cfs, if any, included in the read hydrograph. This baseflow is independent of any baseflow introduced into the data with the BASFLO record.

The table is unlike other tabular data formats in that it can be continued on additional sheets using no more than 400 coordinates (80 records) by crossing out the 9 ENDTBL line on all but the last sheet. The body of the table is similar to the other tables in that each line must be complete or crossed out, decimal points must be shown and commas denoting thousands must not be used.

DURINC

3.8.2 Flow Duration Increment Table

Table 3-8-2. DURINC table records

DURINC - Provides entry of three user selected durations to generate TIME-FLOW records to go with ECON2 data. For discussion, see page 38.

Data Field (Columns)	Value	Type	Description
Record # 1			
2	1	Ie	Data code signifying DURINC table.
4-9	DURINC	A	Operation name.
Record # 2			
2	8	Ie	Data code signifying data in table.
13-17	HOUR or DAYS	Ae	Units for durations.
25-36	Duration	Ne	1st duration (shortest).
37-48	Duration	Ne	2nd duration.
49-60	Duration	Ne	3rd duration (longest).
Record # 3			
2	9	Ie	Data code signifying end of table.
4-9	ENDTBL	A	Operation name.

Figure 3-8-2. DURINC records example

DURINC

1 - 12	13 - 24	25 - 36	37 - 48	49 - 60	61 - 72	73 - 80
Data Code / Table Name						Record Identification
1 DURINC						90
	Hour or Days	FIRST Duration	SECOND Duration	THIRD Duration		
2	HOUR	6.0	12.0	24.0		50
3 ENDTBL		This record must be the last record of this table.				60

1. Maximum of three durations.
2. Data Fields in Col. 25 to 60 require decimal points.

This DURINC Table lists the 3 durations in hours desired for use with ECON2 data in Sample Job 5, Appendix F.

3.8.3 Stream Cross Section Data Table

XSECTN

Table 3-8-3. XSECTN table records

XSECTN - Describes hydraulic conditions for a segment through which reach routing is performed. For discussion, see page 40.

Data Field (Columns)	Value	Type	Description
Record #1			
2	2	Ie	Data code signifying XSECTN table.
4-9	XSECTN	A	Operation name.
13-15	001-200	Ie	Cross Section ID Number.
25-36	DA or 1.0	Ne	Drainage Area: actual in Sq. miles if discharge is in CSM, 1.0 if discharge is in CFS.
37-48	Elev.	(-)N	Bankfull elevation in feet.
49-60	Elev.	(-)N	Zero damage elevation in feet.
61-72	Elev.	(-)N	Low ground elevation in feet.
Record #2-21			
2	8	Ie	Data Code signifying data in table. Each record is one line of data.
25-36	Elev.	(-)Ne	Elevation in feet.
37-48	Discharge	Ne	Discharge in CFS or CSM.
49-60	End Area	Ne	End Area of cross section.
End Record			
2	9	Ie	Data code signifying end of table.
4-9	ENDTBL	A	Operation name.

Figure 3-8-3. XSECTN records example

XSECTN

1 – 12	13 – 24	25 – 36	37 – 48	49 – 60	61 – 72	73 – 80
Data Code	Table Name	Cross Section No.	Drainage Area sq. mi. (use 1.0 if cfs)	Bankfull Elevation–feet	Zero Damage Elevation–feet	Low Ground Elevation–feet	Record Identification
2	XSECTN	3	1.0	10.9	11.9	10.9	70
		(001 to 200)	Elevation feet	Discharge cfs or cms	End Area square feet		Record Identification
			5.2	0.0	0.0		80
			6.0	52.0	25.6		90
			8.0	170.5	92.0		100
			10.0	380.4	190.3		110
			10.9	470.2	280.5		120
			11.9	602.0	384.2		130
			13.0	1057.0	552.0		140
			14.0	1145.0	700.6		150
	1. Maximum of 20 data records.						
	2. Data Fields in Col. 25 to 72 require decimal points.						
	ENDTBL	This record must be the last record of this table.					160

This XSECTN table represents cross-section or reach 003 which has entries for discharge in cfs (cubic feet per second), so the drainage area is set to 1.0, a bankfull elevation of 10.9 feet, a zero damage elevation of 11.9 feet and a low ground elevation of 10.9 feet. Data entries in the table for elevation, discharge and end area must be increasing. The values for discharge and end area must both begin with a zero (0.0) value for the first entry.

STRUCT

3.8.4 Structure Data Table

Table 3-8-4. STRUCT table records

STRUCT - Relates water-surface elevation to spillway discharge and reservoir storage. For discussion, see page 42.

Data Field (Columns)	Value	Type	Description
Record #1			
2	3	Ie	Data code signifying STRUCT table.
4-9	STRUCT	A	Operation name.
16-17	01-99	Ie	Structure identification number.
Record #2-21			
2	8	Ie	Data code signifying data in table. Each record is one line of data.
25-36	Elev	(-)Ne	Elevation in feet.
37-48	Discharge	Ne	Spillway discharge in cfs.
49-60	Storage	Ne	Reservoir storage in acre-feet.
End Record			
2	9	Ie	Data code signifying end of table.
4-9	ENDTBL	A	Operation name.

Figure 3-8-4. STRUCT records example

STRUCT

1 – 12	13 – 24	25 – 36	37 – 48	49 – 60	61 – 72	73 – 80
Data Code, Table Name	Structure No.					Record Identification
3 STRUCT	3					210
	(01 to 99)	Elevation feet	Discharge cfs	Storage acre – feet		Record Identification
		482.	0.0	25.0		220
		486.	31.0	80.0		230
		490.	39.0	130.0		240
		493.	43.0	193.0		250
		497.	47.0	260.0		260
1. Maximum of 20 data records.		500.	52.0	305.0		270
2. Data Fields in Col. 25 to 60 require decimal points.						
ENDTBL	This record must be the last record of this table.					280

This STRUCT table represents structure 03 which has data entries for elevation, discharge and reservoir storage which must be increasing. The first discharge entry must be zero (0.0).

DIMHYD

3.8.5 Dimensionless Hydrograph Table

Table 3-8-5. DIMHYD table records

DIMHYD - Defines the dimensionless unit hydrograph used to generate runoff hydrographs in the program. For discussion, see page 43.

Data Field (Columns)	Value	Type	Description
Record #1			
2	4	Ie	Data code signifying DIMHYD table.
4-9	DIMHYD	A	Operation name.
25-36	Time Increment	Ne	Dimensionless time increment used in hydrograph table.
Record #2-22			
2	8	Ie	Data code signifying data in table. Maximum of 21 data records.
13-24 25-36 37-48 49-60 61-72	Incremental Hydrograph Ratios	Ne	Ratio of discharge to peak discharge for each increment of dimensionless time scale. First and last entries must be zero. Last line must be completed with zeroes. Each line included must have five values.
End Record			
2	9	Ie	Data code signifying end of table.
4-9	ENDTBL	A	Operation name.

Figure 3-8-5. DIMHYD records example

DIMHYD

1 - 12	13 - 24	25 - 36	37 - 48	49 - 60	61 - 72	73 - 80
Data Code / Table Name		Dimensionless Time Increment				Record Identification
4 DIMHYD		0.02				30
	Enter successive entries left to right with first entry for time = 0.0 Fill last row of data with value for dimensionless time = 1.0					Record Identification
1. Maximum of 21 data records 2. Data fields in Col. 13 to 72 require decimal points.	0.0	0.03	0.1	0.19	0.31	40
	0.47	0.66	0.82	0.93	0.99	50
	1.00	0.99	0.93	0.86	0.78	60
	0.68	0.56	0.46	0.39	0.33	70
	0.28	0.241	0.207	0.174	0.147	80
	0.126	0.107	0.091	0.077	0.066	90
	0.055	0.047	0.04	0.034	0.029	100
	0.025	0.021	0.018	0.015	0.013	110
	0.011	0.009	0.008	0.007	0.006	120
	0.005	0.004	0.003	0.002	0.001	130
	0.0	0.0	0.0	0.0	0.0	140
ENDTBL	This record must be the last record of this table.					150

This DIMHYD table with 51 entries has a dimensionless time increment of 0.02. The entries are the ratio of discharge to peak discharge at each incremental time unit. Entries must begin and end with 0.00.

RAINFL

3.8.6 Cumulative Rainfall Table

Table 3-8-6. RAINFL table records

RAINFL - Describes rainfall distribution used to generate runoff hydrographs. For discussion, see page 44.

Data Field (Columns)	Value	Type	Description
Record #1			
2	5	Ie	Data code signifying RAINFL table.
4-9	RAINFL	A	Operation name.
11	1-9	Ie	Rainfall table identification number, use 1 to 9.
17	1 or blank	I	Runoff Option for CN = 100. Leave blank to use standard control CN's.
25-36	Time Increment	Ne	Time increment used in rainfall table in hours or dimensionless.
Record #2-61			
2	8	Ie	Data code signifying data in table. Maximum of 60 data records.
13-24 25-36 37-48 49-60 61-72	Rainfall Depth inches or Ratio of depth to total depth	Ne	Accumulated rainfall depth for actual storm or the ratio of the depth to total depth at a given time for a dimensionless rainfall.
End Record			
2	9	Ie	Data code signifying end of table.
4-9	ENDTBL	A	Operation name.

Figure 3-8-6. RAINFL records example

RAINFL

1 – 12	13 – 24	25 – 36	37 – 48	49 – 60	61 – 72	73 – 80
Data Code / Name / Table No.	Runoff Option	Time Increment Hours				Record Identification
5 RAINFL 1 (1 – 9)	1	0.5				160
	Enter successive entries left to right with first entry for time = 0. Fill last row of data with last entry of table.					Record Identification
1. Maximum of 80 data records. 2. Data Fields in Col. 13 to 72 require decimal points.	0.0	0.008	0.017	0.026	0.035	170
	0.045	0.055	0.065	0.076	0.087	180
	0.099	0.112	0.126	0.14	0.156	190
	0.174	0.194	0.219	0.254	0.303	200
	0.515	0.583	0.624	0.655	0.682	210
	0.706	0.728	0.748	0.766	0.783	220
	0.799	0.815	0.830	0.844	0.857	230
	0.87	0.882	0.893	0.905	0.916	240
	0.926	0.936	0.946	0.956	0.965	250
	0.974	0.983	0.992	1.000	1.000	260
9 ENDTBL	This record must be the last record of this table.					270

These records describe rainfall table 1, which has a dimensionless rainfall amount of 1.0 and time increment of 0.5 hour. When used it will overwrite the type I Rainfall Table with 0.1 hour time increment that is in the default storage location 1. Note: the last line of data is filled in with the last table value.

3.8.7 Read Discharge Hydrograph Table

READHD

Table 3-8-7. READHD table records

READHD - Introduces a discharge hydrograph at any point in the watershed. For discussion, see page 47.

Data Field (Columns)	Value	Type	Description
Record #1			
2	7	Ie	Data code for Executive Control record.
4-9	READHD	A	Operation name.
11	8	Ie	Operation code.
17	1-7	Ie	Storage location of Read Discharge Hydrograph.
Record #2			
2	7	Ie	Data code for Executive Control record.
4-9	READHD	Ae	Operation name.
11	9	Ie	Operation code signifying hydrograph data follows.
13-24	Start Time hours	Ne	Starting time of hydrograph in hours.
25-36	Time Increment hours	Ne	Time increment of hydrograph in hours.
37-48	Drainage Area Square Miles	Ne	Drainage area in square miles associated with the hydrograph.
49-60	Baseflow-cfs	N	Baseflow (cfs) if any, included in the hydrograph.

Data Field (Columns)	Value	Type	Description
Record #3-83			
2	8	Ie	Data code signifying data in table. Maximum of 80 data records.
13-24	Discharge-cfs	Ne	Discharge in cfs in Read Hydrograph at selected time increment. Up to 400 points may be used. Fill last line with last discharge.
25-36	"		
37-48	"		
49-60	"		
61-72	"		
End Record			
2	9	Ie	Data code signifying end of table.
4-9	ENDTBL	A	Operation name.

Figure 3-8-7. READHD records example

READHD

1 - 12	13 - 24	25 - 36	37 - 48	49 - 60	61 - 72	73 - 80
Data Code, Table Name, Char. Code	Storage Location No. 1 to 7					Record Identification
7 READHD 8	3					370
	Starting Time hours	Time Increment hours	Drainage Area square mile	Baseflow included cfs		Record Identification
7 READHD 8	6.0	0.1	1.66	5.0		380
Enter successive discharges left to right with first entry for starting time. Fill last row of data with last entry of table. Include Baseflow if applicable.						
1. Maximum of 80 records. 2. Data Fields in Col. 13 to 72 require decimal points.	5.0	6.0	6.0	7.0	8.0	290
	9.0	10.0	14.0	15.0	17.0	300
	20.0	25.0	31.0	39.0	54.0	310
	98.0	227.0	451.0	677.0	829.0	320
	889.0	878.0	823.0	748.0	664.0	330
	582.0	508.0	441.0	382.0	334.0	340
	244.0	259.0	233.0	211.0	193.0	350
	177.0	165.0	154.0	144.0	136.0	360
	129.0	123.0	119.0	114.0	112.0	370
	109.0	106.0	105.0	97.0	95.0	380
	93.0	91.0	89.0	87.0	85.0	390
	83.0	80.0	78.0	77.0	75.0	400
	73.0	72.0	71.0	69.0	68.0	410
	67.0	66.0	65.0	65.0	64.0	420
	63.0	62.0	62.0	61.0	61.0	430
	59.0	57.0	53.0	49.0	44.0	440
	40.0	36.0	32.0	29.0	26.0	450
	23.0	21.0	20.0	18.0	17.0	460
	16.0	15.0	14.0	13.0	12.0	470
	12.0	11.0	11.0	10.0	10.0	480
	9.0	9.0	9.0	8.0	8.0	490
	8.0	8.0	8.0	7.0	7.0	500
	7.0	7.0	7.0	7.0	7.0	510
	7.0	7.0	7.0	6.0	6.0	520
	6.0	6.0	6.0	6.0	6.0	530
	6.0	6.0	6.0	6.0	6.0	540
	6.0	6.0	6.0	6.0	6.0	550
	6.0	6.0	6.0	6.0	6.0	560
	6.0	6.0	6.0	6.0	5.0	570
8 ENDTBL	This record must be the last record of this table.					580

This READHD table describes a hydrograph to be inserted in storage location 3. The hydrograph has a starting time of 6.0 hours after rainfall begins and a time increment of 0.1 hours. The watershed associated with it is 1.66 square miles in area, and there is 5 cfs baseflow included in the hydrograph. The values in the body of the table are discharge in cfs at the 0.1 hour time increments.

3.9 STANDARD CONTROL RECORD SPECIFICATIONS

3.9.1 Discussion of Input

The Standard Control (see worksheets, Appendix G, pages G-16 and G-18) is used to set forth the sequence in which flood routings through the reaches and structures of a watershed will be performed. The records cause a runoff hydrograph to be developed, to be routed through a structure or stream reach, and to be added to a hydrograph for an intervening area. Standard Control commands are also used to move a hydrograph to a different location in computer storage, or to divide it into two separate hydrographs.

A "6" must be inserted in column 2, the "Data Code", for all Standard Control records except ENDATA. The "Operation" (Columns 4 through 11) is described by a name and code number. The operation names and code numbers are RUNOFF 1, RESVOR 2, REACH 3, ADDHYD 4, SAVMOV 5, and DIVERT 6. The operation names are for the convenience of the user while the corresponding code number in column 11 identifies to the computer the operation to be performed.

The "xsection/structure" heading (Columns 13 thru 17, of the Standard Control worksheet, see p G-16) contains blank spaces that are to be filled with either the cross section number or the structure number. Never use both a cross section and structure number on the same line. Leading zeros do not need to be inserted in the number field but the number must be right justified (no blanks or decimals to the right of the number) within the field. The largest numbers that can be expressed for any structure or cross section are 99 and 200, respectively. The smallest number, in either case, is 1. Ways in which cross section/structure numbers are associated with the records in TR-20 are given in Table 3-9-1-1.

Appendices B through F show completed Standard Control instructions for five related sample jobs. For example, in Sample Job Number 1 (Appendix B and repeated here for the readers' convenience) the first record, RUNOFF 1, causes an inflow hydrograph to be developed for the area above structure 01. The record, RESVOR 2, causes the inflow hydrograph to be routed through structure 01. The record, REACH 3, causes the outflow from structure 01 to be routed through the next stream reach (001). The ENDATA record signifies completion of the Standard Control.

In Sample Job Number 2 (Appendix C), continuing downstream the RUNOFF 1 record for cross section 001 causes a hydrograph to be developed for the local inflow to the reach previously routed. The ADDHYD 4 record causes the reach routed hydrograph to be combined with the local inflow hydrograph at cross section 001. The REACH 3 operation instructs the computer to do the stream routing through reach 002. Thus, the routing sequence can be directed from one reach to the next.

Table 3-9-1-1. Association of cross section/structure number with TR-20 Standard Control records

Record	Number as	What the number designates
6 RUNOFF 1	Cross section or structure	Drainage area for which the hydrograph is developed.
6 RESVOR 2	Structure	Structure through which routing is performed.
6 REACH 3	Cross section	Terminal point to which the stream reach routing is performed.
6 ADDHYD 4	Cross section or structure	Point at which the two hydrographs are combined.
6 SAVMOV 5	Cross section or structure	Hydrograph being moved internally between storage locations.
6 DIVERT 6	Cross section or structure	Inflow hydrograph to be diverted and output hydrograph number 1.

The "Hydrograph Number" heading (Columns 19, 21 and 23 of the Standard Control worksheet, see G-16) provides spaces in which hydrograph storage locations are designated by numbers 1 through 7. Each storage location will hold up to the maximum number of points allowed by the program (400). Each Standard Control operation may need up to three hydrograph storage locations identified. One or two of the hydrograph numbers may be required as input to perform the Standard Control operation and the third hydrograph storage number to save the resultant hydrograph. DIVERT is different in that it has one input hydrograph and two output hydrograph storage locations.

All seven numbered hydrograph storage locations are similar and may be used interchangeably for input and output hydrographs of any operation. However, in order to keep track of hydrographs and assist in error detection the user should standardize storage locations by selecting three locations for the "operating" hydrograph storages. The new user might generally use location 5, 6, and 7 as the "operating" storage locations. For example, 6 ADDHYD 4 5 6 7 would take the hydrographs in locations 5 and 6, add them, and place the resulting hydrograph in location 7. The remaining storage locations (1 to 4) serve as temporary locations to save hydrographs until needed.

The cardinal rule to remember is that only one hydrograph can occupy any one storage location at a time and that there must be a hydrograph in the storage location from which an operation is

"calling it up." An output hydrograph remains in a storage location ready for use until it is used as an input hydrograph. The input hydrograph storage locations, for all Standard Control operations except SAVMOV, are cleared immediately after the hydrograph(s) are used. It is recommended that all storage locations be checked for compliance with these rules before input data are submitted for data entry. The same storage location number must not be used in the input and the output for a single operation.

The three data fields; columns 25 through 36, 37 through 48, and 49 through 60 of the Standard Control are filled with data according to the individual headings as explained below. Data entered in each of these fields must have a decimal point. If no decimal point is entered its location is assumed but probably not where the user intended. No error message is printed for this error, however, any time such data are printed and the number of given positions are exceeded, asterisks are printed in the edited listing of Standard Control records. Commas must not be used within data fields to indicate thousands.

Different output options may be specified in columns 61-72 of the Standard Control. These options are discussed at the end of this section.

6 RUNOFF 1 (See also p. 73)

The RUNOFF record causes a runoff hydrograph to be developed for a subwatershed. The input data are drainage area in square miles, curve number CN, and time of concentration in hours. The drainage area includes that area of the subwatershed that contributes runoff to the hydrograph peak. Determination of the CN is described in Chapters 7, 8, and 9, NEH-4. Techniques in NEH-4, Chapter 15 may be used to estimate the time of concentration.

6 RESVOR 2 (See also p. 75)

The RESVOR record causes an inflow hydrograph to be routed through a structure such as a reservoir, starting with the outflow discharge at the elevation corresponding to the beginning of the storm. The "Start Routing Elevation ft." is the water-surface elevation of the reservoir at the beginning of the storm. If "Start Routing Elevation ft." is left blank, routing begins at the first elevation on the structure data table (page B-5). There are three ways to start routings:

(1) At the principal spillway crest with outflow discharge equal to zero. Normally the starting elevation will be the lowest crest of the principal spillway. The storage associated with the starting elevation can be equal to or greater than zero.

(2) Below the principal spillway crest with zero discharge. The structure table must start below the elevation of the principal spillway. The second and following data records on the structure data table must have a discharge greater than zero and must increase in storage. Therefore, a small discharge (less than 1 cfs) may have to be shown, even though it is not the case. This condition exists when the reservoir level at the start of the storm is drawn down below the crest of the principal spillway.

(3) Above the principal spillway crest where discharge is greater than zero. This condition exists when the reservoir level at the start of the storm is higher than the crest of the principal spillway due to an earlier storm or baseflow.

Routing starts at the start routing elevation or the first elevation of the structure data table and continues until the outflow discharge returns to zero outflow or where it ends because of the maximum point storage limitation. The volume of the outflow hydrograph will not always be equal to inflow. It will include the volume between the starting elevation and the elevation at zero discharge, baseflow, or when it is truncated because of the maximum point storage limitation. The outflow volume is normally less in condition (2) above, when the additional storage below the crest is filled. In condition (3), the outflow volume is normally greater as the additional stage above the crest is converted to outflow.

A RESVOR record should be included in the Standard Control for all potential and existing reservoir sites. This will eliminate modifying the Standard Control for alternative structural combinations. This is done by specifying Null structures in the alternatives without structures). Null structures are discussed in section 3.8.1.

6 REACH 3 (See also p. 77)

The REACH record causes the computer to route an inflow hydrograph through a stream reach. There are two input procedures to represent the discharge-end area relationship in the reach: a 2 XSECTN rating table or "x" and "m" coefficients.

A single reach length or separate floodplain and channel lengths can be entered on the REACH record by the user depending on the procedure. Separate reach lengths can only be used with the 2 XSECTN rating table procedure as the low ground elevation has to be identified. The low ground elevation is considered the dividing line between channel and floodplain storage.

In short reaches, attenuation is lost as the Modified Att-Kin routing procedure tends toward a kinematic routing. In long reaches, with major attenuation, the inflow hydrograph peak used to determine the routing parameters may not be representative of the reach. Guidelines for selecting reach lengths are in Hydrology Note 2.

It should be recognized that entering data in the 2 XSECTN table, in general, will result in more accurate routing than entering "x" and "m" coefficients on the REACH record. In usual cases, one power curve as described by a single pair of "x" and "m" values will not adequately fit the rating curve for a cross section with channel and floodplain flows. However, it may be convenient in some cases to provide a cross section rating in the form of coefficients for rating curves. Once the discharge-storage relation is established for the reach, the routing coefficient is calculated that is used to perform the routing. Details on how the routing coefficient is calculated and how the Modified Att-Kin routing is accomplished are given in Hydrology Note 2.

REACH Procedure 1 -- If columns 37-48 in the REACH record are left blank, a cross section table (2 XSECTN) must have been previously entered and will be used. An "m" value will be determined for each flow listed in the table. The logarithmic slope of the line between each two consecutive data points is weighted by the difference in flow between the two points. In this way, "m" can be computed for each flow in the table based on flow from the lowest flow to the flow in question.

The computation of "m" by the program is described in Hydrology Note 2. This method allows the "m" used in the reach routing to change when the slope of the discharge-end area curve changes. In typical cross sections (with channel and floodplain) the slope of the discharge-end area curve changes (becomes flatter) when the discharge exceeds channel capacity and then changes (becomes steeper) again at a point where water fills the floodplain and depth of flow increases in the floodplain.

It is optional to enter a floodplain length in columns 49-60.

If entered, the reach length in columns 25-36 must be the channel length and the low ground elevation must be entered in columns 61-72 of the first record in the XSECTN Table.

REACH Procedure 2 -- Columns 37-48 and 49-60 in the REACH record provide the option of specifying cross section coefficients ("x" and "m") for a rating curve equation. If cross section parameters have been estimated for one reason or another, corresponding coefficients from the equation $Q = xA^m$ (where Q = discharge and A = cross section end area representative of the reach) can be inserted. Guidelines for estimating "x" and "m" for trapezoidal and triangular cross section shapes are given in Hydrology Note 2. Use of these guidelines requires a minimum amount of topographic and roughness information.

The coefficient "x" is transformed to k, where $k = x/(L^m)$ and L is the single reach length specified in columns 25-36. The reach routing is performed using $Q = kS^m$, which is a straight line log-log relation between discharge (Q) and reach storage (S = LA). When coefficients "x" and "m" are entered, the actual cross section

discharge end-area data as given on a corresponding cross section (2 XSECTN) table are not used.

6 ADDHYD 4 (See also p. 80)

The ADDHYD record causes the hydrographs from two hydrograph storage locations to be combined and places the resultant hydrograph in a third storage location. Only two hydrographs can be combined at one time. For example, if three hydrographs are to be combined to describe a final hydrograph, two ADDHYD records are needed. If the time increments of the hydrographs do not correspond with the current main time increment, they will be adjusted to the main time increment before they are added. When two hydrographs are adjusted and added with different start of runoff times and/or time increments, it is possible to lose volume of runoff by truncation due to the maximum point storage limitation.

6 SAVMOV 5 (See also p. 82)

The SAVMOV record causes the hydrograph in one computer storage location to be placed in another storage location. To facilitate keeping track of hydrographs, the user may standardize on storage locations 5, 6, and 7 as the "operating" locations and use the other locations as temporary storage. In this case, 6 SAVMOV 5 will remove a hydrograph from computer storage location 5, 6, or 7 and place it into location 1, 2, 3 or 4 for safe keeping until called up as input for a subsequent operation.

For example, the computer "operating" storage locations can thus be vacated in order to transfer operations to a tributary. When operations are completed for the tributary, a 6 SAVMOV 5 can recall the hydrograph from its storage location 1, 2, 3 or 4 and place it back into an "operating" location 5 or 6 for adding the tributary to main stem.

Since the SAVMOV input hydrograph storage location is not cleared until replaced by another hydrograph, SAVMOV records can also be used in downstream branching situations. Both the input and output storage location on the SAVMOV record will contain the same hydrograph until the location numbers are reused. Thus, two separate standard control sequences can be setup downstream from the SAVMOV. Three separate branches are possible with back to back SAVMOV records containing the some inflow hydrograph. Additional branches require additional SAVMOV records. With only seven storage locations available, there is a limit of six branches possible.

As an example of branching, the SAVMOV record can be used to help evaluate different project alternatives by storing results of part of the watershed for reuse. For instance, consider a watershed with upstream subwatersheds in which no changes in land use are expected and downstream subwatersheds where proposed projects will alter their characteristics. The user can calculate hydrographs down to

the last ADDHYD combining hydrographs for the upstream subwatersheds and using SAVMOV, store these results in two places at once. The non-project condition can then be evaluated continuing downstream. Next, instead of going back to the top of the watershed and duplicating the calculations, the hydrograph stored by the SAVMOV command can be used to evaluate with project conditions on the downstream watersheds. This can significantly reduce the number of standard control records in a run.

6 DIVERT 6 (See also p. 83)

The DIVERT record is used to separate a hydrograph into two hydrographs. An example of the use of DIVERT is where the maximum flow in a channel must be limited and the excess flow diverted into a floodway or bypass that may or may not reenter the channel at some point downstream in the watershed.

There are three hydrographs involved in this operation - an input hydrograph that is to be separated into output hydrograph #1 and output hydrograph #2. These output hydrographs cannot be stored in the same storage location as the input hydrograph. The cross section or structure ID number (columns 13-15 or 16-17) applies to the input hydrograph as well as to the output hydrograph #1. The cross section number for output hydrograph #2 is placed in a data field (columns 49-60) that requires a decimal point.

Two procedures are available to divert a hydrograph. The first procedure diverts all flow above a constant discharge provided in columns 25-36. If this data field is left blank, the second procedure is assumed and flow is divided based on elevation-discharge data.

To divide the drainage area between the two output hydrographs, place the portion of the drainage area that is to be associated with the output hydrograph #1 in decimal fraction form in columns 37-49. If one square mile of a total of ten square miles drainage area is to be associated with output hydrograph #1, the entry in columns 37-49 would be 0.1. The balance of the drainage area will be associated with output hydrograph #2. If columns 37-49 are left blank, the entire drainage area goes with output hydrograph #2. The drainage areas are not used for separating the hydrographs but are used to compute the output hydrograph runoff volumes in watershed inches and the peak flows in csm in Summary Table 1.

The cross section identification number of output hydrograph #2 must be followed by a decimal (e.g., 008.) in columns 49-60. For procedure 2, this data field cannot be blank, zero, or a structure ID number.

Both output hydrographs from a DIVERT operation can be used downstream in a watershed. Output hydrograph #1 can be moved downstream by using its hydrograph storage location number as the input to the next Standard Control operation. Output hydrograph #2

could be diverted out of the watershed or it may be brought into the Standard Control sequence at some downstream location. However, the user can reverse the diversion by using the hydrograph storage location number for output #2 as input to the next Standard Control operation and output #1 would then be diverted.

Both DIVERT procedures will split constant baseflow. The program's accounting will not include any constant baseflow in the storm runoff volume.

DIVERT Procedure 1 -- This separates a hydrograph into two hydrographs where one hydrograph contains that portion of the inflow hydrograph below a constant specified discharge (column 25-36, outflow hydrograph #1) and the second hydrograph contains that portion above the specified discharge (outflow hydrograph #2) as shown in Figure 3-9-1-1. Rating tables entered for cross section/structure ID numbers are ignored in procedure 1.

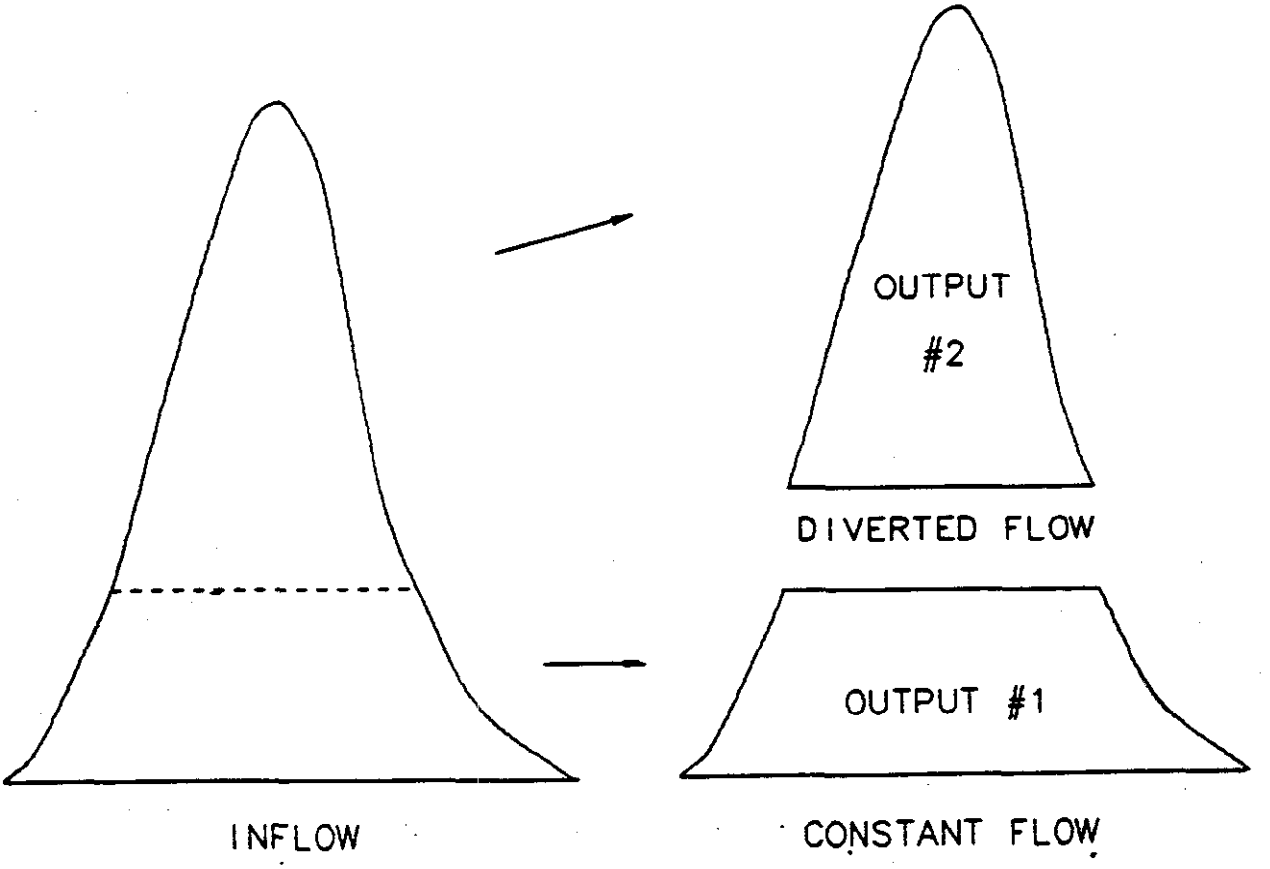


Figure 3-9-1-1. Divert - Procedure 1 with constant flow

The most common use of procedure 1 is where a control structure blocks the channel and allows flow down the channel only through one or more pipes. The remaining flow goes over a weir at or above the elevation required for full pipe flow into either off-channel storage or a floodway. See Sample Job 3, Appendix D for an example of procedure 1.

<u>DIVERT Procedure 2</u> -- This divides a hydrograph into two hydrographs at a split in flow based on the capacity of each branch. Columns 25-36 are left blank or zero and the cross section ID numbers in columns 13-15 and 49-60 must represent 2 XSECTN tables in the tabular input data. All discharges will be proportioned using an elevation versus discharge rating table representative of each branch.

The elevation, discharge, and end area columns of the two cross section data tables need to be completed. The elevations of the two output hydrographs are assumed to be equal to the inflow hydrograph. Therefore, it is essential that the elevations for the two ratings be based on the same datum and be located near the physical control that determines the flow split. It is not necessary that the lowest elevations of the two tables be the same. Figure 3-9-1-2 shows how the hydrographs are separated.

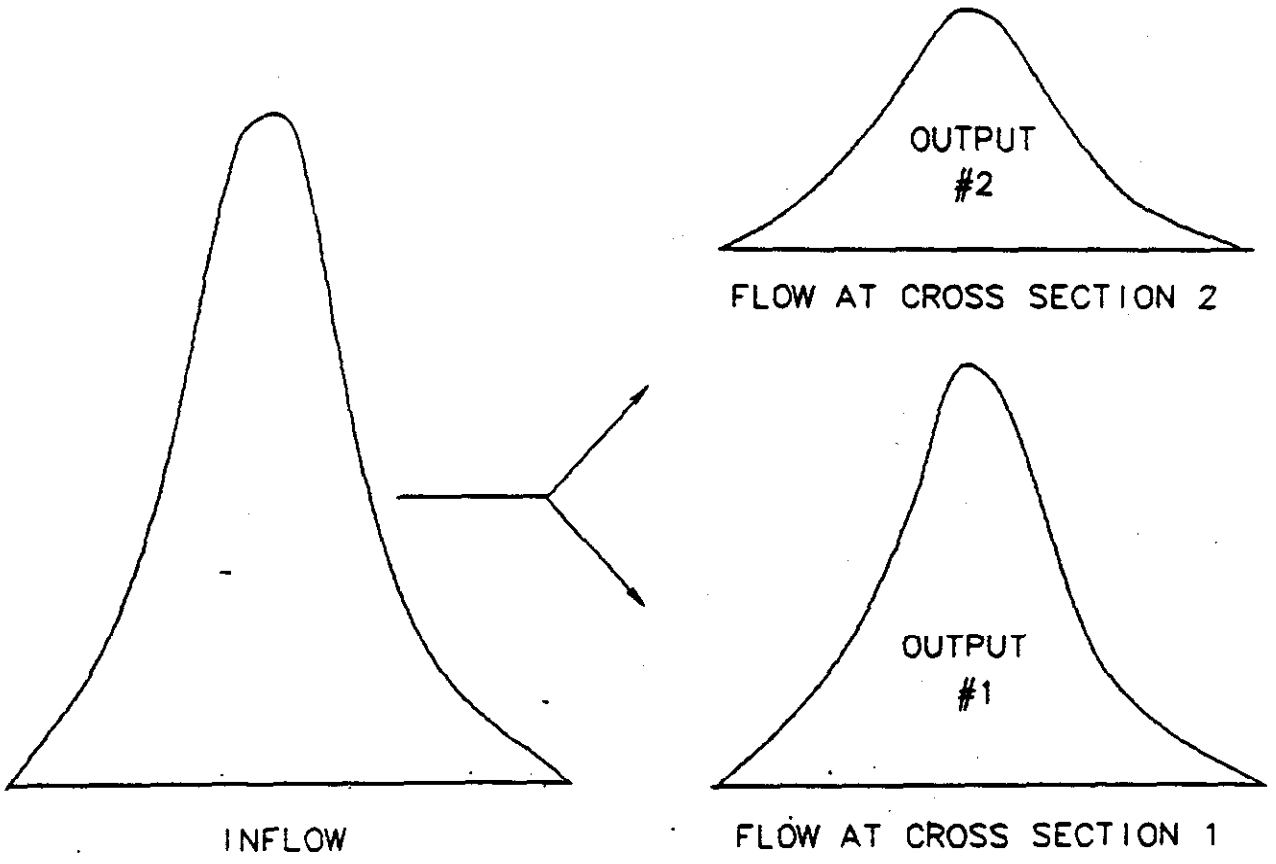


FIGURE 3-9-1-2. DIVERT Procedure 2 with variable flow

The most common use of procedure 2 is where a stream branches into two streams or into a stream and a floodway. See Sample Job 5, Alternate 4, Appendix F for an example of procedure 2.

ENDATA (See also p. 86)

The ENDATA record must be entered at the end of the Standard Control record list. It signifies the end of one complete pass through the watershed.

OUTPUT OPTIONS

The spaces under the "Output Options" heading (Columns 61-71) on all of the Standard Control records permit one to choose the type and kind of hydrograph data to be obtained as output. Table 3-9-1-2 contains information on the six available options. See also Table 3-7-1, p. 30 for the required input option combinations with the JOB record to obtain generated files. If none of the output options or FULLPRINT or SUMMARY are selected, the respective operations will be completed without providing any meaningful output.

TABLE 3-9-1-2. Standard Control output options

Output Option	Use "1" in Column	Produces the following output:
P/V (Peak/ Volume)	61	Peak discharge in cfs; peak time in hours; volume of water above constant baseflow under the hydrograph in inches depth, acre-feet and cfs-hours; and the constant baseflow value in cfs are displayed. Triangular baseflow is included in the volume of the hydrographs. If a rating table is available, the peak elevations are given. Up to 10 highest multiple peaks for each hydrograph will be displayed. If the FULLPRINT option is specified in the JOB record, the P/V option will automatically display the above information for all Standard Control records.
HYD	63	Discharge versus time hydrograph is displayed in tabular form. The main time increment is the time interval between tabulated discharges. Only that part of the hydrograph above zero flow or above baseflow if there is baseflow, is shown (subject to the 400 point limit).

ELEV	65	Elevation versus time hydrograph is displayed in tabular form. The elevation value will correspond to the HYD option discharge value. The ELEV option is usually requested only at cross sections and structures and then only if a rating table is available. For example, the ELEV option should not be selected on the RUNOFF records, nor at REACH records without cross-sectional data.
DUR	67	Discharge versus duration of time that a discharge is equalled or exceeded is tabulated. Up to twelve time-discharge values are shown depending on total base time of the hydrograph. The duration table provides a comment if the hydrograph is truncated or if it is terminated at base flow or below zero damage. To obtain duration data for ECON2 the 1 DURINC table must be entered along with the DUR option at the requested cross sections.
FILE	69	A discharge hydrograph file is generated in a "Read Discharge Hydrograph" (7 READHD) format for use as input to a subsequent TR-20 run. Each hydrograph is identified by the XSECTN/STRUCT number and the alternate and storm numbers in column 73-80 of the first two records. To also display the hydrograph in the output for identification comparison the HYD option must be set to 1. The discharge hydrograph file will be saved on the directory and file name prefix of the users choice and an extension of TRD ("prefix".TRD). See also Table 1-1 (p. 5).
SUM	71	The Standard Control operation results are saved for Summary Tables 1 and 3 and ECON2/URB1 generated files. Each entry in the summary is identified by alternate, storm number, and the cross section or structure identification number. Only the largest peak discharge for each hydrograph is listed in the summary. If the summary is called for at more than one operation with the same cross section or structure number, only the last summary location will be printed in Summary Tables 3 and 4.

If the SUMMARY option is specified on the JOB record, the SUM output option on individual operations is not needed. One of these options must be used to save peak information if the ECON option is specified on the JOB record.

RUNOFF

3.9.2 RUNOFF - STANDARD CONTROL

Table 3-9-2. RUNOFF record

RUNOFF - Generates a runoff hydrograph for a watershed with given data. For discussion, see page 63.

Data Field (Columns)	Value	Type	Description
2	6	Ie	Data Code signifying Standard Control record.
4-9	RUNOFF	A	Operation name.
11	1	Ie	Operation number.
13-15	Subwatershed ID OR	Ie	Cross section number, 1 thru 200, right justified, OR
16-17	Structure ID	Ie	Structure number, 1 thru 99 right justified.
23	1-7	Ie	Output hydrograph storage location no., 1 thru 7 .
25-36	DA, sq. mi.	Ne	Contributing drainage area, sq miles.
37-48	CN	Ne	Runoff curve number.
49-60	Tc, hours	Ne	Time of concentration, hours.
61	1*	I	P/V, display up to ten peak discharges and runoff volume.
63	1*	I	HYD, display discharge hydrograph.
65	1*	I	ELEV, display elevation of hydrograph.
67	1*	I	DUR, display flow duration data.
69	1*	I	FILE, generate discharge hydrograph file.
71	1*	I	SUM, save results for summary tables.

* Enter 1 to select output option otherwise leave it blank.

Figure 3-9-2. RUNOFF record example

RUNOFF

1 - 12			13 - 24				25 - 36	37 - 48	49 - 60	61 - 72	73 - 80
Data Code	Operation Name	No.	ID XSEC	ID STR	HYDRO.	NO. OUT	Drainage Area sq. mi.	Runoff Curve No.	Time Concentration hours	Output Options	Remarks Identification
6	RUNOFF	1									
6	RUNOFF	1		1		6	1.20	75.	0.33		1 6 6

The RUNOFF record shown above would cause an inflow hydrograph to be developed fcr structure 1 in storage location 6. The subwatershed has a drainage of 1.20 square miles, a CN of 75 and a time of concentration of 0.33 hours. The peak discharge, volume, hydrograph, and flow duration of runoff will be displayed in the output and the results will be tabulated in Summary Tables 1 and 3.

RESVOR

3.9.3 RESVOR - STANDARD CONTROL

Table 3-9-3. RESVOR record

RESVOR - Routes inflow hydrograph through a structure. For discussion, see page 63.

Data Field (Columns)	Value	Type	Description
2	6	Ie	Data code signifying Standard Control record.
4	RESVOR	A	Operation name.
4-9	2	Ie	Operation number.
16-17	Structure ID	Ie	Structure number, 1 through 99, right justified.
19	1-7	Ie	Input hydrograph storage location no., 1 thru 7.
23	1-7	Ie	Output hydrograph storage location no., 1 thru 7.
25-36	Start Routing Elev. Feet	Ne	Surface elevation in feet, that routing begins.
61	1*	I	P/V display up to ten peak discharges and runoff volume.
63	1*	I	HYD, display discharge hydrograph.
65	1*	I	ELEV, display elevation of hydrograph.
67	1*	I	DUR, display flow duration data.
69	1*	I	FILE, generate discharge hydrograph file.
71	1*	I	SUM, save results for summary tables.

* Enter 1 to select the option otherwise leave it blank.

RESVOR

Figure 3-9-3. RESVOR record example

1 – 12			13 – 24					25 – 36	37 – 48	49 – 60	51 – 72	73 – 80
Data Code	Operation Name	Operation No.	ID XSEC	ID STR	HYDRO. IN	NO. OUT		Start Routing Elevation – feet			OUTPUT OPTIONS	Record Identification
6	RESVOR	2										
6	RESVOR	2			6		7	521.5			1	70

The RESVOR record shown above would cause the hydrograph in storage location 6 to be routed through structure 1 and the routed hydrograph to be placed in storage location 7. The routing would begin in the structure at elevation 521.5 feet. The peak discharge, volume under the outflow hydrograph, output hydrograph, the water surface elevations and flow duration data will be displayed and the results will be tabulated in Summary Tables 1 and 3.

REACH

3.9.4 REACH - STANDARD CONTROL

Table 3-9-4. REACH record

REACH - Routes an inflow hydrograph through a stream reach: (Procedure 1) using cross-sectional data; (Procedure 2) - using "x" and "m" values representing a cross-section rating. For discussion, see page 64.

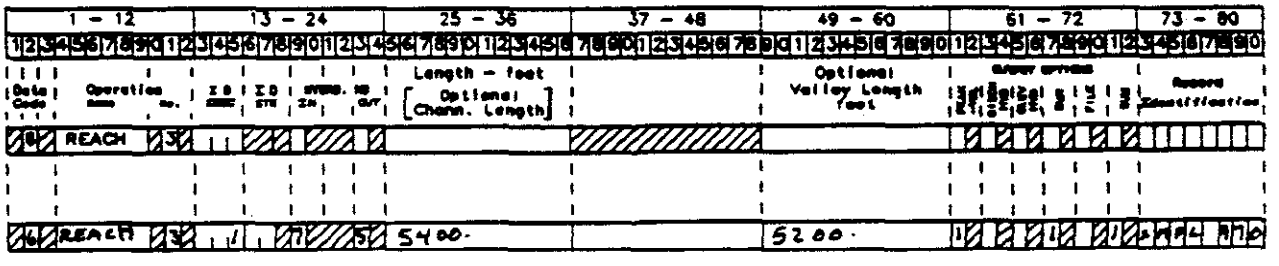
Data Field (Columns)	Value	Type	Description
2	6	Ie	Data code signifying Standard Control record.
4-8	REACH	A	Operation name.
11	3	Ie	Operation number.
13-15	Section ID	Ie	Cross section number, 1 thru 200, right justified.
19	1-7	Ie	Input hydrograph storage location no., 1 thru 7.
23	1-7	Ie	Output hydrograph storage location no., 1 thru 7.
25-36	Reach Length, ft.	Ne	Reach length, feet (see columns 49-60 Procedure 1).
Procedure 1 - Cross-sectional data			
37-48	-	b	Leave blank.
49-60	Flood Plain Length, ft.	N	Floodplain length, feet (optional). If used, the entry in columns 25-36 must be the channel reach length and the low ground elevation must be entered in columns 61-72 of 2 XSECTN header record.
Procedure 2 - "x" and "m" values			
37-48	"x"	Ne	Coefficient, "x" in $Q = xA^m$.
49-60	"m"	Ne	Exponent, "m" in $Q = xA^m$.

Data Field (Columns)	Value	Type	Description
61	1*	I	P/V, display up to ten peak discharges and runoff volume.
63	1*	I	HYD, display discharge hydrograph.
65	1*	I	ELEV, display elevation of hydrograph.
67	1*	I	DUR, display flow duration data.
69	1*	I	FILE, generate discharge hydrograph file.
71	1*	I	SUM, save results for summary tables.

* Enter 1 to select the option otherwise leave it blank.

Figure 3-9-4. REACH record examples

Procedure 1:



This REACH record causes the hydrograph in storage location 7 to be routed through 5400 feet of channel represented by cross section 1 with the outflow hydrograph stored in location 5. The floodplain length is 5200 feet, indicating a meandering pattern for this reach of the stream. The program will use the cross section data in XSECTN 001 to do the routing. The peak discharge, volume, and flow duration data will be displayed and the results tabulated in Summary Tables 1, 2, and 3.

REACH

Procedure 2:

1 – 12	13 – 24	25 – 36	37 – 48	49 – 60	61 – 72	73 – 80
Data Code	Operation Name / No.	Length feet	(Optional) Endrea Coeff x	(Optional) Exponent m	Current Options	Record Identification
5	REACH 3					
6	REACH 3	5400	1.2	1.1		

This REACH record causes the hydrograph in storage location 7 to be routed through 5400 feet of channel represented by cross section 1 with the outflow hydrograph stored in location 5. The "x" and "m" values provided are used in the routing procedure. The peak discharge, the volume under the outflow hydrograph, and the outflow hydrograph flow duration data will be displayed. The results will be tabulated in Summary Tables 1, 2, and 3.

ADDHYD

3.9.5 ADDHYD - STANDARD CONTROL

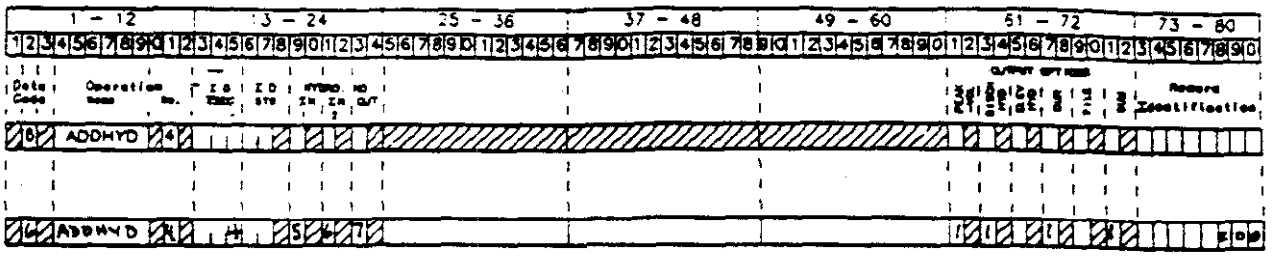
Table 3-9-5. ADDHYD record

ADDHYD - Adds two hydrographs together to generate the resultant hydrograph. For discussion, see page 66.

Data Field (Columns)	Value	Type	Description
2	6	Ie	Data code signifying Standard Control record.
4-9	ADDHYD	A	Operation name.
11	4	Ie	Operation number.
13-15	Section ID	Ie	Cross section no., 1 thru 200, right justified,
	OR		OR
16-17	Structure ID	Ie	Structure no., 1 thru 99, right justified.
19	1-7	Ie	Input hydrograph storage location no., 1 thru 7.
21	1-7	Ie	Input hydrograph storage location no., 1 thru 7.
23	1-7	Ie	Output hydrograph storage location no., 1 thru 7.
61	1*	I	P/V, display up to ten peak discharges and runoff volume.
63	1*	I	HYD, display discharge hydrograph.
65	1*	I	ELEV, display elevation of hydrograph.
67	1*	I	DUR, display flow duration data.
69	1*	I	FILE, generate discharge hydrograph file.
71	1*	I	SUM, save results for summary table.

* Enter 1 to select the option otherwise leave it blank.

Figure 3-9-5. ADDHYD record example



This ADDHYD record causes the hydrograph in storage location 5 to be combined (added) with the hydrograph in location 6 and the resulting hydrograph placed in location 7. The peak discharge(s), the volume under the hydrograph, the output hydrograph, and flow duration data will be displayed and the results will be tabulated in Summary Tables 1 and 3.

3.9.6 SAVMOV - STANDARD CONTROL

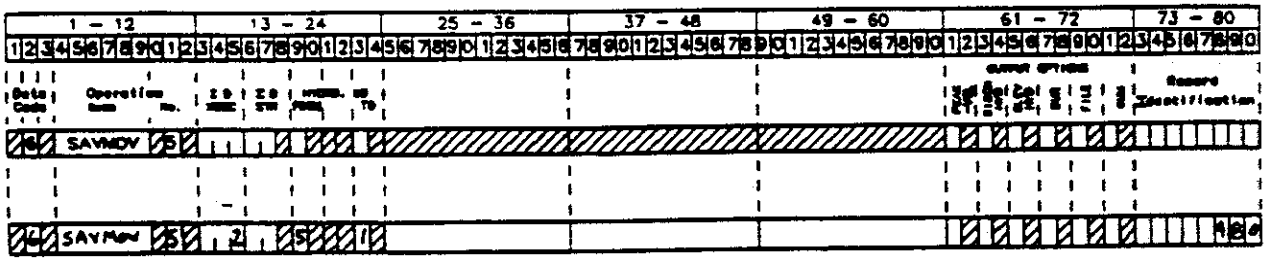
SAVMOV

Table 3-9-6. SAVMOV record

SAVMOV - Moves a hydrograph without changing it from one storage location to another. The hydrograph in both locations can then be available as input into other Standard Control operations. For discussion, see page 66.

Data Field (Columns)	Value	Type	Description
2	6	Ie	Data Code signifying Standard Control record.
4-9	SAVMOV	A	Operation name.
11	5	Ie	Operation number.
13-15	Section ID OR	Ie	Cross section number 1 thru 200, right justified. OR
16-17	Structure ID	Ie	Structure number 1 thru 99, right justified.
19	1-7	Ie	"From" hydrograph storage location no., 1 thru 7.
23	1-7	Ie	"To" hydrograph storage location no., 1 thru 7.

Figure 3-9-6. SAVMOV record example



This SAVMOV record causes the hydrograph in hydrograph storage location 5 to be copied to location 1. The associated cross section number is 2. No output options are active with SAVMOV.

DIVERT

3.9.7 DIVERT - STANDARD CONTROL

Table 3-9-7. DIVERT record

Divert - Separates flow into: (Procedure 1) two hydrographs, above and below a constant discharge; (Procedure 2) two hydrographs split between two rating curves. For discussion, see page 67.

Data Field (Columns)	Value	Type	Description
2	6	Ie	Data Code signifying Standard Control record
4-9	DIVERT	A	Operation name.
11	6	Ie	Operation number.
13-15	Section ID*	Ie	Cross section number 1 thru 200, right justified,
	OR		OR
16-17	Structure ID*	Ie	Structure number 1 thru 99, right justified.
19	1-7	Ie	Input hydrograph storage location no. 1 thru 7.
21	1-7	Ie	Output hydrograph #1 storage location no. 1 thru 7.
23	1-7	Ie	Output hydrograph #2 storage location no., 1 thru 7.
Procedure 1 - divert constant discharge			
25-36	Discharge	Ne	Specified discharge in cfs above which hydrograph is to be diverted, output hydrograph No. 1.
37-48	DA,fraction	N	Decimal fraction of drainage area to be associated with output hydrograph #1 (used only to split the drainage area).
49-60	Section ID followed by a decimal point	N	Cross section number associated with output hydrograph #2 (1. to 200.).

Data Field (Columns)	Value	Type	Description
Procedure 2 - divide flow between two rating curves			
25-36	--		Leave Blank.
37-48	DA,fraction	N	Decimal fraction of drainage area to be associated with output hydrograph #1 (used only to split the drainage area).
49-60	Section ID followed by decimal point	Ne	Cross-section number associated with output hydrograph #2 (1. to 200.). Required for Procedure #2.
61	1**	I	P/V, display up to ten peak discharges and runoff volume.
63	1**	I	HYD. display discharge hydrograph.
65	1**	I	ELEV display elevations associated with hydrograph.
67	1**	I	DUR, display flow duration data.
69	1**	I	FILE, generate discharge hydrograph file.
71	1**	I	SUM, save results for summary tables.

Notes:
* Input ID number is associated with output hydrograph #1.
** Enter 1 to select the option, otherwise leave it blank.

DIVERT

Figure 3-9-7. DIVERT record examples

Procedure #1:

1 - 12			13 - 24					25 - 36	37 - 48	49 - 60	61 - 72	73 - 80
Data Code	Operation Name	No.	ID XSEC	ID STR	HYDRO. IN	HYDRO. OUT 1	NO OUT 2	Diverted Discharge cfs	D.A. Ratio with OUT 1	XSEC ID with OUT 2 (use decimal)	OUTPUT OPTIONS	Record Identification
6	DIVERT	6										
6	DIVERT	6	5		5	7	1	100.	0.4	8.	1 1	5 0 0

This divert record causes the hydrograph in storage location 5 to be separated into two hydrographs. The hydrograph equal to and less than 100 cfs will be placed into storage location 7 and will be associated with cross section 5. The remainder of the hydrograph, all discharges above 100 cfs, will be placed into storage location 1 as output hydrograph #2 and it is associated with cross section 8. Output hydrograph #1 represents 40% of the drainage area. Therefore, 40% of the drainage area will be associated with cross section 5 and 60% with cross section 8. The peak discharges, the hydrographs, volumes and flow duration data will be displayed and the results tabulated in Summary Tables 1 and 3.

Procedure #2:

1 - 12			13 - 24					25 - 36	37 - 48	49 - 60	61 - 72	73 - 80
Data Code	Operation Name	No.	ID XSEC	ID STR	HYDRO. IN	HYDRO. OUT 1	NO OUT 2		D.A. Ratio with OUT 1	XSEC ID with OUT 2 (use decimal)	OUTPUT OPTIONS	Record Identification
6	DIVERT	6										
6	DIVERT	6	5		5	7	1		0.9	8.	1	7 5 0

This example is similar to the example for procedure 1. The primary difference is that since columns 25-36 are blank, procedure #2 is invoked. The input hydrograph will be split proportionately using the data in cross section tables number 5, and number 8. Ninety percent (90%) of the drainage area will be associated with cross section number 5. Both hydrographs will be displayed and results included in Summary Tables 1 and 3.

ENDATA

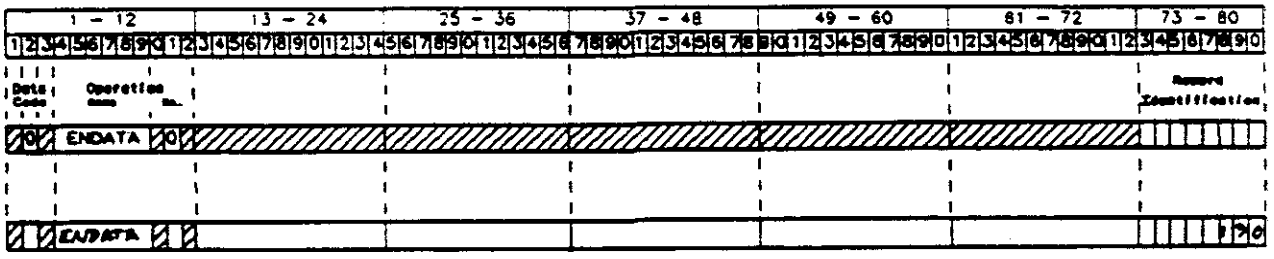
3.9.8 - ENDATA - STANDARD CONTROL

Table 3-9-8. ENDATA record

ENDATA - Indicates the end of the Standard Control records for the initial pass through the watershed. For discussion, see page 70.

Data Field (Columns)	Value	Type	Description
2	--	I	Data Code, blank or zero.
4-9	ENDATA	Ae	Operation name.
11	--	I	Data Code, blank or zero.

Figure 3-9-8. ENDATA record example



The ENDATA record signifies that the Standard Control sequence and all tabular data for the initial pass of the job have been read in and the Executive Control will follow.

3.10 EXECUTIVE CONTROL RECORD SPECIFICATIONS

3.10.1 Discussion of Input

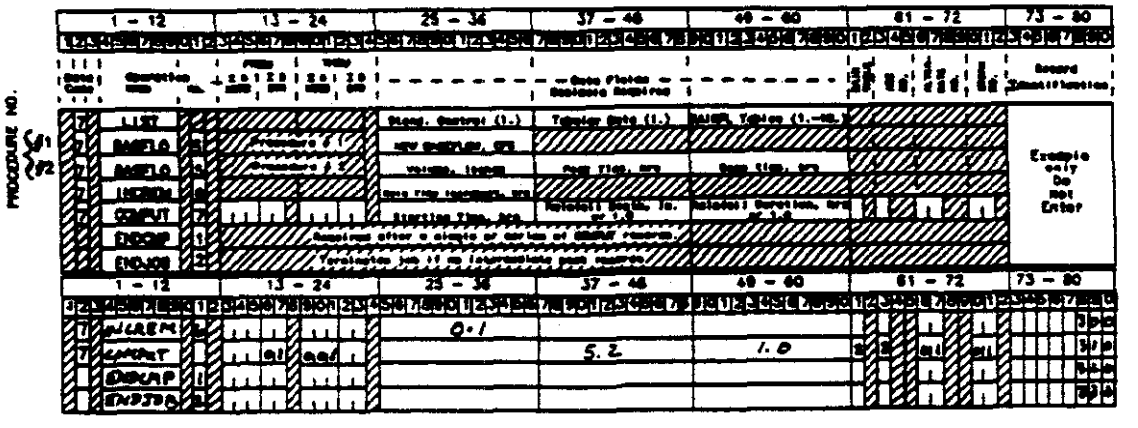
The Executive Control has two functions: (1) to cause the Standard Control records to be executed and (2) to provide additional data necessary for processing. The Executive Control consists of five types of records (see forms, Appendix G, pages G-19 and G-21). They are LIST, BASFLO, INCREM, COMPUT, and ENDCMP. The 7 READHD table is also an Executive Control type, but it is covered under Tabular Data in Section 3.8.7 of this manual. The Executive Control records are placed after the Standard Control records and tabular data to which they pertain.

