United States Department of Agriculture
Natural Resources Conservation Service

EFH-2 Computer Program

Estimating Runoff Volume and Peak Discharge
Version 2.0.11

User's Manual

May 2021

Photo credit NRCSIA99447

Preface

The purpose of this User's Manual is to assist the new or occasional user develop input data and run the EFH-2 Computer Program.

EFH-2 is a single event rainfall-runoff model used to estimate runoff volume and peak discharge for small, single, subarea watersheds. EFH-2 is based on procedures defined in the Natural Resources Conservation Service (NRCS National Engineering Handbook, Part 630, *Hydrology* (NEH 630).

EFH-2 is a Windows® version of the EFM2 DOS computer program, originally developed by the Soil Conservation Service (SCS, now NRCS) in October 1990.

Problems with the EFH-2 Computer Program should be reported to the NRCS State Conservation Engineer within your state.

Acknowledgements

This User's Manual was developed by **Quan D. Quan**, Hydraulic Engineer and **Jacob Dieguez**, Hydraulic Engineer, NRCS, West National Technology Support Center (WNTSC), Water Quality and Quantity Technology Development Team (WQQT); and **Claudia C. Hoeft**, National Hydraulic Engineer, NRCS, Washington, D.C.

Many volunteer users from the U.S. Department of Agriculture, the Natural Resources Conservation Service provided extensive testing and comments. They helped make this version a much better product.

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Introduction

What is EFH-2?

EFH-2 is a computer program used to predict runoff volumes and peak discharge from small, single subarea watersheds in the design of on-farm conservation practices. EFH-2 predictions are based on design rainfall events associated with specific design rainfall intensity storm patterns, or distributions. The computational procedures used in EFH-2 are described in the NRCS National Engineering Handbook, Part 630, *Hydrology* (NEH 630).

System Requirements

EFH-2 is designed to install and operate on computers with Windows® 10 Operating Systems or later. Less than 5 MB of hard drive space is required for program installation.

The program window displays best at a screen resolution of 1076 x 768 pixels or higher. Lower resolutions or reduced screen sizes may cut off some of the label information, particularly on the Runoff Curve Number (RCN) tab.

Program Limits

EFH-2 is applicable to single subarea watersheds where:

- The watershed can accurately be represented by a single runoff curve number between 40 and 98.
- The watershed drainage area is between 1 and 2,000 acres.
- The watershed hydraulic length is between 200 and 26,000 feet.
- The average watershed slope is between 0.5 and 64 percent. Slopes from 0.1 to 0.49 percent may be used with caution but a warning message will be generated. An error message will be generated by entering slopes greater than 64 percent.
- No valley or reservoir routing is required.
- Urban land use within the watershed does not exceed 10 percent.
- The rainfall is between 0.0 and 26 inches.

Data Requirements

The following basic information about the watershed must be derived or obtained in order to use EFH-2 for hydrologic analyses:

1) ***Watershed Drainage Area.*** The watershed must be delineated to determine its size.
2) ***Land use Information.*** Land use information is required for determining the watershed runoff curve number (CN). Land uses are described in the CN tables in EFH-2.
3) ***Soils Information.*** Soils information (hydrologic soil groups (HSG) A, B, C, or D) is required for determining the watershed CN.
4) ***Topographic information.*** Topographic information for the watershed is required for estimating watershed time of concentration (T_c). Both average watershed slope and watershed length are needed to determine T_c using the lag method.

Obtaining this information requires some background knowledge of hydrology.

Basic Data Files

Two specific data files are utilized within EFH-2.

COVER.TXT

The *COVER.TXT* file consists of the runoff curve number (CN) tables found in NEH 630.09, *Hydrologic Soil-Cover Complexes* These tables list CN by HSG, cover type, and hydrologic condition for various land use types. The CN tables are used in computing a weighted CN for the watershed being evaluated.

The *COVER.TXT* file must reside in the same folder as the program executable file, *EFH-2.EXE*. If the *COVER.TXT* file is not available, EFH-2 will not initialize and will not operate.

SOILS.HG

The *SOILS.*HG file is used by the Hydrologic Soil Group (HSG) lookup tool for populating the HSG table. This file is optional meaning it can be created and edited by the user and will be accessed by the program automatically if the filename is maintained.

The *SOILS.HG* file is a three-column text file which can be created using a standard ASCII editor and separating the columns by a comma, a space, or at least one tab. If the soils data file is created using an Excel spreadsheet, use separate columns for each of the fields and save the file as a 'comma delimited text file'. The resulting text file should be checked carefully for any extra characters. The *SOILS.HG* file does not have a required format, so the user is free to enter whatever information into the three columns that he or she wishes. Note, however, that if the maximum number of characters is exceeded, some of the information may be truncated when the *SOILS.HG* file is viewed in EFH-2. A suggested format for the *SOILS.HG* file, denoted by column, is illustrated in Table 3.

Column	*Maximum Number of Characters*	*Data Description*
1	40	Soil map unit name
2	10	Textural class
3	10	Hydrologic soil group

Table 1. Suggested format for SOILS.HG file

A portion of the *SOILS.HG* file developed for Texas is shown in Table 4. This data file was developed using Excel.

Abilene	L	c
Abilene	CL	c
Acadia	SIL	d
Acme	CL	c
Acme	L	c
Acove	FL-FSL	c
Acove	FSL	c
Acuff	L	b
Acuff	CL	b
Acuff	SCL	b
Acuna	SIC	c
Adaton	SIL	d
Addicks	L	d

Table 2. Portion of a SOILS.HG data file created for the State of Texas. (Note that the Abilene, Acme, Acove, and Accuff soils in this example have multiple listings with different textures.)

A sample *SOILS.HG* file is included with the EFH-2 installation package and may be updated with state specific soils data. If a separate soils data file is created, it must be saved with the filename *SOILS.HG* and stored in the EFH-2 program folder to be useable by EFH-2**.** There is no option for designating separate *SOILS.HG* files by state. The file extension '*.HG'* must be maintained or EFH-2 will not be able to locate the file.

NRCS does not maintain a national list of soils by hydrologic soil group in any engineering directives. Any old national lists are obsolete due to revisions and updates to soil surveys and they should be discarded or used with caution. The most up-to-date information on assigned hydrologic soil groups is available through the NRCS **Field Office Technical Guide**, published soil survey databases, and/or the Web Soil Survey website (*http://websoilsurvey.nrcs.usda.gov/*).

It is at the discretion of each NRCS State Conservation Engineer whether or not a certain state list is developed, distributed, and maintained. Individual users might consider maintaining a small list for their own use. Further information on HSG classification can be found in NEH 630.07, *Hydrologic Soil Groups,* and the NRCS National Soil Survey Handbook (NSSH).

See Appendix E for more information regarding the *SOILS.HG* file.

User Responsibility

Results from any computer model can be sensitive to the quality of the input data. It is the user's responsibility to ensure that all input data, whether entered or implied through default values, is appropriate for the situation being analyzed.

User Interface

Data Entry

The user starts data entry on the **Basic data** tab with the Client field and progresses through each of the entry fields. The user moves between entry fields using either the Enter or Tab keys to move forward, or traverses backwards using Shift-Tab. Pressing the ESC key returns a field to its initial value if a mistake is made during entry. Calculated fields are automatically updated when sufficient valid data has been entered for making the calculation. Warning messages appear if invalid entries are made.

After the **Basic data** tab fields are populated, the user typically proceeds to the **Rainfall/Discharge data** tab to continue data entry and view results.

Help is available regarding data entry rules for State, County, Drainage Area, Runoff Curve Number, and Time of Concentration fields through the **Help** button or the **Menu-Help** option.

Table 3 provides details regarding the functions of various keys on the **Basic data** tab fields, **Rainfall/Discharge data** tab fields, and the **RCN** tab fields. Note that function keys may operate slightly differently in the grid cells on the **RCN** tab than on the other tabs.

Key	Function: Basic Data and Rainfall/Discharge Tab	RCN Tab
F1	Display Help	Display Help
F10	Toggles between entry fields and menu bar	Toggles between entry fields and menu bar
ESC	Returns field value to previous value	Returns field value to previous value
Delete	Deletes the character to the right of the cursor	Clears the entire field
Backspace	Deletes the character to the left of the cursor	Delete the last (right most) character in the field
Enter	Completes data entry for the field and advances to the next field	Completes data entry for the field and advances to the next field
Tab	Completes data entry for the field and advances to the next field	Completes data entry for the field and jumps to the next tab stop on the screen
Shift Tab	Completes data entry for the field and moves cursor to the previous field	Completes data entry for the field and jumps to the previous tab stop on the screen
Arrow right	Moves the cursor one character to the right	Moves to the entry cell to the right
Arrow left	Moves the cursor one character to the left	Moves to the entry cell to the left
Arrow up	Moves the cursor one character to the left	Moves up to the entry cell above
Arrow down	Moves the cursor one character to the right	Moves down to the entry cell below
Home	Moves the cursor to the start of the field	Moves up to the last entry cell in the row above
End	Moves the cursor to the end of the field	Moves down to the first entry cell in the row below
Page up	-- no action --	Scrolls up one screen of grid cells
Page down	-- no action --	Scrolls down one screen of grid cells

Table 3. Key Functions

Tool Tip Help

Pausing the mouse pointer briefly over a field will display an abbreviated pop-up help for each data entry field.

