Preface

The WinTR-20 Computer Program for Project Formulation Hydrology version 3.10 has been revised to operate with the Windows 7 Operating System (32-bit and 64-bit). This user guide will assist the new or occasional user to prepare and run the program.

This version of WinTR-20 is improved over the old version of TR-20 February 1992 version with the following features:

- Inclusion of Windows interface
- Updated computational coding
- Muskingum-Cunge reach routing for channel reaches
- Added the time of concentration using Lag method
- Added routines to calculate Runoff Curve Numbers by methods used in Texas, Kansas, and Oklahoma
- Transforms old TR-20 input data to new WinTR-20 format
- HEC-RAS Reformatter that transforms HEC-RAS output profile data to WinTR-20 stream cross section data
- A routine has been added to allow user to import a NOAA Atlas 14 data file downloaded from the NOAA NWS web site into WinTR-20. The rainfall-frequency data at the location will be used to develop site-specific rainfall distributions.
- A routine has been added to allow user to import a Northeast Regional Climate Center (NRCC) data file downloaded from the NRCC web site into WinTR-20. The rainfall-frequency data at the location will be used to develop site-specific rainfall distributions.
- A routine has been added to allow users to develop hydrographs using NRCS TR-60 criteria for Principal Spillway Data and Stability/Freeboard Data.

Please report any problems or comments on the version 3.10 computer program or suggested enhancements to the WinTR-20 development team at NRCS-TR20@usda.gov or the NRCS hydraulic engineer in your state.

Acknowledgments

One of the great pleasures of writing this User Guide is acknowledging the efforts of many people whose hard work, cooperation, friendship, and understanding were crucial to the production of this User Guide. This User Guide was prepared by Helen Fox Moody, Quan D. Quan, and William H. Merkel under direction of Claudia Hoeft, National Hydraulic Engineer, Conservation Engineering Division, United States Department of Agriculture, Natural Resources Conservation Service. Mitchell Neilsen of Kansas State University updated the WinTR-20 Windows Interface. The following persons provided assistance and review comments.

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Chapter 1 Introduction

1.1 Program Description

The WinTR-20 model is a storm event surface water hydrologic model applied at a watershed scale. The model assists in the hydrologic evaluation of flood events for use in the analysis of water resource projects. It can be used to analyze current watershed conditions as well as assess the impact of proposed changes made within the watershed. Multiple storms (or rainfall frequencies) can be analyzed within one model run. A summary table for all storms within the run can be produced. Direct runoff is computed from watershed land areas resulting from synthetic or natural rain events. The runoff is routed through channels and/or impoundments to the watershed outlet.

1.2 Brief History

Natural Resource Conservation Service (NRCS) hydrology techniques are based upon unit hydrograph theory and the runoff curve number method of calculating direct runoff from the rainfall occurring over specified areas (National Engineering Handbook, Part 630, Hydrology, NEH-630.10 and 630.16). The Soil Conservation Service (SCS) and the Agricultural Research Service (ARS) developed the background theory and verification studies for these concepts in the 1940’s and 1950’s. In the beginning, all necessary computations were done by hand or by calculators and an analysis of a sizeable watershed typically took weeks or months.

In the 1960's, the agencies cooperated to hire C-E-I-R, Inc. to write a computer program in Fortran for the IBM 360 mainframe computer system (1964). This reduced calculation time enormously and allowed analysis of complex subwatershed systems to proceed much more rapidly even though the engineer still had to collect the data, code it onto punch cards and get it to the mainframe location system for processing. In the early 1980's, the program code was updated to Fortran 77 for use on the personal computers that were becoming a standard office fixture. The document describing this program was released as an SCS technical release TR-20 “Computer Program for Project Formulation Hydrology” in 1982 (SCS, 1982). Engineers then were able to run the program (version 83(.9) dated 1986) at their own desk.

Numerous minor modifications and additions were made to TR-20 for the next 12 years and several draft versions with improvements had a limited distribution. In late 1998, a WinTR-20 work group was organized to develop the next generation of the program, suitable for triumphant entry into the new millennium and utilizing the expanded capabilities of the latest new computer technologies (Windows 7 operating system).

Model Overview

The major components of the WinTR-20 System are shown in figure 1-1. The program has 5 components shown as rectangular boxes. The System Controller/Editor allows the running of the other program components and the entry/editing of data for the WinTR-20 model.

• The WinTR-20 model is the heart of the system and performs the rainfall-runoff and watershed routing calculations.
The Data Converter transforms old TR-20 input data to the new input format accepted by the WinTR-20 model.

The HEC-RAS Reformatter transforms HEC-RAS output profile data to WinTR-20 stream cross section data.

The NOAA Atlas 14 rainfall data converter imports NOAA data into WinTR-20 (csv or text files).

The NRCC rainfall data converter imports NRCC data to WinTR-20 (text files).

Figure 1-1: WinTR-20 System Diagram

Capabilities and Limitations

WinTR-20 model is a storm event surface water hydrologic model applied at a watershed scale that meets certain criteria. Table 1-1 lists some of these criteria. A more detailed list is in the WinTR-20 User Documentation.
### Table 1-1: WinTR-20 Capabilities and Limitations

<table>
<thead>
<tr>
<th>Variable</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of reaches</td>
<td>Channel or Structure</td>
</tr>
<tr>
<td>Channel Manning “n”</td>
<td>0.01 – 1.0</td>
</tr>
<tr>
<td>Sheet Flow Maximum Length</td>
<td>100 feet</td>
</tr>
<tr>
<td>Sheet Flow Manning “n”</td>
<td>0.01 – 1.00</td>
</tr>
<tr>
<td>Minimum Hydrograph Output Time Increment</td>
<td>0.01 hr</td>
</tr>
<tr>
<td>Minimum Hydrograph Output Discharge Value</td>
<td>0.001 cfs</td>
</tr>
<tr>
<td>Runoff Curve Number</td>
<td>30 – 100</td>
</tr>
<tr>
<td>Weighted Curve Number</td>
<td>30 – 100</td>
</tr>
</tbody>
</table>

Features of the old program versions (MS-DOS 1992 or earlier) that are no longer supported:

- Capabilities associated with IPEAKS and PEAKS. IPEAKS was used in conjunction with the modified Att-Kin channel routing where reach lengths were made as long as possible – not available with the present WinTR-20 model. PEAKS was used to obtain peak discharge values at intermediate points between cross sections and/or structures. Reach length is less important with the Muskingum-Cunge reach routing used in the present model and thus the need to determine peak flow at points within a reach is no longer necessary.
- The use of a rain table as a runoff table can be handled by changing affected sub-area CN to 100, which converts all rainfall to runoff.
- A separate Data Check program is no longer needed as data checking is done within the WinTR-20 Controller/Editor model and Fortran computational engine.
- Options to set up project alternatives were removed.
- Options for economics, time analysis, and duration analysis output were removed.

**Minimum Data Requirements**

WinTR-20 can handle complex as well as very simple problems such as determining the peak flow for one watershed. Analysis of a simple problem can be set up with a few records. These data include:

**WinTR-20 Identifier window**
- Input Units Code
- Output Units Code
- Minimum Hydrograph Value
- Watershed Description

**Sub-Area window**
- Sub-Area Identifier
● Sub-Area Reach Identifier
● Sub-Area Drainage Area
● Sub-Area Weighted Curve Number
  ○ CN Adjustment Based on ARC
  ○ CN Reduction
● Sub-Area Time of Concentration
  ○ Velocity Method
  ○ Lag Method

Storm Analysis window
● Storm Identifier, Gage Rain Table Identifier (Type NO_A, Type NO_B, Type NO_C, Type NO_D, Type NR_A, Type NR_B, Type NR_C, Type NR_D, Type MSE_1, Type MSE_2, Type MSE_3, Type MSE_4, Type MSE_5, Type MSE_6, Type CA-1, Type CA-2, Type CA-3, Type CA-4, Type CA-5, Type CA-6, Type NV_N, Type NV_S, Type NV_W, Type N PAC, Type AMSAM, Type I, Type IA, Type II, Type III, Type I(48), Type II(48), and Type_B_6HR
● Gage Antecedent Runoff Condition (1, 2, or 3).
● 2-Yr 24-Hr Rainfall (only for Sheet Flow calculation of time of concentration using Velocity Method)

Global Output window
● Hydrograph Print Precision
● Minimum Hydrograph Display Flow
● Print Time Increment
● Sub-Area (Default Peak Output Code, Default Hydrograph Output Code, and/or Default Hydrograph File Code)

A number of the values in the list above have default values and may be left blank if the default value is acceptable to the user.

1.3 User Responsibility
Results from the model can be sensitive to the input data. It is the user’s responsibility to ensure that all the input data, whether it is actually entered or assumed through default values for blank data fields, is appropriate for the watershed and watershed conditions being analyzed.

1.4 Overview of This User Guide
This user guide is the primary source of documentation on how to use the WinTR-20 system. The user guide is organized as follows:
● Chapters 1 and 2 provide and introduction and overview of WinTR-20 System, and instructions on how to install and uninstall the software.
● Chapter 3 provides a complete overview of the WinTR-20 System.
● Chapter 4 describes the TR-20 Converter and gives a comparison of Old TR-20 and present WinTR-20 System.
● Chapter 5 describes how the HEC-RAS Reformatter operates.
Chapter 6 describes how to import NOAA Atlas 14 precipitation-frequency data.
Chapter 7 describes how to import NRCC precipitation-frequency data.
Chapter 8 describes how to enter data for principal spillway, stability, and freeboard design hydrograph development.
Chapter 9 includes five examples which illustrate major features of WinTR-20.
Appendix A contains a list of references.
Appendix B contains a list of Error Messages.
Appendix C contains a list of Warning Messages.

A secondary source of information is the WinTR-20 User Documentation. It contains more technical information and background information.
Chapter 2 Installing the WinTR-20 System

2.1 Computer Requirements

The Controller/Editor is the one part of the WinTR-20 system that is Windows based and therefore sensitive to the computer display environment. For best viewing set the monitor resolution to 1024 x 768 and the number of colors to greater than 256. If your computer monitor will not support these requirements, the software will also run with a resolution of 800 x 600 with 256 colors. The viewing quality may be diminished with this color selection as the background color around variable names and other labels may not appear the same as shown in the figures in this manual. The program will run in Windows XP, Windows 7 (both 32-bit and 64-bit), and in Windows 8 and 8.1.

2.2 Installation Procedure

To install the software onto your hard disk for NRCS employees:

• NRCS employees must contact their local ITS staff for installation of the version certified for installation onto USDA CCE computers.
• Download the CCE certification version (WinTR-20 version 3.10)

To install the software onto your hard disk for Non-NRCS users:

• Download the program from our web page: http://go.usa.gov/KoZ
• Follow the setup instruction on the window.

The setup program will automatically create a program group called WinTR-20. In Windows 7 the WinTR-20 program will be listed under the All Programs/Engineering Applications/WinTR20 menu, which is located on the Start menu.

2.3 Uninstall Procedure

To uninstall the software from your hard disk for NRCS employees:

• NRCS employees must contact their local ITS staff for removal or update of the version certified for installation onto USDA computers.

For Non-NRCS users to uninstall the software, do the following:

• From the Start Menu select Control Panel.
• From the Control Panel/Programs select Uninstall a program.
• From the Uninstall or change a program window select the WinTR-20 program, right click and then select the Uninstall.
• Follow the uninstall direction on the window and the software will be removed from your hard drive.
Chapter 3 User’s Overview

The WinTR-20 Watershed Hydrology Model is an NRCS computer program developed to predict the runoff resulting from rainfall over a watershed. The WinTR-20 model is the heart of the system and computes the runoff hydrographs, and performs channel and structure routings for the watershed.

This chapter provides an overview of how a project is developed with the WinTR-20 software. Later chapters cover the WinTR-20 Converter for old TR20 Data (chapter 4), Importing HEC-RAS cross section data (chapter 5), Importing NOAA Atlas 14 Data (chapter 6), Importing NRCC Data (chapter 7), and Entering Principal Spillway, Stability Design, and Freeboard Design Hydrograph data (Chapter 8).

3.1 Starting WinTR-20

When you run the WinTR-20 Setup program, you will get a new group of programs installed named WinTR-20 and a program icon called WinTR-20. The WinTR-20 should appear in the Start menu under All Programs/Engineering Applications/WinTR-20. A shortcut can be created to your desktop, and the icon for WinTR-20 will look similar to figure 3-1.

![WinTR-20 Icon](image)

Figure 3-1: The WinTR-20 icon for Windows

3.2 Steps in Using the WinTR-20 System Controller/Editor

To Start WinTR-20 from Windows click the Start menu, and select All Programs/Engineering Applications/WinTR-20 version 3.10. Double click on the WinTR-20 Icon.

When you start up the WinTR-20 program, the WinTR-20 System Controller / Editor Main Window appears as shown in figure 3-2 with the Disclaimer Statement and New User? Click Here button.
Figure 3-2: The WinTR-20 System Controller/Editor window

The Controller/Editor window contains the program disclaimer and an information button, labelled **New User? Click Here**.

<table>
<thead>
<tr>
<th>Description</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disclaimer</td>
<td>Disclaimer statement</td>
</tr>
<tr>
<td>New User? Click Here</td>
<td>Overview</td>
</tr>
<tr>
<td></td>
<td>Help Facilities</td>
</tr>
<tr>
<td></td>
<td>Getting Started</td>
</tr>
</tbody>
</table>

The **New User? Click Here** button brings up the the **Overview, Help Facilities, and Getting Started**, windows in figures 3.3 through 3.5.

Click the **Help** from the menu bar to bring up the **Overview, Help Facilities, Getting Started, About Controller / Editor, and Smoothed NOAA/NRCC File** windows in figures 3.3 through 3.7.
The WinTR-20 System Controller/Editor allows running any of the system components [TR-20 model, input converter, import NOAA Atlas data, Northeast Regional Climate Center (NRCC) data, and HEC-RAS reformatter] as well as editing a WinTR-20 input file. The Controller/Editor is organized following the input sections described in the WinTR-20 User Guide. For editing, each WinTR-20 input section has its own entry window which is accessible by clicking the input session name on the main window. In addition to the input section entry windows, there are entry windows for locally added land use identifiers [w/ runoff curve numbers by hydrologic soil group (HSG)] and locally added soils [w/ applicable HSG]. Entry windows for these two local additions are accessible from the File pull down on the main window.

Figure 3-3: Overview Help window

Help windows of a general nature on the program system are available via the new user button [available at program start up] or from the Help pull down on the main window. All of the Help windows are available from the pull down while only selected ones are available via the "New User? Click Here" button.

The data entry window that allow for entry and/or editing of input data contain additional Help in the form of information about the current window and information about each variable to be entered. This Help is available by clicking the window or variable name on the entry window. A yellow Help box opens in the lower left corner of the entry window and displays the window or variable name, its description and range of values fit.
To EDIT WinTR-20 INPUT FILE - Select one of the first three File pull down choices [New WinTR-20 File, Open Existing WinTR-20 File, and Re-Open Last Session] on the main window. No matter which of the three are selected, the WinTR-20 Identifier entry window appears. Make sure the proper input unit system [English or Metric] is selected. At least one of the two Watershed Description lines must have an entry. Once the information on the window is completed, accept the data by clicking the "Accept Changes (Close)" button. The WinTR-20 Identifier window will close leaving the main window. Continue by clicking [selecting] another input section entry window from the list on the main window. To save data entered, use the "Save or SaveAs" selections on the File pull down. Remember to save early, and save often.

To CONVERT OLD TR-20 INPUT FILE - Select "Convert Old Data" from the File pull down on the main window. Then select the file name to be converted. When the converter is complete, either the Error File (indicating a problem with converting the data) will be displayed or the WinTR-20 Identifier entry window will open for editing the converted data.

To REFORMAT HEC-RAS DATA - Select "Import HEC-RAS" from the File pull down on the main window. Then select the HEC-RAS output file name to be reformatted. Do not try to import HEC-RAS data onto an existing WinTR-20 input data file as this will cause all the data not associated with HEC-RAS to be deleted. It is recommended to Import HEC-RAS data into a new project only. If a WinTR-20 input file is currently loaded, it should be saved as a separate file. After the reformating is complete either the Error File will be displayed or the WinTR-20 Identifier entry window will open for editing the file containing the reformatted data.

To IMPORT NOAA ATLAS 14 DATA - Select "Import NOAA Atlas Data" from the File pull down on the main window. Then select the NOAA Atlas data csv file. Do not try to import NOAA Atlas Data into a WinTR-20 input data file which currently loaded as the data will be deleted and replaced by the NOAA Atlas Data. It is recommended to open a new file to include only NOAA Atlas Data. (English units only)

Figure 3- 5: Getting Started window
Figure 3-6: About WinTR-20 System Controller / Editor window

This window contains the Version number and the program’s date of compilation.
Using a 24-hour design storm distribution is standard practice in WinTR-20. In order to best reflect the updated NOAA Atlas 14 & Northeast Regional Climate Center (NRCC) precipitation data, a site specific distribution is developed based on the CSV/text file download from the website (English units only). The 24-hour design storm distribution is developed based on maximizing the rainfall during any duration from 5-minutes to 24-hours. The duration from 5 minutes to 24 hours are centered on 12 hours and extend symmetrically for the periods before and after 12 hours. Investigations were conducted which showed that regional storm distributions similar to the prior standard NRCS storm distributions (Type I, Type IA, Type II, and Type III) are feasible in states covered by NOAA Atlas 14 & NRCC. However, a site-specific rainfall distribution is more representative of the relation of intensity-duration-frequency at the specific site.

DATA SMOOTHING TECHNIQUE - several mathematical techniques were investigated to determine a computationally efficient, accurate, practical, stable, and robust procedure. Since the generated hydrograph is primarily dependent on the relationship of precipitation intensity with duration, this relationship is smoothed. This relationship of intensity (inches/hour) and duration is based on a factor defined as incremental intensity. Incremental intensity is defined as the difference in precipitation divided by the difference in duration. The incremental intensity for the 5-minute duration is equal to the 5-minute precipitation divided by 1/12 and has the units of inches per hour. The incremental intensity for the 10-minute duration is the 10-minute precipitation minus the 5-minute precipitation divided by 1/12 in units of inches per hour. Each incremental intensity is calculated based on the difference in precipitation divided by the difference in duration. Incremental intensity is calculated and smoothed for each return period independently.

The final smoothing procedure keeps the 60-minute and 24-hour precipitation unchanged from the original NOAA Atlas 14 & NRCC values. 5, 10, 15, 30, and 120-

Figure 3- 7: Smoothed NOAA/NRCC File window

The **File** button in the menu bar has a number of choices for beginning data input. The same choices are available for the **File** button that appears in the main WinTR-20 window in Figure 3-8, where these are discussed in more detail.
Clicking on **File** in the Main Window opens a menu that will allow the user to start developing a dataset (see figure 3-9). The user may bring in an existing file or develop a new one. **If the user is developing a new file or is using an existing file the file name including the path should not exceed 80 characters.** After initiating the dataset the WinTR-20 main window is available.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Window Title</td>
<td>Displays title of the window</td>
</tr>
<tr>
<td>Menu bar with Pull down</td>
<td>Select menu options with further sub-options</td>
</tr>
<tr>
<td>Entry data window</td>
<td>Enter data into window</td>
</tr>
</tbody>
</table>

**Figure 3- 8: Window Entry Features**
Figure 3-9: WinTR-20 Main Window File menu

<table>
<thead>
<tr>
<th>Menu item</th>
<th>Pull down choice</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>File</td>
<td>New WinTR-20 File</td>
<td>Create a new input file. <strong>The file name and path cannot exceed 80 characters</strong></td>
</tr>
<tr>
<td></td>
<td>Open Existing WinTR-20 File</td>
<td>Open an existing input file. <strong>The file name and path cannot exceed 80 characters</strong></td>
</tr>
<tr>
<td></td>
<td>ReOpen Last Session</td>
<td>ReOpen the last input file</td>
</tr>
<tr>
<td>Convert Old Data</td>
<td></td>
<td>Convert old data file to current version. <strong>The file name and path cannot exceed 80 characters</strong></td>
</tr>
<tr>
<td>Import HEC-RAS</td>
<td></td>
<td>Allows user to import HEC-RAS cross section data. <strong>The file name and path cannot exceed 80 characters</strong></td>
</tr>
<tr>
<td>Import NOAA Atlas Data</td>
<td></td>
<td>Allows user to import NOAA Atlas 14 csv file. <strong>The file name and path cannot exceed 80 characters</strong></td>
</tr>
<tr>
<td>Import NRCC Data</td>
<td></td>
<td>Allows user to import NRCC text file. <strong>The file name and path cannot exceed 80 characters</strong></td>
</tr>
<tr>
<td>Local Land Use</td>
<td></td>
<td>Allows user to add additional local land uses</td>
</tr>
<tr>
<td>Local Soil / HSG</td>
<td></td>
<td>Allows user to generate a list of local soils and HSG values</td>
</tr>
<tr>
<td>Save</td>
<td></td>
<td>Save current input data using current filename</td>
</tr>
<tr>
<td>Save As</td>
<td></td>
<td>Save current input data with different filename</td>
</tr>
<tr>
<td>Exit</td>
<td></td>
<td>Exit program</td>
</tr>
</tbody>
</table>
### Figure 3-10: WinTR-20 Main Window View menu

<table>
<thead>
<tr>
<th>Menu item</th>
<th>Pull down choice</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>View</td>
<td>Schematic</td>
<td>Open Schematic window</td>
</tr>
<tr>
<td></td>
<td>Input File</td>
<td>Open Input File window</td>
</tr>
<tr>
<td></td>
<td>Printed Page File</td>
<td>Open Printed Page File window</td>
</tr>
<tr>
<td></td>
<td>Error File</td>
<td>Open Error File window</td>
</tr>
<tr>
<td></td>
<td>Debug File</td>
<td>Open Debug File window</td>
</tr>
<tr>
<td></td>
<td>Hydrograph File</td>
<td>Open Hydrograph File window</td>
</tr>
<tr>
<td></td>
<td>Smoothed NOAA/NRCC File</td>
<td>Open Smoothed NOAA/NRCC File window</td>
</tr>
</tbody>
</table>

### Figure 3-11: WinTR-20 Main Window Run menu

<table>
<thead>
<tr>
<th>Menu item</th>
<th>Pull down choice</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run</td>
<td></td>
<td>Performs the WinTR-20 calculations</td>
</tr>
</tbody>
</table>
Figure 3-12: WinTR-20 Main Window Plots menu

<table>
<thead>
<tr>
<th>Menu item</th>
<th>Pull down choice</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plots</td>
<td></td>
<td>Allows user to plot hydrograph or multiple hydrographs</td>
</tr>
</tbody>
</table>

Figure 3-13: WinTR-20 Main Window Help menu

<table>
<thead>
<tr>
<th>Menu item</th>
<th>Pull down choice</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Help</td>
<td>WinTR-20 System Diagram</td>
<td>Display WinTR-20 system diagram window</td>
</tr>
<tr>
<td>Overview</td>
<td></td>
<td>Display overview help window</td>
</tr>
<tr>
<td>Help Facilities</td>
<td></td>
<td>Display window with a general description of program Help</td>
</tr>
<tr>
<td>Getting Started</td>
<td></td>
<td>Display getting started help window</td>
</tr>
<tr>
<td>About Controller / Editor</td>
<td></td>
<td>Display program version number and date</td>
</tr>
<tr>
<td>Smoothing NOAA/NRCC Data</td>
<td></td>
<td>Display smoothing NOAA/NRCC Data window</td>
</tr>
</tbody>
</table>
3.3 Input Data Windows

Clicking on **New WinTR-20 File** on the Main Window opens a menu that will allow the user to start developing a dataset. After initiating the dataset, the WinTR-20 main window is available with the various windows for data entry.

<table>
<thead>
<tr>
<th>Main Window</th>
<th>Data Section Name to Enter Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>WinTR-20 System Controller / Editor</td>
<td>Dimensionless Unit Hydrograph:</td>
</tr>
<tr>
<td></td>
<td>Global Output:</td>
</tr>
<tr>
<td></td>
<td>Input Hydrograph:</td>
</tr>
<tr>
<td></td>
<td>Rainfall Distribution:</td>
</tr>
<tr>
<td></td>
<td>Stream Cross Section:</td>
</tr>
<tr>
<td></td>
<td>Stream Reach:</td>
</tr>
<tr>
<td></td>
<td>Storm Analysis:</td>
</tr>
<tr>
<td></td>
<td>Structure Rating:</td>
</tr>
<tr>
<td></td>
<td>Sub-Area:</td>
</tr>
<tr>
<td></td>
<td>WinTR-20 Identifier:</td>
</tr>
<tr>
<td></td>
<td>Verification:</td>
</tr>
<tr>
<td></td>
<td>Principal Spillway Data:</td>
</tr>
<tr>
<td></td>
<td>Stability Freeboard Data:</td>
</tr>
</tbody>
</table>

(An X indicates some data are entered for section)
The data entry windows that allow for entry and/or editing of input data also contain additional Help with information about the current window and each variable to be entered. This Help is available by clicking the window or variable name on the entry window. A yellow Help box opens in the lower left corner of the entry window and displays the window or variable name, its description, and range of values (if appropriate). Only window and variable names shown in blue or black have such help available, as shown in figure 3-15.

![Figure 3- 15: Window Help text](image)

**Accept Changes (Close) button** – All data shown will be written to the input file. Selecting this accepts the data you have entered and returns you to the previous window.

![Figure 3- 16: Accept Changes (Close) button](image)

**No Changes (Close) button** – None of the changes made to items in that window will be written to the input file. Select this to keep the original data and return to the previous window.

![Figure 3- 17: No changes (Close) button](image)
3.4 Steps in Using the Input Data Windows

Starting a New WinTR-20 File

Double-click on the WinTR-20 icon (fig. 3-18) to bring up the WinTR-20 System Controller/Editor window shown in figure 3-19. If there is no icon on the desktop, click Start, All Programs, Engineering Applications, then WinTR-20.

![WinTR-20 icon](Image)

**Figure 3-18: WinTR-20 icon**

![WinTR-20 System Controller/Editor window](Image)

**Figure 3-19: WinTR-20 System Controller/Editor window**

Click on **File** in the Menu bar to open the File options.
To start a new project, click **File** on the WinTR-20 System Controller / Editor window and select **New WinTR-20 File** as in figure 3-20. This will bring up the WinTR-20 Identifier window in figure 3-21.

**Figure 3- 20: WinTR-20 File menu**

**Figure 3- 21: WinTR-20 Identifier window**
The WinTR-20 Identifier: window allows the user to select the following parameters:

- **Input Units Code:** English or Metric (default is English)
- **Output Units Code:** English or Metric (default is English)
- **Minimum Hydrograph Value:** (default for blank value is 0.5 cfs)

Users are encouraged to enter descriptive notes in the Watershed Description lines to help identify the files later. At least one line of the two Watershed Description lines must have an entry for the program to run. Click **Accept Changes (Close)** button or **No Changes (Close)** button to close the WinTR-20 Identifier: window.

**Data Section Name List**

The next step is to enter the necessary data. Choose from the data section name list, which consists of:

- **Dimensionless Unit Hydrograph:**
- **Global Output:**
- **Input Hydrograph:**
- **Rainfall Distribution:**
- **Stream Cross Section:**
- **Stream Reach:**
- **Storm Analysis:**
- **Structure Rating:**
- **Sub-Area:**
- **WinTR-20 Identifier:**
- **Verification:**
- **Principal Spillway Data:**
- **Stability Freeboard Data:**

Selecting the Data Section Name desired brings up a data entry window for that particular data.

**Note:** After the data are entered and accepted by the user, the user will see an X displayed on the left side of the data section name. X indicates that there are some data entered from the user, as shown in figure 3-14. When the value of the data entered is within the normal limits for that variable, the entry box turns blue. When the box turns yellow the data generates a warning in the debug file (*.dbg) but the program will still run. When the box turns red, an error occurs and the program does not run.

**Minimum Data Requirements**

WinTR-20 may be set up with minimal data in order to calculate the peak discharge from one storm on one sub-area. WinTR-20 Identifier, Storm Analysis, and Sub-Area may be used for this basic analysis. The first example in Chapter 9 has a single watershed with minimum input.
Dimensionless Unit Hydrograph window:

The **Dimensionless Unit Hydrograph** window (figure 3-22) is used to edit or enter information for a dimensionless unit hydrograph. Any data entered here will be used in lieu of the standard dimensionless unit hydrograph. **Note:** If the SCS standard dimensionless unit hydrograph 484 is desired then no data should be entered on this window. Dimensionless unit hydrographs for the Delmarva (DMV) Peninsula of Delaware, Maryland, and Virginia and for Peak Rate Factors from 100 to 600 are included in the WinTR-20 User Documentation.

To enter the Dimensionless Unit Hydrograph, the user clicks on **Dimensionless Unit Hydrograph**: from the main window. Once this is selected, the Dimensionless Unit Hydrograph window will open with no data.

![Dimensionless Unit Hydrograph window](image)

**Figure 3-22: Dimensionless Unit Hydrograph window**

To input the dimensionless unit hydrograph for the model, do the following steps:

**Step 1:** Enter or edit the sequential **Dimensionless Hydrograph Points**. The first and last points in the dimensionless unit hydrograph must be zero and one value must be 1.0. Some fields on the last dimensionless hydrograph line of the table after the ending zero is entered may be blank. No blank fields are allowed within the dimensionless hydrograph sequence. If the standard dimensionless unit hydrograph with Peak Factor 484 is desired then no data should be entered on this window. (Range – Blank, or 0.0 to 1.0)

**Note:** Click grid cell to edit previously entered data. Right click to insert or delete a value.

**Step 2:** The **Display Data** button becomes visible when data have been entered (see figure 3-22).

**Step 3:** Click **Display Data** button to view the dimensionless unit hydrograph plot. An example of the Dimensionless Unit Hydrograph window is shown in figure 3-23.
Step 4: The user could delete the current dimensionless unit hydrograph by clicking **Delete DimHyd** button on the Dimensionless Unit Hydrograph window.

Step 5: Click **Accept Changes (Close)** button when done for the interface to accept the data and close the Dimensionless Unit Hydrograph: window.

**Global Output window:**

The **Global Output** window is used to enter or edit data related to hydrograph display in the WinTR-20 output along with the desired default output codes for sub-area and reach data. The default output codes are used where Sub-Area or Reach output codes are left blank in the individual Sub-Area and Stream Reach data entries.

To select the global output, the user clicks on **Global Output**: from the main window. Once selected, the Global Output window will appear as shown in figure 3-24.
To input the global output for the model, do the following steps:

**Step 1:** Enter **Hydrograph Print Precision:** number of decimal places (right of decimal point) to use for hydrograph flows in page formatted output. Blank indicates the default value of 1 will be used. Press **Enter, Tab** key, or click another data box. (Range – Blank, or 0, 1, 2 or 3)

**Step 2:** Enter **Minimum Hydrograph Display Flow:** value of the smallest hydrograph flow point shown for hydrograph flows in page formatted output. Recommend setting this value equal to the Minimum Hydrograph Value in the WinTR-20 Identifier window. Blank indicates the default value 0.5 cfs will be used. Press **Enter, Tab** key, or click another data box. (Range – Blank, or ≥ 0.001)

**Step 3:** Enter **Print Time Increment:** time increment between hydrograph points in page formatted output. Blank indicates the default value of the hydrograph generation time increment will be used. Press **Enter, Tab** key, or click another data box. (Range – Blank, or ≥ 0.01)

**Step 4:** Select **Default Peak Output Code:** codes to use as output default for Sub-Area and Reach Peak Output Code. Default values for both are No. Selecting Yes will produce peak values for all Sub-Areas and Reaches.