While the Standard Control is used to describe the physical characteristics of the watershed, the Executive Control is used to prescribe the meteorological conditions of the watershed including the baseflow. The workhorse of the Executive Control record is the COMPUT record. Its purpose is to prescribe the rainfall and the part of the watershed over which that rainfall is to occur.

All Executive Control records except ENDCMP must have a "7" in column 2. Columns 4-9 are used for the Executive Control operation name. Column 11 is used for the Executive Control operation number which is used by the computer to identify the type of operation.

An example taken from a worksheet in Sample Job 1, Appendix B, is repeated below. The three Executive Control records in the example are the minimum required for a TR-20 computer run. The 7 INCREM 6 record prescribes the main time increment to be used in the run. The 7 COMPUT 7 record causes computations to begin at structure 1 of the Standard Control and proceed through cross section 1 using the rainfall data given in the remainder of the line. The ENDCMP 1 record causes the COMPUT record computations to end. ENDJOB is a job control record but is shown here to identify its typical location.

Figure 3-10-1-1. Example of Executive Control input



7 LIST (See also p. 94)

The LIST Executive control record causes a list of current tabular data and standard control records (including output options in effect) to be displayed. The LIST record will normally be placed (1) prior to the first COMPUT record and/or; (2) after changes in tabular data and Modify Standard Control. The user has the option to list the current Standard Control, the current cross section and structure tables, the flow duration increment table, dimensionless hydrograph table and the rainfall tables, or the entire input data file. One may further choose to list all of the rainfall tables embedded in the program or a selected one.

7 BASFLO 5 (See also p. 96)

The BASFLO Executive Control record causes a baseflow to be added to a flood hydrograph. Two baseflow procedures are available (1) constant and (2) triangular baseflow. For both procedures, the BASFLO precedes a COMPUT. The COMPUT will govern the reaches or subwatersheds in which baseflow will be added. Only one BASFLO record may be used ahead of a COMPUT. If more than one is entered, the last one entered will be used. Both baseflow procedures may be used in the same job providing the above restrictions are met. Figure 3-5 illustrates both procedures.

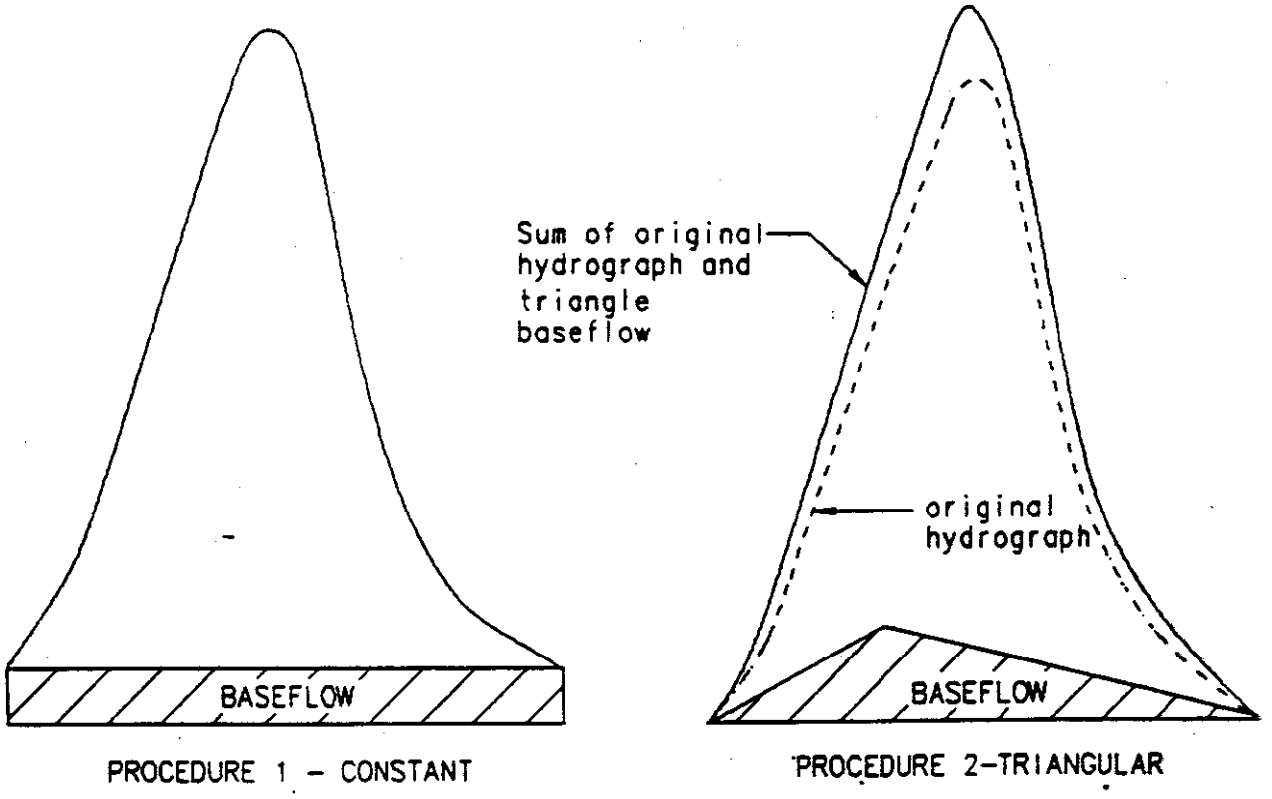


Figure 3-10-1-2. BASFLOW, Procedure 1 and 2

BASEFLOW Procedure 1 -- A uniform constant rate of baseflow can be added to hydrographs only in a reach routing. The total baseflow in cfs is entered in columns 25-36 of the BASFLO record. Procedure 1 is invoked by leaving columns 37-48 and 49-60 either blank or zero.

The baseflow will be combined only with the inflow hydrograph in the next REACH routing following the COMPUT. If a runoff precedes this reach, no baseflow is contained in the hydrograph for that runoff. The baseflow is added in the reach and will remain the same through subsequent reaches that are in a downstream sequence until the ENDCMP is encountered or a new BASFLO and COMPUT record combination is entered. The new baseflow can be greater or less than the one previous. The previous cfs baseflow that is in use is replaced with the new cfs when a new BASFLO record is entered. A new BASFLO of zero or a ENDCMP will eliminate the constant baseflow in the next reach. The baseflow can be changed at any downstream reach by breaking the COMPUT series into appropriate FROM-THRU segments and inserting a new BASFLO record.

Tributaries need to have separate BASFLO and COMPUT records if constant baseflow is to be included in tributary hydrographs. Baseflow from tributaries will be added to main stem baseflow when hydrographs are added.

Constant baseflow is assumed to be the flow prior to, during, and continuing on after the storm runoff. In practice, flood hydrographs are stored in the program with their first and last point at zero cfs or at the constant cfs baseflow, unless the maximum point limitation truncates the hydrograph. When hydrographs of different start of runoff and base times are added, the constant baseflow of the shorter hydrograph is still added to the base of the longer hydrograph.

The DIVERT Standard Control record (both procedures) will split constant baseflow. However, the program's accounting will not include any constant baseflow in the storm runoff volume.

Besides actual baseflow, Procedure 1 is commonly used to represent a steady flow source unrelated to the storm runoff being modeled such as prolonged release rates from a previous storm at a structure or swamp outlet.

BASEFLOW Procedure 2 -- A triangular baseflow hydrograph can be added to any subwatershed runoff hydrograph. The volume of baseflow in watershed inches is entered in columns 25-36. The peak time in hours from the beginning of the runoff to the baseflow hydrograph peak is entered in columns 37-48. The time in hours for the triangular hydrograph base is entered in columns 49-60. This base time must be less than or equal to the time associated with the maximum 400 hydrograph coordinate points to avoid a fatal program error.

The triangular baseflow will be combined with the next and all subsequent runoff hydrographs including tributaries, until a ENDCMP record is encountered or a new or zero BASFLO and COMPUT record combination is added. Triangular baseflow can not be separated from the flood hydrograph once it is added. It is included in the storm runoff volume each time it is added to a runoff hydrograph.

Procedure 2 can be used to represent storm related ground water flow or flow from small lakes or swamps that can be delineated as storage areas with triangular baseflow outflow hydrographs.

7 INCREM 6 (See also p. 98)

The INCREM Executive Control record specifies the main time increment in hours. It remains in effect until superseded by the insertion of a new INCREM record.

All hydrographs generated will be stored and printed at time intervals given by this main time increment with a maximum of 400 coordinates. It is important that the main time increment be made short enough to adequately describe the hydrographs for the smaller subwatershed and large enough that, when multiplied by the number of coordinates, will extend past the peak periods of larger hydrographs so as not to significantly truncate the hydrograph volume used in reach and reservoir routing.

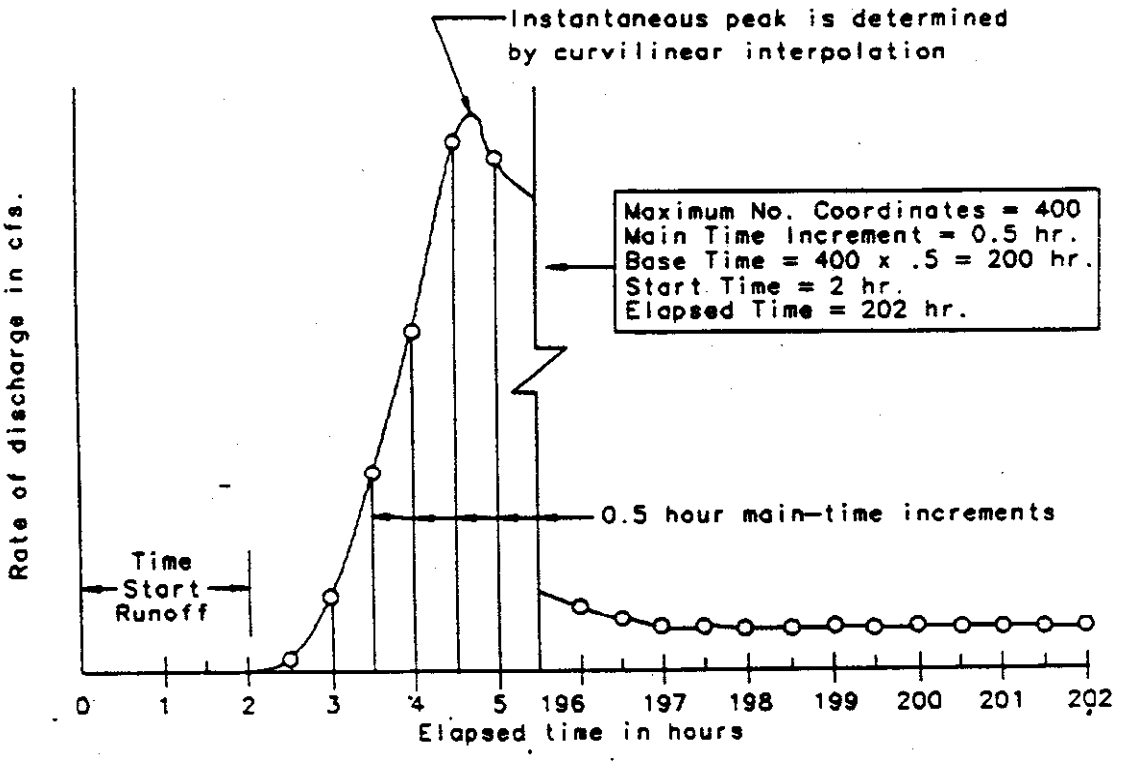


Figure 3-10-1-3. Hydrograph coordinates for main time increment of 0.5 hours

Increments of 0.5 hr., demonstrated in Figure 3-10-1-3, will not adequately define the hydrograph peak for a small subwatershed having a time of concentration of less than one hour (See Hydrograph Development, Section 2.1).

Conversely, a main time increment of 0.1 hr. with 400 coordinates will define only 40 hours of a hydrograph. In some cases this requires that less accuracy in runoff hydrograph definition be tolerated to obtain enough of the larger watershed hydrographs.

The computed peak, as described in Hydrograph Development, Section 2.1, is computed by fitting a curve through the three highest consecutive main time increment points and very rarely falls on a hydrograph coordinate.

An INCREM record must precede the first COMPUT record of any series of COMPUT records. The main time increment is usually held constant during the entire pass through a watershed. It may vary during a pass through the watershed if the time increments increase as one moves down through the Standard Control.

The main time increment is also the time interval used in the Storage Indication method of reservoir routing and in the Modified Att-Kin method of reach routing. A discussion of the time increment in relation to accuracy of reservoir routing is contained in Section 3.8.1 under structure Data Table. For more accurate reach routings the time increment is recommended to be less than the reach travel time. Details concerning time increments and travel times are in Hydrology Note 2.

7 COMPUT 7 (See also p. 99)

The COMPUT Executive Control record controls the processing within a watershed. It specifies the cross section and/or structure locations where routings are to begin and end. It also gives the rainfall starting time, depth and duration, rain table number and antecedent runoff condition that is to apply between the beginning and ending locations. A single COMPUT record may extend over the Standard Control records of an entire watershed or of a part of a watershed. The user may specify an alternate number (1 to 99) and a storm number (1 to 99, with no more than 10 storms per run) on each COMPUT record to keep track of the passes through the watershed.

The starting point for computation is specified by a cross section or structure number (but not both). This number must correspond to a cross section or structure that appears in the xsection/structure column of a record in the Standard Control. Computations will commence with the first cross section or structure number specified under "from" in the COMPUT record and continue through the sequence of Standard Control operations until the end of the first consecutive occurrence of the cross section or structure specified under "thru" has been reached and completed. The computation stops when a record is encountered with a cross section or structure number different and beyond that under "thru". The next Executive Control record is then executed. For example, a COMPUT record contains cross section numbers FROM 001 THRU 007. If two operations at the top of the standard control are both numbered 001, computation begins with the first operation labeled 001. Near the bottom of the standard control, REACH 007 is followed immediately by ADDHYD 007. The program will compute through the ADDHYD. However, if the REACH 007 is followed by RUNOFF 008 and then ADDHYD 007, the computations stop at REACH 007.

Thus, a COMPUT record for Sample Job 3, Appendix D, instructed processing from structure 01 through cross section 004, computation would stop after the 6 ADDHYD 004 record, which is the last Standard Control record for cross section 004. The next instruction is another COMPUT record commencing with the next record in the Standard Control list. The next COMPUT could have changes in one or more data fields; or it could have been an ENDCMP record, resetting the Standard Control list to the first record. This would enable the user to make changes in the tabular or Standard Control data and then continue with another set of Executive Control records.

The rainfall that is to apply to the area covered by the COMPUT record is specified by giving a Rain Table number (column 61) and starting time (Column 25-36) on the COMPUT record. Proper multipliers, or actual values, are entered in Columns 37-48 and 49-60 for Rainfall Depth and Rainfall Duration.

In Standard SCS Rain Tables 1 through 5 (program defaults), the rainfall depth is dimensionless and the time increment is in hours with a total duration of 24 or 48 hours. Therefore, the rainfall depth in inches must be inserted as a multiplier under Rainfall Depth, and a 1.0 under Rainfall Duration. In Standard SCS Rain Table 6 (program default), both the rainfall depth and the time are dimensionless. Therefore, the rainfall depths in inches and duration in hours are inserted as multipliers under both Rainfall Depth (column 37-48) and Rainfall Duration (column 49-60), respectively, on the COMPUT record. Natural storms usually defined as cumulative rainfall depth in inches and time increment in hours may be assigned any table number from 1 through 9. In these cases a 1.0 should be inserted under both Rainfall Depth and Rainfall Duration on the COMPUT record.

An Antecedent Runoff Condition of 1, 2, or 3 must be specified under ARC (column 63 of the COMPUT record). They represent the three

antecedent runoff conditions (ARC) I, II, and III described in Chapter 4, NEH-4, where ARC I and III are runoff condition limits. The runoff curve numbers on the RUNOFF records in the Standard Control format are for an ARC II condition (the average antecedent runoff condition). When a dry condition limit, I, or a wet condition limit, III, are specified under ARC, the curve number is adjusted according to Table 10.1 of NEH 4 by the program. When using a natural storm where the runoff curve number falls between ARC I and ARC II or between ARC II and ARC III, the user should enter the adjusted runoff curve numbers on the RUNOFF Standard Control records and enter ARC 2 on the COMPUT record. The entry describing ARC on the COMPUT record must be numeric (1, 2, or 3,) although historically the literature has used the Roman numerals I, II, and III.

In many cases, a uniform rainfall will be applied over the entire watershed so that only a single COMPUT record is required. However, a series of COMPUT records may be given with different rainfall depths extending over different parts of the watershed. Normally, these COMPUT records will extend over successive parts of the

Standard Control list. For a given COMPUT record, the cross section or structure numbers appearing under "thru" must always be farther down the Standard Control list than the cross section or structure numbers appearing under "from." Likewise the cross section or structure numbers appearing in one of a series of COMPUT records (not separated by an ENDCMP record) must also be farther down on the Standard Control list than the cross section or structure given for a previous COMPUT instruction. A series of COMPUT records may also be used within a single pass through the Standard Control list for changing baseflow, the starting time of rainfall, the rain table, and the runoff condition (ARC).

ENDCMP 1 (See also p. 101)

An ENDCMP record signifies the end of one or more COMPUT records in a series. Normally this completes a "pass" through the entire watershed. There is no limit on the number of passes that can be made through a watershed. The Pass Number will be sequentially increased by one each time an ENDCMP record is encountered.

All hydrograph storage locations are cleared with an ENDCMP. At this point, (1) additional COMPUT records may be used with a different storm, or (2) additional or changed tabular data and/or Modify Standard Control can be followed by additional Executive Control, such as LIST, INCREM, BASFLO and COMPUT records to process the modification, or (3) the ENDJOB record may be used to end the job.

3.10.2 LIST - EXECUTIVE CONTROL

Table 3-10-2. LIST record

LIST - Causes the entire set of current tabular and Standard Control input data or specified portions of it to be listed in the output. For discussion, see page 88.

Data Field (Columns)	Value	Type	Description
2	7	Ie	Data code signifying Executive Control record.
4-7	LIST	A	Operation name.
11	-	B	Blank or zero
25-36	1.*	N	Output current Standard Control only. Enter a 1.
37-48	1.*	N	Output current XSECTN and STRUCT tables only. Enter a 1.
49-60	RAINFL Table Number 1. to 10.*	N	Output current DURINC, DIMHYD, and RAINFL tables only. To list a single rainfall table, enter its number 1. to 9. To show all the rainfall tables, enter 10. The DURINC and DIMHYD tables are automatic.

* Numbers in Data Fields (columns 25-60) must be followed by decimal points. To obtain a complete set of current data, leave all of these columns blank.

LIST

Figure 3-10-2. LIST record example

1 – 12			13 – 24	25 – 36	37 – 48	49 – 60	61 – 72	73 – 80
Data Code	Operation Name	Operation No.		Enter 1.0 for Current Standard Control	Enter 1.0 for XSECTN & STRUCT Tables	For Other Tables Enter RAINFL Table No.		Remark Identification
7	LIST	0						
						[1.0 to 9.0 or 10.0 = All]		
7	LIST			1.0		2.		CH

BASFLO

3.10.3 BASFLO - EXECUTIVE CONTROL

Table 3-10-3. BASFLO record

BASFLO - Causes a baseflow to be added to a flood hydrograph. For discussion, see page 88-90.

Data Field (Columns)	Value	Type	Description
2	7	Ie	Data code signifying Executive Control record.
4-9	BASFLO	A	Operation name.
11	5	Ie	Operation number.
Procedure 1 - Baseflow is constant			
25-36	Baseflow cfs	Ne	Baseflow, cfs, to be added to next reach inflow hydrograph.
37-60	--		Leave Blank.
Procedure 2 - Baseflow is triangular hydrograph			
25-36	Volume inches	Ne	Volume of baseflow in watershed inches, to be added to all subwatershed runoff hydrographs.
37-48	Peak Time hours	Ne	Time, in hours to peak of baseflow hydrograph (measured from beginning of runoff).
49-60	Base Time hours	Ne	Time, in hours, of triangular hydrograph base (must be within 400 point limitation).

BASFLO

Figure 3-10-3. BASFLO record examples

Procedure 1 (constant baseflow):

1 - 12	13 - 24	25 - 36	37 - 48	49 - 60	61 - 72	73 - 80
Date Code	Operation Name	No.		NEW Baseflow cfs		Record Identification
7	BASFLO	5				
7	BASFLO	5		10.0		99

This BASFLO record will cause a baseflow of 10.0 cfs to be added to the next reach routed hydrograph. It will remain the same in all downstream hydrographs associated with the COMPUT records following this BASFLO record unless an ENDCMP record is encountered or the baseflow is changed by succeeding BASFLO and COMPUT records.

Procedure 2 (triangular baseflow hydrograph):

1 - 12	13 - 24	25 - 36	37 - 48	49 - 60	61 - 72	73 - 80
Date Code	Operation Name	No.		Triangular Hydrograph Baseflow		Record Identification
		Volume inches	Peak Time hours	Base Time hours		
7	BASFLO	5				
7	BASFLO	5		0.26	17.8	20.2

This BASFLO record will cause a hydrograph in the shape of a triangle to be added to the next runoff hydrograph. It will be added to all runoff hydrographs associated with the next and all subsequent COMPUT records until an ENDCMP record is encountered or the baseflow is changed by succeeding BASFLO and COMPUT records. The baseflow hydrograph will have a total volume (area under the triangle) of 0.26 watershed inches. The hydrograph will begin at the start of runoff, peak at 17.8 hours and have a base of 20.2 hours.

INCREM

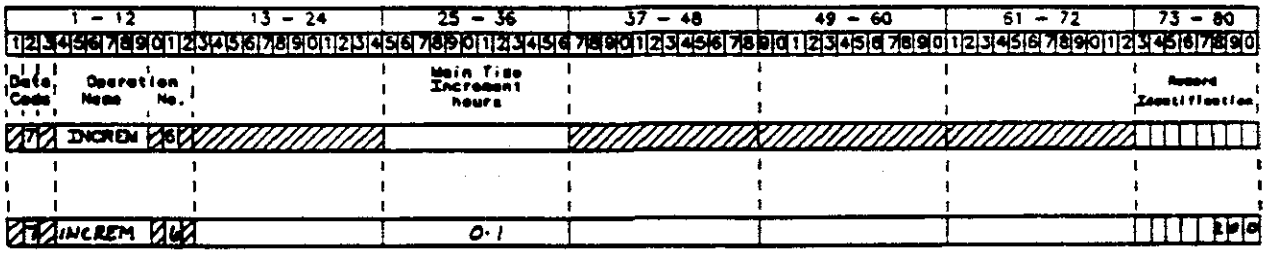
3.10.4 INCREM - EXECUTIVE CONTROL

Table 3-10-4. INCREM record

INCREM - Specifies the main time increment in hours used to store and route all hydrographs. For discussion, see page 90.

Data Field (Columns)	Value	Type	Description
2	7	Ie	Data code signifying Executive Control record.
4-9	INCREM	A	Operation name.
11	6	Ie	Operation number.
25-36	Main Time Increment hours	Ne	Main time increment in hours, usually in the range of 0.1 to 1.0 hours.

Figure 3-10-4. INCREM record example



This INCREM record causes all hydrographs created within the TR-20 program to have a main time increment of 0.1 hours unless the main time increment is changed by a subsequent INCREM record. Since there are 400 hydrograph ordinates, the runoff hydrographs will have a base time of 40 hours from the time runoff begins. It is suggested that the user select the time increment to the nearest tenth of an hour (0.1) as this will facilitate reading the hydrograph tables in the output listing.

3.10.5 COMPUT - EXECUTIVE CONTROL

COMPUT

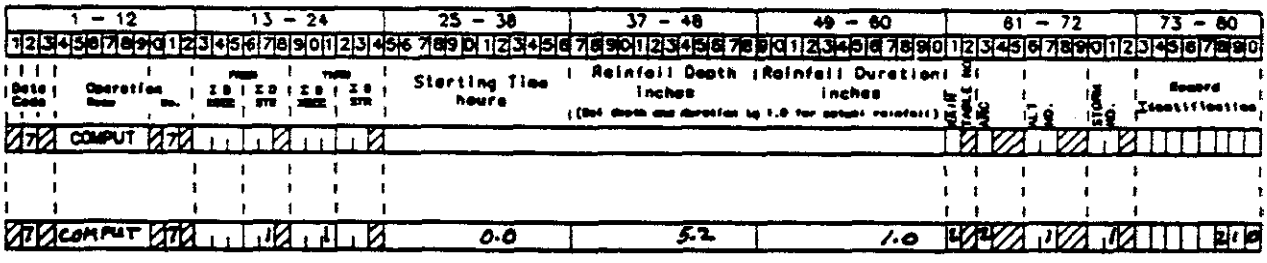
Table 3-10-5. COMPUT record

COMPUT - controls processing within a watershed. It designates where to begin and end Standard Control computations, gives rainfall table, starting time, depth, duration, antecedent runoff condition, and alternate and storm labels. For discussion, see page 91.

Data Field (Columns)	Value	Type	Description
2	7	Ie	Data code signifying Executive Control record.
4-9	COMPUT	A	Operation name.
11	7	Ie	Operation number.
13-15	Section ID OR	I	"From" or beginning cross section no. 1 thru 200, right justified, OR
16-17	Structure ID	I	"From" or beginning structure no. 1 thru 99, right justified.
19-21	Section ID OR	I	"Thru" or ending cross section no. 1 thru 200, right justified, OR
22-23	Structure ID	I	"Thru" or ending structure no. 1 thru 99, right justified.
25-36	Start Time hours	Ne	Starting time in hours; zero if left blank.
37-48	Depth inches or 1.0	Ne	Rainfall depth. If a unit RAINFL table depth is used, enter total rain depth in inches; or if the RAINFL table used cumulative rainfall in inches, enter 1.0.
49-60	Duration hours or 1.0	Ne.	Rainfall duration. If a unit RAINFL table duration is used, enter total duration in hours; or if the RAINFL table time increment is in hours, enter 1.0.

Data Field (Columns)	Value	Type	Description
61	1-9	Ie	Rain table number, 1 thru 9; same as Column 11 of selected 5 RAINFL table header record.
63	1-3	Ie	Antecedent runoff condition, 1, 2, or 3; normally 2 for average runoff condition.
66-67	01-99	I	Alternate number, 01 thru 99; assigned by user to a particular alternative condition. Usually reflects different watershed physical condition.
70-71	01-99	I	Storm number, 01 thru 99; assigned by user with limit of 10 storms per run. Often used to designate different rainfall depths (runoff frequency) with standard SCS RAINFL tables.

Figure 3-10-5. COMPUT record example



This COMPUT record causes hydrographs to be developed and routings to be performed beginning at structure number 1 through cross section 1 (See sample Job Number 1, Appendix B). This is one pass through the complete watershed. The starting time is zero hours. The Standard SCS RAINFL table number 2 is to be used with 5.2 inches of rainfall to create the runoff hydrographs. Since 1.0 is entered in the rainfall duration field, the duration of the rainfall will be as prescribed in the RAINFL table number 2, (240 increments at 0.1 hours = 24 hours). The antecedent runoff condition is 2. The alternate number and storm number are both 1.

ENDCMP

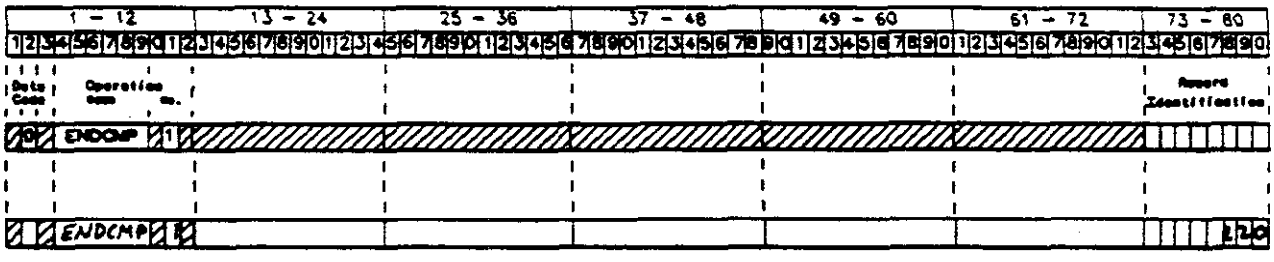
3.10.6 ENDCMP - EXECUTIVE CONTROL

Table 3-10-6. ENDCMP record

ENDCMP - indicates the end of a series of Standard Control computations through a watershed. For discussion, see page 93.

Date Field (Columns)	Value	Type	Description
2	__	I	Data Code, blank or zero.
4-9	ENDCMP	A	Operation name.
11	1	Ie	Operation number.

Figure 3-10-6. ENDCMP record example



The ENDCMP record is required at the end of a series (one or more) COMPUT records. The user may compute through a portion of, or the entire watershed any number of times. Each time the ENDCMP record is used to end a series of COMPUT records. The COMPUT record must always be followed by another COMPUT record, a BASFLO and then a COMPUT record, or an ENDCMP record. Each time an ENDCMP record is encountered the Pass Number is incremented by one.

3.11 MODIFY STANDARD CONTROL RECORD SPECIFICATIONS

3.11.1 Discussion of Input

Having previously described the Standard Control list as a means of establishing a fixed sequence of operations, the means of modifying this fixed sequence for successive passes is described here. The Modify Standard Control records are INSERT, ALTER, and DELETE (see worksheet, Appendix G, page G-22-23). They provide for inserting new records into the Standard Control list, altering data in existing records and deleting any record in the list.

When modifying the Standard Control, processing begins at the top of the Standard Control list and passes one time sequentially through the list. The new Standard Control records must appear in the same sequence as their corresponding records appear in the Standard Control list. Any number or combination of INSERT, ALTER, and DELETE records can be used to maintain this sequence. Modify Standard Control changes are permanently saved automatically in the Standard Control operation sequence.

There is no limit to the number of INSERT, ALTER, and DELETE records that may be used, except that the number of Standard Control records at any time cannot exceed 600. Subject to this constraint, there is also no limit to the number of records that can follow a single Modify Standard Control record.

It is recommended that a LIST record be entered after Modify Standard Control records have been entered. This causes a listing of the current records and enables the user to check if the correct changes have been made.

7 INSERT 2 (See also p. 104)

The INSERT record is used to place one or more new Standard Control records into the existing Standard Control list. It specifies the cross section or structure number after which the insertion is desired. The insertion will be made after the last cross section or structure number in a contiguous series. If there are two series of the same number (separated by some intervening numbers) the insertion will be made at the end of the first series. In Sample Job 5, Appendix F, the first INSERT record in the 3rd alternate is related to section 2 (see page F-7). The two Standard Control records that follow for structure 3 will be inserted after reach 2 in the prior Standard Control list.

The modified sequence must be a continuous sequence of records that fit into the overall Standard Control sequence. This often requires deleting or altering some of the original sequence in order to achieve a continuous sequence. An INSERT record must be used for each location at which an insertion of new data is desired, and any INSERT record must be placed in the same order in which these locations appear on the original Standard Control list.

An INSERT record may not be used to place a record before the first record or after the last record in the Standard Control. In Sample Job 5, Appendix F, a SAVMOV record was used at the end of the list to avoid this situation (Alternate 1, p. F-6). This allowed the insertion after section 7 in Alternate 4 of a REACH at section 8 and an ADDHYD at section 9.

7 ALTER 3 (See also p. 105)

The ALTER record allows changes to be made in a record in the Standard Control sequence. The Standard Control records following the ALTER record completely replace the records to be changed. In locating these records, data given in columns 1 through 17 must be identical with the Standard Control record being altered.

There are situations where two or more Standard Control records will have identical data in columns 1 thru 17. In this case, the change would apply to the first occurrence of the record. If alterations were desired in the second record, the cross section on the Standard Control list would need to be changed to some unused cross section number (reference location). This affixes a unique cross section number as previously described in Section 3.5.

In Sample Job 5, Appendix F, the ALTER record is used in Alternate 3 to revise the reach length for section 3 to 2,000 feet. The reach length was 4,600 feet in the Standard Control for Alternates 1 and 2. The "x" and "m" values remained unchanged, but have to be repeated on the new REACH record.

7 DELETE 4 (See also p. 106)

The DELETE record causes the deletion of the Standard Control records that follow it. When the data in columns 1 thru 17 of the Standard Control record following the DELETE record is identical to that same data on a record in the Standard Control sequence, that record is erased from the Standard Control sequence.

In Sample Job 5, Appendix F, the DELETE record is used to delete the RUNOFF and RESVOR records for structure 2 from the Standard Control list for Alternate 3. Further down in the same Modify Standard Control sequence the DELETE record is used again to delete the RUNOFF and ADDHYD for section 3. Compare listings of input data on pp. F-6, F-13, F-22, and F-29 to see the changes made.

3.11.2 INSERT - MODIFY STANDARD CONTROL

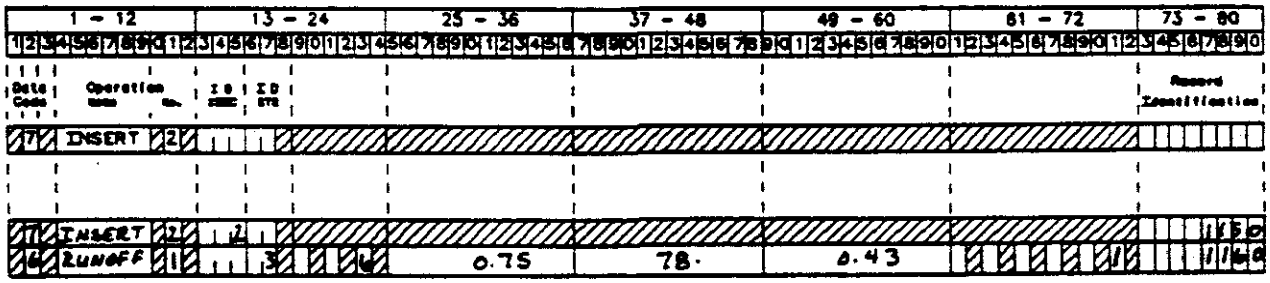
INSERT

Table 3-11-2. INSERT record

INSERT - Allows placement of one or more new lines in the Standard Control following the last use of the specified cross section or structure number in a contiguous series. For discussion, see page 102.

Data Field (Column)	Value	Type	Description
2	7	Ie	Data code signifying Modify Standard Control record.
4-9	INSERT	A	Operation name.
11	2	Ie	Operation number.
13-15	Section ID OR	I	Cross section number 1 thru 200, right justified, OR
16-17	Structure ID	I	Structure no 1 thru 99, right justified.

Figure 3-11-2. INSERT record example



This INSERT record would cause a search of the Standard Control list until finding the first occurrence of cross section 2, then insert the above RUNOFF record into the Standard Control list at a point immediately following the last occurrence of records in a contiguous series containing cross section 2. If there are several series of records containing cross section 2, the insertion will be made after the last record in the first series.

3.11.3 ALTER - MODIFY STANDARD CONTROL

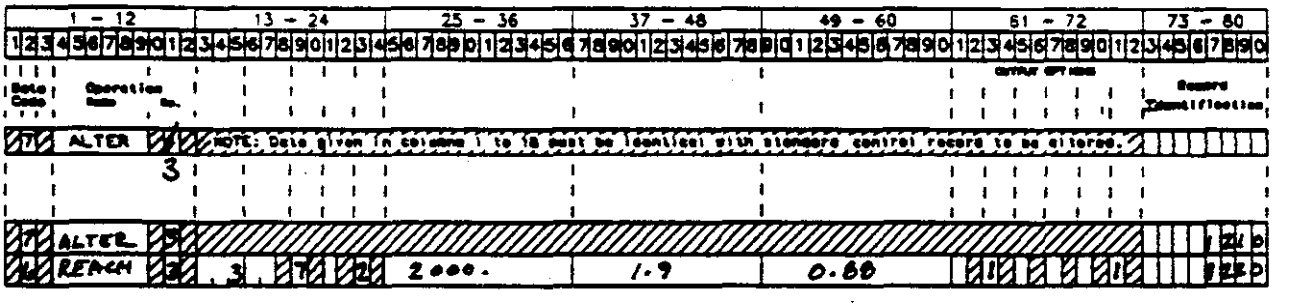
ALTER

Table 3-11-3. ALTER record

ALTER - Allows changes to be made in the Standard Control if records that follow match prior Standard Control in column 1 to 17. For discussion, see page 103.

Data Field (Columns)	Value	Type	Description
2	7	Ie	Data code signifying Modify Standard Control record.
4-8	ALTER	A	Operation name.
11	3	Ie	Operation number.

Figure 3-11-3. ALTER record example



This ALTER record would cause a search of the Standard Control list until the REACH record having section 3 in columns 13-15 is found. The old REACH record is then replaced with the new REACH record for section 3 shown above. Columns 1-17 in the existing REACH record must be identical with those in the replacement REACH record.

3.11.4 DELETE - MODIFY STANDARD CONTROL

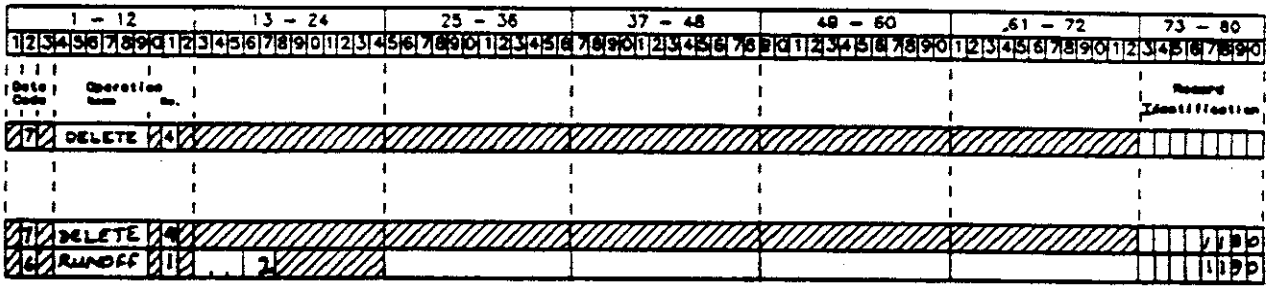
DELETE

Table 3-11-4. DELETE record

DELETE - Removes an entire Standard Control record from prior Standard Control list if records that follow match in columns 1 to 17. For discussion, see page 103.

Data Field (Columns)	Value	Type	Description
2	7	Ie	Data code signifying Modify Standard Control record.
4-9	DELETE	A	Operation name.
11	4	Ie	Operation number.

Figure 3-11-4. DELETE record example



This Delete record would cause a search through the Standard Control list until the first occurrence of a RUNOFF record for structure 2 is found. The RUNOFF record for structure 2 would then be deleted from the Standard Control list.

3.12 INTERMEDIATE PEAK RECORD SPECIFICATIONS

3.12.1 Discussion of Input

Peaks can be computed for additional locations between cross sections/structures using the intermediate peaks records (see worksheet, Appendix G, page G-25). Such intermediate locations may be needed for economic evaluation of the watershed but may not be necessary for development of the hydrology and hydraulics. Using intermediate peaks can reduce the number of Standard Control records by eliminating some small subwatersheds and short reaches.

Intermediate Peaks are interpolated between two cross sections/structures based on relative drainage area size. The following relationships are used in the interpolation.

$$Peak_I = Peak_1 \times (D.A._I/D.A._1)^{Exponent}$$

where: $$Exponent = \frac{\log (Peak_2/Peak_1)}{\log (D.A_2/D.A._1)}$$

and: Peak = peak discharge, cfs
D.A. = drainage area, square miles
subscript I = intermediate location
subscript 1 and 2 = upstream and downstream reference section or structure

Intermediate peak records are placed at the end of a job after the last ENDCMP record at the end of the last set of Executive Control. An ENDJOB record is used after the last PEAKS record. (See sample job 5, Appendix F, the last three input records on F-8.)

IPEAKS (See also p. 109)

The IPEAKS record initiates the computation and precedes the PEAKS records.

PEAKS (see also p. 110)

The intermediate peak locations are defined on PEAKS records. There is no limit to the number of intermediate peaks that can be calculated in a job. Up to four intermediate locations can be identified on each PEAKS record.

The computations are based on Summary Table 3 or 3A (3/3A) drainage areas and peaks. If there are multiple Standard Control operations with the same cross section/structure number, only the peak and drainage area of the last operation are saved in Summary Table 3/3A and are available for the computations. If the drainage area is changed between alternates in a job, Summary Table 3/3A will only retain the last drainage area used for a specific cross section/structure number. This will give erroneous intermediate peaks for previous alternates.

Computed intermediate peaks are displayed in Summary Table 4. Summary Table 4 is similar in format to Summary Table 3/3A.

Intermediate peak data are inserted into the ECON2 generated file if the ECON option (columns 21-25) was selected in the JOB record.

A flow duration analysis cannot be conducted at intermediate peak locations since no hydrograph is available. However, if TIME-FLOW records are requested by the DUR Standard Control option for the THRU ID on the PEAKS record, the ECON2 file will contain TIME-FLOW records with a "USE TIME-FLOW XXX" message where "XXX" is the THRU cross section or structure ID on the PEAKS record.

3.12.2 IPEAKS - INTERMEDIATE PEAKS

Table 3-12-2. IPEAKS record

IPEAKS - Initiates optional intermediate peak computations. The IPEAKS record must follow the last Executive Control of the job and precede all PEAKS records. For discussion, see page 107.

Data Field (Columns)	Value	Type	Description
4-8	IPEAKS	Ae	Operation name.

Example: (Included on the PEAKS record example on p. 111)

The IPEAKS record flags the PEAKS records that follow it.

PEAKS

3.12.3 PEAKS - INTERMEDIATE PEAKS

Table 3-12-3. PEAKS record

PEAKS - Locates and computes intermediate peak discharge values between cross sections/structures. For discussion, see page 107.

Data Field (Columns)	Value	Type	Description
4-8	PEAKS	Ae	Operation name.
13-15	From Upstream Section ID OR	I	Cross section no. 1 thru 200 just upstream of intermediate points, right justified, OR
16-17	From Structure ID	I	Structure no. 1 thru 99 just upstream of intermediate points, right justified.
19-21	Thru Downstream Section ID OR	I	Cross section no. 1 thru 200 just downstream of intermediate points, right justified, OR
22-23	Thru Structure ID	I	Structure no. 1 thru 99 just downstream of intermediate points, right justified.
25-30, 37-42, 49-54, 61-66	Intermediate Point ID's	Ae	Identifier for intermediate points (up to 4 on one record).
31-36, 43-48, 55-60, 67-72	D.A., sq mi	N	Drainage area in square miles associated with identifier in previous field.

Figure 3-12-3. IPEAKS and PEAKS records example

1 - 12	13 - 24	25 - 36	37 - 48	49 - 60	61 - 72	73 - 80
Table Name						Record Identification
IPEAKS	This record must precede all PEAKS records.					
Operation Name / No.	FROM ID XSEC / FROM ID STR / THRU ID XSEC / THRU ID STR	Intermediate points between FROM and THRU Xsecin/structures: Point ID / D.A. sq. mi.	Point ID / D.A. sq. mi.	Point ID / D.A. sq. mi.	Point ID / D.A. sq. mi.	Record Identification
PEAKS						
IPEAKS						1610
PEAKS	6 / 7	7A / 3.9	7B / 4.0			1620
ENDJOB / 2	This record terminates the TR-20 job.					1690

The PEAKS record that follows the IPEAKS record has two intermediate point locations identified. Intermediate point 7A, having a drainage area of 3.9 square miles, and intermediate point a 7B, having a drainage area of 4.0 square miles, lie between cross sections 6 and 7 for which TR-20 computations have been completed. Peak rates of flow will be determined at these two intermediate points using the equations in Section 3.12.1 with subscripts 1 and 2 representing cross sections 6 and 7, and the subscript I representing point 7A and then point 7B.
An ENDJOB record follows the PEAKS record.

CHAPTER 4. OUTPUT DESCRIPTION

The type and amount of output can be controlled by input options on the JOB record (Section 3.7.2) and by the output options on the Standard Control records (Section 3.9.1).

All output associated with the TR-20 microcomputer program is contained within 80 columns and is paginated with headings to facilitate its use. If any input or computed value exceeds the number of allotted output spaces, all asterisks are inserted in the output field.

Examples of different types of output are shown within the sample jobs in Appendices B through F. Appendix A contains an index of TR-20 input and output features and where they are first demonstrated within the sample jobs.

The TR-20 output can be grouped into seven categories for purpose of discussion: (1) input images, (2) message page, (3) page headings, (4) cross section data plots, (5) operation results, (6) summary tables, and (7) output files generated for other SCS programs. Each of these categories is discussed in the sections below.

4.1 INPUT IMAGES (80-80 LIST)

At the start of each run, the input can be listed for all the jobs in the run. This is called the "80-80 List" because the entire 80 column image of each input record is displayed exactly as it was entered. This list is given only if requested on the initial computer screen (See Section 1.3). The list provides a ready reference of the input associated with the output that follows.

All characters will be shown exactly as they appear on the input records. No data checks are made. In later processing, if illegal characters are discovered in any numeric data field, the job will not run successfully. To avoid many of these types of errors, use of the TR-20 data check program (see Appendix H) is recommended. User comments are not permitted in the input except where specified on the TITLE records and in the record identification fields.

Tabular data (standard rainfall tables and the DIMHYD) preloaded in the program will not be in the 80-80 list but may be obtained by using the Executive Control 7 LIST record with appropriate options (see Section 3.10.2).

4.2 MESSAGE PAGE

The message page which contains user notes is output only if requested on the initial computer screen at the front of each job (see Section 1.3). The message page will contain information the user should be aware of when using the TR-20 program. The message page will change as needed in the official SCS version. Minor revisions, modifications, or error corrections will be noted on this page as they are inserted into the program.

4.3 PAGE HEADINGS

The output is divided into page size increments for the user's convenience in viewing, printing, and filing the results. Headings are displayed at the top of each page except for the 80-80 List.

The program identification (TR-20) is shown on the left of the first header line followed by dashes across the page. In the upper left corner starting on the second line is the watershed identification with the current date and time the program was executed below it. The title records are centered in the middle with the pass number on the bottom line. The program revision date and page number are in the upper right corner.

The page numbering is continuous within a run, starting with one on the first page of output. The pass number is increased by one each time an ENDCMP is encountered.

4.4 OPERATION RESULTS

The LIST operation (Section 3.10.2) generates a listing of input data that is current for the alternate and storm to be processed next. This list represents the machine interpretation of the input data including all preceding data modifications. Most data checks will have been made and automatic output options turned on. Numeric values may vary one or more digits from the input due to the number of significant digits displayed. The input options on the LIST record control the amount and type of items in each list.

The Executive Control records are not included with the LIST operation. It is recommended that LIST be used primarily the first time all data are entered and then whenever the Standard Control records are modified. This LIST of data is separate from the 80-80 list mentioned on p. 112.

The other Executive Control operations only echo their input when detected. Whenever a new COMPUT record is encountered, the information associated with it will be displayed at the top of a new page beneath the page heading. If a new BASFLO or INCREM precedes the COMPUT, the new value will also be displayed. The Record Identification field accompanies each Executive Control to help identify it. When the ENDCMP record is encountered, a message "Computations Completed for Pass XXX" will be shown. The ENDJOB record will trigger an "End of XX Jobs in this run" message following the summary tables.

The Standard Control operations used with a COMPUT can be followed step by step if the FULLPRINT option on the JOB record is used. The FULLPRINT option will display for each Standard Control operation: its input, computed intermediate parameters, up to ten computed peaks with their times and elevations if available, and the runoff volume above baseflow under the outflow hydrograph. The intermediate parameters for the RUNOFF operation are: the computed runoff curve number if ARC 1 or 3 is specified on the COMPUTE record; and the computed internal time increment used to develop the hydrograph. The REACH operation intermediate parameters shown are: the coefficients used in the routing; and the computed peak travel time, which is the difference in time between the maximum hydrograph coordinates of the inflow and outflow hydrographs.

The hydrograph coordinates, including both outflow hydrographs for a DIVERT operation, can be obtained if the HYD or FILE output options are requested on the Standard Control records. Discharges in the hydrographs are converted to whole numbers (integers) for the output, except for small discharges under about 100 cfs that are displayed to two decimal places. The READHD and graphic files, however, contain all integers. The starting time associated with each hydrograph is the time from start of rainfall to the start of runoff. This allows the program to handle up to 400 coordinate points above zero cfs or baseflow. Discharges less than 0.5 cfs when converted to integers may be treated as part of the starting time.

If the FULLPRINT option is not used, the peak and volume data are displayed only if requested with the Standard Control output option (P/V). Warning messages will be evoked regardless of the print option, but they may be more difficult to interpret without FULLPRINT. It is advisable to obtain FULLPRINT the first trial pass through a watershed and in complex watershed situations to be sure the watershed is being modeled correctly. The reason for multiple peaks should be analyzed if they occur. They can be detected only by using FULLPRINT or the Peak/Volume (P/V) output options.

4.5 CROSS SECTION DISCHARGE/END AREA DATA PLOTS

Log-log plots of input cross section data are provided to display the discharge-end area curve used in calculating the exponent "m" at each cross section elevation when the option PLOTS is included in the JOB record in column 61-67. The bankfull discharge and end area are plotted on the axis if the bankfull elevation is given on the 2 XSECTN header record (column 37-48). The BANKFULL elevation may help determine the significance of any change in slope of the plotted data. The computed "m" values are tabulated with the plot. The actual value of "m" used in a reach routing is interpolated from this "m" value table based on the routed outflow, providing "m" is within the prescribed limits of the program.

The plots are not obtained when the "x" and "m" coefficients are entered in the REACH operation. The plots are also not obtained if Column 61-67 are left blank or the GRAPHICS option is invoked on the JOB record. However, it is anticipated that the GRAPHICS option when fully developed will provide an alternate means to provide discharge-end area plots from the input data. If the ENDPLOT option is used on the JOB record, the cross section data will be plotted and the job will be terminated without further execution. This enables the user to examine the plots for reasonableness before committing the job for processing. It is advisable to obtain the plots the first time cross sections are used and the last time as job documentation.

4.6 SUMMARY TABLES

The summary tables provide documentation and easy comparisons for checking and analyzing results. The SUMMARY option on the JOB record will provide information on each Standard Control operation except SAVMOV without having to use the SUM output option (Column 71) on each operation. Of the 10 possible peaks, only the maximum peak information for each operation is included in the summary tables. If SUMMARY is not used, only the operations with the SUM output option designated in the Standard Control will be shown in the summary tables. All peak discharges are displayed as integers in the summary tables.

Each of the Summary Tables is preceded by a heading which contains a short description of the table and notes pertaining to that table. Some of the notes are common to several tables. A brief explanation of the various notes follows.

F - FLAT TOP HYDROGRAPH	A hydrograph with no single peak value, but rather a series of consecutive maximum values.
T - TRUNCATED HYDROGRAPH	A hydrograph that does not return to zero or baseflow within the maximum number of points limitation. The program 'truncates' or cuts off such a hydrograph at the discharge of the last point.
R - RISING TRUNCATED HYDROGRAPH	A hydrograph that is truncated on its rising limb without reaching a peak.
S - SHORT HYDROGRAPH	A hydrograph that is shorter in total duration than the longest specified duration in the DURINC table.
QUESTION MARK (?) AFTER: OUTFLOW PEAK - MAX. NUMBER ROUTING ITERATIONS USED.	The maximum allowed number of reach routing iterations (10) has been used. The user should review the input parameters affecting this operation for reasonableness.
QUESTION MARK (?) AFTER: ATT-KIN COEFF - VALUE OUTSIDE ACCEPTABLE LIMITS.	The program has used a routing coefficient of 1.0, which is usually outside of acceptable limits. The outflow hydrograph is identical to the inflow hydrograph. The user should examine input values affecting the reach routing.

Summary Table 1. -- This is a tabulation of the results of the Standard Control operations in the order in which they are performed. The table is subdivided by alternate number and storm number. The rainfall information and main time increment associated with the operations is given ahead of each operation's outflow runoff volume, maximum peak discharge rate, its time of occurrence, and water surface elevation if applicable. The accumulated drainage areas and the peak rate in csm are also computed and displayed. Whenever the rainfall information or main time increment changes, the new amount, duration, starting time, table number, antecedent runoff condition or increment is listed ahead of the Standard Control operations to which they apply.

Examples of Summary Table 1 can be found after the computations in all the sample jobs in Appendices B to F. All operations (except SAVMOV) for all cross sections, structures, storms, and alternates are displayed if requested by the SUM or SUMMARY option.

Summary Table 2. -- This is a tabulation of the reach routing results and parameters used in the routing. A major difference between this table and Summary Table 1 is that the peak discharges and times are based on the maximum hydrograph coordinate at a multiple of the main time increment rather than the interpolated peak used in the normal output. All reach routings are tabulated in the order they are performed, subdivided by alternate number, storm number and baseflow. This table is automatic if reach routing was performed.

The reach routings are identified by their cross section ID numbers and reach lengths. The floodplain reach length is listed separately if provided.

The routing parameters displayed include the coefficient "x", the power or exponent "m", length factor "k*", peak ratio "Q*" (outflow/inflow) and the Modified Att-Kin routing coefficient "C". See Hydrology Note 2 for more detailed descriptions of these parameters.

The Modified Att-Kin coefficient should be less than 1.0 and preferably less than 0.67. If the coefficient is 1.0, the inflow and outflow hydrographs are identical. To reduce the coefficient the user may reduce the main time increment or increase the reach length.

Appendices B through F contain examples of Summary Table 2. Each REACH operation is displayed regardless of the summary options specified. This allows the user to quickly compare the effectiveness of the reach routing in a job.

Summary Table 3. -- This table is a listing of maximum peak discharges, ordered by cross section or structure ID number, by alternate number, and by storm number. The peak discharges are sorted in descending order by ID number with structures listed before cross sections. If more than one Standard Control operation is identified with the same ID number, only the peak discharges from the last one in the Standard Control sequence will be used in Summary Table 3.

The format displayed in Summary Table 3 is similar to the file generated when the ECON output option is entered on the JOB record.

The intermediate peak computations use the peaks and drainage area shown in Summary Table 3. The drainage area displayed in the table is the one associated with the Standard Control operation. If the drainage area changes within a job for this operation, only the last drainage area used will be retained and displayed. This could result in erroneous intermediate peak results.

Both Summary Table 3 and Summary Table 1 are given whenever the SUMMARY or individual SUM output options are specified. Appendices B thru E contain examples of Summary Table 3.

If the ECON and associated flow duration options are all selected, Summary Table 3A will be substituted for Summary Table 3 as seen in Appendix F.

Summary Table 3A. -- This table lists the maximum peak flows and the flow durations ordered by cross section or structure ID for each alternate and storm number. It is similar in format to Summary Table 3, except that only three storms can be displayed per page.

To obtain Summary Table 3A, a DURINC table has to be entered, the ECON option on the JOB record and at least one DUR option on the Standard Control has to be selected. An example of Summary Table 3A is contained in Sample Job 5 in Appendix F.

Summary Table 4. -- This is a tabulation of the intermediate peak data in a format similar to Summary Table 3. All intermediate peak locations entered on the PEAKS records are listed in the sequence they are entered and peaks are ordered by alternate number and by storm number. Like Summary Table 3, if more than one, only the last operation associated with a cross section or structure ID and its last drainage area are used. Appendix F contains an example of Summary Table 4.

4.7 OUTPUT FILES GENERATED

Machine readable files for input into other SCS programs can be generated for certain selected information computed in a TR-20 job. The files can be written to the user's choice of file directory. Table 3-7-1, on p. 30, contains the program defined file names, required input options, and general description of these files.

The following sections provide additional information on the output files that can be saved for future use:

Graphics Files. -- These files summarize detailed output information and related input items in condensed tabular format. Separate ASCII files are used to save Summary Table 1, Summary Table 2(reach data), hydrographs, and flow duration data. A separate utility program is needed to read these files and plot the information. SCS has developed a prototype plotting program that uses proprietary Graphics Kernel System (GKS) software for this purpose.

To obtain these files, the GRAPHICS option (Col. 61-67) on the JOB record and the appropriate Standard Control output option (see Table 3-7-1, p. 30) must be selected. To keep the hydrograph data file within reasonable storage limits, the FILE option should be judiciously used.

Discharge Hydrographs. -- These are generated in the format of the Read Discharge Hydrograph Table (READHD, Section 3.8.7). For each job, the hydrographs generated are numbered consecutively starting with one. The hydrographs might be reentered into another segment of TR-20 or inserted into the DAMS2 computer program for further processing. To obtain this READHD file, the FILE output option (Column 69) on the Standard Control operation must be set to 1. See the last page of Appendix C, Sample Job 2, for an example of a discharge hydrograph file. The READHD file name generated by the program has the user's file prefix, and the extension ".TRD."

ECON2/URB1 Flow-Frequency Data. -- These are generated from Summary Table 3 or 3A and Summary Table 4 peak discharge data. The storms are sorted by alternate and ordered by magnitude of the peak, so that the largest peak value is generated first. This means storms within an alternate do not have to follow a set order of computation.

The data file is generated in the FLOW-FREQ and TIME-FLOW record formats required as input to the SCS Economics - Floodwater Damages (ECON2) and the SCS Urban Floodwater Damage Evaluation (URB1) computer programs. The ECON option on the JOB record (Columns 21-24) and either the SUMMARY option (Columns 51-57) on the JOB record or the SUM output option (Column 71) on the Standard Control operation must be used to save the desired information for Summary Table 3. Time-flow data is only provided for peaks at cross sections or structures where the DUR option (Column 67) is selected and the DURINC table is in the Tabular Data. Intermediate peak data from Summary Table 4 is included in FLOW-FREQ format if the ECON option is given on the JOB record and in the TIME-FLOW format if the THRU ID in the Standard Control has the DUR option selected.

The first records in the ECON2 output file will be the ECON2 job record followed by the TR-20 TITLE records. Next, will be a DUR-INCT Table. This table will contain the given durations in the correct To and From Field increment format for the ECON2 Computer Program. The To and From fields will be equal for the last table increment. Then, three TIME-FLOW records (three durations) will follow each appropriate PEAK-FLOW record in the file if the DUR option is selected on the Standard Control. The TIME-FLOW record information will also be shown in Summary Table 3A.

A message code letter is provide in the output if any special or problem condition exist in the flow duration computations. The following condition codes may be displayed if a user selected duration:

'T' - gives a flow duration value when the flood hydrograph is truncated due to the maximum hydrograph point number limitation in TR-20.

'R' - gives a flow duration value when the flood hydrograph is still rising toward a peak when truncated by the same maximum point limitation.

'S' - exceeds the time base of the entire flood hydrograph.

'B' - is at or below a constant baseflow discharge.

Flow durations unable to be calculated by the above conditions will be shown as asterisks in the output.

See Appendix F, Sample Job 5, for an example of an ECON peak discharge file. The ECON file name generated by the program has the user's file prefix and the extension ".TEC."

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CHAPTER 5. OUTPUT USE

This chapter discusses the use of the output. It includes considerations in checking the input and output, interpretation of the output, and calibration and verification. It also lists all of the program error, warning and informational messages with short discussions on why they are triggered and suggested ways to eliminate them from the output.

5.1 CHECKING INPUT AND OUTPUT

The user must always check input for accuracy and completeness and check output for reasonableness. The following precautions and checks should be made by a user to validate the output from any TR-20 run.

1. Always put a decimal in a real number field such as in Columns 25 through 60 on the Standard Control records and in all real data fields in tabular data. This is a very common input error. The user can make this type of error easier to detect by left justifying input data in decimal fields. Therefore, if the decimal is omitted, the program will place the default decimal at the end of the data field. This will cause the number read to be larger than it actually is and will frequently result in error messages or all asterisks in corresponding numeric fields in the output.