Welcome to EFH-2 Computer Program Window

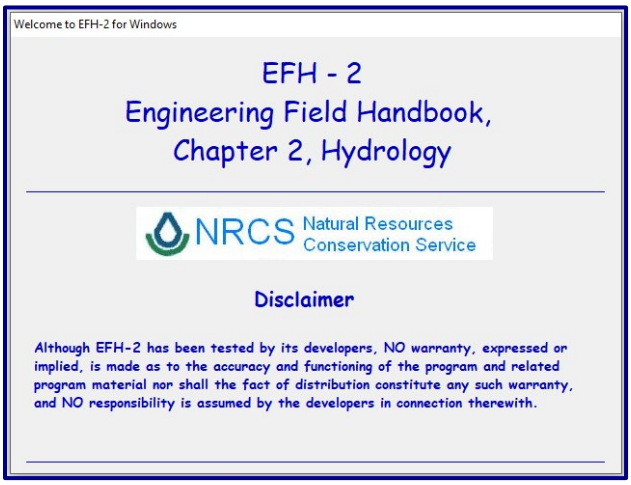

Figure 1. Welcome to EFH-2 dialog window

Upon starting the EFH-2 Computer Program, the **Welcome to EFH-2 for Windows** window (Figure 1) displays with the disclaimer:

> **Although EFH-2 has been tested by its developers, NO warranty, expressed or implied, is made as to the accuracy and functioning of the program and related program material nor shall the fact of distribution constitute any such warranty, and NO responsibility is assumed by the developers in connection therewith.**

Program Window

The EFH-2 program window consists of the Menu bar, the toolbar, and tabbed entry screens. The program initiates to the **Introduction** tab (Figure 2) which details the limits of the program.

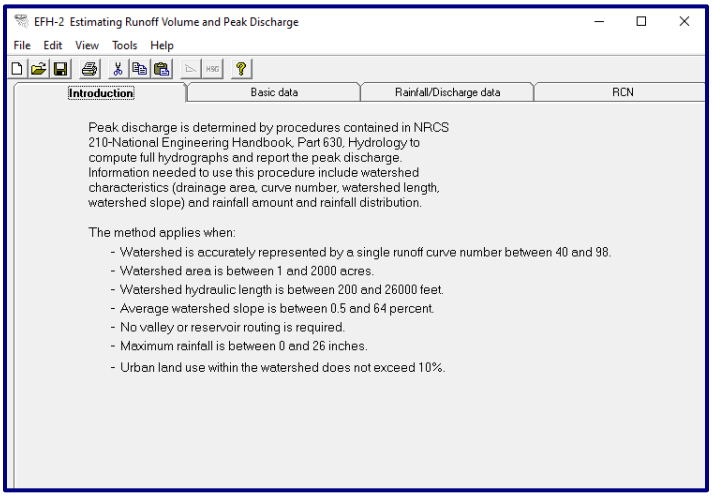

Figure 2. Introduction tab

EFH-2 Menu Bar

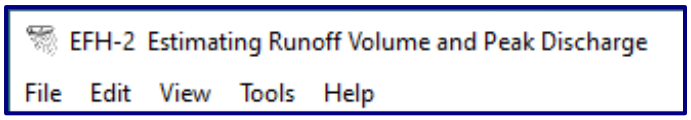

Figure 3. EFH-2 Menu Bar

The Menu bar is a standard Windows® feature that should be familiar to all computer users. Each menu bar item (Figures 4, 5, 6, 7, and 8) has a drop-down menu with features customized for the EFH-2 application. The following is a description of each of the menu bar item's associated drop-down menu features.

Menu *File*

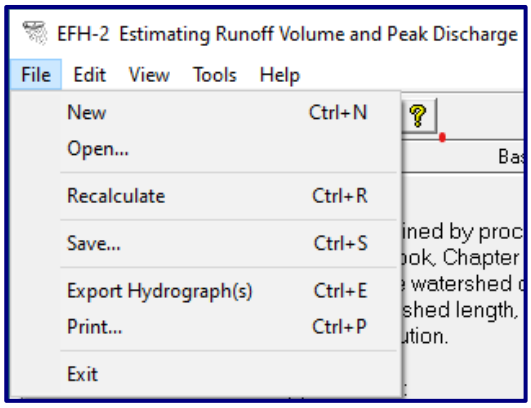

Figure 4. Menu File

Menu Item	Drop-down Choice	Key Shortcut	Explanation
File	New	*Ctrl+N*	Clears all data from the entry fields and resets the program for entering new project data.
	Open…		Opens a standard Windows® dialog window which allows the user to open an existing file.
	Recalculate	*Ctrl+R*	Forces a recalculation of the output data. While the program automatically recalculates with each change in a data field, it does not recalculate upon opening an existing file, allowing the user to observe the data in an existing file without change.
	Save…	*Ctrl+S*	Saves the current data to a file for later retrieval and editing. An *.efm* extension is added to the file name, identifying the file as EFH-2 data.
	Export Hydrograph(s)	*Ctrl+E*	Export hydrographs generated to a comma-separated values (.csv) file which can be opened in Excel for further analysis.
	Print…	*Ctrl+P*	Prints the current data to the default Windows® printer. A dialog window opens allowing the user to change the selected printer and select desired printer parameters. Page one with basic data and discharge information will always print. Page two with runoff curve number calculations will only print if runoff curve number data has been entered or exists within an existing file.
	Exit		Terminates the application.

Table 4. Menu File Descriptions

Printing to a file is possible. However, with most printer drivers, many unwanted characters will be embedded in the printed file. By choosing a generic text printer and selecting the "print to file" check box, an acceptable facsimile of the printout can be sent to a text file. An appropriate print driver is required to take advantage of this option.

Menu *Edit*

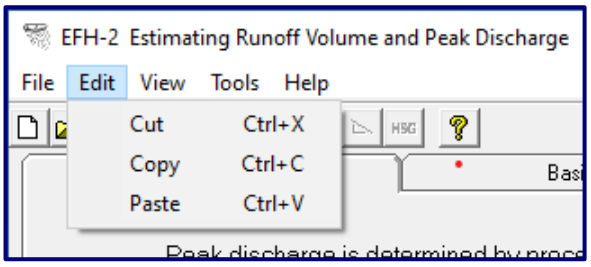

Figure 5. Menu Edit

Menu Item	Drop-down Choice		Explanation
Edit	Cut	*Ctrl+X*	Used to cut selected (highlighted) data from an entry field and move it to another field.
	Copy	*Ctrl+C*	Used to copy selected (highlighted) data from an entry field.
	Paste	*Ctrl+V*	Used to paste, or insert, copied data to the current cursor position in a field. Data highlighted during the execution of this command will be replaced with the pasted data.

Table 5. Menu Edit Descriptions

Menu *View*

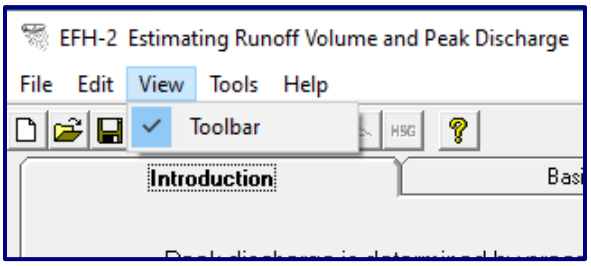

Figure 6. Menu View

Menu Item	Drop-down Choice	Explanation
View	Toolbar	Used to show, or hide, the Toolbar on the main program window.

Table 6. Menu View Description

Menu *Tools*

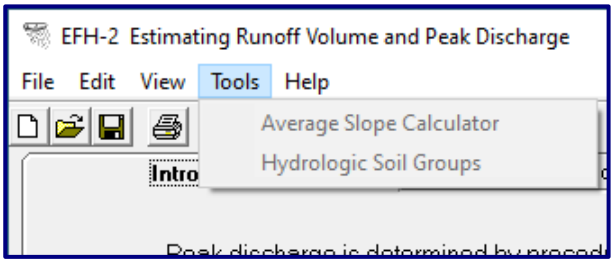

Figure 7. Menu Tools

Menu Item	Drop-down Choice	Explanation
Tools	Average Slope Calculator	Opens the **Average Slope Calculator** dialog window (See ***Time of Concentration Data and Computations*** section for information on the **Average Slope Calculator** dialog window).
	Hydrologic Soil Groups	Opens the **Search for Hydrologic Soil Group** window. (See discussion of the **Hydrologic Soil Group** window under the **RCN Tab** section.)