**Step 5:** Select **Default Hydrograph Output Code:** codes to use as output default for Sub-Area and Reach Hydrograph Output Code. Default values for both are No. Selecting Yes will produce hydrographs for all Sub-Areas and Reaches.
**Step 6:** Select **Default Hydrograph File Code:** codes to use as output default for Sub-Area and Reach Hydrograph File Code. Default values for both are **No.** Selecting **Yes** for both will produce hydrographs for all Sub-Area and Reaches.

**Step 7:** Click **Accept Changes (Close)** button for the interface to accept the data and to close the Global Output: window.

**Input Hydrograph window:**

The Input Hydrograph window is used to enter or edit data about hydrographs added directly to the watershed stream system. The name of the reach which receives the hydrograph and the Storm Identifier to which the hydrograph relates must be specified.

To enter input hydrograph data, click on the **Input Hydrograph:** from main window. Once the input hydrograph identifier is entered or selected, the Input Hydrograph window will appear as shown in figure 3-25. The input hydrograph editor will be blank until some input hydrograph data have been entered.

![Input Hydrograph window](image)

**Figure 3-25: Input Hydrograph window**

To input the input hydrograph for the model, do the following steps:

**Step 1:** Enter **Input Hydrograph Identifier:** unique alphanumeric string identifying the hydrograph. The limit is 10 characters including blank spaces. Press **Enter, Tab** key, or click another data box.
Step 2: Enter an **Input Hydrograph Reach Identifier**: or select one from the pull down list: this is an alphanumeric string identifying the upstream end of the reach where the hydrograph will be added. **This must match a Reach Identifier in the Stream Reach Data.** Press Enter, Tab key, or click another data box.

Step 3: Enter an **Input Hydrograph Storm Identifier**: or select one from the pull-down list: this is an alphanumeric string identifying the storm to use with the hydrograph. **This must match a Storm Identifier in the Storm Analysis Data.** Press Enter, Tab key, or click another data box.

Step 4: Enter **Input Hydrograph Start Time**: time of the first input hydrograph point. (Blank indicates 0.0 hour). Press Enter, Tab key, or click another data box.

Step 5: Enter **Input Hydrograph Time Increment**: time increment used between the input hydrograph points. Press Enter, Tab key, or click another data box. (Range – ≥ 0.01)

Step 6: Enter **Input Hydrograph Drainage Area**: drainage area associated with the source of the input hydrograph. Press Enter, Tab key, or click another data box. (Range – ≥ 0.00015)

Step 7: Enter **Input Hydrograph Base Flow**: constant base flow associated with the source of the input hydrograph. Blank indicates 0.0. Press Enter, Tab key, or click another data box. (Range – Blank, or ≥ 0.0)

Step 8: Enter the **Input Hydrograph Flows** in cfs – sequential input hydrograph flows. First and last points in input hydrograph must be zero. Some fields on last input hydrograph line after ending zero is entered may be blank. No blank fields are allowed within the input hydrograph sequence. (Blank or ≥ 0.0)

Step 9: The **Display Data** button should now be visible.

Step 10: Click on **Display Data** button to view the input hydrograph plot. An example of the Input Hydrograph plot is shown in figure 3-26.

Step 11: Also, the user could delete the current input hydrograph by clicking on **Delete Hydrograph** on the Input Hydrograph window and then repeating steps 1 through 8 as desired to enter a new input hydrograph.

Step 12: Click **Accept Changes (Close)** button for the interface to accept the data.
Rainfall Distribution window:

The Rainfall Distribution window is used to enter or edit rainfall distribution data. Standardized rainfall distributions are built-in to the WinTR-20 model and should not be entered. These have reserved names. A rainfall distribution should not be entered in the Rainfall Distribution window with any one of these names. The standardized rainfall distributions including Type NO_A, Type NO_B, Type NO_C, Type NO_D, Type NR_A, Type NR_B, Type NR_C, Type NR_D, Type MSE1, Type MSE2, Type MSE3, Type MSE4, Type MSE5, Type MSE6, Type CA-1, Type CA-2, Type CA-3, Type CA-4, Type CA-5, Type CA-6, Type NV-N, Type NV-S, Type NV-W, Type N PAC, Type AMSAM, Type I, Type IA, Type II, Type III, Type I (48 hours), Type II (48 hours), and Type_B_6HR are built-in to the WinTR-20 model. All distributions are for 24 hours duration (except Type II (48 hours), Type III (48 hours) and Type_B_6HR). These are described in table 3-1. Documentation for use of these rainfall distributions (including appropriate maps) is available from the West National Technical Support Center (WNTSC) web site http://go.usa.gov/KoZ.
Table 3-1: Rainfall Distribution Built-in Tables

<table>
<thead>
<tr>
<th>Built-in Rainfall Identifier</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type NO_A</td>
<td>NOAA Atlas Type NO_A – 24 hour storm</td>
</tr>
<tr>
<td>Type NO_B</td>
<td>NOAA Atlas Type NO_B – 24 hour storm</td>
</tr>
<tr>
<td>Type NO_C</td>
<td>NOAA Atlas Type NO_C – 24 hour storm</td>
</tr>
<tr>
<td>Type NO_D</td>
<td>NOAA Atlas Type NO_D – 24 hour storm</td>
</tr>
<tr>
<td>Type NR_A</td>
<td>NRCC Type NR_A – 24 hour storm</td>
</tr>
<tr>
<td>Type NR_B</td>
<td>NRCC Type NR_B – 24 hour storm</td>
</tr>
<tr>
<td>Type NR_C</td>
<td>NRCC Type NR_C – 24 hour storm</td>
</tr>
<tr>
<td>Type NR_D</td>
<td>NRCC Type NR_D – 24 hour storm</td>
</tr>
<tr>
<td>Type MSE1</td>
<td>Midwest Southeastern Type MSE1 – 24 hour storm</td>
</tr>
<tr>
<td>Type MSE2</td>
<td>Midwest Southeastern Type MSE2 – 24 hour storm</td>
</tr>
<tr>
<td>Type MSE3</td>
<td>Midwest Southeastern Type MSE3 – 24 hour storm</td>
</tr>
<tr>
<td>Type MSE4</td>
<td>Midwest Southeastern Type MSE4 – 24 hour storm</td>
</tr>
<tr>
<td>Type MSE5</td>
<td>Midwest Southeastern Type MSE5 – 24 hour storm</td>
</tr>
<tr>
<td>Type MSE6</td>
<td>Midwest Southeastern Type MSE6 – 24 hour storm</td>
</tr>
<tr>
<td>Type CA-1</td>
<td>California Type CA-1 – 24 hour storm</td>
</tr>
<tr>
<td>Type CA-2</td>
<td>California Type CA-2 – 24 hour storm</td>
</tr>
<tr>
<td>Type CA-3</td>
<td>California Type CA-3 – 24 hour storm</td>
</tr>
<tr>
<td>Type CA-4</td>
<td>California Type CA-4 – 24 hour storm</td>
</tr>
<tr>
<td>Type CA-5</td>
<td>California Type CA-5 – 24 hour storm</td>
</tr>
<tr>
<td>Type CA-6</td>
<td>California Type CA-6 – 24 hour storm</td>
</tr>
<tr>
<td>Type NV-N</td>
<td>Nevada-North Type NV-N – 24 hour storm</td>
</tr>
<tr>
<td>Type NV-S</td>
<td>Nevada-South Type NV-S – 24 hour storm</td>
</tr>
<tr>
<td>Type NV-W</td>
<td>Nevada-West Type NV-W – 24 hour storm</td>
</tr>
<tr>
<td>Type N PAC</td>
<td>North Pacific Basin Type N PAC – 24 hour storm</td>
</tr>
<tr>
<td>Type AMSAM</td>
<td>American Samoa Type AMSAM – 24 hour storm</td>
</tr>
<tr>
<td>Type I</td>
<td>NRCS Type I – 24 hour storm</td>
</tr>
<tr>
<td>Type IA</td>
<td>NRCS Type IA – 24 hour storm</td>
</tr>
<tr>
<td>Type II</td>
<td>NRCS Type II – 24 hour storm</td>
</tr>
<tr>
<td>Type III</td>
<td>NRCS Type III – 24 hour storm</td>
</tr>
<tr>
<td>Type I (48)</td>
<td>NRCS Type I (48) – 48 hour storm</td>
</tr>
<tr>
<td>Type II (48)</td>
<td>NRCS Type II (48) – 48 hour storm</td>
</tr>
<tr>
<td>Type _B_6HR</td>
<td>NRCS Type _B_6HR – 6 hour storm</td>
</tr>
</tbody>
</table>

Type NO_A, Type NO_B, Type NO_C, and Type NO_D apply in the Ohio Valley and neighboring states. Type NR_A, Type NR_B, Type NR_C, and Type NR_D apply in the New England states and New York.

The rainfall distribution can be either an actual storm or dimensionless synthetic storm. More than one rainfall distribution may be entered if needed. To enter rainfall distribution data, click on **Rainfall Distribution**: from the main window. Once the rainfall distribution is entered or selected, the Rainfall Distribution window will appear as shown in figure 3-27. The rainfall distribution editor will have a blank window until data are entered into it.
To input the rainfall distribution for the model, do the following steps:

**Step 1:** Enter a **Rain Table Identifier:** or select one from the pull down list: this is a unique alphanumeric string identifying the Rain Table. The Rain Table Identifier name is different from any of the built-in standard rainfall table identifiers (see table 3.1). Press **Enter, Tab** key, or click another data box. (Range – 1 to 10 characters)

**Step 2:** Enter **Rain Table Time Increment:** uniform time increment between rain table points (hour). Press **Enter, Tab** key, or click another data box. (Range – 0.001 to 25)

**Step 3:** Enter **Mass Rainfall Points** – sequential mass rainfall points at specified Rain Table Time Increment. First point must be zero and subsequent points must be equal or increase. No blank fields are allowed within the rain table sequence. There are several rainfall distributions built-in the program for users to select from (see Table 3.1 Rainfall Distribution Built-in Tables). **These standardized rainfall distributions should not be entered here.** (Range – Blank, or ≥ 0.0)
Step 4: Now the **Display Data** button should be visible.

Step 5: Click **Display Data** button to view the rainfall distribution plot. An example of a rainfall distribution plot window with cumulative rainfall in inches is shown in figure 3-28.

![Rainfall Distribution Plot](image)

*Figure 3- 28: Display Data – Rainfall Distribution Plot*

Step 6: The user can delete the current rainfall distribution by clicking on **Delete Distribution** button from the Rainfall Distribution window then repeating steps one through five as desired to enter a new rainfall distribution.

Step 7: Click **Accept Changes (Close)** button for the interface to accept the data.

**Stream Cross Section window:**

The **Stream Cross Section** window is used to enter or edit channel routing discharge rating data. The Stream Cross Section Identifiers entered should also appear as Reach Cross Section Identifiers with the Stream Reach data. Rating point information is sorted by increasing elevation as it is entered.
To enter stream cross-section data, click on the Stream Cross Section from the main window. Once a stream cross section is entered or selected, the Stream Cross Section data may be entered or edited as shown in figure 3-29.

![Stream Cross Section window](image)

**Figure 3- 29: Stream Cross Section window**

To input the stream cross section data for the model, do the following steps:

**Step 1:** Enter a **Cross Section Identifier**: or select one from the pull down list: this is a unique alphanumeric string identifying the cross section. Press Enter, Tab key, or click another data box. (Range - 1 to 10 characters)

**Step 2:** Enter **Bankfull Elevation**: elevation at the top of the lowest channel bank in the cross section. Press Enter, Tab key, or click another data box. (Range – within Cross Section Elevation values)

**Step 3:** Enter **Low Ground Elevation**: elevation for lowest elevation in flood plain. The low ground elevation may be lower than bankfull elevation. (Blank defaults to bankfull elevation). Press Enter, Tab key, or click another data box. (Range – within Cross Section Elevation values)
Step 4: Enter the following variables for each cross section – **Elevation (feet), Cross Section Discharge (cfs), Cross Section End Area (sq.ft.), Cross Section Top Width (feet), and Cross Section Energy Grade (E.G.) Slope (ft. / ft.).** The values of elevation, discharge, and end area must increase with each line of the table. The top width may not decrease as elevation increases in the table. An elevation, discharge, end area, and top width are required on each line of the table. A value of E.G. Slope is required on the first line only. If E.G. Slope is blank on any line of the table, it is assumed to be equal to the last entered value. A minimum of 3 lines is acceptable for a cross section. Also, the HEC-RAS Reformatter takes the HEC-RAS output file and develops a rating table formatted for WinTR-20 (See Chapter 5). Right-clicking on a line in the rating table allows the user the option to delete that line.

Step 5: The **Display Data** button should now be visible.

Step 6: Click on **Display Data** button to view the cross section rating curve plot. An example of the Cross Section plot is shown in figure 3-30.

![Cross Section Plot](image)

**Figure 3- 30: Display Data - Cross Section Plot**

Step 7: The user could delete the current stream cross section by clicking on the **Delete Cross Section** button on the Stream Cross Section window and then repeating steps one through four as desired to enter a new stream cross section.

Step 8: Click **Accept Changes (Close)** button for the interface to accept the data.
Stream Reach window:

The **Stream Reach** window is used to enter or edit stream reach flow path data. Each reach must have a Stream Receiving Reach Identifier which defines which reach the current reach drains to. If the reach drains directly to the outlet of the watershed, enter “Outlet” or “outlet”. A reach Cross Section Identifier or Structure Identifier must also be entered. Note: Any reach output code left blank will use the default value from Global Output data.

Recall that the term “Reach” applies to stream reaches and structures. To enter stream reach data, click on the Stream Reach from the main window. The Stream Reach window will appear as shown in figure 3-31 except that the entry boxes will be empty until you have entered the stream reach data.

![Stream Reach window](figure)

**Figure 3- 31: Stream Reach window**

To input the stream reach for the model, do the following steps:

**Step 1:** Enter a **Stream Reach Identifier:** or select one from the pull-down list: this is a unique alphanumeric string identifying the stream reach. “Outlet” is not acceptable as a Stream Reach Identifier. Press **Enter, Tab** key, or click another data box. Range – 1 to 10 characters)

**Step 2:** Enter a **Stream Receiving Reach Identifier:** or select one from pull-down list: this is the name of the reach directly downstream from the Stream Reach Identifier. Must match another Stream Reach
Identifier or enter Outlet if reach flows directly to the watershed outlet. Press Enter, Tab key, or click another data box. (Range – 1 to 10 characters)

Step 3: Enter a **Reach Cross Section Identifier**: or select one from pull-down menu: this is the Cross Section Identifier name for cross section data to use with this stream reach. Also, identifier must match a Cross Section Identifier in the Stream Cross Section Data. **Leave blank if the Reach Structure Identifier: is entered.** Press Enter, Tab key, or click another data box. (Range – 1 to 10 characters)

Step 4: Enter a **Reach Structure Identifier**: or select one from pull-down menu: this is the Structure Identifier name for a structure that occurs in the stream reach. Enter only if there is a structure in the reach. If entered, Identifier must match a Structure Identifier in the Structure Rating Data. **Leave blank if Reach Cross Section Identifier: is entered.** Press Enter, Tab key, or click another data box. (Range – blank or 1 to 10 characters)

Step 5: Enter **Reach Channel Length**: length of the channel in the reach. **Leave blank if the Reach Structure Identifier is entered.** Press Enter, Tab key, or click another data box. (Range – Blank or 1 to 100000 feet)

Step 6: Enter **Reach Valley Length**: length of the valley flow path in the reach. **Leave blank if Reach Structure Identifier is entered.** **Blank will default to Reach Channel Length.** Note: If the Reach Channel Length is same as the Reach Valley Length then only enter a Reach Channel Length. Press Enter, Tab key, or click another data box. (Range – Blank or 1 to 100000 feet)

Step 7: Enter **Constant Base Flow**: constant amount of flow to add to base of the hydrographs. Press Enter, Tab key, or click another data box. Blank defaults to 0.0. (Range – Blank or ≥ 0.0)

Step 8: Select **Reach Peak Output Code**: code to output Reach Peak flow data to the printed page file. Acceptable values are Yes, No, or Blank. Blank defaults to Default Reach Peak Output Code (Global Output).

Step 9: Select **Reach Hydrograph Output Code**: code to output Reach Peak Flow and Hydrograph data to the printed page file. Acceptable values are Yes, No or Blank. Blank defaults to Default Reach Hydrograph Output Code (Global Output).

Step 10: Select **Reach Hydrograph File Code**: code to output Reach Hydrograph data to a hydrograph file. Acceptable values are Yes, No or Blank. Blank defaults to Default Hydrograph File Code (Global Output).

Step 11: Enter **Split Flow Reach Identifier**: or select one from pull-down menu: this is the name of the Stream Reach Identifier that receives the split flow at its upstream end. Must match a Stream Reach Identifier in Stream Reach Data or enter Outlet if the split flow goes directly to the watershed outlet. **Leave blank if split flow is diverted out of the watershed.** Press Enter, Tab key, or click another data box. (Range – Blank or 1 to 10 characters)
Step 12: Enter a **Split Flow Cross Section Identifier**: or select one from pull-down menu: the selected Cross Section Identifier name is used for determining split flow. Must match a Cross Section Identifier in Stream Cross Section Data. **Leave blank if split flow is determined by Starting Split Flow and/or Ending Split Flow.** Press Enter, Tab key, or click another data box. (Range –Blank or 1 to 10 characters)

Step 13: Enter **Starting Split Flow**: starting flow at which water is split to the diversion. Must be blank if Split Flow Cross Section Identifier is entered. Press Enter, Tab key, or click another data box. (Range – Blank or ≥ 0.0)

Step 14: Enter **Ending Split Flow**: ending flow at which water to the diversion ceases. Must be blank if Split Flow Cross Section Identifier is entered; may also be blank if there is no upper limit when using Starting Split Flow. Press Enter, Tab key, or click another data box. (Range – Blank or ≥ 0.0)

Step 15: Enter **Split Flow Drainage Area**: fraction of accumulated drainage area that will go with the split flow reach or diversion. If there is split flow at the reach, split flow drainage area cannot be blank. Press Enter. (Range – Blank or > 0.00001 to 1.0)

Step 16: The user may delete the current Stream Reach by clicking on **Delete Reach** button on the Stream Reach window and then repeating steps one through fifteen as desired to enter and select a new stream reach.

Step 17: Click **Accept Changes (Close)** button for the interface to accept the data.

**Storm Analysis window:**

The **Storm Analysis** window allows entry or editing information on storm rainfall depths, rainfall distributions, and rain gages. **If values are entered into the Storm Analysis window then the Principal Spillway Data and Stability Freeboard Data windows are disabled.**

To enter storm analysis data the user clicks on **Storm Analysis** from the main window. Once Storm Analysis is selected, the Storm Analysis window will appear as shown in figure 3-32 (your input storm analysis editor will come up with a blank window until you have entered some storm analysis data).
To input the storm analysis for the model, do the following steps:

**Step 1:** Enter a **Storm Analysis Identifier:** or select one from the pull-down list: this is a unique alphanumeric string identifying the storm to analyze. Press Enter, Tab key, or click another data box. (Range –1 to 10 characters)

**Step 2:** Enter a **Rain Gage Identifier:** or select one from the pull-down list: this is a unique alphanumeric string identifying the rainfall event characteristics to use in part or the entire watershed for a storm. WinTR-20 has the capability to vary the storm rainfall amount and rainfall distribution within the watershed. Use of Rain Gage Identifiers allows for this. An example of how to use multiple rain gages is to enter a Storm Identifier **Storm 1** with Rain Gage Identifier **Gage A** with 5.5” of rainfall and enter Storm Identifier **Storm 1** with Rain Gage Identifier **Gage B** with 4.5” of rainfall. In other words, there will be two lines in the Storm Analysis table for **Storm 1**. Later, when entering Sub-Area data, there will be an opportunity to define which Rain Gage Identifier is used for a given Sub-Area. **Leave blank if only one rain gage is used for the entire watershed.** Press Enter, Tab key, or click another data box. (Range – 0 to 10 characters)

**Step 3:** Enter **Gage Starting Time:** starting time for the rainfall at the rain gage for the storm. Press Enter, Tab key, or click another data box. (Blank defaults to 0.0 hr).

**Step 4:** Enter **Gage Rainfall:** depth of the rainfall at the Rain Gage Identifier for the given Storm Identifier. Enter a value 1.0 if Rainfall Distribution represents an actual storm. Press Enter, Tab key, or click another data box. (Range – 0.01 to 70)
Step 5: Enter a **Gage Rain Table Identifier**: or select one from the pull-down list: this will identify the rain distribution at the Rain Gage Identifier for the storm. Gage Rain Table Identifier must match a Rain Table Identifier in the Rainfall Distribution data section or one of the standard rainfall distributions including: Type NO_A, Type NO_B, Type NO_C, Type NO_D, Type NR_A, Type NR_B, Type NR_C, Type NR_D, Type MSE1, Type MSE2, Type MSE3, Type MSE4, Type MSE5, Type MSE6, Type CA-1, Type CA-2, Type CA-3, Type CA-4, Type CA-5, Type CA-6, Type NV-S, Type NV-N, Type NV-W, Type N PAC, Type AMSAM, Type I, Type IA, Type II, Type III, Type I (48 hours), Type II (48 hours), and Type B 6HR. Press **Enter**. (Range – 1 to 10 characters)

Step 6: Select **Antecedent Runoff Condition**: antecedent runoff condition to apply to runoff curve numbers in the watershed areas that use the Rain Gage Identifier. Acceptable values are: 1- Dry, 2-Average, and 3-Wet. (Default value is 2-Average). The runoff curve number is adjusted according to the procedure described in NEH Part 630, Chapter 10.

Step 7: Enter **2-Yr 24-Hr Rainfall**: rainfall amount attributed to the 2yr 24 hour event. This 2-Yr 24-Hr rainfall value is needed for computing “Sheet Flow” travel time for the sub-area Time of Concentration (Tc) using the Velocity Method. If no “SHEET FLOW” sub header records are included with Sub-Areas, then it may be left blank. Press **Enter**. (Range – Blank or 0.5 to 12 inches)

Step 8: Click the **Accept Changes (Close)** button for the interface to accept the data.

**Structure Rating window:**

The **Structure Rating** window allows entry or editing of ponded area or structure discharge/storage rating data. Each structure identifier entered should also appear as a Reach Structure Identifier with the Stream Reach data. Rating point information is sorted by increasing elevation as it is entered.

To enter structure-rating data, click on **Structure Rating** from main window. The Structure Rating window will appear as shown in figure 3-33 (your input structure rating editor will come up with a blank window until you have entered some structure data).
To input the structure rating for the model, do the following steps:

**Step 1:** Enter a **Structure Identifier:** or select one from the pull down list: Unique alphanumeric string identifying the structure. Press Enter, Tab key, or click another data box. (Range – 1 to 10 characters)

**Step 2:** Enter **Structure Starting Elevation:** starting elevation for routing hydrograph through the structure. Blank defaults to spillway crest or base flow discharge elevation if base flow is entered for this reach. Press Enter, Tab key, or click another data box. (Range – Blank, at, or above spillway crest elevation)

**Step 3:** Enter **Structure Elevation:** elevation of one point on the structure elevation-discharge-storage relationship. Coincides with elevation and discharge on the same line. Each structure elevation must increase from one line to the next. Press Enter. (Range – Negative, 0.0, or Positive Number)

**Step 4:** Enter **Structure Discharge:** discharge of one point on the structure elevation-discharge-storage relationship. Coincides with elevation and discharge on the same line. Value for lowest elevation must be 0.0. A discharge of 0.0 may be entered for more than one elevation. Each structure discharge must not decrease with elevation. Press Enter. (Range – $\geq 0.0$)

**Step 5:** Enter **Structure Storage:** storage volume of one point on the structure elevation-discharge-storage relationship. Coincides with elevation and discharge on the same line. Value at the lowest elevation
may be greater than or equal to 0.0. Each structure storage must increase with elevation. Press Enter. (Range – ≥ 0.0)

Step 6: The Display Data button should now be visible.

Step 7: Click Display Data button to view the structure rating plot. An example of the Structure Rating plot is shown in figure 3-34.

![Figure 3-34: Display Data – Structure Rating](image)

Step 8: The user could delete the current structure data by clicking on Delete Structure button on the Structure Rating window and then repeating steps one through five as desired to enter a new structure rating table.

Step 9: Click on Accept Changes (Close) button for the interface to accept the data.
Local Land Use window:

If the user routinely uses a set of runoff curve numbers for one or more land use categories that are not in the standard list of land uses in the NRCS curve number table, it would save time to enter the data in the Local Land Use data section so it could be used more efficiently. Use of this window is optional.

Figure 3-35: WinTR-20 File menu

Select Local Land Use from the File menu of the WinTR-20 main window as shown in figure 3-35. The Local Land Use window opens as shown in figure 3-36.
Enter curve number identifier and curve number for the four Hydrologic Soil Groups (HSG’s).

Close the Local Land Use Definitions: window. Click Accept Changes (Close) button when completed with data entry. The Local Land Use data will be included in the WinTR-20 input file at the time it is saved.
Local Soil/HSG window:

The Local Soil/HSG window allows entry or editing of local soil name and hydrologic soil group (HSG) into a database for a particular county and/or state. This will help the user find various soils with their associated hydrologic soil group (HSG). The Local Soil/HSG window will appear as shown in figure 3-38.

![Local Soil / HSG window](image)

**Figure 3- 38: Local Soil / HSG window**

To input the database of the local soil name and hydrologic soil group for your county and/or state, do the following steps:

**Step 1:** Click File from the WinTR-20 System Controller / Editor window. Select Local Soil / HSG (figure 3-20) to bring up the Local Soil / HSG window in Figure 3-38.

**Step 2:** Enter Local Soil Identifier: unique alphanumeric string. Press Enter. (1 to 30 characters)

**Step 3:** Select Hydrologic Soil Groups (HSG) – the Hydrologic Soil Group (A, B, C or D) associated with Local Soil Identifier name.

**Step 4:** Click on Accept Changes (Close) button for the interface to accept the data.

Sub-Area window:

The Sub-Area window allows entry or editing of sub-area data. The sub-area and runoff curve number can be entered directly or details for their computation by WinTR-20 can be entered by clicking on Land Use Details button (figure 3-39). The time of concentration can be entered directly or the details can be entered by clicking the Tc Velocity or Tc Lag button (figure 3-39).

To enter Sub-Area data, click on Sub-Area: from main window. Once Sub-Area: is selected, the Sub-Area: window will appear as shown in figure 3-39 (your input Sub-Area editor will come up with a blank window until you have entered some Sub-Area data).
To input the sub-area data for the model, do the following steps:

**Step 1:** Enter **Sub-Area Identifier**: a unique alphanumeric string identifying the sub-area. Press Enter, Tab key, or click another data box. (Range – 1 to 10 characters)

**Step 2:** Enter **Sub-Area Reach Identifier**: an alphanumeric string identifying the upstream end of the reach where the runoff from the sub-area will be drained. This must match a Stream Reach Identifier in the Stream Reach Data window. Enter “Outlet or outlet” if sub-area joins the stream system at the watershed outlet. Press Enter, Tab key, or click another data box. (Range –1 to 10 characters)

**Step 3:** Enter **Sub-Area Rain Gage Identifier**: an alphanumeric string identifying the rainfall gage to use for the sub-area. Must match with the Gage Identifier in Storm Analysis Data window. Blank is acceptable if it matches a Gage Identifier. Press Enter, Tab key, or click another data box. (Range –blank or 1 to 10 characters)

**Step 4:** Enter **Sub-Area Drainage Area**: the Drainage area associated with the sub-area. The value for drainage area can be entered directly. If drainage area is accumulated from the Land Use Details data, Sub-Area Drainage Area and the Sub-Area Weighted Curve Number are not visible on the Sub-Area window. Press Enter, Tab key, or click another data box. (Range – Blank, or 0.00015 to 100)

**Step 5:** Enter **Sub-Area Weighted Curve Number**: the weighted Runoff Curve Number to use for the sub-area of the watershed. The value for curve number can be entered directly. If blank (and the Sub-
Area Drainage Area blank), curve number may be computed from the Land Use Details data, as shown in figure 3-40. Press Enter, Tab key, or click another data box. (Range –Blank, or 30 to 100)

**Step 6:** Enter **CN Adjustment Based on ARC:** a value of Antecedent Runoff Condition (ARC) between 1.0 and 3.0 to adjust weighted curve number for this Sub-Area. This procedure is used in Texas and Kansas. Press Enter, Tab key, or click another data box. (Range –Blank, or 1.0 to 3.0)

**Step 7:** Enter **CN Reduction:** the value in this data box is subtracted from Sub-Area weighted curve number to adjust for drier than average Antecedent Runoff Condition. This procedure is used in Oklahoma. Press Enter, Tab key, or click another data box. (Range –Blank, or 1 to 14)

**Step 8:** Enter **Sub-Area Time of Concentration:** the time for runoff to travel from the hydraulically most distant point in the sub-area to the sub-area outlet. The time of concentration value can be entered directly (Tc Velocity and Tc Lag buttons will be disabled). If value is computed from the details entered in Tc Velocity or Tc Lag data windows then the Sub-Area Time of Concentration is not visible on the Sub-Area window. Press Enter, Tab key, or click another data box. (Range –Blank or 0.01 to 50)

**Step 9:** Select **Sub-Area Peak Output Code:** the code to output Sub-Area Peak Flow data to printed page file. Acceptable values are: Yes, No or Blank. Blank defaults to Default Sub-Area Peak Output Code (Global Output). If Global Output data are not entered, then **Sub-Area Peak Output Code** must be Yes (otherwise there will be no output).

**Step 10:** Select **Sub-Area Hydrograph Output Code:** the code to output Sub-Area Hydrograph and Peak Flow data to printed page file. Acceptable values are: Yes, No or Blank. Blank defaults to Default Sub-Area Hydrograph Output Code (Global Output).

**Step 11:** Select **Sub-Area Hydrograph File Code:** the code to output Sub-Area Hydrograph data to hydrograph file. Acceptable values are: Yes, No or Blank. Blank defaults to Default Sub-Area Hydrograph File Code (Global Output).

**Step 12:** The **Land Use Details** button should be visible if the user has not entered data in the Sub-Area Drainage Area and/or Sub-Area Weighted Curve Number boxes.

**Step 13:** The **Tc Velocity** and **Tc Lag** buttons should be visible if the user has not entered data in the Sub-Area Time of Concentration box.

**Step 14:** The user could delete the current Sub-Area data by clicking on **Delete Sub-Area** button on the Sub-Area window and then repeating steps 1 through 13 as desired to enter a new sub-area.

**Step 15:** Click on **Accept Changes (Close)** button for the interface to accept the data.
Land Use Details window

The Land Use Details window allows entry or editing land use area data for sub-areas that do not have drainage area and runoff curve number entered directly. The window displays the sum of land area entered and weighted curve number for the current sub-area. The Land Use Details window will appear as shown in figure 3-40. If any Local Land uses were added, they will appear at the top of the Land Use Area Identifier list.

![Figure 3-40: Land Use Details window](image)

To input the sub-area land use data for the model, do the following steps:

**Step 1:** Select from pull-down **Sub-Area Identifier:** unique alphanumeric string identifying the sub-area name. To verify that this is the sub-area intended for land use details, Press **Enter**. ((Range –1 to 10 characters)

**Step 2:** The **Display Local Soils** button is visible. By clicking on this Display Local Soil button, the Display Local Soil/HSG window will appear as shown in figure 3-41 (the user is able to determine the Hydrologic Soil Group (HSG) that is associated with various soils).

**Step 3:** Enter **Land Use Area Drainage Area** – drainage area in square miles associated with each land use and hydrologic soil group (HSG) combination for the sub-area. (Range – Blank, or 0.00015 to 100)
Step 4: The user could delete the current Sub-Area (Land Use) by clicking on the Delete Land Use Details button on the Land Use Details window and then repeating steps one through three as desired to enter new Sub-Area.