2. The first part of the output should be a 80-80 list of the input data. This should be CAREFULLY checked for correctness. The alignment of data field is an important check. Insertion or deletion to an input record by an editor can inadvertently move subsequent data out of their field.

The alignment of data field is an important check. Insertions or deletions to an input record by an editor can inadvertently move subsequent data out of their field.

3. All tabular data and all Standard Control data, followed by an ENDATA record must precede the Executive Control records that pertain to them. There is one exception to this, the READHD table must follow the ENDATA record and precede the COMPUTE record that uses it -- otherwise, the program will go into a loop and have to be stopped by the user.

4. Check the cross section elevation-discharge-end area table input for increasing values with successive elevations. If there is any decrease, a fatal error results.

5. Check the structure elevation-discharge-storage table input for the following:

a. The main time increment should be related to the discharge and storage at each table elevation. Half the discharge should always be less than the storage divided by the main time increment; see Section 3.8.1 under Structure Data Table for the full expression with unit conversions.

b. Successive elevation, discharge, and storage values must increase. If any values decrease a fatal error results.

6. Check the "Start Routing Elev." field on the Standard Control RESVOR record(s). It may contain an elevation higher than the lowest elevation in the corresponding STRUCT table, but it must not contain an elevation lower than any value in the table. If there is baseflow at the reservoir site, the "Start Routing Elev." should correspond to an elevation in the STRUCT table at which the baseflow will pass through the principal spillway.

If the "Start Routing Elev." contains an elevation higher than the zero discharge in the table or constant baseflow for the pool elevation at the beginning of routing the apparent volume of outflow will be increased as the initial volume will be drained in the routing. If the "Start Routing Elev." is lower then the elevation where significant outflow begins (true crest of principal spillway), the volume will be decreased as the additional storage has to be filled before outflow starts.

7. The record identification field, Columns 73-80, should always be used. This field is shown in various places in the output to help the user keep track of what is happening and is also associated with many error messages so the user can locate errors faster.

8. The output should be examined for the occurrence of asterisks filling a data field. This means that the number intended for that field was larger than allowed by the FORTRAN format statement in the program. This applies to the 80-80 Listing of Input Data as well as the remainder of the TR-20 output. Asterisks could trigger an unrelated error or warning message.

9. Search the output file or printed hardcopy for the occurrence of asterisks in columns 1 to 3. This usually indicates an error, warning, or regular message that might otherwise go unnoticed. The effect the messages have on the completeness and reasonableness of the output can be determined by referring to the remarks and actions to be taken in regard to the messages in Section 5.4.

10. Examine the summary tables for notes (letters or question marks) that follow data fields. These may indicate the run is unsatisfactory due to truncated hydrographs or poor selection of input parameters. See Section 4.6 for description of the notes.

11. Spot check the output by closely examining the summary table data. In Summary Table 1, especially compare the accumulated drainage area with that at known locations and the consistency of the runoff volume with that obtained directly from rainfall using the runoff curve number. In Summary Table 2, compare the parameters used in the reach routing between reaches to determine if the routing effects are predictable. In Summary Tables 3, 3A and 4 compare the peak discharges between alternates and storms to see if the magnitudes and order are predictable and reasonable.

12. If there are discrepancies or questionable results in the output and the input is satisfactory, more detailed output may be warranted using the FULLPRINT, SUMMARY, HYD, or DUR output options.

5.2 INTERPRETATION OF OUTPUT

As mentioned in the previous section, the first check of the output data should actually be a thorough review of the program input data. Although use of the data check program (see Appendix H) will eliminate many gross input errors, it does not guard against typing errors, number transposition, leaving out a line of data, and other such data entry mistakes. It is the first responsibility of the user to carefully check and correct these type of errors.

The output data itself should be checked for consistency, error or warning messages, and reasonable results. It is important that the user bear in mind the logical and expected results of a series of operations and continually compare these with the program output. In a large job, this is often easier if the job is broken up into a series of smaller steps. The user may wish to develop tables or graphs in an alternate format to those in the program to trace peaks downstream in some way meaningful to the project. Table 5.1 is an alternate format to the summary tables for the user to summarize output data if it is desired to look at the results in some logical sequence on the main stream or a tributary. This example, based on comparison of peak flow (CFS) and alternates by storm from Sample Job 5 in Appendix F, is only one method by which the many factors such as peak time, peak discharge (CSM) and runoff volume can be tabulated. Only the structure sites and main stem ADDHYD and REACH operations with no local drainage area added were selected for comparison in the example.

Table 5.1. Alternatives Compared - Sample Job 5 - Main Stem Peak Discharge (cfs)

	ID	Total DA (sq. mi.)	Alternatives 1/ 1	2	3	4
Storm #1 (5.2" Rainfall - _____ Yr. Frequency)						
Structure	01	1.20	2128	929	929	2131
ADDHYD	001	1.66	1516	1116	1113	1515
REACH	002	1.66	1073	894	891	1072
Structure 2/	02	0.44	837	247	--	--
Structure 2/	03	0.75	--	--	51F	542
ADDHYD	004	2.41	1436	1166	935	1577
REACH	005	2.41	910	816	602	946
etc.						
Storm #2 (2.6" Rainfall =_____ Yr. Frequency)						
Structure	01	1.20	527	153	153	528
ADDHYD	001	1.66	415	204	202	405
REACH	002	1.66	340	182	180	332
Structure 2/	02	0.44	238	100	--	--
Structure 2/	03	0.75	--	--	41	148
ADDHYD	004	2.41	473	270	214	439
REACH	005	2.41	265	203	168	256
etc.						

1/ Alternative 1 - No sites.
" 2 - Sites 1 and 2 in place.
" 3 - Sites 1 and 3 in place
(Site 3 is downstream from Site 2).
" 4 - No sites.
Baseflow varies between alternates.

2/ Structure is on a lateral.

5.3 CALIBRATION OF THE MODEL

If at all possible, the user should calibrate or validate the results of a TR-20 run against an independent source of measured data. The measured data can come from a stream gage within the watershed or from regional regression equations of stream gage data outside the watershed.

Calibration involves adjusting input parameters until the computed output compares with measured values. Validation involves replication of measured values with computed values without adjusting input parameters. If a split sample set is used, the TR-20 model can be calibrated with half of the data and validated with the remainder of the data.

Calibration of the model with a range of storm or flood hydrographs from stream gage data in or downstream of the watershed under study is the ideal case. If enough years of gage data are available a statistical discharge-frequency relationship may be developed. TR-20 can be calibrated to produce a similar discharge-frequency relationship for a range of return periods such as from the 2-year to 100-year flood. This may be advantageous in checking the reasonableness of a 100-year flood modeled by TR-20 when there are no measured discharges approaching that magnitude.

Calibration with gage data, however, is not always possible. Calibration in this case involves adjusting the input parameters in the program so the computed hydrograph matches the recorded flood hydrograph for a given event. The peak rate of flow, runoff volume, and hydrograph shape are the measured data used for comparison. Any base flow separation is done before the hydrograph calibration is made. Looking at the difference between the computed and the recorded hydrograph, the user must select parameters to adjust and estimate the direction and magnitude of adjustment. Any adjustments to the input parameters must stay within reasonable physical limits. It is best to change parameters one at a time to see clearly the effects of that change. This technique also tests the sensitivity of the selected parameters.

Input parameters that affect the runoff volume include the amount, duration and uniformity of occurrence of the rainfall, the runoff curve number, antecedent runoff condition, the drainage area, and presence or absence of base flow, diversions, and transmission losses. Generally, the runoff volume increases as the total storm amount, runoff curve number, and drainage area increase. The runoff volume decreases as transmission losses and base flow increase.

The timing and the flood hydrograph shape are affected by the time of concentration, reservoir and reach routing, location in the routing sequence, the shape of the unit hydrograph, and the direction of the storm movement across the watershed. The runoff hydrograph shape is directly related to the time of concentration. Generally the flood hydrograph's time base increases as the time of concentration and the amount of available reservoir and channel storage in the watershed increase or as the watershed shape narrows. The flood hydrograph is also a function of the unit hydrograph shape.

Storm characteristics such as rainfall duration and the time and areal distribution also have an impact on the flood hydrograph shape. Increasing the duration of rainfall lengthens the time base of the hydrograph. Multiple bursts of rainfall will usually cause multiple peaks on small watersheds, but may have indistinguishable effects on larger watersheds. Non-uniform areal distribution of rainfall, with high runoff near the watershed outlet will usually result in a rapid rise, sharp peak, and a rapid recession while high runoff in the headwaters will usually produce a slow rise, a broader peak, and a slow recession.

Peak discharge is affected by the runoff volume, the time of concentration, available storage, unit hydrograph shape, drainage area, the storm movement over the watershed, and the distribution and amount of rainfall. The parameters that impact the peak discharge are the same as those that affect the volume of runoff and the flood hydrograph shape. Therefore, it becomes more and more important that the sensitivity of the parameters be closely evaluated and their variation monitored.

As an example of sensitivity, some of the input parameters were varied one at a time and their impact on peak discharge and time analyzed. The results are shown in Table 5-2. The upstream watershed in Sample Job 1 in Appendix B was used to develop the information.

TABLE 5-2. Sensitivity of Input Parameters - Example

Variable	Variation 1/	Value	Peak Disch. cfs (%)	Peak Time hrs (%)
RUNOFF Operation				
Drainage Area	---	1.2 sq.mi.	2128 (100%)	12.09 (100%)
	90%	1.08 sq.mi	1915 (90%)	12.09 (100%)
	110%	1.32 sq.mi	2341 (110%)	12.09 (100%)
Curve Number	---	75	2128 (100%)	12.09 (100%)
	90%	68	1628 (77%)	12.10 (100%)
	110%	83	2733 (128%)	12.09 (100%)
Time Concentration	---	0.33 hr	2128 (100%)	12.09 (100%)
	90%	0.30 hr	2224 (105%)	12.08 (100%)
	110%	0.36 hr	2050 (96%)	12.11 (100%)
Rain Depth	---	5.20 in	2128 (100%)	12.09 (100%)
	90%	4.68 in	1794 (84%)	12.09 (100%)
	110%	5.72 in	2480 (117%)	12.09 (100%)
ARC	---	2	2128 (100%)	12.09 (100%)
	---	1	858 (40%)	12.12 (100%)
	---	3	3087 (145%)	12.08 (100%)
Rain Table	---	Type 2 (Tbl. 2)	2128 (100%)	12.09 (100%)
	---	Type 1 (Tbl. 1)	1069 (50%)	10.09 (83%)
	---	Type 1A (Tbl. 3)	436 (20%)	8.07 (67%)
	---	Type 3 (Tbl. 4)	1543 (73%)	12.24 (101%)
Main Time Increment	---	0.1 hrs	2128 (100%)	12.09 (100%)
	---	0.05 hrs	2131 (100%)	12.09 (100%)
	---	0.2 hrs	1943 (91%)	12.08 (100%)
RESVOR Operation				
Table Discharge	---	---	929 (100%)	12.35 (100%)
	90%	---	890 (96%)	12.36 (100%)
	110%	---	986 (106%)	12.34 (100%)
Table Storage	---	---	929 (100%)	12.35 (100%)
	90%	---	981 (106%)	12.34 (100%)
	110%	---	874 (94%)	12.37 (100%)
Start Elev.	---	521.5	929 (100%)	12.35 (100%)
	---	521.0	916 (99%)	12.36 (100%)
	---	522.0	942 (101%)	12.35 (100%)

TABLE 5-2 Cont'd

Variable	Variation 1/	Value	Peak Disch. cfs (%)	Peak Time hrs (%)
Main Time Increment	---	0.1 hrs	929 (100%)	12.35 (100%)
	---	0.05 hrs	934 (101%)	12.35 (100%)
	---	0.2 hrs	922 (99%)	12.41 (100%)
REACH Operation				
Reach Length	---	5400 ft	729 (100%)	12.79 (100%)
	90%	4860 ft	750 (103%)	12.76 (100%)
	110%	5940 ft	709 (97%)	12.82 (100%)
Coeff. "x"	---	0.42	729 (100%)	12.79 (100%)
	90%	0.38	714 (98%)	12.81 (100%)
	110%	0.46	742 (102%)	12.77 (100%)
Exponent "m"	---	1.35	729 (100%)	12.79 (100%)
	90%	1.22	570 (78%)	13.23 (104%)
	110%	1.49	838 (115%)	12.63 (99%)
Main Time Increment	---	0.1 hrs	729 (100%)	12.79 (100%)
	---	0.05 hrs	728 (100%)	12.76
(100%)				
	---	0.2 hrs	736 (101%)	12.86 (100%)

1/ When variation in percent is shown, 90% = 10% lower and 110% 10% higher then the initial valve.

A typical procedure for calibrating the TR-20 model is shown in Table 5-3. It is assumed that adequate stream gage, rainfall amount and distribution and flood history data are available to work with. Major historical storms may not be desirable for calibration if recorded stream gage data is estimated and watershed and hydraulic conditions have changed.

The extent of calibration depends on the purpose the hydrologic model serves and on the amount and quality of data available for comparison.

If there is no recording stream gage within the watershed, an acceptable alternative is comparison of the peak discharges for selected frequencies with the peak flow frequency curves of available crest stage data. State or other agency publications or frequency curves generated from selected stream gaging stations in the area can also be used for this purpose.

Another method of calibration is to compare actual high water marks from known events with the computed high water marks from the TR-20 hydrologic model and the water surface profile hydraulic model. This alternative is the least desirable alternative because the source of the difference in water surface elevations can be a function of both the hydrologic and hydraulic models. Thus, care must be used in selecting and adjusting the parameters.

Table 5-3. A procedure for Calibrating the TR-20 model.

Steps:

1. Select at least two calibration storms with the following characteristics:

   a. storms large enough to produce significant flooding.

   b. storms with essentially uniform rainfall distribution and amount over the watershed.

   c. storms produced usually by isolated thunderstorms with hydrographs that can be easily separated out in the stream gage data.

   d. recent storms if watershed conditions (i.e. urban development) have changed significantly or if major changes in hydraulic storage and flow characteristics are included in the TR-20 model.

   e. storms that did not produce unusual hydraulic conditions such as major dam failure or questionable gage information (i.e. unanticipated obstruction, loss or bypass of the gage).

2. Plot the gaged storm hydrographs and separate baseflow and flow not related to the selected storms.

3. Measure volume of storm runoff in the gaged hydrograph and convert to inches of runoff over the watershed.

4. Determine curve numbers (CN) for the watershed at the gage for each storm using the actual rainfall and measured runoff volume in inches.

5. Compare each storm CN at antecedent runoff condition II and estimate the antecedent runoff condition related to the storm.

6. Compare the estimated ARC for each storm with the expected storm ARC based on the flood history. If they don't agree - recheck the rainfall and runoff volumes or discard the storm and try another. If the ARC's are in reasonable agreement, the calibration process can begin.

Table 5-3 (continued)

7. To calibrate each storm, adjust the TR-20 CN'S and ARC to produce the storm runoff volume, peak, and timing as nearly as possible. The simplest way is to use the storm CN with ARC 2.

8. Using TR-20 and the actual rainfall table for each calibration storm, produce the computed hydrograph at the gage. Plot this hydrograph on the actual storm runoff gaged hydrograph. Be sure to include baseflow if used in TR-20. Heed all warning messages.

9. Check the volume of direct runoff from the TR-20 unadjusted hydrograph with that of the actual storm. If not the same, recheck step 7 to make adjustments in the CN's or ARC. Also, examine the shape of the TR-20 hydrograph to see if changes in baseflow are warranted.

10. If the runoff volume and general shape is satisfactory, examine the timing and sharpness of the TR-20 hydrograph peak. If there are multiple peaks, note their spacing and relative magnitude. If they don't correspond with the gaged hydrograph, reexamine the input parameters that could affect the peak discharge (i.e. time of concentrations, available storage, representative cross sections, unit hydrograph shape, rainfall distributions, watershed conditions at the time of the storm, etc.). Adjust if necessary within reasonable physical limits.

11. If the above Standard Control and other input parameters are reasonable, consider adjusting the main stem reach velocity parameters next. If there is too little attenuation in the reaches, it could be caused by either the shortness of the reach or by a high velocity. If there is too much attenuation the reach may be too long or the velocity may be too slow. Velocity in the reach is highly dependent on the Manning's "n", which should be checked for reasonableness.

    If XSECTN tables are used for reach routings, a Manning's "n" had to be selected for each reach in order to develop the table. Revising the tables based on higher Manning's "n" values will increase the storage for any given discharge. This will result in more attenuation (lower peaks) and time delay in the reaches. Lower Manning's "n" values will result in the opposite effect, less attenuation and an advance in time. When high water marks are available, the Manning's "n" values can be adjusted in addition to the hydrologic parameters in the TR-20 calibration. The elevation of the high water marks should be matched with the estimated elevation -discharge-frequency from TR-20 runs.

Table 5-3 (continued)

If cross section coefficients are used for reach routing, incremental increases in "x" and "m" will usually increase the peak discharge and advance the peak time. Of the two, the "m" value is more sensitive than the "x" value. Adjustment of the "x" and "m" values to best match the hydrographs should be considered when the reach storage calculated using the end area from the representative reach cross section could differ from the actual total reach storage.

12. Repeat the procedure in steps 7 to 11 for the next calibration storm. Make adjustments as before in the input parameters and compare to the adjustments needed for the earlier storm(s).

13. Select, or average adjustments if appropriate, and rerun storms if necessary to document the calibration.

14. Run the validation or verification storms in the adjusted TR-20 model, using the storm CN and ARC and compare with the gaged hydrographs. The volume of runoff, hydrograph shape, and peaks should agree within reasonable limits to have a successful calibration and a valid TR-20 model.

5.4 PROGRAM MESSAGES

The TR-20 Program will output messages in response to incorrect or questionable input, or in some cases to explain results. All messages begin and end with three consecutive asterisks (***).

Messages are grouped into three categories:

Errors - Incorrect data, run is terminated at point of error. Correct input and rerun.

Warnings - Questionable data, run will continue, but check assumptions and results. Revise input if warranted.

Messages - Informational, be aware of what triggered the message and take appropriate action if necessary.

Program messages are listed alphabetically by category below. Each message is followed by remarks on why the message was given and suggested corrective action items if needed.

5.4.1 Errors

- "DIVERT" MUST HAVE VALUE IN DATA FIELD #1 AND/OR FIELD #3. RUN TERMINATED.

Remarks: The first procedure for DIVERT requires a discharge in col's. 25-36. The second procedure requires a cross section location for output in col's. 49-60.

Action: Correct DIVERT record according to procedure being used, and rerun.

- "ENDATA" ENCOUNTERED IN STANDARD CONTROL, RUN TERMINATED. LAST EXECUTIVE CONTROL RECORD FOLLOWS:

Remarks: Only one ENDATA can follow the Standard Control. One was found after the ALTER OR DELETE record shown.

Action: Remove the ENDATA that follows the record shown and rerun.

- ERROR Occurred - Run TR-20 Data Check

Remarks: A serious error stopped the run. It is probably an input error that the Data Check Program could identify. This message appears on the screen. The output file often contains information on what needs correcting.

Action: Run Data Check Program, correct input and rerun.

- FROM XSECTION/STRUCTURE ID ON "COMPUT" MISSING, RUN TERMINATED.

Remarks: The "FROM" ID on the COMPUT record shown after the message must have a cross section number (1-200) or a structure number (1-99).

Action: Add appropriate ID and rerun.

- FROM XSECTION/STRUCTURE ID ON "COMPUT" NOT FOUND IN STANDARD CONTROL, RUN TERMINATED.

Remarks: The "FROM" xsection/structure ID on the COMPUT record shown after the message does not match any of the xsection/structure ID's in the Standard Control. This message also occurs if a xsection/structure ID is used in a set of COMPUT's with no intervening ENDCMP where the ID's would overlap if the Standard Controls were processed in the given sequence, as in the example "...COMPUT..001...002..." followed by "COMPUT..002...003."

Action: Correct ID and rerun or add missing record and rerun.

- HYDROGRAPH STORAGE LOCATION PROBLEM. RUN DATA CHECK PROGRAM FOR HELP. RUN TERMINATED.

Remarks: The hydrograph storage locations are not correctly accounted for in the Standard Control.

Action: Run data check program, correct error, and rerun.

- INITIAL DISCHARGE IN THE STRUCTURE TABLE MUST BE ZERO CFS. RUN TERMINATED.

Remarks: The first elevation in the STRUCT table must have zero cfs, but the storage in acre-feet can be greater than zero.

Action: Correct rating table and rerun.

- LESS THAN THREE POINTS IN "DIMHYD". RUN TERMINATED.

Remarks: The dimensionless hydrograph to be used in the program must be defined by 4 to 101 points.

Action: Correct the DIMHYD table by adding an appropriate number of points and rerun.

- LESS THAN THREE POINTS IN RATING FOR XSECTN xxx.

Remarks: Cross section rating tables must contain 3 or more points. The maximum is 20 points.

Action: Develop appropriate number of data points for rating table or use "x" and "m" values instead.

- NEGATIVE OR ZERO REACH LENGTH, RUN TERMINATED.

Remarks: The program will not accept values equal to or less than zero as a reach length in the REACH Standard Control.

Action: Correct reach length and rerun.

- NEGATIVE X OR M VALUE ON "REACH", RUN TERMINATED.

Remarks: The "x" and "m" values in the REACH record must be greater than zero. See Hydrology Note No. 2 for suggested values.

Action: Correct error and rerun.

- NO RATING TABLE OR ROUTING COEFFICIENTS. RUN TERMINATED.

Remarks: A cross-section ID has been used on a REACH record, but no "x","m", or cross section data has been provided for it.

Action: Provide appropriate reach data for the cross section, and rerun. If cross-section ID is erroneous, correct and rerun.

- NO XSECTION/STRUCTURE ID FOUND ON STANDARD CONTROL WHILE PROCESSING "COMPUT", RUN TERMINATED.

Remarks: A xsection/structure ID number was found to be missing in the Standard Control when the COMPUT record that follows the message was being processed.

Action: Find and add the appropriate ID in the Standard Control or revise the COMPUT and rerun.

- RAINFALL DEPTH AND DURATION MUST BE GREATER THAN ZERO. RUN TERMINATED.

Remarks: The rainfall depth and duration must be greater than zero to generate a hydrograph.

Action: Correct values and rerun.

- RAINFALL DEPTH AND/OR DURATION OTHER THAN 1.0 ENTERED, BUT RAINTABLE x IS NOT DIMENSIONLESS. RUN TERMINATED. ERROR OCCURRED WHILE PROCESSING FOLLOWING RECORD:

Remarks: The last rainfall depth in the table is greater than 1.0, or the number of values in the RAINFL table times the time interval is greater than 1.0.

Action: If the RAINFL table is not dimensionless, change the depth and/or duration to 1.0 on the Executive Control COMPUT record and rerun.

- RAINTABLE xx IS NOT A VALID NUMBER. RUN TERMINATED.

Remarks: The raintable ID listed is outside the range of 1 to 9.

Action: Correct raintable ID to one within range 1 to 9 and rerun.

- REACH ROUTING COEFFICIENTS MUST BE IN PAIRS, RUN TERMINATED.

Remarks: Both "x" and "m" must be given in the REACH record.

Action: Add missing values to data, or use actual cross section data for the reach routing and rerun.

- "READHD" ENCOUNTERED IN EXECUTIVE CONTROL, RUN TERMINATED.

Remarks: The READHD record shown after the message was out of place. The READHD table must be ahead of the COMPUT record (alternate and storm) which uses the hydrograph in the table.

Action: Reorder input file and rerun.

- READHD IN LOCATION x HAS ONE OR MORE VALUES BELOW BASEFLOW (xxxxxx. CFS). RUN TERMINATED.

Remarks: The baseflow indicated by the message is the value entered in the 7 READHD 9 record. This baseflow is therefore contained in the READHD, and the discharge values in the read hydrograph file must be greater than this baseflow value.

Action: Correct values and rerun

- RECORD OUT OF PLACE. RUN TERMINATED.

Remarks: The record shown after the message is out of place. See Table 3-3 on page 21 for the proper input sequence.

Action: Relocate record in proper place and rerun.

- REQUESTED RAINTABLE xx HAS NOT BEEN LOADED. RUN TERMINATED.

Remarks: The raintable (1-9) requested in the COMPUT record has not been either preloaded into the program or defined in the input data, or the label is wrong on the COMPUT record.

Action: Check that the raintable number requested in the COMPUT record is correct. If it is, include properly labeled and defined raintable in the data and rerun.

- "RUNOFF" CONTAINS BLANK, ZERO OR NEGATIVE VALUE IN DATA FIELD x, RUN TERMINATED.

Remarks: The RUNOFF Standard Control has incomplete or incorrect data, and is probably missing Tc, Drainage Area, or curve number data.

Action: Locate incorrect or incomplete data, correct, and rerun.

- RUNOFF CURVE NUMBER EXCEEDS 100, RUN TERMINATED.

Remarks: The runoff curve number on a RUNOFF Standard Control must be between 1 and 100. The lowest recommended runoff curve number is 40.

Action: Correct entry and rerun.

- 600 STANDARD CONTROL RECORDS EXCEEDED. RUN TERMINATED.

Remarks: The limit for the number of Standard Control records has been exceeded.

Action: Redefine the watershed so that the Standard Controls number less than 600 or use separate TR-20 runs with the READHD option.

- STANDARD CONTROL ENCOUNTERED IN EXECUTIVE CONTROL, RUN TERMINATED.

Remarks: Record shown after message is incorrect or out of place. It should be an Executive Control record.

Action: Correct input file and rerun.

- STARTING DISCHARGE OR END AREA IS LESS THAN ZERO. RUN TERMINATED.

Remarks: The first values of the cross section table for discharge and end area should be equal to zero.

Action: Locate incorrect data, correct, and rerun.

- STARTING DISCHARGE OR STORAGE IS LESS THAN ZERO. RUN TERMINATED.

Remarks: The discharge or storage associated with the first elevation in a structure table is given as a negative value. It must be zero or greater.

Action: Locate incorrect data, correct, and rerun.

- STRUCTURE xx RATING TABLE VALUES (SHOWN BELOW) NOT ALL INCREASING. RUN TERMINATED.

Remarks: Entries for elevation, discharge and storage in the STRUCTURE table must be increasing. The increments can be small (0.01).

Action: Correct data and rerun.

- TABULAR DATA INPUT PROBLEM; ON OR AFTER RECORD LISTED BELOW, RUN TERMINATED.

Remarks: A unacceptable character has been found in a data field.

Action: Example the data entries or run the data through the TR20 data check program to locate the error. Correct the data and rerun.

- TABULAR DATA PROBLEM; 1) TOO MANY POINTS, 2) DATA CODE NOT "8", OR 3) NO "ENDTBL". RUN TERMINATED.

Remarks: One of the above errors has occurred in a table.

Action: Determine the error, correct the data, and rerun.

- THRU XSECTION/STRUCTURE ID ON "COMPUT" MISSING, RUN TERMINATED.

Remarks: The "THRU" ID on the COMPUT record shown after the message must have a cross section number (1-200) or a structure number (1-99) that matches a xsection/structure ID in the Standard Control. This message also occurs if a xsection/structure ID is used in a set of COMPUT's with no intervening ENDCMP where the ID's would overlap if the Standard Controls were processed in the given sequence, as in the example "...COMPUT..001...002" followed by "...COMPUT..002...003."

Action: Add appropriate ID and rerun.

- THRU XSECTION/STRUCTURE ID ON "COMPUT" NOT FOUND IN STANDARD CONTROL, RUN TERMINATED.

Remarks: The "THRU" xsection/structure ID on the COMPUT record shown after the message does not match any of the xsection/structure ID's in the Standard Control.

Action: Correct ID and rerun or add missing table and rerun.

- UNEXPECTED RECORD FOUND IN STANDARD CONTROL, RUN TERMINATED.

Remarks: Standard Control records must have a 6 in column 2. The last Standard Control record must be followed by an ENDATA record. The record shown after the error message is out of place or incorrect. Blank lines are not permitted.

Action: Move, delete, or correct record and rerun.

- XSECTION xxx LOW GROUND (xxxxx.xx) EXCEEDS BANKFULL (xxxxx.xx).

Remarks: The low ground elevation is higher than bankfull elevation. Low ground elevation must be equal to or lower than bankfull elevation for the interpolation routine to work.

Action: Correct error and rerun.

- XSECTION xxx LOW GROUND (xxxxx.xx) IS LESS THAN LOWEST ELEV (xxxxx.xx). LOW GROUND REQUIRED WHEN FLOODPLAIN LENGTH ENTERED. RUN TERMINATED.

Remarks: The low ground value entered with cross section data cannot be lower than the lowest elevation assigned to the cross section. When floodplain length is entered on the REACH record, a low ground entry is required in the XSECTION xxx record.

Action: Correct or add data as appropriate and return.

- XSECTION NUMBER xxx EXCEEDS MAX. OF 200, RUN TERMINATED.

Remarks: Cross section ID numbers must be between 1 and 200.

Action: Use acceptable ID number for the section, including its rating table if given.

- XSECTION xxx RATING TABLE VALUES (SHOWN BELOW) NOT ALL INCREASING. RUN TERMINATED.

Remarks: Entries for elevation, discharge and end area in the XSECTION table must be increasing. The increments can be small (0.01).

Action: Correct data and rerun.

5.4.2 Warnings

- Allow sufficient disk space for temporary and output files. The program disk may be replaced, if necessary, with the input data or scratch disk. If "punch" output files are generated, they are named with the user selected drive ID and file prefix along with standard program extensions. TR-20 temporary files are written on the default drive.

Remarks: This warning on disk space appears on the screen prior to the request for the input file. If there is not enough space, the run will end with a system message when the available space is full. The user specifies the drive, directory path, and file name for the input file. Output files and generated files are assigned according to the user's directions if they are different from the defaults shown. When the output is sent to the screen, then generated files are automatically named with the input prefix and sent to the input drive. Three temporary files are written to the default drive which is the location the program is run from. The temporary files are erased at the successful completion of a job.

Action: If the run aborts due to the lack of disk space, make room or specify a different location for the output files. The temporary files on the default drive beginning with ZZ will need to be erased by the user.

- ANTECEDENT RUNOFF CONDITION ENTERED AS xx, CONDITION 2 ASSUMED.

Remarks: The only valid antecedent runoff conditions are 1,2, and 3.

Action: If condition 2 was not intended, enter the correct value and rerun.

- BANKFULL ELEV (xxxxx.xx FT) EXCEEDS HIGHEST RATING POINT FOR XSECTION xxx.

Remarks: The elevation given as bankfull elevation for the cross section exceeds the highest elevation given in the rating curve, so that all of the elevations are within the channel.

Action: Correct the bankfull elevation if it is incorrect or add more elevations to the cross section data to define out-of-bank flow if needed. Remove bankfull elevation if it is not needed to define out-of-bank flow.

- DIMHYD TIME INCREMENT ENTERED (xx.xxxx) DIFFERS FROM COMPUTED (xx.xxxx). COMPUTED USED.

Remarks: The increment entered does not agree with the number of points entered in the DIMHYD table for the total dimensionless time of 1.0. The program assumes the number of points is correct and

recomputes an increment for comparison. The increment entered is not used.

Action: Correct the dimensionless hydrograph table and rerun if the number of points is wrong.

- DISCHARGE EXCEEDS HIGHEST RATING POINT FOR STRUCTURE xx, VALUE EXTRAPOLATED.

Remarks: Structure rating table was extrapolated as a straight line based on the two highest points.

Action: Consider if the extrapolation is reasonable, and if not add points to the high end of the rating curve to encompass the estimated peak outflow and storage required to handle the peak inflow. This message may also indicate an error elsewhere if the expected discharge should not get this high.

- DUPLICATE INTERMEDIATE SECTION ID (xxxxxx) FOUND. DUPLICATE ID IGNORED.

Remarks: More then one ID with the same name was in the intermediate peaks input. The second ID and drainage area is ignored.

Action: Correct the intermediate peaks input file and rerun if the data is needed.

- ECON2/URB1 "FLOW-FREQ" DATA FOR INTERMEDIATE PEAKS REORDERED IN DESCENDING ORDER.

Remarks: Storm peak discharges for an alternate were rearranged in the ECON file so the largest is first and the smallest last. This is the required structure of the ECON file including intermediate peaks for all data.

Action: If similar type evaluation storms were input on COMPUT records in descending order of rainfall volume, look for a problem that could cause the reordering. If rainfall volumes were not in descending order, this warning will appear so the user will know the reordering took place and it can be checked.

- ELEVATION OUTPUT OPTION REQUESTED BUT NO OUTPUT ELEVATIONS GIVEN. REQUEST IGNORED.

Remarks: The Standard Control elevation option requires a cross section or structure rating table with the same ID to be in the input file ahead of the Executive Control that uses it.

Action: If elevations are needed, insert a XSECTN or STRUCT table in the input file. Otherwise, remove the 1 that requests ELEV as an output for that Standard Control.

- ENTIRE HYDROGRAPH EXCEEDS BASEFLOW. ALL BASEFLOW ASSIGNED TO OUTFLOW HYDROGRAPH #1.

Remarks: Amount of discharge diverted to outflow #1 exceeded the inflow hydrograph baseflow, so the entire baseflow is assigned to outflow #1.

Action: If baseflow should have been split, change the divert procedure or use dummy reaches to change baseflow.

- FROM OR THRU XSECTION/STRUCTURE NOT FOUND, RECORD IGNORED.

Remarks: Both FROM and THRU ID's have to be saved for Summary Table 1 to be used with intermediate peaks. An ID could be incorrect or the total number of peaks could exceed the 24,000 summary table peak storage limit.

Action: If the data is needed, correct the intermediate peaks input file ID's in error and rerun, or if the limit is exceeded split the TR-20 into two runs.

- HIGHEST DISCHARGE (xxxxxxx CFS) AT HYDROGRAPH TRUNCATION.

Remarks: Above this message, a storage location is identified which contains a hydrograph that was still rising when it was truncated by the program's 400-point limitation. The last discharge is shown in the message and is used in the summary tables as the peak with a footnote that the incomplete hydrograph was still rising.

Action: If the true peak portion of the hydrograph is important when accumulated with other hydrographs downstream, increase the main time increment for the whole or portion of the watershed to capture more of the hydrograph.

- INFLOW DISCHARGE EXCEEDS HIGHEST VALUE OF COMBINED OUTFLOW RATING.

Remarks: Inflow discharge exceeds highest combined discharge at the cross section ratings used to divide the flow by DIVERT procedure 2.

Action: Check if extrapolation is reasonable, if not, extend rating curves and rerun. This message may also indicate an error elsewhere if the inflow discharge is larger than expected.

WARNINGS IN - NO

- INPUT M OUTSIDE ACCEPTABLE RANGE X = xxx.xx and M = xx.xx USED FOR XSECTION xxx.

Remarks: The program puts practical limits of 1.00 to 2.00 on exponent "m" as shown in the message.

Action: If the reach routing is not satisfactory, check whether the storage and rating for the xsection are satisfactory and representative for the reach.

- INTERMEDIATE SECTION ID xxxxxx
  WITH AREA OF xxxxxx.x IS NOT BETWEEN xxxxxx.x and xxxxxx.x

Remarks: Drainage area of the intermediate peaks section has to be between the FROM and THRU xsection/structure drainage areas.

Action: Correct the intermediate peaks input file and rerun if the data is needed.

- MAIN TIME INCREMENT (xx.xxx HRS) IS GREATER THAN 50% OF THE TIME OF CONCENTRATION (xx.xx HRS) FOR SUBWATERSHED XSECTION xxx. THIS WILL REDUCE THE COMPUTER PEAK BY ABOUT xx.xx%.

Remarks: The main the time increment is greater than the recommended .1 or .2 times the time of concentration (Tc) for the cross section shown. However, ratios of 0.3 to 0.5 may be acceptable for occasional subwatersheds with small Tc's within a system of larger subwatersheds. With over 0.5 the peak value is underestimated.

Action: The watershed may need to be subdivided again, with a different arrangement of subwatersheds, to have times of concentration more appropriate to the main time increment.

- MAIN TIME INCREMENT (xx.xxx HRS) IS GREATER THAN 50% OF THE TIME OF CONCENTRATION (xx.xx HRS) FOR SUBWATERSHED STRUCTURE xx. THIS WILL REDUCE THE COMPUTED PEAK BY ABOUT xx.x%.

Remarks: The main time increment is greater than the recommended .1 .2 times the time of concentration (Tc) for the structure shown. However, ratios of 0.3 to 0.5 may be acceptable for occasional subwatersheds with small Tc's within a system of larger subwatersheds. With over 0.5 the peak value is underestimated.

Action: The watershed may need to be subdivided again, with a different arrangement of subwatersheds, to have times of concentration more appropriate to the main time increment.

- NO FLOW DIVERTED, HYDROGRAPH TRANSLATED TO OUTPUT #1
  NOT ENOUGH RATING POINTS FOR XSECTIONS (STRUCTURE) xxx or (XSECTION) xxx.

Remarks: Cross section or structure rating tables to be used in Divert Procedure 2 have less than 2 points or have cross section numbers outside of the 1 to 200 range. No flow was diverted to output #2.

Action: Revise the rating tables(s) that caused the problem if flow should have been diverted by adding more points or renaming cross sections to be within 1 - 200 range and rerun.

- NO MAIN TIME INCREMENT ENTERED, 0.5 HOUR USED.

Remarks: In order to run, a main time increment is required. Since the user didn't enter one, the program used 0.5 hour.

Action: Examine the run for messages concerning peak definition, hydrograph truncation, structure and reach routing parameter relationships, and your objectives. Then choose the most ideal main time increment(s) and enter them on an INCREM record ahead of the COMPUT records that will use them and rerun if necessary.

- REACH xx, k* EXCEEDS 10, VALUE SET TO 10. DIVIDE REACH.

Remarks: The length factor k* is set at the practical limit of 10. This means the reach is too long and probably should be shortened for more reasonable results. In practice k* is usually 1 or less so significant division of the reach may be appropriate.

Action: If it is an important reach, consider splitting the reach length in the Standard Control into two reaches if one xsection with two ID's is representative or else add another representative xsection table for a portion of the original reach.

- ROUTING COEFFICIENT (C) EQUALS 1.0,
  CONSIDER SMALLER MAIN TIME INCREMENT FOR XSECTION xxx.

Remarks: The hydrograph is not routed when C = 1.0; it is translated through the reach without any attenuation, and the inflow and outflow hydrographs are identical.

Action: An occasional warning of this type may be acceptable, but if it occurs too often, consider using a smaller main time increment for the whole or portion of the watershed.

- ROUTING COEFFICIENT (C) (xx.xxxxxxx) BELOW MINIMUM VALUE,
  0.01 USED IN ROUTING XSECTION xxx.

Remarks: The routing coefficient is at or below the practical minimum of 0.01. The minimum program limit is 0.01. This essentially represents a storage situation, with a large peak reduction.

Action: Consider whether the reach could be more accurately represented by a structure routing, or break the segment into several reach routings.

- RUNOFF OPTION ON NULL RAINFL TABLE x NOT USED WITH REQUESTED RAINFALL TABLE x ON COMPUT RECORD. CHECK INPUT.

Remarks: The runoff option was not changed because the null (no points) RAINFL table number did not agree with the rainfall table number on the COMPUT record that followed. The null RAINFL table must precede the COMPUT in which it is used.

Action: Correct table numbers or rearrange the input and rerun.

- STRUCTURE xx - See XSECTION for messages that can apply to both structures and cross sections.

- STRUCTURE xx, MAIN TIME INCREMENT EXCEEDS MAXIMUM ALLOWABLE TIME INCREMENT OF xx.xxx HOURS.

Remarks: This check is made to warn of possible oscillation of outflow hydrograph values during the reservoir routing. The inequality delta t > (2S)/O (see section 3.8.1) must be true throughout the reservoir routing or oscillation will occur. The maximum allowable main time increment shown should satisfy this inequality. Use the HYD option on the Standard Control to observe the severity of the oscillation.

Action: Reduce the main time increment and rerun if the oscillation has a significant effect on downstream hydrographs.

- STRUCTURE xx, RESERVOIR ROUTING HAS NEGATIVE DISCHARGES. FIRST NEGATIVE VALUE IS xxxxxx CFS.

Remarks: The reservoir outflow has negative values. This is probably due to oscillation caused by using too large of a main time increment. See previous warning message discussion.

Action: Reduce the main time increment and rerun if it is a problem.

- SUMMARY TABLE #3/3A DATA REORDERED IN DESCENDING ORDER FOR ECON2.

Remarks: Storm peak discharges for an alternate were rearranged in the ECON file so that largest is first and the smallest last. This is the required structure of the ECON file.

Action: If similar type evaluation storms were input on COMPUT records in descending order of rainfall volume, look for a problem that could cause the reordering. If rainfall volumes were not in

descending order, this warning will appear so the user will know the reordering took place and it can be checked.

- TOO MANY COMBINATIONS OF XSECTION/STRUCTURE(xxx), STORM (xx) AND ALTERNATE (xx). FIRST xx ALTERNATES USED.

Remarks: The maximum number of alternatives, storm, and xsections/structures is 24,000.

Action: Break the job into small number of components by using fewer alternatives in each job.

- TRIANGULAR BASEFLOW RISE FOR XSECTION xxx TRUNCATED BY MAX POINT LIMIT AT xxxxx CFS (xx % BASEFLOW PEAK).

Remarks: The time to peak of the baseflow hydrograph is greater than 400 times the main time increment. The program stops computing when the maximum point limitation is reached.

Action: Reduce the time to peak and the base time (if important) of the baseflow hydrograph or increase the main time increment.

- TRIANGULAR BASEFLOW TAIL FOR XSECTION xxx TRUNCATED BY MAX POINT LIMIT AT xxxxx CFS (xx % BASEFLOW PEAK).

Remarks: The time base of the baseflow hydrograph is greater than 400 times the main time increment. The program stops computing when the maximum point limitation is reached.

Action: Consider reducing the time length of the recession limb of the base flow hydrograph if important.

- UNEXPECTED RECORD(S) ENCOUNTERED WHEN LOOKING FOR "JOB" RECORD. IMAGES OF FIRST 10 RECORDS IGNORED FOLLOWS:

Remarks: The first record of a new job must be a JOB record or a ENDJOB record was found out of place. Up to 10 records are shown that were read looking for it. Also may occur after a job is terminated due to an error and it is looking for the next job if any.

Action: Revise input file for the job and rerun.

- UNEXPECTED RECORD TYPE FOUND. FOLLOWING RECORD IGNORED:

Remarks: To process an intermediate peaks record, the operation name has to be PEAKS or blank. If record shown is after the last intermediate peak record, an ENDJOB record must be the last record in the intermediate peaks file.

Action: Correct the intermediate peaks input file and rerun if the data is needed.

- XSECTION xxx CHANNEL TO FLOODPLAIN LENGTH RATIO EXCEEDS 10.

Remarks: The channel length is 10 or more times that of the floodplain length, which is unrealistic even for a highly meandering channel. This message may also appear if the "x" value on the REACH card is omitted, as the program then assumes that the "m" values is a flood plain length.

Action: Check input data.

- XSECTION xxx, INFLOW EXCEEDS MAX TABLE DISCHARGE, EXTRAPOLATION USED.

Remarks: The log-log discharge-end area curve at this xsection was extrapolated above the highest point on the rating table. The extrapolation is based on the highest two points.

Action: Consider if the high inflow peak and the extrapolation are reasonable. If the extrapolation is not reasonable, add more rating curve points to the overbank to encompass the inflow peak discharge and rerun. If the peak inflow is unreasonable, look for errors elsewhere.

- XSECTION xxx, INSUFFICIENT LOW FLOW RATING, PEAK FLOW LESS THAN 2ND TABLE VALUE. THIS REACH ROUTING MAY BE INCORRECT, UNLESS NEW RATING TABLE VALUES ARE INSERTED.

Remarks: It is important to include the channel rating in the calculation of the exponent "m" to improve the routing of low peaks. The log-log discharge-end area curves are extrapolated down based on the lowest 2 points above zero flow. The accuracy of the routing is best with a detailed channel rating.

Action: Consider if the low inflow peak and the extrapolation are correct. If not, add more rating curve points to the xsection in the channel portion and rerun. A minimum of two points should be in the channel.

- XSECTION xxx LOW GROUND (xxxxx.xx) EXCEEDS HIGHEST ELEVATION (xxxxx.xx).

Remarks: The specified low ground elevation is too large considering the rest of the cross section data. The low ground elevation should be at or below the lowest channel bank elevation.

Action: Correct data in cross section rating table.

- XSECTION xxx, or
  STRUCTURE xx HYDROGRAPH VOLUME TRUNCATED AT xxxxxx CFS (xxx.% of MAX. HYDROGRAPH COORDINATE) MAIN TIME INCREMENT TOO SMALL.

Remarks: The hydrograph was truncated after its peak due to the program's 400 point storage limitation. The loss in volume is expressed in terms of percent of the discharge at truncation to the peak discharge with baseflow subtracted from both. This message is triggered at 10%, when the loss of volume might be significant.

Action: The volume is a factor in the routing operations. It is more critical in the structure (storage) routing than in the reach routing. If the volume loss is significant, increase the main time increment for part or all of the watershed as needed.

- XSECTION xxx, or
  STRUCTURE xx MAIN TIME INCREMENT TOO LARGE, COMPUTED PEAK EXCEEDS ADJACENT COORDINATE BY xx%.

Remarks: The computed peak exceeds the maximum hydrograph coordinate by at least 5% at this location. The accuracy of the peak computational procedure is questionable much over 5%.

Action: If this computed peak is important, a smaller main time increment will usually increase its accuracy. Computed peaks are not used in any of the routing, diversion or adding of hydrographs. They are only computed on the outflow hydrographs and used in Summary Table 1, 3, 3A, 4 and in the ECON file.

- XSECTION xxx, or
  STRUCTURE xx NO HYDROGRAPH IN INPUT LOCATION x OR x FOR ADDHYD OPERATION.

Remarks: No hydrograph is available to add in one or both of the specified hydrograph storage locations.

Action: Revise Standard Control if locations are in error.

- XSECTION xxx, or
  STRUCTURE xx VOLUME TRUNCATED AT xx% and xx% WHEN ADDING HYDROGRAPHS IN LOCATIONS x and x.

Remarks: Both hydrographs were previously truncated or truncated when adjusted to a common time increment. This warning only occurs when both hydrographs are truncated and the discharge at truncation of at least one is 10% or greater of its peak above baseflow.

Action: No action required if loss of volume is not critical to downstream routing. If it is, rerun with larger main time increment.

- XSECTION xxx, or
  STRUCTURE xx VOLUME TRUNCATED at xx% IN LOCATION x ADDING HYDROGRAPHS.

Remarks: Specified hydrograph was previously truncated or truncated

when adjusted to a common time increment. This warning only occurs when the discharge at truncation is 10% or greater of its peak above baseflow.

Action: No action required if loss of volume is not critical to downstream routing. If it is, rerun with larger main time increment.

5.4.3 Messages - Informational

- DRAINAGE AREA EXCEEDS 25 SQ MI, IS IT CORRECT?

Remarks: The message applies to the record listed immediately after it. TR-20 was developed for use with small subwatersheds usually much less than 25 sq. mi. in drainage area, although it may be used with caution for larger ones. This is generally the limit of hydrologically homogeneous subareas.

Action: If drainage area is correct, proceed with program. Beware of excessive hydrograph truncation if the main time increment is small.

- "DURINC" TABLE ENTERED BUT "ECON" OPTION NOT SELECTED.

Remarks: The DURINC table is not used unless the ECON option is also used.

Action: If flow duration information only is needed proceed with program, but use the DUR option on the Standard Control.

- ENDJOB2 RECORD ASSUMED, RUN CONTINUED.

Remarks: Although no ENDJOB record is provided, data may follow for another job. The program will run this as a separate job with the same output and generated file names as the first job, and append the output data to that for the first job.

Action: None needed if this is what was intended.

- HYDROGRAPH CONTAINS NO FLOW.
  FOR XSECTION/STRUCTURE xxx, OPERATION xxxxxx.

Remarks: For some reason the hydrograph stored in the location shown above the message has no significant flow (less than 0.01 cfs), including baseflow. Less than 0.01 cfs converts to zero.

Action: Determine if it is a true condition due to: no runoff, such as a low curve number; the result of a DIVERT operation where all the flow was diverted the other way; or an input error. If an error is suspected, first check the manipulation of the hydrograph storage locations in the Standard Control for continuity.

- HYDROGRAPH IS ALL BASEFLOW (xxxxxxx.CFS).
  FOR XSECTION/STRUCTURE xxx, OPERATION xxxxxx.

Remarks: For some reason the hydrograph stored in the location shown above the message has only a constant baseflow.

Action: Determine if it is a true condition due to: no runoff, such as a low curve number; the result of a DIVERT operation where

all the flow except baseflow or a portion of it was diverted the other way; or an input error. If the baseflow is in error, first check the manipulation of the hydrograph storage locations in the Standard Control for continuity.

- LENGTH FACTOR (k*) ABOVE 1,
  CONSIDER DIVIDING REACH LENGTH FOR XSECTION xxx.

Remarks: With the given routing parameters, better reach routing results could be obtained by shortening the reach length. This is normally due to a large reduction of peak flow within the reach when k* exceeds 1. The storage in the reach is generally not well-represented by a single valued storage-discharge relation. A warning is given if k* exceeds 10.

Action: Depending on how important this reach is to the project and how often this message occurs, the easiest way to decrease k* is to split the reach in the Standard Control into two reaches.

- NO DATA TO ECON FILE.

Remarks: Not enough data output or options are provided to create an ECON file.

Action: Check that necessary data and instructions are available in input data file.

- NO PEAK COMPUTED (ONLY xx HYDROGRAPH POINTS).

Remarks: Not enough points were present to compute hydrograph peak.

Action: Check input data and revise if necessary.

- NO HYDROGRAPH POINTS EXCEED TRUNCATED (or
  BASEFLOW) DISCHARGE (xxxxx.x CFS).

Remarks: Flow duration is not calculated since all hydrograph discharges are at or below the last point or baseflow. Hydrograph is still rising when truncated, or all baseflow.

Action: Do nothing if reasonable. The user might have to increase the main time increment and rerun if the hydrograph is truncated before the peak is reached.

- NO SIGNIFICANT PEAK FOUND, MAX DISCHARGE xxxxxx CFS
  AT XSECTION/STRUCTURE xx/xxx.

Remarks: The hydrograph stored in the location shown above the message did not vary in discharge by at least one cfs.

Action: Is the subarea too small for the program? If an input error is suspected, run the Data Check Program.

- ORDER OF MAXIMUM PEAK CHANGED WHEN REACH ROUTED, XSEC xxx. OUTFLOW PEAK SHIFTED xxx.x HOURS.

Remarks: The multiple peak inflow hydrograph for XSEC xxx resulted in a shift in order of the maximum peak when reach routed. If the time shift is negative the maximum outflow peak occurs before the maximum inflow peak due to an earlier inflow peak of lesser magnitude. If the time shift is positive, the maximum outflow peak occurs at least six hours following the maximum inflow peak and is related to another inflow peak of lesser magnitude.

Action: Do nothing if multiple peaks are expected. This message can explain a large change in peak times in the summary tables. If multiple peaks are not expected, check input data.

- RESERVOIR ROUTING, STRUCTURE xx, TRUNCATED AT xxx POINTS WITH xxxxx.xx AC-FT (xx.xx WATERSHED INCHES) FLOOD STORAGE REMAINING IN RESERVOIR AT ELEV. xxxxxx.xx

Remarks: The reservoir routing was truncated at the outflow hydrograph 400 point limitation or, if less than 400 points, the inflow hydrograph was probably truncated here. The remaining flood storage in the reservoir can be added to the outflow hydrograph volume and the sum compared with the inflow hydrograph volume. If the structure has not been drawn down within the point limitation the remaining volume includes the storage between the start routing elevation and zero discharge elevation in the structure rating table. This message is given when the storage volume remaining exceeds 0.05 inches of runoff.

Action: Do nothing if volumes are reasonable. If not, check the input.

- STRUCTURE xx, USER ENTERED STARTING ELEVATION OR STRUCTURE TABLE STARTS xxx.xx FEET BELOW ASSUMED CREST ELEVATION AT xxxxxx.xx. THIS CAN DECREASE OUTFLOW HYDROGRAPH VOLUME.

Remarks: Starting elevation is below the point of significant flow in the structure rating table. This case can occur when a pool is below the principal spillway elevation due to prolonged drought or intense evaporation.

Action: Check if the starting elevation and outflow hydrograph volume are reasonable. If not, examine all the parameters used in the routing for the problem. Since the starting elevation can not be below the first point of the rating table and rating table points must be increasing in discharge, the program finds the highest point

with insignificant discharge of less than 1 cfs. The crest elevation is assumed at this point and the routing starts at a pool level below this assumed crest. Thus runoff volume will fill the void between the start routing elevation and the assumed crest elevation before significant outflow occurs.

- STRUCTURE xx, USER ENTERED STARTING ELEVATION (xxxxx.x FEET) CAN ADD xxx.xxx INCHES OF RUNOFF TO THE OUTFLOW HYDROGRAPH VOLUME.

Remarks: Starting elevation is above the first point of the structure rating table. Volume in the pool at the start of routing will usually be drawn down before inflow exceeds outflow. The volume in the pool can also be drawn down whenever outflow exceeds inflow, especially on the tail of the hydrograph. This total amount of pool volume drawn down will be added to the runoff volume, increasing the outflow volume. This case may occur when the reservoir storage is still filled with flow from a previous storm. If there is baseflow entering the reservoir the starting elevation can be set such that the baseflow will pass through the principal spillway. The pool is not drained below this starting elevation and this message will not be displayed.

Action: Check if the outflow volume is reasonable, adding the extra volume in the reservoir and subtracting any truncated outflow hydrograph volume from the inflow hydrograph volume. If not, examine all the parameters used in the routing for the problem.

- SUMMARY TABLE 1 FORMAT SIZE EXCEEDED, XSECTION/STRUCTURE xxx
  PEAK = xxxxxxxxx PEAK TIME = xxxxxx.xx PEAK ELEV. = xxxxxxxx.xx
  D.A. = xxxxxxx.xx RUNOFF = xxxxxx.xx START HRS. = xxxxxxxx.xx

Remarks: One or more of the data items that follow this message contains a value, that due to its magnitude, can exceed the data field size allowed in the file format used to save data for Summary Table 1. To avoid a system error when the file is read and to flag the problem data, dummy values containing all nines with a minus sign are inserted in the file and used in Summary Table 1. The true value, if not all asterisks, is shown in the message.

Action: Review input data for errors, if value is not reasonable.

- SUMMARY TABLE 2 FORMAT SIZE EXCEEDED, XSEC. ID REACH xxx
  PEAK INFLOW = xxxxxxxxxx COEFF. (x) = xxxxxx.xxxx
  PEAK OUTFLOW = xxxxxxxxxx FACTOR (k*) = xxxxxx.xxxx

Remarks: One or more of the data items that follow this message contains a value, that due to its magnitude, can exceed the data field size allowed in the file format used to save data for Summary Table 1. To avoid a system error when the file is read and to flag

the problem data, dummy positive or negative values containing all nines with a minus sign if appropriate are inserted in the file and used in Summary Table 2. The true value, if not all asterisks, is shown in the message.

Action: Review input data for errors, if value is not reasonable.

- TIME OF CONCENTRATION EXCEEDS 100 HRS, IS IT CORRECT?

Remarks: Normally with watersheds less than 25 square miles in drainage area, the Tc is less than 100 hours. A review of the input data is indicated (the questionable data is shown after the message). Usually the decimal is missing in the Tc data field and the resultant value is greater than 100.

Action: If the Tc is correct proceed with the program. However some consideration should be given to subdividing the watershed.

- XSECTION xxx FLOODPLAIN LENGTH EXCEEDS CHANNEL LENGTH.

Remarks: The floodplain length for a cross section may exceed the channel length when a straight river reach occurs in a sinuous valley. Floodplain to channel length ratios greater than 1.1 should be checked to verify them.

Action: Redefine reach lengths if in error and rerun.

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GLOSSARY

A A - cross sectional or end area, usually in square feet

Acre - a unit of land area; equals 43,560 square feet

Acre foot - A unit of volume equal to the amount of water that will cover one acre to a depth of one foot. Equals 43,560 cubic feet.

Alternate - (1) A system of structural or non-structural measures in a watershed; (2) Index or label number associated with the identification of that system of measures.

Antecedent moisture condition (AMC) - The degree of wetness of the soil in a watershed at the beginning of a storm. The literature has used the Roman Numeral designations I, II, and III. AMC has been replaced by average runoff condition (ARC).

ATT-KIN - See Modified ATT-KIN

Average runoff condition (ARC) - The typical ARC used to develop the runoff curve numbers for a watershed, usually ARC II. The program input range is from 1 to 3.

ASCII - American National Standard Code for Information Interchange - standard code used to exchange information among data processing and communication systems.

B Bankfull - The elevation or capacity of the channel segment of a cross section just before flow is considered to spill over into the floodplain.

Baseflow - The sustained or fair-weather discharge which persists after storm runoff and associated quick return flow have been depleted. It is usually derived from groundwater discharge or gradual snow or ice melt over extended periods of time, but need not be continuous flow. It can be based on annual or seasonal periods depending upon when major floods usually occur.

C cfs - A rate of flow (discharge) in cubic feet per second.

cfs-hours - A unit of volume equal to an average flow rate in cfs over one hour of time. For example, 150 cfs flowing for 30 minutes is (150)(.5) = 75 cfs-hrs. = (75 cfs hrs)(3600 sec/hr) = 270,000 cu. ft.

CN - See runoff curve number (RCN).

Composite flood hydrograph - The hydrograph resulting when two or more hydrographs are added. It is computed by summing the incremental hydrograph ordinates.

Cross section (stream or valley) - The shape of a channel stream or valley viewed in the direction of flow. In watershed investigations, it is determined by a line approximately perpendicular to the main path of waterflow along which measurements of distance and elevation are taken to define the cross-sectional or end area.

Cross section rating - The elevation, discharge and end area data representative of a reach.

csm - A rate of flow; given as cubic feet per second per square mile of drainage area (cfs/mi^2).

Cubic feet per second - A rate of flow (cfs).

D Data Code - required number 0 to 9 that signifies the type of data in Column 2 of most input records.

Data Field - group of consecutive columns on an input record used to enter a specific type of data.

Delta D - (1) The unit hydrograph time increment, in hours or (2) the computational increment used to develop a flood hydrograph.

Default drive - The computer drive from which the TR-20 program is run. For example, c:a:TR20; where c: is the default drive and a: is the drive the program is stored on. Temporary files are always written to the default drive.

Delta T - see main time increment.

Dimensionless hydrograph - Made to represent many unit hydrographs by using the time to peak and the peak rates as basic units and plotting the hydrographs as ratios of these units. See NEH 4.

Drainage area - The surface area of the watershed draining into a stream at a given point, usually expressed in square miles or acres.

E ECON - option to obtain TR-20 output file for input into the USDA, SCS, ECON2 or URB1 Programs--see references on p. 155.

ECON2 - An USDA, SCS economics program to compute average annual damage for agricultural areas--see references on p. 155.

H Hydrograph - (1) A graph showing, for a given point on a stream or for a given point in any drainage system, the discharge, stage, velocity or other property of water with respect to time. (2) Also, the tabular data from which the graph can be plotted.

Hydrograph Coordinates - The discharge values that define the hydrograph tabulated at the main time increment.

Hydrograph storage location - A location within the computer program for storing a hydrograph. There are seven of these locations in which the user may place hydrographs according to the storage location numbers, 1 through 7.

I ID - Abbreviation for identification. Usually represents a cross section or structure identifying name.

Internal time increment - The increment used by the program to develop runoff hydrographs before they are converted to the main time increment.

J Job - The execution of TR-20 from initialization at the JOB record through completion at the first ENDJOB record; may include any number of passes through the watershed.

K k - coefficient in the discharge valley storage relation, $Q = kS^m$, that is applicable for the channel and valley reach. See Hydrology Note 2.

k* - Nondimensioned reach length factor. Indicates relative amount of attenuation in a reach routing.

L - Reach length in feet of stream or valley. See reach.

L Low ground - The lowest floodplain elevation in a cross section outside of the channel banks. It must be at or below the lowest channel bank.