Table 7. Menu Tools Description

Menu *Help*

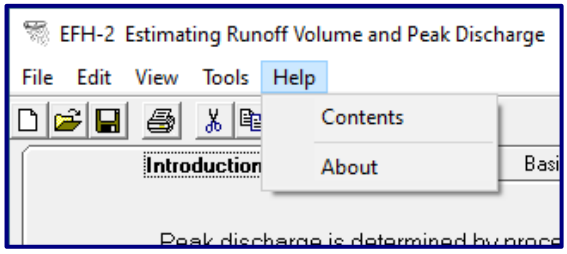

Figure 8. Menu Help

Menu Item	Drop-down Choice	Explanation
Help	Contents	Opens the program help file (Figure 9).
	About	Opens a dialog window containing general information about the EFH-2 program (Figure 10).

Table 8. Menu Help Descriptions

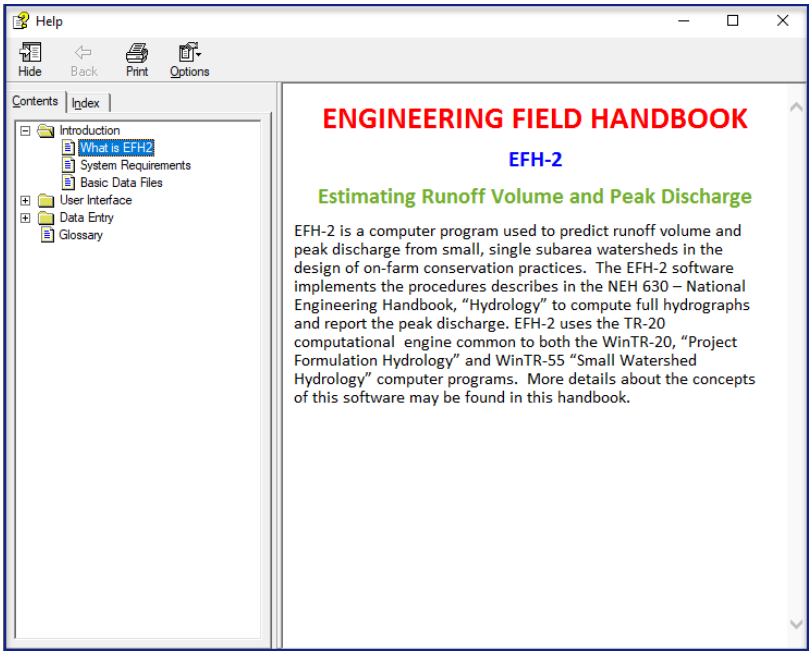

Figure 10. Help - Contents Dialog Window

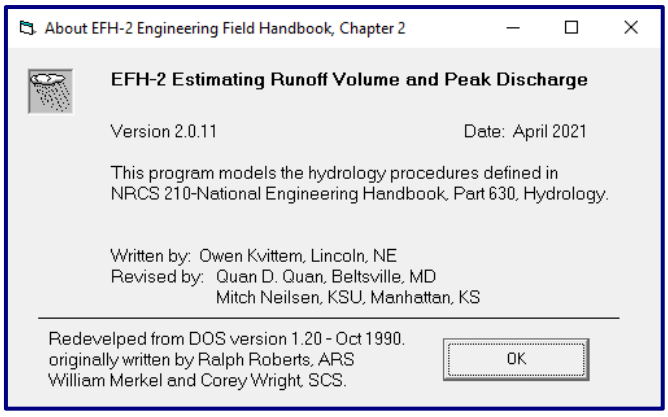

Figure 9. Help - About Dialog Window

EFH-2 Toolbar

The EFH-2 Toolbar (Figure 11) is displayed directly below the menu bar. It offers quick access to the most often used program commands.

Figure 11. Toolbar

Table 9 gives a brief description of each of the toolbar buttons which correspond to the menu bar items.

	"New" command
	"Open" file command
	"Save" file command
	"Print" to printer command
	"Cut" to clipboard command
	"Copy" to clipboard command
	"Paste" from clipboard command
	"Average Slope Calculator" command
	"Hydrologic Soil Group" command
	"Help" command

Table 9. Toolbar Button Descriptions

Basic data tab

Information about the project being evaluated is entered on the **Basic data** tab (Figure 12).

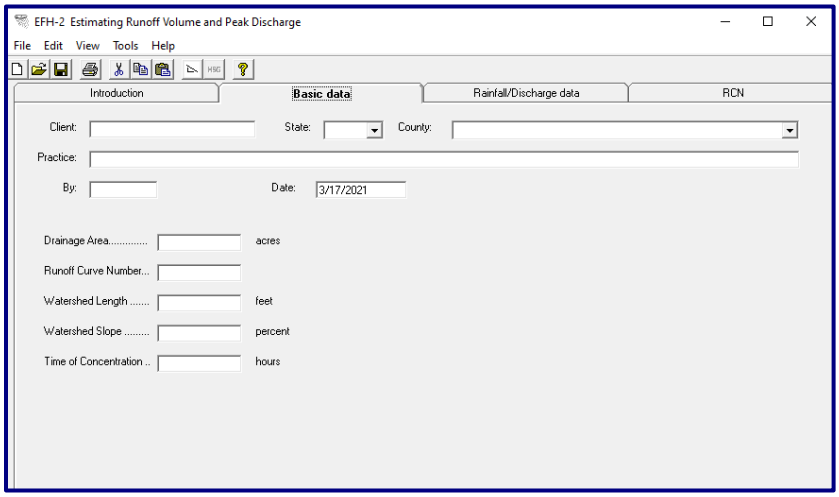

Figure 12. Basic data tab

Client and project location data, as well as Practice identification information and user (By) information, are entered directly. The remaining data are either directly entered or computed using other tabs. Specific notes will appear to indicate that the values were directly entered, computed, or carried over from elsewhere. A more detailed description follows for each of the data entry fields.

General Project Information

Client *field*
Unique project identification information to enable the user to identify the project or client for which the analysis is being performed may be entered in this field.

State *field*
The State field is used to locate the rainfall data, rainfall distribution and dimensionless unit hydrograph files for the state in which the project being evaluated is located. If no entry is made, the County field will remain blank, as will the rainfall data fields on the **Rainfall/Discharge data** tab, and the user will be required to enter the rainfall data manually. This field accepts only two-character, state postal abbreviations.

If the user attempts to leave this field without entering a code, an entry error message will appear (Figure 13).

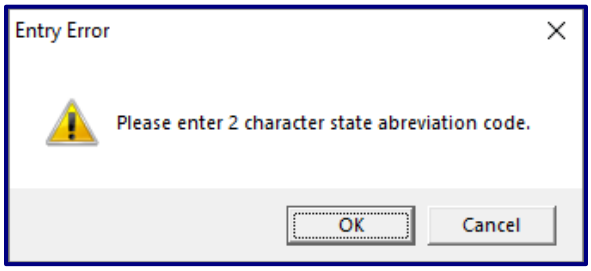

Figure 13. State field Entry Error Message

Selecting OK returns the user to the State field for correction. Selecting Cancel clears the field and moves the cursor to the next data entry field.

Users may choose to leave the State field blank and manually add custom-input data to each of the remaining fields. Note that skipping the State field will prevent any automatic storm-data population on the **Rainfall/Discharge data** tab.

County *field*
Entering/selecting the two-character postal code in the State field will activate the associated county list as a drop-down list in this field. Selecting the county name from the drop-down list will populate the **Rainfall/Discharge data** tab with associated precipitation data in each of the appropriate fields. Refer to the **Rainfall/Discharge data tab** section.

Practice *field*
The Practice field is an optional data field and may be used to enter additional project identification information.

By *field*
In the By field, the user may enter information identifying themselves.

Date *field*
For new files, the Date field is automatically populated using date information from the computer's system files. For existing (opened) files, the date on which the file was previously saved is displayed. Modifying saved files will not update the Date field. If the user wishes to update the displayed date, he or she must manually enter the appropriate date and save the file.

Watershed Data

Drainage Area *field*
The Drainage Area may be entered directly in this field or brought over from the **Average Slope Calculator** window or the **RCN** tab, if either of those features are used, with the most recent entry taking precedence. For example, if the user enters 55 acres on the **Average Slope Calculator** window, but then computes a runoff curve number using the **RCN** tab and enters data for 60 acres, the Drainage Area field on the Basic Data tab will display 60 acres. If the user calculates area with the RCN tab, it will display on the basic data screen with the message indicating that it comes from the RCN calculator. If the user then uses the slope calculator and changes the area, the changed area will appear on the basic data screen though the message attributing the area to the RCN screen will remain.

There are a number of notes that might display depending upon how the Drainage Area data was entered.

- If the user enters the Drainage Area on the **Average Slope Calculator** window, the value is carried from that window to the **Basic data** tab, and no note appears to indicate the source of the data.
- If the user enters Drainage Area directly on the **Basic data** tab, the note 'user entered' is displayed.
- If the user utilizes the **RCN** tab with the Acres option selected, the Accumulated Drainage Area (rounded to the nearest acre) is carried over to the Drainage Area field on the **Basic data** tab upon clicking the Accept button. The note 'from RCN Calculator' is displayed.
- If the user utilizes the **RCN** tab with the Percentage option selected, no Drainage Area entry is carried over to the Drainage Area field and the user must enter it manually on the **Basic Data** tab or in the **Average Slope Calculator** window.