Step 5: Click on Return to Sub-Area button to get back to Sub-Area window.

The user is recommended to select Verification output when weighted curve numbers are computed for sub-areas. A table of land uses for each sub-area with computed weighted curve number is placed in the debug file. See Verification window below for instructions.

**Display Local Soil/HSG window:**

The Display Local Soil/HSG window allows viewing of local soil name and hydrologic soil group (HSG) from the database for a particular county and/or state. This will help the user find various soils with their associated hydrologic soil group (HSG). The Display Local Soil/HSG window will appear as shown in figure 3-41.

![Display Local Soil/HSG window](image)

**Figure 3- 41: Display Local Soil/HSG window**

Click the Close button to return to the Land Use Details window.
Time of Concentration - Velocity Method window:

The Time of Concentration - Velocity Method window allows entry, editing, and/or viewing of sub-area flow path segment data and the resulting segment travel times and time of concentration for sub-areas in the watersheds that have detailed time of concentration data. The Time of Concentration analysis performed here is based on the Velocity method (Chapter 15 NEH Part 630). The Time of Concentration window will appear as shown in figure 3-42.

![Time of Concentration - Velocity Method window](image)

**Figure 3- 42:  Time of Concentration – Velocity Method window**

To input the Time of Concentration Velocity Method data for the model, do the following steps:

**Step 1:** The **Sub-Area Identifier**: current sub-area name from Sub-Area window will appear on the Time of Concentration window. (Range – 1 to 10 characters)

**Step 2:** Enter **Sheet Flow Length** – length along sheet flow path for sub-area. Generally, beyond 100 feet the flow becomes concentrated flow. Therefore, sheet flow length is limited to 100 feet. Press **Enter**, **Tab** key, or click another data box. (Range – Blank or 1.0 to 100). **Note:** 2-yr Rainfall for Sheet Flow is entered with Storm Analysis, Principal Spillway, or Stability Freeboard data.
Step 3: Enter Sheet Flow Slope – slope along the sheet flow path for the sub-area. Press Enter, Tab key, or click another data box. (Range – Blank or 0.001 to 0.64)

Step 4: Enter Sheet Flow Manning “n” – roughness coefficient (n) to use with sheet flow path for the sub-area. Leave blank if Sheet Flow Surface is selected. Press Enter, Tab key, or click another data box. (Range – Blank or 0.01 to 1.0)

Step 5: Select Sheet Flow Surface – code representing the sheet flow path surface with the acceptable pull down values. Leave blank if Sheet Flow Manning “n” is entered. Press Enter, Tab key, or click another data box. (Range – Blank or select from list)

<table>
<thead>
<tr>
<th>Sheet Flow Surface Code</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>A – Smooth Surface</td>
<td>0.011</td>
</tr>
<tr>
<td>B – Fallow (no residue)</td>
<td>0.05</td>
</tr>
<tr>
<td>C – Cultivated &lt; 20% residue</td>
<td>0.06</td>
</tr>
<tr>
<td>D – Cultivated &gt; 20% residue</td>
<td>0.17</td>
</tr>
<tr>
<td>E – Grass – Range, Short</td>
<td>0.15</td>
</tr>
<tr>
<td>F – Grass, Dense</td>
<td>0.24</td>
</tr>
<tr>
<td>G – Grass, Bermuda</td>
<td>0.41</td>
</tr>
<tr>
<td>H – Woods, Light</td>
<td>0.40</td>
</tr>
<tr>
<td>I – Woods, Dense</td>
<td>0.80</td>
</tr>
<tr>
<td>J – Range, Natural</td>
<td>0.13</td>
</tr>
</tbody>
</table>

Step 6: Enter Shallow Concentrated Flow Length – length along shallow concentrated flow path for sub-area. Press Enter, Tab key, or click another data box. (Range – Blank or 1.0 to 10000)

Step 7: Enter Shallow Concentrated Flow Slope – slope along shallow concentrated flow path for the sub-area. Press Enter, Tab key, or click another data box. (Range – Blank or 0.001 to 0.5)

Step 8: Select Shallow Concentrated Flow Surface – code representing the shallow concentrated flow path surface with the acceptable pull-down values.

<table>
<thead>
<tr>
<th>Surface type</th>
<th>Assumed Manning’s n value</th>
</tr>
</thead>
<tbody>
<tr>
<td>P – Paved</td>
<td>0.025</td>
</tr>
<tr>
<td>U – Unpaved</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Step 9: Enter Channel Flow Length – length along the channel flow path for sub-area. Press Enter, Tab key, or click another data box. (Range – Blank or 1.0 to 100000)

Step 10: Enter Channel Flow Slope – slope along the channel flow path for sub-area. Leave blank if channel flow velocity is entered. Press Enter, Tab key, or click another data box. (Range – Blank or 0.0001 to 0.149)

Step 11: Enter Channel Manning “n” – roughness coefficient “n” to use with channel flow path for the sub-area. Leave blank if channel flow velocity is entered. Press Enter, Tab key, or click another data box. (Range – Blank or 0.01 to 1.0)
Step 12: Enter Channel Flow End Area – channel flow path channel cross sectional area to use for the sub-area. Leave blank if channel flow velocity is entered. Press Enter, Tab key, or click another data box. (Range – Blank or 1.0 to 1000000)

Step 13: Enter Channel Flow Wetted Perimeter – channel flow wetted perimeter to use for the sub-area. Leave blank if channel flow velocity is entered. Press Enter, Tab key, or click another data box. (Range – Blank or 1.0 to 1000000)

Step 14: Enter Channel Flow Velocity – channel flow velocity to use for the sub-area. Do not enter a value here if Slope, “n”, End Area, and Wetted Perimeter are entered. Press Enter. (Range – Blank or 0.15 to 20)

Step 15: The user could delete the current time of concentration by clicking on Delete Tc Details button from the Time of Concentration – Velocity Method window and then repeating step 1 through 14 as desired to enter new time of concentration.

Step 16: Click on Return to Sub-Area button to return to the Sub-Area window.

Step 17: Click on Accept Changes (Close) button for the interface to accept the data and return to Sub-Area window.

The user is recommended to select Verification output when times of concentration are computed for sub-areas. A table of sheet flow, shallow flow, and channel flow for each sub-area with computed travel times and time of concentration is placed in the debug file. See Verification window below for instructions.

Time of Concentration - Lag Method window:

The Time of Concentration - Lag method window allows entry, editing, and/or viewing of sub-area flow path data and the resulting time of concentration for sub-areas in the watersheds based on the Lag Method. The time of concentration analysis performed here is based on the Lag method (Chapter 15 NEH Part 630). The Time of Concentration – Lag Method window will appear as shown in figure 3-43. Use of the Lag Method is limited to drainage areas less than 3.125 square miles or 2000 acres.
To input the Time of Concentration Lag Method data for the model, do the following steps:

**Step 1:** Enter **Watershed Length** – length in feet representing the longest flow path from the watershed boundary to the outlet of the sub-area. Press **Enter, Tab** key, or click another data box. (Range – 200 to 26000 feet).

**Step 2:** Enter **Watershed Slope (%)** – average watershed land slope in percent of the all the contributing area within the sub-area boundary. If blank, enter Contour Length and Contour Interval. Press **Enter, Tab** key, or click another data box. (Range – 0.1 to 64)

**Step 3:** **Contour Length** – sum of contour lengths within the Sub-Area. To enter Contour Length, first click the radio button to the left of the Contour Length data box. If Contour Length is entered, a Contour Interval must also be entered. Press **Enter, Tab** key, or click another data box. (Range – Blank or 100 to 1000000)

**Step 4:** Select **Contour Interval** – the difference in elevation between two adjacent contours. This must be the same interval for all contour lengths measured. Press **Enter**. Range – Blank or 0.5 to 100)

**Note:** WinTR-20 computes Watershed Slope based on the Contour Length, Contour Interval, and sub-area drainage area. If the Watershed Slope is less than 0.1% or more than 64%, an error is generated and program execution stops.
Step 5: The user could delete the current time of concentration by clicking on **Delete Tc Lag Details** button on the Time of Concentration – Lag Method window and then repeating step 1 through 4 as desired to enter new time of concentration.

Step 6: Click on **Accept Changes (Close)** button for the interface to accept the data and return to Sub-Area window.

The user is recommended to select Verification output when times of concentration are computed for sub-areas. A table of Lag Tc data for each sub-area with computed time of concentration is placed in the debug file. See **Verification window** below for instructions.

**Verification window:**

The **Verification** window allows the user to select codes via check boxes for output of selected verification (input data, preliminary processing calculations, and/or watershed analysis calculations) data. Check only boxes that output is desired for. All verification output is placed in the Debug file (*.dbg).

To enter verification data, the user clicks on **Verification:** from the main window. The Verification window will appear as shown in figure 3-44. The user checks the blank boxes to request a particular verification item.

![Verification window](image)

**Figure 3- 44: Verification window**
Read Data Section Verification Tables

The first 12 items on the verification window (through Verification Read) refer to the reading of the data by the program. The output echoes the input and can be used as a check for data correctness. There are a few items to be aware of that may be different from what was actually entered. If metric data was entered, values will be expressed as English equivalents as all data are saved within WinTR-20 in English units. For input fields that were left blank, some may show the default for the field (if one exists) or it may show as a –999 in the table indicating that a blank was interpreted for this field. Also some blank fields may show as –999 indicating that the value entered was a blank. The data are listed by using the data section names as headers. If the box is checked in the Verification window, and there is no entry for a particular data section, that section is not listed in the debug file.

The next 16 items on the verification window refer to data checking and preliminary or intermediate calculations of WinTR-20. If Principal Spillway and/or Stability Freeboard data are entered, associated verification data are always automatically placed in the debug file. Examples and explanation of all verification data tables are included in the WinTR-20 User Documentation.

<table>
<thead>
<tr>
<th>Read Data Section</th>
<th>Output in Debug File</th>
<th>Check Boxes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensionless Unit Hydrograph Read</td>
<td>Code indicating whether to output Dimensionless Unit Hydrograph section data after read in and data conversion.</td>
<td>Yes Blank is No</td>
</tr>
<tr>
<td>Global Output Read</td>
<td>Code indicating whether to output Global Output section data after read in and data conversion.</td>
<td>Yes Blank is No</td>
</tr>
<tr>
<td>Input Hydrographs Read</td>
<td>Code indicating whether to output Input Hydrograph section data after read in and data conversion.</td>
<td>Yes Blank is No</td>
</tr>
<tr>
<td>Rainfall Distribution Read</td>
<td>Code indicating whether to output Rainfall Distribution section data after read in and data conversion.</td>
<td>Yes Blank is No</td>
</tr>
<tr>
<td>Runoff Curve Numbers Read</td>
<td>Code indicating whether to output Local Land Uses and Runoff Curve Numbers selected using land Use Details which are included in the Local Land Use Data text file.</td>
<td>Yes Blank is No</td>
</tr>
<tr>
<td>Stream Cross Sections Read</td>
<td>Code indicating whether to output Stream Cross Section data after read in and data conversion.</td>
<td>Yes Blank is No</td>
</tr>
<tr>
<td>Storm Reaches Read</td>
<td>Code indicating whether to output Storm Reach section data after read in and data conversion.</td>
<td>Yes Blank is No</td>
</tr>
<tr>
<td>Storm Analysis Read</td>
<td>Code indicating whether to output Storm Analysis section data after read in and data conversion.</td>
<td>Yes Blank is No</td>
</tr>
<tr>
<td>Structure Ratings Read</td>
<td>Code indicating whether to output Structure Rating section data after read in and data conversion.</td>
<td>Yes Blank is No</td>
</tr>
<tr>
<td>Sub-Areas Read</td>
<td>Code indicating whether to output Sub-Area section data after read in and data conversion.</td>
<td>Yes Blank is No</td>
</tr>
<tr>
<td>WinTR-20 Run Identifier Read</td>
<td>Code indicating whether to output WinTR-20 Run Identifier section data after read in and data conversion.</td>
<td>Yes Blank is No</td>
</tr>
<tr>
<td>Verification Read</td>
<td>Code indicating whether to output Verification section data after read in and data conversion.</td>
<td>Yes Blank is No</td>
</tr>
<tr>
<td>Storms and Rain Gage Combinations</td>
<td>Code indicating whether to output Storm and Rain Gage data.</td>
<td>Yes Blank is No</td>
</tr>
<tr>
<td>Pre-Processing Verification Section</td>
<td>Output in Debug Files</td>
<td>Check Boxes</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Sub-Area Tc Computations</td>
<td>Code indicating whether to output computed sub-area time of concentration details.</td>
<td>Yes</td>
</tr>
<tr>
<td>Sub-Area CN Computations</td>
<td>Code indicating whether to output computed sub-area weighted runoff curve number details.</td>
<td>Yes</td>
</tr>
<tr>
<td>Cross Section Rating Table</td>
<td>Code indicating whether to output rating table and computed reach routing coefficients.</td>
<td>Yes</td>
</tr>
<tr>
<td>Array Indexes / Reference Identifiers</td>
<td>Code indicating whether to output array indexes matching referenced identifiers read in.</td>
<td>Yes</td>
</tr>
<tr>
<td>Rainfall Distributions Used</td>
<td>Code indicating whether to output rainfall distribution matching referenced identifiers. Some or all of the distributions used may be built-in to the model.</td>
<td>Yes</td>
</tr>
<tr>
<td>Reservoir Emptying Time</td>
<td>Code indicating whether to output structure rating table showing time to empty reservoir from each rating point.</td>
<td>Yes</td>
</tr>
<tr>
<td>Upstream Reach Components</td>
<td>Code indicating whether to output list of reach identifiers and the reaches upstream from each.</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of Hydrographs</td>
<td>Code indicating whether to output steps in determining minimum number of hydrograph storage locations needed for the watershed analysis.</td>
<td>Yes</td>
</tr>
<tr>
<td>Watershed Analysis Steps</td>
<td>Code indicating whether to output steps in processing the watershed and how hydrographs are handled.</td>
<td>Yes</td>
</tr>
<tr>
<td>Non-circular Reach Flow Path</td>
<td>Code indicating whether to output steps in checking for circularity of the reach flow path.</td>
<td>Yes</td>
</tr>
<tr>
<td>Hydrograph Generation</td>
<td>Code indicating whether to output data used in generating hydrographs.</td>
<td>Yes</td>
</tr>
<tr>
<td>Hydrograph Channel Routing</td>
<td>Code indicating whether to output data used in channel routing hydrographs.</td>
<td>Yes</td>
</tr>
<tr>
<td>Hydrograph Structure Routing</td>
<td>Code indicating whether to output data used in storage routing hydrographs.</td>
<td>Yes</td>
</tr>
<tr>
<td>Hydrograph Addition</td>
<td>Code indicating whether to output data used in combining two hydrographs.</td>
<td>Yes</td>
</tr>
<tr>
<td>Hydrograph Flow Splitting</td>
<td>Code indicating whether to output data used in splitting a hydrograph into two hydrographs.</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Verification Data for Principal Spillway Data and Stability Freeboard Data are always placed in the .dbg file when these data windows are used.

**Principal Spillway Hydrograph Data window:**

The **Principal Spillway Hydrograph Data** window allows the user to generate a Principal Spillway Hydrograph based on NRCS criteria contained in NRCS TR-60. The objective is to generate a hydrograph which is saved in a WinTR-20 Hydrograph Output File which will then be imported to other software for further analyses. Hydrograph Output File may be selected for all reaches and/or sub-areas in the **Global Output** data window or for individual reaches or sub-areas in **Stream Reach** data or **Sub-Area** data windows. The data in this window will be treated as a storm over the watershed; thus being applied to whatever network of sub-areas and reaches that the user has entered. The explanation of this window covers
basic input. More details and examples are included in Chapters 8 and 9 of this User Guide. If data are entered in the Principal Spillway Hydrograph Data window the Storm Analysis window is disabled.

![Principal Spillway Hydrograph Data window](image)

**Figure 3- 45: Principal Spillway Hydrograph Data window**

Help (definition, use, and limits) is available for each data item by clicking the name for each data box.

To input the Principal Spillway Hydrograph for the model, do the following steps:

**Step 1:** Enter a **Description:** alphanumeric string identifying the situation being modeled (required). Press Enter, Tab key, or click another data box. (Range – 1 through 60 characters)

**Step 2:** Use radio button to select whether to enter [Average Annual Precipitation: and Average Annual Temperature:] or [Climatic Index (Ci):].

**Step 3:** Enter Ave. Annual Precipitation: and Ave. Annual Temperature: or enter Climatic Index or use the Look Up feature to select Ci for a location. Press Enter, Tab key, or click another data box. (Click Help for data limits of each item)

**Step 4:** Quick Return Flow (QRF) will be calculated and displayed if Ave. Annual Precipitation: and Ave. Annual Temperature: or Ci is entered and the value is greater than 1.0. If these three values are blank, a value of QRF may be entered directly. Press Enter, Tab key, or click another data box. (Click Help for data limits of each item)
Step 5: If $C_i$ is less than 1.0, enter **Channel Loss Factor**: or use **Calculate** button to calculate **Channel Loss Factor**: Click **Enter**, **Tab** key, or click another data box. (Click Help for data limits)

Step 6: Enter 2-Yr 24-Hr Rainfall (for computation of $T_c$ using the Velocity Method): this is only required if time of concentration for sub-areas includes sheet flow calculation. Press **Enter**, **Tab** key, or click another data box. (Range – Blank or 0.5 to 12)

Step 7: Use radio button to select whether to enter Principal Spillway storm rainfalls or Principal Spillway runoff volumes.

Step 8: Enter [1-Day Principal Spillway Design Precipitation, 10-Day Principal Spillway Design Precipitation, and 100-Year 10-Day Precipitation], or enter [10-Day Runoff Volume and Q 1-Day / Q 10-Day Ratio]. Press **Enter**, **Tab** key, or click another data box. (Click Help for data limits of each item)

Step 9: Enter **Principal Spillway 1-Day Areal Correction Factor**: this is multiplied by the storm rainfall to reduce rain applied to the watershed. Press **Enter**, **Tab** key, or click another data box. (Range – Blank or 0.8 to 1.0)

Step 10: Enter **Principal Spillway 10-Day Areal Correction Factor**: this is multiplied by the storm rainfall to reduce rain applied to the watershed. Press **Enter**. (Range – Blank or 0.8 to 1.0)

Step 11: Click on **Accept Changes (Close)** button for the interface to accept the data and return to the WinTR-20 Main window.

**Stability/Freeboard Hydrograph Data window:**

The **Stability/Freeboard Hydrograph Data** window allows user to generate Stability Design and Freeboard Design Hydrographs for a watershed based on NRCS criteria contained in NRCS TR-60. The data window may also be used to generate hydrographs based on any precipitation amount and rainfall distribution not based on NRCS criteria. The objective is to generate a hydrograph which is saved in a WinTR-20 Hydrograph Output File which will then be imported to other software for further analyses. Hydrograph Output File may be selected for all reaches and/or sub-areas in the **Global Output** data window or for individual reaches or sub-areas in **Stream Reach** data or **Sub-Area** data windows. The data in this window will be treated as two storms over the watershed; thus being applied to whatever network of sub-areas and reaches that the user has entered. The explanation of this window covers basic input. More details and examples are included in Chapters 8 and 9 of this User Guide. If data are entered in the **Stability/Freeboard Hydrograph Data** window the **Storm Analysis** window is disabled.
# Stability/Freeboard Hydrograph Data

<table>
<thead>
<tr>
<th>Description:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Class:</td>
<td></td>
</tr>
<tr>
<td>Gage Rain Table Identifier:</td>
<td></td>
</tr>
<tr>
<td>Stability Design:</td>
<td></td>
</tr>
<tr>
<td>Freeboard Design:</td>
<td></td>
</tr>
<tr>
<td>Rainfall - NRCS Design Class</td>
<td></td>
</tr>
<tr>
<td>6-HR</td>
<td>12-HR</td>
</tr>
<tr>
<td>Rainfall (P-100):</td>
<td></td>
</tr>
<tr>
<td>Rainfall (PMP):</td>
<td></td>
</tr>
<tr>
<td>Stability Design Rainfall:</td>
<td>in</td>
</tr>
<tr>
<td>Freeboard Design Rainfall:</td>
<td>in</td>
</tr>
<tr>
<td>2-YR 24-HR Rainfall (for computation of Tc)</td>
<td>in</td>
</tr>
</tbody>
</table>

**Figure 3-46: Stability/Freeboard Hydrograph Data window**

Help (definition, use, and limits) is available for each data item by clicking the name for each data box.

To input the Stability Design and Freeboard Hydrographs for the model, do the following steps:

**Step 1:** Enter a **Description**: an alphanumeric string identifying the situation being modeled (required). Press **Enter**, **Tab** key, or click another data box. (Range – 1 through 60 characters)

**Step 2:** Select **Design Class**: use the pull down menu to select from the list of Design Classes including Low1, Low2, Low3, Sig, High, and Other. Press **Enter**, **Tab** key, or click another data box.

**Step 3:** Enter **Gage Rain Table Identifier**: *(Stability Design: and Freeboard Design:)*: use the pull down menu to select from the list of standard and user-entered rain table identifiers. Press **Enter**, **Tab** key, or click another data box. (Range – Blank or one table included in the list)

**Step 4:** Enter **Rainfall – NRCS Design Class (Rainfall (P-100)):** and **Rainfall (PMP):** for 6-HR, 12-HR and 24-HR or **Rainfall – Other Design Class (Stability Design Rainfall: and Freeboard Design Rainfall):**. Press **Enter**, **Tab** key, or click another data box. (Click Help for data limits of each item)
Step 5: Enter **Stability Design Areal Correction Factor**: and **Freeboard Design Areal Correction Factor**: These are multiplied by the storm rainfall to reduce rain applied to the watershed. Press **Enter**, **Tab** key, or click another data box. (Range – Blank or 0.5 to 1.0)

Step 6: Enter **2-Yr 24-Hr Rainfall**: (for computation of Tc using Velocity Method) this is only required if time of concentration for sub-areas includes sheet flow calculation. Press **Enter**. (Range – Blank or 0.5 to 12)

Step 7: Click on **Accept Changes (Close)** button for the interface to accept the data and return to the WinTR-20 Main window.

### 3.5 Saving Input Data

To save the input file, the user can use the **Save** or **SaveAs** option from the File menu of the main window as shown in figure 3-47. When this option is selected, the user is prompted to select a directory and enter a filename for the input data as shown in figure 3-48.

![Figure 3-47: Open Save or SaveAs window](image-url)
The data will be saved on the selected drive with the file name specified. The file extension must be .inp for the program to read the input data. **The filename and path cannot exceed 80 characters.** The user clicks the **Save** button to save as shown in figure 3-48. Then click the **Yes** button to continue the save procedure when a window similar to figure 3-49 opens.

In general, it is a good idea to periodically save the data as you are entering the data. This will prevent the loss of your data in the event of a power failure, or if a program error occurs and the WinTR-20 user interface closes without warning.
3.6 Performing WinTR-20 Calculations

Once all the data are entered and the file is saved, the user can perform the WinTR-20 calculations by clicking on Run from the main window (menu bar). An example of the Run – Perform WinTR-20 Calculation window is show in figure 3-50.

![WinTR-20 System Controller / Editor](image)

**Figure 3-50: Run – Perform WinTR-20 Calculation**

After WinTR-20 has finished the calculations, WinTR-20 will generate the WinTR-20 Printed Page File as shown in figure 3-51. If the data file has errors, the error file opens. An example error file is shown in figure 3-53.
Figure 3- 51: WinTR-20 Printed Page File

Under the WinTR-20 Printed Page File window are the following options:

**Print:** Send the WinTR-20 Printed Page File to a printer.

**View:** The view menu includes: WinTR-20 Input File (fig. 3-52), WinTR-20 Printed Page File (fig. 3-51), WinTR-20 Error File (fig. 3-53), WinTR-20 Debug File (fig. 3-54), WinTR-20 Hydrograph File (fig. 3-55), and Smoothed NOAA/NRCC File (fig. 3-56).

To close the WinTR-20 Printed Page File window, click **Close** button to close the window.
Figure 3- 52: WinTR-20 Input File window

Figure 3- 53: WinTR-20 Error File window
Figure 3- 54: WinTR-20 Debug File window

Figure 3- 55: WinTR-20 Hydrograph File window
3.7 Viewing and Printing Results

After the WinTR-20 has finished all of the calculations you can begin viewing, plotting and printing the results. Under the WinTR-20 main window, View and Plots have the following options.
Figure 3-57: WinTR-20 Main Window menu
Figure 3-58: WinTR-20 Main Window View menu

View: The view menu includes: Schematic (see figure 3-59), Input File (see figure 3-52), Printed Page File (see figure 3-51), Error File (see figure 3-53), Debug File (see figure 3-54), Hydrograph File (see figure 3-55), and Smoothed NOAA/NRCC File (see figure 3-56).
Figure 3-59: WinTR-20 Watershed Schematic window

Plots: Brings up the Graphics Output window (see figure 3-61 and Table 3.2 for more details).

Figure 3-60: WinTR-20 Main Window Plots option
To generate a single hydrograph plot, do the following steps:

**Step 1:** The **Graphic Type:** default is set on **Hydrograph** radio button.
Step 2: The **Multiple Hydrographs**: default is set on **None** radio button.

Step 3: The **Storm**: select a storm from the pull down list. Press **Enter**. (example – 2-year, 5-year, 10-year, or 50-year)

Step 4: Select a single location from either the pull down list of **Sub-Area**: or **Reach**: or select the **Outlet**: If a Reach is selected, then select either the Upstream or Downstream location. Press **Enter**. (example – Area 1, Area 2, Reach 1 Upstream, Reach 2 Downstream, or Outlet)

Step 5: Click the **Display** button – to view the hydrograph plot for the selected location. Click **Display** button. An example of single sub-area (Area 2) for 50-year storm is shown in figure 3-62.

![Hydrograph (Storm - 50-year)](image)

Figure 3- 62: Single Sub-Area – Storm Hydrograph window

If no data are found, the “**No data for requested plot found**” message will appear. Just click **OK**, as shown in figure 3-63. This indicates that the user did not specify that hydrograph output was requested for the sub-area or reach (see figures 3-24, 3-31, and 3-39 for Hydrograph Output Code). Open **Global Output: Sub-Area** or **Stream Reach**: and select **Hydrograph Output**, **Save** the data, and click **Run** again.
Plot Multiple Hydrographs: click on the Location radio button. Select a Storm name. The Multiple Locations window is now visible. Select from Sub-Areas, Reaches, and Outlet where plots are desired. Each item selected will be listed on the Multiple Locations window as shown in figure 3-64. Up to 10 multiple selections may be made.

The Display button should now be visible.
Click the **Display** button to view the Multiple Hydrographs plot. An example of the Multiple Hydrographs plot is shown in figure 3-65.

Click **Close** to get back to the Graphics Output Window and plot the next hydrologic wonder.

![Multiple Location Plot Hydrograph window](image)

**Figure 3- 61: Multiple Location Plot Hydrograph window**

![Tool Buttons – Hydrograph window](image)

**Figure 3- 62: Tool Buttons – Hydrograph window**

The Tool Buttons at the top of the Plot window are defined in figure 3-66.

Besides the Tool Buttons, the WinTR-20 Hydrograph plot window has the following options:
**File:** The file menu currently includes: Save As, Print Preview, Print, and Exit. (See figure 3-67)

**Edit:** The edit menu currently includes: Copy, Zoom In, Zoom Out, Plot Points, Plot Lines, and Plot Grids (See figure 3-67).

**Help:** This would allow the user to view display showing help information. Help files available under the Help menu includes: Contents, Index, and About (See figure 3-67).

---

**Figure 3-67: Menu Options – Hydrograph window**

To generate a Peak Flow plot, do the following steps on the **Graphics Output** window:

**Step 1:** Click on the **Peak Flow** option button.
Step 2: Select **Storm** names.

Step 3: Select **Flow Units** – either in cfs or csm.

Step 4: Select **Sub-Area** or **Reach** or **Outlet**. The user could select all.

Step 5: **Display** button is now visible. Click on the **Display** button to view the Peak Flow plot. An example of the Peak Flow window is shown in figure 3-68.

Step 6: The plot can be shown as point and/or lines with or without a background grid. From the Edit pull down menu, the user could select the plot by Points, Lines, and Grid.

Step 7: Click on X (upper right in window) to close and return to Graphics Output Window.

![Peak Flow window](image)

**Figure 3-68: Peak Flow window**

Close the **Graphics Output** window and close WinTR-20 when analyses are completed.
3.8 Summary

The WinTR-20 Main Window Button Bar (figure 3-8) has the following options:

**File:** This is set up for file management. Options available under the File menu includes: New WinTR-20 File, Open Existing WinTR-20 File, ReOpen Last Session, Convert Old Data, Import HEC-RAS, Import NOAA Atlas Data, Import NRCC Data, Local Land Use, Local Soil / HSG, Save, Save As, and Exit.


**Run:** This option is used to perform the WinTR-20 calculations.

**Plots:** The plots menu currently includes: Graphical Type (Hydrograph and Peak Flow), and Multiple Hydrographs (None, Storm, and Location).

**Help:** This allows the user to get a display showing help information about the WinTR-20 System. Help files available under the Help menu includes WinTR-20 System Diagram, Overview, Help Facilities, Getting Started, About Control / Editor, and Smoothed NOAA/NRCC Data (see figures 3-3 through 3-7).
Chapter 4 WinTR-20 Converter

4.1 Description

The data converter transforms old TR-20 input data from TR-20 versions prior to 1993 into the current WinTR-20 input format. The converter program is a Fortran90 batch process and uses the TR-20 input specifications in the WinTR-20 User Documentation as the basis for input conversions. The Converter is included with the WinTR-20 system package, and is automatically placed in a subdirectory during the installation process.

When the WinTR20 Controller/Editor is started, one of the File menu choices is “Convert Old Data” (see figure 4-1). Making this choice activates the TR-20 Converter and the program asks for an input file (see figure 4-2).

Browse for the old file then click Open. The old data file may have any legal extension (for example, old.dat). During the conversion process the data file that is created is renamed “oldfilename.inp”.

![Figure 4-1: File Menu – WinTR-20 Controller/Editor window](image-url)
Figure 4-2: Input file selected: Data Converter

The program converts what it can of the input file, putting the data into the correct format for the WinTR-20, and displays the WinTR-20 Identifier window (figure 4-3). Where data needed by WinTR-20 is missing the converter flags this by printing “Missing” in the appropriate data field.

Figure 4-3: Converted input file WinTR-20 Identifier window

Click No Changes (Close) button unless changes are made in this window.

The WinTR-20 Main window will open at this point as shown in figure 4-4.
Click **Stream Cross Section**: to view cross section data. Select **Cross Section Identifier**: Xsec 1 as shown in figure 4-5 below.

![Stream Cross Section](image)

**Figure 4-5**: Converted input file, missing energy grade slope data in cross section
The user can now edit the file as necessary prior to running it in the WinTR-20 program. For instance, in the window above, the Energy Grade (E.G.) Slope is missing from the stream cross section data and must be added to the data before WinTR-20 will run successfully. By entering the E.G. Slope on the first line in the table, WinTR-20 assumes it is the same for all other lines in the table.

4.2 Converted Data is Incomplete

Most old data will be transferred but some items such as IPEAKS and multiple changes in main time increment do not translate to the new format. Entry of routing coefficients x and m in lieu of reach cross section rating data is no longer acceptable. Each reach in the watershed must refer to a stream cross section rating or structure rating. Also, the new input requires a top width and energy grade slope for stream cross section data, which were not included in the old input data. The converter generates a top width value for each elevation based on the depth and end area, but it does not generate an energy grade slope and lists the slope as “Missing”. Any reaches in old data sets that used the routing coefficients x and m instead of cross section data will require additional cross section data. Thus, after conversion, some additional data will need to be entered before the file will run in the WinTR-20 model.