M m - (1) Exponent in the discharge valley storage relation, $Q = kS^m$, that is applicable for the channel and valley reach. (2) Exponent in the discharge cross sectional area relation, $Q = xA^m$, that is applicable for the channel and valley reach.

Main time increment (Delta t) - The increment used by the program for all routing computations, adding of hydrographs, and tabulations of hydrograph coordinates.

Modified ATT-KIN - The Modified Attenuation - Kinematic Flood Routing Method. See Hydrology Note 2.

N NEH-4 - SCS National Engineering Handbook, Section 4, Hydrology (see references on p. 155.)

Null Structure - A non-functional or dummy structure that is used to indicate a potential structure location for use in other alternatives. Useful in setting up standard Control for without structure alternative.

O Operation Name and Number - The name (Col. 4 to 9) and required reference number (Col. 11) 0 to 9, on most input records. They dictate the operation to be performed for each type of input data.

O - Outflow discharge in cfs.

P Pass - Each pass through the Standard Control that ends with an ENDCMP record, includes each storm and alternate combination.

Path - The computer drive, directory tree structure, and file needed to read from or write to a specific file storage location.

Q Delta Q - Incremental runoff volume, in watershed inches.

Q - (1) Total runoff volume, in watershed inches, or (2) Discharge, in cfs.

q - Discharge, in cfs.

R Rainfall (depth) - The average depth in inches of rainfall occurring over a watershed or subwatershed.

Reach - A length of stream or valley, selected for generally constant hydrologic or hydraulic characteristics for use in a study. See stream reach.

Record - A single line of input data for computer processing. It also can refer to a single line of output data. TR-20 records have a maximum length of 80 characters.

Reservoir - A pond, lake, tank, basin or other space, either natural in its origin or created in whole or in part by the building of engineering structures, which is used for storage, regulation, and control of water.

Run - A computer processing term; the placing of a program into memory and execution of that program. In TR-20 one or more jobs can be processed within a run.

Runoff curve number (CN) - A dimensionless number of 100 or less that relates runoff to the soil-cover complex of the watershed. Higher numbers mean greater runoff. See NEH 4.

S

S - A measure of volume expressed in acre-feet, cfs-hours or watershed inches; valley storage within a channel reach for a selected discharge.

Storm - (1) A meteorological disturbance accompanied by such phenomena as rain, snow, hail, thunder and lightning, and wind. (2) A meteorological disturbance which is either unusual or of great magnitude, rate or intensity.

Stream reach - A length of stream channel or valley selected for use in hydraulic or other computations. Separate reach lengths can be used for the channel and flood plain if a significant difference occurs within the reach. See reach.

Subarea - See subwatershed.

Subwatershed - A watershed that is part of larger watershed. It is analyzed separately when necessary in order to improve computational accuracy for results on a whole watershed basis, or to get results for that area separately.

T

Delta t - See main time increment.

Tc - See time of concentration.

Time of concentration (Tc) - the time, in hours it takes water from the hydraulically most distant point to reach a watershed outlet. Tc varies with discharge but is often used as constant. See NEH 4 for more information.

TR-20 - (1) Technical Release number 20, a publication in the SCS technical release series, which is the user manual for the computer program of the same name; (2) the computer program described in the user manual. See reference list, p. 155.

Travel time - (1) The average time for water to flow through a reach or other stream or valley length that is less than the total length. A travel time can be part of a Tc but is never the whole Tc; (2) The time it takes for a specific flow to pass through the entire reach, such as the peak travel time.

U

Unit hydrograph - A discharge hydrograph coming from one inch of direct runoff distributed uniformly over the watershed, with the direct runoff generated at a uniform rate during the unit storm duration. A watershed may have 1-hour, 2-hour, etc. unit hydrographs.

URB1 - An USDA, SCS economics program to compute average annual floodwater damage for urban areas. See references on p. 155.

W Watershed - See drainage area.

Watershed inch - A unit of volume equal to one inch of water over the watershed. Watershed inches are usually abbreviated as inches. For example, one-half inch of runoff from a 600-acre watershed will be a volume of 0.5 inches or (0.5)(600)(1/12) = 25 acre-feet.

X x - coefficient in the discharge cross sectional area relation, $Q = xA^m$, that is applicable for the channel and valley reach. It is used as a routing coefficient on the REACH record.

Xsectn - See cross section.

Z Zero damage - The highest elevation or capacity at which no significant floodwater damage is considered to occur at a cross section representing a reach. It is usually at or above low ground in the floodplain, but not higher than the highest bankfull elevation.

CONVERSIONS

THESE UNITS:	MULTIPLIED BY:	GIVES:
cfs days	1.983	AF (acre feet)
cfs days	0.03719	inches depth on 1 square mile
cfs days per square mile	0.03719	inches depth
cfs hours	0.08264	AF
cfs hours per square mile	0.001550	inches depth
cfs	1.983	AF per day
cfs	724.0	AF per year (365 days)
cfs	448.8	U. S. gallons per min.
cfs	0.6463	million U. S. gallons/day
csm	0.03719	inches depth per day
csm	13.57	inches depth per year (365 days)
inches per hour	645.3	csm
inches per hour	1.008	cfs per acre
inches depth	53.33	AF per square mile
inches depth on 1 sq. mi.	53.33	AF
AF (acre feet)	0.5042	cfs days
AF	12.10	cfs hours
AF	0.01875	inches depth on 1 sq. mi.
AF	0.3258	million U. S. gallons
AF per day	0.5042	cfs
AF per square mile	0.01875	inches depth
U. S. gallons per day	0.002228	cfs
million U.S. gallons/day	1.547	cfs
feet per second	0.6818	miles per hour
cubic feet	7.481	U. S. gallons
imperial gallons	1.200	U. S. gallons
inches	*0.0254	meters
inches	*25.4	millimeters
feet	*0.3048	meters
acres	0.40469	hectares
acres	4046.9	square meters
gallons (U. S.)	3.7854	liters
pounds	0.45359	kilograms
cubic meters	*1000.0	liters
acre-feet	1233.5	cubic meters
cubic feet	0.028317	cubic meters
square feet	0.09290	square meters
square miles	2.590	square kilometers
cfs-hours	101.94	cubic meters
csm	0.010933	cubic meters/second /sq. kilometer

* Exact conversion

APPENDIX A

DESCRIPTION OF SAMPLE JOBS

SAMPLE JOBS

Five sample jobs based on an example watershed are shown in the Appendices B through F. The jobs are related in that they incremental increase in content and complexity from first to last as more features of TR-20 are demonstrated.

- **Sample 1** (Appendix B) starts developing a single flood hydrograph on a headwater tributary and routing it through a structure and a reach.
- **Sample 2** (Appendix C) shows the addition of a downstream intervening area.
- **Sample 3** (Appendix D) picks up another tributary and includes a diversion of a constant flow.
- **Sample 4** (Appendix E) uses a READHD from Sample 2 and demonstrates changes in the Tabular data and in the Standard Control.
- **Sample 5** (Appendix F) is a full watershed analysis with two storms and four alternatives.

Each job begins with a schematic sketch and ends with the TR-20 output listing. TR-20 input forms and the initial computer screens are only displayed for the first sample job. The other sample jobs, to save space, start the output listing with the 80-80 listing of the input. Since the total output for Sample 5 with the options chosen is rather large, only parts have been selected for display.

The following list provides a guide to the program features where they are demonstrated in the Appendices, and where they are referenced in the manual. The features are listed in alphabetical order by type of input or output and then by the individual operation or items under them. Only the first appearance of a feature is referenced; it may also appear in subsequent sample jobs. If multiple output pages are shown, the first page refers to the 80-80 list of input if pertinent and the second and succeeding pages to the output listing. The reference page is the location in the TR-20 User's Manual where the feature is discussed.

FEATURE DEMONSTRATED	SAMPLE JOB NUMBER	INPUT/OUTPUT PAGE	REFERENCE PAGE
80-80 List of Input Data	1	B-10	112
ECON file			
PEAK-FLOW Records	5	F-48	107, 118
TIME-FLOW Records	5	F-48	38, 119
Executive Control Operations			
BASFLO			
Procedure #1: Constant	5	F-6/F-14	88
Procedure #2: Triangular	5	F-8/F-30	89
COMPUTE			
Multiple for Pass	3	D-4/D-15	92
Single for Pass	1	B-7/B-12	91
Storms and Alternates			
Single	1	B-7/B-12	91
Multiple	5	F-6/F-35	91
Tzero change	3	D-4/D-15	92
ENDCMP	1	B-7/B-16	93
ENDJOB	1	B-7/B-19	33
INCREM			
Constant	1	B-7/B-12	90
Varying	not shown		91
LIST			
All input	not shown		88
All rainfall tables	not shown		88
Current Cross Section and structure tables	5	F-6/F-9	88
Current Rainfall table	5	F-6/F-12	88
Current Standard Control	5	F-6/F-13	88
Dimensionless Hydrograph Table	5	F-6/F-11	88
Flow Duration Increment Table	5	F-6/F-11	88
Flow Duration			
with ECON option	5	F-5/F-48	31
without ECON option	3	D-4/D-14	38,71
Graphics Files	not shown		30,119
Intermediate Peaks			
IPEAKS	5	F-8/F-45	107
PEAKS	5	F-8/F-45	107
JOB record	1	B-3	29
ECON	5	F-5	31
Peak Discharge File Output	5	F-48	118
ENDPLOT	not shown		33
FULLPRINT	1	B-3	31
GRAPHICS	not shown		33
NOPRINT	2	C-3	32
PASS	not shown		32
PLOT	3	D-3/D-5	32
SUMMARY	2	C-3/C-8	32

FEATURE DEMONSTRATED	SAMPLE JOB NUMBER	INPUT/OUTPUT PAGE	REFERENCE PAGE
TR-20	1	B-3	29
WATERSHED ID	1	B-3	31
Modify Standard Control			
ALTER	5	F-7/F-21	103
DELETE	5	F-7/F-21	103
INSERT	5	F-7/F-21	102
Tabular Data			
DIMHYD Table			
Standard Default	5	F-11	43
User Entered	not shown		43
DURINC Table	5	F-5	38
Null structure	3	D-4	42
RAINFL Table			
Actual rainfall table	3	D-3	44
Program defined table	5	F-12	44
Runoff option	not shown		46
READHD Table			
File Generated by Program	2	C-3/C-7	71
File Used in Program	4	E-3/E-5	47
STRUCT Table	1	B-4	42
XSECTN Table	1	B-5	40
Bankfull Elevation	1	B-5	40
CFS Discharge	1	B-5	40
CSM Discharge	not shown		40
Low Ground Elevation	3	D-3	41
Zero Damage Elevation	3	D-3	40
Summary Tables			
Tables 1, 2, 3	1	B-3/B-17	116, 117
Tables 3A, 4	5	F-5/F-45	118
Standard Control Operations			
ADDHYD	2	C-3/C-5	66
DIVERT			
Procedure #1: constant flow	3	D-4/D-16	68
Procedure #2: divide flow	5	F-8, F-30	69
ENDATA	1	B-6	70
Output Options			
DUR - flow duration data	3	D-4/D-14	71
ELEV - hydrograph elevations	1	B-6/B-13	70
FILE - READHD file	2	C-3/C-7	71
HYD - hydrograph discharges	1	B-6/B-12	70
P/V - peak/volume	1	B-6/B-12	70
SUM - include in summary	1	B-6/B-17	71
REACH			
Using Cross Section Data	1	B-6/B-15	64
Using "x" and "m" data	3	D-4/D-12	65

FEATURE DEMONSTRATED	SAMPLE JOB NUMBER	INPUT/OUTPUT PAGE	REFERENCE PAGE
RESVOR			
Starting elev. given	1	B-6/B-12	63
Starting elev. left blank	2	C-3/C-4	63
Null structure	3	D-4/D-9	42
RUNOFF	1	B-6/B-12	63
SAVMOV	3	D-4/D-11	66
TITLE	1	B-3/B-12	33
User Notes	1	B-11	113

APPENDIX B

SAMPLE JOB NO. 1

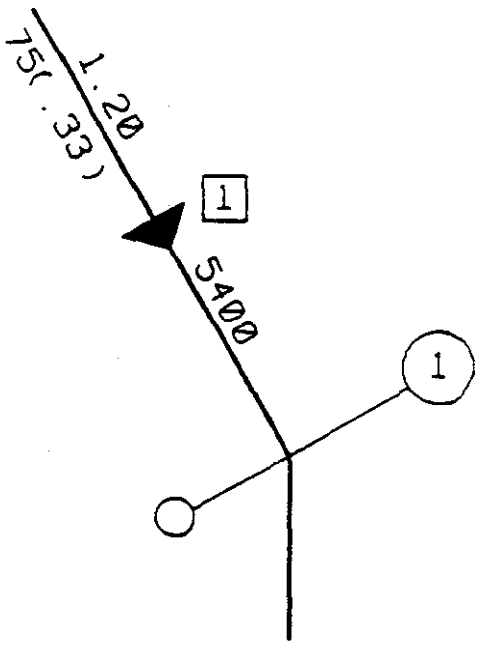
Contents | Page

Schematic Drawing	B - 2
Input Data Sheets	B - 3
Computer Screens	B - 8
Printout	B - 10

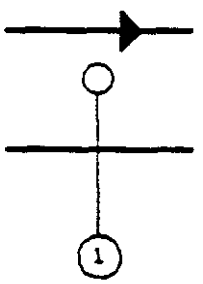
SCHEMATIC DRAWING OF SAMPLE WATERSHED

Sample Job No. 1

(Structure 1 in place)



LEGEND



Structure Number 1

Cross Section Number 1

(at downstream end of reach)

5400 — Reach Length - Feet

1.20 — Drainage Area - Square miles

75(.33) — Runoff Curve Number (Time of Cconcentration-Hours)

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TR-20 – JOB AND TITLE

WORKSHEET
SCS-ENG-264
41-91

LOCATION Annex PREPARED BY NT DATE 3/6/92 PAGE 1
JOB Manual CHECKED BY _____ DATE _____ OF ___

1 – 12	13 – 24	25 – 36	37 – 48	49 – 60	61 – 72	73 – 80
Operation Name	Watershed ID	ECON Option	FULLPRINT Option	Starting Pass No.	SUMMARY Option	PLOTS, ENDPLOT, GRAPHICS Options	Record Identification
JOB TR-20	SAMPLE1		FULLPRINT	PASS 1			10

1 – 12	13 – 24	25 – 36	37 – 48	49 – 60	61 – 72	73 – 80
Operation Name	Job title (one record required . second optional)					Record Identification
TITLE	JOB USES · 24 HR TYPE II STORM, FROM STR 1 to XSEC 1					20
TITLE	WITH FULLPRINT, CROSS SECTION DATA, & OUTPUT OPTIONS ON					30

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TR-20 STREAM CROSS SECTION DATA

WORKSHEET
SCS-ENG-270A
1-90

CROSS SECTION NAME 001 PREPARED BY MT DATE 3/6/92 PAGE 1
JOB MANUAL CHECKED BY _____ DATE _____ OF _____

1 – 12	13 – 24	25 – 36	37 – 48	49 – 60	61 – 72	73 – 80
Data Code / Table Name	Cross Section No.	Drainage Area sq. mi. (use 1.0 if cfs)	Bankfull Elevation-feet	Zero Damage Elevation-feet	Low Ground Elevation-feet	Record Identification
2 XSECTN	001	1.00	508.50			10
	(001 to 200)	Elevation feet	Discharge cfs or csm	End Area square feet		Record Identification
8		503.5	0.0	0.0		50
8		505.21	100.0	57.25		60
8		506.74	300.0	118.20		70
8		508.28	600.0	189.25		80
8		508.50	624.56	200.00		90
8		509.51	1000.00	364.35		100
8		510.37	1500.00	662.99		110
8		511.07	2100.00	963.82		120
8		511.44	2500.00	1134.18		130
8						
8						
8						
8						
8						
8						
8						
8						
8						
8						
9 ENDTBL		This record must be the last record of this table.				140

1. Maximum of 20 data records.
2. Data Fields in Col. 25 to 72 require decimal points.

W-F

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TR-20 STRUCTURE DATA

WORKSHEET
SCS-ENG-269
4-81

STRUCTURE ID 01 PREPARED BY NJ DATE _____ PAGE 1 OF ___
JOB Manual CHECKED BY _____ DATE _____

1 – 12	13 – 24	25 – 36	37 – 48	49 – 60	61 – 72	73 – 80
Data Code / Table Name	Structure No.					Record Identification
3 STRUCT	01					150
	(01 to 99)	Elevation feet	Discharge cfs	Storage acre – feet		Record Identification
6		521.5	0.0	17.0		160
6		521.6	3.0	18.0		170
6		521.8	15.	20.2		180
6		522.0	33	22.5		190
6		522.2	54.	25.0		200
6		522.4	79.	28.0		210
6		526.2	940.	70.0		220
6		526.4	1009.	75.0		230
6		526.6	1071.	80.0		240
6		527.2	1265.	95.0		250
6						
6						
6						
6						
6						
6						
6						
6						
6						
6						
9 ENDTBL	This record must be the last record of this table.					260

1. Maximum of 20 data records.
2. Data Fields in Col. 25 to 60 require decimal points.

B-5

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TR-20 – STANDARD CONTROL FOR WATERSHED

WORKSHEET
SCS-ENG-273
4-81

LOCATION Annex PREPARED BY DM DATE _____ PAGE 1
JOB MANUAL CHECKED BY _____ DATE _____ OF _____

PROCEDURE NO.	1 – 12 Data Code	Operation Name	No.	13 – 24 Xsec	Xsta	Hydrgr. In	Hydrgr. Out	25 – 36	37 – 48	49 – 60	61 – 72 Output Options	73 – 80 Record Identification
								Data Fields Decimals Required				
	6	RUNOFF	1					AREA sq mi	RUNOFF CURVE NO.	Tc hours		Example only Do Not Enter
	6	RESVOR	2					START ELEV. ft.				
#1	6	REACH	3					LENGTH ft.		[VALLEY LENGTH ft]		
#2	6	REACH	3					LENGTH ft.	[END AREA COEF. X]	[EXPONENT m]		
	6	ADDHYD	4									
	6	SAVMOV	5									
#1	6	DIVERT	6					DISCH. cfs OUT1	D.A. RATIO OUT1	XSEC ID OUT2		
#2	6	DIVERT	6						D.A. RATIO OUT1	XSEC ID OUT2		
		ENDATA						Use only at the end of all Standard Control Records				

1 – 12 Data Code	Operation Name	No.	13 – 24 Xsec	Xsta	Hydrgr. In	Hydrgr. Out	25 – 36	37 – 48	49 – 60	61 – 72	73 – 80
6	RUNOFF	1		01		4	1.2	75.	.53	1	010
6	RESVOR	2		01	4	7	521.5			1 1	280
6	REACH	3	01	1	7	5	5400.				290
	ENDATA										300

12-6

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TR-20 – EXECUTIVE CONTROL FOR WATERSHED

WORKSHEET
SCS-ENG-274
10-81

LOCATION Annex PREPARED BY #7 DATE _____ PAGE 1
JOB MANUAL CHECKED BY _____ DATE _____ OF ____

PROCEDURE NO.	1 – 12			13 – 24				25 – 36	37 – 48	49 – 60	61 – 72	73 – 80
	Date Code	Operation Name	No.	FROM X or XSEC	FROM X or SIR	THRU X or XSEC	THRU X or SIR	Data Fields Decimals Required			RAIN TABLE	Record Identification
	7	LIST						Stand. Control (1.)	Tabular Data (1.)	RAINFL Tables (1.–10.)		Example only Do Not Enter
#1	7	BASFLO	5	Procedure # 1				NEW BASEFLOW, CFS				
#2	7	BASFLO	5	Procedure # 2				Volume, inches	Peak Time, hrs	Base time, hrs		
	7	INCREM	6					Main Time Increment, hrs				
	7	COMPUT	7					Starting Time, hrs	Rainfall Depth, in. or 1.0	Rainfall Duration, hrs or 1.0		
		ENDCMP	1	Required after a single or series of COMPUT records.								
		ENDJOB	2	Terminates job if no intermediate peak records.								

1 – 12			13 – 24				25 – 36	37 – 48	49 – 60	61 – 72	73 – 80
7	INCREM	6					0.1				
7	COMPUT	7		011	0011			5.2	1.0	2 2 01 01	3 1 0
	ENDCMP	1									3 3 0
	ENDJOB	2									3 4 0

SOIL CONSERVATION SERVICE (SCS)
U.S. DEPARTMENT OF AGRICULTURE

TR-20
PROJECT FORMULATION
HYDROLOGY
PCVERSION 2.04TEST

..... DISCLAIMER .....

Although this program has been tested by its contributor, NO warranty, expressed or implied, is made by the contributor, as to the accuracy and functioning of the Program and related program material nor shall the fact of distribution constitute any such warranty, and NO responsibility is assumed by the contributor in connection therewith.

```
DO YOU WANT AN INPUT LIST WITH THE OUTPUT?          (Y or N) y
INCLUDE THE LATEST TR-20 USER NOTES IN THE OUTPUT?  (Y or N) y
WRITE ALL WARNINGS AND MESSAGES TO A SEPARATE FILE? (Y or N) n
```

```
SCS TR-20  PROJECT FORMULATION - HYDROLOGY,  VERSION 2.04TEST

                    *** WARNING ***
  Allow sufficient disk space for temporary and output files.
  The program disk may be replaced, if necessary, with the
  input data or scratch disk.  If "punch" output files are
  generated, they are named with the user selected drive ID
  and file prefix along with standard program extensions.
  TR-20 temporary files are written on the default drive.

ENTER INPUT DRIVE ID and FILE NAME:                )--> b:a1.dat

  Output device or file choices:
    Printer = PRN     (Device names)
    Screen  = CON     (  may vary  )
    File, enter drive ID and file name.

ENTER OUTPUT DEVICE or FILE CHOICE:
(Default is b:a1.OUT                               )--> prn
```

B-10

```
******************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY*****************

JOB TR-20 SAMPLE 1              FULLPRINT                                      1(
TITLE     JOB USES - 24HR TYPE II STORM, FROM STR 1 TO XSEC 1                  2(
TITLE     WITH FULLPRINT, CROSS SECTION DATA, & OUTPUT OPTIONS ON.             3(
 2 XSECTN   001          1.00        508.50                                   4(
 8                       503.50      0.0         0.0                          5(
 8                       505.21      100.00      57.25                        6(
 8                       506.74      300.00      118.20                       7(
 8                       508.28      600.00      189.25                       8(
 8                       508.50      624.56      200.00                       9(
 8                       509.51      1000.00     364.35                      10(
 8                       510.37      1500.00     662.99                      11(
 8                       511.07      2100.00     963.82                      12(
 8                       511.44      2500.00     1134.18                     13(
 9 ENDTBL                                                                    14(
 3 STRUCT       01                                                           15(
 8                       521.5       0.0         17.0                         16(
 8                       521.6       3.0         18.0                         17(
 8                       521.8       15.         20.2                         18(
 8                       522.0       33.         22.5                         19(
 8                       522.2       54.         25.0                         20(
 8                       522.4       79.         28.0                         21(
 8                       526.2       948.        70.                          22(
 8                       526.4       1009.       75.                          23(
 8                       526.6       1071.       80.                          2
 8                       527.2       1265.       95.                          2
 9 ENDTBL                                                                    26(
 6 RUNOFF 1     01      6 1.2        75.         0.33          1        1    27(
 6 RESVOR 2     01 6    7 521.5                                1 1      1    28(
 6 REACH  3 001    7    5 5400.                                1        1    29(
   ENDATA                                                                    30(
 7 INCREM 6               0.1                                               31(
 7 COMPUT 7     01 001              5.2         1.0         2 2  01   01    32(
   ENDCMP 1                                                                  33(
   ENDJOB 2                                                                  34(

*******************************END OF 80-80 LIST*******************************
```

COMPUTER PROGRAM FOR PROJECT FORMULATION - HYDROLOGY USER NOTES

The Users' Manual for this program is SCS Technical Release 20 (TR-20), dated April 1990. The TR-20 program is no longer supported on the mainframe since all post 1986 program changes have only been in the IBM compatable microcomputer environnment.

Compatable input and data check programs are TR20INPT.EXE, version III, dated 01/30/90 and TR20CK.EXE, version II, which is forthcoming.

Major changes from the 1986 TR-20 microcomputer version are:

HYDROGRAPH GENERATION: program procedure to develop runoff hydrographs revised to preserve total hydrograph volume as well as the peak discharge. Hydrographs can contain up to four hundred main time increment points from the beginning of runoff.

ATTKIN ROUTING: seperate channel and floodplain lengths can be entered to define additional storage in meandering channels below the representative low ground elevation. Program changes have been made to better handle multiple peaked hydrographs.

FLOW DURATION: can be obtained if requested.

OUTPUT 80 COLUMNS: Output fits 80 column paper. Hydrograph coordinates over 100 cfs are rounded and shown as whole numbers.

ERRORS, WARNINGS, AND MESSAGES: expanded and updated.

LIST OPTIONS: can print all or selected parts of input data.

INTERMEDIATE PEAKS: requires new IPEAKS record.

```
TR20 ------------------------------------------------------------------------ SCS
SAMPLE 1     JOB USES - 24HR TYPE II STORM, FROM STR 1 TO XSEC 1          VERSIO
03/06/92   WITH FULLPRINT, CROSS SECTION DATA, & OUTPUT OPTIONS ON.      2.04TES
07:53:20                    PASS   1   JOB NO.   1                       PAGE


EXECUTIVE CONTROL INCREM    MAIN TIME INCREMENT =   .100 HOURS                310


EXECUTIVE CONTROL COMPUT    FROM STRUCTURE  1  TO XSECTION   1                320
   STARTING TIME =    .00       RAIN DEPTH =  5.20        RAIN DURATION =  1.00
   ANT. RUNOFF COND. = 2        MAIN TIME INCREMENT =   .100 HOURS
   ALTERNATE NO. = 1            STORM NO. = 1             RAIN TABLE NO. = 2


OPERATION RUNOFF   STRUCTURE  1
        OUTPUT HYDROGRAPH =  6       AREA =   1.20 SQ MI
        INPUT RUNOFF CURVE = 75.     TIME OF CONCENTRATION =   .33 HOURS
        COMPUTED INTERNAL TIME INCREMENT =  .0440 HOURS

   PEAK TIME(HRS)              PEAK DISCHARGE(CFS)          PEAK ELEVATION(FEET)
      12.09                          2128.1                        (RUNOFF)

                    HYDROGRAPH POINTS FOR   ALTERNATE = 1,   STORM = 1
    HRS       MAIN TIME INCREMENT =  .100 hr,      DRAINAGE AREA =   1.20 SQ.MI.
    8.60 CFS        .47     1.09     1.92     2.90     4.00     5.17     6.40     7.62
    9.40 CFS       8.80     9.95    11.13    12.43    13.95    15.73    17.73    19.91
   10.20 CFS      22.36    25.18    28.34    31.79    35.59    40.01    45.16    51.0
   11.00 CFS         58       65       74       86      101      119      152       26
   11.80 CFS        534     1073     1826     2125     1690     1106      752      553
   12.60 CFS        425      341      288      253      229      211      196      185
   13.40 CFS        175      166      158      150      143      136      130      124
   14.20 CFS        119      115      113      110      108      106      104      102
   15.00 CFS      99.56    97.48    95.41    93.33    91.26    89.15    87.05    84.94
   15.80 CFS      82.82    80.68    78.56    76.48    74.67    73.27    72.22    71.33
   16.60 CFS      70.52    69.75    69.00    68.25    67.50    66.76    66.02    65.26
   17.40 CFS      64.50    63.75    63.00    62.24    61.48    60.72    59.96    59.19
   18.20 CFS      58.42    57.66    56.89    56.11    55.34    54.57    53.79    53.01
   19.00 CFS      52.24    51.45    50.67    49.89    49.11    48.31    47.53    46.74
   19.80 CFS      45.96    45.16    44.37    43.61    42.97    42.52    42.22    42.00
   20.60 CFS      41.83    41.66    41.51    41.36    41.22    41.07    40.92    40.77
   21.40 CFS      40.63    40.48    40.33    40.18    40.03    39.88    39.74    39.58
   22.20 CFS      39.44    39.29    39.14    38.99    38.84    38.69    38.54    38.38
   23.00 CFS      38.24    38.08    37.93    37.78    37.63    37.48    37.33    37.17
   23.80 CFS      37.02    36.87    36.63    33.31    22.59    11.63     5.42     2.57
   24.60 CFS       1.21      .55      .24

   RUNOFF ABOVE BASEFLOW  (BASEFLOW =    .00 CFS)
                  2.61 WATERSHED INCHES;    2021 CFS-HRS;     167.0 ACRE-FEET.


OPERATION RESVOR   STRUCTURE  1
        INPUT HYDROGRAPH 6          OUTPUT HYDROGRAPH 7
        SURFACE ELEVATION =   521.50
```

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
12.35	928.9	526.12

HYDROGRAPH POINTS FOR ALTERNATE = 1, STORM = 1
MAIN TIME INCREMENT = .100 hr, DRAINAGE AREA = 1.20 SQ.MI.

HRS									
8.50	CFS	.00	.01	.03	.06	.12	.20	.31	.44
8.50	ELEV	521.50	521.50	521.50	521.50	521.50	521.51	521.51	521.51
9.30	CFS	.61	.79	1.00	1.24	1.49	1.78	2.10	2.46
9.30	ELEV	521.52	521.53	521.53	521.54	521.55	521.56	521.57	521.58
10.10	CFS	2.86	3.55	4.44	5.43	6.51	7.71	9.04	10.52
10.10	ELEV	521.60	521.61	521.62	521.64	521.66	521.68	521.70	521.73
10.90	CFS	12.17	14.03	16.58	19.91	23.69	28.07	33.20	40.06
10.90	ELEV	521.75	521.78	521.82	521.85	521.90	521.95	522.00	522.07
11.70	CFS	51	74	183	383	634	834	923	924
11.70	ELEV	522.17	522.36	522.86	523.73	524.82	525.70	526.09	526.09
12.50	CFS	881	819	751	682	617	558	505	457
12.50	ELEV	525.91	525.64	525.34	525.04	524.75	524.49	524.26	524.05
13.30	CFS	415	378	345	316	291	268	248	230
13.30	ELEV	523.87	523.71	523.56	523.44	523.33	523.23	523.14	523.06
14.10	CFS	214	199	186	175	165	156	148	141
14.10	ELEV	522.99	522.93	522.87	522.82	522.78	522.74	522.70	522.67
14.90	CFS	135	130	125	120	116	113	109	106
14.90	ELEV	522.65	522.62	522.60	522.58	522.56	522.55	522.53	522.52
15.70	CFS	103	100	97	94	92	89	87	84
15.70	ELEV	522.50	522.49	522.48	522.47	522.45	522.44	522.43	522.42
16.50	CFS	82.45	80.63	78.99	78.35	77.70	77.05	76.39	75.72
16.50	ELEV	522.42	522.41	522.40	522.39	522.39	522.38	522.38	522.37
17.30	CFS	75.05	74.37	73.69	73.00	72.31	71.62	70.92	70.21
17.30	ELEV	522.37	522.36	522.36	522.35	522.35	522.34	522.34	522.33
18.10	CFS	69.50	68.79	68.08	67.36	66.63	65.91	65.18	64.45
18.10	ELEV	522.32	522.32	522.31	522.31	522.30	522.30	522.29	522.28
18.90	CFS	63.71	62.97	62.23	61.49	60.74	59.99	59.24	58.49
18.90	ELEV	522.28	522.27	522.27	522.26	522.25	522.25	522.24	522.24
19.70	CFS	57.73	56.97	56.21	55.45	54.69	53.93	53.18	52.45
19.70	ELEV	522.23	522.22	522.22	522.21	522.21	522.20	522.19	522.19
20.50	CFS	51.76	51.10	50.47	49.88	49.31	48.77	48.26	47.77
20.50	ELEV	522.18	522.17	522.17	522.16	522.16	522.15	522.15	522.14
21.30	CFS	47.31	46.86	46.44	46.03	45.65	45.28	44.92	44.58
21.30	ELEV	522.14	522.13	522.13	522.12	522.12	522.12	522.11	522.11
22.10	CFS	44.25	43.93	43.62	43.33	43.04	42.76	42.49	42.23
22.10	ELEV	522.11	522.10	522.10	522.10	522.10	522.09	522.09	522.09
22.90	CFS	41.98	41.73	41.50	41.26	41.03	40.81	40.59	40.38
22.90	ELEV	522.09	522.08	522.08	522.08	522.08	522.07	522.07	522.07
23.70	CFS	40.17	39.96	39.76	39.56	39.25	38.49	37.06	35.14
23.70	ELEV	522.07	522.07	522.06	522.06	522.06	522.05	522.04	522.02
24.50	CFS	33.05	31.10	29.20	27.40	25.69	24.09	22.58	21.16
24.50	ELEV	522.00	521.98	521.96	521.94	521.92	521.90	521.88	521.87
25.30	CFS	19.84	18.59	17.43	16.34	15.31	14.55	13.90	13.29
25.30	ELEV	521.85	521.84	521.83	521.81	521.80	521.79	521.78	521.77
26.10	CFS	12.71	12.15	11.61	11.10	10.61	10.14	9.69	9.27

26.10	ELEV	521.76	521.75	521.74	521.73	521.73	521.72	521.71	521.70
26.90	CFS	8.86	8.47	8.09	7.74	7.40	7.07	6.76	6.46
26.90	ELEV	521.70	521.69	521.68	521.68	521.67	521.67	521.66	521.66
27.70	CFS	6.18	5.90	5.64	5.39	5.16	4.93	4.71	4.50
27.70	ELEV	521.65	521.65	521.64	521.64	521.64	521.63	521.63	521.63
28.50	CFS	4.31	4.12	3.93	3.76	3.60	3.44	3.29	3.14
28.50	ELEV	521.62	521.62	521.62	521.61	521.61	521.61	521.60	521.60
29.30	CFS	3.00	2.93	2.86	2.79	2.72	2.65	2.59	2.52
29.30	ELEV	521.60	521.60	521.60	521.59	521.59	521.59	521.59	521.58
30.10	CFS	2.46	2.40	2.34	2.28	2.23	2.17	2.12	2.07
30.10	ELEV	521.58	521.58	521.58	521.58	521.57	521.57	521.57	521.57
30.90	CFS	2.02	1.97	1.92	1.87	1.83	1.78	1.74	1.70
30.90	ELEV	521.57	521.57	521.56	521.56	521.56	521.56	521.56	521.56
31.70	CFS	1.66	1.61	1.58	1.54	1.50	1.46	1.43	1.39
31.70	ELEV	521.56	521.55	521.55	521.55	521.55	521.55	521.55	521.55
32.50	CFS	1.36	1.32	1.29	1.26	1.23	1.20	1.17	1.14
32.50	ELEV	521.55	521.54	521.54	521.54	521.54	521.54	521.54	521.54
33.30	CFS	1.11	1.09	1.06	1.03	1.01	.98	.96	.94
33.30	ELEV	521.54	521.54	521.54	521.53	521.53	521.53	521.53	521.53
34.10	CFS	.91	.89	.87	.85	.83	.81	.79	.77
34.10	ELEV	521.53	521.53	521.53	521.53	521.53	521.53	521.53	521.53
34.90	CFS	.75	.73	.71	.69	.68	.66	.65	.63
34.90	ELEV	521.52	521.52	521.52	521.52	521.52	521.52	521.52	521.52
35.70	CFS	.61	.60	.58	.57	.56	.54	.53	.57
35.70	ELEV	521.52	521.52	521.52	521.52	521.52	521.52	521.52	521.5.
36.50	CFS	.50	.49	.48	.47	.46	.44	.43	.42
36.50	ELEV	521.52	521.52	521.52	521.52	521.52	521.51	521.51	521.51
37.30	CFS	.41	.40	.39	.38	.37	.36	.36	.35
37.30	ELEV	521.51	521.51	521.51	521.51	521.51	521.51	521.51	521.51
38.10	CFS	.34	.33	.32	.31	.31	.30	.29	.28
38.10	ELEV	521.51	521.51	521.51	521.51	521.51	521.51	521.51	521.51
38.90	CFS	.28	.27	.26	.26	.25	.25	.24	.23
38.90	ELEV	521.51	521.51	521.51	521.51	521.51	521.51	521.51	521.51
39.70	CFS	.23	.22	.22	.21	.21	.20	.20	.19
39.70	ELEV	521.51	521.51	521.51	521.51	521.51	521.51	521.51	521.51
40.50	CFS	.19	.18	.18	.17	.17	.16	.16	.16
40.50	ELEV	521.51	521.51	521.51	521.51	521.51	521.51	521.51	521.51
41.30	CFS	.15	.15	.15	.14	.14	.14	.13	.13
41.30	ELEV	521.51	521.51	521.50	521.50	521.50	521.50	521.50	521.50
42.10	CFS	.13	.12	.12	.12	.11	.11	.11	.11
42.10	ELEV	521.50	521.50	521.50	521.50	521.50	521.50	521.50	521.50
42.90	CFS	.10	.10	.10	.10	.09	.09	.09	.09
42.90	ELEV	521.50	521.50	521.50	521.50	521.50	521.50	521.50	521.50
43.70	CFS	.08	.08	.08	.08	.08	.07	.07	.07
43.70	ELEV	521.50	521.50	521.50	521.50	521.50	521.50	521.50	521.50
44.50	CFS	.07	.07	.07	.06	.06	.06	.06	.06
44.50	ELEV	521.50	521.50	521.50	521.50	521.50	521.50	521.50	521.50
45.30	CFS	.06	.06	.05	.05	.05	.05	.05	.05
45.30	ELEV	521.50	521.50	521.50	521.50	521.50	521.50	521.50	521.50

46.10 CFS	.05	.05	.04	.04	.04	.04	.04	.04
46.10 ELEV	521.50	521.50	521.50	521.50	521.50	521.50	521.50	521.50
46.90 CFS	.04	.04	.04	.04	.03	.03	.03	.03
46.90 ELEV	521.50	521.50	521.50	521.50	521.50	521.50	521.50	521.50
47.70 CFS	.03	.03	.03	.03	.03	.03		
47.70 ELEV	521.50	521.50	521.50	521.50	521.50	521.50		

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
2.61 WATERSHED INCHES; 2021 CFS-HRS; 167.0 ACRE-FEET.

OPERATION REACH XSECTION 1
INPUT HYDROGRAPH 7 OUTPUT HYDROGRAPH 5
CHANNEL LENGTH = 5400.00 FT
INPUT = RATING CURVE REPRESENTATIVE OF REACH

COMPUTED COEFFICIENTS RELATED TO CROSS SECTION AREA, X = .418, M = 1.35
MODIFIED ATT-KIN ROUTING COEFFICIENT = .25, PEAK TRAVEL TIME = .40 HOUR

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET
12.78	731.5	508.79

HYDROGRAPH POINTS FOR ALTERNATE = 1, STORM = 1
MAIN TIME INCREMENT = .100 hr, DRAINAGE AREA = 1.20 SQ.MI

HRS								
9.50 CFS	.43	.57	.73	.92	1.13	1.37	1.64	1.94
10.30 CFS	2.34	2.86	3.49	4.24	5.09	6.07	7.17	8.40
11.10 CFS	9.79	11.47	13.55	16.06	19.02	22.52	26.85	32.90
11.90 CFS	43	78	153	272	411	537	633	694
12.70 CFS	725	731	719	694	660	622	581	540
13.50 CFS	500	462	426	393	362	334	308	285
14.30 CFS	264	244	227	212	198	186	175	165
15.10 CFS	156	149	142	135	130	125	120	116
15.90 CFS	112	108	105	101	98	95	93	90
16.70 CFS	87.82	85.64	83.84	82.32	81.02	79.88	78.85	77.91
17.50 CFS	77.04	76.21	75.42	74.65	73.90	73.16	72.43	71.71
18.30 CFS	70.99	70.27	69.55	68.83	68.11	67.38	66.66	65.93
19.10 CFS	65.20	64.46	63.73	62.99	62.25	61.51	60.76	60.01
19.90 CFS	59.26	58.51	57.75	57.00	56.24	55.48	54.73	54.00
20.70 CFS	53.28	52.59	51.92	51.27	50.65	50.06	49.50	48.96
21.50 CFS	48.44	47.94	47.47	47.02	46.59	46.18	45.78	45.40
22.30 CFS	45.04	44.69	44.35	44.03	43.71	43.41	43.12	42.84
23.10 CFS	42.57	42.30	42.04	41.79	41.55	41.31	41.08	40.85
23.90 CFS	40.63	40.42	40.20	39.97	39.60	38.97	38.03	36.80
24.70 CFS	35.39	33.86	32.26	30.64	29.02	27.43	25.88	24.39
25.50 CFS	22.96	21.59	20.29	19.06	17.95	16.95	16.04	15.22
26.30 CFS	14.46	13.76	13.10	12.48	11.90	11.36	10.84	10.35
27.10 CFS	9.89	9.44	9.02	8.62	8.24	7.87	7.52	7.19
27.90 CFS	6.87	6.57	6.28	6.00	5.74	5.48	5.24	5.01
28.70 CFS	4.79	4.58	4.38	4.18	4.00	3.82	3.65	3.49
29.50 CFS	3.35	3.23	3.12	3.02	2.93	2.84	2.76	2.69
30.30 CFS	2.62	2.55	2.48	2.42	2.36	2.30	2.24	2.19

```
TR20 ------------------------------------------------------------------------ SCS
SAMPLE 1      JOB USES - 24HR TYPE II STORM, FROM STR 1 TO XSEC 1          VERSI(
03/06/92    WITH FULLPRINT, CROSS SECTION DATA, & OUTPUT OPTIONS ON.      2.04TE'
07:53:20                      PASS   1   JOB NO.   1                      PAGE
```

31.10 CFS	2.13	2.08	2.03	1.98	1.93	1.88	1.84	1.79
31.90 CFS	1.75	1.70	1.66	1.62	1.58	1.54	1.50	1.47
32.70 CFS	1.43	1.40	1.36	1.33	1.30	1.26	1.23	1.20
33.50 CFS	1.17	1.14	1.12	1.09	1.06	1.04	1.01	.99
34.30 CFS	.96	.94	.92	.89	.87	.85	.83	.81
35.10 CFS	.79	.77	.75	.73	.71	.70	.68	.66
35.90 CFS	.65	.63	.62	.60	.58	.57	.56	.54
36.70 CFS	.53	.52	.50	.49				

```
RUNOFF ABOVE BASEFLOW  (BASEFLOW =     .00 CFS)
                2.61 WATERSHED INCHES;    2021 CFS-HRS;     167.0 ACRE-FEET.

EXECUTIVE CONTROL ENDCMP    COMPUTATIONS COMPLETED FOR PASS   1              330
```

SUMMARY TABLE 1

SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL IN ORDER PERFORMED.
A CHARACTER FOLLOWING THE PEAK DISCHARGE TIME AND RATE (CFS) INDICATES:
F-FLAT TOP HYDROGRAPH T-TRUNCATED HYDROGRAPH R-RISING TRUNCATED HYDROGRAPH

RAINFALL OF 5.20 inches AND 24.00 hr DURATION, BEGINS AT .0 hrs.
RAINTABLE NUMBER 2, ARC 2
MAIN TIME INCREMENT .100 HOURS

ALTERNATE 1 STORM 1

XSECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)
STRUCTURE 1	RUNOFF	1.20	2.61	---	12.09	2128	1773.3
STRUCTURE 1	RESVOR	1.20	2.61	526.12	12.35	929	774.2
XSECTION 1	REACH	1.20	2.61	508.79	12.78	732	610.0

SUMMARY TABLE 2

MODIFIED ATT-KIN REACH ROUTING IN ORDER PERFORMED.
QUESTION MARK (?) AFTER: OUTFLOW PEAK - MAX. NUMBER ROUTING ITERATIONS USED;
LENGTH FACTOR - VALUE K* GREATER THAN 1.0;
ATT-KIN COEFF - VALUE C GREATER THAN 0.667.

			HYDROGRAPH INFORMATION				ROUTING PARAMETERS				
		FLOOD	INFLOW		OUTFLOW		Q-A EQ.			PEAK	ATT-
XSEC	REACH	PLAIN							LENGTH	RATIO	KIN
ID	LENGTH	LENGTH	PEAK	TIME	PEAK	TIME	COEFF	POWER	FACTOR	Q/I	COEFF
	(FT)	(FT)	(CFS)	(HR)	(CFS)	(HR)	(X)	(M)	(k*)	(Q*)	(C)
BASEFLOW IS .0 CFS											
ALTERNATE 1 STORM 1											
1	5400		924	12.4	731	12.8	.42	1.35	.129	.792	.25

SUMMARY TABLE 3

STORM DISCHARGES (CFS) AT XSECTIONS AND STRUCTURES FOR ALL ALTERNATES
QUESTION MARK (?) AFTER: OUTFLOW PEAK - RISING TRUNCATED HYDROGRAPH.

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS..... 1
STRUCTURE 1	1.20	
ALTERNATE 1		929
XSECTION 1	1.20	
ALTERNATE 1		732

B-2C

```
TR20 ------------------------------------------------------------------------ SCS -
SAMPLE 1      JOB USES - 24HR TYPE II STORM, FROM STR 1 TO XSEC 1          VERSION
03/06/92    WITH FULLPRINT, CROSS SECTION DATA, & OUTPUT OPTIONS ON.      2.04TEST

END OF  1 JOBS IN THIS RUN

                    SCS  TR-20,  VERSION 2.04TEST
                          SAMPLE 1  FILES

    INPUT  = b:a1.dat                                  , GIVEN DATA FILE
    OUTPUT = prn                                       , DATED 03/06/92,07:53:20

             FILES GENERATED - DATED 03/06/92,07:53:20

                              NONE!

          TOTAL NUMBER OF WARNINGS =   0,  MESSAGES =   0

                    *** TR-20 RUN COMPLETED ***
```

APPENDIX C

SAMPLE JOB NO. 2

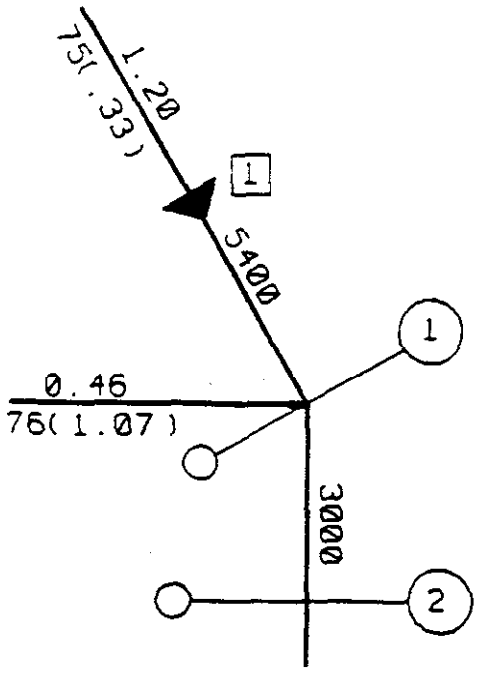
Contents **Page**

Schematic Drawing	C - 2
Printout	C - 3

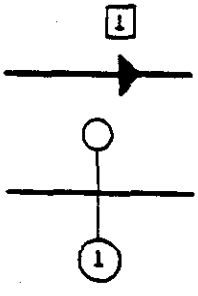
SCHEMATIC DRAWING OF SAMPLE WATERSHED

Sample Job No. 2

(Structure 1 in place)



LEGEND



Structure Number 1

Cross Section Number 1
(at downstream end of reach)

5400 — Reach Length - Feet

1.20 — Drainage Area - Square miles

75(.33) — Runoff Curve Number (Time of Concentration-Hours)

Intervening area

```
***************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY*****************

JOB TR-20 SAMPLE 2                                  SUMMARY
TITLE     JOB USES - 24HR TYPE II STORM, FROM STR 1 TO XSEC 2
TITLE     WITH NOPRINT, SUMMARY, ADDHYD, & PEAK-VOL, HYD & FILE OPTIONS.
 2 XSECTN   001          1.00        508.50
 8                       503.50      0.0         0.0
 8                       505.21      100.00      57.25
 8                       506.74      300.00      118.20
 8                       508.28      600.00      189.25
 8                       508.50      624.56      200.00
 8                       509.51      1000.00     364.35
 8                       510.37      1500.00     662.99
 8                       511.07      2100.00     963.82
 8                       511.44      2500.00     1134.18
 9 ENDTBL
 2 XSECTN   002          1.00        501.27
 8                       496.27      0.0         0.0
 8                       498.24      90.00       66.78
 8                       499.98      270.00      138.93
 8                       501.27      441.18      200.00
 8                       501.66      540.00      235.25
 8                       502.80      900.00      530.50
 8                       504.43      1960.00     1237.82
 9 ENDTBL
 2 STRUCT       01
                         521.5        0.0         17.0
 8                       521.6        3.0         18.0
 8                       521.8        15.         20.2
 8                       522.0        33.         22.5
 8                       522.2        54.         25.0
 8                       522.4        79.         28.0
 8                       526.2        948.        70.
 8                       526.4        1009.       75.
 8                       526.6        1071.       80.
 8                       527.2        1265.       95.
 9 ENDTBL
 6 RUNOFF 1     01      6 1.20        75.         0.33
 6 RESVOR 2     01 6    7
 6 REACH  3 001    7    5 5400.                                1 1
 6 RUNOFF 1 001         6 0.46        76.         1.07         1
 6 ADDHYD 4 001    5 6 7                                        1
 6 REACH  3 002    7    5 3000.                                1 1      1
   ENDATA
 7 INCREM 6              0.1
 7 COMPUT 7     01 002                5.2         1.0          2 2  01  01
   ENDCMP 1
   ENDJOB 2

*********************************END OF 80-80 LIST*********************************
```

TR20 ---------- SCS
SAMPLE 2 JOB USES - 24HR TYPE II STORM, FROM STR 1 TO XSEC 2 VERSIC
03/06/92 WITH NOPRINT, SUMMARY, ADDHYD, & PEAK-VOL, HYD & FILE OPTIONS. 2.04TES
07:55:47 PASS 1 JOB NO. 1 PAGE

EXECUTIVE CONTROL INCREM MAIN TIME INCREMENT = .100 HOURS 430

EXECUTIVE CONTROL COMPUT FROM STRUCTURE 1 TO XSECTION 2 440
STARTING TIME = .00 RAIN DEPTH = 5.20 RAIN DURATION = 1.00
ANT. RUNOFF COND. = 2 MAIN TIME INCREMENT = .100 HOURS
ALTERNATE NO. = 1 STORM NO. = 1 RAIN TABLE NO. = 2

OPERATION REACH XSECTION 1

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET
12.78	731.5	508.79

HYDROGRAPH POINTS FOR ALTERNATE = 1, STORM = 1
MAIN TIME INCREMENT = .100 hr, DRAINAGE AREA = 1.20 SQ.MI

HRS								
9.50 CFS	.43	.57	.73	.92	1.13	1.37	1.64	1.94
10.30 CFS	2.34	2.86	3.49	4.24	5.09	6.07	7.17	8.40
11.10 CFS	9.79	11.47	13.55	16.06	19.02	22.52	26.85	32.90
11.90 CFS	43	78	153	272	411	537	633	694
12.70 CFS	725	731	719	694	660	622	581	540
13.50 CFS	500	462	426	393	362	334	308	28[illegible]
14.30 CFS	264	244	227	212	198	186	175	16
15.10 CFS	156	149	142	135	130	125	120	116
15.90 CFS	112	108	105	101	98	95	93	90
16.70 CFS	87.82	85.64	83.84	82.32	81.02	79.88	78.85	77.91
17.50 CFS	77.04	76.21	75.42	74.65	73.90	73.16	72.43	71.71
18.30 CFS	70.99	70.27	69.55	68.83	68.11	67.38	66.66	65.93
19.10 CFS	65.20	64.46	63.73	62.99	62.25	61.51	60.76	60.01
19.90 CFS	59.26	58.51	57.75	57.00	56.24	55.48	54.73	54.00
20.70 CFS	53.28	52.59	51.92	51.27	50.65	50.06	49.50	48.96
21.50 CFS	48.44	47.94	47.47	47.02	46.59	46.18	45.78	45.40
22.30 CFS	45.04	44.69	44.35	44.03	43.71	43.41	43.12	42.84
23.10 CFS	42.57	42.30	42.04	41.79	41.55	41.31	41.08	40.85
23.90 CFS	40.63	40.42	40.20	39.97	39.60	38.97	38.03	36.80
24.70 CFS	35.39	33.86	32.26	30.64	29.02	27.43	25.88	24.39
25.50 CFS	22.96	21.59	20.29	19.06	17.95	16.95	16.04	15.22
26.30 CFS	14.46	13.76	13.10	12.48	11.90	11.36	10.84	10.35
27.10 CFS	9.89	9.44	9.02	8.62	8.24	7.87	7.52	7.19
27.90 CFS	6.87	6.57	6.28	6.00	5.74	5.48	5.24	5.01
28.70 CFS	4.79	4.58	4.38	4.18	4.00	3.82	3.65	3.49
29.50 CFS	3.35	3.23	3.12	3.02	2.93	2.84	2.76	2.69
30.30 CFS	2.62	2.55	2.48	2.42	2.36	2.30	2.24	2.19
31.10 CFS	2.13	2.08	2.03	1.98	1.93	1.88	1.84	1.79
31.90 CFS	1.75	1.70	1.66	1.62	1.58	1.54	1.50	1.47
32.70 CFS	1.43	1.40	1.36	1.33	1.30	1.26	1.23	1.20
33.50 CFS	1.17	1.14	1.12	1.09	1.06	1.04	1.01	.99
34.30 CFS	.96	.94	.92	.89	.87	.85	.83	.8[illegible]
35.10 CFS	.79	.77	.75	.73	.71	.70	.68	.6[illegible]

C-5

35.90 CFS	.65	.63	.62	.60	.58	.57	.56	.54
36.70 CFS	.53	.52	.50	.49				

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
2.61 WATERSHED INCHES; 2021 CFS-HRS; 167.0 ACRE-FEET.

OPERATION RUNOFF XSECTION 1

HYDROGRAPH POINTS FOR ALTERNATE = 1, STORM = 1
MAIN TIME INCREMENT = .100 hr, DRAINAGE AREA = .46 SQ.MI.

HRS								
8.80 CFS	.37	.56	.78	1.05	1.37	1.71	2.09	2.48
9.60 CFS	2.90	3.33	3.78	4.25	4.76	5.30	5.91	6.57
10.40 CFS	7.32	8.15	9.08	10.11	11.28	12.58	14.05	15.72
11.20 CFS	17.63	19.84	22.43	25.61	30.08	37.67	52.48	80.80
12.00 CFS	127	190	263	331	380	403	402	382
12.80 CFS	349	307	266	230	200	176	156	138
13.60 CFS	124	112	101	92	85	78	73	68
14.40 CFS	63.46	59.72	56.49	53.71	51.30	49.17	47.23	45.45
15.20 CFS	43.84	42.44	41.27	40.23	39.24	38.30	37.39	36.50
16.00 CFS	35.62	34.76	33.91	33.09	32.29	31.54	30.85	30.22
16.80 CFS	29.65	29.13	28.67	28.24	27.84	27.46	27.10	26.76
17.60 CFS	26.42	26.09	25.78	25.46	25.15	24.84	24.54	24.23
18.40 CFS	23.93	23.63	23.32	23.02	22.72	22.42	22.12	21.81
19.20 CFS	21.51	21.21	20.91	20.60	20.30	19.99	19.69	19.38
20.00 CFS	19.07	18.77	18.47	18.17	17.89	17.63	17.39	17.18
20.80 CFS	16.99	16.83	16.69	16.57	16.46	16.36	16.27	16.19
21.60 CFS	16.11	16.04	15.97	15.90	15.84	15.77	15.71	15.65
22.40 CFS	15.59	15.53	15.47	15.41	15.35	15.29	15.23	15.17
23.20 CFS	15.11	15.05	14.99	14.94	14.88	14.82	14.76	14.70
24.00 CFS	14.64	14.48	14.15	13.53	12.53	11.19	9.66	8.10
24.80 CFS	6.60	5.27	4.13	3.23	2.55	2.01	1.59	1.25
25.60 CFS	.99	.78	.61	.48				

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
2.70 WATERSHED INCHES; 801 CFS-HRS; 66.2 ACRE-FEET.

OPERATION ADDHYD XSECTION 1

HYDROGRAPH POINTS FOR ALTERNATE = 1, STORM = 1
MAIN TIME INCREMENT = .100 hr, DRAINAGE AREA = 1.66 SQ.MI.

HRS								
8.80 CFS	.38	.58	.83	1.14	1.50	1.93	2.40	2.91
9.60 CFS	3.47	4.06	4.70	5.38	6.13	6.94	7.85	8.91
10.40 CFS	10.18	11.64	13.32	15.21	17.34	19.75	22.45	25.51
11.20 CFS	29	33	38	45	53	65	85	124
12.00 CFS	205	343	534	742	917	1036	1097	1107
12.80 CFS	1080	1026	960	890	822	757	696	639
13.60 CFS	586	538	494	454	418	386	357	331
14.40 CFS	308	287	268	252	237	224	212	202
15.20 CFS	192	184	177	170	164	158	153	148
16.00 CFS	144	139	135	131	128	124	121	118
16.80 CFS	115	113	111	109	108	106	105	104

17.60 CFS	103	102	10.	99	98	97	96	95
18.40 CFS	94.20	93.17	92.15	91.13	90.10	89.07	88.04	87.01
19.20 CFS	85.98	84.94	83.90	82.85	81.80	80.75	79.70	78.64
20.00 CFS	77.58	76.52	75.46	74.41	73.37	72.36	71.39	70.46
20.80 CFS	69.58	68.75	67.96	67.22	66.52	65.86	65.23	64.63
21.60 CFS	64.06	63.51	62.99	62.49	62.01	61.55	61.11	60.69
22.40 CFS	60.27	59.88	59.49	59.12	58.76	58.41	58.07	57.74
23.20 CFS	57.41	57.10	56.79	56.49	56.19	55.90	55.61	55.33
24.00 CFS	55.06	54.69	54.12	53.13	51.50	49.21	46.46	43.49
24.80 CFS	40.47	37.53	34.77	32.25	29.98	27.90	25.98	24.21
25.60 CFS	22.58	21.07	19.67	18.42	17.32	16.34	15.45	14.63
26.40 CFS	13.89	13.20	12.56	11.96	11.40	10.87	10.37	9.90
27.20 CFS	9.44	9.02	8.62	8.24	7.87	7.52	7.19	6.87
28.00 CFS	6.57	6.28	6.00	5.74	5.48	5.24	5.01	4.79
28.80 CFS	4.58	4.38	4.18	4.00	3.82	3.65	3.49	3.35
29.60 CFS	3.23	3.12	3.02	2.93	2.84	2.76	2.69	2.62
30.40 CFS	2.55	2.48	2.42	2.36	2.30	2.24	2.19	2.13
31.20 CFS	2.08	2.03	1.98	1.93	1.88	1.84	1.79	1.75
32.00 CFS	1.70	1.66	1.62	1.58	1.54	1.50	1.47	1.43
32.80 CFS	1.40	1.36	1.33	1.30	1.26	1.23	1.20	1.17
33.60 CFS	1.14	1.12	1.09	1.06	1.04	1.01	.99	.96
34.40 CFS	.94	.92	.89	.87	.85	.83	.81	.79
35.20 CFS	.77	.75	.73	.71	.70	.68	.66	.65
36.00 CFS	.63	.62	.60	.58	.57	.56	.54	.53
36.80 CFS	.52	.50	.49					

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
2.63 WATERSHED INCHES; 2822 CFS-HRS; 233.2 ACRE-FEET.

OPERATION REACH XSECTION 2

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
13.16	886.3	502.76

HYDROGRAPH POINTS FOR ALTERNATE = 1, STORM = 1
MAIN TIME INCREMENT = .100 hr, DRAINAGE AREA = 1.66 SQ.MI.