Curve Number *field*
If the user enters a runoff curve number directly in this field, the 'user entered' note appears. Another option is to compute the curve number using the **RCN** tab. The Weighted Curve Number value is carried over to the Runoff Curve Number field on the **Basic data** tab upon completion of data entry on the **RCN** tab and clicking the Accept button. The note 'from RCN Calculator' appears.

Time of concentration data and computations

If time of concentration (T_c) is known, the user may skip the Watershed length and Watershed slope fields and enter the T_c directly in the Time of Concentration field; the note 'user entered' will display. If T_c is not known, the user must enter Watershed length and Watershed slope to compute T_c. In this case, the note 'calculated' will appear.

Watershed length *field*
Watershed length, or flow length, is defined as the path length along which water flows from the watershed divide to the outlet. For hydrologic evaluation purposes, this path is identified as the length from the hydraulically most distant point along the watershed divide to the watershed outlet. In other words, it is the path along which runoff will take the longest time to reach the outlet. If the user is computing T_c within EFH-2, the Watershed length must be entered directly. Flow length can be measured using aerial photographs, quadrangle sheets, or Geographic Information System (GIS) techniques.

Kent (1973) developed a relationship between flow length and drainage area characteristics useful for estimating watershed flow length:

$$l = 209A^{0.6}$$

where:
l = flow length, feet
A = drainage area, acres

Watershed Slope *field*
The watershed slope, or average watershed land slope, is used in the Lag Equation to estimate the watershed T_c. (See NEH 630.15, *Time of Concentration* for more information on the Lag Method.)

Watershed slope is not to be confused with the slope of the flow path. The average land slope for small watersheds can be determined several different ways:

- using GIS techniques;
- by assuming land slope is equal to the soil map unit slope as published in the soil survey;
- by using a clinometer to measure landform slope in the field;
- by drawing three to four lines perpendicular to the contour lines in various locations on the watershed map to best represent average slope based on spacing of the contour lines (see Example Problem B);
- by determining the average of the land slope from grid points using a dot counter; and
- by using the following equation from Chow (1964) and illustrated in Example Problem C:

$$Y = \frac{100(CI)}{A}$$

where:
Y = average land slope, percent
C = summation of the lengths of all contour lines that pass through the watershed drainage area, feet
I = contour interval corresponding to the contour lines, feet
A = drainage area, ft^2 (1 acre = 43,560 ft^2).

If using EFH-2 to compute T_c, a Watershed Slope must be entered. However, Watershed Slope may be carried over from the **Average Slope Calculator** dialogue window (Figure 14). This window is available only when the **Basic Data** tab is activated.

The following data inputs are required: (1) the sum of the lengths of all the contours within the drainage area boundary, (2) the associated contour interval, and (3) the watershed drainage area. Using this data, the average watershed slope is computed using the Chow equation.

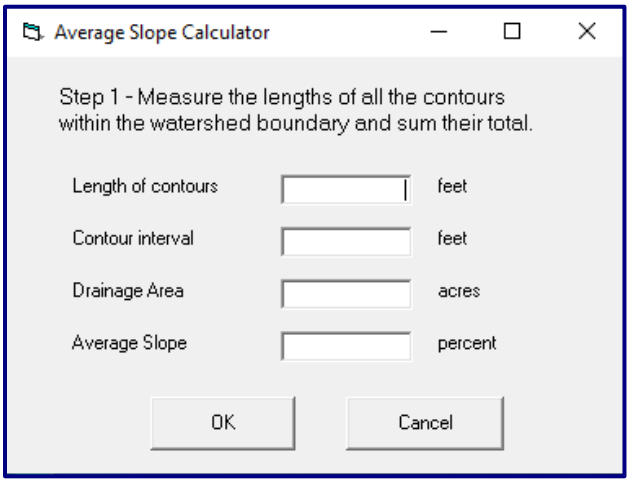

Figure 14. Average Slope Calculator Dialog Window

Upon exiting the **Average Slope Calculator** window, the values for average slope and drainage area are transferred to the **Basic data** tab entry fields. Because EFH-2 is limited to a maximum drainage area of 2,000 acres, the time of concentration computation results will not display if an area greater than 2,000 acres is entered. If the user entry in the **Average Slope Calculator** window exceeds 2,000 acres and he/she does not revise the drainage area before exiting, the following warning message (Figure 15) will appear indicating that the drainage area entered is greater than 2,000 acres, and the area value and slope will not be transferred to the **Basic data** tab.

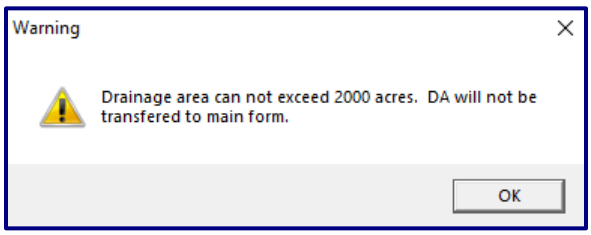

Figure 15. Average Slope Calculator Warning Message for drainage area entry greater than 2,000 acres

Time of Concentration *field*
The user may directly enter a time of concentration value or calculate it within EFH-2. If the user determines T_c outside of the program and manually enters it, the note 'user entered' will display next to the field. If the user is using EFH-2 to calculate T_c, the value will be computed using the Lag Equation and displayed with the note 'calculated' as soon as valid data is entered into the Runoff Curve Number, Watershed Length, and Watershed Slope fields. Subsequent changes to the Runoff Curve Number, Watershed Length, or Watershed Slope fields will automatically replace the user entered data with the new calculated value.

The Lag Equation is used to compute T_c within EFH-2:

$$T_c = \frac{l^{0.8}(S+1)^{0.7}}{1{,}140 Y^{0.5}}$$

where:

T_c = time of concentration, hours
l = flow length, feet
Y = average watershed land slope, percent
S = maximum potential retention, inches
$= \frac{1{,}000}{CN} - 10$
CN = runoff curve number

More information on the derivation of the Lag Equation can be found in NEH 630.15, *Time of Concentration*.

Rainfall/Discharge data tab

EFH-2 automatically populates the storm data (Storm #/Frequency, 24-HR Rain, Rainfall Distribution, Dimensionless Unit Hydrograph) fields on the **Rainfall/Discharge data** tab (Figure 16) as soon as a state and county are identified on the **Basic data** tab. The Dimensionless Unit Hydrograph will default to <standard> (Peak Rate Factor (PRF) 484) though the user may select a different PRF (Delmarva, 100-600) if appropriate. See NEH 630.16, *Hydrographs*.

Peak flow, Runoff volume and select Hydrographs are computed values displayed only when sufficient data has been entered into: the **Basic data** tab, the Storm #/Frequency, Rainfall Distribution and Dimensionless Unit Hydrograph fields on this tab, and/or the **RCN** tab. Peak discharge, runoff volume and full hydrograph(s) development and computation procedures are described in NEH 630.16, *Hydrology*.

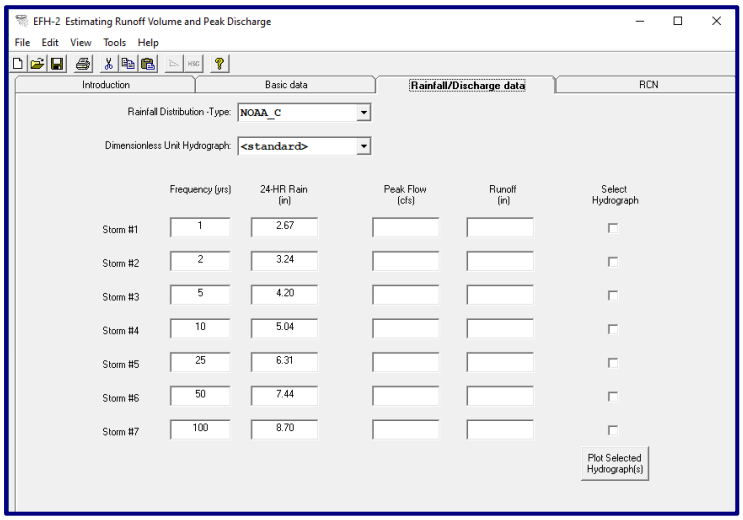

Figure 16. Rainfall/Discharge data Tab

Rainfall Distribution - Type *field*

The Rainfall Distribution - Type will vary based on the state and county in which the project is located. A majority of the continental United States will fall under NOAA A, B, C or D distributions – though there are certain exceptions (WA, OR, ID, WY, MT) as shown in Figure 17. Note that EFH-2 will automatically populate the default distribution corresponding to the selected county. In some cases, based upon state-specific evaluations, states may use a different distribution and may manually select from the drop-down list.