The IPEAKS feature and the option of using the rainfall table as a runoff table that were part of the old TR-20 have not been included in the WinTR-20 System model. If they are part of an old data set that is being converted, they do not cause an error as they are just not retained in the newly created input file. Also, multiple main time increments are not used in WinTR-20.

4.3 Verify Converted Data

While the converter attempts to convert as much of the old input data as possible, some situations may not convert as expected, such as diversions. It is the responsibility of the user to verify that the converted data are still representative of the watershed being modeled. The user should especially check the WinTR-20 reach data and schematic diagram if there are diversions in the old TR-20 data file.

4.4 Output Files

Three output files are generated from the TR-20 Converter. They are the WinTR-20 input file (xxx.inp), an error file (xxx.err) and debug file (xxx.dbg). Any errors encountered while converting the data set are written to the error file. Any warning messages will be written to the debug file. A listing of the error and warning messages can be found in the User Guide Appendices B and C.
4.5 Comparison of old and present WinTR-20

Running the old data set in figure 4-6 through the converter produces the WinTR-20 input file in figure 4-7.

<table>
<thead>
<tr>
<th>JOB TR-20 SAMPLE 2</th>
<th>FULLPRINT</th>
<th>SUMMARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>TITLE</td>
<td>JOB USES - 24HR TYPE II STORM, FROM STR 1 TO XSEC 2</td>
<td>10</td>
</tr>
<tr>
<td>TITLE</td>
<td>FULLPRINT, SUMMARY, ADDHYD, PEAK-VOL, HYD &amp; FILE OPTIONS.</td>
<td>20</td>
</tr>
<tr>
<td>XSECTN 001</td>
<td>1.00</td>
<td>508.50</td>
</tr>
<tr>
<td>8</td>
<td>503.50</td>
<td>0.0</td>
</tr>
<tr>
<td>8</td>
<td>505.21</td>
<td>100.00</td>
</tr>
<tr>
<td>8</td>
<td>506.74</td>
<td>300.00</td>
</tr>
<tr>
<td>8</td>
<td>508.28</td>
<td>600.00</td>
</tr>
<tr>
<td>8</td>
<td>508.50</td>
<td>624.56</td>
</tr>
<tr>
<td>8</td>
<td>509.51</td>
<td>1000.00</td>
</tr>
<tr>
<td>8</td>
<td>510.37</td>
<td>1500.00</td>
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<td>8</td>
<td>511.44</td>
<td>2500.00</td>
</tr>
<tr>
<td>ENDtbl</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XSECTN 002</td>
<td>1.00</td>
<td>501.27</td>
</tr>
<tr>
<td>8</td>
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<td>0.0</td>
<td>0.33</td>
</tr>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>7 5400.0</td>
<td></td>
</tr>
<tr>
<td>REACH 3 001 7</td>
<td>1 11</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>6 0.46</td>
<td>76.0</td>
</tr>
<tr>
<td>RUNOFF 1 001</td>
<td>6 1.07</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>7 567</td>
<td></td>
</tr>
<tr>
<td>ADDHYD 4 001 5 67</td>
<td>1 1</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>7 3000.0</td>
<td></td>
</tr>
<tr>
<td>REACH 3 002 7</td>
<td>1 1 1</td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
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<td>0.1</td>
<td></td>
</tr>
<tr>
<td>COMPUT 7 01 002</td>
<td>5.2</td>
<td>1.0</td>
</tr>
<tr>
<td>7</td>
<td>2 2 01 01</td>
<td></td>
</tr>
<tr>
<td>ENDCMP 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENDDOC 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 4-6: Old TR-20 input data
**Figure 4- 7: Converted Input Data**

The word “Missing” is placed in the data field for the energy grade slope value, which is required for the Muskingum-Cunge reach routing method. If the energy grade slope does not change in the rating, only one entry on the first line is needed.

![Input Data Table](image)
4.6 Summary on converting Old TR-20 Data

An important feature of WinTR-20 is the ability to convert old TR-20 data (DOS) into the current WinTR-20 format. The converter program is a Fortran90 batch process and uses the TR-20 input specifications in the WinTR-20 User Documentation as the basis for input conversions.

Before converting the old TR-20 data into the WinTR-20 format, there are several things that the user should be aware of: First, the Input File name that is used by TR-20 converter. Second, not all of the old TR-20 data will be transferred to the WinTR-20 format. Third, the output files generated from the TR-20 Converter contain useful information, errors, and warnings about the conversion process.

1. Input File

   **Old TR-20 input** – contains all of the data that is watershed specific for an Old TR-20 analysis. Refer to WinTR-20 User Documentation for more information on data converted.

2. Data Processing

   **Converted Data is Incomplete**

   Most of the Old TR-20 data will be transferred but some items such as IPEAKS and multiple changes in main time increment do not translate to the new format.

   - Entry of routing coefficients (x and m) in lieu of a reach cross section is no longer acceptable. Any reaches in old data sets that used the routing coefficients instead of cross section data will require additional cross section data.
   - Each reach in the watershed must refer to a stream cross section rating or structure rating.
   - If there are diversions in the old TR-20 data, check that the converter program set up the correct network of reaches and diversions. These may be checked by plotting the WinTR-20 schematic diagram and checking reach and diversion organization.
   - The converter program will generate a top width value for each elevation (based on the depth and end area). This should be viewed for reasonableness using the Cross Section Display data button.
   - The converter program does not generate an energy grade slope and lists the energy grade slope as “Missing”.
   - **Unconverted Items**
     - The IPEAKS feature from old TR-20 will not be included in the WinTR-20.
     - Also, multiple main time increment functionality is not used in the WinTR-20.
   - **Verify Converted Data**
     - While the converter attempts to convert as much of the old input data as possible, it is the responsibility of the user to verify that the converted data is still representative of the watershed being modeled.

3. Output Files

   - There are three output files generated from the WinTR-20 Converter: WinTR-20 input file (**xxx.inp**), Error file (**xxx.err**), and Debug file (**xxx.dbg**).
   - A listing of the error and warning messages can be found from the WinTR-20 User Guide in Appendices B and C.
Chapter 5 HEC-RAS Reformatter

5.1 Description

The Corps of Engineer’s HEC-RAS water surface profile program is used by many NRCS engineers in lieu of the older and now obsolete WSP2 Water Surface Profile program (NEH Part 630 Chapter 31, 1994) for computing water surface profiles and developing cross section rating tables used in the WinTR-20 model for the flood routing of stream reaches. The WSP2 program developed these tables as an output option. However, HEC-RAS does not automatically develop these tables in the correct format for WinTR-20. For this reason, a reformatter program (TR20_HECRAS_Rating.exe) has been developed that takes a HEC-RAS output file and develops rating tables formatted for input to WinTR-20. The TR20_HEC-RAS_Rating program is a stand-alone Fortran90 batch process program.

HEC-RAS has many optional output variables and allows for the development of customized tables with certain desired information. Such customized tables, once created and saved, can be accessible whenever HEC-RAS is run on various projects and plans. This chapter of the User Guide discusses in detail how to organize a HEC-RAS output table for use in the reformatter. The reformatter was written based on output from HEC-RAS version 4.1.0. As future releases of HEC-RAS and WinTR-20 are distributed, the reformatter will be tested and revised as needed to be compatible with both the newer HEC-RAS versions and the WinTR-20 model.

5.2 Input: Running the TR20_HEC-RAS_Rating program

The TR20_HEC-RAS_Rating program may be run from Windows Explorer, other file managers, or from the WinTR-20 Controller/Editor. To run it from the Controller/Editor, click the File menu on the Main window and then click Import HEC-RAS in the pull down menu. The program then allows the user to browse for the input file name. Note: Do not try to import HEC-RAS data into an exising WinTR-20 input data file. It will cause all the data not associated with HEC-RAS to be deleted. It is recommended to import HEC-RAS data into a new project only.

The reformatter reads the file created from HEC-RAS output as input. Reformatter output consists of a file with WinTR-20 cross section rating tables and an error file with any irregularities identified which would cause WinTR-20 execution problems.

5.3 Data Processing

River Station Identification and WinTR-20 Cross Section Number

WinTR-20 accepts alphanumeric cross section names of up to ten characters in length. HEC-RAS permits a River Station (cross section location) to be identified by an integer or decimal number up to eight characters in length. All cross sections (including interpolated cross sections) in the HEC-RAS output file may be included in the TR20_HEC-RAS_Rating output file. The contents of the HEC-RAS output file can be selected prior to saving the text file if not all of the HEC-RAS river stations or reaches are desired as WinTR-20 rating tables.
Bankfull Elevation

This elevation is placed on the WinTR-20 cross section header record. The assumption made is that the Bankfull Elevation is the lower of the left overbank elevation (LOB Elev) and the right overbank elevation (ROB Elev). This is consistent with the definition in WinTR-20. If Bankfull Elevation is higher than the highest water surface profile elevation, it is set equal to the highest profile elevation. As no information is present for the Low Ground elevation, it is left blank and in this case WinTR-20 assumes Low Ground elevation is the same as Bankfull Elevation. Users can revise these elevations, if desired, in the cross section data prior to running WinTR-20.

Data Checking

Profile elevation, discharge, and area must increase with successive profiles in the table. WinTR-20 produces an error if elevation, discharge, or area does not increase from one profile to the next in the table. The top width of the cross section may remain constant with elevation (for example in a rectangular channel) but an error will be generated if the top width decreases as the elevation increases. The Energy Grade Slope is checked to see if it is 0.00001 or greater. If an error occurs, an error message is placed in the error file, which identifies the cross section and profile where it occurs. The data need to be revised in order for WinTR-20 to run successfully.

Number of profiles in the HEC-RAS output table

WinTR-20 requires a minimum of two non-zero discharge profiles in a cross section rating table. If there is only one profile run in HEC-RAS, an error is placed in the error file. Though there is no limit to the maximum number of profiles run in HEC-RAS or that are acceptable to WinTR-20, the TR20_HEC-RAS_Rating program has a limit of 200.

5.4 Output File

In the output file which is actually a WinTR-20 input file, a WinTR-20 Identifier record and two WinTR-20 Watershed Description records which contain the two title records from the HEC-RAS output table are placed at the beginning of the file. These are provided for data identification (project, plan, etc) and for the possibility of importing this file to the WinTR-20 Controller/Editor as an existing file. The reformatted cross section data then follow.

5.5 Importing HEC-RAS Data

As mentioned previously, the customized table needs to be organized only one time. When the table is saved, it will be accessible any time HEC-RAS is operated. To customize the HEC-RAS output summary table, follow the steps below in the order listed.

1. After running HEC-RAS for a project and plan, click the Profile Table icon or click View, then Profile Table.
2. This will bring up a standard HEC-RAS Profile Output Table – Standard Table 1 output table.

3. It is optional to display various reaches and profiles in this table. Select the profiles and reaches for which the TR-20 rating tables are desired.

4. Click Options, then select Define Table.

5. The initial window has a series of output variables pre-selected as shown in figure 5-3. The contents and order of this table will be revised.
Figure 5-3: HEC-RAS Create a Table Heading, initial window

6. Select variables to appear in the table. The order of this selection is important because the TR20_HEC-RAS_Rating program expects the variables in the following specific order. Click heading column number 1 to select the first column.
Figure 5-4: Create a Table heading Window, select Column 1

Then scroll down the list of variables and select (double-click) “Min Ch. El.” (Minimum channel elevation).

Min Ch El will be placed in Column 1 as shown in figure 5-5 below.
Click column 2 and select (double click) **LOB Elev** (ground elevation at the left bank of the main channel). Select the following variables in columns in the order listed.

- Column 3, **ROB Elev** (ground elevation at the right bank of the main channel),
- Column 4, **W.S.Elev** (calculated water surface elevation from energy equation),
- Column 5, **Q Total** (total flow in cross section),
- Column 6, **Flow Area** (total area of cross section active flow),
- Column 7, **Top Width** (top width of wetted cross section), and
- Column 8, **E. G. Slope** (slope of energy grade line at cross section).

At this point, there will still be data in columns 9 and 10. To delete these two columns, select the column number in the table and press the **Delete** key to set the column to be blank.
Figure 5-6: Create a Table Heading Window, Columns 1 through 8 complete

When each selection is made, the table is built on the window with each added variable. After all eight variables are selected; the table is complete on the window. The completed table should appear similar to figure 5-6 above. Do not click OK yet.

7. Click the Additional Options tab. The table appearing on the window may include bridges and culverts. Only valley cross sections are used in WinTR-20 so we would like to eliminate bridges and culverts from this table. In order to do this, make sure the only box checked on that window is Cross Sections. If check marks appear in any other boxes, click those boxes to remove the check mark. Click OK to exit this window.
Figure 5-7: Create a Table heading - Additional Option window

8. The next step is to save this customized table so it can be stored and then used whenever HEC-RAS is operated. In order to do this, click Options, then Save Table.
9. Then enter a name for the table.

![Figure 5-9: Name the saved table](image)

10. One possible selection for the name is **WinTR-20 Xsec**. After naming the table, click **OK** to exit.

11. At this point, the table as named will appear in the list of **User Tables** as an option for viewing output. Click **User Tables** to verify that the table is saved with the assigned name.
12. Lastly create an ASCII text file with the selected profiles and reaches in the format shown in the window. To do this, click **File** and **Write to Text File**.

13. Select a directory to save the data and enter the name of the file to be saved, such as `project_cross_sections.txt`, then click **Save** to exit.
Figure 5-12: Select directory and enter file name for saved text file

14. This is the file which the HEC-RAS Reformatter program will use to develop the rating tables. Save the project and close HEC-RAS.
15. Open the WinTR-20 Controller/Editor. Select **File** and **Import HEC-RAS**.
16. Browse for the file named project_cross_sections.txt and click Open.
17. The WinTR-20 Identifier window should then open (if there are no errors). The user may revise the Watershed Description if desired.

![WinTR-20 Identifier window](image)

**Figure 5-15: WinTR-20 Identifier opens after successful import of data**

18. Click **Accept Changes (Close)** button to return to the Main WinTR-20 window. It should show an “X” for the Stream Cross Section: data window.
19. Click View and Input File.

Figure 5- 16: WinTR-20 Main Window with data for WinTR-20 Identifier and Stream Cross Section data
20. Close the Input File window. At this point other WinTR-20 data may be added to complete the project such as Sub-Area, Stream Reach, Storm Analysis, etc. **Note: Do not try to import HEC-RAS data into an existing WinTR-20 input data file. It will cause all the data not associated with HEC-RAS to be deleted. It is recommended to import HEC-RAS data into a new project only.**
Chapter 6 Import NOAA Atlas 14 Data

6.1 Introduction

The NOAA National Weather Service (NWS) has published Volumes 1 through 9 of NOAA Atlas 14 which contain updated rainfall frequency information for 37 states, Puerto Rico, the US Virgin Islands, and selected Pacific Islands. This atlas replaces the NOAA and NWS documents TP-40, Hydro-35, NOAA Atlas 2, TP-42, TP-47, and TP-49 for the areas covered.

Previously, NRCS standard design rainfall distributions Type I, Type IA, Type II, and Type III were developed for use with WinTR-20. Studies of the NOAA Atlas 14 rainfall data have shown that these standard rainfall distributions do not accurately represent the relations of rainfall intensity, duration, and frequency. For this reason, in the states and other areas covered by NOAA Atlas 14 the recommended approach to using NOAA Atlas 14 data with WinTR-20 is to obtain site-specific rainfall data at the intended project location directly from the NOAA NWS web site. An option has been added to WinTR-20 that will develop a site-specific rainfall distribution based on the NOAA Atlas 14 data for each frequency from 1-year through 500-year. This option has been used to develop regional rainfall distributions that may be used instead of the site-specific rainfall distribution. Technical information about these procedures may be found in Chapter 4 of NRCS NEH Part 630 Hydrology. The following instructions will illustrate how to obtain the data from the NOAA NWS web site and import the data to WinTR-20 Version 3.10.

6.2 Obtaining rainfall-frequency data from NOAA NWS web site

Open the NOAA NWS web site at http://hdsc.nws.noaa.gov/

Figure 6-1: NOAA Atlas 14 web site URL
Figure 6-2: NOAA Atlas 14 national web page

Data for the states and other areas shaded in blue are available. Click on the desired state or use the State pull-down menu to select a state to load.
The state of Maryland was selected for this example. Select the data type precipitation depth, select english units, and partial duration. Partial Duration or annual series results may be obtained. In general, NRCS recommends partial duration data. The NOAA Converter program is designed to accept partial duration series and not annual series data.

Data may be requested in three different ways. One way is to place the cursor (hand icon in figure 6.3) on the location where data are desired. Using the zoom feature on the top left of the map window allows for a better location of the project site. The second way is to select a specific observing station from a drop-down list. The third way to obtain data is to enter a latitude and longitude (with longitude in negative degrees) for the project location and then click the Submit button.
For this example, the red cross-hair was placed at the estimated project location. The hand icon shown in figure 6-4 may be used to drag the red cross-hair to another location. Use the scroll bar at the right side of the map window to scroll down to the bottom of the web page to view the data for the project location. The top part of the table is shown in figure 6-5.

![Figure 6-4: Zoom to select site location more accurately](image)

![Figure 6-5: Top part of table containing precipitation frequency estimates for project location](image)
Even though NOAA Atlas 14 includes the 1,000-year precipitation estimates, NRCS does not use it in typical engineering projects. If a single number such as the 25-year 24-hour precipitation is desired, it may be recorded at this time. If the complete table is desired, it may be saved as a comma-separated value (csv) file for importing to WinTR-20, opening with spreadsheet software, or opening with a text editor. At the bottom of the web page there is an option to save the file as shown in figure 6-6.

![Figure 6-6: Option to save the file in csv format](image)

Click the **Submit** button.

![Figure 6-7: Option to open or save the file](image)

Click **Save** and **Save as** to open a window to select a directory and enter a file name.

![Figure 6-8: Select a directory and enter file name for the NOAA Atlas 14 data file](image)
The table saved in the figure above is named Maryland_project_1.csv. It is comma delimited. After it is downloaded, it may be imported to WinTR-20 and also be imported to an Excel spreadsheet for other types of analysis. Click Save.

![The Maryland_project_1.csv download has completed](image)

**Figure 6-9: Window indicating file is saved successfully**

Close the window that is similar to the one shown in figure 6-9. Close the NOAA Atlas 14 web page if finished with data retrieval.

### 6.3 Importing NOAA Atlas 14 data into WinTR-20

The following steps show how to import the csv file from NOAA Atlas 14 into WinTR-20.

![WinTR-20 System Controller / Editor](image)

**Figure 6-10: Open WinTR-20 Controller/Editor window**

Open WinTR-20. Click **File** and **Import NOAA Atlas Data** (see figure 6-11).
Figure 6-11: Import NOAA Atlas Data

Figure 6-12: Browse to locate the NOAA Atlas data file.

Browse to find the csv file saved in the previous steps. Click the Open button. A small window opens to ask if data are to be smoothed (figure 6-13).
The concepts used in data smoothing are included in a Help window shown in figure 3-7. Clicking the Yes button to smooth the data is recommended. The next window to open is the **WinTR-20 Identifier** window (figure 6-14). The file name for the WinTR-20 input data is defined as the first part of the NOAA text file name with the extension as .inp. Information from the NOAA Atlas 14 csv file is placed in the watershed description boxes. This may be accepted as-is or edited to any desired text. If no changes are made to the window, click the **No Changes (Close)** button. If any changes are made, click the **Accept Changes (Close)** button.
Figure 6-15: WinTR-20 Main Window after importing NOAA Atlas 14 data

There should be data in the three categories shown in figure 6-15: Rainfall Distribution, Storm Analysis, and WinTR-20 Identifier. After importing and smoothing the NOAA Atlas 14 data, an output file is generated which contains the original precipitation values and the smoothed values for each return period and duration. Click the View menu and select Smoothed NOAA/NRCC File to view this file.

Open the Rainfall Distribution data window. The Rain Table Identifier has a pull-down selection with the rain tables for the 1-year to 500-year storms. To view one of them, select it from the pull-down list. Press the Enter key. In this example, we are selecting the 10_yr_sm. The “sm” in the rainfall distribution name indicates it is based on smooth data.
Figure 6- 16: Rainfall Distribution window with 10-year rainfall distribution selected

Press the Enter key.

Figure 6- 17: Rainfall Distribution window with 10-year rainfall table shown
The time increment is 0.1 hours and the mass curve coordinates are in the table. To view the plot, click the **Display Data** button.

**Figure 6- 18: 10-year rainfall distribution plot**

The figure above shows the plot of the non-dimensional rainfall distribution mass curve for the 10-year storm. The advantage of developing a rainfall distribution for each return period is that the rainfall distribution accurately represents the original NOAA Atlas 14 data. For example, from the data table displayed in figure 6-5, the 10-year 60-minute rainfall is 2.07 inches and the 10-year 24-hour rainfall is 4.89 inches. By using the rainfall distribution plotted above, since the rainfall distribution is symmetrical about 12 hours, there will be 2.07 inches of rainfall between 11.5 and 12.5 hours. The entire storm will include 4.89 inches. The other storms from 1-year to 500-year may be viewed individually in the same way. Close the rainfall distribution plot and rainfall distribution data window.

Click **Storm Analysis** and the window in figure 6-19 opens.
The storms from 1-year to 500-year have been organized with the 24-hour rainfall in the Rain column. A rainfall distribution was developed for each return period based on the values in the NOAA Atlas 14 csv file for the 5-minute through 24-hour rainfall. The Rain Table Id is automatically entered. The 2-yr 24-hour rainfall is entered on the first line of the table in the last column. The sm in the Storm Id and the Rain Table Id indicate they are based on smooth data. If the precipitation data are not smoothed, the Storm Id would be 10_yr_stm and the Rain Table Id would be 10_yr_tbl for the 10-year storm, for example. The Gage Antecedent Runoff Condition (ARC) may be edited as desired.
Figure 6-20: Storm Analysis window with partial list of Rain Table Identifiers

The pull-down list of Rain Table Identifiers includes the 32 standard rainfall distributions included in the WinTR-20 software (Table 3.1) plus the 9 rainfall distributions developed based on the imported NOAA Atlas 14 data for the project location. It is possible to select any of these to use with any storm. However, the only alternative rainfall distribution appropriate for this location in Maryland is the Type NO_C which is a regional rainfall distribution that includes the central part of Maryland. The user is encouraged to visit the NRCS West National Technical Support Center (WNTSC) web site http://go.usa.gov/KoZ to obtain maps and other information regarding regional rainfall distributions developed based on NOAA Atlas 14 data.

The Storm Analysis window contains all storms from the 1-year to 500-year and WinTR-20 will run all these storms since they are entered here. If any storm is not to be run, the line in the table for that storm may be deleted. However, once it is deleted, it is difficult to bring it back as it will need to be entered by hand.

If no changes are made to the window, click the No Changes (Close) button. If any changes are made, click the Accept Changes (Close) button.

To complete the WinTR-20 dataset, enter appropriate Sub-Area, Reach, Cross Section, Global Output data, etc. Save the file and then Run.

Important Notes:

1. If the NOAA Atlas 14 csv file is opened using EXCEL spreadsheet software and saved, it will not import to the WinTR-20 program correctly. Saving the file using EXCEL will remove trailing zeros from the data values. For example 6.20 will be saved as 6.2. This will cause the values to be shifted
such that the values will not be in the expected columns of the data records. If any changes are to be made to the csv file, it is recommended to open it, edit it, and save it using NotePad, WordPad, or an equivalent text editor.

2. **Do not try to import NOAA Atlas 14 rainfall data into a WinTR-20 input file currently opened in the WinTR-20 Controller/Editor. All data in the Controller/Editor will be deleted and the NOAA Atlas 14 data substituted for it.** To import NOAA Atlas 14 data into an existing WinTR-20 input file, it is recommended to open a new file to include only the NOAA Atlas 14 data. Close WinTR-20. Copy and paste the NOAA Atlas 14 rainfall distributions and storm analysis data into the existing WinTR-20 input file using Notepad or an equivalent text editor. Be aware of the possible conflict of having two groups of Storm Analysis and/or Rainfall Distributions in the same data file. If there are two in the WinTR-20 input data file, one must be deleted or merged with the other before bringing that file into the WinTR-20 Controller/Editor.

3. The NOAA Atlas 14 csv files must be in English units.
Chapter 7 Import NRCC precipitation data

7.1 Introduction

The Northeast Regional Climate Center (NRCC), headquartered in Ithaca, NY, has published a precipitation frequency atlas for New York and the 6 New England states. This atlas replaces the NOAA and NWS documents TP-40, Hydro-35, and TP-49 for the states covered.

Previously, the NRCS standard design rainfall distributions Type I, Type IA, Type II, and Type III were developed for use with WinTR-20. Studies of the NRCC rainfall data have shown that these standard rainfall distributions do not accurately represent the relationship of rainfall intensity, duration, and frequency. For this reason, in the states covered by NRCC the recommended approach to using NRCC data with WinTR-20 is to obtain site-specific rainfall data at the intended project location directly from the NRCC web site. An option has been added to WinTR-20 that will develop a site-specific rainfall distribution based on the NRCC data for each frequency from 1-year through 500-year. This option has been used to develop regional rainfall distributions that may be used instead of the site-specific rainfall distributions. Technical information about these procedures may be found in Chapter 4 of NRCS NEH Part 630 Hydrology. The following instructions will illustrate how to obtain the data from the NRCC web site and import the data to WinTR-20 Version 3.10.

7.2 Obtaining rainfall-frequency data from the NRCC web site

Open the NRCC web site at http://www.precip.net/
Figure 7-1: NRCC web site Homepage

Much information is available at this web site. Select the **Data & Products** tab to open the interactive map to select a location and retrieve precipitation frequency data.

Under the **Select Products** Menu on the left side of the page, select the second item **Extreme Precipitation Tables – Text/CSV**.

The data file may be saved with the extension .txt or .csv. Both formats will import to WinTR-20. If the NRCC data file is opened using EXCEL spreadsheet software and saved, it will not import to the WinTR-20 program correctly. Saving the file using EXCEL will remove trailing zeros from the data values. For example 6.20 will be saved as 6.2. This will cause the values to be shifted such that the values will not be in the expected columns of the data records. If any changes are to be made to the data file, it is recommended to open it, edit it, and save it using NotePad, WordPad, or an equivalent text editor.
Use the hand icon and zoom feature to locate the project site (see figure 7-3). Click on the desired state or use the State/County pull-down menu to select a location.
The state of Massachusetts was selected for this example. Partial Duration series results may be obtained. In general, NRCS recommends partial duration data. The NRCC Converter program is designed to accept partial duration series.

Data may be requested in four different ways. One way is just to place the cursor (hand icon in figure 7-3) on the location where data are desired. Using the zoom feature on the top left of the map window allows for selection of a more accurate location of the project site. The second way is to enter an address in the Locate by Address box. A third way to obtain data is to enter a latitude and longitude (with longitude in positive degrees) for the project location. A fourth way is to select a State/County from the pull-down list on the top right corner of the window.

For this example, the hand icon was placed at the estimated project location. After double-clicking, the red push-pin symbol is placed at the selected point.
Figure 7-4: Requesting the NRCC data file for the selected location

To select the table to save as a text file, select Smoothing option No, and click the Submit button as shown in figure 7-4. The reason to select No smoothing is that when importing the data to WinTR-20 there is the opportunity to select the smoothing data option. A window similar to that shown in figure 7-5 allows the options to Open or Save the data file.

Figure 7-5: Option to open or save the file

Click Save and Save as to open a window to select a directory and enter a file name.
Figure 7-6: Select a directory and enter file name for the NRCC data file

The table saved in the figure above is named MASS_project_1.txt. It is comma delimited. After it is downloaded, it may imported to WinTR-20 and also be imported to an Excel spreadsheet for other types of analysis. Click Save.

Figure 7-7: Window indicating file is saved successfully

Close the window that is similar to the one shown in figure 7-7. Close the NRCC web page if finished with data retrieval.

Browse to the directory where the file is saved and open it with a text editor such as Notepad or WordPad.

Figure 7-8: Opened NRCC text file for project location
On the second line of the file, it indicates the data are unsmoothed. The file also includes a latitude and longitude. If a location were available from Google it would be stated as the Location. If a single number such as the 25-year 24-hour precipitation is desired, it may be recorded at this time. The complete table may be imported to WinTR-20, opened with spreadsheet software, or opened with a text editor.

7.3 Importing NRCC data into WinTR-20

The following steps show how to import the text file from NRCC into WinTR-20. **Do not try to import NRCC rainfall data into a WinTR-20 input file currently opened in the WinTR-20 Controller/Editor. All data in the Controller/Editor will be deleted and the NRCC data substituted for it.** To import NRCC data into an existing WinTR-20 input file, it is recommended to open a new file to include only the NRCC data.

![WinTR-20 System Controller / Editor](image)

Figure 7-9: Open WinTR-20 Controller/Editor window

Open WinTR-20. Click **File** and **Import NRCC Data** (see figure 7-10).
Figure 7-10: Select File and Import NRCC Data

Figure 7-11: Browse to locate the NRCC data file
Click the **Open** button. A small window opens to ask if data are to be smoothed (figure 7-12).

![WinTR-20 System](image)

**Figure 7- 12: Smooth data selection option**

The concepts used in data smoothing are included in a Help window shown in figure 3-7. The same procedures are used to smooth the NRCC data as were used with the NOAA Atlas 14 data. Clicking the **Yes** button to smooth the data is recommended. The next window to open is the WinTR-20 Identifier window (figure 7-13). The file name for the WinTR-20 input data is defined as the first part of the NRCC text file name with the extension as .inp. Information from the NRCC text file is placed in the watershed description boxes. This may be accepted as is or edited to any desired text. If no changes are made to the window, click the **No Changes (Close)** button. If any changes are made, click the **Accept Changes (Close)** button.

![WinTR-20 Identifier](image)

**Figure 7- 13: WinTR-20 Identifier window with NRCC Watershed Description**
There should be data in the three categories shown in figure 7-14: Rainfall Distribution, Storm Analysis, and WinTR-20 Identifier. After importing and smoothing the NRCC data, an output file is generated which contains the original precipitation values and the smoothed values for each return period and duration. Click the View menu and select Smoothed NOAA/NRCC File.

Open the Rainfall Distribution data window. The Rain Table Identifier has a pull-down selection with the rain tables for the 1-year to 500-year storms. To view one of them, select it from the pull-down list. Press the Enter key. In this example, we are selecting the 10_yr_sm. The sm in the rainfall distribution name indicates it is based on smooth data.
Figure 7- 15: Rainfall Distribution window with 10-year rainfall distribution selected

Press the Enter key to see the rainfall distribution table.

Figure 7- 16: Rainfall Distribution window with 10-year rainfall table shown
The time increment is 0.1 hours and the mass curve coordinates are in the table. To view the plot, click the Display Data button.

Figure 7-17: 10-year rainfall distribution plot

The figure above shows the plot of the non-dimensional rainfall distribution mass curve for the 10-year storm. This plot has been edited to show only the rainfall distribution line (not line and points) and the x-y grid. The advantage of developing a rainfall distribution for each return period is that the rainfall distribution accurately represents the original NRCC data. For example, from the data table displayed in figure 7-8, the 10-year 60-minute rainfall is 1.61 inches and the 10-year 24-hour rainfall is 4.56 inches. By using the rainfall distribution plotted above, since the rainfall distribution is symmetrical about 12 hours, there will be 1.61 inches of rainfall between 11.5 and 12.5 hours. The entire storm will include 4.56 inches. The other storms from 1-year to 500-year may be viewed individually in the same way. Close the rainfall distribution plot and rainfall distribution data window.