HRS								
9.10 CFS	.34	.50	.71	.95	1.24	1.58	1.96	2.38
9.90 CFS	2.85	3.36	3.92	4.53	5.19	5.94	6.80	7.77
10.70 CFS	8.89	10.16	11.61	13.25	15.10	17.20	19.60	22.38
11.50 CFS	26	29	34	40	49	64	93	143
12.30 CFS	222	327	446	565	672	760	824	865
13.10 CFS	884	885	873	849	818	782	743	701
13.90 CFS	659	618	578	539	503	468	436	406
14.70 CFS	378	353	329	308	289	271	255	241
15.50 CFS	228	216	206	196	188	180	172	166
16.30 CFS	160	154	149	144	139	135	131	127
17.10 CFS	124	121	118	116	114	112	110	108
17.90 CFS	107	105	104	102	101	100	99	98
18.70 CFS	96.58	95.48	94.39	93.32	92.26	91.20	90.15	89.1
19.50 CFS	88.05	87.00	85.95	84.90	83.86	82.80	81.75	80.7

20.30 CFS	79.64	78.59	77.54	76.49	75.46	74.46	73.47	72.52
21.10 CFS	71.60	70.72	69.87	69.06	68.29	67.55	66.85	66.17
21.90 CFS	65.53	64.92	64.33	63.77	63.24	62.72	62.23	61.75
22.70 CFS	61.30	60.86	60.44	60.03	59.63	59.25	58.88	58.52
23.50 CFS	58.17	57.83	57.50	57.18	56.86	56.55	56.25	55.94
24.30 CFS	55.57	55.08	54.36	53.32	51.94	50.23	48.26	46.10
25.10 CFS	43.82	41.49	39.17	36.89	34.69	32.58	30.56	28.65
25.90 CFS	26.84	25.14	23.57	22.11	20.76	19.53	18.39	17.34
26.70 CFS	16.38	15.49	14.66	13.90	13.19	12.52	11.90	11.32
27.50 CFS	10.78	10.26	9.78	9.32	8.89	8.49	8.10	7.73
28.30 CFS	7.38	7.05	6.73	6.43	6.14	5.87	5.61	5.36
29.10 CFS	5.12	4.90	4.68	4.47	4.27	4.09	3.91	3.75
29.90 CFS	3.61	3.47	3.34	3.22	3.12	3.02	2.92	2.83
30.70 CFS	2.75	2.67	2.59	2.52	2.45	2.39	2.33	2.27
31.50 CFS	2.21	2.15	2.10	2.04	1.99	1.94	1.89	1.85
32.30 CFS	1.80	1.76	1.71	1.67	1.63	1.59	1.55	1.51
33.10 CFS	1.48	1.44	1.40	1.37	1.33	1.30	1.27	1.24
33.90 CFS	1.21	1.18	1.15	1.12	1.09	1.07	1.04	1.01
34.70 CFS	.99	.97	.94	.92	.90	.87	.85	.83
35.50 CFS	.81	.79	.77	.75	.73	.71	.70	.68
36.30 CFS	.66	.65	.63	.62	.60	.59	.57	.56
37.10 CFS	.54	.53	.52	.50	.49			

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
2.63 WATERSHED INCHES; 2822 CFS-HRS; 233.2 ACRE-FEET.

--- XSECTION 2, ALTERNATE 1, STORM 1, HYDROGRAPH ADDED TO READHD FILE ---

EXECUTIVE CONTROL ENDCMP COMPUTATIONS COMPLETED FOR PASS 1 450

SUMMARY TABLE 1

SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL IN ORDER PERFORMED.
A CHARACTER FOLLOWING THE PEAK DISCHARGE TIME AND RATE (CFS) INDICATES:
F-FLAT TOP HYDROGRAPH T-TRUNCATED HYDROGRAPH R-RISING TRUNCATED HYDROGRAPH

XSECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)
RAINFALL OF 5.20 inches AND 24.00 hr DURATION, BEGINS AT .0 hrs.							
RAINTABLE NUMBER 2, ARC 2							
MAIN TIME INCREMENT .100 HOURS							
ALTERNATE 1 STORM 1							
STRUCTURE 1	RUNOFF	1.20	2.61	---	12.09	2128	1773.3
STRUCTURE 1	RESVOR	1.20	2.61	526.12	12.35	929	774.2
XSECTION 1	REACH	1.20	2.61	508.79	12.78	732	610.0
XSECTION 1	RUNOFF	.46	2.70	---	12.55	406	882.6
XSECTION 1	ADDHYD	1.66	2.63	509.70	12.68	1108	667.5
XSECTION 2	REACH	1.66	2.63	502.76	13.16	886	533.7

SUMMARY TABLE 2

MODIFIED ATT-KIN REACH ROUTING IN ORDER PERFORMED.
QUESTION MARK (?) AFTER: OUTFLOW PEAK - MAX. NUMBER ROUTING ITERATIONS USED;
LENGTH FACTOR - VALUE K* GREATER THAN 1.0;
ATT-KIN COEFF - VALUE C GREATER THAN 0.667.

			HYDROGRAPH INFORMATION				ROUTING PARAMETERS				
		FLOOD	INFLOW		OUTFLOW		Q-A EQ.			PEAK	ATT-
XSEC ID	REACH LENGTH (FT)	PLAIN LENGTH (FT)	PEAK (CFS)	TIME (HR)	PEAK (CFS)	TIME (HR)	COEFF (X)	POWER (M)	LENGTH FACTOR (k*)	RATIO Q/I (Q*)	KIN COEFF (C)

BASEFLOW IS .0 CFS

ALTERNATE 1 STORM 1

1	5400	924	12.4	731	12.8	.42	1.35	.129	.792	.25
2	3000	1107	12.7	885	13.2	.96	1.09	.165	.799	.20

SUMMARY TABLE 3

STORM DISCHARGES (CFS) AT XSECTIONS AND STRUCTURES FOR ALL ALTERNATES
QUESTION MARK (?) AFTER: OUTFLOW PEAK - RISING TRUNCATED HYDROGRAPH.

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS..... 1
STRUCTURE 1	1.20	
ALTERNATE 1		929
XSECTION 1	1.66	
ALTERNATE 1		1108
XSECTION 2	1.66	
ALTERNATE 1		886

```
TR20 ------------------------------------------------------------------------ SCS -
SAMPLE 2      JOB USES - 24HR TYPE II STORM, FROM STR 1 TO XSEC 2        VERSION
03/06/92 WITH NOPRINT, SUMMARY, ADDHYD, & PEAK-VOL, HYD & FILE OPTIONS.2.04TEST


END OF  1 JOBS IN THIS RUN


                    SCS  TR-20,  VERSION 2.04TEST
                          SAMPLE 2  FILES

    INPUT  = b:a2.dat                                  , GIVEN DATA FILE
    OUTPUT = prn                                       , DATED 03/06/92,07:55:47

             FILES GENERATED - DATED 03/06/92,07:55:47

   FILE b:a2.TRD CONTAINS READHD INFORMATION


         TOTAL NUMBER OF WARNINGS =   0,  MESSAGES =   0

                    *** TR-20 RUN COMPLETED ***
```

APPENDIX D

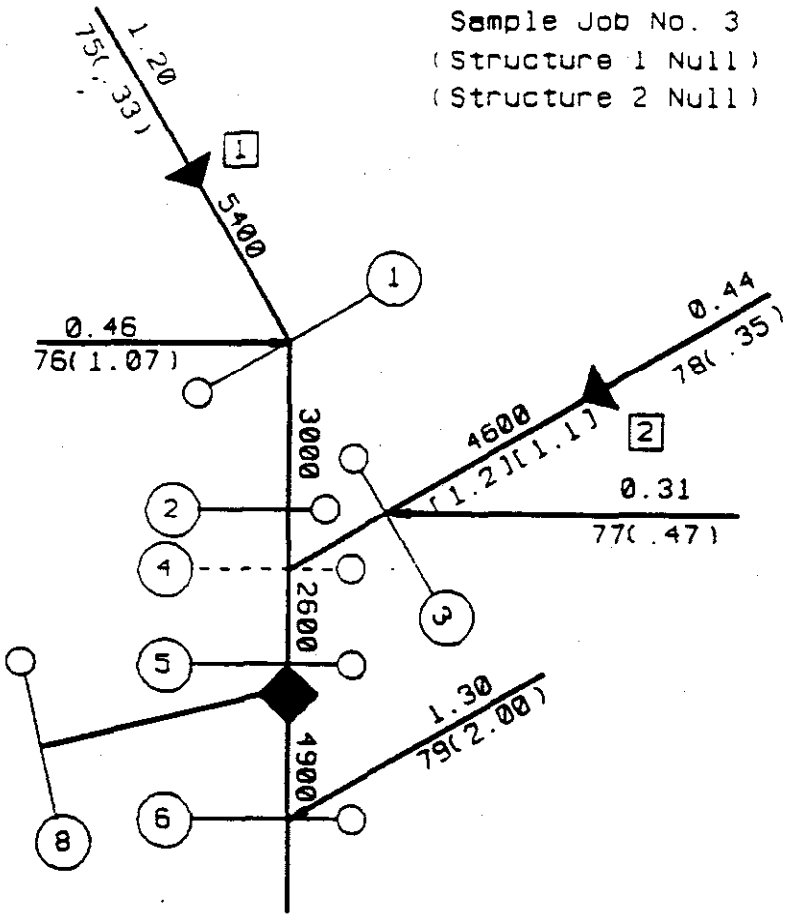
SAMPLE JOB NO. 3

Contents **Page**

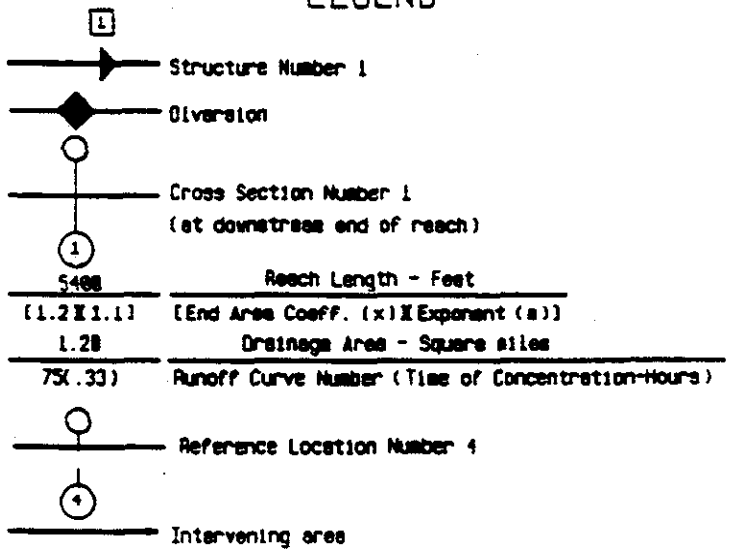
Schematic Drawings	D - 2
Printout	D - 3

SCHEMATIC DRAWING OF SAMPLE WATERSHED

Sample Job No. 3
(Structure 1 Null)
(Structure 2 Null)



LEGEND



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******************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY******************

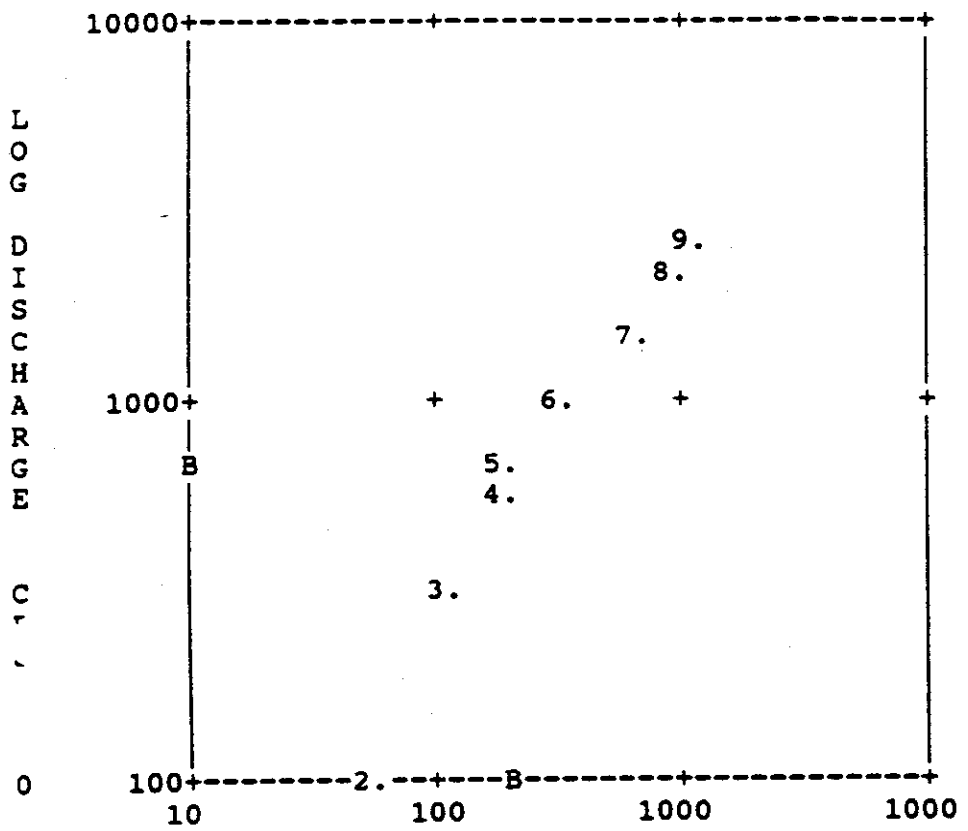
JOB TR-20 SAMPLE 3              FULLPRINT            SUMMARY   PLOTS
TITLE     JOB USES - ACTUAL STORM, FROM STR 1 TO XSEC 6; WITH
TITLE     FULLPRINT, SUMMARY, PLOTS, XSEC COEFFS, DIVERT, DUR, & TZERO.
 5 RAINFL 7                1.0
 8          0.00          0.06          0.11          0.14          0.17
 8          0.17          0.17          0.17          0.28          0.48
 8          1.18          1.42          1.57          1.60          1.74
 8          1.74          1.74          1.81          2.08          2.83
 8          4.28          5.35          5.98          6.45          7.21
 8          7.48          7.88          7.98          8.08          8.43
 8          8.83          9.33          9.77         10.32         10.61
 8         10.86         11.09         11.30         11.52         11.81
 8         12.02         12.06         12.16         12.16         12.16
 9 ENDTBL
 2 XSECTN   001          1.00        508.50
 8                      503.50          0.0           0.0
 8                      505.21        100.00         57.25
 8                      506.74        300.00        118.20
 8                      508.28        600.00        189.25
 8                      508.50        624.56        200.00
 8                      509.51       1000.00        364.35
 8                      510.37       1500.00        662.99
 8                      511.07       2100.00        963.82
 8                      511.44       2500.00       1134.18
   ENDTBL
   XSECTN   002          1.00        501.27
 8                      496.27          0.0           0.0
 8                      498.24         90.00         66.78
 8                      499.98        270.00        138.93
 8                      501.27        441.18        200.00
 8                      501.66        540.00        235.25
 8                      502.80        900.00        530.50
 8                      504.43       1960.00       1237.82
 9 ENDTBL
 2 XSECTN   005          1.0         495.5         495.5         495.0
 8                      490.            0.0           0.0
 8                      492.           17.           24.
 8                      494.           57.           56.
 8                      495.           86.           75.
 8                      495.5         106.           96.
 8                      496.          132.          138.
 8                      496.5         164.          202.
 8                      497.          205.          287.
 8                      498.          319.          522.
 8                      499.          482.          843.
 8                      500.          705.         1250.
 8                      502.         1362.         2330.
 8                      504.         2361.         3770.
 9 ENDTBL
 2 XSECTN   006          1.0         484.3         484.0         484.0
```

```
**********************80-80 LIST OF INPUT DATA (CONTINUED)*********************

 8                          480.        0.0         0.0
 8                          482.        29.         46.
 8                          484.        97.         104.
 8                          485.        144.        138.
 8                          485.5       176.        168.
 8                          486.        215.        226.
 8                          487.        320.        459.
 8                          488.        485.        875.
 8                          490.        1072.       2060.
 8                          492.        1971.       3629.
 9 ENDTBL
 6 RUNOFF 1     01      6 1.20        75.         0.33
 6 RESVOR 2     01 6    7 521.5
 6 REACH  3 001    7    5 5400.
 6 RUNOFF 1 001         6 0.46        76.         1.07
 6 ADDHYD 4 001    5 6 7
 6 REACH  3 002    7    5 3000.
 6 SAVMOV 5 002    5    1
 6 RUNOFF 1     02      6 0.44        78.         0.35
 6 RESVOR 2     02 6    7
 6 REACH  3 003    7    5 4600.       1.2         1.1
 6 RUNOFF 1 003         6 0.31        77.         0.47
 6 ADDHYD 4 003    5 6 7
 6 SAVMOV 5 004    7    5
 6 SAVMOV 5 004    1    6
 6 ADDHYD 4 004    5 6 7                                        1
 6 REACH  3 005    7    5 2600.                            1    1
 6 DIVERT 6 005    5 7 1 100.        0.4         8.       1    1
 6 REACH  3 006    7    5 4900.
 6 RUNOFF 1 006         6 1.30        79.         2.00
 6 ADDHYD 4 006    5 6 7                                  1    1
   ENDATA
 7 INCREM 6               0.25
 7 COMPUT 7     01 004                1.0         1.0      7 1  01  06
 7 COMPUT 7 005    006    2.5         1.0         1.0      7 1  01  06
   ENDCMP 1
   ENDJOB 2

*********************************END OF 80-80 LIST*********************************
```

XSECTION 1 END AREA VS DISCHARGE



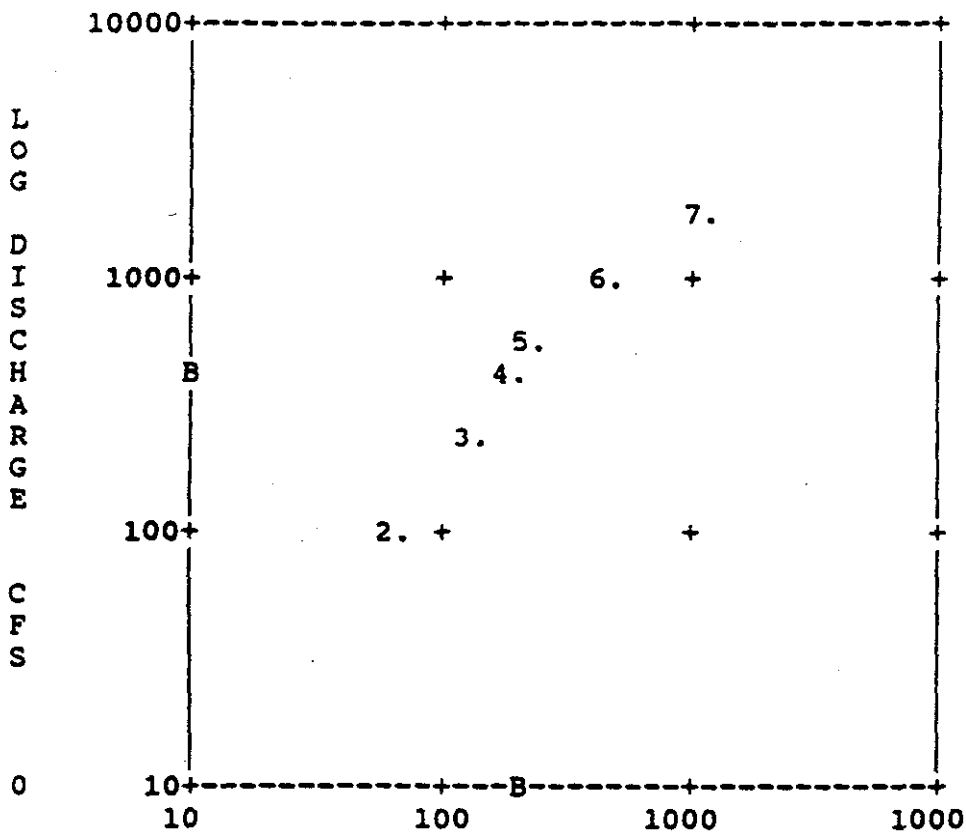
PLOT NO.	DIS-CHARGE (CFS)	END AREA (SQ FT)	COMPUTED M
1	.0	.0	1.52
2	100.0	57.3	1.52
3	300.0	118.2	1.52
4	600.0	189.3	1.49
5	624.6	200.0	1.46
6	1000.0	364.4	1.21
7	1500.0	663.0	1.03
8	2100.0	963.8	.99
9	2500.0	1134.2	1.01

NOTE: '*' INDICATES THE COMPUTED M VALUE IS OUTSIDE THE RANGE (1.00 - 2.00). THE CLOSEST LIMITING M VALUE WILL BE USED IN ROUTING.

LEGEND

+ = GRID REFERENCE
. = LOCATION OF PLOTTED VALUE
3 = PLOT NO. (ANY INTEGER)
X = MULTIPLE PLOT NUMBERS
B = BANKFULL (SHOWN ON AXIS)
AREA= 200.0 SQ FT
DISCHARGE= 624.6 CFS

XSECTION 2 END AREA VS DISCHARGE

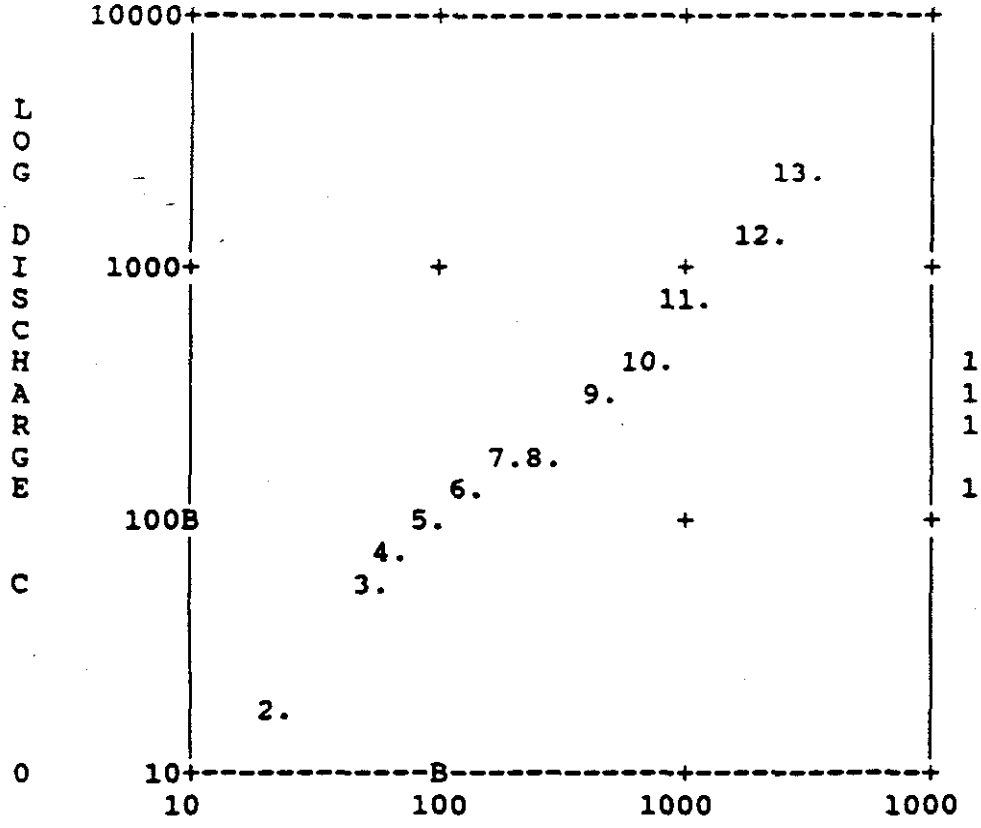


PLOT NO.	DIS-CHARGE (CFS)	END AREA (SQ FT)	COMPUTED M
1	.0	.0	1.50
2	90.0	66.8	1.50
3	270.0	138.9	1.50
4	441.2	200.0	1.44
5	540.0	235.3	1.40
6	900.0	530.5	1.09
7	1960.0	1237.8	1.00

NOTE: '*' INDICATES THE COMPUTED M VALUE IS OUTSIDE THE RANGE (1.00 - 2.00). THE CLOSEST LIMITING M VALUE WILL BE USED IN ROUTING.

LEGEND
+ = GRID REFERENCE
. = LOCATION OF PLOTTED VALUE
3 = PLOT NO. (ANY INTEGER)
X = MULTIPLE PLOT NUMBERS
B = BANKFULL (SHOWN ON AXIS)
AREA= 200.0 SQ FT
DISCHARGE= 441.2 CFS

XSECTION 5 END AREA VS DISCHARGE

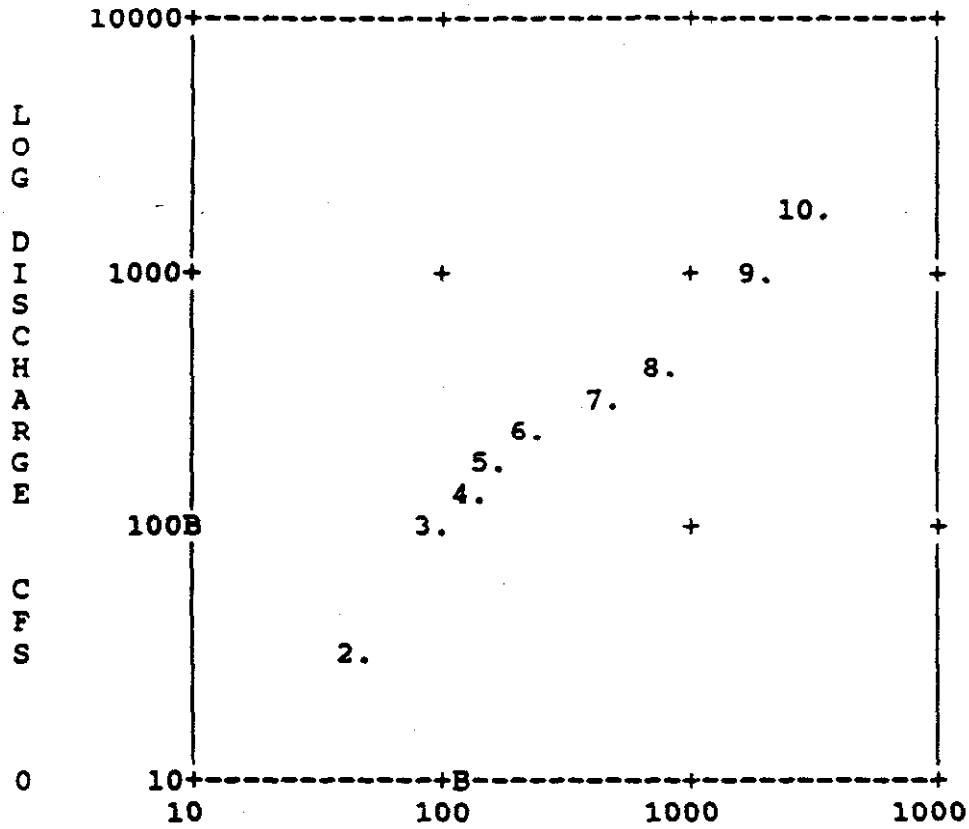


PLOT NO.	DIS-CHARGE (CFS)	END AREA (SQ FT)	COMPUTED M
1	.0	.0	1.43
2	17.0	24.0	1.43
3	57.0	56.0	1.43
4	86.0	75.0	1.42
5	106.0	96.0	1.31
6	132.0	138.0	1.17
7	164.0	202.0	1.06
8	205.0	287.0	.97
9	319.0	522.0	.89
10	482.0	843.0	.88
11	705.0	1250.0	.91
12	1362.0	2330.0	.98
13	2361.0	3770.0	1.05

NOTE: '*' INDICATES THE COMPUTED M VALUE IS OUTSIDE THE RANGE (1.00 - 2.00). THE CLOSEST LIMITING M VALUE WILL BE USED IN ROUTING.

LEGEND
+ = GRID REFERENCE
. = LOCATION OF PLOTTED VALUE
3 = PLOT NO. (ANY INTEGER)
X = MULTIPLE PLOT NUMBERS
B = BANKFULL (SHOWN ON AXIS)
AREA= 96.0 SQ FT
DISCHARGE= 106.0 CFS

XSECTION 6 END AREA VS DISCHARGE



PLOT NO.	DIS-CHARGE (CFS)	END AREA (SQ FT)	COMPUTED M
1	.0	.0	1.48
2	29.0	46.0	1.48
3	97.0	104.0	1.48
4	144.0	138.0	1.45
5	176.0	168.0	1.37
6	215.0	226.0	1.25
7	320.0	459.0	1.02
8	485.0	875.0	.89
9	1072.0	2060.0	.91
10	1971.0	3629.0	.99

NOTE: '*' INDICATES THE COMPUTED M VALUE IS OUTSIDE THE RANGE (1.00 - 2.00). THE CLOSEST LIMITING M VALUE WILL BE USED IN ROUTING.

LEGEND
+ = GRID REFERENCE
. = LOCATION OF PLOTTED VALUE
3 = PLOT NO. (ANY INTEGER)
X = MULTIPLE PLOT NUMBERS
B = BANKFULL (SHOWN ON AXIS)
AREA= 114.2 SQ FT
DISCHARGE= 111.1 CFS

D-7

EXECUTIVE CONTROL INCREM MAIN TIME INCREMENT = .250 HOURS 830

EXECUTIVE CONTROL COMPUT FROM STRUCTURE 1 TO XSECTION 4 840
STARTING TIME = .00 RAIN DEPTH = 1.00 RAIN DURATION = 1.00
ANT. RUNOFF COND. = 1 MAIN TIME INCREMENT = .250 HOURS
ALTERNATE NO. = 1 STORM NO. = 6 RAIN TABLE NO. = 7

OPERATION RUNOFF STRUCTURE 1
OUTPUT HYDROGRAPH = 6 AREA = 1.20 SQ MI
INPUT RUNOFF CURVE = 75. TIME OF CONCENTRATION = .33 HOURS
COMPUTED CURVE NO. = 57. ANT. RUNOFF COND. = 1
COMPUTED INTERNAL TIME INCREMENT = .0440 HOURS

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
13.88	4.8	(RUNOFF)
20.70	426.7	(RUNOFF)
23.88	400.9	(RUNOFF)
25.88	226.3	(RUNOFF)
30.88	292.2	(RUNOFF)
32.88	342.1	(RUNOFF)
38.88	186.7	(RUNOFF)
41.88	68.0	(RUNOFF)

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
6.23 WATERSHED INCHES; 4824 CFS-HRS; 398.7 ACRE-FEET.

*** WARNING - MAIN TIME INCREMENT (.250) IS GREATER THAN 50% OF THE
TIME OF CONCENTRATION (.33) FOR SUBWATERSHED STRUCTURE 1.
THIS WILL REDUCE THE COMPUTED PEAK BY ABOUT -.1%. ***

OPERATION RESVOR STRUCTURE 1
INPUT HYDROGRAPH 6 OUTPUT HYDROGRAPH 7
SURFACE ELEVATION = 521.50

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
13.88	4.8	(NULL)
20.70	426.7	(NULL)
23.88	400.9	(NULL)
25.88	226.3	(NULL)
30.88	292.2	(NULL)
32.88	342.1	(NULL)
38.88	186.7	(NULL)
41.88	68.0	(NULL)

D -

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
6.23 WATERSHED INCHES; 4824 CFS-HRS; 398.7 ACRE-FEET.

OPERATION REACH XSECTION 1
INPUT HYDROGRAPH 7 OUTPUT HYDROGRAPH 5
CHANNEL LENGTH = 5400.00 FT
INPUT = RATING CURVE REPRESENTATIVE OF REACH

COMPUTED COEFFICIENTS RELATED TO CROSS SECTION AREA, X = .227, M = 1.50
MODIFIED ATT-KIN ROUTING COEFFICIENT = .53, PEAK TRAVEL TIME = .50 HOUR

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET
14.19	4.2	503.57
21.13	429.3	507.40
24.17	375.2	507.13
26.15	213.9	506.08
31.26	284.8	506.62
33.16	328.8	506.89
39.19	180.0	505.82
42.16	62.2	504.56

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
6.23 WATERSHED INCHES; 4824 CFS-HRS; 398.7 ACRE-FEET

OPERATION RUNOFF XSECTION 1
OUTPUT HYDROGRAPH = 6 AREA = .46 SQ MI
INPUT RUNOFF CURVE = 76. TIME OF CONCENTRATION = 1.07 HOURS
COMPUTED CURVE NO. = 58. ANT. RUNOFF COND. = 1
COMPUTED INTERNAL TIME INCREMENT = .1427 HOURS

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
14.21	2.0	(RUNOFF)
21.04	166.0	(RUNOFF)
24.17	137.2	(RUNOFF)
26.10	78.8	(RUNOFF)
31.35	108.6	(RUNOFF)
33.14	122.5	(RUNOFF)
39.22	67.3	(RUNOFF)
42.14	22.1	(RUNOFF)

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
6.39 WATERSHED INCHES; 1896 CFS-HRS; 156.7 ACRE-FEET.

OPERATION ADDHYD XSECTION 1
INPUT HYDROGRAPHS 5,6 OUTPUT HYDROGRAPH 7

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
14.19	6.1	503.60
21.13	595.5	508.26
24.17	512.4	507.83
26.15	293.2	506.69
31.28	393.1	507.22
33.16	451.3	507.52
39.20	247.3	506.34
42.16	84.3	504.94

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
6.27 WATERSHED INCHES; 6720 CFS-HRS; 555.4 ACRE-FEET.

OPERATION REACH XSECTION 2
INPUT HYDROGRAPH 7 OUTPUT HYDROGRAPH 5
CHANNEL LENGTH = 3000.00 FT
INPUT = RATING CURVE REPRESENTATIVE OF REACH

COMPUTED COEFFICIENTS RELATED TO CROSS SECTION AREA, X = .314, M = 1.35
MODIFIED ATT-KIN ROUTING COEFFICIENT = .61, PEAK TRAVEL TIME = .28 HOURS

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
14.53	5.6	496.39
21.41	588.1	501.81
24.49	489.7	501.46
26.43	284.4	500.09
31.68	386.4	500.86
33.46	439.9	501.26
39.53	241.3	499.70
42.45	80.0	498.02

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
6.27 WATERSHED INCHES; 6720 CFS-HRS; 555.4 ACRE-FEET.

OPERATION SAVMOV XSECTION 2
INPUT HYDROGRAPH 5 OUTPUT HYDROGRAPH 1

OPERATION RUNOFF STRUCTURE 2
OUTPUT HYDROGRAPH = 6 AREA = .44 SQ MI
INPUT RUNOFF CURVE = 78. TIME OF CONCENTRATION = .35 HOURS
COMPUTED CURVE NO. = 60. ANT. RUNOFF COND. = 1
COMPUTED INTERNAL TIME INCREMENT = .0467 HOURS

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TR20 ------------------------------------------------------------------------ SCS
SAMPLE 3     JOB USES - ACTUAL STORM, FROM STR 1 TO XSEC 6;  WITH        VERSIO
03/06/92 FULLPRINT, SUMMARY, PLOTS, XSEC COEFFS, DIVERT, DUR, & TZERO. 2.04TES
07:58:51                      PASS   1   JOB NO.   1                     PAGE
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PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET
11.88	2.1	(RUNOFF)
13.88	3.9	(RUNOFF)
19.96	178.3	(RUNOFF)
23.88	156.3	(RUNOFF)
25.88	87.3	(RUNOFF)
30.89	112.1	(RUNOFF)
32.88	130.1	(RUNOFF)
38.88	70.6	(RUNOFF)
41.88	25.6	(RUNOFF)

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
6.69 WATERSHED INCHES; 1901 CFS-HRS; 157.1 ACRE-FEET.

*** WARNING - MAIN TIME INCREMENT (.250) IS GREATER THAN 50% OF THE
TIME OF CONCENTRATION (.35) FOR SUBWATERSHED STRUCTURE 2.
THIS WILL REDUCE THE COMPUTED PEAK BY ABOUT .1%. **

OPERATION RESVOR STRUCTURE 2
INPUT HYDROGRAPH 6 OUTPUT HYDROGRAPH 7
SURFACE ELEVATION = .00

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEE
11.88	2.1	(NULL)
13.88	3.9	(NULL)
19.96	178.3	(NULL)
23.88	156.3	(NULL)
25.88	87.3	(NULL)
30.89	112.1	(NULL)
32.88	130.1	(NULL)
38.88	70.6	(NULL)
41.88	25.6	(NULL)

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
6.69 WATERSHED INCHES; 1901 CFS-HRS; 157.1 ACRE-FEET.

OPERATION REACH XSECTION 3
INPUT HYDROGRAPH 7 OUTPUT HYDROGRAPH 5
CHANNEL LENGTH 4600.00 FT
INPUT = COEFFICIENTS RELATED TO XSECTION AREA, X= 1.20, M= 1.10

MODIFIED ATT-KIN ROUTING COEFFICIENT = .34, PEAK TRAVEL TIME = 1.25 HOURS

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
12.31	1.5	(NULL)
14.25	3.0	(NULL)
21.18	167.7	(NULL)
24.22	136.7	(NULL)
26.16	81.3	(NULL)
31.44	104.8	(NULL)
33.20	120.3	(NULL)
39.27	65.1	(NULL)
42.17	22.9	(NULL)

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
6.69 WATERSHED INCHES; 1901 CFS-HRS; 157.1 ACRE-FEET.

OPERATION RUNOFF XSECTION 3
OUTPUT HYDROGRAPH = 6 AREA = .31 SQ MI
INPUT RUNOFF CURVE = 77. TIME OF CONCENTRATION = .47 HOURS
COMPUTED CURVE NO. = 59. ANT. RUNOFF COND. = 1
COMPUTED INTERNAL TIME INCREMENT = .0627 HOURS

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
13.90	2.1	(RUNOFF)
20.17	119.3	(RUNOFF)
23.89	105.0	(RUNOFF)
25.89	58.8	(RUNOFF)
30.94	77.3	(RUNOFF)
32.89	89.1	(RUNOFF)
38.90	48.6	(RUNOFF)
41.89	17.2	(RUNOFF)

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
6.54 WATERSHED INCHES; 1309 CFS-HRS; 108.1 ACRE-FEET.

*** WARNING - MAIN TIME INCREMENT (.250) IS GREATER THAN 50% OF THE
TIME OF CONCENTRATION (.47) FOR SUBWATERSHED XSECTION 3.
THIS WILL REDUCE THE COMPUTED PEAK BY ABOUT .4%. ***

OPERATION ADDHYD XSECTION 3
INPUT HYDROGRAPHS 5,6 OUTPUT HYDROGRAPH 7

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TR20 ------------------------------------------------------------------------ SCS
SAMPLE 3     JOB USES - ACTUAL STORM, FROM STR 1 TO XSEC 6;  WITH        VERSIO
03/06/92 FULLPRINT, SUMMARY, PLOTS, XSEC COEFFS, DIVERT, DUR, & TZERO. 2.04TES
07:58:51                      PASS   1   JOB NO.   1                     PAGE
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PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET
12.17	2.3	(NULL)
14.06	4.7	(NULL)
20.94	282.7	(NULL)
24.00	232.5	(NULL)
25.93	137.1	(NULL)
31.20	179.3	(NULL)
32.97	204.6	(NULL)
39.05	111.3	(NULL)
41.94	38.7	(NULL)

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
6.63 WATERSHED INCHES; 3210 CFS-HRS; 265.2 ACRE-FEET.

OPERATION SAVMOV XSECTION 4
INPUT HYDROGRAPH 7 OUTPUT HYDROGRAPH 5

OPERATION SAVMOV XSECTION 4
INPUT HYDROGRAPH 1 OUTPUT HYDROGRAPH 6

OPERATION ADDHYD XSECTION 4
INPUT HYDROGRAPHS 5,6 OUTPUT HYDROGRAPH 7

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
14.29	9.2	(NULL)
21.16	855.7	(NULL)
24.30	682.6	(NULL)
26.15	402.1	(NULL)
31.61	561.1	(NULL)
33.24	622.7	(NULL)
39.39	343.8	(NULL)
42.20	109.5	(NULL)

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
6.38 WATERSHED INCHES; 9930 CFS-HRS; 820.6 ACRE-FEET.

DURATION(HRS)	3	6	9	12	15	18	21	24
FLOW(CFS)	623	559	446	376	314	275	160	83

DURATION(HRS)	27	30	33	34
FLOW(CFS)	9	3	1	0

EXECUTIVE CONTROL COMPUT FROM XSECTION 5 TO XSECTION 6 850
STARTING TIME = 2.50 RAIN DEPTH = 1.00 RAIN DURATION = 1.00
ANT. RUNOFF COND. = 1 MAIN TIME INCREMENT = .250 HOURS
ALTERNATE NO. = 1 STORM NO. = 6 RAIN TABLE NO. = 7

OPERATION REACH XSECTION 5
INPUT HYDROGRAPH 7 OUTPUT HYDROGRAPH 5
CHANNEL LENGTH = 2600.00 FT
INPUT = RATING CURVE REPRESENTATIVE OF REACH

COMPUTED COEFFICIENTS RELATED TO CROSS SECTION AREA, X = .570, M = 1.00
MODIFIED ATT-KIN ROUTING COEFFICIENT = .18, PEAK TRAVEL TIME = 1.27 HOURS

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
15.28	5.8	490.68
22.56	682.9	499.90
25.04	627.8	499.65
34.12	564.9	499.37
40.31	319.3	498.00

HYDROGRAPH POINTS FOR ALTERNATE = 1, STORM = 6
MAIN TIME INCREMENT = .250 hr, DRAINAGE AREA = 2.41 SQ.MI.

HRS								
12.00 CFS	.35	.64	.99	1.32	1.56	1.70	1.79	1.93
14.00 CFS	2.29	2.94	3.85	4.80	5.48	5.75	5.60	5.15
16.00 CFS	4.56	3.94	3.35	2.89	2.70	2.82	3.25	4.21
18.00 CFS	6.06	9.08	13.24	19.58	29.78	45.54	66.96	95.84
20.00 CFS	136	191	263	342	420	493	557	610
22.00 CFS	650	674	683	680	669	652	632	612
24.00 CFS	599	596	605	619	628	623	602	572
26.00 CFS	540	512	492	475	458	434	403	367
28.00 CFS	331	298	268	244	229	225	232	248
30.00 CFS	268	290	313	336	360	384	410	435
32.00 CFS	457	476	489	500	511	524	539	554
34.00 CFS	564	563	552	533	510	486	462	440
36.00 CFS	419	400	383	368	355	342	331	321
38.00 CFS	313	306	300	297	296	298	304	311
40.00 CFS	317	319	318	313	303	286	264	238
42.00 CFS	214	193	178	165	154	141	126	110
44.00 CFS	94.26	79.55	66.52	55.29	45.77	37.78	31.13	25.61
46.00 CFS	21.06	17.30	14.21	11.66	9.57	7.86	6.45	5.29
48.00 CFS	4.34	3.56	2.92	2.39	1.96	1.61	1.32	1.08
50.00 CFS	.89	.73	.60	.49				

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
6.38 WATERSHED INCHES; 9930 CFS-HRS; 820.6 ACRE-FEET.

DURATION(HRS)	4	8	12	16	20	24	28	32
FLOW(CFS)	572	489	383	313	248	96	13	4

DURATION(HRS)	36	39
FLOW(CFS)	2	0

ZERO DAMAGE DISCHARGE (106 CFS) OCCURS AT 24.1 HOURS FLOW DURATION.

OPERATION DIVERT XSECTION 5
INPUT HYDROGRAPH 5 XSECTION 5 — OUTPUT #1 HYDROGRAPH 7 XSECTION 5 — #2 HYDROGRAPH 1 XSECTION 8

OUTPUT #1 HYDROGRAPH

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
15.28	5.8	490.68
20.00	100.0 *	495.35

* FIRST POINT OF FLAT PEAK

HYDROGRAPH POINTS FOR ALTERNATE = 1, STORM = 6
MAIN TIME INCREMENT = .250 hr, DRAINAGE AREA = .96 SQ.MI.

HRS								
12.00 CFS	.35	.64	.99	1.32	1.56	1.70	1.79	1.93
14.00 CFS	2.29	2.94	3.85	4.80	5.48	5.75	5.60	5.1
16.00 CFS	4.56	3.94	3.35	2.89	2.70	2.82	3.25	4.21
18.00 CFS	6.06	9.08	13.24	19.58	29.78	45.54	66.96	95.84
20.00 CFS	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
22.00 CFS	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
24.00 CFS	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
26.00 CFS	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
28.00 CFS	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
30.00 CFS	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
32.00 CFS	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
34.00 CFS	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
36.00 CFS	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
38.00 CFS	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
40.00 CFS	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
42.00 CFS	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
44.00 CFS	94.26	79.55	66.52	55.29	45.77	37.78	31.13	25.61
46.00 CFS	21.06	17.30	14.21	11.66	9.57	7.86	6.45	5.29
48.00 CFS	4.34	3.56	2.92	2.39	1.96	1.61	1.32	1.08
50.00 CFS	.89	.73	.60	.49				

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
4.22 WATERSHED INCHES; 2628 CFS-HRS; 217.2 ACRE-FEET.

DURATION(HRS)	4	8	12	16	20	24	28	32
FLOW(CFS)	100	100	100	100	100	96	13	4

DURATION(HRS)	36	39
FLOW(CFS)	2	0

OUTPUT #2 DIVERTED HYDROGRAPH (XSECTION 8)

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
22.56	582.9	(DIVERT)
25.04	527.8	(DIVERT)
34.12	464.9	(DIVERT)
40.31	219.3	(DIVERT)

HYDROGRAPH POINTS FOR ALTERNATE = 1, STORM = 6
MAIN TIME INCREMENT = .250 hr, DRAINAGE AREA = 1.45 SQ.MI.

HRS								
19.75 CFS	0	36	91	163	242	320	393	457
21.75 CFS	510	550	574	583	580	569	552	532
23.75 CFS	512	499	496	505	519	528	523	502
25.75 CFS	472	440	412	392	375	358	334	303
27.75 CFS	267	231	198	168	144	129	125	132
29.75 CFS	148	168	190	213	236	260	284	310
31.75 CFS	335	357	376	389	400	411	424	439
33.75 CFS	454	464	463	452	433	410	386	362
35.75 CFS	340	319	300	283	268	255	242	231
37.75 CFS	221	213	206	200	197	196	198	204
39.75 CFS	211	217	219	218	213	203	186	164
41.75 CFS	138	114	93	78	65	54	41	26
43.75 CFS	10.21	.00						

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
7.82 WATERSHED INCHES; 7301 CFS-HRS; 603.4 ACRE-FEET.

DURATION(HRS)	2	4	6	8	10	12	14	16
FLOW(CFS)	523	472	433	389	335	287	231	213

DURATION(HRS)	18	20	22	24
FLOW(CFS)	197	148	91	0

OPERATION REACH XSECTION 6
INPUT HYDROGRAPH 7 OUTPUT HYDROGRAPH 5
CHANNEL LENGTH = 4900.00 FT
INPUT = RATING CURVE REPRESENTATIVE OF REACH

COMPUTED COEFFICIENTS RELATED TO CROSS SECTION AREA, X = .101, M = 1.48
MODIFIED ATT-KIN ROUTING COEFFICIENT = .23, PEAK TRAVEL TIME = 9.75 HOURS

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TR20 ------------------------------------------------------------------------ SCS
SAMPLE 3     JOB USES - ACTUAL STORM, FROM STR 1 TO XSEC 6;  WITH        VERSIC
03/06/92 FULLPRINT, SUMMARY, PLOTS, XSEC COEFFS, DIVERT, DUR, & TZERO. 2.04TES
07:58:51                      PASS   1   JOB NO.   1                     PAGE
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PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET
16.14	4.6	480.31
29.75	100.0 *	484.06

* FIRST POINT OF FLAT PEAK

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
4.22 WATERSHED INCHES; 2628 CFS-HRS; 217.2 ACRE-FEET.

OPERATION RUNOFF XSECTION 6
OUTPUT HYDROGRAPH = 6 AREA = 1.30 SQ MI
INPUT RUNOFF CURVE = 79. TIME OF CONCENTRATION = 2.00 HOURS
COMPUTED CURVE NO. = 62. ANT. RUNOFF COND. = 1
COMPUTED INTERNAL TIME INCREMENT = .2667 HOURS

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET
17.11	9.5	(RUNOFF)
24.04	485.5	(RUNOFF)
26.99	373.3	(RUNOFF)
35.96	336.5	(RUNOFF)
42.22	183.4	(RUNOFF)

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
7.00 WATERSHED INCHES; 5874 CFS-HRS; 485.4 ACRE-FEET

OPERATION ADDHYD XSECTION 6
INPUT HYDROGRAPHS 5,6 OUTPUT HYDROGRAPH 7

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
17.03	13.3	480.92
24.05	584.6	488.34
26.99	473.2	487.93
35.96	436.5	487.71
42.22	283.4	486.65

HYDROGRAPH POINTS FOR ALTERNATE = 1, STORM = 6
MAIN TIME INCREMENT = .250 hr, DRAINAGE AREA = 2.26 SQ.MI.

HRS								
12.75 CFS	.47	.89	1.53	2.36	3.32	4.39	5.64	7.02
14.75 CFS	8.39	9.57	10.33	10.62	10.60	10.63	11.03	11.88
16.75 CFS	12.79	13.28	12.97	11.91	10.50	9.17	8.32	8.34
18.75 CFS	9.49	12.15	16.99	24.91	36.79	53.87	69.97	84.49
20.75 CFS	99	116	138	164	195	236	288	349
22.75 CFS	412	469	518	554	576	584	580	566
24.75 CFS	545	521	496	472	454	444	445	455
26.75 CFS	467	473	467	447	419	390	368	355
28.75 CFS	348	339	324	302	276	251	229	212
30.75 CFS	203	201	208	222	242	263	283	30[illegible]
32.75 CFS	318	333	349	365	380	392	400	4[illegible]

34.75 CFS	408	412	418	426	433	436	431	417
36.75 CFS	397	375	355	337	322	311	301	292
38.75 CFS	285	279	274	269	265	262	260	258
40.75 CFS	259	261	265	271	278	282	283	281
42.75 CFS	275	264	249	231	212	195	181	169
44.75 CFS	159	148	134	117	100	83	68	56
46.75 CFS	45.39	37.22	30.54	25.05	20.58	16.91	13.91	11.44
48.75 CFS	9.42	7.78	6.42	5.31	4.38	3.60	2.96	2.42
50.75 CFS	1.99	1.64	1.36	1.12	.93	.77	.63	.52
52.75 CFS	.43							

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
5.82 WATERSHED INCHES; 8502 CFS-HRS; 702.6 ACRE-FEET.

DURATION(HRS)	4	8	12	16	20	24	28	32
FLOW(CFS)	447	392	318	274	231	134	25	11

DURATION(HRS)	36	40
FLOW(CFS)	4	0

ZERO DAMAGE DISCHARGE (97 CFS) OCCURS AT 25.3 HOURS FLOW DURATION.

EXECUTIVE CONTROL ENDCMP COMPUTATIONS COMPLETED FOR PASS 1 860

SUMMARY TABLE 1

SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL IN ORDER PERFORMED.
A CHARACTER FOLLOWING THE PEAK DISCHARGE TIME AND RATE (CFS) INDICATES:
F-FLAT TOP HYDROGRAPH T-TRUNCATED HYDROGRAPH R-RISING TRUNCATED HYDROGRAP

XSECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)
RAINFALL OF 12.16 inches AND 42.00 hr DURATION, BEGINS AT .0 hrs.							
RAINTABLE NUMBER 7, ARC 1							
MAIN TIME INCREMENT .250 HOURS							
ALTERNATE 1 STORM 6							
STRUCTURE 1	RUNOFF	1.20	6.23	---	20.70	427	355.8
STRUCTURE 1	RESVOR	1.20	6.23	---	20.70	427	355.8
XSECTION 1	REACH	1.20	6.23	507.40	21.13	429	357.5
XSECTION 1	RUNOFF	.46	6.39	---	21.04	166	360.9
XSECTION 1	ADDHYD	1.66	6.27	508.26	21.13	595	358.4
XSECTION 2	REACH	1.66	6.27	501.81	21.41	588	354.2
STRUCTURE 2	RUNOFF	.44	6.69	---	19.96	178	404.5
STRUCTURE 2	RESVOR	.44	6.69	---	19.96	178	404.5
XSECTION 3	REACH	.44	6.69	---	21.18	168	381.8
XSECTION 3	RUNOFF	.31	6.54	---	20.17	119	383.9
XSECTION 3	ADDHYD	.75	6.63	---	20.94	283	377.3
XSECTION 4	ADDHYD	2.41	6.38	---	21.16	856	355.2
RAINFALL OF 12.16 inches AND 42.00 hr DURATION, BEGINS AT 2.5 hrs.							
XSECTION 5	REACH	2.41	6.38	499.90	22.56	683	283.4
XSECTION 5	DIVERT	.96	4.22	495.35	20.00F	100F	104.2
XSECTION 8	DIVERT	1.45	7.82	---	22.56	583	402.1
XSECTION 6	REACH	.96	4.22	484.06	29.75F	100F	104.2
XSECTION 6	RUNOFF	1.30	7.00	---	24.04	485	373.1
XSECTION 6	ADDHYD	2.26	5.82	488.34	24.05	585	258.8

D-2

SUMMARY TABLE 2

MODIFIED ATT-KIN REACH ROUTING IN ORDER PERFORMED.
QUESTION MARK (?) AFTER: OUTFLOW PEAK - MAX. NUMBER ROUTING ITERATIONS USED;
LENGTH FACTOR - VALUE K* GREATER THAN 1.0;
ATT-KIN COEFF - VALUE C GREATER THAN 0.667.

BASEFLOW IS .0 CFS

ALTERNATE 1 STORM 6

XSEC ID	REACH LENGTH (FT)	FLOOD PLAIN LENGTH (FT)	HYDROGRAPH INFORMATION: INFLOW PEAK (CFS)	INFLOW TIME (HR)	OUTFLOW PEAK (CFS)	OUTFLOW TIME (HR)	ROUTING PARAMETERS: Q-A EQ. COEFF (X)	Q-A EQ. POWER (M)	LENGTH FACTOR (k*)	PEAK RATIO Q/I (Q*)	ATT-KIN COEFF (C)
1	5400		427	20.8	425	21.3	.23	1.50	.010	.996	.53
2	3000		589	21.3	586	21.5	.31	1.35	.010	.994	.61
3	4600		178	20.0	167	21.3	1.20	1.10	.048	.939	.34
5	2600		854	21.3	683	22.5	.57	1.00	.109	.799	.18
	4900		100	20.0	100	29.8	.10	1.48	.014	1.000	.23

D.

SUMMARY TABLE 3

STORM DISCHARGES (CFS) AT XSECTIONS AND STRUCTURES FOR ALL ALTERNATES
QUESTION MARK (?) AFTER: OUTFLOW PEAK - RISING TRUNCATED HYDROGRAPH.

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS..... 6
STRUCTURE 2	.44	
ALTERNATE 1		178
STRUCTURE 1	1.20	
ALTERNATE 1		427
XSECTION 1	1.66	
ALTERNATE 1		595
XSECTION 2	1.66	
ALTERNATE 1		588
XSECTION 3	.75	
ALTERNATE 1		283
XSECTION 4	2.41	
ALTERNATE 1		856
XSECTION 5	.96	
ALTERNATE 1		100
XSECTION 6	2.26	
ALTERNATE 1		585
XSECTION 8	1.45	
ALTERNATE 1		583

```
TR20 ------------------------------------------------------------------------ SCS -
SAMPLE 3     JOB USES - ACTUAL STORM, FROM STR 1 TO XSEC 6;  WITH        VERSION
03/06/92 FULLPRINT, SUMMARY, PLOTS, XSEC COEFFS, DIVERT, DUR, & TZERO. 2.04TEST


END OF  1 JOBS IN THIS RUN


                    SCS  TR-20,  VERSION 2.04TEST
                          SAMPLE 3  FILES

    INPUT  = b:a3.dat                                  , GIVEN DATA FILE
    OUTPUT = prn                                       , DATED 03/06/92,07:58:51

             FILES GENERATED - DATED 03/06/92,07:58:51

                              NONE!


