TR-20, PROJECT FORMULATION
HYDROLOGY (1982 VERSION)
TECHNICAL RELEASE NUMBER 20

1007.120

PB83-222768

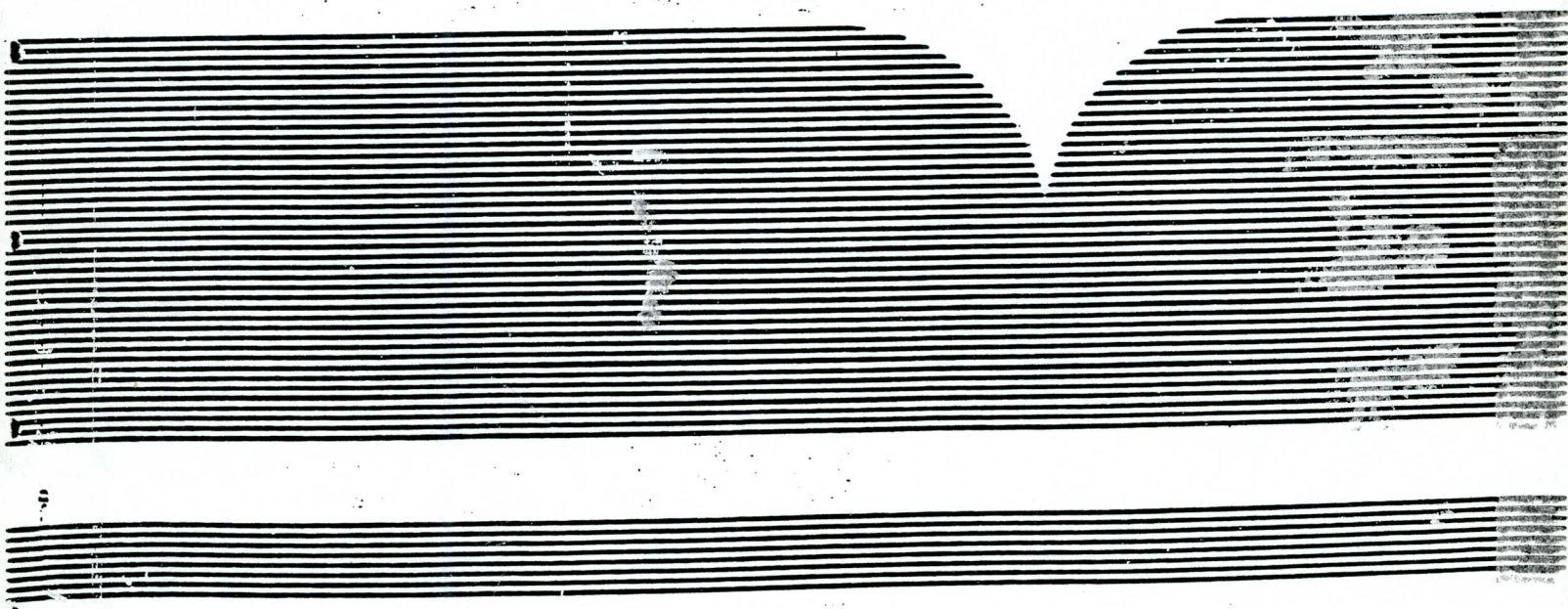
[redacted]

TR-20, PROJECT FORMULATION - HYDROLOGY (1982 VERSION) TECHNICAL RELEASE NUMBER 20

Soil Conservation Service
Lanham, MD

Property of
Flood Control District of MC Library
Please Return to
2801 W. Durango
Phoenix, AZ 85009

May 82



U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
NTIS

PB83-223768

Property of
Flood Control District of MC Library
Please Return to
2801 W. Durango
Phoenix, AZ 85009

DRAFT

TR-20
COMPUTER PROGRAM
FOR
PROJECT FORMULATION
HYDROLOGY

Revised by
Northeast NTC and Hydrology Unit
Soil Conservation Service
May 1982

Draft of Second Edition, May 1983

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. USDA/DF-83/010a SCS/ENG/TR-20	2.	3. Recipient's Accession No. PB83-223768

4. Title and Subtitle
TR-20, Project Formulation - Hydrology (1982 Vers.), Technical Release Number 20

5. Report Date May 1982

6.

7. Author(s)
Hydrology Unit, Engineering Division

8. Performing Organization Rept. No. TR-20

9. Performing Organization Name and Address
Soil Conservation Service
Hydrology Unit
10000 Aerospace Road
Lanham, Maryland 20706

10. Project/Task/Work Unit No. --

11. Contract(C) or Grant(G) No.
(C)
(G) --

12. Sponsoring Organization Name and Address
USDA, Soil Conservation Service
P.O. Box 2890
Washington, DC 20013

13. Type of Report & Period Covered Draft User's Manual

14.

15. Supplementary Notes
This document is the user's manual for the revised TR-20 computer program that uses the Modified Att-Kin coefficient method for stream flood routing. It supercedes the previous PB-233 778. For magnetic tape, see PB83-223107

16. Abstract (Limit: 200 words)
The TR-20 program provides for hydrologic analyses of a watershed under present conditions and various combinations of land cover/use and structural or channel modifications using single event storm rainfall-frequency data.

Output consists of peaks and/or flood hydrographs, their time of occurrence and water surface elevations at any desired cross section or structure.

Subarea surface runoff hydrographs are developed from storm rainfall using a dimensionless unit hydrograph, drainage areas, times of concentration, and SCS runoff curve numbers. Instructions to develop, route, add, store, divert, or divide hydrographs are established to convey floodwater from the headwaters to the watershed outlet. Reach routing is by a coefficient (Modified Att-Kin) method with a typical cross section stage - discharge-area curve representing a reach. Reservoir routing is by the storage indication method. Uniform rain depth and distribution are assumed over a subarea, groups of sequential subareas or the whole watershed. Snowmelt runoff can be accounted for by baseflow for interflow hydrographs.

In one continuous operation, the program can route through 99 reservoirs and 200 stream reaches using 9 rainfall distributions.

Appendices include information on the Modified Att-Kin flood routing method and users instruction on the TR-20 data check program (SCSCHK20).

17. Document Analysis a. Descriptors
Runoff
Hydrology
Flood Routing
Watersheds
Flood Control

b. Identifiers/Open-Ended Terms
TR-20 computer program
Rainfall/runoff event model
Project Formulation - Hydrology model
Modified Att-Kin flood routing method

c. COSATI Field/Group

18. Availability Statement:
Draft user's manual available only through NTIS

19. Security Class (This Report) unclassified

20. Security Class (This Page) unclassified

21.

22.

NOTICE

THIS DOCUMENT HAS BEEN REPRODUCED FROM THE BEST COPY FURNISHED US BY THE SPONSORING AGENCY. ALTHOUGH IT IS RECOGNIZED THAT CERTAIN PORTIONS ARE ILLEGIBLE, IT IS BEING RELEASED IN THE INTEREST OF MAKING AVAILABLE AS MUCH INFORMATION AS POSSIBLE.

TECHNICAL RELEASE 20

COMPUTER PROGRAM FOR PROJECT FORMULATION

HYDROLOGY

TABLE OF CONTENTS

	Page
CHAPTER 1 - INTRODUCTION	1-1
1.1 Program Purpose	1-1
1.2 Computer Requirements	1-2
1.3 Program Availability	1-2
CHAPTER 2 - PROGRAM DESCRIPTION	2-1
2.1 Methodology for Hydrology and Hydraulics	2-1
2.2 Program Organization	2-4
2.3 Capabilities and Limitations	2-4
2.4 Input Data Structure	2-7
CHAPTER 3 - INPUT PREPARATION	3-1
3.1 Minimum Data Requirements	3-1
3.2 Input Requirements & Forms	3-1
3.3 Job Control	3-5
3.3.1 Operating System Control Language	3-5
3.3.2 JOB and TITLE Statements	3-5
3.3.2.1 HOLDOUT Option	3-5
3.3.2.2 ECON Option	3-10
3.3.2.3 PRINT Option	3-10
3.3.2.4 PASS Option	3-11
3.3.2.5 SUMMARY Option	3-11
3.3.2.6 PLOT Option	3-11
3.4 Watershed Subdivisions	3-12
3.5 Schematic Drawing	3-13
3.6 Standard Control Statements	3-15
3.6.1 RUNOFF	3-18
3.6.2 RESVOR	3-18
3.6.3 REACH	3-21
3.6.4 ADDHYD	3-23

3.6.5	SAVMOV	3-25
3.6.6	DIVERT	3-25
3.6.7	ENDATA	3-30
3.6.8	Output Options	3-30
3.7	Tabular Data	3-33
3.7.1	Dimensionless Hydrograph Table - 4 DIMHYD	3-34
3.7.2	Cumulative Rainfall Table - 5 RAINFL	3-34
3.7.3	Stream Cross Section Data Table - 2 XSECTN	3-38
3.7.4	Structure Data Table - 3 STRUCT	3-39
	Null Structure	3-40
3.7.5	Read-Discharge-Hydrograph Data Table - 7 READHD	3-41
3.8	Executive Control Statements	3-42
3.8.1	LIST	3-43
3.8.2	BASFLO	3-43
3.8.3	INCREM	3-47
3.8.4	COMPUT	3-50
3.8.5	ENDCMP	3-55
3.8.6	ENDJOB	3-55
3.9	Modify Standard Control Statements	3-55
3.9.1	INSERT	3-56
3.9.2	ALTER	3-58
3.9.3	DELETE	3-58
3.10	Intermediate Peaks	3-58
3.11	Input Data Sequence	3-62

CHAPTER 4 - OUTPUT DESCRIPTION		4-1
4.1	Output Categories	4-1
4.1.1	Input Images (80-80 list)	4-1
4.1.2	Message Page	4-1
4.1.3	Page Headings	4-2
4.1.4	Operation Results	4-2
4.1.5	Cross-Section Data Plots	4-3
4.1.6	Summary Tables	4-4
4.1.7	Output Files Generated	4-6
4.2	Interpretation of output Data	4-7

Page

4.3 Calibration of the Model 4-8
4.4 Error Detection 4-8
4.4.1 TR-20 Output Error Messages 4-8
4.4.2 FORTRAN Diagnostic Messages 4-13
4.4.3 Computer System Messages 4-15
4.4.5 Checking Input and Output 4-15
4.5 Sample Jobs 4-17

REFERENCES 5-1

GLOSSARY 6-1
CONVERSIONS 7-1
APPENDICES
Appendix A (Sample Job #1) A-1
Schematic Drawing A-2
Input Data Sheets A-3
Printout A-7
Appendix B (Sample Job #2) B-1
Schematic Drawing B-2
Input Data Sheets B-3
Printout B-7
Appendix C (Sample Job #3) C-1
Schematic Drawing C-2
Input Data Sheets C-3
Printout C-10
Appendix D (Sample Job #4) D-1
Schematic Drawing D-2
Input Data Sheets D-3
Printout D-8
Appendix E (Sample Job #5) E-1
Schematic Drawings E-2
Input Data Sheets E-5
Printout E-27
Appendix F (Blank Input Forms and Preloaded Tabular Data) F-1
SCS-ENG-264 JOB and TITLE F-2
SCS-ENG-265 DIMHYD F-3

		Page
Standard SCS	DIMHYD Table, peak factor 484	F-4
SCS-ENG-269	STRUCT	F-5
SCS-ENG-270	XSECTN	F-6
SCS-ENG-271	RAINFL	F-7
Standard SCS	RAINFL Tables 1 through 6	F-8
SCS-ENG-273	Standard Control	F-14
SCS-ENG-273A	Standard Control Continuation Sheet	F-15
SCS-ENG-274	Executive Control	F-16
SCS-ENG-275	Modify Standard Control	F-17
SCS-ENG-276	READHD	F-18

APPENDIX G - Modified Att-Kin Method G-1

APPENDIX H - Rating Curve Coefficients x and m and Reach Length Guidelines H-1

APPENDIX I DATA CHECK Computer Program (SCSCHK20) I-1

Number	LIST OF TABLES	Page
3-1.--	Example Input Data for Small Watershed	3-2
3-2.--	List of TR-20 Input Data Forms	3-4
3-3.--	TR-20 Job Control File Descriptions	3-6
3-4.--	Association of Cross Section/Structure Numbers with TR-20 Standard Control Statements	3-17
4-1 --	Alternates Compared	4-7a
4-2.--	Features Demonstrated in Sample Jobs	4-654

Number	LIST OF FIGURES	Page
2-1.--	Simplified Processing Sequence in TR-20	2-5
3-1.--	JOB Statement	3-7
3-2.--	TITLE Statement	3-8
3-3.--	RUNOFF Statement	3-19
3-4.--	RESVOR Statement	3-20
3-5.--	REACH Statement	3-22
3-6.--	ADDHYD Statement	3-24
3-7.--	SAVMOV Statement	3-26
3-8.--	DIVERT Statement	3-27
3-9.--	ENDATA Statement	3-31
3-10.--	LIST Statement	3-44
3-11.--	BASFLO Statement	3-45
3-12.--	INCREM Statement	3-48
3-13.--	Hydrograph Coordinates Determined by Computer for ΔD = 0.5 hours	3-49
3-14.--	COMPUT Statement	3-51
3-15.--	ENDCMP & ENDJOB Statement	3-54
3-16.--	INSERT Statement	3-57
3-17.--	ALTER Statement	3-59
3-18.--	DELETE Statement	3-60
3-19.--	PEAKS Statement	3-61
3-20.--	Arrangement of Data Input Sheets	3-63

TECHNICAL RELEASE 2?
COMPUTER PROGRAM FOR PROJECT FORMULATION
HYDROLOGY

CHAPTER 1. INTRODUCTION

This chapter describes the Computer Program for Project Formulation, Hydrology (TR-20) in terms of the purpose, computer requirements, and availability of the program. The remaining chapters describe in detail: the program organization, capabilities, and limitations; input preparation; and output description. The appendices contain five sample jobs showing different levels of complexity, blank input forms, a description of the reach routing procedure and guidelines for rating curve coefficients and reach lengths.

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 single 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. It develops flood hydrographs from runoff and routes the flow through stream channels and reservoirs. It combines the routed hydrograph with those from tributaries and computes the peak discharges, their times of occurrence and the water surface elevations at any desired cross section or structure. Any one of the above items can be printed out as well as discharge hydrograph elevations, 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 work. Such analysis can be performed on as many as 200 reaches and 99 structures in any one continuous run. The program uses the 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 Appendixes G & H until Chapter 17, NEH-4 can be revised.

The program was originally developed by the Hydrology Branch of the Soil Conservation Service (SCS) in cooperation with the Hydrology Laboratory,

Agricultural Research through a contract with C-E-I-R, Inc. Modifications and additions have since been made both through the Economics, Statistics, and Cooperations Service (ESCS) and by the SCS.

1.2 COMPUTER REQUIREMENTS

TR-20 is written in FORTRAN IV computer language for an IBM S360 or S370 computer. It has been compiled using the IBM G1 compiler. The subroutine DATE is written in IBM assembler language and is available in a special library for link editing. TR-20 has been adapted to other computer systems.

The program requires about 320 kilobytes of core storage and 3 temporary data files. TR-20 programming documentation is being developed by the SCS Hydrology Unit of the Engineering Technology Development Staff to aid in implementing, understanding, debugging, and modifying the program.

1.3 PROGRAM AVAILABILITY

The TR-20 program may be obtained by others outside the SCS from the National Technical Information Service and is supplied on magnetic tape. Specific information about the data files and sample operating system control language statements used to compile, load, and run the program are on comment statements at the beginning of the magnetic tape listing.

The program is available from:

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22161

The program is available to Federal Government agencies from:

Management Services Staff
Soil Conservation Service
10000 Aerospace Rd.
Lanham, Md. 20706

The program is usually available to State and local public agencies by contacting the SCS State Conservationist in the particular State that the agency is in.

CHAPTER 2. PROGRAM DESCRIPTION

This chapter provides an understanding of the TR-20 computer program organization and features. Terminology in general usage by engineers is used without definition. Terminology and acronyms used solely for this computer program are defined the first time they are used and in the Glossary.

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. See Chapter 6, NEH-4.

Rainfall Distribution

Either actual or synthetic cumulative rainfall distributions may be used. Rainfall distributions (mass time-depth data) must be representative of the watershed area under study. This could be 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. 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 antecedent moisture condition limits (AMC) I or III according to Table 10.1 NEH-4. If the user needs to adjust the runoff volume within the AMC limits, either the CN's or rainfall will need to be adjusted.

Hydrograph Development

An incremental unit hydrograph is developed for each subwatershed as shown in Chapter 16, NEH-4. The unit hydrograph time increment (ΔD) is calculated as a function of the time of concentration (T_c). Coordinates of the incremental unit hydrograph are determined as shown in Example 1, Chapter 16, NEH-4 using ΔD, T_c and the drainage area. The incremental runoff volume (ΔQ) is determined for each ΔD. The composite flood hydrograph is computed by summing the incremental hydrograph ordinates as shown in the same Example. The time increment for the composite flood hydrograph ~~used~~ is the main time increment (Δt) as specified by the user on the INCREM statement.

A maximum of 300 ordinates (discharge values) can be stored for any composite flood hydrograph. 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 thru 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. Composite flood hydrographs from subwatersheds are developed using ΔD as a time interval, but are converted to the main time increment (Δt) specified by the user before being stored for subsequent use. The main time increment should be about 0.1 to 0.2 T_c of the ~~smallest subwatershed~~ shortest T_c. Hydrograph definition decreases when the time increment is larger than this range of values. Generally, the main time increment need not be smaller than 0.1 hour.

Several factors must be considered by the user when selecting the main time increment. The user must consider the longest 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 0.8 hour would provide the necessary 240 hours (300 x 0.8 =240). However, for a small watershed with a time of concentration of 0.25 hour, a main time increment of ~~at least~~ 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 300 ordinates applies to all hydrographs that are generated by the operations in the program.

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 outflow hydrograph in cfs and/or elevation can be printed at multiples of the main time increment (subject to the 300 point limit). The peak discharges and associated elevations are determined using the peak flow routine described in the previous Hydrograph Development section. The following criteria applies to the main time increment, Δt, for reservoir routing (pg. 17-22, NEH-4):

$$\frac{S_2}{\Delta t} > \frac{O_2}{2}$$

where Δt=the main time increment in hours (see discussion page 3-40)

S_2=storage volume at end of time period

O_2=outflow rate at end of time period

REACH ROUTING

The composite flood hydrograph is routed through a valley reach using a Modified Attenuation-Kinematic (Att-Kin) method as described in Appendix G. The routing time interval is the main time increment. The routing reach length (L) is specified by the user.

The routing coefficient (C) is developed from the valley storage-discharge curve ($Q = kS^m$, where S = valley storage) that represents the reach and

the maximum inflow hydrograph peak coordinate and volume. The user must provide either a cross section rating curve (Q vs. A, where Q = discharge and A = cross sectional area) or the "x" and "m" values which describe a rating curve ($Q = xA^m$, where A = S/L). See Appendix G & H.

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 sheets. 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. Data described on the input data sheets are entered at a computer terminal or punched onto computer cards. 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 is used to describe the physical watershed conditions and the Executive Control data is 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. Compute up to 300 coordinates of a hydrograph at selected points in a watershed and print out the discharge and elevation for each coordinate.

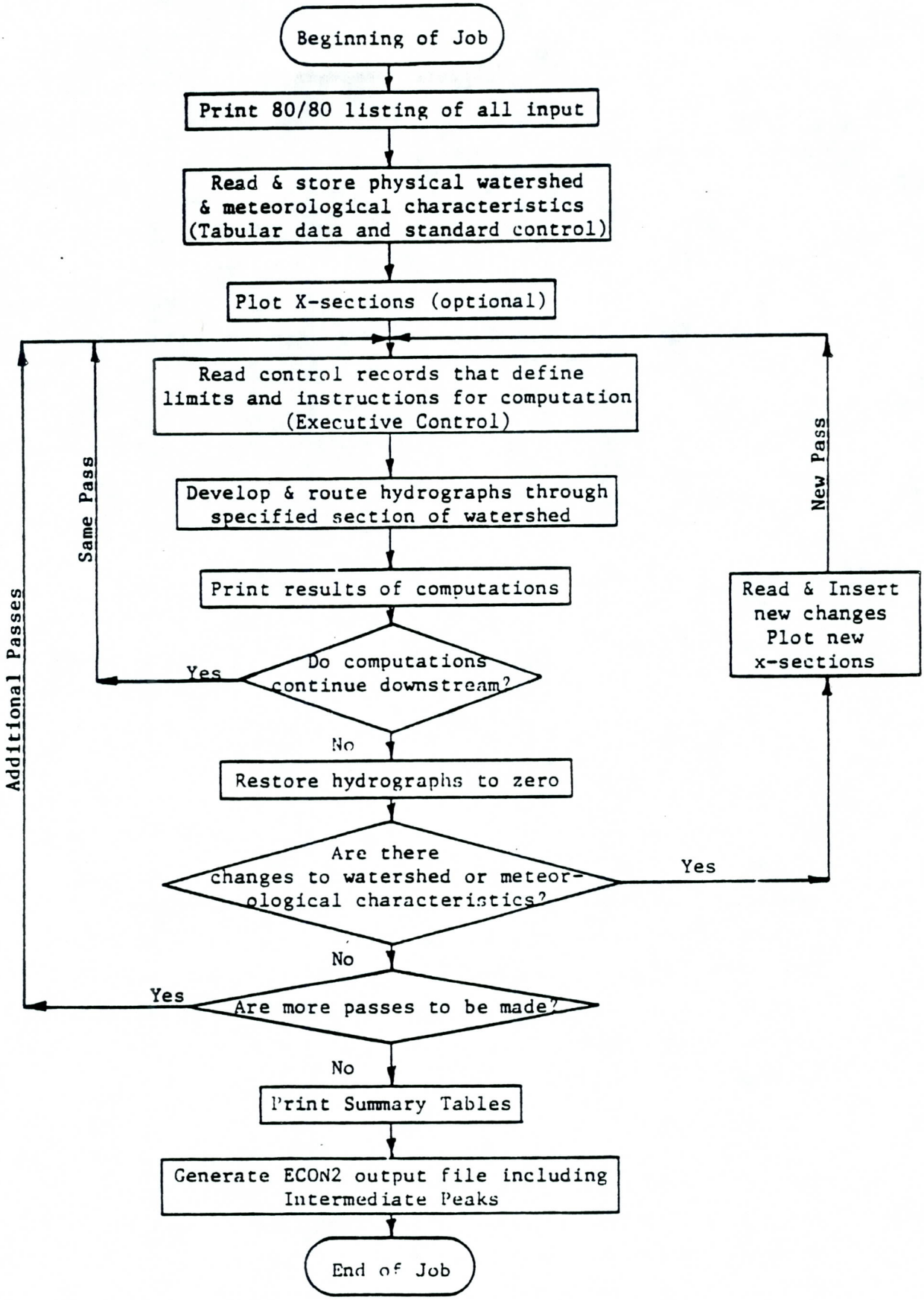


Figure 2-1. Simplified Processing Sequence in TR-20

4. Do as many as 99 alternates in a watershed, excluding variations in rainfall amounts, rainfall starting times and duration and antecedent moisture condition.

5. Develop and route the runoff from as many as 9 different rainfall distributions and 10 different storms for each rainfall distribution. Runoff depths and durations will be developed and routed for a rainfall distribution defined in either dimensionless units or actual time units.

6. Combine hydrographs from an almost unlimited number of tributaries and reaches (the limitation being the total number of standard control operations).

7. Divide hydrographs into two separate hydrographs.

8. Read a discharge hydrograph and route it through a watershed.

9. Store up to seven computed hydrographs at any one time.

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 stored in Summary Table No. 1. The number of peaks is equal to the product of the number of storms times the number of alternates times the sum of the number of cross sections and the number of structures. No. Peaks = (Storms x Alternates x (cross section + Structures)). The only restriction to those items described as being unlimited is the processing cost and the practicability of dealing with too much output data.

The program has been developed with strict adherence to a policy of having it: (1) as flexible as possible in the use of input data; (2) provide for the maximum use of engineering judgment; (3) engineer oriented rather than machine oriented; and (4) written in the FORTRAN IV language to provide for ease in future extensions, alterations and recompilation for other computer hardware. The input data sheets 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 routing for an average watershed can be processed within 3-4 seconds on an IBM S370. However, the processing time and the total cost is increased each time an error in input data has to be searched out, corrected and the data returned to the computer.

2.4 INPUT DATA STRUCTURE

The input data for a TR-20 run consists of the following six general statement types: job control, tabular data, Standard Control statements, Executive Control statements, Modify Standard Control statements and Intermediate Peaks statements.

The job control statements are the JOB statement, the two TITLE statements, the ENDATA statement, the ENDCMP statement and the ENDJOB statement. The JOB and TITLE statements must appear first, second and third, respectively, in a run and the ENDJOB statement must appear last. The ENDATA statement separates the Standard Control and tabular data from the Executive Control statements. The ENDCMP statement is used to signify the end of a pass thru a watershed or a subwatershed thereby allowing conditions to be changed by the user before further processing.

The tabular data, which follows the TITLE statements, can be subdivided into the following: Structure Data, Stream Cross Section Data, Cumulative Rainfall Data, and the Dimensionless Hydrograph Data. 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 as the necessary input for routing through the particular structure.

The Standard Control statements 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 reach

termini. The Standard Control thus establishes a series of consecutive steps through which any number of hydrologic events can be routed for analysis. The Standard Control input form is illustrated in Appendix F.

The Executive Control statements: (1) initiate and control the computational process, (2) describe the meteorological characteristics of each situation to be applied to the watershed, (3) provide baseflow data, and (4) modify the Standard Control for various alternate conditions. This modification 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 standard input form is displayed in Appendix F.

After an initial computational pass through the watershed, the Modify Standard Control statements may be used to modify the Standard Control. This may be done to describe an alternative watershed situation to be analyzed. Executive Control statements must then be provided for subsequent analysis.

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. A simple problem can be done with as few as ten statements, including data. Complex problems can require many pages of input data. An example of the required input data for a small watershed is summarized in Table 3-1.

3.2 INPUT REQUIREMENTS AND FORMS

A blank form for listing each type of input data is included in Appendix F. Each line of data on the form is a record to be entered at a computer terminal or on a single computer card. The 80 columns across the top of the form represent the 80 positions on a record. Each statement is used to perform a specific operation. The ordering of the records determines the sequence in which the operations are to be performed. There can be up to 600 Standard Control statements (records or cards) for each TR-20 job.

The "Data Code" heading (Input forms, Appendix F, Column 2), indicates the type of data on that line. For example, "8" signifies that the line contains tabular data. The data code is a required entry and is preprinted on most of the forms.

A name appears in Columns 4 through 9 of all lines 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.

Table 3-1. -- EXAMPLE INPUT DATA FOR SMALL WATERSHED

Item	Example of Data
To develop a hydrograph:	
Subwatershed (at least one required)	
drainage area	1.2 (sq. mi.)*
runoff curve number	75.
time of concentration	0.33 (hours)*
Rainfall (required)	
antecedent moisture condition	2
rainfall depth	5.2 (inches)*
or rain table	2
Main time increment for hydrographs, etc. (default = 0.5 hour)	0.1 (hours)*
For each valley reach:	
length of reach	5400. (feet)*
cross section data (elevation, discharge, end area)	table
or rating curve coefficients x and m	0.5, 1.3
For each structure:	
elevation, discharge, storage	table

*Items in parentheses are units and are not input data.

Where "table" is given, the input is a complete table consisting of several lines of input data.

Great care should be taken to assure that decimal points are included in all of the labeled data fields. Omission of these decimal points is the most common source of error. Commas must not be used to signify thousands. Preprinted data must be crossed out on all unused lines. A list of TR-20 input data forms is given in Table 3-2.

Schematic drawings, completed input data sheets, computer listing of input data, and computer output for five sample jobs are shown in Appendices A through E.

Preparation of input data can be divided into the following requirements and functions:

1. Prepare a schematic drawing that conveniently identifies the locations, drainage areas, CNs, T_c, and reach lengths for the watershed. It should display all alternate structural systems together with the routing and evaluation reaches through which they are to be analyzed (Appendix A, page A-2).

2. Establish a Standard Control list for the watershed. (Appendix A, page A-5).

3. Compile the tabular data to support the requirements of the Standard Control list. This may consist of Structure Data, Stream Cross Section Data, Cumulative Rainfall Data, and the Dimensionless Hydrograph Table.

4. Establish the Executive Control statements that describe each storm and alternative situation that is to be analyzed through the Standard Control list. (Appendix A, page A-6).

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

Form Title	Form Number (SCS-ENG)	Appendix F Page No.
Job and Title - JOB, TITLE	264	F-2
Dimensionless Hydrograph Table - 4 DIMHYD:	265*	F-3
Structure Data - 3 STRUCT	269	F-5
Stream Cross Section Data - 2 XSECTN	270	F-6
Cumulative Rainfall Tables - 5 RAINFL:	271*	F-7
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	F-14 & F-16
Executive Control - 7 LIST, 7 BASFLO 5, 7 INCREM 6, 7 COMPUT 7, ENDCMP 1, ENDJOB 2	274	F-17
Modify Standard Control - 7 INSERT 6, 7 ALTER 3, 7 DELETE 4	275	F-19
Read Discharge Hydrograph - 7 READHD 8, 7 READHD 9	276	F-21
Intermediate Peaks - PEAKS	277	F-22

* 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 F. Brief instructions for the preparation of input data are printed on each form.

3.3 JOB CONTROL

3.3.1 Operating System Control Language

The operating system control language necessary to initiate a TR-20 job varies with different computers. To assist users that may want to run TR-20 on various computers, file descriptions and specifications are given in Table 3-3.

3.3.2 JOB and TITLE Statements (Figures 3-1 and 3-2)

The input data begin with the JOB and one or two TITLE statements. The JOB statement and one TITLE statement are required for each job. The letters "JOB" in columns 1-3, is the only required entry in the JOB statement (Figure 3-1). There are seven additional fields that are optional in the JOB statement. These fields are for processing options. One or Two TITLE statements (Figure 3-2) follow the JOB statement providing a one or two line title that is printed at the top of each page of output. The word "TITLE" is the only required entry in these statements. If the user desires to number successive runs to facilitate keeping track of various runs or to maintain a file number system, a file number may be entered as a three-digit integer in columns 7-9 of the first TITLE statement. The titles are entered in columns 11-80.

The processing options in the JOB statement and the TITLE statements remain in effect through all alternates and storms until reset by another JOB statement at the beginning of another TR-20 job. The JOB statement options are discussed in Section 3.3.3 through 3.3.8.

Not operational

3.3.2.1 HOLDOUT option -- Preliminary investigations in large watersheds may result in the identification of numerous floodwater retarding structure sites in tributary areas. Shortcut procedures are required to estimate the effect of the structures on the flow of the tributaries and main stem and for possible coordination with the evaluation of proposed flood control structures by others. The development and routing of holdout hydrographs can be a useful method to estimate the downstream effects.

Table 3-3. -- TR-20 JOB CONTROL FILE DESCRIPTIONS

		File Specifications[1/]					
File Name	Req'd	RECFM	LRECL	BLOCKSIZE[2/]	SPACE[3/]	Disposition	Description
FT01F001	Yes	VBS	92	924	200	New, Delete	Temp. - Data for Sum. Table 2
FT02F001	Yes	FB	80	800	60	New, Delete	Temp. - Stores Standard Control
FT04F001	Yes	VBS	60	604	200	New, Delete	Temp. - Data for Sum Tables 1 & 3
FT05F001	Yes	FB	80	3600[4/] or 4560	---	User directed	Read Input Unit file
FT06F001	Yes	FBA	133	Track[5/]	50	User directed	Print file - normally directed to printer.
FT07F001	7/	FB	80	3600[6/]	5	User directed	Stores peak discharge input data for ECON2 or URB1 and hydrograph data.

1/ As used on IBM 360, 370 or 3033

2/ Blocksizes shown are for IBM 3350 disk; sizes may vary according to system

3/ Suggested Minimum

4/ Multiple of LRECL; 3600 is 45 records, 4560 is 57 records per block

5/ Multiple of LRECL - full track size = 19019 on IBM 3350 disks (143 print lines per track)

6/ Multiple of LRECL; 3600 is 45 records; Need 1 record per cross section, for 1-5 storms; 2 records per cross section for 6-10 storms.

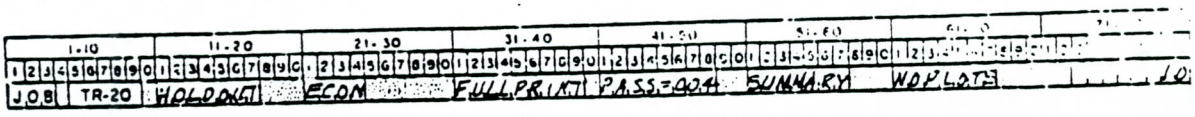
7/ Only if ECON is requested on JOB statement or hydrographs requested under FILE option

Col. No.	Value	Description
1-3	JOB	Required data code signifying a TR-20 job follows
5-9	TR-20	Program identifier
11-17	b or HOLDOUT	Used to request a holdout hydrograph ← Not operational
21-25	b or ECON	Used to request that a peak discharge data file be created for ECON2/URB1
31-39	b or FULLPRINT	Used to request FULLPRINT option
41-48	b or PASS=XXX	Used to assign a pass number other than 1. XXX is three digit integer, right justified.
51-57	b or SUMMARY	Use only if Summary Tables 1 and 3 are to include all Standard Control operations (except SAVMOV).
61-67	NOPLOTS	No cross section discharge-area plots are desired.
	ENDPLOT	Request cross section discharge-area plots only routings through watershed will not be done.
	b	Default - provides plotted cross sections
71-80	b or var.	Optional user information, printed at top of input data listing

Note: var. - variable data entered by the user
b - denotes blank

Reproduced from best available copy.

Example:



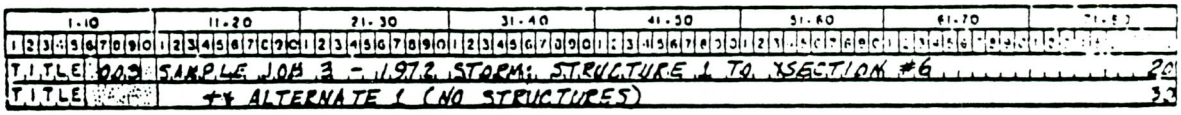
This statement causes a TR-20 job to be initiated. A HOLDOUT hydrograph will be developed. A data set containing peak discharge data will be createdfor later input to ECON2 or URB1 program. The FULLPRINT option for the output will be invoked. The pass number is four indicating that three other passes were made previously. A summary will include all Standard Control operations encountered. No plots of any stream cross section data will be made.

Figure 3-1. -- JOB Statement

Col. No.	Value	Description
1-5	TITLE	Required data code signifying a TITLE statement
7-9	b or var.*	An optional right justified integer for run number or a user file number
11-80	b or var.	Optional title of any characters to be listed at the top of each output page.

Note: var. - variable data to be entered by the user
b - denotes blank
* - Used only on the first TITLE statement

Example:



This TITLE statement has prescribed a file number of 3. Both lines of the job title, columns 11-80, will appear at the top of each page of output. The statement numbers, 20 and 30, will appear as part of the title since they are within the title field.

Figure 3-2. -- TITLE Statement

The holdout hydrograph at a flood control structure site is a discharge hydrograph consisting of the difference between the inflow and outflow hydrographs. The discharge values will be negative when the outflow exceeds the inflow. At present, the holdout hydrographs can be obtained only at the structure sites. This version of TR-20 will not allow the negative portion of the holdout hydrograph to be reach routed downstream. Furthermore, the routing coefficient in the Modified Att-Kin reach routing method varies with the magnitude of the inflow hydrograph peak and volume (See theory in Appendices G and H). Thus, the holdout portion of a storm hydrograph cannot be routed downstream separately with any degree of consistency to compare with the unmodified total storm hydrograph. The amount of attenuation and kinematic translation will vary with magnitude of the hydrograph being routed. Additional study will determine what shortcuts or improvements may be needed to continue use of this routing technique commonly called tabular routing. The holdout procedure must be completed by other means at this time.

Not operational

The holdout procedure is to route the holdout hydrographs from structure sites for a particular storm downstream without adding any uncontrolled area. This entails a separate set of Standard Control statements that develop the inflow hydrographs above the structures, reservoir routes through the structures, then reach routes through consecutive reaches generating output files for evaluation at selected points of interest. The holdout hydrographs from the structures must be combined algebraically with the proper timing at all stream junctions to form a composite holdout hydrograph. The modified storm hydrograph at any point of interest may be obtained by subtracting the composite holdout hydrograph from the total storm hydrograph obtained by the regular TR-20 procedure. The advantage of the procedure is that individual site or group of site holdout hydrographs can be developed and routed downstream and subtracted from the composite holdout hydrograph to analyze their separate effect.

To properly evaluate the downstream effect of the combined structure release rates and their timing, the main time increment should be small enough to adequately define the hydrograph peak yet large enough so that the entire hydrograph will fit within the 300 elements of the hydrograph.

To cause a holdout hydrograph to be developed at a structure site, enter HOLDOUT in columns 11-17 of the JOB statement. The procedure will not work with null structures.

3.3.2.2 ECON option -- The SCS computer programs, ECON2 and URB1, require percent chance versus discharge data. A peak discharge data file can be created by the TR-20 program with the ECON option. The peak discharges can be related to runoff volumes and percent chance. The ECON option is invoked by entering ECON in columns 21-25 of the JOB statement. The user can select cross sections and structures that are to be included in this data by placing a "1" in the SUM column (71) of the output options on the standard control statements. The SUMMARY option (Section 3.3.2.5) can also provide the peak discharge data but at each cross section and structure. Peak discharges for each alternate and each storm will be provided. Summary Tables 3 and 4 contain the peak discharge information prepared for the ECON option.

3.3.2.3 Print option -- The Print option field is columns 31-39 of the JOB statement. 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 this output is the step-by-step list of each Standard Control instruction warning messages and some basic data printed as the operations are executed. This detailed printout including multiple peaks is suppressed if the FULLPRINT option is not specified unless individual options on the Standard Control statements are on. All changes to tabular data and Executive Control statements are printed as before with Noprint. Exceptions to this are that requested hydrographs peaks and volumes (columns 61, 63 and 67 in the Standard Control statements) will continue to be printed. Summary Tables are not affected by the Print option. An example of the default Noprint output is shown in Appendix B. Noprint can reduce

cost of the job by up to 30 percent. An example of FULLPRINT output is shown in Appendix A. The Standard Control output options are discussed in Section 3.6.8.

3.3.2.4 PASS option -- 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 rainfall over the watershed or a certain set of alternatives. The pass number is incremented by one when an ENDCMP Executive Control statement 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 columns 41-48 of the JOB statement. The XXX is a right justified integer. The pass number is printed in the top, right corner of each page of output, except the summary pages.

3.3.2.5 SUMMARY option -- The SUMMARY option field is columns 51-60 of the JOB statement. 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 SAMOV 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 3.6.8. 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 Noprint option and no other Standard Contro options on, this will result in a run with no computational results printed out.

3.3.2.6 PLOT option -- The PLOT option can be used to have plots made of discharge vs. end area for cross sections having tabular data. This option is controlled by control words placed into the field in columns 61-67 of the JOB statement. There are three options when using PLOT. These are:

1. The default option, obtained by leaving the control word field blank, provides a discharge end area plot for each ~~plotted~~ cross section before processing and printing of the results of routings. It is good practice to obtain the plots with the output to facilitate checking of the results.

2. The plots may be obtained without any other processing by entering ENDPLOT in Columns 61-67. The 80/80 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.

3. The plots will not be made if NOPLOTS is entered in columns 61-67 of the JOB statement.

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 delineating subwatersheds are also described in Section 2.1. 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 subwatershed, 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 drainage areas of 0.1, 2.1, and 15.2 square miles is only as accurate as the hydrograph from the 15.2-square-mile area. Therefore, unless since it is much larger than the smallest drainage area

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.

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 major tributary to another. See Appendix H for further explanation.

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 Appendix C, page C-2. 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 page C-2. The reach length, time of concentration (T_c), drainage area and the runoff curve number 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 page C-2, where 001 and 002 represent rating sections while 004 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 on page C-2 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 with a reach length of 5400 feet, an end area coefficient, x, of 0.4; and an exponent, m, of 1.33. 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 mi^2) 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.

Another runoff hydrograph is to be developed upstream of structure 2 (D.A.=0.44 mi^2), routed through structure 2, and then through reach 3. A runoff hydrograph for the intervening area (D.A.=0.31 mi^2) 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. Since a section rating table (elevation-discharge-endarea data) will be provided for reach 5, no values are given for x and m.

A diversion structure is located at the downstream end of reach 5 that will divert part of the hydrograph 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 mi^2).

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.

3.6 STANDARD CONTROL STATEMENTS

The Standard Control (see form, Appendix F, pages F-14 and F-15) is used to set forth the sequence in which flood routings through the reaches and structures of a watershed will be performed. The statements on the completed form cause a runoff hydrograph to be developed, to be routed through a structure or routing reach, and to be added to hydrographs for intervening areas. They may also be used to move a hydrograph to a different location in computer storage, or to divide it into 2 separate hydrographs.

A "6" must be inserted in column 2, the "Data Code", for all Standard Control statements except ENDATA. The "Operation" (Columns 4 through 11) is described by a code name and a number. The code names are RUNOFF, RESVOR, REACH, ADDHYD, SAVMOV, DIVERT, and ENDATA. These names are for the convenience of the user while the corresponding number in column 11 identifies to the computer the operation to be performed. Appendices A through E show completed Standard Control instructions for five related sample jobs. For example, in Sample Job Number 1 (Appendix A, page A-5 and repeated below for the readers' convenience) the first statement, RUNOFF 1 causes an inflow hydrograph to be developed for the area above structure 1. The statement, RESVOR 2, causes the inflow hydrograph to be routed through structure 1. The statement, REACH 3, causes the outflow from structure 1 to be routed through the next stream reach (1). The ENDATA card signifies completion of the Standard Control.

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
6 RUNOFF	1	6 1.2		75.	0.33		.160
6 RESVOR	2 1 6	7 521.5					.170
6 REACH	3 1 7	5 5400.		0.4	1.33		.180
ENDATA							.190

In Sample Job number 2 (page B-5), continuing downstream the RUNOFF 1 statement for cross section 1 causes a hydrograph to be developed for the local inflow to the reach previously routed. The ADDHYD 4 statement causes the reach routed hydrograph to be combined with the local inflow hydrograph. The REACH 3 operation instructs the computer to do the

reach routing through reach 2. Thus, the routing sequence can be directed from one reach to the next. The SAVMOV 5 and DIVERT 6 statements will be explained in sections 3.6.6 and 3.6.7.

The "xsection/structure" heading (Columns 13 thru 18, page A-5) contains blank spaces that are to be filled in with either the cross section number or the structure number. A cross section and structure number must never both be used on the same line. Leading zeros do not need to be inserted in the number 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 statements in TR-20 are given in Table 3-4.

The "Hydrograph Number" heading (Columns 19 through 24) provides spaces in which a hydrograph storage location is designated by numbers 1 through 7. Up to three hydrograph storage location numbers are specified on each Standard Control operation in these columns. One or two of the hydrographs may be required to be available to perform the Standard Control operation and the third hydrograph storage number to save the resultant operation hydrograph. DIVERT is different in that it has one source hydrograph and two resultant hydrographs. All seven storage locations are similar and may be used inter-changeably 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 user might generally use locations 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. Use remaining (1 to 4) as temporary storage 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." A hydrograph remains in a storage location ready for use until new data is placed into that location. It is recommended that all storage locations be checked for compliance with these rules before field input data are submitted for data entry. The same storage location must not be used in the input and the output for a single operation. For example, 6 ADDHYD 4 7 2 7 should be 6 ADDHYD 4 7 2 5.

Table 3-4. Association of cross section/structure numbers with TR-20 Standard Control statements

Statement	Number of	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	Output hydrograph number 1

The three "Data Field" headings (Columns 25 through 36, 37 through 48, and 49 through 60) are filled with data according to the individual headings as explained below. Data entered in each of these field 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 exceeds the number of print positions, asterisks are printed in the edited listing of Standard Control instructions. Commas must not be used within data fields to indicate thousands.

Different output options may be specified in columns 61-72. These options are discussed in Section 3.6.9.[8]

3.6.1 RUNOFF (Fig. 3-3)

The RUNOFF statement causes a runoff hydrograph to be developed for a subwatershed. The input data is drainage area, CN and time of concentration. Determination of the CN is described in Chapters 7, 8, and 9, NEH-4. Techniques in NEH-4, Chapter 15 may be used for estimation of time of concentration.

3.6.2 RESVOR (Fig. 3-4)

The RESVOR statement causes an inflow hydrograph to be routed through a structure such as a reservoir, starting with the outflow discharge rate at the elevation corresponding to the beginning of the storm. The "Surf. Elev. at T = 0, Ft." is the water-surface elevation at the structure at the beginning of the storm (See page A-5, record 170). The routing continues until the outflow rate returns to zero or until the 300 ordinate limit for a hydrograph is reached. If "Surf. Elev. at T = 0, Ft." is left blank, routing begins at the first elevation on the structure data table (page A-4). There are three ways to start routings: (1) Normally the starting elevation will be the lowest crest of the principal spillway, with outflow discharge equal to zero. The storage associated with the starting elevation can be equal to or greater than zero. ~~Two alternate ways to start routings are~~:

(2) Below the principal spillway crest with zero discharge. The second data card on the structure data table must have a discharge greater than zero and must increase in storage. Therefore, a small discharge may have to be shown, even though it is not the case.

(3) Above the principal spillway crest where discharge is greater than zero. Routing starts at the start routing elevation and ~~zero discharge but will immediately increase to the discharge shown for the starting elevation and routing~~ continues until the outflow discharge returns to zero or where it ends because of 300 point storage limitation. The volume of the outflow hydrograph will include the volume between the starting elevation and the elevation at zero discharge or when it ends because of the 300 point storage limitation.

Col. No.	Value	Description
2	6	Data code signifying Standard Control statement
4-9	RUNOFF	Operation name
11	1	Operation number
13-15	b or var.	Cross section number, 1 thru 200, right justified } must enter one but not both
16-17	b or var.	Structure number, 1 thru 99, right justified } must enter one but not both
19-21	b	
23	var.	Output hydrograph storage location no., 1 thru 7
25-36	*var.	Drainage area, sq. miles
37-48	*var.	Runoff curve number
49-60	*var.	Time of concentration, hours
61	b or 1	**Output option, print peak discharge
63	b or 1	" " " discharge hydrograph
65	b	
67	b or 1	" " " runoff volume
69	b or 1	" generate discharge hydrograph file
71	b or 1	" " save results for summary tables
73-80	b or var.	Record/statement identification, optional

Notes: * Decimal required in these fields, omitted in all others
** Enter 1 to turn the option on, otherwise leave it blank
var. - variable data to be entered by user
b - denotes blank

Example:

1-10			11-20			21-30			31-40	41-50	51-60	61-70	71-80
DATA CODE	OPERATION NAME	NO.	X SECT. / STRUCT. ID.		HYDRO. NUMBER IN-PUT #1	IN-PUT #2	OUT-PUT	DATA FIELD # 1	DATA FIELD # 2	DATA FIELD # 3	OUTPUT OPTIONS PRINT		RECORD IDENT.
6	RUNOFF	1		1			6	1.2	75.	0.33	1	1	160

The RUNOFF statement shown above would cause an inflow hydrograph to be developed for structure 1. The subwatershed has a drainage of 1.20 square miles, a RCN of 75 and a time of concentration of 0.33 hours. The hydrograph is placed in storage location 6. The hydrograph will be printed out and the results will be printed in Summary Tables 1 and 3. The peak discharge and volume of runoff will also be printed.

Figure 3-3. -- RUNOFF Statement

Col. No.	Value	Description
2	6	Data code signifying Standard Control statement
4-9	RESVOR	Operation name
11	2	Operation number
13-15	b	
16-17	var.	Structure number, 1 through 99, right justified
19	var.	Input hydrograph storage location no., 1 thru 7
23	var.	Output hydrograph storage location no., 1 thru 7
25-36	*var.	Surface elevation in feet, that routing begins
37-60	b	
61	b or 1	**Output option, print peak discharge
63	b or 1	" " " discharge hydrograph
65	b or 1	" " " elevation hydrograph
67	b or 1	" " " runoff volume
69	b or 1	" " generate discharge hydrograph file
71	b or 1	" " save results for summary tables
73-80	b or X var.	Record/statement identification, optional.

Notes: * Decimal required in these fields, omitted in all others
** Enter 1 to turn the option on, otherwise leave it blank
var. - variable data to be entered by user.
b - denotes blank

Example:

Reproduced from best available copy.

1-10			11-20			21-30	31-40	41-50	51-60	61-70						71-80
DATA CODE	OPERATION		X SECT / STRUCT.		HYDRO. NUMBER					OUTPUT OPTIONS						RECORD IDENT
	NAME	NO.	XSECT ID.	STRUCT ID.	IN-PUT #1	IN-PUT #2	OUT PUT	DATA FIELD # 1	DATA FIELD # 2	DATA FIELD # 3	PRINT				PLOT		
											PEAK	HYD	ELEV	RNOF			
6	RESVOR	2		1	6		7	521.5			1	1	1	1			470

The RESVOR statement shown above would cause the hydrograph in computer 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 output hydrograph and water surface elevations will be printed and the results will be printed in Summary Tables 1 and 3. The peak discharge and the volume under the outflow hydrograph will also be printed.

Figure 3-4. -- RESVOR Statement

A RESVOR statement 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 a null structure for the alternative without a structure. Null structures are discussed in section 3.7.4.

3.6.3 REACH (Figure 3-5)

The REACH statement causes the computer to route an inflow hydrograph to be routed through a stream reach.

The reach length should reflect the flood plain length if the flow is primarily overbank or the channel length if the flow is primarily in the channel. ~~The results are more accurate when a reach length is long as contracted with the reach being divided into shorter reaches.~~ In short reaches, attenuation is lost as the Modified Att-Kin routing procedure tends toward a kinematic routing. Guidelines for selecting reach lengths are in Appendix H.

It should be recognized that entering data in the XSECTN table, in general, will result in more accurate routings than entering "x" and "m" coefficients on the REACH statement. 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. Data Fields #2 and #3 in the REACH statement 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 as shown on page A-5, record 180).

Guidelines for estimating "x" and "m" for trapezoidal and triangular cross section shapes are given in Appendix H. Use of these guidelines requires a minimum amount of topographic and roughness information.

Col. No.	Value	Description
2	6	Data code signifying Standard Control statement
4-8	REACH	Operation name
11	3	Operation number
13-15	var.	Cross section number, 1 thru 200, right justify.
19	var.	Input hydrograph storage location no., 1 thru 7
21	b	
23	var.	Output hydrograph storage location no., 1 thru 7
25-26	*var.	Reach length, feet
37-48	*b or var.***	Coefficient, x in $Q = xA^m$ must be positive number } if both are blank actual cross section will be used
49-60	*b or var.***	Exponent, m, in $Q = xA^m$ } if both are blank actual cross section will be used
61	b or 1	**Output option, print peak discharge
63	b or 1	" " " discharge hydrograph
65	b or 1	" " " elevation hydrograph
67	b or 1	" " runoff volume above baseflow
69	b or 1	" " generate discharge hydrograph file
71	b or 1	" " save results for summary tables
73-80	b or var.	Record/statement identification, optional.

*** x & m values override cross section data

Notes: * Decimal required in these fields, omitted in all other
** Enter 1 to turn the option on, otherwise leave it blank
var. - variable data to be entered by user.
b - denotes blank

Example:

Reproduced from best available copy.

1-10			11-20			21-30		31-40	41-50	51-60	61-70						71-80
DATA CODE	OPERATION NAME	OPERATION NO.	X SECT / STRUCT. XSECT ID.	X SECT / STRUCT. STRUCT ID.	HYDRO NUMBER INPUT #1	HYDRO NUMBER INPUT #2	HYDRO NUMBER OUTPUT	DATA FIELD #1	DATA FIELD #2	DATA FIELD #3	OUTPUT OPTIONS PRINT PEAK	PRINT HYDRO	PRINT VOLUME	PRINT CC			RECORD IDENT
6	REACH	3	.1		7		5	5400.			1	1		1		1	XMPL9990

This REACH statement causes the hydrograph in computer storage location 7 to be routed through 5400 feet of channel or floodplain ending at cross section 1 with the hydrograph at that section stored in storage location 5. The peak discharge, the output hydrograph, and the volume under the outflow hydrograph would be printed out and these results would be printed in Summary Tables 1 and 3.

Figure 3-5. -- REACH Statement

The coefficient x is transformed to k, where $k = x \div L^m$ and L is the reach length specified in Data Field #1. 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). Therefore, when coefficients x and m are entered in Data Fields 2 and 3, the actual cross section discharge end-area data as given on the corresponding cross section table are not used.

Conversely, if the Data Fields 2 and 3 are left blank, a cross section table must have been previously entered and will be used. An "m" value will be determined for each flow listed in the table. The 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" is described in Appendices G and H. This method allows the "m" used in the reach routing to change when the slope of the discharge-area curve changes. In typical cross sections (with channel and floodplain) the slope of the discharge-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.

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 Appendix G.

3.6.4 ADDHYD (Figure 3-6)

The 6 ADDHYD 4 5 statement causes the hydrographs from two hydrograph storage locations to be combined and places the resultant hydrograph in a third storage location (See page B-5, record 200). Only two hydrographs can be combined at one time. For example, if 3 hydrographs are to be combined to describe a final hydrograph, two ADDHYD statements are needed.

Col. No.	Value	Description
2	6	Data code signifying Standard Control statement
4-9	ADDHYD	Operation number
11	4	Operation name
13-15	b or var.	Cross section no., 1 thru 200, right justified
16-17	b or var.	Structure no., 1 thru 99, right justified
		} must enter one but not both
19	var.	Input hydrograph storage location no., 1 thru 7
21	var.	Input hydrograph storage location no., 1 thru 7
23	var.	Output hydrograph storage location no., 1 thru 7
25-60	b	
61	b or 1	**Output option, print peak discharge
63	b or 1	" " " discharge hydrograph
65	b or 1	" " " elevation hydrograph
67	b or 1	" " runoff volume
69	b or 1	" " generate discharge hydrograph file
71	b or 1	" " save results for summary table
73-80	b or var.	Record/statement identification, optional.

Notes: ** Enter 1 to turn the option on, otherwise leave it blank
var. - variable data to be entered by user.
b - denotes blank

Example:

Reproduced from best available copy.

1-10			11-20			21-30		31-40	41-50	51-60	61-70		71-80
DATA CODE	OPERATION		X SECT / STRUCT.		HYDRO. NUMBER						OUTPUT OPTIONS		RECORD IDENT.
	NAME	NO	XSECT ID.	STR. ID.				DATA FIELD # 1	DATA FIELD # 2	DATA FIELD # 3	PRINT		
6	ADDHYD	4			5	6	7						200

This ADDHYD statement causes the hydrograph in computer storage location 5 to be combined (added) with the hydrograph in location 6 and the resulting hydrograph placed in location 7. The peak discharge, the output hydrograph, and the volume under the hydrograph will be printed out and the results will be printed in Summary Tables 1 and 3.

Figure 3-6. -- ADDHYD Statement

3.6.5 SAVMOV (Figure 3-7)

The 6 SAVMOV 5 statement 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. The computer "operating" storage locations can thus be vacated in order to transfer operations to a tributary (See page C-7, record 480). 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 (See page C-8, record 550).

3.6.6 DIVERT (Figure 3-8)

The 6 DIVERT 6 control statement 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 main 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. For example, on page C-8, record 580, the inflow hydrograph is in storage location 5. Therefore, the outflow hydrographs must be placed in locations other than 5. The cross section or structure number (columns 13-15 or 16-17) applies to the output hydrograph #1. The cross section number for output hydrograph #2 is placed in Data Field #3. A structure number is not permitted for output hydrograph #2.

Two procedures are available to divert a hydrograph. The first procedure diverts all flow above a constant discharge provided in Data Field #1.

Col. No.	Value	Description	
2	6	Data code signifying Standard Control statement	
4-9	SAVMOV	Operation name	
11	5	Operation number	
13-15	b or var.	Cross section no., 1 thru 200, right justified	must enter one but not both
16-17	b or var.	Structure no., 1 thru 99, right justified	
19	var.	"From" hydrograph storage location no., 1 thru 7	
21-23	var.	"To" hydrograph storage location no., 1 thru 7	
25-60	b		
73-80	b or var.	Record/statement identification, optional	

Notes: var. - variable data to be entered by user
b - denotes blank

Example:

Reproduced from best available copy.

DATA CODE	OPERATION NAME	OPERATION NO.	X SECT./STRUCT. XSECT ID.	X SECT./STRUCT. STRUCT ID.	HYDRO. NUMBER INPUT #1	HYDRO. NUMBER INPUT #2	HYDRO. NUMBER OUTPUT	DATA FIELD #1	DATA FIELD #2	DATA FIELD #3	OUTPUT OPTIONS PRINT	RECORD IDENT
6	SAVMOV	5	2		5		1					480

This SAVMOV statement causes the hydrograph in hydrograph storage location 5 to be moved to location 1. The associated cross section is 2. No output options work with SAVMOV.

Figure 3-7. -- SAVMOV Statement

Col. No.	Value	Description
2	6	Data code signifying Standard Control statement
4-9	DIVERT	Operation name
11	6	Operation number
13-15	var.	Cross section no., 1 thru 200, right justified — Associated with output hydrograph #1
16-17	var.	Structure no., 1 thru 99, right justified — Associated with output hydrograph #1
19	var.	Input hydrograph storage location no., 1 thru 7
21	var.	Output hydrograph #1 storage location no., 1 thru 7
23	var.	Output hydrograph #2 storage location no., 1 thru 7
25-36	*b to var.	Specified discharge; cfs invokes procedure 1, blank invokes procedure 2
37-48	*var.	Decimal fraction of drainage area to be associated with output hydrograph #1 (used only to split the drainage area.)
49-60	*var.	Cross section number associated with output hydrograph #2 (1 thru 200). Required for Procedure #2.
61	b or 1	**Output option, print peak discharge
63	b or 1	" " " discharge hydrograph
65	b or 1	" " " elevations associated with hydrograph
67	b or 1	" " " runoff volume
69	b or 1	" " generate discharge hydrograph file
71	b or 1	" " save results for summary tables
73-80	b or ~~Var.~~	Record/statement identification, optional

Notes: * Decimal required in these fields except when blank
** Enter 1 to turn the option on, otherwise leave it blank
var. - variable data to be entered by user.
b - denotes blank

Figure 3-8. -- DIVERT Statement

Example for DIVERT Procedure #1

1-10			11-20				21-30	31-40	41-50	51-60	61-70		71-80
DATA CODE	OPERATION NAME	OPERATION NO.	X SECT./ STRUCT. XSECT ID.	X SECT./ STRUCT. STRUCT ID.	HYDRO NUMBER INPUT #1	HYDRO NUMBER INPUT #2	DATA FIELD # 1	DATA FIELD # 2	DATA FIELD # 3	OUTPUT OPTIONS PRINT			RECORD IDENT.
										PEAK	HYD	PEAK/VOL	
6	DIVERT	6	5		5	7	100.	0.4	8.	1	1	1	550

DATA FIELD # 1: cfs
DATA FIELD # 2: Decimal % D.A. w/output #1
DATA FIELD # 3: xsection w/output #2

This DIVERT statement causes the hydrograph in hydrograph storage location 5 to be separated into two hydrographs. The hydrograph equal to and less than 100 cfs will be placed into computer 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 computer 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, and volumes will be printed out and the results will be printed in Summary Tables 1 and 3.

Example for DIVERT Procedure #2

Reproduced from best available copy.

1-10			11-20				21-30	31-40	41-50	51-60	61-70		71-80
DATA CODE	OPERATION NAME	OPERATION NO.	X SECT / STRUCT. XSECT ID.	X SECT / STRUCT. STRUCT ID.	HYDRO NUMBER INPUT #1	HYDRO NUMBER INPUT #2	DATA FIELD # 1	DATA FIELD # 2	DATA FIELD # 3	OUTPUT OPTIONS PRINT			RECORD IDENT.
										PEAK	HYD	PEAK/VOL	
6	DIVERT	6	5		5	7		0.9	8.	1		1	1480

DATA FIELD # 2: Decimal % D.A. w/ Output #1
DATA FIELD # 3: xsection with Output Hyd. #2

This example is similar to the example for procedure #1. The primary difference is that since data field #1 is blank procedure #2 is invoked. The input hydrograph will be split proportionately using the data in cross section tables number 5, page E-6 and number 8 page E2I^2 (App. E). Ninety percent of the drainage area (90%) will be associated with cross section number 5. The hydrograph will be printed and results included in Summary Tables 1 and 3.

Figure 3-8. -- DIVERT Statement (Continued)

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, in decimal fraction form, in Data Field #2 that is to be associated with the output hydrograph #1. The balance of the drainage area will be associated with output hydrograph #2. If data field #2 is 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 for output hydrograph #2 must be followed by a decimal (e.g., 008.) in Data Field #3. This data field cannot be blank or zero for procedure #2.

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 would then be diverted and 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 #2 would then be diverted.

Procedure 1 --This procedure separates a hydrograph into two hydrographs where one hydrograph contains that portion of the inflow hydrograph below a specified discharge (Data Field #1, outflow hydrograph #1) and the second hydrograph contains that portion above the specified discharge (outflow hydrograph #2) as shown below.

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 is 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 C for an example of procedure #1, (page C-8, record 580).

Procedure 2 --

This procedure is used where a stream branches into two streams or into a stream and a floodway. Data Field #1 is left blank or zero. All discharges will be proportioned using an elevation versus discharge rating table representative of each branch. The elevation, ~~and~~ discharge, and end area columns of the cross section ~~or structure~~ data tables need to be completed. ~~are used~~. The elevations of the two output hydrographs are assumed to be equal, 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. See Sample Job 5, Alternate 4, Appendix E for an example of procedure #2, (page E-23, record 1480).

3.6.7 ENDATA (Figure 3-9)

The ENDATA statement must be entered at the end of the Standard Control input data list.

3.6.8 Output Options

The spaces under the "Output Options" heading (Columns 61-71) on the Standard Control permit one to choose the type and kind of hydrograph data to be obtained as output.

Output Option	Use "1" in Column #	Produces the following output:
PEAK	61	Peak Discharge, Peak Time and, if a rating table is available, the Peak Elevation are printed. Up to 10 highest multiple peaks for each hydrograph will be printed. If the

Col. No.	Value	Description
2	b	
4-9	ENDATA	Operation name
11-72	b	
73-80	b or var.	Record/statement identification, optional

Note: var. - variable data to be entered by user.
Example:

1-10			11-20		21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	OPERATION NAME	NO.	x SECT./ STRUCT. XSECT ID.	STRUCT ID.	HYDRO. NUMBER IN-PUT #1	IN-PUT #2	OUT PUT	DATA FIELD # 1	DATA FIELD # 2	DATA FIELD # 3	OUTPUT OPTIONS PRINT	RECORD IDENT
	ENDATA											190

The ENDATA statement signifies that the Standard Control sequence and all tabular data for a job have been read in and the Executive Control will follow.

Reproduced from best available copy.

Figure 3-9. -- ENDATA Statement

FULLPRINT option is specified in the JOB statement, the PEAK option will be automatically set to 1. The maximum peak data only is printed in the Summary Tables if one of the summary options is requested.

HYD	63	Discharge versus time 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 printed out (subject to the 300 point limit).
ELEV	65	Elevation versus time in tabular form. An elevation value will be printed that corresponds to the HYD option discharge value. The ELEV option is requested only at cross sections and structures and then only if a rating table is available. For example, the ELEV option would not be selected on the RUNOFF statement.
VOL	67	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 printed. If the FULLPRINT option is specified in the JOB statement, the VOL option will be automatically set to 1. The volume will be printed in Summary Table 1 if one of the summary options is requested. Triangular baseflow is included in the volume of the hydrographs.
FILE	69	A discharge hydrograph file is generated in a "Read-Discharge-Hydrograph" format for use as input to a subsequent TR-20 run. See page B-13, App. B. The hydrograph file is ~~only~~ identified by ~~a hydrograph number which~~ the SEC /STR number and

the alternate and storm numbers in columns 73-80 ~~increases by one for each hydrograph generated from a job~~ of the first two records. To print the hydrograph for identification comparison the HYD option must also be set to 1. The discharge hydrograph file may be saved and/or printed if the user alters the system control language to change the output form.

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 (when used) and the cross section or structure identification number. Only the largest peak discharge for each hydrograph is listed in the summary. If Summary is called for more than once for the same cross section or structure, only the last summary location will be printed in Summary Tables 3 and 4. If the SUMMARY option is specified on the JOB statement, the SUM output option on individual operations is not needed. One of these options must be on to save peak information if the ECON option is specified on the JOB statement.

If none of the output options or FULLPRINT or SUMMARY are selected the respective operation will be completed without providing any printout.

3.7 TABULAR DATA

There are five tabular data formats to support the Standard Control statements. The tabular data formats are: (1) Dimensionless Hydrograph (2) Cumulative Rainfall, (3) Stream Cross Section Data, (4) Structure Data, and (5) Read Discharge Hydrograph. Each tabular data set has a header line specifying the type of data that is entered before the tabular data. Each line of tabular data has an 8 in column 2 and five 12-column data fields. Decimal points must accompany all figures in

the data fields. Commas must not be used with figures to denote thousands. All unused lines must be crossed out.

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

3.7.1 Dimensionless Hydrograph Table - 4 DIMHYD - (Form SCS-ENG-265, Page F-3)

The standard SCS dimensionless unit hydrograph is contained in the program and is not required in the input. This input data sheet is required only if another dimensionless hydrograph is required. The dimensionless unit hydrograph described in Chapter 16, NEH 4 is used in the RUNOFF operation for developing runoff hydrographs from subwatersheds. The data lines on page F-4 contain the ratio of discharge to peak discharge for each 0.02 increment of the dimensionless time scale. Any dimensionless distribution graph may be used but the number of entries must not exceed 55. The product of the number of non zero entries plus one and the dimensionless time increment (Data Field No. 2) of the 4 DIMHYD statement (first line of page F-4) must equal 1.0. The standard SCS dimensionless hydrograph peak factor is 484. See Chapter 16, NEH 4.

3.7.2 Cumulative Rainfall Table -5 RAINFL - (Form SCS-ENG-271, Page F-7)

TR-20 was designed to allow almost complete freedom for input of rainfall and its distribution.

There are four methods to input rainfall distributions. They differ in the specification of the rainfall volume and duration with both actual and dimensionless values available for use. The four methods are:

a. cumulative rainfall in inches - time increment in hours

b. cumulative rainfall in inches - dimensionless time increment

c. cumulative dimensionless rainfall - time increment in hours

d. cumulative dimensionless rainfall - dimensionless time increment

A total of nine actual or synthetic rainfall distributions can be used in any run. They can be input using Cumulative-Rainfall Table form SCS-271 (page F-7). Appendix C, page C-4, shows how an actual 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. The time increment is specified in the space in which the 1.0 appears on line page C-4, record 40. The number of entries in the body of the format cannot exceed 20 lines (100 entries). This means that if a 1-hour time increment is specified, storms up to 99 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 Data Field No. 3 of record 130 is the end of rainfall, however, the value of 12.16 inches is repeated in Data Fields 4 and 5 to complete the line. The 9 ENDTBL line 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 C, page C-4 is identified as Table Number 7 on the header in column 11 of record 40. When it is desired to route this storm through the watershed, Rainfall Table Number 7 is specified in the Executive Control COMPUT statement as shown on page C-9, record 640. 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 time increment in hours and cumulative rainfall depth in inches.

The SCS has six standard synthetic rainfall distributions. The standard distributions are listed as in Tables 1 through 6 on pages F-8 to F-13 in Appendix F. Each standard table has been designed to be used for a distinct purpose and has certain limitations. They 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 wide range of climatic and watershed

conditions. If none of the standard distributions is suitable the user may choose to enter other distributions.

The six standard rainfall distributions as shown in Tables 1 through 6 in Appendix F have been preloaded into TR-20. The user does not need to enter these tables, but needs only to use the proper raintable number on the COMPUT statement. 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 F-8, is used in California and is accepted in some areas because it approximates peaks resulting from less severe short duration intensities. The time increment used for this distribution is 0.5 hour.

The 24-hour type-II distribution (Table 2), which is shown on page F-9, is generally used east of the Cascade and Sierra-Nevada Mountains. The time increment of 0.25 hours gives good definition of the resulting hydrograph for the short duration intensities.

The 24-hour type-IA distribution (Table 3), which is shown on pages F-10, 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, ~~and~~ Washington and northern California. The time increment used for this distribution is 0.5 hour.

The 48-hour type-I and II storm distributions, (Tables 4 and 5), which are shown on pages F-11 and F-12, are similar to the 24-hour storms of the same types. These 48-hour distributions 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 time increment used for these distributions is 0.5 hours. The 48 hour distribution should be evaluated by the user for applicability, especially in relation to peaks and runoff volume.

Note that these 24- and 48-hour distribution tables are dimensionless rainfall vs. time increment in hours (0.25 or 0.5) tables. Each entry in the table is the ratio of the storm accumulation to total storm depth.

When any of these five 24 and 48 hour distribution tables are specified in the COMPUT Executive Control statement, a storm rainfall depth in inches must be shown in Data Field #2 of that COMPUT statement because these units are dimensionless, and a 1.0 for duration in Data Field #3 because time increment is in hours (See page A-6, record 210). 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 F-13. This table is a dimensionless rainfall vs. dimensionless time table. Both depth and duration must be supplied in Data Field Nos. 2 and 3, respectively, on the COMPUT statement 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.

Runoff option. -- The runoff option, invoked by placing a one in column 17 of the ~~first~~ 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.

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.

3.7.3 Stream Cross Section Data Table - 2 XSECTN - (Form SCS-ENG-270, Page F-6)

The stream cross section table relates the water surface elevation to discharge in cubic-feet-per-second-per-square-mile (csm) or cfs and to the cross-sectional area in square feet. These data may be from 1) water surface profiles, 2) a user weighted average of flow and area at two or more cross sections or 3) solution of Manning's equation assuming normal 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 ~~recommended~~ necessary that the user enter flow and area data for elevations below channel bank 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 must correspond with the cross section number on the REACH statement. 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 Data Field No. 1 on the 2 XSECTN record, Appendix C, page C-5. The figure shown in this space is multiplied by the discharge in csm in order to convert to cfs. Usually the discharge in Data Field No. 2 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 coordinates describing each cross section cannot exceed the data records on a single input form (20 elevations).

The discharge-end area data in Data Fields No. 2 and 3 are used to compute the discharge-storage equation representative of the reach. (See section 3.6.4.) The first data point must be at zero discharge and zero end area. All other data points (minimum of 2 and a maximum of 19) must be greater than zero and increase in magnitude with elevation.

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 statements for that 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 statements. 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. The elevations, discharges and end areas in Data Fields 1 through 3 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.

3.7.4 Structure Data Table - 3 STRUCT - (Form SCS-ENG-269, Page F-5)

Structure data tables relate the water-surface elevation to spillway discharge and reservoir storage. The numbering of structures must correspond with the structure number on the RESVOR Standard Control statement. Structure numbering need not be consecutive, and the data tables preceding each respective set of Executive Control statements 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 line in Data Field No. 2 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 "Surface Elevation at T = 0, ft.," Data Field No. 1, of the RESVOR statement, Section 3.6.2 if routing begins above or below crest elevation of the low stage outlet. The elevations, discharges, and volumes in Data Field Nos. 1-3 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. Also, if needed, an extrapolation

of data above the highest elevation is performed by extending a line linearly through the last two data entries.

The main time increment (in the Executive Control) and the discharge and storage (from the structure data table) must be such that the following inequality holds true (See p. 17-22, NEH-4):

$$\frac{\Delta O}{2} < \frac{\Delta S}{\Delta t} \cdot \frac{43560}{3600}$$

where ΔO = the incremental outflow in cfs between two successive lines in the table,

ΔS = the incremental storage in ~~cfs-hrs~~ acre-feet between two successive lines in the table,

Δt = the main time increment in hours.

If this inequality is not true oscillations will occur in the descending limb of the hydrograph including negative discharges. The usual need is to ~~adjust the structure table, not Δt~~ decrease the Δt.

Null structure.-- There are usually two structure conditions described for each site. One is the Null structure, and the other is for the structure 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 be done using Modify Standard Control statements which will be discussed later. Any number of structure conditions can be processed for each numbered site.

A Null structure is indicated by one of two methods. The ~~suggested~~ first method is placing a 3 STRUCT statement followed by a 9 ENDTBL statement without any intervening "8" data statements. A second method is leaving out all ~~structure~~ 3 STRUCT statements referring to a structure. To use the Null structure, the two statements (3 STRUCT and 9 END TBL) are inserted into the runstream just prior to the Executive Control statements to

which they pertain (See page E-20, record 1330-1340). When a new structure table is entered, the new structure table replaces any previous data for that table. When a structure table, including a null table, is entered, it remains in effect until replaced. When only 2 statements 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 statements to which it pertains.

Each structure data table must have a structure number and a 9 ENDTBL statement. The number of coordinates describing a structure cannot exceed the data records on a single input form (20 elevations).

3.7.5 Read-Discharge-Hydrograph Data Table - 7 READHD - (Form SCS-ENG-276, Page F-21)

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 and must be placed after the ENDATA statement and before the COMPUT statement in which it will be used.

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 data where appropriate. In addition, the table 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.

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 3.5.1. Second, each table is inserted into the runstream ahead of the COMPUT statement that will require the data.

For example, a "6" in column 17 of the 7 READHD 8 statement 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 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 point of the hydrograph is to be related, (2) the time increment in hours, (3) the drainage area in square miles associated with the hydrograph and (4) the baseflow in cfs, if any, ~~to be added to~~ included in the hydrograph. The table is unlike other tabular data formats in that it can be continued on additional sheets using no more than 300 coordinates 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.

3.8 EXECUTIVE CONTROL STATEMENTS (Form SCS-ENG-274, Page F-17)

The Executive Control has two functions: (1) to cause the Standard Control statements to be executed and (2) to provide additional data necessary for processing. The Executive Control consists of six types of statements. They are LIST, BASFLO, INCREM, COMPUT, ENDCMP and ENDJOB. The Executive Control statements are placed after the Standard Control statements and tabular data to which they pertain.

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

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

An example is given in Appendix A, page A-6 and is repeated below for the reader's convenience. The four Executive Control statements in the example are the minimum required for a TR-20 computer run. The 7 INCREM 6 statement prescribes the main time increment to be used in the run. The 7 COMPUT 7 statement causes computations to begin at structure 1 of the Standard Control and proceed through cross section 1 using the hydrologic data given in the remainder of the line. The ENDCMP 1 statement causes computations to end and the ENDJOB 2 causes the whole job to end.

Example

DATA CODE	OPERATION		DATA FIELD #1	DATA FIELD #2	DATA FIELD #3	DATA FIELD #4	RECORD IDENT.
7	INCREM	6	0.1				200
7	COMPUT	7	1	5.2	1.0	2 1	210
	ENDCMP	1					220
	ENDJOB	2					230

3.8.1 LIST (Figure 3-10)

The LIST Executive Control statement causes a listing of all current tabular data and Standard Control statements (including output options in effect) to be printed. The LIST statement also permanently saves the current Modified Standard Control in the Standard Control operation sequence. The LIST statement will normally be placed prior to the first COMPUT statement and after changes in tabular data and Standard Control.

3.8.2 BASFLO (Figure 3-11)

The BASFLO Executive Control statement causes a baseflow to be added to a flood hydrograph. Two procedures are available to do this. 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 statement 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. The two procedures are:

Procedure 1 -- A uniform or constant rate of baseflow can be added to hydrographs by entering the total ~~channel~~ baseflow in cfs in Data

Col. No.	Value	Description
2	7	Data code signifying Executive Control statement.
4-7	LIST	Operation name
73-80	var.	Record/statement Identification, optional.

Note: var. - variable data to be entered by the user

Example:

1-10	11-20	21-30	31-40	41-50	51-60	61-72	73-80
DATA CODE	OPERATION		DATA FIELD #1	DATA FIELD #2	DATA FIELD #3	DATA FIELD #4	RECORD IDENT.
7	LIST	This records is used for control of output data and standard control that are currently effective.					642

This LIST statement causes all the tabular data and Standard Control (including output options in effect at the time the LIST statement is encountered) to be printed.

Reproduced from best available copy.

Figure 3-10.--LIST Statement

Col. No.	Value	Description
2	7	Data code signifying Executive Control statement
4-9	BASFLO	Operation name
11	5	Operation number
		Procedure 1 - Baseflow is constant
25-36	*var.	Baseflow, cfs, to be added to next reach inflow hydrograph
37-48	b or 0.	
49-60	b or 0.	
		Procedure 2 - Baseflow is triangular hydrograph
25-36	*var.	Volume of baseflow in watershed inches
37-48	*var.	Time, in hours, that baseflow hydrograph peaks (measured from beginning of storm)
49-60	*var.	Time, in hours, of triangular hydrograph
73-80	var.	Record/statement identification, optional

Notes: * Decimal required in these fields, omitted in all other
var. - variable data to be entered by the user
b - denotes blank field

Figure 3-11.--BASFLO Statement

Examples:

Procedure 1 (Constant baseflow)

1-10		11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	OPERATION		DATA FIELD #1	DATA FIELD #2	DATA FIELD #3	DATA FIELD #4	RECORD IDENT
17	BASFLO		10.0				990

This BASFLO statement 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 statement following this BASFLO statement unless an ENDCMP is encountered or the baseflow is changed by a succeeding BASFLO and COMPUT statement.

Procedure 2 (triangular hydrograph)

1-10		11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	OPERATION		DATA FIELD #1	DATA FIELD #2	DATA FIELD #3	DATA FIELD #4	RECORD IDENT
17	BASFLO		0.26	17.8	20.2		

Reproduced from best available copy.

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

Figure 3-11.--BASFLO Statement (continued)

Field #1 of the BASFLO statement. This procedure is invoked by leaving Data Fields #2 and #3 either blank or zero. The baseflow will be combined only with the inflow hydrograph in the next reach routing following the COMPUT. The baseflow will remain the same through subsequent reaches that are in a downstream sequence until the ENDCMP ~~or DIVERT~~ is encountered or a new BASFLO is entered. The new baseflow can be greater or less than the one previous. The previous baseflow that was in use is dropped when a new BASFLO statement 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 statement. Tributaries need to have separate BASEFLO and COMPUT statements if constant baseflow is to be included in tributary hydrographs. Baseflow from tributaries will be added to main stem baseflow when hydrographs are added.

Procedure 2--A triangular baseflow hydrograph can be added to any subwatershed runoff hydrograph. The volume of baseflow in watershed inches is entered in Data Field #1. The time in hours from the beginning of the storm that the baseflow hydrograph peaks is entered in Data Field #2. The time in hours for the triangular hydrograph base is entered in Data Field #3. This base time must be less than or equal to the time associated with the maximum 300 hydrograph coordinate points to avoid a fatal computer error. The triangular baseflow will be combined with the next and all subsequent runoff hydrographs until a ENDCMP statement is encountered or a new or zero BASFLO statement is added.

3.8.3 INCREM (Figure 3-12)

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

All hydrographs generated will be stored and printed at time intervals given by this main time increment with a maximum of 300 coordinates (See Figure 3-13). It is important that the main time increment be made short enough to adequately describe the hydrographs for the smaller

Col. No.	Value	Description
2	7	Data code signifying Executive Control statement
4-9	INCREM	Operation name
11	6	Operation number
25-36	*var.	Main time increment in hours, usually in the range of 0.1 to 1.0
73-80	var.	Record/statement identification, optional.

Notes: * Decimal required in this field, omitted in all others
var. - variable data to be entered by the user

Example:

This INCREM statement causes all hydrographs created within the TR-20 program to have a Δt_{main} time increment (Δt) of 0.1 hours unless the main time increment is changed by a subsequent INCREM statement. Since there are 300 hydrograph ordinates, the hydrographs will have a length of 30 hours. The user should select the time increment to the nearest tenth of an hour as this will facilitate reading the hydrographs in the output listing.

Reproduced from best available copy.

Figure 3-12.--INCREM Statement

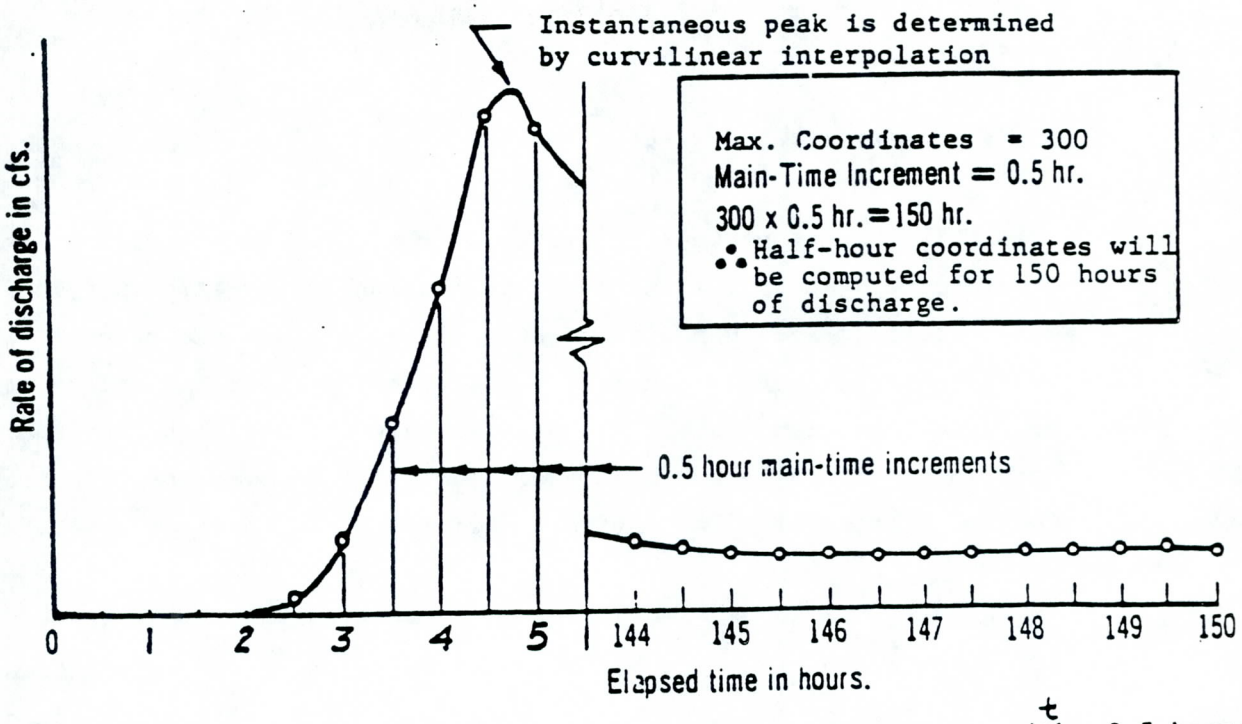


FIGURE 3-13. Hydrograph coordinates determined by computer for Δt = 0.5 hours

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 routing. Increments of 0.5 hr. will not adequately define the hydrograph for a small subwatershed having time of concentration of less than one hour (See Hydrograph Development). Conversely, a main time increment of 0.1 hr. with 300 coordinates will define only 30 hours of a hydrograph. In some cases this requires that less accuracy in runoff hydrograph definition be tolerated to obtain enough of the larger hydrographs.

An INCREM statement must precede the first COMPUT statement of any series of COMPUT statements. (See page A-6, record 200). The main time increment may vary but is recommended that it be held constant during the entire pass through a watershed. 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.

In the REACH operation the inflow hydrograph is delayed a minimum of one time increment even if the kinematic travel time is less than one time increment. 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 Appendix H, Reach Length Guidelines.

3.8.4 COMPUT (Figure 3-14)

The COMPUT Executive Control statement 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 moisture condition that is to apply between the beginning and ending locations. A single COMPUT statement may extend over the Standard Control statements of an entire watershed or of a part of a 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 x-section/structure column of a statement in the Standard Control. Computations will commence with the first cross section or structure number specified under "from" in the COMPUT statement and continue through the sequence of Standard Control operations until the end of the first consecutive occurrence of the the cross section or structure specified under "thru" has been reached and completed. The computation stops when a statement is encountered with a cross-section or structure number different and beyond that under "thru". The next Executive Control statement is executed. Thus, if a COMPUT statement for Sample Job #3, pages C-7 and C-8, instructed processing from structure 1 thru cross section 4, computation would stop after record 560 of the Standard Control data. The next instruction could be another COMPUT card commencing with the next statement in the Standard Control list with or without changes in one or more data fields; or it could be ENDCMP, resetting the Standard Control list to the first statement and to make changes in the tabular or Standard Control data as directed by other Executive Control statements and then continue with another COMPUT series.

The rainfall that is to apply to the area covered by the COMPUT statement is specified by giving a Rain Table number (column 61) and starting

Col. No.	Value	Description	
2	7	Date code signifying Executive Control statement	
4-9	COMPUT	Operation name	
11	7	Operation number	
13-15	b or var.	"From" cross section no., 1 thru 200, right justified	must enter one but not both
16-17	b or var.	"From" structure no., 1 thru 99, right justified	
19-21	b or var.	~~"To"~~ Thru "cross section no., 1 thru 200, right justified	must enter one but not both
22-23	b or var.	~~"To"~~ Thru "structure no., 1 thru 99, right justified	
25-36	b or var.*	Starting time in hours; zero if left blank.	
37-48	var.*	Rainfall depth. If a unit RAINFL table is used, enter rain depth in inches or if cumulative rainfall in inches is used in RAINFL table, enter 1.0.	
49-60	var.*	Rain ~~table~~ fall duration. If a unit RAINFL table is used, enter total duration in hours or if time increment in hours is used in RAINFL table, enter 1.0.	
61	var.	Rain table number, 1 thru 9; same as Column 11 of 5 RAINFL statement	
63	var.	Antecedent moisture condition, 1, 2, or 3; normally 2.	
66-67	var.	Alternate number, 01 thru 99; assigned by user to a particular alternative condition. Usually reflects different structural configurations	
69-70	var.	Storm number, 01 thru 10; assigned by user.	
73-80	var.	Record/statement identification, optional	

Notes: * Decimal required in this field; omitted in all others
var. - variable data entered by the user
b - denotes blank

Figure 3-14.--COMPUT Statement

Example:

1-10		11-20		21-30	31-40	41-50	51-60	61-70				71-80
DATA CODE	OPERATION			DATA FIELD # 1	DATA FIELD # 2	DATA FIELD # 3	DATA FIELD # 4					IDENT
		FROM	THRU	STARTING TIME HOURS	RAINFALL DEPTH INCHES (Set depth and duration to 0.0 for actual rainfall)	RAINFALL DURATION HOURS	RAIN TABLE NO	ANC	ALTERNATE NO	STORM NO		
		OR XSECT	OR STRUCT									
COMPUT		1		0.0	5.2	1.0	2	2	1	1		21.0

This COMPUT statement causes hydrographs to be determined and routings to be performed beginning at structure number 1 through cross section 1 (See sample Job Number 1). This is one pass through the complete watershed. The starting time is zero hours (since Data Field #1 is blank). The unit 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 (Data Field #3), the duration of the rainfall will be as prescribed in the RAINFL table, (96 increments at 0.25 hours = 24 hours). The antecedent moisture condition is 2. The alternate number and storm number are both 01.

Reproduced from best available copy.

Figure 3-14.--COMPUT Statement (Continued)

time (Data Field 1) on the COMPUT statement. Proper multipliers are entered in Data Fields 2 and 3 for Rainfall Depth and Rainfall Duration.

In standard Rain Tables 1 through 5 the rainfall depth is dimensionless and the time increment is in hours giving a duration of 24 or 48 hours. Therefore, the ~~storm~~ rainfall depth in inches must be inserted as a multiplier under Rainfall Depth, and a 1.0 under Rainfall Duration. In standard Rain Table 6, both the rainfall depth and the time are dimensionless. Therefore, the ~~storm~~ rainfall depth in inches and duration in hours are inserted as multipliers under both Rainfall Depth (Data Field #2) and Rainfall Duration (Data Field #3), respectively, on the COMPUT statement. Natural storms usually defined as cumulative rainfall depth in inches and time increment in hours may be assigned any unused table numbers from 1 through 9. In these cases a 1.0 should be inserted under both Rainfall Depth and Rainfall Duration on the COMPUT statement.

An Antecedent Moisture Condition of 1, 2, or 3 must be specified under AMC (column 63 of the COMPUT statement). They represent the three antecedent moisture conditions (AMC) I, II, and III described in Chapter 4, NEH-4, where AMC I and III are moisture condition limits. The runoff curve numbers in the RUNOFF operations on the Standard Control format are for an AMC 2 condition (the average condition when rainfall occurs is AMC 2). When a dry condition limit, 1, or a wet condition limit, 3, are specified under AMC, the curve number is adjusted according to Table 10.1 of NEH 4. When using a natural storm where the runoff curve number falls between AMC 1 and AMC 2 or between AMC 2 and AMC 3, the user should enter the adjusted runoff curve numbers on the RUNOFF Standard Control records and enter AMC 2 on the COMPUT record.

In many cases, a uniform rainfall will be applied over the entire watershed so that only a single COMPUT statement is required. However, a series of COMPUT statements may be given with different rainfall depths extending over different parts of the watershed. Normally, these COMPUT statements will extend over successive parts of the Standard Control list. For a given COMPUT statement, the cross section or structure appearing under thru must always be farther down the Standard Control list than the cross section or structure appearing

ENDCMP

Col. No.	Value	Description
4-9	ENDCMP	Operation name
11	1	Operation number
73-80	b or var.	Record/statement identification optional.

Example:

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	OPERATION		DATA FIELD #1	DATA FIELD #2	DATA FIELD #3	DATA FIELD #4	RECORD IDENT
	ENDCMP	1	This record is required at "end" of a watershed. It may follow a series of COMPUT records				220

The ENDCMP statement is required at the end of a series (one or more) COMPUT statements. The user may run through the watershed any number of times, each time using the ENDCMP statement to end a series of COMPUT statements. The COMPUT statement must always be followed by another COMPUT statement or an ENDCMP statement.

ENDJOB

4-9	ENDJOB	Operation name
11	2	Operation number
73-80	b or var.	Record/statement identification, optional.

Note: var. - variable data to be entered by user
b - denotes blank

Example:

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	OPERATION		DATA FIELD #1	DATA FIELD #2	DATA FIELD #3	DATA FIELD #4	RECORD IDENT
	ENDJOB	2	This record terminates routing computation and precedes the PEAKS record, if any				23

The ENDJOB statement is required at the end of a TR-20 run. It is also required before the PEAKS statement. Thus a PEAKS statement will have an ENDJOB statement before and after it.

Figure 3-15.--ENDCMP and ENDJOB Statement

under from. Likewise the cross section or structures appearing in one of a series of COMPUT statements (not separated by an ENDCMP statement) 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 statements may also be used for changing baseflow, starting time of rainfall, rain tables and runoff conditions (AMC) within a single pass through the Standard Control list.

3.8.5 ENDCMP (Figure 3-15)

An ENDCMP statement signifies the end of one or more COMPUT statements in a series. Normally this completes a "pass" through the entire watershed (See page E-11, record 680). At this point additional Executive Control statements may be used, such as LIST, INCREM or BASFLO to identify any modifications to the Standard Control or tabular data for further processing, or the ENDJOB statement may be used to end the job. 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 statement is encountered.

3.8.6 ENDJOB (Figure 3-15)

An ENDJOB statement is required following the last ENDCMP statement (See page E-25, record 1610) and also following the last PEAKS statement (record 1630). For a discussion on the PEAKS statement, see Section 3.10. When an ENDJOB statement is encountered a check is made to see if a PEAKS statement follows. If there is none, the job is ended. Any PEAKS statements found are processed until a second ENDJOB statement is found. Then the TR-20 job is ended. A check is made to see if there is another JOB statement to initiate another TR-20 job. If there is none, control returns to the computer operating system.

3.9 MODIFY STANDARD CONTROL STATEMENTS

(Form SCS-ENG-275, Page F-19)

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 statements are INSERT, ALTER, and DELETE. The Modify Standard Control provides for inserting new statements into the Standard Control list, altering data in existing statements and deleting any statement 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 statements must appear in the same sequence as their corresponding statement appears in the Standard Control list. Modified Standard Control changes are permanently saved in the Standard Control operation sequence when followed by a LIST statement.

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

3.9.1 INSERT (Figure 3-16)

The INSERT statement is used to place one or more new Standard Control statements 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. All statements following the INSERT statement are placed at that location. Note that page E-17, record 1150, will cause the data on records 1160 and 1170 to be inserted following record 470. The modified sequence must be a continuous sequence of statements 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 statement must be used for each location at which an insertion of new data is desired, and any INSERT statement must be placed in the same order in which these locations appear on the original Standard Control list. An INSERT may not be used to place a statement after the last statement in the Standard Control. In Sample Job 5 a SAVMOV (page E-10, record 620) was used to avoid this situation with the INSERT record 1510.

Col. No	Value	Description	
2	7	Data code signifying Modify Standard Control statement	
4-9	INSERT	Operation name	
11	2	Operation number	
13-15	b or var.	Cross section number, 1 thru 200, right justified	must enter one but not both
16-17	b or var.	Structure no., 1 thru 99, right justified	
73-80	b or var.	Record/statement identification, optional	

Note: var - variable data entered by user
b - denotes blank

Example:

Reproduced from best available copy.

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

Figure 3-16.--INSERT Statement

3.9.2 ALTER (Figure 3-17)

The ALTER statement allows changes to be made in a statement in the Standard Control sequence. The Standard Control statements following the ALTER statement completely replace the statements to be changed. See records 1210 and 1220, page E-18 and compare record 1220 with record 500, page E-9.

In locating these statements data given in columns 1 ~~to~~ thru 7 18 must be identical with the Standard Control statement being altered.

There are situations where two or more Standard Control statements will have identical data in columns 1 ~~to~~ thru 7 18. In this case the change would apply to the first occurrence of the statement. If alterations were desired in the second statement, the cross section on the Standard Control list would need to be changed to some unused cross section number (control point). This affixes a control point to be recognized as previously described in Section 3.8.4.

3.9.3 DELETE (Figure 3-18)

The DELETE statement causes the deletion of the entire Standard Control statement. When the data in columns 1 ~~to~~ thru 7 18 of the Standard Control statement following the DELETE statement is identical to that same data in a statement in the Standard Control sequence, that statement is erased from the Standard Control sequence. See page E-17, records 1180 and 1190, where record 1190 erases record 480 on page E-9.