Click Storm Analysis and the window in figure 7-18 opens.
The storms from 1-year to 500-year have been organized with the 24-hour rainfall in the Rain column. A rainfall distribution was developed for each return period based on the values in the NRCC text file for the 5-minute through 24-hour rainfall. The Rain Table Id is automatically entered. The 2-yr 24-hour rainfall is entered on the first line of the table. The **sm** in the Storm Id and the Rain Table Id indicate they are based on smooth data. If the precipitation data are not smoothed, the Storm Id would be **10_yr_stm** and the Rain Table Id would be **10_yr_tbl** for the 10-year storm, for example. The **ARC** may be edited as desired.
The pull-down list of Rain Table Identifiers includes the 32 standard rainfall distributions included in the WinTR-20 software (Table 3.1) plus the 9 rainfall distributions developed based on the imported NRCC data for the project location. It is possible to select any of these to use with any storm. However, the only alternative rainfall distribution appropriate for this location in Massachusetts is the Type NR_D which is a regional rainfall distribution that includes the central part of Massachusetts. The user is encouraged to visit the NRCC West National Technical Support Center (WNTSC) web site: http://go.usa.gov/KoZ to obtain maps and other information regarding regional rainfall distributions developed based on NRCC data.

The Storm Analysis window contains all storms from the 1-year to 500-year and WinTR-20 will run all these storms since they are entered here. If any storm is not to be run, the line in the table for that storm may be deleted. However, once it is deleted, it is difficult to bring it back as it will need to be entered by hand.

If no changes are made to the window, click the No Changes (Close) button. If any changes are made, click the Accept Changes (Close) button.

To complete the WinTR-20 dataset, enter appropriate Sub-Area, Reach, Cross Section, Global Output data, etc. Save the file and then Run.

Important Notes:

1. **Do not try to import NRCC rainfall data into a WinTR-20 input file currently opened in the WinTR-20 Controller/Editor.** All data in the Controller/Editor will be deleted and the NRCC data substituted for it. To import NRCC data into an existing WinTR-20 input file, it is recommended to open a new file to include only the NRCC data. Close WinTR-20. Copy and paste the NRCC rainfall distributions and storm analysis data into the existing WinTR-20 input file using Notepad or an equivalent text editor. Be aware of the possible conflict of having two groups of Storm Analysis and/or Rainfall Distributions in the same data file. If there are two in the WinTR-20 input data file, one must be deleted or merged with the other before bringing that file into the WinTR-20 Controller/Editor.

2. The data file may be saved with the extension .txt or .csv. Both formats will import to WinTR-20. If the NRCC data file is opened using EXCEL spreadsheet software and saved, it will not import to the WinTR-20 program correctly. Saving the file using EXCEL will remove trailing zeros from the data values. For example 6.20 will be saved as 6.2. This will cause the values to be shifted such that the values will not be in the expected columns of the data records. If any changes are to be made to the data file, it is recommended to open it, edit it, and save it using NotePad, WordPad, or an equivalent text editor.
Chapter 8 Entering data to analyze Principal Spillway, Stability, and Freeboard Hydrograph Development

8.1 Introduction

The SITES Water Resource Site Analysis computer program version 2005.1.7 analyzes the hydrology and hydraulics for designs of typical NRCS dams and ponds according to NRCS design criteria. The program develops inflow hydrographs and uses the storage-discharge relationships at dam sites to flood route hydrographs through existing or potential reservoirs. Equivalent techniques used in SITES have been added to WinTR-20 to develop principal spillway, stability, and freeboard hydrographs for watersheds.

Inflow hydrographs may be actual historical data or the program may develop the hydrograph from design rainfall distributions. SITES is used in the design and proportioning of dams with floodwater features as well as to flood route historical or synthetic storms through existing dams and reservoirs and to predict or evaluate earth spillway performance. SITES also analyzes the stability and integrity of the auxiliary spillways of the structures under design with historical or simulated rainfall events.

WinDAM_B is a computer program that will analyze erosion on the dam itself as well as breaching of the structure. WinDAM_B does not develop hydrographs to route through the structure so WinTR-20 has been enhanced to develop these inflow hydrographs. In order to use WinTR-20 to generate hydrographs for WinDAM_B, WinTR-20 would first be applied to the watershed upstream of the site in question. This could be a single sub-area or a complex network including multiple sub-areas, reaches, structures, diversions, etc. The user should select hydrograph file output for appropriate sub-areas, reaches, and/or outlet in order to be able to import these hydrographs into WinDAM_B. The application of WinTR-20 in this way is covered in other chapters of this User Guide. Once WinTR-20 is set up for the watershed, additional data are required in order to generate hydrographs based on NRCS Technical Release 60 (TR-60) criteria. Input consists of two data windows; one for principal spillway hydrograph (PSH) data and the other for stability design hydrograph (SDH) and freeboard design hydrograph (FBH) data. The WinTR-20 input file may have PSH data, SDH / FBH data, or both. In other words, the PSH hydrograph may be developed separately in a separate WinTR-20 run from the SDH and FBH.

It is recommended that the user review TR-60 and NEH 630 - Chapter 21 to become familiar with the terminology and criteria used in this chapter. The PSH data and SDH / FBH data windows are described in Chapter 3 of this User Guide. This chapter includes more background information, modeling techniques, and more explanation of the various data variables. There are also notes on how the interface and software operate. WinTR-20 does a detailed check of input data before and during computations. Each variable has upper and/or lower limits where errors and warnings are generated. These are listed in Appendices B and C the WinTR-20 User Guide. For certain variables (not all), the limits are included in this chapter.

Example 9-5 in Chapter 9 of this User Guide includes use of PSH and SDH/FBH data to develop hydrographs. Several other brief examples are included in this chapter.

WinTR-20 will allow for input and output in both English and Metric units. Since WinDAM_B only allows English units as input, WinTR-20 generates an error message if the user tries to develop these hydrographs and asks for output in Metric units. However, Metric input may be used as input in the Principal Spillway
and Stability Freeboard Data windows. The Metric input data are converted to English units after they are read in. All internal computations in WinTR-20 are in English units.

8.2 Principal Spillway Data

Description: A brief description of the structure or project is required.

Climatic Index (Ci) and related input variables
The user may enter the Average Annual Precipitation (AAP) and temperature (AAT) and the WinTR-20 interface calculates and displays the Climatic Index (Ci) and Quick Return Flow (QRF) if Ci is greater than 1.0. If the Ci is greater than or equal to 1.0, the Channel Loss Factor data field must be blank. If the Ci is less than 1.0, the QRF data field must be blank. An error is generated if the user enters AAP, AAT, and Ci. In the following data descriptions, the English and Metric units are shown at the end of each data element definition.

Average Annual Precipitation: Optional entry. If entered, the AAT must be entered in inches or millimeters.

Average Annual Temperature: Optional entry. If entered, the AAP must be entered in degrees F or degrees C.

Climatic Index (Ci): Optional entry. If the user enters both the AAP and AAT, then Ci is computed. If AAP and AAT are blank, the user can enter a Ci. For Metric units input, the user must enter the AAP in mm and AAT in degrees C. The user gets an error if Ci is entered with Metric input. There is a Lookup table available for the user to select a Ci in English units for specific locations in the US.

Quick Return Flow: (QRF). Optional entry. Enter a value consistent with tables in TR-60 only if AAP, AAT, and Ci are blank. If blank and Ci is greater than 1.0, the QRF will be determined from TR-60 methods (cfs/sqmi or csm, cms/sqkm).

Channel Loss Factor: Optional entry. Enter value as a decimal number between 0.3 and 1.0. If the computed or entered Ci is less than 1.0, the user must enter a Channel Loss Factor. Chapter 21 of NRCS NEH Part 630 has a table for determining the Channel Loss Factor based on drainage area and Ci. There is a calculate option which allows the user to enter a drainage area (DA) and WinTR-20 calculates the Channel Loss Factor based on the entered Ci and entered DA. The DA should be entered for the location where the dam or proposed dam is situated. For a watershed divided into sub-areas and reaches, this means that the hydrographs generated for this WinTR-20 run will be applicable only at that location. If principal spillway hydrographs are desired at other locations in the watershed, each site needs to be run separately with its unique drainage area used to compute the Channel Loss Factor. The hydrograph values are multiplied by the Channel Loss Factor so a value of 1.0 results in no channel loss. A Channel Loss Factor of 0.3 results in 70% loss of volume. The user may enter QRF or Channel Loss Factor but not both. The Channel Loss Factor is a non-dimensional value and is the same in both English and Metric units.
Precipitation/Runoff and related input variables

**Principal Spillway Areal Correction Factor (1-Day):** Optional entry. Enter a value as a decimal number between 0.8 and 1.0. If blank, a default value of 1.0 will be used which assumes no areal correction of rainfall. The areal correction factor is non-dimensional with the same value in both English and Metric units. Areal Correction Factors are typically used if the drainage area is more than 10 square miles. For drainage areas less than or equal to 10 square miles a value of 1.0 is generally used or assumed.

**Principal Spillway Areal Correction Factor (10-Day):** Optional entry. Enter a value as a decimal number between 0.8 and 1.0. If blank, a default value of 1.0 will be used which assumes no areal correction of rainfall. The areal correction factor is non-dimensional with the same value in both English and Metric units. Areal Correction Factors are typically used if the drainage area is more than 10 square miles. For drainage areas less than or equal to 10 square miles a value of 1.0 is generally used or assumed.

The user must determine the design rainfall from TR-60 Table 2-2 before entering the data into WinTR-20. The user has the choice to enter P 1-Day, P 10-Day, and P 100-Yr 10-Day or enter Q 10-Day runoff volume and Q 1-Day/Q 10-Day Ratio. **Both rainfall and runoff input options are subject to the areal correction factors.** WinTR-20 has error checks built in which will display error messages for various combinations of data. Some of these are P 10-Day must be greater than P 1-Day and P 100-Yr 10-Day needs to be equal or greater than the P 10-Day. Q1/Q10 Ratio must be between 0.2 and 0.6.

**Precipitation 1-Day:** One day PSH design rainfall. Optional data entry. If P 1-Day is entered, then P 10-Day must be entered (inches, millimeters).

**Precipitation 10-Day:** Ten day PSH design rainfall. Optional data entry. If P 10-Day is entered, then P 1-Day must be entered. If P 10-Day is less than 6.0 inches then P 100-Yr 10-Day must be entered (inches, millimeters).

**P 100-Year 10-Day:** 100-Year ten day rainfall. Optional data entry. If P 10-Day is less than 6.0 inches then P 100-Year 10-Day must be entered (inches, millimeters).

**Q 10-Day:** Ten day runoff volume. Optional data entry. If Q 10-Day is entered, then Q1/Q10 Ratio must be entered. If P 1-Day and P 10-Day are blank, then Q 10-Day must be entered (inches, millimeters). Baseflow, if any, is assumed to be included in the ten day runoff volume value entered here. Baseflow values may be entered with Reach Data, but they will not cause an increase in peak discharge for any particular reach. If baseflow is entered for a particular reach, discharges on the rising and falling limbs of the hydrograph less than the baseflow value are increased to the baseflow value. Discharges above baseflow are not changed. Figure 8-1 illustrates this. The baseflow in figure 8-1 is 50 cfs. Where the hydrograph with no baseflow is not visible, it plots directly under the hydrograph with baseflow (the hydrograph values are the same).
Figure 8-1: PSH (runoff volume option) with and without baseflow

Q1-Day/Q10-Day Ratio: Ratio of one day runoff volume to 10 day runoff volume. Optional data entry. If Q 10-Day is entered, then Q1/Q10 Ratio must be entered. TR-60 has a map of the Q1/Q10 Ratio (non-dimensional value same in both English and Metric units).

2-Yr 24-Hr Rainfall: Optional entry. Since WinTR-20 will not allow both Storm Analysis and Principal Spillway Data, this value must be entered either with the PSH data or SDH/FBH data. It is required only if the user desires to use the built-in Tc calculator which computes travel times for sheet flow, shallow flow, and channel flow (inches, millimeters).

Example 8-1: Average annual precipitation, temperature, and areal corrections are entered. Climatic Index is greater than 1.0 (QRF left blank). 1-Day and 10-Day rainfalls are entered. 2-Yr 24-Hr Rainfall is entered. English units.
Example 8-2: Climatic Index greater than 1.0 is entered. No areal correction. 10-Day rainfall is less than 6 inches. 100-Year 10-Day precipitation of 8.1 inches is entered. 2-Yr 24-Hr Rainfall entered. English units.

Figure 8-2: Principal Spillway Hydrograph Data for Example 8-1

Figure 8-3: Principal Spillway Hydrograph Data for Example 8-2
Example 8-3: Channel Loss Factor of 0.95 is entered. No areal correction. 10-Day runoff and 1-Day/10-Day runoff ratio are entered. No 2-Yr 24-Hr Rainfall. English units.

**Figure 8-4: Principal Spillway Hydrograph Data for Example 8-3**

### 8.3 Stability Freeboard Data

#### General Information

**Description:** A brief description of the structure or project is required.

**Design Class:** Required entry. A pull-down list is available to select the design class of the structure being evaluated. The NRCS Design Classes **Low1, Low2, Low3, Sig** (Significant), and **High** hazard are available (see NRCS TR-60 for definitions). Design hydrographs can be generated by WinTR-20 for NRCS standard 378 ponds (2011) without using the PSH and SD/FB data windows. A design class **Other** has been added for those users not subject to NRCS design standards.

**Gage Rain Table Identifier for the Rainfall Distribution for SDH storm:** Optional entry. The user may open a pull-down menu that will allow selection of any standard or previously-entered rainfall distribution. The user has the option of entering a rainfall mass curve as the rainfall distribution before they enter SDH and FBH data. The rainfall distribution may be left blank for only one situation. If the user enters the set of 6 rainfalls (100-year and PMP), WinTR-20 will develop a 5-point 24-hour rainfall distribution table and use it to develop the SDH. One of the possible selections is the Type_B_6-hr rainfall distribution based on TR-60 Figure 2-4. The duration of the design storm is determined from the rainfall distribution table that has
been selected. Based on information in the NWS HMR publication series, design storm durations are typically between 6 and 72 hours.

**Gage Rain Table Identifier for the Rainfall Distribution for FBH storm:** Optional entry. The user may open a pull-down menu that will allow selection of any standard or previously entered rainfall distribution. The user has the option of entering a rainfall mass curve as the rainfall distribution before they enter SDH and FBH data. The rainfall distribution may be left blank for only one situation. If the user enters the set of 6 rainfalls (100-year and PMP), WinTR-20 will develop a 5-point 24-hour rainfall distribution table and use it to develop the FBH. One of the possible selections is the Type_B_6-hr rainfall distribution based on TR-60 Figure 2-4. The duration of the design storm is determined from the rainfall distribution table that has been selected. Based on information in the NWS HMR publication series, design storm durations are typically between 6 and 72 hours.

**Areal Correction Factor for Stability Design Hydrograph:** Optional entry. If a value is entered it must be between 0.5 and 1.0. If blank, the value will default to 1.0 which assumes no areal correction (non-dimensional value same in both English and Metric units). Areal Correction Factors are generally used if the drainage area is more than 10 square miles. For drainage areas less than or equal to 10 square miles a value of 1.0 is generally used or assumed.

**Areal Correction Factor for Freeboard Design Hydrograph:** Optional entry. If a value is entered it must be between 0.5 and 1.0. If blank, the value will default to 1.0 which assumes no areal correction (non-dimensional value same in both English and Metric units). Areal Correction Factors are generally used if the drainage area is more than 10 square miles. For drainage areas less than or equal to 10 square miles a value of 1.0 is generally used or assumed.

**Design Rainfall for Stability Design Storm:** Optional entry. This is directly related to the design class Other. If the user selects design class Other, then this data must be entered. If the user enters a value here, the set of 6 rainfalls (100-year and PMP) must be blank. For the user with a NRCS Design Class, the rainfall must be entered as the set of 6 rainfalls (inches, millimeters).

**Design Rainfall for Freeboard Design Storm:** Optional entry. This is directly related to the design class “Other”. If the user selects design class Other, then this data must be entered. If the user enters a value here, the set of 6 rainfalls (100-year and PMP) must be blank. For the user with a NRCS Design Class, the rainfall must be entered as the set of 6 rainfalls (inches, millimeters).

If the user enters a Low1, Low2, Low3, Sig, or High design class, enters the following set of 6 rainfall values, and leaves the rainfall distribution identifier blank, then WinTR-20 will develop a 5-point 24-hour rainfall table for each design storm based on the design rainfall developed from equations in TR-60 Table 2-5. It would be developed from the design rainfalls of 6, 12, and 24-hours. There would be a slightly different rainfall table for the SDH and FBH depending on the ratio of 6/24 and 12/24 hour rainfalls. These computed rainfall distributions are displayed in the output debug file (with file extension .dbg).

**Rainfall 100-Year 6-Hr:** From NOAA Atlas 14, TP-40, NOAA Atlas 2, or equivalent. Optional entry (inches, millimeters).
**Rainfall 100-Year 12-Hr:** From NOAA Atlas 14, TP-40, NOAA Atlas 2, or equivalent. Optional entry (inches, millimeters).

**Rainfall 100-Year 24-Hr:** From NOAA Atlas 14, TP-40, NOAA Atlas 2, or equivalent. Optional entry (inches, millimeters).

**Rainfall 6-Hr PMP:** From a NWS Probable Maximum Precipitation publication (such as HMR-51) where available. Optional entry (inches, millimeters).

**Rainfall 12-Hr PMP:** From a NWS Probable Maximum Precipitation publication (such as HMR-51) where available. Optional entry (inches, millimeters).

**Rainfall 24-Hr PMP:** From a NWS Probable Maximum Precipitation publication (such as HMR-51) where available. Optional entry (inches, millimeters).

**2-Yr 24-Hr rainfall:** Optional entry. Since WinTR-20 will not allow both Storm Analysis and Stability/Freeboard Data, this value must be entered either with the PSH data or SDH/FBH data. It appears in both the Principal Spillway and SD/ FB data because the user has the option to run either one and not necessarily both. If it is entered in Principal Spillway Data, it need not be entered here. If it is entered in both places and the values are different, an error message is generated and the run is completely stopped. It is required only if the user desires to use the built-in $T_c$ calculator which computes travel times for sheet flow, shallow flow, and channel flow method (inches, millimeters).

Example 8-4: **High** hazard design class, Type B 6-hour storm, areal corrections, set of six rainfalls, 2-yr 24-hour rainfall. English units.

![Stability/Freeboard Hydrograph Data](image)

**Figure 8-5: Stability/Freeboard Hydrograph Data for Example 8-4**
Example 8-5: **Significant** (Sig) design class and set of 6 rainfalls. No areal correction. No 2-Yr 24-Hr Rainfall. 5-point 24-hour rainfall distribution developed by WinTR-20. English units.

Figure 8-6: Stability/Freeboard Hydrograph Data for Example 8-5

Example 8-6: **Other** design class, areal corrections, design rainfall for SD and FB hydrographs, 2-yr 24-hour rainfall. User-entered rainfall distributions named Dist_SD and Dist_FB. These rainfall distributions were entered in the Rainfall Distribution data window prior to being selected to use with the SDH and FBH storms. These distribution mass curves may have any appropriate duration and shape. English units.
8.4 Principal Spillway and Stability Freeboard Operational Details

The following notes address detailed concerns involved in using WinTR-20 to generate design hydrographs for WinDAM_B.

1. Areal correction values apply to the drainage area at the structure site being evaluated, even though the watershed upstream of the site may be divided into several sub-areas and reaches and the watershed downstream of the site may be included in the WinTR-20 data. If hydrographs at additional sites within the watershed are to be developed, a separate WinTR-20 data file will need to be saved with areal corrections based on the drainage area of the site being evaluated. However, if there are no areal corrections of rainfall (the entire watershed is less than or equal to 10 square miles), the user may select hydrograph output at any location in the watershed where a potential structure site is located.

2. If the watershed is analyzed as a single sub-area, then the hydrograph at the outlet of the watershed may be saved and imported to WinDAM_B. Since base flow is not recognized in sub-area hydrograph generation, if the user desires to have base flow included in the design hydrograph, then a reach must be entered downstream of the sub-area. If there are reaches in the watershed, see note 3 below.
3. The WinTR-20 hydrograph file output (with hydrographs formatted for import to WinDAM_B) includes hydrographs at the sub-areas, downstream end of reaches, and at the outlet. Hydrographs at the upstream end of reaches are not included in the hydrograph file output. If the user selects hydrograph file output from the **Global Output** window, hydrographs at all sub-areas and/or reaches are saved. The other option is to select individual sub-areas and reaches where hydrograph file output is to be saved. It is strongly recommended to define a sub-area in WinTR-20 such that the sub-area outlet is at the proposed or existing structure site. In this way, the correct drainage area may be accumulated to the site being evaluated. If the user desires to enter base flow, a Reach downstream of the watershed must be entered along with the reach, base flow, and cross section data. The user can insert a dummy reach just below the site (with reach length 1 foot) in order that the downstream hydrograph from the reach is identical to the hydrograph at the upstream end of the reach. It is the user's responsibility to know which of the hydrographs in the hydrograph file output is the correct one to import to Windam B.

4. Design hydrographs for NRCS standard 378 ponds may be generated with WinTR-20 without entering Principal Spillway and/or Stability/Freeboard Data. A tutorial on the WNTSC web site [http://go.usa.gov/KoZ](http://go.usa.gov/KoZ) shows how to generate 378 design hydrographs with WinTR-20.

5. The user may set up a WinTR-20 input data file with only Principal Spillway Data, with only Stability/Freeboard Data, or with both Principal Spillway and Stability/Freeboard Data. For example, the user can set up the data to run a Principal Spillway storm (10-Day storm) and Stability/Freeboard Data to run the 6-hour design storm. A second data set can be set up to run the Stability/Freeboard Data for the 24-hour design storm. The user need only run the Principal Spillway storm once so the second design run may have only the SDH and FBH data entered.

6. The Type B storm from TR-60 is treated with a fixed duration of 6 hours. The Type B 6-hour distribution is included as a standard rainfall distribution selection from the pull-down list. The user also has the opportunity to enter a table in the Rainfall Distribution data window for use with SDH and FBH storms.
Chapter 9 Working with Projects: Examples 9-1 to 9-5

The City of Spring Valley, Minnesota has a flooding problem. From a preliminary water surface profile analysis, significant flooding occurs when discharges exceed 5000 cfs upstream of the city. The City would like protection from flooding for up to the 100-year event. An upstream reservoir has been proposed to reduce the peak discharges.

The watershed upstream of the city has a total drainage area of 8,806 acres (13.76 square miles). For this hydrologic analysis, the watershed is broken down into eight (8) sub-areas. Four (4) reaches are used for connecting the sub-areas and channel/storage routing. A plan view of the City of Spring Valley watershed is shown in figure 9-1.

**Spring Valley Watershed WinTR-20 Sub-Area / Reach Layout**

![Spring Valley Watershed WinTR-20 Sub-Area / Reach Layout](image)

**Figure 9-1: Plan View of City of Spring Valley Watershed**

Five Win-TR20 models will be developed to illustrate usage of the program:

**Single Sub-Area Model (Example 9-1)** – This example will illustrate how to set up the simplest model which contains a single watershed without reaches at the upstream tributary of the watershed. Time of concentration (Tc) and Runoff Curve Number (RCN) will be determined using the built-in calculation option which uses basic physical data of the Sub-Area (flow lengths/roughness for Tc and land use/soils for RCN).

**Entire Upstream Watershed Model (Example 9-2)** – This is a model of the entire watershed upstream of the City. The watershed will be comprised of 8 sub-areas and 4 reaches. The rating curves for the reaches were developed using HEC-RAS. This is considered the Present Condition Model.

**Entire Upstream Watershed – With Reservoir in Model (Example 9-3)** – This is a model of the entire watershed upstream of the City with the proposed reservoir in place. The rating curve for the structure is based on a two-stage riser design. A second dimensionless unit hydrograph (DUH) is entered into the model and run to show the effects of a different DUH on the results.
Part of Watershed - With Diversion in Place Model (Example 9-4) – Import NOAA Atlas 14 data and use input hydrograph. This is a model of part of the watershed upstream of the City with a proposed diversion in place. This example will illustrate the ability to divert some flow from the main stream out of the watershed.

Principal spillway and freeboard routing for design of structure at a location (Example 9-5). Develop principal spillway, stability, and freeboard design hydrographs to be used for the design of the proposed structure. These hydrographs will be used by other software to set the elevation of the auxiliary spillway, analyze the stability of the auxiliary with respect to erosion, and set the top of dam elevation.

Note: These examples emphasize the set up, running, and obtaining and viewing output. It is not the intent of these examples to provide detailed descriptions of input sources, design of structures, theory of hydrologic processes, and interpretation of output. Thus, discussion of these subjects is very limited.

Example 9-1: Determining Runoff from a Single Sub-Area Model with Minimum Data

Background

The City of Spring Valley, located in Fillmore County in southeastern Minnesota has a flooding problem. From a preliminary water surface profile analysis, significant flooding occurs when discharges exceed 5,000 cfs just upstream of the city. The City would like protection from flooding for up to the 100-year event. An upstream reservoir has been proposed to reduce the peak discharges. This example illustrates the model set up of sub-area 001, the furthest upstream tributary of the Spring Valley watershed. This will illustrate the setup of the simplest type of model – a single watershed without reaches. Time of concentration (Tc) and Runoff Curve Number (RCN) will be determined using the built-in calculation option which uses basic physical data of the sub-area (flow lengths/roughness for Tc and land use/soils for RCN).

Solution

Determine the peak discharge and runoff volume for sub-area 001 for the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year storms. The rainfall values are those from the NOAA Atlas 14 recommended for use in the county conservation projects and the rainfall distribution is the Type MSE3 developed from the NOAA Atlas 14 data. Check in the Minnesota State Supplement for EFH-2 (2013, draft) for Fillmore County and find the values for the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year storms to be 3.02 inches, 3.81 inches, 4.56 inches, 5.72 inches, 6.73 inches, and 7.83 inches respectively.

Win-TR20 Data Entry

Step 1: To get started, double click the WinTR20 icon. This will bring up the main Win-TR20 System Controller/Editor window. The disclaimer window should appear as shown in figure 9-2. To start a new project, go to the File menu on the disclaimer window and select New WinTR-20 File, as shown in figure 9-3.
Figure 9-2: WinTR-20 System Controller / Editor window

Figure 9-3: WinTR-20 File menu in WinTR-20 System Controller / Editor window
This will bring up the **WinTR-20 Identifier: window**, as shown in figure 9.4. Keep the default English Input and Output Units. Set the minimum hydrograph value to 1.0 cfs then enter a description for your model, details given in table 9.1. Select **Accept Changes (Close)** button to continue.

### Table 9-1: Watershed Description in WinTR-20 Identifier window

<table>
<thead>
<tr>
<th>Variable</th>
<th>Default / Enter Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Units Code:</td>
<td>Default to English</td>
</tr>
<tr>
<td>Output Units Code:</td>
<td>Default to English</td>
</tr>
<tr>
<td>Minimum Hydrograph Value:</td>
<td>1.0 cfs</td>
</tr>
<tr>
<td>Watershed Description:</td>
<td>Example 9-1 – Sub-area 001</td>
</tr>
<tr>
<td></td>
<td>Upstream Tributary of Spring Valley Watershed</td>
</tr>
</tbody>
</table>

![WinTR-20 Identifier window](image)

**Figure 9-4: WinTR-20 Identifier window**
Storm Analysis Entry

Step 2: Next, select Storm Analysis: from the WinTR-20 main window to enter rainfall amounts, distribution, and antecedent runoff condition. The Storm Analysis: window will appear as shown in figure 9-5.

![Storm Analysis Window]

Figure 9- 5: Storm Analysis window

Type in 2-year for the Storm Identifier: text box. Rain Gage Identifier: can be left blank if all the sub-areas within the model use the same rainfall amount and distribution, which these examples do. Enter 3.02 inches for Gage Rainfall; click on the arrow on the text box of Gage Rain Table Identifier: then select Type MSE3 from the pull down menu; enter 3.02 inches for the 2-Yr 24-Hr Rainfall1; as shown in figure 9-6. The Gage Starting Time may be left blank to default to a value of 0.0. The Gage Antecedent Runoff Condition: defaults to 2 but may be changed to 1 or 3. For this example, leave the ARC with a value of 2.

---

1 This entry is only used in Tc Velocity calculations. Sheet flow calculations require a 2-yr rainfall amount. For models with multiple storm analysis, this entry is only required on the first storm. If Tc is entered directly for all sub areas (Tc Velocity not used), this 2-yr rainfall amount is not a required entry.
Figure 9-6: Storm Analysis – 2-year Storm

To enter the remaining storms, simply place the cursor over the Storm Identifier: text box and type in the next storm identifier name (5-year, 10-year, etc.); details given in Table 9-2. Note that when you place the cursor in the Storm Identifier: text box, the previous storm’s name remains highlighted until you type in the new name and click Enter. After all storms have been entered, the Storm Analysis: window should look like Figure 9-7:

Table 9-2: Storm Details

<table>
<thead>
<tr>
<th>Storm Identifier</th>
<th>Gage Rainfall (inch)</th>
<th>Gage Rain Table Identifier:</th>
<th>Gage Antecedent Runoff Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-year</td>
<td>3.02</td>
<td>Type MSE3</td>
<td>2</td>
</tr>
<tr>
<td>5-year</td>
<td>3.81</td>
<td>Type MSE3</td>
<td>2</td>
</tr>
<tr>
<td>10-year</td>
<td>4.56</td>
<td>Type MSE3</td>
<td>2</td>
</tr>
<tr>
<td>25-year</td>
<td>5.72</td>
<td>Type MSE3</td>
<td>2</td>
</tr>
<tr>
<td>50-year</td>
<td>6.73</td>
<td>Type MSE3</td>
<td>2</td>
</tr>
<tr>
<td>100-year</td>
<td>7.83</td>
<td>Type MSE3</td>
<td>2</td>
</tr>
</tbody>
</table>
Figure 9- 7: Storm Analysis window

Click the Accept Changes (Close) button to return to the main window.

Sub-Area Data Entry

Step 3: At this point, you are returned to the main window. Notice that the Storm Analysis: line is now checked (X), as shown in figure 9-8. A check by any of these lines indicates that some data records now exist for that item. From this same menu, select Sub-Area: to enter drainage area, runoff curve number (RCN), and time of concentration (Tc) for a sub-area, as shown in figure 9-9.
Let’s call this sub-area 001. Enter this into the **Sub-Area Identifier:** field of the Sub-Area window and press return. The next piece of data needed is the name of the reach that the sub-area flows into. This will be entered into the **Sub-Area Reach Identifier:** field. The last outflow point of any WinTR20 model, either with a singular sub-area or one with many sub-areas and reaches, is always designated as **Outlet.** Enter **Outlet** in the **Sub-Area Reach Identifier:** field, as shown in figure 9-9.

Notice that when the sub-area name 001 was entered three new buttons popped up – **Land Use Details, Tc Velocity,** and **Tc Lag.** The user has the choice of entering an RCN directly or using the **Land Use Details** window to enter the Land Use by Hydrologic Soil Group and letting the program calculate the weighted curve number. Time of Concentration (Tc) may be calculated by either the Velocity Method or the Lag Method or entered directly. Click either Tc button and enter the appropriate information and let the program calculate the Tc. For this example, we will have the program calculate both from basic data given in table 9-3 and table 9-4.
Figure 9- 9: Sub-Area window

When the **Land Use Details** button is selected, the **Land Use Details**: window will appear, as shown in figure 9.10. You will enter the land use area drainage area based on the land use / hydrologic soil group details given in table 9-3. As you are entering the land use drainage area, the program will calculate the accumulated drainage area and sub-area weighted curve number. Note the summary of table information result shown at the bottom of **Land Use Details**: window: the accumulated drainage area is 3.73 square miles with a sub-area weighted curve number of 76.8, as shown figure 9.10.