          TOTAL NUMBER OF WARNINGS =   3,  MESSAGES =   0

                    *** TR-20 RUN COMPLETED ***
```

APPENDIX E

SAMPLE JOB NO. 4

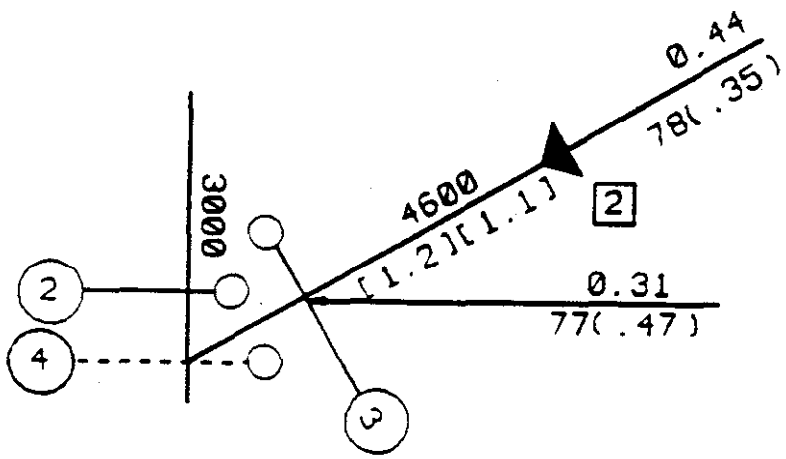
Contents | Page

Schematic Drawing	E - 2
Printout	E - 3

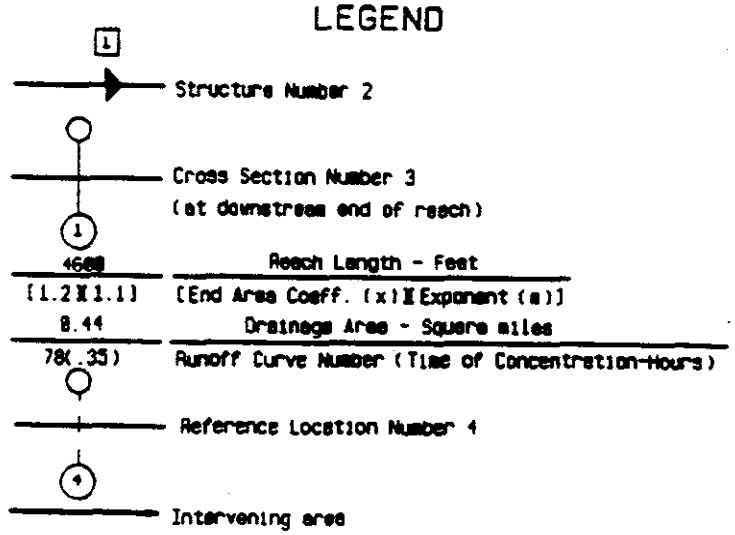
SCHEMATIC DRAWING OF SAMPLE WATERSHED

Sample Job No. 4

(Structure 2 Null)



LEGEND



```
*****************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY*****************

JOB TR-20 SAMPLE 4
TITLE     JOB USES -- 24HR TYPE II STORM, FROM XSEC 2 TO XSEC 4;  WITH
TITLE     NOPRINT, READ DISCH. HYDR. & NON STANDARD HYDR. NO. LOCATIONS.
 6 RUNOFF 1     02      6 0.44        78.         0.35                  1
 6 RESVOR 2     02 6    7                                               1
 6 REACH  3 003    7    4 4600.       1.2         1.1                   1
 6 RUNOFF 1 003         6 0.31        77.         0.47                  1
 6 ADDHYD 4 003    4 6  7                                        1      1
 6 ADDHYD 4 004    5 7  3                                        1   1  1
   ENDATA                                                                 1
 7 READHD 8      5                                                   XS  2
 7 READHD 9        9.1000       .1000      1.6600       .0000          A 1  S
 8                     0.          1.          1.          1.          1.     1
 8                     2.          2.          2.          3.          3.     1
 8                     4.          5.          5.          6.          7.     1
 8                     8.          9.         10.         12.         13.     1
 8                    15.         17.         20.         22.         26.     1
 8                    29.         34.         40.         49.         64.     1
 8                    93.        143.        222.        327.        446.     1
 8                   565.        672.        760.        824.        865.     2
 8                   884.        885.        873.        849.        818.     2
 8                   782.        743.        701.        659.        618.     2
 8                   578.        539.        503.        468.        436.     2
 8                   406.        378.        353.        329.        308.     2
                     289.        271.        255.        241.        228.     2
 8                   216.        206.        196.        188.        180.     2
 8                   172.        166.        160.        154.        149.     2
 8                   144.        139.        135.        131.        127.     2
 8                   124.        121.        118.        116.        114.     2
 8                   112.        110.        108.        107.        105.     3
 8                   104.        102.        101.        100.         99.     3
 8                    98.         97.         95.         94.         93.     3
 8                    92.         91.         90.         89.         88.     3
 8                    87.         86.         85.         84.         83.     3
 8                    82.         81.         80.         79.         78.     3
 8                    76.         75.         74.         73.         73.     3
 8                    72.         71.         70.         69.         68.     3
 8                    68.         67.         66.         66.         65.     3
 8                    64.         64.         63.         63.         62.     3
 8                    62.         61.         61.         60.         60.     4
 8                    60.         59.         59.         59.         58.     4
 8                    58.         57.         57.         57.         57.     4
 8                    56.         56.         56.         55.         54.     4
 8                    53.         52.         50.         48.         46.     4
 8                    44.         41.         39.         37.         35.     4
 8                    33.         31.         29.         27.         25.     4
 8                    24.         22.         21.         20.         18.     4
 8                    17.         16.         15.         15.         14.     4
 8                    13.         13.         12.         11.         11.     4
                      10.         10.          9.          9.          8.     5
```

```
**********************80-80 LIST OF INPUT DATA (CONTINUED)*********************

 8                      8.          8.          7.          7.          7.     5
 8                      6.          6.          6.          6.          5.     5
 8                      5.          5.          5.          4.          4.     5
 8                      4.          4.          4.          4.          3.     5
 8                      3.          3.          3.          3.          3.     5
 8                      3.          3.          3.          3.          3.     5
 8                      2.          2.          2.          2.          2.     5
 8                      2.          2.          2.          2.          2.     5
 8                      2.          2.          2.          2.          2.     5
 8                      2.          2.          2.          2.          2.     6
 8                      1.          1.          1.          1.          1.     6
 8                      1.          1.          1.          1.          1.     6
 8                      1.          1.          1.          1.          1.     6
 8                      1.          1.          1.          1.          1.     6
 8                      1.          1.          1.          1.          1.     6
 8                      1.          1.          1.          1.          1.     6
 8                      1.          1.          1.          1.          1.     6
 8                      1.          1.          1.          1.          1.     6
 8                      1.          1.          1.          1.          1.     6
 8                      1.          1.          1.          1.          0.     6
 9 ENDTBL                                                                      7
 7 INCREM 6              0.1                                                   7
 7 COMPUT 7     02 004                 5.2         1.0         2 2  01  01     7
   ENDCMP 1                                                                    7
   ENDJOB 2                                                                    7

*********************************END OF 80-80 LIST*********************************
```

EXECUTIVE CONTROL READHD DISCHARGE HYDROGRAPH, IN LOCATION 5 XS 2 03

STARTING TIME = 9.10 TIME INCREMENT = .100
DRAINAGE AREA = 1.66 BASE FLOW = .00

8	.00	1.00	1.00	1.00	1.00
8	2.00	2.00	2.00	3.00	3.00
8	4.00	5.00	5.00	6.00	7.00
8	8.00	9.00	10.00	12.00	13.00
8	15.00	17.00	20.00	22.00	26.00
8	29.00	34.00	40.00	49.00	64.00
8	93.00	143.00	222.00	327.00	446.00
8	565.00	672.00	760.00	824.00	865.00
8	884.00	885.00	873.00	849.00	818.00
8	782.00	743.00	701.00	659.00	618.00
8	578.00	539.00	503.00	468.00	436.00
8	406.00	378.00	353.00	329.00	308.00
8	289.00	271.00	255.00	241.00	228.00
8	216.00	206.00	196.00	188.00	180.00
8	172.00	166.00	160.00	154.00	149.00
8	144.00	139.00	135.00	131.00	127.00
8	124.00	121.00	118.00	116.00	114.00
	112.00	110.00	108.00	107.00	105.00
8	104.00	102.00	101.00	100.00	99.00
8	98.00	97.00	95.00	94.00	93.00
8	92.00	91.00	90.00	89.00	88.00
8	87.00	86.00	85.00	84.00	83.00
8	82.00	81.00	80.00	79.00	78.00
8	76.00	75.00	74.00	73.00	73.00
8	72.00	71.00	70.00	69.00	68.00
8	68.00	67.00	66.00	66.00	65.00
8	64.00	64.00	63.00	63.00	62.00
8	62.00	61.00	61.00	60.00	60.00
8	60.00	59.00	59.00	59.00	58.00
8	58.00	57.00	57.00	57.00	57.00
8	56.00	56.00	56.00	55.00	54.00
8	53.00	52.00	50.00	48.00	46.00
8	44.00	41.00	39.00	37.00	35.00
8	33.00	31.00	29.00	27.00	25.00
8	24.00	22.00	21.00	20.00	18.00
8	17.00	16.00	15.00	15.00	14.00
8	13.00	13.00	12.00	11.00	11.00
8	10.00	10.00	9.00	9.00	8.00
8	8.00	8.00	7.00	7.00	7.00
8	6.00	6.00	6.00	6.00	5.00
8	5.00	5.00	5.00	4.00	4.00
8	4.00	4.00	4.00	4.00	3.00
	3.00	3.00	3.00	3.00	3.00

```
TR20 ------------------------------------------------------------------------ SCS
SAMPLE 4 JOB USES - 24HR TYPE II STORM, FROM XSEC 2 TO XSEC 4;  WITH    VERSIO
03/06/92 NOPRINT, READ DISCH. HYDR. & NON STANDARD HYDR. NO. LOCATIONS.2.04TES
08:02:33                        PASS   1   JOB NO.   1                     PAGE

8                    3.00        3.00        3.00        3.00        3.00
8                    2.00        2.00        2.00        2.00        2.00
8                    2.00        2.00        2.00        2.00        2.00
8                    2.00        2.00        2.00        2.00        2.00
8                    2.00        2.00        2.00        2.00        2.00
8                    1.00        1.00        1.00        1.00        1.00
8                    1.00        1.00        1.00        1.00        1.00
8                    1.00        1.00        1.00        1.00        1.00
8                    1.00        1.00        1.00        1.00        1.00
8                    1.00        1.00        1.00        1.00        1.00
8                    1.00        1.00        1.00        1.00        1.00
8                    1.00        1.00        1.00        1.00        1.00
8                    1.00        1.00        1.00        1.00        1.00
8                    1.00        1.00        1.00        1.00
9 ENDTBL


EXECUTIVE CONTROL INCREM    MAIN TIME INCREMENT =    .100 HOURS              710


EXECUTIVE CONTROL COMPUT    FROM STRUCTURE  2  TO XSECTION   4               720
   STARTING TIME =    .00       RAIN DEPTH =  5.20        RAIN DURATION =  1.00
   ANT. RUNOFF COND. = 2        MAIN TIME INCREMENT =    .100 HOURS
   ALTERNATE NO. = 1            STORM NO. = 1             RAIN TABLE NO. = 2


OPERATION ADDHYD   XSECTION   3

                    HYDROGRAPH POINTS FOR   ALTERNATE = 1,   STORM = 1
    HRS       MAIN TIME INCREMENT =  .100 hr,      DRAINAGE AREA =     .75 SQ.MI.
    8.20 CFS       .33       .56       .85      1.19      1.58      2.02      2.52      3.07
    9.00 CFS      3.67      4.32      5.02      5.75      6.50      7.25      8.02      8.82
    9.80 CFS      9.66     10.56     11.56     12.64     13.85     15.19     16.69     18.36
   10.60 CFS     20.21     22.27     24.62     27.25     30.22     33.57     37.44     42.09
   11.40 CFS        48        54        64        86       136       232       388       537
   12.20 CFS       615       636       638       622       582       529       476       425
   13.00 CFS       379       339       303       272       245       222       202       184
   13.80 CFS       169       156       144       133       124       116       109       103
   14.60 CFS     97.44     92.70     88.52     84.83     81.54     78.58     75.90     73.44
   15.40 CFS     71.17     69.05     67.06     65.17     63.36     61.63     59.95     58.33
   16.20 CFS     56.78     55.33     54.00     52.77     51.65     50.64     49.70     48.85
   17.00 CFS     48.05     47.31     46.61     45.95     45.32     44.71     44.12     43.54
   17.80 CFS     42.98     42.43     41.88     41.35     40.82     40.29     39.77     39.25
   18.60 CFS     38.73     38.22     37.70     37.19     36.67     36.16     35.65     35.14
   19.40 CFS     34.62     34.11     33.60     33.08     32.57     32.05     31.54     31.03
   20.20 CFS     30.53     30.07     29.64     29.26     28.92     28.61     28.34     28.10
   21.00 CFS     27.88     27.68     27.50     27.34     27.18     27.04     26.90     26.77
   21.80 CFS     26.65     26.53     26.42     26.30     26.19     26.08     25.98     25.87
   22.60 CFS     25.77     25.66     25.56     25.46     25.36     25.26     25.16     25.05
   23.40 CFS     24.95     24.85     24.75     24.65     24.55     24.45     24.34      23.8
   24.20 CFS     22.32     20.02     17.67     15.33     13.09     10.98      9.13       7.5.
```

25.00 CFS	6.25	5.17	4.27	3.52	2.91	2.40	1.99	1.65
25.80 CFS	1.37	1.13	.94	.78	.64	.53	.44	

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
2.84 WATERSHED INCHES; 1375 CFS-HRS; 113.6 ACRE-FEET.

OPERATION ADDHYD XSECTION 4

HYDROGRAPH POINTS FOR ALTERNATE = 1, STORM = 1
MAIN TIME INCREMENT = .100 hr, DRAINAGE AREA = 2.41 SQ.MI.

HRS								
8.20 CFS	.33	.56	.85	1.19	1.58	2.02	2.52	3.07
9.00 CFS	3.67	4.32	6.02	6.75	7.50	8.25	10.02	10.82
9.80 CFS	11.66	13.56	14.56	16.64	18.85	20.19	22.69	25.36
10.60 CFS	28.21	31.27	34.62	39.25	43.22	48.57	54.44	62.09
11.40 CFS	70	80	93	120	176	281	452	630
12.20 CFS	758	858	965	1068	1147	1201	1236	1249
13.00 CFS	1244	1223	1188	1145	1094	1040	984	927
13.80 CFS	870	815	762	711	663	619	577	539
14.60 CFS	503	471	442	414	390	368	347	328
15.40 CFS	312	297	283	271	259	250	240	230
16.20 CFS	223	215	208	202	196	190	185	180
17.00 CFS	175	171	168	164	161	159	156	154
17.80 CFS	151	149	147	145	143	141	140	138
18.60 CFS	137	135	133	131	130	128	127	125
19.40 CFS	124	122	121	119	118	116	115	113
20.20 CFS	112	110	109	107	105	104	102	101
21.00 CFS	101	100	99	97	96	95	95	94
21.80 CFS	92.65	92.53	91.42	90.30	90.19	89.08	88.98	87.87
22.60 CFS	87.77	86.66	86.56	85.46	85.36	85.26	84.16	84.05
23.40 CFS	83.95	82.85	82.75	81.65	81.55	81.45	81.34	79.83
24.20 CFS	78.32	76.02	72.67	69.33	66.09	62.98	59.13	55.57
25.00 CFS	52.25	49.17	45.27	42.52	39.91	37.40	34.99	32.65
25.80 CFS	30.37	28.13	25.94	24.78	22.64	21.53	20.44	18.36
26.60 CFS	17.30	16.25	15.21	15.17	14.14	13.12	13.10	12.08
27.40 CFS	11.06	11.05	10.04	10.03	9.03	9.02	8.02	8.02
28.20 CFS	8.01	7.01	7.01	7.00	6.00	6.00	6.00	6.00
29.00 CFS	5.00	5.00	5.00	5.00	4.00	4.00	4.00	4.00
29.80 CFS	4.00	4.00	3.00	3.00	3.00	3.00	3.00	3.00
30.60 CFS	3.00	3.00	3.00	3.00	3.00	2.00	2.00	2.00
31.40 CFS	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
32.20 CFS	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
33.00 CFS	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
33.80 CFS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
34.60 CFS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
35.40 CFS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
36.20 CFS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
37.00 CFS	1.00	1.00	1.00	1.00	1.00	.00		

RUNOFF ABOVE BASEFLOW (BASEFLOW = .00 CFS)
2.70 WATERSHED INCHES; 4196 CFS-HRS; 346.7 ACRE-FEET.

E 2

```
TR20 ------------------------------------------------------------------------ SCS -
SAMPLE 4 JOB USES - 24HR TYPE II STORM, FROM XSEC 2 TO XSEC 4;  WITH    VERSION
03/06/92 NOPRINT, READ DISCH. HYDR. & NON STANDARD HYDR. NO. LOCATIONS.2.04TEST
08:02:33                      PASS   1   JOB NO.   1                      PAGE


   DURATION(HRS)   3      6      9     12     15     18     21     24
   FLOW(CFS)     390    151    104     83     31     10      3      2

   DURATION(HRS)  27     29
   FLOW(CFS)       1      0


EXECUTIVE CONTROL ENDCMP    COMPUTATIONS COMPLETED FOR PASS   1            730
```

E9

SUMMARY TABLE 1

SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL IN ORDER PERFORMED.
A CHARACTER FOLLOWING THE PEAK DISCHARGE TIME AND RATE (CFS) INDICATES:
F-FLAT TOP HYDROGRAPH T-TRUNCATED HYDROGRAPH R-RISING TRUNCATED HYDROGRAPH

XSECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)

RAINFALL OF 5.20 inches AND 24.00 hr DURATION, BEGINS AT .0 hrs.
RAINTABLE NUMBER 2, ARC 2
MAIN TIME INCREMENT .100 HOURS

ALTERNATE 1 STORM 1

STRUCTURE	2	RUNOFF	.44	2.88	---	12.10	837	1902.3
STRUCTURE	2	RESVOR	.44	2.88	---	12.10	837	1902.3
XSECTION	3	REACH	.44	2.88	---	12.59	412	936.4
XSECTION	3	RUNOFF	.31	2.79	---	12.17	481	1551.6
XSECTION	3	ADDHYD	.75	2.84	---	12.36	640	853.3
:CTION	4	ADDHYD	2.41	2.70	---	12.92	1249	518.3

SUMMARY TABLE 2

MODIFIED ATT-KIN REACH ROUTING IN ORDER PERFORMED.
QUESTION MARK (?) AFTER: OUTFLOW PEAK - MAX. NUMBER ROUTING ITERATIONS USED;
LENGTH FACTOR - VALUE K* GREATER THAN 1.0;
ATT-KIN COEFF - VALUE C GREATER THAN 0.667.

			HYDROGRAPH INFORMATION				ROUTING PARAMETERS				
		FLOOD	INFLOW		OUTFLOW		Q-A EQ.			PEAK	ATT-
XSEC ID	REACH LENGTH (FT)	PLAIN LENGTH (FT)	PEAK (CFS)	TIME (HR)	PEAK (CFS)	TIME (HR)	COEFF (X)	POWER (M)	LENGTH FACTOR (k*)	RATIO Q/I (Q*)	KIN COEFF (C)
BASEFLOW IS .0 CFS											
ALTERNATE 1 STORM 1											
3	4600		837	12.1	412	12.6	1.20	1.10	.571	.492	.17

SUMMARY TABLE 3

STORM DISCHARGES (CFS) AT XSECTIONS AND STRUCTURES FOR ALL ALTERNATES
QUESTION MARK (?) AFTER: OUTFLOW PEAK - RISING TRUNCATED HYDROGRAPH.

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS..... 1
STRUCTURE 2	.44	
ALTERNATE 1		837
XSECTION 3	.75	
ALTERNATE 1		640
XSECTION 4	2.41	
ALTERNATE 1		1249

```
TR20 ------------------------------------------------------------------------ SCS
SAMPLE 4 JOB USES - 24HR TYPE II STORM, FROM XSEC 2 TO XSEC 4;  WITH    VERSIO
03/06/92 NOPRINT, READ DISCH. HYDR. & NON STANDARD HYDR. NO. LOCATIONS.2.04TES


END OF  1 JOBS IN THIS RUN


                    SCS  TR-20,  VERSION 2.04TEST
                          SAMPLE 4  FILES

    INPUT  = b:a4.dat                                  , GIVEN DATA FILE
    OUTPUT = prn                                       , DATED 03/06/92,08:02:33

             FILES GENERATED - DATED 03/06/92,08:02:33

                              NONE!


          TOTAL NUMBER OF WARNINGS =   0,  MESSAGES =   0

                   *** TR-20 RUN COMPLETED ***
```

APPENDIX F

SAMPLE JOB NO. 5

Contents **Page**

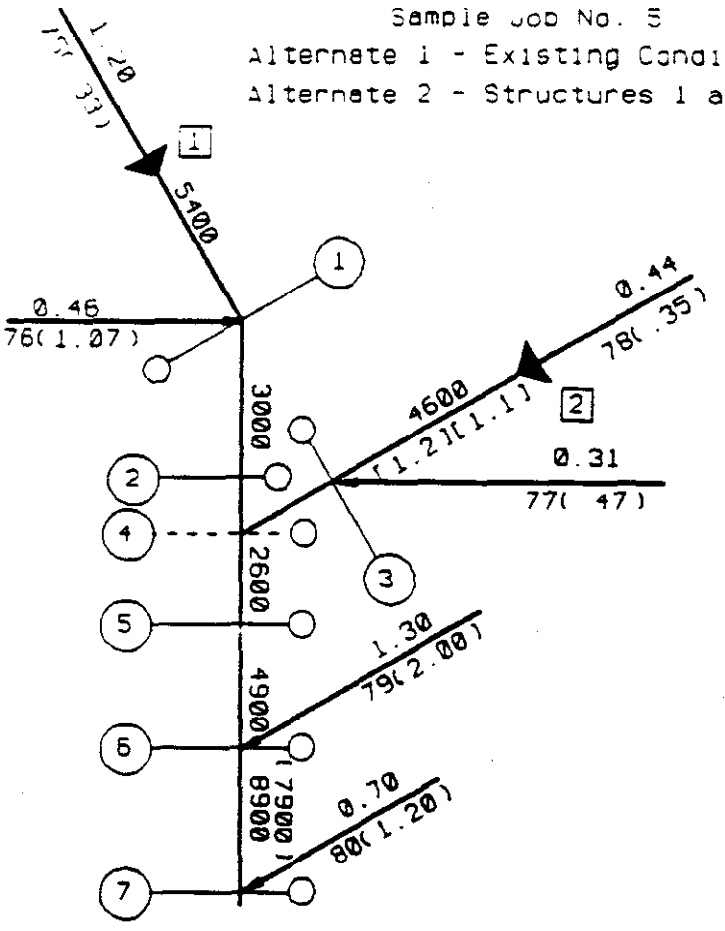
Schematic Drawings	F-2
Printout	F-5

SCHEMATIC DRAWING OF SAMPLE WATERSHED

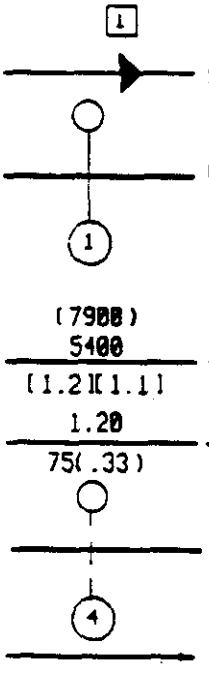
Sample Job No. 5

Alternate 1 - Existing Conditions

Alternate 2 - Structures 1 and 2 added



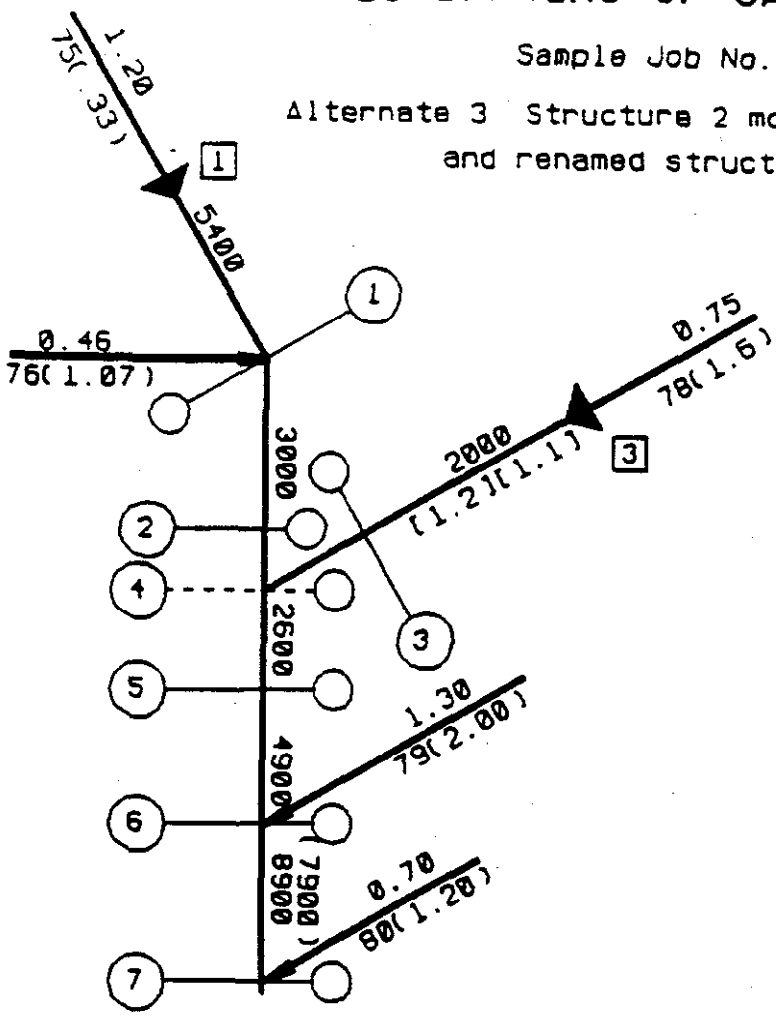
LEGEND



SCHEMATIC DRAWING OF SAMPLE WATERSHED

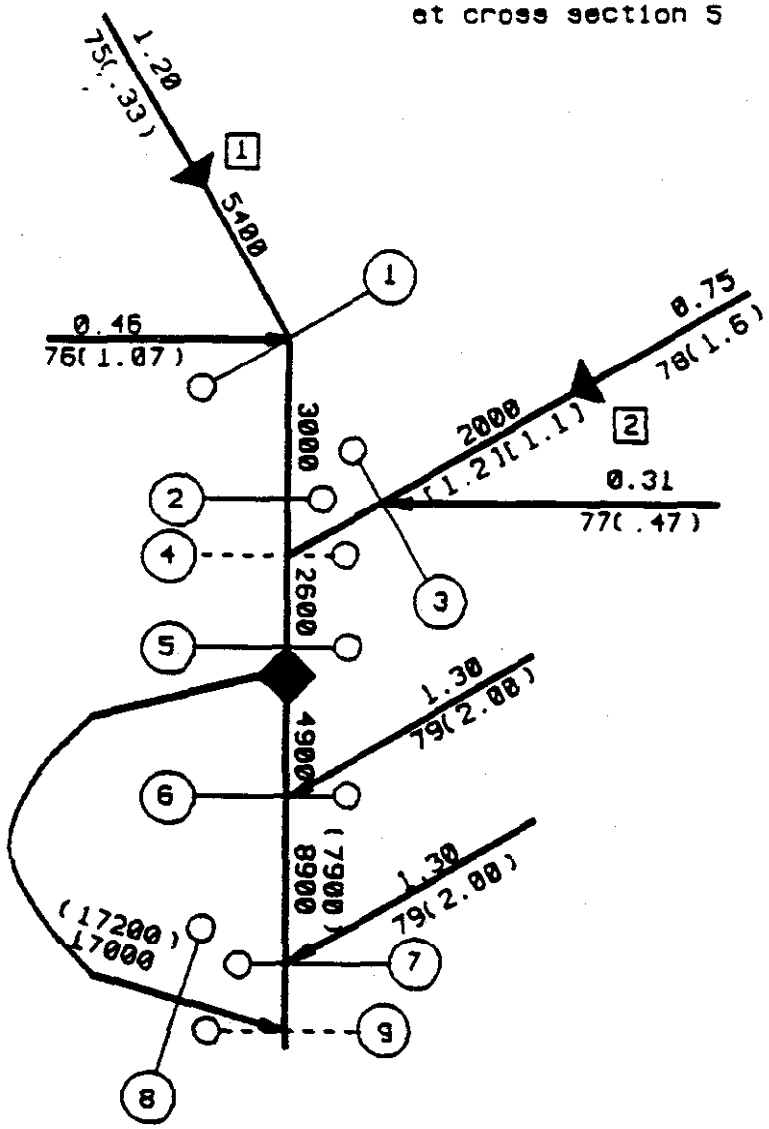
Sample Job No. 5

Alternate 3 Structure 2 moved downstream
and renamed structure 3.

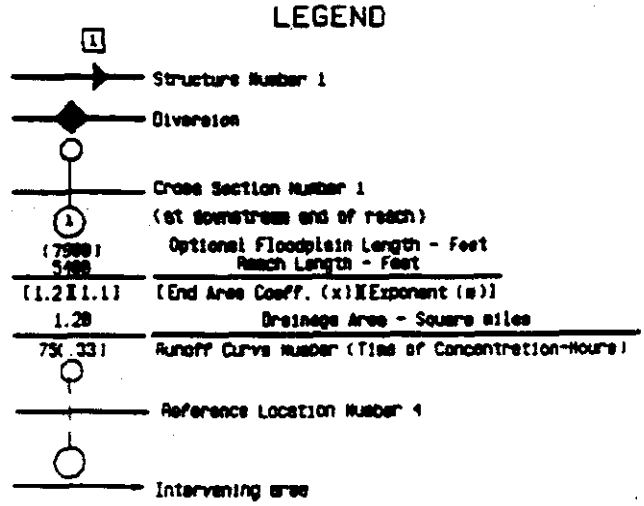


SCHEMATIC DRAWING OF SAMPLE WATERSHED

Alternate 4 - Diversion added to divide flow
at cross section 5



LEGEND



```
***************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY*****************

JOB TR-20 SAMPLE 5 -ECON                          SUMMARY                    10
TITLE     JOB USES - TWO-24HR TYPE II STORMS OVER WATERSHED, WITH ECON,      20
TITLE     BF, MOD. S.C.; ALT'S 1=EXIST., 2=SITES, 3=MOVE SITE, 4=DIVIDE      30
 1 DURINC                                                                   40
 8          HOURS        6.0          12.0         24.0                     50
 9 ENDTBL                                                                   60
 2 XSECTN   001          1.00         508.50                                70
 8                       503.50       0.0          0.0                      80
 8                       505.21       100.00       57.25                    90
 8                       506.74       300.00       118.20                   100
 8                       508.28       600.00       189.25                   110
 8                       508.50       624.56       200.00                   120
 8                       509.51       1000.00      364.35                   130
 8                       510.37       1500.00      662.99                   140
 8                       511.07       2100.00      963.82                   150
 8                       511.44       2500.00      1134.18                  160
 9 ENDTBL                                                                   170
 2 XSECTN   002          1.00         501.27                                180
 8                       496.27       0.0          0.0                      190
 8                       498.24       90.00        66.78                    200
 8                       499.98       270.00       138.93                   210
 8                       501.27       441.18       200.00                   220
 8                       501.66       540.00       235.25                   230
                         502.80       900.00       530.50                   240
                         504.43       1960.00      1237.82                  250
 9 ENDTBL                                                                   260
 2 XSECTN   005          1.0          495.5        495.5        495.5       270
 8                       490.         0.0          0.0                      280
 8                       492.         17.          24.                      290
 8                       494.         57.          56.                      300
 8                       495.         86.          75.                      310
 8                       495.5        106.         96.                      320
 8                       496.         132.         138.                     330
 8                       497.         205.         287.                     340
 8                       498.         319.         522.                     350
 8                       499.         482.         843.                     360
 8                       500.         705.         1250.                    370
 8                       502.         1362.        2330.                    380
 8                       504.         2361.        3770.                    390
 9 ENDTBL                                                                   400
 2 XSECTN   006          1.0          484.3        484.0        484.0       410
 8                       480.         0.0          0.0                      420
 8                       482.         29.          46.                      430
 8                       484.         97.          104.                     440
 8                       485.         144.         138.                     450
 8                       485.5        176.         168.                     460
 8                       486.         215.         226.                     470
 8                       487.         320.         459.                     480
 8                       488.         485.         875.                     490
                         490.         1072.        2060.                    500
```

```
**********************80-80 LIST OF INPUT DATA (CONTINUED)********************

 8                          492.        1971.       3629.                      51
 9 ENDTBL                                                                      52
 2 XSECTN   007             1.0         479.5       479.5       479.2          53
 8                          474.        0.          0.                         54
 8                          475.        12.         31.                        55
 8                          477.        76.         99.                        56
 8                          479.        178.        175.                       57
 8                          479.5       214.        210.                       58
 8                          480.        255.        255.                       59
 8                          481.        381.        579.                       60
 8                          483.        783.        1337.                      61
 8                          485.        1406.       2397.                      62
 8                          487.        2214.       3906.                      63
 9 ENDTBL                                                                      64
 6 RUNOFF 1     01      6 1.20          75.         0.33                       65
 6 RESVOR 2     01 6    7                                                      66
 6 REACH  3 001    7    5 5400.                                                67
 6 RUNOFF 1 001         6 0.46          76.         1.07                       68
 6 ADDHYD 4 001    5 6  7                                                      69
 6 REACH  3 002    7    1 3000.                                                70
 6 RUNOFF 1     02      6 0.44          78.         0.35                       71
 6 RESVOR 2     02 6    7                                                      72
 6 REACH  3 003    7    5 4600.         1.2         1.1                        73
 6 RUNOFF 1 003         6 0.31          77.         0.47
 6 ADDHYD 4 003    5 6  2
 6 ADDHYD 4 004    1 2  3                                                      76
 6 REACH  3 005    3    5 2600.                                                77
 6 SAVMOV 5 006    5    7                                                      78
 6 REACH  3 006    7    5 4900.                                                79
 6 RUNOFF 1 006         6 1.30          79.         2.0                        80
 6 ADDHYD 4 006    5 6  7                                                      81
 6 RFACH  3 007    7    5 8900.                     7900.                      82
 6 RUNOFF 1 007         6 0.70          80.         1.20                       83
 6 ADDHYD 4 007    5 6  4                                      1    1 1        84
 6 SAVMOV 5 008    4    1                                                      85
   ENDATA                                                                      86
 7 LIST                     1.          1.          2.                         87
 7 INCREM 6                 0.1                                                88
 7 BASFLO 5                 6.0                                                89
 7 COMPUT 7     01 007                  5.2         1.0         2 2  01   01   90
   ENDCMP 1                                                                    91
 7 BASFLO 5                 6.0                                                92
 7 COMPUT 7     01 007                  2.6         1.0         2 2  01   02   93
   ENDCMP 1                                                                    94
 3 STRUCT       01                                                            95
 8                          521.5        0.0         17.0                      96
 8                          521.6        3.0         18.0                      97
 8                          521.8        15.         20.2                      98
 8                          522.0        33.         22.5                      99
 8                          522.2        54.         25.0
```

```
*******************80-80 LIST OF INPUT DATA (CONTINUED)*********************
8                          522.4        79.         28.0                    101
8                          526.2        948.        70.                     102
8                          526.4        1009.       75.                     103
8                          526.6        1071.       80.                     104
8                          527.2        1265.       95.                     105
9 ENDTBL                                                                    106
3 STRUCT       02                                                           107
8                          496.         0.0         16.                     108
8                          498.         210.        27.                     109
8                          500.         252.        40.                     110
8                          502.         294.        62.                     111
8                          504.         336.        85.                     112
8                          506.         378.        112.                    113
8                          508.         420.        145.                    114
8                          509.         441.        176.                    115
8                          510.         556.        190.                    116
8                          512.         1129.       237.                    117
8                          514.         2086.       285.                    118
8                          516.         3288.       340.                    119
8                          517.         4030.       367.                    120
9 ENDTBL                                                                    121
7 BASFLO 5                 10.0                                             122
7 COMPUT 7     01     02               5.2         1.0         2 2  02  01  123
  COMPUT 7 003    007                  5.2         1.0         2 2  02  01  124
  ENDCMP 1                                                                  125
7 BASFLO 5                 8.0                                              126
7 COMPUT 7     01     02               2.6         1.0         2 2  02  02  127
7 COMPUT 7 003    007                  2.6         1.0         2 2  02  02  128
  ENDCMP 1                                                                  129
3 STRUCT       02                                                           130
9 ENDTBL                                                                    131
3 STRUCT       03                                                           132
8                          484.         0.0         5.                      133
8                          488.         32.         8.                      134
8                          492.         40.         14.                     135
8                          495.         45.         27.                     136
8                          498.         48.         48.                     137
8                          500.         52.         80.                     138
9 ENDTBL                                                                    139
7 INSERT 2 002                                                              140
6 RUNOFF 1     03      6 0.75           78.         1.60                    141
6 RESVOR 2     03 6    7                                                    142
7 DELETE 4                                                                  143
6 RUNOFF 1     02                                                           144
6 RESVOR 2     02                                                           145
7 ALTER  3                                                                  146
6 REACH  3 003    7    2 2000.          1.2         1.1                     147
7 DELETE 4                                                                  148
6 RUNOFF 1 003                                                              149
  ADDHYD 4 003                                                              150
```

```
**********************80-80 LIST OF INPUT DATA (CONTINUED)********************

 7 LIST                    1.0                                                  15
 7 BASFLO 5                6.0                                                  15
 7 COMPUT 7     01 007                5.2          1.0          2 2  03  01     15
   ENDCMP 1                                                                     15
 7 BASFLO 5                6.0                                                  15
 7 COMPUT 7     01 007                2.6          1.0          2 2  03  02     15
   ENDCMP 1                                                                     15
 3 STRUCT       01                                                              15
 9 ENDTBL                                                                       15
 3 STRUCT       03                                                              16
 9 ENDTBL                                                                       16
 2 XSECTN    008           1.0         494.5        494.3        493.3          16
 8                         492.        0.0          0.0                         16
 8                         493.        21.          23.                         16
 8                         494.        64.          52.                         16
 8                         495.        133.         87.                         16
 8                         496.        232.         128.                        16
 8                         497.        360.         175.                        16
 8                         498.        515.         228.                        16
 8                         500.        827.         405.                        17
 9 ENDTBL                                                                       171
 7 INSERT 2 005                                                                 172
 6 DIVERT 6 005    5 7 1               0.9          8.             1     1      173
 7 DELETE 4                                                                     1
 6 SAVMOV 5 006                                                                 1
 7 INSERT 2 007                                                                 176
 6 REACH  3 008    1    2 17000.                    17200        1              177
 6 ADDHYD 4 009    2 4 7                            1 1    1 1                  178
 7 LIST                    1.0                      .                           179
 7 BASFLO 5                0.2         15.0         25.0                        180
 7 COMPUT 7     01 009                5.2          1.0          2 2  04  01     181
   ENDCMP 1                                                                     182
 7 BASFLO 5                0.1         12.0         25.0                        183
 7 COMPUT 7     01 009                2.6          1.0          2 2  04  02     184
   ENDCMP 1                                                                     185
   IPEAKS                                                                       186
   PEAKS     006    007    7A    3.90  7B    4.00                              187
   ENDJOB 2                                                                     188

*********************************END OF 80-80 LIST*********************************
```

```
TR20 ------------------------------------------------------------------------ SCS -
SAMPLE 5 JOB USES - TWO-24HR TYPE II STORMS OVER WATERSHED, WITH ECON,  VERSIO
03/06/92 BF, MOD. S.C.; ALT'S 1=EXIST., 2=SITES, 3=MOVE SITE, 4=DIVIDE 2.04TES
  :32:48                    PASS   1   JOB NO.   1                     PAGE   1
```

EXECUTIVE CONTROL LIST 1. 1. 2. 870

LISTING OF CURRENT DATA

	XSECTN NO.	DRAINAGE AREA	BANKFULL	ZERO DAMAGE	LOW GROUND
2 XSECTN	1	1.0000	508.5000	.0000	.0000

	ELEVATION	DISCHARGE	END AREA
8	503.50	.00	.00
8	505.21	100.00	57.25
8	506.74	300.00	118.20
8	508.28	600.00	189.25
8	508.50	624.56	200.00
8	509.51	1000.00	364.35
8	510.37	1500.00	662.99
8	511.07	2100.00	963.82
^	511.44	2500.00	1134.18

ENDTBL

	XSECTN NO.	DRAINAGE AREA	BANKFULL	ZERO DAMAGE	LOW GROUND
2 XSECTN	2	1.0000	501.2700	.0000	.0000

	ELEVATION	DISCHARGE	END AREA
8	496.27	.00	.00
8	498.24	90.00	66.78
8	499.98	270.00	138.93
8	501.27	441.18	200.00
8	501.66	540.00	235.25
8	502.80	900.00	530.50
8	504.43	1960.00	1237.82

9 ENDTBL

	XSECTN NO.	DRAINAGE AREA	BANKFULL	ZERO DAMAGE	LOW GROUND
2 XSECTN	5	1.0000	495.5000	495.5000	495.5000

	ELEVATION	DISCHARGE	END AREA
8	490.00	.00	.00
8	492.00	17.00	24.00
8	494.00	57.00	56.00
8	495.00	86.00	75.00
8	495.50	106.00	96.00
8	496.00	132.00	138.00
8	497.00	205.00	287.00
8	498.00	319.00	522.00
8	499.00	482.00	843.00
8	500.00	705.00	1250.00
8	502.00	1362.00	2330.00
8	504.00	2361.00	3770.00
9 ENDTBL			

	XSECTN NO.	DRAINAGE AREA	BANKFULL	ZERO DAMAGE	LOW GROUND
2 XSECTN	6	1.0000	484.3000	484.0000	484.0000

	ELEVATION	DISCHARGE	END AREA
8	480.00	.00	.00
8	482.00	29.00	46.00
8	484.00	97.00	104.00
8	485.00	144.00	138.00
8	485.50	176.00	168.00
8	486.00	215.00	226.00
8	487.00	320.00	459.00
8	488.00	485.00	875.00
8	490.00	1072.00	2060.00
8	492.00	1971.00	3629.00
9 ENDTBL			

	XSECTN NO.	DRAINAGE AREA	BANKFULL	ZERO DAMAGE	LOW GROUND
2 XSECTN	7	1.0000	479.5000	479.5000	479.2000

		ELEVATION	DISCHARGE	END AREA
8		474.00	.00	.00
8		475.00	12.00	31.00
8		477.00	76.00	99.00
8		479.00	178.00	175.00
8		479.50	214.00	210.00
8		480.00	255.00	255.00
8		481.00	381.00	579.00
8		483.00	783.00	1337.00
8		485.00	1406.00	2397.00
8		487.00	2214.00	3906.00
9 ENDTBL				
1 DURINC				
8	HOURS	6.0	12.0	24.0
9 ENDTBL				

COMPUTED TIME INCREMENT

DIMHYD		.0200			
8	.0000	.0300	.1000	.1900	.3100
8	.4700	.6600	.8200	.9300	.9900
8	1.0000	.9900	.9300	.8600	.7800
8	.6800	.5600	.4600	.3900	.3300
8	.2800	.2410	.2070	.1740	.1470
8	.1260	.1070	.0910	.0770	.0660
8	.0550	.0470	.0400	.0340	.0290
8	.0250	.0210	.0180	.0150	.0130
8	.0110	.0090	.0080	.0070	.0060
8	.0050	.0040	.0030	.0020	.0010
8	.0000	.0000	.0000	.0000	.0000
9 ENDTBL					

COMPUTED PEAK RATE FACTOR = 484.000

```
TR20 ------------------------------------------------------------------------ SCS -
SAMPLE 5 JOB USES - TWO-24HR TYPE II STORMS OVER WATERSHED, WITH ECON,  VERSION
03/06/92 BF, MOD. S.C.; ALT'S 1=EXIST., 2=SITES, 3=MOVE SITE, 4=DIVIDE 2.04TEST
07:32:48                    PASS   1   JOB NO.   1                        PAGE
```

	TABLE NO.	TIME INCREMENT				
5	RAINFL 2	.1000				
8		.0000	.0010	.0020	.0030	.0041
8		.0051	.0062	.0072	.0083	.0094
8		.0105	.0116	.0127	.0138	.0150
8		.0161	.0173	.0184	.0196	.0208
8		.0220	.0232	.0244	.0257	.0269
8		.0281	.0294	.0306	.0319	.0332
8		.0345	.0358	.0371	.0384	.0398
8		.0411	.0425	.0439	.0452	.0466
8		.0480	.0494	.0508	.0523	.0538
8		.0553	.0568	.0583	.0598	.0614
8		.0630	.0646	.0662	.0679	.0696
8		.0712	.0730	.0747	.0764	.0782
8		.0800	.0818	.0836	.0855	.0874
8		.0892	.0912	.0931	.0950	.0970
8		.0990	.1010	.1030	.1051	.1072
8		.1093	.1114	.1135	.1156	.1178
8		.1200	.1222	.1246	.1270	.1296
8		.1322	.1350	.1379	.1408	.1438
8		.1470	.1502	.1534	.1566	.1598
8		.1630	.1663	.1697	.1733	.1771
8		.1810	.1851	.1895	.1941	.1989
8		.2040	.2094	.2152	.2214	.2280
8		.2350	.2427	.2513	.2609	.2715
8		.2830	.3068	.3544	.4308	.5679
8		.6630	.6820	.6986	.7130	.7252
8		.7350	.7434	.7514	.7588	.7656
8		.7720	.7780	.7836	.7890	.7942
8		.7990	.8036	.8080	.8122	.8162
8		.8200	.8237	.8273	.8308	.8342
8		.8376	.8409	.8442	.8474	.8505
8		.8535	.8565	.8594	.8622	.8649
8		.8676	.8702	.8728	.8753	.8777
8		.8800	.8823	.8845	.8868	.8890
8		.8912	.8934	.8955	.8976	.8997
8		.9018	.9038	.9058	.9078	.9097
8		.9117	.9136	.9155	.9173	.9192
8		.9210	.9228	.9245	.9263	.9280
8		.9297	.9313	.9330	.9346	.9362
8		.9377	.9393	.9408	.9423	.9438
8		.9452	.9466	.9480	.9493	.9507
8		.9520	.9533	.9546	.9559	.9572
8		.9584	.9597	.9610	.9622	.9635
8		.9647	.9660	.9672	.9685	.9697
8		.9709	.9722	.9734	.9746	.9758
8		.9770	.9782	.9794	.9806	.9818
8		.9829	.9841	.9853	.9864	.9876
8		.9887	.9899	.9910	.9922	.9933
8		.9944	.9956	.9967	.9978	.9989
8		1.0000	1.0000	1.0000	1.0000	1.0000
9	ENDTBL					

STANDARD CONTROL INSTRUCTIONS

6	RUNOFF	1		1		6	1.2000	75.0000	.33000	0	0	0	0	1
6	RESVOR	2		1	6	7	.0000		0	0	0	0	0	1
6	REACH	3	1		7	5	5400.0000	.0000	.00000	0	0	0	0	1
6	RUNOFF	1	1			6	.4600	76.0000	1.07000	0	0	0	0	1
6	ADDHYD	4	1		5	6 7			0	0	0	0	0	1
6	REACH	3	2		7	1	3000.0000	.0000	.00000	0	0	0	0	1
6	RUNOFF	1		2		6	.4400	78.0000	.35000	0	0	0	0	1
6	RESVOR	2		2	6	7	.0000		0	0	0	0	0	1
6	REACH	3	3		7	5	4600.0000	1.2000	1.10000	0	0	0	0	1
6	RUNOFF	1	3			6	.3100	77.0000	.47000	0	0	0	0	1
6	ADDHYD	4	3		5	6 2			0	0	0	0	0	1
6	ADDHYD	4	4		1	2 3			0	0	0	0	0	1
6	REACH	3	5		3	5	2600.0000	.0000	.00000	0	0	0	0	1
6	SAVMOV	5	6		5	7								
6	REACH	3	6		7	5	4900.0000	.0000	.00000	0	0	0	0	1
6	RUNOFF	1	6			6	1.3000	79.0000	2.00000	0	0	0	0	1
6	ADDHYD	4	6		5	6 7			0	0	0	0	0	1
6	REACH	3	7		7	5	8900.0000	.0000	7900.00000	0	0	0	0	1
	RUNOFF	1	7			6	.7000	80.0000	1.20000	0	0	0	0	1
	ADDHYD	4	7		5	6 4			0	1	0	1	1	1
6	SAVMOV	5	8		4	1								
	ENDATA													

END OF LISTING

```
TR20 ------------------------------------------------------------------------ SCS
SAMPLE 5 JOB USES - TWO-24HR TYPE II STORMS OVER WATERSHED, WITH ECON,  VERSIO
03/06/92 BF, MOD. S.C.; ALT'S 1=EXIST., 2=SITES, 3=MOVE SITE, 4=DIVIDE 2.04TE
07:32:48                    PASS   1   JOB NO.   1                      PAGE


EXECUTIVE CONTROL INCREM    MAIN TIME INCREMENT =   .100 HOURS              880


EXECUTIVE CONTROL BASFLO    CONSTANT BASEFLOW =   6.00 CFS                  890


EXECUTIVE CONTROL COMPUT    FROM STRUCTURE  1  TO XSECTION   7              900
   STARTING TIME =    .00      RAIN DEPTH =  5.20        RAIN DURATION =  1.00
   ANT. RUNOFF COND. = 2       MAIN TIME INCREMENT =   .100 HOURS
   ALTERNATE NO. = 1           STORM NO. = 1             RAIN TABLE NO. = 2


OPERATION ADDHYD   XSECTION   7

                    HYDROGRAPH POINTS FOR   ALTERNATE = 1,   STORM = 1
   HRS       MAIN TIME INCREMENT =  .100 hr,      DRAINAGE AREA =   4.41 SQ.MI
   7.60 CFS      6.37    6.55    6.77    7.02    7.30    7.62    7.97    8.35
   8.40 CFS      8.76    9.20    9.69   10.24   10.83   11.49   12.21   12.99
   9.20 CFS     13.84   14.76   15.72   16.73   17.78   18.86   19.97   21.14
  10.00 CFS     22.38   23.71   25.17   26.77   28.54   30.50   32.68   35.09
  10.80 CFS     37.76   40.72   44.02   47.71   51.85   56.56   61.95   68.19
  11.60 CFS        76      88     110     150     216     306     416      53
  12.40 CFS       630     697     731     738     721     689     646     60
  13.20 CFS       566     538     518     502     490     480     473     466
  14.00 CFS       461     457     454     452     450     450     450     451
  14.80 CFS       452     454     456     459     463     466     470     474
  15.60 CFS       478     482     487     491     496     500     505     509
  16.40 CFS       513     518     522     525     529     533     536     539
  17.20 CFS       542     545     548     550     552     554     556     557
  18.00 CFS       558     559     560     560     560     560     559     559
  18.80 CFS       558     557     556     554     552     551     549     546
  19.60 CFS       544     541     539     536     533     530     526     523
  20.40 CFS       519     516     512     508     505     501     497     493
  21.20 CFS       489     485     481     477     473     469     465     460
  22.00 CFS       456     452     448     443     439     435     431     426
  22.80 CFS       422     418     414     410     405     401     397     393
  23.60 CFS       389     385     381     376     372     368     364     359
  24.40 CFS       354     349     343     337     331     325     319     314
  25.20 CFS       308     303     299     294     290     285     281     277
  26.00 CFS       273     268     264     261     257     253     249     245
  26.80 CFS       242     238     234     231     227     224     220     217
  27.60 CFS       213     210     207     203     200     197     194     191
  28.40 CFS       187     184     181     178     175     172     169     166
  29.20 CFS       163     160     158     155     152     149     146     144
  30.00 CFS       141     139     136     133     131     128     126     123
  30.80 CFS       121     119     116     114     112     110     108     105
  31.60 CFS       103     101      99      97      95      93      91      8
  32.40 CFS     87.59   85.78   84.01   82.27   80.56   78.88   77.23   75.
  33.20 CFS     74.03   72.47   70.95   69.45   67.99   66.55   65.14   63.76
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TR20 ------------------------------------------------------------------------ SCS -
SAMPLE 5 JOB USES - TWO-24HR TYPE II STORMS OVER WATERSHED, WITH ECON,  VERSION
03/06/92 BF, MOD. S.C.; ALT'S 1=EXIST., 2=SITES, 3=MOVE SITE, 4=DIVIDE 2.04TEST
  :32:48                    PASS   1   JOB NO.   1                      PAGE
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34.00 CFS	62.41	61.08	59.79	58.52	57.27	56.06	54.86	53.69
34.80 CFS	52.55	51.43	50.34	49.27	48.22	47.20	46.19	45.22
35.60 CFS	44.26	43.32	42.40	41.51	40.63	39.78	38.94	38.12
36.40 CFS	37.32	36.54	35.78	35.04	34.31	33.60	32.90	32.23
37.20 CFS	31.56	30.92	30.29	29.67	29.07	28.48	27.91	27.35
38.00 CFS	26.81	26.27	25.75	25.25	24.75	24.27	23.80	23.34
38.80 CFS	22.89	22.45	22.02	21.61	21.20	20.81	20.42	20.04
39.60 CFS	19.68	19.32	18.97	18.63	18.30	17.97	17.66	17.35
40.40 CFS	17.05	16.76	16.48	16.20	15.93	15.67	15.41	15.16
41.20 CFS	14.92	14.68	14.45	14.22	14.00	13.79	13.58	13.38
42.00 CFS	13.18	12.99	12.80	12.62	12.44	12.27	12.10	11.93
42.80 CFS	11.77	11.62	11.46	11.32	11.17	11.03	10.90	10.76
43.60 CFS	10.63	10.51	10.39	10.27	10.15	10.04	9.93	9.82
44.40 CFS	9.72	9.61	9.52	9.42	9.32	9.23	9.15	9.06
45.20 CFS	8.98	8.89	8.81	8.73	8.66	8.59	8.52	8.44
46.00 CFS	8.38	8.31	8.25	8.19	8.12	8.06	8.01	7.95

RUNOFF ABOVE BASEFLOW (BASEFLOW = 6.00 CFS)
2.83 WATERSHED INCHES; 8067 CFS-HRS; 666.7 ACRE-FEET.

DURATION(HRS)	4	8	12	16	20	24	28	32
FLOW(CFS)	533	466	364	200	99	48	25	15

DURATION(HRS)	36	39
FLOW(CFS)	10	8 TRUNCATED

ZERO DAMAGE DISCHARGE (214 CFS) OCCURS AT 15.7 HOURS FLOW DURATION.

--- XSECTION 7, ALTERNATE 1, STORM 1, HYDROGRAPH ADDED TO READHD FILE ---

EXECUTIVE CONTROL ENDCMP COMPUTATIONS COMPLETED FOR PASS 1 910

EXECUTIVE CONTROL BASFLO CONSTANT BASEFLOW = 6.00 CFS 920

EXECUTIVE CONTROL COMPUT FROM STRUCTURE 1 TO XSECTION 7 930
STARTING TIME = .00 RAIN DEPTH = 2.60 RAIN DURATION = 1.00
ANT. RUNOFF COND. = 2 MAIN TIME INCREMENT = .100 HOURS
ALTERNATE NO. = 1 STORM NO. = 2 RAIN TABLE NO. = 2

OPERATION ADDHYD XSECTION 7

HYDROGRAPH POINTS FOR ALTERNATE = 1, STORM = 2
MAIN TIME INCREMENT = .100 hr, DRAINAGE AREA = 4.41 SQ.MI

HRS								
10.90 CFS	6.39	6.65	7.01	7.50	8.13	8.93	9.99	11.50
11.70 CFS	14	19	30	48	74	107	144	178

12.50 CFS	204	221	229	231	228	222	215	209
13.30 CFS	207	207	208	211	214	217	221	225
14.10 CFS	229	232	236	240	244	247	251	254
14.90 CFS	257	259	262	263	265	266	267	267
15.70 CFS	268	267	267	266	265	264	262	260
16.50 CFS	258	256	253	251	248	245	242	239
17.30 CFS	236	233	230	226	223	219	216	212
18.10 CFS	209	205	202	198	195	191	188	185
18.90 CFS	181	178	175	172	168	165	162	159
19.70 CFS	156	153	151	148	145	142	140	137
20.50 CFS	135	132	130	128	126	123	121	119
21.30 CFS	117	115	113	112	110	108	106	105
22.10 CFS	103	102	100	99	97	96	95	93
22.90 CFS	92.16	90.96	89.79	88.65	87.56	86.49	85.46	84.46
23.70 CFS	83.50	82.56	81.65	80.77	79.87	78.90	77.83	76.60
24.50 CFS	75.18	73.63	72.00	70.36	68.75	67.20	65.73	64.34
25.30 CFS	63.05	61.82	60.62	59.45	58.29	57.14	56.00	54.86
26.10 CFS	53.72	52.59	51.45	50.32	49.18	48.05	46.92	45.79
26.90 CFS	44.67	43.55	42.44	41.33	40.23	39.15	38.07	37.01
27.70 CFS	35.97	34.94	33.93	32.94	31.96	31.01	30.07	29.16
28.50 CFS	28.27	27.40	26.55	25.73	24.93	24.15	23.40	22.67
29.30 CFS	21.96	21.27	20.61	19.97	19.36	18.76	18.19	17.64
30.10 CFS	17.11	16.59	16.10	15.63	15.18	14.75	14.33	13.93
30.90 CFS	13.55	13.18	12.83	12.50	12.18	11.87	11.58	11.3
31.70 CFS	11.04	10.78	10.54	10.31	10.09	9.88	9.68	9.4
32.50 CFS	9.31	9.14	8.97	8.82	8.67	8.53	8.39	8.27
33.30 CFS	8.15	8.03	7.92	7.82	7.72	7.63	7.54	7.45
34.10 CFS	7.37	7.30	7.23	7.16	7.09	7.03	6.98	6.92
34.90 CFS	6.87	6.82	6.77	6.73	6.69	6.65	6.61	6.58
35.70 CFS	6.55	6.51	6.48					

RUNOFF ABOVE BASEFLOW (BASEFLOW = 6.00 CFS)
.83 WATERSHED INCHES; 2368 CFS-HRS; 195.7 ACRE-FEET.

DURATION(HRS)	3	6	9	12	15	18	21	24
FLOW(CFS)	236	195	117	79	44	19	9	7

DURATION(HRS)	25
FLOW(CFS)	6 BASEFLOW

ZERO DAMAGE DISCHARGE (214 CFS) OCCURS AT 4.9 HOURS FLOW DURATION.

--- XSECTION 7, ALTERNATE 1, STORM 2, HYDROGRAPH ADDED TO READHD FILE ---

EXECUTIVE CONTROL ENDCMP COMPUTATIONS COMPLETED FOR PASS 2 940

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TR20 ------------------------------------------------------------------------ SCS
SAMPLE 5 JOB USES - TWO-24HR TYPE II STORMS OVER WATERSHED, WITH ECON,  VERSIO
03/06/92 BF, MOD. S.C.; ALT'S 1=EXIST., 2=SITES, 3=MOVE SITE, 4=DIVIDE 2.04TES
  :32:48                      PASS   3   JOB NO.   1                      PAGE
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CHANGES TO TABULAR DATA FOLLOW

STRUCT DATA, STRUCTURE 1

	ELEVATION	DISCHARGE	STORAGE
8	521.50	.00	17.00
8	521.60	3.00	18.00
8	521.80	15.00	20.20
8	522.00	33.00	22.50
8	522.20	54.00	25.00
8	522.40	79.00	28.00
8	526.20	948.00	70.00
8	526.40	1009.00	75.00
8	526.60	1071.00	80.00
8	527.20	1265.00	95.00

9 ENDTBL

STRUCT DATA, STRUCTURE 2

	ELEVATION	DISCHARGE	STORAGE
8	496.00	.00	16.00
	498.00	210.00	27.00
8	500.00	252.00	40.00
8	502.00	294.00	62.00
8	504.00	336.00	85.00
8	506.00	378.00	112.00
8	508.00	420.00	145.00
8	509.00	441.00	176.00
8	510.00	556.00	190.00
8	512.00	1129.00	237.00
8	514.00	2086.00	285.00
8	516.00	3288.00	340.00
8	517.00	4030.00	367.00

9 ENDTBL

EXECUTIVE CONTROL BASFLO CONSTANT BASEFLOW = 10.00 CFS 1220

EXECUTIVE CONTROL COMPUT FROM STRUCTURE 1 TO STRUCTURE 2 1230
STARTING TIME = .00 RAIN DEPTH = 5.20 RAIN DURATION = 1.00
ANT. RUNOFF COND. = 2 MAIN TIME INCREMENT = .100 HOURS
ALTERNATE NO. = 2 STORM NO. = 1 RAIN TABLE NO. = 2

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TR20 ------------------------------------------------------------------------ SCS
SAMPLE 5 JOB USES - TWO-24HR TYPE II STORMS OVER WATERSHED, WITH ECON,  VERSIO
03/06/92 BF, MOD. S.C.; ALT'S 1=EXIST., 2=SITES, 3=MOVE SITE, 4=DIVIDE 2.04TES
07:32:48                    PASS   3   JOB NO.   1                      PAGE
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EXECUTIVE CONTROL COMPUT FROM XSECTION 3 TO XSECTION 7 1240
STARTING TIME = .00 RAIN DEPTH = 5.20 RAIN DURATION = 1.00
ANT. RUNOFF COND. = 2 MAIN TIME INCREMENT = .100 HOURS
ALTERNATE NO. = 2 STORM NO. = 1 RAIN TABLE NO. = 2

OPERATION ADDHYD XSECTION 7

HYDROGRAPH POINTS FOR ALTERNATE = 2, STORM = 1
MAIN TIME INCREMENT = .100 hr, DRAINAGE AREA = 4.41 SQ.MI

HRS								
7.60 CFS	10.37	10.55	10.77	11.02	11.30	11.62	11.97	12.35
8.40 CFS	12.76	13.20	13.70	14.24	14.83	15.49	16.21	16.99
9.20 CFS	17.84	18.76	19.73	20.74	21.78	22.86	23.98	25.15
10.00 CFS	26.39	27.73	29.19	30.79	32.57	34.53	36.71	39.12
10.80 CFS	41.80	44.77	48.08	51.77	55.92	60.63	66.03	72.28
11.60 CFS	80	92	114	154	220	310	420	535
12.40 CFS	634	701	736	742	726	693	651	607
13.20 CFS	571	544	523	508	496	487	480	474
14.00 CFS	469	465	463	461	459	459	459	459
14.80 CFS	460	462	464	467	469	472	475	479
15.60 CFS	482	485	489	493	497	501	505	508
16.40 CFS	512	515	519	522	525	529	532	534
17.20 CFS	537	540	542	544	546	548	549	55
18.00 CFS	551	552	552	553	553	553	552	552
18.80 CFS	551	550	549	547	546	544	542	540
19.60 CFS	538	535	533	530	527	524	521	518
20.40 CFS	514	511	507	504	500	497	493	489
21.20 CFS	485	482	478	474	470	466	462	458
22.00 CFS	454	450	446	442	438	434	430	426
22.80 CFS	422	418	414	410	406	401	397	393
23.60 CFS	390	386	382	378	374	370	366	361
24.40 CFS	356	351	345	339	333	328	322	317
25.20 CFS	311	307	302	297	293	289	285	280
26.00 CFS	276	272	268	265	261	257	253	250
26.80 CFS	246	242	239	235	232	228	225	222
27.60 CFS	218	215	212	208	205	202	199	196
28.40 CFS	193	190	187	184	181	178	175	172
29.20 CFS	169	167	164	161	159	156	153	151
30.00 CFS	148	146	143	141	138	136	133	131
30.80 CFS	129	127	124	122	120	118	116	114
31.60 CFS	112	109	107	106	104	102	100	98
32.40 CFS	96.16	94.38	92.63	90.90	89.21	87.54	85.90	84.30
33.20 CFS	82.71	81.16	79.64	78.14	76.67	75.22	73.81	72.42
34.00 CFS	71.05	69.71	68.40	67.11	65.84	64.60	63.39	62.19
34.80 CFS	61.03	59.88	58.76	57.66	56.58	55.52	54.49	53.47
35.60 CFS	52.48	51.51	50.55	49.62	48.71	47.81	46.94	46.08
36.40 CFS	45.24	44.42	43.62	42.83	42.06	41.31	40.57	39.85
37.20 CFS	39.15	38.46	37.79	37.13	36.48	35.85	35.24	34.6
38.00 CFS	34.05	33.47	32.91	32.36	31.82	31.30	30.78	30.2

38.80 CFS	29.79	29.31	28.85	28.39	27.94	27.51	27.08	26.67
39.60 CFS	26.26	25.86	25.47	25.09	24.73	24.36	24.01	23.67
40.40 CFS	23.33	23.00	22.68	22.37	22.07	21.77	21.48	21.19
41.20 CFS	20.92	20.64	20.38	20.12	19.87	19.62	19.38	19.15
42.00 CFS	18.92	18.70	18.48	18.27	18.06	17.86	17.66	17.47
42.80 CFS	17.28	17.10	16.92	16.75	16.58	16.41	16.25	16.09
43.60 CFS	15.94	15.79	15.64	15.50	15.36	15.23	15.09	14.97
44.40 CFS	14.84	14.72	14.60	14.48	14.36	14.25	14.15	14.04
45.20 CFS	13.94	13.84	13.74	13.64	13.55	13.46	13.37	13.29
46.00 CFS	13.20	13.12	13.04	12.96	12.89	12.81	12.74	12.67

RUNOFF ABOVE BASEFLOW (BASEFLOW = 10.00 CFS)
2.83 WATERSHED INCHES; 8064 CFS-HRS; 666.4 ACRE-FEET.