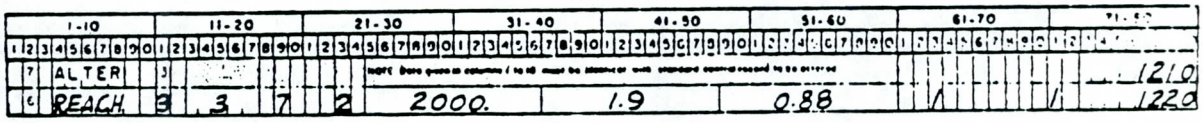
3.10 INTERMEDIATE PEAKS (Figure 3-19)

Peaks can be computed for additional locations between xsections/structures tabulated in Summary Table 3 using Intermediate Peaks control statements. 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 statements by eliminating some small subwatersheds and short reaches.

Col. No	Value	Description
2	7	Data code signifying Modify Standard Control statement
4-8	ALTER	Operation name
11	3	Operation number
73-80	var.	Record/statement identification, optional

Note: var. - variable data entered by user

Example:



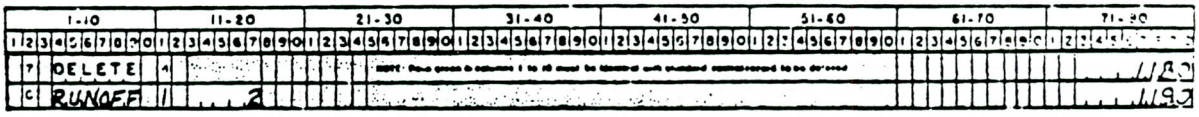
This ALTER statement would cause a search of the Standard Control list until the REACH statement having 3 in columns 13-15 is found. The old REACH statement is then replaced with the new REACH statement shown above. Columns 1-18 in the existing REACH statement must be identical with those in the replacement REACH statement.

Figure 3-17.--ALTER Statement

Col. No.	Value	Description
2	7	Data code signifying Modify Standard Control statement
4-9	DELETE	Operation name
11	4	Operation number
73-80	var.	Record/statement identification, optional

Note: var - variable data entered by user

Example:



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

Figure 3-18.--DELETE Statement

Col. No.	Value	Description	
4-8	PEAKS	Operation name	
13-15	b or var.	Cross section no. (1 thru 200) just upstream of intermediate points, right justified	must enter one but not both
16-17	b or var.	Structure no. (1 thru 99) just upstream of intermediate point, right justified.	must enter one but not both
19-21	b or var.	Cross section no. (1 thru 200) just downstream of intermediate points, right justified.	must enter one but not both
22-23	b or var.	Structure no. (1 thru 99) just downstream of intermediate points, right justified.	must enter one but not both
25-30, 37-42, 49-54, 61-66	alpha-meric	Identifier for intermediate points (up to 4 on one statement).	
31-36, 43-48, 55-60, 67-72	*var.	Drainage area in square miles associated with identifier in previous field.	
73-80	b or var.	Record identification (optional)	

Notes: * Decimal point required if not blank.
b Denotes blank.

Example:

	OPERATION	FROM (XSECT / STRUCT)	THRU (XSECT / STRUCT)	INTERMEDIATE POINTS BETWEEN FROM AND THRU XSECTION / STRUCTURES: POINT ID.	DRAINAGE AREA (Sq. Mi.)	POINT ID.	DRAINAGE AREA (Sq. Mi.)	POINT ID.	DRAINAGE AREA (Sq. Mi.)	POINT ID.	DRAINAGE AREA (Sq. Mi.)	RECORD IDENT.
	ENDJOB 2	This record terminates routing computation and precedes the PEAKS record, if any										1621
	PEAKS	6	7	7A	3.9	7B	4.0					1622
	ENDJOB 2	This record terminates routing computation and precedes the PEAKS record, if any										1623

Intermediate point 7A, having a D.A. of 3.9 square miles, and intermediate point 7B, having a D.A. 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 3.10 with subscripts 1 and 2 representing cross sections 6 and 7, and the subscript I representing point 7A and then point 7B.

Figure 3-19.--PEAKS Statement

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

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

and

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

where:

Peak = peak discharge, cfs

D.A. = drainage area, square miles

subscript 1 and 2 = upstream and downstream reference section or structure

subscript I = intermediate location

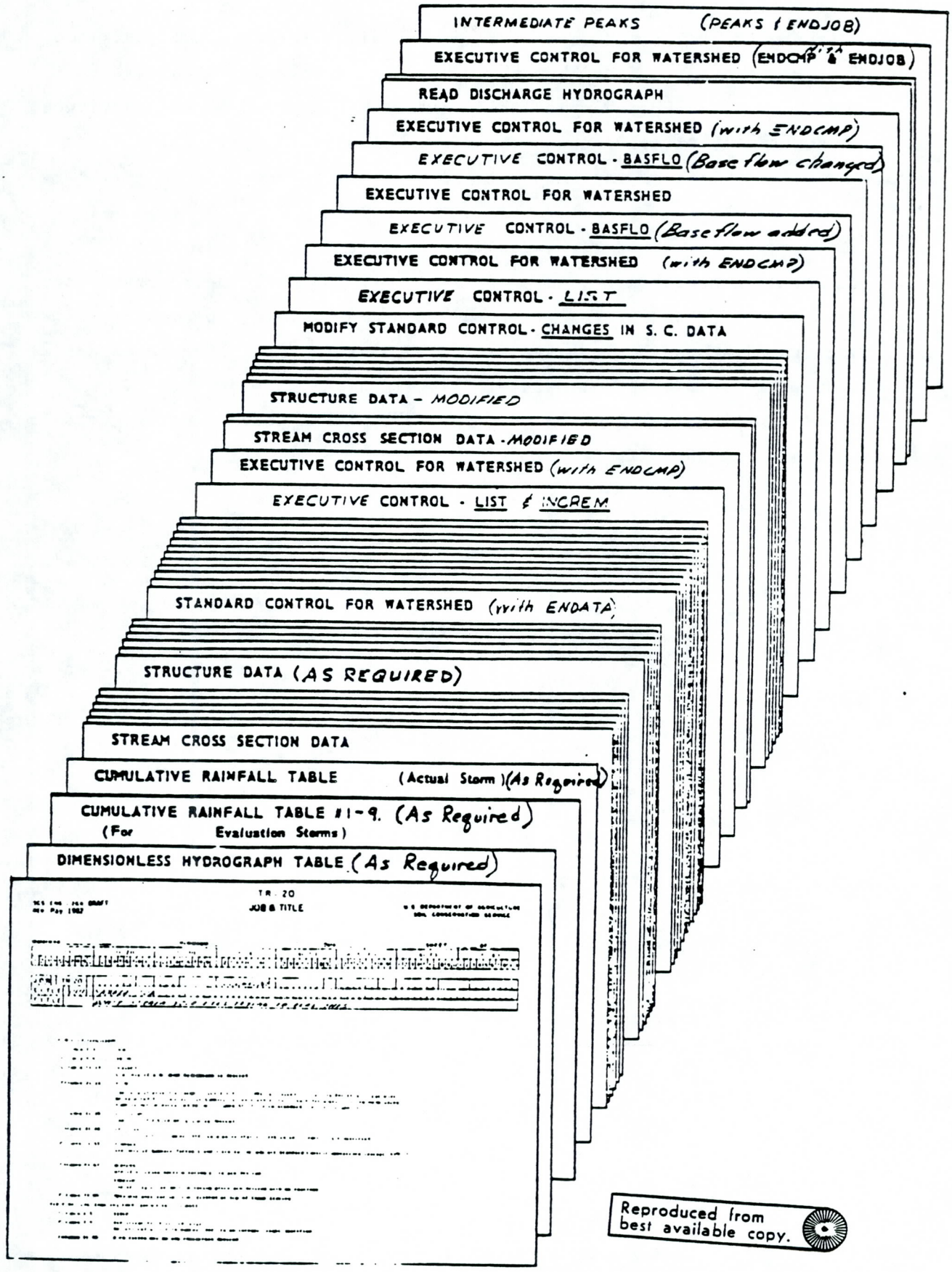
Intermediate peak locations are defined on PEAKS control statements. These statements are placed after the ENDJOB statement at the end of the Executive Control. A second ENDJOB statement is used after the last Intermediate Peaks statement. (See page E-26, records 1620 and 1630). There is no limit to the number of intermediate peaks that can be calculated in a job.

Computed intermediate peaks are displayed in Summary Table 4. The computations are based on Summary Table 3 drainage areas and peaks. Summary Table 4 is similar in format to Summary Table 3. A machine readable intermediate peak file is generated for ECON2/URB1 if the ECON option (columns 21-25) was selected in the JOB statement.

3.11 INPUT DATA SEQUENCE

Figure 3-20 is an example of the order in which the input data should be sequenced for a typical job.

The space labeled "Record Identification" under columns 73 through 80 is usually not filled in until all input data forms for a watershed



Reproduced from best available copy.

FIGURE 3-20.-- Arrangement of data input sheets.

have been completed and placed in order. The numbering in the examples starts with 10 for the first line on the first sheet in the stack and increments by 10. Note that the numbering in columns 73 through 80 commences with 10 on Sample Job 5, Appendix E, page E-5, and continues consecutively to 1630 at the end of the input data, page E-26. These numbers are used in the output to help identify records.

The numbers should be right justified. If there are less than a thousand lines of input, columns 77 through 80 should be reserved for this numbering and if there are one thousand or more, columns 76 through 80 should be reserved (assuming that the beginning number and increment is 10). The remaining columns in the 73 - 80, Record Identification field can be used for abbreviated words, letters, etc. to assist in identifying the data.

CHAPTER 4. OUTPUT DESCRIPTION

The type and amount of output can be controlled by input options on the JOB record (Section 3.3.2) and by the output options on the Standard Control records (Section 3.6.9). Examples of different types of output are shown with the sample jobs in Appendices A through E. If any input or computed value exceeds the number of allowed spaces, asterisks are printed in the print field.

4.1 OUTPUT CATEGORIES

The TR-20 output can be grouped into seven categories for purpose of discussion: input images, message page, page headings, cross section data plots, operation results, summary tables, and output files generated for other SCS programs. Each of these categories is discussed below.

4.1.1 Input Images (80-80 List)

At the start of each run, the input is 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 printed exactly as it was entered. This list is automatic. No data checks are made.

All characters will be printed exactly as they appear on the input records. In later processing, if illegal characters are discovered in any numeric data field the job will not run successfully. This means user comments are not permitted except where specified on the JOB and TITLE records.

4.1.2 Message Page

The message page is printed at the front of each job. It will contain information the user should be aware of when using the 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. The user file number if entered on the first TITLE record is also given on this page.

4.1.3 Page Headings

Headings are printed at the top of each page except for the 80-80 List. In the upper left corner is printed the current date the program was executed (XEQ) and the last program revision (REV) date. The title records are printed in the middle and the current job, pass and page number printed in the upper right corner.

The job number starts at one and is incremented by one when a new JOB record is encountered within the same run. If the HOLDOUT option is used the word HOLDOUT will appear under the job number.

The pass number is incremented within a job, starting at one or at the PASS number entered on the JOB statement. On summary tables the word SUMMARY appears in place of the pass number.

The page numbering is continuous within a run, starting with one on the message page of job one.

4.1.4 Operation Results

The LIST operation 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 have been made. Numeric values may vary one or more digits due to the number of significant digits displayed. All program defined rainfall tables are listed each time. The Executive Control records are not listed. It is recommended that LIST be used primarily the first time all data are entered and then whenever the Standard Control are modified.

Whenever a new COMPUT statement is encountered, the information associated with it will be printed. If the FULLPRINT option is on, the information

will be printed at the top of a new page beneath the page heading. If a new BASFLO or INCREM precedes the COMPUT, it will also be printed. The Record Identification field accompanies each Executive Control printed to help identify it.

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 print the input, give coefficients used in reach routing and list the computed peaks and volume for each operation. The hydrograph data, including both outflow hydrographs for a DIVERT operation, can be obtained if the output options are requested. If the FULLPRINT option is not used, the hydrograph data is printed only if requested on the Standard Control records. Warning messages will be printed regardless of the print option. It is advisable to obtain FULLPRINT the first trial pass through a watershed and in complex watershed situations. The reasons for multiple peaks should be analyzed if they occur. They can be detected only by using FULLPRINT.

4.1.5 Cross-Section Data Plots

Log-log plots of input cross section data are provided to display the discharge-end area curve used in calculating the coefficient m at each cross section elevation. The bankfull discharge and end area are plotted on the axis if the bankfull elevation is given. This 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 eliminated with the NOPLOTS option on the JOB statement. If the ENDPLOT option is used on the JOB statement 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.

4.1.6 Summary Tables

The summary tables provide complete documentation and easier comparisons for checking and analyzing results. The SUMMARY option on the JOB statement will provide information on each Standard Control operation except SAVMOV without having to use the SUM output option (Col. 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.

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 associated with each operation is printed along with the runoff volume, maximum peak discharge, its time of occurrence and the water surface elevation if applicable. The accumulated drainage area and the peak rate in csm are also computed and displayed. Page A-12 is an example of Summary Table 1. All operations (except SAVMOV) for all cross sections, structures, storms and alternates will be 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. The major difference between this table and Summary Table 1 is that the peak discharges and time 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 and storm number. This table is always printed if reach routing was performed. Since the Modified Att-Kin reach routing is new to this program, the user should become familiar with the routing parameters. The parameters are discussed in Appendices G and H. The results of the routing also include the effects of adding an intervening drainage area hydrograph, computed by the RUNOFF operation, directly to the routed outflow hydrograph. The maximum coordinate of the ADDHYD operation is tabulated under the Outflow + Interv. Area column as the peak and time coordinate. If there is no intervening area, these columns will be zero.

The Att-Kin coefficient, C_Y, should be less than 1.0 (preferably less than 2/3) to be consistent with reach length guidelines in Appendix H. If the coefficient is greater than 2/3 the user can reduce the main time increment or increase the reach length to be consistent with the guidelines.

An asterisk after the computed volume of the inflow hydrograph indicates the hydrograph was truncated at some discharge above baseflow. A significant truncation may affect the routing results and cause loss of runoff volume and the job should be rerun with adjustments to subarea size and the main time increment to keep within the 300 point limit if possible. Page A-12 is an example of Summary Table 2. Each REACH operation is displayed regardless of the summary options specified.

Summary Table 3. -- This table is a listing of the maximum peak discharge ordered by cross section or structure ID number, by alternate number and by storm number. The peak discharges are sorted 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 Table 3.

The format displayed is similar to the file generated when the ECON output option is entered on the JOB statement. Summary Table 3 is obtained along with Summary Table 1 whenever the SUMMARY or individual SUM output options are specified as described under the first paragraph of Section 4.1.6. Page A-16 is an example of Summary Table 3.

Summary Table 4. -- This is a tabulation of the intermediate peaks 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. Page E-62 is an example of Summary Table 4.

4.1.7 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 any storage media available on the computer system (i.e., disk, magnetic tape or punch cards). The media for each file is specified with the operating system control language. Table 3-X contains the file names and general contents for such files.

The following describes the types of files that can be saved for future use:

Discharge Hydrographs. -- These are generated in the format of the Read Discharge-Hydrograph Table (Section 3.7.5). For each job, each hydrograph generated is numbered consecutively starting with one. The hydrographs might be processed and plotted by a graphics program, re-entered into another segment of TR-20 or inserted into the DAMS2 computer program for further processing. To obtain this file, the FILE output option (col. 69) on the Standard Control operation must be set to 1. See page B-13 for an example of a discharge hydrograph file.

Holdout Hydrograph. -- These are similar to discharge hydrographs except the discharges are the difference between the inflow and outflow hydrographs at the structure sites. The holdout hydrographs have positive values when inflow exceeds outflow and negative values when outflow exceeds inflow.

(Not operational)

To obtain the downstream effects of a structure, the holdout hydrograph for a storm should be routed downstream and subtracted from the storm hydrograph for the total watershed with null structures above each point of interest. The TR-20 Modified Att-Kin program can produce the holdout hydrographs at the sites and the hydrographs for the entire watershed with separate JOB statements and Standard Control for each. However, the user may have to perform the reach routing for the holdout hydrographs. The Modified Att-Kin method is not applicable to multiple routings through the same reach where the individual hydrographs are added together to produce the total flood hydrograph. The program

will also not perform the subtraction from the total hydrograph at selected downstream points. See Section 3.3.2.1 for specific requirements for holdout hydrographs. To obtain holdout hydrographs the HOLDOUT option must be on the JOB statement and the FILE output option (col. 69) on the Standard Control operation must be set to 1.

ECON2/URB1 Flow-Freq. Data. -- These are generated from Summary Table 3 and Summary Table 4 peak discharge data. The storms are sorted by alternate and ordered by magnitude of the peak ~~within each alternate~~, so that the largest peak value is generated first regardless of the storm number and the lowest peak value is generated last. 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 format required as input to the Project Formulation - Economics (ECON2) and the Urban Floodwater Drainage Economic Evaluation (URB1) computer programs. The ECON option on the JOB statement (col. 21-24) and either the SUMMARY option (col. 51-57) on the JOB statement or the SUM output option (col. 71) on the Standard Control operation must be used to save the desired information for Summary Table 3. See page E-63 for an example of an ECON peak discharge file.

4.2 INTERPRETATION OF OUTPUT DATA

Printouts of output data for Sample Jobs 1 through 5 are in Appendices A through E. Output data should be checked for consistency, error or warning messages and reasonable results. The following table (Table 4.1) 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 and alternates by storm from Sample Job 5, is only one method that the many factors such as peak time, peak discharge (csm) and runoff volume can be tabulated. Only the structure sites and ADDHYD operations on the main stream were selected for comparison in the example.

Table 4.1

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

	ID	Σ DA (sq. mi)	Alternatives 1/ 1	2	3	4
Storm #1 (5.2" Rainfall = ___ yr. Frequency)						
Structure	01	1.20	2095	923	923	2105
Addhyd	001	1.66	1681	1071	1067	1689
Reach	002	1.66	1397	980	976	1405
Structure (Lat.)	02 2/	0.44	817	246	-	-
Structure (Lat.)	03	0.75	-	-	36	523
Addhyd	004	2.41	1587	1195	987	1675
Reach	005	2.41	928	801	599	948
etc.						
Storm #2 (2.6" Rainfall = ___ yr. Frequency)						
Structure	01	1.20	528	153	153	534
Addhyd	001	1.66	360	190	187	362
Reach	002	1.66	305	175	173	307
Structure (Lat.)	02	0.44	232	99	-	-
Structure (Lat.)	03	0.75	-	-	13	144
Addhyd	004	2.41	395	247	176	398
Reach	005	2.41	244	193	144	251
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

2/ Lat. is abbreviation for lateral

Note: Baseflow varies between alternates.

4.3 CALIBRATION OF THE MODEL

Calibration of the resultant TR-20 hydrologic model with a stream gage in or downstream of the watershed can be accomplished in several ways. One method is to compare the frequency discharge relationship developed by TR-20 with the relationship developed from statistical analysis of the stream gage data. Another method is to run data from actual storms through the model and compare the peaks, volumes and hydrograph shapes with stream gage data and high water marks. Still another method is to combine the two methods above. The extent of calibration depends on the purpose the hydrologic model serves. If no stream gage data is available for calibration, the model should be verified with historical flood information such as rainfall data, highwater marks and past flood history. Applicable stream gage information from regional studies should also be used for comparisons.

4.4 ERROR DETECTION

Errors in the input data are the most serious problem especially for an inexperienced user. This section is included to assist the user in finding and solving error problems.

4.4.1 TR-20 Output Error Messages

The following explanation of error messages written by the TR-20 program should help to determine the cause of a particular problem. Those messages deemed self explanatory are not included here. This list is alphabetized to help the user find a specific message.

BASEFLOW HYD BASETIME EXCEEDS 300 PTS -- BASEFLOW NOT ADDED, CALLING EXIT.
HYD BASETIME = XXX

The base time entered in Data Field #3 of the 7 BASFLO 5 statement divided by the main time increment (Data Field #1 of the 7 INCREM 6 statement) exceeds 300. The base flow hydrograph is truncated at the 300th point. Summary tables are printed to this point and data is scanned for the next JOB statement.

CROSS SECTION NUMBER XXX EXCEEDS LIMIT OF 200. CALLING EXIT.

There is a limit of 200 cross sections and the greatest cross section number cannot be greater than 200. Processing ceases without further action.

***ERROR - FOLLOWING RECORD IS INCORRECT OR OUT OF PLACE.
>>>Record Image is written here. <<<

UNRECOVERABLE ERROR. CALLING EXIT

For example, tabular data with no header statement will produce this error. Summary tables are printed to this point and data is scanned for another JOB statement.

The next error message to be discussed here consists of the following lines:

ERROR IN MAIN PROGRAM AT STATEMENT NUMBER XXX. SEE USER MANUAL FOR INTERPRETATION

CURRENT EXECUTIVE CONTROL RECORD FOLLOWS:
>>>Record image is written here. <<<

LAST RECORD READ IS:
>>>Record image is written here. <<<

UNRECOVERABLE ERROR. CALLING EXIT.

Calculations stop at this point and results are printed in the summary tables. The type of error is indicated by statement number XXX of the main program as shown above. Following is a discussion of the errors signified by each number:

220 - A Standard Control statement (data code 6) was found mixed with Executive Control statements (data code 7) or a Data Code (col. 2) was found to be negative.

320 - An Operation Code on an Executive Control statement is negative.

360 - A READHD 8 or a READHD 9 statement occurs out of the proper sequence in the input data.

410 - The cross section/structure on the INSERT record was not found in the Standard Control list. It may have read past the insert location from a previous ALTER or DELETE.

440 - In attempting to find the last cross section/structure in a series in an INSERT operation, the ENDATA record was encountered. An insert cannot be made after the last Standard Control record.

500 - Same as 410, except it occurred during an ALTER or DELETE operation.

600 - A COMPUT statement has a negative "From" cross section number.

620 - (1) an ENDCMP 1 statement was left out, or (2) the "From" cross section on an Executive Control statement was not found in the Standard Control file, or (3) the starting cross section on the new COMPUT statement is the same as the ending cross section on the previous COMPUT statement within a pass.

640 - Both the "To" cross section and the "To" structure fields were blank or zero on an Executive Control statement.

670 - The "From" cross section number on a COMPUT statement is negative number.

690 - The "From" structure on an Executive Control statement was not found in the Standard Control file.

730 - Both the cross section and structure numbers were zero or blank on a Standard Control statement.

***TABULAR DATA ERROR -- 1) TOO MANY POINTS; 2) NO ENDTBL: 3) DATA CODE NOT EQUAL TO 8. RECORD CAUSING ERROR FOLLOWS.
>>>Record image is written here. <<<

Either a 9 ENDTBL statement is omitted, no data statements were included or more than the maximum number of data statements were read. Summary tables are printed to this point and data is scanned for another JOB statement.

IPEAKS - UNEXPECTED RECORD FOUND (IGNORED).
>>>Record Image is written here. <<<

Program is looking for a PEAK or ENDJOB record, but the above record was read and ignored.

MAIN - UNEXPECTED RECORD FOUND (IGNORED).
>>>Record image is written here. <<<

Program is looking for a JOB or PEAK record, but the above record was read and ignored.

RAINTABLE NUMBER XX HAS NOT BEEN LOADED. JOB CANCELLED AND SUMMARY PRINTED TO THIS POINT.

UNRECOVERABLE ERROR. CALLING EXIT

The raintable number specified on the COMPUT statement was not loaded. Summary tables are printed to this point and data is scanned for another JOB statement.

RATING TABLE FOR INFLOW XSECTION/STRUCTURE XXX/YY OR OUTFLOW XSECTION XXX HAS ONE POINT OR LESS -- ERROR

One of the two rating tables specified in procedure 2 of the DIVERT subroutine has only one point or has not been entered. Inflow hydrograph transferred to outflow storage location #1.

***RECORD OUT OF PLACE AT OR FOLLOWING RECORD PRINTED BELOW. CALLING EXIT. >>>Record image is written here. <<<

A statement with a data code (column 2) less than 7 is in the indicated table. ENDATA is misspelled or statement missing data code. Summary tables are printed to this point and data is scanned for next JOB statement.

SUMMARY - TOO MANY COMBINATIONS OF ALTERNATES, STORMS, AND XSECTION/STRUCTURES ONLY THE FIRST XX ALTERNATES ARE INCLUDED FOR THE YY STORMS AND ZZZ XSECTIONS/STRUCTURES.

The maximum number of peaks that can be saved for the summary tables is 24,000. Too many peaks were generated. All peaks from combinations beyond the limit have been ignored.

*** WARNING - MAIN TIME INCREMENT MAY BE TOO LARGE. COMPUTED PEAK (XXXXXXX.XX) AT XSECTION XXX (OR STRUCTURE XX) EXCEEDS MAX. ADJACENT HYDROGRAPH COORDINATE BY YY%

The calculated peak discharge is more than 5 percent above the largest adjacent tabular hydrograph value. This message is printed only for peaks that exceed 25% of the maximum hydrograph coordinate. The hydrograph is automatically printed with this message.

*** WARNING - INFLOW EXCEEDED MAX. FLOW IN XSECTN TABLE XXX BY YY.Y CFS.

Inflow discharge exceeded the maximum flow value in cross section number XXX. Flow and area were linearly extrapolated for the reach routing and processing continued.

***WARNING - LACK OF LOW FLOW DEFINITION FOR XSECT TABLE XXX. MAX. FLOW LESS THAN TABLE VALUES.

The peak discharge tried to be used is less than the first non-zero point on the rating table. The m value below the second point is based on the slope below the second and third points. Additional data points below the peak flow under consideration will provide a better estimate of m.

***WARNING - REACH ZZZ INFLOW HYDROGRAPH VOLUME TRUNCATED ABOVE BASEFLOW AT XX.X CFS, Y.YY % OF PEAK.

The inflow hydrograph to the reach routing was truncated at 300 points, which affects the computed volume and the accuracy of succeeding reach routings. At the point of truncation, the discharge minus baseflow was YYY percent of the peak flow.

***WARNING - XSECTION YYY (OR STRUCTURE YY) RUNOFF VOLUME TRUNCATED WHEN ADDING HYDROGRAPHS STORED IN LOCATIONS XX AND XX

Hydrographs with different time increments are added together using the current main time increment. In the process some volume was lost.

4.4.2 Fortran Diagnostic Messages

When input data do not conform to what are expected by the computer, the computer may try to make a standard fixup. Depending upon the seriousness of the error, the results may or may not be accurate. For instance, an error in the title will have little effect on the results, but an omitted runoff curve number, time of concentration or reach length will significantly change the answer. If the fixup is performed, a value of 0 is usually assumed. The user should carefully examine results that occur after any diagnostic messages in the output.

Diagnostic messages are produced by the Fortran library for certain errors occurring during execution of a TR-20 program. Different computer systems will produce slightly different forms of these diagnostic messages. The messages have the following form:

IHNXXXI IBCOM - Description

where - IHNXXXI is an error code. The first three characters may be other than IHN, and XXX is a three digit code number;

- IBCOM is the Fortran routine where the error occurred.

Those messages most likely to occur during a TR-20 run are summarized below:

IHN207I IBCOM - Program Interrupt - Overflow

This indicates that an exponent overflow occurred and occurs when the result of a decimal number arithmetic operation is greater than the largest decimal number that can be represented in the computer (approximately 7.2×10^{75} on IBM S370). TR-20 execution continues with the result of the arithmetic operation set to the largest number possible on the computer.

IHN208I IBCOM - Program Interrupt - Underflow

This indicates a similar problem as above, except that it results in an exponent underflow (on IBM S370, a number less than approximately 5.4×10^{-79}). Execution continues with result set to true zero.

IHN209I IBCOM - Program Interrupt - Divide Check

This messages indicates an attempt was made to divide by zero.

IHN215I CONVERT - Illegal Decimal Character X

An invalid character was found during an attempt to read a decimal field. The record is displayed with the illegal character replaced with a zero. The x represents the illegal character.

IHN217I FIOCS - END OF DATA SET ON UNIT XX

An attempt to read past an end-of-file was made in input unit number XX. This usually means that an ENDJOB statement was omitted at the end of the input data.

IHN218I FIOCS I/O ERROR WRNG. LEN. RECORD

An attempt was made to read a variable length record file that has no records in it.

4.4.3 Computer System Messages

The most frequent computer system message occurs when the TR-20 execution time exceeds the time allotted by the user. On an IBM S370 this message is

ABEND S322

where - ABEND means the job ended (aborted) abnormally
- S322 is a system code meaning that allowable CPU time was exceeded.

This means that the job was not completed within the time limit prescribed by the user. There are two causes for this:

1. The user misjudged the time required for the job to execute.
2. The program went into a loop due to some error made in the input data - usually statements omitted or out of order.

4.4.4 Checking Input and Output

The user must always check input for accuracy and completeness and check output for reasonableness. There are a number of precautions to be taken and checks to 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 Data Fields 1, 2, and 3 on the Standard Control statements and in all 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 data in decimal fields. Therefore, if the decimal is omitted, the Fortran format default decimal will cause the number read to be larger than it actually is. This will frequently result in asterisks printed in corresponding numeric fields in the output.

2. The first part of the output is a list of the input data. This should be CAREFULLY checked for correctness.

3. All tabular data and all Standard Control data, followed by an ENDATA statement must precede the Executive Control statements. There are two exceptions to this:

   a. The READHD table must follow the ENDATA statement - otherwise, the program will go into a loop and ABEND with maximum time.
   b. Standard Control statements that follow INSERT, ALTER or DELETE Executive Control statements.

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

5. 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. This applies to the 80-80 Listing of Input Data as well as the remainder of the TR-20 output.

6. Check the cross section elevation-discharge-end area tables for increasing values with successive elevations.

7. Check the structure elevation-discharge-storage tables for the following:

   a. The warning in section 3.7.4 has not been violated.
   b. Successive discharge and storage values must increase.

Unexplained multiple peaks or negative discharge values in the outflow hydrograph may be caused by errors in this table.

8. The "Surf. El at T=0" field on the RESVOR statement may contain an elevation lower than the lowest elevation in the corresponding STRUCT table, but it must not contain an elevation higher than any value in the table. It also must not contain an elevation higher than the principal spillway crest elevation or the pool elevation at the beginning of routing - otherwise the apparent volume and discharges will be increased.

4.5 SAMPLE JOBS

Five sample jobs are shown in the Appendices A through E. Each job begins with a schematic sketch and ends with the TR-20 output listing. The features demonstrated in each job are listed in Table 4.2 according to the first occurrence of a feature. A feature may also occur in succeeding jobs.

Table 4.2 -- Features Demonstrated in Sample Jobs

SAMPLE JOB #	FEATURE DEMONSTRATED[1]
1	80-80 List of Input Data
	JOB and TITLE Records
	FULLPRINT
	Dimensionless Rain Table (RAINFL)
	(Using program defined table)
	Structure Data Table (STRUCT)
	Standard Control Operations
	RUNOFF
	RESVOR (Starting elevation = prin. spwy. elev.)
	REACH (x and m input data)
	ENDATA
	Output Options
	HYD
	ELEV
	SUM
	Executive Control Operations
	INCREM
	COMPUT
	ENDCMP
	ENDJOB
	Summary Tables 1, 2 and 3
2	JOB Statement
	Noprint
	SUMMARY

Standard Control Operations
- RESVOR (Starting elevation left blank)
- ADDHYD
- Output Options
  - PEAK
  - VOL
  - FILE

SAMPLE JOB #	FEATURE DEMONSTRATED[1]
3	Actual Rain Table Cross Section Data Table (XSECTN) Standard Control Operations SAVMOV DIVERT (Procedure #1) REACH (Using Cross Section Data) Rainfall delayed 2½ hours on ½ of watershed Plot of discharge vs. Cross Sectional Area
4	Read-Discharge-Hydrograph (READHD) Tzero
5	JOB Statement NOPLOT Standard Control Operation DIVERT (Procedure #2) Modify Standard Control INSERT ALTER DELETE Peak Discharge File (ECON Option) Four alternatives with two storms each Executive Control Operations LIST BASFLO (Constant and triangular) Intermediate Peaks - PEAKS Summary Table 4 (For ECON2)

CPU time on IBM 3033

Sample Job #1 = 0.49 seconds
Sample Job #2 = 0.66 seconds
Sample Job #3 = 1.16 seconds
Sample Job #4 = 0.81 seconds
Sample Job #5 = 7.97 seconds

[1]First appearance of feature; may appear in subsequent sample jobs.

TECHNICAL RELEASE 20
COMPUTER PROGRAM FOR PROJECT FORMULATION
HYDROLOGY
REFERENCES

American Society of Civil Engineers, Nomenclature for Hydraulics, Manuals and Reports on Engineering Practice., No. 43, New York, N.Y., 501 pp., 1962.

USDA, Soil Conservation Service, Computer Program for Project Formulation - Structure Site Analysis (DAMS2), Technical Release No. 48 (TR-48), March, 1971.

USDA, Soil Conservation Service, Earth Dams and Reservoirs, Technical Release No. 60 (TR-60), August, 1981. (Amended February, 1982)

USDA, Soil Conservation Service, Hydrology, National Engineering Handbook, Section 4, (NEH-4), August, 1972.

USDA, Soil Conservation Service, Simplified Dam-Breach Routing Procedure, Technical Release No. 66 (TR-66), March, 1979.

USDA, Soil Conservation Service, WSP2 Computer Program, Technical Release No. 61 (TR-61), May, 1976.

Wylie, C.R. Jr., Advanced Engineering Mathematics, Third Edition, McGraw-Hill Book Co., 813 pp., 1966.

GLOSSARY

A A - cross sectional 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 - The degree of wetness of the soil in a watershed at the beginning of a storm.

AMC - See antecedent moisture condition

ATT-KIN - The Attenuation - Kinematic Flood Routing Method. See Appendix G.

B 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 CN - See runoff curve number

cfs - See 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.

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 across the axis. 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 area.

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 ΔD - (1) The unit hydrograph time increment, in hours. (2) The duration of unit excess rainfall.

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.

Drainage area - The surface area draining into a stream at a given point.

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 storage location - A location within the computer used 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.

J Job - The execution of TR-20 from initialization at the beginning through close out at the end; may include any number of passes through the program.

K k - coefficient in the discharge valley storage relation, $Q = kS^m$, that is applicable for the valley through a channel reach.

L Line - The collection of horizontal spaces across an input data sheet including any data that may have been entered in those spaces: a line becomes a record when input to the computer.

M m - (1) Exponent in the discharge valley storage relation, $Q = kS^m$, that is applicable for the valley through a channel reach. (2) Exponent in the discharge cross sectional area relation, $Q = xA^m$, that is applicable for the valley thru a channel reach.

N NEH-4 - SCS National Engineering Handbook, Section 4, Hydrology. See References.

Null Structure - A non-functional or dummy structure that is used to indicate a potential structure location for use in other alternatives.

Q ΔQ - Incremental runoff volume, in watershed inches.

Q - (1) Total runoff volume, in watershed inches. (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 data for computer processing.

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 - A dimensionless number of 100 or less that relates runoff to the soil-cover complex of the watershed. Higher numbers mean greater runoff.

S S - A measure of volume expressed in acre-feet or watershed inches; valley storage within a channel reach for a selected discharge;

Statement - A record consisting of a control word such as JOB, COMPUT or DELETE together with the other data corresponding to that control word.

Storm - (1) A meteorological disturbance accompanied by such phenomena as rain, snow, hail, thunder and lightning, and wind, although wind storms may be described in accordance with the material such as dust and sand which is carried in suspension in the air. (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.

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 only.

Δt - Main time increment. The user selected time interval at which hydrographs are reach or reservoir routed, stored, and printed.

T T_c - See time of concentration.

Time of concentration - the time, in hours it takes water from the hydraulically most distant point to reach a watershed outlet. T_c varies with discharge but is often used as constant.

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.

Travel time - 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 T_c but is never the whole T_c.

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.

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 valley reach.

XSECTN - See cross section.

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 minute
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. mile
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 minute	0.002228	cfs
million U. S. gallons per 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	metres
inches	*25.4	millimetres
feet	*0.3048	metres
acres	0.40469	hectares
acres	4046.9	square metres
gallons (U. S.)	3.7854	litres
pounds	0.45359	kilograms
cubic metres	*1000.0	litres
acre-feet	1233.5	cubic metres
cubic feet	0.028317	cubic metres
square feet	0.09290	square metres
square miles	2.590	square kilometres
cfs-hours	101.94	cubic metres
csm	0.010933	cubic metres/second/sq. kilometre

*Exact conversion

APPENDIX A

SAMPLE JOB NØ. 1

Contents

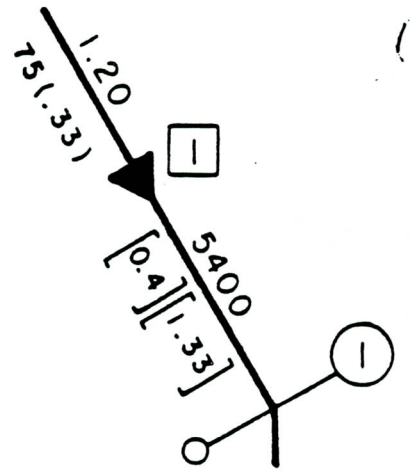
	Page
Schematic Drawing	A-2
Input Data Sheets	A-3
Printout	A-7

A-2

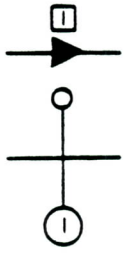
SCHEMATIC DRAWING OF SAMPLE WATERSHED

Sample Job No. 1

(Structure 1 in place)



LEGEND



Structure Number 1

Cross Section Number 1
(at downstream end of reach)

$$\frac{5400}{[0.4][1.33]} \quad \frac{\text{Reach Length - Feet}}{[\text{End Area Coeff (x)}][\text{Exponent (M)}]}$$

$$\frac{1.20}{75\ (.33)} \quad \frac{\text{Drainage Area - Square Miles}}{\text{Runoff Curve Number (Time of Concentration-Hours)}}$$

SCS-ENG.-264 DRAFT
REV. May 1982

TR-20
JOB & TITLE

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed SAMPLE JOB 1 Hydrologist JEZ Date 5/24/82 SHEET 1 OF 4

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
JOB TR-20			FULLPRINT				10
TITLE 001	SAMPLE JOB 1 USING 24HR TYPE II STORM FROM STR 1 TO XSECT 1						20
TITLE	INCLUDES GIVEN REACH COEFF'S, FULLPRINT/ALL OUTPUT OPTIONS ON						30

JOB Record (required)

Columns 1-3	JOB
Columns 5-9	TR-20
Columns 11-17	HOLDOUT Use only if a holdout hydrograph is desired.
Columns 21-24	ECON Use only if peak discharge output for ECON2/URB1 is desired. Locations for this output must be selected for inclusion in Summary Tables 1 and 3 also. Such designation can be made using summary option explained below (columns 51-57) or on Standard Control (column 71).
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 61-67	NOPLOTS Use if no cross section rating plots are desired. ENDPLOT Use if only cross section rating plots are desired with no routings.
Columns 73-80	Optional user information, printed at top of input listing.

TITLE Records (one required, second is optional)

Columns 1-5	TITLE
Columns 7-9	XXX (first TITLE record only). An optional user file number, XXX, is an integer, right justified.
Columns 11-80	Both titles may be any characters desired.

SCS-ENG.-269 DRAFT
REV. May 1982

TR-20
STRUCTURE DATA
STRUCTURE NO. 1

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

A-4

Watershed SAMPLE JOB 1 Hydrologist JEZ Date 5/24/82 SHEET 2 OF 4

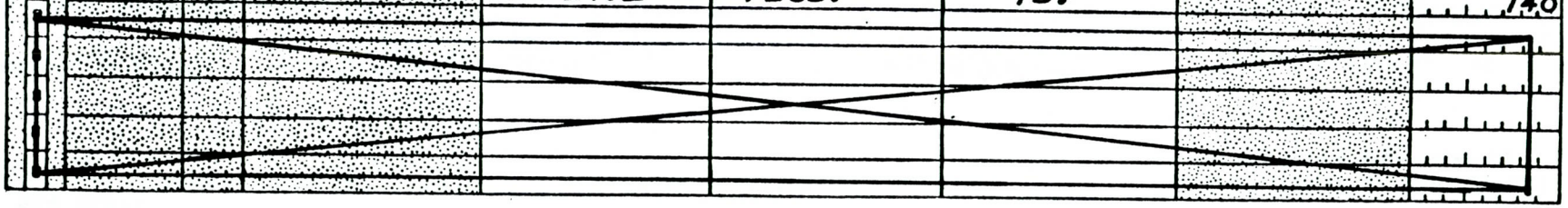
1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE / TABLE NAME		DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3			RECORD IDENT.

IMPORTANT: Line out unused lines. Data fields require decimal points.

		STRUCTURE ID. (01-99)				
3	STRUCT	01				40

NOTE: Maximum of 20 data records allowed.

	Elevation, Ft.	Discharge, CFS	Storage, Acre, Ft.		
8	521.5	0.0	17.0		50
8	521.6	3.0	18.0		60
8	521.8	15.	20.2		70
8	522.0	33.	22.5		80
8	522.2	54.	25.0		90
8	522.4	79.	28.0		100
8	526.2	948.	70.		110
8	526.4	1009.	75.		120
8	526.6	1071.	80.		130
8	527.2	1265.	95.		140



9	ENDTBL	NOTE: This record must be the last record of this table.	150

SCS-ENG.-273 DRAFT
REV. May 1982

TR-20
STANDARD CONTROL FOR WATERSHED

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed SAMPLE JOB 1 Hydrologist JEZ Date 5/24/82 SHEET 3 OF 4

DATA CODE	OPERATION NAME	OPERATION NO.	XSECT ID.	STRUCT ID.	HYDRO NUMBER INPUT #1	HYDRO NUMBER INPUT #2	HYDRO NUMBER OUTPUT	DATA FIELD #1	DATA FIELD #2	DATA FIELD #3	OUTPUT OPTIONS PRINT PEAK	PRINT HYD	PRINT ELEV	PRINT VOL	FILE	SUM	RECORD IDENT.
EXAMPLES DO NOT ENTER																	
6	RUNOFF	1					6	AREA, SQ. MI.	RUNOFF CURVE NO.	T_c, HRS.							
6	RESVOR	2			6		7	SURF. EL. AT T=0, FT.									
6	REACH	3			7		5	LENGTH, FT.	(OPTIONAL) END AREA COEFF (X)	(OPTIONAL) EXPONENT (M)							
6	ADDHYD	4			5	6	7										
6	SAVMOV	5			FROM IN		TO OUT1										
6	DIVERT	6					TO OUT2	OUT1 DISCHARGE, CFS	OUT 1, Decimal % D.A.	OUT2, I.D.							
	ENDATA							This record is to be used only at end of all standard control records.									
			(Right justify these fields)					IMPORTANT: Data Fields No. 1,2, and 3 require decimal points.									
6	RUNOFF	1		01			6	1.20	75.	0.33	1	1		1		1	160
6	RESVOR	2		01	6		7	521.5			1	1	1	1		1	170
6	REACH	3	001		7		5	5400.	0.4	1.33	1	1		1		1	180
	ENDATA																190

NOTE: This form was suggested by members of Massachusetts Planning Staff.

112

A-5

SCS-ENG.-274 DRAFT
REV. May 1982

TR-20
EXECUTIVE CONTROL FOR WATERSHED

U.S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

A-6

Watershed SAMPLE JOB 1 Hydrologist JEZ Date 5/24/82 SHEET 4 OF 4

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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	OPERATION		DATA FIELD # 1	DATA FIELD # 2	DATA FIELD # 3		RECORD IDENT.
7	LIST		This record is used for printout of tabular data and standard control list that are currently effective				
7	BASFLO	5	NEW BASE FLOW, CFS or VOLUME IN INCHES	IF VOLUME IS IN DATA FIELD No 1: PEAK TIME, HOURS / BASE TIME, HOURS			
7	INCREM	6	MAIN TIME INCREMENT, HRS.	This increment is required for initial computations. Remains in force until new increment is entered.			

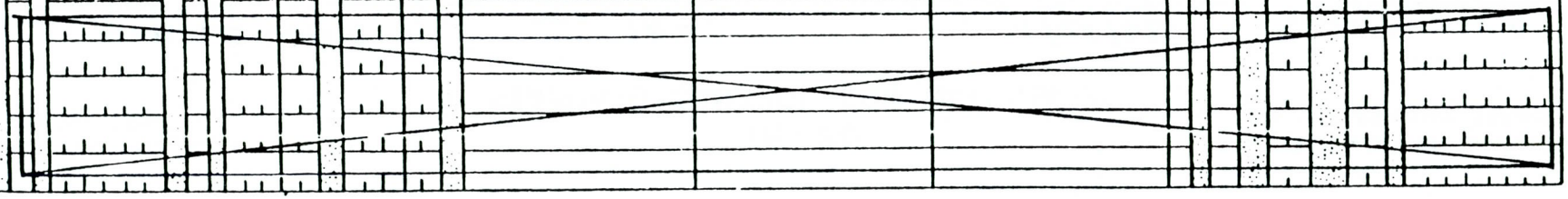
EXAMPLES DO NOT ENTER

			FROM (OR XSECT / STRUCT)	THRU (OR XSECT / STRUCT)	STARTING TIME HOURS	RAINFALL DEPTH INCHES (Set depth and duration to 10 for actual rainfall)	RAINFALL DURATION HOURS	RAIN TABLE NO.	AMC	ALTERNATE NO.	STROM NO.	EXAMPLES DO NOT ENTER
7	COMPUT	7										
	ENDCMP	1	This record is required at "end" of a watershed, it may follow a series of COMPUT records									
	ENDJOB	2	This record terminates routing computation and precedes the PEAKS record, if any									

Right justify these fields

IMPORTANT: Data Fields No 1, 2, and 3 require decimal points.

7	INCREM	6			0.1							200
7	COMPUT	7	01	001		5.2	1.0	2	2	01	01	210
	ENDCMP	1										220
	ENDJOB	2										230



113

```
********************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY********************

JOB TR20                                FULLPRINT                                    00000010
TITLE 001 SAMPLE JOB 1  USING 24HR TYPE II STORM FROM STR 1 TO XSECT 1               00000020
TITLE     INCLUDES GIVEN REACH COEFF'S, FULLPRINT/ALL OUTPUT OPTIONS ON              00000030
 3 STRUCT       01                                                                   00000040
 8                          521.5          0.0          17.0                        00000050
 8                          521.6          3.0          18.0                        00000060
 8                          521.8          15.          20.2                        00000070
 8                          522.0          33.          22.5                        00000080
 8                          522.2          54.          25.0                        00000090
 8                          522.4          79.          28.0                        00000100
 8                          526.2          948.         70.                         00000110
 8                          526.4          1009.        75.                         00000120
 8                          526.6          1071.        80.                         00000130
 8                          527.2          1265.        95.                         00000140
 9 ENDTBL                                                                          00000150
 6 RUNOFF 1     01      6 1.20           75.          0.33          1 1   1    1 00000160
 6 RESVOR 2     01 6    7 521.5                                     1 1 1 1    1 00000170
 6 REACH  3 001    7    5 5400.          0.4.         1.33          1 1   1    1 00000180
   ENDATA                                                                          00000190
 7 INCREM 6             0.1                                                       00000200
 7 COMPUT 7     01 001                   5.2          1.0           2 2  01   01 00000210
   ENDCMP 1                                                                        00000220
   ENDJOB 2                                                                        00000230

**********************************END OF 80-80 LIST**********************************
```

FILE NO. 1

A-8

COMPUTER PROGRAM FOR PROJECT FORMULATION - HYDROLOGY USER NOTES

THE USERS MANUAL FOR THIS PROGRAM IS THE MAY 1982 DRAFT OF TR-20. CHANGES FROM THE 2/14/74 VERSION INCLUDE:

REACH ROUTING - THE MODIFIED ATT-KIN ROUTING PROCEDURE REPLACES THE CONVEX METHOD. INPUT DATA PREPARED FOR PREVIOUS PROGRAM VERSIONS USING CONVEX ROUTING COEFFICIENTS WILL NOT RUN ON THIS VERSION.

THE PREFERRED TYPE OF DATA ENTRY IS CROSS SECTION DATA REPRESENTATIVE OF A REACH. IT IS RECOMMENDED THAT THE OPTIONAL CROSS SECTION DISCHARGE-AREA PLOTS BE OBTAINED WHENEVER NEW CROSS SECTION DATA IS ENTERED. THE PLOTS SHOULD BE CHECKED FOR REASONABLENESS AND ADEQUACY OF INPUT DATA FOR THE COMPUTATION OF "M" VALUES USED IN THE ROUTING PROCEDURE.

GUIDELINES FOR DETERMINING OR ANALYZING REACH LENGTHS AND COEFFICIENTS (X,M) ARE AVAILABLE IN THE USERS MANUAL. SUMMARY TABLE 2 DISPLAYS REACH ROUTING RESULTS AND ROUTING PARAMETERS FOR COMPARISON AND CHECKING.

HYDROGRAPH GENERATION - THE PROCEDURE TO CALCULATE THE INTERNAL TIME INCREMENT AND PEAK TIME OF THE UNIT HYDROGRAPH HAVE BEEN IMPROVED. PEAK DISCHARGES AND TIMES MAY DIFFER FROM THE PREVIOUS VERSION. OUTPUT HYDROGRAPHS ARE STILL INTERPOLATED, PRINTED, AND ROUTED AT THE USER SELECTED MAIN TIME INCREMENT.

INTERMEDIATE PEAKS - METHOD ADDED TO PROVIDE DISCHARGES AT INTERMEDIATE POINTS WITHIN REACHES WITHOUT ROUTING.

OTHER - THIS VERSION CONTAINS SOME ADDITIONS TO THE INPUT AND NUMEROUS MODIFICATIONS TO THE OUTPUT. USER OPTIONS HAVE BEEN MODIFIED AND AUGMENTED ON THE JOB RECORD, RAINTABLES ADDED, ERROR AND WARNING MESSAGES EXPANDED, AND THE SUMMARY TABLES COMPLETELY REVISED. THE HOLDOUT OPTION IS NOT OPERATIONAL AT THIS TIME.

PROGRAM QUESTIONS OR PROBLEMS SHOULD BE DIRECTED TO HYDRAULIC ENGINEERS AT THE SCS NATIONAL TECHNICAL CENTERS:

BROOMALL, PA (NORTHEAST) -- 489-3229 (FTS). FORT WORTH, TX (SOUTH) -- 334-5242 (FTS)
LINCOLN, NB (MIDWEST) -- 541-5318 (FTS). PORTLAND, OR (WEST) -- 423-2357 (FTS)
OR HYDROLOGY UNIT, NATIONAL ENGINEERING STAFF, LANHAM, MD -- 436-7383 (FTS).

PROGRAM CHANGES SINCE MAY 1982:

NONE

EXECUTIVE CONTROL OPERATION INCREM MAIN TIME INCREMENT = 0.10 HOURS RECORD ID 00000200

EXECUTIVE CONTROL OPERATION COMPUT FROM STRUCTURE 1 TO XSECTION 1 RECORD ID 00000210
STARTING TIME = 0.0 RAIN DEPTH = 5.20 RAIN DURATION= 1.00 RAIN TABLE NO.= 2 ANT. MOIST. COND= 2
ALTERNATE NO.= 1 STORM NO.= 1 MAIN TIME INCREMENT = 0.10 HOURS

OPERATION RUNOFF STRUCTURE 1
OUTPUT HYDROGRAPH= 6
AREA= 1.20 SQ MI INPUT RUNOFF CURVE= 75. TIME OF CONCENTRATION= 0.33 HOURS
INTERNAL HYDROGRAPH TIME INCREMENT= 0.0440 HOURS

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
12.10	2097.04	(RUNOFF)
16.46	76.40	(RUNOFF)
17.66	64.19	(RUNOFF)
19.66	51.94	(RUNOFF)
23.66	39.57	(RUNOFF)

TIME(HRS) FIRST HYDROGRAPH POINT = 0.0 HOURS TIME INCREMENT = 0.10 HOURS DRAINAGE AREA = 1.20 SQ.MI.

8.00	DISCHG	0.0	0.0	0.0	0.0	0.01	0.16	0.60	1.30	2.13	3.02
9.00	DISCHG	3.93	4.94	6.17	7.49	8.74	9.93	11.24	12.90	14.64	16.22
10.00	DISCHG	17.67	19.27	21.34	23.62	26.66	30.43	34.64	40.34	46.47	53.42
11.00	DISCHG	61.32	69.36	78.90	88.90	101.41	118.21	175.19	333.20	556.83	1013.89
12.00	DISCHG	1699.99	2096.98	1719.05	1144.40	768.99	553.56	432.04	359.65	314.18	280.14
13.00	DISCHG	250.11	228.85	210.77	196.10	183.98	172.76	163.48	153.15	144.06	137.02
14.00	DISCHG	130.97	126.07	120.78	116.04	111.31	106.20	101.68	96.55	92.15	89.77
15.00	DISCHG	88.69	88.25	88.09	87.74	85.38	81.35	78.42	77.04	76.42	76.17
16.00	DISCHG	76.08	76.08	76.11	76.16	76.23	76.29	75.23	71.56	67.76	65.67
17.00	DISCHG	64.73	64.31	64.12	64.06	64.06	64.08	64.12	64.17	63.86	61.43
18.00	DISCHG	57.31	54.29	52.84	52.15	51.85	51.72	51.67	51.66	51.67	51.70
19.00	DISCHG	51.73	51.75	51.78	51.81	51.84	51.86	51.89	51.92	51.67	49.16
20.00	DISCHG	44.95	41.83	40.36	39.68	39.35	39.21	39.15	39.13	39.12	39.14
21.00	DISCHG	39.15	39.17	39.18	39.20	39.21	39.23	39.24	39.25	39.27	39.28
22.00	DISCHG	39.30	39.31	39.33	39.34	39.36	39.37	39.39	39.40	39.41	39.43
23.00	DISCHG	39.44	39.46	39.47	39.48	39.50	39.51	39.53	39.54	39.26	36.73
24.00	DISCHG	32.35	26.82	17.75	9.14	4.30	2.02	0.93	0.42	0.18	0.07
25.00	DISCHG	0.01									

RUNOFF VOLUME ABOVE BASEFLOW = 2.61 WATERSHED INCHES, 2025.05 CFS-HRS, 167.35 ACRE-FEET; BASEFLOW = 0.0 CFS

OPERATION RESVOR STRUCTURE 1
INPUT HYDROGRAPH= 6 OUTPUT HYDROGRAPH= 7
SURFACE ELEVATION= 521.50

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
12.36	926.87	526.11

A-10

FIRST HYDROGRAPH POINT = 0.0 HOURS TIME INCREMENT = 0.10 HOURS DRAINAGE AREA = 1.20 SQ.MI.

TIME(HRS)											
8.00	DISCHG	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.03	0.08	0.14
8.00	ELEV	521.50	521.50	521.50	521.50	521.50	521.50	521.50	521.50	521.50	521.50
9.00	DISCHG	0.22	0.32	0.45	0.61	0.79	1.00	1.23	1.50	1.80	2.13
9.00	ELEV	521.51	521.51	521.51	521.52	521.53	521.53	521.54	521.55	521.56	521.57
10.00	DISCHG	2.50	2.89	3.56	4.40	5.31	6.34	7.49	8.81	10.34	12.08
10.00	ELEV	521.58	521.60	521.61	521.62	521.64	521.66	521.67	521.70	521.72	521.75
11.00	DISCHG	14.08	16.90	20.49	24.46	28.89	34.03	41.59	55.84	85.50	195.75
11.00	ELEV	521.78	521.82	521.86	521.91	521.95	522.01	522.08	522.21	522.43	522.91
12.00	DISCHG	378.67	618.08	821.28	917.44	923.62	882.30	820.94	753.98	688.28	626.66
12.00	ELEV	523.71	524.76	525.65	526.07	526.09	525.91	525.64	525.35	525.06	524.79
13.00	DISCHG	569.71	517.69	470.77	428.65	391.07	357.56	327.72	301.03	277.02	255.52
13.00	ELEV	524.55	524.32	524.11	523.93	523.76	523.62	523.49	523.37	523.27	523.17
14.00	DISCHG	236.38	219.39	204.27	190.74	178.60	167.60	157.57	148.36	139.85	132.15
14.00	ELEV	523.09	523.01	522.95	522.89	522.84	522.79	522.74	522.70	522.67	522.63
15.00	DISCHG	125.39	119.57	114.63	110.42	106.66	102.99	99.35	95.94	92.92	90.30
15.00	ELEV	522.60	522.58	522.56	522.54	522.52	522.50	522.49	522.47	522.46	522.45
16.00	DISCHG	88.06	86.18	84.59	83.26	82.14	81.21	80.35	79.26	78.47	77.69
16.00	ELEV	522.44	522.43	522.42	522.42	522.41	522.41	522.41	522.40	522.40	522.39
17.00	DISCHG	76.86	76.03	75.25	74.50	73.81	73.16	72.56	72.00	71.46	70.88
17.00	ELEV	522.38	522.38	522.37	522.36	522.36	522.35	522.35	522.34	522.34	522.33
18.00	DISCHG	70.11	69.16	68.12	67.08	66.07	65.12	64.23	63.39	62.61	61.88
18.00	ELEV	522.33	522.32	522.31	522.30	522.30	522.29	522.28	522.27	522.27	522.26
19.00	DISCHG	61.21	60.58	59.99	59.44	58.94	58.46	58.03	57.62	57.23	56.78
19.00	ELEV	522.26	522.25	522.25	522.24	522.24	522.24	522.23	522.23	522.23	522.22
20.00	DISCHG	56.13	55.28	54.34	53.38	52.45	51.56	50.73	49.95	49.23	48.55
20.00	ELEV	522.22	522.21	522.20	522.19	522.19	522.18	522.17	522.16	522.15	522.15
21.00	DISCHG	47.92	47.33	46.78	46.27	45.80	45.36	44.95	44.56	44.21	43.88
21.00	ELEV	522.14	522.14	522.13	522.13	522.12	522.12	522.11	522.11	522.11	522.10
22.00	DISCHG	43.57	43.28	43.02	42.77	42.54	42.33	42.13	41.95	41.77	41.62
22.00	ELEV	522.10	522.10	522.10	522.09	522.09	522.09	522.09	522.08	522.08	522.08
23.00	DISCHG	41.47	41.33	41.21	41.09	40.98	40.88	40.79	40.71	40.62	40.44
23.00	ELEV	522.08	522.08	522.08	522.08	522.08	522.07	522.07	522.07	522.07	522.07
24.00	DISCHG	40.05	39.35	38.20	36.54	34.54	32.47	30.53	28.66	26.88	25.20
24.00	ELEV	522.07	522.06	522.05	522.03	522.01	521.99	521.97	521.95	521.93	521.91
25.00	DISCHG	23.63	22.15	20.76	19.46	18.24	17.10	16.03	15.02	14.35	13.72
25.00	ELEV	521.90	521.88	521.86	521.85	521.84	521.82	521.81	521.80	521.79	521.78
26.00	DISCHG	13.12	12.54	11.98	11.46	10.95	10.47	10.01	9.57	9.14	8.74
26.00	ELEV	521.77	521.76	521.75	521.74	521.73	521.72	521.72	521.71	521.70	521.70
27.00	DISCHG	8.36	7.99	7.63	7.30	6.98	6.67	6.37	6.09	5.83	5.57
27.00	ELEV	521.69	521.68	521.68	521.67	521.67	521.66	521.66	521.65	521.65	521.64
28.00	DISCHG	5.32	5.09	4.86	4.65	4.44	4.25	4.06	3.88	3.71	3.55
28.00	ELEV	521.64	521.63	521.63	521.63	521.62	521.62	521.62	521.61	521.61	521.61
29.00	DISCHG	3.39	3.24	3.10	2.98	2.91	2.83	2.77	2.70	2.63	2.57
29.00	ELEV	521.61	521.60	521.60	521.60	521.60	521.59	521.59	521.59	521.59	521.59

RUNOFF VOLUME ABOVE BASEFLOW = 2.60 WATERSHED INCHES, 2013.37 CFS-HRS, 166.39 ACRE-FEET; BASEFLOW = 0.0 CFS

OPERATION REACH CROSS SECTION 1
INPUT HYDROGRAPH= 7 OUTPUT HYDROGRAPH= 5
LENGTH = 5400.00 FEET INPUT = COEFFICIENTS RELATED TO CROSS SECTIONAL AREA, X= 0.40, M= 1.33

MODIFIED ATT-KIN ROUTING COEFFICIENT = 0.22 PEAK TRAVEL TIME = 0.43

PEAK TIME(HRS) 12.84 PEAK DISCHARGE(CFS) 700.68 PEAK ELEVATION(FEET) (NULL)

FIRST HYDROGRAPH POINT = 0.0 HOURS TIME INCREMENT = 0.10 HOURS DRAINAGE AREA = 1.20 SQ.MI.

TIME(HRS)											
8.00	DISCHG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.02
9.00	DISCHG	0.04	0.08	0.13	0.20	0.29	0.40	0.53	0.68	0.85	1.06
10.00	DISCHG	1.29	1.55	1.84	2.21	2.68	3.25	3.92	4.69	5.58	6.61
11.00	DISCHG	7.79	9.15	10.82	12.91	15.41	18.32	21.71	26.01	32.45	43.92
12.00	DISCHG	76.73	141.98	244.88	369.45	487.88	582.05	646.94	684.54	699.55	697.11
13.00	DISCHG	681.88	657.64	627.39	593.54	557.91	521.85	486.34	452.06	419.42	388.64
14.00	DISCHG	359.87	333.18	308.59	286.04	265.44	246.67	229.58	214.02	199.83	186.87
15.00	DISCHG	175.04	164.31	154.64	145.99	138.30	131.46	125.31	119.70	114.57	109.89
16.00	DISCHG	105.65	101.85	98.46	95.46	92.82	90.52	88.50	86.74	85.13	83.69
17.00	DISCHG	82.39	81.19	80.08	79.03	78.05	77.14	76.28	75.47	74.72	74.02
18.00	DISCHG	73.34	72.64	71.89	71.07	70.21	69.31	68.41	67.50	66.62	65.75
19.00	DISCHG	64.91	64.11	63.35	62.62	61.93	61.29	60.68	60.10	59.56	59.06
20.00	DISCHG	58.57	58.04	57.44	56.77	56.04	55.26	54.46	53.65	52.85	52.07
21.00	DISCHG	51.31	50.58	49.88	49.21	48.57	47.97	47.41	46.87	46.37	45.90
22.00	DISCHG	45.47	45.05	44.67	44.31	43.98	43.67	43.38	43.11	42.85	42.62
23.00	DISCHG	42.40	42.20	42.01	41.84	41.68	41.53	41.39	41.26	41.14	41.03
24.00	DISCHG	40.90	40.71	40.42	39.94	39.20	38.19	36.96	35.57	34.07	32.52
25.00	DISCHG	30.94	29.36	27.80	26.28	24.80	23.38	22.02	20.73	19.49	18.38
26.00	DISCHG	17.37	16.45	15.61	14.82	14.09	13.41	12.78	12.18	11.61	11.08
27.00	DISCHG	10.57	10.09	9.64	9.20	8.79	8.40	8.02	7.67	7.33	7.00
28.00	DISCHG	6.69	6.40	6.11	5.84	5.58	5.34	5.10	4.88	4.66	4.45
29.00	DISCHG	4.26	4.07	3.89	3.72	3.56	3.42	3.29	3.18	3.07	2.98

RUNOFF VOLUME ABOVE BASEFLOW = 2.60 WATERSHED INCHES, 2011.60 CFS-HRS, 166.24 ACRE-FEET; BASEFLOW = 0.0 CFS

EXECUTIVE CONTROL OPERATION ENDCMP COMPUTATIONS COMPLETED FOR PASS 1

RECORD ID 00000220

EXECUTIVE CONTROL OPERATION ENDJOB

RECORD ID 00000230

A-12

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH.)

SECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)
ALTERNATE 1 STORM 1													
STRUCTURE 1	RUNOFF	1.20	2	2	0.10	0.0	5.20	24.00	2.61	---	12.10	2097.04	1747.5
STRUCTURE 1	RESVOR	1.20	2	2	0.10	0.0	5.20	24.00	2.60	526.11	12.36	926.87	772.4
XSECTION 1	REACH	1.20	2	2	0.10	0.0	5.20	24.00	2.60	---	12.84	700.68	583.9

SUMMARY TABLE 2 - SELECTED MODIFIED ATT-KIN REACH ROUTINGS IN ORDER OF STANDARD EXECUTIVE CONTROL INSTRUCTIONS
(A STAR(*) AFTER VOLUME ABOVE BASE(IN) INDICATES A HYDROGRAPH TRUNCATED AT A VALUE EXCEEDING BASE + 10% OF PEAK)

XSEC ID	REACH LENGTH (FT)	HYDROGRAPH INFORMATION: INFLOW PEAK (CFS)	INFLOW TIME (HR)	OUTFLOW PEAK (CFS)	OUTFLOW TIME (HR)	OUTFLOW+ INTERV.AREA PEAK (CFS)	OUTFLOW+ INTERV.AREA TIME (HR)	BASE-FLOW (CFS)	ROUTING PARAMETERS: VOLUME ABOVE BASE (IN)	MAIN TIME INCR (HR)	ITER-ATION #	Q AND A EQUATION COEFF (X)	Q AND A EQUATION POWER (M)	LENGTH FACTOR (K*)	PEAK RATIO O/I (Q*)	S/Q @PEAK (K) (SEC)	ATT-KIN COEFF (C)	PEAK TRAVEL TIME STOR-AGE (HR)	PEAK TRAVEL TIME KINE-MATIC (HR)
ALTERNATE 1 STORM 1																			
1	5400	924	12.4	700	12.8	---	---	0	2.60	0.10	1	.400	1.33	0.160	0.757	1486	0.22	0.40	0.43

SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS..... 1
STRUCTURE 1	1.20	
ALTERNATE 1		926.87
XSECTION 1	1.20	
ALTERNATE 1		700.68

END OF 1 JOBS IN THIS RUN

Note: Each Summary Table would nc ·lly start on a separate sheet.

APPENDIX B

SAMPLE JOB NØ. 2

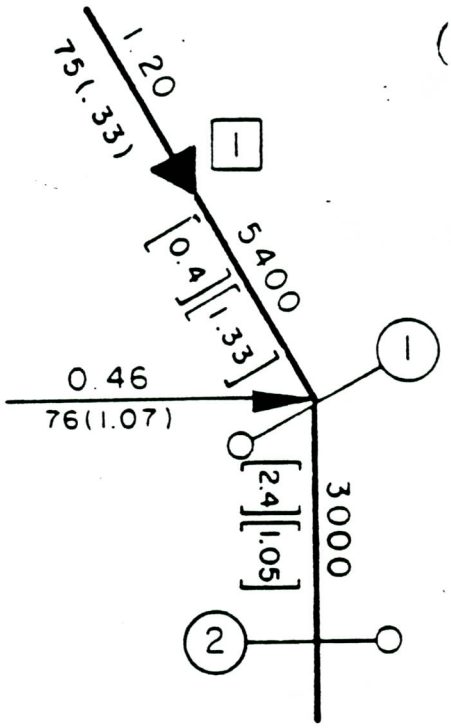
Contents	Page
Schematic Drawing	B-2
Input Data Sheets	B-3
Printout	B-7
READHD File	B-13

B-2

SCHEMATIC DRAWING OF SAMPLE WATERSHED

Sample Job No. 2

(structure 1 in place)



LEGEND

1 — Structure Number 1

Cross Section Number 1 (at downstream end of reach)

5400 / [0.4][1.33] — Reach Length, Feet / [End Area Coeff (x)][Exponent (M)]

1.20 / 75 (.33) — Drainage Area - Square Miles / Runoff Curve Number (Time of Concentration - Hours)

Intervening Area

SCS-ENG.-264 DRAFT
REV. May 1982

TR-20
JOB & TITLE

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed SAMPLE JOB 2 Hydrologist JEZ Date 5/24/82 SHEET 1 OF 4

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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

JOB	TR-20	SUMMARY 10
TITLE	002	SAMPLE JOB 2, USING 24HR TYPE II STORM FROM STR 1 TO XSECT 2 20
TITLE		INCLUDES ADDHYD, REACH COEFF'S, NOPRINT, SUM, HYD'S & FILE GEN. 30

JOB Record (required)

Columns 1-3 JOB

Columns 5-9 TR-20

Columns 11-17 HOLDOUT
Use only if a holdout hydrograph is desired.

Columns 21-24 ECON

Use only if peak discharge output for ECON2/URB1 is desired. Locations for this output must be selected for inclusion in Summary Tables 1 and 3 also. Such designation can be made using summary option explained below (columns 51-57) or on Standard Control (column 71).

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 61-67 NOPLOTS
Use if no cross section rating plots are desired.

ENDPLOT
Use if only cross section rating plots are desired with no routings.

Columns 73-80 Optional user information, printed at top of input listing.

TITLE Records (one required, second is optional)

Columns 1-5 TITLE

Columns 7-9 XXX (first TITLE record only).
An optional user file number, XXX, is an integer, right justified.

Columns 11-80 Both titles may be any characters desired.

SCS - ENG. - 269 DRAFT
REV. May 1982

TR - 20
STRUCTURE DATA
STRUCTURE NO. 1

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

B-4

Watershed SAMPLE JOB 2 Hydrologist JEZ Date 5/24/82 SHEET 2 OF 4

DATA CODE	TABLE NAME				DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3		RECORD IDENT.
3	STRUCT	STRUCTURE ID. (01-99) 01							40
		NOTE: Maximum of 20 data records allowed.							
					Elevation, Ft.	Discharge, CFS	Storage, Acre, Ft.		
8					521.5	0.0	17.0		50
8					521.6	3.0	18.0		60
8					521.8	15.	20.2		70
8					522.0	33.	22.5		80
8					522.2	54.	25.0		90
8					522.4	79.	28.0		100
8					526.2	948.	70.		110
8					526.4	1009.	75.		120
8					526.6	1071.	80.		130
8					527.2	1265.	95.		140
9	ENDTBL	NOTE: This record must be the last record of this table.							150

IMPORTANT: Line out unused lines. Data fields require decimal points.

SCS-ENG.-273 DRAFT
REV May 1982

TR-20
STANDARD CONTROL FOR WATERSHED

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed SAMPLE JOB 2 Hydrologist JEZ Date 5/24/82 SHEET 3 OF 4

DATA CODE	OPERATION NAME	NO.	XSECT. ID.	STRUCT. ID.	HYDRO. NUMBER IN-PUT #1	IN-PUT #2	OUT-PUT	DATA FIELD #1	DATA FIELD #2	DATA FIELD #3	OUTPUT OPTIONS PRINT PEAK	HYD	ELEV	VOL	FILE	SUM	RECORD IDENT.
6	RUNOFF	1					6	AREA, SQ. MI.	RUNOFF CURVE NO.	T_c, HRS.							EXAMPLES DO NOT ENTER
6	RESVOR	2			6		7	SURF. EL. AT T=0, FT.									
6	REACH	3			7		5	LENGTH, FT.	(OPTIONAL) END AREA COEFF (X)	(OPTIONAL) EXPONENT (M)							
6	ADDHYD	4			5	6	7										
6	SAVMOV	5			IN FROM	OUT1	OUT2 TO										
6	DIVERT	6						OUT1 DISCHARGE, CFS	OUT 1, Decimal % D.A.	OUT2, I.D.							
	ENDATA							This record is to be used only at end of all standard control records.									

(Right justify these fields)

IMPORTANT: Data Fields No. 1, 2, and 3 require decimal points.

6	RUNOFF	1		0.1			6	1.20	75.	0.33							160
6	RESVOR	2		0.1	6		7										170
6	REACH	3	001		7		5	5400.	0.4	1.33	1	1		1			180
6	RUNOFF	1	001				6	0.46	76.	1.07		1					190
6	ADDHYD	4	001		5	6	7					1					200
6	REACH	3	002		7		5	3000.	2.4	1.05		1			1		210
	ENDATA																220

NOTE: This form was suggested by members of Massachusetts Planning Staff.

EXAMPLES DO NOT ENTER

1.34

B-5

SCS-ENG.-274 DRAFT
REV. May 1982

TR - 20
EXECUTIVE CONTROL FOR WATERSHED

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

B-6

Watershed SAMPLE JOB 2 Hydrologist JEZ Date 5/24/82 SHEET 4 OF 4

DATA CODE	OPERATION		DATA FIELD # 1	DATA FIELD # 2	DATA FIELD # 3		RECORD IDENT.
7	LIST	This record is used for printout of tabular data and standard control list that are currently effective					
7	BASFLO	5	NEW BASE FLOW, CFS or VOLUME IN INCHES	IF VOLUME IS IN DATA FIELD No 1 PEAK TIME, HOURS	BASE TIME, HOURS		
7	INCREM	6	MAIN TIME INCREMENT, HRS.	This increment is required for initial computations. Remains in force until new increment is entered.			

EXAMPLES DO NOT ENTER

			FROM XSECT	FROM OR STRUCT	THRU XSECT	THRU OR STRUCT	STARTING TIME HOURS	RAINFALL DEPTH INCHES (Set depth and duration to 10 for actual rainfall)	RAINFALL DURATION HOURS	RAIN TABLE NO	AMC	ALTERNATE NO.	STROM NO.	EXAMPLES DO NOT ENTER
7	COMPUT	7												
	ENDCMP	1	This record is required at "end" of a watershed, it may follow a series of COMPUT records											
	ENDJOB	2	This record terminates routing computation and precedes the PEAKS record, if any											

Right justify these fields

IMPORTANT: Data Fields No. 1, 2, and 3 require decimal points.

7	INCREM	6				0.1								
7	COMPUT	7		0.1	0.02		5.2	1.0	2	2	0.1	0.1		230
	ENDCMP	1												240
	ENDJOB	2												250
														260

```
******************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY******************

JOB TR-20                                                    SUMMARY                  00000010
TITLE 002 SAMPLE JOB 2  USING 24HR TYPE II STORM FROM STR 1 TO XSECT 2               00000020
TITLE     INCLUDES ADDHYD,REACH COEFF'S ,NOPRINT, SUM, HYD'S & FILE GEN.             00000030
 3 STRUCT      01                                                                    00000040
 8                        521.5        0.0          17.0                           00000050
 8                        521.6        3.0          18.0                           00000060
 8                        521.8        15.          20.2                           00000070
 8                        522.0        33.          22.5                           00000080
 8                        522.2        54.          25.0                           00000090
 8                        522.4        79.          28.0                           00000100
 8                        526.2        948.         70.                            00000110
 8                        526.4        1009.        75.                            00000120
 8                        526.6        1071.        80.                            00000130
 8                        527.2        1265.        95.                            00000140
 9 ENDTBL                                                                          00000150
 6 RUNOFF 1    01      6 1.20         75.          0.33                           00000160
 6 RESVOR 2    01 6    7                                                          00000170
 6 REACH  3 001   7    5 5400.        0.4          1.33        1 1   1            00000180
 6 RUNOFF 1 001       6 0.46         76.          1.07          1                00000190
 6 ADDHYD 4 001   5 6 7                                         1                00000200
 6 REACH  3 002   7    5 3000.        2.4          1.05          1     1          00000210
   ENDATA                                                                         00000220
 7 INCREM 6               0.1                                                    00000230
 7 COMPUT 7    01 002                  5.2          1.0         2 2  01  01       00000240
   ENDCMP 1                                                                       00000250
   ENDJOB 2                                                                       00000260

*********************************END OF 80-80 LIST*********************************
```

Note: The User Notes, page 1, is not repeated in this Sample Job (See page A-8).

SAMPLE JOB 2 USING 24HR TYPE II STORM FROM STR 1 TO XSECT 2 00000020
INCLUDES ADDHYD,REACH COEFF'S ,NOPRINT, SUM, HYD'S & FILE GEN.00000030

EXECUTIVE CONTROL OPERATION INCREM MAIN TIME INCREMENT = 0.10 HOURS RECORD ID 00000230

EXECUTIVE CONTROL OPERATION COMPUT FROM STRUCTURE 1 TO XSECTION 2 RECORD ID 00000240
STARTING TIME = 0.0 RAIN DEPTH = 5.20 RAIN DURATION= 1.00 RAIN TABLE NO.= 2 ANT. MOIST. COND= 2
ALTERNATE NO.= 1 STORM NO.= 1 MAIN TIME INCREMENT = 0.10 HOURS

OPERATION REACH CROSS SECTION 1

PEAK TIME(HRS) 12.84 PEAK DISCHARGE(CFS) 700.68 PEAK ELEVATION(FEET) (NULL)

TIME(HRS)		FIRST HYDROGRAPH POINT = 0.0 HOURS				TIME INCREMENT = 0.10 HOURS			DRAINAGE AREA = 1.20 SQ.MI.		
8.00	DISCHG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.02
9.00	DISCHG	0.04	0.08	0.13	0.20	0.29	0.40	0.53	0.68	0.85	1.06
10.00	DISCHG	1.29	1.55	1.84	2.21	2.68	3.25	3.92	4.69	5.58	6.61
11.00	DISCHG	7.79	9.15	10.82	12.91	15.41	18.32	21.71	26.01	32.45	43.92
12.00	DISCHG	76.73	141.98	244.88	369.45	487.88	582.05	646.94	684.54	699.55	697.11
13.00	DISCHG	681.88	657.64	627.39	593.54	557.91	521.85	486.34	452.06	419.42	388.64
14.00	DISCHG	359.87	333.18	308.59	286.04	265.44	246.67	229.58	214.02	199.83	186.87
15.00	DISCHG	175.04	164.31	154.64	145.99	138.30	131.46	125.31	119.70	114.57	109.89
16.00	DISCHG	105.65	101.85	98.46	95.46	92.82	90.52	88.50	86.74	85.13	83.69
17.00	DISCHG	82.39	81.19	80.08	79.03	78.05	77.14	76.28	75.47	74.72	74.02
18.00	DISCHG	73.34	72.64	71.89	71.07	70.21	69.31	68.41	67.50	66.62	65.75
19.00	DISCHG	64.91	64.11	63.35	62.62	61.93	61.29	60.68	60.10	59.56	59.06
20.00	DISCHG	58.57	58.04	57.44	56.77	56.04	55.26	54.46	53.65	52.85	52.07
21.00	DISCHG	51.31	50.58	49.88	49.21	48.57	47.97	47.41	46.87	46.37	45.90
22.00	DISCHG	45.47	45.05	44.67	44.31	43.98	43.67	43.38	43.11	42.85	42.62
23.00	DISCHG	42.40	42.20	42.01	41.84	41.68	41.53	41.39	41.26	41.14	41.03
24.00	DISCHG	40.90	40.71	40.42	39.94	39.20	38.19	36.96	35.57	34.07	32.52
25.00	DISCHG	30.94	29.36	27.80	26.28	24.80	23.38	22.02	20.73	19.49	18.38
26.00	DISCHG	17.37	16.45	15.61	14.82	14.09	13.41	12.78	12.18	11.61	11.08
27.00	DISCHG	10.57	10.09	9.64	9.20	8.79	8.40	8.02	7.67	7.33	7.00
28.00	DISCHG	6.69	6.40	6.11	5.84	5.58	5.34	5.10	4.88	4.66	4.45
29.00	DISCHG	4.26	4.07	3.89	3.72	3.56	3.42	3.29	3.18	3.07	2.98

RUNOFF VOLUME ABOVE BASEFLOW = 2.60 WATERSHED INCHES, 2011.60 CFS-HRS, 166.24 ACRE-FEET; BASEFLOW = 0.0 CFS

OPERATION RUNOFF CROSS SECTION 1

TIME(HRS)		FIRST HYDROGRAPH POINT = 0.0 HOURS				TIME INCREMENT = 0.10 HOURS			DRAINAGE AREA = 0.46 SQ.MI.		
8.00	DISCHG	0.0	0.0	0.0	0.01	0.03	0.07	0.14	0.25	0.39	0.57
9.00	DISCHG	0.79	1.05	1.33	1.65	2.00	2.37	2.78	3.21	3.67	4.16
10.00	DISCHG	4.68	5.22	5.80	6.40	7.06	7.79	8.62	9.59	10.72	12.07
11.00	DISCHG	13.64	15.46	17.53	19.88	22.55	25.69	30.44	38.13	52.47	79.02

12.00	DISCHG	121.62	179.16	246.45	312.23	362.37	389.34	393.49	379.12	351.28	315.10
13.00	DISCHG	276.26	240.72	211.36	187.14	166.59	148.87	133.53	120.40	109.06	99.22
14.00	DISCHG	90.71	83.38	77.05	71.52	66.68	62.41	58.61	55.21	52.14	49.35
15.00	DISCHG	46.80	44.46	42.38	40.56	39.04	37.80	36.77	35.80	34.88	34.01
16.00	DISCHG	33.22	32.52	31.93	31.44	31.06	30.78	30.52	30.26	29.95	29.54
17.00	DISCHG	29.04	28.50	27.94	27.41	26.93	26.52	26.19	25.94	25.73	25.52
18.00	DISCHG	25.26	24.92	24.48	23.97	23.42	22.87	22.37	21.92	21.54	21.24
19.00	DISCHG	21.02	20.84	20.70	20.59	20.50	20.44	20.39	20.35	20.30	20.22
20.00	DISCHG	20.07	19.81	19.44	18.96	18.44	17.92	17.42	16.98	16.61	16.32
21.00	DISCHG	16.10	15.92	15.79	15.68	15.59	15.52	15.47	15.43	15.40	15.38
22.00	DISCHG	15.36	15.35	15.34	15.33	15.33	15.32	15.32	15.32	15.33	15.33
23.00	DISCHG	15.33	15.33	15.34	15.34	15.35	15.35	15.36	15.36	15.35	15.29
24.00	DISCHG	15.14	14.82	14.24	13.38	12.23	10.84	9.34	7.83	6.42	5.17
25.00	DISCHG	4.11	3.25	2.57	2.05	1.63	1.29	1.02	0.81	0.64	0.51
26.00	DISCHG	0.40	0.31	0.25	0.19	0.15	0.11	0.09	0.07	0.05	0.03
27.00	DISCHG	0.02	0.01	0.01	0.0						

OPERATION ADDHYD CROSS SECTION 1

TIME(HRS) FIRST HYDROGRAPH POINT = 0.0 HOURS TIME INCREMENT = 0.10 HOURS DRAINAGE AREA = 1.66 SQ.MI.

8.00	DISCHG	0.0	0.0	0.0	0.01	0.03	0.07	0.14	0.25	0.40	0.59
9.00	DISCHG	0.84	1.13	1.47	1.85	2.28	2.77	3.30	3.89	4.52	5.22
10.00	DISCHG	5.97	6.77	7.63	8.61	9.74	11.04	12.54	14.27	16.30	18.68
11.00	DISCHG	21.43	24.61	28.36	32.80	37.96	44.02	52.15	64.14	84.92	122.94
12.00	DISCHG	198.35	321.14	491.33	681.68	850.25	971.39	1040.43	1063.66	1050.83	1012.21
13.00	DISCHG	958.14	898.36	838.75	780.68	724.49	670.72	619.88	572.46	528.48	487.86
14.00	DISCHG	450.59	416.56	385.64	357.56	332.12	309.08	288.20	269.23	251.97	236.22
15.00	DISCHG	221.84	208.77	197.02	186.55	177.34	169.27	162.08	155.50	149.44	143.90
16.00	DISCHG	138.87	134.37	130.39	126.90	123.89	121.29	119.03	117.00	115.07	113.23
17.00	DISCHG	111.43	109.69	108.02	106.44	104.99	103.66	102.47	101.41	100.45	99.53
18.00	DISCHG	98.60	97.56	96.37	95.04	93.63	92.19	90.77	89.42	88.16	86.99
19.00	DISCHG	85.93	84.95	84.05	83.21	82.44	81.72	81.06	80.45	79.87	79.28
20.00	DISCHG	78.63	77.85	76.88	75.73	74.48	73.18	71.89	70.64	69.47	68.39
21.00	DISCHG	67.41	66.50	65.66	64.88	64.16	63.50	62.88	62.31	61.77	61.28
22.00	DISCHG	60.83	60.40	60.01	59.64	59.31	58.99	58.70	58.43	58.18	57.95
23.00	DISCHG	57.73	57.54	57.35	57.18	57.03	56.88	56.75	56.62	56.49	56.32
24.00	DISCHG	56.04	55.53	54.66	53.32	51.43	49.04	46.29	43.40	40.49	37.68
25.00	DISCHG	35.05	32.60	30.37	28.32	26.43	24.68	23.05	21.54	20.13	18.89
26.00	DISCHG	17.77	16.77	15.85	15.01	14.24	13.53	12.86	12.24	11.66	11.11
27.00	DISCHG	10.60	10.11	9.65	9.20	8.79	8.40	8.02	7.67	7.33	7.00
28.00	DISCHG	6.69	6.40	6.11	5.84	5.58	5.34	5.10	4.88	4.66	4.45
29.00	DISCHG	4.26	4.07	3.89	3.72	3.56	3.42	3.29	3.18	3.07	2.98

OPERATION REACH CROSS SECTION 2

TIME(HRS) FIRST HYDROGRAPH POINT = 0.0 HOURS TIME INCREMENT = 0.10 HOURS DRAINAGE AREA = 1.66 SQ.MI.

8.00	DISCHG	0.0	0.0	0.0	0.0	0.0	0.01	0.03	0.07	0.13	0.22

B-10

9.00	DISCHG	0.34	0.51	0.72	0.97	1.26	1.61	2.00	2.43	2.92	3.46
10.00	DISCHG	4.05	4.69	5.39	6.15	6.97	7.90	8.96	10.16	11.54	13.14
11.00	DISCHG	15.00	17.16	19.67	22.59	26.02	30.03	34.73	40.59	48.51	60.75
12.00	DISCHG	81.66	120.90	188.23	290.15	421.80	565.87	702.22	815.95	899.24	950.21
13.00	DISCHG	971.06	966.72	943.73	908.43	865.47	818.07	768.52	718.54	669.42	622.02
14.00	DISCHG	576.91	534.43	494.80	458.09	424.28	393.29	364.98	339.16	315.64	294.23
15.00	DISCHG	274.72	256.94	240.74	226.04	212.76	200.85	190.23	180.77	172.27	164.59
16.00	DISCHG	157.63	151.32	145.62	140.50	135.93	131.88	128.32	125.19	122.44	119.96
17.00	DISCHG	117.70	115.59	113.60	111.73	109.95	108.28	106.72	105.29	103.99	102.80
18.00	DISCHG	101.70	100.65	99.61	98.52	97.35	96.10	94.78	93.43	92.08	90.76
19.00	DISCHG	89.49	88.30	87.17	86.12	85.14	84.23	83.39	82.61	81.88	81.20
20.00	DISCHG	80.56	79.91	79.22	78.43	77.52	76.50	75.38	74.20	73.01	71.82
21.00	DISCHG	70.66	69.57	68.54	67.57	66.66	65.82	65.04	64.31	63.64	63.01
22.00	DISCHG	62.43	61.89	61.39	60.92	60.49	60.09	59.72	59.38	59.06	58.76
23.00	DISCHG	58.49	58.23	58.00	57.78	57.58	57.39	57.22	57.06	56.91	56.77
24.00	DISCHG	56.62	56.42	56.12	55.63	54.85	53.70	52.13	50.17	47.89	45.40
25.00	DISCHG	42.81	40.20	37.64	35.20	32.89	30.71	28.68	26.79	25.02	23.38
26.00	DISCHG	21.87	20.49	19.24	18.10	17.06	16.11	15.24	14.44	13.70	13.02
27.00	DISCHG	12.38	11.78	11.21	10.69	10.19	9.72	9.27	8.85	8.45	8.07
28.00	DISCHG	7.71	7.37	7.04	6.73	6.43	6.14	5.87	5.61	5.36	5.13
29.00	DISCHG	4.90	4.68	4.48	4.28	4.09	3.91	3.74	3.59	3.45	3.32

--- HYDROGRAPH ADDED TO OUTPUT HYDROGRAPH FILE WITH SEQUENCE NUMBER 1 ---

EXECUTIVE CONTROL OPERATION ENDCMP COMPUTATIONS COMPLETED FOR PASS 1 RECORD ID 00000250

EXECUTIVE CONTROL OPERATION ENDJOB RECORD ID 00000260

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH.)

SECTION/ STRUCTURE ID		STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)
ALTERNATE	1	STORM 1												
STRUCTURE	1	RUNOFF	1.20	2	2	0.10	0.0	5.20	24.00	2.61	---	12.10	2097.04	1747.5
STRUCTURE	1	RESVOR	1.20	2	2	0.10	0.0	5.20	24.00	2.60	526.11	12.36	926.87	772.4
XSECTION	1	REACH	1.20	2	2	0.10	0.0	5.20	24.00	2.60	---	12.84	700.68	583.9
XSECTION	1	RUNOFF	0.46	2	2	0.10	0.0	5.20	24.00	2.70	---	12.57	394.20	857.0
XSECTION	1	ADDHYD	1.66	2	2	0.10	0.0	5.20	24.00	2.63	---	12.71	1064.04	641.0
XSECTION	2	REACH	1.66	2	2	0.10	0.0	5.20	24.00	2.62	---	13.03	972.41	585.8

SUMMARY TABLE 2 - SELECTED MODIFIED ATT-KIN REACH ROUTINGS IN ORDER OF STANDARD EXECUTIVE CONTROL INSTRUCTIONS
(A STAR(*) AFTER VOLUME ABOVE BASE(IN) INDICATES A HYDROGRAPH TRUNCATED AT A VALUE EXCEEDING BASE + 10% OF PEAK)

XSEC ID	REACH LENGTH (FT)	HYDROGRAPH INFORMATION: INFLOW PEAK (CFS)	INFLOW TIME (HR)	OUTFLOW PEAK (CFS)	OUTFLOW TIME (HR)	OUTFLOW+ INTERV.AREA PEAK (CFS)	OUTFLOW+ INTERV.AREA TIME (HR)	BASE-FLOW (CFS)	ROUTING PARAMETERS: VOLUME ABOVE BASE (IN)	MAIN TIME INCR (HR)	ITER-ATION #	Q AND A EQUATION COEFF (X)	Q AND A EQUATION POWER (M)	LENGTH FACTOR (K*)	PEAK RATIO O/I (Q*)	S/Q @PEAK (K) (SEC)	ATT-KIN COEFF (C)	PEAK TRAVEL TIME STOR-AGE (HR)	PEAK TRAVEL TIME KINE-MATIC (HR)
ALTERNATE	1	STORM 1																	
1	5400	924	12.4	700	12.8	1064	12.7	0	2.60	0.10	1	.400	1.33	0.160	0.757	1486	0.22	0.40	0.43
2	3000	1064	12.7	971	13.0	---	---	0	2.63	0.10	1	2.40	1.05	0.087	0.913	891	0.34	0.30	0.25

Note: Each Summary Table would normally start on a separate sheet.

B-12

SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS..... 1
STRUCTURE 1	1.20	
ALTERNATE 1		926.87
XSECTION 1	1.66	
ALTERNATE 1		1064.04
XSECTION 2	1.66	
ALTERNATE 1		972.41

END OF 1 JOBS IN THIS RUN

7 READHD 8	5					HYD	1
7 READHD 9	0.0	0.1000	1.6600	0.0			1
8	0.0	0.0	0.0	0.0	0.0		2
8	0.0	0.0	0.0	0.0	0.0		3
8	0.0	0.0	0.0	0.0	0.0		4
8	0.0	0.0	0.0	0.0	0.0		5
8	0.0	0.0	0.0	0.0	0.0		6
8	0.0	0.0	0.0	0.0	0.0		7
8	0.0	0.0	0.0	0.0	0.0		8
8	0.0	0.0	0.0	0.0	0.0		9
8	0.0	0.0	0.0	0.0	0.0		10
8	0.0	0.0	0.0	0.0	0.0		11
8	0.0	0.0	0.0	0.0	0.0		12
8	0.0	0.0	0.0	0.0	0.0		13
8	0.0	0.0	0.0	0.0	0.0		14
8	0.0	0.0	0.0	0.0	0.0		15
8	0.0	0.0	0.0	0.0	0.0		16
8	0.0	0.0	0.0	0.0	0.0		17
8	0.01	0.03	0.07	0.13	0.22		18
8	0.34	0.51	0.72	0.97	1.26		19
8	1.61	2.00	2.43	2.92	3.46		20
8	4.05	4.69	5.39	6.15	6.97		21
8	7.90	8.96	10.16	11.54	13.14		22
8	15.00	17.16	19.67	22.59	26.02		23
8	30.03	34.73	40.59	48.51	60.75		24
8	81.66	120.90	188.23	290.15	421.80		25
8	565.87	702.22	815.95	899.24	950.21		26
8	971.06	966.72	943.73	908.43	865.47		27
8	818.07	768.52	718.54	669.42	622.02		28
8	576.91	534.43	494.80	458.69	424.28		29
8	393.29	364.98	339.16	315.64	294.23		30
8	274.72	256.94	240.74	226.04	212.76		31
8	200.85	190.23	180.77	172.27	164.59		32
8	157.63	151.32	145.62	140.50	135.93		33
8	131.88	128.32	125.19	122.44	119.96		34
8	117.70	115.59	113.60	111.73	109.95		35
8	108.28	106.72	105.29	103.99	102.80		36
8	101.70	100.65	99.61	98.52	97.35		37
8	96.10	94.78	93.43	92.08	90.76		38
8	89.49	88.30	87.17	86.12	85.14		39
8	84.23	83.39	82.61	81.88	81.20		40

Effective 5/2/83
This will show the XSEC/STRUC NO. and ALT & STORM NO

Continued on Page B-14

READHD FILE GENERATED BY HYD OPTION COLUMN 69, RECORD 210

Continued from Page B-13

8	80.56	79.91	79.22	78.43	77.52	41
8	76.50	75.38	74.20	73.01	71.82	42
8	70.66	69.57	68.54	67.57	66.66	43
8	65.82	65.04	64.31	63.64	63.01	44
8	62.43	61.89	61.39	60.92	60.49	45
8	60.09	59.72	59.38	59.06	58.76	46
8	58.49	58.23	58.00	57.78	57.58	47
8	57.39	57.22	57.06	56.91	56.77	48
8	56.62	56.42	56.12	55.63	54.85	49
8	53.70	52.13	50.17	47.89	45.40	50
8	42.81	40.20	37.64	35.20	32.89	51
8	30.71	28.68	26.79	25.02	23.38	52
8	21.87	20.49	19.24	18.10	17.06	53
8	16.11	15.24	14.44	13.70	13.02	54
8	12.38	11.78	11.21	10.69	10.19	55
8	9.72	9.27	8.85	8.45	8.07	56
8	7.71	7.37	7.04	6.73	6.43	57
8	6.14	5.87	5.61	5.36	5.13	58
8	4.90	4.69	4.48	4.28	4.09	59
8	3.91	3.74	3.59	3.45	3.32	60
9 ENDTBL						

Note: For format, see Form #276, Page F-18.