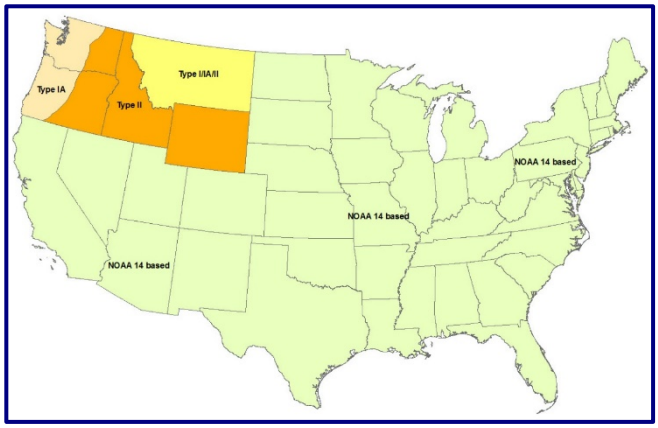

Figure 17. Approximate geographic boundaries for NRCS, NOAA rainfall distributions

Dimensionless Unit Hydrograph *field*
The user can transform the standard SCS dimensionless unit hydrograph (DUH) into a discharge versus time hydrograph (UH) for any watershed, given drainage area, time of concentration, and peak rate factor. The standard dimensionless unit hydrograph (Peak Rate Factor = 484 <standard>) is default and has been used as an NRCS standard for many years. Users may find that a different DUH is more appropriate to the watershed of concern based on factors such as size, geomorphic characteristics, watershed slope, length, available storage, degree of channelization within the stream network, and degree of urbanization. Several additional dimensionless unit hydrographs have been developed for peak rate factors (PRF) ranging from 100 to 600. See NEH 630.16, *Hydrographs* for further details.

For watersheds located in the Delaware-Maryland-Virginia, or Delmarva, peninsula, a rainfall distribution has been developed and is identified as delmarva. The Delmarva DUH is a combination of the NRCS Type II rainfall distribution and a dimensionless unit hydrograph developed specifically for the Delmarva peninsula which yields better predictions of peak discharges for that part of the country than does use of the NRCS distribution with the standard (484) unit hydrograph.

Storm Data

Rainfall volume by frequency (the Frequency and 24-HR Rain fields on the **Rainfall/Discharge data** tab) may be included for evaluation of up to seven (7) storms on the project watershed.

Frequency *fields*
The storm frequency by return period associated with the rainfall volume entered in the 24-HR Rain column is shown here in the Frequency column. The user may manually replace information in these cells if needed.

24-HR Rain *fields*
The 24-hour rainfall volume for the appropriate return interval indicated in the Frequency column is listed here. The 24-HR Rain column is populated automatically but may be manually updated by the user. Data sources may vary depending upon when rainfall data for a particular location were last updated in the Rainfall Data source. The user is encouraged to verify that the rainfall volume data are correct and appropriate for the watershed being evaluated using standard rainfall data sources.

Discharge data

The discharge data, Peak Flow, Runoff, and Hydrograph Plots are computed when sufficient information has been entered to identify the watershed drainage area, runoff curve number, time of concentration, and rainfall volumes for the storm or storm being evaluated.

Peak Flow *fields*
Peak Flow is the maximum discharge expected to occur per storm frequency and is estimated using the procedures described in 210-NEH-630, *Hydrology* to compute full hydrographs and report the peak discharge. EFH-2 utilizes the TR-20 computational engine common to both WinTR-20, "Project Formulation Hydrology" and WinTR-55, "Small Watershed Hydrology" computer programs.

Runoff *fields*
Runoff volume for the watershed is determined using the SCS/NRCS runoff equation, defined in NEH 630.10, *Estimation of Direct Runoff from Storm Rainfall*.

Select Hydrograph *checkbox button*
Users can choose to plot selected output hydrographs by clicking the checkbox(es) under the Select Hygrograph column. Click the Plot Selected Hydrograph(s) button to display the selected hydrographs in the Input/Output Plots window (Figure 18).

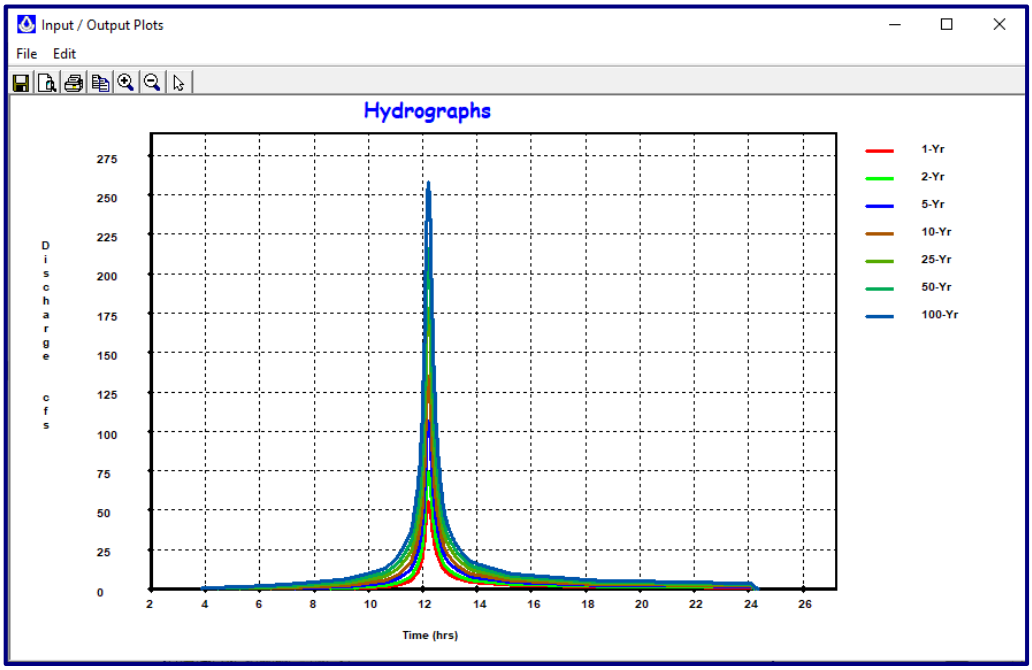

Figure 18. Hydrograph Input/Output Plots window

From the Input/Output Plots screen, users can save, open, print, copy to clipboard, zoom in, zoom out, or identify the coordinates of the nearest point on the hydrographs using the toolbar or menu options.

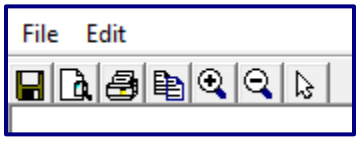

Figure 20. Hydrograph Input/Output Plot Toolbar

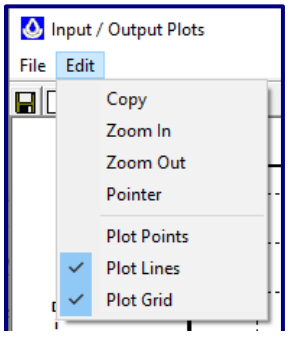

Figure 19. Hydrograph Input/Output Plots - Edit tab

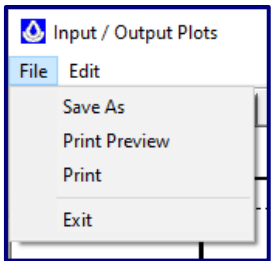

Figure 22. Hydrograph Input/Output Plots - File tab

To zoom in, users click on the zoom-in "magnifier" (+) icon and either click on a location to zoom in by a set 50% or click and hold the left-mouse button to drag a bounding rectangle and specify a zoom range (Figure 22). Users can return to the original extent, by clicking on the zoom-out "magnifier" (-) icon.

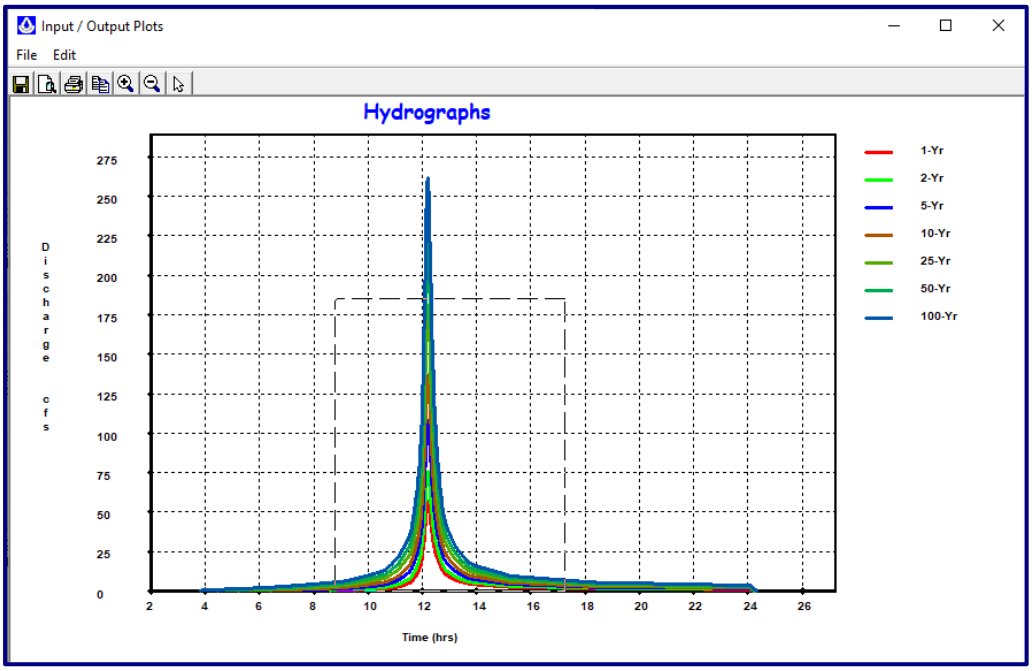

Figure 21. Hydrograph Plot - Zoom Range Definition

Users can also export the hydrograph data as a comma-separated values (.csv) file which can be opened in Excel for further analysis. As shown in Figure 4, return to the Menu bar and click *File* | *Export Hydrograph(s)* to open a file browsing window. Navigate to an appropriate file location and save the file.