**Table 9- 3: Land Use Area**

<table>
<thead>
<tr>
<th>Land Use Area Identifier</th>
<th>Hydrologic Soil Group</th>
<th>Area (sq. mi.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Row Crop (SR – Poor)</td>
<td>B</td>
<td>0.48</td>
</tr>
<tr>
<td>Row Crop (SR + CR - Poor)</td>
<td>B</td>
<td>1.27</td>
</tr>
<tr>
<td>Row Crop (SR + CR - Good)</td>
<td>B</td>
<td>1.27</td>
</tr>
<tr>
<td>Row Crop (C + CR - Good)</td>
<td>B</td>
<td>0.34</td>
</tr>
<tr>
<td>Pasture (Fair)</td>
<td>B</td>
<td>0.37</td>
</tr>
</tbody>
</table>
Figure 9-10: Land Use Areas window

Select the **Return to Sub-Area** button. This will bring you back to the main Sub-Area window. Click **Tc Velocity** button to open **Time of Concentration – Velocity Method:** window and enter the appropriate data given in table 9-4 to compute the sub-area time of concentration. After the data have been entered you should see a window similar to what is shown figure 9-11 below:

### Table 9-4: Time of Concentration Details

<table>
<thead>
<tr>
<th>Flow Type</th>
<th>Length (ft)</th>
<th>Slope (ft/ft)</th>
<th>Flow Surface</th>
<th>Velocity (ft/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheet Flow</td>
<td>100</td>
<td>0.04</td>
<td>D Cultivated &gt; 20% residue cover</td>
<td></td>
</tr>
<tr>
<td>Shallow Concentrated</td>
<td>3100</td>
<td>0.004</td>
<td>Unpaved</td>
<td></td>
</tr>
<tr>
<td>Channel</td>
<td>13300</td>
<td></td>
<td></td>
<td>2.00</td>
</tr>
</tbody>
</table>

---

2 Since Sheet Flow is a function of the 2-year precipitation amount, the time for this component of the Tc will not show up unless that precipitation amount is entered within the Storm Analysis input window.
The 2-Yr 24-Yr Rainfall value was entered in the Storm Analysis window and is shown in the Tc Velocity window. It is used to calculate the travel time for sheet flow. When you return back to the Sub-Area window, the Land Use Details and Tc Velocity buttons appear (as shown in figure 9.12). When data are entered directly, both buttons would disappear.
Figure 9-12: Sub-Area window with complete data

The output options are also available. Any output option selected here would apply only to that sub-area. To apply the same output options to all sub-areas and reaches, Global Output would be used. This will be covered next.

Select the Accept Changes (Close) button to return to the main window.

Setting Output Options

Step 4: The last data entry step before running this example is setting the output options. Output options can be set in two places: 1) within Sub-Area for the individual sub-area, as shown in figure 9-12), or within the Global Output window, as shown in figure 9-13. Using Global Output results in the same output option for ALL sub-areas and stream reaches. For this example, we will use Global Output. Select Global Output: from the main window. For this first run, enter 1 for Hydrograph Print Precision:, enter 1.0 cfs for Minimum Hydrograph Display Flow:, enter 0.25 hr for Print Time Increment:, and select Default Peak Output Code: to Yes for the Sub-Area. This results in the cleanest, most readable output. If you plan on using the hydrograph plotting option, you must select the Hydrograph Output Code: either within the Global Output or in the sub-area or reach where you want to make the plot. Unfortunately this can produce excessive output in the printed output page since the hydrographs are displayed in tabular format between peak flow calculations.
Select Accept Changes (Close) button to return to the WinTR-20 main window.

Saving, Viewing Schematic, Viewing Input, Running the Model

**Step 5:** Before the user can run the model, the input file must be saved. To save the data, click **File** and **Save As** from the WinTR-20 main window. Give the file an identifiable name and place it in the desired directory (such that the file name including the path is 80 characters or less). Once the file is saved, the **View** and **Run** options appear at the top of the WinTR-20 window, as shown in figures 9-14 and 9-15. **View** allows the user to look at the watershed schematic and the input file in an ASCI format. A schematic view is applicable only to watersheds with one or more reaches so this option does not apply to this example (see Example 9-2 for an example of a schematic plot). The input file for this particular example is viewable and is shown below in figure 9-16.
Figure 9-14: WinTR-20 Main window

Figure 9-15: WinTR-20 Main window – View menu
To run the model simply select Run from the WinTR-20 main window.

Output – Printed Page

Step 6: Following a successful run, the WinTR-20 Printed Page File window containing the output will appear, as shown in figures 9-17 and 9-18.
Figure 9- 17: Example 9-1- WinTR-20 Printed Page File, Input data list

The first part of WinTR-20 Printed Page File includes a listing of the input data. After that, output displays Area or Reach Identifier, Drainage Area, Runoff Amount, Time of Peak, and Peak Discharge for each Sub-Area by Storm. For this example, output for sub-area 001 is shown along with the Outlet. Since this particular model only has one sub-area without any reaches, the results for these two locations will be same (sub-area 001 peak equals outlet peak), as the details in table 9-5 show.
Table 9-5: Example 9-1 – Output

<table>
<thead>
<tr>
<th>Area or Reach Identifier</th>
<th>Storm Identifier</th>
<th>Drainage Area (sq. mi)</th>
<th>Runoff Amount (in)</th>
<th>Peak Flow Rate (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2-year</td>
<td>3.73</td>
<td>1.072</td>
<td>13.94</td>
</tr>
<tr>
<td></td>
<td>5-year</td>
<td>3.73</td>
<td>1.649</td>
<td>13.94</td>
</tr>
<tr>
<td></td>
<td>10-year</td>
<td>3.73</td>
<td>2.242</td>
<td>13.98</td>
</tr>
<tr>
<td></td>
<td>25-year</td>
<td>3.73</td>
<td>3.215</td>
<td>13.91</td>
</tr>
<tr>
<td></td>
<td>50-year</td>
<td>3.73</td>
<td>4.101</td>
<td>13.87</td>
</tr>
<tr>
<td></td>
<td>100-year</td>
<td>3.73</td>
<td>5.094</td>
<td>13.90</td>
</tr>
<tr>
<td><strong>Outlet</strong></td>
<td>2-year</td>
<td>3.73</td>
<td>1.072</td>
<td>13.94</td>
</tr>
<tr>
<td></td>
<td>5-year</td>
<td>3.73</td>
<td>1.649</td>
<td>13.94</td>
</tr>
<tr>
<td></td>
<td>10-year</td>
<td>3.73</td>
<td>2.242</td>
<td>13.98</td>
</tr>
<tr>
<td></td>
<td>25-year</td>
<td>3.73</td>
<td>3.215</td>
<td>13.91</td>
</tr>
<tr>
<td></td>
<td>50-year</td>
<td>3.73</td>
<td>4.101</td>
<td>13.87</td>
</tr>
<tr>
<td></td>
<td>100-year</td>
<td>3.73</td>
<td>5.094</td>
<td>13.90</td>
</tr>
</tbody>
</table>

To view the summary table on the WinTR-20 Printed Page File, the user must scroll down to the bottom of the WinTR-20 Printed Page File. The summary table which lists only peak discharge (cubic feet per second) by storm, as details in table 9-6 show.

Table 9-6: Example 9-1 – Results Summary Table

<table>
<thead>
<tr>
<th>Storm Identifier</th>
<th>Peak Discharge (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-year</td>
<td>692.7</td>
</tr>
<tr>
<td>5-year</td>
<td>1095.8</td>
</tr>
<tr>
<td>10-year</td>
<td>1508.0</td>
</tr>
<tr>
<td>25-year</td>
<td>2185.6</td>
</tr>
<tr>
<td>50-year</td>
<td>2798.3</td>
</tr>
<tr>
<td>100-year</td>
<td>3477.5</td>
</tr>
</tbody>
</table>

Note: The WinTR-20 Printed Page File is also automatically saved as a *.out file (* = input file name prefix) which can be brought into MS-Word, Notepad, etc. for printing or insertion into other project documents. It is saved to the same directory as the input file.

Plotting a Hydrograph

**Step 7:** To view a hydrograph plot at a particular location, the hydrograph output code for that location must be set to Yes. For this example, go back into the Global Output: window and set the hydrograph output code for Sub-Areas to Yes and then select the Accept Changes (Close) button to return to the WinTR-20 main window. Notice that the Run option on the main menu bar is not shown. Since a change to the file was made (Global Output hydrograph now requested), the new input must be saved before the Run option appears. Select File then Save As from WinTR-20 main...
window and then **Run**. After the model runs, note that the **WinTR-20 Printed Page File** now contains a tabular hydrograph for each storm, as shown in figure 9-18.

![WinTR-20 Printed Page File](image)

**Figure 9-18: Example 9-1 – WinTR-20 Printed Page File window**

After closing the **WinTR-20 Printed Page File** window select **Plots** on the WinTR-20 System main window menu. Once in the **Graphics Output** window, use the drop down menus to select the 25-year storm and sub-area 001 from the Storm and Sub-Area choices respectively. The **Graphics Output** window should look like figure 9-19.
Select the **Display** button to view the hydrograph plot for the 25-year at sub-area **001**, as shown on figure 9-20.
Multiple plots (storms or locations) can also be viewed. After closing out of the 25-year storm display and going back to the Graphics Output: window, select Storm to the right of Multiple Hydrographs. Directly below, in the pull-down menu to the right of Storm, select the storms you would like to view by highlighting the storm name and pressing the Enter key. This action places each selected storm name in the Multiple Storms window located in the lower right, as shown in figure 9-21. Selecting the Display button now should show all the selected storm hydrographs. For this example, we have selected the 2-year, 10-year, and 25-year events, as shown in figure 9-21 and figure 9-22.

![Multiple Hydrographs and Storm Selection](image)

**Figure 9-21: Example 9-1- Selected Multiple Storms window**
On Figure 9-22, notice that the hydrographs are plotted as lines with points instead of lines and a plotted grid is shown. These were selected by opening the Edit menu at the top of the plot window.

Results

The 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year storm events were analyzed and peak discharges and runoff volume obtained for sub-area 001. The WinTR-20 Printed Page File contains a listing of peak discharges and runoff volume for sub-area 001. See figure 9-23 and table 9-7. The peak discharges for all the storms were less than 3,500 cfs.
Figure 9-23: WinTR-20 Printed Page File window

Table 9-7: Example 9-1 – Results

<table>
<thead>
<tr>
<th>Storm Identifier</th>
<th>Peak Discharge (cfs)</th>
<th>Runoff Amount (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-year</td>
<td>692.7</td>
<td>1.072</td>
</tr>
<tr>
<td>5-year</td>
<td>1095.8</td>
<td>1.649</td>
</tr>
<tr>
<td>10-year</td>
<td>1508.0</td>
<td>2.242</td>
</tr>
<tr>
<td>25-year</td>
<td>2185.6</td>
<td>3.215</td>
</tr>
<tr>
<td>50-year</td>
<td>2798.3</td>
<td>4.101</td>
</tr>
<tr>
<td>100-year</td>
<td>3477.5</td>
<td>5.094</td>
</tr>
</tbody>
</table>
Example 9-2: Entire Upstream Watershed Model

Background

The City of Spring Valley, located in Fillmore County in southeastern Minnesota, has a flooding problem. From a preliminary water surface profile analysis, significant flooding occurs when discharges exceed 5,000 cfs just upstream of the city. The City would like protection from flooding for up to the 100-year event. This example illustrates the model of the entire watershed upstream of the city. The watershed will be comprised of 8 sub-areas, 4 reaches, and the rating curves for the reaches were developed using HEC-RAS.

Solution

Determine the peak discharge and runoff volume for the entire watershed above the city for the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year floods with the present conditions.

WinTR-20 Data Entry

Step 1: For this example, we build upon Example 9-1 to include all the sub-areas and reaches for the entire watershed. Start the WinTR-20 Program and open the Open Existing WinTR-20 File and locate the Example_9-1.inp file. Alternatively, selecting File and ReOpen Last Session would open the file if it was used when WinTR-20 was opened previously.

Step 2: Edit the Watershed Description to Example 9-2 – Comprised of 8 Sub-areas and 4 Reaches. Click on the Accept Changes (Close) button to accept the changes and return to WinTR-20 Main Window. Now would be a great time to save your data. To save the data, click File and SaveAs. In the Save WinTR-20 file popup window, specify a location and the new file name Example_9-2 and click “Save”. The data is saved, the popup window closes and the “WinTR-20 Main Window” is redisplayed.

Sub-Area Data Entry

Step 3: Click on Sub-Area: from the WinTR-20 Main Window to open the Sub-Area: window. In the Sub-Area: window, edit and enter the Sub-Areas, Sub-Area Reach, Drainage Area, Weighted Curve Number, and Time of Concentration as appropriate details given in table 9-8, and click Accept Change (Close) button to accept the changes and return to WinTR-20 Main Window. Note: The Sub-Area 001 no longer has Outlet as its downstream receiving reach. We need to change the Sub-Area Reach Identifier from Outlet to R01 as shown in table 9-8 and figure 9-24.
Table 9- 8: Sub-Areas Data

<table>
<thead>
<tr>
<th>Sub-Area Identifier</th>
<th>Sub-Area Reach Identifier</th>
<th>Drainage Area (sq. mi)</th>
<th>Weighted Curve Number</th>
<th>Time of Concentration hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>R01</td>
<td>From Example 9-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>003</td>
<td>R02</td>
<td>1.90</td>
<td>72</td>
<td>2.30</td>
</tr>
<tr>
<td>005</td>
<td>R02</td>
<td>0.94</td>
<td>70</td>
<td>1.77</td>
</tr>
<tr>
<td>007</td>
<td>R03</td>
<td>2.27</td>
<td>80</td>
<td>2.76</td>
</tr>
<tr>
<td>009</td>
<td>R04</td>
<td>0.88</td>
<td>76</td>
<td>1.99</td>
</tr>
<tr>
<td>011</td>
<td>R04</td>
<td>2.29</td>
<td>73</td>
<td>2.50</td>
</tr>
<tr>
<td>013</td>
<td>Outlet</td>
<td>0.38</td>
<td>81</td>
<td>0.98</td>
</tr>
<tr>
<td>015</td>
<td>Outlet</td>
<td>1.37</td>
<td>79</td>
<td>2.03</td>
</tr>
</tbody>
</table>

Figure 9- 24: Sub-Area 001 window

After changing the highlighted Sub-Area Identifier: text box from 001 to 003, enter the remainder of the information for sub-area 003 as shown in figure 9-25. Note that Sub-Area Rain Gage Identifier: is left blank. This field would only be used if the watershed analysis uses different rainfall amounts or distributions between sub-areas. Since this example will be using uniform rainfall and the NOAA Type MSE3 Distribution for the entire watershed, no entry is required. Note: As the entry for each sub-area is completed, the list within the drop down text boxes grows to include new sub-areas and reaches, as shown in figure 9-26 and figure 9-27.
Figure 9-25: Sub-Area 003 window

Figure 9-26: All Sub-Area Identifiers
Upon completion of the data, click **Accept Changes (Close)** button to accept the data and return to the WinTR-20 Main Window.

**Reach Data Entry**

**Step 4:** Click on **Stream Reach:** to open the **Stream Reach:** window. Within the stream reach window, the following information will be provided for each reach:

- The name of the downstream reach that receives this reach’s flow.
- If this is a “channel routing” reach, the name of the cross section rating curve associated with this reach and the channel and floodplain distances.
- If this is a “structure routing” reach, the name of structure rating curve associated with this reach.
- Base flow, if any, to add to this reach’s hydrograph.

Note: The split flow options shown to the bottom right of the **Stream Reach:** window are only used when the model includes diverting flows. This tells the program that flow is diverted out of a reach. For this example, the split flow fields will be left blank.

If you had entered reach names during the sub-area entry above, all these names should appear in the drop down menu next to the **Stream Reach Identifier:** window. Use this to highlight the reach you want to enter data for\(^3\). The stream reach data details are given in table 9-9 below.

---

\(^3\) If you had decided to enter all your reach information before sub-area entry, the names will not automatically appear in this drop down menu and you will have to enter the names directly into the reach identifier window.
Table 9-9: Stream Reach Data

<table>
<thead>
<tr>
<th>Stream Reach Identifier</th>
<th>Stream Receiving Reach Identifier</th>
<th>Stream Cross Section Rating Name</th>
<th>Reach Channel Length (ft)</th>
<th>Reach Valley Length (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R01</td>
<td>R02</td>
<td>DF-6</td>
<td>6,870</td>
<td>5,350</td>
</tr>
<tr>
<td>R02</td>
<td>R03</td>
<td>LB-4</td>
<td>12,130</td>
<td>10,560</td>
</tr>
<tr>
<td>R03</td>
<td>R04</td>
<td>LB-4</td>
<td>4,220</td>
<td>3,970</td>
</tr>
<tr>
<td>R04</td>
<td>Outlet</td>
<td>LL-31</td>
<td>4,260</td>
<td>3,800</td>
</tr>
</tbody>
</table>

Enter the data for each of the four reaches. The data entry for reach R01 should appear as shown in figure 9-28.

Figure 9-28: Stream Reach data window

Cross Section Rating Data Entry

Step 5: Next, we need to enter the stream cross section rating table with elevation, discharge, end area, top width, and energy grade slope for each stream routing reach. Click on Stream Cross Section: from the WinTR-20 Main Window to open the Stream Cross Section: window. Note: This information is developed outside of the WinTR-20 program using uniform flow relationships (i.e. Manning’s Equation) or a non-uniform open channel hydraulics model (i.e. HEC-RAS). Note:
For this example, the data for the four reaches were determined using an HEC-RAS model. The ratings for the reaches are details given in the tables 9-10, 9-11, and 9-12 respectively (bankfull elevation in bold\textsuperscript{4}). Recall that both reaches R02 and R03 both use the same stream cross section rating (LB-4).

### Table 9- 10: Stream Cross Section DF-6 Data

<table>
<thead>
<tr>
<th>Elevation (ft)</th>
<th>Discharge (cfs)</th>
<th>End Area (ft(^2))</th>
<th>Top Width (ft)</th>
<th>Energy Grade Slope (ft/ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1321.7</td>
<td>0.</td>
<td>0.</td>
<td>0.</td>
<td>0.00020</td>
</tr>
<tr>
<td>1323.7</td>
<td>28.</td>
<td>13.7</td>
<td>8.9</td>
<td>0.0022</td>
</tr>
<tr>
<td>1324.4</td>
<td>48.</td>
<td>23.4</td>
<td>22.7</td>
<td>0.0023</td>
</tr>
<tr>
<td>1325.6</td>
<td>118.</td>
<td>68.6</td>
<td>82.1</td>
<td>0.0030</td>
</tr>
<tr>
<td><strong>1326.6</strong></td>
<td>311.</td>
<td>260.5</td>
<td>278.3</td>
<td><strong>0.0035</strong></td>
</tr>
<tr>
<td>1327.0</td>
<td>526.</td>
<td>414.8</td>
<td>345.3</td>
<td>0.0029</td>
</tr>
<tr>
<td>1327.7</td>
<td>943.</td>
<td>644.2</td>
<td>364.3</td>
<td>0.0027</td>
</tr>
<tr>
<td>1328.2</td>
<td>1379.</td>
<td>832.3</td>
<td>372.6</td>
<td>0.0024</td>
</tr>
<tr>
<td>1328.7</td>
<td>1967.</td>
<td>1049.0</td>
<td>383.6</td>
<td>0.0021</td>
</tr>
<tr>
<td>1330.0</td>
<td>3400.0</td>
<td>1700.0</td>
<td>600.0</td>
<td></td>
</tr>
<tr>
<td>1335.0</td>
<td>9000.0</td>
<td>5200.0</td>
<td>800.0</td>
<td></td>
</tr>
</tbody>
</table>

### Table 9- 11: Stream Cross Section LB-4 Data

<table>
<thead>
<tr>
<th>Elevation (ft)</th>
<th>Discharge (cfs)</th>
<th>End Area (ft(^2))</th>
<th>Top Width (ft)</th>
<th>Energy Grade Slope (ft/ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1306.2</td>
<td>0.</td>
<td>0.</td>
<td>0.</td>
<td>0.0040</td>
</tr>
<tr>
<td>1307.6</td>
<td>28.</td>
<td>17.9</td>
<td>18.3</td>
<td>0.0042</td>
</tr>
<tr>
<td>1308.1</td>
<td>56.</td>
<td>28.1</td>
<td>20.6</td>
<td>0.0052</td>
</tr>
<tr>
<td>1308.7</td>
<td>95.</td>
<td>40.3</td>
<td>22.5</td>
<td>0.0068</td>
</tr>
<tr>
<td>1310.1</td>
<td>237.</td>
<td>78.1</td>
<td>29.3</td>
<td>0.0051</td>
</tr>
<tr>
<td><strong>1311.0</strong></td>
<td>506.</td>
<td>133.2</td>
<td>35.1</td>
<td><strong>0.0060</strong></td>
</tr>
<tr>
<td>1312.4</td>
<td>622.</td>
<td>156.8</td>
<td>38.3</td>
<td>0.0040</td>
</tr>
<tr>
<td>1316.4</td>
<td>1886.</td>
<td>367.9</td>
<td>93.3</td>
<td>0.0037</td>
</tr>
<tr>
<td>1317.9</td>
<td>2758.</td>
<td>579.0</td>
<td>159.5</td>
<td>0.0025</td>
</tr>
<tr>
<td>1319.5</td>
<td>3934.</td>
<td>860.0</td>
<td>199.8</td>
<td>0.0020</td>
</tr>
<tr>
<td>1325.0</td>
<td>9000.0</td>
<td>2700.0</td>
<td>500.0</td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{4}The bankfull and low ground elevation entries are used to adjust reach routing parameters which compensate for reaches having different floodplain and channel routing distances (usually channel routing distance is longer than floodplain routing distance). The program will use the low ground elevation in deciding the End Area amounts in the channel vs. floodplain. If the low ground elevation is blank, the bankfull elevation is used instead.
### Table 9-12: Stream Cross Section LL-31 Data

<table>
<thead>
<tr>
<th>Elevation</th>
<th>Discharge (cfs)</th>
<th>End Area (ft²)</th>
<th>Top Width (ft)</th>
<th>Energy Grade Slope (ft/ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1276.0</td>
<td>0.</td>
<td>0.</td>
<td>0.</td>
<td>0.0047</td>
</tr>
<tr>
<td>1278.9</td>
<td>50.</td>
<td>53.</td>
<td>40.</td>
<td>0.0047</td>
</tr>
<tr>
<td>1279.5</td>
<td>100.</td>
<td>84.</td>
<td>55.</td>
<td>0.0051</td>
</tr>
<tr>
<td>1280.4</td>
<td>250.</td>
<td>141.</td>
<td>78.</td>
<td>0.0065</td>
</tr>
<tr>
<td>1281.1</td>
<td>500.</td>
<td>218.</td>
<td>129.</td>
<td>0.0080</td>
</tr>
<tr>
<td>1281.7</td>
<td>750.</td>
<td>292.</td>
<td>160.</td>
<td>0.0082</td>
</tr>
<tr>
<td>1282.0</td>
<td>1000.</td>
<td>355.</td>
<td>166.</td>
<td>0.0084</td>
</tr>
<tr>
<td>1282.7</td>
<td>1500.</td>
<td>465.</td>
<td>177.</td>
<td>0.0085</td>
</tr>
<tr>
<td>1283.3</td>
<td>2000.</td>
<td>575.</td>
<td>186.</td>
<td>0.0088</td>
</tr>
<tr>
<td>1283.9</td>
<td>2500.</td>
<td>695.</td>
<td>196.</td>
<td>0.0074</td>
</tr>
<tr>
<td>1284.6</td>
<td>3000.</td>
<td>825.</td>
<td>207.</td>
<td>0.0062</td>
</tr>
<tr>
<td>1285.2</td>
<td>3500.</td>
<td>970.</td>
<td>233.</td>
<td>0.0054</td>
</tr>
<tr>
<td>1285.9</td>
<td>4000.</td>
<td>1130.</td>
<td>251.</td>
<td>0.0046</td>
</tr>
<tr>
<td>1286.5</td>
<td>4500.</td>
<td>1300.</td>
<td>265.</td>
<td>0.0041</td>
</tr>
<tr>
<td>1287.0</td>
<td>5000.</td>
<td>1425.</td>
<td>276.</td>
<td>0.0039</td>
</tr>
<tr>
<td>1293.0</td>
<td>26000.0</td>
<td>7000.0</td>
<td>800.0</td>
<td></td>
</tr>
</tbody>
</table>

Back at the WinTR-20 main window, select **Stream Cross Section**: to begin the data entry process for these three ratings. When the **Stream Cross Section**: editor window appears, select the down arrow button to the right of **Cross Section Identifier**: field. Notice that the three reaches requiring rating curves show up (DF-6, LB-4, LL-31) in figure 9-29.
Figure 9-29: Stream Cross Section window (DF-6, LB-4, and LL-31)

Highlight the DF-6 and then click Enter. Enter all the data for this cross section (low ground elevation may be left blank). Note that the data are entered within the boxes on the left. When all five pieces of data (elevation, discharge, end area, top width, and energy grade (E.G) slope) have been entered, click Enter and the data is transferred to the table on the right hand side. Data cannot be directly entered or altered, except to delete a line, from within the table. If you realize you’ve made an entry error after the data are transferred to the table, simply click on the line in the table and the data are brought back into the four boxes on the left where they can be edited. When all the data have been entered, the window should look like figure 9-30.
To view the Stream Cross Section plot for DL-6 data, click the **Display Data** button, as shown in figure 9-31. Note: This can be useful for checking for inconsistencies in the data.
Figure 9-31: Cross Section Plot for DF-6

After the first cross section has been entered, go back up and select the next cross section (LB-4) using the down arrow adjacent to **Cross Section Identifier**: Enter the data for that cross section. Finally, repeat the process one more time to enter the final rating for cross section LL-31. Select **Accept Changes (Close)** when finished to return to the WinTR-20 Main Window.

**Entering the Storm Data**

**Step 6:** The storm data should already exist. This example was built from the Example 9-1 data set. To view the storm data, click on **Storm Analysis:** from the WinTR-20 Main Window to open the **Storm Analysis:** window. If not, see Example 9-1 on how to enter these data.

**Setting Output Parameters**

**Step 7:** From WinTR-20 Main Window, select **Global Output:** Once in **Global Output:** window select “Default Peak Output Code” for both sub-areas and reaches. Select **Accept Changes (Close)** button to return to the WinTR-20 Main Window. Note: As pointed out in Example 9-1, it is best to make an initial run by selecting peak discharge information only. Selecting hydrograph output for plotting or tabular viewing at this point can clutter up the “WinTR-20 Printed Page File” output.
Viewing Schematic, Viewing Input, and Running the Model

**Step 8:** Before the user can run the model, the input file must be saved. Select **File** and **Save** from the WinTR-20 Main Window. Clicking **Save** will save the file with the name defined in Step 2 above. Once the file is saved, the **View** and **Run** options appear at the top of the WinTR-20 Main Window, as shown in figure 9-32. **View** allows the user to look at the watershed schematic and the input file in an ASCII format. To view the schematic select **View** then **Schematic**.

![WinTR-20 System Controller / Editor](image)

*Figure 9-32: WinTR-20 Main window. Select View and Schematic*

The Schematic will open as shown in figure 9-33.
Verify that the sub-areas and reaches logically represent the intended hydrologic routing of the watershed.

The input file for this particular example is viewable by selecting View then Input File from the pull down menu, and is shown in figure 9-34 below.

Figure 9-33: Example 9-2 - Schematic
Figure 9- 34: Example 9-2 – WinTR-20 Input File

Using the scroll bar on the right side of the window will allow review of remaining input data.

To run the model simply select Run from the WinTR-20 Main Window.

Output – Printed Page

Step 9: Following a successful run, the WinTR-20 Printed Page File window containing the output will appear. The summary table at the end of the WinTR-20 Printed Page File is shown here as Figure 9-35.
As mentioned in Example 9-1, the "WinTR-20 Printed Page File" is also automatically saved as an "*.out" file (* = input file name prefix) which can be brought into MS-Word, Notepad, etc. for printing or insertion into other project documents. It is saved to the same directory as the input file. Since flooding in the city begins at a discharge of 5,000 cfs, flooding would occur on the 25-year, 50-year, and 100-year storms.

### Graphical Output

**Step 10:** To be able to view hydrographs, the hydrograph output code option for the sub-area or reach of interest will have to be turned on. To simplify for this example, on the WinTR-20 Main Window select **Global Output:** and set the **Default Hydrograph Output Code:** to **Yes** for sub-areas and

---

### Example 9-2 Summary

As mentioned in Example 9-1, the “WinTR-20 Printed Page File” is also automatically saved as an “*.out” file (* = input file name prefix) which can be brought into MS-Word, Notepad, etc. for printing or insertion into other project documents. It is saved to the same directory as the input file. Since flooding in the city begins at a discharge of 5,000 cfs, flooding would occur on the 25-year, 50-year, and 100-year storms.

### Graphical Output

**Step 10:** To be able to view hydrographs, the hydrograph output code option for the sub-area or reach of interest will have to be turned on. To simplify for this example, on the WinTR-20 Main Window select **Global Output:** and set the **Default Hydrograph Output Code:** to **Yes** for sub-areas and

---

### Table: Example 9-2 Summary

<table>
<thead>
<tr>
<th>Area or Reach Identifier</th>
<th>Drainage Area (sq mi)</th>
<th>2-year (cfs)</th>
<th>5-year (cfs)</th>
<th>10-year (cfs)</th>
<th>25-year (cfs)</th>
<th>50-year (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>3.730</td>
<td>692.7</td>
<td>1093.8</td>
<td>1508.0</td>
<td>2183.6</td>
<td>2798.3</td>
</tr>
<tr>
<td>002</td>
<td>1.900</td>
<td>300.7</td>
<td>509.9</td>
<td>733.6</td>
<td>1110.0</td>
<td>1453.8</td>
</tr>
<tr>
<td>005</td>
<td>0.940</td>
<td>134.7</td>
<td>217.7</td>
<td>399.6</td>
<td>618.9</td>
<td>820.5</td>
</tr>
<tr>
<td>007</td>
<td>2.270</td>
<td>518.4</td>
<td>787.3</td>
<td>1058.7</td>
<td>1493.2</td>
<td>1881.2</td>
</tr>
<tr>
<td>009</td>
<td>0.880</td>
<td>202.9</td>
<td>324.3</td>
<td>448.8</td>
<td>655.9</td>
<td>842.3</td>
</tr>
<tr>
<td>011</td>
<td>2.290</td>
<td>364.8</td>
<td>608.6</td>
<td>868.9</td>
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<td>1695.7</td>
</tr>
<tr>
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<td>291.3</td>
<td>386.9</td>
<td>541.0</td>
<td>677.1</td>
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<td>573.7</td>
<td>776.2</td>
<td>1103.4</td>
<td>1395.0</td>
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<tr>
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<td>3.730</td>
<td>692.7</td>
<td>1095.8</td>
<td>1508.0</td>
<td>2185.6</td>
<td>2798.3</td>
</tr>
<tr>
<td>DOWNSTREAM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R02</td>
<td>6.570</td>
<td>662.2</td>
<td>1057.1</td>
<td>1468.2</td>
<td>2132.4</td>
<td>2731.4</td>
</tr>
<tr>
<td>R03</td>
<td>8.840</td>
<td>856.4</td>
<td>1456.9</td>
<td>2127.2</td>
<td>3233.4</td>
<td>4220.9</td>
</tr>
<tr>
<td>DOWNSTREAM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R04</td>
<td>12.010</td>
<td>1117.3</td>
<td>2012.3</td>
<td>2955.7</td>
<td>4423.8</td>
<td>5636.6</td>
</tr>
<tr>
<td>DOWNSTREAM</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R05</td>
<td>1511.3</td>
<td>2644.2</td>
<td>3840.0</td>
<td>5660.8</td>
<td>7127.1</td>
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<tr>
<td>OUTLET</td>
<td>13.760</td>
<td>1510.9</td>
<td>2641.5</td>
<td>3829.5</td>
<td>5630.1</td>
<td>7092.4</td>
</tr>
</tbody>
</table>

| Area or Reach Identifier | Drainage Area (sq mi) | Peak Flow by Storm
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>100-year (cfs)</td>
<td>(cfs)</td>
<td>(cfs)</td>
</tr>
<tr>
<td>001</td>
<td>3.730</td>
<td>3477.5</td>
</tr>
<tr>
<td>003</td>
<td>1.900</td>
<td>1842.0</td>
</tr>
<tr>
<td>005</td>
<td>0.940</td>
<td>1050.2</td>
</tr>
<tr>
<td>007</td>
<td>2.270</td>
<td>2315.3</td>
</tr>
<tr>
<td>009</td>
<td>0.880</td>
<td>1048.5</td>
</tr>
<tr>
<td>011</td>
<td>2.290</td>
<td>2142.3</td>
</tr>
<tr>
<td>013</td>
<td>0.380</td>
<td>825.9</td>
</tr>
<tr>
<td>015</td>
<td>1.370</td>
<td>1717.7</td>
</tr>
<tr>
<td>R01</td>
<td>3.730</td>
<td>3477.5</td>
</tr>
<tr>
<td>DOWNSTREAM</td>
<td></td>
<td>3396.4</td>
</tr>
<tr>
<td>R02</td>
<td>6.570</td>
<td>5291.2</td>
</tr>
<tr>
<td>DOWNSTREAM</td>
<td></td>
<td>5137.1</td>
</tr>
<tr>
<td>R03</td>
<td>8.840</td>
<td>6885.0</td>
</tr>
<tr>
<td>DOWNSTREAM</td>
<td></td>
<td>6769.2</td>
</tr>
<tr>
<td>R04</td>
<td>12.010</td>
<td>8614.3</td>
</tr>
<tr>
<td>DOWNSTREAM</td>
<td></td>
<td>8571.8</td>
</tr>
<tr>
<td>OUTLET</td>
<td>13.760</td>
<td>9398.6</td>
</tr>
</tbody>
</table>
reaches. This will place hydrographs for all reaches and sub-areas in the WinTR-20 Printed Page File. Save the file and then re-run it.