APPENDIX C

SAMPLE JOB NØ. 3

Contents

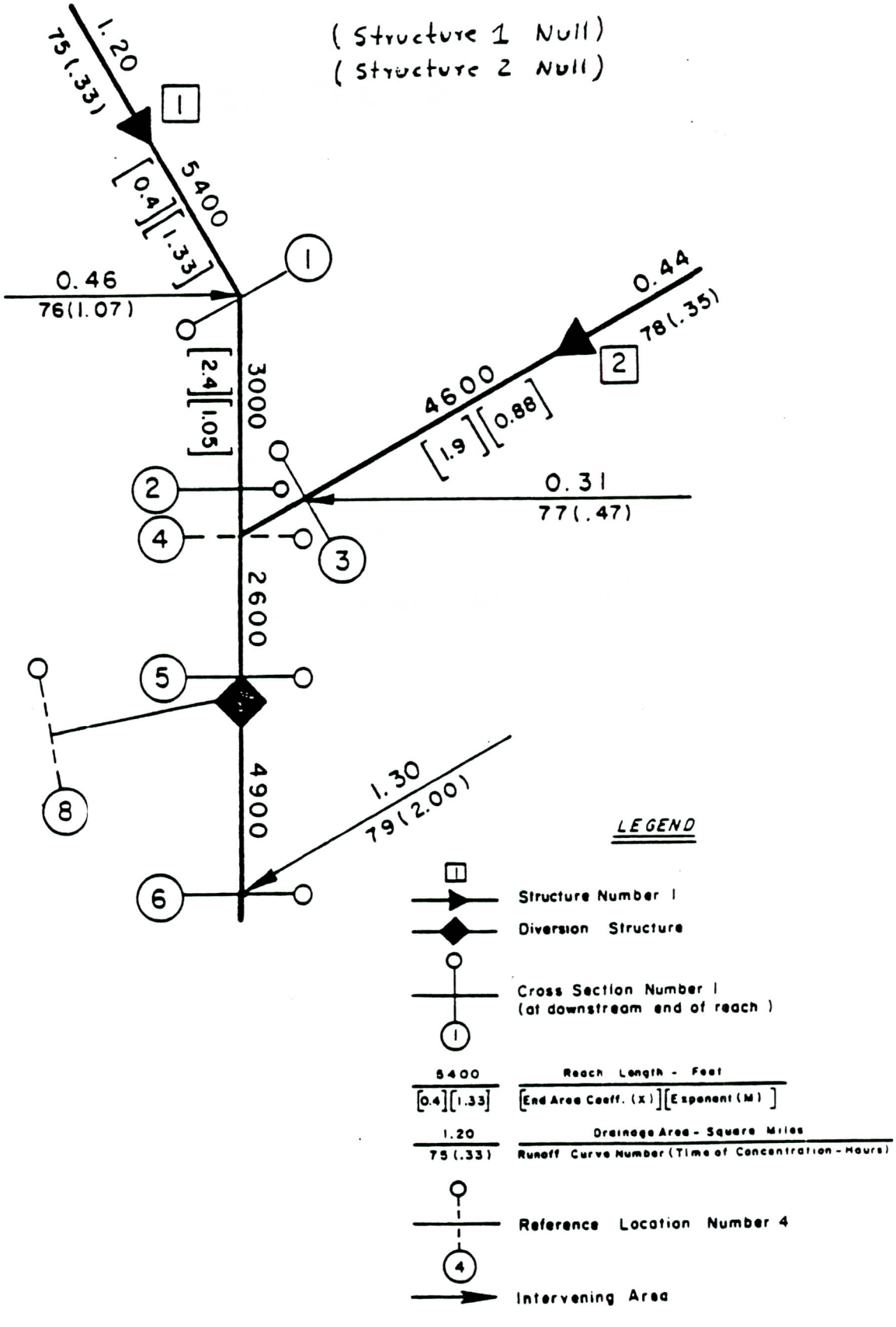
	Page
Schematic Drawing	C-2
Input Data Sheets	C-3
Printout	C-10

C-2

SCHEMATIC DRAWING OF SAMPLE WATERSHED

Sample Job No. 3

(Structure 1 Null)
(Structure 2 Null)



SCS-ENG.-264 DRAFT
REV. May 1982

TR-20
JOB & TITLE

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed SAMPLE JOB 3 Hydrologist JEZ Date 5/24/82 SHEET 1 OF 7

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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

JOB	TR-20	FULLPRINT SUMMARY	10
TITLE	003	SAMPLE JOB 3, USING ACTUAL STORM FROM STRUC. 1 TO XSECT 6	20
TITLE		INCLUDES X-SEC. TABLE, DIVERT, PLOT, FULLPRINT, SUM., TZERO	30

JOB Record (required)

Columns 1-3 JOB

Columns 5-9 TR-20

Columns 11-17 HOLDOUT
Use only if a holdout hydrograph is desired.

Columns 21-24 ECON

Use only if peak discharge output for ECON2/URB1 is desired. Locations for this output must be selected for inclusion in Summary Tables 1 and 3 also. Such designation can be made using summary option explained below (columns 51-57) or on Standard Control (column 71).

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 61-67 NOPLOTS
Use if no cross section rating plots are desired.

ENDPLOT
Use if only cross section rating plots are desired with no routings.

Columns 73-80 Optional user information, printed at top of input listing.

TITLE Records (one required, second is optional)

Columns 1-5 TITLE

Columns 7-9 XXX (first TITLE record only).
An optional user file number, XXX, is an integer, right justified.

Columns 11-80 Both titles may be any characters desired.

SCS-ENG.-271 DRAFT
REV. May 1982

TR-20

CUMULATIVE RAINFALL TABLE

"AGNES" 1972

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STORM TYPE OR DATE SUNBURY GAGE

Watershed SAMPLE JOB 3 Hydrologist JEZ Date 5/24/82 SHEET 2 OF 7

C-4

1-10			11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE I.D. NAME	TABLE I.D. NO.	DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3	DATA FIELD NO. 4	DATA FIELD NO. 5		RECORD IDENT.
		(1-9)	RUNOFF OPTION	TIME INCREMENT					
5	RAINFL	7		1.0					40

IMPORTANT: Line out unused lines. Data fields require decimal points.

NOTE: A maximum of 100 entries (20 records) are allowed.

Enter successive entries left to right with first entry for time = 0. Fill last row of data with last entry of table.

8	0.00	0.06	0.11	0.14	0.17	50
8	0.17	0.17	0.17	0.28	0.48	60
8	1.18	1.42	1.57	1.60	1.74	70
8	1.74	1.74	1.81	2.08	2.83	80
8	4.28	5.35	5.98	6.45	7.21	90
8	7.48	7.88	7.98	8.08	8.43	100
8	8.83	9.33	9.77	10.32	10.61	110
8	10.86	11.09	11.30	11.52	11.81	120
8	12.02	12.06	12.16	12.16	12.16	130

9	ENDTBL	NOTE: This record must be the last record of this table.	140

SCS - ENG. - 270 DRAFT
REV. May 1982

TR - 20

STREAM CROSS SECTION DATA

CROSS SECTION NO. 5

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed SAMPLE JOB 3 Hydrologist JEZ Date 5/24/82 SHEET 3 OF 7

DATA CODE	TABLE NAME			DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3		RECORD IDENT.
			X SECTION ID. (001 - 200)	IMPORTANT: Line out unused lines. Data fields require decimal points. Drainage Area, Sq. Mi.	Bankfull Elevation, Ft.			
2	XSECTN		005	1.0	495.5			150
			(Use 1.0 unless discharge in CSM.)					
			NOTE: Maximum of 20 data records allowed.					
				Elevation, Ft.	Discharge, CFS	End Area, Sq. Ft.		
8				490.	0.0	0.0		160
8				492.	17.	24.		170
8				494.	57.	56.		180
8				495.	86.	75.		190
8				495.5	106.	96.		200
8				496.	132.	138.		210
8				496.5	164.	202.		220
8				497.	205.	287.		230
8				498.	319.	522.		240
8				499.	482.	843.		250
8				500.	705.	1250.		260
8				502.	1362.	2330.		270
8				504.	2361.	3770.		280
9	ENDTBL			NOTE: This record must be the last record of this table.				290

SCS-ENG.-270 DRAFT
REV. May 1982

TR-20

STREAM CROSS SECTION DATA

CROSS SECTION NO. 6

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

C-6

Watershed SAMPLE JOB 3 Hydrologist JEZ Date 5/24/82 SHEET 4 OF 7

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE / TABLE NAME		DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3			RECORD IDENT.

IMPORTANT: Line out unused lines. Data fields require decimal points.

		X SECTION ID. (001-200)	Drainage Area, Sq. Mi.	Bankfull Elevation, Ft.			
2	XSECTN	006	1.0	484.3			300

(Use 1.0 unless discharge in CSM.)

NOTE: Maximum of 20 data records allowed.

	Elevation, Ft.	Discharge, CFS	End Area, Sq. Ft.		
8	480.	0.0	0.0		310
8	482.	29.	46.		320
8	484.	97.	104.		330
8	485.	144.	138.		340
8	485.5	176.	168.		350
8	486.	215.	226.		360
8	487.	320.	459.		370
8	488.	485.	875.		380
8	490.	1072.	2060.		390
8	492.	1971.	3629.		400

9 DTBL NOTE: This record must be [illegible] record of this table. 4

SCS-ENG.-273 DRAFT
REV. May 1982

TR-20
STANDARD CONTROL FOR WATERSHED

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed SAMPLE JOB 3 Hydrologist JEZ Date 5/24/82 SHEET 5 OF 7

DATA CODE	OPERATION NAME	OPERATION NO.	XSECT / STRUCT. XSECT I.D.	XSECT / STRUCT. STRUCT I.D.	HYDRO. NUMBER INPUT #1	HYDRO. NUMBER INPUT #2	HYDRO. NUMBER OUTPUT	DATA FIELD #1	DATA FIELD #2	DATA FIELD #3	OUTPUT OPTIONS PRINT PEAK	PRINT HYD	PRINT ELEV	PRINT VOL	FILE	SUM	RECORD IDENT.
EXAMPLES DO NOT ENTER																	
6	RUNOFF	1					6	AREA, SQ. MI.	RUNOFF CURVE NO.	T_c, HRS.							
6	RESVOR	2			6		7	SURF.EL. AT T=0, FT.									
6	REACH	3			7		5	LENGTH, FT.	(OPTIONAL) END AREA COEFF. (X)	(OPTIONAL) EXPONENT (M)							EXAMPLES DO NOT ENTER
6	ADDHYD	4			5	6	7										
6	SAVMOV	5			FROM		TO										
6	DIVERT	6			IN	OUT1	OUT2	OUT1 DISCHARGE, CFS	OUT 1, Decimal % D.A.	OUT2, I.D.							
	ENDATA							This record is to be used only at end of all standard control records.									
			(Right justify these fields)					IMPORTANT: Data Fields No. 1, 2, and 3 require decimal points.									
6	RUNOFF	1		0.1			6	1.20	75.	0.33							420
6	RESVOR	2		0.1	6		7	521.5									430
6	REACH	3	0.01		7		5	5400.	0.4	1.33							440
6	RUNOFF	1	0.01				6	0.46	76.	1.07							450
6	ADDHYD	4	0.01		5	6	7										460
6	REACH	3	0.02		7		5	3000.	2.4	1.05							470
6	SAVMOV	5	0.02		5		1										480
6	RUNOFF	1		0.2			6	0.44	78.	0.35							490
6	RESVOR	2		0.2	6		7										500
6	REACH	3	0.03		7		5	4600.	1.9	0.88							510
6	RUNOFF	1	0.03				6	0.31	77.	0.47							520

NOTE: This form was suggested by members of Massachusetts Planning Staff.

C-7

0-1

SCS-ENG.-273A DRAFT
REV. May 1982

TR-20

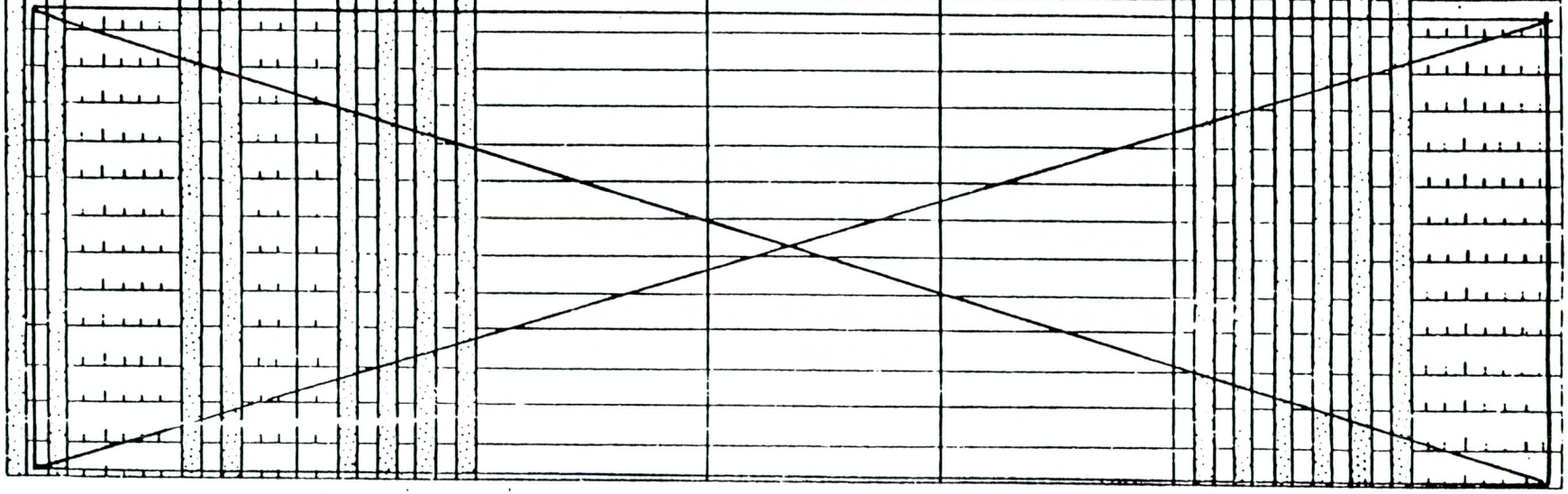
STANDARD CONTROL FOR WATERSHED

CONTINUATION SHEET

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed SAMPLE JOB 3 Hydrologist JEZ Date 5/24/82 SHEET 6 OF 7

CODE	OPERATION	XSEC	STRIC	HYD. NO.	DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3	OUTPUT OPTIONS	RECORD ID.
		(Right justify these fields)			IMPORTANT: Data Fields No 1, 2, and 3 require decimal points.				
6	ADDHYD	003		567					530
6	SAVMOV	004		75					540
6	SAVMOV	004		16					550
6	ADDHYD	004		567				1	560
6	REACH	005		75	2600.			1	570
6	DIVERT	005		5T1	100.	0.4	8.	1	580
6	REACH	006		75	4900.			1	590
6	RUNOFF	006		6	1.30	79.	2.00	1	600
6	ADDHYD	006		567				1	610
	ENDATA								620



SCS-ENG.-274 DRAFT
REV. May 1982

TR-20
EXECUTIVE CONTROL FOR WATERSHED

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed SAMPLE JOB.3 Hydrologist JEZ Date 5/24/82 SHEET 7 OF 7

DATA CODE	OPERATION		DATA FIELD #1	DATA FIELD #2	DATA FIELD #3		RECORD IDENT.
7	LIST	This record is used for printout of tabular data and standard control list that are currently effective.					
7	BASFLO 5		NEW BASE FLOW, CFS or VOLUME IN INCHES	IF VOLUME IS IN DATA FIELD No. 1: PEAK TIME, HOURS	BASE TIME, HOURS		
7	INCREM 6		MAIN TIME INCREMENT, HRS.	This increment is required for initial computations. Remains in force until new increment is entered.			
EXAMPLES DO NOT ENTER		FROM OR XSECT / STRUCT	THRU OR XSECT / STRUCT	STARTING TIME HOURS	RAINFALL DEPTH INCHES (Set depth and duration to 1.0 for actual rainfall)	RAINFALL DURATION HOURS	RAIN TABLE NO. / AMC / ALTERNATE NO. / STROM NO.	EXAMPLES DO NOT ENTER
7	COMPUT 7						
	ENDCMP 1	This record is required at "end" of a watershed, it may follow a series of COMPUT records					
	ENDJOB 2	This record terminates routing computation and precedes the PEAKS record, if any.					
		Right justify these fields		IMPORTANT: Data Fields No. 1, 2, and 3 require decimal points.			
7	INCREM 6			0.25				630
7	COMPUT 7		0.1 / 004		1.0	1.0	7 / 1 / 01 / 06	640
7	COMPUT 7	005	006	2.5	1.0	1.0	7 / 1 / 01 / 06	650
	ENDCMP 1							660
	ENDJOB 2							670

C-9

```
********************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY*******************

JOB TR-20                              FULLPRINT          SUMMARY                    00000010
TITLE 003 SAMPLE JOB 3    USING ACTUAL STORM FROM STRUC 1 TO XSECT 6               00000020
TITLE     INCLUDES X-SEC,TABLE, DIVERT, PLOT, FULLPRINT, SUM.,TZERO                00000030
 5 RAINFL 7                1.0                                                    00000040
 8           0.00          0.06          0.11          0.14          0.17         00000050
 8           0.17          0.17          0.17          0.28          0.48         00000060
 8           1.18          1.42          1.57          1.60          1.74         00000070
 8           1.74          1.74          1.81          2.08          2.83         00000080
 8           4.28          5.35          5.98          6.45          7.21         00000090
 8           7.48          7.88          7.98          8.08          8.43         00000100
 8           3.83          9.33          9.77         10.32         10.61         00000110
 8          10.86         11.09         11.30         11.52         11.81         00000120
 8          12.02         12.06         12.16         12.16         12.16         00000130
 9 ENDTBL                                                                         00000140
 2 XSECTN    005           1.0           495.5                                    00000150
 8                         490.          0.0           0.0                        00000160
 8                         492.          17.           24.                        00000170
 8                         494.          57.           56.                        00000180
 8                         495.          86.           75.                        00000190
 8                         495.5         106.          96.                        00000200
 8                         496.          132.          138.                       00000210
 8                         496.5         164.          202.                       00000220
 8                         497.          205.          287.                       00000230
 8                         498.          319.          522.                       00000240
 8                         499.          482.          843.                       00000250
 8                         500.          705.          1250.                      00000260
 8                         502.          1362.         2330.                      00000270
 8                         504.          2361.         3770.                      00000280
 9 ENDTBL                                                                         00000290
 2 XSECTN    006           1.0           484.3                                    00000300
 8                         480.          0.0           0.0                        00000310
 8                         482.          29.           46.                        00000320
 8                         484.          97.           104.                       00000330
 8                         485.          144.          138.                       00000340
 8                         485.5         176.          168.                       00000350
 8                         486.          215.          226.                       00000360
 8                         487.          320.          459.                       00000370
 8                         488.          485.          875.                       00000380
 8                         490.          1072.         2060.                      00000390
 8                         492.          1971.         3629.                      00000400
 9 ENDTBL                                                                         00000410
 6 RUNOFF 1    01      6 1.20          75.           0.33                         00000420
 6 RESVOR 2    01 6    7 521.5                                                    00000430
 6 REACH  3 001  7     5 5400.         0.4           1.33                         00000440
 6 RUNOFF 1 001        6 0.46          76.           1.07                         00000450
 6 ADDHYD 4 001  5 6 7                                                            00000460
```

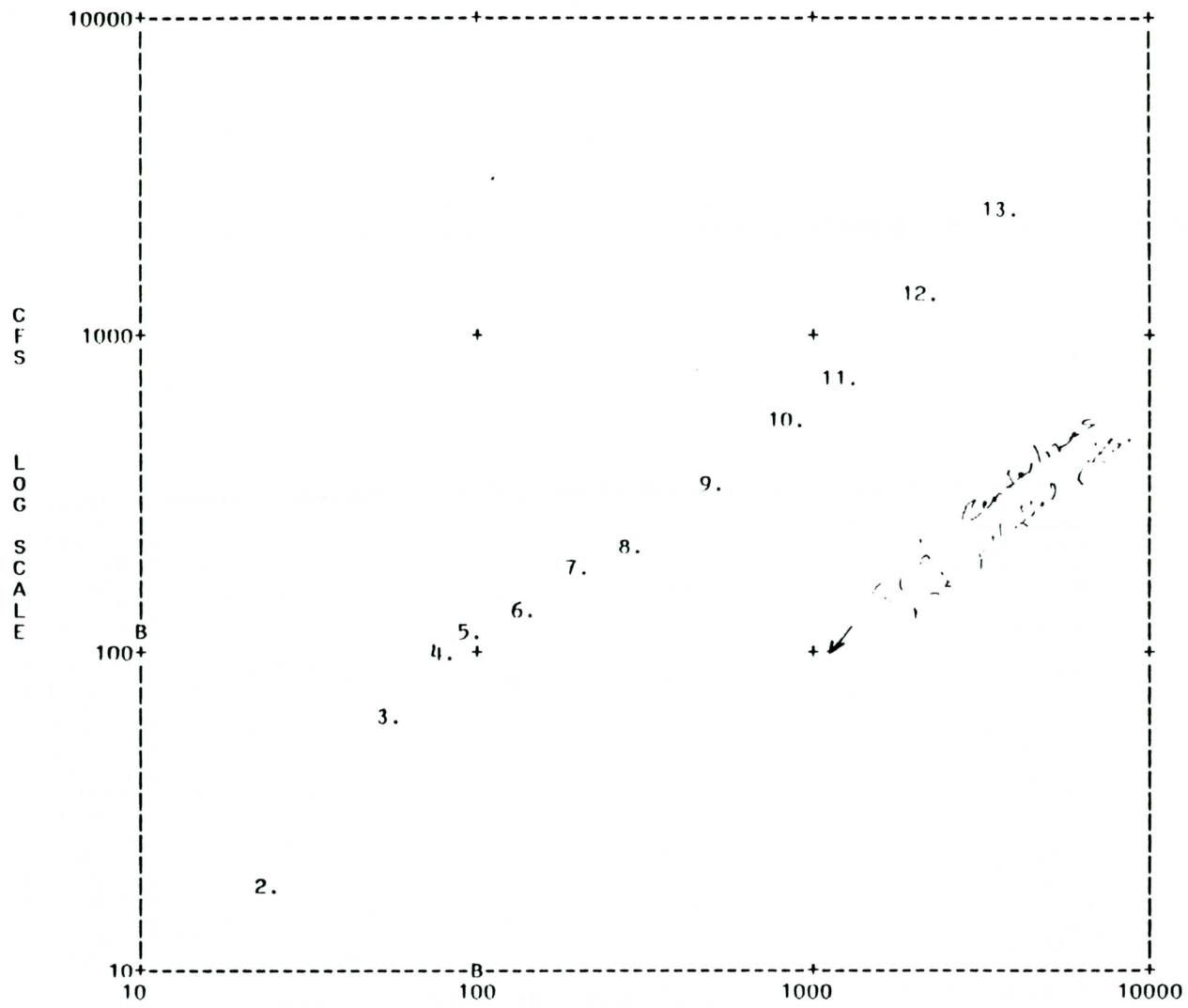
```
**********80-80 LIST OF INPUT DATA (CONTINUED)**********

 6 REACH   3 002    7    5 3000.        2.4            1.05                        00000470
 6 SAVMOV  5 002    5    1                                                         00000480
 6 RUNOFF  1     02       6 0.44         78.            0.35                        00000490
 6 RESVOR  2     02 6     7                                                        00000500
 6 REACH   3 003    7    5 4600.        1.9            0.88                        00000510
 6 RUNOFF  1 003         6 0.31         77.            0.47                        00000520
 6 ADDHYD  4 003    5 6  7                                                        00000530
 6 SAVMOV  5 004    7    5                                                         00000540
 6 SAVMOV  5 004    1    6                                                         00000550
 6 ADDHYD  4 004    5 6  7                                                        00000560
 6 REACH   3 005    7    5 2600.                                        1          00000570
 6 DIVERT  6 005    5 7  1 100.    0.4             8.                  1          00000580
 6 REACH   3 006    7    5 4900.                                        1          00000590
 6 RUNOFF  1 006         6 1.30         79.            2.00            1          00000600
 6 ADDHYD  4 006    5 6  7                                              1          00000610
   ENDATA                                                                         00000620
 7 INCREM  6                0.25                                                  00000630
 7 COMPUT  7     01 004                 1.0            1.0          7 1  01  06  00000640
 7 COMPUT  7 005    006     2.5         1.0            1.0          7 1  01  06  00000650
   ENDCMP  1                                                                    00000660
   ENDJOB  2                                                                    00000670

**********END OF 80-80 LIST**********
```

Note: The User Notes, page 1, is not repeated in this Sample Job (See page A-8).

C-12



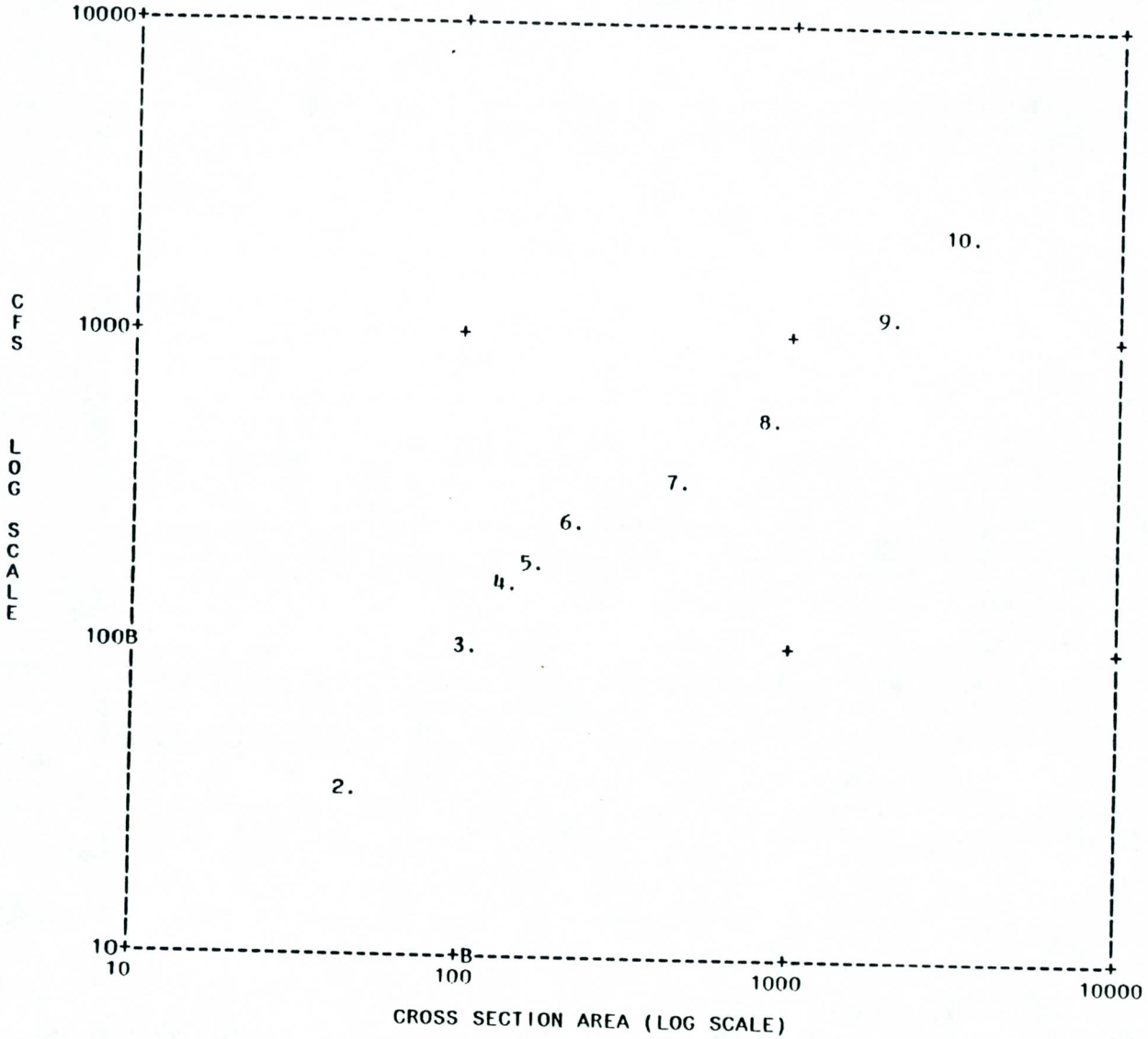
CROSS SECTION 5 DISCHARGE-AREA DATA

REFERENCE NO'S	DISCHARGE (CFS)	AREA (SQ FT)	M	
1	0.0	0.0	1.43	
2	17.00	24.00	1.43	
3	57.00	56.00	1.43	
4	86.00	75.00	1.42	
5	106.00	96.00	1.31	
6	132.00	138.00	1.17	
7	164.00	202.00	1.06	
8	205.00	287.00	0.97	*
9	319.00	522.00	0.89	*
10	482.00	843.00	0.88	*
11	705.00	1250.00	0.91	*
12	1362.00	2330.00	0.98	*
13	2361.00	3770.00	1.05	

A STAR (*) INDICATES A COMPUTED M VALUE IS OUTSIDE THE 1.00 - 2.00 RANGE. IN ROUTING THIS REACH THE M VALUE WILL BE SET TO THE CLOSEST LIMIT VALUE.

LEGEND

. = LOCATION OF PLOTTED VALUE
3 = REFERENCE NO. OF PLOTTED VALUE
X = MULTIPLE REFERENCE NUMBERS
B = BANKFULL RELATION SHOWN ON AXIS
AREA= 96.0 SQ FT DISCHARGE= 106.0 CFS



CROSS SECTION 6 DISCHARGE-AREA DATA

REFERENCE NO'S	DISCHARGE (CFS)	AREA (SQ FT)	M
1	0.0	0.0	1.48
2	29.00	46.00	1.48
3	97.00	104.00	1.48
4	144.00	138.00	1.45
5	176.00	168.00	1.37
6	215.00	226.00	1.25
7	320.00	459.00	1.02
8	485.00	875.00	0.89 *
9	1072.00	2060.00	0.91 *
10	1971.00	3629.00	0.99 *

A STAR (*) INDICATES A COMPUTED M VALUE IS OUTSIDE THE 1.00 - 2.00 RANGE. IN ROUTING THIS REACH THE M VALUE WILL BE SET TO THE CLOSEST LIMIT VALUE.

LEGEND

. = LOCATION OF PLOTTED VALUE
3 = REFERENCE NO. OF PLOTTED VALUE
X = MULTIPLE REFERENCE NUMBERS
B = BANKFULL RELATION SHOWN ON AXIS
AREA= 104.0 SQ FT DISCHARGE= 97.0 CFS

C-14

EXECUTIVE CONTROL OPERATION INCREM MAIN TIME INCREMENT = 0.25 HOURS RECORD ID 00000630

EXECUTIVE CONTROL OPERATION COMPUT FROM STRUCTURE 1 TO XSECTION 4 RECORD ID 00000640
STARTING TIME = 0.0 RAIN DEPTH = 1.00 RAIN DURATION= 1.00 RAIN TABLE NO.= 7 ANT. MOIST. COND= 1
ALTERNATE NO.= 1 STORM NO.= 6 MAIN TIME INCREMENT = 0.25 HOURS

OPERATION RUNOFF STRUCTURE 1
OUTPUT HYDROGRAPH= 6
AREA= 1.20 SQ MI INPUT RUNOFF CURVE= 75. TIME OF CONCENTRATION= 0.33 HOURS
COMPUTED CURVE NO. = 57. INTERNAL HYDROGRAPH TIME INCREMENT= 0.0440 HOURS

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
20.03	474.02	(RUNOFF)
20.92	450.91	(RUNOFF)
21.90	293.23	(RUNOFF)
23.89	404.75	(RUNOFF)
25.88	227.30	(RUNOFF)
30.90	293.34	(RUNOFF)
32.88	342.98	(RUNOFF)
34.88	155.31	(RUNOFF)
35.88	143.92	(RUNOFF)
38.88	186.89	(RUNOFF)

RUNOFF VOLUME ABOVE BASEFLOW = 6.22 WATERSHED INCHES, 4817.57 CFS-HRS, 398.12 ACRE-FEET; BASEFLOW = 0.0 CFS

OPERATION RESVOR STRUCTURE 1
INPUT HYDROGRAPH= 6 OUTPUT HYDROGRAPH= 7
SURFACE ELEVATION= 521.50

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
20.03	474.02	(NULL)
20.92	450.91	(NULL)
21.90	293.23	(NULL)
23.89	404.75	(NULL)
25.88	227.30	(NULL)
30.90	293.34	(NULL)
32.88	342.98	(NULL)
34.88	155.31	(NULL)
35.88	143.92	(NULL)
38.88	186.89	(NULL)

RUNOFF VOLUME ABOVE BASEFLOW = 6.22 WATERSHED INCHES, 4817.57 CFS-HRS, 398.12 ACRE-FEET; BASEFLOW = 0.0 CFS

OPERATION REACH CROSS SECTION 1
INPUT HYDROGRAPH= 7 OUTPUT HYDROGRAPH= 5
LENGTH = 5400.00 FEET INPUT = COEFFICIENTS RELATED TO CROSS SECTIONAL AREA, X= 0.40, M= 1.33

MODIFIED ATT-KIN ROUTING COEFFICIENT = 0.41 PEAK TRAVEL TIME = 1.25

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
14.29	3.97	(NULL)
21.20	429.30	(NULL)
24.21	361.48	(NULL)
26.16	210.47	(NULL)
31.33	279.42	(NULL)
33.18	321.63	(NULL)
39.23	175.68	(NULL)
42.17	60.40	(NULL)

RUNOFF VOLUME ABOVE BASEFLOW = 6.23 WATERSHED INCHES, 4823.04 CFS-HRS, 398.58 ACRE-FEET; BASEFLOW = 0.0 CFS

OPERATION RUNOFF CROSS SECTION 1
OUTPUT HYDROGRAPH= 6
AREA= 0.46 SQ MI INPUT RUNOFF CURVE= 76. TIME OF CONCENTRATION= 1.07 HOURS
COMPUTED CURVE NO. = 58. INTERNAL HYDROGRAPH TIME INCREMENT= 0.1427 HOURS

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
14.27	2.12	(RUNOFF)
21.07	168.84	(RUNOFF)
24.19	137.94	(RUNOFF)
26.11	78.96	(RUNOFF)
31.36	108.97	(RUNOFF)
33.15	122.72	(RUNOFF)
39.22	67.39	(RUNOFF)
42.13	22.09	(RUNOFF)

RUNOFF VOLUME ABOVE BASEFLOW = 6.42 WATERSHED INCHES, 1904.97 CFS-HRS, 157.43 ACRE-FEET; BASEFLOW = 0.0 CFS

OPERATION ADDHYD CROSS SECTION 1
INPUT HYDROGRAPHS= 5,6 OUTPUT HYDROGRAPH= 7

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
14.28	6.09	(NULL)
21.18	598.68	(NULL)
24.20	499.37	(NULL)
26.16	290.03	(NULL)
31.34	388.37	(NULL)
33.18	444.27	(NULL)
39.23	243.06	(NULL)
42.16	82.45	(NULL)

RUNOFF VOLUME ABOVE BASEFLOW = 6.28 WATERSHED INCHES, 6728.00 CFS-HRS, 556.00 ACRE-FEET; BASEFLOW = 0.0 CFS

OPERATION REACH CROSS SECTION 2

C-16

INPUT HYDROGRAPH= 7 OUTPUT HYDROGRAPH= 5
LENGTH 3000.00 FEET INPUT = COEFFICIENTS RELATED TO CROSS SECTIONAL AREA, X= 2.40, M= 1.05

MODIFIED ATT-KIN ROUTING COEFFICIENT = 0.66 PEAK TRAVEL TIME = 0.25

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
18.62	5.54	(NULL)
21.46	590.94	(NULL)
24.51	481.94	(NULL)
26.43	284.12	(NULL)
31.75	383.45	(NULL)
33.47	435.59	(NULL)
39.56	238.56	(NULL)
42.45	79.65	(NULL)

RUNOFF VOLUME ABOVE BASEFLOW = 6.28 WATERSHED INCHES, 6726.16 CFS-HRS, 555.85 ACRE-FEET; BASEFLOW = 0.0 CFS

OPERATION SAVHOV CROSS SECTION 2
INPUT HYDROGRAPH= 5 OUTPUT HYDROGRAPH= 1

OPERATION RUNOFF STRUCTURE 2
OUTPUT HYDROGRAPH= 6
AREA 0.44 SQ MI INPUT RUNOFF CURVE 78. TIME OF CONCENTRATION= 0.35 HOURS
COMPUTED CURVE NO. = 61. INTERNAL HYDROGRAPH TIME INCREMENT= 0.0467 HOURS

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
13.91	4.62	(RUNOFF)
20.02	199.76	(RUNOFF)
20.91	183.85	(RUNOFF)
21.89	117.75	(RUNOFF)
23.89	159.16	(RUNOFF)
25.88	88.47	(RUNOFF)
30.90	113.36	(RUNOFF)
32.88	131.39	(RUNOFF)
38.88	71.15	(RUNOFF)
41.88	25.78	(RUNOFF)

RUNOFF VOLUME ABOVE BASEFLOW = 6.78 WATERSHED INCHES, 1925.48 CFS-HRS, 159.12 ACRE-FEET; BASEFLOW = 0.0 CFS

OPERATION RESVOR STRUCTURE 2
INPUT HYDROGRAPH 6 OUTPUT HYDROGRAPH= 7
SURFACE ELEVATION 0.0

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
13.91	4.62	(NULL)
20.02	199.76	(NULL)
20.91	183.85	(NULL)
21.89	117.75	(NULL)
23.89	159.16	(NULL)
25.88	88.47	(NULL)
30.90	113.36	(NULL)
32.88	131.39	(NULL)
38.88	71.15	(NULL)
41.88	25.78	(NULL)

RUNOFF VOLUME ABOVE BASEFLOW = 6.78 WATERSHED INCHES, 1925.48 CFS-HRS, 159.12 ACRE-FEET; BASEFLOW = 0.0 CFS

OPERATION REACH CROSS SECTION 3
INPUT HYDROGRAPH= 7 OUTPUT HYDROGRAPH= 5
LENGTH = 4600.00 FEET INPUT = COEFFICIENTS RELATED TO CROSS SECTIONAL AREA, X= 1.90, M= 0.88

INPUT COEFFICIENTS ADJUSTED DUE TO LIMITS, X= 1.01 M= 1.00 USED IN ROUTING

MODIFIED ATT-KIN ROUTING COEFFICIENT = 0.18 PEAK TRAVEL TIME = 1.50

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
14.35	2.60	(NULL)
21.39	147.04	(NULL)
24.26	129.92	(NULL)
33.27	112.43	(NULL)
39.35	62.04	(NULL)

RUNOFF VOLUME ABOVE BASEFLOW = 6.78 WATERSHED INCHES, 1926.57 CFS-HRS, 159.21 ACRE-FEET; BASEFLOW = 0.0 CFS

OPERATION RUNOFF CROSS SECTION 3
OUTPUT HYDROGRAPH= 6
AREA= 0.31 SQ MI INPUT RUNOFF CURVE= 77. TIME OF CONCENTRATION= 0.47 HOURS
COMPUTED CURVE NO. = 59. INTERNAL HYDROGRAPH TIME INCREMENT= 0.0627 HOURS

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
13.96	2.43	(RUNOFF)
20.13	130.47	(RUNOFF)
20.93	122.70	(RUNOFF)
23.91	106.54	(RUNOFF)
25.89	59.41	(RUNOFF)
30.95	77.86	(RUNOFF)
32.89	89.53	(RUNOFF)
38.91	48.85	(RUNOFF)
41.89	17.24	(RUNOFF)

RUNOFF VOLUME ABOVE BASEFLOW = 6.60 WATERSHED INCHES, 1320.83 CFS-HRS, 109.15 ACRE-FEET; BASEFLOW = 0.0 CFS

OPERATION ADDHYD CROSS SECTION 3
INPUT HYDROGRAPHS= 5,6 OUTPUT HYDROGRAPH= 7

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
14.07	4.61	(NULL)
21.06	261.01	(NULL)
23.97	229.89	(NULL)
25.88	148.30	(NULL)
31.26	168.34	(NULL)
32.97	197.51	(NULL)
39.02	108.66	(NULL)
41.70	45.80	(NULL)

RUNOFF VOLUME ABOVE BASEFLOW = 6.71 WATERSHED INCHES, 3247.37 CFS-HRS, 268.36 ACRE-FEET; BASEFLOW = 0.0 CFS

OPERATION SAVMOV CROSS SECTION 4
INPUT HYDROGRAPH= 7 OUTPUT HYDROGRAPH= 5

OPERATION SAVMOV CROSS SECTION 4
INPUT HYDROGRAPH= 1 OUTPUT HYDROGRAPH= 6

OPERATION ADDHYD CROSS SECTION 4
INPUT HYDROGRAPHS= 5,6 OUTPUT HYDROGRAPH= 7

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
14.38	8.59	(NULL)
21.24	835.10	(NULL)
24.33	668.69	(NULL)
26.01	412.54	(NULL)
31.76	549.95	(NULL)
33.26	611.08	(NULL)
39.44	338.49	(NULL)
42.09	115.59	(NULL)

FIRST HYDROGRAPH POINT = 0.0 HOURS TIME INCREMENT = 0.25 HOURS DRAINAGE AREA = 2.41 SQ.MI.

TIME(HRS)											
10.00	DISCHG	0.0	0.0	0.0	0.0	0.10	0.59	1.14	1.73	2.41	2.79
12.50	DISCHG	2.78	2.84	2.75	3.04	4.04	5.43	7.28	8.48	8.50	7.64
15.00	DISCHG	5.95	4.25	2.94	2.04	1.43	1.46	2.18	3.34	4.89	7.86
17.50	DISCHG	12.77	19.29	27.62	41.93	64.83	96.63	138.53	198.26	279.63	384.35
20.00	DISCHG	513.09	633.01	727.81	791.27	825.70	835.09	824.34	791.58	740.06	687.92
22.50	DISCHG	642.79	602.11	563.64	545.73	552.74	585.34	637.42	666.87	660.29	613.09
25.00	DISCHG	534.35	466.25	424.06	408.60	412.54	408.96	388.60	346.41	287.49	234.27
27.50	DISCHG	194.90	168.48	151.24	151.19	168.71	205.18	255.76	303.77	342.92	374.64
30.00	DISCHG	401.39	426.58	451.74	479.56	509.77	532.91	546.29	549.95	546.58	547.38

32.50	DISCHG	556.07	574.47	600.02	611.07	601.50	567.62	515.70	466.14	426.69	396.16
35.00	DISCHG	371.79	353.03	338.79	327.28	317.45	308.98	301.58	294.48	287.48	282.32
37.50	DISCHG	279.40	278.62	279.40	284.04	292.78	306.57	324.13	335.64	338.22	331.11
40.00	DISCHG	316.73	294.31	264.94	226.05	179.99	143.41	121.31	113.32	115.41	115.12
42.50	DISCHG	107.99	91.94	69.01	48.22	32.76	22.30	15.42	10.90	7.89	5.85
45.00	DISCHG	4.43	3.41	2.66	2.11	1.69	1.36	1.11	0.90	0.73	0.59
47.50	DISCHG	0.49	0.40	0.33	0.27	0.22	0.18	0.15	0.12	0.10	0.08
50.00	DISCHG	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01
52.50	DISCHG	0.01	0.00								

RUNOFF VOLUME ABOVE BASEFLOW = 6.41 WATERSHED INCHES, 9973.54 CFS-HRS, 824.21 ACRE-FEET; BASEFLOW = 0.0 CFS

C-20

EXECUTIVE CONTROL OPERATION COMPUT FROM XSECTION 5 TO XSECTION 6 RECORD ID 00000650
STARTING TIME= 2.50 RAIN DEPTH = 1.00 RAIN DURATION= 1.00 RAIN TABLE NO.= 7 ANT. MOIST. COND= 1
ALTERNATE NO.= 1 STORM NO.= 6 MAIN TIME INCREMENT = 0.25 HOURS

OPERATION REACH CROSS SECTION 5
INPUT HYDROGRAPH= 7 OUTPUT HYDROGRAPH= 5
LENGTH = 2600.00 FEET INPUT = RATING CURVE REPRESENTATIVE OF REACH

COEFFICIENTS USED IN ROUTING RELATED TO CROSS SECTION AREA, X= 0.57 M= 1.00

MODIFIED ATT-KIN ROUTING COEFFICIENT = 0.18 PEAK TRAVEL TIME = 1.27

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
15.16	5.79	490.68
22.48	670.55	499.85
24.81	628.09	499.66
33.93	557.81	499.34
40.09	319.19	498.00

TIME(HRS)		FIRST HYDROGRAPH POINT = 0.0 HOURS				TIME INCREMENT = 0.25 HOURS			DRAINAGE AREA =		2.41 SQ.MI.
10.00	DISCHG	0.0	0.0	0.0	0.0	0.0	0.02	0.12	0.30	0.56	0.89
12.50	DISCHG	1.23	1.51	1.74	1.92	2.12	2.47	3.00	3.77	4.61	5.31
15.00	DISCHG	5.72	5.77	5.49	5.04	4.50	3.95	3.50	3.26	3.28	3.57
17.50	DISCHG	4.34	5.85	8.26	11.73	17.15	25.70	38.42	56.38	81.82	117.30
20.00	DISCHG	165.20	227.60	300.31	376.99	451.30	518.45	575.24	619.92	650.71	666.74
22.50	DISCHG	670.53	665.56	654.18	637.94	621.40	609.08	604.82	610.67	620.75	627.84
25.00	DISCHG	625.19	608.90	583.31	554.75	528.53	507.72	490.01	471.82	449.32	420.30
27.50	DISCHG	386.93	352.48	319.48	289.30	264.53	247.34	239.78	242.64	253.61	269.63
30.00	DISCHG	288.46	308.72	329.86	351.72	374.65	398.88	422.92	445.05	463.86	478.70
32.50	DISCHG	491.02	502.68	515.56	530.71	545.12	555.23	557.45	549.96	534.93	515.51
35.00	DISCHG	494.10	472.16	450.79	430.70	412.15	395.16	379.70	365.69	352.92	341.18
37.50	DISCHG	330.62	321.43	313.75	307.59	303.36	301.47	302.38	306.28	311.54	316.33
40.00	DISCHG	318.98	318.57	314.22	305.38	291.15	271.21	248.29	225.51	205.39	189.25
42.50	DISCHG	175.95	163.76	150.88	136.19	120.41	104.69	89.91	76.55	64.77	54.57
45.00	DISCHG	45.83	38.40	32.13	26.84	22.40	18.69	15.58	12.98	10.81	9.01
47.50	DISCHG	7.50	6.24	5.19	4.32	3.59	2.99	2.48	2.06	1.71	1.42
50.00	DISCHG	1.18	0.98	0.81	0.67	0.56	0.46	0.38	0.32	0.26	0.22
52.50	DISCHG	0.18	0.15	0.12	0.10	0.08	0.07	0.05	0.04	0.04	0.03
55.00	DISCHG	0.02	0.02	0.01	0.01	0.01	0.01	0.00			

RUNOFF VOLUME ABOVE BASEFLOW = 6.41 WATERSHED INCHES, 9973.54 CFS-HRS, 824.21 ACRE-FEET; BASEFLOW = 0.0 CFS

OPERATION DIVERT CROSS SECTION 5
INPUT HYDROGRAPH = 5 OUTPUT #1 HYDROGRAPH = 7 OUTPUT #2 HYDROGRAPH = 1
XSECTION = 5 XSECTION = 5 DIVERTED XSECTION = 8
OUTPUT #1 HYDROGRAPH

PEAK TIME(HRS)
15.16
19.75

PEAK DISCHARGE(CFS)
5.79
100.00

PEAK ELEVATION(FEET)
490.68
495.35

FIRST HYDROGRAPH POINT = 0.0 HOURS TIME INCREMENT = 0.25 HOURS DRAINAGE AREA = 0.96 SQ.MI.

TIME(HRS)											
10.00	DISCHG	0.0	0.0	0.0	0.0	0.0	0.02	0.12	0.30	0.56	0.89
12.50	DISCHG	1.23	1.51	1.74	1.92	2.12	2.47	3.00	3.77	4.61	5.31
15.00	DISCHG	5.72	5.77	5.49	5.04	4.50	3.95	3.50	3.26	3.28	3.57
17.50	DISCHG	4.34	5.85	8.26	11.73	17.15	25.70	38.42	56.38	81.82	100.00
20.00	DISCHG	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
22.50	DISCHG	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
25.00	DISCHG	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
27.50	DISCHG	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
30.00	DISCHG	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
32.50	DISCHG	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
35.00	DISCHG	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
37.50	DISCHG	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
40.00	DISCHG	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
42.50	DISCHG	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
45.00	DISCHG	45.83	38.40	32.13	26.84	22.40	18.69	15.58	12.98	10.81	9.01
47.50	DISCHG	7.50	6.24	5.19	4.32	3.59	2.99	2.48	2.06	1.71	1.42
50.00	DISCHG	1.18	0.98	0.81	0.67	0.56	0.46	0.38	0.32	0.26	0.22
52.50	DISCHG	0.18	0.15	0.12	0.10	0.08	0.07	0.05	0.04	0.04	0.03
55.00	DISCHG	0.02	0.02	0.01	0.01	0.01	0.01	0.00			

RUNOFF VOLUME ABOVE BASEFLOW = 4.25 WATERSHED INCHES, 2646.75 CFS-HRS, 218.73 ACRE-FEET; BASEFLOW = 0.0 CFS

OUTPUT #2 DIVERTED HYDROGRAPH FOLLOWS

PEAK TIME(HRS)
22.48
24.81
33.93
40.09

PEAK DISCHARGE(CFS)
570.55
528.09
457.81
219.19

PEAK ELEVATION(FEET)
(DIVERT)
(DIVERT)
(DIVERT)
(DIVERT)

FIRST HYDROGRAPH POINT = 0.0 HOURS TIME INCREMENT = 0.25 HOURS DRAINAGE AREA = 1.45 SQ.MI.

TIME(HRS)											
17.50	DISCHG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.30
20.00	DISCHG	65.20	127.60	200.31	276.99	351.30	418.45	475.24	519.92	550.71	566.74
22.50	DISCHG	570.53	565.56	554.18	537.94	521.40	509.08	504.82	510.67	520.75	527.84
25.00	DISCHG	525.19	508.90	483.31	454.75	428.53	407.72	390.01	371.82	349.32	320.30
27.50	DISCHG	286.93	252.48	219.48	189.30	164.53	147.34	139.78	142.64	153.61	169.63
30.00	DISCHG	188.46	208.72	229.86	251.72	274.65	298.88	322.92	345.05	363.86	378.70
32.50	DISCHG	391.02	402.68	415.56	430.71	445.12	455.23	457.45	449.96	434.93	415.51
35.00	DISCHG	394.10	372.16	350.79	330.70	312.15	295.16	279.70	265.69	252.92	241.18
37.50	DISCHG	230.62	221.43	213.75	207.59	203.36	201.47	202.38	206.28	211.54	216.33
40.00	DISCHG	218.98	218.57	214.22	205.38	191.15	171.21	148.29	125.51	105.39	89.25
42.50	DISCHG	75.95	63.76	50.88	36.19	20.41	4.69	0.0			

RUNOFF VOLUME ABOVE BASEFLOW = 7.85 WATERSHED INCHES, 7326.79 CFS-HRS, 605.49 ACRE-FEET; BASEFLOW = 0.0 CFS

OPERATION REACH CROSS SECTION 6
INPUT HYDROGRAPH= 7 OUTPUT HYDROGRAPH= 5
LENGTH = 4900.00 FEET INPUT = RATING CURVE REPRESENTATIVE OF REACH

COEFFICIENTS USED IN ROUTING RELATED TO CROSS SECTION AREA, X= 0.10 M= 1.48

MODIFIED ATT-KIN ROUTING COEFFICIENT = 0.23 PEAK TRAVEL TIME = 10.00

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
29.75	100.00	484.06

TIME(HRS)		FIRST HYDROGRAPH POINT = 0.0 HOURS				TIME INCREMENT = 0.25 HOURS			DRAINAGE AREA =		0.96 SQ.MI.
10.00	DISCHG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.03	0.09	0.19
12.50	DISCHG	0.35	0.55	0.76	0.99	1.20	1.41	1.65	1.95	2.36	2.87
15.00	DISCHG	3.42	3.94	4.35	4.61	4.71	4.66	4.50	4.27	4.04	3.87
17.50	DISCHG	3.80	3.92	4.36	5.24	6.71	9.07	12.84	18.63	27.18	39.55
20.00	DISCHG	53.24	63.83	72.02	78.36	83.26	87.05	89.98	92.25	94.00	95.36
22.50	DISCHG	96.41	97.22	97.85	98.34	98.71	99.00	99.23	99.40	99.54	99.64
25.00	DISCHG	99.72	99.78	99.83	99.87	99.90	99.92	99.94	99.95	99.96	99.97
27.50	DISCHG	99.98	99.98	99.98	99.99	99.99	99.99	99.99	99.99	99.99	100.00
30.00	DISCHG	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
32.50	DISCHG	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
35.00	DISCHG	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
37.50	DISCHG	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
40.00	DISCHG	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
42.50	DISCHG	100.00	100.00	100.00	100.00	100.00	100.00	100.00	97.71	92.92	86.54
45.00	DISCHG	79.30	71.72	64.17	56.92	50.10	43.83	38.13	33.03	28.49	24.48
47.50	DISCHG	20.98	17.92	15.28	12.99	11.03	9.34	7.90	6.67	5.63	4.74
50.00	DISCHG	3.99	3.35	2.81	2.36	1.98	1.66	1.38	1.16	0.97	0.81
52.50	DISCHG	0.67	0.56	0.47	0.39	0.32	0.27	0.22	0.18	0.15	0.12
55.00	DISCHG	0.10	0.08	0.07	0.06	0.04	0.04	0.03	0.02	0.02	0.01
57.50	DISCHG	0.01	0.01	0.00							

RUNOFF VOLUME ABOVE BASEFLOW = 4.25 WATERSHED INCHES, 2646.29 CFS-HRS, 218.69 ACRE-FEET; BASEFLOW = 0.0 CFS

OPERATION RUNOFF CROSS SECTION 6
OUTPUT HYDROGRAPH= 6
AREA= 1.30 SQ MI INPUT RUNOFF CURVE= 79. TIME OF CONCENTRATION= 2.00 HOURS
COMPUTED CURVE NO. = 62. INTERNAL HYDROGRAPH TIME INCREMENT= 0.2667 HOURS

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
17.16	9.07	(RUNOFF)
24.05	486.35	(RUNOFF)
27.00	375.42	(RUNOFF)
35.95	335.25	(RUNOFF)
42.23	183.18	(RUNOFF)

TIME(HRS) FIRST HYDROGRAPH POINT = 2.50 HOURS TIME INCREMENT = 0.25 HOURS DRAINAGE AREA = 1.30 SQ.MI.

12.50	DISCHG	0.0	0.01	0.05	0.20	0.59	1.29	2.30	3.49	4.76	5.88
15.00	DISCHG	6.65	6.87	6.62	6.23	6.04	6.32	7.13	8.15	8.92	9.02
17.50	DISCHG	8.33	7.08	5.62	4.21	3.07	2.37	2.15	2.48	3.33	4.84
20.00	DISCHG	7.27	10.93	16.11	23.41	34.04	49.31	70.10	97.57	133.80	181.93
22.50	DISCHG	241.60	305.85	366.70	417.11	453.89	476.79	486.10	481.97	467.35	446.56
25.00	DISCHG	422.54	397.02	372.71	353.86	343.32	343.61	354.46	368.15	375.42	368.12
27.50	DISCHG	346.58	318.00	289.92	267.78	253.83	245.28	236.17	221.64	200.57	175.79
30.00	DISCHG	151.00	128.95	111.45	101.29	99.13	106.60	121.94	141.53	162.44	182.87
32.50	DISCHG	201.30	217.54	232.87	248.51	264.36	279.01	291.12	299.57	304.14	306.70
35.00	DISCHG	309.94	316.12	324.81	332.49	335.12	329.50	315.54	296.20	275.03	254.55
37.50	DISCHG	236.56	221.97	210.14	200.19	191.80	184.95	179.05	173.68	168.86	164.79
40.00	DISCHG	161.61	159.41	158.34	158.68	160.82	165.10	171.08	177.22	181.75	183.16
42.50	DISCHG	181.14	175.04	164.82	149.36	130.43	111.33	94.71	82.31	74.62	70.14
45.00	DISCHG	66.10	60.35	52.23	42.70	33.15	24.67	17.94	13.14	9.66	7.07
47.50	DISCHG	5.15	3.73	2.69	1.93	1.37	0.97	0.69	0.50	0.36	0.25
50.00	DISCHG	0.17	0.09	0.04	0.01	0.00					

RUNOFF VOLUME ABOVE BASEFLOW = 6.97 WATERSHED INCHES, 5846.62 CFS-HRS, 483.17 ACRE-FEET; BASEFLOW = 0.0 CFS

OPERATION ADDHYD CROSS SECTION 6
INPUT HYDROGRAPHS= 5,6 OUTPUT HYDROGRAPH= 7

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
17.09	13.00	480.90
24.05	585.62	488.34
27.00	475.38	487.94
35.95	435.25	487.70
42.23	283.17	486.65

TIME(HRS) FIRST HYDROGRAPH POINT = 0.0 HOURS TIME INCREMENT = 0.25 HOURS DRAINAGE AREA = 2.26 SQ.MI.

10.00	DISCHG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.03	0.09	0.19
12.50	DISCHG	0.35	0.55	0.81	1.19	1.79	2.69	3.94	5.45	7.12	8.75
15.00	DISCHG	10.08	10.82	10.98	10.84	10.75	10.98	11.62	12.42	12.96	12.88
17.50	DISCHG	12.13	11.00	9.98	9.45	9.78	11.45	14.99	21.11	30.51	44.39
20.00	DISCHG	60.51	74.76	88.13	101.77	117.30	136.36	160.09	189.82	227.81	277.29
22.50	DISCHG	338.01	403.08	464.55	515.44	552.60	575.79	585.33	581.37	566.89	546.21
25.00	DISCHG	522.26	496.81	472.54	453.73	443.22	443.53	454.40	468.11	475.38	468.09
27.50	DISCHG	446.55	417.98	389.90	367.77	353.82	345.27	336.16	321.64	300.57	275.78
30.00	DISCHG	250.99	228.94	211.44	201.29	199.13	206.59	221.93	241.52	262.43	282.86
32.50	DISCHG	301.29	317.54	332.87	348.50	364.36	379.01	391.11	399.56	404.14	406.70
35.00	DISCHG	409.94	416.12	424.81	432.49	435.11	429.50	415.54	396.20	375.03	354.55
37.50	DISCHG	336.55	321.96	310.14	300.19	291.79	284.94	279.05	273.68	268.85	264.78
40.00	DISCHG	261.60	259.40	258.33	258.67	260.82	265.10	271.07	277.21	281.74	283.16
42.50	DISCHG	281.14	275.04	264.81	249.36	230.43	211.32	194.71	180.02	167.54	156.68
45.00	DISCHG	145.41	132.07	116.40	99.61	83.26	68.50	56.07	46.16	38.15	31.56
47.50	DISCHG	26.12	21.65	17.97	14.92	12.40	10.31	8.59	7.17	5.99	4.99
50.00	DISCHG	4.16	3.45	2.86	2.37	1.98	1.66	1.38	1.16	0.97	0.81
52.50	DISCHG	0.67	0.56	0.47	0.39	0.32	0.27	0.22	0.18	0.15	0.12

SAMPLE JOB 3 USING ACTUAL STORM FROM STRUC 1 TO XSECT 6 00000020
INCLUDES X-SEC. TABLE, DIVERT, PLOT, FULLPRINT, SUM., IZERO 00000030

C-24

55.00	DISCHG	0.10	0.08	0.07	0.06	0.04	0.04	0.03	0.02	0.02	0.01
57.50	DISCHG	0.01	0.01	0.00							

RUNOFF VOLUME ABOVE BASEFLOW = 5.81 WATERSHED INCHES, 8492.94 CFS-HRS, 701.86 ACRE-FEET; BASEFLOW = 0.0 CFS

EXECUTIVE CONTROL OPERATION ENDCMP COMPUTATIONS COMPLETED FOR PASS 1

RECORD ID 00000660

EXECUTIVE CONTROL OPERATION ENDJOB

RECORD ID 00000670

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH.)

SECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)
ALTERNATE 1 STORM 6													
STRUCTURE 1	RUNOFF	1.20	7	1	0.25	0.0	12.16	42.00	6.22	---	20.03	474.02	395.0
STRUCTURE 1	RESVOR	1.20	7	1	0.25	0.0	12.16	42.00	6.22	---	20.03	474.02	395.0
XSECTION 1	REACH	1.20	7	1	0.25	0.0	12.16	42.00	6.23	---	21.20	429.30	357.8
XSECTION 1	RUNOFF	0.46	7	1	0.25	0.0	12.16	42.00	6.42	---	21.07	168.84	367.0
XSECTION 1	ADDHYD	1.66	7	1	0.25	0.0	12.16	42.00	6.28	---	21.18	598.68	360.7
XSECTION 2	REACH	1.66	7	1	0.25	0.0	12.16	42.00	6.28	---	21.46	590.94	356.0
STRUCTURE 2	RUNOFF	0.44	7	1	0.25	0.0	12.16	42.00	6.78	---	20.02	199.76	454.0
STRUCTURE 2	RESVOR	0.44	7	1	0.25	0.0	12.16	42.00	6.78	---	20.02	199.76	454.0
XSECTION 3	REACH	0.44	7	1	0.25	0.0	12.16	42.00	6.78	---	21.39	147.04	334.2
XSECTION 3	RUNOFF	0.31	7	1	0.25	0.0	12.16	42.00	6.60	---	20.13	130.47	420.9
XSECTION 3	ADDHYD	0.75	7	1	0.25	0.0	12.16	42.00	6.71	---	21.06	261.01	348.0
XSECTION 4	ADDHYD	2.41	7	1	0.25	0.0	12.16	42.00	6.41	---	21.24	835.10	346.5
XSECTION 5	REACH	2.41	7	1	0.25	0.0	12.16	42.00	6.41	499.85	22.48	670.55	278.2
XSECTION 5	DIVERT	0.96	7	1	0.25	0.0	12.16	42.00	4.25	495.35	19.75*	100.00*	103.7
XSECTION 8	DIVERT	1.45	7	1	0.25	0.0	12.16	42.00	7.85	---	22.48	570.55	394.6
XSECTION 6	REACH	0.96	7	1	0.25	0.0	12.16	42.00	4.25	484.06	29.75*	100.00*	103.7
XSECTION 6	RUNOFF	1.30	7	1	0.25	2.5	12.16	42.00	6.97	---	24.05	486.35	374.1
XSECTION 6	ADDHYD	2.26	7	1	0.25	0.0	12.16	42.00	5.81	488.34	24.05	585.62	258.7

C-26

SUMMARY TABLE 2 - SELECTED MODIFIED ATT-KIN REACH ROUTINGS IN ORDER OF STANDARD EXECUTIVE CONTROL INSTRUCTIONS
(A STAR(*) AFTER VOLUME ABOVE BASE(IN) INDICATES A HYDROGRAPH TRUNCATED AT A VALUE EXCEEDING BASE + 10% OF PEAK)

XSEC ID	REACH LENGTH (FT)	HYDROGRAPH INFORMATION: INFLOW PEAK (CFS)	INFLOW TIME (HR)	OUTFLOW PEAK (CFS)	OUTFLOW TIME (HR)	OUTFLOW+ INTERV. AREA PEAK (CFS)	AREA TIME (HR)	BASE-FLOW (CFS)	ROUTING PARAMETERS: VOLUME ABOVE BASE (IN)	MAIN TIME INCR (HR)	ITER-ATION #	Q AND A EQUATION COEFF (X)	Q AND A EQUATION POWER (M)	LENGTH FACTOR (K*)	PEAK RATIO O/I (Q*)	S/Q @PEAK (K) (SEC)	ATT-KIN COEFF (C)	PEAK TRAVEL STOR-AGE (HR)	PEAK TIME KINE-MATIC (HR)
ALTERNATE	1	STORM	6																
1	5400	474	20.0	428	21.3	597	21.3	0	6.22	0.25	1	.400	1.33	0.026	0.905	1754	0.41	1.25	0.49
2	3000	597	21.3	591	21.5	---	---	0	6.28	0.25	1	2.40	1.05	0.020	0.990	915	0.66	0.25	0.25
3	4600	200	20.0	147	21.5	261	21.0	0	6.78	0.25	1	1.01	1.00	0.132	0.734	4567	0.18	1.50	1.27
5	2600	835	21.3	671	22.5	---	---	0	6.41	0.25	1	.569	1.00	0.106	0.803	4568	0.18	1.25	1.27
6	4900	100	19.8	100	29.8	585	24.0	0	4.25	0.25	1	.101	1.48	0.014	1.000	3524	0.23	10.00	0.98

SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS..... 6
STRUCTURE 2	0.44	
ALTERNATE 1		199.76
STRUCTURE 1	1.20	
ALTERNATE 1		474.02
XSECTION 1	1.66	
ALTERNATE 1		598.68
XSECTION 2	1.66	
ALTERNATE 1		590.94
XSECTION 3	0.75	
ALTERNATE 1		261.01
XSECTION 4	2.41	
ALTERNATE 1		835.10
XSECTION 5	0.96	
ALTERNATE 1		100.00
XSECTION 6	2.26	
ALTERNATE 1		585.62
XSECTION 8	1.45	
ALTERNATE 1		570.55

END OF 1 JOBS IN THIS RUN

APPENDIX D

SAMPLE JOB NØ. 4

Contents Page

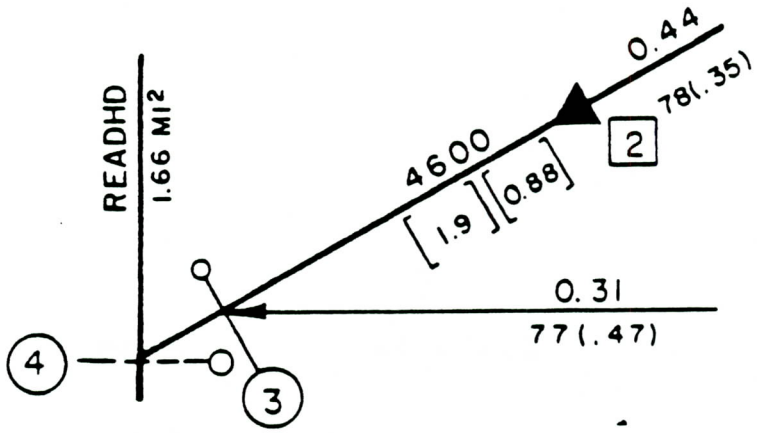
Schematic Drawing	D-2
Input Data Sheets	D-3
Printout	D-8

D-2

SCHEMATIC DRAWING OF SAMPLE WATERSHED

Sample Job No. 4

(Structure 2 Null)



LEGEND

2 — Structure Number 2

3 — Cross Section Number 3 (at downstream end of reach)

4600 / [1.9][0.88] — Reach Length - Feet / [End Area Coeff (X)][Exponent (M)]

0.44 / 78 (.35) — Drainage Area - Square Miles / Runoff Curve Number (Time of Concentration - Hours)

4 — Reference Location Number 4

Intervening Area

SCS-ENG.-264 DRAFT
REV. May 1982

TR-20
JOB & TITLE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed SAMPLE JOB 4 Hydrologist JEZ Date 5/24/82 SHEET 1 OF 5

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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

JOB	TR-20	10
TITLE	004	SAMPLE JOB 4, USING 24HR TYPE II STORM, FROM XSEC 2 TO XSEC 4 20
TITLE		INCLUDES READ DISCH. HYDR. & NON STANDARD HYDR. NO. LOCATIONS 30

JOB Record (required)

Columns 1-3	JOB
Columns 5-9	TR-20
Columns 11-17	HOLDOUT Use only if a holdout hydrograph is desired.
Columns 21-24	ECON Use only if peak discharge output for ECON2/URB1 is desired. Locations for this output must be selected for inclusion in Summary Tables 1 and 3 also. Such designation can be made using summary option explained below (columns 51-57) or on Standard Control (column 71).
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 SAVHOV).
Columns 61-67	NOPLOTS Use if no cross section rating plots are desired. ENDPLOT Use if only cross section rating plots are desired with no routings.
Columns 73-80	Optional user information, printed at top of input listing.

TITLE Records (one required, second is optional)

Columns 1-5	TITLE
Columns 7-9	XXX (first TITLE record only). An optional user file number, XXX, is an integer, right justified.
Columns 11-80	Both titles may be any characters desired.

SCS-ENG.-273 DRAFT
REV. May 1982

TR-20
STANDARD CONTROL FOR WATERSHED

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

D-4

Watershed SAMPLE JOB 4 Hydrologist JEZ Date 5/24/82 SHEET 2 OF 5

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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

EXAMPLES DO NOT ENTER

DATA CODE	OPERATION NAME	OPERATION NO.	X SECT / STRUCT. XSECT ID.	X SECT / STRUCT. STRUCT ID.	HYDRO. NUMBER INPUT #1 (FROM IN)	HYDRO. NUMBER INPUT #2 (CUT)	HYDRO. NUMBER OUTPUT (OUT2 TO)	DATA FIELD # 1	DATA FIELD # 2	DATA FIELD # 3	OUTPUT OPTIONS PRINT PEAK	PRINT HYD	PRINT FLEV	PRINT VOL	FILE	SUM	RECORD IDENT.
6	RUNOFF	1					6	AREA, SQ. MI.	RUNOFF CURVE NO.	T_c, HRS.							EXAMPLES DO NOT ENTER
6	RESVOR	2			6		7	SURF. EL. AT T=0, FT.									
6	REACH	3			7		5	LENGTH, FT.	(OPTIONAL) END AREA COEFF (X)	(OPTIONAL) EXPONENT (M)							
6	ADDHYD	4			5	6	7										
6	SAVMOV	5															
6	DIVERT	6			IN	CUT	OUT2 TO	OUT1 DISCHARGE, CFS	OUT 1, Decimal % D.A	OUT2, I.D.							
	ENDATA							This record is to be used only at end of all standard control records.									

(Right justify these fields)

IMPORTANT: Data Fields No. 1, 2, and 3 require decimal points.

6	RUNOFF	1		02			6	0.44	78.	0.35					1		40
6	RESVOR	2		02	6		7								1		50
6	REACH	3	003		7		4	4600.	1.9	0.88					1		60
6	RUNOFF	1	003				6	0.31	77.	0.47					1		70
6	ADDHYD	4	003		4	6	7				1	1		1	1		80
6	ADDHYD	4	004		5	7	3				1	1		1	1		90
	ENDATA																100

NOTE: This form was suggested by members of Massachusetts Planning Staff.

HYDROGRAPH FILE GENERATED BY SAMPLE JOB 2, PAGES B-16 & 17
Ready to merge into this Jobstream

```
7 READHD A      5
7 READHD 9          0.0          0.1000       1.6600       0.0                                  110
8                     0.0          0.0          0.0          0.0          0.0                  120
8                     0.0          0.0          0.0          0.0          0.0                  130
8                     0.0          0.0          0.0          0.0          0.0                  140
8                     0.0          0.0          0.0          0.0          0.0                  150
8                     0.0          0.0          0.0          0.0          0.0                  160
8                     0.0          0.0          0.0          0.0          0.0                  170
8                     0.0          0.0          0.0          0.0          0.0                  180
8                     0.0          0.0          0.0          0.0          0.0                  190
8                     0.0          0.0          0.0          0.0          0.0                  200
8                     0.0          0.0          0.0          0.0          0.0                  210
8                     0.0          0.0          0.0          0.0          0.0                  220
8                     0.0          0.0          0.0          0.0          0.0                  230
8                     0.0          0.0          0.0          0.0          0.0                  240
8                     0.0          0.0          0.0          0.0          0.0                  250
8                     0.0          0.0          0.0          0.0          0.0                  260
8                     0.0          0.0          0.0          0.0          0.0                  270
8                     0.0          0.0          0.0          0.0          0.0                  280
8                     0.0          0.0          0.0          0.0          0.0                  290
8                     0.01         0.03         0.07         0.13         0.22                 300
8                     0.34         0.51         0.72         0.97         1.26                 310
8                     1.61         2.00         2.43         2.92         3.46                 320
8                     4.05         4.69         5.39         6.15         6.97                 330
8                     7.90         8.96        10.16        11.54        13.14                 340
8                    15.00        17.16        19.67        22.59        26.02                 350
8                    30.03        34.73        40.59        48.51        60.75                 360
8                    81.66       120.90       188.23       290.15       421.80                 370
8                   565.87       702.22       815.95       899.24       950.21                 380
8                   971.96       966.72       943.73       908.43       865.47                 390
8                   818.37       768.52       718.54       669.42       622.02                 400
8                   576.91       534.43       494.80       458.09       424.28                 410
8                   393.29       364.98       339.16       315.64       294.23                 420
8                   274.72       256.94       240.74       226.04       212.76                 430
8                   200.85       190.23       180.77       172.27       164.59                 440
8                   157.63       151.32       145.62       140.50       135.93                 450
8                   131.88       128.32       125.19       122.44       119.96                 460
```

Continued on Page D-6

READHD FILE GENERATED BY SAMPLE JOB 2, PAGES B-16 & 17
Ready to merge into this Jobstream. Continued from Page D-5

8	117.70	115.59	113.60	111.73	109.95	470
8	108.28	106.72	105.29	103.99	102.80	480
8	101.70	100.65	99.61	98.52	97.35	490
8	96.10	94.78	93.43	92.08	90.76	500
8	89.49	88.30	87.17	86.12	85.14	510
8	84.23	83.39	82.61	81.88	81.20	520
8	80.56	79.91	79.22	78.43	77.52	530
8	76.50	75.38	74.20	73.01	71.82	540
8	70.66	69.57	68.54	67.57	66.66	550
8	65.82	65.04	64.31	63.64	63.01	560
8	62.43	61.89	61.39	60.92	60.49	570
8	60.09	59.72	59.38	59.06	58.76	580
8	58.49	58.23	58.00	57.78	57.58	590
8	57.39	57.22	57.06	56.91	56.77	600
8	56.62	56.42	56.12	55.63	54.85	610
8	53.70	52.13	50.17	47.89	45.40	620
8	42.81	40.20	37.64	35.20	32.89	630
8	30.71	28.68	26.79	25.02	23.38	640
8	21.87	20.49	19.24	18.10	17.06	650
8	16.11	15.24	14.44	13.70	13.02	660
8	12.38	11.78	11.21	10.69	10.19	670
8	9.72	9.27	8.85	8.45	8.07	680
8	7.71	7.37	7.04	6.73	6.43	690
8	6.14	5.87	5.61	5.36	5.13	700
8	4.90	4.68	4.48	4.28	4.09	710
8	3.91	3.74	3.59	3.45	3.32	720
9 ENDTBL						730

Note: For format see Form #276, Page F-18.

SCS-ENG.-274 DRAFT
REV. May 1982

TR-20
EXECUTIVE CONTROL FOR WATERSHED

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed SAMPLE JOB 4 Hydrologist JEZ Date 5/24/82 SHEET 5 OF 5

DATA CODE	OPERATION		DATA FIELD #1	DATA FIELD #2	DATA FIELD #3		RECORD IDENT.
7	LIST	This record is used for printout of tabular data and standard control list that are currently effective.					
7	BASFLØ	5	NEW BASE FLOW, CFS or VOLUME IN INCHES	IF VOLUME IS IN DATA FIELD No. 1: PEAK TIME, HOURS	BASE TIME, HOURS		
7	INCREM	6	MAIN TIME INCREMENT, HRS.	This increment is required for initial computations. Remains in force until new increment is entered.			

EXAMPLES DO NOT ENTER

			FROM XSECT OR STRUCT	THRU XSECT OR STRUCT	STARTING TIME HOURS	RAINFALL DEPTH INCHES (Set depth and duration to LO for actual rainfall)	RAINFALL DURATION HOURS	RAIN TABLE NO.	AMC	ALTERNATE NO.	STROM NO.	EXAMPLES DO NOT ENTER
7	COMPUT	7										
	ENDCMP	1	This record is required at "end" of a watershed, it may follow a series of COMPUT records									
	ENDJØB	2	This record terminates routing computation and precedes the PEAKS record, if any.									

Right justify these fields

IMPORTANT: Data Fields No. 1, 2, and 3 require decimal points.

7	INCREM	6			0.1							740
7	COMPUT	7	.02	004		5.2	1.0	2	2	0.1	0.1	750
	ENDCMP	1										760
	ENDJOB	2										770

```
*******************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY*******************

JOB TR-20                                                                       00000010
TITLE 004 SAMPLE JOB 4 USING 24HR TYPE II STORM, FROM XSEC 2 TO XSEC 4          00000020
TITLE     INCLUDES READ DISCH.HYDR. & NON STANDARD HYDR. NO. LOCATIONS          00000030
 6 RUNOFF 1    02     6 0.44        78.          0.35                      1 00000040
 6 RESVOR 2    02 6   7                                                    1 00000050
 6 REACH  3 003   7   4 4600.       1.9          0.88                      1 00000060
 6 RUNOFF 1 003       6 0.31        77.          0.47                      1 00000070
 6 ADDHYD 4 003   4 6 7                                          1 1   1   1 00000080
 6 ADDHYD 4 004   5 7 3                                          1 1   1   1 00000090
   ENDATA                                                                       00000100
 7 READHD 8     5                                                              00000110
 7 READHD 9       0.0          0.1000       1.6600       0.0                   00000120
 8                  0.0          0.0          0.0          0.0          0.0 00000130
 8                  0.0          0.0          0.0          0.0          0.0 00000140
 8                  0.0          0.0          0.0          0.0          0.0 00000150
 8                  0.0          0.0          0.0          0.0          0.0 00000160
 8                  0.0          0.0          0.0          0.0          0.0 00000170
 8                  0.0          0.0          0.0          0.0          0.0 00000180
 8                  0.0          0.0          0.0          0.0          0.0 00000190
 8                  0.0          0.0          0.0          0.0          0.0 00000200
 8                  0.0          0.0          0.0          0.0          0.0 00000210
 8                  0.0          0.0          0.0          0.0          0.0 00000220
 8                  0.0          0.0          0.0          0.0          0.0 00000230
 8                  0.0          0.0          0.0          0.0          0.0 00000240
 8                  0.0          0.0          0.0          0.0          0.0 00000250
 8                  0.0          0.0          0.0          0.0          0.0 00000260
 8                  0.0          0.0          0.0          0.0          0.0 00000270
 8                  0.0          0.0          0.0          0.0          0.0 00000280
 8                  0.0          0.0          0.0          0.0          0.0 00000290
 8                 0.01         0.03         0.07         0.13          0.2200000300
 8                 0.34         0.51         0.72         0.97          1.2600000310
 8                 1.61         2.00         2.43         2.92          3.4600000320
 8                 4.05         4.69         5.39         6.15          6.9700000330
 8                 7.90         8.96        10.16        11.54         13.1400000340
 8                15.00        17.16        19.67        22.59         26.0200000350
 8                30.03        34.73        40.59        48.51         60.7500000360
 8                81.66       120.90       188.23       290.15        421.8000000370
 8               565.87       702.22       815.95       899.24        950.2100000380
 8               971.06       966.72       943.73       908.43        865.4700000390
 8               818.07       768.52       718.54       669.42        622.0200000400
 8               576.91       534.43       494.80       458.09        424.2800000410
 8               393.29       364.98       339.16       315.64        294.2300000420
 8               274.72       256.94       240.74       226.04        212.7600000430
 8               200.85       190.23       180.77       172.27        164.5900000440
 8               157.63       151.32       145.62       140.50        135.9300000450
 8               131.88       128.32       125.19       122.44        119.9600000460
```

```
**********80-80 LIST OF INPUT DATA (CONTINUED)**********

8                117.70      115.59      113.60      111.73      109.9500000470
8                108.28      106.72      105.29      103.99      102.8000000480
8                101.70      100.65       99.61       98.52       97.3500000490
8                 96.10       94.78       93.43       92.08       90.7600000500
8                 89.49       88.30       87.17       86.12       85.1400000510
8                 84.23       83.39       82.61       81.88       81.2000000520
8                 80.56       79.91       79.22       78.43       77.5200000530
8                 76.50       75.38       74.20       73.01       71.8200000540
8                 70.66       69.57       68.54       67.57       66.6600000550
8                 65.82       65.04       64.31       63.64       63.0100000560
8                 62.43       61.89       61.39       60.92       60.4900000570
8                 60.09       59.72       59.38       59.06       58.7600000580
8                 58.49       58.23       58.00       57.78       57.5800000590
8                 57.39       57.22       57.06       56.91       56.7700000600
8                 56.62       56.42       56.12       55.63       54.8500000610
8                 53.70       52.13       50.17       47.89       45.4000000620
8                 42.81       40.20       37.64       35.20       32.8900000630
8                 30.71       28.68       26.79       25.02       23.3800000640
8                 21.87       20.49       19.24       18.10       17.0600000650
8                 16.11       15.24       14.44       13.70       13.0200000660
8                 12.38       11.78       11.21       10.69       10.1900000670
8                  9.72        9.27        8.85        8.45        8.0700000680
8                  7.71        7.37        7.04        6.73        6.4300000690
8                  6.14        5.87        5.61        5.36        5.1300000700
8                  4.90        4.68        4.48        4.28        4.0900000710
8                  3.91        3.74        3.59        3.45        3.3200000720
9 ENDTBL                                                                00000730
7 INCREM 6              0.1                                             00000740
7 COMPUT 7     02 004                5.2         1.0          2 2  01  01 00000750
  ENDCMP 1                                                              00000760
  ENDJOB 2                                                              00000770

**********END OF 80-80 LIST**********
```

Note: The User Notes, page 1, is not repeated in this Sample Job (See page A-8).

D-10

EXECUTIVE CONTROL OPERATION READHD DISCHARGE HYDROGRAPH, HYDROGRAPH LOCATION 5 RECORD ID 00000110

STARTING TIME= 0.0 TIME INCREMENT= 0.10 DRAINAGE AREA= 1.66 BASE FLOW= 0.0

8	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
8	0.01	0.03	0.07	0.13	0.22
8	0.34	0.51	0.72	0.97	1.26
8	1.61	2.00	2.43	2.92	3.46
8	4.05	4.69	5.39	6.15	6.97
8	7.90	8.96	10.16	11.54	13.14
8	15.00	17.16	19.67	22.59	26.02
8	30.03	34.73	40.59	48.51	60.75
8	81.66	120.90	188.23	290.15	421.80
8	565.87	702.22	815.95	899.24	950.21
8	971.06	966.72	943.73	908.43	865.47
8	818.07	768.52	718.54	669.42	622.02
8	576.91	534.43	494.80	458.09	424.28
8	393.29	364.98	339.16	315.64	294.23
8	274.72	256.94	240.74	226.04	212.76
8	200.85	190.23	180.77	172.27	164.59
8	157.63	151.32	145.62	140.50	135.93
8	131.88	128.32	125.19	122.44	119.96
8	117.70	115.59	113.60	111.73	109.95
8	108.28	106.72	105.29	103.99	102.80
8	101.70	100.65	99.61	98.52	97.35
8	96.10	94.78	93.43	92.08	90.76
8	89.49	88.30	87.17	86.12	85.14
8	84.23	83.39	82.61	81.88	81.20
8	80.56	79.91	79.22	78.43	77.52
8	76.50	75.38	74.20	73.01	71.82
8	70.66	69.57	68.54	67.57	66.66

8	65.82	65.04	64.31	63.64	63.01
8	62.43	61.89	61.39	60.92	60.49
8	60.09	59.72	59.38	59.06	58.76
8	58.49	58.23	58.00	57.78	57.58
8	57.39	57.22	57.06	56.91	56.77
8	56.62	56.42	56.12	55.63	54.85
8	53.70	52.13	50.17	47.89	45.40
8	42.81	40.20	37.64	35.20	32.89
8	30.71	28.68	26.79	25.02	23.38
8	21.87	20.49	19.24	18.10	17.06
8	16.11	15.24	14.44	13.70	13.02
8	12.38	11.78	11.21	10.69	10.19
8	9.72	9.27	8.85	8.45	8.07
8	7.71	7.37	7.04	6.73	6.43
8	6.14	5.87	5.61	5.36	5.13
8	4.90	4.68	4.48	4.28	4.09
8	3.91	3.74	3.59	3.45	3.32
9 ENDTBL					

EXECUTIVE CONTROL OPERATION INCREM MAIN TIME INCREMENT = 0.10 HOURS RECORD ID 00000740

EXECUTIVE CONTROL OPERATION COMPUT FROM STRUCTURE 2 TO XSECTION 4 RECORD ID 00000750
STARTING TIME = 0.0 RAIN DEPTH = 5.20 RAIN DURATION= 1.00 RAIN TABLE NO.= 2 ANT. MOIST. COND= 2
ALTERNATE NO.= 1 STORM NO.= 1 MAIN TIME INCREMENT = 0.10 HOURS

OPERATION ADDHYD CROSS SECTION 3

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
12.18	486.88	(NULL)
13.27	290.62	(NULL)

FIRST HYDROGRAPH POINT = 0.0 HOURS TIME INCREMENT = 0.10 HOURS DRAINAGE AREA = 0.75 SQ.MI.

TIME(HRS)											
7.00	DISCHG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01
8.00	DISCHG	0.04	0.10	0.21	0.36	0.55	0.78	1.04	1.32	1.61	1.91
9.00	DISCHG	2.22	2.57	2.97	3.45	3.96	4.47	5.00	5.61	6.28	6.97
10.00	DISCHG	7.63	8.33	9.11	10.01	11.06	12.31	13.77	15.53	17.53	19.76
11.00	DISCHG	22.25	24.91	27.85	31.06	34.74	39.60	50.03	76.30	123.29	204.71
12.00	DISCHG	334.09	456.02	485.41	423.13	327.81	251.28	205.29	183.78	184.80	210.12
13.00	DISCHG	247.98	276.71	289.20	290.34	285.50	277.79	268.91	259.25	249.25	239.21
14.00	DISCHG	229.40	219.94	210.76	201.89	193.29	184.94	176.86	168.98	161.43	154.41
15.00	DISCHG	148.02	142.17	136.75	131.61	126.50	121.27	116.13	111.33	107.00	103.08
16.00	DISCHG	99.51	96.23	93.21	90.36	87.62	84.98	82.37	79.55	76.63	73.89
17.00	DISCHG	71.51	69.48	67.70	66.10	64.66	63.31	61.99	60.66	59.33	57.79
18.00	DISCHG	55.97	54.11	52.47	51.13	50.05	49.11	48.28	47.54	46.81	46.03
19.00	DISCHG	45.23	44.44	43.69	42.99	42.33	41.72	41.16	40.63	40.10	39.33
20.00	DISCHG	38.23	37.04	36.03	35.29	34.75	34.32	33.97	33.67	33.34	32.94

21.00	DISCHG	32.49	32.03	31.58	31.15	30.75	30.38	30.03	29.71	29.41	29.13
22.00	DISCHG	28.87	28.63	28.41	28.21	28.02	27.84	27.68	27.53	27.39	27.27
23.00	DISCHG	27.15	27.04	26.94	26.84	26.76	26.68	26.61	26.54	26.43	26.07
24.00	DISCHG	25.32	24.16	22.44	20.38	18.58	17.31	16.60	16.14	15.80	15.45
25.00	DISCHG	15.03	14.43	13.66	12.80	11.94	11.12	10.34	9.61	8.92	8.29
26.00	DISCHG	7.69	7.14	6.63	6.16	5.72	5.31	4.93	4.57	4.25	3.94
27.00	DISCHG	3.66	3.40	3.15	2.93	2.72	2.52	2.34	2.17	2.02	1.87
28.00	DISCHG	1.74	1.61	1.50	1.39	1.29	1.20	1.11	1.03	0.96	0.89
29.00	DISCHG	0.82	0.77	0.71	0.66	0.61	0.57	0.53	0.49	0.45	0.42

RUNOFF VOLUME ABOVE BASEFLOW = 2.84 WATERSHED INCHES, 1374.61 CFS-HRS, 113.60 ACRE-FEET; BASEFLOW = 0.0 CFS

OPERATION ADDHYD CROSS SECTION 4

PEAK TIME(HRS) 13.12 PEAK DISCHARGE(CFS) 1244.12 PEAK ELEVATION(FEET) (NULL)

TIME(HRS) FIRST HYDROGRAPH POINT = 0.0 HOURS TIME INCREMENT = 0.10 HOURS DRAINAGE AREA = 2.41 SQ.MI.

7.00	DISCHG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01
8.00	DISCHG	0.04	0.10	0.21	0.36	0.55	0.79	1.07	1.39	1.74	2.13
9.00	DISCHG	2.56	3.08	3.69	4.42	5.22	6.08	7.00	8.04	9.20	10.43
10.00	DISCHG	11.68	13.02	14.50	16.16	18.03	20.21	22.73	25.69	29.07	32.90
11.00	DISCHG	37.25	42.07	47.52	53.65	60.76	69.63	84.76	116.89	171.80	265.46
12.00	DISCHG	415.75	576.92	673.64	713.28	749.61	817.15	907.51	999.73	1084.04	1160.33
13.00	DISCHG	1219.04	1243.43	1232.93	1198.77	1150.97	1095.86	1037.43	977.79	918.67	861.23
14.00	DISCHG	806.31	754.37	705.56	659.98	617.57	578.23	541.84	508.14	477.07	448.64
15.00	DISCHG	422.74	399.11	377.49	357.65	339.26	322.12	306.36	292.10	279.27	267.67
16.00	DISCHG	257.14	247.55	238.83	230.86	223.55	216.86	210.69	204.74	199.07	193.85
17.00	DISCHG	189.21	185.07	181.30	177.83	174.61	171.59	168.71	165.95	163.32	160.59
18.00	DISCHG	157.67	154.76	152.08	149.65	147.40	145.21	143.06	140.97	138.89	136.79
19.00	DISCHG	134.72	132.74	130.86	129.11	127.47	125.95	124.55	123.24	121.98	120.53
20.00	DISCHG	118.79	116.95	115.25	113.72	112.27	110.82	109.35	107.87	106.35	104.76
21.00	DISCHG	103.15	101.60	100.12	98.72	97.41	96.20	95.07	94.02	93.05	92.14
22.00	DISCHG	91.30	90.52	89.80	89.13	88.51	87.93	87.40	86.91	86.45	86.03
23.00	DISCHG	85.64	85.27	84.94	84.62	84.34	84.07	83.83	83.60	83.34	82.84
24.00	DISCHG	81.94	80.58	78.56	76.01	73.43	71.01	68.73	66.31	63.69	60.85
25.00	DISCHG	57.84	54.63	51.30	48.00	44.83	41.83	39.02	36.40	33.94	31.67
26.00	DISCHG	29.56	27.63	25.87	24.26	22.78	21.42	20.17	19.01	17.95	16.96
27.00	DISCHG	16.04	15.18	14.36	13.62	12.91	12.24	11.61	11.02	10.47	9.94
28.00	DISCHG	9.45	8.98	8.54	8.12	7.72	7.34	6.98	6.64	6.32	6.02
29.00	DISCHG	5.72	5.45	5.19	4.94	4.70	0.57	0.53	0.49	0.45	0.42

RUNOFF VOLUME ABOVE BASEFLOW = 2.69 WATERSHED INCHES, 4184.79 CFS-HRS, 345.83 ACRE-FEET; BASEFLOW = 0.0 CFS

EXECUTIVE CONTROL OPERATION ENDCMP COMPUTATIONS COMPLETED FOR PASS 1 RECORD ID 00000760

EXECUTIVE CONTROL OPERATION ENDJOB RECORD ID 00000770

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH.)

SECTION/ STRUCTURE ID		STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)
ALTERNATE 1 STORM 1														
STRUCTURE	2	RUNOFF	0.44	2	2	0.10	0.0	5.20	24.00	2.88	---	12.11	818.18	1859.5
STRUCTURE	2	RESVOR	0.44	2	2	0.10	0.0	5.20	24.00	2.88	---	12.11	818.18	1859.5
XSECTION	3	REACH	0.44	2	2	0.10	0.0	5.20	24.00	2.88	---	13.36	231.32	525.7
XSECTION	3	RUNOFF	0.31	2	2	0.10	0.0	5.20	24.00	2.79	---	12.18	469.85	1515.6
XSECTION	3	ADDHYD	0.75	2	2	0.10	0.0	5.20	24.00	2.84	---	12.18	486.88	649.2
XSECTION	4	ADDHYD	2.41	2	2	0.10	0.0	5.20	24.00	2.69	---	13.12	1244.12	516.2

SUMMARY TABLE 2 - SELECTED MODIFIED ATT-KIN REACH ROUTINGS IN ORDER OF STANDARD EXECUTIVE CONTROL INSTRUCTIONS
(A STAR(*) AFTER VOLUME ABOVE BASE(IN) INDICATES A HYDROGRAPH TRUNCATED AT A VALUE EXCEEDING BASE + 10% OF PEAK)

		HYDROGRAPH INFORMATION							ROUTING PARAMETERS									PEAK TRAVEL TIME	
XSEC ID	REACH LENGTH (FT)	INFLOW PEAK (CFS)	INFLOW TIME (HR)	OUTFLOW PEAK (CFS)	OUTFLOW TIME (HR)	OUTFLOW+ INTERV.AREA PEAK (CFS)	OUTFLOW+ INTERV.AREA TIME (HR)	BASE-FLOW (CFS)	VOLUME ABOVE BASE (IN)	MAIN TIME INCR (HR)	ITER-ATION #	Q AND A EQUATION COEFF (X)	Q AND A EQUATION POWER (M)	LENGTH FACTOR (K*)	PEAK RATIO O/I (Q*)	S/Q @PEAK (K) (SEC)	ATT-KIN COEFF (C)	STOR-AGE (HR)	KINE-MATIC (HR)
ALTERNATE 1 STORM 1																			
3	4600	817	12.1	231	13.4	485	12.2	0	2.88	0.10	3	.948	1.00	1.348	0.283	4855	0.07	0.50	1.35

Note: Each Summary Table would normally start on a separate sheet.