DURATION(HRS)	4	8	12	16	20	24	28	32
FLOW(CFS)	530	470	366	205	107	56	32	20

DURATION(HRS)	36	38
FLOW(CFS)	14	13 TRUNCATED

ZERO DAMAGE DISCHARGE (214 CFS) OCCURS AT 15.8 HOURS FLOW DURATION.

--- XSECTION 7, ALTERNATE 2, STORM 1, HYDROGRAPH ADDED TO READHD FILE ---

EXECUTIVE CONTROL ENDCMP COMPUTATIONS COMPLETED FOR PASS 3 1250

EXECUTIVE CONTROL BASFLO CONSTANT BASEFLOW = 8.00 CFS 1260

EXECUTIVE CONTROL COMPUT FROM STRUCTURE 1 TO STRUCTURE 2 1270
STARTING TIME = .00 RAIN DEPTH = 2.60 RAIN DURATION = 1.00
ANT. RUNOFF COND. = 2 MAIN TIME INCREMENT = .100 HOURS
ALTERNATE NO. = 2 STORM NO. = 2 RAIN TABLE NO. = 2

EXECUTIVE CONTROL COMPUT FROM XSECTION 3 TO XSECTION 7 1280
STARTING TIME = .00 RAIN DEPTH = 2.60 RAIN DURATION = 1.00
ANT. RUNOFF COND. = 2 MAIN TIME INCREMENT = .100 HOURS
ALTERNATE NO. = 2 STORM NO. = 2 RAIN TABLE NO. = 2

OPERATION ADDHYD XSECTION 7

HYDROGRAPH POINTS FOR ALTERNATE = 2, STORM = 2
MAIN TIME INCREMENT = .100 hr, DRAINAGE AREA = 4.41 SQ.MI.

HRS								
10.90 CFS	8.39	8.65	9.01	9.50	10.13	10.94	11.99	13.51
11.70 CFS	16	21	32	50	76	110	147	181

12.50 CFS	207	225	234	237	235	230	224	220
13.30 CFS	219	220	222	224	227	230	233	236
14.10 CFS	238	241	243	246	248	250	251	253
14.90 CFS	254	255	256	257	257	258	258	257
15.70 CFS	257	256	255	254	253	251	249	247
16.50 CFS	245	243	241	239	236	234	231	228
17.30 CFS	226	223	220	217	214	211	208	205
18.10 CFS	202	199	196	193	190	187	184	181
18.90 CFS	178	175	173	170	167	164	162	159
19.70 CFS	156	154	151	148	146	144	141	139
20.50 CFS	136	134	132	130	128	126	124	122
21.30 CFS	120	118	116	115	113	111	110	108
22.10 CFS	107	105	104	102	101	100	98	97
22.90 CFS	95.83	94.64	93.49	92.38	91.29	90.23	89.21	88.21
23.70 CFS	87.25	86.31	85.40	84.50	83.59	82.62	81.53	80.28
24.50 CFS	78.85	77.28	75.62	73.95	72.31	70.71	69.18	67.74
25.30 CFS	66.39	65.09	63.82	62.57	61.34	60.12	58.92	57.72
26.10 CFS	56.54	55.36	54.20	53.06	51.92	50.80	49.69	48.60
26.90 CFS	47.52	46.45	45.40	44.37	43.35	42.34	41.35	40.38
27.70 CFS	39.43	38.49	37.58	36.68	35.80	34.93	34.09	33.26
28.50 CFS	32.45	31.66	30.89	30.14	29.40	28.68	27.99	27.31
29.30 CFS	26.65	26.00	25.38	24.77	24.19	23.61	23.06	22.52
30.10 CFS	22.00	21.50	21.01	20.55	20.09	19.65	19.23	18.82
30.90 CFS	18.42	18.04	17.68	17.32	16.98	16.65	16.34	16.0[illegible]
31.70 CFS	15.74	15.46	15.18	14.92	14.67	14.43	14.20	13.9[illegible]
32.50 CFS	13.76	13.55	13.35	13.16	12.98	12.81	12.64	12.47
33.30 CFS	12.32	12.17	12.02	11.88	11.75	11.62	11.50	11.38
34.10 CFS	11.27	11.16	11.05	10.95	10.85	10.76	10.67	10.58
34.90 CFS	10.50	10.41	10.34	10.26	10.19	10.12	10.06	9.99
35.70 CFS	9.93	9.87	9.81	9.76	9.70	9.65	9.60	9.55
36.50 CFS	9.50	9.46	9.42	9.37	9.33	9.29	9.26	9.22
37.30 CFS	9.18	9.15	9.12	9.09	9.05	9.02	8.99	8.97
38.10 CFS	8.94	8.91	8.89	8.86	8.84	8.81	8.79	8.77
38.90 CFS	8.75	8.73	8.71	8.69	8.67	8.65	8.63	8.62
39.70 CFS	8.60	8.58	8.57	8.55	8.54	8.52	8.51	8.49

RUNOFF ABOVE BASEFLOW (BASEFLOW = 8.00 CFS)
.83 WATERSHED INCHES; 2368 CFS-HRS; 195.7 ACRE-FEET.

DURATION(HRS)	3	6	9	12	15	18	21	24
FLOW(CFS)	236	190	120	83	46	23	14	10

DURATION(HRS)	27	29	
FLOW(CFS)	9	8	BASEFLOW

ZERO DAMAGE DISCHARGE (214 CFS) OCCURS AT 5.2 HOURS FLOW DURATION.

--- XSECTION 7, ALTERNATE 2, STORM 2, HYDROGRAPH ADDED TO READHD FILE ---

F-20A

EXECUTIVE CONTROL ENDCMP COMPUTATIONS COMPLETED FOR PASS 4 1290

CHANGES TO TABULAR DATA FOLLOW

STRUCT DATA, STRUCTURE 2

	ELEVATION	DISCHARGE	STORAGE
ENDTBL			

STRUCT DATA, STRUCTURE 3

	ELEVATION	DISCHARGE	STORAGE
8	484.00	.00	5.00
8	488.00	32.00	8.00
8	492.00	40.00	14.00
8	495.00	45.00	27.00
8	498.00	48.00	48.00
8	500.00	52.00	80.00
9 ENDTBL			

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TR20 ------------------------------------------------------------------------ SCS
SAMPLE 5 JOB USES - TWO-24HR TYPE II STORMS OVER WATERSHED, WITH ECON,  VERSIO
03/06/92 BF, MOD. S.C.; ALT'S 1=EXIST., 2=SITES, 3=MOVE SITE, 4=DIVIDE 2.04TE
07:32:48                    PASS   5   JOB NO.   1                      PAGE

CHANGES TO STANDARD CONTROL LIST FOLLOW

EXECUTIVE CONTROL INSERT    XSECTION   2                                    1400

   STANDARD CONTROL OPERATION RUNOFF   STRUCTURE  3                         1410
OUTPUT HYDROGRAPH = 6    DATA FIELDS =       .7500     78.0000      1.6000
OUTPUT OPTIONS IN EFFECT  SUM

   STANDARD CONTROL OPERATION RESVOR   STRUCTURE  3                         1420
INPUT  HYDROGRAPH = 6
OUTPUT HYDROGRAPH = 7    DATA FIELDS =       .0000       .0000       .0000
OUTPUT OPTIONS IN EFFECT  SUM

EXECUTIVE CONTROL DELETE                                                    1430

   STANDARD CONTROL OPERATION RUNOFF   STRUCTURE  2                         1440

   STANDARD CONTROL OPERATION RESVOR   STRUCTURE  2                         1450

EXECUTIVE CONTROL ALTER                                                     146

   STANDARD CONTROL OPERATION REACH    XSECTION   3                         1470
INPUT  HYDROGRAPH = 7
OUTPUT HYDROGRAPH = 2    DATA FIELDS =   2000.0000      1.2000      1.1000
OUTPUT OPTIONS IN EFFECT  SUM

EXECUTIVE CONTROL DELETE                                                    1480

   STANDARD CONTROL OPERATION RUNOFF   XSECTION   3                         1490

   STANDARD CONTROL OPERATION ADDHYD   XSECTION   3                         1500
```

```
TR20 ------------------------------------------------------------------------ SCS -
SAMPLE 5 JOB USES - TWO-24HR TYPE II STORMS OVER WATERSHED, WITH ECON,  VERSION
^^/06/92 BF, MOD. S.C.; ALT'S 1=EXIST., 2=SITES, 3=MOVE SITE, 4=DIVIDE 2.04TEST
  :32:48                    PASS   5   JOB NO.   1                     PAGE  16
```

EXECUTIVE CONTROL LIST 1. 0. 0. 1510

LISTING OF CURRENT DATA

STANDARD CONTROL INSTRUCTIONS

```
6 RUNOFF 1     1     6      1.2000     75.0000      .33000 0 0 0 0 1
6 RESVOR 2     1 6   7       .0000                        0 0 0 0 0 1
6 REACH  3   1   7   5    5400.0000      .0000      .00000 0 0 0 0 1
6 RUNOFF 1   1         6       .4600     76.0000     1.07000 0 0 0 0 1
6 ADDHYD 4   1   5 6 7                                     0 0 0 0 0 1
6 REACH  3   2   7   1    3000.0000      .0000      .00000 0 0 0 0 1
6 RUNOFF 1     3       6       .7500     78.0000     1.60000 0 0 0 0 1
6 RESVOR 2     3 6   7       .0000                        0 0 0 0 0 1
6 REACH  3   3   7   2    2000.0000     1.2000     1.10000 0 0 0 0 1
6 ADDHYD 4   4   1 2 3                                     0 0 0 0 0 1
  REACH  3   5   3   5    2600.0000      .0000      .00000 0 0 0 0 1
  SAVMOV 5   6   5   7
6 REACH  3   6   7   5    4900.0000      .0000      .00000 0 0 0 0 1
6 RUNOFF 1   6         6      1.3000     79.0000     2.00000 0 0 0 0 1
6 ADDHYD 4   6   5 6 7                                     0 0 0 0 0 1
6 REACH  3   7   7   5    8900.0000      .0000   7900.00000 0 0 0 0 1
6 RUNOFF 1   7         6       .7000     80.0000     1.20000 0 0 0 0 1
6 ADDHYD 4   7   5 6 4                                     0 1 0 1 1 1
6 SAVMOV 5   8   4   1
  ENDATA
```

END OF LISTING

```
TR20 ------------------------------------------------------------------------ SCS
SAMPLE 5 JOB USES - TWO-24HR TYPE II STORMS OVER WATERSHED, WITH ECON,  VERSIO
03/06/92 BF, MOD. S.C.; ALT'S 1=EXIST., 2=SITES, 3=MOVE SITE, 4=DIVIDE 2.04TE^
07:32:48                    PASS   5   JOB NO.   1                      PAGE


EXECUTIVE CONTROL BASFLO    CONSTANT BASEFLOW =   6.00 CFS                1520


EXECUTIVE CONTROL COMPUT    FROM STRUCTURE  1  TO XSECTION   7            1530
   STARTING TIME =    .00      RAIN DEPTH =  5.20       RAIN DURATION =  1.00
   ANT. RUNOFF COND. = 2       MAIN TIME INCREMENT =   .100 HOURS
   ALTERNATE NO. = 3           STORM NO. = 1            RAIN TABLE NO. = 2


OPERATION ADDHYD   XSECTION   7

                 HYDROGRAPH POINTS FOR   ALTERNATE = 3,   STORM = 1
   HRS       MAIN TIME INCREMENT =  .100 hr,      DRAINAGE AREA =   4.41 SQ.MI
   7.60 CFS      6.37     6.55     6.77     7.02     7.30     7.62     7.97     8.35
   8.40 CFS      8.76     9.21     9.70    10.25    10.84    11.50    12.23    13.02
   9.20 CFS     13.87    14.79    15.77    16.78    17.84    18.92    20.05    21.23
  10.00 CFS     22.48    23.83    25.30    26.91    28.70    30.67    32.87    35.29
  10.80 CFS     37.98    40.97    44.28    47.99    52.16    56.88    62.30    68.57
  11.60 CFS        76       89      110      150      216      307      417      532
  12.40 CFS       631      699      734      741      725      693      652      608
  13.20 CFS       572      546      526      511      499      490      483      477
  14.00 CFS       472      468      465      463      461      460      459      45
  14.80 CFS       459      460      461      462      464      465      467      46.
  15.60 CFS       470      472      474      476      478      479      481      483
  16.40 CFS       484      485      487      488      489      490      491      491
  17.20 CFS       492      492      493      493      493      493      492      492
  18.00 CFS       491      490      489      488      487      485      484      482
  18.80 CFS       480      478      476      474      472      469      467      464
  19.60 CFS       461      458      455      452      449      446      443      440
  20.40 CFS       436      433      430      426      423      420      416      413
  21.20 CFS       409      406      403      399      396      393      389      386
  22.00 CFS       383      379      376      373      369      366      363      360
  22.80 CFS       357      353      350      347      344      341      338      335
  23.60 CFS       332      329      326      323      320      317      314      310
  24.40 CFS       306      302      297      292      287      282      278      273
  25.20 CFS       269      265      262      258      255      251      248      245
  26.00 CFS       242      239      235      232      230      227      224      221
  26.80 CFS       218      215      213      210      208      205      202      200
  27.60 CFS       197      195      193      190      188      185      183      181
  28.40 CFS       179      176      174      172      170      168      166      164
  29.20 CFS       162      160      158      156      154      152      150      148
  30.00 CFS       146      145      143      141      139      138      136      134
  30.80 CFS       133      131      130      128      127      125      124      122
  31.60 CFS       121      119      118      117      115      114      113      111
  32.40 CFS       110      109      108      106      105      104      103      102
  33.20 CFS       101      100       99       98       97       96       95       94
  34.00 CFS     92.75    91.83    90.93    90.05    89.19    88.34    87.51    86.6^
  34.80 CFS     85.89    85.11    84.34    83.59    82.86    82.13    81.43    80.
  35.60 CFS     80.05    79.39    78.74    78.10    77.47    76.86    76.26    75.67
```

36.40 CFS	75.09	74.53	73.97	73.43	72.90	72.38	71.86	71.36
37.20 CFS	70.87	70.39	69.92	69.46	69.00	68.56	68.12	67.69
38.00 CFS	67.27	66.86	66.45	66.05	65.66	65.27	64.89	64.52
38.80 CFS	64.16	63.80	63.45	63.10	62.76	62.42	62.09	61.77
39.60 CFS	61.45	61.13	60.82	60.52	60.22	59.92	59.62	59.33
40.40 CFS	59.04	58.76	58.47	58.19	57.91	57.64	57.36	57.09
41.20 CFS	56.82	56.55	56.28	56.01	55.74	55.47	55.19	54.92
42.00 CFS	54.64	54.36	54.07	53.78	53.48	53.17	52.86	52.54
42.80 CFS	52.22	51.88	51.53	51.18	50.82	50.45	50.07	49.68
43.60 CFS	49.28	48.87	48.45	48.03	47.59	47.15	46.70	46.24
44.40 CFS	45.78	45.31	44.83	44.35	43.86	43.37	42.87	42.37
45.20 CFS	41.86	41.35	40.84	40.33	39.81	39.29	38.78	38.26
46.00 CFS	37.74	37.22	36.70	36.19	35.67	35.16	34.65	34.14

RUNOFF ABOVE BASEFLOW (BASEFLOW = 6.00 CFS)
2.80 WATERSHED INCHES; 7973 CFS-HRS; 658.9 ACRE-FEET.

DURATION(HRS)	3	6	9	12	15	18	21	24
FLOW(CFS)	488	465	409	314	213	148	105	79

DURATION(HRS)	27	30	33	36
FLOW(CFS)	65	57	47	34 TRUNCATED

ZERO DAMAGE DISCHARGE (214 CFS) OCCURS AT 15.1 HOURS FLOW DURATION.

--- XSECTION 7, ALTERNATE 3, STORM 1, HYDROGRAPH ADDED TO READHD FILE ---

EXECUTIVE CONTROL ENDCMP COMPUTATIONS COMPLETED FOR PASS 5 1540

EXECUTIVE CONTROL BASFLO CONSTANT BASEFLOW = 6.00 CFS 1550

EXECUTIVE CONTROL COMPUT FROM STRUCTURE 1 TO XSECTION 7 1560
STARTING TIME = .00 RAIN DEPTH = 2.60 RAIN DURATION = 1.00
ANT. RUNOFF COND. = 2 MAIN TIME INCREMENT = .100 HOURS
ALTERNATE NO. = 3 STORM NO. = 2 RAIN TABLE NO. = 2

OPERATION ADDHYD XSECTION 7

HYDROGRAPH POINTS FOR ALTERNATE = 3, STORM = 2
MAIN TIME INCREMENT = .100 hr, DRAINAGE AREA = 4.41 SQ.MI.

HRS								
10.90 CFS	6.39	6.65	7.01	7.50	8.13	8.94	9.99	11.52
11.70 CFS	14	19	30	48	74	108	145	179
12.50 CFS	205	222	231	233	231	225	218	213
13.30 CFS	211	210	211	212	214	215	217	219
14.10 CFS	221	222	224	225	226	228	229	230

14.90 CFS	230	231	232	232	232	232	232	232
15.70 CFS	232	231	230	229	228	227	226	225
16.50 CFS	223	222	220	218	216	214	213	211
17.30 CFS	209	207	205	203	200	198	196	194
18.10 CFS	192	190	187	185	183	181	179	177
18.90 CFS	175	172	170	168	166	164	162	160
19.70 CFS	158	156	154	153	151	149	147	145
20.50 CFS	143	142	140	138	137	135	134	132
21.30 CFS	131	129	128	126	125	124	122	121
22.10 CFS	120	118	117	116	115	113	112	111
22.90 CFS	110	109	107	106	105	104	103	102
23.70 CFS	100	99	98	97	96	95	93	92
24.50 CFS	89.82	87.93	85.95	83.94	81.97	80.04	78.19	76.43
25.30 CFS	74.76	73.15	71.58	70.04	68.53	67.04	65.57	64.12
26.10 CFS	62.69	61.28	59.90	58.53	57.19	55.86	54.56	53.27
26.90 CFS	52.01	50.76	49.53	48.32	47.13	45.96	44.81	43.68
27.70 CFS	42.57	41.48	40.40	39.35	38.32	37.30	36.31	35.33
28.50 CFS	34.38	33.45	32.54	31.65	30.77	29.92	29.09	28.29
29.30 CFS	27.50	26.73	25.99	25.26	24.56	23.88	23.22	22.58
30.10 CFS	21.95	21.35	20.77	20.21	19.66	19.14	18.63	18.14
30.90 CFS	17.67	17.22	16.78	16.36	15.96	15.57	15.19	14.83
31.70 CFS	14.48	14.15	13.83	13.52	13.23	12.95	12.68	12.42
32.50 CFS	12.17	11.93	11.70	11.48	11.27	11.06	10.87	10.69
33.30 CFS	10.51	10.34	10.17	10.02	9.87	9.72	9.58	9.4
34.10 CFS	9.32	9.20	9.09	8.98	8.87	8.77	8.67	8.5.
34.90 CFS	8.48	8.40	8.31	8.23	8.16	8.08	8.01	7.94
35.70 CFS	7.88	7.82	7.76	7.70	7.64	7.59	7.53	7.49
36.50 CFS	7.44	7.39	7.35	7.30	7.26	7.22	7.19	7.15
37.30 CFS	7.11	7.08	7.05	7.01	6.98	6.95	6.93	6.90
38.10 CFS	6.87	6.85	6.82	6.80	6.77	6.75	6.73	6.71
38.90 CFS	6.69	6.67	6.65	6.63	6.61	6.60	6.58	6.56
39.70 CFS	6.55	6.53	6.52	6.50	6.49			

RUNOFF ABOVE BASEFLOW (BASEFLOW = 6.00 CFS)
.84 WATERSHED INCHES; 2378 CFS-HRS; 196.5 ACRE-FEET.

DURATION(HRS)	3	6	9	12	15	18	21	24
FLOW(CFS)	221	183	131	95	50	23	12	8

DURATION(HRS)	27	29
FLOW(CFS)	7	6 BASEFLOW

ZERO DAMAGE DISCHARGE (214 CFS) OCCURS AT 3.9 HOURS FLOW DURATION.

--- XSECTION 7, ALTERNATE 3, STORM 2, HYDROGRAPH ADDED TO READHD FILE ---

F-2

EXECUTIVE CONTROL ENDCMP COMPUTATIONS COMPLETED FOR PASS 6 1570

CHANGES TO TABULAR DATA FOLLOW

STRUCT DATA, STRUCTURE 1

	ELEVATION	DISCHARGE	STORAGE
9 ENDTBL			

STRUCT DATA, STRUCTURE 3

	ELEVATION	DISCHARGE	STORAGE
9 ENDTBL			

XSECT DATA - XSECTION 8

DRAINAGE AREA	BANKFULL	ZERO DAMAGE	LOW GROUND
1.00	494.50	494.30	493.30

	ELEVATION	DISCHARGE	END AREA
8	492.00	.00	.00
8	493.00	21.00	23.00
8	494.00	64.00	52.00
8	495.00	133.00	87.00
8	496.00	232.00	128.00
8	497.00	360.00	175.00
8	498.00	515.00	228.00
8	500.00	827.00	405.00
9 ENDTBL			

```
TR20 ------------------------------------------------------------------------ SCS -
SAMPLE 5 JOB USES - TWO-24HR TYPE II STORMS OVER WATERSHED, WITH ECON,  VERSIO
03/06/92 BF, MOD. S.C.; ALT'S 1=EXIST., 2=SITES, 3=MOVE SITE, 4=DIVIDE 2.04TES
  :32:48                    PASS   7   JOB NO.   1                      PAGE  2

CHANGES TO STANDARD CONTROL LIST FOLLOW

EXECUTIVE CONTROL INSERT    XSECTION   5                                    1720

   STANDARD CONTROL OPERATION DIVERT   XSECTION   5                         1730
INPUT  HYDROGRAPH  = 5
OUTPUT HYDROGRAPHS = 7,1 DATA FIELDS =       .0000       .9000      8.0000
OUTPUT OPTIONS IN EFFECT  HYD   FILE  SUM

EXECUTIVE CONTROL DELETE                                                    1740

   STANDARD CONTROL OPERATION SAVMOV   XSECTION   6                         1750

EXECUTIVE CONTROL INSERT    XSECTION   7                                    1760

   STANDARD CONTROL OPERATION REACH    XSECTION   8                         1770
INPUT  HYDROGRAPH = 1
OUTPUT HYDROGRAPH = 2    DATA FIELDS =  17000.0000       .0000  17200.0000
OUTPUT OPTIONS IN EFFECT  PEAK  SUM

  * MESSAGE - XSECTION   8 FLOODPLAIN LENGTH EXCEEDS CHANNEL LENGTH.       ***

   STANDARD CONTROL OPERATION ADDHYD   XSECTION   9                         1780
INPUT  HYDROGRAPHS = 2,4
OUTPUT HYDROGRAPH  = 7   DATA FIELDS =       .0000       .0000       .0000
OUTPUT OPTIONS IN EFFECT  PEAK  HYD   DUR   FILE  SUM
```

```
TR20 ------------------------------------------------------------------------ SCS -
SAMPLE 5 JOB USES - TWO-24HR TYPE II STORMS OVER WATERSHED, WITH ECON,  VERSION
03/06/92 BF, MOD. S.C.; ALT'S 1=EXIST., 2=SITES, 3=MOVE SITE, 4=DIVIDE 2.04TEST
07:32:48                    PASS   7   JOB NO.   1                      PAGE
```

EXECUTIVE CONTROL LIST 1. 0. 0. 1790

LISTING OF CURRENT DATA

STANDARD CONTROL INSTRUCTIONS

```
6 RUNOFF 1     1     6      1.2000     75.0000      .33000 0 0 0 0 1
6 RESVOR 2     1 6   7       .0000                       0 0 0 0 0 1
6 REACH  3   1   7   5    5400.0000       .0000      .00000 0 0 0 0 1
6 RUNOFF 1   1         6       .4600     76.0000     1.07000 0 0 0 0 1
6 ADDHYD 4   1   5 6 7                                     0 0 0 0 0 1
6 REACH  3   2   7   1    3000.0000       .0000      .00000 0 0 0 0 1
6 RUNOFF 1     3       6       .7500     78.0000     1.60000 0 0 0 0 1
6 RESVOR 2     3 6   7       .0000                       0 0 0 0 0 1
6 REACH  3   3   7   2    2000.0000      1.2000     1.10000 0 0 0 0 1
6 ADDHYD 4   4   1 2 3                                     0 0 0 0 0 1
6 REACH  3   5   3   5    2600.0000       .0000      .00000 0 0 0 0 1
6 DIVERT 6   5   5 7 1       .0000      .9000     8.00000 1 0 0 1 1
6 REACH  3   6   7   5    4900.0000       .0000      .00000 0 0 0 0 1
6 RUNOFF 1   6         6      1.3000     79.0000     2.00000 0 0 0 0 1
6 ADDHYD 4   6   5 6 7                                     0 0 0 0 0 1
6 REACH  3   7   7   5    8900.0000       .0000   7900.00000 0 0 0 0 1
6 RUNOFF 1   7         6       .7000     80.0000     1.20000 0 0 0 0 1
6 ADDHYD 4   7   5 6 4                                     0 1 0 1 1 1
6 REACH  3   8   1   2   17000.0000       .0000  17200.00001 0 0 0 0 1
6 ADDHYD 4   9   2 4 7                                     1 1 0 1 1 1
6 SAVMOV 5   8   4   1
  ENDATA
```

END OF LISTING

EXECUTIVE CONTROL BASFLO TRIANGLE VOLUME = .20 IN., 1800
PEAK TIME = 15.0 HRS., BASE = 25. HRS.

EXECUTIVE CONTROL COMPUT FROM STRUCTURE 1 TO XSECTION 9 1810
STARTING TIME = .00 RAIN DEPTH = 5.20 RAIN DURATION = 1.00
ANT. RUNOFF COND. = 2 MAIN TIME INCREMENT = .100 HOURS
ALTERNATE NO. = 4 STORM NO. = 1 RAIN TABLE NO. = 2

OPERATION DIVERT XSECTION 5
OUTPUT #1 HYDROGRAPH

HYDROGRAPH POINTS FOR ALTERNATE = 4, STORM = 1
MAIN TIME INCREMENT = .100 hr, DRAINAGE AREA = 2.17 SQ.MI

HRS								
9.20 CFS	.44	.55	.68	.85	1.05	1.30	1.60	1.96
10.00 CFS	2.39	2.90	3.49	4.17	4.94	5.81	6.77	7.84
10.80 CFS	9.01	10.30	11.71	13.26	14.95	16.80	17.90	18.99
11.60 CFS	20.19	21.52	22.99	24.62	26.44	28.48	30.82	33.60
12.40 CFS	37	40	44	50	59	72	89	110
13.20 CFS	138	169	200	233	265	292	315	337
14.00 CFS	354	366	373	376	375	372	366	357
14.80 CFS	348	336	324	313	301	290	279	267
15.60 CFS	256	245	234	223	213	203	195	187
16.40 CFS	180	173	166	160	153	148	142	137
17.20 CFS	132	127	123	119	115	111	108	105
18.00 CFS	102	100	98	95	93	91	90	88
18.80 CFS	86.28	84.71	83.22	81.81	80.48	79.21	78.01	76.87
19.60 CFS	75.79	74.75	73.76	72.82	71.92	71.05	70.22	69.42
20.40 CFS	68.65	67.91	67.19	66.50	65.83	65.17	64.54	63.92
21.20 CFS	63.32	62.74	62.17	61.62	61.10	60.59	60.10	59.63
22.00 CFS	59.18	58.76	58.35	57.97	57.60	57.26	56.93	56.60
22.80 CFS	56.28	55.99	55.71	55.44	55.19	54.95	54.72	54.50
23.60 CFS	54.29	54.09	53.89	53.71	53.53	53.35	53.18	53.02
24.40 CFS	52.85	52.70	52.54	52.38	52.22	52.05	51.85	51.62
25.20 CFS	51.32	50.93	50.44	49.86	49.17	48.39	47.54	46.63
26.00 CFS	45.67	44.67	43.66	42.64	41.63	40.63	39.66	38.70
26.80 CFS	37.78	36.84	35.54	34.29	33.10	31.96	30.89	29.87
27.60 CFS	28.91	28.00	27.14	26.33	25.57	24.85	24.18	23.54
28.40 CFS	22.94	22.37	21.84	21.34	20.86	20.42	19.99	19.59
29.20 CFS	19.21	18.85	18.51	18.19	17.88	17.58	17.30	17.03
30.00 CFS	16.54	16.04	15.55	15.09	14.64	14.20	13.78	13.38
30.80 CFS	12.99	12.60	12.23	11.87	11.52	11.18	10.84	10.51
31.60 CFS	10.19	9.87	9.56	9.25	8.95	8.65	8.35	8.06
32.40 CFS	7.78	7.49	7.21	6.93	6.65	6.38	6.11	5.85
33.20 CFS	5.60	5.35	5.11	4.87	4.63	4.41	4.19	3.97
34.00 CFS	3.76	3.56	3.36	3.17	2.98	2.81	2.63	2.46
34.80 CFS	2.31	2.15	2.01	1.87	1.74	1.62	1.50	1.39
35.60 CFS	1.29	1.20	1.11	1.03	.95	.88	.81	.75
36.40 CFS	.69	.64	.59	.54	.50			

RUNOFF INCLUDING TRIANGULAR BASEFLOW
1.35 WATERSHED INCHES; 1889 CFS-HRS; 156.1 ACRE-FEET.

--- XSECTION 5, ALTERNATE 4, STORM 1, HYDROGRAPH ADDED TO READHD FILE ---

HYDROGRAPH POINTS FOR ALTERNATE = 4, STORM = 1
MAIN TIME INCREMENT = .100 hr, DRAINAGE AREA = .24 SQ.MI.

HRS								
11.30 CFS	.00	.94	2.09	3.35	4.74	6.29	8.00	9.91
12.10 CFS	12.06	14.51	17.43	21.12	27.61	36.71	49.93	69.62
12.90 CFS	99	139	190	242	297	351	399	441
13.70 CFS	478	510	532	548	560	566	569	569
14.50 CFS	565	560	552	542	532	520	506	491
15.30 CFS	476	460	444	429	414	399	385	371
16.10 CFS	357	343	329	316	304	292	280	270
16.90 CFS	259	250	240	232	223	215	207	200
17.70 CFS	193	186	180	173	167	162	156	151
18.50 CFS	146	142	138	134	130	126	123	120
19.30 CFS	117	114	111	109	106	104	102	99
20.10 CFS	97.44	95.46	93.56	91.73	89.96	88.26	86.60	85.00
20.90 CFS	83.45	81.94	80.47	79.04	77.65	76.31	75.00	73.75
21.70 CFS	72.54	71.37	70.26	69.19	68.18	67.22	66.30	65.43
22.50 CFS	64.61	63.84	63.13	62.46	61.83	61.23	60.65	60.11
23.30 CFS	59.59	59.10	58.63	58.17	57.74	57.32	56.92	56.5[illegible]
24.10 CFS	56.16	55.79	55.43	55.09	54.75	54.41	54.07	53.7[illegible]
24.90 CFS	53.35	52.94	52.43	51.79	50.95	49.91	48.64	47.16
25.70 CFS	45.50	43.66	41.70	39.63	37.49	35.32	33.13	30.96
26.50 CFS	28.81	26.71	24.66	22.69	20.83	19.46	18.15	16.90
27.30 CFS	15.71	14.58	13.51	12.50	11.55	10.65	9.80	9.00
28.10 CFS	8.24	7.53	6.87	6.24	5.64	5.08	4.55	4.06
28.90 CFS	3.59	3.14	2.72	2.32	1.94	1.59	1.25	.92
29.70 CFS	.61	.32						

RUNOFF INCLUDING TRIANGULAR BASEFLOW
16.97 WATERSHED INCHES; 2639 CFS-HRS; 218.1 ACRE-FEET.

--- XSECTION 8, ALTERNATE 4, STORM 1, HYDROGRAPH ADDED TO READHD FILE ---

OPERATION ADDHYD XSECTION 7

HYDROGRAPH POINTS FOR ALTERNATE = 4, STORM = 1
MAIN TIME INCREMENT = .100 hr, DRAINAGE AREA = 4.17 SQ.MI.

HRS								
7.40 CFS	.42	.57	.77	1.00	1.28	1.60	1.95	2.33
8.20 CFS	2.74	3.19	3.66	4.17	4.73	5.33	5.99	6.71
9.00 CFS	7.50	8.35	9.26	10.24	11.27	12.35	13.46	14.60
9.80 CFS	15.79	17.02	18.33	19.74	21.27	22.95	24.81	26.85
10.60 CFS	29.10	31.59	34.34	37.38	40.76	44.52	48.73	53.49
11.40 CFS	59	65	73	85	107	147	212	30[illegible]
12.20 CFS	409	522	618	682	713	716	696	6[illegible]
13.00 CFS	620	576	542	517	499	488	479	47[illegible]
13.80 CFS	469	467	466	464	463	462	462	462
14.60 CFS	461	461	462	462	463	464	464	465

15.40 CFS	465	465	466	466	466	466	466	465
16.20 CFS	465	464	463	461	460	458	457	455
17.00 CFS	453	451	448	446	444	441	438	435
17.80 CFS	432	429	425	422	418	415	411	407
18.60 CFS	403	399	395	391	387	383	379	375
19.40 CFS	370	366	362	358	354	349	345	341
20.20 CFS	337	333	329	325	321	317	313	309
21.00 CFS	305	302	298	294	291	287	284	281
21.80 CFS	277	274	271	268	264	261	258	255
22.60 CFS	252	249	246	244	241	238	235	233
23.40 CFS	230	227	225	222	220	218	215	213
24.20 CFS	210	207	204	200	196	192	188	183
25.00 CFS	179	176	172	169	166	163	161	158
25.80 CFS	155	153	150	148	146	143	141	139
26.60 CFS	136	134	132	130	128	125	123	121
27.40 CFS	119	117	115	113	111	110	108	106
28.20 CFS	104	102	100	99	97	95	93	92
29.00 CFS	90.05	88.40	86.78	85.17	83.58	82.01	80.46	78.93
29.80 CFS	77.42	75.93	74.47	73.02	71.59	70.19	68.80	67.44
30.60 CFS	66.10	64.77	63.46	62.18	60.91	59.65	58.42	57.20
31.40 CFS	56.00	54.81	53.65	52.49	51.35	50.30	49.27	48.25
32.20 CFS	47.24	46.25	45.27	44.32	43.38	42.46	41.55	40.66
33.00 CFS	39.79	38.93	38.09	37.27	36.46	35.66	34.88	34.12
33.80 CFS	33.36	32.62	31.89	31.18	30.48	29.79	29.11	28.45
34.60 CFS	27.80	27.16	26.53	25.91	25.31	24.71	24.13	23.55
35.40 CFS	22.99	22.43	21.89	21.36	20.84	20.32	19.82	19.33
36.20 CFS	18.84	18.37	17.90	17.44	17.00	16.56	16.13	15.71
37.00 CFS	15.30	14.90	14.50	14.12	13.74	13.37	13.01	12.66
37.80 CFS	12.31	11.98	11.65	11.32	11.01	10.70	10.41	10.11
38.60 CFS	9.83	9.55	9.28	9.02	8.76	8.51	8.26	8.03
39.40 CFS	7.79	7.57	7.35	7.13	6.93	6.72	6.53	6.33
40.20 CFS	6.15	5.97	5.79	5.62	5.45	5.29	5.13	4.97
41.00 CFS	4.82	4.68	4.54	4.40	4.27	4.14	4.01	3.89
41.80 CFS	3.77	3.66	3.55	3.44	3.33	3.23	3.13	3.04
42.60 CFS	2.94	2.85	2.76	2.68	2.59	2.51	2.44	2.36
43.40 CFS	2.29	2.22	2.15	2.08	2.02	1.95	1.89	1.83
44.20 CFS	1.77	1.72	1.66	1.61	1.56	1.51	1.47	1.42
45.00 CFS	1.37	1.33	1.29	1.25	1.21	1.17	1.13	1.10
45.80 CFS	1.06	1.03	.99	.96	.93	.90	.87	.84
46.60 CFS	.82	.79						

RUNOFF INCLUDING TRIANGULAR BASEFLOW
2.24 WATERSHED INCHES; 6022 CFS-HRS; 497.7 ACRE-FEET.

DURATION(HRS)	4	8	12	16	20	24	28	32
FLOW(CFS)	461	337	213	110	56	28	13	5

DURATION(HRS)	36	39
FLOW(CFS)	2	1 TRUNCATED

ZERO DAMAGE DISCHARGE (214 CFS) OCCURS AT 12.1 HOURS FLOW DURATION.

--- XSECTION 7, ALTERNATE 4, STORM 1, HYDROGRAPH ADDED TO READHD FILE ---

OPERATION REACH XSECTION 8

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
15.88	409.4	497.32

RUNOFF INCLUDING TRIANGULAR BASEFLOW
16.97 WATERSHED INCHES; 2639 CFS-HRS; 218.1 ACRE-FEET.

OPERATION ADDHYD XSECTION 9

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
12.67	723.4	(NULL)
15.87	875.3	(NULL)

HYDROGRAPH POINTS FOR ALTERNATE = 4, STORM = 1
MAIN TIME INCREMENT = .100 hr, DRAINAGE AREA = 4.41 SQ.MI.

HRS								
7.40 CFS	.42	.57	.77	1.00	1.28	1.60	1.95	2.3
8.20 CFS	2.74	3.19	3.66	4.17	4.73	5.33	5.99	6.7
9.00 CFS	7.50	8.35	9.26	10.24	11.27	12.35	13.46	14.60
9.80 CFS	15.79	17.02	18.33	19.74	21.27	22.95	24.81	26.85
10.60 CFS	29.10	31.59	34.34	37.38	40.76	44.52	48.73	53.49
11.40 CFS	59	65	73	85	107	147	213	303
12.20 CFS	411	525	621	686	718	722	705	674
13.00 CFS	635	597	570	556	551	555	565	580
13.80 CFS	598	618	640	662	683	704	725	744
14.60 CFS	763	780	796	811	824	836	846	854
15.40 CFS	861	867	871	873	875	875	874	872
16.20 CFS	869	865	861	855	848	841	834	826
17.00 CFS	817	808	799	789	780	770	759	749
17.80 CFS	738	728	717	706	696	685	674	663
18.60 CFS	653	642	631	621	611	601	590	581
19.40 CFS	571	561	552	542	533	524	516	507
20.20 CFS	498	490	482	474	466	459	451	444
21.00 CFS	437	430	424	417	411	405	399	393
21.80 CFS	387	381	376	370	365	360	355	350
22.60 CFS	345	340	335	331	326	322	318	314
23.40 CFS	310	306	302	298	295	291	288	284
24.20 CFS	281	277	273	268	263	258	253	248
25.00 CFS	244	239	235	231	228	224	221	217
25.80 CFS	214	211	207	204	200	197	193	190
26.60 CFS	186	183	179	175	172	168	164	161
27.40 CFS	157	154	151	147	144	141	137	13
28.20 CFS	131	128	125	122	119	117	114	1
29.00 CFS	108	106	103	101	98	96	94	91

29.80 CFS	89.00	86.80	84.65	82.55	80.50	78.52	76.59	74.73
30.60 CFS	72.91	71.14	69.42	67.75	66.12	64.53	62.97	61.46
31.40 CFS	59.98	58.54	57.13	55.75	54.40	53.15	51.93	50.73
32.20 CFS	49.56	48.42	47.31	46.22	45.15	44.12	43.10	42.11
33.00 CFS	41.15	40.20	39.28	38.38	37.50	36.63	35.79	34.96
33.80 CFS	34.15	33.36	32.59	31.83	31.08	30.36	29.64	28.94
34.60 CFS	28.26	27.59	26.93	26.29	25.66	25.04	24.43	23.84
35.40 CFS	23.26	22.68	22.12	21.57	21.04	20.51	19.99	19.49
36.20 CFS	18.99	18.51	18.03	17.57	17.11	16.67	16.23	15.80
37.00 CFS	15.39	14.98	14.58	14.19	13.80	13.43	13.07	12.71
37.80 CFS	12.36	12.02	11.69	11.36	11.05	10.74	10.44	10.14
38.60 CFS	9.85	9.57	9.30	9.03	8.78	8.52	8.28	8.04
39.40 CFS	7.81	7.58	7.36	7.14	6.93	6.73	6.53	6.33
40.20 CFS	6.15	5.97	5.79	5.62	5.45	5.29	5.13	4.97
41.00 CFS	4.82	4.68	4.54	4.40	4.27	4.14	4.01	3.89
41.80 CFS	3.77	3.66	3.55	3.44	3.33	3.23	3.13	3.04
42.60 CFS	2.94	2.85	2.76	2.68	2.59	2.51	2.44	2.36
43.40 CFS	2.29	2.22	2.15	2.08	2.02	1.95	1.89	1.83
44.20 CFS	1.77	1.72	1.66	1.61	1.56	1.51	1.47	1.42
45.00 CFS	1.37	1.33	1.29	1.25	1.21	1.17	1.13	1.10
45.80 CFS	1.06	1.03	.99	.96	.93	.90	.87	.84
46.60 CFS	.82	.79						

RUNOFF INCLUDING TRIANGULAR BASEFLOW
3.04 WATERSHED INCHES; 8661 CFS-HRS; 715.7 ACRE-FEET.

DURATION(HRS)	4	8	12	16	20	24	28	32
FLOW(CFS)	705	490	284	141	59	28	13	5

DURATION(HRS)	36	39
FLOW(CFS)	2	1 TRUNCATED

--- XSECTION 9, ALTERNATE 4, STORM 1, HYDROGRAPH ADDED TO READHD FILE ---

EXECUTIVE CONTROL ENDCMP COMPUTATIONS COMPLETED FOR PASS 7 1820

EXECUTIVE CONTROL BASFLO TRIANGLE VOLUME = .10 IN., 1830
PEAK TIME = 12.0 HRS., BASE = 25. HRS.

EXECUTIVE CONTROL COMPUT FROM STRUCTURE 1 TO XSECTION 9 1840
STARTING TIME = .00 RAIN DEPTH = 2.60 RAIN DURATION = 1.00
ANT. RUNOFF COND. = 2 MAIN TIME INCREMENT = .100 HOURS
ALTERNATE NO. = 4 STORM NO. = 2 RAIN TABLE NO. = 2

* Program output pages 24-33 omitted

TR20 ---------- SCS -
SAMPLE 5 JOB USES - TWO-24HR TYPE II STORMS OVER WATERSHED, WITH ECON, VERSION
03/06/92 BF, MOD. S.C.; ALT'S 1=EXIST., 2=SITES, 3=MOVE SITE, 4=DIVIDE 2.04TEST
07:32:48 SUMMARY, JOB NO. 1 PAGE

SUMMARY TABLE 1

SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL IN ORDER PERFORMED.
A CHARACTER FOLLOWING THE PEAK DISCHARGE TIME AND RATE (CFS) INDICATES:
F-FLAT TOP HYDROGRAPH T-TRUNCATED HYDROGRAPH R-RISING TRUNCATED HYDROGRAPH

XSECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)
RAINFALL OF 5.20 inches AND 24.00 hr DURATION, BEGINS AT .0 hrs.							
RAINTABLE NUMBER 2, ARC 2							
MAIN TIME INCREMENT .100 HOURS							
ALTERNATE 1 STORM 1							
STRUCTURE 1	RUNOFF	1.20	2.61	---	12.09	2128	1773.3
STRUCTURE 1	RESVOR	1.20	2.61	---	12.09	2128	1773.3
XSECTION 1	REACH	1.20	2.61	509.70	12.55	1111	925.8
XSECTION 1	RUNOFF	.46	2.70	---	12.55	406	882.6
XSECTION 1	ADDHYD	1.66	2.63	510.39	12.55	1516	913.3
XSECTION 2	REACH	1.66	2.63	503.07	13.11	1073	646.4
STRUCTURE 2	RUNOFF	.44	2.88	---	12.10	837	1902.3
STRUCTURE 2	RESVOR	.44	2.88	---	12.10	837	1902.3
XSECTION 3	REACH	.44	2.88	---	12.59	412	936.4
XSECTION 3	RUNOFF	.31	2.79	---	12.17	481	1551.6
XSECTION 3	ADDHYD	.75	2.84	---	12.36	640	853.3
XSECTION 4	ADDHYD	2.41	2.70	---	12.98	1436	595.9
XSECTION 5	REACH	2.41	2.70	500.62	14.15	910	377.6
XSECTION 6	REACH	2.41	2.70	488.13	16.76	525	217.8
XSECTION 6	RUNOFF	1.30	2.97	---	13.14	824	633.8
XSECTION 6	ADDHYD	3.71	2.79	489.24	13.16	849	228.8
XSECTION 7	REACH	3.71	2.79	481.70	18.60	521	140.4
XSECTION 7	RUNOFF	.70	3.06	---	12.62	658	940.0
XSECTION 7	ADDHYD	4.41	2.83	482.78	12.68	738	167.3
RAINFALL OF 2.60 inches AND 24.00 hr DURATION, BEGINS AT .0 hrs.							
ALTERNATE 1 STORM 2							
STRUCTURE 1	RUNOFF	1.20	.71	---	12.11	527	439.2
STRUCTURE 1	RESVOR	1.20	.71	---	12.11	527	439.2
XSECTION 1	REACH	1.20	.71	506.83	12.55	317	264.2
XSECTION 1	RUNOFF	.46	.76	---	12.60	102	221.7
XSECTION 1	ADDHYD	1.66	.72	507.33	12.56	415	250.

SUMMARY TABLE 1

SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL IN ORDER PERFORMED.
A CHARACTER FOLLOWING THE PEAK DISCHARGE TIME AND RATE (CFS) INDICATES:
F-FLAT TOP HYDROGRAPH T-TRUNCATED HYDROGRAPH R-RISING TRUNCATED HYDROGRAPH

XSECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)
ALTERNATE 1 STORM 2							
XSECTION 2	REACH	1.66	.72	500.51	12.88	340	204.8
STRUCTURE 2	RUNOFF	.44	.85	---	12.11	238	540.9
STRUCTURE 2	RESVOR	.44	.85	---	12.11	238	540.9
XSECTION 3	REACH	.44	.85	---	12.74	104	236.4
XSECTION 3	RUNOFF	.31	.80	---	12.19	128	412.9
XSECTION 3	ADDHYD	.75	.83	---	12.61	148	197.3
XSECTION 4	ADDHYD	2.41	.76	---	12.83	473	196.3
XSECTION 5	REACH	2.41	.76	497.53	13.93	265	110.0
XSECTION 6	REACH	2.41	.76	485.83	15.06	202	83.8
XSECTION 6	RUNOFF	1.30	.91	---	13.21	233	179.2
XSECTION 6	ADDHYD	3.71	.81	486.89	13.73	308	83.0
XSECTION 7	REACH	3.71	.81	479.86	15.89	244	65.8
XSECTION 7	RUNOFF	.70	.96	---	12.66	194	277.1
XSECTION 7	ADDHYD	4.41	.83	480.10	15.70	268	60.8

RAINFALL OF 5.20 inches AND 24.00 hr DURATION, BEGINS AT .0 hrs.

ALTERNATE 2 STORM 1							
STRUCTURE 1	RUNOFF	1.20	2.61	---	12.09	2128	1773.3
STRUCTURE 1	RESVOR	1.20	2.61	526.12	12.35	929	774.2
XSECTION 1	REACH	1.20	2.61	508.81	12.79	740	616.7
XSECTION 1	RUNOFF	.46	2.70	---	12.55	406	882.6
XSECTION 1	ADDHYD	1.66	2.63	509.71	12.68	1116	672.3
XSECTION 2	REACH	1.66	2.63	502.78	13.16	894	538.6
STRUCTURE 2	RUNOFF	.44	2.88	---	12.10	837	1902.3
STRUCTURE 2	RESVOR	.44	2.88	499.74	12.49	247	561.4
XSECTION 3	REACH	.44	2.88	---	13.54	214	486.4
XSECTION 3	RUNOFF	.31	2.79	---	12.17	481	1551.6
XSECTION 3	ADDHYD	.75	2.84	---	12.20	561	748.0
XSECTION 4	ADDHYD	2.41	2.70	---	13.14	1166	483.8

SUMMARY TABLE 1

SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL IN ORDER PERFORMED.
A CHARACTER FOLLOWING THE PEAK DISCHARGE TIME AND RATE (CFS) INDICATES:
F-FLAT TOP HYDROGRAPH T-TRUNCATED HYDROGRAPH R-RISING TRUNCATED HYDROGRAPH

XSECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)
ALTERNATE 2 STORM 1							
XSECTION 5	REACH	2.41	2.70	500.34	14.34	816	338.6
XSECTION 6	REACH	2.41	2.70	488.07	16.87	504	209.1
XSECTION 6	RUNOFF	1.30	2.97	---	13.14	824	633.8
XSECTION 6	ADDHYD	3.71	2.79	489.27	13.18	859	231.5
XSECTION 7	REACH	3.71	2.79	481.66	18.61	514	138.5
XSECTION 7	RUNOFF	.70	3.06	---	12.62	658	940.0
XSECTION 7	ADDHYD	4.41	2.83	482.80	12.68	743	168.5

RAINFALL OF 2.60 inches AND 24.00 hr DURATION, BEGINS AT .0 hrs.

ALTERNATE 2 STORM 2							
STRUCTURE 1	RUNOFF	1.20	.71	---	12.11	527	439.2
STRUCTURE 1	RESVOR	1.20	.71	522.72	12.54	153	127.5
XSECTION 1	REACH	1.20	.71	505.39	13.14	124	103.3
XSECTION 1	RUNOFF	.46	.76	---	12.60	102	221.7
XSECTION 1	ADDHYD	1.66	.72	506.01	12.80	204	122.9
XSECTION 2	REACH	1.66	.72	499.13	13.23	182	109.6
STRUCTURE 2	RUNOFF	.44	.85	---	12.11	238	540.9
STRUCTURE 2	RESVOR	.44	.85	496.95	12.42	100	227.3
XSECTION 3	REACH	.44	.85	---	13.09	67	152.3
XSECTION 3	RUNOFF	.31	.80	---	12.19	128	412.9
XSECTION 3	ADDHYD	.75	.83	---	12.23	145	193.3
XSECTION 4	ADDHYD	2.41	.76	---	13.14	270	112.0
XSECTION 5	REACH	2.41	.76	496.98	14.10	203	84.2
XSECTION 6	REACH	2.41	.76	485.49	15.19	175	72.6
XSECTION 6	RUNOFF	1.30	.91	---	13.21	233	179.2
XSECTION 6	ADDHYD	3.71	.81	486.94	13.51	314	84.6
XSECTION 7	REACH	3.71	.81	479.72	15.72	232	62.5
XSECTION 7	RUNOFF	.70	.96	---	12.66	194	277.
XSECTION 7	ADDHYD	4.41	.83	480.02	15.41	258	58.

SUMMARY TABLE 1

SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL IN ORDER PERFORMED.
A CHARACTER FOLLOWING THE PEAK DISCHARGE TIME AND RATE (CFS) INDICATES:
F-FLAT TOP HYDROGRAPH T-TRUNCATED HYDROGRAPH R-RISING TRUNCATED HYDROGRAPH

XSECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)
RAINFALL OF 5.20 inches AND 24.00 hr DURATION, BEGINS AT .0 hrs.							
ALTERNATE 3 STORM 1							
STRUCTURE 1	RUNOFF	1.20	2.61	---	12.09	2128	1773.3
STRUCTURE 1	RESVOR	1.20	2.61	526.12	12.35	929	774.2
XSECTION 1	REACH	1.20	2.61	508.80	12.79	737	614.2
XSECTION 1	RUNOFF	.46	2.70	---	12.55	406	882.6
XSECTION 1	ADDHYD	1.66	2.63	509.70	12.68	1113	670.5
SECTION 2	REACH	1.66	2.63	502.77	13.16	891	536.7
STRUCTURE 3	RUNOFF	.75	2.88	---	12.88	539	718.7
STRUCTURE 3	RESVOR	.75	2.88	499.74	17.20F	51F	68.0
XSECTION 3	REACH	.75	2.88	---	17.50F	51F	68.0
XSECTION 4	ADDHYD	2.41	2.71	---	13.17	935	388.0
XSECTION 5	REACH	2.41	2.71	499.54	14.53	602	249.8
XSECTION 6	REACH	2.41	2.70	487.42	16.66	389	161.4
XSECTION 6	RUNOFF	1.30	2.97	---	13.14	824	633.8
XSECTION 6	ADDHYD	3.71	2.79	489.24	13.17	848	228.6
XSECTION 7	REACH	3.71	2.75	481.34	17.87	450	121.3
XSECTION 7	RUNOFF	.70	3.06	---	12.62	658	940.0
XSECTION 7	ADDHYD	4.41	2.80	482.79	12.68	741	168.0
RAINFALL OF 2.60 inches AND 24.00 hr DURATION, BEGINS AT .0 hrs.							
ALTERNATE 3 STORM 2							
STRUCTURE 1	RUNOFF	1.20	.71	---	12.11	527	439.2
STRUCTURE 1	RESVOR	1.20	.71	522.72	12.54	153	127.5

SUMMARY TABLE 1

SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL IN ORDER PERFORMED.
A CHARACTER FOLLOWING THE PEAK DISCHARGE TIME AND RATE (CFS) INDICATES:
F-FLAT TOP HYDROGRAPH T-TRUNCATED HYDROGRAPH R-RISING TRUNCATED HYDROGRAPH

XSECTION/ STRUCTURE ID		STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)
ALTERNATE 3 STORM 2								
XSECTION	1	REACH	1.20	.71	505.37	13.14	121	100.8
XSECTION	1	RUNOFF	.46	.76	---	12.60	102	221.7
XSECTION	1	ADDHYD	1.66	.72	505.99	12.80	202	121.7
XSECTION	2	REACH	1.66	.72	499.11	13.23	180	108.4
STRUCTURE	3	RUNOFF	.75	.85	---	12.95	147	196.0
STRUCTURE	3	RESVOR	.75	.85	492.89	14.81	41	54.7
XSECTION	3	REACH	.75	.85	---	15.25	41	54.7
XSECTION	4	ADDHYD	2.41	.76	---	13.31	214	88.8
XSECTION	5	REACH	2.41	.76	496.49	14.35	168	69.7
XSECTION	6	REACH	2.41	.76	485.06	15.53	148	61.4
XSECTION	6	RUNOFF	1.30	.91	---	13.21	233	179.2
XSECTION	6	ADDHYD	3.71	.81	486.58	13.48	276	74.4
XSECTION	7	REACH	3.71	.81	479.40	15.78	207	55.8
XSECTION	7	RUNOFF	.70	.96	---	12.66	194	277.1
XSECTION	7	ADDHYD	4.41	.84	479.73	12.80	233	52.8

RAINFALL OF 5.20 inches AND 24.00 hr DURATION, BEGINS AT .0 hrs.

ALTERNATE 4 STORM 1								
STRUCTURE	1	RUNOFF	1.20	2.81	---	12.09	2131	1775.8
STRUCTURE	1	RESVOR	1.20	2.81	---	12.09	2131	1775.8
XSECTION	1	REACH	1.20	2.81	509.70	12.55	1109	924.2
XSECTION	1	RUNOFF	.46	2.90	---	12.55	407	884.8
XSECTION	1	ADDHYD	1.66	2.83	510.39	12.55	1515	912.7
XSECTION	2	REACH	1.66	2.83	503.07	13.11	1072	645.8
STRUCTURE	3	RUNOFF	.75	3.08	---	12.88	542	722.7
STRUCTURE	3	RESVOR	.75	3.08	---	12.88	542	722.7
XSECTION	3	REACH	.75	3.08	---	13.18	506	674.7
XSECTION	4	ADDHYD	2.41	2.91	---	13.13	1577	654.4
XSECTION	5	REACH	2.41	2.91	500.73	14.34	946	392.[illegible]

SUMMARY TABLE 1

SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL IN ORDER PERFORMED.
A CHARACTER FOLLOWING THE PEAK DISCHARGE TIME AND RATE (CFS) INDICATES:
F-FLAT TOP HYDROGRAPH T-TRUNCATED HYDROGRAPH R-RISING TRUNCATED HYDROGRAPH

XSECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)
ALTERNATE 4 STORM 1							
XSECTION 5	DIVERT	2.17	1.35	498.35	14.34	376	173.3
XSECTION 8	DIVERT	.24	16.97	498.35	14.34	570	2375.0
XSECTION 6	REACH	2.17	1.35	486.44	15.80	261	120.3
XSECTION 6	RUNOFF	1.30	3.17	---	13.14	829	637.7
XSECTION 6	ADDHYD	3.47	2.03	489.26	13.16	855	246.4
XSECTION 7	REACH	3.47	2.03	481.12	16.45	404	116.4
XSECTION 7	RUNOFF	.70	3.26	---	12.62	661	944.3
ECTION 7	ADDHYD	4.17	2.24	482.67	12.66	717	171.9
XSECTION 8	REACH	.24	16.97	497.32	15.88	409	1704.2
XSECTION 9	ADDHYD	4.41	3.04	---	15.87	875	198.4

RAINFALL OF 2.60 inches AND 24.00 hr DURATION, BEGINS AT .0 hrs.

ALTERNATE 4 STORM 2							
STRUCTURE 1	RUNOFF	1.20	.81	---	12.11	528	440.0
STRUCTURE 1	RESVOR	1.20	.81	---	12.11	528	440.0
XSECTION 1	REACH	1.20	.81	506.78	12.45	308	256.7
XSECTION 1	RUNOFF	.46	.86	---	12.60	103	223.9
XSECTION 1	ADDHYD	1.66	.82	507.28	12.48	405	244.0
XSECTION 2	REACH	1.66	.82	500.45	12.81	332	200.0
STRUCTURE 3	RUNOFF	.75	.95	---	12.95	148	197.3
STRUCTURE 3	RESVOR	.75	.95	---	12.95	148	197.3
XSECTION 3	REACH	.75	.95	---	13.28	136	181.3
XSECTION 4	ADDHYD	2.41	.86	---	12.90	439	182.2
XSECTION 5	REACH	2.41	.86	497.45	14.02	256	106.2
XSECTION 5	DIVERT	2.17	.51	495.26	14.02	97	44.7
XSECTION 8	DIVERT	.24	4.03	495.26	14.02	159	662.5
XSECTION 6	REACH	2.17	.51	483.47	15.19	79	36.4
XSECTION 6	RUNOFF	1.30	1.01	---	13.21	234	180.0
XSECTION 6	ADDHYD	3.47	.70	486.41	13.36	258	74.4

SUMMARY TABLE 1

SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL IN ORDER PERFORMED.
A CHARACTER FOLLOWING THE PEAK DISCHARGE TIME AND RATE (CFS) INDICATES:
F-FLAT TOP HYDROGRAPH T-TRUNCATED HYDROGRAPH R-RISING TRUNCATED HYDROGRAPH

XSECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)
ALTERNATE 4 STORM 2							
XSECTION 7	REACH	3.47	.70	478.90	14.87	173	49.9
XSECTION 7	RUNOFF	.70	1.06	---	12.66	195	278.6
XSECTION 7	ADDHYD	4.17	.76	479.70	12.81	231	55.4
XSECTION 8	REACH	.24	4.03	494.39	16.34	91	379.2
XSECTION 9	ADDHYD	4.41	.94	---	15.53	278	63.0

SUMMARY TABLE 2

MODIFIED ATT-KIN REACH ROUTING IN ORDER PERFORMED.
QUESTION MARK (?) AFTER: OUTFLOW PEAK - MAX. NUMBER ROUTING ITERATIONS USED;
LENGTH FACTOR - VALUE K* GREATER THAN 1.0;
ATT-KIN COEFF - VALUE C GREATER THAN 0.667.

XSEC ID	REACH LENGTH (FT)	FLOOD PLAIN LENGTH (FT)	HYDROGRAPH INFORMATION INFLOW PEAK (CFS)	INFLOW TIME (HR)	OUTFLOW PEAK (CFS)	OUTFLOW TIME (HR)	ROUTING PARAMETERS Q-A EQ. COEFF (X)	Q-A EQ. POWER (M)	LENGTH FACTOR (k*)	PEAK RATIO Q/I (Q*)	ATT-KIN COEFF (C)
BASEFLOW IS 6.0 CFS											
ALTERNATE 1 STORM 1											
1	5400		2131	12.1	1103	12.6	1.02	1.15	.509	.516	.2
2	3000		1505	12.6	1073	13.1	1.17	1.05	.248	.712	.1
SEFLOW IS .0 CFS											
3	4600		837	12.1	412	12.6	1.20	1.10	.571	.489	.1
BASEFLOW IS 6.0 CFS											
5	2600		1435	13.0	909	14.2	.59	1.00	.418	.632	.0
6	4900		909	14.2	524	16.8	.53	1.00	.556	.574	.0
7	8900	7900	848	13.2	521	18.6	.52	1.04	.439	.612	.0
ALTERNATE 1 STORM 2											
1	5400		532	12.1	311	12.5	.23	1.50	.326	.579	.2
2	3000		413	12.6	340	12.9	.19	1.46	.097	.820	.3
BASEFLOW IS .0 CFS											
3	4600		237	12.1	104	12.7	1.20	1.10	.615	.423	.1
BASEFLOW IS 6.0 CFS											
5	2600		473	12.8	265	13.9	.63	1.00	.451	.555	.0
6	4900		265	13.9	202	15.1	.22	1.27	.216	.756	.0
7	8900	7900	308	13.7	244	15.9	.12	1.39	.241	.787	.0

BASEFLOW IS 10.0 CFS

SUMMARY TABLE 2

MODIFIED ATT-KIN REACH ROUTING IN ORDER PERFORMED.
QUESTION MARK (?) AFTER: OUTFLOW PEAK - MAX. NUMBER ROUTING ITERATIONS USED;
LENGTH FACTOR - VALUE K* GREATER THAN 1.0;
ATT-KIN COEFF - VALUE C GREATER THAN 0.667.

			HYDROGRAPH INFORMATION				ROUTING PARAMETERS				
			INFLOW		OUTFLOW		Q-A EQ.				
XSEC ID	REACH LENGTH (FT)	FLOOD PLAIN LENGTH (FT)	PEAK (CFS)	TIME (HR)	PEAK (CFS)	TIME (HR)	COEFF (X)	POWER (M)	LENGTH FACTOR (k*)	PEAK RATIO Q/I (Q*)	ATT-KIN COEFF (C)
ALTERNATE 2 STORM 1											
1	5400		934	12.4	740	12.8	.43	1.35	.131	.790	.25
2	3000		1115	12.7	893	13.2	.98	1.09	.166	.799	.20
BASEFLOW IS .0 CFS											
3	4600		247	12.5	214	13.5	1.20	1.10	.168	.862	.15
BASEFLOW IS 10.0 CFS											
5	2600		1164	13.1	816	14.3	.58	1.00	.343	.698	.08
6	4900		816	14.3	504	16.9	.53	1.00	.491	.613	.04
7	8900	7900	859	13.2	514	18.6	.52	1.04	.440	.594	.03
BASEFLOW IS 8.0 CFS											
ALTERNATE 2 STORM 2											
1	5400		161	12.5	123	13.1	.22	1.52	.092	.756	.19
2	3000		204	12.8	182	13.2	.17	1.50	.042	.888	.27
BASEFLOW IS .0 CFS											
3	4600		100	12.4	67	13.1	1.20	1.10	.260	.639	.14

SUMMARY TABLE 2

MODIFIED ATT-KIN REACH ROUTING IN ORDER PERFORMED.
QUESTION MARK (?) AFTER: OUTFLOW PEAK - MAX. NUMBER ROUTING ITERATIONS USED;
LENGTH FACTOR - VALUE K* GREATER THAN 1.0;
ATT-KIN COEFF - VALUE C GREATER THAN 0.667.

			HYDROGRAPH INFORMATION				ROUTING PARAMETERS				
		FLOOD	INFLOW		OUTFLOW		Q-A EQ.			PEAK	ATT-
XSEC ID	REACH LENGTH (FT)	PLAIN LENGTH (FT)	PEAK (CFS)	TIME (HR)	PEAK (CFS)	TIME (HR)	COEFF (X)	POWER (M)	LENGTH FACTOR (k*)	RATIO Q/I (Q*)	KIN COEFF (C)
BASEFLOW IS 8.0 CFS											
ALTERNATE 2 STORM 2											
5	2600		270	13.1	203	14.1	.70	1.00	.228	.746	.09
6	4900		203	14.1	175	15.2	.16	1.36	.124	.856	.1(
7	8900	7900	314	13.5	232	15.7	.11	1.41	.235	.733	.06
BASEFLOW IS 6.0 CFS											
ALTERNATE 3 STORM 1											
1	5400		930	12.4	736	12.8	.43	1.35	.130	.790	.2
2	3000		1112	12.7	890	13.2	.97	1.09	.165	.799	.2(
BASEFLOW IS .0 CFS											
3	2000		51	17.2	51	17.5	1.20	1.10	.008	1.000	.2
BASEFLOW IS 6.0 CFS											
5	2600		934	13.2	602	14.5	.57	1.00	.278	.642	.0
6	4900		602	14.5	389	16.7	.61	1.00	.316	.643	.0
7	8900	7900	847	13.2	450	17.9	.47	1.06	.418	.528	.0

SUMMARY TABLE 2

MODIFIED ATT-KIN REACH ROUTING IN ORDER PERFORMED.
QUESTION MARK (?) AFTER: OUTFLOW PEAK - MAX. NUMBER ROUTING ITERATIONS USED;
LENGTH FACTOR - VALUE K* GREATER THAN 1.0;
ATT-KIN COEFF - VALUE C GREATER THAN 0.667.

XSEC ID	REACH LENGTH (FT)	FLOOD PLAIN LENGTH (FT)	HYDROGRAPH INFORMATION INFLOW PEAK (CFS)	INFLOW TIME (HR)	OUTFLOW PEAK (CFS)	OUTFLOW TIME (HR)	ROUTING PARAMETERS Q-A EQ. COEFF (X)	Q-A EQ. POWER (M)	LENGTH FACTOR (k*)	PEAK RATIO Q/I (Q*)	ATT-KIN COEFF (C)
ALTERNATE 3 STORM 2											
1	5400		159	12.5	121	13.1	.22	1.52	.092	.755	.19
2	3000		202	12.8	180	13.2	.17	1.50	.042	.887	.27
BASEFLOW IS .0 CFS											
3	2000		41	14.8	41	15.2	1.20	1.10	.024	.999	.28
BASEFLOW IS 6.0 CFS											
5	2600		214	13.3	168	14.3	.60	1.05	.143	.779	.11
6	4900		168	14.3	148	15.5	.12	1.43	.082	.878	.11
7	8900	7900	276	13.5	207	15.8	.088	1.46	.182	.744	.06
BASEFLOW IS A TRIANGLE											
ALTERNATE 4 STORM 1											
1	5400		2128	12.1	1101	12.6	1.01	1.16	.467	.517	.20
2	3000		1505	12.6	1072	13.1	1.17	1.05	.230	.712	.19
3	2000		542	12.9	506	13.2	1.20	1.10	.076	.934	.34
5	2600		1575	13.1	945	14.3	.60	1.00	.422	.600	.08
6	4900		376	14.3	261	15.8	.38	1.13	.282	.695	.07
7	8900	7900	854	13.2	404	16.4	.44	1.07	.609	.473	.03
8	17000	17200	569	14.3	409	15.9	.27	1.39	.327	.719	.06

SUMMARY TABLE 2

MODIFIED ATT-KIN REACH ROUTING IN ORDER PERFORMED.
QUESTION MARK (?) AFTER: OUTFLOW PEAK - MAX. NUMBER ROUTING ITERATIONS USED;
LENGTH FACTOR - VALUE K* GREATER THAN 1.0;
ATT-KIN COEFF - VALUE C GREATER THAN 0.667.

			HYDROGRAPH INFORMATION				ROUTING PARAMETERS				
			INFLOW		OUTFLOW		Q-A EQ.				
XSEC ID	REACH LENGTH (FT)	FLOOD PLAIN LENGTH (FT)	PEAK (CFS)	TIME (HR)	PEAK (CFS)	TIME (HR)	COEFF (X)	POWER (M)	LENGTH FACTOR (k*)	PEAK RATIO Q/I (Q*)	ATT-KIN COEFF (C)
ALTERNATE 4			STORM 2								
1	5400		527	12.1	305	12.5	.23	1.50	.268	.578	.26
2	3000		405	12.5	332	12.8	.19	1.46	.079	.821	.32
3	2000		147	12.9	136	13.3	1.20	1.10	.075	.922	.31
5	2600		439	12.9	256	14.0	.64	1.00	.368	.582	.09
6	4900		97	14.0	79	15.2	.10	1.48	.091	.818	.10
7	8900	7900	258	13.4	173	14.9	.069	1.52	.211	.669	.07
8	17000	17200	159	14.0	91	16.3	.27	1.38	.676	.572	.05

SUMMARY TABLE 3A

STORM FLOW DURATION DISCHARGES (CFS) AT XSECTIONS/STRUCTURES FOR ALL ALTERNATE
A CHARACTER FOLLOWING THE DISCHARGE FOR A STORM-ALTERNATE COMBINATION INDICATE
S-SHORT HYDROGRAPH w/o BASEFLOW T-TRUNCATED HYDROGRAPH
B-SHORT HYDROGRAPH w/ BASEFLOW R-RISING TRUNCATED HYDROGRAPH

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM 1 PEAK FLOW (CFS)	STORM 1 FLOW DURATION (HRS.) 6	12	24	STORM 2 PEAK FLOW (CFS)	STORM 2 FLOW DURATION (HRS.) 6	12	24
STRUCTURE 3	.75								
ALTERNATE 3		51				41			
ALTERNATE 4		542				148			
STRUCTURE 2	.44								
ALTERNATE 1		837				238			
ALTERNATE 2		247				100			
STRUCTURE 1	1.20								
ALTERNATE 1		2128				527			
ALTERNATE 2		929				153			
ALTERNATE 3		929				153			
ALTERNATE 4		2131				528			
XSECTION 1	1.66								
ALTERNATE 1		1516				415			
ALTERNATE 2		1116				204			
ALTERNATE 3		1113				202			
ALTERNATE 4		1515				405			
XSECTION 2	1.66								
ALTERNATE 1		1073				340			
ALTERNATE 2		894				182			
ALTERNATE 3		891				180			
ALTERNATE 4		1072				332			
XSECTION 3	.75								
ALTERNATE 1		640				148			
ALTERNATE 2		561				145			
ALTERNATE 3		51				41			
ALTERNATE 4		506				136			

SUMMARY TABLE 3A

STORM FLOW DURATION DISCHARGES (CFS) AT XSECTIONS/STRUCTURES FOR ALL ALTERNATE
A CHARACTER FOLLOWING THE DISCHARGE FOR A STORM-ALTERNATE COMBINATION INDICATE
S-SHORT HYDROGRAPH w/o BASEFLOW T-TRUNCATED HYDROGRAPH
B-SHORT HYDROGRAPH w/ BASEFLOW R-RISING TRUNCATED HYDROGRAPH

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM 1 PEAK FLOW (CFS)	STORM 1 FLOW DURATION (HRS.) 6	12	24	STORM 2 PEAK FLOW (CFS)	STORM 2 FLOW DURATION (HRS.) 6	12	24
XSECTION 4	2.41								
ALTERNATE 1		1436				473			
ALTERNATE 2		1166				270			
ALTERNATE 3		935				214			
ALTERNATE 4		1577				439			
XSECTION 5	2.17								
ALTERNATE 1		910				265			
ALTERNATE 2		816				203			
ALTERNATE 3		602				168			
ALTERNATE 4		376				97			
XSECTION 6	3.47								
ALTERNATE 1		849				308			
ALTERNATE 2		859				314			
ALTERNATE 3		848				276			
ALTERNATE 4		855				258			
XSECTION 7	4.17								
ALTERNATE 1		738	501	364	48	268	195	79	7
ALTERNATE 2		743	500	366	56	258	190	83	10
ALTERNATE 3		741	465	314	79	233	183	95	8
ALTERNATE 4		717	415	213	28	231	130	71	6
XSECTION 8	.24								
ALTERNATE 4		409				91			
XSECTION 9	4.41								
ALTERNATE 4		875	598	284	28	278	194	90	6

SUMMARY TABLE 4

DISCHARGES (CFS) AT INTERMEDIATE SECTIONS FOR ALL STORMS AND ALTERNATES

INTER. SECT. ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS..... 1	2
7A	3.90	LOCATED BETWEEN SEC 6 & SEC 7	
ALTERNATE	1	777	282
ALTERNATE	2	783	277
ALTERNATE	3	778	248
ALTERNATE	4	764	240
7B	4.00	LOCATED BETWEEN SEC 6 & SEC 7	
ALTERNATE	1	762	277
ALTERNATE	2	768	270
ALTERNATE	3	764	242
ALTERNATE	4	746	237

ECON2 DATA FILE

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ECON2
 TLE     JOB USES - TWO-24HR TYPE II STORMS OVER WATERSHED, WITH ECON,
 LE      BF, MOD. S.C.; ALT'S 1=EXIST., 2=SITES, 3=MOVE SITE, 4=DIVIDE
DUR-INCT        H       .0  6.0  6.0 12.0 12.0 24.0 24.0 24.0
FLOW-FREQ    -3     ********************                          ALT  1
FLOW-FREQ    -2            837.      238.                         ALT  1
FLOW-FREQ    -1           2128.      527.                         ALT  1
FLOW-FREQ     1           1516.      415.                         ALT  1
FLOW-FREQ     2           1073.      340.                         ALT  1
FLOW-FREQ     3            640.      148.                         ALT  1
FLOW-FREQ     4           1436.      473.                         ALT  1
FLOW-FREQ     5            910.      265.                         ALT  1
FLOW-FREQ     6            849.      308.                         ALT  1
FLOW-FREQ     7            738.      268.                         ALT  1
TIME-FLOW     7    6       501.      195.                         ALT  1
TIME-FLOW     7   12       364.       79.                         ALT  1
TIME-FLOW     7   24        48.        7.                         ALT  1
FLOW-FREQ     8      ********************                          ALT  1
FLOW-FREQ     9      ********************                          ALT  1
FLOW-FREQ 7A                777.      282.                         ALT  1 9
TIME-FLOW 7A         USE TIME-FLOW    7                           ALT  1 9
FLOW-FREQ 7B                762.      277.                         ALT  1 9
TIME-FLOW 7B         USE TIME-FLOW    7                           ALT  1 9
FLOW-FREQ    -3      ********************                          ALT  2
FLOW-FREQ    -2            247.      100.                         ALT  2
FLOW-FREQ    -1            929.      153.                         ALT  2
FLOW-FREQ     1           1116.      204.                         ALT  2
 OW-FREQ      2            894.      182.                         ALT  2
 LOW-FREQ     3            561.      145.                         ALT  2
FLOW-FREQ     4           1166.      270.                         ALT  2
FLOW-FREQ     5            816.      203.                         ALT  2
FLOW-FREQ     6            859.      314.                         ALT  2
FLOW-FREQ     7            743.      258.                         ALT  2
TIME-FLOW     7    6       500.      190.                         ALT  2
TIME-FLOW     7   12       366.       83.                         ALT  2
TIME-FLOW     7   24        56.       10.                         ALT  2
FLOW-FREQ     8      ********************                          ALT  2
FLOW-FREQ     9      ********************                          ALT  2
FLOW-FREQ 7A                783.      277.                         ALT  2 9
TIME-FLOW 7A         USE TIME-FLOW    7                           ALT  2 9
FLOW-FREQ 7B                768.      270.                         ALT  2 9
TIME-FLOW 7B         USE TIME-FLOW    7                           ALT  2 9
FLOW-FREQ    -3             51.       41.                         ALT  3
FLOW-FREQ    -2      ********************                          ALT  3
FLOW-FREQ    -1            929.      153.                         ALT  3
FLOW-FREQ     1           1113.      202.                         ALT  3
FLOW-FREQ     2            891.      180.                         ALT  3
FLOW-FREQ     3             51.       41.                         ALT  3
FLOW-FREQ     4            935.      214.                         ALT  3
FLOW-FREQ     5            602.      168.                         ALT  3
FLOW-FREQ     6            848.      276.                         ALT  3
FLOW-FREQ     7            741.      233.                         ALT  3
 IME-FLOW     7    6       465.      183.                         ALT  3
 IME-FLOW     7   12       314.       95.                         ALT  3
TIME-FLOW     7   24        79.        8.                         ALT  3
FLOW-FREQ     8      ********************                          ALT  3
FLOW-FREQ     9      ********************                          ALT  3
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FLOW-FREQ 7A			778.	248.	ALT	3	90
TIME-FLOW 7A		USE TIME-FLOW		7	ALT	3	90
FLOW-FREQ 7B			764.	242.	ALT	3	91
TIME-FLOW 7B		USE TIME-FLOW		7	ALT	3	91
FLOW-FREQ	-3		542.	148.	ALT	4	
FLOW-FREQ	-2	**********			ALT	4	
FLOW-FREQ	-1		2131.	528.	ALT	4	4
FLOW-FREQ	1		1515.	405.	ALT	4	4
FLOW-FREQ	2		1072.	332.	ALT	4	5
FLOW-FREQ	3		506.	136.	ALT	4	5
FLOW-FREQ	4		1577.	439.	ALT	4	5
FLOW-FREQ	5		376.	97.	ALT	4	5
FLOW-FREQ	6		855.	258.	ALT	4	5
FLOW-FREQ	7		717.	231.	ALT	4	5
TIME-FLOW	7	6	415.	130.	ALT	4	5
TIME-FLOW	7	12	213.	71.	ALT	4	5
TIME-FLOW	7	24	28.	6.	ALT	4	5
FLOW-FREQ	8		409.	91.	ALT	4	5
FLOW-FREQ	9		875.	278.	ALT	4	6
TIME-FLOW	9	6	598.	194.	ALT	4	6
TIME-FLOW	9	12	284.	90.	ALT	4	6
TIME-FLOW	9	24	28.	6.	ALT	4	6
FLOW-FREQ 7A			764.	240.	ALT	4	90
TIME-FLOW 7A		USE TIME-FLOW		7	ALT	4	90
FLOW-FREQ 7B			746.	237.	ALT	4	91
TIME-FLOW 7B		USE TIME-FLOW		7	ALT	4	91

F-5L