After closing the WinTR-20 Printed Page File window select Plots from the WinTR-20 Main Window menu. Graphic Output: can plot one location and one storm per plot or multiple locations and storms at once. For Example 9-2, we’ll look at multiple locations. In the Graphics Output: window, select Location from Multiple Hydrographs. Next to Storms, select 100-year from the pull-down menu. Next to Sub-area box, select enter for both sub-areas “001” and “009”. These locations should now show up in the Multiple Locations window in the lower right. Selecting Display will bring up a window that looks similar to figure 9-36:

![Figure 9-36: 100-year storm hydrographs for Sub-areas 001 and 009](image)

The Edit menu on the plot window was used to plot the grid lines in the background. Plotting multiple locations can also be used to graphically show the impacts of structure or reach routings. Close the current display to return to the Graphics Output: window. Select each of the 001 and 009 within the Multiple Location window to delete them. Next, using the pull-down menu next to the Reach: box, select R01 then click Enter. You’ll notice that Upstream and Downstream options show up to the right. Select both options. Notice that the R01 – Upstream and R01 – Downstream
show up in the **Multiple Location** window. Change the storm to the 10-year storm. Selecting **Display** should bring up a window that looks similar to figure 9-37:

![Figure 9-37: Hydrograph 10-year for R01 Upstream and Downstream](example_9.2.png)

**Figure 9-37: Hydrograph 10-year for R01 Upstream and Downstream**

Notice that there appears to be very little attenuation of the peak discharge from upstream to downstream of reach R01. The peak is translated in time approximately 1 hour.
Example 9-3: Adding a reservoir in the watershed and changing dimensionless unit hydrograph

Background:

The City of Spring Valley, located in Fillmore County in southeastern Minnesota, has a flooding problem. From a preliminary water surface profile analysis, significant flooding occurs when discharges exceed 5,000 cfs just upstream of the city. The City would like protection from flooding for up to the 100-year event. An upstream reservoir has been proposed to reduce the peak discharges.

For this example, we will use Example 9-2 as a base line and add a reservoir. Open WinTR-20 and open the input file for Example 9-2. Click File and Save As Example_3A.inp.

Solution:
Example 9-3 Part A: The required changes to the model are:

- Change file name to Example_3A.inp.
- Change the project description in the WinTR-20 Identifier window to Example 3A.
- Enter the structure data.
- Insert a new reach named Res_01 between R02 and R03 to represent the structure routing. Reach R02 will flow into reach Res_01 and reach Res_01 will flow into reach R03.
- Change receiving reach ID for sub-area 007 from R03 to Res_01.

Example 9-3 Part B: Use a dimensionless unit hydrograph with Peak Rate Factor of 400.
9-3A, Step 1: The rating for this structure is given in the table 9-13:

Table 9-13: Proposed Structure Data

<table>
<thead>
<tr>
<th>Elevation</th>
<th>Discharge (cfs)</th>
<th>Storage (acre-feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1307.0</td>
<td>0.</td>
<td>717.0</td>
</tr>
<tr>
<td>1307.5</td>
<td>7.1</td>
<td>754.3</td>
</tr>
<tr>
<td>1308.0</td>
<td>14.2</td>
<td>792.1</td>
</tr>
<tr>
<td>1308.5</td>
<td>21.3</td>
<td>829.8</td>
</tr>
<tr>
<td>1309.0</td>
<td>28.4</td>
<td>867.5</td>
</tr>
<tr>
<td>1309.5</td>
<td>35.5</td>
<td>905.2</td>
</tr>
<tr>
<td>1310.0</td>
<td>42.6</td>
<td>942.9</td>
</tr>
<tr>
<td>1310.5</td>
<td>49.7</td>
<td>1060.8</td>
</tr>
<tr>
<td>1311.0</td>
<td>56.8</td>
<td>1178.7</td>
</tr>
<tr>
<td>1311.5</td>
<td>63.9</td>
<td>1296.5</td>
</tr>
<tr>
<td>1312.0</td>
<td>71.0</td>
<td>1414.4</td>
</tr>
<tr>
<td>1312.5</td>
<td>92.6</td>
<td>1532.3</td>
</tr>
<tr>
<td>1313.0</td>
<td>114.1</td>
<td>1650.1</td>
</tr>
<tr>
<td>1313.5</td>
<td>135.7</td>
<td>1768.0</td>
</tr>
<tr>
<td>1314.0</td>
<td>157.2</td>
<td>1885.9</td>
</tr>
<tr>
<td>1314.5</td>
<td>178.8</td>
<td>2003.7</td>
</tr>
<tr>
<td>1315.0</td>
<td>200.3</td>
<td>2121.6</td>
</tr>
<tr>
<td>1315.5</td>
<td>221.9</td>
<td>2239.5</td>
</tr>
<tr>
<td>1316.0</td>
<td>243.4</td>
<td>2357.3</td>
</tr>
<tr>
<td>1316.5</td>
<td>265.0</td>
<td>2475.2</td>
</tr>
<tr>
<td>1318.0</td>
<td>1000.0</td>
<td>2800.0</td>
</tr>
</tbody>
</table>

Enter Structure Data

Select **Structure Rating** from the WinTR-20 Main Window. Enter str_01 into the **Structure Identifier** text box. Leave the **Structure Starting Elevation** field blank. The program will assume the starting elevation is the lowest structure elevation or base flow discharge elevation, if any. As with the cross section data, the three elements per line (elevation, discharge, and storage) are entered, as shown in figure 9-38. To view the structure rating plot, click on “Display Data” button, as shown in figure 9-39. After all the data are entered, select **Accept Changes (Close)** button to take you back to the WinTR-20 Main Window.
Figure 9-38: Structure Rating for Structure str_01
9-3A, Step 2: Enter Reach Data

Open the Reach Data window and enter a new reach Res_01 as shown in figure 3-40. Reach Res_01 will drain to reach R03 and use Reach Structure Identifier: str_01.
Figure 9- 40: Stream Reach Identifier Res_01 added

Using the **Stream Reach Identifier**: pull-down menu, select reach R02. Change the **Stream Receiving Reach Identifier**: to Res_01 as shown in figure 9-41.

Figure 9- 41: Stream Reach Identifier R02 revised
Click **Accept Changes (Close)** button to return to the WinTR-20 Main Window.

**9-3A, Step 3: Revise Sub-area Data**

Sub-area 007 drained to reach R03 in Example 9-2. Now it drains to reach Res_01. Open the Sub-area data window and select Sub-area 007. Use the **Sub-area Reach Identifier:** pull-down menu to select reach Res_01 as shown in figure 9-42. Click **Accept Changes (Close)** button to return to the WinTR-20 Main Window.

![Sub-Area Data Window](image)

**Figure 9-42: Sub-area 007 drains to reach Res_01**

**9-3A, Step 4: Schematic, Viewing Input, and Running the Program**

Select **File** then **Save** to get the **View** and **Run** buttons to appear. When you view the schematic, it shows you the organization of sub-areas and reaches in the whole watershed with the reservoir as in figure 9-43.
Figure 9-43: Schematic diagram showing added reservoir

View the input data. From the WinTR-20 Main Window, click on View then Input File. The beginning of the input file is shown in figure 9-44.
To run the model, simply select **Run** from the WinTR-20 Main Window. When the **WinTR-20 Printed Page File** window appears, scroll down to the end of the end of the table to view the peak discharge summary table. The 100-year storm portion of the summary should look similar to figure 9-45.

![WinTR-20 Input File](image)

**Figure 9- 44:  Input File for Example 9-3A**

To run the model, simply select **Run** from the WinTR-20 Main Window. When the **WinTR-20 Printed Page File** window appears, scroll down to the end of the end of the table to view the peak discharge summary table. The 100-year storm portion of the summary should look similar to figure 9-45.
Figure 9- 45: WinTR-20 Printed Page File for Example 9-3A - Structure

From the output, one can see that the reservoir reduces peak discharge from the 100-year event from 6885 cfs down to 683 cfs. At the point just upstream of the city (at the Outlet point of the model), the reservoir reduces the 100-year peak discharge from 9399 cfs (see Example 9-2 output) down to 4973 cfs.

9-3A, Step 5: Display Graphical Output

After the run completes, open the Plots window. Select Multiple Locations and Reach Res_01 upstream and downstream hydrographs for the 25-year storm.

Select Display button and view 5 (this plot has been zoomed in to 10 to 80 hours) the hydrograph plot, as shown n figure 9-46.

5 If you get an error message at this point that states “No data for requested plot found” it likely means that the hydrograph output option has not been set. Go back to Global Output and select “yes” for sub-area and reach hydrographs, save the input, and rerun the model. The hydrograph plot should now work.
The 25-year peak discharge at the upstream end of reach R03 in Example 9-2 is 4423.8 cfs and in Example 9-3A is 184.0 cfs. The difference is 4239.8 cfs. This shows the impact of the reservoir at that specific location.

The 25-year peak discharge at the outlet in Example 9-2 is 6225.0 cfs and in Example 9-3A is 3107.1 cfs. The difference is 3117.9 cfs. This shows the impact of the reservoir at the outlet.

**Part B. Use dimensionless unit hydrograph with Peak Rate Factor of 400 instead of 484**

If a dimensionless unit hydrograph is not entered in the WinTR-20 **Dimensionless Unit Hydrograph** data window, the standard NRCS dimensionless unit hydrograph (DUH) with a Peak Rate Factor of 484 is used. Please refer to NEH Part 630 Chapter 16 for the definition, use, and derivation of the DUH.

A DUH may be entered by the user in the **Dimensionless Unit Hydrograph** data window. However, to save time, NRCS has developed a number of DUH’s with different Peak Rate Factors for use. These are in tabular text file format and may be copied or pasted into the WinTR-20 input data file using a text editor such as Notepad. This procedure is illustrated in Example 9-3B.
9-3B, Step 1: Enter selected DUH. Click File and SaveAs to save the WinTR-20 input data file with the name Example_9-3B.inp. Open the WinTR-20 Identifier window and change the Watershed description to include “Use DUH with Peak Rate Factor of 400”. Close the WinTR-20 Identifier window. Click File and Save. Close WinTR-20.

Open the file named Example_9-3_PRF_400.duh. It is shown as figure 9-47.

![Figure 9-47: DUH table with Peak Rate Factor 400](image)

Select the table heading line and the table of values as shown in figure 9-48. Click Control-C (Ctrl-C) to copy the data.

![Figure 9-48: Select DUH data table in text editor](image)

Close the text editor and open the WinTR-20 input file Example_9-3B.inp using a text editor. Add two blank lines and paste Control-V (Ctrl-V) the data into the WinTR-20 input file as in figure 9-49.
There should be at least one blank line before the Dimensionless Unit Hydrograph record and at least one blank line following the table. Save the WinTR-20 input file and close the text editor. Open the WinTR-20 interface and click **File** and **Open Existing WinTR-20 File**. Browse to the file named Example_9-3B.inp and click **Open**. The main window will have an X before **Dimensionless Unit Hydrograph**: as in figure 9-50.
Open the **Dimensionless Unit Hydrograph**: data window as shown in figure 9-51. The table which was copied and pasted into the WinTR-20 input file is shown in this table.

![Dimensionless Unit Hydrograph](image)

**Figure 9-51: Opened Dimensionless Unit Hydrograph data window**
Click **Display Data** to view the plot as shown in figure 9-52.

![Dimensionless Unit Hydrograph](example_9-38.inp)

**Figure 9-52: Plot of Dimensionless hydrograph data**

**3B, Step 2: Run the program.** Close the plot and return to the WinTR-20 Main Window. Open the **Verification** data window (see figure 9-53). Select **Hydrograph Generation** output. Any output selected in the **Verification** data window will be placed in the file with the extension `.dbg`. By selecting the **Hydrograph Generation** output, the `.dbg` file will display the computed Peak Rate Factor and the dimensionless unit hydrograph. This is another check that the dimensionless unit hydrograph has the intended Peak Rate Factor. If the user enters a DUH in the WinTR-20 **Dimensionless Unit Hydrograph** window without knowing what the Peak Rate Factor is, the **Hydrograph Generation** output will display the computed Peak Rate Factor for the user.
Figure 9-53: Open Verification data window with Hydrograph Generation output selected

Click **Accept Changes (Close)** button to close the **Verification** data window. Click **File** and **Save**, then **Run** WinTR-20. The 100-year storm peak discharge summary is shown in figure 9-54.
The 100-year peak discharge at the outlet is 4421.8 cfs. This is somewhat less than the 100-year peak discharge for Example 9-3 Part A which was 4973 cfs. The difference is caused by using the DUH of 400 versus using the standard NRCS DUH of 484.

Close the WinTR-20 Printed Page File and click View and select Debug File to open the Debug file. The Debug File showing a sample Hydrograph Generation output is shown in figure 9-55. The computed Peak Rate Factor is 400.034; very close to the intended value of 400.
Example 9-4 Part of the Watershed Upstream of the City with Diversion

Background

This example utilizes three features not found in the previous examples: Import NOAA Atlas 14 rainfall data, Input Hydrograph, and Split Flow. Importing NOAA Atlas 14 rainfall data will allow for the use of site-specific rainfall frequency data and rainfall distributions. Input Hydrograph allows the user to input a hydrograph directly into a WinTR-20 model. An example would be a historic hydrograph from gage information. The Split Flow function in WinTR-20 will “split” an inflow hydrograph based on two stage-discharge relationships. An example of this would be where the user wants to model a lateral diversion of water through a channel side weir.

In this example, the flap gate has broken off from a side inlet along a dike section of channel. The user is asked to determine maximum flow and total runoff volume that leaves the channel by flow back through the side inlet for both an actual event and 1-year through 10-year 24-hour hypothetical events.

Figures 9-56 and 9-57 below show a plan and a cross section view of the situation.

Figure 9-56: Plan View

Figure 9-57: Cross Section View
Step 1: Cross Section Data

Reach/Split Flow Ratings - For this example, it is assumed that the flow out of the culvert is a single stage-discharge relationship (WinTR-20 cannot model flows with varying tailwater conditions). The Stage-Discharge-End Area-Top Width-Energy Grade Slope for the main channel just upstream of the culvert was developed using HEC-RAS outside Win-TR20; the details are given in table 9-14.

Table 9-14: HEC-RAS Defined Table for Xsect_1

<table>
<thead>
<tr>
<th>Elevation (msl)</th>
<th>Discharge (cfs)</th>
<th>End Area (sq ft)</th>
<th>Top Width (ft)</th>
<th>Energy Grade Slope (ft/ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>958.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.00011</td>
</tr>
<tr>
<td>961.8</td>
<td>50.</td>
<td>127.</td>
<td>47.</td>
<td>0.00111</td>
</tr>
<tr>
<td>962.3</td>
<td>100.</td>
<td>151.</td>
<td>50.</td>
<td>0.00026</td>
</tr>
<tr>
<td>962.7</td>
<td>200.</td>
<td>173.</td>
<td>53.</td>
<td>0.00069</td>
</tr>
<tr>
<td>963.1</td>
<td>300.</td>
<td>192.</td>
<td>55.</td>
<td>0.001129</td>
</tr>
<tr>
<td>963.4</td>
<td>400.</td>
<td>208.</td>
<td>57.</td>
<td>0.001571</td>
</tr>
<tr>
<td>963.6</td>
<td>500.</td>
<td>222.</td>
<td>59.</td>
<td>0.001999</td>
</tr>
<tr>
<td>963.8</td>
<td>600.</td>
<td>235.</td>
<td>66.</td>
<td>0.002446</td>
</tr>
<tr>
<td>964.0</td>
<td>700.</td>
<td>248.</td>
<td>70.</td>
<td>0.002819</td>
</tr>
<tr>
<td>964.3</td>
<td>800.</td>
<td>263.</td>
<td>76.</td>
<td>0.003103</td>
</tr>
<tr>
<td>964.6</td>
<td>1000.</td>
<td>285.</td>
<td>82.</td>
<td>0.003795</td>
</tr>
<tr>
<td>965.5</td>
<td>1400.</td>
<td>420.</td>
<td>120.</td>
<td>0.0039</td>
</tr>
<tr>
<td>967.0</td>
<td>2000.</td>
<td>600.</td>
<td>140.</td>
<td></td>
</tr>
</tbody>
</table>

The main channel is 2,000 feet long with the culvert at the downstream end of the reach.

The rating table for the culvert backflow out of the channel was also developed externally to WinTR-20 (i.e. simple Inlet Control calculations, HEC-RAS, BPR charts, etc.). The rating table data details are given in table 9-15.

Table 9-15: Rating Table Data for Xsect_2

<table>
<thead>
<tr>
<th>Elevation (msl) (ft)</th>
<th>Discharge (cfs)</th>
<th>End Area (sq.ft)</th>
<th>Top Width (ft)</th>
<th>Energy Grade Slope (ft/ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>958.0</td>
<td>0.</td>
<td>0.</td>
<td>0.</td>
<td>0.01</td>
</tr>
<tr>
<td>959.2</td>
<td>5.</td>
<td>5.</td>
<td>5.</td>
<td></td>
</tr>
<tr>
<td>959.8</td>
<td>10.</td>
<td>10.</td>
<td>10.</td>
<td></td>
</tr>
<tr>
<td>960.4</td>
<td>15.</td>
<td>15.</td>
<td>15.</td>
<td></td>
</tr>
<tr>
<td>961.0</td>
<td>20.</td>
<td>20.</td>
<td>20.</td>
<td></td>
</tr>
<tr>
<td>961.9</td>
<td>25.</td>
<td>25.</td>
<td>25.</td>
<td></td>
</tr>
<tr>
<td>963.0</td>
<td>30.</td>
<td>30.</td>
<td>30.</td>
<td></td>
</tr>
<tr>
<td>963.4</td>
<td>35.</td>
<td>35.</td>
<td>35.</td>
<td></td>
</tr>
<tr>
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<td>40.</td>
<td>40.</td>
<td>40.</td>
<td></td>
</tr>
<tr>
<td>965.6</td>
<td>45.</td>
<td>45.</td>
<td>45.</td>
<td></td>
</tr>
<tr>
<td>967.0</td>
<td>50.</td>
<td>50.</td>
<td>50.</td>
<td></td>
</tr>
</tbody>
</table>
Step 2: Storm Data:

The watershed is located in southern Minnesota near latitude 44.0 and longitude -94.0. Instructions from Chapter 6 of this User Guide were followed to download the precipitation-frequency data for that location. The table of values is shown in figure 9-58 and the file with the data was saved with the name User_Guide_Ex_4_NOAA_14.csv.

![Figure 9-58: NOAA Atlas 14 precipitation-frequency data for Example 9-4](image)

<table>
<thead>
<tr>
<th>Duration</th>
<th>1</th>
<th>2</th>
<th>5</th>
<th>10</th>
<th>25</th>
<th>50</th>
<th>100</th>
<th>200</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.min</td>
<td>0.386</td>
<td>0.460</td>
<td>0.584</td>
<td>0.689</td>
<td>0.837</td>
<td>0.954</td>
<td>1.07</td>
<td>1.20</td>
<td>1.36</td>
</tr>
<tr>
<td>10.min</td>
<td>0.555</td>
<td>0.674</td>
<td>0.855</td>
<td>1.01</td>
<td>1.23</td>
<td>1.40</td>
<td>1.57</td>
<td>1.75</td>
<td>2.00</td>
</tr>
<tr>
<td>15.min</td>
<td>0.699</td>
<td>0.822</td>
<td>1.04</td>
<td>1.23</td>
<td>1.50</td>
<td>1.70</td>
<td>1.92</td>
<td>2.14</td>
<td>2.44</td>
</tr>
<tr>
<td>30.min</td>
<td>0.925</td>
<td>1.11</td>
<td>1.41</td>
<td>1.67</td>
<td>2.04</td>
<td>2.33</td>
<td>2.63</td>
<td>2.93</td>
<td>3.35</td>
</tr>
<tr>
<td>60.min</td>
<td>1.19</td>
<td>1.42</td>
<td>1.81</td>
<td>2.16</td>
<td>2.66</td>
<td>3.06</td>
<td>3.48</td>
<td>3.93</td>
<td>4.55</td>
</tr>
<tr>
<td>2.hr</td>
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<td>1.74</td>
<td>2.22</td>
<td>2.54</td>
<td>3.27</td>
<td>3.79</td>
<td>4.34</td>
<td>4.92</td>
<td>5.74</td>
</tr>
<tr>
<td>3.hr</td>
<td>1.64</td>
<td>1.94</td>
<td>2.48</td>
<td>2.97</td>
<td>3.69</td>
<td>4.30</td>
<td>4.95</td>
<td>5.65</td>
<td>6.65</td>
</tr>
<tr>
<td>6.hr</td>
<td>1.94</td>
<td>2.32</td>
<td>2.92</td>
<td>3.57</td>
<td>4.40</td>
<td>5.15</td>
<td>5.96</td>
<td>6.85</td>
<td>8.11</td>
</tr>
<tr>
<td>12.hr</td>
<td>2.22</td>
<td>2.62</td>
<td>3.34</td>
<td>4.01</td>
<td>5.03</td>
<td>5.90</td>
<td>6.83</td>
<td>7.85</td>
<td>9.31</td>
</tr>
<tr>
<td>24.hr</td>
<td>2.52</td>
<td>2.94</td>
<td>3.71</td>
<td>4.43</td>
<td>5.53</td>
<td>6.47</td>
<td>7.49</td>
<td>8.61</td>
<td>10.2</td>
</tr>
</tbody>
</table>

Step 3: Stream Gage Data. In addition to analyzing the 1-year through 10-year storm events, an actual hydrograph measured at a gage located in the upstream watershed will be routed through the reach where the culvert is located. The gage data for the upstream watershed is given in table 9-16.
Step 4: Sub-area Data:

The upstream watershed data is based on Sub-area 001 of Example 9-1, above.

- Drainage area = 3.73 square miles
- Runoff Weighted Curve Number = 76.8
- Time of Concentration = 2.83 hours
Notes on Basic WinTR-20 Setup

The hydrograph from the upstream area will be routed through a 2,000’ reach named Rch_1 which will route the hydrograph to the culvert location. A very short reach (10’) downstream of the culvert will be created to analyze the split flow. This reach will be designated Rch_2. The rating Xsect_1 that is used for Rch_1 will be used for this short reach also. Note that only a stage-discharge relationship was provided for the split flow out through the culvert. It is assigned the cross section name Xsect_2. WinTR-20 may use the same stage-discharge-end area-top width-energy grade slope data for both split flow and reach routing tables. To complete the rating table that will be used for the split flow out through the culvert, end area, top width, and energy grade slope must be entered. For the end area and top width, the discharge itself will be used as “filler values” (anything could be used as long as they increase with elevation). For energy grade slope, assume 0.01 (ft/ft). These “filler values” will not affect the results since 1) the split flow routine will only use the stage-discharge portion of the table and 2) the downstream reach is so short (10’) that the calculation reach inflow and outflow will essentially be identical. A simplified schematic of the example is shown in figure 9-59.

Step 5: Data Entry

To start a new project by importing NOAA Atlas 14 data, open WinTR-20, go to File and select Import NOAA Atlas Data, as shown in figure 9-60. Browse for the file named User_Guide_Ex_4_NOAA_14.csv. When asked if data should be smoothed, select Smooth Data.
Figure 9-60: Select Import NOAA Atlas Data

When the WinTR-20 Identifier window opens as in figure 9-61, enter 1.0 for **Minimum Hydrograph Value**.
By importing the NOAA Atlas 14 data, the two watershed description lines were generated from information in the NOAA Atlas 14 data file. These may be revised now if desired. Click **Accept Changes (Close)** button. The main WinTR-20 window should show data in three data groups; **WinTR-20 Identifier: Storm Analysis:,** and **Rainfall Distribution:**. Open each of those data windows to view input data. **Warning: Do not attempt to import NOAA Atlas 14 data into an existing WinTR-20 input file. All other data will be deleted and just the NOAA Atlas 14 related data will remain. Import NOAA Atlas 14 data into a new WinTR-20 project only.** Other data such as sub-areas, cross sections, and reaches may either be added using the WinTR-20 Controller/Editor or copied and pasted into the WinTR-20 data file using a text editor such as Notepad or WordPad.

**Step 6: Revise Storm Analysis data**

Open the Storm Analysis data window as shown in figure 9-62. By importing the NOAA Atlas 14 data, 9 storms were set up (1-year through 500-year).
Figure 9-62: Storm Analysis data window for Example 9-4 with all storms

Since this current project only requires the 1-year thorough 10-year storms we will delete the 25-year through 500-year storms. Right click on these storms one by one in the table and select to delete the storm. See figures 9-63 and 9-64.

Figure 9-63: Select Yes to delete the storm
Step 7: Input Reach and Split Flow Rating Information:

Two rating curves are needed for this example. The first one will be called Xsec_1 which will describe the rating for the 2000 foot dike section of channel. The actual stage/discharge/end area/top width/energy grade slope information was developed from an outside program such as HEC-RAS (see table 9-14). From the WinTR-20 Main Window, select **Stream Cross Section:** and enter the data details given in table 9-14. The window appears as shown in figure 9-65.
Click **Display Data** button to check for possible data entry errors.

The second rating curve describes the hydraulics of the flow out of the channel through the culvert. This rating curve will be named Xsect_2. The only information that the program needs to perform the split flow is stage and discharge. However, WinTR-20 requires that end area, top width, and energy grade slope fields must also be filled in. The stage/discharge relationship for the culvert is given in table 9-15. From the main WinTR-20 Main Window select **Stream Cross Section**: and enter the data details given in table 9-15 (as shown in figure 9-66).
Step 8: Input Stream Reach Data:

The main reach that conveys the flows from the upstream drainage area will be named Rch_1. The user will need to enter data given in table 9-17.

Table 9-17: Stream Reach Data for Rch_1

<table>
<thead>
<tr>
<th>Description</th>
<th>Input Variable / Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stream Reach Identifier:</td>
<td>Rch_1</td>
</tr>
<tr>
<td>Stream Receiving Reach Identifier:</td>
<td>Rch_2</td>
</tr>
<tr>
<td>Reach Cross Section Identifier:</td>
<td>Xsect_1</td>
</tr>
<tr>
<td>Reach Channel Length:</td>
<td>2000 feet</td>
</tr>
</tbody>
</table>

For additional information, click on the text variable names within the input editor window as shown in figure 9-67. To turn the information off, click on the text variable name again.
Figure 9-67: Additional information on Reach Channel Length

Stream reach data Rch_1 should be entered in the Stream Reach: input editor window, as shown in figure 9-68.

Figure 9-68: Data for Stream Reach Rch_1
The reach at the culvert location will be named Rch_2. This is simply a short 10 foot long reach to provide for the splitting of flow between the downstream channel and flow through the culvert. The information required for this reach includes in table 9-18:

**Table 9-18: Stream Reach Data for “Rch_2”**

<table>
<thead>
<tr>
<th>Description</th>
<th>Input Variable / Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stream Reach Identifier:</td>
<td>Rch_2</td>
</tr>
<tr>
<td>Stream Receiving Reach Identifier:</td>
<td>outlet</td>
</tr>
<tr>
<td>Reach Cross Section Identifier:</td>
<td>Xsect_1</td>
</tr>
<tr>
<td>Reach Channel Length</td>
<td>10 feet</td>
</tr>
<tr>
<td>Reach Split Flow Cross Section Identifier:</td>
<td>Xsect_2</td>
</tr>
<tr>
<td>Split Flow Drainage Area</td>
<td>0.00001</td>
</tr>
</tbody>
</table>

The **Split Flow Drainage Area** is set as low as possible so the volume of flow out of the culvert may be computed later. Stream reach data for Rch_2 should be entered in the Stream Reach window, as shown in figure 9-69.

**Figure 9-69: Stream Reach Data for Rch_2**

Select **Accept Changes (Close)** button when data from both reaches have been entered.
Step 9: Input Sub-Area Data:

Select **Sub-Area**: from the WinTR-20 Main Window. Enter Sub 001 for the sub-area identifier. This flow from this sub-area will be going into the upper end of reach Rch_1. Select this from the pull down menu to the right of Sub-Area Reach Identifier. Fill out the rest of the data as shown in figure 9-70, and then select **Accept Changes (Close)** button when the data have been entered.

![Sub-Area Data](image)

**Figure 9-70: Sub-Area Data for Sub 001**

Step 10: Input Global Output Data:

Open the Global Output window and enter 1.0 for the Minimum Hydrograph Display Flow. Select Peak Discharge Output for all sub-areas and reaches. **Accept Changes (Close)** button when the data have been entered.

Step 11: Input Verification Data:

Open the Verification data window and select output for Hydrograph Flow Splitting as shown in figure 9-71. This will place the combined rating curve to split the hydrograph and the two split hydrographs for each storm in the .dbg file.
Select Accept Changes (Close) button when the data have been entered. Click File and Save (save early and save often).

**Step 12: Add Storm Analysis Data**

In addition to the 1-year through 10-year storms, a storm is needed to represent the gaged event. Open the Storm Analysis Data window. Click on the open line just below the 10-year storm and enter a Storm Id “historic” in the data box on the left side of the window. We will need to enter a small enough rainfall depth such that no runoff will be generated from Sub-Area 001 (the user will enter the runoff directly using the “Input Hydrograph” for this event). Enter 0.1” rainfall. Enter the data as shown in figure 9-72.
Step 13: Input Hydrograph Entry:

Back at the WinTR-20 main window, select Input Hydrograph: Once the user is taken to the Input Hydrograph Input window, enter Elk Ck Hyd as an identifier for the input hydrograph. Select Rch_1 from the pull down menu next to the Input Hydrograph Reach Identifier text box. This designates the reach that the hydrograph will flow into. Next, using the pull down menu next to the Input Hydrograph Storm Identifier window, select “historic”. This identifier tells the program which Storm Event to use this hydrograph in.