D-14

SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

XSECTION/ STRUCTURE ID		DRAINAGE AREA (SQ MI)	STORM NUMBERS..... 1
STRUCTURE	2	0.44	
ALTERNATE	1		818.18
XSECTION	3	0.75	
ALTERNATE	1		486.88
XSECTION	4	2.41	
ALTERNATE	1		1244.12

END OF 1 JOBS IN THIS RUN

APPENDIX E

SAMPLE JOB NØ. 5

Contents

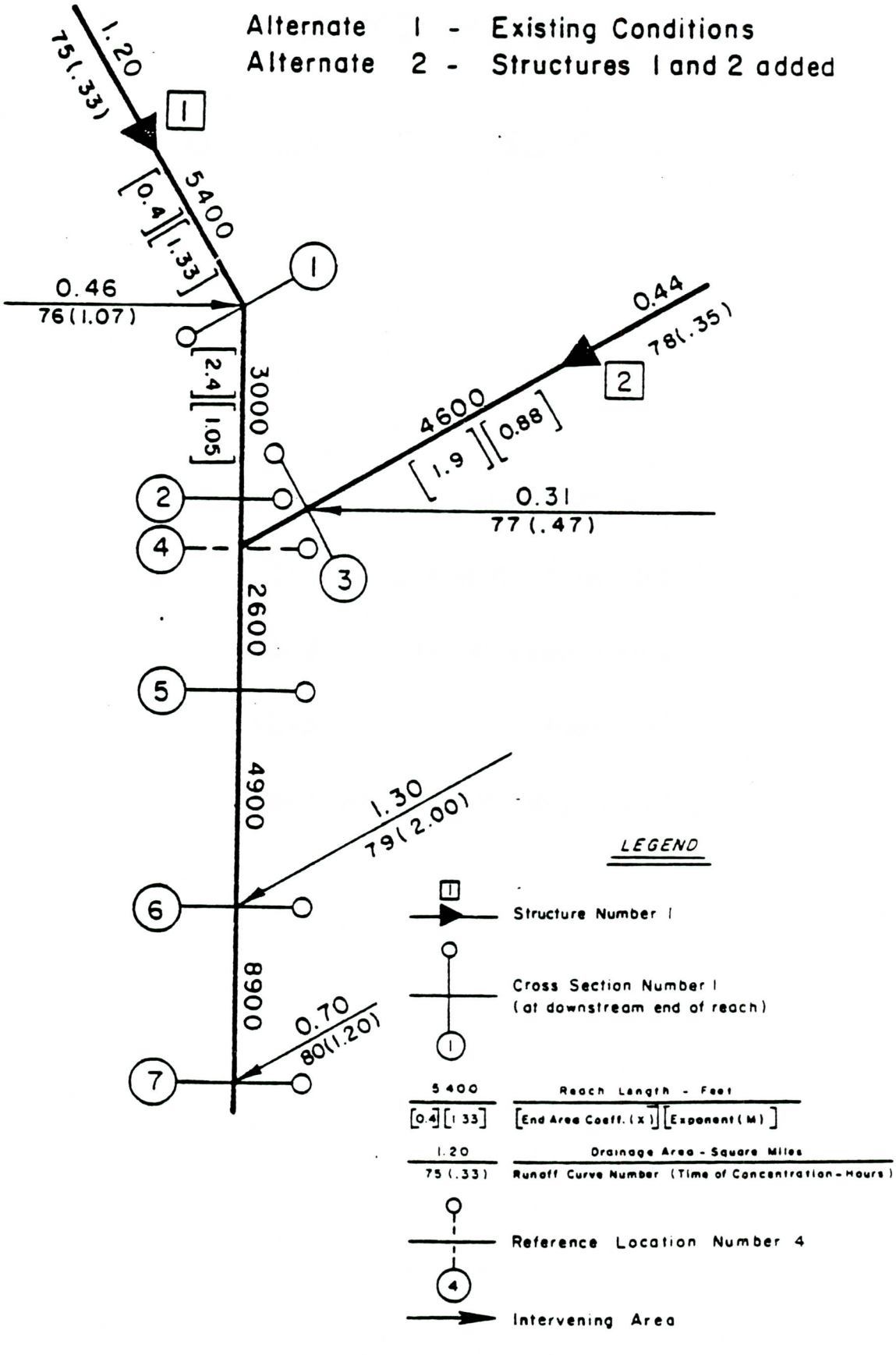
	Page
Schematic Drawing	E-2
Input Data Sheets	E-5
Printout	E-27
ECON2/URB1 Peak File	E-63

E-2

SCHEMATIC DRAWING OF SAMPLE WATERSHED

Sample Job No. 5

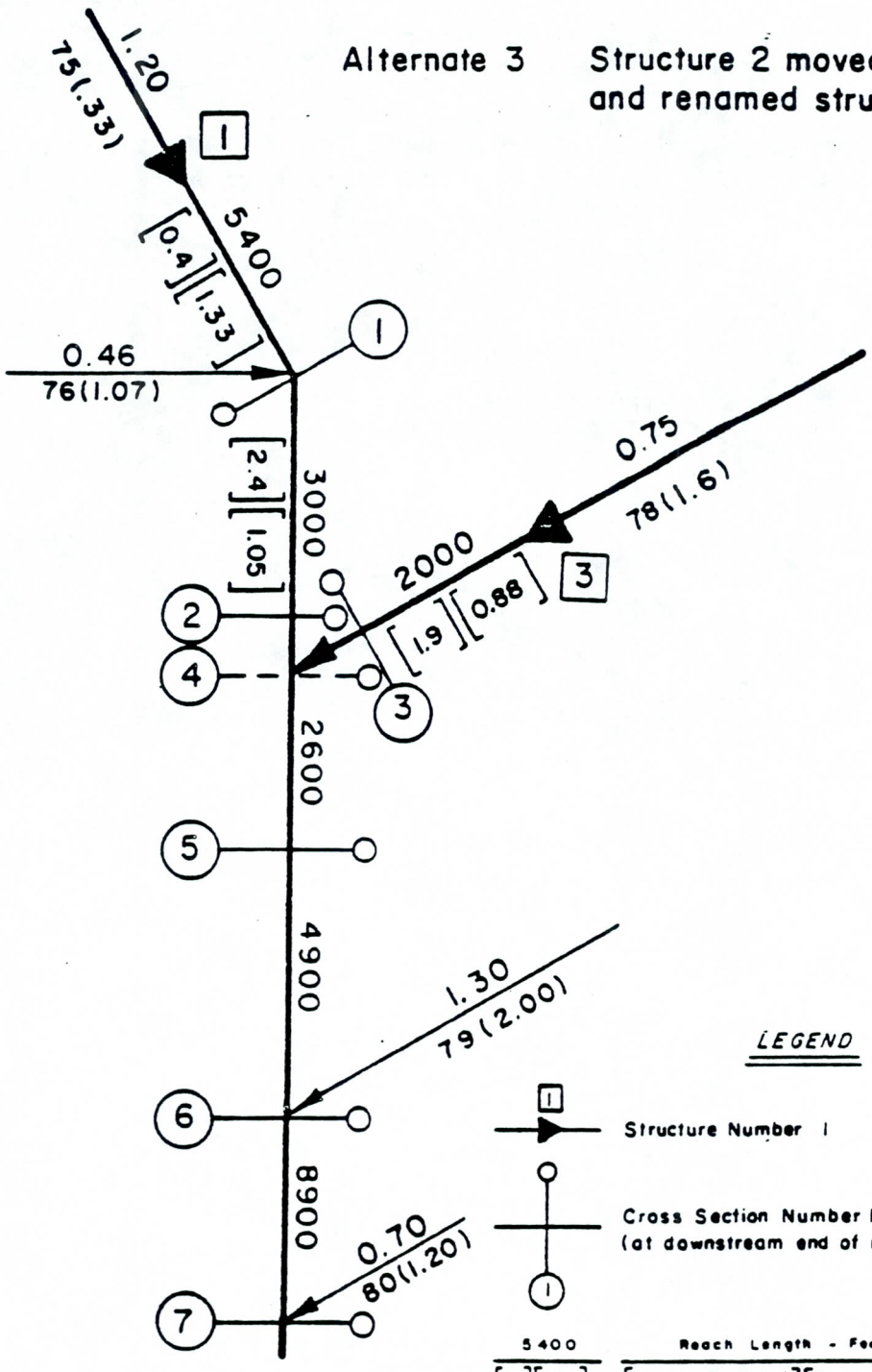
Alternate 1 - Existing Conditions
Alternate 2 - Structures 1 and 2 added



SCHEMATIC DRAWING OF SAMPLE WATERSHED

Sample Job No. 5

Alternate 3 Structure 2 moved downstream and renamed structure 3.



LEGEND

1 — Structure Number 1

Cross Section Number 1 (at downstream end of reach)

$\frac{5400}{[0.4][1.33]}$ — Reach Length - Feet / [End Area Coeff (X)][Exponent (M)]

$\frac{1.20}{75(33)}$ — Drainage Area - Square Miles / Runoff Curve Number (Time of Concentration-Hours)

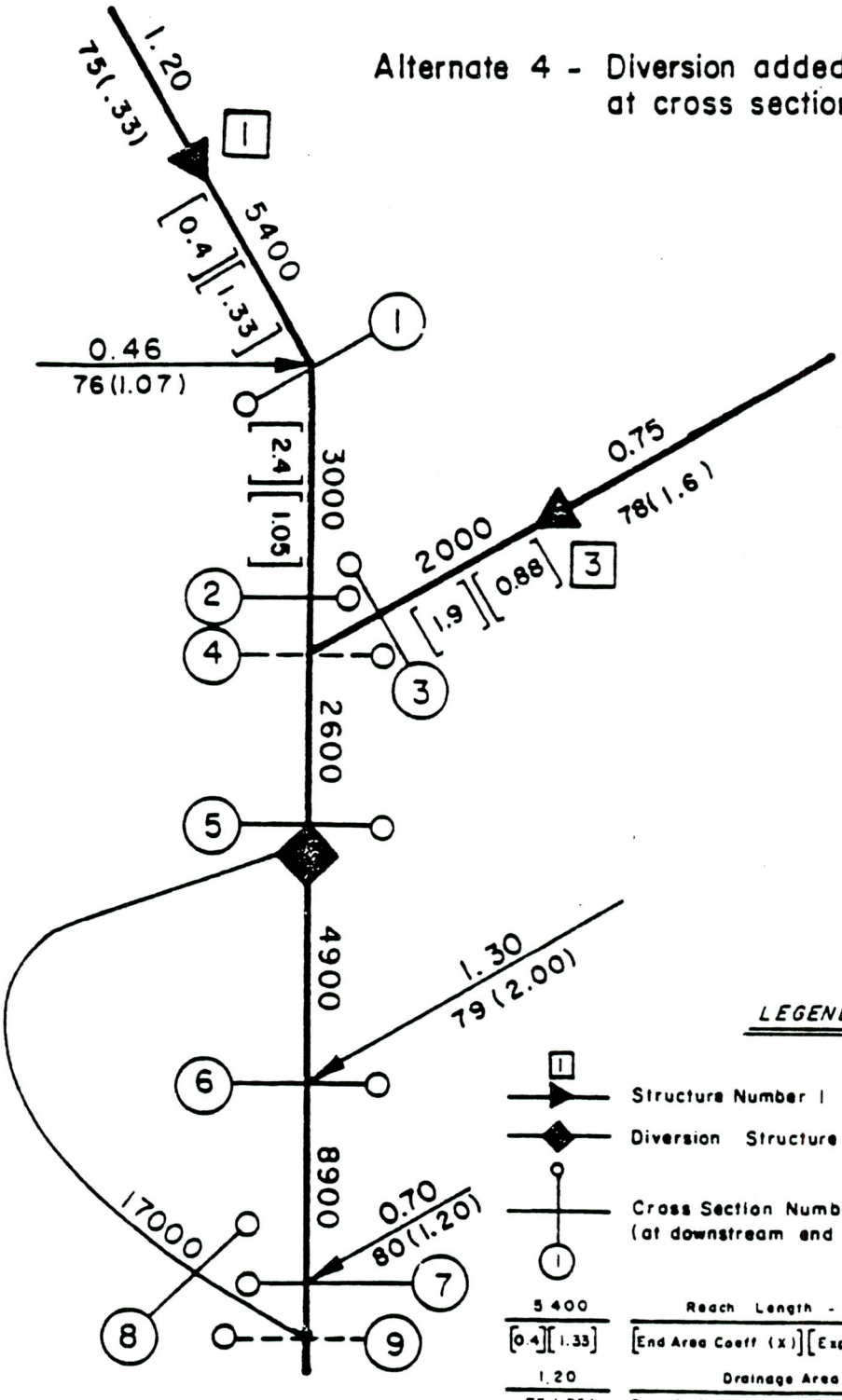
Reference Location Number 4

Intervening Area

SCHEMATIC DRAWING OF SAMPLE WATERSHED

Sample Job No. 5

Alternate 4 - Diversion added to divide flow at cross section 5.



LEGEND

- Structure Number 1
- Diversion Structure
- Cross Section Number 1 (at downstream end of reach)
- 5400 / [0.4][1.33] — Reach Length - Feet / [End Area Coeff (X)][Exponent (M)]
- 1.20 / 75(.33) — Drainage Area - Square Miles / Runoff Curve Number (Time of Concentration - Hours)
- Reference Location Number 4
- Intervening Area

SCS-ENG.-264 DRAFT
REV. May 1982

TR-20
JOB & TITLE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed SAMPLE JOB 5 Hydrologist JEZ Date 5/24/82 SHEET 1 OF 22

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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

JOB	TR-20		ECON			SUMMARY	NOPLOTS	10
TITLE	005	SAMPLE JOB 5 , USING 24HR TYPE II STORM OVER ENTIRE WATERSHED						20
TITLE		ALT1=EXIST., ALT2=2-SITES, ALT3=MOVE SITE#2, ALT4=DIVIDE FLOW						30

JOB Record (required)

Columns 1-3	JOB
Columns 5-9	TR-20
Columns 11-17	HOLDOUT Use only if a holdout hydrograph is desired.
Columns 21-24	ECON Use only if peak discharge output for ECON2/URB1 is desired. Locations for this output must be selected for inclusion in Summary Tables 1 and 3 also. Such designation can be made using summary option explained below (columns 51-57) or on Standard Control (column 71).
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 SAVHOV).
Columns 61-67	NOPLOTS Use if no cross section rating plots are desired. ENDPLOT Use if only cross section rating plots are desired with no routings.
Columns 73-80	Optional user information, printed at top of input listing.

TITLE Records (one required, second is optional)

Columns 1-5	TITLE
Columns 7-9	XXX (first TITLE record only). An optional user file number, XXX, is an integer, right justified.
Columns 11-80	Both titles may be any characters desired.

E-5

SCS-ENG.-270 DRAFT
REV. May 1982

TR-20
STREAM CROSS SECTION DATA
CROSS SECTION NO. 5

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

E-6

Watershed SAMPLE JOB 5 Hydrologist JEZ Date 5/24/82 SHEET 2 OF 22

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME		DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3		RECORD IDENT.

IMPORTANT: Line out unused lines. Data fields require decimal points.

		X SECTION ID. (001-200)	Drainage Area, Sq. Mi.	Bankfull Elevation, Ft.			
2	XSECTN	005	1.0	495.5			40

(Use 1.0 unless discharge in CSM.)

NOTE: Maximum of 20 data records allowed.

	Elevation, Ft.	Discharge, CFS	End Area, Sq Ft.		
	490.	0.0	0.0		50
	492.	17.	24.		60
	494.	57.	56.		70
	495.	86.	75.		80
	495.5	106.	96.		90
	496.	132.	138.		100
	497.	205.	287.		110
	498.	319.	522.		120
	499.	482.	843.		130
	500.	705.	1250.		140
	502.	1362.	2330.		150
	504.	2361.	3770.		160

9	ENDTBL	NOTE: This record must be the last record of this table.	170

SCS-ENG.-270 DRAFT
REV. May 1982

TR-20
STREAM CROSS SECTION DATA
CROSS SECTION NO. 6

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed SAMPLE JOB 5 Hydrologist JEZ Date 5/24/82 SHEET 3 OF 22

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME		DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3		RECORD IDENT.

IMPORTANT: Line out unused lines. Data fields require decimal points.

		X SECTION ID. (001-200)	Drainage Area, Sq. Mi.	Bankfull Elevation, Ft.			
2	XSECTN	006	1.0	484.3			180

(Use 1.0 unless discharge in CSM.)

NOTE: Maximum of 20 data records allowed.

Elevation, Ft.	Discharge, CFS	End Area, Sq. Ft.		
480.	0.0	0.0		190
482.	29.	46.		200
484.	97.	104.		210
485.	144.	138.		220
485.5	176.	168.		230
486.	215.	226.		240
487.	320.	459.		250
488.	485.	875.		260
490.	1072.	2060.		270
492.	1971.	3629.		280

5	ENDTBL	NOTE. This record must be last record of this table.	290

181

E-7

SCS-ENG.-270 DRAFT
REV. May 1982

TR-20
STREAM CROSS SECTION DATA
CROSS SECTION NO. 7

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

E-8

Watershed SAMPLE JOB 5 Hydrologist JEZ Date 5/24/82 SHEET 4 OF 22

1-10		11-20		21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME			DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3			RECORD IDENT.
		X SECTION ID. (1001-2001)		IMPORTANT: Line out unused lines. Data fields require decimal points. Drainage Area, Sq. Mi.	Bankfull Elevation, Ft.				
2	XSECTN	007		1.0	479.5				30.0
		(Use 1.0 unless discharge in CSM.)							
		NOTE: Maximum of 20 data records allowed.							
				Elevation, Ft.	Discharge, CFS	End Area, Sq. Ft.			
e				474.	0.	0.			31.0
e				475.	12.	31.			32.0
e				477.	76.	99.			33.0
e				479.	178.	175.			34.0
e				479.5	214.	210.			35.0
e				480.	255.	255.			36.0
e				481.	381.	579.			37.0
e				483.	783.	1337.			38.0
e				485.	1406.	2397.			39.0
e				487.	2214.	3906.			40.0
9	ENDTBL			NOTE: This record must be the last record of this table.					41.0

SCS - ENG. - 273 DRAFT
REV. May 1982

TR - 20
STANDARD CONTROL FOR WATERSHED

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed SAMPLE JOB 5 Hydrologist JEZ Date 5/24/82 SHEET 5 OF 22

DATA CODE	OPERATION NAME	OPERATION NO.	XSECT. / STRUCT. XSECT ID.	XSECT. / STRUCT. STRUCT ID.	HYDRO. NUMBER INPUT #1	HYDRO. NUMBER INPUT #2	HYDRO. NUMBER OUTPUT	DATA FIELD # 1	DATA FIELD # 2	DATA FIELD # 3	OUTPUT OPTIONS PRINT PEAK	PRINT HYD	PRINT ELEV	PRINT VOL.	FILE	SUM	RECORD IDENT.
6	RUNOFF	1					6	AREA, SQ. MI.	RUNOFF CURVE NO.	T_c, HRS.							EXAMPLES DO NOT ENTER
6	RESVOR	2			6		7	SURF. EL. AT T=0, FT.									
6	REACH	3			7		5	LENGTH, FT.	(OPTIONAL) END AREA COEFF. (X)	(OPTIONAL) EXPONENT (M)							
6	ADDHYD	4			5	6	7										
6	SAVMOV	5															
6	DIVERT	6			IN FROM	OUT1	OUT2 TO	OUT1 DISCHARGE, CFS	OUT 1, Decimal % D.A.	OUT2, I.D.							
	ENDATA							This record is to be used only at end of all standard control records.									

EXAMPLES DO NOT ENTER

(Right justify these fields)

IMPORTANT: Data Fields No. 1, 2, and 3 require decimal points.

6	RUNOFF	1		01			6	1.20	75.	0.33							420
6	RESVOR	2		01	6		7										430
6	REACH	3	001		7		5	5400.	0.4	1.33							440
6	RUNOFF	1	001				6	0.46	76.	1.07							450
6	ADDHYD	4	001		5	6	7										460
6	REACH	3	002		7		1	3000.	2.4	1.05							470
6	RUNOFF	1		02			6	0.44	78.	0.35							480
6	RESVOR	2		02	6		7										490
6	REACH	3	003		7		5	4600.	1.9	0.88							500
6	RUNOFF	1	003				6	0.31	77.	0.47							510
6	ADDHYD	4	003		5	6	2										520

NOTE: This form was suggested by members of Massachusetts Planning Staff.

E-9

E-8

SCS-ENG.-273A DRAFT
REV. May 1982

TR-20

STANDARD CONTROL FOR WATERSHED

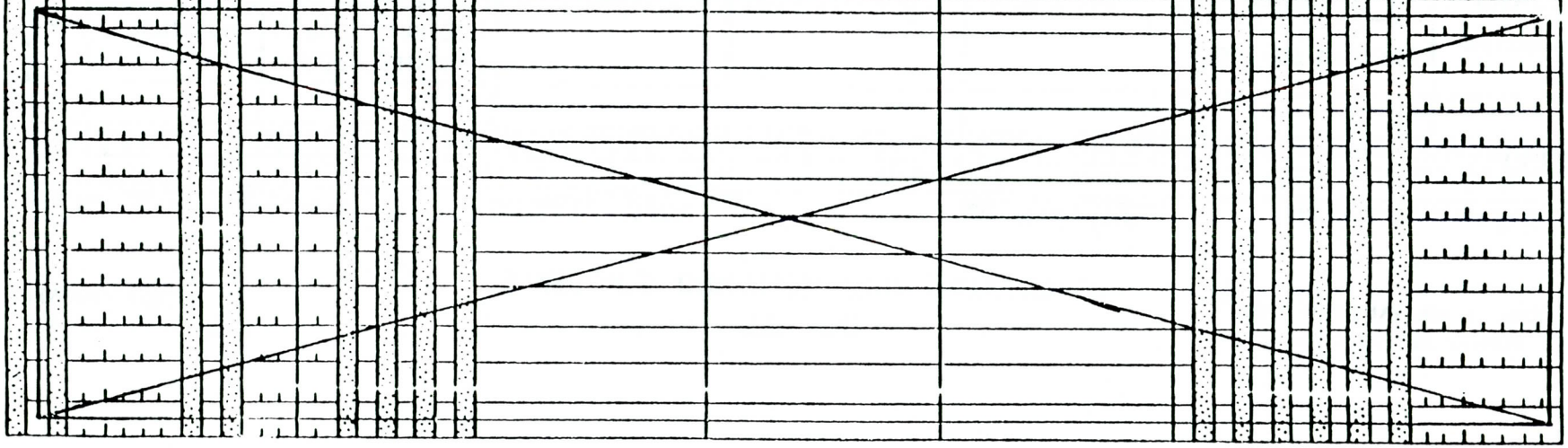
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

E-10

CONTINUATION SHEET

Watershed SAMPLE JOB 5 Hydrologist JEZ Date 5/24/82 SHEET 6 OF 22

CODE	OPERATION	XSEC (Right justify these fields)	STRUC	HYD NO	DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3	OUTPUT OPTIONS	RECORD ID.
					IMPORTANT: Data Fields No 1, 2, and 3 require decimal points.				
6	ADDHYD	4	004	123					590
6	REACH	3	005	35	2600.				540
6	SAVMOV	5	006	57					550
6	REACH	3	006	75	4900.				560
6	RUNOFF	1	006	6	1.30	79.	2.0		570
6	ADDHYD	4	006	567					580
6	REACH	3	007	75	8900.				590
6	RUNOFF	1	007	6	0.70	80.	1.20		600
6	ADDHYD	4	007	564					610
6	SAVMOV	5	008	41					620
	ENDATA								630



SCS-ENG.-274 DRAFT
REV. May 1982

TR-20
EXECUTIVE CONTROL FOR WATERSHED

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed SAMPLE JOB 5 Hydrologist JEZ Date 5/24/82 SHEET 7 OF 22

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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	OPERATION		DATA FIELD # 1	DATA FIELD # 2	DATA FIELD # 3		RECORD IDENT.
7	LIST	This record is used for printout of tabular data and standard control list that are currently effective.					
7	BASFLO	5	NEW BASE FLOW, CFS or VOLUME IN INCHES	IF VOLUME IS IN DATA FIELD No. 1: PEAK TIME, HOURS	BASE TIME, HOURS		
7	INCREM	6	MAIN TIME INCREMENT, HRS.	This increment is required for initial computations. Remains in force until new increment is entered.			

EXAMPLES DO NOT ENTER

			FROM XSECT	FROM OR STRUCT	THRU XSECT	THRU OR STRUCT	STARTING TIME HOURS	RAINFALL DEPTH INCHES (Set depth and duration to 1.0 for actual rainfall)	RAINFALL DURATION HOURS	RAIN TABLE NO.	AMC	ALTERNATE NO.	STROM NO.	EXAMPLES DO NOT ENTER
7	COMPUT	7												
	ENDCMP	1	This record is required at "end" of a watershed, it may follow a series of COMPUT records.											
	ENDJOB	2	This record terminates routing computation and precedes the PEAKS record, if any.											

Right justify these fields

IMPORTANT: Data Fields No. 1, 2, and 3 require decimal points.

7	LIST													640
7	INCREM	6				0.1								650
7	BASFLO	5				6.0								660
7	COMPUT	7		0.1	0.07		5.2	1.0	2	2	0.1	0.1		670
	ENDCMP	1												680
7	BASFLO	5				6.0								690
7	COMPUT	7		0.1	0.07		2.6	1.0	2	2	0.1	0.2		700
	ENDCMP	1												710

E-11

.581

SCS - ENG. - 269 DRAFT
REV. May 1982

TR - 20
STRUCTURE DATA
STRUCTURE NO. 1

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

E-12

Watershed SAMPLE JOB 5 Hydrologist JEZ Date 5/24/82 SHEET 8 OF 22

1-10		11-20		21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME			DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3			RECORD IDENT.
		STRUCTURE ID. (01-99)		IMPORTANT: Line out unused lines. Data fields require decimal points.					
3	STRUCT		01						720
		NOTE: Maximum of 20 data records allowed.							
				Elevation, Ft.	Discharge, CFS	Storage, Acre, Ft.			
8				521.5	0.0	17.0			730
8				521.6	3.0	18.0			740
8				521.8	15.	20.2			750
8				522.0	33.	22.5			760
8				522.2	54.	25.0			770
8				522.4	79.	28.0			780
8				526.2	948.	70.			790
8				526.4	1009.	75.			800
8				526.6	1071.	80.			810
8				527.2	1265.	95.			820
9	ENDTBL	NOTE: This record must be the last record of this table.							830

SCS-ENG. - 269 DRAFT
REV. May 1982

TR-20
STRUCTURE DATA
STRUCTURE NO. 2

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed SAMPLE JOB 5 Hydrologist JEZ Date 5/24/82 SHEET 9 OF 22

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME		DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3		RECORD IDENT.
		STRUCTURE ID. (01-99)	IMPORTANT: Line out unused lines. Data fields require decimal points.				
3	STRUCT	02					840
		NOTE: Maximum of 20 data records allowed.					
			Elevation, Ft.	Discharge, CFS	Storage, Acre, Ft.		
8			496.	0.0	16.		850
8			498.	210.	27.		860
8			500.	252.	40.		870
8			502.	294.	62.		880
8			504.	336.	85.		890
8			506.	378.	112.		900
8			508.	420.	145.		910
8			509.	441.	176.		920
8			510.	556.	190.		930
6			512.	1129.	237.		940
0			514.	2086.	285.		950
8			516.	3288.	340.		960
8			517.	4030.	367.		970
8							
8							
9	ENDTBL	NOTE: This record must be the last record of this table.					980

187

E-13

SCS-ENG.-274 DRAFT
REV. May 1982

TR-20
EXECUTIVE CONTROL FOR WATERSHED

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

E-14

Watershed SAMPLE JOB 5 Hydrologist JEZ Date 5/24/82 SHEET 10 OF 22

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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	OPERATION		DATA FIELD #1	DATA FIELD #2	DATA FIELD #3		RECORD IDENT.
7	LIST		This record is used for printout of tabular data and standard control list that are currently effective.				
7	BASFLO	5	NEW BASE FLOW, CFS or VOLUME IN INCHES	IF VOLUME IS IN DATA FIELD No 1. PEAK TIME, HOURS	BASE TIME, HOURS		
7	INCREM	6	MAIN TIME INCREMENT, HRS.	This increment is required for initial computations Remains in force until new increment is entered.			

EXAMPLES DO NOT ENTER

			FROM OR XSECT	FROM OR STRUCT	THRU OR XSECT	THRU OR STRUCT	STARTING TIME HOURS	RAINFALL DEPTH INCHES (Set depth and duration to 10 for actual rainfall)	RAINFALL DURATION HOURS	RAIN TABLE NO.	AMC	ALTERNATE NO.	STROM NO.	EXAMPLES DO NOT ENTER
7	COMPUT	7												
	ENDCMP	1	This record is required at "end" of a watershed, it may follow a series of COMPUT records											
	ENDJOB	2	This record terminates routing computation and precedes the PEAKS record, if any											

Right justify these fields | IMPORTANT: Data Fields No. 1, 2, and 3 require decimal points.

7	BASFLO	5					10.0								990
7	COMPUT	7		01		02		5.2	1.0	2	2	02	01		1000
7	COMPUT	7	003		007			5.2	1.0	2	2	02	01		1010
	ENDCMP	1													1020
7	BASFLO	5					8.0								1030
7	COMPUT	7		01		02		2.6	1.0	2	2	02	02		1040
7	COMPUT	7	003		007			2.6	1.0	2	2	02	02		1050
	ENDCMP	1													1060

TR - 20
STRUCTURE DATA
STRUCTURE NO. 2

SCS - ENG. - 269 DRAFT
REV. May 1982

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed SAMPLE JOB 5 Hydrologist JEZ Date 5/24/82 SHEET 11 OF 22

1-10		11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME		DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3			RECORD IDENT.
		STRUCTURE ID. (01-99)	IMPORTANT: Line out unused lines. Data fields require decimal points.					
3	STRUCT	02						1061

NOTE: Maximum of 20 data records allowed.

Elevation, Ft.	Discharge, CFS	Storage, Acre, Ft.

9	ENDTBL	NOTE: This record must be the last record of this table.	1062

E-15

SCS-ENG. - 269 DRAFT
REV. May 1982

TR-20
STRUCTURE DATA
STRUCTURE NO. 3

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

E-16

Watershed SAMPLE JOB 5 Hydrologist JEZ Date 5/24/82 SHEET 12 OF 22

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME		DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3		RECORD IDENT.
		STRUCTURE ID. (01-99)	IMPORTANT: Line out unused lines. Data fields require decimal points.				
3	STRUCT	03					1070
		NOTE: Maximum of 20 data records allowed.					
			Elevation, Ft.	Discharge, CFS	Storage, Acre, Ft.		
8			484.	0.0	25.		1080
8			488.	32.	80.		1090
8			492.	40.	130.		1100
8			495.	45.	193.		1110
8			498.	48.	260.		1120
8			500.	52.	305.		1130
9	ENDTBL	NOTE: This record must be the last record of this table.					1140

SCS - ENG. - 275 DRAFT
REV. May 1982

TR - 20
MODIFY STANDARD CONTROL

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed SAMPLE JOB 5 Hydrologist JEZ Date 5/24/82 SHEET 13 OF 22

DATA CODE	OPERATION NAME	OPERATION NO.	X SECT. / STRUCT. XSECT ID	X SECT. / STRUCT. STRUCT ID.	HYDRO. NUMBER IN-PUT #1	HYDRO. NUMBER IN-PUT #2	HYDRO. NUMBER OUT-PUT	DATA FIELD #1	DATA FIELD #2	DATA FIELD #3	OUTPUT OPTIONS PRINT PEAK	PRINT HYD	PRINT ELEV	PRINT VOL	FILE	SUM	RECORD IDENT.
								IMPORTANT Line out unused lines. Data fields require decimal points.									
								IMPORTANT Modifications must be given in the order that they appear on the standard control list.									
7	INSERT	2	002					NOTE The following records are inserted following the XSECTN / STRUCTURE specified									1,150
6	RUNOFF	1		03			6	0.75	78.	1.60							1,160
6	RESVOR	2		03	6		7										1,170
6																	
6																	
7	ALTER	1						NOTE Data given in columns 1 to 18 must be identical with standard control record to be altered									
6																	
6																	
6																	
6																	
7	DELETE	1						NOTE Data given in columns 1 to 18 must be identical with standard control record to be deleted									1,180
6	RUNOFF	1		02													1,190
6	RESVOR	2		02													1,200
6																	
6																	

H-261

E-17

SCS - ENG - 275 DRAFT
REV. May 1982

TR - 20
MODIFY STANDARD CONTROL

U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

E-18

Watershed SAMPLE JOB 5 Hydrologist JEZ Date 5/24/82 SHEET 14 OF 22

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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	OPERATION NAME	OPERATION NO.	X SECT / STRUCT. XSECT ID.	X SECT / STRUCT. STRUCT ID.	HYDRO NUMBER IN-PUT #1	HYDRO NUMBER IN-PUT #2	HYDRO NUMBER OUT-PUT	DATA FIELD #1	DATA FIELD #2	DATA FIELD #3	OUTPUT OPTIONS PRINT YEAR	PRINT HYD	PRINT ELEV	PRINT VOL	FILE	SUM	RECORD IDENT.
					IMPORTANT Line out unused lines. Data fields require decimal points.												
					IMPORTANT Modifications must be given in the order that they appear on the standard control list.												
4	INSERT	2						NOTE The following records are inserted following the XSECTN / STRUCTURE specified									
5	ALTER							NOTE Data given in columns 1 to 18 must be identical with standard control record to be altered									1210
6	REACH	3	003		7		2	2000.	1.9	0.88							1220
7																	
8																	
9	DELETE							NOTE Data given in columns 1 to 18 must be identical with standard control record to be deleted									1230
10	RUNOFF	1	003														1240
11	ADDHYD	4	003														1250
12																	
13																	

101

SCS-ENG.-274 DRAFT
REV. May 1982

TR-20
EXECUTIVE CONTROL FOR WATERSHED

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed SAMPLE JOB 5 Hydrologist JEZ Date 5/24/82 SHEET 15 OF 22

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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	OPERATION		DATA FIELD # 1	DATA FIELD # 2	DATA FIELD # 3		RECORD IDENT.
7	LIST		This record is used for printout of tabular data and standard control list that are currently effective				
7	BASFLO	5	NEW BASE FLOW, CFS or VOLUME IN INCHES	# VOLUME IS IN DATA FIELD No. 1 PEAK TIME, HOURS	BASE TIME, HOURS		
7	INCREM	6	MAIN TIME INCREMENT, HRS.	This increment is required for initial computations Remains in force until new increment is altered.			

EXAMPLES DO NOT ENTER

			FROM OR XSECT	FROM OR STRUCT	THRU OR XSECT	THRU OR STRUCT	STARTING TIME HOURS	RAINFALL DEPTH INCHES (Set depth and duration to 10 for actual rainfall)	RAINFALL DURATION HOURS	RAIN TABLE NO.	AMC	ALTERNATE NO.	STROM NO.	EXAMPLES DO NOT ENTER
7	COMPUT	7												
	ENDCMP	1	This record is required at "end" of a watershed, it may follow a series of COMPUT records											
	ENDJOB	2	This record terminates routing computation and precedes the PEAKS record, if any.											

Right justify these fields

IMPORTANT: Data Fields No. 1, 2, and 3 require decimal points.

7	LIST													.1260
7	BASFLO	5					6.0							.1270
7	COMPUT	7		0.1		0.07		5.2	1.0	2	2	0.3	0.1	.1280
	ENDCMP	1												.1290
7	BASFLO	5					6.0							.1300
7	COMPUT	7		0.1		0.07		2.6	1.0	2	2	0.3	0.2	.1310
	ENDCMP	1												.1320

193

E-19

SCS-ENG. - 269 DRAFT
REV. May 1982

TR-20
STRUCTURE DATA
STRUCTURE NO. 1

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

E-20

Watershed SAMPLE JOB 5 Hydrologist JEZ Date 5/24/82 SHEET 16 OF 22

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME		DATA FIELD NO 1	DATA FIELD NO. 2	DATA FIELD NO. 3		RECORD IDENT.

IMPORTANT: Line out unused lines. Data fields require decimal points.

	STRUCTURE ID. (01-99)		
3 STRUCT	01		1330

NOTE: Maximum of 20 data records allowed.

Elevation, Ft.	Discharge, CFS	Storage, Acre, Ft.

9 ENDTBL	NOTE: This record must be the last record of this table.	1340

SCS - ENG. - 269 DRAFT
REV. May 1982

TR - 20
STRUCTURE DATA
STRUCTURE NO. 3

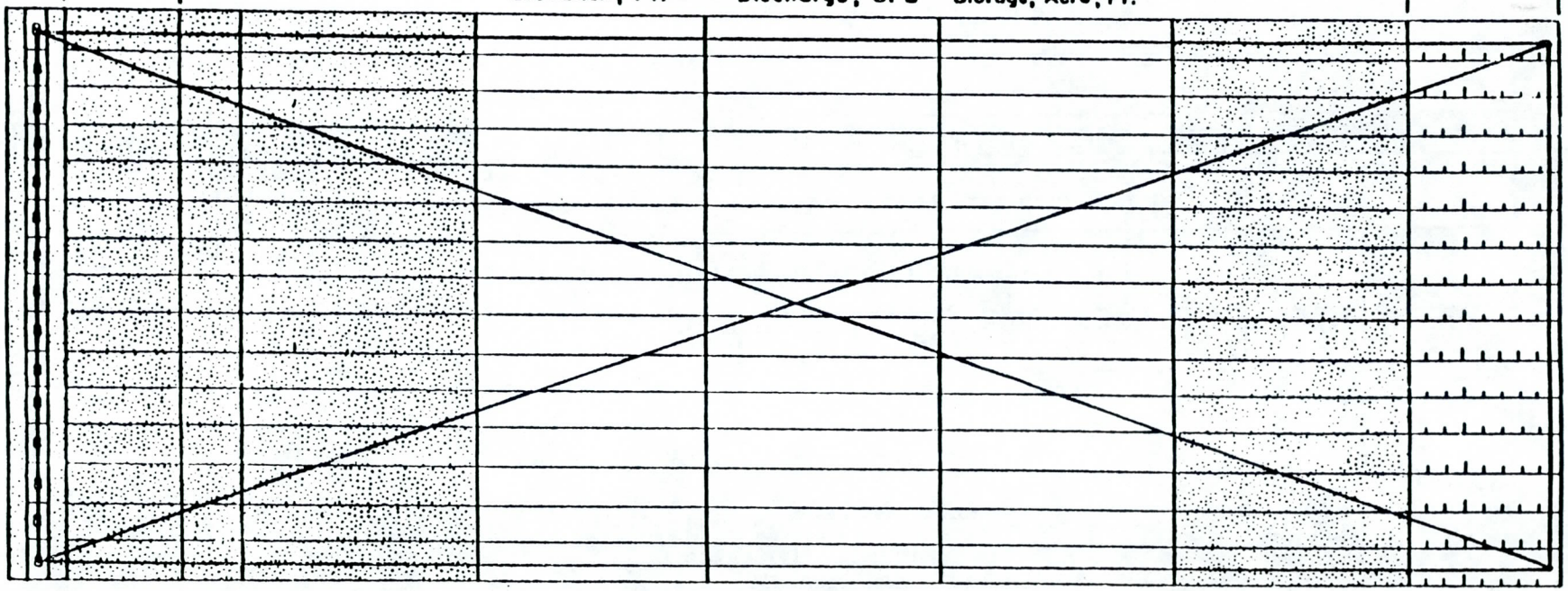
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed SAMPLE JOB 5 Hydrologist JEZ Date 5/24/82 SHEET 17 OF 22

1-10		11-20			21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME				DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3			RECORD IDENT.
		STRUCTURE ID. (01-99)			IMPORTANT: Line out unused lines. Data fields require decimal points.					
3	STRUCT		0	3						1350

NOTE: Maximum of 20 data records allowed.

Elevation, Ft.	Discharge, CFS	Storage, Acre, Ft.



9	ENDTBL	NOTE: This record must be the last record of this table.	1360

461

E-21

SCS - ENG. - 270 DRAFT
REV. May 1982

TR - 20

STREAM CROSS SECTION DATA

CROSS SECTION NO. 8

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

E-22

Watershed SAMPLE JOB 5 Hydrologist JEZ Date 5/24/82 SHEET 18 OF 22

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME		DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3		RECORD IDENT.

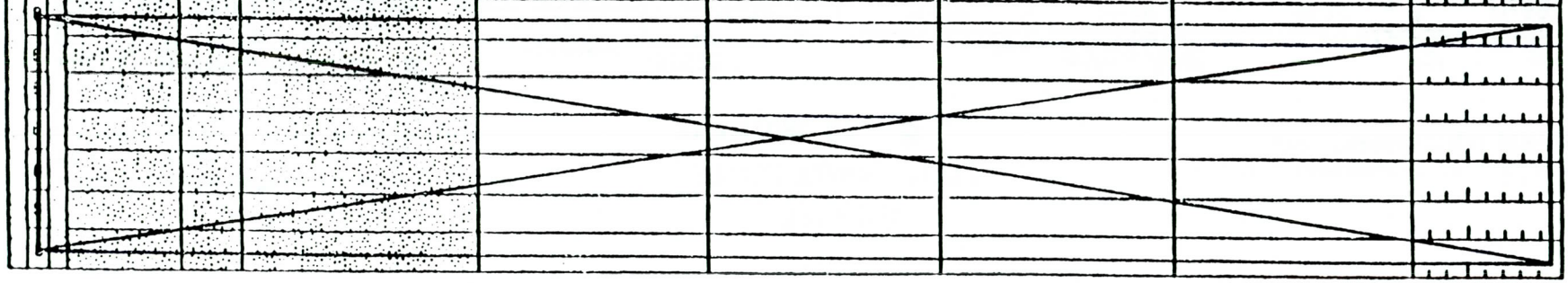
IMPORTANT: Line out unused lines. Data fields require decimal points.

		X SECTION ID. (001-200)	Drainage Area, Sq. Mi.	Bankfull Elevation, Ft.			
2	XSECTN	008	1.0	494.5			1370

(Use 1.0 unless discharge in CSM.)

NOTE: Maximum of 20 data records allowed.

	Elevation, Ft.	Discharge, CFS	End Area, Sq. Ft.		
8	492.	0.0	0.0		1380
8	493.	21.	23.		1390
8	494.	64.	52.		1400
8	495.	133.	87.		1410
8	496.	232.	128.		1420
8	497.	360.	175.		1430
8	498.	515.	228.		1440
8	500.	827.	405.		1450



9	ENDTBL	NOTE: This record must be the last record of this table.	1460

195

SCS - ENG. - 275 DRAFT
REV. May 1982

TR - 20
MODIFY STANDARD CONTROL

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed SAMPLE JOB 5 Hydrologist JEZ Date 5/24/82 SHEET 19 OF 22

DATA CODE	OPERATION NAME	OPERATION NO.	X SECT. / STRUCT. XSECT ID.	X SECT. / STRUCT. STRUCT ID.	HYDRO. NUMBER IN-PUT #1	HYDRO. NUMBER IN-PUT #2	HYDRO. NUMBER OUT-PUT	DATA FIELD #1	DATA FIELD #2	DATA FIELD #3	OUTPUT OPTIONS PRINT PEAK	PRINT HYD	PRINT ELEV	PRINT VOL	FILE	SUM	RECORD IDENT.
	IMPORTANT Line out unused lines. Data fields require decimal points.																
	IMPORTANT Modifications must be given in the order that they appear on the standard control list.																
7	INSERT	2	005					NOTE The following records are inserted following the XSECTN / STRUCTURE specified									1470
6	DIVERT	6	005		5	7	1		0.9	8.	1						1480
	ALTER							NOTE Data given in columns 1 to 18 must be identical with standard control record to be altered									
7	DELETE							NOTE Data given in columns 1 to 18 must be identical with standard control record to be deleted									1490
	SAVMOV	5	006														1500

196

E-23

SCS - ENG. - 275 DRAFT
REV. May 1982

TR - 20
MODIFY STANDARD CONTROL

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

E-24

Watershed SAMPLE JOB 5 Hydrologist JEZ Date 5/24/82 SHEET 20 OF 22

DATA CODE	OPERATION NAME	OPERATION NO.	X SECT. / STRUCT. XSECT ID.	X SECT. / STRUCT. STRUCT ID.	HYDRO. NUMBER IN-PUT #1	HYDRO. NUMBER IN-PUT #2	HYDRO. NUMBER OUT-PUT	DATA FIELD #1	DATA FIELD #2	DATA FIELD #3	OUTPUT OPTIONS PRINT YEAR	PRINT HYD	PRINT ELEV	PRINT VOL	FILE	SUM	RECORD IDENT.
					IMPORTANT: Line out unused lines. Data fields require decimal points.												
					IMPORTANT: Modifications must be given in the order that they appear on the standard control list.												
7	INSERT	2	007					NOTE: The following records are inserted following the XSECTN / STRUCTURE specified									
6	REACH	3	008		1		2	17000.				1					1510
6	ADDHYD	4	009		2	4	7				1	1		1			1520
6																	1530
6																	
7	ALTER	3						NOTE: Data given in columns 1 to 10 must be identical with standard control record to be altered.									
7	DELETE	4						NOTE: Data given in columns 1 to 10 must be identical with standard control record to be deleted.									

L6.1

SCS-ENG.-274 DRAFT
REV. May 1982

TR-20
EXECUTIVE CONTROL FOR WATERSHED

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed SAMPLE JOB 5 Hydrologist JEZ Date 5/24/82 SHEET 21 OF 22

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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	OPERATION		DATA FIELD #1	DATA FIELD #2	DATA FIELD #3		RECORD IDENT.
7	LIST		This record is used for printout of tabular data and standard control list that are currently effective				
7	BASFLO	5	NEW BASE FLOW, CFS or VOLUME IN INCHES	IF VOLUME IS IN DATA FIELD No. 1. PEAK TIME, HOURS	BASE TIME, HOURS		
7	INCREM	6	MAIN TIME INCREMENT, HRS.	This increment is required for initial computations. Remains in force until new increment is altered.			

EXAMPLES DO NOT ENTER

			FROM XSECT	FROM OR STRUCT	THRU XSECT	THRU OR STRUCT	STARTING TIME HOURS	RAINFALL DEPTH INCHES (Set depth and duration to 10 for actual rainfall)	RAINFALL DURATION HOURS	RAIN TABLE NO.	AMC	ALTERNATE NO.	STROM NO.	EXAMPLES DO NOT ENTER
7	COMPUT	7												
	ENDCMP	1	This record is required at "end" of a watershed, it may follow a series of COMPUT records											
	ENDJOB	2	This record terminates routing computation and precedes the PEAKS record, if any.											

Right justify these fields | IMPORTANT: Data Fields No. 1, 2, and 3 require decimal points.

7	LIST													1540
7	BASFLO	5				0.2	15.0	25.0						1550
7	COMPUT	7		01	009		5.2	1.0	2	2	04	01		1560
	ENDCMP	1												1570
7	BASFLO	5				0.1	12.0	25.0						1580
7	COMPUT	7		01	009		2.6	1.0	2	2	04	02		1590
	ENDCMP	1												1600
	ENDJOB	2												1610

E-25

SCS-ENG.-277 DRAFT
Rev. May 1982

TR-20
INTERMEDIATE PEAKS

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

E-26

Watershed SAMPLE JOB 5 Hydrologist JEZ Date 5/24/82 SHEET 22 OF 22

OPERATION	FROM OR XSECT	FROM OR STRUCT	THRU OR XSECT	THRU OR STRUCT	INTERMEDIATE POINTS BETWEEN FROM AND THRU XSECTION / STRUCTURES: POINT ID.	DRAINAGE AREA (Sq. Mi.)	POINT ID.	DRAINAGE AREA (Sq. Mi.)	POINT ID.	DRAINAGE AREA (Sq. Mi.)	POINT ID.	DRAINAGE AREA (Sq. Mi.)	RECORD IDENT.
PEAKS	006		007		7A	3.90	7B	4.00					1620
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
ENDJOB	2	This record terminates the entire TR-20 job.											1630

691

```
********************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY********************

JOB TR-20              ECON                                SUMMARY   NOPLOTS      00000010
TITLE 005 SAMPLE JOB 5   USING 24HR TYPE II STORM OVER ENTIRE WATERSHED 00000020
TITLE     ALT1=EXIST., ALT2=2-SITES, ALT3=MOVE SITE#2, ALT4=DIVIDE FLOW 00000030
 2 XSECTN   005           1.0          495.5                              00000040
 8                        490.         0.0          0.0                   00000050
 8                        492.         17.          24.                   00000060
 8                        494.         57.          56.                   00000070
 8                        495.         86.          75.                   00000080
 8                        495.5        106.         96.                   00000090
 8                        496.         132.         138.                  00000100
 8                        497.         205.         287.                  00000110
 8                        498.         319.         522.                  00000120
 8                        499.         482.         843.                  00000130
 8                        500.         705.         1250.                 00000140
 8                        502.         1362.        2330.                 00000150
 8                        504.         2361.        3770.                 00000160
 9 ENDTBL                                                                 00000170
 2 XSECTN   006           1.0          484.3                              00000180
 8                        480.         0.0          0.0                   00000190
 8                        482.         29.          46.                   00000200
 8                        484.         97.          104.                  00000210
 8                        485.         144.         138.                  00000220
 8                        485.5        176.         168.                  00000230
 8                        486.         215.         226.                  00000240
 8                        487.         320.         459.                  00000250
 8                        488.         485.         875.                  00000260
 8                        490.         1072.        2060.                 00000270
 8                        492.         1971.        3629.                 00000280
 9 ENDTBL                                                                 00000290
 2 XSECTN   007           1.0          479.5                              00000300
 8                        474.         0.           0.                    00000310
 8                        475.         12.          31.                   00000320
 8                        477.         76.          99.                   00000330
 8                        479.         178.         175.                  00000340
 8                        479.5        214.         210.                  00000350
 8                        480.         255.         255.                  00000360
 8                        481.         381.         579.                  00000370
 8                        483.         783.         1337.                 00000380
 8                        485.         1406.        2397.                 00000390
 8                        487.         2214.        3906.                 00000400
 9 ENDTBL                                                                 00000410
 6 RUNOFF 1     01      6 1.20         75.          0.33                  00000420
 6 RESVOR 2     01 6    7                                                 00000430
 6 REACH  3 001     7    5 5400.       0.4          1.33                  00000440
 6 RUNOFF 1 001         6 0.46         76.          1.07                  00000450
 6 ADDHYD 4 001     5 6 7                                                 00000460
```

200

```
**********80-80 LIST OF INPUT DATA (CONTINUED)**********

 6 REACH   3 002    7    1 3000.        2.4          1.05                    00000470
 6 RUNOFF  1    02       6 0.44         78.          0.35                    00000480
 6 RESVOR  2    02 6     7                                                    00000490
 6 REACH   3 003    7    5 4600.        1.9          0.88                    00000500
 6 RUNOFF  1 003         6 0.31         77.          0.47                    00000510
 6 ADDHYD  4 003    5 6  2                                                    00000520
 6 ADDHYD  4 004    1 2  3                                                    00000530
 6 REACH   3 005    3    5 2600.                                              00000540
 6 SAVHOV  5 006    5    7                                                    00000550
 6 REACH   3 006    7    5 4900.                                              00000560
 6 RUNOFF  1 006         6 1.30         79.          2.0                     00000570
 6 ADDHYD  4 006    5 6  7                                                    00000580
 6 REACH   3 007    7    5 8900.                                              00000590
 6 RUNOFF  1 007         6 0.70         80.          1.20                    00000600
 6 ADDHYD  4 007    5 6  4                                                    00000610
 6 SAVHOV  5 008    4    1                                                    00000620
   ENDATA                                                                    00000630
 7 LIST                                                                      00000640
 7 INCREM  6                 0.1                                             00000650
 7 BASFLO  5                 6.0                                             00000660
 7 COMPUT  7    01 007               5.2          1.0          2 2  01  01  00000670
   ENDCMP  1                                                                 00000680
 7 BASFLO  5                 6.0                                             00000690
 7 COMPUT  7    01 007               2.6          1.0          2 2  01  02  00000700
   ENDCMP  1                                                                 00000710
 3 STRUCT       01                                                          00000720
 8                           521.5         0.0          17.0                00000730
 8                           521.6         3.0          18.0                00000740
 8                           521.8         15.          20.2                00000750
 8                           522.0         33.          22.5                00000760
 8                           522.2         54.          25.0                00000770
 8                           522.4         79.          28.0                00000780
 8                           526.2         948.         70.                 00000790
 8                           526.4         1009.        75.                 00000800
 8                           526.6         1071.        80.                 00000810
 8                           527.2         1265.        95.                 00000820
 9 ENDTBL                                                                    00000830
 3 STRUCT       02                                                          00000840
 8                           496.          0.0          16.                 00000850
 8                           498.          210.         27.                 00000860
 8                           500.          252.         40.                 00000870
 8                           502.          294.         62.                 00000880
 8                           504.          336.         85.                 00000890
 8                           506.          378.         112.                00000900
 8                           508.          420.         145.                00000910
 8                           509.          441.         176.                00000920
```

```
**********80-80 LIST OF INPUT DATA (CONTINUED)**********

 8                          510.      556.      190.                          00000930
 8                          512.      1129.     237.                          00000940
 8                          514.      2086.     285.                          00000950
 8                          516.      3288.     340.                          00000960
 8                          517.      4030.     367.                          00000970
 9 ENDTBL                                                                     00000980
 7 BASFLO 5                 10.0                                              00000990
 7 COMPUT 7    01    02                5.2       1.0       2 2  02  01 00001000
 7 COMPUT 7 003    007                 5.2       1.0       2 2  02  01 00001010
   ENDCMP 1                                                                  00001020
 7 BASFLO 5                 8.0                                               00001030
 7 COMPUT 7    01    02                2.6       1.0       2 2  02  02 00001040
 7 COMPUT 7 003    007                 2.6       1.0       2 2  02  02 00001050
   ENDCMP 1                                                                  00001060
 3 STRUCT      02                                                           00001061
 9 ENDTBL                                                                   00001062
 3 STRUCT      03                                                           00001070
 8                          484.      0.0       25.                         00001080
 8                          488.      32.       80.                         00001090
 8                          492.      40.       130.                        00001100
 8                          495.      45.       193.                        00001110
 8                          498.      48.       260.                        00001120
 8                          500.      52.       305.                        00001130
 9 ENDTBL                                                                   00001140
 7 INSERT 2 002                                                             00001150
 6 RUNOFF 1    03     6 0.75          78.       1.60                        00001160
 6 RESVOR 2    03 6   7                                                     00001170
 7 DELETE 4                                                                 00001180
 6 RUNOFF 1    02                                                           00001190
 6 RESVOR 2    02                                                           00001200
 7 ALTER  3                                                                 00001210
 6 REACH  3 003   7   2 2000.         1.9       0.88                        00001220
 7 DELETE 4                                                                 00001230
 6 RUNOFF 1 003                                                             00001240
 6 ADDHYD 4 003                                                             00001250
 7 LIST                                                                     00001260
 7 BASFLO 5                 6.0                                             00001270
 7 COMPUT 7    01 007                5.2       1.0       2 2  03  01 00001280
   ENDCMP 1                                                                 00001290
 7 BASFLO 5                 6.0                                             00001300
 7 COMPUT 7    01 007                2.6       1.0       2 2  03  02 00001310
   ENDCMP 1                                                                 00001320
 3 STRUCT      01                                                           00001330
 9 ENDTBL                                                                   00001340
 3 STRUCT      03                                                           00001350
 9 ENDTBL                                                                   00001360
```

202

E-29

```
**********80-80 LIST OF INPUT DATA (CONTINUED)**********

 2 XSECTN   008          1.0          494.5                                  00001370
 8                       492.         0.0          0.0                       00001380
 8                       493.         21.          23.                       00001390
 8                       494.         64.          52.                       00001400
 8                       495.         133.         87.                       00001410
 8                       496.         232.         128.                      00001420
 8                       497.         360.         175.                      00001430
 8                       498.         515.         228.                      00001440
 8                       500.         827.         405.                      00001450
 9 ENDTBL                                                                    00001460
 7 INSERT 2 005                                                              00001470
 6 DIVERT 6 005   5 7 1               0.9          8.           1            00001480
 7 DELETE 4                                                                  00001490
 6 SAVMOV 5 006                                                              00001500
 7 INSERT 2 007                                                              00001510
 6 REACH  3 008   1   2 17000.                                    1           00001520
 6 ADDHYD 4 009   2 4 7                                        1 1   1       00001530
 7 LIST                                                                      00001540
 7 BASFLO 5               0.2          15.0         25.0                     00001550
 7 COMPUT 7    01 009                  5.2          1.0          2 2  04  01 00001560
   ENDCMP 1                                                                  00001570
 7 BASFLO 5               0.1          12.0         25.0                     00001580
 7 COMPUT 7    01 009                  2.6          1.0          2 2  04  02 00001590
   ENDCMP 1                                                                  00001600
   ENDJOB 2                                                                  00001610
   PEAKS    006   007   7A    3.90  7B    4.00                              00001620
   ENDJOB 2                                                                  00001630

**********END OF 80-80 LIST**********
```

Note: The User Notes, page 1, is not repeated in this Sample Job (See page A-8).

EXECUTIVE CONTROL OPERATION LIST RECORD ID 00000640

LISTING OF CURRENT DATA

	XSECTN NO.	DRAINAGE AREA
2 XSECTN	5	1.0000

	ELEVATION	DISCHARGE	END AREA
8	490.00	0.0	0.0
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
2 XSECTN	6	1.0000

	ELEVATION	DISCHARGE	END AREA
8	480.00	0.0	0.0
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

2 XSECTN ? 1.0000

	ELEVATION	DISCHARGE	END AREA
8	474.00	0.0	0.0
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

	TIME INCREMENT				
4 DIMHYD	0.0200				
8	0.0	0.0300	0.1000	0.1900	0.3100
8	0.4700	0.6600	0.8200	0.9300	0.9900
8	1.0000	0.9900	0.9300	0.8600	0.7800
8	0.6800	0.5600	0.4600	0.3900	0.3300
8	0.2800	0.2410	0.2070	0.1740	0.1470
8	0.1260	0.1070	0.0910	0.0770	0.0660
8	0.0550	0.0470	0.0400	0.0340	0.0290
8	0.0250	0.0210	0.0180	0.0150	0.0130
8	0.0110	0.0090	0.0080	0.0070	0.0060
8	0.0050	0.0040	0.0030	0.0020	0.0010
8	0.0	0.0	0.0	0.0	0.0

9 ENDTBL

COMPUTED PEAK RATE FACTOR = 484.00

	TABLE NO.	TIME INCREMENT			
5 RAINFL 1		0.5000			
8	0.0	0.0080	0.0170	0.0260	0.0350
8	0.0450	0.0550	0.0650	0.0760	0.0870
8	0.0990	0.1120	0.1260	0.1400	0.1560
8	0.1740	0.1940	0.2190	0.2540	0.3030
8	0.5150	0.5830	0.6240	0.6550	0.6820
8	0.7060	0.7280	0.7480	0.7660	0.7830
8	0.7990	0.8150	0.8300	0.8440	0.8570
8	0.8700	0.8820	0.8930	0.9050	0.9160
8	0.9260	0.9360	0.9460	0.9560	0.9650
8	0.9740	0.9830	0.9920	1.0000	1.0000

```
9 ENDTBL

     TABLE NO.        TIME INCREMENT
5 RAINFL 2                    0.2500

8                0.0       0.0020    0.0050    0.0080    0.0110
8                0.0140    0.0170    0.0200    0.0230    0.0260
8                0.0290    0.0320    0.0350    0.0380    0.0410
8                0.0440    0.0480    0.0520    0.0560    0.0600
8                0.0640    0.0680    0.0720    0.0760    0.0800
8                0.0850    0.0900    0.0950    0.1000    0.1050
8                0.1100    0.1150    0.1200    0.1260    0.1330
8                0.1400    0.1470    0.1550    0.1630    0.1720
8                0.1810    0.1910    0.2030    0.2180    0.2360
8                0.2570    0.2830    0.3870    0.6630    0.7070
8                0.7350    0.7580    0.7760    0.7910    0.8040
8                0.8150    0.8250    0.8340    0.8420    0.8490
8                0.8560    0.8630    0.8690    0.8750    0.8810
8                0.8870    0.8930    0.8980    0.9030    0.9080
8                0.9130    0.9180    0.9220    0.9260    0.9300
8                0.9340    0.9380    0.9420    0.9460    0.9500
8                0.9530    0.9560    0.9590    0.9620    0.9650
8                0.9680    0.9710    0.9740    0.9770    0.9800
8                0.9830    0.9860    0.9890    0.9920    0.9950
8                0.9980    1.0000    1.0000    1.0000    1.0000
9 ENDTBL

     TABLE NO.        TIME INCREMENT
5 RAINFL 3                    0.5000

8                0.0       0.0100    0.0220    0.0360    0.0510
8                0.0670    0.0830    0.0990    0.1160    0.1350
8                0.1560    0.1790    0.2040    0.2330    0.2680
8                0.3100    0.4250    0.4800    0.5200    0.5500
8                0.5770    0.6010    0.6230    0.6440    0.6640
8                0.6830    0.7010    0.7190    0.7360    0.7530
8                0.7690    0.7850    0.8000    0.8150    0.8300
8                0.8440    0.8580    0.8710    0.8840    0.8960
8                0.9080    0.9200    0.9320    0.9440    0.9560
8                0.9670    0.9780    0.9890    1.0000    1.0000
9 ENDTBL

     TABLE NO.        TIME INCREMENT
5 RAINFL 4                    0.5000

8                0.0       0.0040    0.0080    0.0120    0.0160
```

```
8                0.0200    0.0250    0.0300    0.0350    0.0400
8                0.0450    0.0500    0.0550    0.0600    0.0650
8                0.0700    0.0750    0.0810    0.0870    0.0930
8                0.0990    0.1050    0.1110    0.1180    0.1250
8                0.1320    0.1400    0.1480    0.1560    0.1650
8                0.1740    0.1840    0.1950    0.2070    0.2200
8                0.2360    0.2550    0.2770    0.3030    0.4090
8                0.5150    0.5490    0.5830    0.6050    0.6240
8                0.6400    0.6550    0.6690    0.6820    0.6940
8                0.7050    0.7160    0.7270    0.7380    0.7480
8                0.7580    0.7670    0.7760    0.7840    0.7920
8                0.8000    0.8080    0.8160    0.8230    0.8300
8                0.8370    0.8440    0.8510    0.8580    0.8640
8                0.8700    0.8760    0.8820    0.8880    0.8940
8                0.9000    0.9060    0.9110    0.9160    0.9210
8                0.9260    0.9310    0.9360    0.9410    0.9460
8                0.9510    0.9560    0.9610    0.9660    0.9710
8                0.9760    0.9800    0.9840    0.9880    0.9920
8                0.9960    1.0000    1.0000    1.0000    1.0000
9 ENDTBL

      TABLE NO.          TIME INCREMENT
5 RAINFL 5                       0.5000

8                0.0       0.0020    0.0050    0.0080    0.0110
8                0.0140    0.0170    0.0200    0.0230    0.0260
8                0.0290    0.0320    0.0350    0.0380    0.0410
8                0.0440    0.0470    0.0510    0.0550    0.0590
8                0.0630    0.0670    0.0710    0.0750    0.0790
8                0.0840    0.0890    0.0940    0.0990    0.1040
8                0.1090    0.1140    0.1200    0.1260    0.1330
8                0.1400    0.1470    0.1540    0.1620    0.1710
8                0.1810    0.1920    0.2040    0.2170    0.2330
8                0.2520    0.2770    0.3180    0.6380    0.6980
8                0.7290    0.7520    0.7700    0.7850    0.7980
8                0.8090    0.8190    0.8290    0.8380    0.8460
8                0.8540    0.8610    0.8680    0.8740    0.8800
8                0.8860    0.8920    0.8970    0.9020    0.9070
8                0.9120    0.9170    0.9210    0.9250    0.9290
8                0.9330    0.9370    0.9410    0.9450    0.9490
8                0.9530    0.9570    0.9600    0.9630    0.9660
8                0.9690    0.9720    0.9750    0.9780    0.9810
8                0.9840    0.9870    0.9900    0.9930    0.9960
8                0.9980    1.0000    1.0000    1.0000    1.0000
9 ENDTBL
```

```
      TABLE NO.        TIME INCREMENT
5 RAINFL 6                    0.0200

8                0.0     0.0080    0.0162    0.0246    0.0333
8              0.0425    0.0524    0.0630    0.0743    0.0863
8              0.0990    0.1124    0.1265    0.1420    0.1595
8              0.1800    0.2050    0.2550    0.3450    0.4370
8              0.5300    0.6030    0.6330    0.6600    0.6840
8              0.7050    0.7240    0.7420    0.7590    0.7750
8              0.7900    0.8043    0.8180    0.8312    0.8439
8              0.8561    0.8678    0.8790    0.8898    0.9002
8              0.9103    0.9201    0.9297    0.9391    0.9483
8              0.9573    0.9661    0.9747    0.9832    0.9916
8              1.0000    1.0000    1.0000    1.0000    1.0000
9 ENDTBL
```

208

E-36

STANDARD CONTROL INSTRUCTIONS

```
6 RUNOFF 1      1      6      1.2000      75.0000      0.33000 0 0 0 0 1
6 RESVOR 2      1 6    7       0.0                          0 0 0 0 0 1
6 REACH  3   1    7    5   5400.0000       0.4000      1.33000 0 0 0 0 1
6 RUNOFF 1   1         6      0.4600      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       2.4000      1.05000 0 0 0 0 1
6 RUNOFF 1     2       6      0.4400      78.0000      0.35000 0 0 0 0 1
6 RESVOR 2     2 6     7       0.0                          0 0 0 0 0 1
6 REACH  3   3    7    5   4600.0000       1.9000      0.88000 0 0 0 0 1
6 RUNOFF 1   3         6      0.3100      77.0000      0.47000 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       0.0          0.0   0 0 0 0 0 1
6 SAVHOV 5   6    5    7
6 REACH  3   6    7    5   4900.0000       0.0          0.0   0 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       0.0          0.0   0 0 0 0 0 1
6 RUNOFF 1   7         6      0.7000      80.0000      1.20000 0 0 0 0 1
6 ADDHYD 4   7    5 6 4                                      0 0 0 0 0 1
6 SAVHOV 5   8    4    1
  ENDATA
```

END OF LISTING

EXECUTIVE CONTROL OPERATION INCREM MAIN TIME INCREMENT = 0.10 HOURS RECORD ID 00000650

EXECUTIVE CONTROL OPERATION BASFLO NEW BASEFLOW = 6.00 CFS RECORD ID 00000660

EXECUTIVE CONTROL OPERATION COMPUT FROM STRUCTURE 1 TO XSECTION 7 RECORD ID 00000670
STARTING TIME = 0.0 RAIN DEPTH = 5.20 RAIN DURATION= 1.00 RAIN TABLE NO.= 2 ANT. MOIST. COND= 2
ALTERNATE NO.= 1 STORM NO.= 1 MAIN TIME INCREMENT = 0.10 HOURS

EXECUTIVE CONTROL OPERATION ENDCMP COMPUTATIONS COMPLETED FOR PASS 1 RECORD ID 00000680

EXECUTIVE CONTROL OPERATION BASFLO NEW BASEFLOW = 6.00 CFS RECORD ID 00000690

EXECUTIVE CONTROL OPERATION COMPUT FROM STRUCTURE 1 TO XSECTION 7 RECORD ID 00000700
STARTING TIME = 0.0 RAIN DEPTH = 2.60 RAIN DURATION= 1.00 RAIN TABLE NO.= 2 ANT. MOIST. COND= 2
ALTERNATE NO.= 1 STORM NO.= 2 MAIN TIME INCREMENT = 0.10 HOURS

EXECUTIVE CONTROL OPERATION ENDCMP COMPUTATIONS COMPLETED FOR PASS 2 RECORD ID 00000710

CHANGES TO TABULAR DATA FOLLOW

STRUCTURE DATA, STRUCTURE NO. 1

	ELEVATION	DISCHARGE	STORAGE
8	521.50	0.0	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			

STRUCTURE DATA, STRUCTURE NO. 2

	ELEVATION	DISCHARGE	STORAGE
8	496.00	0.0	16.00
8	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 OPERATION BASFLO NEW BASEFLOW = 10.00 CFS RECORD ID 00000990

EXECUTIVE CONTROL OPERATION COMPUT FROM STRUCTURE 1 TO STRUCTURE 2 RECORD ID 00001000
STARTING TIME = 0.0 RAIN DEPTH = 5.20 RAIN DURATION= 1.00 RAIN TABLE NO.= 2 ANT. MOIST. COND= 2
ALTERNATE NO.= 2 STORM NO.= 1 MAIN TIME INCREMENT = 0.10 HOURS

```
EXECUTIVE CONTROL OPERATION COMPUT      FROM XSECTION   3  TO XSECTION   7                    RECORD ID 00001010
      STARTING TIME =  0.0      RAIN DEPTH =  5.20    RAIN DURATION=  1.00    RAIN TABLE NO.= 2    ANT. MOIST. COND= 2
      ALTERNATE NO.= 2          STORM NO.= 1    MAIN TIME INCREMENT =  0.10 HOURS

EXECUTIVE CONTROL OPERATION ENDCMP      COMPUTATIONS COMPLETED FOR PASS  3                    RECORD ID 00001020


EXECUTIVE CONTROL OPERATION BASFLO      NEW BASEFLOW =    8.00 CFS                           RECORD ID 00001030

EXECUTIVE CONTROL OPERATION COMPUT      FROM STRUCTURE  1  TO STRUCTURE  2                   RECORD ID 00001040
      STARTING TIME =  0.0      RAIN DEPTH =  2.60    RAIN DURATION=  1.00    RAIN TABLE NO.= 2    ANT. MOIST. COND= 2
      ALTERNATE NO.= 2          STORM NO.= 2    MAIN TIME INCREMENT =  0.10 HOURS

EXECUTIVE CONTROL OPERATION COMPUT      FROM XSECTION   3  TO XSECTION   7                    RECORD ID 00001050
      STARTING TIME =  0.0      RAIN DEPTH =  2.60    RAIN DURATION=  1.00    RAIN TABLE NO.= 2    ANT. MOIST. COND= 2
      ALTERNATE NO.= 2          STORM NO.= 2    MAIN TIME INCREMENT =  0.10 HOURS

EXECUTIVE CONTROL OPERATION ENDCMP      COMPUTATIONS COMPLETED FOR PASS  4                    RECORD ID 00001060
```

CHANGES TO TABULAR DATA FOLLOW

STRUCTURE DATA, STRUCTURE NO. 2

	ELEVATION	DISCHARGE	STORAGE
9 ENDTBL			

STRUCTURE DATA, STRUCTURE NO. 3

	ELEVATION	DISCHARGE	STORAGE
8	484.00	0.0	25.00
8	488.00	32.00	80.00
8	492.00	40.00	130.00
8	495.00	45.00	193.00
8	498.00	48.00	260.00
8	500.00	52.00	305.00
9 ENDTBL			

CHANGES TO STANDARD CONTROL LIST FOLLOW

EXECUTIVE CONTROL OPERATION INSERT XSECTION 2 — RECORD ID 00001150

STANDARD CONTROL OPERATION RUNOFF STRUCTURE 3 — RECORD ID 00001160
OUTPUT HYDROGRAPH = 6
OUTPUT OPTIONS IN EFFECT SUM
DATA FIELD VALUES = 0.7500 78.0000 1.6000

STANDARD CONTROL OPERATION RESVOR STRUCTURE 3 — RECORD ID 00001170
INPUT HYDROGRAPH = 6 OUTPUT HYDROGRAPH = 7
OUTPUT OPTIONS IN EFFECT SUM
DATA FIELD VALUES = 0.0 0.0 0.0

EXECUTIVE CONTROL OPERATION DELETE — RECORD ID 00001180

STANDARD CONTROL OPERATION RUNOFF STRUCTURE 2 — RECORD ID 00001190

STANDARD CONTROL OPERATION RESVOR STRUCTURE 2 — RECORD ID 00001200

EXECUTIVE CONTROL OPERATION ALTER — RECORD ID 00001210

STANDARD CONTROL OPERATION REACH CROSS SECTION 3 — RECORD ID 00001220
INPUT HYDROGRAPH = 7 OUTPUT HYDROGRAPH = 2
OUTPUT OPTIONS IN EFFECT SUM
DATA FIELD VALUES = 2000.0000 1.9000 0.8800

EXECUTIVE CONTROL OPERATION DELETE — RECORD ID 00001230

STANDARD CONTROL OPERATION RUNOFF CROSS SECTION 3 — RECORD ID 00001240

STANDARD CONTROL OPERATION ADDHYD CROSS SECTION 3 — RECORD ID 00001250

EXECUTIVE CONTROL OPERATION LIST — RECORD ID 00001260

LISTING OF CURRENT DATA

Note: The listing of Tabular Data from the Executive Control Operation List is not repeated for this pass. (pages 13 to 17)

E-42

STANDARD CONTROL INSTRUCTIONS

```
6 RUNOFF 1     1       6      1.2000      75.0000      0.33000 0 0 0 0 1
6 RESVOR 2     1 6     7       0.0                          0 0 0 0 0 1
6 REACH  3   1   7     5    5400.0000      0.4000      1.33000 0 0 0 0 1
6 RUNOFF 1   1         6       0.4600      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      2.4000      1.05000 0 0 0 0 1
6 RUNOFF 1     3       6       0.7500      78.0000      1.60000 0 0 0 0 1
6 RESVOR 2     3 6     7       0.0                          0 0 0 0 0 1
6 REACH  3   3   7     2    2000.0000      1.9000      0.88000 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      0.0         0.0  0 0 0 0 0 1
6 SAVMOV 5   6   5     7
6 REACH  3   6   7     5    4900.0000      0.0         0.0  0 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      0.0         0.0  0 0 0 0 0 1
6 RUNOFF 1   7         6       0.7000      80.0000      1.20000 0 0 0 0 1
6 ADDHYD 4   7   5 6   4                                  0 0 0 0 0 1
6 SAVMOV 5   8   4     1
  ENDATA
```

END OF LISTING

EXECUTIVE CONTROL OPERATION BASFLO NEW BASEFLOW = 6.00 CFS RECORD ID 00001270

EXECUTIVE CONTROL OPERATION COMPUT FROM STRUCTURE 1 TO XSECTION 7 RECORD ID 00001280
STARTING TIME = 0.0 RAIN DEPTH = 5.20 RAIN DURATION= 1.00 RAIN TABLE NO.= 2 ANT. MOIST. COND= 2
ALTERNATE NO.= 3 STORM NO.= 1 MAIN TIME INCREMENT = 0.10 HOURS

*** WARNING - REACH 3 INFLOW HYDROGRAPH VOLUME TRUNCATED ABOVE BASEFLOW AT 33.65 CFS, 92.47 % OF PEAK.

EXECUTIVE CONTROL OPERATION ENDCMP COMPUTATIONS COMPLETED FOR PASS 5 RECORD ID 00001290

EXECUTIVE CONTROL OPERATION BASFLO NEW BASEFLOW = 6.00 CFS RECORD ID 00001300

EXECUTIVE CONTROL OPERATION COMPUT FROM STRUCTURE 1 TO XSECTION 7 RECORD ID 00001310
STARTING TIME 0.0 RAIN DEPTH = 2.60 RAIN DURATION= 1.00 RAIN TABLE NO.= 2 ANT. MOIST. COND= 2
ALTERNATE NO.= 3 STORM NO.= 2 MAIN TIME INCREMENT = 0.10 HOURS

*** WARNING - REACH 3 INFLOW HYDROGRAPH VOLUME TRUNCATED ABOVE BASEFLOW AT 10.08 CFS, 76.27 % OF PEAK.

EXECUTIVE CONTROL OPERATION ENDCMP COMPUTATIONS COMPLETED FOR PASS 6 RECORD ID 00001320

E-44

CHANGES TO TABULAR DATA FOLLOW

STRUCTURE DATA, STRUCTURE NO. 1

	ELEVATION	DISCHARGE	STORAGE
9 ENDTBL			

STRUCTURE DATA, STRUCTURE NO. 3

	ELEVATION	DISCHARGE	STORAGE
9 ENDTBL			

CROSS-SECTION DATA, CROSS-SECTION NO. 8 DRAINAGE AREA= 1.00 BANKFULL ELEV.= 494.50

	ELEVATION	DISCHARGE	END AREA
8	492.00	0.0	0.0
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			

CHANGES TO STANDARD CONTROL LIST FOLLOW

EXECUTIVE CONTROL OPERATION INSERT XSECTION 5 RECORD ID 00001470

STANDARD CONTROL OPERATION DIVERT CROSS SECTION 5 RECORD ID 00001480
INPUT HYDROGRAPH = 5 OUTPUT HYDROGRAPHS = 7,1 DATA FIELD VALUES = 0.0 0.9000 8.0000
OUTPUT OPTIONS IN EFFECT HYD SUM

EXECUTIVE CONTROL OPERATION DELETE RECORD ID 00001490

STANDARD CONTROL OPERATION SAVMOV CROSS SECTION 6 RECORD ID 00001500

EXECUTIVE CONTROL OPERATION INSERT XSECTION 7 RECORD ID 00001510

STANDARD CONTROL OPERATION REACH CROSS SECTION 8 RECORD ID 00001520
INPUT HYDROGRAPH = 1 OUTPUT HYDROGRAPH = 2 DATA FIELD VALUES = 17000.0000 0.0 0.0
OUTPUT OPTIONS IN EFFECT HYD SUM

STANDARD CONTROL OPERATION ADDHYD CROSS SECTION 9 RECORD ID 00001530
INPUT HYDROGRAPHS = 2,4 OUTPUT HYDROGRAPH = 7 DATA FIELD VALUES = 0.0 0.0 0.0
OUTPUT OPTIONS IN EFFECT PEAK HYD VOL SUM

EXECUTIVE CONTROL OPERATION LIST RECORD ID 00001540

LISTING OF CURRENT DATA

Note: The listing of Tabular Data from the Executive Control Operation List is not repeated for this pass. (pages 22 to 26)

E-46

STANDARD CONTROL INSTRUCTIONS

```
6 RUNOFF 1      1      6      1.2000      75.0000      0.33000 0 0 0 0 1
6 RESVOR 2      1 6    7       0.0                          0 0 0 0 0 1
6 REACH  3   1    7     5  5400.0000       0.4000      1.33000 0 0 0 0 1
6 RUNOFF 1   1         6       0.4600      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       2.4000      1.05000 0 0 0 0 1
6 RUNOFF 1      3      6       0.7500      78.0000      1.60000 0 0 0 0 1
6 RESVOR 2      3 6    7       0.0                          0 0 0 0 0 1
6 REACH  3   3    7     2  2000.0000       1.9000      0.88000 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       0.0         0.0  0 0 0 0 0 1
6 DIVERT 6   5    5 7 1       0.0         0.9000      8.00000 1 0 0 0 1
6 REACH  3   6    7     5  4900.0000       0.0         0.0  0 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       0.0         0.0  0 0 0 0 0 1
6 RUNOFF 1   7         6       0.7000      80.0000      1.20000 0 0 0 0 1
6 ADDHYD 4   7    5 6 4                                      0 0 0 0 0 1
6 REACH  3   8    1     2 17000.0000       0.0         0.0  0 1 0 0 0 1
6 ADDHYD 4   9    2 4 7                                      1 1 0 1 0 1
6 SAVMOV 5   8    4     1
  ENDATA
```

END OF LISTING

EXECUTIVE CONTROL OPERATION BASFLO BASEFLOW VOL = 0.20 IN., PEAK TIME = 15.0 HRS., BASE TIME = 25. HRS. RECORD ID 00001550

EXECUTIVE CONTROL OPERATION COMPUT FROM STRUCTURE 1 TO XSECTION 9 RECORD ID 00001560
STARTING TIME = 0.0 RAIN DEPTH = 5.20 RAIN DURATION= 1.00 RAIN TABLE NO.= 2 ANT. MOIST. COND= 2
ALTERNATE NO.= 4 STORM NO.= 1 MAIN TIME INCREMENT = 0.10 HOURS

OPERATION DIVERT CROSS SECTION 5 OUTPUT #1 HYDROGRAPH

TIME(HRS)		FIRST HYDROGRAPH POINT = 0.0 HOURS				TIME INCREMENT = 0.10 HOURS			DRAINAGE AREA =		2.17 SQ.MI.
0.0	DISCHG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.02
1.00	DISCHG	0.03	0.06	0.08	0.12	0.16	0.21	0.27	0.33	0.40	0.48
2.00	DISCHG	0.56	0.65	0.75	0.85	0.96	1.07	1.18	1.30	1.42	1.55
3.00	DISCHG	1.68	1.81	1.95	2.08	2.22	2.36	2.51	2.65	2.80	2.95
4.00	DISCHG	3.10	3.25	3.41	3.56	3.71	3.87	4.03	4.19	4.34	4.50
5.00	DISCHG	4.66	4.82	4.98	5.14	5.31	5.47	5.63	5.79	5.96	6.12
6.00	DISCHG	6.28	6.45	6.61	6.78	6.94	7.11	7.27	7.44	7.60	7.77
7.00	DISCHG	7.93	8.10	8.27	8.43	8.60	8.76	8.93	9.10	9.26	9.43
8.00	DISCHG	9.59	9.76	9.93	10.09	10.26	10.43	10.60	10.77	10.94	11.12
9.00	DISCHG	11.30	11.49	11.70	11.92	12.16	12.43	12.75	13.13	13.57	14.07
10.00	DISCHG	14.66	15.34	16.11	16.98	17.37	17.78	18.24	18.73	19.28	19.87
11.00	DISCHG	20.50	21.19	21.93	22.74	23.62	24.60	25.70	26.93	28.31	29.87
12.00	DISCHG	31.64	33.65	35.98	38.78	42.42	47.70	55.74	65.68	80.59	101.35
13.00	DISCHG	131.00	166.19	201.33	238.90	272.57	300.95	324.87	346.23	361.84	372.34
14.00	DISCHG	378.36	380.52	379.40	375.54	369.43	361.50	352.11	341.56	330.14	318.24
15.00	DISCHG	307.85	297.24	286.49	275.71	264.97	254.32	243.82	233.50	223.41	213.60
16.00	DISCHG	204.22	196.36	188.79	181.52	174.54	167.85	161.44	155.32	149.48	143.94
17.00	DISCHG	138.67	133.69	129.13	124.92	120.93	117.17	113.59	110.19	106.94	104.20
18.00	DISCHG	101.73	99.39	97.16	95.06	93.07	91.19	89.41	87.73	86.12	84.54
19.00	DISCHG	83.01	81.52	80.09	78.70	77.37	76.08	74.86	73.69	72.57	71.51
20.00	DISCHG	70.51	69.56	68.67	67.82	67.03	66.27	65.56	64.88	64.22	63.55
21.00	DISCHG	62.88	62.20	61.52	60.83	60.15	59.47	58.81	58.16	57.53	56.90
22.00	DISCHG	56.14	55.41	54.71	54.04	53.40	52.80	52.22	51.67	51.15	50.66
23.00	DISCHG	50.19	49.75	49.33	48.93	48.55	48.20	47.86	47.54	47.23	46.94
24.00	DISCHG	46.67	46.40	46.15	45.92	45.69	45.47	45.25	45.02	44.76	44.44
25.00	DISCHG	44.03	43.48	42.79	41.95	40.98	39.89	38.73	37.50	36.24	34.96
26.00	DISCHG	33.68	32.42	31.18	29.97	28.80	27.68	26.60	25.58	24.60	23.67
27.00	DISCHG	22.79	21.96	21.18	20.44	19.75	19.10	18.49	17.92	17.38	16.70
28.00	DISCHG	15.49	14.36	13.30	12.32	11.41	10.56	9.76	9.03	8.35	7.72
29.00	DISCHG	7.13	6.58	6.08	5.61	5.18	4.78	4.41	4.06	3.75	3.45

OUTPUT #2 DIVERTED HYDROGRAPH, CROSS SECTION = 8

TIME(HRS)		FIRST HYDROGRAPH POINT = 0.0 HOURS				TIME INCREMENT = 0.10 HOURS			DRAINAGE AREA =		0.24 SQ.MI.
10.00	DISCHG	0.0	0.0	0.0	0.0	0.59	1.25	1.98	2.78	3.65	4.59

11.00	DISCHG	5.60	6.70	7.89	9.18	10.60	12.17	13.92	15.88	18.10	20.60
12.00	DISCHG	23.43	26.64	30.37	34.85	40.67	49.12	61.98	84.65	120.13	171.00
13.00	DISCHG	230.10	291.95	353.57	406.09	451.88	490.46	520.62	541.06	556.00	566.05
14.00	DISCHG	571.82	573.88	572.80	569.11	563.27	555.67	546.68	536.59	525.67	513.96
15.00	DISCHG	499.85	485.41	470.80	456.14	441.54	427.06	412.78	398.75	385.03	371.69
16.00	DISCHG	358.63	344.85	331.58	318.84	306.60	294.86	283.62	272.89	262.66	252.93
17.00	DISCHG	243.70	234.96	226.54	218.51	210.93	203.76	196.95	190.47	184.29	178.03
18.00	DISCHG	171.94	166.14	160.63	155.42	150.49	145.84	141.44	137.28	133.30	129.53
19.00	DISCHG	125.88	122.35	118.93	115.63	112.45	109.41	106.49	103.70	101.05	98.53
20.00	DISCHG	96.15	93.89	91.76	89.75	87.85	86.07	84.37	82.75	81.17	79.59
21.00	DISCHG	77.99	76.38	74.75	73.11	71.49	69.88	68.30	66.76	65.26	63.84
22.00	DISCHG	62.62	61.45	60.33	59.26	58.24	57.27	56.35	55.47	54.64	53.85
23.00	DISCHG	53.11	52.40	51.73	51.09	50.49	49.91	49.37	48.86	48.37	47.91
24.00	DISCHG	47.46	47.05	46.65	46.27	45.90	45.55	45.20	44.84	44.42	43.91
25.00	DISCHG	43.25	42.37	41.26	39.92	38.36	36.63	34.76	32.80	30.78	28.73
26.00	DISCHG	26.69	24.67	22.68	20.75	18.88	17.09	15.37	13.72	12.16	10.68
27.00	DISCHG	9.27	7.94	6.69	5.51	4.40	3.36	2.39	1.47	0.62	0.0

OPERATION REACH CROSS SECTION 8

TIME(HRS) FIRST HYDROGRAPH POINT = 0.0 HOURS TIME INCREMENT = 0.10 HOURS DRAINAGE AREA = 0.24 SQ.MI.

10.00	DISCHG	0.0	0.0	0.0	0.0	0.0	0.04	0.12	0.24	0.40	0.62
11.00	DISCHG	0.88	1.19	1.55	1.96	2.44	2.97	3.58	.25	5.02	5.88
12.00	DISCHG	6.84	7.93	9.16	10.55	12.15	14.02	16.32	19.32	23.61	29.95
13.00	DISCHG	39.21	51.75	67.52	86.31	107.31	129.94	153.62	177.72	201.58	224.86
14.00	DISCHG	247.27	268.58	288.63	307.29	324.49	340.17	354.32	366.95	378.09	387.78
15.00	DISCHG	396.07	402.88	408.30	412.41	415.28	417.00	417.66	417.34	416.12	414.08
16.00	DISCHG	411.29	407.83	403.70	398.96	393.70	387.98	381.86	375.41	368.67	361.71
17.00	DISCHG	354.56	347.28	339.90	332.46	324.97	317.48	310.01	302.59	295.22	287.94
18.00	DISCHG	280.72	273.57	266.52	259.56	252.72	246.01	239.43	232.99	226.70	220.57
19.00	DISCHG	214.59	208.76	203.09	197.56	192.18	186.94	181.85	176.90	172.09	167.42
20.00	DISCHG	162.90	158.52	154.27	150.16	146.20	142.36	138.67	135.10	131.66	128.34
21.00	DISCHG	125.14	122.04	119.04	116.13	113.31	110.56	107.89	105.29	102.76	100.29
22.00	DISCHG	97.90	95.58	93.34	91.17	89.08	87.05	85.09	83.21	81.38	79.63
23.00	DISCHG	77.93	76.30	74.73	73.22	71.77	70.37	69.02	67.73	66.49	65.30
24.00	DISCHG	64.16	63.06	62.01	61.00	60.03	59.10	58.21	57.36	56.53	55.74
25.00	DISCHG	54.96	54.19	53.41	52.62	51.78	50.90	49.96	48.96	47.90	46.78
26.00	DISCHG	45.59	44.35	43.06	41.72	40.34	38.93	37.49	36.04	34.57	33.10
27.00	DISCHG	31.63	30.16	28.70	27.25	25.82	24.42	23.03	21.68	20.35	19.05
28.00	DISCHG	17.80	16.63	15.54	14.52	13.56	12.67	11.84	11.06	10.33	9.65
29.00	DISCHG	9.02	8.43	7.87	7.35	6.87	6.42	6.00	5.60	5.23	4.89

OPERATION ADDHYD CROSS SECTION 9

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
12.67	695.74	(NULL)
15.85	868.12	(NULL)

TIME(HRS) FIRST HYDROGRAPH POINT = 0.0 HOURS TIME INCREMENT = 0.10 HOURS DRAINAGE AREA = 4.41 SQ.MI.

0.0	DISCHG	0.0	0.05	0.10	0.15	0.19	0.24	0.29	0.34	0.39	0.44
1.00	DISCHG	0.49	0.55	0.60	0.66	0.73	0.79	0.86	0.92	1.00	1.07
2.00	DISCHG	1.14	1.22	1.30	1.37	1.46	1.54	1.63	1.71	1.80	1.89
3.00	DISCHG	1.99	2.08	2.18	2.28	2.38	2.49	2.60	2.70	2.82	2.93
4.00	DISCHG	3.05	3.17	3.29	3.42	3.55	3.68	3.81	3.95	4.09	4.23
5.00	DISCHG	4.38	4.53	4.68	4.83	4.99	5.15	5.31	5.48	5.64	5.81
6.00	DISCHG	5.99	6.17	6.34	6.53	6.71	6.90	7.09	7.28	7.47	7.67
7.00	DISCHG	7.88	8.09	8.32	8.57	8.85	9.17	9.52	9.91	10.33	10.79
8.00	DISCHG	11.27	11.77	12.31	12.87	13.47	14.12	14.82	15.57	16.38	17.23
9.00	DISCHG	18.11	19.03	19.97	20.94	21.96	23.02	24.13	25.30	26.52	27.80
10.00	DISCHG	29.16	30.57	32.05	33.60	35.25	37.08	39.14	41.51	44.22	47.34
11.00	DISCHG	50.94	55.05	59.70	64.90	70.71	77.18	85.98	99.11	120.53	157.95
12.00	DISCHG	218.78	299.88	396.72	500.67	593.63	657.17	689.91	695.01	678.74	648.28
13.00	DISCHG	611.90	573.69	542.54	526.38	522.08	526.85	538.78	555.13	575.12	597.81
14.00	DISCHG	621.90	646.61	671.26	695.40	718.72	740.60	760.81	779.10	795.39	809.84
15.00	DISCHG	822.46	833.26	842.48	850.26	856.53	861.37	864.86	867.02	868.01	868.02
16.00	DISCHG	867.16	865.35	862.62	859.07	854.77	849.83	844.26	838.07	831.28	823.89
17.00	DISCHG	815.92	807.46	798.62	789.48	780.13	770.64	761.05	751.43	741.79	732.10
18.00	DISCHG	722.29	712.34	702.22	691.95	681.59	671.22	660.89	650.66	640.55	630.60
19.00	DISCHG	620.84	611.25	601.83	592.55	583.41	574.41	565.54	556.81	548.20	539.66
20.00	DISCHG	531.18	522.71	514.21	505.71	497.25	488.89	480.67	472.65	464.84	457.26
21.00	DISCHG	449.91	442.79	435.87	429.11	422.50	416.03	409.68	403.45	397.33	391.32
22.00	DISCHG	385.41	379.62	373.94	368.38	362.92	357.58	352.34	347.22	342.21	337.30
23.00	DISCHG	332.50	327.81	323.23	318.74	314.37	310.09	305.91	301.83	297.83	293.86
24.00	DISCHG	289.90	285.83	281.53	276.96	272.07	266.85	261.45	256.00	250.66	245.49
25.00	DISCHG	240.68	236.15	231.89	227.90	224.09	220.39	216.76	213.14	209.54	205.92
26.00	DISCHG	202.27	198.60	194.89	191.15	187.39	183.60	179.80	175.99	172.18	168.38
27.00	DISCHG	164.59	160.83	157.10	153.40	149.74	146.13	142.56	139.05	135.58	132.18
28.00	DISCHG	128.84	125.62	122.49	119.46	116.52	113.68	110.91	108.23	105.63	103.10
29.00	DISCHG	100.64	98.25	95.92	93.65	91.44	89.28	87.18	85.12	83.11	81.15

RUNOFF VOLUME ABOVE BASEFLOW = 2.94 WATERSHED INCHES, 8353.53 CFS-HRS, 690.34 ACRE-FEET; BASEFLOW = 0.0 CFS

EXECUTIVE CONTROL OPERATION ENDCMP COMPUTATIONS COMPLETED FOR PASS 7 RECORD ID 00001570

EXECUTIVE CONTROL OPERATION BASFLO BASEFLOW VOL = 0.10 IN., PEAK TIME = 12.0 HRS., BASE TIME = 25. HRS. RECORD ID 00001580

EXECUTIVE CONTROL OPERATION COMPUT FROM STRUCTURE 1 TO XSECTION 9 RECORD ID 00001590
STARTING TIME = 0.0 RAIN DEPTH = 2.60 RAIN DURATION= 1.00 RAIN TABLE NO.= 2 ANT. MOIST. COND= 2
ALTERNATE NO. 4 STORM NO.= 2 MAIN TIME INCREMENT = 0.10 HOURS

E-50

OPERATION DIVERT CROSS SECTION 5 OUTPUT #1 HYDROGRAPH

TIME(HRS) FIRST HYDROGRAPH POINT = 0.0 HOURS TIME INCREMENT = 0.10 HOURS DRAINAGE AREA = 2.17 SQ.MI.