RCN tab

Using the **RCN** tab (Figure 23), the user calculates the runoff curve number for the watershed by entering the appropriate area or percentage of area by land use description and hydrologic soil group. Some fields on this screen respond slightly differently to keystrokes than they do in previous screens. See the Data Entry: General Data Entry help screen for function details of keys.

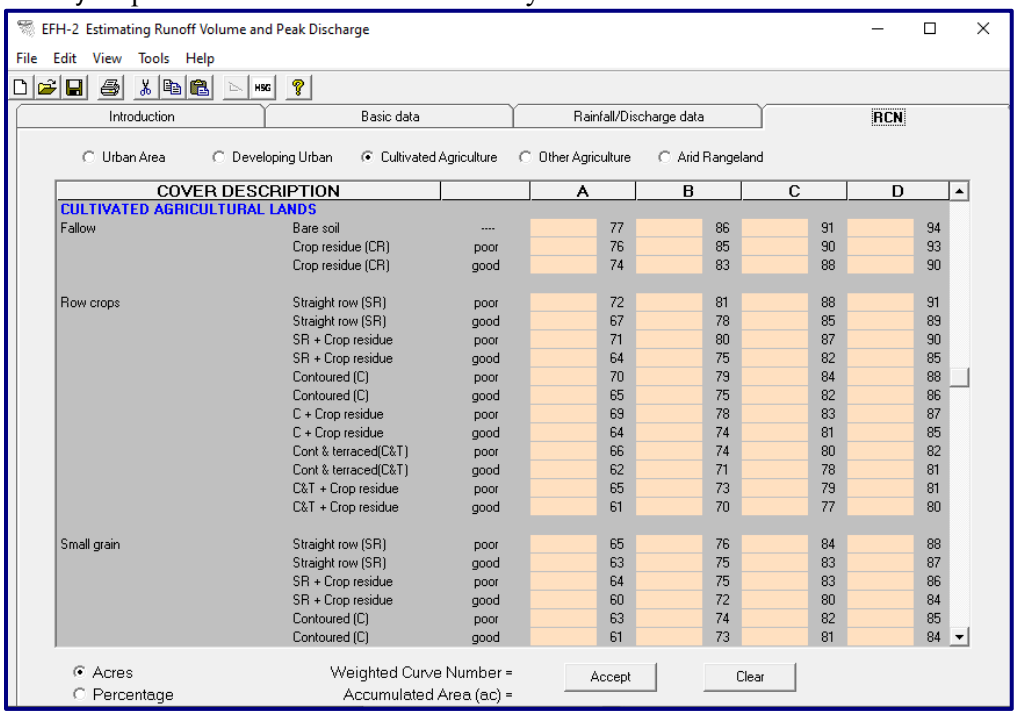

Figure 23. RCN Tab

Radio Buttons

Radio buttons at the top of the entry screen allow the user to jump directly to the beginning of each Cover Description list under each specific Land Use type. Cover descriptions are given for the following Land Use types:

- Urban Area;
- Developing Urban;
- Cultivated Agriculture;
- Other Agriculture; and
- Arid Rangeland.

The vertical scroll bar along the right side of the Cover Description window allows the user to manually scroll through the table entries.

COVER DESCRIPTION is a combination of a land use, treatment class, and hydrologic condition. For example, under the 'CULTIVATED AGRICULTURAL LANDS', 'Small grain' cover description, there are several treatment classes listed:

- Straight Row (SR)
- SR + Crop Residue (CR)
- Contoured (C)
- C + Crop Residue
- Cont & terraced (C&T)
- C&T + Crop residue

Each contains a poor and good hydrologic condition for each of the treatment classes.

The vertical scroll bar or land use category radio buttons are used to find and view specific cover descriptions. Drag the scroll bar up or down to change the displayed portion of the COVER DESCRIPTION list. Resizing the window to a larger window displays more lines of land cover.

Scrolling from top to bottom may be time consuming since the table is long. Clicking any of the land use categories radio buttons causes the display window to jump directly to the beginning of that category's cover descriptions in the COVER DESCRIPTION list. Similarly, the complete list of descriptions for a single Land Use category may be too long to display at one time. In this case, use the vertical scroll bar to scroll down and view additional cover descriptions.

Hydrologic Soil Groups

Once the desired cover description is in view in the table, enter the area (or percentage, see ***Units of area measurement, Acres or Percentage*** section) in the appropriate hydrologic soil group column (A, B, C, or D). Multiple hydrologic soil group entries can be made for a single cover description.

If the optional *SOILS.HG* file exists, it can be viewed using the **Search for Hydrologic Soil Group dialog window** (Figure 24) to look up the hydrologic group A, B, C, or D for various soil types. Activate this file by clicking on the button labeled HGS on the toolbar. (See the discussion on ***SOILS.HG*** for more information on creating this file). If the file is not present in the EFH-2 directory, clicking the HGS button brings up the window entitled "Search for Hydrologic Soil Group", however the window will be empty.

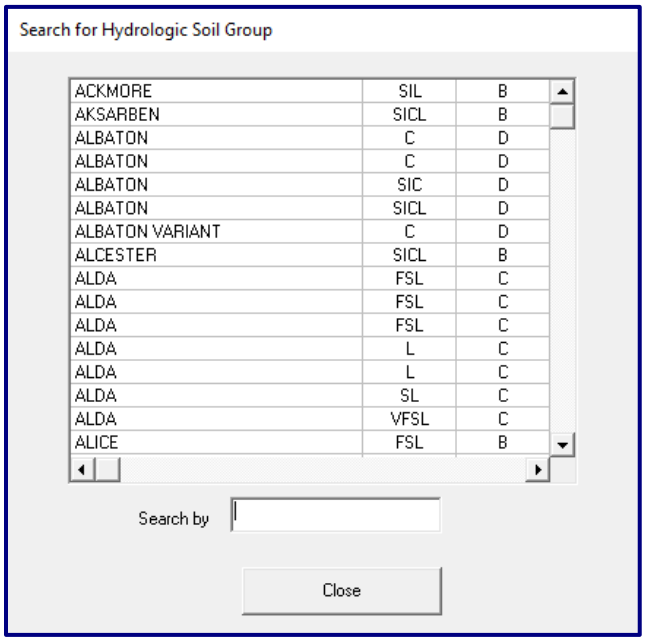

Figure 24. Hydrologic Soil Groups Window with the file populated

Runoff Curve Numbers *fields*

A soil-cover complex is a combination of a hydrologic soil group, land use, and treatment class (cover description). An index value, known as a runoff curve number (RCN or CN) is assigned to each soil-cover complex which indicates its runoff potential during periods when the soil is not frozen. RCN's are shown on the **RCN** tab in columns separated by hydrologic soil group for each cover description.

Units of area measurement, Acres or Percentage *radio buttons*

The radio buttons in the lower left portion of the screen switch between acres or percentages as a basis for data entry. The default is Acres. If the user wishes to switch to data entry in percentages, select the Percentage radio button PRIOR TO MAKING ANY DATA INPUTS on the RCN tab. The Accumulated Area display at the bottom of the screen will change from (ac) to (%).

If the user has already started entering data and then decides to change the data input from Area to Percentage, the **RCN Data Conversion** window (Figure 20) will appear asking if the data already added should be converted at all, be converted based upon the area already entered, or based upon the drainage area as input on the **Basic Data** tab.

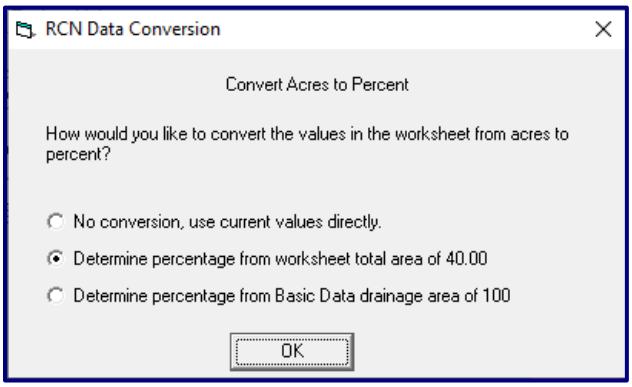

Figure 25. RCN Data Conversion window

If the user originally indicated percentages as the unit for data input and then decides to switch to acres, the Acres radio button may be selected and the **RCN Data Conversion** window (Figure 20) will appear; however the second option to determine percentages from the worksheet total area will not be available. Repeatedly going back and forth between acres and percentages is not recommended.