Note that the drainage area is set as 0.00015 square miles (the lower limit for a drainage area in WinTR-20). The reason for this is because this particular model contains a Sub-Area that has the 3.73 square miles associated with it already. If we were to enter 3.73 square miles within the Input Hydrograph data, the program accumulates this drainage area with the area from Sub-Area sub 001 to come up with an erroneous 7.46 square miles at the split hydrograph point. Figure 9-73 shows the completed window.
Figure 9-73: Input Hydrograph Data for Elk Ck Hyd

After the data have been entered, select the Display Data button to view the hydrograph in figure 9-74.

Figure 9-74: Hydrograph Plot Elk Ck Hyd
Close the hydrograph window and select **Accept Changes (Close)** button to return to the WinTR-20 Main Window.

**Step 14: Viewing Schematic, Running the Model, Viewing Output**

**Schematic:**
After returning to the main window, go to the **Global Output** window and select **Default Peak Output Code** from within the **Global Output** window. Save the file. After saving, the **View** option should appear along the top of the window. Select **Schematic** from the **View** pull-down menu, as shown in figure 9-75.

![Schematic Plot for Example 9-4 with diversion out of the watershed](image)

**Figure 9- 75: Schematic Plot for Example 9-4 with diversion out of the watershed**

**Running and Viewing Printed Page Output:**
Closing out the schematic and returning to the WinTR-20 Main Window, select **Run** from the menu along the top. The resultant WinTR-20 printed page 10-year storm summary should appear as figure 9-76.
Figure 9-76: Summary WinTR-20 output for Example 9-4 10-year storm

The output can be interpreted as follows: For the 10-year event, the peak discharge just upstream of the culvert is 1396 cfs. The peak discharge at the downstream end of the reach is 1351 cfs. The difference of 45 cfs is diverted out of the channel through the culvert. The volume of water lost from the main channel through the culvert is approximately 35 Acre-Feet.

For the historic event shown in figure 9-77, at the downstream of reach Rch_1, the peak discharge is 676 cfs. A maximum of 37 cfs is diverted out of the channel through the culvert. The volume of water lost from the main channel through the culvert is approximately 54 Acre-Feet.

Figure 9-77: Summary WinTR-20 output for Example 9-4 historic storm

\[ \text{Volume lost} = (2.137 \text{ watershed inches} - 1.963 \text{ watershed inches}) \times (3.73 \text{ mi}^2) \times (640 \text{ acres/mi}^2) \times (1 \text{ foot/12 inches}) \]

\[ \text{Volume lost} = (2.818 \text{ watershed inches} - 2.546 \text{ watershed inches}) \times (3.73 \text{ mi}^2) \times (640 \text{ acres/mi}^2) \times (1 \text{ foot/12 inches}) \]
Note the 0 cfs coming from Sub 001 for the historic event. This worked as planned since we wanted only the runoff from the Input Hydrograph to end up at the split point. The 0.1" of rainfall generated no runoff. During the 10-year event, the 4.43” of rainfall generated 2.137” of runoff from Sub 001. There was no Input Hydrograph associated with this event thus the only runoff at the split point was the WinTR-20 generated hydrograph.

**Step 15: Viewing Hydrographs:**

In order to view the hydrographs within WinTR-20, the hydrograph option for the sub-area or reach of interest must be selected for output. To make plots of all locations possible, set the hydrograph output option for sub-areas and reaches to **Yes** in the Global Output window. Save the file, then run again. Now all the hydrographs should be interspersed within the printed page output.

Select **Plot** from the WinTR-20 Main Window. Select **Hydrograph** as Graphic Type and **Location** next for Multiple Hydrographs. Select the historic storm, then Rch_2 from the pull-down menu next to Reach. Select upstream and downstream for reach Rch_2. These should now appear in the **Multiple Locations** box to the right as shown in figure 9-78.

![Graphics Output window](image)

**Figure 9-78:** Graphic Output window with hydrographs selected for Example 9–4
Finally, select the **Display** button to view the hydrographs. The plot shows the hydrographs just upstream and just downstream of the culvert. The difference between the two hydrographs in figure 9-79 is diverted water flowing through the culvert.

![Hydrograph Plot –Historic Storm](image)

**Figure 9- 79:  Hydrograph Plot –Historic Storm**

A plot of the hydrograph of water diverting through the culvert is not possible within the setup of reaches in the current model. Any water diverted out of the watershed is not saved in the WinTR-20 output. In order to be able to plot the diverted hydrograph, the water being diverted needs to be sent to another reach in the watershed by selecting a Split Flow Reach Identifier in the Stream Reach data window. In this example, a new reach could be inserted to receive the diverted flow.
Example 9-5: Develop Principal Spillway, Stability, and Freeboard Design Hydrographs for reservoir site within the watershed

Background

This example will start with the WinTR-20 input data set up in Example 9-3 Part A. In Example 9-3 Part A, a reservoir was placed in the watershed and impacts were simulated for the 2-year through 100-year storms. Principal Spillway, Stability, and Freeboard design hydrographs are used to set the elevation of an auxiliary spillway, analyze head cutting and erosion in the auxiliary spillway, and set the top of dam elevation according to NRCS criteria.

Since the proposed dam is located above the town, it is a high hazard structure because a failure could cause loss of life. NRCS criteria for determining hazard class, design storm rainfall, and other related items are published in Technical Release 60.

Step 1: Open input data file and make preliminary modifications

Open WinTR-20 and click File and Open Existing WinTR-20 file. Browse for the file named Example_9-3A.inp. The first data window to open will be the WinTR-20 Identifier window. Change the Watershed Description as shown in figure 9-80.

![WinTR-20 Identifier](image)

**Figure 9- 80: WinTR-20 Watershed Description for Example 9-5**

Click the Accept Changes (Close) button to return to the WinTR-20 Main Window. Click File and Save As Example_9-5.inp.
Since we will want to enter Principal Spillway and Stability/Freeboard data, data in the Storm Analysis data window will need to be removed. Open the Storm Analysis data window as shown in figure 9-81.

![Storm Analysis](image)

**Figure 9- 81: Storm Analysis data for Example 9-5**

Right-click on the first storm listed in the table on the right side of the window. A window will appear asking if the storm is to be deleted (figure 9-82). Click the Yes button. Repeat this step for all storms. All storms should be removed.

![Delete Storm](image)

**Figure 9- 82: Delete a single storm**
Use the **Accept Changes (Close)** button to return to the WinTR-20 Main Window. On the WinTR-20 main window there should be no “X” next to Storm Analysis and the Principal Spillway Data and Stability Freeboard Data windows should be in the list of data groups as shown in figure 9-83.

![WinTR-20 System Controller / Editor](image)

**Figure 9-83: WinTR-20 Main window with available data groups after deleting the Storm Analysis data**

**Step 2: Enter Principal Spillway data**

Open the Principal Spillway Data window and enter a Description. A Description is a required entry even if it is very brief. See figure 9-84.
There are several input data options on this window. In this example, we will use the **Look Up** button to select a location near the project site which has a **Climatic Index (Ci)** assigned. Click the **Look Up** button associated with **Climatic Index (Ci)**. A **Look Up** window, such as shown in figure 9-85, will open.
Figure 9-85: Principal Spillway data window Climatic Index Look Up window

For this example, select the location shown in figure 9-85. Click the OK button to return to the Principal Spillway Data window, figure 9-86.
The value of Quick Return Flow (QRF) is calculated from the Climatic Index (Ci) value of 1.66. It may not be changed at this point without changing the Climatic Index value. The 2yr 24-hr rainfall value was entered in Example 9-3 in the Storm Analysis data window. Since that value was removed, it must be entered in this window. Enter a 2-yr 24-hr rainfall of 3.02 inches.

There is an option to enter rainfall values or runoff volumes in the right side of the window. For this example, we will enter the 1-day and 10-day rainfall values according to criteria published in TR-60. According to TR-60 criteria, a high hazard design class must be designed using the 1-day and 10-day 100-year rainfall values. For the project location these are 6.22” and 9.96”, respectively. Since the reservoir drainage area of 8.84 square miles, which is less than 10 square miles, Principal Spillway Areal Correction values are not changed from the default values of 1.0. The completed Principal Spillway data window is shown in figure 9-87.
Figure 9- 87: Completed Principal Spillway Data window

Data boxes have a blue color which means the values are within the normal range. If the data boxes were yellow, that would mean the values were within the Warning range and if the data boxes were red, the values would be in the Error range. Click **Accept Changes (Close)** button to return to the WinTR-20 Main Window. Click **File** and **Save**.

**Step 3: Enter Stability Freeboard data**

Next, open the Stability Freeboard Data window. Enter a Description (required) as in figure 9-88.
Use the pull-down list to select Design Class “High”. Next, select Gage Rainfall Distribution Table Identifiers from the pull down lists. For this example, select TYPE_B_6HR for both storms. Enter values for the 100-year and Probable Maximum Precipitation (PMP) in the data boxes on the left side of the window. The values have been entered in figure 9-89, below.
Figure 9-89: Completed Stability Freeboard Data window

The 2-Yr 24-Hr Rainfall value was entered in the Principal Spillway Data window and transferred automatically to this window. Click *Accept Changes (Close)* button to return to the WinTR-20 Main Window. Click *File* and *Save*.

**Step 4: Revise Reach Data**

In this example, we would like to save the inflow hydrograph to the reservoir in order to efficiently import the hydrograph to the WinDAM_B computer program. In order to save this hydrograph in the hydrograph output file, a reach needs to be inserted between the downstream end of Reach R02 and the upstream end of Reach Res_01. This new reach will be extremely short (1 foot) so it will not influence the hydrograph routing results. If the hydrograph is not to be saved, this step is not needed. Figure 9-90 shows the new reach Res_01_in as the reach receiving the flow from R02.
Figure 9- 90: Stream Reach window with new receiving reach for Reach R02 selected

Add Stream Reach Identifier: Res_01_in for the Stream Receiving Reach Identifier: Res_01 and press the Enter key (figure 9-91).
Figure 9-91: Stream Reach with the Stream Reach Identifier Res_01_in inserted

The completed data window with the short reach length is shown in figure 9-92. Click Accept Changes (Close) button to return to the WinTR-20 Main Window.
Open the Global Output window and make sure the Reach Hydrograph Output Code Yes, and Reach Hydrograph File Code Yes are selected. Click Accept Changes (Close) button to return to the WinTR-20 Main Window.

Open the Sub-area data window and change the Sub-area Receiving Reach Identifier: for Sub-area 007 to Res_01_in. Click Accept Changes (Close) button to return to the WinTR-20 Main Window. Save the file and click View Schematic. The schematic is displayed in figure 9-93.
Step 5: Run WinTR-20 and View Output

Click the Run command and the Error message in figure 9-94 appears.

WinTR-20 will not extrapolate tables for cross sections or structures. If during the hydrograph computations for a particular storm, a cross section or structure table is exceeded, WinTR-20 stops execution at that point. Since this is the first run for this example, there may be other corrections needed before a complete run is executed. Remember that in the example, the PMP storm is being routed. So there is a very good chance other tables will be exceeded for SD and/or FB storms. To
save the time it takes to make multiple WinTR-20 runs, enter the following extensions to the cross section and structure rating tables.

Open the Stream Cross Section data window and add one line to both the DF-6 table and the LB-4 tables (data from table 9-19). Click **Accept Changes (Close)** button to return to the WinTR-20 Main Window.

**Table 9-19: Additional data for cross section rating tables**

<table>
<thead>
<tr>
<th>Cross Section</th>
<th>Elevation - feet</th>
<th>Discharge - cfs</th>
<th>End Area – sq ft</th>
<th>Top Width - feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>DF-6</td>
<td>1340</td>
<td>19000</td>
<td>10200</td>
<td>1200</td>
</tr>
<tr>
<td>LB-4</td>
<td>1330</td>
<td>27000</td>
<td>8000</td>
<td>1100</td>
</tr>
</tbody>
</table>

Open the Structure Rating data window and add three lines to the **str_01** table (data from table 9-20).

**Table 9-20: Additional data for structure rating table**

<table>
<thead>
<tr>
<th>Structure</th>
<th>Elevation - feet</th>
<th>Discharge - cfs</th>
<th>Storage – ac-ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>str_01</td>
<td>1320</td>
<td>3000</td>
<td>3200</td>
</tr>
<tr>
<td></td>
<td>1324</td>
<td>8000</td>
<td>4200</td>
</tr>
<tr>
<td></td>
<td>1326</td>
<td>25000</td>
<td>5000</td>
</tr>
</tbody>
</table>

Click **Accept Changes (Close)** button to return to the WinTR-20 Main Window. Click **File, Save**, then **Run**.

The peak discharge summary is shown in figure 9-95.
Figure 9-95: Printed Page WinTR-20 summary output

The plot of the principal spillway, stability design, and freeboard hydrographs is shown in figure 9-96.
Figure 9-96: Plot of principal spillway, stability design, and freeboard hydrographs

Documentation for the PS, SD, and FB storms are in the .dbg file. The summaries are shown in figures 9-97 and 9-98. This information documents the application of NRCS criteria which are contained in TR-60 and NEH Part 630 Chapter 21.
The hydrographs to import to the WinDAM_B computer program are included in the .hyd file. There are several hydrographs included for each storm. For reaches in WinTR-20, only the downstream
hydrograph is included in the .hyd file. For this example, the hydrographs to import as inflow to the reservoir are those for the downstream end of reach Res_01_in. A view of the Freeboard Hydrograph in the .hyd file is included in figure 9-99. Instructions for importing the hydrographs are included in the WinDAM_B documentation.

Figure 9-99: Part of the Freeboard Hydrograph for inflow to Res_01_in
Appendix A: References


Appendix B Error Messages

WinTR-20 Error Messages

1st WinTR-20 input file record is not the required WinTR-20: Version 3.10 record --- CANNOT PROCESS FILE

Blank numeric field (Input Field Name) for Identifier Name (Identifier) of Data Section Data Section Header (XXX)

Blank record encountered before end of Data Type for Identifier Name (Identifier) of Data Section Data Section Header (XXX)

Blank record expected at end of Data Section (Data Section Header)

Blank text field (Input Field Name) for Identifier Name (Identifier) of Data Section Data Section Header (XXX)

Blank Y/N or 0/1 field (Input Field Name) for Identifier Name (Identifier) of Data Section Data Section Header (XXX)

Both Input Field name and Another Input Field Name cannot be the same (Input) for Identifier Name (Identifier) of Data Section Data Section Header (XXX)

Cannot find TR-20 input data file (Input File Name)

Circular pattern detected for reaches beginning at reach Reach Identifier

Data Section Name (Data Section Header) is not a TR-20 header - Skip to next Data Section

Decimal point in integer field (Input) for Input Field Name and Identifier Name (Identifier) of Data Section Data Section Header (XXX)

Duplicate Data Section Header section in TR-20 input file

Duplicate Input Field Name (Input) encountered for Identifier Name (Identifier) of Data Section Data Section Header (XXX)

Extraneous data in columns XXX-XXX for Identifier Name (Identifier) of Data Section Data Section Header (XXX)

Entries Input Field Name and Another Input Field Name cannot both be blank for Identifier Name (Identifier) of Data Section Data Section Header (XXX)

Entries Sheet Flow Manning n and Sheet Flow surface cannot both be entered for Identifier Name (Identifier) of Data Section Data Section Header (XXX)
Entry **Input** required when **Another Input** is entered for **Identifier Name** (Identifier) of Data Section **Data Section Header (XXX)**

Entry (X.XXX) for **Input Field Name** not greater than **Another Input Field Name** (X.XXX) for **Identifier Name** (Identifier) of Data Section **Data Section Header (XXX)**

**First or Last** point of **Data Type** must be 0.0 for **Identifier Name** (Identifier) of Data Section **Data Section Header (XXX)**

**Identifier** (Input) for **Input Field Name** used with **Data Type** (Data Type Value) not found

Imbedded blank(s) in (Input) for **Input Field Name** and **Identifier Name** (Identifier) of Data Section **Data Section Header (XXX)**

Imbedded sign(s) (+ or -) in (Input) for **Input Field Name** and **Identifier Name** (Identifier) of Data Section **Data Section Header (XXX)**

**Input Field Name** Elevation (X.XXX) must be within **structure or cross section** elevation range (X.XXX - X.XXX) for **Structure or Cross section** Identifier (Identifier Value)

**Input Field Name** (Input) must not decrease for **Identifier Name** (Identifier) of Data Section **Data Section Header (XXX)**

**Input Field Name** (X.XXX) must be increasing for **Identifier Name** (Identifier) of Data Section **Data Section Header (XXX)**

Input for **Identifier** (Identifier Value) must include **Input Field Name(s)** or **Data Section Sub-header** data

Invalid character (Input) found in **Y/N or 0/1** input for **Input Field Name** field and **Identifier Name** (Identifier) of Data Section **Data Section Header (XXX)**

Less than two greater than zero **Data Types** for **Input Field Identifier** (Identifier Value)

Maximum number of hydrograph points (XXXXX) exceeded while channel routing, adding hydrographs, generating hydrographs, or storage routing (Identifier) Storm (Storm Identifier)

More **Data Type** than expected (XXX) encountered for **Identifier Name** (Identifier) of Data Section **Data Section Header (XXX)**

Multiple characters in (Input) found in **Y/N or 0/1** input for **Input Field Name** field and Data Section **Data Section Header (XXX)**

Multiple **Data Section Sub-header** subheaders provided for current reach and, current sub-area and, or blank **Identifier Name** (Identifier) of Data Section **Data Section Header (XXX)**
Multiple decimal points in (Input) for Input Field Name and Identifier Name (Identifier) of Data Section Data Section Header (XXX)

No Data Type data read from TR-20 input file

No decimal point in (Input) for Input Field Name and Identifier Name (Identifier) of Data Section Data Section Header (XXX)

No empty hydrograph storage location for saving Input Hyd, Sub-Area or Split Flow Storm Identifier Value

No Input Field Name data entered for Another Input Field Name (Input)

Non-numeric character(s) in (Input) for Input Field Name and Identifier Name (Identifier) of Data Section Data Section Header (XXX)

No output using global codes, sub-area codes or reach codes were selected. No output - no run.

No rainfall data entered for Storm Identifier (Identifier) and Rain gage (Identifier) combination.

Peak diverted flow (XXX.XXXXX) exceeds highest cross section flow (XXX.) for Reach (Reach Identifier) Storm Id (Storm Identifier)

PSH data read error: Error description

Rain Table Id (Rain Table Identifier) used with Storm Id (Storm Identifier) not found

Reach (Identifier) cannot have both a Reach Cross Section Identifier (Identifier) and a Reach Structure Identifier (Identifier)

Reach (Identifier) has a Structure Identifier. Split Flow is not permitted in structure reaches

Reach (Identifier) has no inflows at upstream end

Reach (Identifier) must have either a Reach Cross Section Identifier or a Reach Structure Identifier

Reference flow (XXX.XX) exceeds highest cross section flow (XXX.) for reach (Identifier) and Storm (Identifier)

Required storage exceeds highest rating storage (XXX.X) and discharge (XXX.X) combination while storage routing reach (Identifier) and Storm (Identifier)

Runoff curve numbers for Curve Number Identifier (Identifier) are decreasing from Curve Number 'A' to Curve Number 'D'
Runoff curve numbers for Curve Number Identifier (Identifier Value) not increasing from Curve Number 'A' to Curve Number 'D'

SDH-FBH data read error: Error description

Split flow discharge (XX.X) must be greater than base flow (XXX) for Stream Reach Identifier (Identifier)

Structure Flow (XX.X) must not decrease for Structure Identifier (Identifier) of Data Section STRUCTURE

RATING: (XX)

Subheader Data Section Sub-header not used as Data Type provided for Input Field Identifier (Identifier Value) and Identifier Name (Identifier) of Data Section Data Section Header (XXX)

Subheader (Input) encountered for Identifier Name (Identifier) of Data Section Data Section Header (XXX), but not required Input Field Name or Another Input Field Name has been identified

Text field (Input Field Name) contains more than X character(s) for Identifier Name (Identifier) of Data Section Data Section Header (XXX)

Too many Input Field Names encountered in Data Section Header data section

Two different Input Variable Name (X.XXX & X.XXX) entered for Another Input Variable Name (Input Value)

Unacceptable character(s) in (Input) for Input Field Name field for Identifier Name (Identifier) of Data Section Data Section Header (XXX)

Unexpected end of file encountered after Identifier Name (Identifier) of Data Section Data Section Header (XXX)

Unexpected new Data Type encountered for Identifier Name (Identifier) of Data Section Data Section Header (XXX)

Unrecognized input data (Input Record) encountered for Identifier Name (Identifier) of Data Section Data Section Header (XXX)

Unrecognized Input Field Name value (Input) encountered for Identifier Name (Identifier) of Data Section Data Section Header (XXX)

Unrecognized subheader (Input) for Identifier Name (Identifier) of Data Section Data Section Header (XXX)

Value (Input) above acceptable maximum (Minimum Input Value) for Input Field Name and Identifier Name (Identifier) of Data Section Data Section Header (XXX)
Value (Input) below acceptable minimum (Minimum Input Value) for Input Field Name and Identifier Name (Identifier) of Data Section Data Section Header (XXX)

Value (X.XXX) below minimum (0.2) for PSH Q1/Q10 Ratio for Sub-Area (Identifier) error 46

Value (X.XXX) converted from Input above acceptable maximum (Maximum Input Value) for Input Field Name and Identifier Name (Identifier) of Data Section Data Section Header (XXX)

X Record(s) not starting in column(s) XX and XX found in Data Section Header data - Entire data section skipped

TR-20 Converter Error Messages

1st WinTR-20 Input Converter input file record is not the required WinTR-20 Input Converter: Version 3.1 record --- CANNOT PROCESS FILE

Cannot find old TR-20 input data file (Input File Name)

Data Section Name (Operation Name) is not a old TR-20 header - Skip to next Data Section

Decimal point in integer field (XXX) for Input Field Name and Identifier Name (Identifier) (XXX) of Data Section Data Section Header (XXX)

Duplicate Operation Name section in TR-20 Input Converter input file

Entry (X.XXX) for Rain Table Depth/Ratio not greater than previous Rain Table Depth/Ratio (X.XXX) for rainfall number (X) of Data Section Data Section Header (XXX)

First point of Data Type must be 0.0 for Identifier Name (Identifier) of Data Section Data Section Header (XXX)

Imbedded blank(s) in (XXX.XX) for Identifier Name (Identifier) (XXX) of Data Section Data Section Header (XXX)

Imbedded sign(s) (+ or -) in (XXX) for Input Field Name and Identifier Name (Identifier) of Data Section Data Section Header (XXX)

Input Field Name (X.XXX) must be increasing for Identifier Name (Identifier) of Data Section Data Section Header (XXX)

Multiple decimal points in (XXXX) for Structure Discharge and Identifier Name (Identifier) of Data Section Data Section Header (XXX)

No decimal point in (XXXX) for Input Field Name and Identifier Name (Identifier) of Data Section Data Section Header (X)
Non-numeric character(s) in (XXX.XX) for Input Field Name and Identifier Name (Identifier) of Data Section Data Section Header (X).

To section/structure not found in following COMPUTE line, standard control pointer reset to first one.

Value (XXX.) above acceptable maximum (XXX.) for Input Field Name and Identifier Name (Identifier) of Data Section Data Section Header (X).

Value (XX.XX) above acceptable maximum (3.125) for Sub-Area drainage area for Sub_Area Identifier (Identifier)

Value (XX.XX) above acceptable maximum (64.0) for Calculated Average Watershed Slope for Sub_Area Identifier (Identifier)

Value (XX.XX) below acceptable minimum (0.1) for Calculated Average Watershed Slope for Sub_Area Identifier (Identifier)

Value (XXX.XX) below acceptable minimum (XX.XX) for Input Field Name and Identifier Name (Identifier) of Data Section Data Section Header (X).

HEC-RAS Error Messages

Area of successive profiles not increasing for River Station (Identifier) on profile number (XX)

Blank data fields for River Station (Identifier) indicate this River Station is not a channel/valley cross section. Only channel/valley cross sections may be included in the HEC-RAS output table.

Blank numeric field Input Field Name on record (Data Record Type) of HEC-RAS Data

Blank text field Input Field Name on record (Data Record Type) of HEC-RAS Data

Cannot find Rating Table input data file (Input File Name)

Discharge of successive profiles not increasing for River Station (Identifier) on profile number (XX)

Elevation of successive profiles not increasing for River Station (Identifier) on profile number (XX)

Energy Grade Slope less than 0.00001 for River Station (Identifier) on profile number (XX)

Entry (X.XXX) for Input Field Name not greater than Another Input Field Name (X.XXX) for River Station (Identifier) of Data Section HEC-RAS Data (XXX)

Less than two profiles in HEC-RAS data. Cannot generate cross section data
Number of profiles is less than 2. Rerun HEC-RAS with more than 1 profile or select more than one for the HEC-RAS output table. TR-20 XSECTN table has a minimum limit of 2.

Unexpected end of file encountered after HEC-RAS output file record (Identifier) of Data Section HEC-RAS Data (XXX)

Value (XXX.X), outside acceptable range (XXX.X – XXX.X), for", Input Field Name on record (Data Record Type) of HEC-RAS Data

NOAA Atlas 14 and NRCC Data Error Messages

Blank Input Field Name field on record (Data Record Type) of (NOAA Atlas 14 Data)

Blank Input Field Name field on record (Data Record Type) of (NRCC Atlas 14 Data)

Blank numeric field Input Field Name on record (Data Record Type) of (NOAA Atlas 14 Data)

Blank numeric field Input Field Name on record (Data Record Type) of (NRCC Atlas 14 Data)

Blank text field Input Field Name on record (Data Record Type) of (NOAA Atlas 14 Data)

Blank text field Input Field Name on record (Data Record Type) of (NRCC Atlas 14 Data)

Cannot find input data file.

Decimal point in integer field Input Field Name on record (Data Record Type) of (NOAA Atlas 14 Data)

Decimal point in integer field Input Field Name on record (Data Record Type) of (NRCC Atlas 14 Data)

Duration (Duration) precipitation (Frequency 2) must be greater than (Frequency 1)

Imbedded blank(s) in Input Field Name on record (Data Record Type) of (NOAA Atlas 14 Data)

Imbedded blank(s) in Input Field Name on record (Data Record Type) of (NRCC Atlas 14 Data)

Imbedded sign(s) (+ or -) in Input Field Name on record (Data Record Type) of (NOAA Atlas 14 Data)

Imbedded sign(s) (+ or -) in Input Field Name on record (Data Record Type) of (NRCC Atlas 14 Data)

Multiple decimal points in Input Field Name on record (Data Record Type) of (NOAA Atlas 14 Data)

Multiple decimal points in Input Field Name on record (Data Record Type) of (NRCC Atlas 14 Data)

No decimal point in Input Field Name on record (Data Record Type) of (NOAA Atlas 14 Data)
No decimal point in **Input Field Name** on record **(Data Record Type)** of **(NRCC Atlas 14 Data)**

NOAA ATLAS 14 data file has been altered. Please import a NOAA ATLAS 14 data file with the original format.

No decimal point in **Input Field Name** on record **(Data Record Type)** of **(NOAA Atlas 14 Data)**

No decimal point in **Input Field Name** on record **(Data Record Type)** of **(NRCC Atlas 14 Data)**

Non-numeric character(s) in **Input Field Name** on record **(Data Record Type)** of **(NOAA Atlas 14 Data)**

Non-numeric character(s) in **Input Field Name** on record **(Data Record Type)** of **(NRCC Atlas 14 Data)**

Multiple decimal points in **Input Field Name** on record **(Data Record Type)** of **(NOAA Atlas 14 Data)**

Multiple decimal points in **Input Field Name** on record **(Data Record Type)** of **(NRCC Atlas 14 Data)**

Return period **(Frequency)** precipitation **(Duration 2)** must be greater than **(Duration 1)**

Slope Multiplier for **(Frequency)** year storm is less than 0.4. Rainfall data too irregular to develop a rainfall distribution.

Unacceptable character(s) in **Input Field Name** field on record **(Data Record Type)** of **(NOAA Atlas 14 Data)**

Unacceptable character(s) in **Input Field Name** field on record **(Data Record Type)** of **(NRCC Atlas 14 Data)**

Value **(XX.XX)** outside acceptable range **(XX.XX – XX.XX)** for **Input Field Name** on record **(Data Record Type)** of **(NOAA Atlas 14 Data)**

Value **(XX.XX)** outside acceptable range **(XX.XX – XX.XX)** for **Input Field Name** on record **(Data Record Type)** of **(NRCC Atlas 14 Data)**
Appendix C: Warning Messages

WinTR-20 Warning Messages

100-yr 10-Day less than 6.0, 1-Day CN used for PSH.

Base flow (X.XXX) for reach Reach Identifier is less than Minimum. Hydrograph Display Flow. Hydrograph tails are truncated.

Base flow (X.XXX) for reach Reach Identifier is less than Minimum Hydrograph Value. Hydrograph tails are truncated.

Channel routing parameters Courant Number and Grid Reynolds Number are beyond accuracy limits. View reach US/DS hydrograph plots for reasonableness. Storage or unsteady routing recommended for Reach Reach Identifier and storm Storm Identifier.

Check hydrograph truncation level. Channel routing results in no outflow for reach Reach Identifier and storm Storm Identifier.

Computed Climatic Index is greater than 3.0.

Computed Climatic Index is less than 0.4.

Entered Structure Starting Elevation is higher than baseflow discharge elevation for reach Reach Identifier. Runoff volume may increase at downstream end of reach.

Gage Rainfall amounts for multiple Storm Identifiers are the same for Rain Gage Identifier (Rain Gage Identifier).

Multiple Gage Rain Table Identifiers assigned to Rain Gage Identifier (Rain Gage Identifier).

Q1-Day to Q10-Day ratio greater than 1.0, used 1.0.

Reach Channel Length/Valley Length is greater than 2 for Reach Reach Identifier.

Reach Channel Length/Valley Length is less than 0.5 for Reach Reach Identifier.

Runoff curve numbers (XX.X) for Curve Number Identifier (Identifier Value) are the same for all hydrologic soil groups.

Runoff curve numbers (XX.) for 'Land Use Identifier' are the same for all hydrologic soil groups.

Structure starting elevation raised to baseflow discharge elevation for reach Reach Identifier.
Value (X.XXX) converted from (X.XXX) is greater than the usual maximum (X.XXX) for Input Field Name on record XXX of Data Section Header

Value (X.XXX) converted from (X.XXX) is less than the usual minimum (X.XXX) for Input Field Name on record XXX of Data Section Header

Value (X.XXX) is greater than the usual maximum (X.XXX) for Input Field Name on record XXX of Data Section Header

Value (X.XXX) is less than the usual minimum (X.XXX) for Input Field Name on record XXX of Data Section Header

Value (XXX) is greater than the usual maximum (XXX) for Input Field Name on record XXX of Data Section Header

Value (XXX) is less than the usual minimum (XXX) for Input Field Name on record XXX of Data Section Header

**NOAA Atlas 14 and NRCC Data Warnings**

12-hr rainfall for storm(freq)-year exceeds XX.XX inches. Value changed to XX.XX inches to develop rainfall distribution.

12-hr rainfall for storm(freq)-year is less than XX.XX inches. Value changed to XX.XX inches to develop rainfall distribution.

2-hr rainfall for storm(freq)-year is less than XX.XX inches. Value changed to XX.XX inches to develop rainfall distribution.

2-hr rainfall for storm(freq)-year is more than XX.XX inches. Value changed to XX.XX inches to develop rainfall distribution.