0.0	DISCHG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.02	0.04
1.00	DISCHG	0.05	0.08	0.10	0.13	0.17	0.21	0.25	0.30	0.35	0.41
2.00	DISCHG	0.47	0.53	0.60	0.67	0.74	0.81	0.89	0.97	1.05	1.13
3.00	DISCHG	1.22	1.31	1.39	1.48	1.58	1.67	1.76	1.85	1.95	2.05
4.00	DISCHG	2.14	2.24	2.34	2.44	2.54	2.63	2.73	2.83	2.94	3.04
5.00	DISCHG	3.14	3.24	3.34	3.44	3.55	3.65	3.75	3.85	3.96	4.06
6.00	DISCHG	4.16	4.27	4.37	4.47	4.58	4.68	4.78	4.89	4.99	5.10
7.00	DISCHG	5.20	5.30	5.41	5.51	5.62	5.72	5.82	5.93	6.03	6.14
8.00	DISCHG	6.24	6.34	6.45	6.55	6.66	6.76	6.86	6.97	7.07	7.18
9.00	DISCHG	7.28	7.39	7.49	7.60	7.70	7.81	7.91	8.01	8.12	8.22
10.00	DISCHG	8.33	8.43	8.54	8.64	8.75	8.85	8.96	9.06	9.16	9.27
11.00	DISCHG	9.37	9.48	9.58	9.69	9.79	9.90	10.01	10.13	10.25	10.41
12.00	DISCHG	10.62	10.97	11.65	13.02	15.69	18.41	21.79	27.13	34.34	42.86
13.00	DISCHG	52.02	60.24	66.97	73.14	78.60	83.28	87.14	90.19	92.52	94.20
14.00	DISCHG	95.28	95.83	95.91	95.59	94.93	93.98	92.80	91.42	89.89	88.25
15.00	DISCHG	86.51	84.68	82.79	80.88	78.96	77.04	75.15	73.28	71.46	69.69
16.00	DISCHG	67.98	66.32	64.73	63.19	61.72	60.31	58.97	57.69	56.31	54.82
17.00	DISCHG	53.41	52.07	50.82	49.63	48.51	47.44	46.42	45.44	44.52	43.63
18.00	DISCHG	42.80	42.00	41.25	40.54	39.86	39.23	38.62	38.03	37.46	36.91
19.00	DISCHG	36.37	35.85	35.34	34.85	34.38	33.92	33.49	33.07	32.68	32.31
20.00	DISCHG	31.95	31.62	31.30	31.00	30.72	30.45	30.19	29.92	29.65	29.38
21.00	DISCHG	29.11	28.82	28.54	28.26	27.98	27.71	27.44	27.17	26.92	26.67
22.00	DISCHG	26.43	26.20	25.99	25.78	25.58	25.39	25.22	25.05	24.89	24.74
23.00	DISCHG	24.60	24.46	24.33	24.21	24.10	23.99	23.89	23.79	23.70	23.62
24.00	DISCHG	23.54	23.46	23.38	23.31	23.24	23.17	23.08	22.98	22.84	22.66
25.00	DISCHG	22.43	22.15	21.82	21.44	21.03	20.59	20.13	19.66	19.18	18.70
26.00	DISCHG	18.23	17.77	17.32	16.69	15.60	14.56	13.57	12.62	11.73	10.89
27.00	DISCHG	10.10	9.35	8.66	8.00	7.39	6.83	6.30	5.81	5.35	4.93
28.00	DISCHG	4.54	4.17	3.84	3.53	3.24	2.98	2.73	2.51	2.30	2.11
29.00	DISCHG	1.94	1.78	1.63	1.49	1.36	1.25	1.14	1.05	0.96	0.88

OUTPUT #2 DIVERTED HYDROGRAPH, CROSS SECTION = 8

TIME(HRS) FIRST HYDROGRAPH POINT = 0.0 HOURS TIME INCREMENT = 0.10 HOURS DRAINAGE AREA = 0.24 SQ.MI.

12.00	DISCHG	0.0	0.0	0.0	0.0	0.0	2.25	7.66	16.21	27.75	41.38
13.00	DISCHG	56.03	71.70	87.73	102.41	115.38	126.52	135.82	143.36	149.14	153.30
14.00	DISCHG	155.97	157.32	157.52	156.73	155.10	152.75	149.82	146.42	142.63	138.56
15.00	DISCHG	134.27	129.86	125.37	120.82	116.25	111.69	107.18	102.75	98.41	94.20
16.00	DISCHG	90.12	86.18	82.39	78.74	75.23	71.88	68.68	65.63	62.90	60.51
17.00	DISCHG	58.25	56.12	54.11	52.21	50.41	48.70	47.07	45.51	44.03	42.62
18.00	DISCHG	41.28	40.00	38.80	37.66	36.58	35.56	34.59	33.65	32.74	31.85
19.00	DISCHG	30.99	30.15	29.34	28.56	27.80	27.08	26.38	25.72	25.09	24.49
20.00	DISCHG	23.92	23.39	22.88	22.41	21.95	21.52	21.10	20.67	20.25	19.81

213

21.00	DISCHG	19.37	18.92	18.47	18.02	17.57	17.13	16.70	16.28	15.87	15.47
22.00	DISCHG	15.09	14.73	14.38	14.05	13.73	13.43	13.15	12.88	12.62	12.38
23.00	DISCHG	12.15	11.94	11.73	11.54	11.36	11.19	11.03	10.87	10.73	10.59
24.00	DISCHG	10.46	10.33	10.22	10.10	9.99	9.87	9.73	9.56	9.35	9.06
25.00	DISCHG	8.69	8.24	7.71	7.11	6.45	5.74	5.01	4.26	3.49	2.73
26.00	DISCHG	1.97	1.23	0.51	0.0						

OPERATION REACH CROSS SECTION 8

TIME(HRS) FIRST HYDROGRAPH POINT = 0.0 HOURS TIME INCREMENT = 0.10 HOURS DRAINAGE AREA = 0.24 SQ.MI.

13.00	DISCHG	0.0	0.10	0.46	1.19	2.43	4.24	6.66	9.69	13.33	17.48
14.00	DISCHG	22.05	26.92	32.00	37.19	42.42	47.59	52.64	57.52	62.19	66.60
15.00	DISCHG	70.72	74.55	78.06	81.25	84.11	86.65	88.87	90.78	92.39	93.72
16.00	DISCHG	94.77	95.56	96.10	96.41	96.50	96.39	96.10	95.64	95.02	94.26
17.00	DISCHG	93.37	92.37	91.26	90.07	88.80	87.48	86.11	84.71	83.29	81.84
18.00	DISCHG	80.37	78.89	77.41	75.92	74.43	72.95	71.47	70.00	68.55	67.10
19.00	DISCHG	65.68	64.28	62.89	61.53	60.18	58.86	57.56	56.28	55.03	53.79
20.00	DISCHG	52.58	51.39	50.22	49.08	47.96	46.86	45.79	44.75	43.73	42.73
21.00	DISCHG	41.76	40.82	39.90	39.00	38.13	37.27	36.43	35.62	34.82	34.03
22.00	DISCHG	33.27	32.51	31.77	31.05	30.34	29.65	28.97	28.30	27.65	27.02
23.00	DISCHG	26.40	25.79	25.20	24.63	24.07	23.52	22.99	22.47	21.97	21.49
24.00	DISCHG	21.01	20.55	20.11	19.68	19.26	18.86	18.46	18.08	17.72	17.36
25.00	DISCHG	17.02	16.68	16.36	16.04	15.73	15.41	15.10	14.78	14.45	14.11
26.00	DISCHG	13.75	13.38	12.98	12.58	12.15	11.71	11.26	10.79	10.31	9.83
27.00	DISCHG	9.37	8.93	8.51	8.12	7.74	7.38	7.03	6.70	6.39	6.09
28.00	DISCHG	5.81	5.54	5.28	5.03	4.79	4.57	4.36	4.15	3.96	3.77
29.00	DISCHG	3.60	3.43	3.27	3.12	2.97	2.83	2.70	2.57	2.45	2.34

OPERATION ADDHYD CROSS SECTION 9

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
12.82	230.38	(NULL)
15.56	293.19	(NULL)

TIME(HRS) FIRST HYDROGRAPH POINT = 0.0 HOURS TIME INCREMENT = 0.10 HOURS DRAINAGE AREA = 4.41 SQ.MI.

0.0	DISCHG	0.0	0.03	0.06	0.09	0.13	0.17	0.21	0.26	0.31	0.36
1.00	DISCHG	0.41	0.47	0.53	0.59	0.65	0.72	0.78	0.85	0.93	1.00
2.00	DISCHG	1.08	1.15	1.23	1.32	1.40	1.49	1.58	1.68	1.77	1.87
3.00	DISCHG	1.97	2.08	2.18	2.29	2.40	2.52	2.64	2.76	2.88	3.00
4.00	DISCHG	3.13	3.26	3.39	3.53	3.67	3.81	3.95	4.09	4.24	4.39
5.00	DISCHG	4.54	4.69	4.84	5.00	5.15	5.31	5.47	5.63	5.80	5.96
6.00	DISCHG	6.13	6.30	6.46	6.63	6.80	6.97	7.15	7.32	7.50	7.67
7.00	DISCHG	7.85	8.02	8.20	8.38	8.56	8.74	8.92	9.10	9.28	9.47
8.00	DISCHG	9.65	9.83	10.02	10.20	10.39	10.57	10.76	10.94	11.13	11.31
9.00	DISCHG	11.50	11.69	11.88	12.06	12.25	12.44	12.63	12.82	13.00	13.19
10.00	DISCHG	13.38	13.57	13.76	13.95	14.14	14.34	14.55	14.79	15.07	15.42
11.00	DISCHG	15.86	16.39	17.05	17.85	18.82	19.98	21.67	24.37	29.23	38.63

12.00	DISCHG	55.25	78.74	108.39	142.28	174.93	200.23	217.29	226.79	230.24	229.07
13.00	DISCHG	225.19	219.30	213.94	211.88	212.39	214.73	218.51	223.06	228.39	234.29
14.00	DISCHG	240.36	246.37	252.17	257.71	263.02	267.98	272.56	276.69	280.36	283.58
15.00	DISCHG	286.31	288.55	290.34	291.72	292.65	293.12	293.16	292.76	291.98	290.86
16.00	DISCHG	289.46	287.75	285.77	283.53	281.08	278.44	275.61	272.60	269.41	266.04
17.00	DISCHG	262.49	258.79	254.98	251.10	247.16	243.22	239.28	235.36	231.48	227.61
18.00	DISCHG	223.73	219.85	215.94	212.00	208.06	204.15	200.28	196.47	192.73	189.08
19.00	DISCHG	185.53	182.07	178.70	175.41	172.20	169.06	166.00	163.01	160.08	157.20
20.00	DISCHG	154.36	151.54	148.72	145.92	143.13	140.40	137.72	135.11	132.59	130.15
21.00	DISCHG	127.81	125.55	123.36	121.25	119.19	117.20	115.25	113.36	111.52	109.72
22.00	DISCHG	107.97	106.26	104.60	102.98	101.40	99.87	98.38	96.93	95.52	94.15
23.00	DISCHG	92.82	91.52	90.27	89.06	87.88	86.73	85.63	84.55	83.51	82.47
24.00	DISCHG	81.44	80.35	79.16	77.86	76.42	74.83	73.14	71.40	69.68	67.99
25.00	DISCHG	66.40	64.89	63.45	62.10	60.81	59.55	58.30	57.06	55.81	54.57
26.00	DISCHG	53.31	52.04	50.77	49.48	48.20	46.90	45.61	44.31	43.01	41.71
27.00	DISCHG	40.43	39.18	37.95	36.74	35.55	34.38	33.22	32.10	30.99	29.90
28.00	DISCHG	28.84	27.79	26.77	25.77	24.79	23.83	22.90	21.99	21.10	20.24
29.00	DISCHG	19.41	18.59	17.81	17.04	16.30	15.59	14.89	14.23	13.58	12.96

RUNOFF VOLUME ABOVE BASEFLOW = 0.93 WATERSHED INCHES, 2637.90 CFS-HRS, 218.00 ACRE-FEET; BASEFLOW = 0.0 CFS

EXECUTIVE CONTROL OPERATION ENDCMP COMPUTATIONS COMPLETED FOR PASS 8 RECORD ID 00001600

EXECUTIVE CONTROL OPERATION ENDJOB RECORD ID 00001610

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH.)

SECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)
ALTERNATE 1 STORM 1													
STRUCTURE 1	RUNOFF	1.20	2	2	0.10	0.0	5.20	24.00	2.61	---	12.10	2097.04	1747.5
STRUCTURE 1	RESVOR	1.20	2	2	0.10	0.0	5.20	24.00	2.61	---	12.10	2097.04	1747.5
XSECTION 1	REACH	1.20	2	2	0.10	0.0	5.20	24.00	2.61	---	12.53	1292.03	1076.7
XSECTION 1	RUNOFF	0.46	2	2	0.10	0.0	5.20	24.00	2.70	---	12.57	394.20	857.0
XSECTION 1	ADDHYD	1.66	2	2	0.10	0.0	5.20	24.00	2.64	---	12.54	1685.33	1015.3
XSECTION 2	REACH	1.66	2	2	0.10	0.0	5.20	24.00	2.64	---	12.82	1402.25	844.7
STRUCTURE 2	RUNOFF	0.44	2	2	0.10	0.0	5.20	24.00	2.88	---	12.11	818.18	1859.5
STRUCTURE 2	RESVOR	0.44	2	2	0.10	0.0	5.20	24.00	2.88	---	12.11	818.18	1859.5
XSECTION 3	REACH	0.44	2	2	0.10	0.0	5.20	24.00	2.88	---	13.36	231.32	525.7
XSECTION 3	RUNOFF	0.31	2	2	0.10	0.0	5.20	24.00	2.79	---	12.18	469.85	1515.6
XSECTION 3	ADDHYD	0.75	2	2	0.10	0.0	5.20	24.00	2.84	---	12.18	486.88	649.2
XSECTION 4	ADDHYD	2.41	2	2	0.10	0.0	5.20	24.00	2.70	---	12.85	1591.21	660.3
XSECTION 5	REACH	2.41	2	2	0.10	0.0	5.20	24.00	2.70	500.70	14.06	933.70	387.4
XSECTION 6	REACH	2.41	2	2	0.10	0.0	5.20	24.00	2.62	488.12	16.74	520.19	215.8
XSECTION 6	RUNOFF	1.30	2	2	0.10	0.0	5.20	24.00	2.97	---	13.23	783.42	602.6
XSECTION 6	ADDHYD	3.71	2	2	0.10	0.0	5.20	24.00	2.74	489.11	13.27	809.50	218.2
XSECTION 7	REACH	3.71	2	2	0.10	0.0	5.20	24.00	2.49	481.58	18.86	498.56	134.4
XSECTION 7	RUNOFF	0.70	2	2	0.10	0.0	5.20	24.00	3.07	---	12.65	637.79	911.1
XSECTION 7	ADDHYD	4.41	2	2	0.10	0.0	5.20	24.00	2.58	482.62	12.70	705.71	160.0
ALTERNATE 1 STORM 2													
STRUCTURE 1	RUNOFF	1.20	2	2	0.10	0.0	2.60	24.00	0.71	---	12.12	529.00	440.8
STRUCTURE 1	RESVOR	1.20	2	2	0.10	0.0	2.60	24.00	0.71	---	12.12	529.00	440.8
XSECTION 1	REACH	1.20	2	2	0.10	0.0	2.60	24.00	0.71	---	12.62	262.62	218.8
XSECTION 1	RUNOFF	0.46	2	2	0.10	0.0	2.60	24.00	0.76	---	12.63	99.24	215.7
XSECTION 1	ADDHYD	1.66	2	2	0.10	0.0	2.60	24.00	0.72	---	12.62	361.83	218.0
XSECTION 2	REACH	1.66	2	2	0.10	0.0	2.60	24.00	0.72	---	12.95	306.33	184.5
STRUCTURE 2	RUNOFF	0.44	2	2	0.10	0.0	2.60	24.00	0.85	---	12.12	232.15	527.6
STRUCTURE 2	RESVOR	0.44	2	2	0.10	0.0	2.60	24.00	0.85	---	12.12	232.15	527.6
XSECTION 3	REACH	0.44	2	2	0.10	0.0	2.60	24.00	0.85	---	13.19	68.57	155.8
XSECTION 3	RUNOFF	0.31	2	2	0.10	0.0	2.60	24.00	0.80	---	12.20	126.88	409.3
XSECTION 3	ADDHYD	0.75	2	2	0.10	0.0	2.60	24.00	0.83	---	12.21	127.93	170.5
XSECTION 4	ADDHYD	2.41	2	2	0.10	0.0	2.60	24.00	0.76	---	12.98	397.71	165.0
XSECTION 5	REACH	2.41	2	2	0.10	0.0	2.60	24.00	0.76	497.36	14.06	246.36	102.2
XSECTION 6	REACH	2.41	2	2	0.10	0.0	2.60	24.00	0.75	485.76	15.19	196.44	81.5

E-54

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH.)

SECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)
ALTERNATE 1 STORM 2													
XSECTION 6	RUNOFF	1.30	2	2	0.10	0.0	2.60	24.00	0.90	---	13.32	222.19	170.9
XSECTION 6	ADDHYD	3.71	2	2	0.10	0.0	2.60	24.00	0.81	486.91	13.84	310.66	83.7
XSECTION 7	REACH	3.71	2	2	0.10	0.0	2.60	24.00	0.80	479.83	15.97	240.72	64.9
XSECTION 7	RUNOFF	0.70	2	2	0.10	0.0	2.60	24.00	0.96	---	12.70	187.96	268.5
XSECTION 7	ADDHYD	4.41	2	2	0.10	0.0	2.60	24.00	0.82	480.06	15.75	262.85	59.6
ALTERNATE 2 STORM 1													
STRUCTURE 1	RUNOFF	1.20	2	2	0.10	0.0	5.20	24.00	2.61	---	12.10	2097.04	1747.5
STRUCTURE 1	RESVOR	1.20	2	2	0.10	0.0	5.20	24.00	2.60	526.11	12.36	926.87	772.4
XSECTION 1	REACH	1.20	2	2	0.10	0.0	5.20	24.00	2.60	---	12.84	711.24	592.7
XSECTION 1	RUNOFF	0.46	2	2	0.10	0.0	5.20	24.00	2.70	---	12.57	394.20	857.0
XSECTION 1	ADDHYD	1.66	2	2	0.10	0.0	5.20	24.00	2.62	---	12.71	1074.75	647.4
XSECTION 2	REACH	1.66	2	2	0.10	0.0	5.20	24.00	2.62	---	13.03	983.05	592.2
STRUCTURE 2	RUNOFF	0.44	2	2	0.10	0.0	5.20	24.00	2.88	---	12.11	818.18	1859.5
STRUCTURE 2	RESVOR	0.44	2	2	0.10	0.0	5.20	24.00	2.88	499.71	12.50	245.99	559.1
XSECTION 3	REACH	0.44	2	2	0.10	0.0	5.20	24.00	2.88	---	13.84	173.72	394.8
XSECTION 3	RUNOFF	0.31	2	2	0.10	0.0	5.20	24.00	2.79	---	12.18	469.85	1515.6
XSECTION 3	ADDHYD	0.75	2	2	0.10	0.0	5.20	24.00	2.84	---	12.19	518.24	691.0
XSECTION 4	ADDHYD	2.41	2	2	0.10	0.0	5.20	24.00	2.69	---	13.02	1202.88	499.1
XSECTION 5	REACH	2.41	2	2	0.10	0.0	5.20	24.00	2.68	500.31	14.23	807.79	335.2
XSECTION 6	REACH	2.41	2	2	0.10	0.0	5.20	24.00	2.59	488.05	16.84	498.53	206.9
XSECTION 6	RUNOFF	1.30	2	2	0.10	0.0	5.20	24.00	2.97	---	13.23	783.42	602.6
XSECTION 6	ADDHYD	3.71	2	2	0.10	0.0	5.20	24.00	2.73	489.16	13.31	826.01	222.6
XSECTION 7	REACH	3.71	2	2	0.10	0.0	5.20	24.00	2.47	481.56	18.84	493.31	133.0
XSECTION 7	RUNOFF	0.70	2	2	0.10	0.0	5.20	24.00	3.07	---	12.65	637.79	911.1
XSECTION 7	ADDHYD	4.41	2	2	0.10	0.0	5.20	24.00	2.56	482.64	12.70	710.09	161.0
ALTERNATE 2 STORM 2													
STRUCTURE 1	RUNOFF	1.20	2	2	0.10	0.0	2.60	24.00	0.71	---	12.12	529.00	440.8
STRUCTURE 1	RESVOR	1.20	2	2	0.10	0.0	2.60	24.00	0.70	522.73	12.54	154.21	128.5
XSECTION 1	REACH	1.20	2	2	0.10	0.0	2.60	24.00	0.70	---	13.30	115.89	96.6
XSECTION 1	RUNOFF	0.46	2	2	0.10	0.0	2.60	24.00	0.76	---	12.63	99.24	215.7
XSECTION 1	ADDHYD	1.66	2	2	0.10	0.0	2.60	24.00	0.71	---	12.85	190.57	114.8
XSECTION 2	REACH	1.66	2	2	0.10	0.0	2.60	24.00	0.71	---	13.25	176.42	106.3
STRUCTURE 2	RUNOFF	0.44	2	2	0.10	0.0	2.60	24.00	0.85	---	12.12	232.15	527.6
STRUCTURE 2	RESVOR	0.44	2	2	0.10	0.0	2.60	24.00	0.85	496.95	12.42	99.37	225.8
XSECTION 3	REACH	0.44	2	2	0.10	0.0	2.60	24.00	0.85	---	13.49	53.55	121.7
XSECTION 3	RUNOFF	0.31	2	2	0.10	0.0	2.60	24.00	0.80	---	12.20	126.88	409.3

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH.)

SECTION/ STRUCTURE ID		STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)
ALTERNATE 2 STORM 2														
XSECTION	3	ADDHYD	0.75	2	2	0.10	0.0	2.60	24.00	0.83	---	12.22	132.48	176.6
XSECTION	4	ADDHYD	2.41	2	2	0.10	0.0	2.60	24.00	0.75	---	13.22	250.18	103.8
XSECTION	5	REACH	2.41	2	2	0.10	0.0	2.60	24.00	0.75	496.87	14.24	195.71	81.2
XSECTION	6	REACH	2.41	2	2	0.10	0.0	2.60	24.00	0.74	485.43	15.34	171.58	71.2
XSECTION	6	RUNOFF	1.30	2	2	0.10	0.0	2.60	24.00	0.90	---	13.32	222.19	170.9
XSECTION	6	ADDHYD	3.71	2	2	0.10	0.0	2.60	24.00	0.80	486.89	13.66	308.27	83.1
XSECTION	7	REACH	3.71	2	2	0.10	0.0	2.60	24.00	0.79	479.69	15.82	229.43	61.8
XSECTION	7	RUNOFF	0.70	2	2	0.10	0.0	2.60	24.00	0.96	---	12.70	187.96	268.5
XSECTION	7	ADDHYD	4.41	2	2	0.10	0.0	2.60	24.00	0.82	479.98	15.50	253.04	57.4
ALTERNATE 3 STORM 1														
STRUCTURE	1	RUNOFF	1.20	2	2	0.10	0.0	5.20	24.00	2.61	---	12.10	2097.04	1747.5
STRUCTURE	1	RESVOR	1.20	2	2	0.10	0.0	5.20	24.00	2.60	526.11	12.36	926.87	772.4
XSECTION	1	REACH	1.20	2	2	0.10	0.0	5.20	24.00	2.60	---	12.84	707.02	589.2
XSECTION	1	RUNOFF	0.46	2	2	0.10	0.0	5.20	24.00	2.70	---	12.57	394.20	857.0
XSECTION	1	ADDHYD	1.66	2	2	0.10	0.0	5.20	24.00	2.63	---	12.71	1070.46	644.9
XSECTION	2	REACH	1.66	2	2	0.10	0.0	5.20	24.00	2.62	---	13.03	978.80	589.6
STRUCTURE	3	RUNOFF	0.75	2	2	0.10	0.0	5.20	24.00	2.88	---	12.95	517.68	690.2
STRUCTURE	3	RESVOR	0.75	2	2	0.10	0.0	5.20	24.00	1.25	490.19	19.40*	36.39*	48.5
XSECTION	3	REACH	0.75	2	2	0.10	0.0	5.20	24.00	1.22	---	19.90*	36.38*	48.5
XSECTION	4	ADDHYD	2.41	2	2	0.10	0.0	5.20	24.00	2.19	---	13.04	989.77	410.7
XSECTION	5	REACH	2.41	2	2	0.10	0.0	5.20	24.00	2.15	499.55	14.27	603.63	250.5
XSECTION	6	REACH	2.41	2	2	0.10	0.0	5.20	24.00	2.04	487.37	16.54	380.60	157.9
XSECTION	6	RUNOFF	1.30	2	2	0.10	0.0	5.20	24.00	2.97	---	13.23	783.42	602.6
XSECTION	6	ADDHYD	3.71	2	2	0.10	0.0	5.20	24.00	2.37	489.10	13.28	807.33	217.6
XSECTION	7	REACH	3.71	2	2	0.10	0.0	5.20	24.00	2.16	481.26	17.93	432.34	116.5
XSECTION	7	RUNOFF	0.70	2	2	0.10	0.0	5.20	24.00	3.07	---	12.65	637.79	911.1
XSECTION	7	ADDHYD	4.41	2	2	0.10	0.0	5.20	24.00	2.30	482.64	12.71	709.86	161.0
ALTERNATE 3 STORM 2														
STRUCTURE	1	RUNOFF	1.20	2	2	0.10	0.0	2.60	24.00	0.71	---	12.12	529.00	440.8
STRUCTURE	1	RESVOR	1.20	2	2	0.10	0.0	2.60	24.00	0.70	522.73	12.54	154.21	128.5
XSECTION	1	REACH	1.20	2	2	0.10	0.0	2.60	24.00	0.70	---	13.30	113.79	94.8
XSECTION	1	RUNOFF	0.46	2	2	0.10	0.0	2.60	24.00	0.76	---	12.63	99.24	215.7
XSECTION	1	ADDHYD	1.66	2	2	0.10	0.0	2.60	24.00	0.71	---	12.85	188.41	113.5
XSECTION	2	REACH	1.66	2	2	0.10	0.0	2.60	24.00	0.71	---	13.25	174.26	105.0
STRUCTURE	3	RUNOFF	0.75	2	2	0.10	0.0	2.60	24.00	0.85	---	13.02	141.23	188.3
STRUCTURE	3	RESVOR	0.75	2	2	0.10	0.0	2.60	24.00	0.42	485.65	19.90*	13.22*	17.6

E-56

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH.)

SECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)
ALTERNATE 3 STORM 2													
XSECTION 3	REACH	0.75	2	2	0.10	0.0	2.60	24.00	0.41	---	20.30*	13.22*	17.6
XSECTION 4	ADDHYD	2.41	2	2	0.10	0.0	2.60	24.00	0.62	---	13.28	177.01	73.4
XSECTION 5	REACH	2.41	2	2	0.10	0.0	2.60	24.00	0.61	496.18	14.18	144.98	60.2
XSECTION 6	REACH	2.41	2	2	0.10	0.0	2.60	24.00	0.60	484.59	15.30	124.64	51.7
XSECTION 6	RUNOFF	1.30	2	2	0.10	0.0	2.60	24.00	0.90	---	13.32	222.19	170.9
XSECTION 6	ADDHYD	3.71	2	2	0.10	0.0	2.60	24.00	0.71	486.55	13.61	272.58	73.5
XSECTION 7	REACH	3.71	2	2	0.10	0.0	2.60	24.00	0.69	479.28	15.44	198.31	53.5
XSECTION 7	RUNOFF	0.70	2	2	0.10	0.0	2.60	24.00	0.96	---	12.70	187.96	268.5
XSECTION 7	ADDHYD	4.41	2	2	0.10	0.0	2.60	24.00	0.74	479.65	14.90	226.58	51.4
ALTERNATE 4 STORM 1													
STRUCTURE 1	RUNOFF	1.20	2	2	0.10	0.0	5.20	24.00	2.81	---	12.10	2107.10	1755.9
STRUCTURE 1	RESVOR	1.20	2	2	0.10	0.0	5.20	24.00	2.81	---	12.10	2107.10	1755.9
XSECTION 1	REACH	1.20	2	2	0.10	0.0	5.20	24.00	2.81	---	12.53	1296.24	1080.2
XSECTION 1	RUNOFF	0.46	2	2	0.10	0.0	5.20	24.00	2.90	---	12.57	398.21	865.7
XSECTION 1	ADDHYD	1.66	2	2	0.10	0.0	5.20	24.00	2.84	---	12.54	1693.54	1020.2
XSECTION 2	REACH	1.66	2	2	0.10	0.0	5.20	24.00	2.84	---	12.82	1410.42	849.7
STRUCTURE 3	RUNOFF	0.75	2	2	0.10	0.0	5.20	24.00	3.08	---	12.95	524.41	699.2
STRUCTURE 3	RESVOR	0.75	2	2	0.10	0.0	5.20	24.00	3.08	---	12.95	524.41	699.2
XSECTION 3	REACH	0.75	2	2	0.10	0.0	5.20	24.00	3.08	---	13.52	409.68	546.2
XSECTION 4	ADDHYD	2.41	2	2	0.10	0.0	5.20	24.00	2.91	---	12.87	1680.75	697.4
XSECTION 5	REACH	2.41	2	2	0.10	0.0	5.20	24.00	2.91	500.76	14.12	954.48	396.0
XSECTION 5	DIVERT	2.17	2	2	0.10	0.0	5.20	24.00	1.34	498.38	14.12	380.56	175.5
XSECTION 8	DIVERT	0.24	2	2	0.10	0.0	5.20	24.00	17.04	498.38	14.12	573.92	2381.4
XSECTION 6	REACH	2.17	2	2	0.10	0.0	5.20	24.00	1.33	486.47	15.56	264.33	121.9
XSECTION 6	RUNOFF	1.30	2	2	0.10	0.0	5.20	24.00	3.17	---	13.23	795.34	611.8
XSECTION 6	ADDHYD	3.47	2	2	0.10	0.0	5.20	24.00	2.02	489.23	13.32	845.06	243.6
XSECTION 7	REACH	3.47	2	2	0.10	0.0	5.20	24.00	1.89	481.13	16.95	407.66	117.5
XSECTION 7	RUNOFF	0.70	2	2	0.10	0.0	5.20	24.00	3.27	---	12.65	643.92	919.9
XSECTION 7	ADDHYD	4.17	2	2	0.10	0.0	5.20	24.00	2.12	482.48	12.66	677.56	162.5
XSECTION 8	REACH	0.24	2	2	0.10	0.0	5.20	24.00	16.99	497.37	15.62	417.68	1733.1
XSECTION 9	ADDHYD	4.41	2	2	0.10	0.0	5.20	24.00	2.94	---	15.85	868.12	196.9
ALTERNATE 4 STORM 2													
STRUCTURE 1	RUNOFF	1.20	2	2	0.10	0.0	2.60	24.00	0.81	---	12.12	535.13	445.9
STRUCTURE 1	RESVOR	1.20	2	2	0.10	0.0	2.60	24.00	0.81	---	12.12	535.13	445.9
XSECTION 1	REACH	1.20	2	2	0.10	0.0	2.60	24.00	0.81	---	12.62	262.68	218.9
XSECTION 1	RUNOFF	0.46	2	2	0.10	0.0	2.60	24.00	0.86	---	12.63	101.50	220.7

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH.)

SECTION/ STRUCTURE ID		STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION			RUNOFF AMOUNT (IN)	PEAK DISCHARGE			
							BEGIN (HR)	AMOUNT (IN)	DURATION (HR)		ELEVATION (FT)	TIME (HR)	RATE (CFS)	RATE (CSM)
ALTERNATE 4 STORM 2														
XSECTION	1	ADDHYD	1.66	2	2	0.10	0.0	2.60	24.00	0.82	---	12.62	364.15	219.4
XSECTION	2	REACH	1.66	2	2	0.10	0.0	2.60	24.00	0.82	---	12.95	309.09	186.2
STRUCTURE	3	RUNOFF	0.75	2	2	0.10	0.0	2.60	24.00	0.95	---	13.02	144.79	193.1
STRUCTURE	3	RESVOR	0.75	2	2	0.10	0.0	2.60	24.00	0.95	---	13.02	144.79	193.1
XSECTION	3	REACH	0.75	2	2	0.10	0.0	2.60	24.00	0.95	---	13.55	118.80	158.4
XSECTION	4	ADDHYD	2.41	2	2	0.10	0.0	2.60	24.00	0.86	---	13.05	398.88	165.5
XSECTION	5	REACH	2.41	2	2	0.10	0.0	2.60	24.00	0.86	497.43	14.17	253.49	105.2
XSECTION	5	DIVERT	2.17	2	2	0.10	0.0	2.60	24.00	0.49	495.25	14.17	95.93	44.2
XSECTION	8	DIVERT	0.24	2	2	0.10	0.0	2.60	24.00	4.23	495.25	14.17	157.57	653.8
XSECTION	6	REACH	2.17	2	2	0.10	0.0	2.60	24.00	0.49	483.54	15.33	81.39	37.5
XSECTION	6	RUNOFF	1.30	2	2	0.10	0.0	2.60	24.00	1.00	---	13.32	228.21	175.5
XSECTION	6	ADDHYD	3.47	2	2	0.10	0.0	2.60	24.00	0.68	486.44	13.47	261.24	75.3
XSECTION	7	REACH	3.47	2	2	0.10	0.0	2.60	24.00	0.67	479.05	15.04	181.75	52.4
XSECTION	7	RUNOFF	0.70	2	2	0.10	0.0	2.60	24.00	1.06	---	12.70	191.38	273.4
XSECTION	7	ADDHYD	4.17	2	2	0.10	0.0	2.60	24.00	0.74	479.70	12.82	230.38	55.3
XSECTION	8	REACH	0.24	2	2	0.10	0.0	2.60	24.00	4.19	494.47	16.40	96.50	400.4
XSECTION	9	ADDHYD	4.41	2	2	0.10	0.0	2.60	24.00	0.93	---	15.56	293.19	66.5

E-58

SUMMARY TABLE 2 - SELECTED MODIFIED ATT-KIN REACH ROUTINGS IN ORDER OF STANDARD EXECUTIVE CONTROL INSTRUCTIONS
(A STAR(*) AFTER VOLUME ABOVE BASE(IN) INDICATES A HYDROGRAPH TRUNCATED AT A VALUE EXCEEDING BASE + 10% OF PEAK)

XSEC ID	REACH LENGTH (FT)	HYDROGRAPH INFORMATION: INFLOW PEAK (CFS)	INFLOW TIME (HR)	OUTFLOW PEAK (CFS)	OUTFLOW TIME (HR)	OUTFLOW+ INTERV. AREA PEAK (CFS)	AREA TIME (HR)	BASE-FLOW (CFS)	ROUTING PARAMETERS: VOLUME ABOVE BASE (IN)	MAIN TIME INCR (HR)	ITER-ATION #	Q AND A EQUATION COEFF (X)	Q AND A EQUATION POWER (M)	LENGTH FACTOR (K*)	PEAK RATIO O/I (Q*)	S/Q @PEAK (K) (SEC)	ATT-KIN COEFF (C)	PEAK TRAVEL TIME STOR-AGE (HR)	PEAK TRAVEL TIME KINE-MATIC (HR)
ALTERNATE 1 STORM 1																			
1	5400	2103	12.1	1282	12.5	1672	12.5	6	2.61	0.10	1	.400	1.33	0.360	0.609	1211	0.26	0.20	0.36
2	3000	1672	12.5	1401	12.8	---	---	6	2.64	0.10	1	2.40	1.05	0.136	0.837	872	0.34	0.30	0.24
3	4600	817	12.1	231	13.4	485	12.2	0	2.88	0.10	3	.948	1.00	1.348	0.283	4855	0.07	0.50	1.35
5	2600	1587	12.9	933	14.1	---	---	6	2.70	0.10	1	.596	1.00	0.456	0.586	4364	0.08	0.80	1.21
6	4900	933	14.1	520	16.7	809	13.3	6	2.70	0.10	1	.526	1.00	0.572	0.555	9313	0.04	1.90	2.59
7	8900	809	13.3	499	18.9	706	12.7	6	2.74	0.10	2	.544	1.02	0.487	0.613	14279	0.02	5.60	3.98
ALTERNATE 1 STORM 2																			
1	5400	531	12.1	262	12.6	361	12.6	6	0.71	0.10	1	.400	1.33	0.510	0.488	1705	0.19	0.30	0.51
2	3000	361	12.6	305	13.0	---	---	6	0.72	0.10	1	2.40	1.05	0.113	0.842	938	0.32	0.40	0.26
3	4600	230	12.1	69	13.2	128	12.2	0	0.85	0.10	3	1.12	1.00	1.083	0.298	4106	0.08	0.50	1.14
5	2600	397	13.0	246	14.1	---	---	6	0.76	0.10	3	.651	1.00	0.369	0.614	3992	0.09	0.90	1.11
6	4900	246	14.1	196	15.2	311	13.8	6	0.76	0.10	3	.210	1.29	0.190	0.793	3747	0.09	1.10	1.07
7	8900	311	13.8	241	16.0	263	15.8	6	0.81	0.10	4	.121	1.38	0.255	0.771	6111	0.06	2.20	1.76
ALTERNATE 2 STORM 1																			
1	5400	934	12.4	710	12.8	1074	12.7	10	2.60	0.10	1	.400	1.33	0.160	0.758	1482	0.22	0.40	0.43
2	3000	1074	12.7	982	13.0	---	---	10	2.63	0.10	1	2.40	1.05	0.088	0.913	890	0.34	0.30	0.25
3	4600	246	12.5	174	13.8	518	12.2	0	2.88	0.10	1	.979	1.00	0.393	0.706	4699	0.07	1.30	1.31
5	2600	1202	13.0	808	14.2	---	---	10	2.69	0.10	1	.581	1.00	0.354	0.669	4478	0.08	1.00	1.24
6	4900	808	14.2	498	16.8	826	13.3	10	2.68	0.10	1	.532	1.00	0.489	0.612	9206	0.04	2.00	2.56
7	8900	826	13.3	493	18.8	710	12.7	10	2.73	0.10	2	.542	1.02	0.497	0.592	14242	0.02	5.50	3.97
ALTERNATE 2 STORM 2																			
1	5400	162	12.5	116	13.3	190	12.8	8	0.70	0.10	1	.400	1.33	0.152	0.703	2290	0.15	0.80	0.66
2	3000	190	12.8	176	13.2	---	---	8	0.71	0.10	1	2.40	1.05	0.059	0.924	967	0.31	0.40	0.27
3	4600	99	12.4	54	13.5	132	12.2	0	0.85	0.10	2	1.16	1.00	0.453	0.540	3979	0.09	1.00	1.11
5	2600	250	13.2	196	14.2	---	---	8	0.75	0.10	3	.722	1.00	0.208	0.775	3602	0.10	1.00	1.00
6	4900	196	14.2	172	15.3	308	13.7	8	0.75	0.10	3	.156	1.37	0.117	0.872	3365	0.10	1.10	0.95
7	8900	308	13.7	229	15.8	253	15.5	8	0.80	0.10	4	.110	1.40	0.242	0.738	5906	0.06	2.10	1.71
ALTERNATE 3 STORM 1																			
1	5400	930	12.4	706	12.8	1070	12.7	6	2.60	0.10	1	.400	1.33	0.160	0.758	1483	0.22	0.40	0.43
2	3000	1070	12.7	977	13.0	---	---	6	2.63	0.10	1	2.40	1.05	0.088	0.913	890	0.34	0.30	0.25
3	2000	36	19.4	36	19.9	---	---	0	1.25*	0.10	1	1.27	1.00	0.026	1.000	1574	0.21	0.50	0.44

SUMMARY TABLE 2 - SELECTED MODIFIED ATT-KIN REACH ROUTINGS IN ORDER OF STANDARD EXECUTIVE CONTROL INSTRUCTIONS
(A STAR(*) AFTER VOLUME ABOVE BASE(IN) INDICATES A HYDROGRAPH TRUNCATED AT A VALUE EXCEEDING BASE + 10% OF PEAK)

XSEC ID	REACH LENGTH (FT)	HYDROGRAPH INFORMATION: INFLOW PEAK (CFS)	INFLOW TIME (HR)	OUTFLOW PEAK (CFS)	OUTFLOW TIME (HR)	OUTFLOW+ INTERV. AREA PEAK (CFS)	OUTFLOW+ INTERV. AREA TIME (HR)	BASE-FLOW (CFS)	ROUTING PARAMETERS: VOLUME ABOVE BASE (IN)	MAIN TIME INCR (HR)	ITER-ATION #	Q AND A EQUATION COEFF (X)	Q AND A EQUATION POWER (M)	LENGTH FACTOR (K*)	PEAK RATIO O/I (Q*)	S/Q @PEAK (k) (SEC)	ATT-KIN COEFF (C)	PEAK TRAVEL TIME STOR-AGE (HR)	PEAK TRAVEL TIME KINE-MATIC (HR)
ALTERNATE 3 STORM 1																			
5	2600	988	13.0	603	14.3	---	---	6	2.19	0.10	1	.574	1.00	0.363	0.609	4526	0.08	1.10	1.26
6	4900	603	14.3	381	16.5	807	13.3	6	2.15	0.10	3	.615	1.00	0.396	0.627	7962	0.04	1.80	2.21
7	8900	807	13.3	432	17.9	710	12.7	6	2.37	0.10	3	.480	1.04	0.526	0.532	13189	0.03	4.60	3.71
ALTERNATE 3 STORM 2																			
1	5400	160	12.5	114	13.3	188	12.8	6	0.70	0.10	1	.400	1.33	0.152	0.702	2297	0.15	0.80	0.66
2	3000	188	12.8	174	13.2	---	---	6	0.71	0.10	1	2.40	1.05	0.059	0.924	967	0.31	0.40	0.37
3	2000	13	19.9	13	20.3	---	---	0	0.42*	0.10	1	1.46	1.00	0.025	1.000	1371	0.23	0.30	0.38
5	2600	177	13.3	145	14.2	---	---	6	0.62	0.10	3	.495	1.11	0.115	0.813	2603	0.13	0.90	0.73
6	4900	145	14.2	125	15.3	273	13.6	6	0.61	0.10	1	.113	1.45	0.092	0.854	3238	0.11	1.10	0.92
7	8900	273	13.6	198	15.4	227	14.9	6	0.71	0.10	4	0.083	1.47	0.215	0.721	5440	0.06	1.80	1.59
ALTERNATE 4 STORM 1																			
1	5400	2107	12.1	1287	12.5	1680	12.5	TRIANGLE	2.81	0.10	1	.400	1.33	0.328	0.611	1211	0.26	0.20	0.36
2	3000	1680	12.5	1409	12.8	---	---	TRIANGLE	2.84	0.10	1	2.40	1.05	0.127	0.839	871	0.34	0.30	0.24
3	2000	523	12.9	410	13.5	---	---	TRIANGLE	3.08	0.10	1	.883	1.00	0.220	0.783	2264	0.15	0.60	0.63
5	2600	1679	12.9	954	14.1	---	---	TRIANGLE	2.91	0.10	1	.577	1.00	0.444	0.568	4312	0.08	0.90	1.20
6	4900	381	14.1	264	15.6	845	13.3	TRIANGLE	1.34	0.10	3	.390	1.12	0.294	0.694	5321	0.07	1.40	1.51
7	8900	845	13.3	408	16.9	676	12.7	TRIANGLE	2.02	0.10	3	.457	1.05	0.684	0.482	12753	0.03	2.90	3.60
8	17000	574	14.1	418	15.6	---	---	TRIANGLE	17.04	0.10	3	.271	1.39	0.323	0.728	5302	0.07	1.50	1.54
ALTERNATE 4 STORM 2																			
1	5400	531	12.1	262	12.6	364	12.6	TRIANGLE	0.81	0.10	1	.400	1.33	0.433	0.494	1704	0.19	0.30	0.51
2	3000	364	12.6	307	12.9	---	---	TRIANGLE	0.82	0.10	1	2.40	1.05	0.101	0.846	937	0.32	0.30	0.26
3	2000	145	13.0	119	13.5	---	---	TRIANGLE	0.95	0.10	1	1.05	1.00	0.165	0.820	1901	0.17	0.50	0.53
5	2600	398	13.1	253	14.2	---	---	TRIANGLE	0.86	0.10	3	.646	1.00	0.331	0.637	4024	0.09	1.00	1.12
6	4900	96	14.2	81	15.3	261	13.5	TRIANGLE	0.49	0.10	1	.100	1.48	0.096	0.849	3563	0.10	1.10	1.02
7	8900	261	13.5	182	15.0	230	12.8	TRIANGLE	0.68	0.10	4	0.071	1.51	0.226	0.696	5198	0.07	1.40	1.53
8	17000	158	14.2	97	16.4	---	---	TRIANGLE	4.23	0.10	1	.257	1.40	0.610	0.613	7539	0.05	1.70	2.24

E-60

SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

XSECTION/ STRUCTURE ID		DRAINAGE AREA (SQ MI)	STORM NUMBERS..... 1	2
STRUCTURE 3		0.75		
ALTERNATE	3		36.39	13.22
ALTERNATE	4		524.41	144.79
STRUCTURE 2		0.44		
ALTERNATE	1		818.18	232.15
ALTERNATE	2		245.99	99.37
STRUCTURE 1		1.20		
ALTERNATE	1		2097.04	529.00
ALTERNATE	2		926.87	154.21
ALTERNATE	3		926.87	154.21
ALTERNATE	4		2107.10	535.13
XSECTION 1		1.66		
ALTERNATE	1		1685.33	361.83
ALTERNATE	2		1074.75	190.57
ALTERNATE	3		1070.46	188.41
ALTERNATE	4		1693.54	364.15
XSECTION 2		1.66		
ALTERNATE	1		1402.25	306.33
ALTERNATE	2		983.05	176.42
ALTERNATE	3		978.80	174.26
ALTERNATE	4		1410.42	309.09
XSECTION 3		0.75		
ALTERNATE	1		486.88	127.93
ALTERNATE	2		518.24	132.48
ALTERNATE	3		36.38	13.22
ALTERNATE	4		409.68	118.80
XSECTION 4		2.41		
ALTERNATE	1		1591.21	397.71
ALTERNATE	2		1202.88	250.18
ALTERNATE	3		989.77	177.01
ALTERNATE	4		1680.75	398.88
XSECTION 5		2.17		
ALTERNATE	1		933.70	246.36
ALTERNATE	2		807.79	195.71

SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

XSECTION/ STRUCTURE ID		DRAINAGE AREA (SQ MI)	STORM NUMBERS..... 1	2
XSECTION	5	2.17		
ALTERNATE	3		603.63	144.98
ALTERNATE	4		380.56	95.93
XSECTION	6	3.47		
ALTERNATE	1		809.50	310.66
ALTERNATE	2		826.01	308.27
ALTERNATE	3		807.33	272.58
ALTERNATE	4		845.06	261.24
XSECTION	7	4.17		
ALTERNATE	1		705.71	262.85
ALTERNATE	2		710.09	253.04
ALTERNATE	3		709.86	226.58
ALTERNATE	4		677.56	230.38
XSECTION	8	0.24		
ALTERNATE	4		417.68	96.50
XSECTION	9	4.41		
ALTERNATE	4		868.12	293.19

ECON2/URB1 PEAK FLOW FILE GENERATED IN "FLOW-FREQ" FORMAT (DECENDING MAGNITUDE)

234

E-62

SUMMARY TABLE 4 - DISCHARGES (CFS) AT INTERMEDIATE SECTIONS FOR ALL STORMS AND ALTERNATES

INTER. SECT. ID	DRAINAGE AREA (SQ MI)	LOCATED BETWEEN		STORM NUMBERS..... 1	2
7A	3.90	SEC 6 & SEC 7			
		ALTERNATE	1	741.74	279.28
		ALTERNATE	2	750.14	271.83
		ALTERNATE	3	743.79	242.30
		ALTERNATE	4	734.11	241.13
7B	4.00	SEC 6 & SEC 7			
		ALTERNATE	1	727.85	272.92
		ALTERNATE	2	734.68	264.54
		ALTERNATE	3	730.72	236.21
		ALTERNATE	4	712.11	236.99

ECON2/URB1 PEAK FLOW FILE GENERATED IN "FLOW-FREQ" FORMAT (DECENDING MAGNITUDE)

234

END OF 1 JOBS IN THIS RUN

ECON2/URB1 PEAK FLOW FILE GENERATED IN 'FLOW-FREQ' FORMAT
BY THE ECON OPTION ON JOB RECORD 10, PAGE E-5
AND THE PEAKS RECORD 1620, PAGE E-26

```
SAMPLE JOB 5   USING 24HR TYPE II STORM OVER ENTIRE WATERSHED 00000020
ALT1=EXIST., ALT2=2-SITES, ALT3=MOVE SITE#2, ALT4=DIVIDE FLOW 00000030
FLOW-FREQ    -3          36.39     13.22
FLOW-FREQ    -3         524.41    144.79
FLOW-FREQ    -2         818.18    232.15
FLOW-FREQ    -2         245.99     99.37
FLOW-FREQ    -1        2097.04    529.00
FLOW-FREQ    -1         926.87    154.21
FLOW-FREQ    -1         926.87    154.21
FLOW-FREQ    -1        2107.10    535.13
FLOW-FREQ     1        1685.33    361.83
FLOW-FREQ     1        1074.75    190.57
FLOW-FREQ     1        1070.46    188.41
FLOW-FREQ     1        1693.54    364.15
FLOW-FREQ     2        1402.25    306.33
FLOW-FREQ     2         983.05    176.42
FLOW-FREQ     2         978.80    174.26
FLOW-FREQ     2        1410.42    309.09
FLOW-FREQ     3         486.88    127.93
FLOW-FREQ     3         518.24    132.48
FLOW-FREQ     3          36.38     13.22
FLOW-FREQ     3         409.68    118.80
FLOW-FREQ     4        1591.21    397.71
FLOW-FREQ     4        1202.88    250.18
FLOW-FREQ     4         989.77    177.01
FLOW-FREQ     4        1680.75    398.88
FLOW-FREQ     5         933.70    246.36
FLOW-FREQ     5         807.79    195.71
FLOW-FREQ     5         603.63    144.98
FLOW-FREQ     5         380.56     95.93
FLOW-FREQ     6         809.50    310.66
FLOW-FREQ     6         826.01    308.27
FLOW-FREQ     6         807.33    272.58
FLOW-FREQ     6         845.06    261.24
FLOW-FREQ     7         705.71    262.85
FLOW-FREQ     7         710.09    253.04
FLOW-FREQ     7         709.86    226.58
FLOW-FREQ     7         677.56    230.38
FLOW-FREQ     8         417.68     96.50
FLOW-FREQ     9         868.12    293.19
FLOW-FREQ 7A            741.74    279.28
FLOW-FREQ 7A            750.14    271.83
FLOW-FREQ 7A            743.79    242.30
FLOW-FREQ 7A            734.11    241.13
FLOW-FREQ 7B            727.65    272.92
FLOW-FREQ 7B            734.68    264.54
FLOW-FREQ 7B            730.72    236.21
FLOW-FREQ 7B            712.11    236.99
```

```
ALT  3   1
ALT  4   2
ALT  1   3
ALT  2   4
ALT  1   5
ALT  2   6
ALT  3   7
ALT  4   8
ALT  1   9
ALT  2  10
ALT  3  11
ALT  4  12
ALT  1  13
ALT  2  14
ALT  3  15
ALT  4  16
ALT  1  17
ALT  2  18
ALT  3  19
ALT  4  20
ALT  1  21
ALT  2  22
ALT  3  23
ALT  4  24
ALT  1  25
ALT  2  26
ALT  3  27
ALT  4  28
ALT  1  29
ALT  2  30
ALT  3  31
ALT  4  32
ALT  1  33
ALT  2  34
ALT  3  35
ALT  4  36
ALT  4  37
ALT  4  38
ALT  1 901
ALT  2 902
ALT  3 903
ALT  4 904
ALT  ; 905
ALT  2 906
ALT  3 907
ALT  4 908
```

Reordered by alternates effective 5/2/83

APPENDIX F

Blank Input Forms
and
Preloaded Tabular Data

SCS-ENG.-264 DRAFT
REV. May 1982

TR-20
JOB & TITLE

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
	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
		HOLDOUT	ECON	FULLPRINT	PASS=XXX	SUMMARY	NOPLOT ENDPLOT	RECORD ID
JOB	TR-20							
TITLE								
TITLE								

JOB Record (required)

Columns 1-3 JOB

Columns 5-9 TR-20

Columns 11-17 HOLDOUT
Use only if a holdout hydrograph is desired.

Columns 21-24 ECON

Use only if peak discharge output for ECON2/URB1 is desired. Locations for this output must be selected for inclusion in Summary Tables 1 and 3 also. Such designation can be made using summary option explained below (columns 51-57) or on Standard Control (column 71).

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 SAVHOV).

Columns 61-67 NOPLOTS
Use if no cross section rating plots are desired.

ENDPLOT
Use if only cross section rating plots are desired with no routings.

Columns 73-80 Optional user information, printed at top of input listing.

TITLE Records (one required, second is optional)

Columns 1-5 TITLE

Columns 7-9 XXX (first TITLE record only).
An optional user file number, XXX, is an integer, right justified.

Columns 11-80 Both titles may be any characters desired.

SCS-ENG.-265 DRAFT
REV. May 1982

TR-20

DIMENSIONLESS HYDROGRAPH TABLE

DISCHARGE VS. TIME

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

F-3

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10			11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME		DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3	DATA FIELD NO. 4	DATA FIELD NO. 5		RECORD IDENT.
			IMPORTANT: Line out unused lines. Data fields require decimal points.						
			DIMENSIONLESS TIME INCREMENT (Last entry must be made for dimensionless time 1.0)						
4	DIMHYD								
			NOTE: A maximum of 55 entries (11 records) are allowed.						
			Enter successive entries left to right. First and last entries must be = 0. Fill last row of data with zeros.						
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
9	ENDTBL		NOTE: This record must be the last record of this table						

STANDARD SCS DIMENSIONLESS HYDROGRAPH

COMPUTED PEAK FACTOR = 484.00

		TIME INCREMENT				
4	DIMHYD		0.0200			
8		0.0	0.0300	0.1000	0.1900	0.3100
8		0.4700	0.6600	0.8200	0.9300	0.9900
8		1.0000	0.9900	0.9300	0.8600	0.7800
8		0.6800	0.5600	0.4600	0.3900	0.3300
8		0.2800	0.2410	0.2070	0.1740	0.1470
8		0.1260	0.1070	0.0910	0.0770	0.0660
8		0.0550	0.0470	0.0400	0.0340	0.0290
8		0.0250	0.0210	0.0180	0.0150	0.0130
8		0.0110	0.0090	0.0080	0.0070	0.0060
8		0.0050	0.0040	0.0030	0.0020	0.0010
8		0.0	0.0	0.0	0.0	0.0
9	ENDTBL					

COMPUTED PEAK RATE FACTOR = 484.00

The format for this table is Form #265, Page F-3.

SCS-ENG.-269 DRAFT
REV. May 1982

TR-20
STRUCTURE DATA

STRUCTURE NO._____

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

F-5

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10		11-20		21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME			DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3			RECORD IDENT.
		STRUCTURE ID. (01-99)	IMPORTANT: Line out unused lines. Data fields require decimal points.						
3	STRUCT								
		NOTE: Maximum of 20 data records allowed.							
				Elevation, Ft.	Discharge, CFS	Storage, Acre, Ft.			
8					0.0				
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
9	ENDTBL	NOTE: This record must be the last record of this table.							

SCS-ENG.-270 DRAFT
REV. May 1982

TR-20
STREAM CROSS SECTION DATA
CROSS SECTION NO. _____

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10		11-20		21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME			DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3			RECORD IDENT.
		X SECTION ID. (001-200)		IMPORTANT: Line out unused lines. Data fields require decimal points. Drainage Area, Sq. Mi.	Bankfull Elevation, Ft.				
2	XSECTN								
		(Use 1.0 unless discharge in CSM.)							
		NOTE: Maximum of 20 data records allowed.							
				Elevation, Ft.	Discharge, CFS (or CSM)	End Area, Sq. Ft.			
8					0.0	0.0			
9									
6									
8									
8									
8									
0									
2									
2									
6									
9									
0									
3									
3									
0									

9	ENDTBL		NOTE: This record must be the last record of this table.

243

F-6

SCS-ENG.-271 DRAFT
REV. May 1982

TR-20
CUMULATIVE RAINFALL TABLE

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

F-7

STORM TYPE OR DATE _____

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10			11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE I.D. NAME	TABLE I.D. NO.	DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3	DATA FIELD NO. 4	DATA FIELD NO. 5		RECORD IDENT.
		(1-9)	RUNOFF OPTION	IMPORTANT: Line out unused lines. Data fields require decimal points. TIME INCREMENT					
5	RAINFL								
			NOTE: A maximum of 100 entries (20 records) are allowed.						
			Enter successive entries left to right with first entry for time = 0. Fill last row of data with last entry of table.						
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
9	ENDTBL		NOTE: This record must be the last record of this table.						

3.7.2

RAINFALL TABLE 1

STANDARD SCS 24-HOUR, TYPE I DISTRIBUTION
CUMULATIVE RAINFALL TABLE
(REVISED MAY 1982)

	TABLE NO.	TIME INCREMENT				
5	RAINFL 1		0.5000			
8		0.0	0.0080	0.0170	0.0260	0.0350
8		0.0450	0.0550	0.0650	0.0760	0.0870
8		0.0990	0.1120	0.1260	0.1400	0.1560
8		0.1740	0.1940	0.2190	0.2540	0.3030
8		0.5150	0.5830	0.6240	0.6550	0.6820
8		0.7060	0.7280	0.7480	0.7660	0.7830
8		0.7990	0.8150	0.8300	0.8440	0.8570
8		0.8700	0.8820	0.8930	0.9050	0.9160
8		0.9260	0.9360	0.9460	0.9560	0.9650
8		0.9740	0.9830	0.9920	1.0000	1.0000
9	ENDTBL					

Note: On Executive Control use Rainfall Depth in inches and Rainfall Duration of 1.0.
The format for this table is Form #271, Page F-7.

RAINFALL TABLE 2

STANDARD SCS 24-HOUR, TYPE II DISTRIBUTION
CUMULATIVE RAINFALL TABLE
(REVISED MAY 1982)

TABLE NO.	TIME INCREMENT				
5 RAINFL 2		0.2500			
8	0.0	0.0020	0.0050	0.0080	0.0110
8	0.0140	0.0170	0.0200	0.0230	0.0260
8	0.0290	0.0320	0.0350	0.0380	0.0410
8	0.0440	0.0480	0.0520	0.0560	0.0600
8	0.0640	0.0680	0.0720	0.0760	0.0800
8	0.0850	0.0900	0.0950	0.1000	0.1050
8	0.1100	0.1150	0.1200	0.1260	0.1330
8	0.1400	0.1470	0.1550	0.1630	0.1720
8	0.1810	0.1910	0.2030	0.2180	0.2360
8	0.2570	0.2830	0.3870	0.6630	0.7070
8	0.7350	0.7580	0.7760	0.7910	0.8040
8	0.8150	0.8250	0.8340	0.8420	0.8490
8	0.8560	0.8630	0.8690	0.8750	0.8810
8	0.8870	0.8930	0.8980	0.9030	0.9080
8	0.9130	0.9180	0.9220	0.9260	0.9300
8	0.9340	0.9380	0.9420	0.9460	0.9500
8	0.9530	0.9560	0.9590	0.9620	0.9650
8	0.9680	0.9710	0.9740	0.9770	0.9800
8	0.9830	0.9860	0.9890	0.9920	0.9950
8	0.9980	1.0000	1.0000	1.0000	1.0000
9 ENDTBL					

Note: On Executive Control use Rainfall Depth in inches and Rainfall Duration of 1.0.
The format for this table is Form #271, Page F-7.

RAINFALL TABLE 3

STANDARD SCS 24-HOUR, TYPE IA DISTRIBUTION
CUMULATIVE RAINFALL TABLE
(REVISED MAY 1982)

TABLE NO.	TIME INCREMENT				
5 RAINFL 3		0.5000			
8	0.0	0.0100	0.0220	0.0360	0.0510
8	0.0670	0.0830	0.0990	0.1160	0.1350
8	0.1560	0.1790	0.2040	0.2330	0.2680
8	0.3100	0.4250	0.4800	0.5200	0.5500
8	0.5770	0.6010	0.6230	0.6440	0.6640
8	0.6830	0.7010	0.7190	0.7360	0.7530
8	0.7690	0.7850	0.8000	0.8150	0.8300
8	0.8440	0.8580	0.8710	0.8840	0.8960
8	0.9080	0.9200	0.9320	0.9440	0.9560
8	0.9670	0.9780	0.9890	1.0000	1.0000
9 ENDTBL					

Note: On Executive Control use Rainfall Depth in inches and Rainfall Duration of 1.0.
The format for this table is Form #271, Page F-7.

RAINFALL TABLE 4

STANDARD SCS 48-HOUR, TYPE I DISTRIBUTION
CUMULATIVE RAINFALL TABLE
(REVISED MAY 1982)

	TABLE NO.	TIME INCREMENT				
5	RAINFL 4	0.5000				
8		0.0	0.0040	0.0080	0.0120	0.0160
8		0.0200	0.0250	0.0300	0.0350	0.0400
8		0.0450	0.0500	0.0550	0.0600	0.0650
8		0.0700	0.0750	0.0810	0.0870	0.0930
8		0.0990	0.1050	0.1110	0.1180	0.1250
8		0.1320	0.1400	0.1480	0.1560	0.1650
8		0.1740	0.1840	0.1950	0.2070	0.2200
8		0.2360	0.2550	0.2770	0.3030	0.4090
8		0.5150	0.5490	0.5830	0.6050	0.6240
8		0.6400	0.6550	0.6690	0.6820	0.6940
8		0.7050	0.7160	0.7270	0.7380	0.7480
8		0.7580	0.7670	0.7760	0.7840	0.7920
8		0.8000	0.8080	0.8160	0.8230	0.8300
8		0.8370	0.8440	0.8510	0.8580	0.8640
8		0.8700	0.8760	0.8820	0.8880	0.8940
8		0.9000	0.9060	0.9110	0.9160	0.9210
8		0.9260	0.9310	0.9360	0.9410	0.9460
8		0.9510	0.9560	0.9610	0.9660	0.9710
8		0.9760	0.9800	0.9840	0.9880	0.9920
8		0.9960	1.0000	1.0000	1.0000	1.0000
9	ENDTBL					

Note: On Executive Control use Rainfall Depth in inches and Rainfall Duration of 1.0. The format for this table is Form #271, Page F-7.

RAINFALL TABLE 5

STANDARD SCS 48-HOUR, TYPE II DISTRIBUTION
CUMULATIVE RAINFALL TABLE
(REVISED MAY 1982)

TABLE NO.		TIME INCREMENT			
5 RAINFL 5		0.5000			
8	0.0	0.0020	0.0050	0.0080	0.0110
8	0.0140	0.0170	0.0200	0.0230	0.0260
8	0.0290	0.0320	0.0350	0.0380	0.0410
8	0.0440	0.0470	0.0510	0.0550	0.0590
8	0.0630	0.0670	0.0710	0.0750	0.0790
8	0.0840	0.0890	0.0940	0.0990	0.1040
8	0.1090	0.1140	0.1200	0.1260	0.1330
8	0.1400	0.1470	0.1540	0.1620	0.1710
8	0.1810	0.1920	0.2040	0.2170	0.2330
8	0.2520	0.2770	0.3180	0.6380	0.6980
8	0.7290	0.7520	0.7700	0.7850	0.7980
8	0.8090	0.8190	0.8290	0.8380	0.8460
8	0.8540	0.8610	0.8680	0.8740	0.8800
8	0.8860	0.8920	0.8970	0.9020	0.9070
8	0.9120	0.9170	0.9210	0.9250	0.9290
8	0.9330	0.9370	0.9410	0.9450	0.9490
8	0.9530	0.9570	0.9600	0.9630	0.9660
8	0.9690	0.9720	0.9750	0.9780	0.9810
8	0.9840	0.9870	0.9900	0.9930	0.9960
8	0.9980	1.0000	1.0000	1.0000	1.0000
9 ENDTBL					

Note: On Executive Control use Rainfall Depth in inches and Rainfall Duration of 1.0.
The format for this table is Form #271, Page F-7.

RAINFALL TABLE 6

STANDARD SCS DIMENSIONLESS DISTRIBUTION
for
EMERGENCY SPILLWAY ~~FOR~~ AND FREEBOARD HYDROGRAPHS
CUMULATIVE RAINFALL TABLE
(REVISED MAY 1982)

TABLE NO.	TIME INCREMENT				
5 RAINFL 6	0.0200				
8	0.0	0.0080	0.0162	0.0246	0.0333
8	0.0425	0.0524	0.0630	0.0743	0.0863
8	0.0990	0.1124	0.1265	0.1420	0.1595
8	0.1800	0.2050	0.2550	0.3450	0.4370
8	0.5300	0.6030	0.6330	0.6600	0.6840
8	0.7050	0.7240	0.7420	0.7590	0.7750
8	0.7900	0.8043	0.8180	0.8312	0.8439
8	0.8561	0.8678	0.8790	0.8898	0.9002
8	0.9103	0.9201	0.9297	0.9391	0.9483
8	0.9573	0.9661	0.9747	0.9832	0.9916
8	1.0000	1.0000	1.0000	1.0000	1.0000
9 ENDTBL					

Note: On Executive Control use Rainfall Depth in inches and Rainfall Duration in hours.
The format for this table is Form #271, Page F-7.

SCS - ENG. - 273 DRAFT
REV. May 1982

TR - 20
STANDARD CONTROL FOR WATERSHED

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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	OPERATION NAME	OPERATION NO.	X SECT./STRUCT. XSECT ID.	X SECT./STRUCT. STRUCT ID.	HYDRO. NUMBER INPUT #1	HYDRO. NUMBER INPUT #2	HYDRO. NUMBER OUTPUT	DATA FIELD # 1	DATA FIELD # 2	DATA FIELD # 3	OUTPUT OPTIONS PRINT PEAK	PRINT HYD.	PRINT ELEV.	PRINT VOL.	FILE	SUM.	RECORD IDENT.
6	RUNOFF	1					6	AREA, SQ. MI.	RUNOFF CURVE NO.	T_c, HRS.							EXAMPLES DO NOT ENTER
6	RESVOR	2			6		7	SURF. EL. AT T=0, FT.									
6	REACH	3			7		5	LENGTH, FT.	(OPTIONAL) END AREA COEFF (X)	(OPTIONAL) EXPONENT (M)							
6	ADDHYD	4			5	6	7										
6	SAVMOV	5			IN FROM		OUT TO										
6	DIVERT	6			OUT1		OUT2	OUT1 DISCHARGE, CFS	OUT 1, Decimal % D.A	OUT2, I.D.							
	ENDATA							This record is to be used only at end of all standard control records.									

EXAMPLES DO NOT ENTER

(Right justify these fields)

IMPORTANT: Data Fields No. 1, 2, and 3 require decimal points.

NOTE: This form was suggested by members of Massachusetts Planning Staff.

F-14

257

STANDARD CONTROL

Data Code/Operation

6 RUNOFF 1 — Develops a runoff hydrograph using the data from Data Fields #1, 2, and 3.

6 RESVOR 2 — Performs storage indication routing of a hydrograph. Data Field #1 is the starting elevation for routing to begin. If Data Field #1 is left blank, the routing will begin at the first entry in the STRUCT table.

6 REACH 3 — Performs ATT-KIN reach routing using the reach length (Data Field #1) and, optionally, the end area coefficient, x, (Data Field #2) and the exponent, m, (Data Field #3) in the equation $Q = xA^m$. If Data Fields #2 and 3 are not used, a XSECTN table for the specific cross section is required.

6 ADDHYD 4 — Adds two hydrographs together.

6 SAVMOV 5 — Moves a hydrograph from one storage location to another storage location.

6 DIVERT 6 — Divides an inflow hydrograph into two separate outflow hydrographs. Two procedures are available with this operation:

Procedure #1 — Output #1 will contain that portion of the inflow hydrograph below and equal to the discharge given in the Data Field #1. Output #2 will contain that portion of the inflow hydrograph above the given discharge in Data Field #1.

Col. 25-36 — Data Field No. 1 - Maximum discharge in cfs for Output #1 hydrograph.
Col. 37-48 — Data Field No. 2 - Drainage area split in decimal fraction to retain with Output #1 hydrograph. If left blank, all drainage area goes with Output #2 hydrograph.
Col. 49-60 — Data Field No. 3 - XSECTN ID associated with Output #2 hydrograph. (Note - ID must be provided in decimal form, i.e., 102.)

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 given for the XSECTN.

Output Options — If a particular option is wanted, put a "1" in the appropriate column.

Col. 61 — PEAK - Will print Peak discharge, Peak Time and Peak Elev. (if rating table is available). Will supply up to the ten largest peaks of multi-peaked hydrographs.

Col. 63 — HYD - Will print hydrograph discharges in tabular form.

Col. 65 — ELEV - Will print hydrograph elevations in tabular form.

Col. 67 — VOL - Will print the volume minus constant baseflow under the hydrograph in Inches, cfs-hrs, and ac-ft and the current constant baseflow in cfs.

Col. 69 — FILE - Will generate a file of the discharge hydrograph coordinates in machine readable READHD format.

Col. 71 — SUM - Requests the results of the operation be inserted in Summary Tables 1 and 3 at the end of the job. ECON output must appear in Summary Table 1 but does not have to be selected here.

Col. 73-80 — RECORD identification. Any characters including blanks.

SCS-ENG.-273A DRAFT
REV. May 1982

TR-20

STANDARD CONTROL FOR WATERSHED

CONTINUATION SHEET

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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

CODE	OPERATION	XSEC	STRUC	HYD. NO.	DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3	OUTPUT OPTIONS						RECORD ID.
		(Right justify these fields)			IMPORTANT: Data Fields No 1, 2, and 3 require decimal points.			P	H	E	V	F	S	

F-16

Data Code/Operation

6 RUNOFF 1	Develops a runoff hydrograph using the data from Data Fields #1, 2, and 3.
6 RESVOR 2	Performs storage indication routing of a hydrograph. Data Field #1 is the starting elevation for routing to begin. If Data Field #1 is left blank, the routing will begin at the first entry in the STRUCT table.
6 REACH 3	Performs ATT-KIN reach routing using the reach length (Data Field #1) and, optionally, the end area coefficient, x, (Data Field #2) and the exponent, m, (Data Field #3) in the equation $Q = xA^m$. If Data Fields #2 and 3 are not used, a XSECTN table for the specific cross section is required.
6 ADDHYD 4	Adds two hydrographs together.
6 SAVHOV 5	Moves a hydrograph from one storage location to another storage location.
6 DIVERT 6	Divides an inflow hydrograph into two separate outflow hydrographs. Two procedures are available with this operation:
Procedure #1	Output #1 will contain that portion of the inflow hydrograph below and equal to the discharge given in the Data Field #1. Output #2 will contain that portion of the inflow hydrograph above the given discharge in Data Field #1
Col. 25-36	Data Field No. 1 - Maximum discharge in cfs for Output #1 hydrograph.
Col. 37-48	Data Field No. 2 - Drainage area split in decimal fraction to retain with Output #1 hydrograph. If left blank, all drainage area goes with Output #2 hydrograph.
Col. 49-60	Data Field No. 3 - XSECTN ID associated with Output #2 hydrograph. (Note - ID must be provided in decimal form, i.e., 102.)
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 cros 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 given for the XSECTN.

Output Options — If a particular option is wanted, put a "1" in the appropriate column.

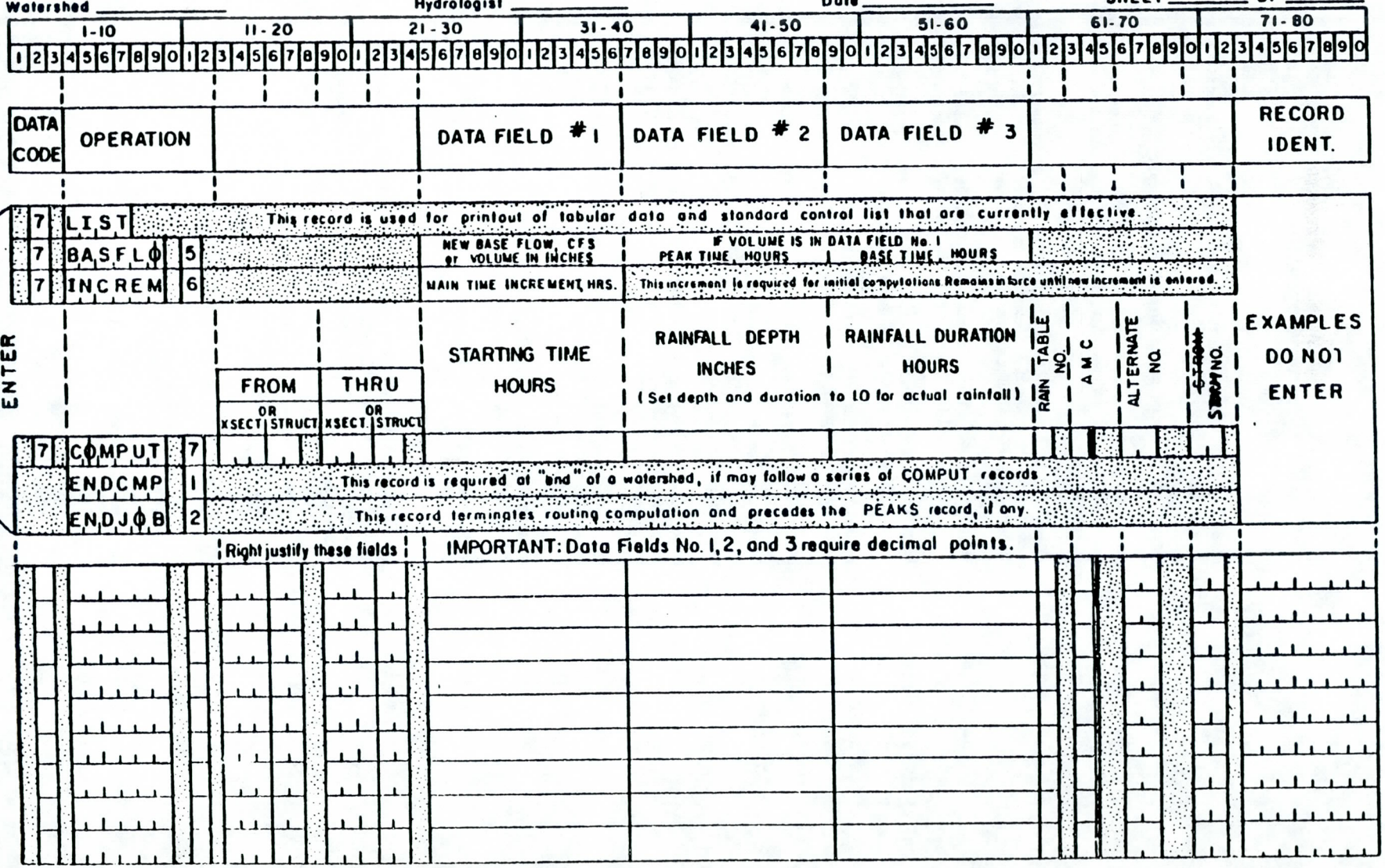
Col. 61	PEAK - Will print Peak discharge, Peak Time and Peak Elev. (if rating table is available). Will supply up to the ten largest peaks of multi-peaked hydrographs.
Col. 63	HYD - Will print hydrograph discharges in tabular form.
Col. 65	ELEV - Will print hydrograph elevations in tabular form.
Col. 67	VOL - Will print the volume minus constant baseflow under the hydrograph in Inches, cfs-hrs, and ac-ft and the current constant baseflow in cfs.
Col. 69	FILE - Will generate a file of the discharge hydrograph coordinates in machine readable READHD format.
Col. 71	SUM - Requests the results of the operation be inserted in Summary Tables 1 and 3 at the end of the job. ECON output must appear in Summary Table 1 but does not have to be selected here.
Col. 73-80	RECORD identification. Any characters including blanks.

SCS-ENG.-274 DRAFT
REV. May 1982

TR-20
EXECUTIVE CONTROL FOR WATERSHED

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____



F-17

EXECUTIVE CONTROL

Data Code/Operation

7 LIST	Tabular data and Standard Control (S. C.) instructions in effect at the time are printed.
7 BASFLO 5	Baseflow is added to an inflow hydrograph.
Col. 25-36 or	Data Field #1 - Insert the 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	Data Field #1 - The volume in inches in triangular hydrograph form that is added to each runoff hydrograph computed. For this procedure, Data Field #2 columns 37-48 and Data Field #3, columns 49-60 must be used.
Col. 37-48	Data Field #2 - Time in hours that the triangular hydrograph peaks. (Note: If a field is left blank or zero, constant baseflow procedure is used).
Col. 49-60	Data Field #3 - Time in hours that the triangular hydrograph base extends. (Note: Cannot exceed 298 main time increments.)
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	Data Field #1 is time increment in hours. A decimal is required.
7 COMPUT 7	Specifies the beginning and ending S.C. instructions to be executed. One pass through the watershed (S.C. list) requires one or more COMPUT Records.
Col. 13-17	Specifies the beginning location. This must correspond to a cross-section or structure number that appears in the XSECTN/STRUC column of an S.C. instruction.
Col. 19-22	Specifies the ending location. The sequence or 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	Data Field #1 is the beginning time in hours of each hydrograph developed under this COMPUT. A decimal is required.
Col. 37-40	Data Field #2 is 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	Data Field #3 is the duration of the rain table to be used. If a unit time (dimensionless) RAINFL table is used, enter the total duration in hrs. If a time increment in hours is used in the RAINFL table, enter a 1.0. A decimal is required.

Data Field #4 contains additional data, as follows:

Col. 61	The RAINFL table to be used (1-9).
Col. 63	The Antecedent Moisture 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 (1-10) to be associated with this COMPUT.
	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.
ENDJOB 2	Terminates routing computations. Causes Summary Table 2 to be printed and Summary Tables #1 and #3 if selected. Job is terminated unless PEAKS information follows.

TR - 20

MODIFY STANDARD CONTROL

SCS - ENG. - 275 DRAFT
REV. May 1982

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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	OPERATION		X SECT. / STRUCT.		HYDRO. NUMBER			DATA FIELD # 1	DATA FIELD # 2	DATA FIELD # 3	OUTPUT OPTIONS						RECORD IDENT.
	NAME	NO.	XSECT ID.	STRUCT ID.	IN-PUT #1	IN-PUT #2	OUT-PUT				PRINT				FILE	SUM	
											PEAK	HYD.	ELEV	VOL.			

IMPORTANT. Line out unused lines. Data fields require decimal points.

IMPORTANT: Modifications must be given in the order that they appear on the standard control list.

7	INSERT	2						NOTE: The following records are inserted following the XSECTN / STRUCTURE specified.										
6																		
6																		
6																		
6																		

7	ALTER	3						NOTE Data given in columns 1 to 18 must be identical with standard control record to be altered.										
6																		
6																		
6																		
6																		

7	DELETE	4						NOTE Data given in columns 1 to 18 must be identical with standard control record to be deleted.										
6																		
6																		
6																		

MODIFY STANDARD CONTROL

Modify Standard Control is used to insert new instruction, alter existing instructions, or delete instructions in the Standard Control (S.C.) list. The modifications of the 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 S.C. is recycled by a 7 LIST, or 7 COMPUT 7 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 first series or string of S.C. instructions for XSECTN/STRUCT named. The new S.C. records are filled out in the same format as described on the S.C. data form.
7 ALTER 3	Will substitute the following S.C. records for the S.C instructions that match column 1-18 of each new S.C record. The S.C. records are filled out in the same format as described on the S.C. data form.
7 DELETE 4	Will delete the S.C. instructions that match column 1-18 of the records that follow.

TR - 20

SCS - ENG. - 276 DRAFT
REV. May 1982

READ DISCHARGE HYDROGRAPH

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10			11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME		DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3	DATA FIELD NO. 4	DATA FIELD NO. 5		RECORD IDENT.
			IMPORTANT: Line out unused lines. Data fields require decimal points.						
			HYDROGRAPH NO.						
7	READHD	8							
			STARTING TIME, HRS.	TIME INCREMENT, HRS.	DRAINAGE AREA, SQ. MI.	BASE FLOW, CFS			
7	READHD	9							
			Enter successive entries left to right with first entry for time = 0. Fill last row of data with last entry of table. Σ Baseflow						
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
9	ENDTBL		NOTE: This record must be the last record of this table.						

SCS-ENG.-277 DRAFT
Rev. May 1982

TR - 20
INTERMEDIATE PEAKS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

F-22

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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	FROM		THRU		INTERMEDIATE POINTS BETWEEN FROM AND THRU XSECTION / STRUCTURES								RECORD IDENT.
	OR XSECT	OR STRUCT	OR XSECT	OR STRUCT	POINT ID.	DRAINAGE AREA (Sq. Mi.)	POINT ID.	DRAINAGE AREA (Sq. Mi.)	POINT ID.	DRAINAGE AREA (Sq. Mi.)	POINT ID.	DRAINAGE AREA (Sq. Mi.)	
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
END JOB	2				This record terminates the entire TR-20 job.								

TECHNICAL RELEASE 20
COMPUTER PROGRAM FOR PROJECT FORMULATION
HYDROLOGY

APPENDIX G
THE MODIFIED ATT-KIN ROUTING MODEL

INTRODUCTION

This appendix presents the math model to be used for channel flood routing. The model, a Modified Att-Kin (attenuation-kinematic) procedure, replaces the convex procedure which is in the previous Technical Release 20. The TR-20 computer program was developed in 1964 and incorporated manual flood routing procedures, but current technology and changing requirements for the use of TR-20 called for improved yet uncomplicated procedures. The Modified Att-Kin procedure fills this need.

The Modified Att-Kin procedure for valley flood routing is based on the Att-Kin procedure described in TR-66[1/]. The TR-66 Att-Kin procedure was modified to conform to the structure of the existing TR-20 computer program. The Modified Att-Kin procedure [redacted] is an interim procedure to be used until more complete routing models are included.

The Modified Att-Kin procedure does not alter the basic form of the original convex routing equation. It provides a better physical basis for determining the routing coefficient while using a numerical technique that satisfies the intended math model. The physical basis of the Modified Att-Kin procedure is twofold: (1) it satisfies the time to peak of the hydrograph throughout the valley; and (2) it satisfies the conservation of mass at the time to peak. To accomplish these items, the Modified Att-Kin method combines the best features of both the storage and the kinematic math models.

DESCRIPTION OF MATH MODELS

Before describing the Att-Kin procedure a brief description of the physical behavior of natural floodwaves is necessary.

Linsley, Kohler and Paulhus[2/] describe two general classes of natural floodwaves. The first includes waves in which forces of momentum and acceleration control. These waves are fast rising, and occur frequently in streams of steep gradient. The second class includes floodwaves in which friction is the predominant force. Slow rising floodwaves on streams of mild gradients are examples of this class.

The movement of a floodwave down a stream system may be described in terms of translation and reservoir effects. These represent characteristics of the two general classes of natural flood waves. Translation involves maintaining the same hydrograph shape as the flood wave moves downstream. The reservoir effect involves use of valley storage to reduce the peak flow and change the shape of the hydrograph.

The Att-Kin procedure is based on storage and kinematic models to reflect the reservoir and translation effects on natural flood waves, respectively.

The storage math model is physically related to reservoir routing applications. The mathematical behavior produces instantaneous translation with maximum attenuation for the storage involved. Closed-form solutions can be developed for analytic inflow hydrographs with linear storage-discharge relationships. Simple numeric techniques can be constructed and easily solved that satisfy the math model without any stability problems. However, care must be taken not to needlessly subdivide the reach, because the numeric results then approach a kinematic rather than storage math model solution.

The kinematic math model is physically related to wave propagation situations. The mathematical behavior produces translation for any discharge with absolutely no attenuation. Simple closed-form solutions can be done for any type of inflow hydrograph and nonlinear storage-discharge relationship. Numeric models can be constructed and solved that satisfy the math model.

Proper unsteady flow models describing the passage of flood hydrographs through a reach must at least be a combination of both kinematic for translation and storage for attenuation. The full dynamic equations simultaneously account for both effects, but they are very difficult to apply to general field situations. However, coefficient procedures which are simpler than unsteady flow models, can be used for most field applications if (1) a math model is chosen that describes the important physical processes, (2) the routing coefficients are determined for each application to reflect the actual site-specific physical relationships, and (3) a numeric technique is constructed that satisfies the chosen math model.

Att-Kin Procedure

A thorough discussion of the Att-Kin procedure is presented in TR-66. This brief discussion is included as an introduction to the procedure.

For each channel (valley) reach, the Att-Kin procedure routes an inflow hydrograph through the reach using a storage math model. The procedure then positions the peak in time and distorts the storage routed hydrograph using a kinematic model. These routings cannot be done simultaneously but must be done as a linear combination of the storage and math kinematic models. The combined routing is done so the outflow hydrograph satisfies the conservation of mass equation at the time to peak of the outflow hydrograph. Figure G-1 illustrates the two models which make up the Att-Kin procedure. The storage routing provides attenuation but does not describe translation; the kinematic routing provides translation and distortion but does not attenuate the peak.

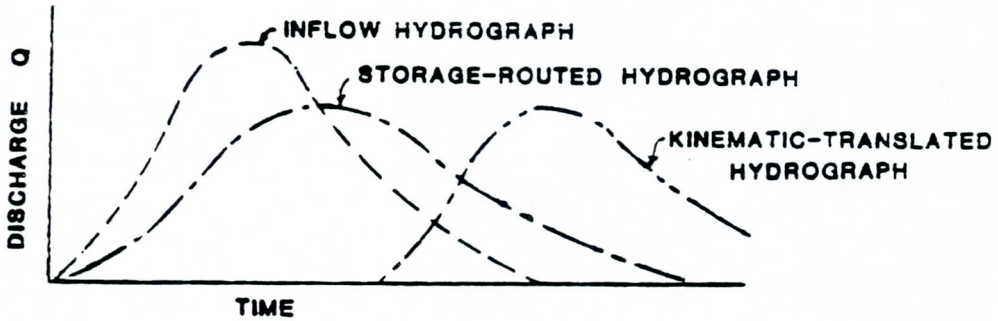


Figure G-1. Hydrographs resulting from storage routing and kinematic translation.

The inflow hydrograph is storage routed using the storage indication method to solve the integral form of the conservation of mass equation using a single-valued valley storage-discharge relationship. The equations which reflect attenuation are:

$$(\overline{Q}_I - \overline{Q}_O)(t_2 - t_1) = S(t_2) - S(t_1) \qquad \text{Eq. G-1}$$

$$Q(t) = k\,[S(t)]^m \qquad \text{Eq. G-2}$$

where: t_1 = time at the beginning of the interval
t_2 = time at the end of the interval
$\overline{Q}_I$ = the average inflow over the time interval $t_2 - t_1$
$\overline{Q}_O$ = the average outflow over the time interval $t_2 - t_1$
$S(t)$ = valley storage in the reach at time t
$Q(t)$ = outflow at the downstream end of the reach at time t
k and m = coefficient and exponent for the single valued storage - discharge relationship

The storage routed hydrograph is then translated and distorted by kinematic routing. Kinematic routing solves the differential form of the conservation of mass equation using a single-valued flow area-discharge relationship. The equations used to effect translation are:

$$\frac{\partial Q}{\partial X} + \frac{\partial A}{\partial t} = 0 \qquad \text{Eq. G-3}$$

where: Q = discharge, cfs
X = distance, ft
A = area, ft^2
t = time, sec

and: $Q = xA^m$ Eq. G-4

where: Q = discharge at any distance and time
A = Area at any distance and time
x and m = coefficient and exponent for the single valued flow area-discharge relationship

These two routing equations (Equations G-1 and G-3) require two separate single-valued discharge relationships. The two single-valued functions can be related by

$$S = LA \qquad \text{Eq. G-5}$$

where: S = valley storage
L = valley length
A = valley cross-section area

An inherent assumption made in equation (G-5) is that a constant or representative cross section shape for the length of the reach exists. The flow area-discharge relationship can be determined from the valley storage-discharge relationship by

$$Q = kS^m = kL^mA^m = xA^m \qquad \text{Eq. G-6}$$

Some, but not all, of the valley storage results in attenuation of the peak. Part of the storage is used for translation; that is, when the attenuated hydrograph is kinematic routed, some of the valley storage is filled. Therefore, the storage volume used in the storage-routing portion of the Att-Kin procedure is related to the valley storage-discharge relationship by a constant of proportionality, as follows:

$$Q_{po} = k\,[C_2 S_{po}]^m \qquad \text{Eq. G-7}$$

$$C_2 = \frac{V_s}{S_{po}} \qquad \text{Eq. G-8}$$

where: C_2 = constant of proportionality
S_{po} = maximum valley storage in the reach during passage of and assumed coincident with the outflow peak of the kinematic translated hydrograph.
Q_{po} = peak of the outflow hydrograph
V_s = net storage used in computing the outflow peak by the storage routing math model.

V_s can be determined from the relationship:

$$V_s = V_o - (V_t + V_d) \qquad \text{Eq. G-9}$$

Each term in equation G-9 is described below and illustrated on Figure G-2.

V_o = the maximum valley storage; difference between the accumulated inflow volume and the accumulated outflow volume at the time to peak of the outflow hydrograph.

$$V_o = \int_o^{t_{po}} Q\,(t,o)dt - \int_o^{t_{po}} Q(t,L)\,dt \qquad \text{Eq. G-10}$$

where: $Q(t,o)$ = discharge at time t at upstream end of reach

$Q(t,L)$ = discharge at time t at downstream end of reach.

t_{po} = time to peak discharge of the kinematic translated hydrograph.

The volume V_t is the additional inflow that occurs between the times of the storage and kinematic-routed peaks and is defined as

$$V_t = \int_{t_{ps}}^{t_{po}} Q(t,o)dt \qquad \text{Eq. G-11}$$

where t_{ps} = time to peak of the storage routed hydrograph.

The distortion volume is defined as

$$V_d = \int_o^{Q_o} \left(\frac{L}{C} - \frac{L}{C_o}\right) dQ \qquad \text{Eq. G-12}$$

where: L = reach length, ft

Q_o = peak outflow discharge, cfs

$C = m(Q/A)$, ft/sec.

$C_o = m\,(Q_o/A_o)$ ft/sec

m = exponent of flow area-discharge relationship.

A_o = flow area associated with Q_o

The distortion volume (V_d) is a result of steepening the rising limb of the storage routed hydrograph. Offsetting the entire hydrograph by the kinematic travel time of the peak would not be correct. Each discharge travels at a different celerity resulting in a distortion of the rising limb of the hydrograph. This distortion is the difference between the travel times of the instantaneous discharges (L/C) and peak discharge (L/C_o). Integrating these differences over the rising limb of the hydrograph gives V_d. (This is illustrated by placing the kinematic-routed hydrograph so that its peak is coincident with the storage-routed hydrograph). The volume V_t is the additional inflow that occurs between the times of the storage and kinematic-routed peaks. The storage volume (V_s) is that part of the valley storage which causes attenuation.

The solution of the Att-Kin procedure is iterative and involves selecting a value of C_2 (defined by equation G-8). The inflow hydrograph is then storage-routed.

V_d is computed from equation G-12 and the hydrograph is translated through the kinematic routing. V_s is computed from equation G-9 and compared with V_s resulting from the storage routing. If the two values are not equal then a new value of C_2 is assumed and the process repeated until they are equal. At this point V_o equals S_{po}. This iterative procedure insures a balance of the conservation of mass at the time of the peak outflow.

Modified Att-Kin Procedure

The Modified Att-Kin procedure replaces the Convex procedure but uses a similar derivation with three exceptions. (1) An arithmetic average of flow at consecutive time intervals is assumed for the outflow, (2) the determination of the routing coefficient, C_R, is related to the site-specific physical processes, and (3) the numeric model is constructed to satisfy the math model.

The structure of the TR-20 computer program dictates a routing equation of the form

$$O_2 = C_R I_1 + (1 - C_R)\, O_1 \qquad \text{Eq. G-13}$$

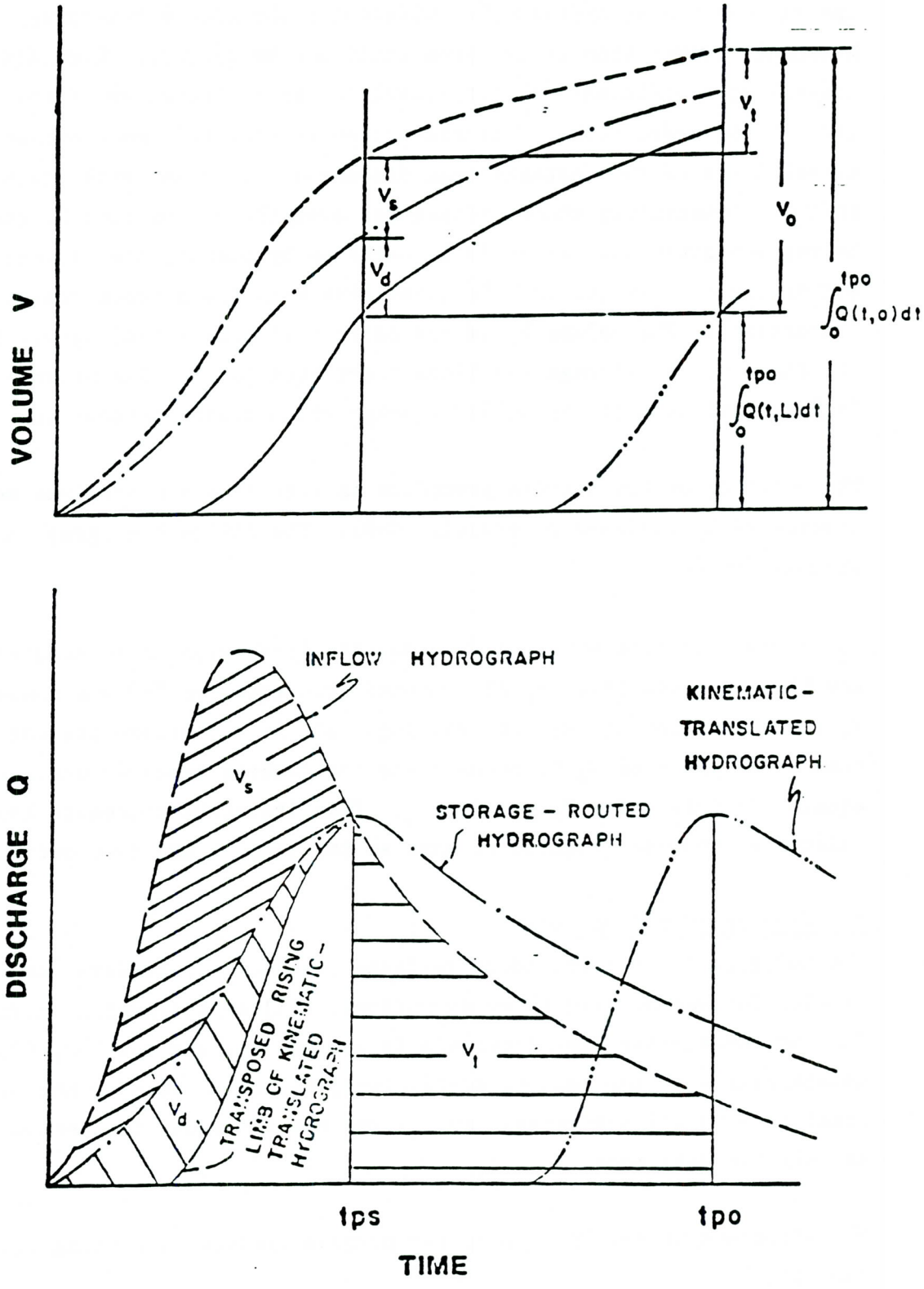


Figure G-2. Volumes used in the Att-Kin routing procedure.

where: O_1 = the outflow at time 1
O_2 = the outflow at time 2
I_1 = the inflow at time 1
C_R = coefficient for routing

The equation for conservation of mass can be written as

$$I - O = \frac{\Delta S}{\Delta t} \qquad \text{Eq. G-14}$$

and solved by assuming I_1 is the average inflow over the time interval Δt and $\left(\frac{O_2 + O_1}{2}\right)$ is the average outflow over the same time interval. Making this assumption results in a simpler routing equation involving I_1, O_1 and O_2 rather than I_1, I_2, O_1, and O_2. If Δt is chosen such that there is not a large difference between consecutive discharges this is a reasonable assumption. This gives

$$I_1 - \left(\frac{O_2 + O_1}{2}\right) = \frac{\Delta S}{\Delta t} \qquad \text{Eq. G-15}$$

Let $S = KO$, where K approximates the slope of storage-outflow curve at the peak outflow discharge. The best straight line estimate of the slope is the chord between the base flow (S_b and Q_b) and the peak outflow (S_s and Q_{po}) point (Figure G-3).