Weighted Curve Number
The Weighted Curve Number for the watershed is computed automatically as the user enters land use/hydrologic soil group data and displayed at the bottom center of the **RCN** tab.

Accumulated Area
The total Accumulated Area of the watershed is calculated as the user enters land use/hydrologic soil group data and displayed at the bottom center of the window below the Weighted Curve Number. This total includes all land use descriptions used to describe the watershed drainage area. As additional areas are entered or deleted, the summary values change. If both boxes are blank, no detailed land use description data has been entered for this subarea.

Accept button
Click the Accept button to retain all data entered on the window and transfer appropriate values for drainage area and runoff curve number to the **Basic data** tab.

Clear button
Clicking on the Clear button will clear all data entries of area by land use previously entered.

Intentionally Blank

References

United States Department of Agriculture, Natural Resources Conservation Service. 2009. National Engineering Handbook, Part 630, Hydrology, Chapter 7, *Hydrologic Soil Groups*. Washington, D.C. (NEH 630.07)

United States Department of Agriculture, Natural Resources Conservation Service. 2004. National Engineering Handbook, Part 630, Hydrology, Chapter 9, *Hydrologic Soil-Cover Complexes*. Washington, D.C. (NEH 630.09)

United States Department of Agriculture, Natural Resources Conservation Service. 2004. National Engineering Handbook, Part 630, Hydrology, Chapter 10, *Estimation of Direct Runoff from Storm Rainfall*. Washington, D.C. (NEH 630.10)

United States Department of Agriculture, Natural Resources Conservation Service. 2010. National Engineering Handbook, Part 630, Hydrology, Chapter 15, *Time of Concentration*. Washington, D.C. (NEH 630.15)

United States Department of Agriculture, Natural Resources Conservation Service. 2007. National Engineering Handbook, Part 630, Hydrology, Chapter 16, *Hydrographs*. Washington, D.C. (NEH 630.16)

United States Department of Agriculture, Natural Resources Conservation Service. 2021, 2nd Edition. National Engineering Handbook, Part 650, Engineering Field Handbook, Chapter 2, Estimating Runoff and Peak Discharges. Washington, D.C. (NEH 650.02)

U.S. Department of Agriculture, Natural Resources Conservation Service, 2007. National Soil Survey Handbook, Title 430-VI.

Chow, Ven Te, editor-in-chief. 1964. Handbook of Applied Hydrology: A compendium of water resource technology. McGraw-Hill. New York, NY.

United States Department of Agriculture, Soil Conservation Service, Kent, K.M., 1973. Technical Paper Number 149 (SCS-TP-149), A Method for Estimating Volume and Rate of Runoff in Small Watersheds. Washington, D.C.

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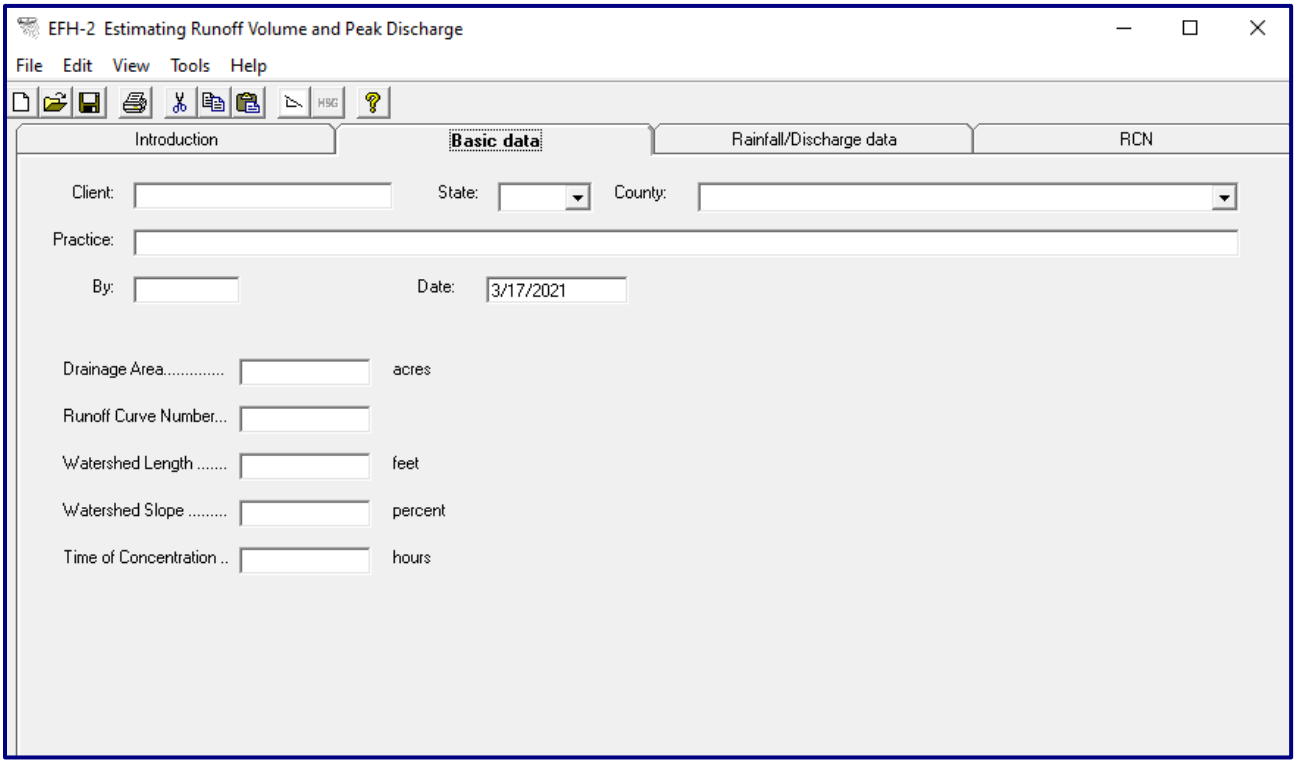
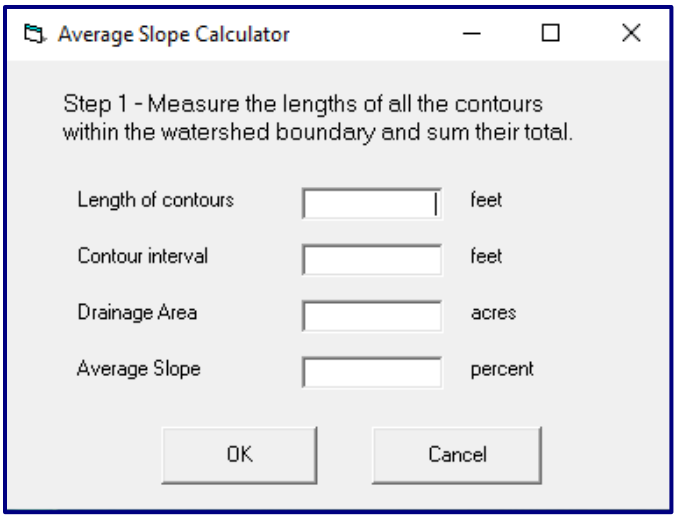
EFH-2 Reference Guide

Basic data tab



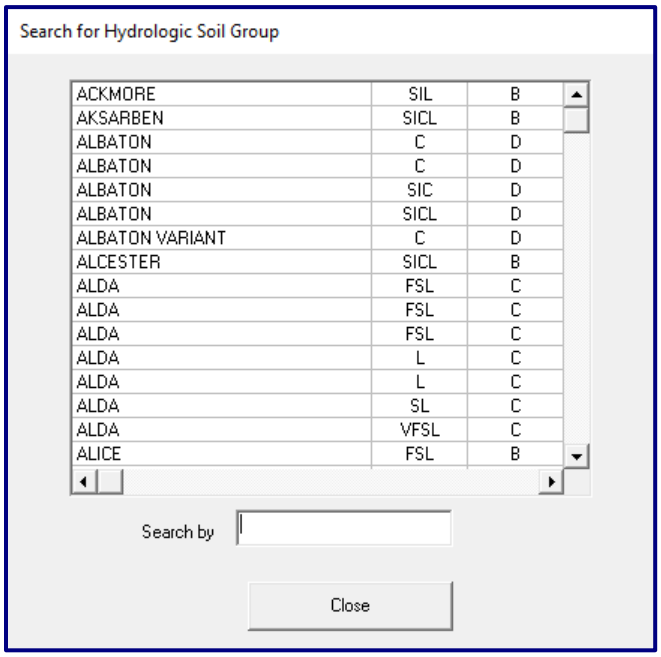
Field	*Definition*
Client	Name of the producer, participant, or landowner.
State	Two letter postal code representing the State where the project is located. Requires two letters. Enter/select from the drop-down list.
County	County where project is located. May be typed in directly, but better selected from the drop-down list after the State has been entered.
Practice	Name or description of the practice for the project.
By	Initials or name of the person making the hydrologic analysis.
Date	Automatically opens with the system (today's) date. May be entered manually.
Drainage Area	Area in acres within the watershed boundary contributing to the project site. Allowable range: 1 to 2000 acres
Runoff Curve Number	Weighted NRCS curve number representing the portion of precipitation that runs off the land. Allowable range: 40 to 98
Watershed Length	Length in feet along the flow path from the hydraulically most distant point to the project site. Allowable range: 200 to 26000 feet
Watershed Slope	Average slope in percent of the all the contributing land within the watershed boundary. Allowable range: 0.5 to 64 percent Slopes from 0.1 to 0.49 percent may be used; however, the user should be very cautious with such use. Warning messages will be generated for slopes in the 0.1 to 0.49 percent range.
Time of Concentration	Time in hours for runoff to flow from the most hydraulically remote point to the project site. Calculated by the program but may be manually calculated from the sum of the projected flow velocities of each reach along the flow path. Allowable range: 0.1 to 10 hours Calculated values outside of the allowable range are reset to the nearest limit.