```
TR20 ------------------------------------------------------------------------ SCS -
SAMPLE 5 JOB USES - TWO-24HR TYPE II STORMS OVER WATERSHED, WITH ECON,  VERSION
03/06/92 BF, MOD. S.C.; ALT'S 1=EXIST., 2=SITES, 3=MOVE SITE, 4=DIVIDE 2.04TEST


END OF  1 JOBS IN THIS RUN


                    SCS  TR-20,  VERSION 2.04TEST
                          SAMPLE 5  FILES

 INPUT  = b:a5.dat                                  , GIVEN DATA FILE
 OUTPUT = prn                                       , DATED 03/06/92,07:32:48

          FILES GENERATED - DATED 03/06/92,07:32:48

FILE b:a5.TEC CONTAINS ECON2 INFORMATION

FILE b:a5.TRD CONTAINS READHD INFORMATION


       TOTAL NUMBER OF WARNINGS =   0,  MESSAGES =   1

                 *** TR-20 RUN COMPLETED ***
```

APPENDIX G

Standard Worksheets

and

Preloaded Tabular Data

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U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TR-20 – JOB AND TITLE

WORKSHEET
SCS-ENG-264
41-91

LOCATION _____ PREPARED BY _____ DATE _____ PAGE ___
JOB _____ CHECKED BY _____ DATE _____ OF ___

1 – 12	13 – 24	25 – 36	37 – 48	49 – 60	61 – 72	73 – 80
1 2 3 4 5 6 7 8 9 0 1 2	3 4 5 6 7 8 9 0 1 2 3 4	5 6 7 8 9 0 1 2 3 4 5 6	7 8 9 0 1 2 3 4 5 6 7 8	9 0 1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0 1 2	3 4 5 6 7 8 9 0
Operation Name	Watershed ID	ECON Option	FULLPRINT Option	Starting Pass No.	SUMMARY Option	PLOTS, ENDPLOT, GRAPHICS Options	Record Identification
JOB TR-20				PASS –			

1 – 12	13 – 24	25 – 36	37 – 48	49 – 60	61 – 72	73 – 80
1 2 3 4 5 6 7 8 9 0 1 2	3 4 5 6 7 8 9 0 1 2 3 4	5 6 7 8 9 0 1 2 3 4 5 6	7 8 9 0 1 2 3 4 5 6 7 8	9 0 1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0 1 2	3 4 5 6 7 8 9 0
Operation Name	– – – – – – – – – – – Job title (one record required . second optional) – – – – – – – – – – –					Record Identification
TITLE						
TITLE						

JOB and TITLE

JOB Record (required)

Columns 1-3	JOB
Columns 5-9	TR-20
Columns 11-17	Watershed identification
Columns 21-24	ECON Use only if peak discharge and/or flow duration outpu for ECON/URB1 is desired. Locations for this output must be selected for inclusion in Summary Tables 1 an 3 also. Such designation can be made using summary option explained below (columns 51-57) or the SUM option on Standard Control (column 71), the DURINC table, and the DUR Standard Control option (column 67).
Columns 31-39	FULLPRINT Use only if FULLPRINT option is desired.
Columns 41-48	PASS=XXX Use only if PASS number, XXX, is greater than 1. XXX is an integer, right, justified.
Columns 51-57	SUMMARY Use only if Summary Tables 1 and 3 are to include all Standard Control operations (except SAVMOV).
Columns 61-68	---- Leave blank if no cross section discharge-end area plots are desired. ENDPLOT Use if only cross section discharge-end area plots ar desired with no routings. PLOTS Provides discharge-end area plots of cross section tables with regular output. GRAPHICS Generates data files for use with SCS graphics programs
Columns 73-80	Optional user information, printed at top of 80-80 input listing.

TITLE Records (one required, second is optional)

Columns 1-5	TITLE
Columns 11-72	Both titles may be any characters desired.
Columns 73-80	Optional record identification.

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TR-20 FLOW DURATION FOR ECON2

WORKSHEET
SCS-ENG-272
41-91

TABLE _____ PREPARED BY _____ DATE _____ PAGE ___
JOB _____ CHECKED BY _____ DATE _____ OF ___

1 - 12	13 - 24	25 - 36	37 - 48	49 - 60	61 - 72	73 - 80
1 2 3 4 5 6 7 8 9 0 1 2	3 4 5 6 7 8 9 0 1 2 3 4	5 6 7 8 9 0 1 2 3 4 5 6	7 8 9 0 1 2 3 4 5 6 7 8	9 0 1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0 1 2	3 4 5 6 7 8 9 0
Data Code / Table Name						Record Identification
1 DURINC						
	HOUR or DAYS	FIRST Duration	SECOND Duration	THIRD Duration		
8						
9 ENDTBL	This record must be the last record of this table.					

1. *Maximum of three durations.*
2. Data Fields in Col. 25 to 60 require decimal points.

U.S. DEPARTMENT OF AGRICULTURE
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TR-20 STREAM CROSS SECTION DATA

WORKSHEET
SCS-ENG-270A
1-90

CROSS SECTION NAME ______________ PREPARED BY ______________ DATE __________ PAGE ___

JOB ______________ CHECKED BY ______________ DATE __________ OF ___

1 – 12			13 – 24	25 – 36	37 – 48	49 – 60	61 – 72	73 – 80
Data Code		Table Name	Cross Section No.	Drainage Area sq. mi. (use 1.0 if cfs)	Bankfull Elevation-feet	Zero Damage Elevation-feet	Low Ground Elevation-feet	Record Identification
2		XSECTN						
			(001 to 200)	Elevation feet	Discharge cfs or cms	End Area square feet		Record Identification
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
9		ENDTBL	This record must be the last record of this table.					

1. Maximum of 20 data records.
2. Data Fields in Col. 25 to 72 require decimal points.

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TR-20 STRUCTURE DATA

WORKSHEET
SCS-ENG-269
4-91

STRUCTURE ID _____ PREPARED BY _____ DATE _____ PAGE ___
JOB _____ CHECKED BY _____ DATE _____ OF ___

1 – 12	13 – 24	25 – 36	37 – 48	49 – 60	61 – 72	73 – 80
Data Code / Table Name	Structure No.					Record Identification
3 STRUCT						
	(01 to 99)	Elevation feet	Discharge cfs	Storage acre – feet		Record Identification
8						
8						
8						
8						
8						
8						
8						
8						
8						
8						
8						
8						
8						
8						
8						
8						
8						
8						
9 ENDTBL	This record must be the last record of this table.					

1. Maximum of 20 data records.
2. Data Fields in Col. 25 to 80 require decimal points.

G-6

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TR-20 DIMENSIONLESS HYDROGRAPH TABLE

WORKSHEET
SCS-ENG-266
4-91

TABLE _____ PREPARED BY _____ DATE _____ PAGE ___
JOB _____ CHECKED BY _____ DATE _____ OF ___

1 – 12	13 – 24	25 – 36	37 – 48	49 – 60	61 – 72	73 – 80
Data Code / Table Name		Dimensionless Time Increment				Record Identification
4 DIMHYD						
	Enter successive entries left to right with first entry for time = 0.0 *Fill last row of data with value for dimensionless time = 1.0*					Record Identification
1. Maximum of 21 data records 2. Data Fields in Col. 13 to 72 require decimal points.						
0 ENDTBL	This record must be the last record of this table.					

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TR-20 DIMENSIONLESS HYDROGRAPH TABLE

WORKSHEET
SCS-ENG-266
4-81

TABLE STANDARD 484 HYD. PREPARED BY M DATE 4/22/91 PAGE 1
JOB TR20 CHECKED BY _____ DATE _____ OF 1

1 – 12	13 – 24	25 – 36	37 – 48	49 – 60	61 – 72	73 – 80
Data Code / Table Name		Dimensionless Time Increment				Record Identification
22 DIMHYD		.02				
	Enter successive entries left to right with first entry for time = 0.0 Fill last row of data with value for dimensionless time = 1.0					Record Identification
1. Maximum of 11 data records 2. Data Fields in Col. 13 to 72 require decimal points.	.0000	.0300	.1000	.1900	.3100	
	.4700	.6600	.8200	.9300	.9900	
	1.0000	.9900	.9300	.8600	.7800	
	.6800	.5600	.4600	.3900	.3300	
	.2800	.2410	.2070	.1740	.1470	
	.1260	.1070	.0910	.0770	.0660	
	.0550	.0470	.0400	.0340	.0290	
	.0250	.0210	.0180	.0150	.0130	
	.0110	.0090	.0080	.0070	.0060	
	.0050	.0040	.0030	.0020	.0010	
	.0000	.0000	.0000	.0000	.0000	
0 ENDTBL	This record must be the last record of this table.					

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TR-20 CUMULATIVE RAINFALL TABLE

WORKSHEET
SCS-ENG-271
4-81

LOCATION ID _____ PREPARED BY _____ DATE _____ PAGE ___
JOB _____ CHECKED BY _____ DATE _____ OF ___

1 - 12			13 - 24	25 - 36	37 - 48	49 - 60	61 - 72	73 - 80
Data Code	Name	Table No.	Runoff Option	Time Increment hours				Record Identification
5	RAINFL	(1 - 9)						
			Enter successive entries left to right with first entry for time = 0 Fill last row of data with last entry of table.					Record Identification
6	1. Maximum of 50 data records 2. Data Fields in Col. 13 to 72 require decimal points.							
9	ENDTBL		This record must be the last record of this table.					

Type I, 24 hrs

	TABLE NO.	TIME INCREMENT				
5	RAINFL 1		.1000			
8		.0000	.0017	.0035	.0052	.0070
8		.0087	.0105	.0122	.0139	.0157
8		.0174	.0192	.0210	.0227	.0245
8		.0262	.0280	.0297	.0315	.0332
8		.0350	.0368	.0386	.0404	.0423
8		.0442	.0461	.0480	.0500	.0520
8		.0540	.0561	.0582	.0603	.0625
8		.0647	.0669	.0691	.0714	.0737
8		.0760	.0784	.0807	.0831	.0855
8		.0878	.0902	.0926	.0951	.0975
8		.1000	.1024	.1049	.1073	.1098
8		.1123	.1148	.1174	.1199	.1225
8		.1250	.1276	.1303	.1332	.1361
8		.1391	.1423	.1456	.1489	.1524
8		.1560	.1597	.1633	.1671	.1708
8		.1746	.1784	.1823	.1861	.1901
8		.1940	.1982	.2027	.2077	.2132
8		.2190	.2252	.2318	.2388	.2462
8		.2540	.2623	.2714	.2812	.2917
8		.3030	.3194	.3454	.3878	.4632
8		.5150	.5322	.5476	.5612	.5730
8		.5830	.5919	.6003	.6083	.6159
8		.6230	.6298	.6365	.6430	.6493
8		.6555	.6615	.6674	.6731	.6786
8		.6840	.6892	.6944	.6995	.7044
8		.7092	.7140	.7186	.7232	.7276
8		.7320	.7362	.7404	.7444	.7484
8		.7523	.7560	.7596	.7632	.7667
8		.7700	.7733	.7766	.7798	.7830
8		.7862	.7894	.7926	.7958	.7989
8		.8020	.8051	.8082	.8112	.8142
8		.8173	.8202	.8232	.8262	.8291
8		.8320	.8349	.8378	.8406	.8434
8		.8462	.8490	.8518	.8546	.8573
8		.8600	.8627	.8654	.8680	.8706
8		.8733	.8758	.8784	.8810	.8835
8		.8860	.8885	.8910	.8934	.8958
8		.8982	.9006	.9030	.9054	.9077
8		.9100	.9123	.9146	.9168	.9190
8		.9212	.9234	.9256	.9278	.9299
8		.9320	.9341	.9362	.9382	.9402
8		.9423	.9442	.9462	.9482	.9501
8		.9520	.9539	.9558	.9576	.9594
8		.9613	.9630	.9648	.9666	.9683
8		.9700	.9717	.9734	.9750	.9766
8		.9783	.9798	.9814	.9830	.9845
8		.9860	.9875	.9890	.9904	.9918
8		.9933	.9946	.9960	.9974	.9987
8		1.0000	1.0000	1.0000	1.0000	1.0000
9	ENDTBL					

Type II, 24 hrs

	TABLE NO.	TIME INCREMENT				
5	RAINFL 2	.1000				
8		.0000	.0010	.0020	.0030	.0041
8		.0051	.0062	.0072	.0083	.0094
8		.0105	.0116	.0127	.0138	.0150
8		.0161	.0173	.0184	.0196	.0208
8		.0220	.0232	.0244	.0257	.0269
8		.0281	.0294	.0306	.0319	.0332
8		.0345	.0358	.0371	.0384	.0398
8		.0411	.0425	.0439	.0452	.0466
8		.0480	.0494	.0508	.0523	.0538
8		.0553	.0568	.0583	.0598	.0614
8		.0630	.0646	.0662	.0679	.0696
8		.0712	.0730	.0747	.0764	.0782
8		.0800	.0818	.0836	.0855	.0874
8		.0892	.0912	.0931	.0950	.0970
8		.0990	.1010	.1030	.1051	.1072
8		.1093	.1114	.1135	.1156	.1178
8		.1200	.1222	.1246	.1270	.1296
8		.1322	.1350	.1379	.1408	.1438
8		.1470	.1502	.1534	.1566	.1598
8		.1630	.1663	.1697	.1733	.1771
8		.1810	.1851	.1895	.1941	.1989
8		.2040	.2094	.2152	.2214	.2280
8		.2350	.2427	.2513	.2609	.2715
8		.2830	.3068	.3544	.4308	.5679
8		.6630	.6820	.6986	.7130	.7252
8		.7350	.7434	.7514	.7588	.7656
8		.7720	.7780	.7836	.7890	.7942
8		.7990	.8036	.8080	.8122	.8162
8		.8200	.8237	.8273	.8308	.8342
8		.8376	.8409	.8442	.8474	.8505
8		.8535	.8565	.8594	.8622	.8649
8		.8676	.8702	.8728	.8753	.8777
8		.8800	.8823	.8845	.8868	.8890
8		.8912	.8934	.8955	.8976	.8997
8		.9018	.9038	.9058	.9078	.9097
8		.9117	.9136	.9155	.9173	.9192
8		.9210	.9228	.9245	.9263	.9280
8		.9297	.9313	.9330	.9346	.9362
8		.9377	.9393	.9408	.9423	.9438
8		.9452	.9466	.9480	.9493	.9507
8		.9520	.9533	.9546	.9559	.9572
8		.9584	.9597	.9610	.9622	.9635
8		.9647	.9660	.9672	.9685	.9697
8		.9709	.9722	.9734	.9746	.9758
8		.9770	.9782	.9794	.9806	.9818
8		.9829	.9841	.9853	.9864	.9876
8		.9887	.9899	.9910	.9922	.9933
8		.9944	.9956	.9967	.9978	.9989
8		1.0000	1.0000	1.0000	1.0000	1.0000
9	ENDTBL					

Type IA, 24 hrs

TABLE NO.		TIME INCREMENT				
5	RAINFL 3		.1000			
8		.0000	.0022	.0043	.0063	.0082
8		.0100	.0118	.0137	.0157	.0178
8		.0200	.0228	.0257	.0287	.0318
8		.0350	.0380	.0410	.0439	.0470
8		.0500	.0531	.0563	.0595	.0628
8		.0660	.0692	.0724	.0756	.0788
8		.0820	.0851	.0883	.0915	.0947
8		.0980	.1015	.1050	.1086	.1123
8		.1160	.1197	.1234	.1272	.1311
8		.1350	.1390	.1431	.1473	.1516
8		.1560	.1606	.1653	.1701	.1750
8		.1800	.1849	.1900	.1952	.2005
8		.2060	.2120	.2181	.2243	.2306
8		.2370	.2429	.2488	.2549	.2613
8		.2680	.2752	.2829	.2912	.3002
8		.3100	.3314	.3547	.3788	.4026
8		.4250	.4394	.4517	.4623	.4716
8		.4800	.4890	.4975	.5055	.5130
8		.5200	.5266	.5329	.5389	.5446
8		.5500	.5556	.5612	.5666	.5718
8		.5770	.5820	.5868	.5916	.5964
8		.6010	.6058	.6104	.6150	.6196
8		.6240	.6284	.6326	.6368	.6410
8		.6450	.6489	.6527	.6565	.6603
8		.6640	.6677	.6715	.6753	.6791
8		.6830	.6866	.6903	.6939	.6974
8		.7010	.7047	.7084	.7120	.7155
8		.7190	.7225	.7259	.7293	.7326
8		.7360	.7394	.7428	.7461	.7495
8		.7528	.7561	.7594	.7627	.7660
8		.7692	.7725	.7757	.7789	.7821
8		.7853	.7885	.7916	.7947	.7979
8		.8010	.8041	.8071	.8102	.8132
8		.8163	.8193	.8223	.8252	.8282
8		.8312	.8341	.8370	.8399	.8428
8		.8457	.8486	.8514	.8542	.8570
8		.8598	.8626	.8654	.8681	.8709
8		.8736	.8763	.8790	.8817	.8844
8		.8870	.8896	.8923	.8949	.8974
8		.9000	.9026	.9051	.9076	.9101
8		.9126	.9151	.9176	.9200	.9225
8		.9249	.9273	.9297	.9321	.9344
8		.9368	.9391	.9414	.9437	.9460
8		.9482	.9505	.9527	.9550	.9572
8		.9594	.9615	.9637	.9658	.9680
8		.9701	.9722	.9743	.9764	.9784
8		.9804	.9825	.9845	.9865	.9884
8		.9904	.9924	.9943	.9962	.9981
8		1.0000	1.0000	1.0000	1.0000	1.0000
9	ENDTBL					

Table 11.4 – SCS Type III, 24 hrs Dabel

TABLE NO.		TIME INCREMENT				
5 RAINFL 4		.1000				
8	.0000	.0010	.0020	.0030	.0040
8	.0050	.0060	.0070	.0080	.0090
8	.0100	.0110	.0120	.0130	.0140
8	.0150	.0160	.0170	.0180	.0190
8	.0200	.0210	.0220	.0231	.0241
8	.0252	.0263	.0274	.0285	.0296
8	.0308	.0319	.0331	.0343	.0355
8	.0367	.0379	.0392	.0404	.0417
8	.0430	.0443	.0456	.0470	.0483
8	.0497	.0511	.0525	.0539	.0553
8	.0567	.0582	.0597	.0612	.0627
8	.0642	.0657	.0673	.0688	.0704
8	.0720	.0736	.0753	.0770	.0788
8	.0806	.0825	.0844	.0864	.0884
8	.0905	.0926	.0948	.0970	.0993
8	.1016	.1040	.1064	.1089	.1114
8	.1140	.1167	.1194	.1223	.1253
8	.1284	.1317	.1350	.1385	.1421
8	.1458	.1496	.1535	.1575	.1617
8	.1659	.1703	.1748	.1794	.1842
8	.1890	.1940	.1993	.2048	.2105
8	.2165	.2227	.2292	.2359	.2428
8	.2500	.2578	.2664	.2760	.2866
8	.2980	.3143	.3394	.3733	.4160
8	.5000	.5840	.6267	.6606	.6857
8	.7020	.7134	.7240	.7336	.7422
8	.7500	.7572	.7641	.7708	.7773
8	.7835	.7895	.7952	.8007	.8060
8	.8110	.8158	.8206	.8252	.8297
8	.8341	.8383	.8425	.8465	.8504
8	.8543	.8579	.8615	.8650	.8683
8	.8716	.8747	.8777	.8806	.8833
8	.8860	.8886	.8911	.8936	.8960
8	.8984	.9007	.9030	.9052	.9074
8	.9095	.9116	.9136	.9156	.9175
8	.9194	.9212	.9230	.9247	.9264
8	.9280	.9296	.9312	.9327	.9343
8	.9358	.9373	.9388	.9403	.9418
8	.9433	.9447	.9461	.9475	.9489
8	.9503	.9517	.9530	.9544	.9557
8	.9570	.9583	.9596	.9609	.9621
8	.9634	.9646	.9658	.9670	.9682
8	.9694	.9706	.9718	.9729	.9741
8	.9752	.9764	.9775	.9786	.9797
8	.9808	.9818	.9829	.9839	.9850
8	.9860	.9870	.9880	.9890	.9900
8	.9909	.9919	.9928	.9938	.9947
8	.9956	.9965	.9974	.9983	.9991
8	1.0000	1.0000	1.0000	1.0000	1.0000
9 ENDTBL					

Table # 5 — SCS Type II, 48 hrs Ideal

	TABLE NO.	TIME INCREMENT				
5	RAINFL 5	.5000				
8		.0000	.0020	.0050	.0080	.0110
8		.0140	.0170	.0200	.0230	.0260
8		.0290	.0320	.0350	.0380	.0410
8		.0440	.0470	.0510	.0550	.0590
8		.0630	.0670	.0710	.0750	.0790
8		.0840	.0890	.0940	.0990	.1040
8		.1090	.1140	.1200	.1260	.1330
8		.1400	.1470	.1540	.1620	.1710
8		.1810	.1920	.2040	.2170	.2330
8		.2520	.2770	.3180	.6380	.6980
8		.7290	.7520	.7700	.7850	.7980
8		.8090	.8190	.8290	.8380	.8460
8		.8540	.8610	.8680	.8740	.8800
8		.8860	.8920	.8970	.9020	.9070
8		.9120	.9170	.9210	.9250	.9290
8		.9330	.9370	.9410	.9450	.9490
8		.9530	.9570	.9600	.9630	.9660
8		.9690	.9720	.9750	.9780	.9810
8		.9840	.9870	.9900	.9930	.9960
8		.9980	1.0000	1.0000	1.0000	1.0000
9	ENDTBL					

Emergency Spillway & Freeboard Design

TABLE NO.	TIME INCREMENT				
5 RAINFL 6		.0200			
8	.0000	.0080	.0162	.0246	.0333
8	.0425	.0524	.0630	.0743	.0863
8	.0990	.1124	.1265	.1420	.1595
8	.1800	.2050	.2550	.3450	.4370
8	.5300	.6030	.6330	.6600	.6840
8	.7050	.7240	.7420	.7590	.7750
8	.7900	.8043	.8180	.8312	.8439
8	.8561	.8678	.8790	.8898	.9002
8	.9103	.9201	.9297	.9391	.9483
8	.9573	.9661	.9747	.9832	.9916
8	1.0000	1.0000	1.0000	1.0000	1.0000
9 ENDTBL					

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Data Code	Operation Name	No.	1 – 12	13 – 24 (Ia XSEC, Ia SIR, HYDRO. IN, HYDRO. OUT)	25 – 36	37 – 48	49 – 60	61 – 72 (OUTPUT OPTIONS)	73 – 80 (Record Identification)
					Data fields Decimals Required				
6	RUNOFF	1			AREA sq mi	RUNOFF CURVE NO.	Tc hours		Example only Do Not Enter
6	RESVOR	2			START ELEV. ft.				
6	REACH	3			LENGTH ft.		(VALLEY LENGTH ft)		
6	REACH	3			LENGTH ft.	(END AREA COEF. X)	(EXPONENT m)		
6	ADDHYD	4							
6	SAVMOV	5							
6	DIVERT	6			DISCH. cfs OUT1	D.A. RATIO OUT1	XSEC ID OUT2		
6	DIVERT	6				D.A. RATIO OUT1	XSEC ID OUT2		
	ENDATA		Use only at the end of all Standard Control Records						

PROCEDURE NO. #1 #2 #1 #2

1 – 12	13 – 24	25 – 36	37 – 48	49 – 60	61 – 72	73 – 80

STANDARD CONTROL

Data Code/Operation

6 RUNOFF 1	Develops a runoff hydrograph using the data from columns 25-36, 37-48, and 49-60.
6 RESVOR 2	Performs storage indication routing of a hydrograph. Columns 25-36 contain the starting elevation for routing to begin. If these are left blank, the routin will begin at the first entry in the STRUCT table.
6 REACH 3	Performs Modified ATT-KIN reach routing using the reac length in columns 25-36, a cross section rating table, or optionally the end area coefficient, x (columns 37 -48), and the exponent, m (columns 49-60) in the equation $Q = xA^m$. If values appear in columns 37-48 and 49-60, they override use of a XSECTN table. The floodplain length is a optional entry in columns 49-60. If it is entered there must be a channel reach length in columns 25-36 of this record and a low groun entry in columns 61-72 of the 2 XSECTN record.
6 ADDHYD 4	Adds two hydrographs together.
6 SAVMOV 5	Moves a hydrograph from one storage location to anothe storage location.
6 DIVERT 6	Divides an inflow hydrograph into two separate outflow hydrographs. Two procedures are available with this operaton.
Procedure #1	Output #1 will contain that portion of the inflow hydrograph below and equal to the discharge given in the columns 25-36. Output #2 will contain that portic of the inflow hydrograph above the given discharge in columns 25-36.
Col. 25-36	Maximum discharge in cfs for Output #1 hydrograph.
Col. 37-48	Drainage area split in decimal fraction to retain wit Output #1 hydrograph. If left blank, all drainage are goes with Output #2 hydrograph.
Col. 49-60	XSECTN ID associated with Output #2 hydrograph.

Procedure #2	The inflow hydrograph may be divided proportionally using two elevation vs. discharge rating tables. These tables must be provided by the user as cross sections
Col. 13-15	ID of rating table associated with Output #1 hydrograph.
Col. 25-36	Blank or Zero.
Col. 37-48	Same as Procedure #1.
Col. 49-60	Same as Procedure #1 and a rating table must be included for the XSECTN ID.
Output Options	If a particular option is wanted, put a "1" in the appropriate column.
Col. 61	P/V - Displays peak discharge, peak time, peak elev. (if rating table is available) and runoff volume minus constant baseflow under hydrograph in inches, cfs-hrs, and ac-ft, and current constant baseflow in cfs. Will supply up to ten largest peaks of multi-peaked hydrographs.
Col. 63	HYD - Displays hydrograph discharge in tabular form.
Col. 65	ELEV - Displays hydrograph elevations in tabular form.
Col. 67	DUR - Displays discharge versus duration of time that a discharge is equaled or exceeded.
Col. 69	FILE - Generates a file of discharge hydrograph coordinates in machine readable READHD format.
Col. 71	SUM - Requests results of the operation be inserted in Summary Tables 1 and 3 at the end of the job.
Col. 73-80	RECORD identification. Any characters including blank

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1 – 12				13 – 24				25 – 36	37 – 48	49 – 60	61 – 72	73 – 80
Data Code	Operation Name	No.		Σ D XREC	Σ D SRR	HYDRO. IN	HD OUT	Data Fields Decimals Required			OUTPUT OPTIONS: Rec Id, Rec Id, Rec Id, Rec Id, Rec Id, Rec Id	Record Identification

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CHECKED BY _____ DATE _____ OF ___

LOCATION _____
JOB _____

PROCEDURE NO. #1 #2

1 – 12			13 – 24		25 – 36	37 – 48	49 – 60	61 – 72	73 – 80
Date Code	Operation Name	No.	FROM X or KWDC	THRU X or STR	Stand. Control (1.)	Tabular Date (1.)	RAINFL Tables (1.-10.)		Record Identification
7	LIST		Procedure # 1		NEW BASEFLOW, CFS				Example only Do Not Enter
7	BASFLO	5	Procedure # 2		Volume, inches	Peak Time, hrs	Base time, hrs		
7	BASFLO	5			Main Time Increment, hrs	Rainfall Depth, in. or 1.0	Rainfall Duration, hrs or 1.0		
7	INCREM	6			Starting Time, hrs				
7	COMPUT	7	Required after a single or series of COMPUT records.						
	ENDCMP	1	Terminates job if no intermediate peak records.						
	ENDJOB	2							

1 – 12	13 – 24	25 – 36	37 – 48	49 – 60	61 – 72	73 – 80

EXECUTIVE CONTROL

Data Code/Operation

7 LIST	The entire set of tabular data and Standard Control (S.C.) instructions in effect or specified portions ar printed.
7 BASFLO 5	Baseflow is specified prior to the COMPUT record(s) where it is to be added.
Col. 25-36 or	Insert the constant baseflow cfs to be part of the inflow hydrograph in the next and subsequent reach routings until changed by another 7 BASFLO 5 record.
Col. 25-36	The volume in inches in triangular hydrograph form tha is added to each runoff hydrograph computed. Columns 37-48 and columns 49-60 must also be used.
Col. 37-48	Time in hours that the triangular hydrograph peaks. (Note: If field is left blank or zero, constant baseflow procedure is used).
Col. 49-60	Time in hours that the triangular hydrograph base extends. (Note: Cannot exceed 398 main time increments). Leave blank for constant baseflow.
7 INCREM 6	Sets the time interval between elements of the hydrograph to be used for subsequent computations. This record must be read before any COMPUT record.
Col. 25-36	Main time increment in hours; a decimal is required.
7 COMPUT 7	Specifies the beginning and ending S.C. instructions t be executed. One pass through the watershed (S.C. list) requires one or more COMPUT Records.
Col. 13-17	Specifies the beginning or FROM location: This must correspond to a cross-section or structure number that appears in the XSECTN/STRUC column of a S.C. instruction.
Col. 19-23	Specifies the ending or THRU location. The sequence c instruction given by the S.C. is continued until the cross-section or structure specified under thru has been reached and completed.
Col. 25-36	The starting time in hours of each hydrograph develope under this COMPUT. A decimal is required.

Col. 37-48	The rain depth to be used. If a unit depth dimensionless) RAINFL table is used, enter the total rain depth in inches. If an actual storm is used, enter a 1.0. A decimal is required.
Col. 49-60	Rainfall duration or if actual storm duration is given in RAINFL table enter 1.0. A decimal is required.
Col. 61	The RAINFL table to be used (1-9).
Col. 63	The Antecedent Runoff Condition to be used (1, 2, or 3).
Col. 66-67	The alternate number (1-99) associated with this COMPUT. Usually reflects changes in the watershed.
Col. 70-71	The storm number (1-99) to be associated with this COMPUT, with no more than 10 storms per run.

Note: The last two data items are used to order the summary table output data and for generating the peak discharge file in machine readable form for use in the ECON2 or URB1 computer programs.

ENDCMP 1	Resets the program to the beginning of the S.C. list. This record must be used anytime it is desired to start another pass through the watershed.
ENDCMP 2	Terminates routing computations. Causes Summary Tab. #2 to be printed and Summary Tables #1 and #3 if selected. Job is terminated unless PEAKS information follows.

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JOB _____ CHECKED BY _____ DATE _____ OF ___

1 – 12			13 – 24				25 – 36	37 – 48	49 – 60	61 – 72						73 – 80
Data Code	Operation Name	No.	FROM Σ Q XSEC	FROM Σ Q STR	THRU Σ Q XSEC	THRU Σ Q STR	Data Fields Decimals Required			Time Step	Unit Area	Area	Area Type	Area Name	Record Identification

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TR-20 – MODIFY STANDARD CONTROL

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TABLE _____ PREPARED BY _____ DATE _____ PAGE ___ OF ___

JOB _____ CHECKED BY _____ DATE _____

1 – 12			13 – 24			25 – 36	37 – 48	49 – 60	61 – 72	73 – 80
Date Code	Operation Name	No.	X B SEC	X D STM	HYDRO. IN	HYDRO. OUT	Data Fields – Decimals Required		Output Options	Record Identification
INSERT		2			NOTE: The following records are inserted following the XSECTN/STRUCTURE specified					
ALTER		3	NOTE: Data given in columns 1 to 17 must be identical with standard control record to be altered.							
DELETE		4	NOTE: Data given in columns 1 to 17 must be identical with standard control record to be deleted.							

IMPORTANT: Modifications must be given in the order that they appear on the standard control list

MODIFY STANDARD CONTROL

Modify Standard Control is used to insert new instructions, or alter o delete existing instructions in the Standard Control (S.C.) list. The modifications of S.C. are done in sequential order starting at the top of the list with the first S.C. instruction to be modified. After a S.C. instruction is passed, it may not be modified until the program h passed a 7 LIST, or 7 COMPUT Executive Control record.

Data Code/Operation

7 INSERT 2	Will insert the S.C. instructions that follow into the S.C. list.
Col. 13-15 or Col. 16-17	The XSECTN/STRUCT identification where the new S.C. instructions are to be inserted. The location in the S.C. list is immediately following the end of the firs series or string of S.C. instructions for SECTN/STRUC named. The new S.C. records are filled out in the sar format as described on the S.C. worksheet.
7 ALTER 3	Will substitute the following S.C. records for the S.(instructions that match column 1-17 of each new S.C. record. The S.C. records are filled out in the same format as described on the S.C. worksheet.
7 DELETE 4	Will delete the S.C. instructions that match column 1-17 of the records that follow.

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TR-20 READ DISCHARGE HYDROGRAPH

WORKSHEET
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HYDROGRAPH LOCATION _____ PREPARED BY _____ DATE _____ PAGE ___
JOB _____ CHECKED BY _____ DATE _____ OF ___

1 – 12	13 – 24	25 – 36	37 – 48	49 – 60	61 – 72	73 – 80
Data Code / Table Name / Opp. Code	Storage Location No. 1 to 7					Record Identification
7 READHD 8						
	Starting Time hours	Time Increment hours	Drainage Area square mile	Baseflow Included cfs		Record Identification
7 READHD 9						
Enter successive discharges left to right with first entry for starting time. Fill last row of data with last entry of table. Include Baseflow if applicable.						
1. Maximum of 80 records. 2. Data Fields in Col. 13 to 72 require decimal points.						
9 ENDTBL	This record must be the last record of this table.					

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TR-20 – INTERMEDIATE PEAKS

WORKSHEET
SCS-ENG-277
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TABLE _____ PREPARED BY _____ DATE _____ PAGE ___
JOB _____ CHECKED BY _____ DATE _____ OF ___

1 – 12			13 – 24				25 – 36		37 – 48		49 – 60		61 – 72		73 – 80
	Table Name														Record Identification
	IPEAKS		This record must precede all PEAKS records.												
	Operation Name	No.	FROM ID XSEC	FROM ID STR	THRU ID XSEC	THRU ID STR	Intermediate points between FROM and THRU Xsectn/structures: Point ID	D.A. sq. mi.	Point ID	D.A. sq. mi.	Point ID	D.A. sq. mi.	Point ID	D.A. sq. mi.	Record Identification
	PEAKS														
	PEAKS														
	PEAKS														
	PEAKS														
	PEAKS														
	PEAKS														
	PEAKS														
	PEAKS														
	PEAKS														
	PEAKS														
	PEAKS														
	PEAKS														
	PEAKS														
	ENDJOB	2	This record terminates the TR-20 job.												

APPENDIX H

Associated Utility Programs

INTRODUCTION

Most problems associated with successful application of the TR-20 Project Formulation Hydrology computer program are due to input errors. These errors tend to truncate runs or lengthen execution time, cause inaccurate output, and increase the total cost of operation. Two utility programs, an input program and a data check program, are available to assist the user in data entry and checking. Use of these programs will hopefully reduce the errors and lower the average user frustration level.

DATA INPUT PROGRAM

The TR-20 input program (TR20INPT) is an interactive input program in BASIC. The program will assist the user to develop a data file with a minimum of errors.

The program writes data to a drive and file specified by the user. If the file already exists, data is appended to it, if not, a new file is created. The file may also be directed as it is created to a printer.

Several screens of instructions provide information related to the setup of the program. They are followed by a menu screen, from which the user chooses the operation code corresponding to the desired entry. Operation codes are related to the entry type; for instance "J" calls up the JOB record format, "2" calls up the 2 XSECTN table format, "61" calls up the 6 RUNOFF 1 record format, and so on.

The operation formats contain a series of queries to the user concerning the input for each particular record. The program arranges all the spacing required in the record and inserts decimals after whole numbers where they are needed, so that the user is only concerned with the content of the records. The whole record is displayed after it is developed, giving the user a chance to accept it or to revise it before continuing. Tabular data is displayed on the screen as it is developed and limited editing is permitted before the entire table is accepted. Operation formats are available in the menu for all the records and tables needed for a TR-20 run. The menu also allows direct access to help screens, a view function to display the input file on the screen at any time, and a quit function to exit the program.

The program does not sequence the operations in the order required for TR-20. It is the responsibility of the user to select the correct operation order from the menu. See Table 3-3 in the User's Manual for the preferred input sequence. After a record or table is saved to the input file, they can not be altered or deleted from within the input program. Another corrected record or table, however, can be added to the file. Using any local editor, the incorrect record(s) can be deleted and the new record(s) moved into the correct sequence.

There is very limited data checking in the input program, but output is in the format ready to run through the data check program. After quitting the program, the data file can be edited with any local editor either before or after running it through the data check program. It is always recommended to run the data check program after using an editor to insert or delete characters, since data can inadvertently be shifted out of a required data field.

DATA CHECK PROGRAM

The data check computer program (TR20CK) was designed to aid the user of the TR-20 program by identifying the most common data input errors. Appropriate error messages will be printed when data problems are found. Users of the TR-20 program are encouraged to run the TR20CK program prior to initial use of any set of input data. Corrections made due to use of this program will lead to cost and time savings.

The data check program applies to all versions of TR-20 beginning with the version dated May 2, 1982. It has been updated to include the new or revised features in the current PC version. The program in FORTRAN was converted for use on a PC from a mainframe program.

PROCEDURE

Input data to the data check program is identical to the data that would be entered into the TR-20 program.

The output from the program is 80 character records. On the screen these records will wrap around and be confusing. All program error messages are shown indented below the echo print of the input record being analyzed. Multiple errors detected in a record may cause that record to be repeated in the listing with the error messages. Most types of input records are analyzed for errors independently of the other records. Only a limited amount of information is stored for checking data sequence. Information messages follow the block of records to which they pertain. All the messages are readily identifiable.

Two types of markers are used to assist the user in identifying errors. These markers are located on a print line below the input data record. They are as follows:

1. The field markers consists of a series of underscores extending the full width of data field. This is helpful in detecting errors in data that begins or ends in the wrong column.

2. A column pointer consisting of one or more carats (^) is used to point to a column-preceding line where the program detected an error. For example, if two decimals are found in a field, it will point to the second decimal, even though the first may be the one in error.

TYPES OF MESSAGES

There are two types of error messages printed out to aid the user in identifying input errors. They are:

1) Errors identified by ***, which notify the user of any mistakes within the numeric or alphanumeric data fields of an input record, or problems with the positioning of a record within the data sequence. They are usually fatal to the program if not corrected.

2) Possible errors identified by ???, which notify the user that the specific input may contain a mistake, be missing, or be positioned in error. But the data could be correct depending on usage (as in the example of a Null structure).

Additionally, the TR-20 data check program prints out specific informational messages identified by >>>. These messages notify the user of pertinent information, such as the number of Standard Control records entered in relation to the input.

Most messages printed by the program are self-explanatory, or specifically reference the position in the input record where the error exists. Yet, there are a few messages that need further explanation and are given below.

***XSECTION XXX NOT PREVIOUSLY LOADED - Requested cross section data table is not available. Cross section data is required for: 1) a reach record with no routing coefficients given or 2) a DIVERT record (procedure 2) with no discharge given. This message also appears for an INSERT record or a Standard Control record following a DELETE record which references a section number not previously used.

???STRUCTURE XX NOT PREVIOUSLY LOADED - Structure information is required for a reservoir routing. A Null structure does not require a structure rating table. An INSERT record or a Standard Control following a DELETE record which references a structure number not previously used is an error.

???RAIN TABLE XX NOT LOADED - Requested Rain Table is not included in TR-20 data file. Rain Tables 1 to 6 are default tables included in the TR-20 program. Should the user input additional data with these rain table numbers, they will override the tables in the program. Also, Tables 7 to 9, if used, must be loaded. If using a default rain table, this message can be ignored.

???XSECTION XXX ALREADY LOADED,
???STRUCTURE XX ALREADY LOADED, or
???RAIN TABLE XX ALREADY LOADED - Table data has previously been loaded. The addition of this data will replace the existing information. If this is the intent, the message can be ignored.

***ERROR IN FIELD MARKED ABOVE: IT SHOULD BE "XXX XXX" ??? - Operation name may actually be misspelled or there is an error in the data code or operation number. The operation name that corresponds to the data code and operation number is shown. The "XXX.XXX" represents the best guess that the program could make as to the correct value in the field.

***ILLEGAL VALUE IN COL. XX - XX - This appears when there is a negat: value in a READHD table. It will also appear if there is a value of zero in the first three data fields of a 7 READHD 9 record.

???BANKFULL ELEVATION LESS THAN SECOND POINT - The bankfull elevation is below the first non-zero discharge point of XSECTN rating table. The channel segment should be adequately defined to provide accurate rating exponent (m) estimates.

???DIVERTED FLOW XSECTION NO. IS ZERO - If diverted flow will be used later, it is generally referenced by a cross section number (1 to 200). If diverted flow will not be used, a blank or zero section number is acceptable.

>>>TOTAL DRAINAGE AREA IS XXX.XX SQ MI - This appears when an ENDATA record is encountered. It is the sum of the drainage areas found on the runoff records between the JOB and ENDATA records.

```
>>>No. STORMS                    = XX
>>>No. ALTERNATES                = XX
>>>No. STANDARD CONTROLS         = XXX
```

These messages are printed when the ENDJOB record is encountered. The number of storms and the number of alternates correspond to the different numbers referenced on Executive Control records. The number of Standard Controls is the sum of all Standard Controls

including those following INSERT and ALTER records but not including those following a DELETE.

The data check program is strongly recommended for use prior to utilizing the TR-20 program. Additional data checks that require more complex logic are included in the TR-20 program, however, many of the simpler data errors, such as data being out of its field or the wrong type, are identified by the data check program. By checking all initial input data, the user will increase the probability of achieving a successful TR-20 run.