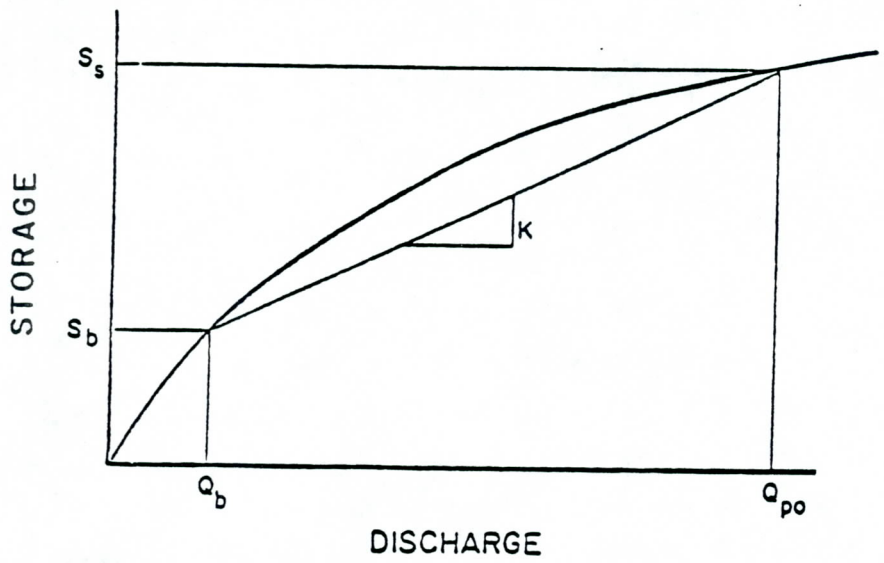


Figure G-3. Storage-outflow slope used in the Modified Att-Kin routing

Equation G-15 becomes

$$I_1 - \left(\frac{O_2 + O_1}{2}\right) = K\left(\frac{O_2 - O_1}{\Delta t}\right) \qquad \text{Eq. G-16}$$

Expressing equation 16 in the form of equation 13 (see Theory Development for the Modified Att-Kin Routings eqs. G-20 thru G-22) yields an equation for C_R.

$$C_R = \left(\frac{2\Delta t}{2K + \Delta t}\right) \qquad \text{Eq. G-17}$$

K is computed from the storage and outflow (Figure G-3) using the equation

$$K = \frac{S_s - S_b}{Q_{po} - Q_b} \qquad \text{Eq. G-18}$$

Since the actual outflow peak and associated storage is not known it must be estimated before the routing. The equations and their derivation are shown in Theory Development equations G-23 to G-28.

The value of K computed in Equation G-18 is used in equation G-17 to solve for C_R. C_R is not allowed to exceed 1. The routing is done using equation G-13. The time difference between the inflow peak and the outflow peak is Δt_{ps}. The value of Δt_{ps} is a multiple of the main time increment used in the reach routing. The minimum value of Δt_{ps} is the main time increment. The resulting hydrograph is then positioned in time so the difference between the time to peak of inflow and outflow is

$$\Delta t_p = \frac{S_{pi} - S_{po}}{Q_{pi} - Q_{po}} \left(\frac{1}{3600}\right) \qquad \text{Eq. G-19}$$

where:
- S_{pi} = valley storage associated with the inflow peak, ft^3
- S_{po} = maximum valley storage in the reach during the passage of and assumed coincident with the outflow peak, ft^3
- Q_{pi} = peak of the inflow hydrograph including baseflow, cfs
- Q_{po} = peak of the outflow hydrograph including baseflow
- Δt_p = elasped time between the inflow and outflow peaks, hrs

The equation for Δt_p is developed from the kinematic travel time assuming that peak discharge varies linearly with time during its movement through the reach.

The time to the peak of the kinematic routed hydrograph (Δt_p) is used to position the outflow hydrograph if $\Delta t_p > \Delta t_{ps}$.

THEORY DEVELOPMENT FOR THE MODIFIED ATT-KIN ROUTING

The development of the Modified Att-Kin routing method involves the definition of C_R, the routing coefficient used in the routing equation G-13.

The equation for the storage routing is repeated for the following derivation of the routing equation.

$$I_1 - \left(\frac{O_2 + O_1}{2}\right) = K\left(\frac{O_2 - O_1}{\Delta t}\right) \qquad \text{Eq. G-16}$$

where: I_1 = average inflow discharge, cfs
O_2 = outflow discharge at time 2, cfs
O_1 = outflow discharge at time 1, cfs
K = approximate slope of the storage discharge curve at the peak outflow.

Multiply equation G-16 by $2\Delta t$.

$$2\Delta t\ I_1 - \Delta t\ (O_2 + O_1) = 2K\ (O_2 - O_1) \qquad \text{Eq. G-20}$$

Add $2KO_1$ and $\Delta t\ O_2$ to both sides of equation G-20.

$$2\Delta t\ I_1 - \Delta t\ O_1 + 2KO_1 = 2KO_2 + \Delta t\ O_2$$

or

$$2\Delta t\ I_1 + (2K - \Delta t)\ O_1 = (2K + \Delta t)\ O_2 \qquad \text{Eq. G-21}$$

Divide both sides of equation G-21 by $2K + \Delta t$ and solve for O_2.

$$O_2 = \left(\frac{2\Delta t}{2K + \Delta t}\right) I_1 + \left(\frac{2K - \Delta t}{2K + \Delta t}\right) O_1$$

Substitute $\Delta t - 2\Delta t$ for $- \Delta t$,

$$O_2 = \left(\frac{2\Delta t}{2K + \Delta t}\right) I_1 + \left(\frac{2K + \Delta t - 2\Delta t}{2K + \Delta t}\right) O_1$$

$$O_2 = \left(\frac{2\Delta t}{2K + \Delta t}\right) I_1 + \left(1 - \frac{2\Delta t}{2K + \Delta t}\right) O_1 \qquad \text{Eq. G-22}$$

Substituting C_R for $\frac{2\Delta t}{2K + \Delta t}$, equation G-22 becomes

$$O_2 = C_R I_1 + (1 - C_R) O_1$$

Before C_R can be computed, K is needed. The equations which are used in the TR-20 program to compute K are derived below.

The single valued storage - discharge relationship is calculated from the flow area-discharge relationship and the reach length appearing in equation G-6.

The next step is to compute the length factor, k*. The equation defining k* is:

$$k^* = \frac{Q_I}{k\ V_I^{\ m}} \qquad \text{Eq. G-23}$$

where: Q_I = peak of runoff hydrograph, cfs
V_I = volume of runoff hydrograph, ft^3
k, m = coefficients of storage-discharge relationship.

The value of k* appears in output Summary Table 2 under the heading, LENGTH FACTOR (K*).

The denominator of equation G-23 represents the discharge at which all the inflow volume is stored in the reach. This discharge is inversely related to the reach length. For short reach lengths, this discharge could be extremely large and for long reach lengths, this discharge could be comparable to the peak of the runoff hydrograph, Q_I. Therefore, k* is directly related to reach length.

For example
As the reach length increases, k* increases.

An estimate of the peak outflow is needed in order to compute K, the slope of the storage-discharge curve. This estimated peak, denoted $\hat{Q}_o$, is equal to

$$\hat{Q}_o = k\ V_I^{\ m}$$

or if baseflow is present,

$$\hat{Q}_o = k\ (V_I + S_b)^m$$

where: S_b = volume of baseflow stored in the reach, ft^3.

$\hat{Q}_o$ is not allowed to be greater than the peak of the inflow hydrograph.

The storage for this discharge, $\hat{Q}_o$, is estimated from the following equation.

$$V_o = \left(\frac{\hat{Q}_o}{k}\right)^{1/m} \qquad \text{Eq. G-24}$$

The V_s (as illustrated in Figure G-2) is calculated from Eq. G-9.

$$\text{Then, } V_s = V_o - (V_t + V_d) \qquad \text{Eq. G-25}$$

These volumes are defined in equations G-10, G-11, and G-12 of this appendix. The equation for V_d (equation G-12) can be integrated to obtain.

$$V_d = V_o \left[1 - \frac{1}{m} + \frac{1}{m}\left(\frac{Q_b}{\hat{Q}_o}\right)\right] - S_b \qquad \text{Eq. G-26}$$

where: Q_b = baseflow discharge, cfs.

V_t is not used in this procedure, because it cannot be calculated without integrating part of the inflow hydrograph. To compensate for not using V_t, a curve fit was used to modify V_d so that a close approximation to the data was achieved. $V_d \left(\frac{\hat{Q}_o - Q_b}{Q_I - Q_b}\right)^{I/2}$ was substituted for $V_t + V_d$ in equation G-25.

Simplifying and combining equations G-18, G-25, and G-26 and making the substitution for $V_t + V_d$ yields the following equation.

$$K = \frac{V_I}{Q_I} \frac{\{k*(\hat{Q}_o+Q_b)/Q_I\}^{1/m}}{\hat{Q}_o/Q_I} \{\{(1-\sqrt{\hat{Q}_o/Q_I})\ \ (1-\{Q_b/(\hat{Q}_o+Q_b)\}^{1/m})\}$$

$$+ 1/m\ \sqrt{Q_c/Q_I} * \{1-Q_b/(\hat{Q}_o+Q_b)\}\} \qquad \text{Eq. G-27}$$

All variables on the right side of equation G-27 are known so K may be computed. This value of K appears in the output Summary Table 2 under the heading S/Q @ PEAK (K).

Using this value of K, C_R is computed from the equation G-17

$$C_R = \frac{2\Delta t \quad (3600)}{2K + \Delta t \ (3600)}$$

where Δt is the main time increment in hours. This value of C_R is output Summary Table 2 as ATT-KIN COEFF (C). A discussion of the relationship of C_R, Δt, K and L can be found in Reach Length Guidelines of Appendix H.

The inflow hydrograph is then routed according to equation G-13.

The difference in peak times for the inflow and outflow hydrographs is then computed. This time represents the travel time of the peak discharge through the reach based on the storage routing. This time is denoted Δ_{tps} and appears in Summary Table 2 under the heading, PEAK TRAVEL TIME-STORAGE. The kinematic routing is then accomplished by computing the kinematic travel time, Δt_p, which appears in Summary Table 2 as Peak Travel Time, Kinematic. Equation G-19 is derived to a different form in the TR-20 program.

Substituting

$$Q_{pi} = Q_I + Q_b$$

$$S_{pi} = \left(\frac{Q_I + Q_b}{k}\right)^{1/m}$$

$$S_{po} = \left(\frac{Q_{po}}{k}\right)^{1/m}$$

into Equation G-19 yields Equation G-28.

$$\Delta t_p = \frac{S_{po}}{Q_{po}} * \frac{\left(\frac{Q_I + Q_b}{Q_{po}}\right)^{1/m} - 1}{\left(\frac{Q_I + Q_b}{Q_{po}}\right) - 1} * \frac{1}{3600} \qquad \text{Eq. G-28}$$

where: Q_I = peak of inflow hydrograph due to direct runoff, cfs
Q_b = baseflow, cfs
k,m = coefficient and exponent of valley storage-discharge relationship.

Other variables are as defined on page G-10.

If Δt_p is greater than Δt_{ps} then the outflow is positioned such that the peak of the outflow hydrograph occurs Δt_p hours after the peak of the inflow hydrograph. If Δt_p is less than Δt_{ps} then the positioning of the outflow hydrograph remains unchanged.

If x and m coefficients are entered as input data and the m value is within the program limits (1.0 to 2.0) see Appendix H pages H-2 and H-3, ~~(used up to this point in the discussion)~~ The routing is completed for the reach. If m is outside the program limits, an iteration technique is used to route the hydrograph through the reach such that the area corresponding to the outflow peak discharge falls within 5% of the area as computed from the discharge-flow area equation (defined by the input x and m). In these iterations if the input m is greater than 2.0 then the m used in the routing is 2.0 and if the input m is less than 1.0 then m used in the reach routing is 1.0. The iteration technique makes a correction to x at the end of each routing trial to put the next trial closer to the final result. Figure G-4 illustrates how the program handles the routing with an input m less than 1.0. The final routing has m = 1.0 and the outflow falling on (or within the program tolerance of) the discharge-area curve as defined by the input x and m. This insures that the peak outflow is the peak corresponding to the maximum valley storage or $Q_{po} = k\ (S_{po})^m$ where variables are defined in Equation G-7.

The ITERATION number appearing in output Summary Table 2 is the number of routing trials required to reach the final result. If a rating table is entered as cross section data, a similar iteration technique is used with the added requirement that the m used in the final routing trial must be within 0.02 of the m at the peak outflow discharge. At the end of

each routing trial, corrections to the values of m and x are made to put the next routing trial closer to the final result. A maximum of 10 iterations is set in the program.

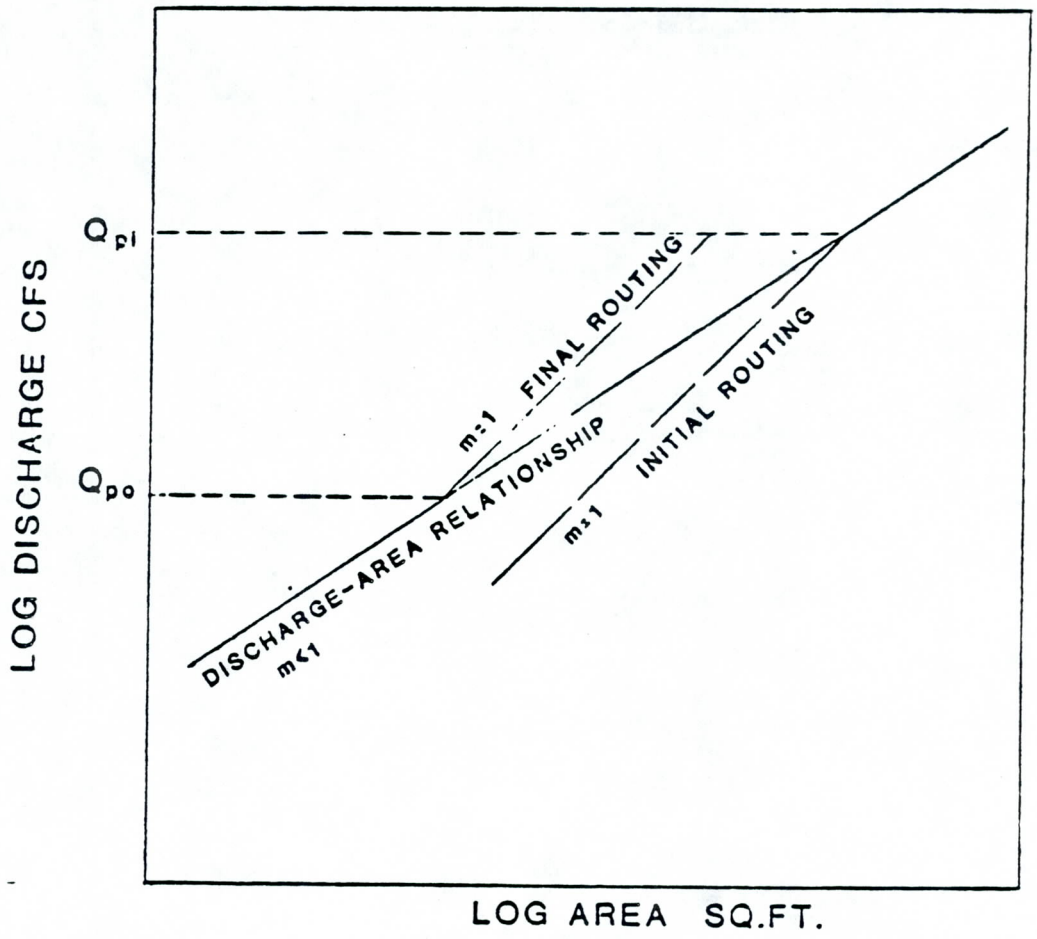


Figure G-4. Illustration of routing iterations in TR-20 program.

References

1. USDA, Soil Conservation Service, Technical Release 66, Simplified Dam-Breach Routing Procedure, March 1979.

2. Linsley, Kohler, Paulhus. 1949. Applied Hydrology, p. 485-488, McGraw Hill Book Co., New York.

TECHNICAL RELEASE 20
COMPUTER PROGRAM FOR PROJECT FORMULATION
HYDROLOGY

APPENDIX H

RATING CURVE COEFFICIENTS x AND m and REACH LENGTH GUIDELINES

DEFINITION AND SIGNIFICANCE OF m

The ~~coefficient~~ exponent m has a physical meaning which can add to the understanding of the Modified Att-Kin routing procedures. The discharge-flow area relationship for simple cross sections (rectangular, triangular, trapezoidal) may be fit by a power curve function of the form

$$Q = xA^m \qquad \text{Eq. H-1}$$

where variables are as defined in Eq. G-4.

According to hydraulic theory, the speed at which a flood wave travels downstream is called the celerity and is equal to the slope of the discharge-flow area curve at a given discharge. In equation form

$$C = \frac{dQ}{dA} \qquad \text{Eq. H-2}$$

where C is celerity, ft/sec

Differentiating equation H-1 with respect to area results in

$$C = \frac{dQ}{dA} = xmA^{m-1} = \frac{m(xA^m)}{A} = m\left(\frac{Q}{A}\right) \qquad \text{Eq. H-3}$$

$$C = mV \qquad \text{Eq. H-4}$$

where: V = average velocity, $\frac{Q}{A}$

$$m = \frac{C}{V}$$

m is therefore a factor relating average velocity and wave velocity (celerity). The wave velocity is important to the Modified Att-Kin

routing method in computation of the Modified Att-Kin routing coefficient and the travel time of the peak discharge through the reach. For details on routing equations see Appendix G.

The value of m used in the routing has a major effect on the calculation of travel time of the hydrograph through a reach. The larger the value of m, the shorter the travel time. Therefore the selection of m can affect the timing of peaks in any reach and can affect the way in which tributary hydrographs add to the peak of the hydrograph on the main stream.

The TR-20 program has internally set limits on the value of m used in reach routings. If the m is too large or too small there is a weakness in both the math and numeric models. A value of m less than 1.0 is unrealistic because the wave velocity (celerity) is less than the average flow velocity. Therefore, the m value used in any given routing is not allowed to be less than 1.0.

To set an upper limit for the value of m, test routings were made with a range of m values from 1.0 to 2.8. The attenuation and peak travel times for each routing were compared with those using an m of 5/3.

This value of m was assumed to provide the most accurate routing. m of 5/3 may be obtained from the following derivation.

The familiar Manning's equation for discharge can be rearranged to the following:

$$Q = \left(\frac{1.49\ s^{1/2}}{n\ p^{2/3}}\right) A^{5/3} \qquad \text{Eq. H-5}$$

where: n = Mannings roughness coefficient,
s = hydraulic gradient
p = wetted perimeter, ft,
A = flow area, ft^2, and Q = discharge in cfs.

For cross sections where the hydraulic radius (A/p) can be approximated by the depth (wide channels), the equation takes the form:

$$Q = xA^m$$

where: $x = \frac{1.49\ s^{1/2}}{n\ B^{2/3}}$ and $m = 5/3$, and B = bottom width

From the test routings, if m was greater than 2.0, the travel time of the peak flow and the amount of attenuation reduced significantly when compared to the routing where m was 5/3. Unacceptable error was introduced if m was greater than 2.0. Therefore the upper limit for m is set at 2.0.

The discussion above concerning celerity and Mannings equation dealt with simple cross section shapes but is also applicable to most cross sections with one segment such as a natural channel. Discharge-area data for these types of channels can usually be fit by a power curve adequately (Equation H-1). When routings are done through complex cross sections (irregularly shaped, multiple segments, or changes in roughness) m can be difficult to determine. Discharge-area plots for these types of cross sections generally exhibit changes in slope and attempting to fit one power curve to the data can result in significant differences between the power curve and the actual data.

If the slope of the discharge-area curve (plotted on log-log paper) is greater than one then the average velocity at the cross section is increasing with increasing discharge. If the slope should happen to be less than one, then the average velocity is decreasing with increasing discharge. The third possibility is that the slope equals one and the velocity is constant regardless of discharge. For any simple segment of a multi-segment cross section, the average velocity should increase with increasing discharge. However, when adding the flow and area for all segments to get the total flow and total area at a cross section there can be elevations where the average velocity actually decreases as flow

increases. The most common occurrence of this is at discharges exceeding channel capacity with shallow depth in the floodplain for which the velocity in the channel is much larger than the velocity in the floodplain.

The slope of the discharge-area curve where the average velocity decreases (which can be significantly less than one) does not represent the true celerity or wave propagation speed. For this reason, a procedure to calculate m at a cross section was developed. The procedure is described in the following section of this appendix.

CALCULATION OF m FROM RATING TABLE DATA

The TR-20 user has the input option of entering a rating table to represent flow in a reach. Data required include elevation, flow and area for a minimum of three discharges (two greater than zero) to a maximum of twenty discharges (nineteen greater than zero). Elevation, flow and area must all increase from one value to the next in the table. If any value of flow or area is the same or decreasing there will be an error message.

When a rating table is entered, m is computed at each flow value of the table. This procedure will reflect changes in slope of the Q and A curve typically occurring above the bankfull discharge and at large floodplain discharges.

The equations used to compute m are

$$m = S(2,3) \qquad \text{for } Q \leq Q(3)$$

$$m(I) = \frac{Q(3)\,S(2,3) + \ldots \left(Q(I)-Q(I-1)\right) S(I-1, I)}{Q(I)} \qquad \text{for } Q(3) < Q < Q(J)$$

Eq. H-6

m is extrapolated (log-log) from the last two tabulated points for discharges larger than the last tabulated value.

where: m(I) = m at flow number I

Q = flow rate CFS

Q( ) = flow rate at subscript point number, Q(1) = 0

S(2,3) = log-log slope of discharge-area curve between points 2 and 3

S(I-1, I) = log-log slope of discharge-area curve between points I-1 and I.

m calculated this way can be considered a weighted slope.

For example, the m at the fifth tabulated discharge would be calculated

$$m(5) = \frac{Q(3)\ S(2,3) + \left(Q(4) - Q(3)\right)\ S(3,4) + \left(Q(5) - Q(4)\right)\ S(4,5)}{Q(5)}$$

When m is desired at a nontabulated point, m is linearly interpolated on a log-log basis.

If the log-log slope between each two consecutive points in a rating table is the same then m will be the same for all discharges, in other words, one power curve will fit the data accurately. When the log-log slope of the discharge-area curve changes then m will change. How m is used in the reach routing is described in Appendix G.

DEFINITION AND SIGNIFICANCE OF x

The coefficient x in equation H-1 is an important parameter in the Modified Att-Kin routing procedure.

$$Q = xA^m \qquad \text{Eq. H-1}$$

Holding m constant, the average flow velocity is

$$v = \frac{Q}{A} = \frac{xA^m}{A} = x(A^{m-1})$$

x is a proportionality constant relating area and velocity. If x is small, velocity is small and if x is large, velocity is large.

If x is small, there must be more flow area at the cross section to maintain a discharge than if x were larger. Increased flow area translates to increased storage because storage equals length times flow area.

With respect to flood routing, holding m constant, the smaller value of x will result in more attenuation of the peak discharge. This is due to reduced velocity and increased storage in the reach.

GUIDELINES FOR ESTIMATING x AND m

There is a TR-20 option of entering x and m value for the equation $Q = xA^m$ to represent the Q and A relationship for a reach. These input values may be derived in several ways. One method would involve plotting Q and A points on log-log paper and visually fitting a line to the data. The slope of the line is m and the intercept at A = 1 is x. A second method would involve fitting Q and A data with a power curve function by some statistical method (method of averages or least squares). A third method involves use of guidelines for estimating x and m given in this section.

This section includes equations and nomographs for estimating x and m coefficients for trapezoidal and triangular cross sections. These guidelines based on simplified cross sections require a minimum of topographic and roughness data. They are to be used in absence of detailed cross section information for a reach where a routing is desired. If detailed information is available, a rating table should be calculated and the resulting table entered as a cross section table. A limitation of these guidelines is that they are based on one segment cross sections (one roughness value). A channel or floodplain cross section may

be approximated by a triangular or trapezoidal shape. For example, if peak discharges are expected to be contained in a channel, a triangular or trapezoidal representation could apply. If the channel carries insignificant flow with respect to the floodplain, the floodplain may be given a simple geometry.

Both x and m values from these guidelines will not accurately represent x and m for complex multi-segment cross sections with varying roughness. These types of cross sections generally exhibit changes in slope of the discharge-area curve (plotted on log-log paper).

The assumption of normal flow with constant slope for all discharges was used in developing these guidelines. This is a reasonable assumption for small streams with moderate to steep slopes, but is not reasonable for flat slopes with backwater influences.

The equations for x and m for a trapezoidal cross section are based on the assumption that discharge-area data plot as a straight line on log-log paper. The purpose of this section is to calculate x and m such that one power curve will fit the actual flow and area data for all discharges at the cross section.

Substituting A = 1 into Manning's equation (H-5) results in

$$Q = x = \frac{1.49}{n} \frac{s^{1/2}}{p^{2/3}} \qquad \text{Eq. H-7}$$

When the bottom width (B) of the channel is greater than or equal to five feet the approximation p = B may be made. This results in the equation

$$x = \frac{1.49}{n} \frac{s^{1/2}}{B^{2/3}} \qquad \text{Eq. H-8}$$

where: s = slope ft/ft

n = Manning's roughness coefficient

B = Bottom width (ft.)

Figure H-1 is a nomograph to solve Equation H-8 for x with s, n and B given.

In equation form, the slope equals

$$m = \frac{\log Q(2) - \log Q(1)}{\log A(2) - \log A(1)} = \frac{\log \left[\frac{Q(2)}{Q(1)}\right]}{\log \left[\frac{A(2)}{A(1)}\right]} \qquad \text{Eq. H-9}$$

Substituting $Q(1) = x$ and $A(1) = 1$

$$m = \frac{\log (Q(2)/x)}{\log A(2)} \qquad \text{Eq. H-10}$$

Substituting $Q(2) = \frac{1.49}{n} A(2) \left(\frac{A(2)}{p}\right)^{2/3} s^{1/2}$ and

$$x = \frac{1.49}{n} \frac{s^{1/2}}{B^{2/3}}$$

the equation for m simplifies to

$$m = \frac{\log \left[A(2)^{5/3} \left(\frac{1}{1 + \frac{2D}{B}\sqrt{1 + Z^2}}\right)^{2/3}\right]}{\log A(2)} \qquad \text{Eq. H-11}$$

where: D = maximum depth of channel, ft

B = bottom width, ft

Z = side slope, ft/ft

$A(2) = BD + ZD^2$

Figure H-2 is a nomograph for solution of equation H-11.

x and m for rectangular cross sections may estimated by using side slope ratio (Z) of zero.

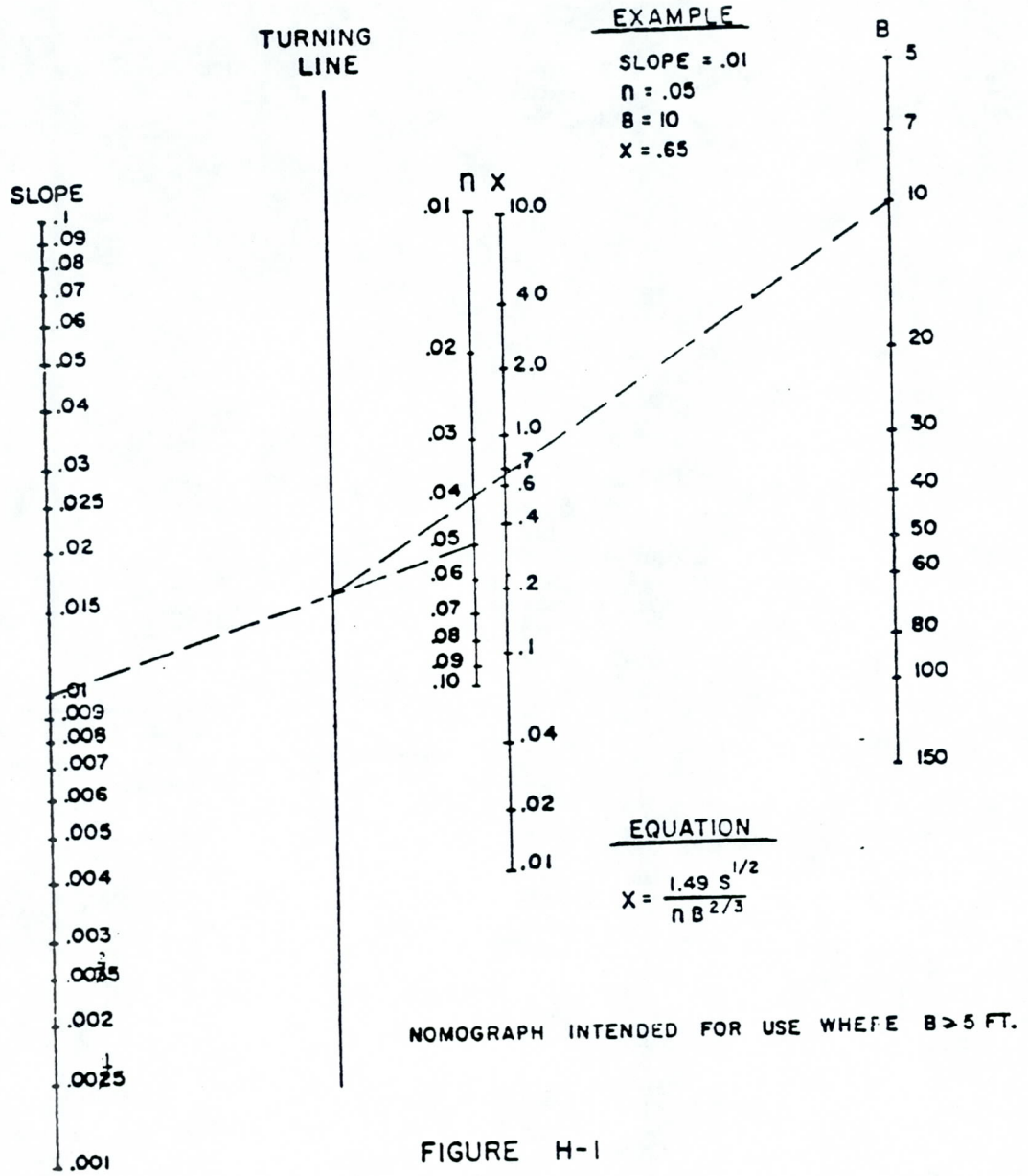
Example 1

Estimate x and m for the channel with the following characteristics.

NOMOGRAPH FOR ESTIMATING X FOR A TRAPEZOIDAL CHANNEL

$Q = XA^M$

SLOPE = BOTTOM SLOPE (FT/FT)
n = MANNING'S n
B = BOTTOM WIDTH (FT)



NOMOGRAPH INTENDED FOR USE WHERE B > 5 FT.

FIGURE H-1

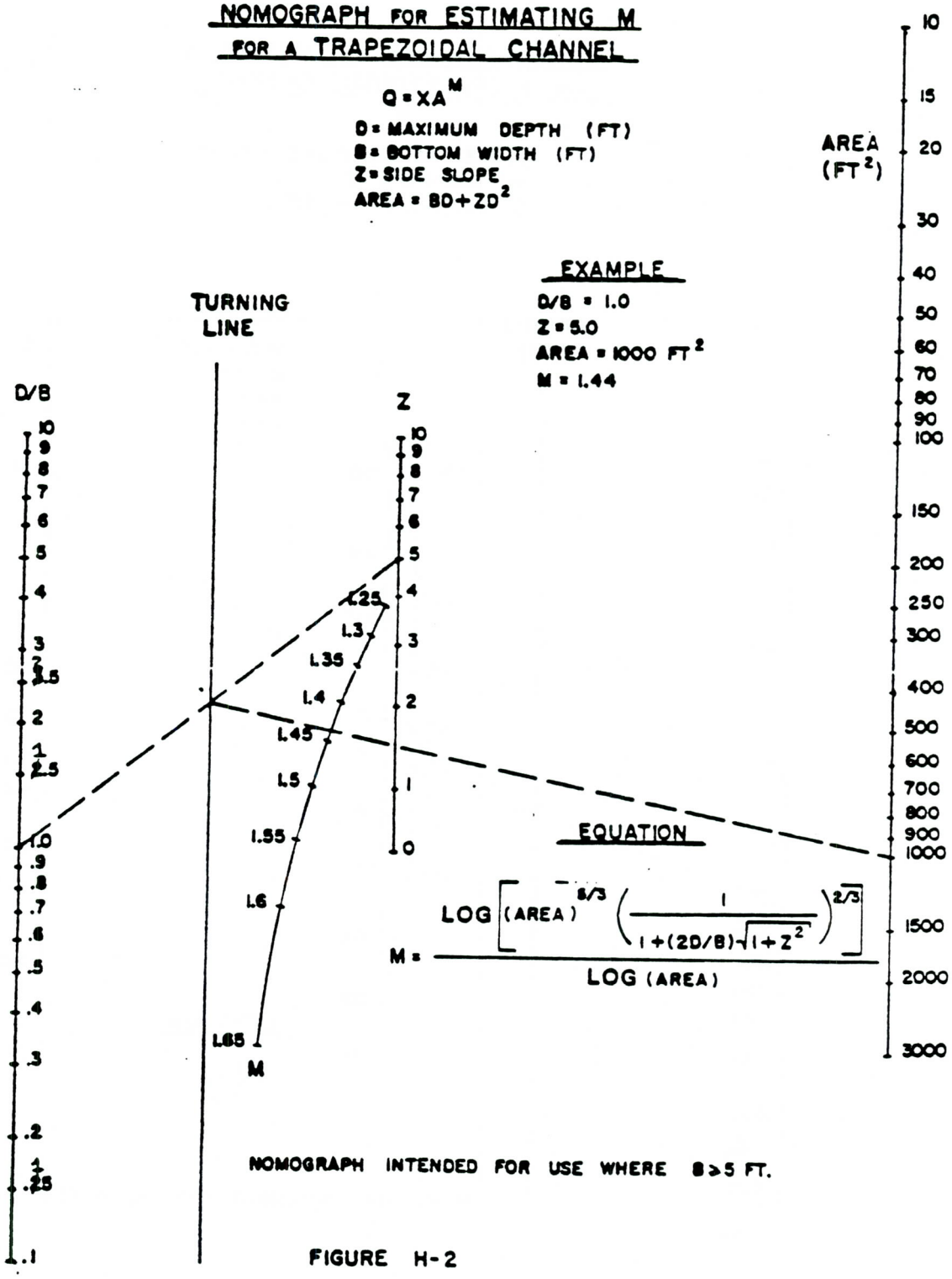
NOMOGRAPH FOR ESTIMATING M FOR A TRAPEZOIDAL CHANNEL

$Q = XA^M$

D = MAXIMUM DEPTH (FT)
B = BOTTOM WIDTH (FT)
Z = SIDE SLOPE
AREA = $BD + ZD^2$

EXAMPLE

D/B = 1.0
Z = 5.0
AREA = 1000 FT^2
M = 1.44



EQUATION

$$M = \frac{\log\left[(\text{AREA})^{-5/3}\left(\frac{1}{1+(2D/B)\sqrt{1+Z^2}}\right)^{2/3}\right]}{\log(\text{AREA})}$$

NOMOGRAPH INTENDED FOR USE WHERE B > 5 FT.

FIGURE H-2

bottom width = 10 feet

side slopes = 5:1

maximum depth = 8 feet

n = .04

bottom slope = 0.5%

Using equation H-8 to estimate x,

$$x = \frac{1.49}{.04} \frac{(.005)^{1/2}}{(10)^{2/3}} = 0.57$$

$$\text{AREA} = BD + ZD^2 = (10 \times 8) + (5 \times 8^2) = 400$$

Using equation H-11 to estimate m,

$$m = \frac{\log \left((400)^{5/3} \left(\frac{1}{1 + \frac{2(8)}{10}\sqrt{1 + 5^2}} \right)^{2/3} \right)}{\log 400}$$

$$m = 1.42$$

The discharge-area equation is

$$Q = 0.57\ A^{1.42}$$

The x and m can be entered into TR-20 if the trapezoidal cross section is representative of the reach.

For a triangular cross section, Manning's equation may be put in the form $Q = xA^m$ through the following derivation.

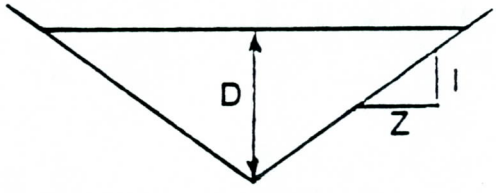


Figure H-3

$$A = Z\ D^2,\ ft^2$$

$$p = 2D\sqrt{1 + Z^2}\ ,\ ft.$$

where: Z = side slope ratio, ft/ft

D = depth, ft

A = area, ft^2

p = wetted perimeter ft.

Z and D are defined as shown on Figure H-3.

Substituting into Manning's equation and simplifying,

$$Q = \frac{0.94}{n} s^{1/2} \left(\frac{Z}{1 + Z^2}\right)^{1/3} A^{4/3} \qquad \text{Eq. H-12}$$

if $Z \geq 3$ the equation H-12 may be approximated by

$$Q = \frac{0.94}{n} \frac{s^{1/2}}{(Z)^{1/3}} A^{4/3} \qquad \text{Eq. H-13}$$

Therefore, for a triangular cross section

$$x = \frac{0.94}{n} \frac{s^{1/2}}{Z^{1/3}} \qquad \text{Eq. H-14}$$

For all triangular sections, assuming uniform roughness and normal flow,

$$m = 4/3 \qquad \text{Eq. H-15}$$

An example of application of the triangular cross section guidelines follows.

Example 2.

From a topographic map, the following data is obtained. Slope of channel bottoms is

$$s = \frac{10 \text{ ft.}}{10000 \text{ ft.}} = .001$$

At one contour interval (10 feet) above the channel bottom the top width of the cross section is measured to be 800 feet. Therefore,

$$Z = \frac{1}{2} \times \frac{800 \text{ ft}}{10 \text{ ft}} = 40$$

The n value (based on vegetation and obstructions in the cross section) is estimated to be 0.05.

Therefore, using equation H-14 to estimate x,

$$x = \frac{0.94}{.05} \frac{(.001)^{1/2}}{(40)^{1/3}} = .17$$

From equation H-15,

$m = 1.33$

The equation for the discharge-area relationship is

$$Q = .17\ A^{1.33}$$

The x and m can be entered into TR-20 if the triangular cross section is representative of the reach.

REACH LENGTH GUIDELINES

Reach Length in Relation to Attenuation

Reach routings using the Modified Att-Kin model approach a kinematic model routing if the reach lengths are short. The inflow hydrograph is essentially translated in time with little or no attenuation of the peak.

For a given valley cross section and inflow hydrograph, the attenuation increases as the reach length increases. To illustrate this concept, consider the length factor k* (as defined in Appendix G.)

$$k^* = \frac{Q_I}{k\ V_I^{\ m}}$$

where: Q_I = peak of runoff hydrograph, cfs.

V_I = volume of runoff hydrograph, ft^3.

k,m = coefficients of valley storage discharge relationship, $Q = kS^m$.

Using the valley storage–discharge equation and the flow area–discharge equation, it can be shown that

$$k = x/L^m \qquad \text{Eq. H-16}$$

Substituting the value of k from equation H-16 into H-15,

$$k^* = \frac{Q_I \, L^m}{x \, V_I^m} = \left(\frac{Q_I}{x V_I^m}\right) L^m \qquad \text{Eq. H-17}$$

Thus, for a given inflow hydrograph (with Q_I and V_I) and valley cross section (with x and m), the value of k* increases with increasing reach length.

Figure H-4 shows a relationship of k* versus Q*. Q* is a measure of peak flow reduction or attenuation.

$$Q^* = \frac{Q_o - Q_b}{Q_I - Q_b}$$

where: Q_o = peak of outflow hydrograph, cfs.
Q_I = peak of inflow hydrograph, cfs.
Q_b = baseflow, cfs.

Figure H-4 shows typical k* versus Q* curves for two given inflow hydrographs and valley cross sections as well as the limits on k* and Q* defined by kinematic routing, conservation of mass and routing through a cascade of linear reservoirs. The linear reservoir limit is unique for a particular hydrograph and valley configuration. As the routing reach length increases, k* increases and Q* decreases. k* versus Q* plots for other hydrographs and valley cross sections could plot anywhere below the kinematic and conservation of mass limits plotted on Figure H-4 and above a unique linear reservoir routing limit.

Data used to calculate curve 1 include:

Q_I = 4,000 cfs, V_I = 1,221 ac-ft
x = 0.4 and m = 1.3 for lengths ranging from 2,000 feet to 25,000 feet.

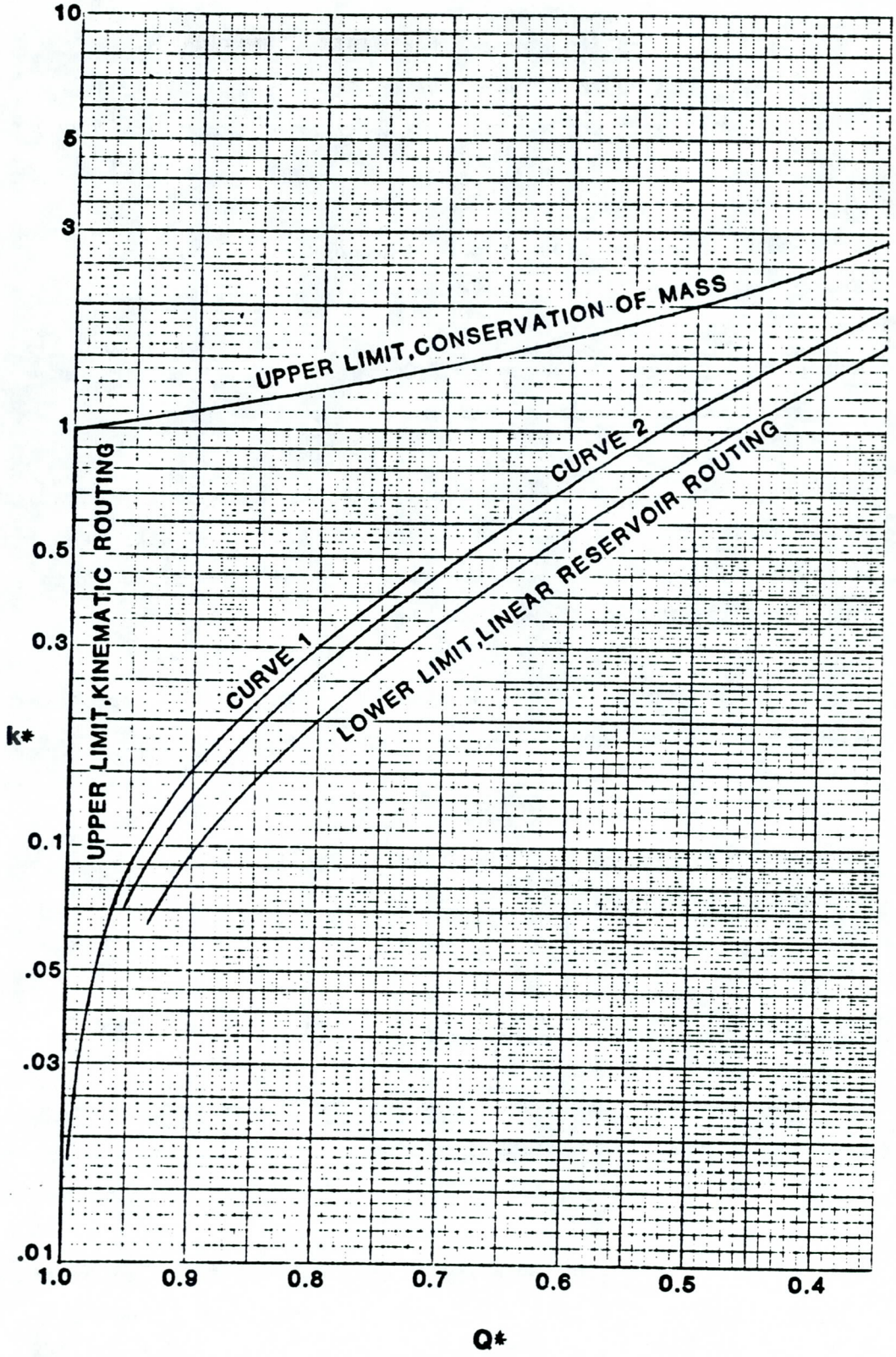


FIGURE H-4

ATTENUATION VERSUS LENGTH FACTOR

Data used to calculate curve 2 include:

Q_I = 4,000 cfs, V_I = 888 ac-ft

x = 0.15 and m = 1.3 for lengths ranging from 2,000 feet to 25,000 feet.

From these two examples, it can be seen that with different values of V_I and x that a significant difference in peak outflow will result.

For curve 1, a reach length of 2,000 feet would result in k* = .017 (from Eq. H-17) and less than 1% reduction in peak discharge.

With this small attenuation, the routing approaches a kinematic routing. However, for curve 2, a reach length of 2,000 feet will result in k* = .07 (from Eq. H-17) and a peak flow reduction of almost 5%. This routing has much less kinematic effect than that for curve 1.

The reach length at which a Modified Att-Kin routing approaches a kinematic routing depends on the four variables Q_I, V_I, x and m.

The value of k* (which is related to each of the four variables) determines to what degree the Modified Att-Kin routing approaches a kinematic routing.

Reach Length in relation to Travel Time

The following discussion will explain the general reach length guidelines and provide details on selecting a main time increment and/or reach lengths for routings.

As a general guideline, if a reach length is selected such that the kinematic travel time is longer than the main time increment, a kinematic routing (one with no attenuation and only translation) will be avoided.

Conversely, if the main time increment is chosen such that it is less than the travel time, a kinematic routing will be avoided.

The relationship of main time increment, peak travel time (kinematic), reach length and kinematic routing effect can be illustrated through equation G-17.

$$C_R = \frac{2\Delta t}{2K + \Delta t} \qquad \text{Eq. G-17}$$

where: C_R = Modified Att Kin routing coefficient.

Δt = main time increment, seconds or hours.

K = slope of storage discharge curve, seconds or hours.

K is also the kinematic travel time of the peak discharge through the reach. For the case where there is no baseflow and $\hat{Q}_o$ equals Q_I, combining Eq. G-27 and H-17 and simplifying,

$$K = \frac{L}{m\left(\frac{Q_I}{A}\right)} = \frac{L}{mV} \qquad \text{Eq. H-18}$$

where: L = reach length, ft.

m = exponent of discharge storage relationship.

A = flow area, ft^2

mV = wave celerity, ft/sec.

To be consistent with the computer program, m should be between 1.0 and 2.0.

Pure translation of the inflow hydrograph occurs when C_R equals 1.0.

In order to avoid a kinematic translation of the inflow hydrograph,

$$K > \frac{\Delta t}{2} \qquad \text{Eq. H-19}$$

The travel time should be greater than one half the main time increment. In terms of reach length and travel time,

$$\frac{L_{min}}{mV} = \frac{\Delta t}{2} \qquad \text{Eq. H-20}$$

where: L_{min} = minimum acceptable reach length, feet.

Solving equation H-20 for L_{min},

$$L_{min} = \frac{\Delta t}{2} mV \qquad \text{Eq. H-21}$$

In Equation H-20 and H-21, if V is in ft. per second then Δt must be in seconds.

The reach length for which the travel time equals one-half the main time increment is the minimum reach length to select in order to avoid kinematic translation. At this length, the peak travel time would be rounded up to the main time increment. If a number of these reaches were routed consecutively, the time error would accumulate. It should be realized that in certain circumstances such as routing structure outflows, routing hydrographs on steep streams with high velocities, or routing 10 day duration hydrographs that this length may be impractical to use.

In order to minimize error in rounding the peak travel time to the main time increment (if the kinematic travel time is less than the main time increment), the reach length should be selected such that the travel time is greater than or equal to the main time increment.

$$K = \frac{L_R}{mV} = \Delta t \qquad \text{Eq. H-22}$$

where: L_R = minimum recommended reach length, ft.

$$L_R = \Delta t \; mV \qquad \text{Eq. H-23}$$

If $K = \Delta t$ then

$$C_R = \frac{2\Delta t}{2\Delta t + \Delta t} = 2/3 \qquad \text{Eq. H-24}$$

If $K > \Delta t$ then $C_R < 2/3$ and the reach length is in the recommended range. If C_R is between 2/3 and 1.0 the length is in the acceptable range. If C_R is 1.0 the reach length is too short.

Figure H-5 is a nomograph for selecting the main time increment, on the minimum reach length (L_{min}) or the minimum recommended reach length (L_R).

Example 3

At a particular cross section mV is estimated to be 4 ft/sec based on normal flow assumptions. If the desired main time increment is .20 hours, from Eq. H-20

$$L_{min} = 4 \text{ ft/sec} \times \frac{.20}{2} \text{ hours} \times 3600 \text{ sec/hr} = \frac{1440}{\cancel{2880}} \text{ feet.}$$

From Equation H-23,

$$L_R = 4 \text{ ft/sec} \times .20 \text{ hours} \times 3600 \text{ sec/hr} = 2880 \text{ feet.}$$

A reach length shorter than 1440 feet is considered too short, a reach length between 1440 and 2880 feet is acceptable and a reach length greater than 2880 feet is recommended.

If L_{min} is too long for a particular application of TR-20 then the main time increment may be reduced to give a shorter L_{min}.

In section 3.8.3 it is recommended not to change the main time increment within a pass. However, if there is need to maintain short reaches, the main time increment may be changed within a pass with consideration given to the possibility of truncating the hydrograph at 300 points.

NOMOGRAPH RELATING MAIN TIME INCREMENT WITH REACH LENGTH

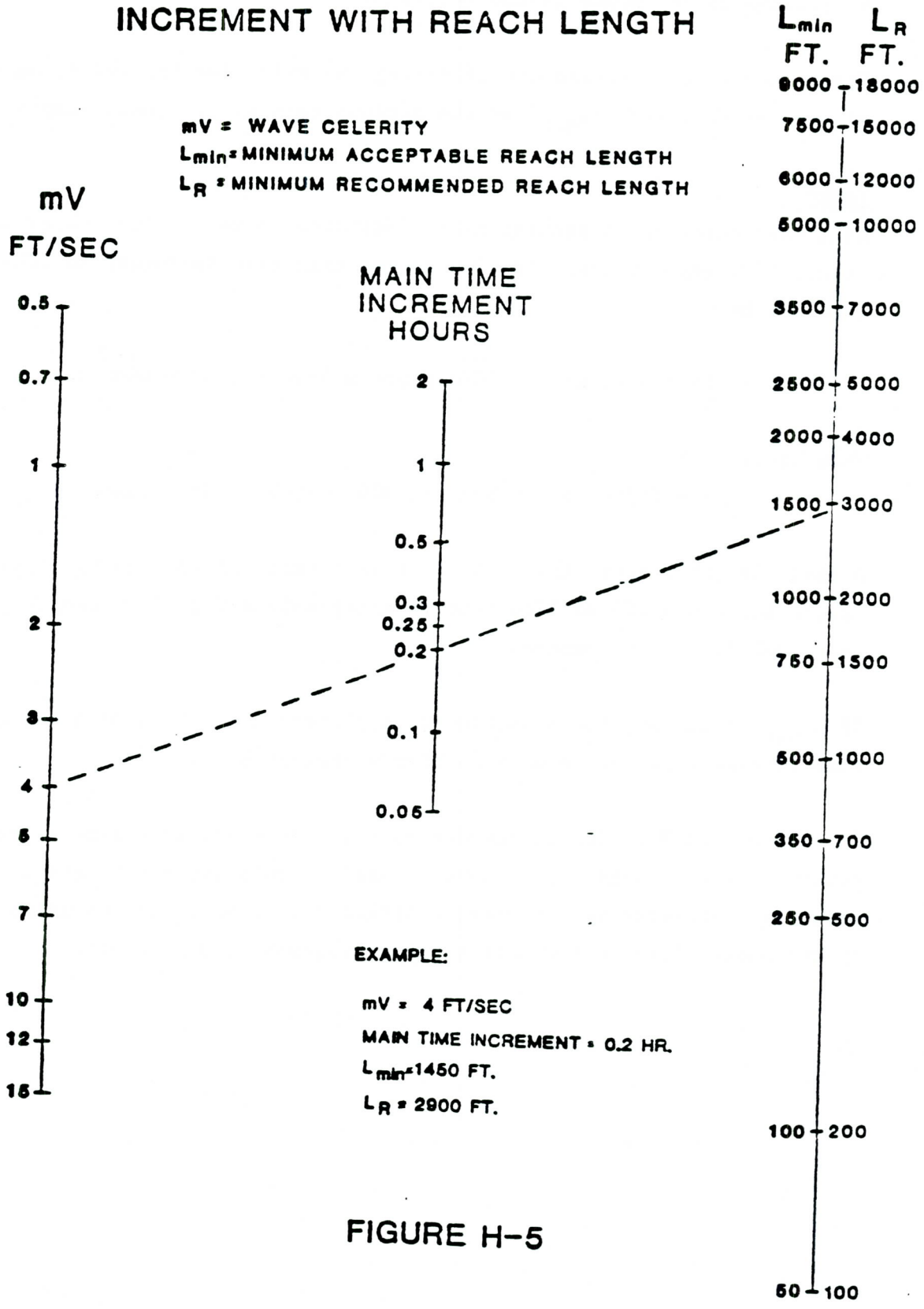


FIGURE H-5

References

Chow, V. T. 1959. Open Channel Hydraulics, McGraw Hill Book Co.

Haung, Y. H. 1978. Channel Routing by Finite Difference Method, Journal of the Hydraulics Division, ASCE, Vol. 104, Oct. 1978.

Theurer, F. D. and Comer, G. H., Verification of SCS Dam-Breach Routing Procedure, Presented at 1979 Winter Meeting of American Society of Agricultural Engineers.

Comer, G. H., Theurer, F. D. and Richardson, H. H., The Modified Att-Kin Routing Model, presented at the International Symposium on Rainfall-Runoff Modeling, Mississippi State University, May 1981.

:U.S. GOVERNMENT PRINTING OFFICE: 1982-360-931:SCS:685

TECHNICAL RELEASE 20

APPENDIX I

DATA CHECK COMPUTER PROGRAM (SCSCHK20)

USER INSTRUCTIONS

INTRODUCTION

Most problems associated with applying the ~~revised (May, 24, 1982)~~ TR-20 Project Formulation Hydrology computer program successfully 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.

The data check computer program (SCSCHK20) has been designed to aid the user of the TR-20 program by identifying most data errors. Appropriate error messages will be printed when data problems are found. Users of the TR-20 program are encouraged to run the SCSCHK20 program prior to initial use of any set of data. Corrections made due to use of this program will lead to cost and time savings.

PROCEDURE

Input data to the data check program is identical to the data that would be entered into the ~~May, 24, 1982, revised~~ TR-20 program. More than one job may be entered at a time. The program will also handle intermediate peaks data at the end of a job.

All program error messages are printed below and to the right of the echo print of the input record being analyzed. Most types of input records are analyzed independently for errors. Only a limited amount of information is stored for checking data sequence. Informational messages follow the block of records they pertain to and are also printed to the right of the input records. Thus, all the messages are readily identifiable on the right side of the output.

TYPES OF MESSAGES

There are two types of error messages printed out to aid the user in identifying input mistakes. 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 and

2) possible errors identified by ???, which notify the user that the specific input may contain a mistake or be positioned in error, but could be correct dependent on usage (as in the example of a null site).

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 information is not available. Cross section information is required for: 1) a REACH record with no routing coefficient given, 2) a DIVERT record with no OUT 1 discharge given, 3) standard control records following a DELETE record which reference a section number not previously used, ~~or 4) a cross section number on an INSERT record which references a section not previously used~~. This message also appears for an INSERT record or

???STRUCTURE XX NOT PREVIOUSLY LOADED - Structure information is required for a reservoir routing. A null site does not require a structure rating table. An INSERT record or A standard control following a DELETE ~~or INSERT~~ record which references a structure number not previously used is an error.

???RAIN TABLE XX NOT LOADED - A requested rain table is not included in TR-20 data. Rain tables 1 to 6 are 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.

???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.

???OPERATION XXXXXX MISSPELLED - Operation name may actually be misspelled or there is an error in the data code or operation number.

***ILLEGAL VALUE IN COL. XX - XX - This appears when there is a negative value in a READHD table. It will also appear if there is a value of zero in the first three data fields of a READHD 9 record.

???BANKFULL ELEVATION LESS THAN SECOND POINT - The bankfull elevation is below the first non zero discharge point of rating. 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.

SUMMARY

The data check program is recommended for use prior to utilizing the ~~May 24, 1982, version of the~~ TR-20 program. By checking all initial input data, the user will increase the probability of achieving a successful TR-20 run.

Additional data checks that require more complex logic are included in the TR-20 program; however, many of the simpler data errors may only be identified by the data check program.

COMPUTATION SHEET
SCS-ENG-523 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE ARIZONA | PROJECT BUCKHORN-MESA W/S
BY | DATE | CHECKED BY | DATE | JOB NO.
SUBJECT CN- CALCULATION SUBAREA 31 | SHEET ____ OF ____

CLASS PROBLEM

385
385
42

SUBAREA NO.	HYD. SOIL GROUP	COVER TYPE	COVER DENSITY (%)	% OF SUBAREA	CN	WEIGHTED CN
31	B	DESERT BR.	15 %	55	77	42.35
	B	URBAN	30% IMPER.	15	72	10.80
	B	URBAN	65% IMPER	30	85	25.50
						78.65
32	B	URBAN	65% IMPER.	50	85	42.5
	B	URBAN	30% IMPER.	50	72	36
						78.5
5	B	DESERT BR,	15%	25	77	
	C	DESERT BR.	15%	29.5	85	
	D	DESERT BR.	15%	45.5	88	

SCS-ENG.-269 DRAFT
REV. May 1982

TR-20
STRUCTURE DATA

STRUCTURE NO._____

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

F-5

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10		11-20		21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME				DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3		RECORD IDENT.
		STRUCTURE ID. (01-99)			IMPORTANT: Line out unused lines. Data fields require decimal points.				
3	STRUCT								
		NOTE: Maximum of 20 data records allowed.							
					Elevation, Ft.	Discharge, CFS	Storage, Acre, Ft.		
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
9	ENDTBL	NOTE: This record must be the last record of this table.							

SCS - ENG. - 273 DRAFT
REV. May 1982

TR - 20
STANDARD CONTROL FOR WATERSHED

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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

EXAMPLES DO NOT ENTER

DATA CODE	OPERATION NAME	OPERATION NO.	X SECT./STRUCT. XSECT. ID.	X SECT./STRUCT. STRUCT ID.	HYDRO. NUMBER INPUT #1	HYDRO. NUMBER INPUT #2	HYDRO. NUMBER OUTPUT	DATA FIELD # 1	DATA FIELD # 2	DATA FIELD # 3	OUTPUT OPTIONS PRINT PEAK	PRINT HYD.	PRINT ELEV.	PRINT VOL.	FILE	SUM.	RECORD IDENT.
6	RUNOFF	1					6	AREA, SQ. MI.	RUNOFF CURVE NO.	T_c, HRS.							EXAMPLES DO NOT ENTER
6	RESVOR	2			6		7	SURF. EL. AT T=0, FT.									
6	REACH	3			7		5	LENGTH, FT.	(OPTIONAL) END AREA COEFF. (X)	(OPTIONAL) EXPONENT (M)							
6	ADDHYD	4			5 (FROM)	6	7										
6	SAVMOV	5															
6	DIVERT	6			IN	OUT1	OUT2 TO	OUT1 DISCHARGE, CFS	OUT 1, Decimal % D.A.	OUT2, I.D.							
	ENDATA							This record is to be used only at end of all standard control records.									
			(Right justify these fields)					IMPORTANT: Data Fields No. 1, 2, and 3 require decimal points.									

NOTE: This form was suggested by members of Massachusetts Planning Staff.

F-14

SCS-ENG.-277 DRAFT
Rev. May 1982

TR-20
INTERMEDIATE PEAKS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

F-22

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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	FROM		THRU		INTERMEDIATE POINTS BETWEEN FROM AND THRU XSECTION / STRUCTURES								RECORD IDENT.
	OR XSECT.	STRUCT.	OR XSECT.	STRUCT.	POINT ID.	DRAINAGE AREA (Sq. Mi.)	POINT ID.	DRAINAGE AREA (Sq. Mi.)	POINT ID.	DRAINAGE AREA (Sq. Mi.)	POINT ID.	DRAINAGE AREA (Sq. Mi.)	
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
ENDJOB	2	This record terminates the entire TR-20 job.											

SCS-ENG.-273A DRAFT
REV. May 1982

TR-20

STANDARD CONTROL FOR WATERSHED

CONTINUATION SHEET

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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

CODE	OPERATION	XSEC	STRUC	HYD. NO.	DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3	OUTPUT OPTIONS	RECORD ID.
		(Right justify these fields)			IMPORTANT: Data Fields No 1, 2, and 3 require decimal points.				

F-16

TR-20

SCS-ENG.-276 DRAFT
REV. May 1982

READ DISCHARGE HYDROGRAPH

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10			11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME		DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3	DATA FIELD NO. 4	DATA FIELD NO. 5	RECORD IDENT.	
			IMPORTANT: Line out unused lines. Data fields require decimal points.						
			HYDROGRAPH NO.						
7	READHD	8							
			STARTING TIME, HRS.	TIME INCREMENT, HRS.	DRAINAGE AREA, SQ. MI.	BASE FLOW, CFS			
7	READHD	9							
			Enter successive entries left to right with first entry for time = 0. Fill last row of data with last entry of table.						
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
9	ENDTBL		NOTE: This record must be the last record of this table.						

SCS-ENG.-274 DRAFT
REV. May 1982

TR-20
EXECUTIVE CONTROL FOR WATERSHED

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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

EXAMPLES DO NOT ENTER

DATA CODE	OPERATION		DATA FIELD #1	DATA FIELD #2	DATA FIELD #3		RECORD IDENT.
7	LIST		This record is used for printout of tabular data and standard control list that are currently effective.				
7	BASFLO	5	NEW BASE FLOW, CFS or VOLUME IN INCHES	IF VOLUME IS IN DATA FIELD No. 1: PEAK TIME, HOURS	BASE TIME, HOURS		
7	INCREM	6	MAIN TIME INCREMENT, HRS.	This increment is required for initial computations. Remains in force until new increment is entered.			

			FROM		THRU									EXAMPLES DO NOT ENTER
			XSECT.	OR STRUCT.	XSECT.	OR STRUCT.	STARTING TIME HOURS	RAINFALL DEPTH INCHES (Set depth and duration to LO for actual rainfall)	RAINFALL DURATION HOURS	RAIN TABLE NO.	AMC	ALTERNATE NO.	STROM NO.	
7	COMPUT	7												
	ENDCMP	1	This record is required at "end" of a watershed, it may follow a series of COMPUT records.											
	ENDJOB	2	This record terminates routing computation and precedes the PEAKS record, if any.											

Right justify these fields

IMPORTANT: Data Fields No. 1, 2, and 3 require decimal points.

TR-20

SCS-ENG.-276 DRAFT
REV. May 1982

READ DISCHARGE HYDROGRAPH

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10		11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME	DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3	DATA FIELD NO. 4	DATA FIELD NO. 5		RECORD IDENT.
7	READHD	8 HYDROGRAPH NO.						
7	READHD	9	STARTING TIME, HRS.	TIME INCREMENT, HRS.	DRAINAGE AREA, SQ. MI.	BASE FLOW, CFS		
			Enter successive entries left to right with first entry for time = 0. Fill last row of data with last entry of table.					
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
9	ENDTBL	NOTE: This record must be last record of this table.						

SCS - ENG. - 275 DRAFT
REV. May 1982

TR - 20
MODIFY STANDARD CONTROL

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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	OPERATION NAME	OPERATION NO.	X SECT. / STRUCT. X SECT. ID.	X SECT. / STRUCT. STRUCT ID.	HYDRO. NUMBER IN-PUT #1	HYDRO. NUMBER IN-PUT #2	HYDRO. NUMBER OUT-PUT	DATA FIELD #1	DATA FIELD #2	DATA FIELD #3	OUTPUT OPTIONS PRINT PEAK	PRINT HYD.	PRINT ELEV.	PRINT VOL.	FILE	SUM.	RECORD IDENT.
					IMPORTANT: Line out unused lines. Data fields require decimal points.												
					IMPORTANT: Modifications must be given in the order that they appear on the standard control list.												
7	INSERT	2						NOTE: The following records are inserted following the XSECTN / STRUCTURE specified.									
6																	
6																	
6																	
6																	
7	ALTER	3						NOTE: Data given in columns 1 to 18 must be identical with standard control record to be altered.									
6																	
6																	
6																	
6																	
7	DELETE	4						NOTE: Data given in columns 1 to 18 must be identical with standard control record to be deleted.									
6																	
6																	
6																	
6																	

SCS-ENG.-277 DRAFT
Rev. May 1982

TR-20
INTERMEDIATE PEAKS

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

F-22

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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	FROM OR XSECT.	FROM OR STRUCT	THRU OR XSECT.	THRU OR STRUCT	INTERMEDIATE POINTS BETWEEN FROM AND THRU XSECTION / STRUCTURES: POINT ID.	DRAINAGE AREA (Sq. Mi.)	POINT ID.	DRAINAGE AREA (Sq. Mi.)	POINT ID.	DRAINAGE AREA (Sq. Mi.)	POINT ID.	DRAINAGE AREA (Sq. Mi.)	RECORD IDENT.
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
END JOB	2	This record terminates the entire TR-20 job.											

SCS-ENG.-271 DRAFT
REV. May 1982

TR-20
CUMULATIVE RAINFALL TABLE

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

F-7

STORM TYPE OR DATE _____

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10			11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE I.D. NAME	TABLE I.D. NO.	DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3	DATA FIELD NO. 4	DATA FIELD NO. 5		RECORD IDENT.
		(1-9)	RUNOFF OPTION	IMPORTANT: Line out unused lines. Data fields require decimal points. TIME INCREMENT					
5	RAINFL								

NOTE: A maximum of 100 entries (20 records) are allowed.

Enter successive entries left to right with first entry for time = 0. Fill last row of data with last entry of table.

8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									

9	ENDTBL		NOTE: This record must be the last record of this table.

SCS-ENG.-270 DRAFT
REV. May 1982

TR-20
STREAM CROSS SECTION DATA
CROSS SECTION NO. _____

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10		11-20		21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME			DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3			RECORD IDENT.

IMPORTANT: Line out unused lines. Data fields require decimal points.

			X SECTION ID. (001-200)	Drainage Area, Sq. Mi.	Bankfull Elevation, Ft.			
2	XSECTN							

(Use 1.0 unless discharge in CSM.)

NOTE: Maximum of 20 data records allowed.

				Elevation, Ft.	Discharge, CFS	End Area, Sq. Ft.		
8					0.0	0.0		
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								

9	ENDTBL	NOTE: This record must be the last record of this table.

SCS - ENG. - 269 DRAFT
REV. May 1982

TR - 20
STRUCTURE DATA
STRUCTURE NO._____

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

F-5

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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			DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3	RECORD IDENT.
		STRUCTURE ID. (01-99)	IMPORTANT: Line out unused lines. Data fields require decimal points.				
3	STRUCT						
		NOTE: Maximum of 20 data records allowed.					
				Elevation, Ft.	Discharge, CFS	Storage, Acre, Ft.	
8							
8							
8							
8							
8							
8							
8							
8							
8							
8							
8							
8							
8							
8							
8							
9	ENDTBL	NOTE: This record must be the last record of this table.					

SCS-ENG.-270 DRAFT
REV. May 1982

TR-20

STREAM CROSS SECTION DATA

CROSS SECTION NO. _____

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10		11-20		21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME			DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3			RECORD IDENT.

IMPORTANT: Line out unused lines. Data fields require decimal points.

			X SECTION ID. (001-200)	Drainage Area, Sq. Mi.	Bankfull Elevation, Ft.		
2	XSECTN						

(Use 1.0 unless discharge in CSM.)

NOTE: Maximum of 20 data records allowed.

		Elevation, Ft.	Discharge, CFS	End Area, Sq. Ft.		
8			0.0	0.0		
8						
8						
8						
8						
8						
8						
8						
8						
8						
8						
8						
8						
8						
8						

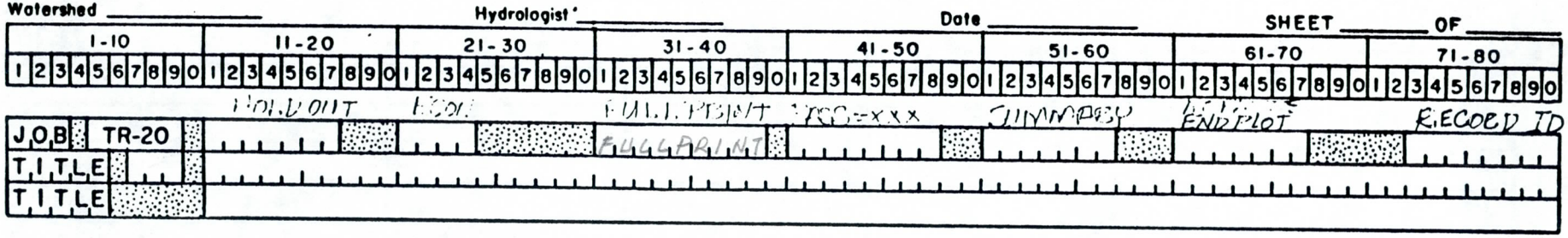
9	ENDTBL	NOTE: This record must be the last record of this table.

SCS-ENG.-264 DRAFT
REV. May 1982

TR-20
JOB & TITLE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____



JOB Record (required)

Columns 1-3	JOB
Columns 5-9	TR-20
Columns 11-17	HOLDOUT Use only if a holdout hydrograph is desired.
Columns 21-24	ECON Use only if peak discharge output for ECON2/URB1 is desired. Locations for this output must be selected for inclusion in Summary Tables 1 and 3 also. Such designation can be made using summary option explained below (columns 51-57) or on Standard Control (column 71).
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 61-67	NOPLOTS Use if no cross section rating plots are desired. ENDPLOT Use if only cross section rating plots are desired with no routings.
Columns 73-80	Optional user information, printed at top of input listing.

TITLE Records (one required, second is optional)

Columns 1-5	TITLE
Columns 7-9	XXX (first TITLE record only). An optional user file number, XXX, is an integer, right justified.
Columns 11-80	Both titles may be any characters desired.

SCS-ENG.-265 DRAFT
REV. May 1982

TR-20

DIMENSIONLESS HYDROGRAPH TABLE

DISCHARGE VS. TIME

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

F-3

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10			11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME		DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3	DATA FIELD NO. 4	DATA FIELD NO. 5		RECORD IDENT.
			IMPORTANT: Line out unused lines. Data fields require decimal points.						
			DIMENSIONLESS TIME INCREMENT (Last entry must be made for dimensionless time 1.0)						
4	DIMHYD								
			NOTE: A maximum of 55 entries (11 records) are allowed.						
			Enter successive entries left to right. First and last entries must be = 0. Fill last row of data with zeros.						
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
9	ENDTBL		NOTE: This record must be the last record of this table						

This diskette contains the USDA, Soil Conservation Service (SCS) 09/83(.2) microcomputer version of the TR-20, Project Formulation - Hydrology program and associated data check and interactive input programs. The programs have the same input requirements and provide the same output as the 9/1/83 mainframe computer programs. The revised second edition draft user's manual dated May 1983 applies to both the mainframe and microcomputer versions.

The programs can be run on IBM compatible microcomputers with 1 or 2 drives and a MS-DOS 2.X operating system. TR-20 and data check programs will require 512 K of memory. The 8087 coprocessor is not required to run the programs.

Files on the diskette include:

System Files

CONFIG.SYS - contains the minimum numbers of files (handles) needed to run TR-20. (FILES = 11).

Program Files

TR20INPT.BAS - an interpreted BASIC interactive input program.

TRCK.EXE - a compiled FORTRAN TR-20 data check program.

TR20.EXE - a compiled FORTRAN TR-20 program.

Sample Data Files

A3.DAT & A5.DAT - the sample (data) jobs 3 & 5 from the TR-20 User's Manual.

The system and program files should be copied onto two formatted diskettes that contain the operating system files to boot your system. The TR20INPT program, BASICA, and ASCII editor can be copied onto one. On the second, copy the CONFIG.SYS file and the TRCK and TR20 programs. The program diskettes should be write-protected to keep from writing output files on the small amount of remaining disk space.

The TR-20 sample data files should be copied onto another diskette for testing as needed.

Output can be directed to a printer, a file, or the screen. Using a printer may slow down execution as printer speed is slower than output file generation. Output file generation is the fastest but TR-20 may require a large amount of disk storage. Screen output may not be too readible as line wrap is used for long lines and printer control characters are displayed and may cause over-printing. The user must decide which output method best suits his/her needs for each run.

The TR-20 and data check programs were compiled using the Microsoft FORTRAN Compiler (3.31). The FORTRAN source code for the PC is not available at this time. The input program was developed using BASICA.

Detailed instructions on how to execute each program follow. The programs are in the normal sequence of use.

A. TR20INPT.BAS - Interactive Program for Creating TR20 Input Data.

1. Load BASICA from a system or from your first program diskette.

2. Enter RUN"TR20INPT from your first program diskette.*

3. You will be prompted for the drive and filename to store the output from this program. Be sure file space is available for the output to be generated. If a one drive system the program diskette can be replaced by a blank diskette for the output.

4. Generated data is appended to the back of the file specified. If the file does not exist, then one is created.

5. If desired, be sure printer is on and ready to echo generated data saved on a diskette. The printer helps you keep track of the data entry. Turn the Caps Lock on before answering the "Output to Printer" prompt.

6. Program comments, instructions, and a data format menu will appear. The menu is ordered by data groups using the TR-20 data code numbers or first letter of the control word for response.

7. Data for a given format line is:

   a. developed by querying the user for input;
   b. the input is then displayed as selected;
   c. if the line is okay, the line is written to a user defined file and to the printer (if on). If not okay, you can reenter the entire line.

8. There is very little data checking in this program, output data is in the input format to be run through the TRCK data check program.

9. To exit the TR20INPT program, enter Q (quit) from the menu to return to the DOS operating system.

10. A locally available ASCII editor program can be used to correct obvious errors in the generated file prior to running TRCK.

B. TRCK.EXE - TR-20 Data Check Program.

1. Enter TRCK from your second program diskette.**

2. Insert the diskette containing the generated file from the TR20INPT program or other input data to be run through the data check program.

3. Following prompt for the input file, enter the drive and filename. On a one drive system, the program diskette can now be removed and the input file data diskette inserted.

4. Following prompt for the output file, enter:

   a. LPT1: to send output to the printer;
   b. CON: to display output on the screen; or
   c. a drive ID and filename to store output on a diskette.

5. The program will read and echo the input and give error, warning, or informational messages to the right of the data.

6. At the end of the input file, an additional data set can be run by answering "Y" or "y" to the RUN ANOTHER JOB? question. Any other response will return you to the DOS operating system.

7. An ASCII editor can be used to correct any identified errors in the input data prior to running TR-20.

C. TR20.EXE - TR-20 Program.

1. Enter TR20 from your second program diskette.**

2. Prompts allow a choice in providing the echo (80-80) list of input and the user notes in the output file. It is recommended that the input list be obtained to identify the output associated with it. The choice is provided to reduce run time on trial runs. The user notes can be printed and kept for future reference.

3. It is important to remove your program diskette and insert a blank diskette in the default drive, or one with the input file, but be sure there is room for the three temporary files. The temporary files generated by the program in the default drive are:

   a. TEMP1 - a binary file of data in Summary Table 2.
   b. TEMP2 - contains the current Standard Control Data.
   c. TEMP4 - a binary file of data in Summary Table 1.

   The temporary files will remain on the diskette in the default drive. The contents of previous files will be destroyed when another TR-20 job is run. Avoid using those names as your filenames.

4. Following prompt for the input file, enter the drive and file name.

5. Following prompt for the output file, enter:

   a. LPT1: to send output to the printer;
   b. CON: to display output on the screen; or
   c. a drive ID and file name to store output on a diskette.

6. Following prompt for the punch output file, enter NUL if no punch output is desired, or a drive ID and file name to store output on a diskette. It is also possible to review the punch output by using LPT1: or CON:.

7. The program will give the 80-80 list, messages, and the computational output similiar to the mainframe version of TR-20.

8. When sending output to a file or to the printer, a status message is displayed on the screen as computations are completed for a section or structure giving the storm and alternate number.

9. If the program terminates due to a fatal error, a message announcing the termination will appear on the screen.

10. At the end of the input file, an additional data set can be run by answering "Y" or "y" to the RUN ANOTHER JOB? question. Any other response will return to the DOS operating system.

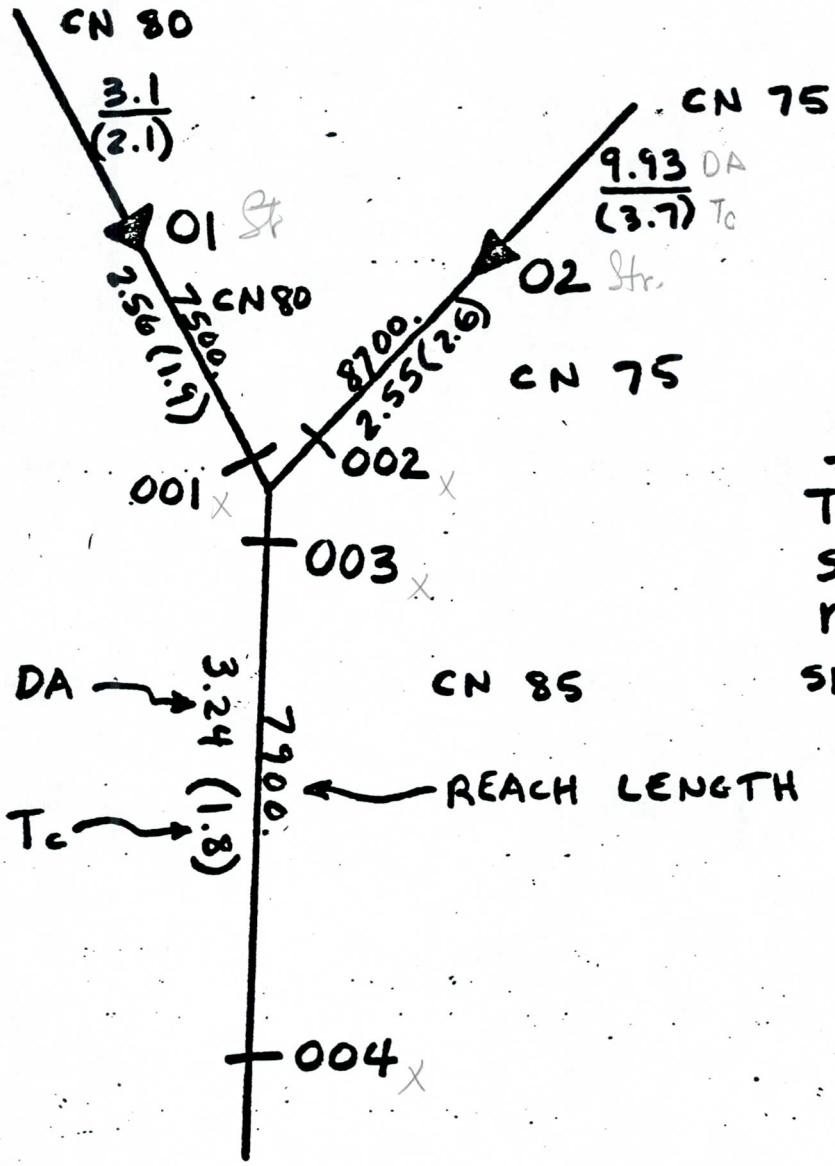
Questions or problems with the programs should be directed to the SCS state conservation engineer in your state. The local Soil and Water Conservation District or USDA, Soil Conservation Service office can provide the address and telephone number.

CREDITS--The TR-20 and TR-20 data check programs were originally converted to MS-DOS by Ted Burns, SCS, Storrs, Connecticut. The TR-20 interactive input program was developed by Luther McDougal and Calvin Jackson, SCS, Fort Worth, Texas. Improvements prior to distribution were made by Harvey Richardson and Roger Cronshey, SCS, Hydrology Unit, Engineering Division, Washington, D.C.

* The TR20INPT.BAS file can also be compiled as an ASCII file. The SCS TR20 program diskette for use with the 8087 coprocessor contains a TR20INPT.EXE file compiled and linked using the IBM BASIC Compiler (1.0). Due to lack of disk space, the smaller interpeted BASIC file is included on this diskette. If using TR20INPT.EXE, steps 1 and 2 are replaced by inserting your program diskette and entering TR20INPT direct from the DOS prompt.

** An alternate way to run the programs on a two drive system is to make B: (or a hard disk) the default drive and enter the programs as A:TR20INPT, A:TRCK, or A:TR20. This allows room for the input/output and TR-20 temporary files on drive B. For large files you can still replace the program diskette with a blank or data diskette for additional space.

TR 20 CLASS PROBLEM



REACH 001 DATA

TRIANGULAR FLOODPL
S=.002
n=.05
SIDE SLOPE 20:1
(SEE P. H-12 TR-20 USERS MANUAL)

For X & M values
X=.31 m=4/3=1.33

USING TR-20 DETERMINE PEAK DISCHARGES FOR 4.5" AND 7.8" OF RAINFALL IN 24 HOURS. USE A TYPE 2 DISTRIBUTION.

DETERMINE DISCHARGES WITH AND WITHOUT STRUCTURES 1 AND 2 IN PLACE.

COMPUTATION SHEET
SCS-ENG-523 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE ANYSTATE	PROJECT TR-20 CLASS PROBLEM		
BY Hem / DATE 9/10/87	CHECKED BY	DATE	JOB NO.
SUBJECT X-SECTION & STR DATA			SHEET ____ OF ____

X-SECTION 002

ELEV (FT)	DISCHARGE (CFS)	END AREA (FT^2)
554.5	0.0	0.0
556.4	144.5	92.6
557.8	433.5	145.9
559.9	1083.7	279.5
561.6	1806.1	408.3
563.2	2889.8	688.1
564.5	4334.7	1320.6
565.4	5779.6	1887.3
566.1	7224.5	2417.1
567.1	9398.1	3143.1

BANK FULL ELEV - 561.4

X-SECTION 004

ELEV (FT.)	DISCHARGE (CFS.)	END AREA (FT^2)
540.6	0.0	0.0
542.3	201.9	95.2
543.7	605.6	209.1
545.8	1513.9	386.6
547.5	2523.2	535.9
549.2	4037.1	1388.0
550.1	6055.7	2249.3
550.7	8074.2	2948.2
551.2	10092.8	3540.1
551.9	13120.6	4328.7

BANK FULL ELEV - 548.7

STR. NO. 01

ELEV. (FT)	DISCHARGE (CFS)	STORAGE (AC-FT)
630.	0.0	500.
632.	88.	900.
634.	245.	1300.
636.	365.	1720.
638.	377.	2200.
640.	388.	2700.

STR. NO. 02

ELEV (FT)	DISCHARGE (CFS)	STORAGE (AC-FT)
605.	0.0	900.
606.	88.	1300.
607.	245.	1700.
609.	377.	2600.
611.	400.	3630.
613.	420.	4770.
615.	438.	6050.

**********80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY**********

```
JOB TR-20                                          SUMMARY   NOPLOTS
TITLE 000 LOT 119 - CLEARWATER HILLS , MOREA HALL ENGINEERING, INC
TITLE 000 PROJECT HYDROLOGY - 100 YEAR STORM      J.N. P93-000-000
 3 STRUCT      01
 8                      73.0        0.0         0.0
 8                      74.0        28.0        .004
 8                      75.0        75.0        .012
 8                      76.0        110.0       .035
 8                      77.0        151.0       .085
 8                      78.0        199.0       .169
 8                      79.0        270.0       .297
 8                      80.0        355.0       .461
 8                      81.0        468.0       .674
 8                      82.0        564.0       .923
 8                      83.0        645.0       1.21
 9 ENDTBL
 6 RUNOFF 1 001       5 .375        89.         .317        1     1
 6 RESVOR 2    01 5   6 73.0                                1     1
   ENDATA
 7 INCREM 6             .08
 7 COMPUT 7 001      01             3.8         1.          2 2  01  01
   ENDCMP 1
   ENDJOB 2
```

**********END OF 80-80 LIST**********

EXECUTIVE CONTROL OPERATION INCREM MAIN TIME INCREMENT = .08 HOURS RECORD ID

EXECUTIVE CONTROL OPERATION COMPUT FROM XSECTION 1 TO STRUCTURE 1 RECORD ID

STARTING TIME = .00 RAIN DEPTH = 3.80 RAIN DURATION= 1.00 RAIN TABLE NO.= 2 ANT. MOIST. COND= 2

ALTERNATE NO.= 1 STORM NO.= 1 MAIN TIME INCREMENT = .08 HOURS

OPERATION RUNOFF CROSS SECTION 1

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
12.08	660.67	(RUNOFF)
16.44	20.29	(RUNOFF)
17.66	16.96	(RUNOFF)
19.65	13.63	(RUNOFF)
23.65	10.29	(RUNOFF)

RUNOFF VOLUME ABOVE BASEFLOW = 2.62 WATERSHED INCHES, 635.08 CFS-HRS, 52.48 ACRE-FEET; BASEFLOW = .00 CFS

OPERATION RESVOR STRUCTURE 1

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
12.12	636.43	82.89
16.45	20.29	73.72
17.66	16.96	73.61
19.65	13.63	73.49

(7A)

AR12 Buckhorn Mesa W/S

Hem 10/18/84

ESTI. 1-Hour Precipitation

From NOAA ATLAS 2, Vol VIII, ARIZONA, P 15.

$$Y_2 = -0.011 + 0.942\left[(X_1)(X_1/X_2)\right]$$

$$Y_{100} = 0.494 + 0.755\left[(X_3)(X_3/X_4)\right]$$

Where

Y_2 = 2 yr, 1-hr esti. value

Y_{100} = 100 yr, 1-hr est. value

X_1 = 2 yr, 6-hr value for Watershed from Atlas = 1.27"

X_2 = 2 yr, 24-hr value for Watershed from Atlas = 1.63"

X_3 = 100-yr, 6-Hr value for watershed from Atlas = 3.28"

X_4 = 100-yr, 24-Hr value for watershed from Atlas = 4.00"

$$Y_2 = -0.011 + 0.942\left[(1.27)(1.27/1.63)\right]$$

$$Y_2 = -0.011 + 0.942(0.990)$$

$$Y_2 = -0.011 + .932 = 0.92"$$

$$Y_{100} = 0.494 + 0.755\left[(3.28)(3.28/4.00)\right]$$

$$= 0.494 + 0.755(2.690)$$

$$= 0.494 + 2.030 = 2.52"$$

40 (U.S. Weather Bureau 1961) only after investigation demonstrated their applicability to data from the area covered by the Atlas.

(7B)

Figure 15. *Precipitation depth-duration diagram (1- to 6-hr).*

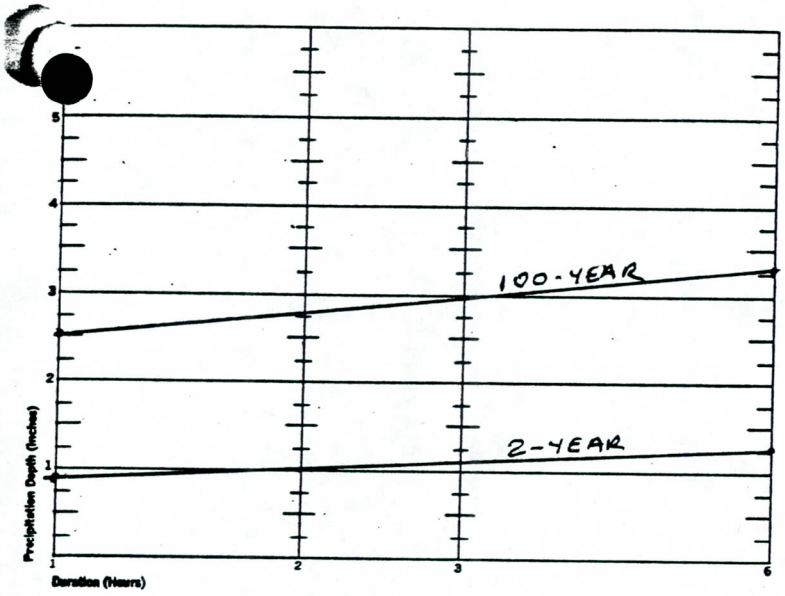


Table 11. *Equations for estimating 1-*

Equation
$Y_2 = -0.011 + 0.942[(X_1)(X_1/X_2)]$
$Y_{100} = 0.494 + 0.755[(X_3)(X_3/X_4)]$
List of variables
Y_2 = 2-yr 1-hr estimated value
Y_{100} = 100-yr 1-hr estimated value
X_1 = 2-yr 6-hr value from precipitation-
X_2 = 2-yr 24-hr value from precipitatio
X_3 = 100-yr 6-hr value from precipitati
X_4 = 100-yr 24-hr value from precipitat

cent. In fact, nine stations at elevations over 6,000 ft had ratios showing differences of less than 5 percent.

The ratio between 2-yr 24-hr values for all data and data the rain-only series was plotted on a map of Arizona. This ed that seven of the nine stations at elevations over 6,000 ft wit tios greater than 1.10 between the two series were concentrated along the front face of the Mogollon Rim or just slightly over the crest of the rim. In this limited region, the data suggest that a series composed of observations containing exclusively rain would be 10 to 20 percent below the 2-yr 24-hr values from the Atlas maps. At the 25-yr return period, differences would likely be about half the 2-yr 24-hr differences; and at the 100-yr return period, there would be no difference. At the 6-hr duration, differences between the two data series are less than 10 percent at all durations. Over the rest of Arizona, the data do not indicate significant differences between a rain-only series and the series composed of all maximum annual events.

Procedures for Estimating Values for Durations Other Than 6 and 24 Hrs

The isopluvial maps in this Atlas are for 6- and 24-hr durations. For many hydrologic purposes, values for other durations essary. Such values can be estimated using the 6- and 24-hr nd the empirical methods outlined in the following sections. The procedures detailed below for obtaining 1-, 2-, and 3-hr estimate re developed specifically for this Atlas. The procedures for obtaining estimates for less than 1-hr duration and for 12-hr duration were adopted from Weather Bureau Technical Paper No. 40 (U.S. Weather Bureau 1961) only after investigation demonstrated their applicability to data from the area covered by this Atlas.

Procedures for estimating 1-hr (60-min) precipitation-frequency values. Multiple-regression screening techniques were used to develop equations for estimating 1-hr values. Factors considered in the screening process were restricted to those that could be determined easily from the maps of this Atlas or from generally available topographic maps.

The 11 western states were separated into several geographic regions. The regions were chosen on the basis of meteorological and climatological homogeneity and are generally combinations of river basins separated by prominent divides. Arizona is located wholly within a region that extends from the crest of the Continental Divide, the Sangre de Cristo Range, and the Sacramento Mountains in Colorado and New Mexico westward to southwestern California, the Virgin River Basin in Nevada, and the Wasatch divide in Utah. Equations to provide estimates for the 1-hr duration for 2- and 100-yr return periods are shown in table 11. Also listed are the statistical parameters associated with each equation. In these equations, the variable $[(X_1)(X_1/X_2)]$ or $[(X_3)(X_3/X_4)]$ can be regarded as the 6-hr value times the slope of the line connecting the 6- and 24-hr values for the appropriate return period.

Estimates of 1-hr precipitation-frequency values for return periods between 2 and 100 yrs. The 1-hr values for the 2- and 100-yr return periods can be plotted on the nomogram of figure 6 to obtain values for return periods greater than 2 yrs or less than 100 yrs. Draw a straight line connecting the 2- and 100-yr values and read the desired return-period value from the nomogram.

Estimates for 2- and 3-hr (120- and 180-min) precipitation-frequency values. To obtain estimates of precipitation-frequency values for 2 or 3 hrs, plot the 1- and 6-hr values from the Atlas on the appropriate nomogram of figure 15. Draw a straight line connecting the 1- and 6-hr values, and read the 2- and 3-hr values from the nomogram. This nomogram is independent of return period. It was developed using data from the same region used to develop the 1-hr equations.

(11A)

ARIZONA BUCKHORN-MESA WATERSHED

R. McArthur 7/30/79 Hem 11/19/80

PRECIPITATION-FREQUENCY RELATIONSHIP

SOURCE: NOAA ATLAS 2 "PRECIPITATION-FREQUENCY ATLAS OF WESTERN U.S. VOL. VIII ARIZONA

6 HR DURATION POINT PRECIP

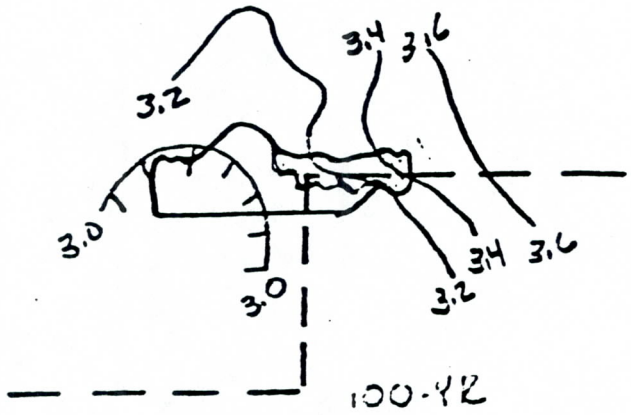
FREQUENCY (Yrs)	MEAN MAP VALUE (In)	FACTOR	PLOTTED ANNUAL SERIES VALUE (In)	ANNUAL SERIES VALUE USED (In)
100	3.28	1.00	3.28	3.28
50	2.89	1.00	2.89	2.89
25	2.56	1.00	2.56	2.50
10	2.08	0.99	2.06	2.04
5	1.76	0.96	1.69	1.67
2	1.27	0.88	1.12	1.13

24 HR DURATION POINT PRECIP

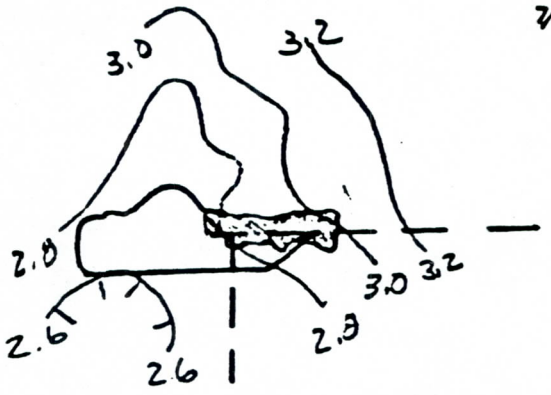
FREQUENCY (Yrs)	MEAN MAP VALUE (In)	FACTOR	PLOTTED ANNUAL SERIES VALUE (In)	ANNUAL SERIES VALUE USED (In)
100	4.00	1.00	4.00	4.05
50	3.58	1.00	3.58	3.58
25	3.18	1.00	3.18	3.15
10	2.59	0.99	2.56	2.58
5	2.23	0.96	2.14	2.10
2	1.63	0.88	1.43	1.45

(11B) SOURCE: NOAA ATLAS 2 "PRECIPITATION-FREQUENCY ATLAS OF WESTERN UNITED STATES" VOL. VIII ARIZONA

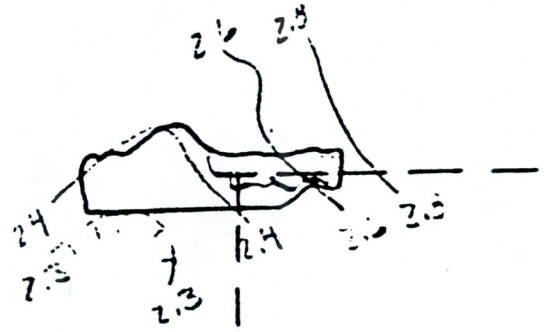
RPM 7/30/79



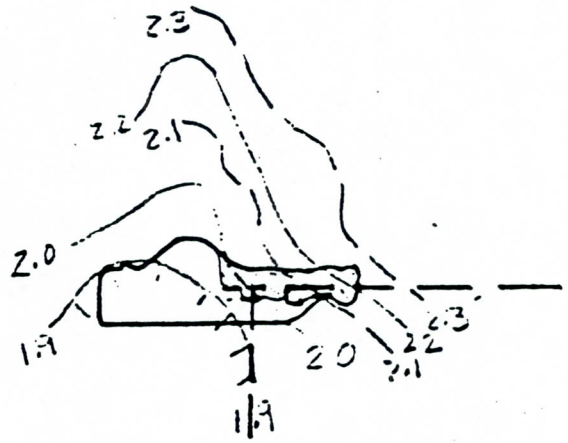
100-YR



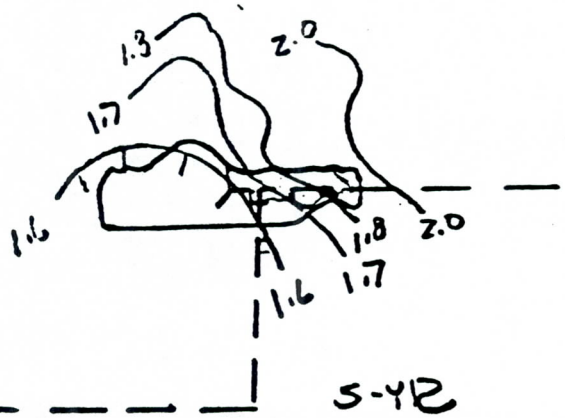
50-YR



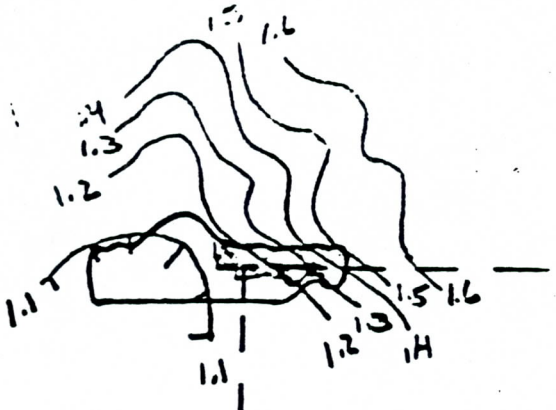
25-YR



10-YR



5-YR



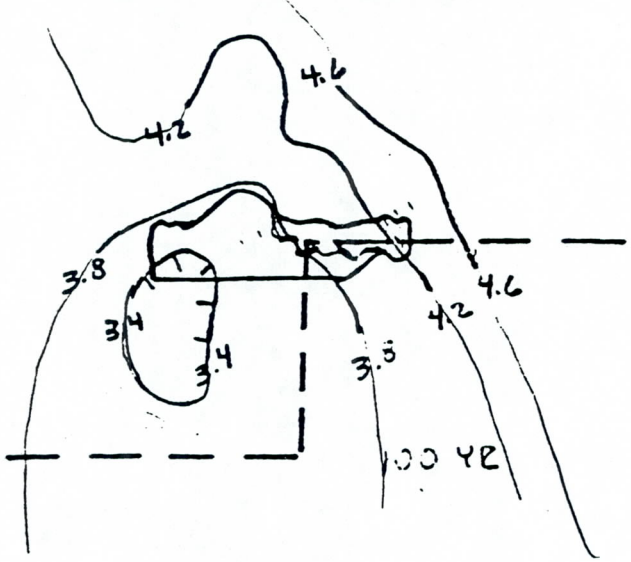
2-YR

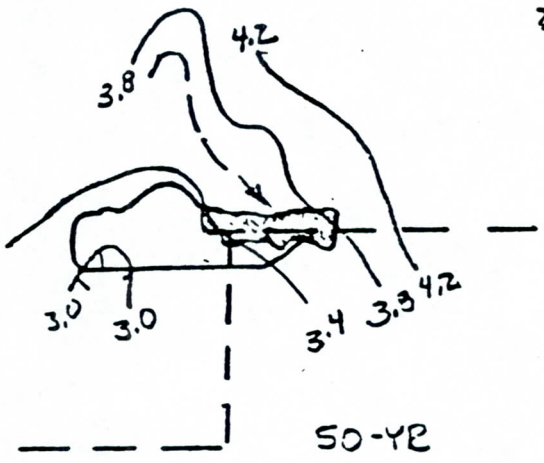
6 HR DURATION

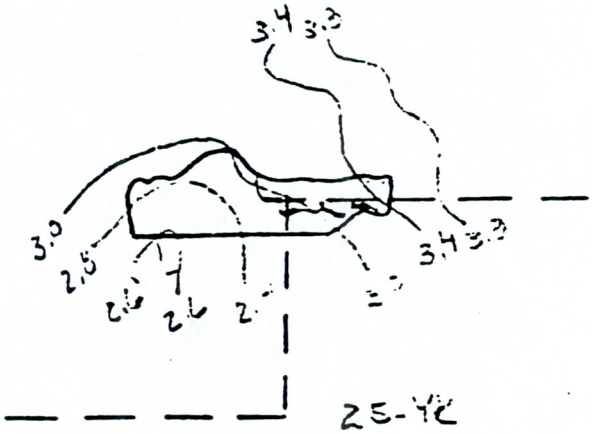
BUCKHORN-MESA WATERSHED
PRECIPITATION ISOHYETS

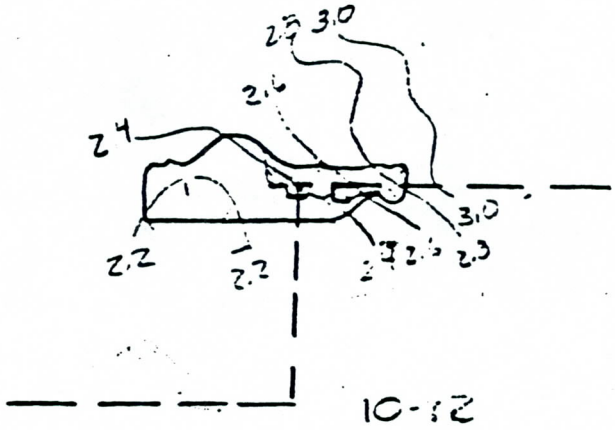
(11.C) SOURCE: NOAA ATLAS 2 "PRECIPITATION-FREQUENCY ATLAS OF WESTERN UNITED STATES" VOL. VIII ARIZONA

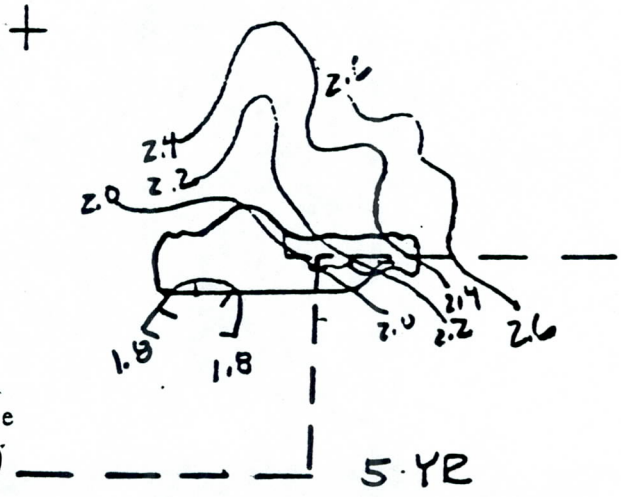
RDM 2/30/79

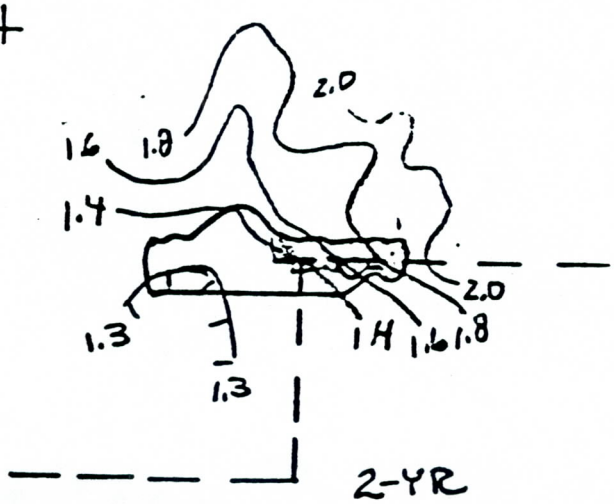












24-HR DURATION

BUCKHORN-MESA WATERSHED
PRECIPITATION ISOHYETS

(11D)

ARIZONA — BUCKHORN--MESA WATERSHED

R.McArthur 7/30/79-

COMPUTATION OF WEIGHTED POINT PRECIP VALUES OVER THE WATERSHED AREA

100 YR 6 HR

P	P_{avg}	NO. OF DOTS	%/100
3.47	3.43	2	0.22
3.4	3.3	4	0.44
3.2	3.15	3	0.34
3.1			
		3.28"	

50 YR 6 HR

P	P_{avg}	NO. OF DOTS	%/100
3.03	3.02	1	0.11
3.0	2.9	6	0.67
2.8	2.79	2	0.22
2.78			
		2.89"	

25 YR 6 HR

P	P_{avg}	NO. OF DOTS	%/100
2.73	2.67	3	0.33
2.6	2.51	6	0.67
2.42			
		2.56"	

10 YR 6 HR

P	P_{avg}	NO. OF DOTS	%/100
2.25	2.23	1	0.11
2.2	2.15	3	0.33
2.1	2.05	3	0.33
2.0	1.97	2	0.23
1.95			
		2.08"	

5 YR 6 HR

P	P_{avg}	NO. OF DOTS	%/100
1.95	1.88	3	0.33
1.8	1.75	3	0.34
1.7	1.65	3	0.33
1.6			
		1.76"	

2 YR 6 HR

P	P_{avg}	NO. OF DOTS	%/100
1.5	1.45	1	0.11
1.4	1.35	2	0.23
1.3	1.25	3	0.33
1.2	1.17	3	0.33
1.15			
		1.27"	

100 YR 24 HR

P	P_{avg}	NO. OF DOTS	%/100
4.3	4.25	1	0.11
4.2	4.0	7	0.78
3.8	3.78	1	0.11
3.76			
		4.00"	

50 YR 24 HR

P	P_{avg}	NO. OF DOTS	%/100
3.9	3.85	1	0.11
3.8	3.6	6	0.67
3.4	3.38	2	0.22
3.36			
		3.58"	

25 YR 24 HR

P	P_{avg}	NO. OF DOTS	%/100
3.5	3.45	1	0.11
3.4	3.2	6	0.67
3.0	2.97	2	0.22
2.95			
		3.18"	

10 YR 24 HR

P	P_{avg}	NO. OF DOTS	%/100
2.9	2.85	1	0.11
2.8	2.7	3	0.33
2.6	2.5	4	0.44
2.4	2.38	1	0.12
2.35			
		2.59"	

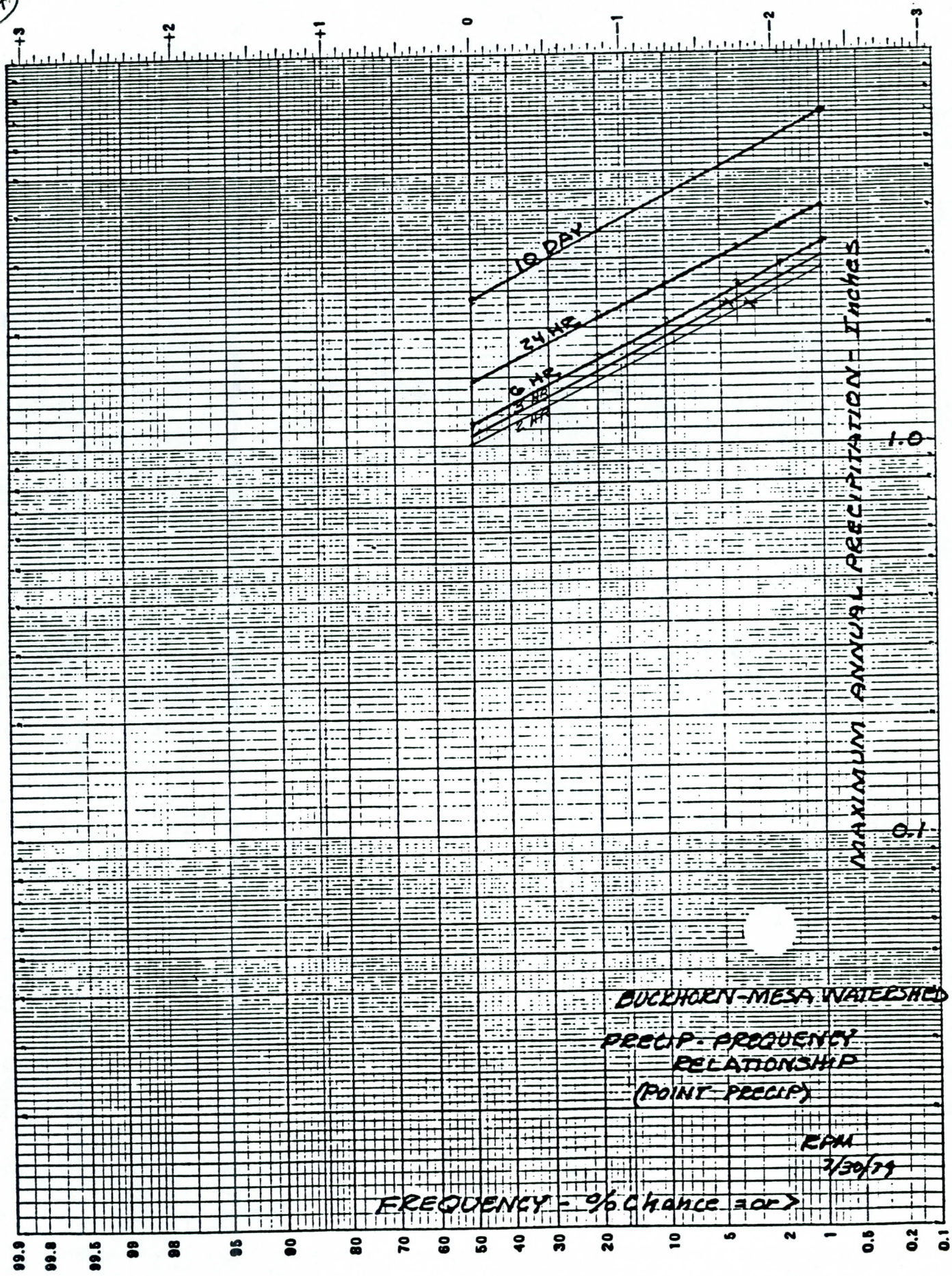
5 YR 24 HR

P	P_{avg}	NO. OF DOTS	%/100
2.47	2.43	1	0.11
2.4	2.3	4	0.45
2.2	2.1	4	0.44
2.0			
		2.23"	

2 YR 6 HR

P	P_{avg}	NO. OF DOTS	%/100
1.9	1.85	2	0.22
1.8	1.7	3	0.34
1.6	1.5	3	0.33
1.4	1.39	1	0.11
1.38			
		1.78"	

(12A)



GRAPH PAPER

(16A)

Dames & Moore
Jim Geiser

FILE 12674-002
SUBJECT Rainfall vs Time For July 17-18 Storm SHEET ___ OF ___

Ref: (1) D. M Calculations For Hydrologic Analysis By Anand Prakash
(2) Report On Meteorology Of The Storm Of July 17 By Bob Allen, D. M Dated Aug 30, 1984
(3) Rainfall Data For Spook Hill & AT&T Station By MCFCD

REVISIONS
BY ____ DATE ____ TO EO ____
BY ____ DATE ____ TO EO ____

Time Minutes	P/P_{TOTAL} (Ratio)
0	0
12	0.020
24	0.065
36	0.160
48	0.460
60	0.755
72	0.880
84	0.920
96	0.935
109	0.944
120	0.952
132	0.960
144	0.968
156	0.976
168	0.984
180	0.992
192	1.000

DATE 10/8/84
CHECKED BY ____
COPY TO EO ____

Dames & Moore

(16B)

COMPUTATION SHEET

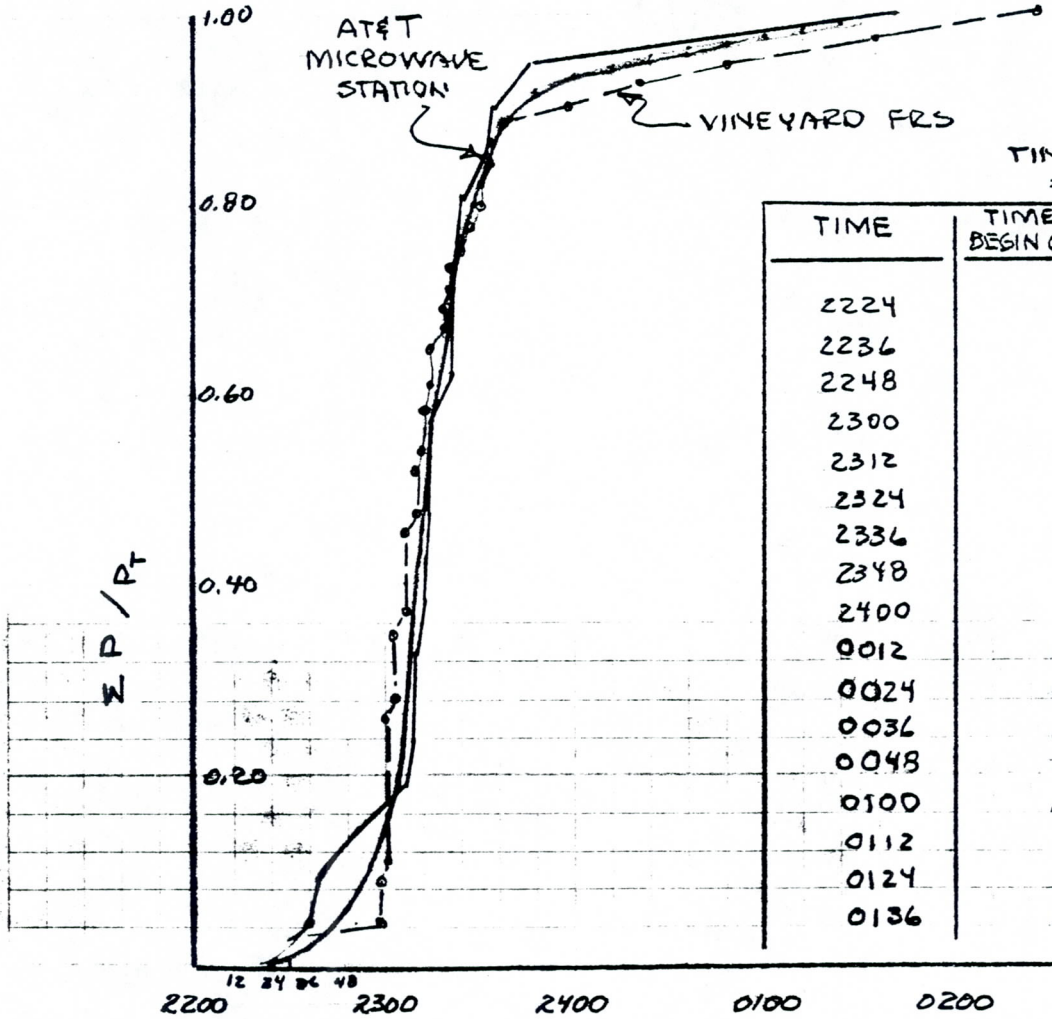
SCS–ENG–523 Rev. 8–69

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE		PROJECT		
ARIZONA		BUCKHORN-MESA WATERSHED		
BY	DATE	CHECKED BY	DATE	JOB NO.
R. McArthur	8/8/84			
SUBJECT				SHEET ____ OF ____
DERIVATION OF STORM DISTRIBUTION				

JULY 17-18, 1984

STORM DURATION APPROX FROM 10:30 pm (2230) July 17
UNTIL 1:30 am (0130) July 18, 1984
(3 Hrs)



TIME INCREMENT
= 12 Min = 0.20 Hrs.

TIME	TIME FROM BEGIN OF STORM	P/Pt	
2224	0	0	0.02
2236	12	0.020	0.045
2248	24	0.065	0.095
2300	36	0.160	0.300
2312	48	0.460	0.295
2324	60	0.755	0.125
2336	72	0.880	0.040
2348	84	0.920	0.015
2400	96	0.935	0.009
0012	108	0.944	0.008
0024	120	0.952	0.008
0036	132	0.960	0.008
0048	144	0.968	0.008
0100	156	0.976	0.008
0112	168	0.984	0.008
0124	180	0.992	0.008
0136	192	1.000	

(16C)

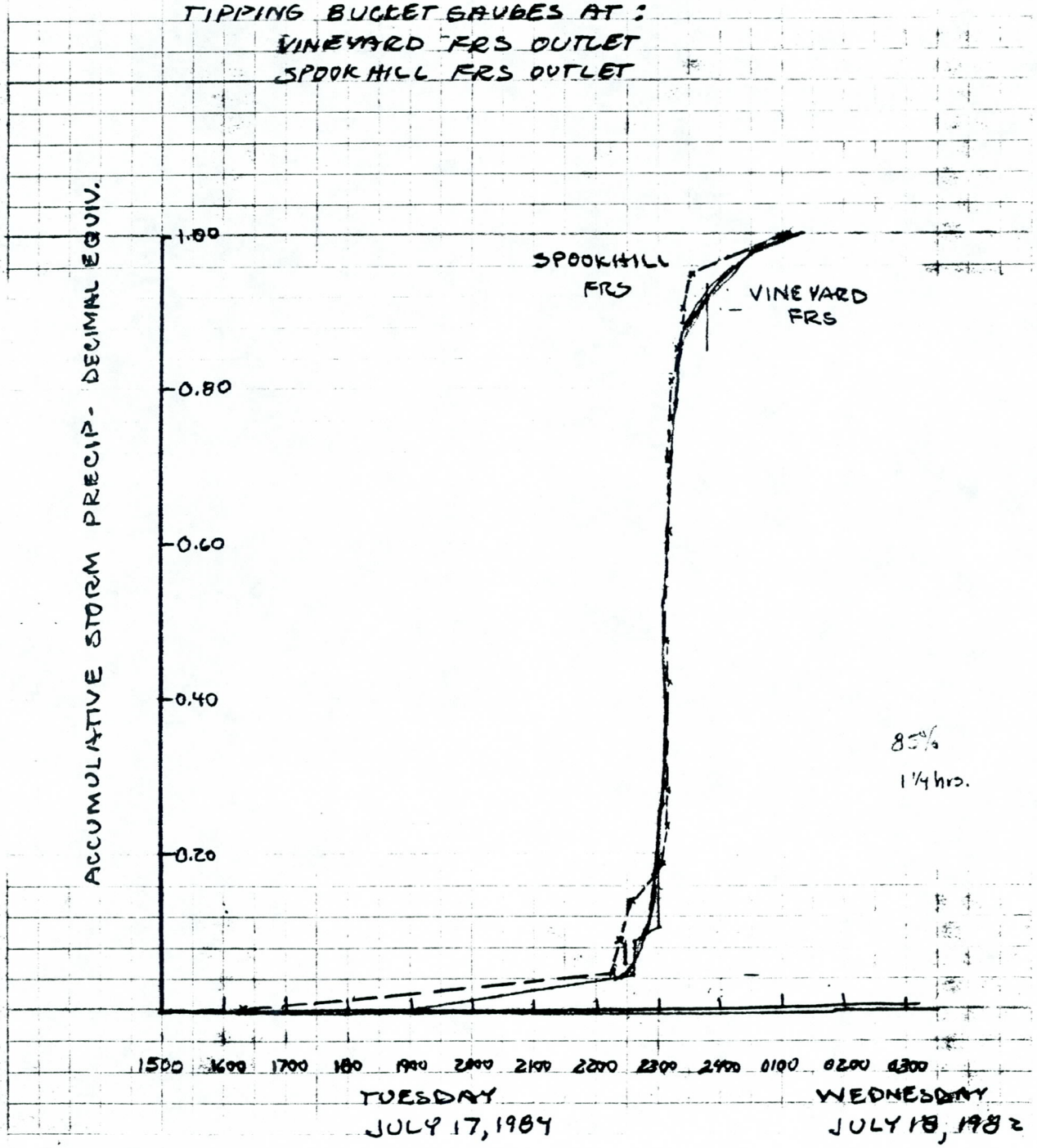
COMPUTATION SHEET
SCS-ENG-523 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE		PROJECT		
ARIZONA		BUCKHORN - MESA		
BY	DATE	CHECKED BY	DATE	JOB NO.
R McArthur	7/30/84			
SUBJECT				SHEET ____ OF ____
STORM DISTRIBUTION JULY 17-18, 1984				

SOURCE OF DATE: MARICOPA COUNTY FLOOD CONTROL DISTRICT

TIPPING BUCKET GAUGES AT:
VINEYARD FRS OUTLET
SPOOKHILL FRS OUTLET



0.8
T.2

TR-20 LESSON OUTLINE

I. GENERAL

- A. PURPOSE
- B. DEVELOPMENT
- C. BASIC ASSUMPTIONS
- D. CAPABILITIES AND LIMITATIONS

II. INPUT DATA

- A. DRAINAGE AREA AND SUB-AREAS
- B. RAINFALL
  - (1) DURATION (HRS)
  - (2) AMOUNT (IN)
  - (3) DISTRIBUTION
- C. RUNOFF CURVE NUMBERS
- D. TIME OF CONCENTRATIONS
- E. CROSS SECTION DATA OR X AND M VALUES
  - (1) ELEVATION OR STAGE
  - (2) DISCHARGE
  - (3) END AREA
- F. STRUCTURE DATA
  - (1) ELEVATION OR STAGE
  - (2) DISCHARGE
  - (3) STORAGE
- G. REACH LENGTHS
  - (1) RELATIONSHIP TO KINEMATIC TRAVEL TIME AND MAIN TIME INCREMENT

(2) LMIN = $\frac{\Delta T}{2}$ mV

(3) LR = ΔTmV

III. HYDROGRAPH DEVELOPMENT

- A. INTRODUCTION
- B. RAINFALL
- C. CONVERSION OF RAINFALL TO RUNOFF
- D. UNIT HYDROGRAPH THEORY
- E. PEAK RATE EQUATION
- F. COMPOSITE FLOOD HYDROGRAPH
- G. COMBINING HYDROGRAPHS

IV. RESERVOIR ROUTING

V. REACH ROUTING

VI. STANDARD CONTROL

VII. EXECUTIVE CONTROL

VIII. ADDITIONAL CAPABILITIES

- A. MODIFY STANDARD CONTROL
- B. INTERMEDIATE PEAKS
- C. READ-DISCHARGE HYDROGRAPH

IX. ORDER OF INPUT

X. CLASS PROBLEM

XI. VERIFICATION OF RESULTS

(1)

PURPOSE OF THE TR-20 COMPUTER PROGRAM

1. TO ASSIST THE ENGINEER IN HYDROLOGIC EVALUATION OF FLOOD EVENTS FOR USE IN ANALYSIS OF WATER RESOURCE PROJECTS.

2. IMPROVE QUALITY OF WATERSHED PLANNING BY ANALYZING MORE ALTERNATIVES.

3. ALTERNATIVES CAN INCLUDE VARIOUS LAND USE AND COVER CONDITIONS--STRUCTURAL AND NON-STRUCTURAL.

4. IT IS A SINGLE EVENT MODEL WHICH COMPUTES DIRECT RUNOFF RESULTING FROM ANY SYNTHETIC OR NATURAL RAINSTORM.

5. IT DEVELOPS FLOOD HYDROGRAPHS AND ROUTES THE FLOW THROUGH STREAM CHANNELS AND RESERVOIRS.

6. IT COMBINES ROUTED HYDROGRAPHS WITH THOSE FROM TRIBUTARIES AND COMPUTES PEAK DISCHARGES, THEIR TIME OF OCCURRENCE AND THE WATER SURFACE ELEVATIONS AT ANY DESIRED CROSS SECTION OF STRUCTURE.

BASIC ASSUMPTIONS

1. A method to analyze a single event

2. A rainfall-runoff model of direct runoff; a base flow can be added

3. Engineer oriented; developed with ease of use as a major objective

4. Designed to use available soils data along with land use information

5. Uses basic hydrology concepts described in SCS National Engineering Handbook (NEH) Sec. 4 - Hydrology

CAPABILITIES AND LIMITATIONS

1. ROUTE THROUGH 99 STRUCTURES.

2. ROUTE THROUGH 200 STREAM REACHES.

3. COMPUTE UP TO 300 ORDINATES OF A HYDROGRAPH AND PRINT OUT DISCHARGE AND ELEVATION FOR EACH.

4. MAKES AN UNLIMITED NUMBER OF ROUTINGS THROUGH A WATERSHED.

5. DEVELOPS AND ROUTES THE RUNOFF FROM 9 DIFFERENT STORM DISTRIBUTIONS.

6. COMBINES HYDROGRAPHS FROM AN UNLIMITED NUMBER OF TRIBUTARIES AND REACH TERMINALS, BUT COMBINATIONS OF STRUCTURES AND CROSS-SECTIONS ARE LIMITED BY ITEMS 1 & 2.

7. DIVIDES A HYDROGRAPH INTO TWO SEPARATE HYDROGRAPHS.

8. READS A DISCHARGE HYDROGRAPH AND ROUTES IT THROUGH A WATERSHED.

9. STORES UP TO SEVEN COMPUTED HYDROGRAPHS AT ANY TIME.

10. EACH STORM DISTRIBUTION IS LIMITED TO 100 INPUT VALVES, CROSS-SECTION AND STRUCTURE. DATA ARE LIMITED TO 20 LINES.

11. THERE IS A LIMITATION AT 600 STANDARD CONTROL STATEMENTS.

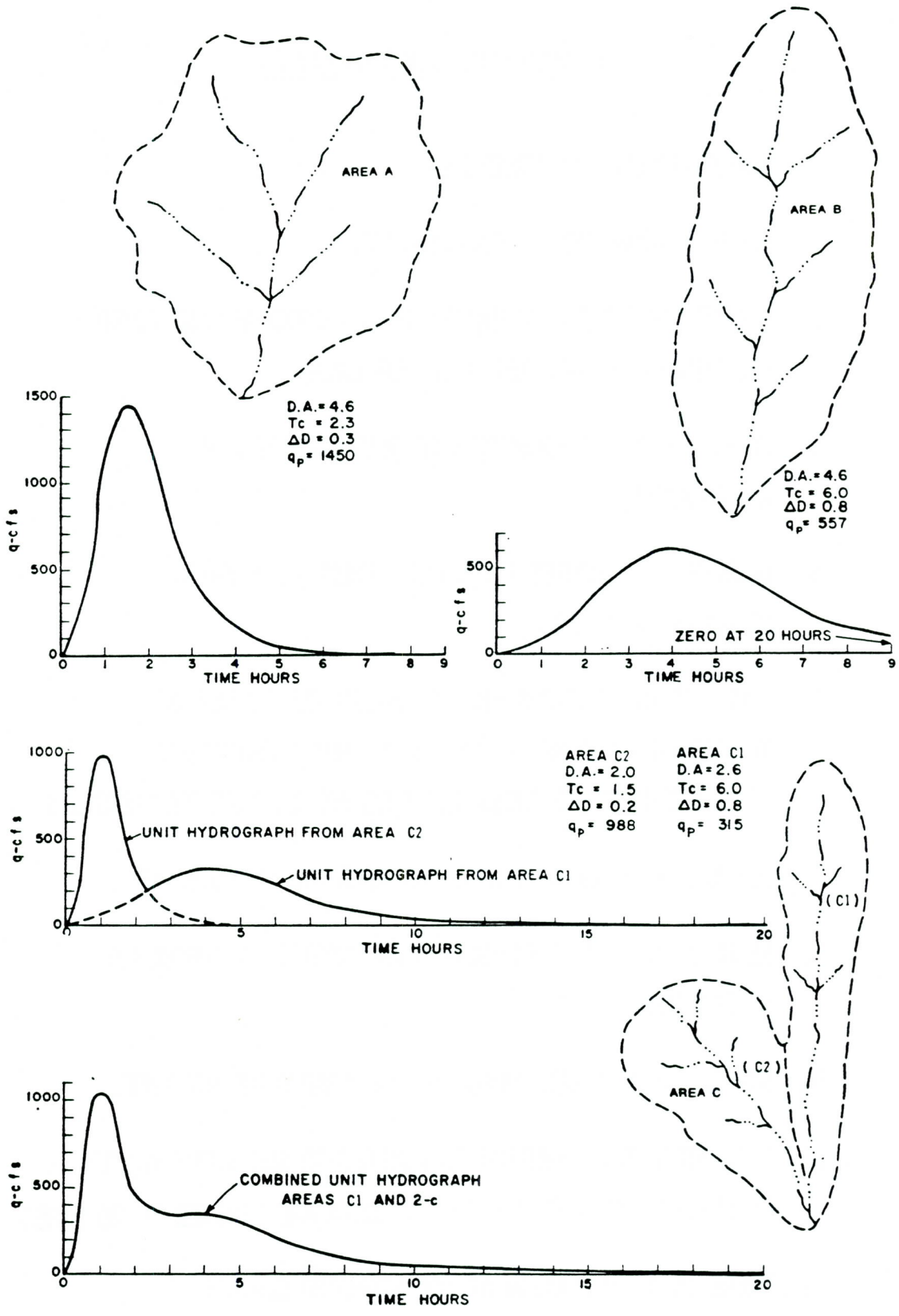


Figure 16.3 The effect of watershed shape on the peaks of unit hydrographs

(5)

RAINFALL

1. HISTORICAL

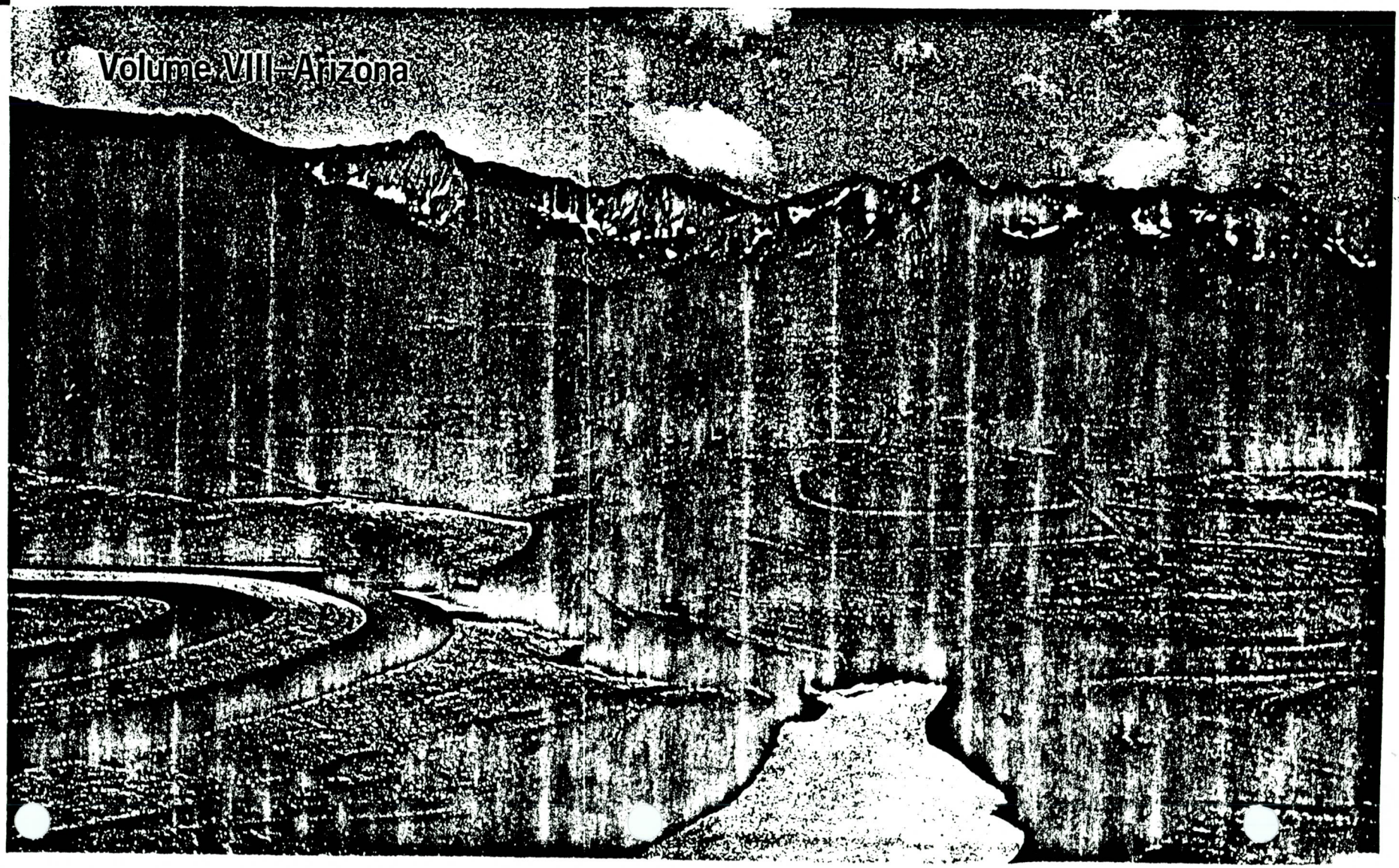
2. SYNTHETIC

A UNITED STATES DEPARTMENT OF COMMERCE PUBLICATION

NOAA ATLAS 2

Precipitation-Frequency Atlas of the Western United States

J. F. Miller, R. H. Frederick, and R. J. Tracey



U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

National Weather Service

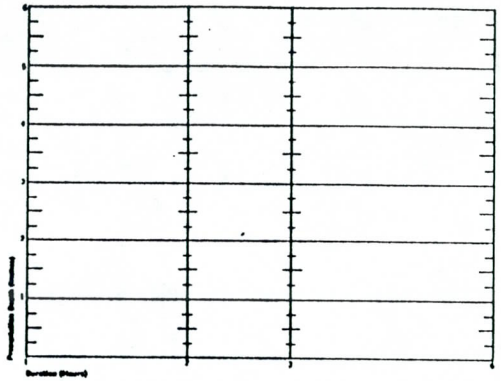
Silver Spring, Md.
1973

present precipitation-frequency maps
: durations for return periods of 2, 5,
ie isopluvial maps represent the 360-
the partial-duration series. Data were
ervation-day intervals for the annual
y the empirical factors given in the

>line interval selected was designed to
ie description of the isopluvial pattern
ate. The isoline interval on the maps
:ation is 0.2 in. for values below 3.0 in.
eriod, the interval is 0.5 in. for values
lods of 10 yrs or greater, the interval
in. is 0.4 in. For the maps at the 6-hr
.1 in. for precipitation-frequency values
.6 to 4.0 in., and 0.5 in. at values over
lines have been placed between widely
regions where a linear interpolation
vial interval would lead to erroneous
close within the boundaries of a par-
utched on the low-valued side of the

in precipitation-frequency values. The
sent frequency values of precipitation
any hydrologic purposes, precipitation
ted in a different manner from that fall-
ition of snow amounts to precipitation-
ona and the western states has been
reas with similar snow climatology. Ari-
: in the intermountain zone, which is
a west of a line from the Mogollon and
Mexico through the Wasatch Range in
thern California coastal ranges and the
e area extends from the Mexican border
: Northwest.

unusual for a maximum annual precipi-
ig the colder months of the year. During
uary, and February, just over 20 percent
4-hr events were reported. This figure is
ll data are considered or only data from
6,000 ft. Of the maximum annual events
, less than half contain any snow.
zona had 10 to 15 yrs of observations
e precipitation observing program. For
o data series were formed as discussed
:sults, Importance of Snow in Estimating
these data, a ratio was formed between
the series containing maximum annual
r value for the series with snow occur-
er 80 percent of such ratios showed less
s between the two values. Elevation did
since there were only nine stations over
nce of greater than 10 percent and 10
on showing differences less than 10 per-



cent. In fact, nine stations at elevations over 6,000 ft had ratios showing differences of less than 5 percent.

The ratio between 2-yr 24-hr values for all data and data from the rain-only series was plotted on a map of Arizona. This showed that seven of the nine stations at elevations over 6,000 ft with ratios greater than 1.10 between the two series were concentrated along the front face of the Mogollon Rim or just slightly over the crest of the rim. In this limited region, the data suggest that a series composed of observations containing exclusively rain would be 10 to 20 percent below the 2-yr 24-hr values from the Atlas maps. At the 25-yr return period, differences would likely be about half the 2-yr 24-hr differences; and at the 100-yr return period, there would be no difference. At the 6-hr duration, differences between the two data series are less than 10 percent at all durations. Over the rest of Arizona, the data do not indicate significant differences between a rain-only series and the series composed of all maximum annual events.

Procedures for Estimating Values for Durations Other Than 6 and 24 Hrs

The isopluvial maps in this Atlas are for 6- and 24-hr durations. For many hydrologic purposes, values for other durations are necessary. Such values can be estimated using the 6- and 24-hr maps and the empirical methods outlined in the following sections. The procedures detailed below for obtaining 1-, 2-, and 3-hr estimates were developed specifically for this Atlas. The procedures for obtaining estimates for less than 1-hr duration and for 12-hr duration were adopted from Weather Bureau Technical Paper No. 40 (U.S. Weather Bureau 1961) only after investigation demonstrated their applicability to data from the area covered by this Atlas.

Equation	Corr. coeff.	No. of stations	Mean of computed stn. values (inches)	Standard error of estimate (inches)
$Y_2 = -0.011 + 0.942[(X_1)(X_1/X_2)]$	0.95	86	0.72	0.085
$Y_{100} = 0.494 + 0.755[(X_3)(X_3/X_4)]$	.90	85	1.96	.290

List of variables
Y_2 = 2-yr 1-hr estimated value
Y_{100} = 100-yr 1-hr estimated value
X_1 = 2-yr 6-hr value from precipitation-frequency maps
X_2 = 2-yr 24-hr value from precipitation-frequency maps
X_3 = 100-yr 6-hr value from precipitation-frequency maps
X_4 = 100-yr 24-hr value from precipitation-frequency maps

Procedures for estimating 1-hr (60-min) precipitation-frequency values. Multiple-regression screening techniques were used to develop equations for estimating 1-hr values. Factors considered in the screening process were restricted to those that could be determined easily from the maps of this Atlas or from generally available topographic maps.

The 11 western states were separated into several geographic regions. The regions were chosen on the basis of meteorological and climatological homogeneity and are generally combinations of river basins separated by prominent divides. Arizona is located wholly within a region that extends from the crest of the Continental Divide, the Sangre de Cristo Range, and the Sacramento Mountains in Colorado and New Mexico westward to southwestern California, the Virgin River Basin in Nevada, and the Wasatch divide in Utah. Equations to provide estimates for the 1-hr duration for 2- and 100-yr return periods are shown in table 11. Also listed are the statistical parameters associated with each equation. In these equations, the variable $[(X_1)(X_1/X_2)]$ or $[(X_3)(X_3/X_4)]$ can be regarded as the 6-hr value times the slope of the line connecting the 6- and 24-hr values for the appropriate return period.

Estimates of 1-hr precipitation-frequency values for return periods between 2 and 100 yrs. The 1-hr values for the 2- and 100-yr return periods can be plotted on the nomogram of figure 6 to obtain values for return periods greater than 2 yrs or less than 100 yrs. Draw a straight line connecting the 2- and 100-yr values and read the desired return-period value from the nomogram.

Estimates for 2- and 3-hr (120- and 180-min) precipitation-frequency values. To obtain estimates of precipitation-frequency values for 2 or 3 hrs, plot the 1- and 6-hr values from the Atlas on the appropriate nomogram of figure 15. Draw a straight line connecting the 1- and 6-hr values, and read the 2- and 3-hr values from the nomogram. This nomogram is independent of return period. It was developed using data from the same regions used to develop the 1-hr equations.

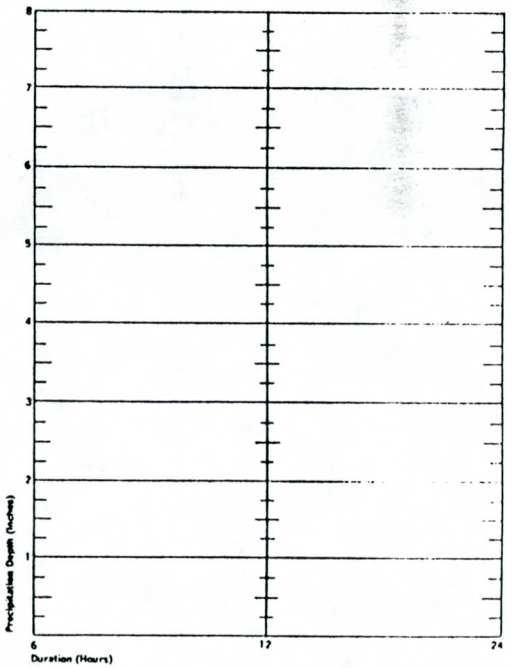


Figure 16. *Precipitation depth-duration diagram (6- to 24-hr).*

RAINFALL

FREQUENCY SERIES TYPES

ANNUAL SERIES

The largest value in each year

PARTIAL DURATION SERIES

All values equal to or larger than a base value

EMPIRICAL RELATIONSHIP

RECURRENCE INTERVAL (YRS)	RATIO ANNUAL SERIES / PARTIAL DURATION SERIES
100	1.00
50	1.00
25	1.00
10	0.99
5	0.96
2	0.88

(9)

COMPUTATION SHEET
SCS-ENG-523 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE ARIZONA		PROJECT		
BY	DATE	CHECKED BY	DATE	JOB NO.

SUBJECT PRECIPITATION-FREQUENCY RELATIONSHIP SHEET ____ OF ____

POINT PRECIPITATION AMOUNTS

REF.: NOAA ATLAS 2 - "PRECIPITATION-FREQUENCY ATLAS OF THE WESTERN UNITED STATES" VOL. VIII ARIZONA

STORM DURATION (HRS)	RECURRENCE INTERVAL (YRS)	PARTIAL DURATION SERIES (IN)	FACTOR	ANNUAL SERIES (IN.)	USE VALUE FROM PLOT (IN)
24	100		1.00		
	50		1.00		
	25		1.00		
	10		0.99		
	5		0.96		
	2		0.88		
6	100		1.00		
	50		1.00		
	25		1.00		
	10		0.99		
	5		0.96		
	2		0.88		

(10)

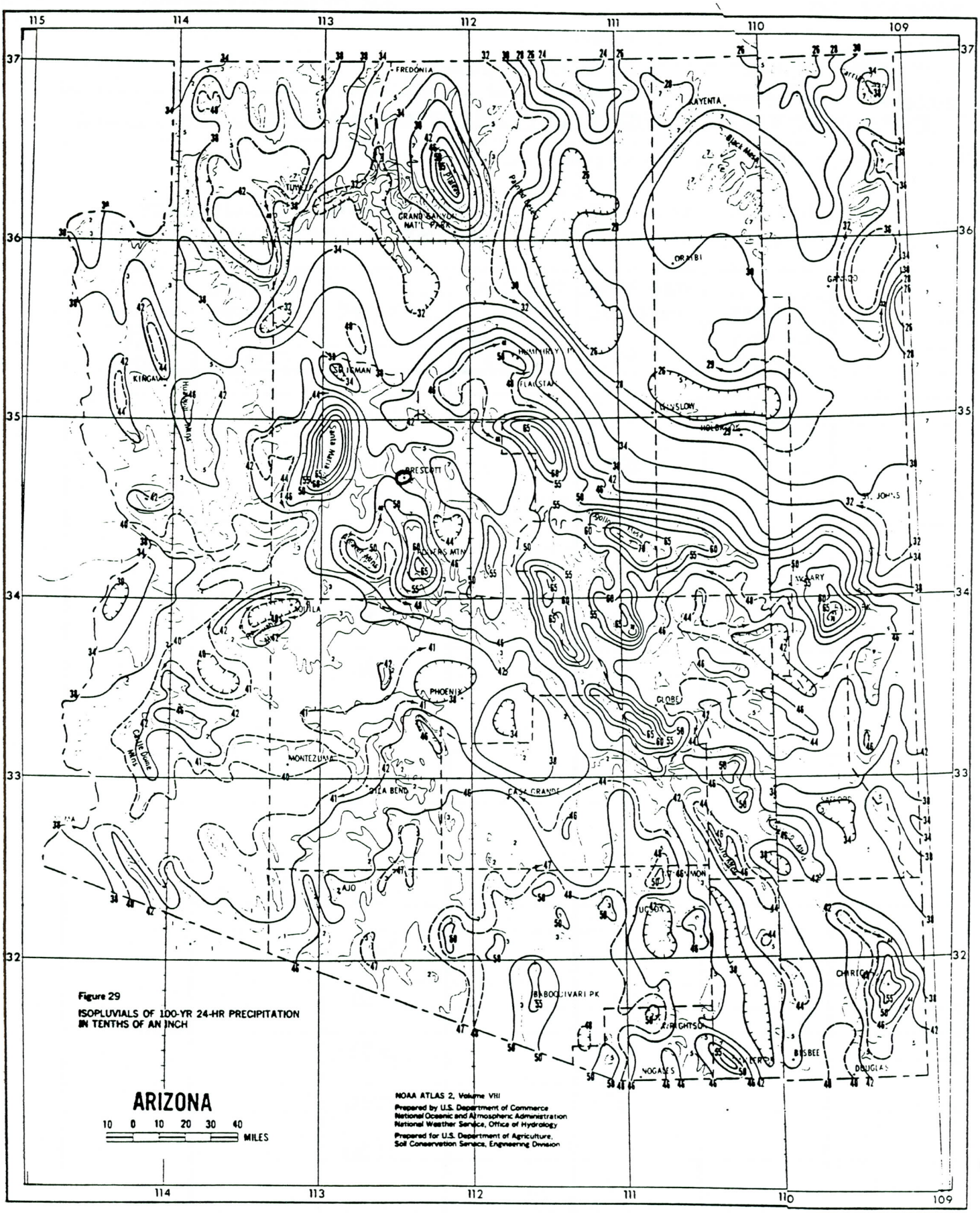


Figure 29

ISOPLUVIALS OF 100-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

ARIZONA

10 0 10 20 30 40 MILES

NOAA ATLAS 2, Volume VIII

Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology

Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

(11)

COMPUTATION SHEET
SCS-ENG-823 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE	PROJECT		
ARIZONA	YAVAPAI COUNTY TRAINING		
BY: R McArthur / DATE: 3/10/87	CHECKED BY	DATE	JOB NO.

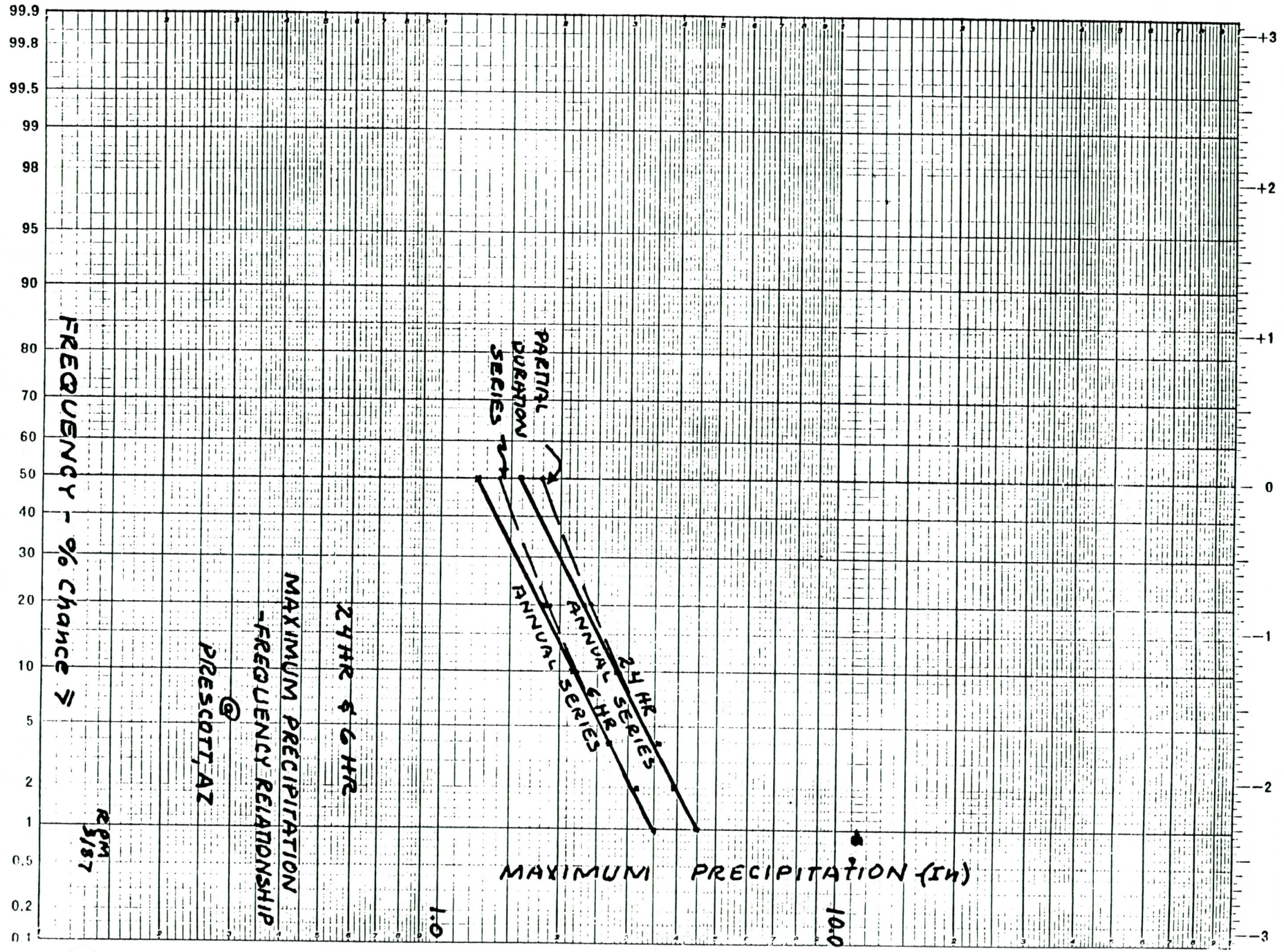
SUBJECT: PRECIPITATION-FREQUENCY RELATIONSHIP SHEET ____ OF ____

POINT PRECIPITATION AMOUNTS AT PRESCOTT, AZ

REF.: NOAA ATLAS 2 - "PRECIPITATION-FREQUENCY ATLAS OF THE WESTERN UNITED STATES" VOL. VIII - ARIZONA

STORM DURATION (HRS)	RECURRENCE INTERVAL (YRS)	PARTIAL DURATION SERIES (IN)	FACTOR	ANNUAL SERIES (IN.)	USE VALUE FROM PLOT (IN)
24	100	4.5	1.00	4.5	4.5
	50	3.95	1.00	3.95	3.95
	25	3.6	1.00	3.6	3.45
	10	2.83	0.99	2.8	2.8
	5	2.4	0.96	2.3	2.3
	2	1.8	0.88	1.58	1.58
6	100	3.5	1.00	3.5	3.5
	50	3.18	1.00	3.18	3.05
	25	2.7	1.00	2.7	2.7
	10	2.2	0.99	2.18	2.18
	5	1.9	0.96	1.82	1.78
	2	1.4	0.88	1.23	1.23

NO. 31.376. LOGARITHMIC NORMAL.
codex GRAPH PAPER ® IN STOCK DIRECT FROM CODEX BOOK CO. INC. NORWOOD, MASS. 02062
PRINTED IN U. S. A.



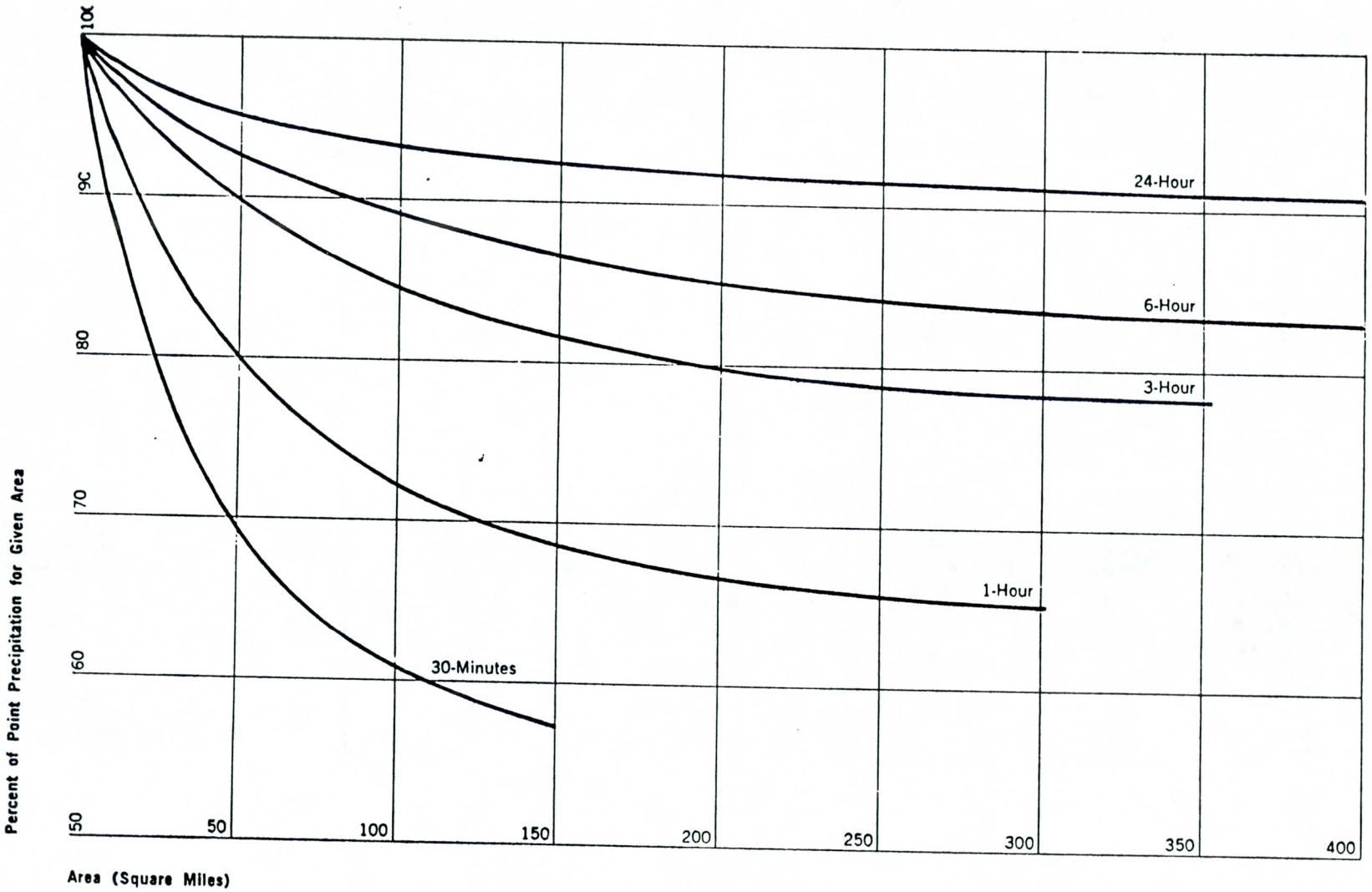


Figure 14. *Depth-Area curves.*

RAINFALL TABLE 2

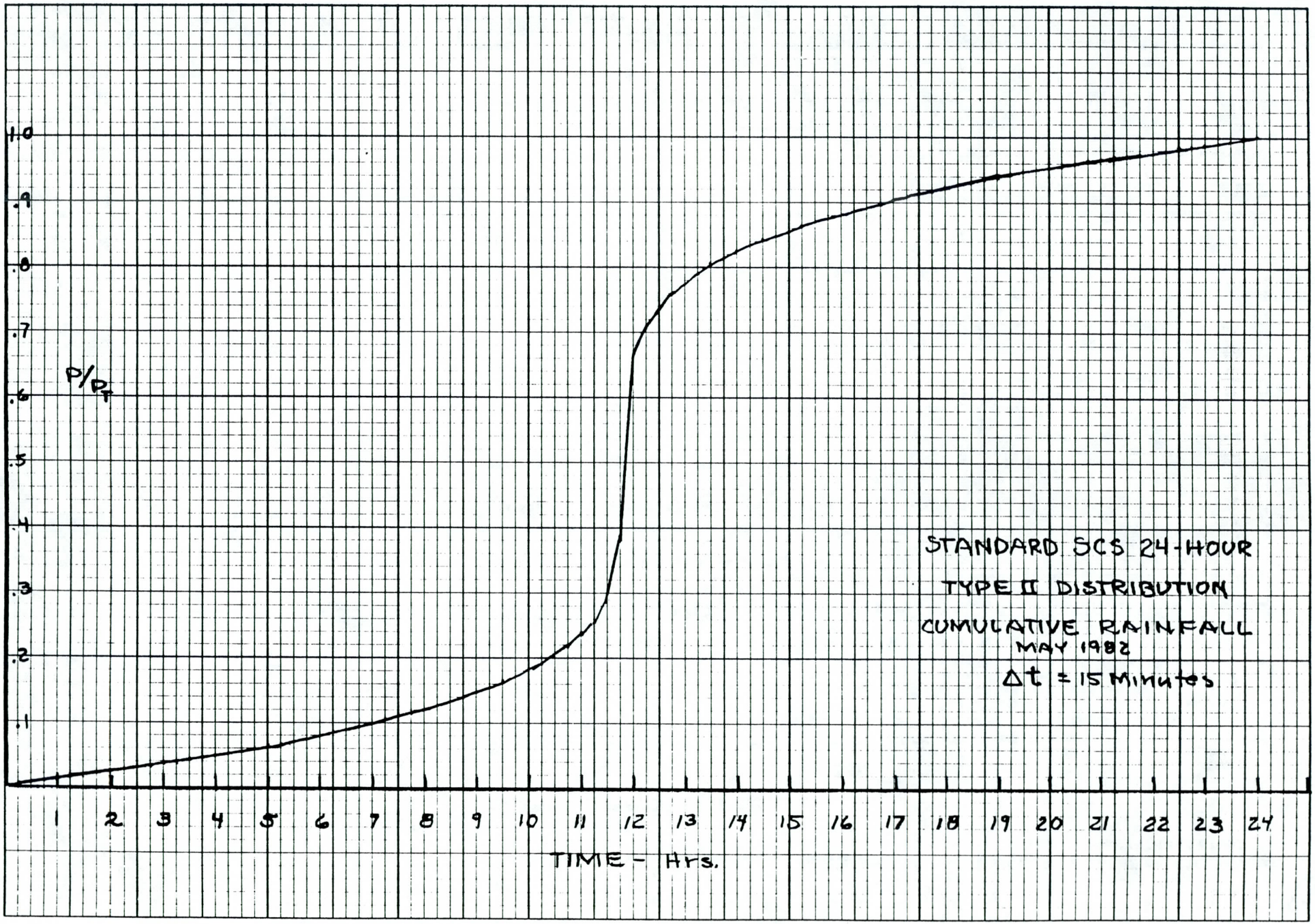
STANDARD SCS 24-HOUR, TYPE II DISTRIBUTION
CUMULATIVE RAINFALL TABLE
(REVISED MAY 1982)

	TABLE NO.	TIME INCREMENT				
5	RAINFL 2	0.2500				
8		0.0	0.0020	0.0050	0.0080	0.0110
8		0.0140	0.0170	0.0200	0.0230	0.0260
8		0.0290	0.0320	0.0350	0.0380	0.0410
8		0.0440	0.0480	0.0520	0.0560	0.0600
8		0.0640	0.0680	0.0720	0.0760	0.0800
8		0.0850	0.0900	0.0950	0.1000	0.1050
8		0.1100	0.1150	0.1200	0.1260	0.1330
8		0.1400	0.1470	0.1550	0.1630	0.1720
8		0.1810	0.1910	0.2030	0.2180	0.2360
8		0.2570	0.2830	0.3870	0.6630	0.7070
8		0.7350	0.7580	0.7760	0.7910	0.8040
8		0.8150	0.8250	0.8340	0.8420	0.8490
8		0.8560	0.8630	0.8690	0.8750	0.8810
8		0.8870	0.8930	0.8980	0.9030	0.9080
8		0.9130	0.9180	0.9220	0.9260	0.9300
8		0.9340	0.9380	0.9420	0.9460	0.9500
8		0.9530	0.9560	0.9590	0.9620	0.9650
8		0.9680	0.9710	0.9740	0.9770	0.9800
8		0.9830	0.9860	0.9890	0.9920	0.9950
8		0.9980	1.0000	1.0000	1.0000	1.0000
9	ENDTBL					

Note: On Executive Control use Rainfall Depth in inches and Rainfall Duration of 1.0. The format for this table is Form #271, Page F-7.

K+E 10 X 10 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

(15)



SCS-ENG.-271 DRAFT
REV. May 1982

TR-20
CUMULATIVE RAINFALL TABLE

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

F-7

STORM TYPE OR DATE _____

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10			11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE I.D. NAME	TABLE I.D. NO.	DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3	DATA FIELD NO. 4	DATA FIELD NO. 5		RECORD IDENT.
5	RAINFL	(1-9)	RUNOFF OPTION	TIME INCREMENT					

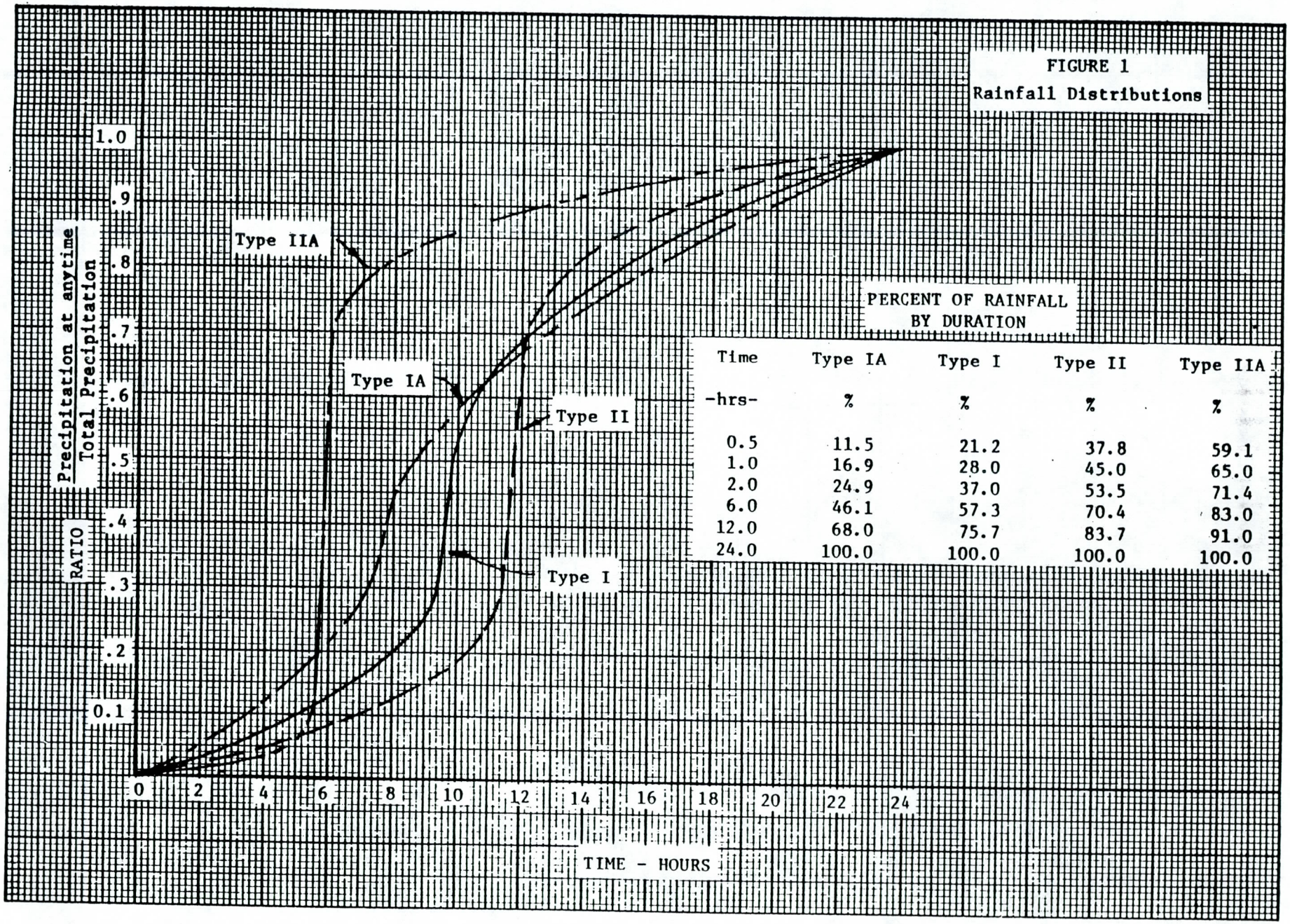
IMPORTANT: Line out unused lines. Data fields require decimal points.

NOTE: A maximum of 100 entries (20 records) are allowed.

Enter successive entries left to right with first entry for time = 0. Fill last row of data with last entry of table.

8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									
8									

9	ENDTBL		NOTE: This record must be the last record of this table.



PERCENT OF RAINFALL BY DURATION

Time	Type IA	Type I	Type II	Type IIA
-hrs-	%	%	%	%
0.5	11.5	21.2	37.8	59.1
1.0	16.9	28.0	45.0	65.0
2.0	24.9	37.0	53.5	71.4
6.0	46.1	57.3	70.4	83.0
12.0	68.0	75.7	83.7	91.0
24.0	100.0	100.0	100.0	100.0

(18)

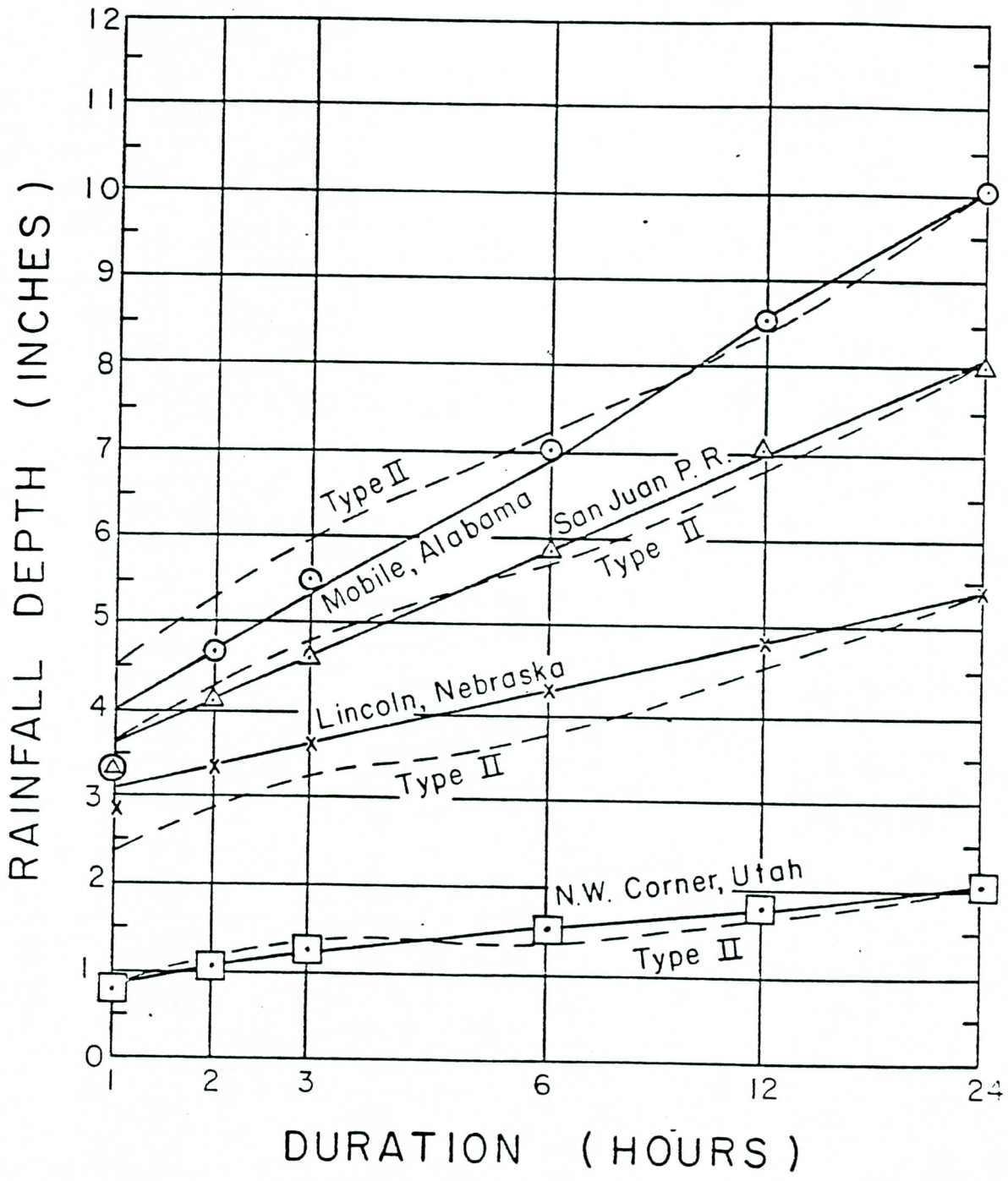


FIGURE 2, TP-149 GENERALIZED 25-YEAR FREQUENCY RAINFALL DEPTH-DURATION RELATIONSHIPS

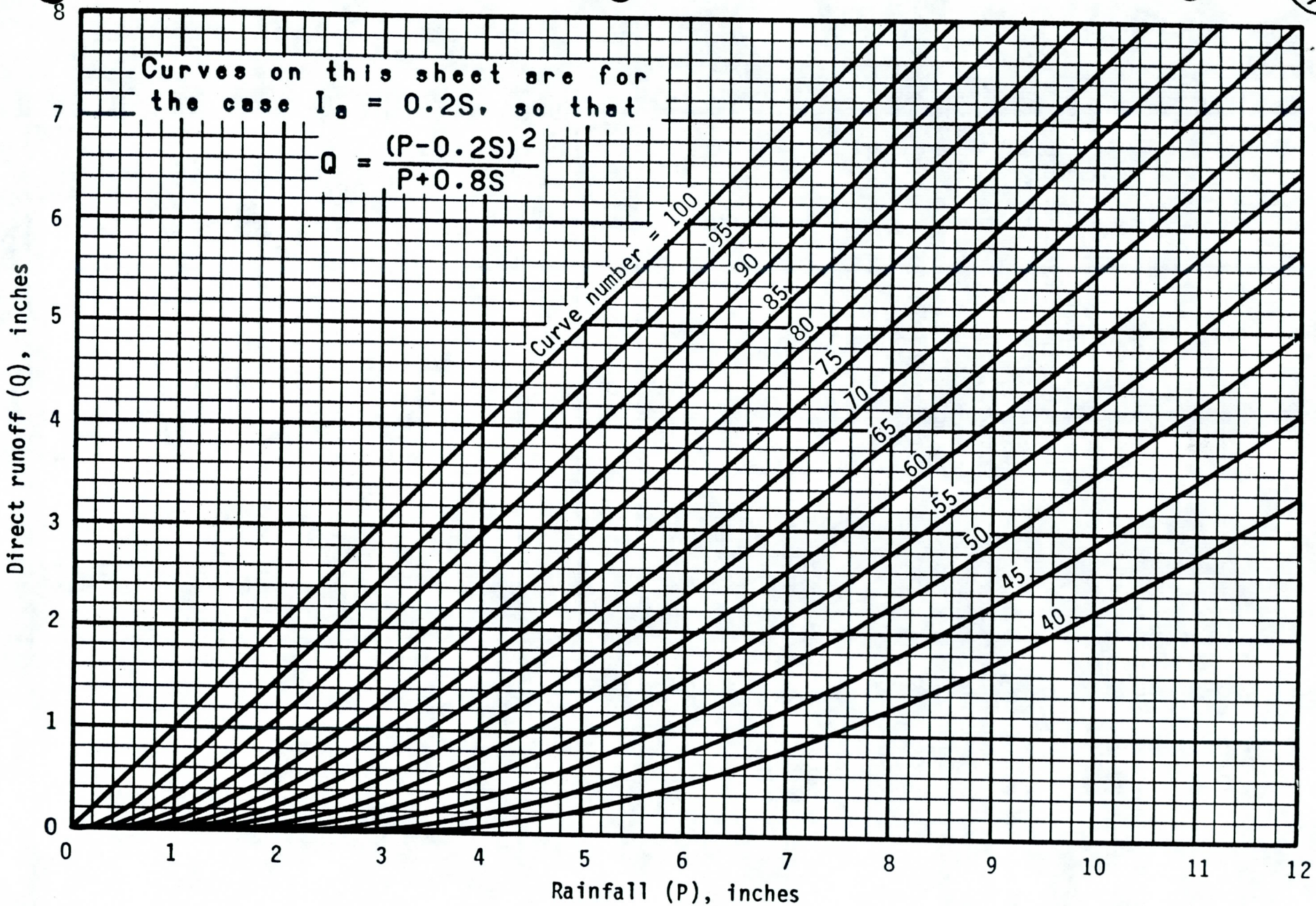


Figure 2-1.—Solution of runoff equation.

texture is given in appendix A for determining the HSG classification for disturbed soils.

Cover type

Table 2-2 addresses most cover types, such as vegetation, bare soil, and impervious surfaces. There are a number of methods for determining cover type. The most common are field reconnaissance, aerial photographs, and land use maps.

Treatment

Treatment is a cover type modifier (used only in table 2-2b) to describe the management of cultivated agricultural lands. It includes mechanical practices, such as contouring and terracing, and management practices, such as crop rotations and reduced or no tillage.

Hydrologic condition

Hydrologic condition indicates the effects of cover type and treatment on infiltration and runoff and is generally estimated from density of plant and residue cover on sample areas. *Good* hydrologic condition indicates that the soil usually has a low runoff potential for that specific hydrologic soil group, cover type, and treatment. Some factors to consider in estimating the effect of cover on infiltration and runoff are (a) canopy or density of lawns, crops, or other vegetative areas; (b) amount of year-round cover; (c) amount of grass or close-seeded legumes in rotations; (d) percent of residue cover; and (e) degree of surface roughness.

Table 2-1.—Runoff depth for selected CN's and rainfall amounts[1]

Rainfall	Runoff depth for curve number of—												
	40	45	50	55	60	65	70	75	80	85	90	95	98
	inches												
1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.17	0.32	0.56	0.79
1.2	.00	.00	.00	.00	.00	.00	.03	.07	.15	.27	.46	.74	.99
1.4	.00	.00	.00	.00	.00	.02	.06	.13	.24	.39	.61	.92	1.18
1.6	.00	.00	.00	.00	.01	.05	.11	.20	.34	.52	.76	1.11	1.38
1.8	.00	.00	.00	.00	.03	.09	.17	.29	.44	.65	.93	1.29	1.58
2.0	.00	.00	.00	.02	.06	.14	.24	.38	.56	.80	1.09	1.48	1.77
2.5	.00	.00	.02	.08	.17	.30	.46	.65	.89	1.18	1.53	1.96	2.27
3.0	.00	.02	.09	.19	.33	.51	.71	.96	1.25	1.59	1.98	2.45	2.77
3.5	.02	.08	.20	.35	.53	.75	1.01	1.30	1.64	2.02	2.45	2.94	3.27
4.0	.06	.18	.33	.53	.76	1.03	1.33	1.67	2.04	2.46	2.92	3.43	3.77
4.5	.14	.30	.50	.74	1.02	1.33	1.67	2.05	2.46	2.91	3.40	3.92	4.26
5.0	.24	.44	.69	.98	1.30	1.65	2.04	2.45	2.89	3.37	3.88	4.42	4.76
6.0	.50	.80	1.14	1.52	1.92	2.35	2.81	3.28	3.78	4.30	4.85	5.41	5.76
7.0	.84	1.24	1.68	2.12	2.60	3.10	3.62	4.15	4.69	5.25	5.82	6.41	6.76
8.0	1.25	1.74	2.25	2.78	3.33	3.89	4.46	5.04	5.63	6.21	6.81	7.40	7.76
9.0	1.71	2.29	2.88	3.49	4.10	4.72	5.33	5.95	6.57	7.18	7.79	8.40	8.76
10.0	2.23	2.89	3.56	4.23	4.90	5.56	6.22	6.88	7.52	8.16	8.78	9.40	9.76
11.0	2.78	3.52	4.26	5.00	5.72	6.43	7.13	7.81	8.48	9.13	9.77	10.39	10.76
12.0	3.38	4.19	5.00	5.79	6.56	7.32	8.05	8.76	9.45	10.11	10.76	11.39	11.76
13.0	4.00	4.89	5.76	6.61	7.42	8.21	8.98	9.71	10.42	11.10	11.76	12.39	12.76
14.0	4.65	5.62	6.55	7.44	8.30	9.12	9.91	10.67	11.39	12.08	12.75	13.39	13.76
15.0	5.33	6.36	7.35	8.29	9.19	10.04	10.85	11.63	12.37	13.07	13.74	14.39	14.76

[1]Interpolate the values shown to obtain runoff depths for CN's or rainfall amounts not shown.

(21)

CURVE
80

RUNOFF FOR INCHES OF RAINFALL

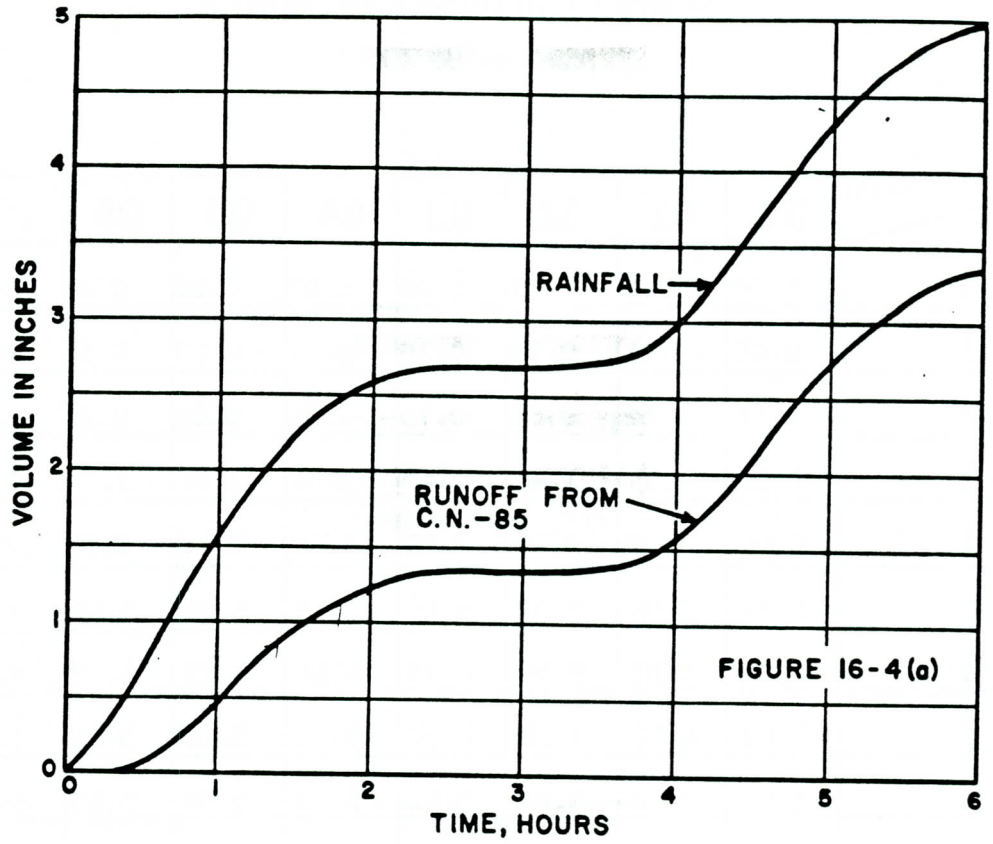
(Curve No. 80)

Inches \ Tenths	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.05
1	0.08	0.11	0.15	0.19	0.24	0.29	0.34	0.39	0.44	0.50
2	0.56	0.62	0.68	0.75	0.82	0.89	0.96	1.03	1.10	1.17
3	1.25	1.33	1.40	1.48	1.56	1.64	1.72	1.80	1.88	1.96
4	2.04	2.12	2.20	2.29	2.38	2.46	2.55	2.63	2.72	2.81
5	2.89	2.98	3.07	3.16	3.25	3.34	3.43	3.52	3.61	3.69
6	3.78	3.87	3.96	4.05	4.14	4.23	4.32	4.42	4.51	4.60
7	4.69	4.79	4.88	4.97	5.06	5.16	5.25	5.34	5.44	5.53
8	5.62	5.72	5.81	5.91	6.00	6.09	6.19	6.28	6.38	6.47
9	6.57	6.66	6.76	6.85	6.95	7.04	7.14	7.23	7.33	7.43
10	7.52	7.62	7.71	7.81	7.90	8.00	8.10	8.19	8.29	8.38
11	8.48	8.58	8.67	8.77	8.87	8.97	9.06	9.16	9.26	9.35
12	9.45	9.55	9.65	9.75	9.84	9.94	10.04	10.14	10.24	10.33
13	10.42	10.52	10.62	10.72	10.82	10.91	11.01	11.11	11.20	11.30
14	11.39	11.49	11.59	11.69	11.79	11.88	11.98	12.08	12.18	12.28
15	12.37	12.47	12.57	12.67	12.77	12.86	12.96	13.06	13.16	13.25
16	13.35	13.45	13.55	13.65	13.75	13.85	13.94	14.04	14.14	14.24
17	14.33	14.43	14.53	14.63	14.73	14.82	14.92	15.02	15.12	15.22
18	15.32	15.41	15.51	15.61	15.70	15.80	15.90	16.00	16.10	16.20
19	16.30	16.40	16.50	16.59	16.69	16.79	16.89	16.99	17.09	17.19
20	17.29	17.38	17.48	17.58	17.68	17.78	17.88	17.98	18.08	18.18

NOTE: Runoff value determined by equation $Q = \frac{(P-0.2\,S)^2}{P+0.8\,S}$

REFERENCE: Hydrology Guide

EXAMPLE: 4.50 inches rainfall = 2.46 inches runoff.



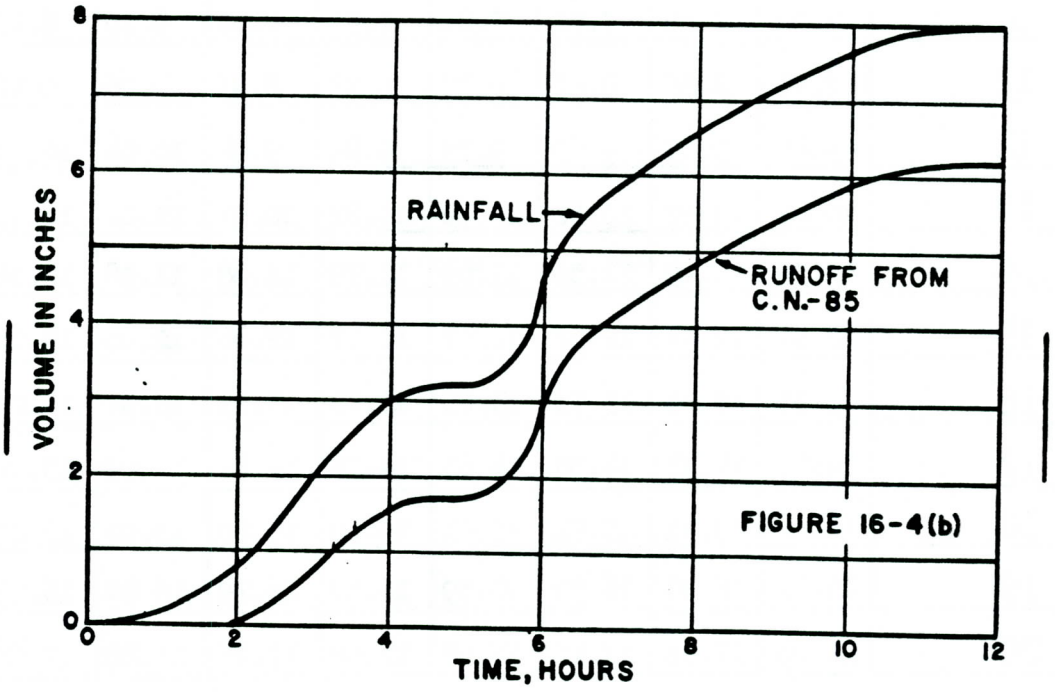


Figure 16.4 Accumulated rainfall and runoff for CN-85 taken from a recording rain gage.

HYDROLOGIC SOIL GROUPS

A. (Low runoff potential). Soils having high inflitration rates even when thoroughly wetted and consisting chiefly of deep, well to excessively drained sands or gravels. These soils have a high rate of water transmission.

B. Soils having moderate inflitration rates when thoroughly wetted and consisting chiefly of modertely deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

C. Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.

D. (High runoff potential). Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

HYDROLOGIC SOIL GROUP CLASSIFICATION

SOIL GROUP	RUNOFF POTENTIAL	INFILTRATION RATE *	CHIEF SOIL CHARACTERISTICS			TRANSMISSION RATE
			DEPTH	DRAINAGE	TEXTURE	
A	LOW	HIGH	DEEP	EXCESSIVE TO WELL	COURSE-SAND OR GRAVELS	HIGH
B	MODERATELY LOW	MODERATE	DEEP TO MOD. WELL	WELL TO MOD. WELL	MOD. COURSE TO MOD. FINE	MODERATE
C	MODERATELY HIGH	SLOW	MOD. DEEP TO MOD. SHALLOW (HARDPANS)	MOD. WELL TO POOR	MOD. FINE TO FINE	SLOW
D	HIGH	VERY SLOW	SHALLOW [OVER NEARLY IMPERVIOUS MATERIAL]	VERY POOR [PERMANENT HIGH WATER TABLE]	FINE [CLAYS WITH HIGH SWELLING PONTENTIAL]	VERY SLOW [HARDPANS AT OR NEAR SURFACE]

* INFILTRATION RATE WHEN THOROUGHLY WETTED.

(24 A)

Exhibit A-1: Hydrologic soil groups for United States soils

AABAB	D	ADAVEN	C	AHREN	B	ALDING	D	ALSEA	B
AABERG	D	ADDICKS	D	AHRNKLIN	C	ALDINO	C	ALSPAUGH	C
AARON	C	ADDIELOU	B	AHRS	B	ALEDO	C	ALSTAD	C
AASTAD	B	ADE	A	AHTANUM	D	ALEGROS	C	ALSTONY	B
AAZDAHL	B	ADEK	B	AHTANUM, DRAINED	C	ALEKNAGIK	C	ALSUP	C
ABAC	D	ADEL	B	AHWAHNEE	B	ALEMEDA	C	ALTAMONT	D
ABAJO	C	ADEL, WET	D	AIEONITO	C	ALEX	B	ALTAPEAK	B
ABALOBADIAH	B	ADELAIDE	D	AIDO	D	ALEXANDER	C	ALTAR	B
ABARCA	B	ADELANTO	B	AIKEN	B	ALEXANDRIA	C	ALTAVISTA	C
ABBAYE	B	ADELINO	B	AIKMAN	D	ALFIR	B	ALTDORF	D
ABBIE	B	ADELINO,	C	AIKMAN, STONY	C	ALFLACK	C	ALTHOUSE	B
ABBOTT	D	SALINE-ALKALI		AILEY	B	ALFORD	B	ALTICREST	B
ABBOTTSTOWN	C	ADELPHIA	B/C	AIMELIIA	B	ALGANSEE	B	ALTITA	C
ABCAL	D	ADEN	C	AINAKEA	B	ALGARROBO	A	ALTMAR	B
ABEGG	B	ADENA	C	AINSLEY	B	ALGERITA	B	ALTO	C
ABELA	B	ADGER	D	AINSWORTH	B	ALGIERS	C/D	ALTOGA	C
ABELL	B	ADIEUX	B	AIRMONT	C	ALGOA	C	ALTON	A
ABERDEEN	C	ADILIS	B	AIRPORT	D	ALGOMA	B/D	ALTOONA	C
ABERONE	B	ADIN	D	AITS	B	ALHAMBRA	B	ALTUDA	D
ABERSITO	C	ADIOS	D	AJO	C	ALHARK	B	ALTURAS	C
ABERT	B	ADJUNTAS	C	AJOLITO	D	ALICE	B	ALTUS	B
ABES	D	ADKINS	B	AKAD	C	ALICEL	B	ALTVAN	B
ABGESE	B	ADKINS, ALKALI	C	AKAKA	A	ALICIA	B	ALUF	A
ABILENE	C	ADKINS, WET	C	AKAN	B/D	ALIDA	B	ALUM	B
ABIQUA	B	ADLER	C	AKASKA	B	ALIKCHI	B	ALUSA	D
ABIQUA, FLOODED	C	ADMAN	D	AKELA	D	ALINE	A	ALVARADO	B
ABITA	C	ADOBE	C	AKERCAN	B	ALKIPIDGE	C	ALVIN	B
ABO	C	ADOLPH	B/D	AKERUE	D	ALKO	D	ALVIRA	C
ABOR	D	ADOS	C	AKINA	B	ALLAGASH	B	ALVISO	D
ABORIGINE	D	ADRIAN	A/D	AKLEF	D	ALLAMORE	D	ALVODEST	D
ABOTEN	D	ADVOKAY	D	ALADDIN	B	ALLANTON	B/D	ALVOR	D
ABRA	B	AECET	C	ALADSHI	B	ALLANTON,	D	ALVOR, DRAINED	C
ABRAHAM	B	AENEAS	B	ALAE	A	DEPRESSIONAL		ALVOR, PROTECTED	C
ABRAZO	D	AFFEY	C	ALAELOA	B	ALLARD	B	ALWILDA	B
ABRAZO, GRAVELLY	C	AFLEY	B	ALAGA	A	ALLDOWN	B	ALYAN	C
ABREU	B	AFTADEN	D	ALAKAI	C	ALLEGHENY	B	ALZADA	D
ABRIGO	B	AFTON	C/D	ALAMA	B	ALLEMANDS	D	ALZOLA	C
ABSAROKEE	C	AGA	B	ALAMADITAS	C	ALLEN	B	AMADOR	D
ABSCOTA	A	AGAIPAH	D	ALAMANCE	B	ALLENDALE	B	AMAGON	D
ABSHER	D	AGAN	D	ALAMBIQUE	B	ALLENDORF	B	AMALIA	B
ABSTED	C	AGAR	B	ALAMO	D	ALLENS PARK	B	AMALU	D
ABSTED, FLOODED	D	AGASSIZ	D	ALAMOGORDO	B	ALLENS PARK, STONY	C	AMANA	B
ABSTON	C	AGATE	D	ALAMOSA	D	ALLENTINE	D	AMANDA	C
ACACIO	B	AGATHA	B	ALAMOSA, DRAINED	B	ALLENWOOD	B	AMARILLO	B
ACADEMY	C	AGAWAM	B	ALAMUCHEE	B	ALLEY	B	AMASA	B
ACADIA	D	AGENCY	C	ALANCO	D	ALLHANDS	D	AMASA, MODERATELY	C
ACANA	D	AGER	D	ALAPAHA	D	ALLIANCE	B	WET, SANDY	
ACANOD	C	AGFAYAN	D	ALAPAI	A	ALLIGATOR	D	SURSTRATUM	
ACASCO	D	AGNAL	D	ALAZAN	B	ALLIS	D	AMBER	B
ACCELERATOR	B	AGNESTON	B	ALBAN	B	ALLISON	B	AMBIA	D
ACEITUNAS	B	AGNESTON, COBBLY	C	ALBAND	D	ALLKER	B	AMBOAT	C
ACEL	C	SUBSTRATUM		ALBANY	C	ALLOR	B	AMBOY	C
ACHIMIN	C	AGNESTON, COBBLY	C	ALBATON	D	ALLOUEZ	B	AMBRANT	B
ACKER	B	AGNESTON,	C	ALBEE	C	ALMAC	B	AMBRAW	B/D
ACKERMAN	A/D	NONGRAVELLY		ALBEMARLE	B	ALMANOR	B	AMELIA	C
ACKERVILLE	C	AGNEW	C	ALBERTON	B	ALMAVILLE	D	AMENE	D
ACKETT	D	AGNOS	D	ALBERTVILLE	C	ALMENA	C	AMENIA	B
ACKLEY	B	AGON	C	ALBINAS	B	ALMERIA	D	AMENSON	D
ACKMEN	B	AGORT	C	ALBION	B	ALMIRANTE	B	AMERICANOS	B
ACKMORE	B	AGRA	D	ALBRIGHTS	C	ALNO	D	AMERICUS	A
ACKWATER	D	AGUA	B	ALBURZ	C	ALMONT	D	AMERY	B
ACME	C	AGUA DULCE	B	ALBURZ, DRAINED	B	ALMOTA	C	AMES	C/D
ACO	B	AGUA FRIA	C	ALBUS	B	ALMY	B	AMESHA	B
ACOMA	C	AGUA FRIA, HIGH	B	ALCAN	D	ALNITE	D	AMESMONT	C
ACORD	C	RAINFALL		ALCESTER	B	ALO	D	AMHERST	D
ACOVE	C	AGUA FRIA, STONY	B	ALCOA	B	ALOHA	C	AMISTAD	D
ACREDALE	D	AGUADILLA	A	ALCONA	B	ALOMAX	D	AMITY	D
ACREE	C	AGUALT	B	ALCOT	A	ALONA	B	AMMON	B
ACRELANE	C	AGUEDA	B	ALCOVA	B	ALONSO	B	AMODAC	C
ACTON	B	AGUILARES	B	ALDA	C	ALOVAR	C	AMOLE	A
ACUFF	B	AGUILITA	B	ALDA, SALINE	B/D	ALPENA	A	AMOR	B
ACUNA	C	AGUIRRE	D	ALDAX	D	ALPHA	B	AMORUS	D
ACY	C	AGUSTIN	B	ALDEN	D	ALPIN	A	AMOS	C
ADA	C	AHART	C	ALDER	C	ALPON	B	AMOSTOWN	C
ADAIR	C	AHL	C	ALDERDALE	C	ALPOWA	B	AMPAD	C
ADAMS	A	AHLSTROM	D	ALDERMAND	B	ALRED	B	AMPHION	C
ADAMSON	B	AHMEEK	C	ALDERWOOD	C	ALROS	C	AMSDEN	B
ADAMSVILLE	C	AHOLT	D	ALDI	D	ALS	A	AMSTERDAM	B
ADATON	D	AHPAH	B	ALDINE	D	ALSCO	B	AMTOFT	D

NOTES: TWO HYDROLOGIC SOIL GROUPS SUCH AS B/C INDICATES THE DRAINED/UNDRAINED SITUATION.
MODIFIERS SHOWN, E.G., BEDROCK SUBSTRATUM, REFER TO A SPECIFIC SOIL SERIES PHASE FOUND IN SOIL MAP LEGEND.

(25)

Table 2-2a.—Runoff curve numbers for urban areas[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type and hydrologic condition	Average percent impervious area[2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.)[3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only)[4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation)[5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1]Average runoff condition, and $I_a = 0.2S$.
[2]The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.
[3]CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
[4]Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
[5]Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4, based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

(26)

Table 2-2b.—Runoff curve numbers for cultivated agricultural lands[1]

Cover description			Curve numbers for hydrologic soil group—			
Cover type	Treatment[2]	Hydrologic condition[3]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T + CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T + CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

[1]Average runoff condition, and $I_a = 0.2S$.

[2]*Crop residue cover* applies only if residue is on at least 5% of the surface throughout the year.

[3]Hydrologic condition is based on combination of factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes in rotations, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

(27)

Table 2-2c.—Runoff curve numbers for other agricultural lands[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	[4]30	48	65	73
Woods—grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	[4]30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

[1]Average runoff condition, and $I_a = 0.2S$.

[2]*Poor:* <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.

[3]*Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

[4]Actual curve number is less than 30; use CN = 30 for runoff computations.

[5]CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[6]*Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

(28)

Table 2-2d.—Runoff curve numbers for arid and semiarid rangelands[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition[2]	A[3]	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

[1]Average runoff condition, and I_a = 0.2S. For range in humid regions, use table 2-2c.

[2]*Poor:* <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: >70% ground cover.

[3]Curve numbers for group A have been developed only for desert shrub.

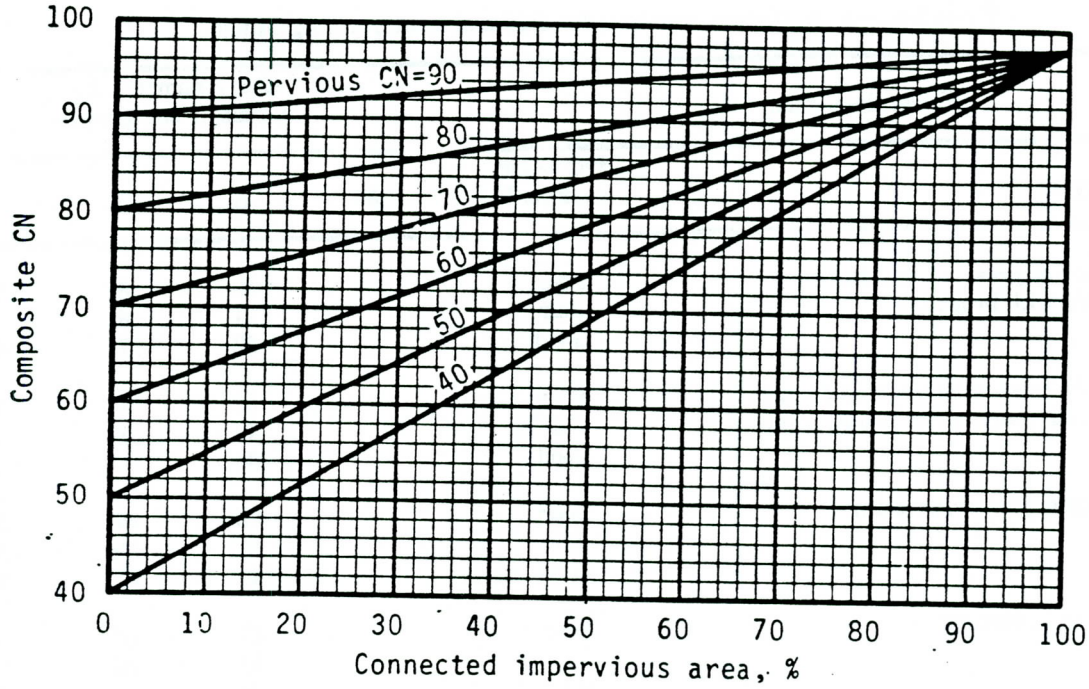


Figure 2-3.—Composite CN with connected impervious area.

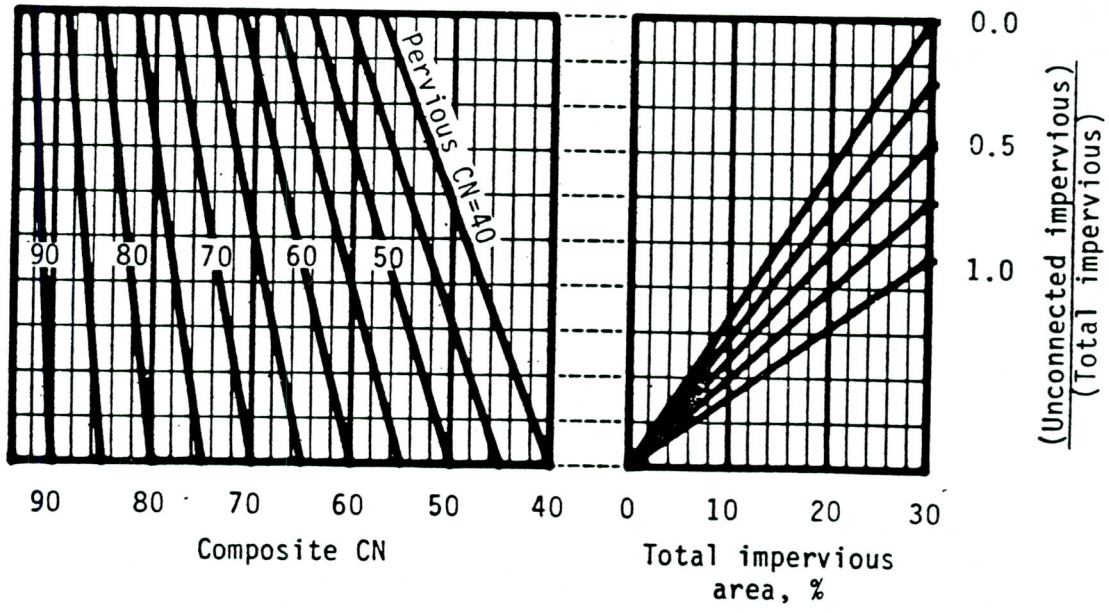


Figure 2-4.—Composite CN with unconnected impervious areas and total impervious area less than 30%.

TABLE 10.1 CURVE NUMBERS (CN) AND CONSTANTS FOR THE CASE $I_A = 0.2\ S$

CN FOR CONDITION II	CN FOR CONDITION I	CN CONDITION III	S VALUES (INCHES)	CURVE* STARTS WHERE P= (INCHES)
100	100	100	0	0
95	87	98	.526	.11
90	78	96	1.11	.22
85	70	94	1.76	.35
80	63	91	2.50	.50
75	57	88	3.33	.67
70	51	85	4.28	.86
65	45	82	5.38	1.08
60	40	78	6.67	1.33
55	35	74	8.18	1.64
50	31	70	10.0	2.00
45	26	65	12.2	2.44
40	22	60	15.0	3.00
35	18	55	18.6	3.72
30	15	50	23.3	4.66
25	12	43	30.0	6.00
20	9	37	40.0	8.00
15	6	30	56.7	11.34
10	4	22	90.0	18.00
5	2	13	190.0	38.00
0	0	0	INFINITY	INFINITY

*CN CONDITION II.

(3)

Worksheet 2: Runoff curve number and runoff

Project _____ By _____ Date _____

Location _____ Checked _____ Date _____

Circle one: Present Developed _____

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/ Table 2-2	CN 1/ Fig. 2-3	CN 1/ Fig. 2-4	Area ☐acres ☐mi² ☐%	Product of CN x area
			Area			
		CN TABLE	CONNECTED IMP.	UNCONNECTED IMP AREA		
Totals =						

1/ Use only one CN source per line.

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = _____ = _____; Use CN = ☐

2. Runoff

	Storm #1	Storm #2	Storm #3
Frequency ..... yr			
Rainfall, P (24-hour) ..... in			
Runoff, Q ..... in (Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)			

(32)

COMPUTATION SHEET
SCS-ENG-523 Rev. 8-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

STATE ARIZONA		PROJECT		
BY	DATE	CHECKED BY	DATE	JOB NO.

SUBJECT COMPUTATION OF RUNOFF CURVE NUMBER SHEET ____ OF ____

(HYDROLOGIC SOIL-COVER COMPLEX) BY SUB DRAINAGE AREA

SUB AREA	LAND USE AND CONDITION	RUNOFF CURVE NUMBER DISTRIBUTION												TOTAL NO. OF DOTS	WEIGHTED RCN
		SOIL GROUP A			SOIL GROUP B			SOIL GROUP C			SOIL GROUP D				
		NO OF DOTS	%/100	RCN	NO OF DOTS	%/100	RCN	NO. OF DOTS	%/100	RCN	NO. OF DOTS	%/100	RCN		
														4	

32A

CLASS PROBLEM
WILLOW CREEK W/S
CN - CALCULATIONS

SITE #1

HYD. SOIL GROUP	COVER CONDITIONS	CN	% OF AREA	PRODUCT CN X %
C	PONDEROSA PINE - 30% CANOPY	75	100	75

SITE #2

A	GRASS OR PASTURE - FAIR	49	1	0.5
B	HERBACEOUS - FAIR	71	6	4.4
C	PONDEROSA PINE - 30% CANOPY	75	71	53.3
D	PONDEROSA PINE - 20% CANOPY	83	22	18.3

WEIGHTED CN = 76.5

USE CN = 77

SITE #3

A	GRASS OR PASTURE - FAIR	49	3	1.5
B	WOODS - GRASS COMBINATION - FAIR	76	22	16.7
C	PONDEROSA PINE - 30% CANOPY	75	45	33.8
D	PONDEROSA PINE - 20% CANOPY	83	30	24.9

WEIGHTED CN = 76.9

USE CN = 77

WEIGHTED CN FOR TOTAL WATERSHED ABOVE DAM

SITE #1	75	39	29.3
SITE #2	77	39	30.0
SITE #3	77	22	16.9

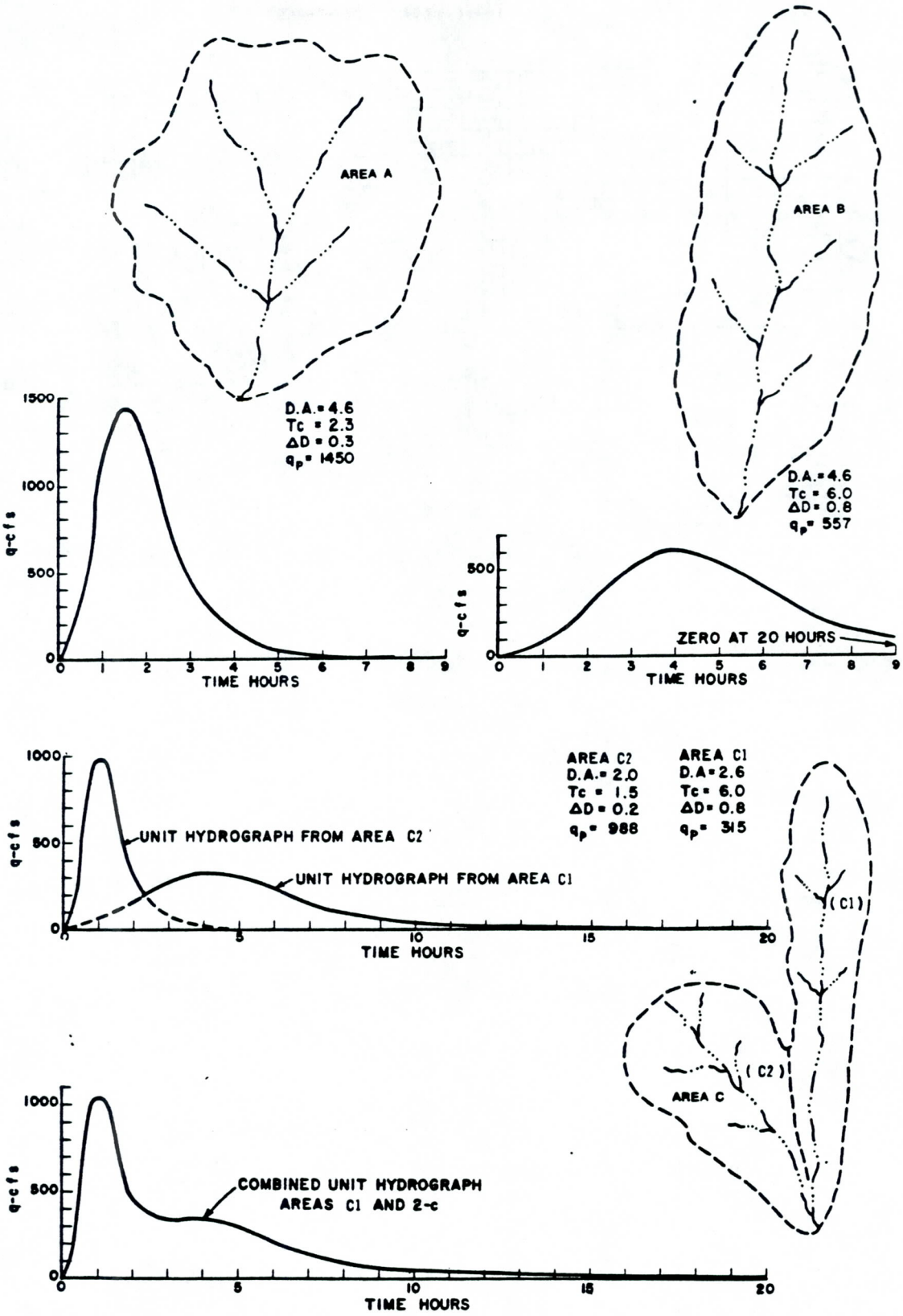


Figure 16.3 The effect of watershed shape on the peaks of unit hydrographs

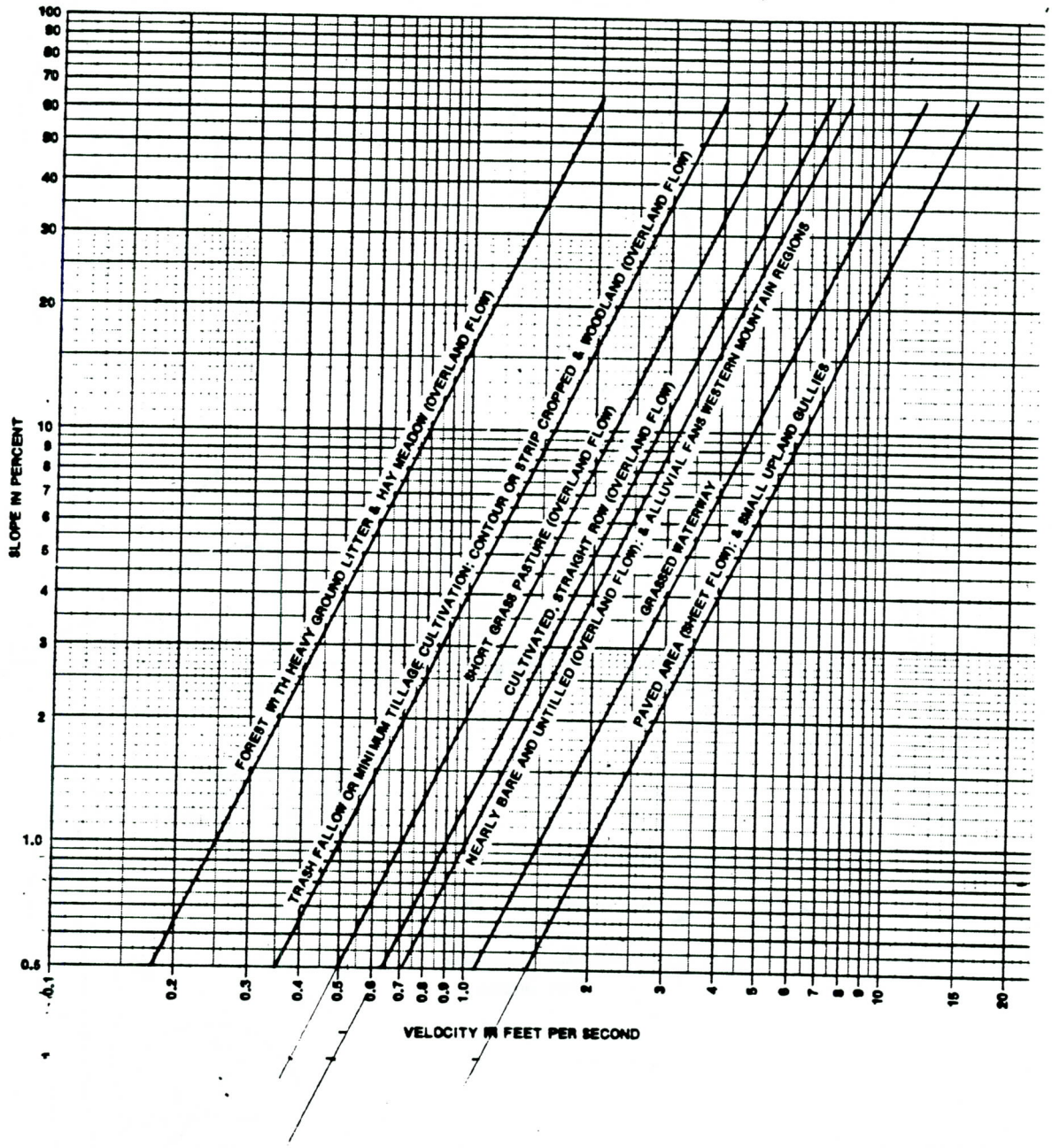


Figure 15.2.—Velocities for upland method of estimating T_c

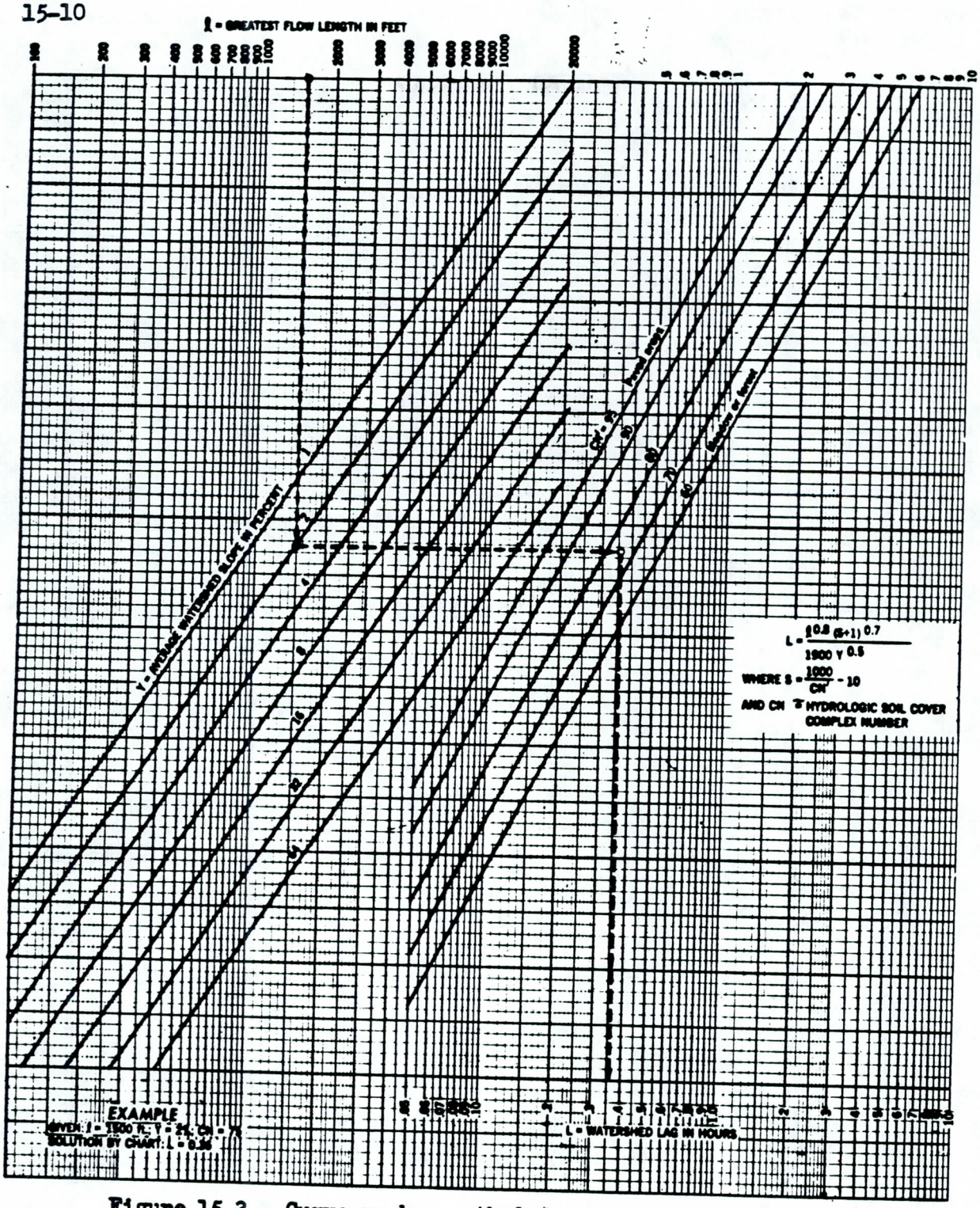


Figure 15.3.—Curve number method for estimating lag (L)

35A

COMPUTATION SHEET
SCS-ENG-523A Rev. 9-69

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
GPO 1969 O—364-109

STATE		PROJECT		
ARIZONA				
BY	DATE	CHECKED BY	DATE	JOB NO.
Hcm	12/21/72			

SUBJECT TIME OF CONCENTRATION FORMULAS SHEET ____ OF ____

$$T_c = \frac{L^{1.15}}{7700\,H^{0.38}}$$

KIRPICH'S FORMULA

T_c = TIME OF CONCENTRATION IN HOURS

L = DISTANCE IN FEET MEASURED ALONG AND TO THE END OF THE WATER COURSE, THENCE IN A STRAIGHT LINE TO THE FURTHEST POINT ON THE DRAINAGE BASIN BOUNDRY

H = RELIEF OF THE BASIN IN FEET, MEASURED AS THE DIFFERENCE IN ELEV. BETWEEN THE FURTHEST POINT ON BASIN BOUNDRY AND THE POINT WHERE DISCHARGE IS OBSERVED.

$$T_c = \left(\frac{2Ln}{3S}\right)^{0.467}$$

BRUCE & CLARK FORMULA

T_c = MINUTES

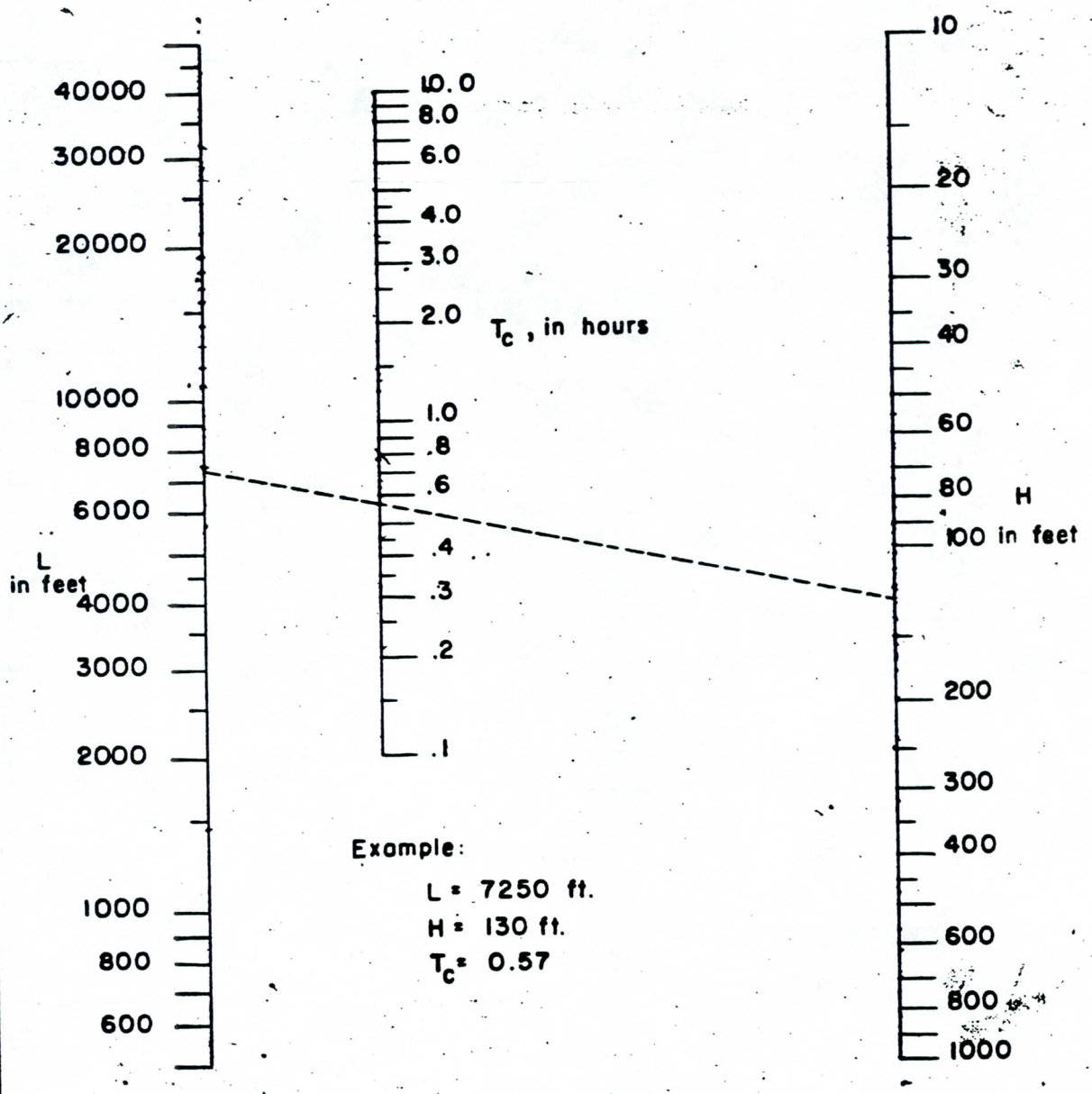
L = SAME AS ABOVE

n = ROUGHNESS FACTOR GIVEN BY BRUCE & CLARK

S = MEAN SLOPE OF MAIN DRAINAGEWAY

NOTE: THE ABOVE FORMULAS WERE TAKEN FROM SPECIAL REPORT 171, WASTEWATER MANAGEMENT BY DISPOSAL ON LAND BY CORPS OF ENGINEERS US ARMY COLD REGIONS RESEARCH AND ENGINEERING LABORATORY (CRREL) HANOVER, NEW HAMPSHIRE, MAY 1972

KIRPICH NOMOGRAPH



Example:

L = 7250 ft.

H = 130 ft.

T_c = 0.57

Figure V-10-2
3-L-45007 RM

(36)

Worksheet 3: Time of concentration (T_c) or travel time (T_t)

Project _____ By _____ Date _____

Location _____ Checked _____ Date _____

Circle one: Present Developed _____

Circle one: T_c T_t through subarea _____

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)		Segment ID		
1. Surface description (table 3-1)				
2. Manning's roughness coeff., n (table 3-1) ..				
3. Flow length, L (total L $\leq$ 300 ft)	ft			
4. Two-yr 24-hr rainfall, P_2	in			
5. Land slope, s	ft/ft			
6. $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute T_t	hr		+	=

Shallow concentrated flow		Segment ID		
7. Surface description (paved or unpaved)				
8. Flow length, L	ft			
9. Watercourse slope, s	ft/ft			
10. Average velocity, V (figure 3-1)	ft/s			
11. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		+	=

Channel flow		Segment ID		
12. Cross sectional flow area, a	ft^2			
13. Wetted perimeter, p_w	ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r	ft			
15. Channel slope, s	ft/ft			
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V	ft/s			
18. Flow length, L	ft			
19. $T_t = \frac{L}{3600\ V}$ Compute T_t	hr		+	=
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19)	hr			

SCS-ENG.-270 DRAFT
REV. May 1982

TR-20
STREAM CROSS SECTION DATA
CROSS SECTION NO. _____

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10		11-20		21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME			DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3			RECORD IDENT.

IMPORTANT: Line out unused lines. Data fields require decimal points.

		X SECTION ID. (001-200)	Drainage Area, Sq. Mi.	Bankfull Elevation, Ft.			
2	XSECTN						

(Use 1.0 unless discharge in CSM.)

NOTE: Maximum of 20 data records allowed.

	Elevation, Ft.	Discharge, CFS	End Area, Sq. Ft.		
8		0.0	0.0		
8					
8					
8					
8					
8					
8					
8					
8					
8					
8					
8					
8					
8					
8					
8					

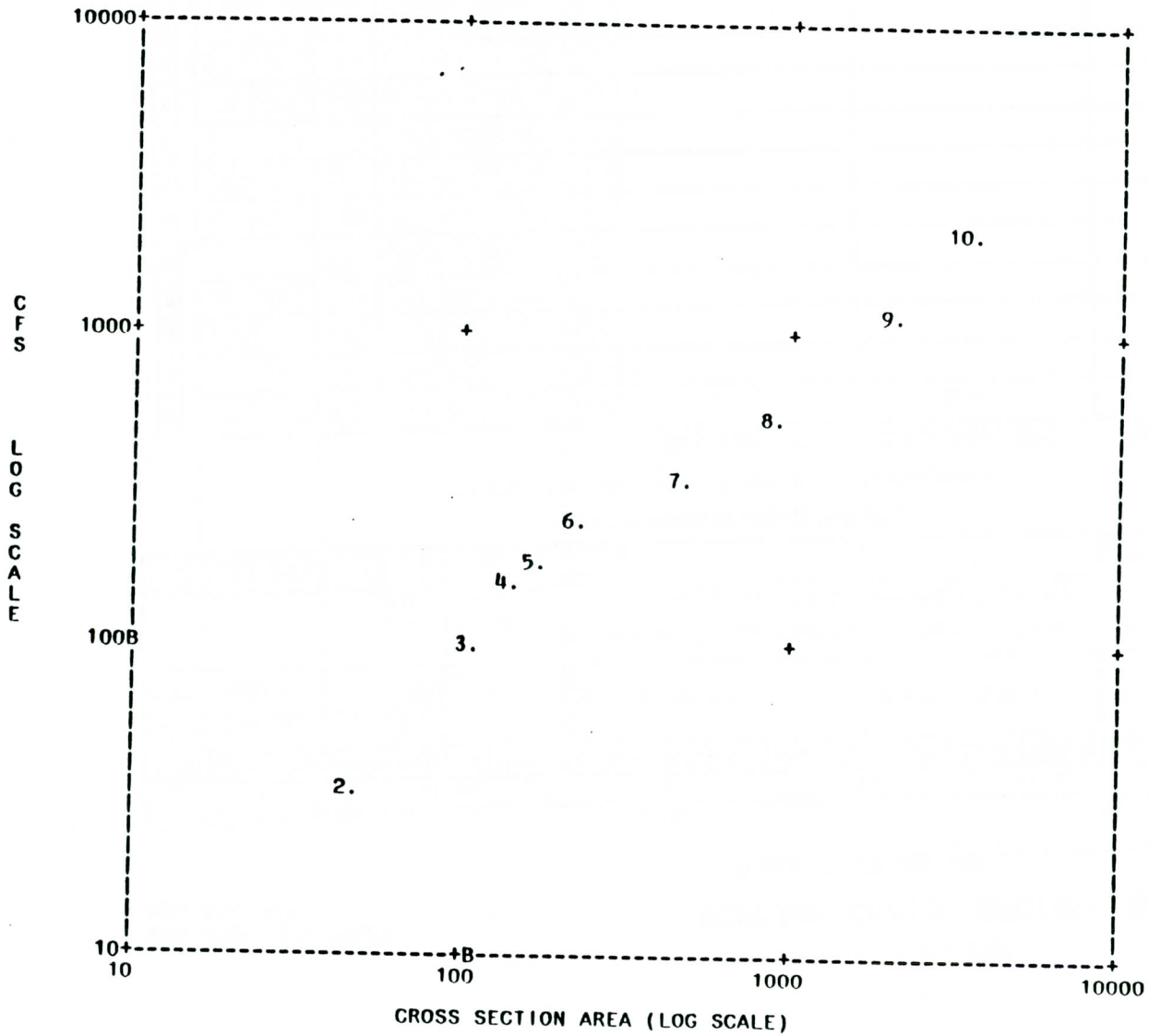
9	ENDTBL	NOTE: This record must be the last record of this table.

F-6

TR20 XEQ 05/25/82
REV 05/24/82

SAMPLE JOB 3 USING ACTUAL STORM FROM STRUC 1 TO XSECT 6 00000020
INCLUDES X-SEC. TABLE, DIVERT, PLOT, FULLPRINT, SUM., TZERO 00000030

JOB 1 PASS 1
PAGE 3



CROSS SECTION 6 DISCHARGE-AREA DATA

REFERENCE NO'S	DISCHARGE (CFS)	AREA (SQ FT)	M
1	0.0	0.0	1.48
2	29.00	46.00	1.48
3	97.00	104.00	1.48
4	144.00	138.00	1.45
5	176.00	168.00	1.37
6	215.00	226.00	1.25
7	320.00	459.00	1.02
8	485.00	875.00	0.89 *
9	1072.00	2060.00	0.91 *
10	1971.00	3629.00	0.99 *

A STAR (*) INDICATES A COMPUTED M VALUE IS OUTSIDE THE 1.00 - 2.00 RANGE. IN ROUTING THIS REACH THE M VALUE WILL BE SET TO THE CLOSEST LIMIT VALUE.

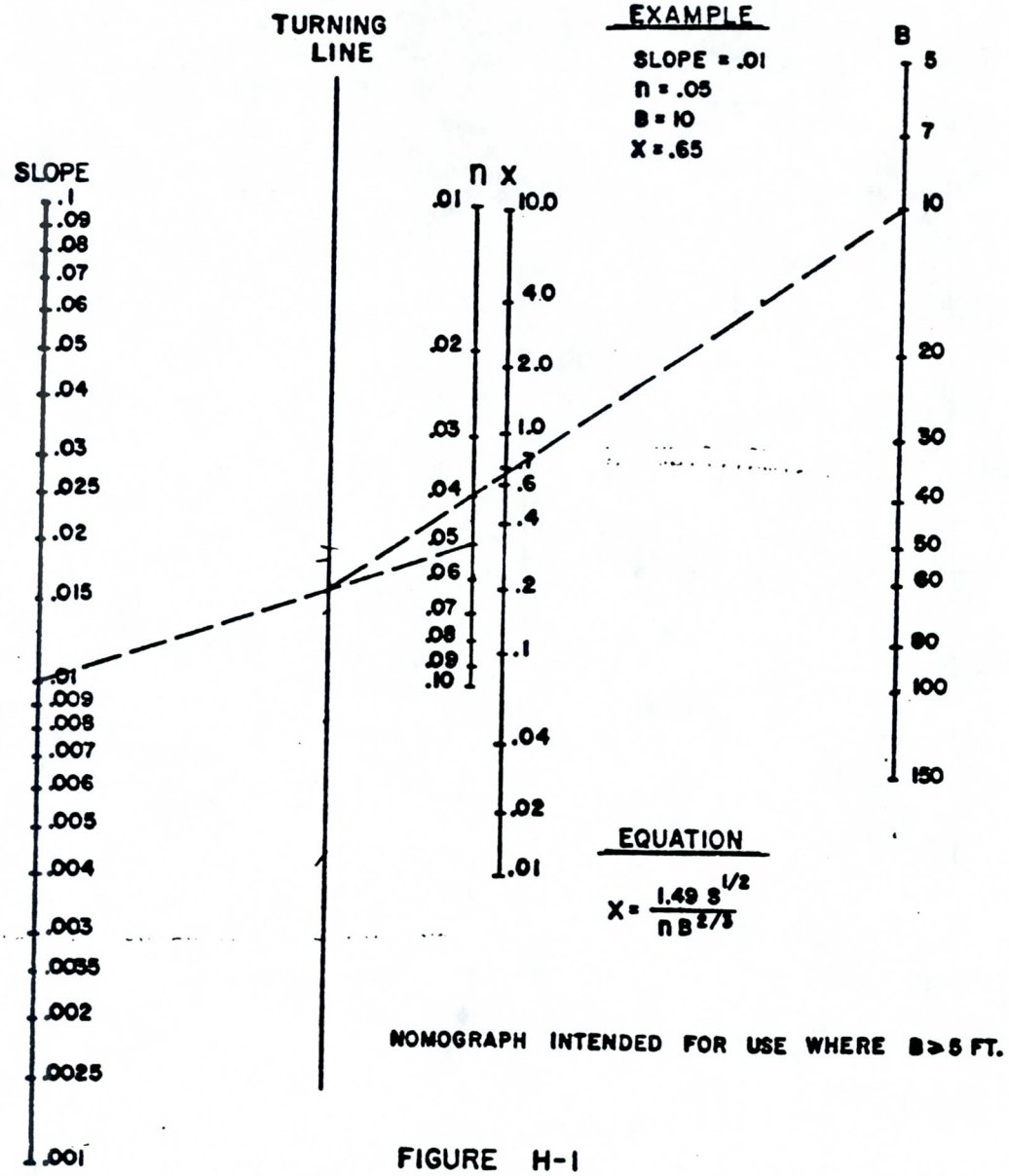
LEGEND

. = LOCATION OF PLOTTED VALUE
3 = REFERENCE NO. OF PLOTTED VALUE
X = MULTIPLE REFERENCE NUMBERS
B = BANKFULL RELATION SHOWN ON AXIS
AREA= 104.0 SQ FT DISCHARGE= 97.0 CFS

NOMOGRAPH FOR ESTIMATING X FOR A TRAPEZOIDAL CHANNEL

$Q = XA^M$

SLOPE = BOTTOM SLOPE (FT/FT)
n = MANNING'S n
B = BOTTOM WIDTH (FT)



NOMOGRAPH INTENDED FOR USE WHERE B > 5 FT.

FIGURE H-1

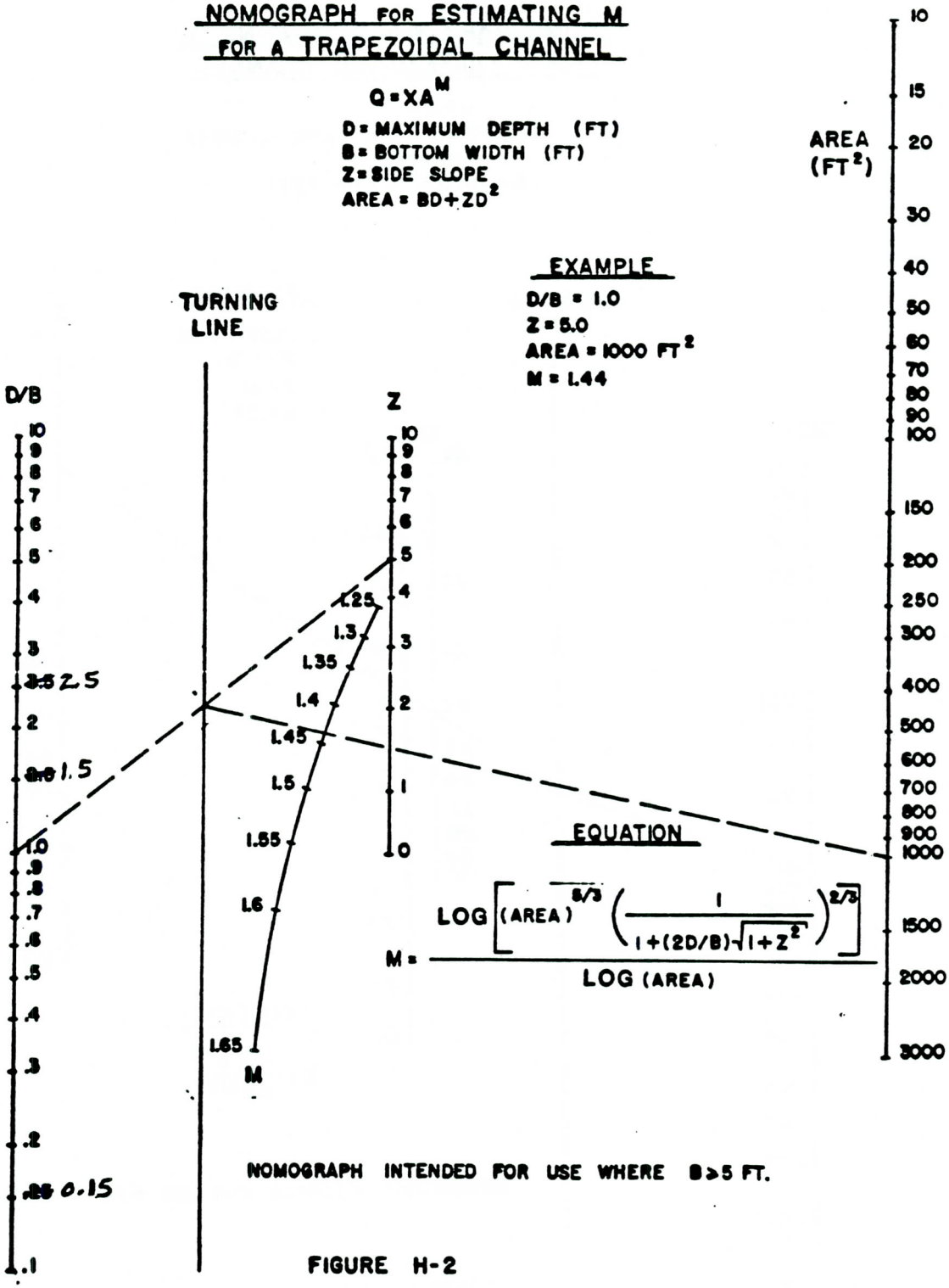
NOMOGRAPH FOR ESTIMATING M FOR A TRAPEZOIDAL CHANNEL

$Q = XA^M$

D = MAXIMUM DEPTH (FT)
B = BOTTOM WIDTH (FT)
Z = SIDE SLOPE
AREA = $BD + ZD^2$

EXAMPLE

D/B = 1.0
Z = 5.0
AREA = 1000 FT^2
M = 1.44



EQUATION

$$M = \frac{\log\left[(\text{AREA})^{5/3}\left(\frac{1}{1+(2D/B)\sqrt{1+Z^2}}\right)^{2/3}\right]}{\log(\text{AREA})}$$

NOMOGRAPH INTENDED FOR USE WHERE B > 5 FT.

FIGURE H-2

TR-20

STRUCTURE DATA

SCS-ENG.-269 DRAFT
REV. May 1982

STRUCTURE NO._____

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

F-5

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10		11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME		DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3			RECORD IDENT.
		STRUCTURE ID. (01-99)	IMPORTANT: Line out unused lines. Data fields require decimal points.					
3	STRUCT							
		NOTE: Maximum of 20 data records allowed.						
			Elevation, Ft.	Discharge, CFS	Storage, Acre, Ft.			
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
9	ENDTBL	NOTE: This record must be the last record of this table.						

NOMOGRAPH RELATING MAIN TIME INCREMENT WITH REACH LENGTH

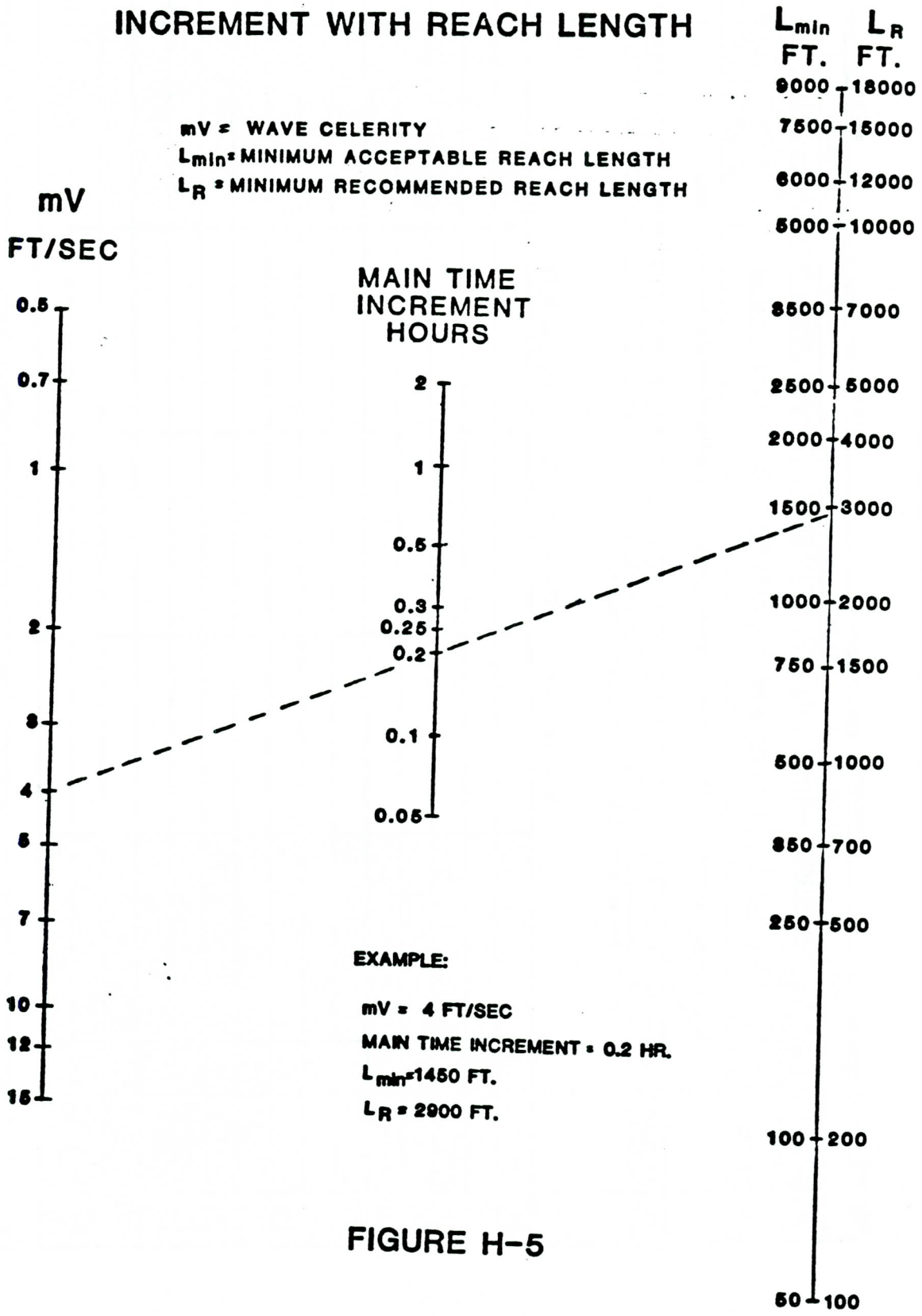
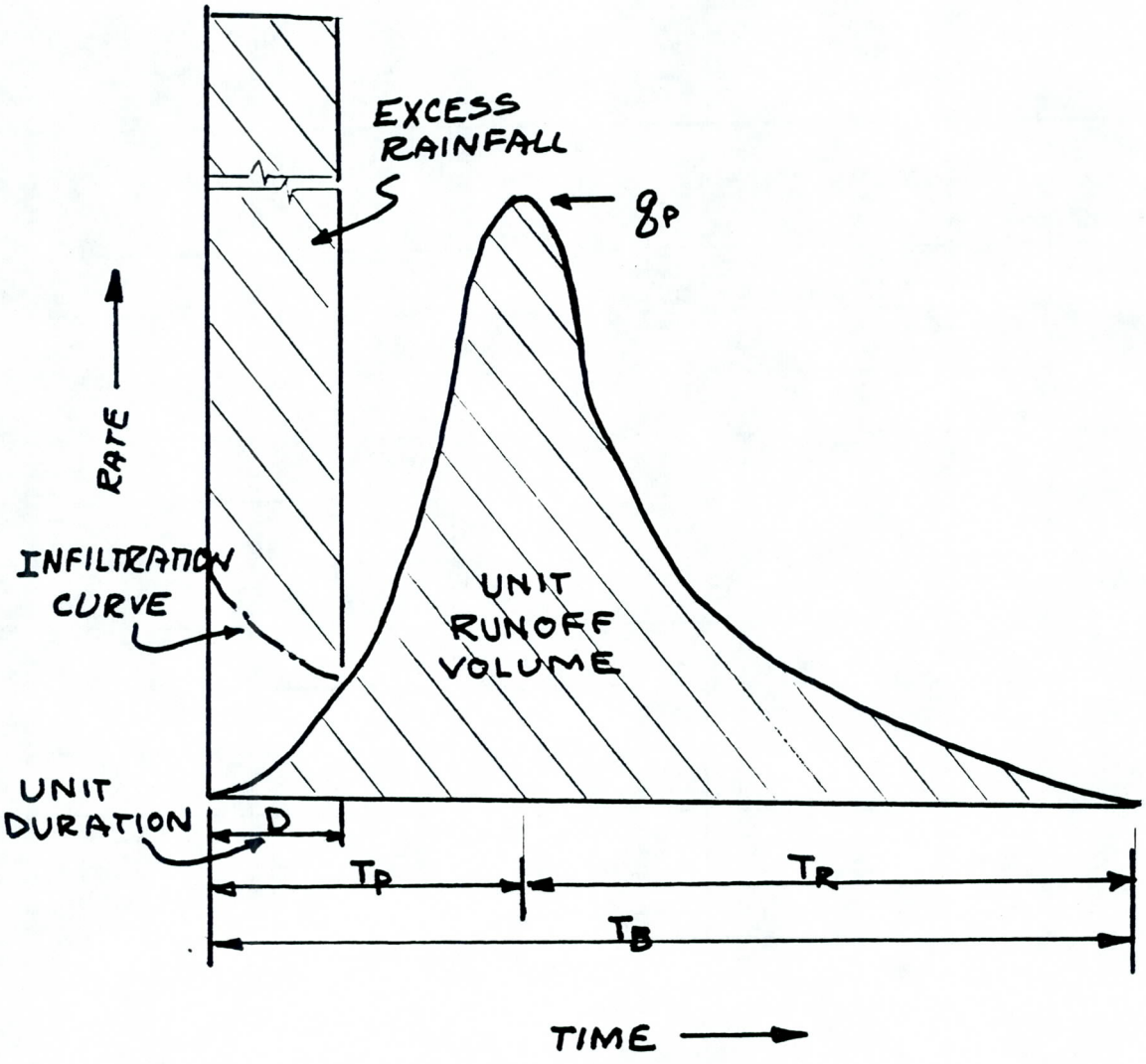


FIGURE H-5



UNIT HYDROGRAPH AND INFILTRATION CURVE

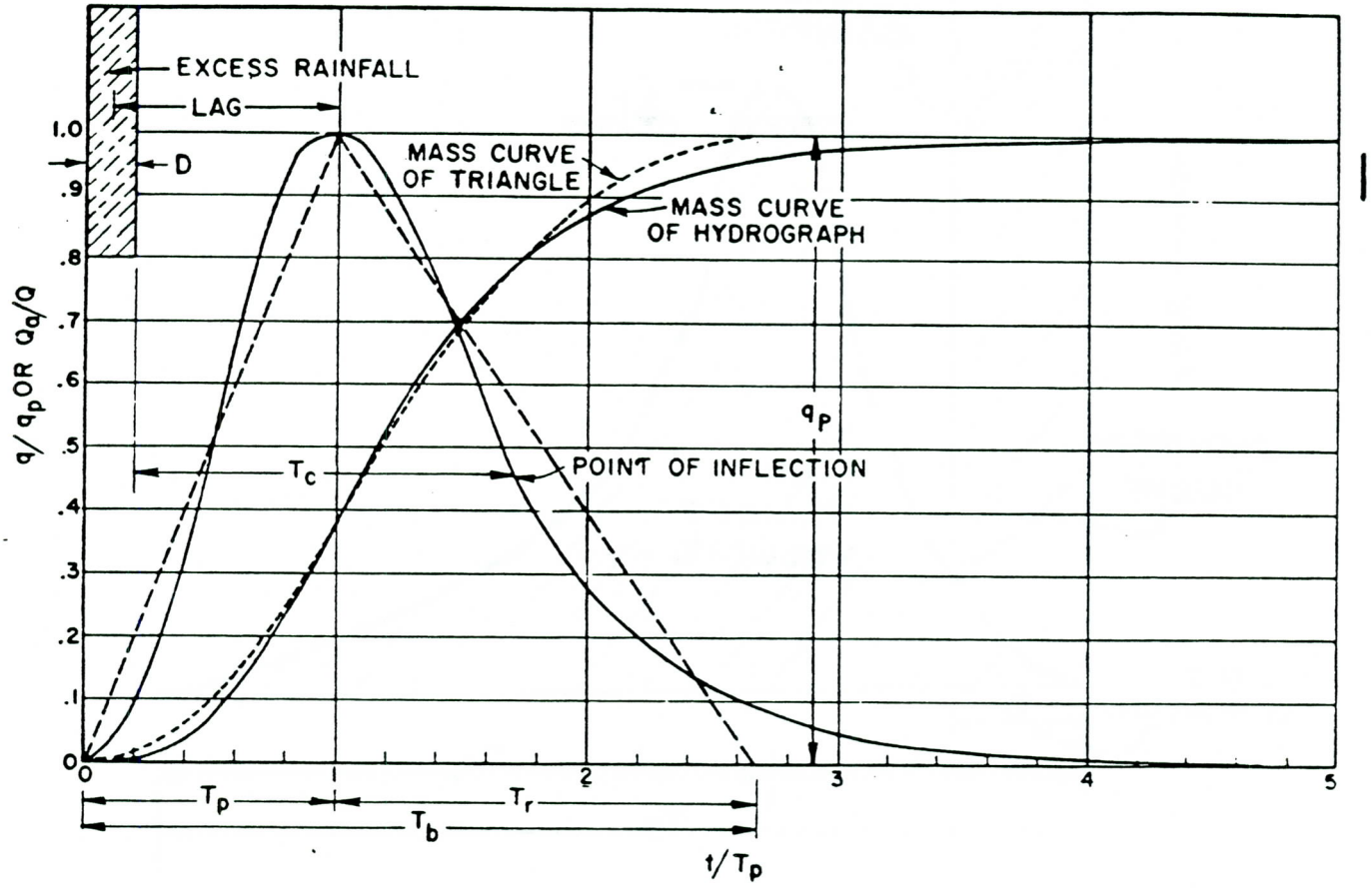
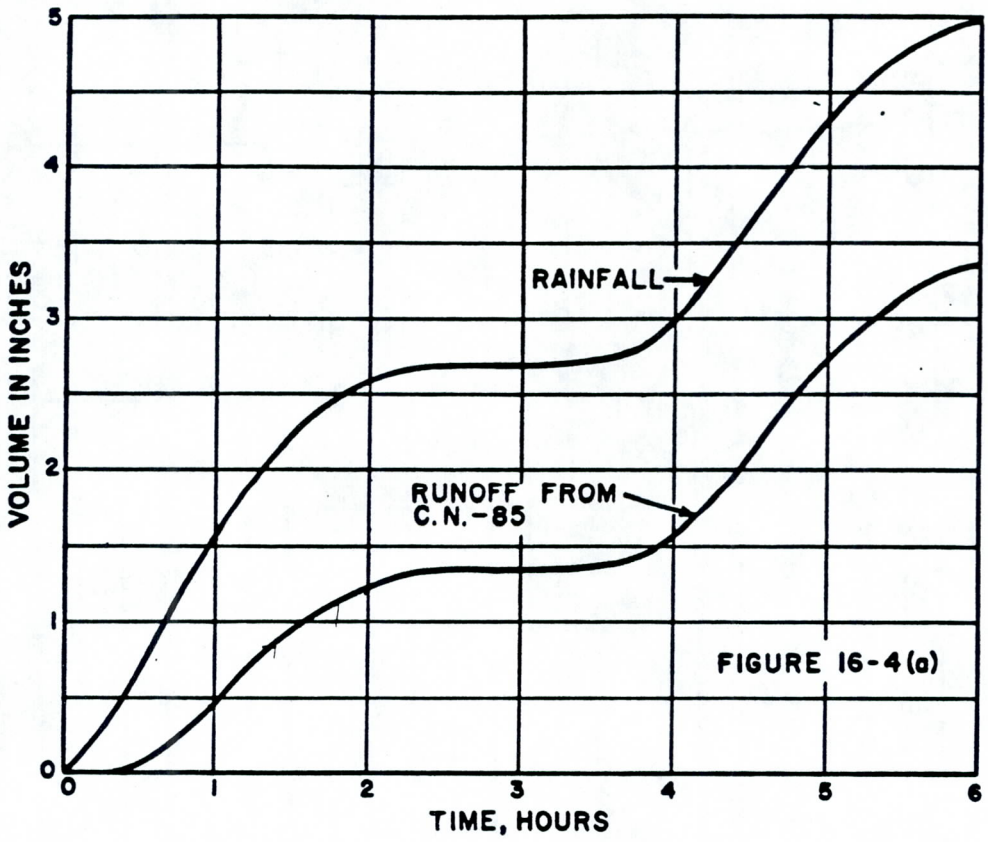


Figure 16.2 Dimensionless curvilinear unit hydrograph and equivalent triangular hydrograph



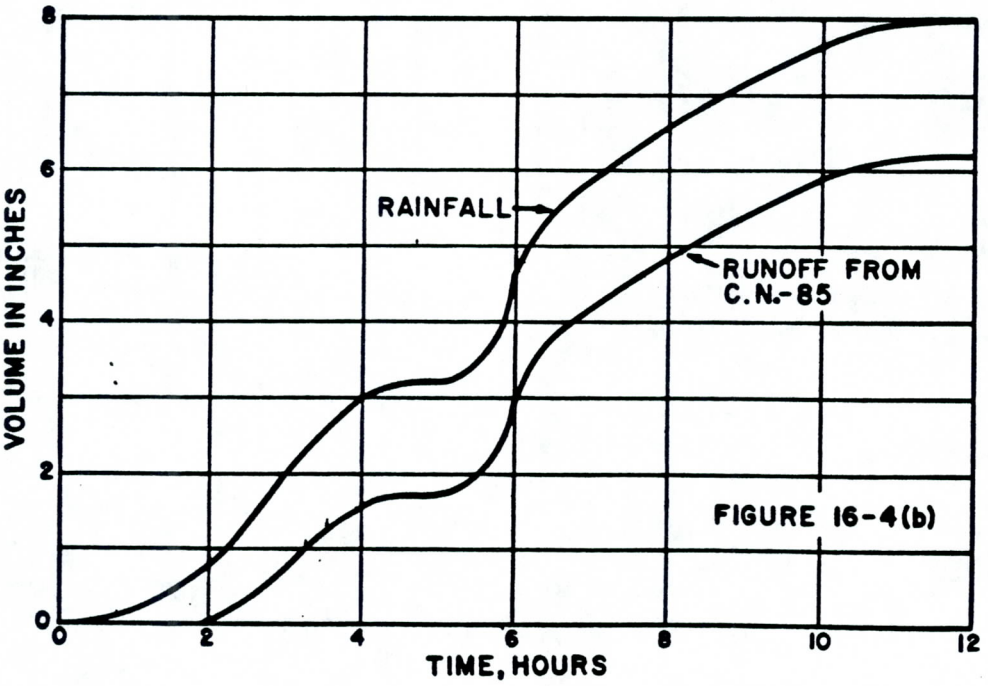


Figure 16.4 Accumulated rainfall and runoff for CN-85 taken from a recording rain gage.

SCS - ENG. - 269 DRAFT
REV. May 1982

TR - 20
STRUCTURE DATA

STRUCTURE NO._____

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10		11-20			21-30	31-40	41-50	51-60	61-70	71-80
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				DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3			RECORD IDENT.
		STRUCTURE ID. (01-99)			IMPORTANT: Line out unused lines. Data fields require decimal points.					
3	STRUCT									
		NOTE: Maximum of 20 data records allowed.								
					Elevation, Ft.	Discharge, CFS	Storage, Acre, Ft.			
8										
8										
8										
8										
8										
8										
8										
8										
8										
8										
8										
8										
8										
9	ENDTBL	NOTE: This record must be the last record of this table.								

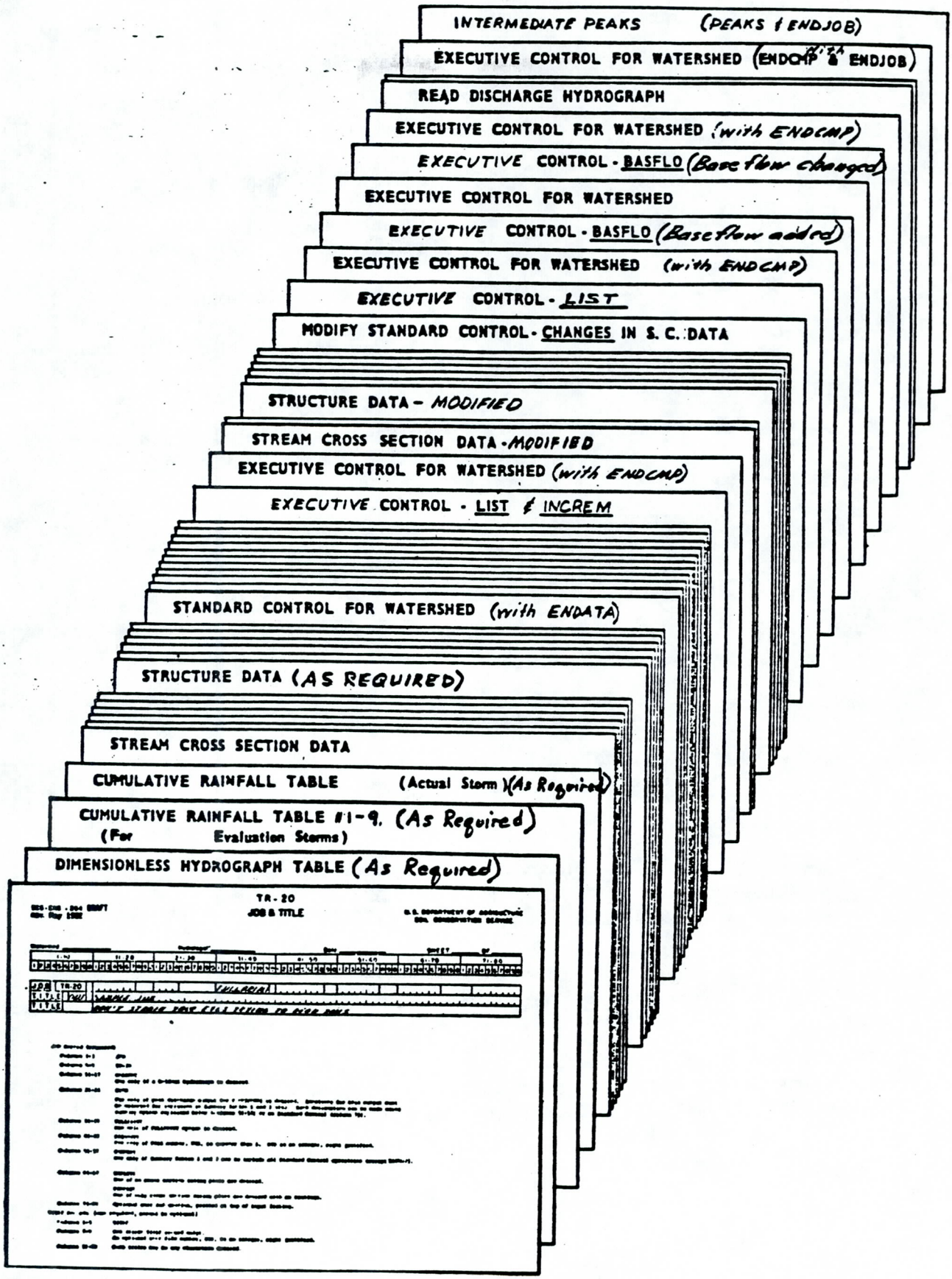
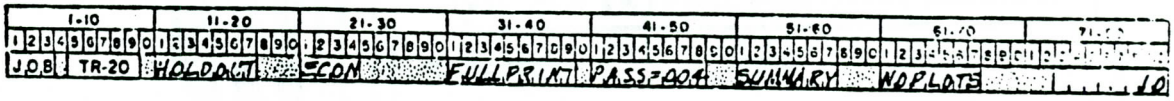


FIGURE 3-20.-- Arrangement of data input sheets.

Col. No.	Value	Description
1-3	JOB	Required data code signifying a TR-20 job follows
5-9	TR-20	Program identifier
11-17	b or HOLDOUT	Used to request a holdout hydrograph
21-25	b or ECON	Used to request that a peak discharge data file be created for ECON2/URB1
31-39	b or FULLPRINT	Used to request FULLPRINT option
41-48	b or PASS=XXX	Used to assign a pass number other than 1. XXX is three digit integer, right justified.
51-57	b or SUMMARY	Use only if Summary Tables 1 and 3 are to include all Standard Control operations (except SAVMOV).
61-67	NOPLOTS	No cross section discharge-area plots are desired.
	ENDPLOT	Request cross section discharge-area plots only; routings through watershed will not be done.
71-80	b or var.	Optional user information, printed at top of input data listing

Note: var. - variable data entered by the user
b - denotes blank

Example:



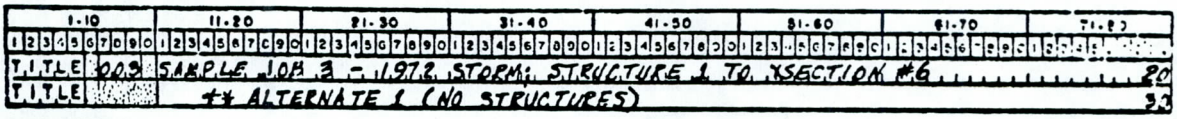
This statement causes a TR-20 job to be initiated. A HOLDOUT hydrograph will be developed. A data set containing peak discharge data will be created for later input to ECON2 or URB1 program. The FULLPRINT option for the output will be invoked. The pass number is four indicating that three other passes were made previously. A summary will include all Standard Control operations encountered. No plots of any stream cross section data will be made.

Figure 3-1. -- JOB Statement

Col. No.	Value	Description
1-5	TITLE	Required data code signifying a TITLE statement
7-9	b or var.*	An optional right justified integer for run number or a user file number
11-80	b or var.	Optional title of any characters to be listed at the top of each output page.

Note: var. - variable data to be entered by the user
b - denotes blank
* - Used only on the first TITLE statement

Example:



This TITLE statement has prescribed a file number of 3. Both lines of the job title, columns 11-80, will appear at the top of each page of output. The statement numbers, 20 and 30, will appear as part of the title since they are within the title field.

Figure 3-2. -- TITLE Statement

SUB-ROUTINE OPERATIONS

RUNOFF - Instruction for the machine to route the inflow hydrograph to a structure or routing reach; or to develop a hydrograph for the local intervening area contributing to a routing reach.

RESVOR - Instruction for the machine to route the inflow hydrograph through a structure.

REACH - Instruction for the machine to route the inflow hydrograph through a stream reach.

ADDHYD - Instruction for the machine to combine two hydrographs.

SAVMOV - Instruction for the machine to set a hydrograph aside in machine memory for subsequent consideration. It can be recalled by a SAVMOV instruction or by ADDHYD, REACH or RESVOR depending on its location and the next step in the standard control sequence.

DIVERT - Divides hydrograph into two separate hydrographs using two different procedures.

ENDATA - Last entry in standard control record.

SCS-ENG.-273 DRAFT
REV. May 1982

TR-20
STANDARD CONTROL FOR WATERSHED

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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	OPERATION NAME	OPERATION NO.	X SECT./STRUCT. XSECT. ID.	X SECT./STRUCT. STRUCT ID.	HYDRO. NUMBER INPUT #1	HYDRO. NUMBER INPUT #2	HYDRO. NUMBER OUTPUT	DATA FIELD # 1	DATA FIELD # 2	DATA FIELD # 3	OUTPUT OPTIONS PRINT PEAK	PRINT HYD.	PRINT ELEV.	PRINT VOL.	FILE	SUM.	RECORD IDENT.
6	RUNOFF	1					6	AREA, SQ. MI.	RUNOFF CURVE NO.	T_c, HRS.							EXAMPLES DO NOT ENTER
6	RESVOR	2			6		7	SURF. EL. AT T=0, FT.									
6	REACH	3			7		5	LENGTH, FT.	(OPTIONAL) END AREA COEFF. (X)	(OPTIONAL) EXPONENT (M)							
6	ADDHYD	4			5	6	7										
6	SAVMOV	5			FROM		TO										
6	DIVERT	6			IN	OUT 1	OUT 2	OUT 1 DISCHARGE, CFS	OUT 1, Decimal % D.A.	OUT 2, I.D.							
	ENDATA							This record is to be used only at end of all standard control records.									

EXAMPLES DO NOT ENTER

might justify these fields

IMPORTANT: Data Fields No. 1, 2, and 3 require decimal points.

NOTE: This form was suggested by members of Massachusetts Planning Staff.

F-14

SCS-ENG.-273A DRAFT
REV. May 1982

TR-20

STANDARD CONTROL FOR WATERSHED

CONTINUATION SHEET

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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

CODE	OPERATION	XSEC	STRUC	HYD. NO.	DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3	OUTPUT OPTIONS	RECORD ID.
		Right justify these fields			IMPORTANT: Data Fields No 1, 2, and 3 require decimal points.				

F-16

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 is 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 C for an example of procedure #1.

Procedure 2 --
This procedure is used where a stream branches into two streams or into a stream and a floodway. Data Field #1 is left blank or zero. All discharges will be proportioned using an elevation versus discharge rating table representative of each branch. The elevation and discharge columns of the cross section or structure data tables are used. The elevations of the two output hydrographs are assumed to be equal, 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. See Sample Job 5, Alternate 4, Appendix E for an example of procedure #2.

3.6.7 ENDATA (Figure 3-9)

The ENDATA statement must be entered at the end of the Standard Control input data list.

3.6.8 Output Options

The spaces under the "Output Options" heading (Columns 61-71) on the Standard Control permit one to choose the type and kind of hydrograph data to be obtained as output.

Output Option	Use "1" in Column #	Produces the following output:
PEAK	61	Peak Discharge, Peak Time and, if a rating table is available, the Peak Elevation are printed. Up to 10 highest multiple peaks for each hydrograph will be printed. If the

FULLPRINT option is specified in the JOB statement, PEAK will be automatically set to 1. The maximum peak data only is printed in the Summary Tables if one of the summary options is requested.

HYD	63	Discharge versus time 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 printed out (subject to the 300 point limit).
ELEV	65	Elevation versus time in tabular form. An elevation value will be printed that corresponds to the HYD option discharge value. The ELEV option is requested only at cross sections and structures and then only if a rating table is available. For example, the ELEV option would not be selected on the RUNOFF statement.
VOL	67	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 printed. If the FULLPRINT option is specified in the JOB statement, VOL will be automatically set to 1. The volume will be printed in Summary Table 1 if one of the summary options is requested. Triangular baseflow is included in the volume of the hydrographs.
FILE	69	A discharge hydrograph file is generated in a "Read-Discharge-Hydrograph" format for use as input to a subsequent TR-20 run. See page B-13, App. B. The file is only identified by a hydrograph number which

increases by one for each hydrograph generated from a job. To print the hydrograph for identification comparison the HYD option must also be set to 1. The discharge hydrograph file may be saved and/or printed if the user alters the system control language to change the output form.

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 (when used) and the cross section or structure identification number. Only the largest peak discharge for each hydrograph is listed in the summary. If Summary is called for more than once for the same cross section or structure, only the last summary location will be printed in Summary Tables 3 and 4. If the SUMMARY option is specified on the JOB statement, the SUM output option on individual operations is not needed. One of these options must be on to save peak information if the ECON option is specified on the JOB statement.

* If none of the output options or FULLPRINT or SUMMARY are selected the respective operation will be completed without providing any printout.

3.7 TABULAR DATA

There are five tabular data formats to support the Standard Control statements. The tabular data formats are: (1) Dimensionless Hydrograph (2) Cumulative Rainfall, (3) Stream Cross Section Data, (4) Structure Data, and (5) Read Discharge Hydrograph. Each tabular data set has a header line specifying the type of data that is entered before the tabular data. Each line of tabular data has an 8 in column 2 and five 12-column data fields. Decimal points must accompany all figures in

SCS-ENG.-274 DRAFT
REV. May 1982

TR-20
EXECUTIVE CONTROL FOR WATERSHED

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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

EXAMPLES DO NOT ENTER

DATA CODE	OPERATION		DATA FIELD #1	DATA FIELD #2	DATA FIELD #3		RECORD IDENT.
7	LIST	This record is used for printout of tabular data and standard control list that are currently effective.					
7	BASFLO	5	NEW BASE FLOW, CFS or VOLUME IN INCHES	IF VOLUME IS IN DATA FIELD No. 1. PEAK TIME, HOURS	BASE TIME, HOURS		
7	INCREM	6	MAIN TIME INCREMENT, HRS.	This increment is required for initial computations. Remains in force until new increment is entered.			
7	COMPUT	7	FROM OR XSECT. / FROM OR STRUCT.	THRU OR XSECT. / THRU OR STRUCT.	STARTING TIME HOURS	RAINFALL DEPTH INCHES (Set depth and duration to LO for actual rainfall)	RAINFALL DURATION HOURS	RAIN TABLE NO. / AMC / ALTERNATE NO. / STORM NO.	EXAMPLES DO NOT ENTER
	ENDCMP	1	This record is required at "end" of a watershed, it may follow a series of COMPUT records						
	ENDJOB	2	This record terminates routing computation and precedes the PEAKS record, if any.						

Right justify these fields

IMPORTANT: Data Fields No. 1, 2, and 3 require decimal points.

R-17

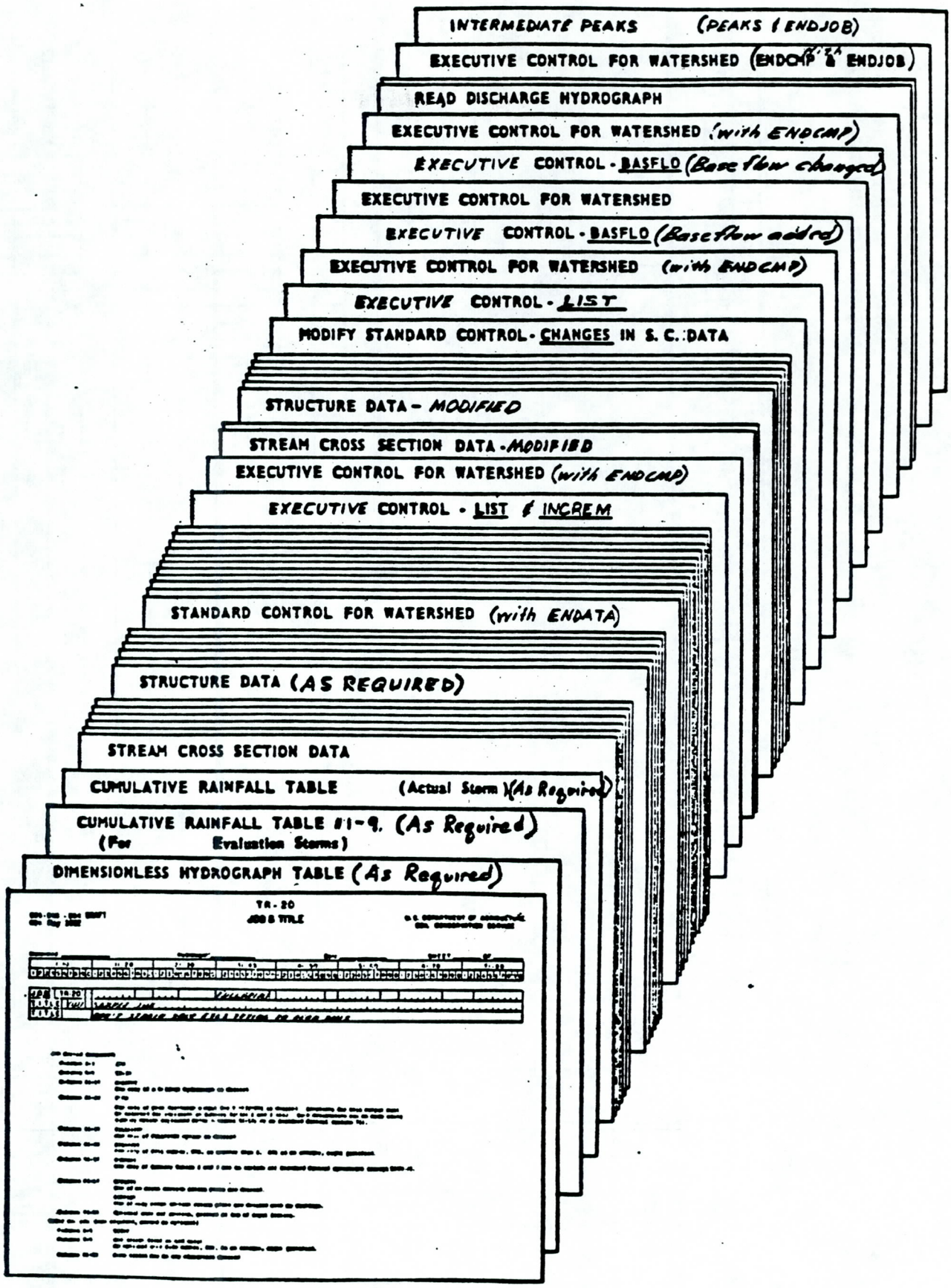


FIGURE 3-20--Arrangement of data input sheets.

SCS - ENG. - 275 DRAFT
REV. May 1982

TR - 20
MODIFY STANDARD CONTROL

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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	OPERATION NAME	OPERATION NO.	X SECT. / STRUCT. X SECT. ID.	X SECT. / STRUCT. STRUCT ID.	HYDRO. NUMBER INPUT #1	HYDRO. NUMBER INPUT #2	HYDRO. NUMBER OUTPUT	DATA FIELD #1	DATA FIELD #2	DATA FIELD #3	OUTPUT OPTIONS PRINT PEAK	PRINT HYD.	PRINT ELEV.	PRINT VOL.	FILE	SUM.	RECORD IDENT.
					IMPORTANT: Line out unused lines. Data fields require decimal points.												
					IMPORTANT: Modifications must be given in the order that they appear on the standard control list.												
7	INSERT	2						NOTE: The following records are inserted following the XSECTN / STRUCTURE specified.									
6																	
6																	
6																	
6																	
7	ALTER	3						NOTE: Data given in columns 1 to 18 must be identical with standard control record to be altered.									
6																	
6																	
6																	
6																	
7	DELETE	4						NOTE: Data given in columns 1 to 18 must be identical with standard control record to be deleted.									
6																	
6																	
6																	
6																	

SCS-ENG.-277 DRAFT
Rev. May 1982

TR-20
INTERMEDIATE PEAKS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

F-22

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
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	FROM OR XSECT.	FROM OR STRUCT	THRU OR XSECT.	THRU OR STRUCT	INTERMEDIATE POINTS BETWEEN FROM AND THRU XSECTION / STRUCTURES: POINT ID.	DRAINAGE AREA (Sq. Mi.)	POINT ID.	DRAINAGE AREA (Sq. Mi.)	POINT ID.	DRAINAGE AREA (Sq. Mi.)	POINT ID.	DRAINAGE AREA (Sq. Mi.)	RECORD IDENT.
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
PEAKS													
ENDJOB	2	This record terminates the entire TR-20 job.											

SCS-ENG.-276 DRAFT
REV. May 1982

TR - 20
READ DISCHARGE HYDROGRAPH

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

(59)

Watershed _____ Hydrologist _____ Date _____ SHEET _____ OF _____

1-10		11-20	21-30	31-40	41-50	51-60	61-70	71-80
DATA CODE	TABLE NAME	DATA FIELD NO. 1	DATA FIELD NO. 2	DATA FIELD NO. 3	DATA FIELD NO. 4	DATA FIELD NO. 5	RECORD IDENT.	

IMPORTANT: Line out unused lines. Data fields require decimal points.

7	READHD	8	HYDROGRAPH NO.					
7	READHD	9	STARTING TIME, HRS.	TIME INCREMENT, HRS.	DRAINAGE AREA, SQ. MI.	BASE FLOW, CFS		

Enter successive entries left to right with first entry for time = 0. Fill last row of data with last entry of table. ← Base flow. If any

8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								
8								

9	ENDTBL	NOTE: This record must be the last record of this table.

F-21

EXECUTIVE CONTROL OPERATION INCREM RECORD ID
+ MAIN TIME INCREMENT = .08 HOURS

EXECUTIVE CONTROL OPERATION COMPUT RECORD ID
+ FROM XSECTION 1
+ TO STRUCTURE 1
STARTING TIME = .00 RAIN DEPTH = 3.80 RAIN DURATION= 1.00 RAIN TABLE NO.= 2 ANT. MOIST. COND= 2
ALTERNATE NO.= 1 STORM NO.= 1 MAIN TIME INCREMENT = .08 HOURS

OPERATION RUNOFF CROSS SECTION 1

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
12.08	660.67	(RUNOFF)
16.44	20.29	(RUNOFF)
17.66	16.96	(RUNOFF)
19.65	13.63	(RUNOFF)
23.65	10.29	(RUNOFF)

RUNOFF VOLUME ABOVE BASEFLOW = 2.62 WATERSHED INCHES, 635.08 CFS-HRS, 52.48 ACRE-FEET; BASEFLOW = .00 CFS

OPERATION RESVOR STRUCTURE 1

PEAK TIME(HRS)	PEAK DISCHARGE(CFS)	PEAK ELEVATION(FEET)
12.12	636.43	82.89
16.45	20.29	73.72
17.66	16.96	73.61
19.65	13.63	73.49
23.65	10.29	73.37

RUNOFF VOLUME ABOVE BASEFLOW = 2.62 WATERSHED INCHES, 634.95 CFS-HRS, 52.47 ACRE-FEET; BASEFLOW = .00 CFS

EXECUTIVE CONTROL OPERATION ENDCMP RECORD ID
+ COMPUTATIONS COMPLETED FOR PASS 1

EXECUTIVE CONTROL OPERATION ENDJOB RECORD ID
1

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

SECTION/ STRUCTURE ID	STANDARD CONTROL OPERATION	DRAINAGE AREA (SQ MI)	RAIN TABLE #	ANTEC MOIST COND	MAIN TIME INCREM (HR)	PRECIPITATION BEGIN (HR)	PRECIPITATION AMOUNT (IN)	PRECIPITATION DURATION (HR)	RUNOFF AMOUNT (IN)	PEAK DISCHARGE ELEVATION (FT)	PEAK DISCHARGE TIME (HR)	PEAK DISCHARGE RATE (CFS)	PEAK DISCHARGE RATE (CSM)
ALTERNATE 1 STORM 1													
XSECTION 1	RUNOFF	.38	2	2	.08	.0	3.80	24.00	2.62	---	12.08	660.67	1761.8
STRUCTURE 1	RESVOR	.38	2	2	.08	.0	3.80	24.00	2.62	82.89	12.12	636.43	1697.1

1

SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

XSECTION/ STRUCTURE ID	DRAINAGE AREA (SQ MI)	STORM NUMBERS..... 1
0 STRUCTURE 1	.38	
+ ALTERNATE 1		636.43
0 XSECTION 1	.38	
+ ALTERNATE 1		660.67

1END OF 1 JOBS IN THIS RUN

```
1


 *****************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY*****************

 JOB TR-20           FULLPRINT                      SUMMARY   NOPLOT
 TITLE     LOT 119 CLEARWATER HILLS, CHK BY FCD DRAINAGE BRANCH -8/5/93
 TITLE     HYDROLOGY USING 100YR-6HR STORM = 3.20 INCHES
  5 RAINFL 7            0.25
  8          0.0          0.028       0.051       0.080       0.109
  8          0.134        0.163       0.190       0.214       0.242
  8          0.280        0.320       0.380       0.520       0.806
  8          1.440        2.220       2.670       2.880       3.000
  8          3.040        3.080       3.120       3.160       3.200
  9 ENDTABL
  6 RUNOFF 1 001       5 .375       89.         .317        1     1
  6 RESVOR 2    01 5   6 73.0                               1     1
    ENDATA
  7 INCREM 6            0.250
  7 COMPUT 7 001      01             1.          1.          7 2  01  01
    ENDCMP 1
    ENDJOB 2
0******************************END OF 80-80 LIST******************************


 EXECUTIVE CONTROL OPERATION INCREM                                                                   RECORD ID
+                                     MAIN TIME INCREMENT =   .25 HOURS


 EXECUTIVE CONTROL OPERATION COMPUT                                                                   RECORD ID
+                                     FROM XSECTION   1
+                                                        TO STRUCTURE  1
        STARTING TIME =   .00    RAIN DEPTH =  1.00    RAIN DURATION=  1.00    RAIN TABLE NO.= 7    ANT. MOIST. COND= 2
        ALTERNATE NO.= 1         STORM NO.= 1    MAIN TIME INCREMENT =   .25 HOURS


 OPERATION RUNOFF   CROSS SECTION   1

           PEAK TIME(HRS)              PEAK DISCHARGE(CFS)            PEAK ELEVATION(FEET)
               4.09                          518.61                        (RUNOFF)
               5.88                           37.76                        (RUNOFF)

   RUNOFF VOLUME ABOVE BASEFLOW =  2.07 WATERSHED INCHES,    501.40 CFS-HRS,    41.44 ACRE-FEET;   BASEFLOW =    .00 CFS


 OPERATION RESVOR   STRUCTURE  1

           PEAK TIME(HRS)              PEAK DISCHARGE(CFS)            PEAK ELEVATION(FEET)
               4.09                          518.61                        (NULL)
               5.88                           37.76                        (NULL)

   RUNOFF VOLUME ABOVE BASEFLOW =  2.07 WATERSHED INCHES,    501.40 CFS-HRS,    41.44 ACRE-FEET;   BASEFLOW =    .00 CFS


 EXECUTIVE CONTROL OPERATION ENDCMP                                                                   RECORD ID
+                                     COMPUTATIONS COMPLETED FOR PASS   1



 EXECUTIVE CONTROL OPERATION ENDJOB                                                                   RECORD ID
1


 TR20 XEQ 08-05-93  16:31       LOT 119 CLEARWATER HILLS, CHK BY FCD DRAINAGE BRANCH -8/5/93                    JOB  1   SUMMARY
      REV PC 09/83(.2)          HYDROLOGY USING 100YR-6HR STORM = 3.20 INCHES                                            PAGE   1


 SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
                  (A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
                   A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

 SECTION/    STANDARD             RAIN  ANTEC  MAIN         PRECIPITATION                          PEAK DISCHARGE
 STRUCTURE    CONTROL   DRAINAGE  TABLE MOIST  TIME    -------------------------  RUNOFF   -------------------------------------------
    ID       OPERATION    AREA      #    COND  INCREM  BEGIN    AMOUNT  DURATION  AMOUNT   ELEVATION   TIME       RATE        RATE
                        (SQ MI)                 (HR)   (HR)      (IN)     (HR)     (IN)      (FT)      (HR)      (CFS)       (CSM)


    ALTERNATE    1   STORM    1
+   ---------------------------
 XSECTION   1  RUNOFF      .38      7     2     .25      .0      3.20     6.00     2.07       ---       4.09      518.61      1383.0
 STRUCTURE  1  RESVOR      .38      7     2     .25      .0      3.20     6.00     2.07       ---       4.09      518.61      1383.0
1


 TR20 XEQ 08-05-93  16:31       LOT 119 CLEARWATER HILLS, CHK BY FCD DRAINAGE BRANCH -8/5/93                    JOB  1   SUMMARY
      REV PC 09/83(.2)          HYDROLOGY USING 100YR-6HR STORM = 3.20 INCHES                                            PAGE   2


 SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

 XSECTION/            DRAINAGE
 STRUCTURE              AREA      STORM NUMBERS..........
   ID                  (SQ MI)          1

0 STRUCTURE   1           .38
+ ---------------------------
     ALTERNATE    1                  518.61
0 XSECTION    1           .38
+ ---------------------------
     ALTERNATE    1                  518.61
1END OF  1 JOBS IN THIS RUN
```