Average Slope Calculator



Field	*Definition*
Length of Contours	The sum of the lengths of all the contours within the watershed
Contour interval	The difference in elevation between adjacent contours. This must be the same interval for all contour lengths measured
Drainage Area	The area in acres within the watershed boundary contributing to the project site.
Average slope	The calculated average slope in percent of all the contributing land within the watershed boundary. It is the product of the length of contours times the contour interval divided by the drainage area.

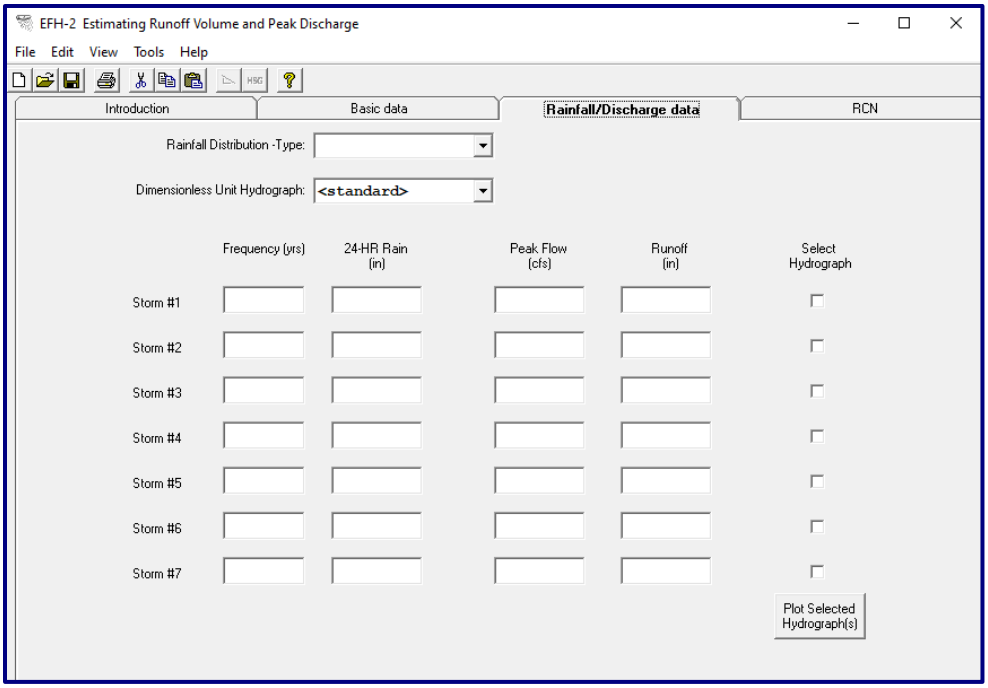
Optional Hydrologic Soils Group data file:



SOILS.HG. (Hydrologic Soil Group Window).
Format of the *SOILS.HG* file is at the discretion of the user. Three columns may be used with whatever information the user chooses to include however the columns have restrictions on the numbers of characters. A suggested format for the *SOILS.HG* file, by columns, is shown below:

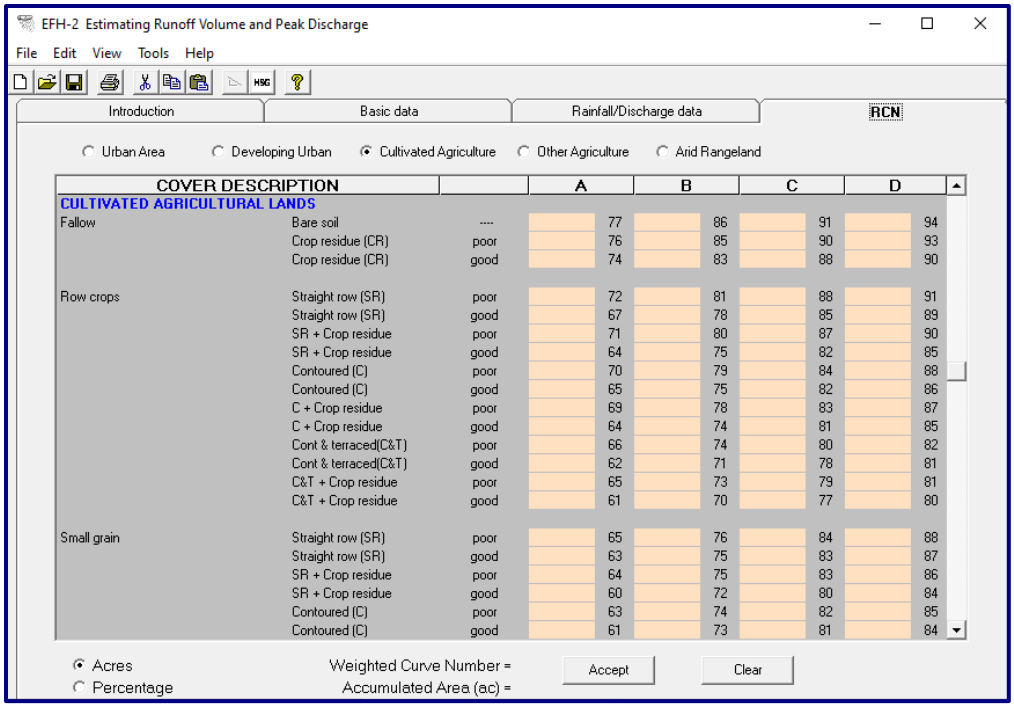
Column	*Maximum Number of Characters*	*Data Description*
1	40	Soil map unit name
2	10	Textural class
3	10	Hydrologic soil group

Rainfall / Discharge Data tab



Field	***Definition***
Rainfall Type	The type of storm rainfall distribution.
Storm #	Storm identifier. Up to seven (7) 24-hour storms of varying return intervals can be evaluated at one time.
Frequency	Recurrence interval in years for the storm.
24-HR Rain	Amount of rainfall in a 24-hour period corresponding to the recurrence interval.
Peak Flow	Maximum discharge in cubic feet per second (cfs) for the runoff resulting from the defined storm.
Runoff	The volume of excess precipitation, in inches on the watershed, not absorbed by the soil nor held on the vegetation (runoff).

RCN Tab



Key	*Function: Basic Data and Rainfall/Discharge Tab*	*RCN Tab*
F1	**Display Help**	**Display Help**
F10	**Toggles between entry fields and menu bar**	**Toggles between entry fields and menu bar**
ESC	**Returns field value to previous value**	**Returns field value to previous value**
Delete	**Deletes the character to the right of the cursor**	**Clears the entire field**
Backspace	**Deletes the character to the left of the cursor**	**Delete the last (right most) character in the field**
Enter	**Completes data entry for the field and advances to the next field**	**Completes data entry for the field and advances to the next field**
Tab	**Completes data entry for the field and advances to the next field**	**Completes data entry for the field and jumps to the next tab stop on the screen**
Shift Tab	**Completes data entry for the field and moves cursor to the previous field**	**Completes data entry for the field and jumps to the previous tab stop on the screen**
Arrow right	**Moves the cursor one character to the right**	**Moves to the entry cell to the right**
Arrow left	**Moves the cursor one character to the left**	**Moves to the entry cell to the left**
Arrow up	**Moves the cursor one character to the left**	**Moves up to the entry cell above**
Arrow down	**Moves the cursor one character to the right**	**Moves down to the entry cell below**
Home	**Moves the cursor to the start of the field**	**Moves up to the last entry cell in the row above**
End	**Moves the cursor to the end of the field**	**Moves down to the first entry cell in the row below**
Page up	**-- no action --**	**Scrolls up one screen of grid cells**
Page down	**-- no action --**	**Scrolls down one screen of grid cells**

Appendix A: Example Problem A

Problem Statement

A grassed waterway is planned in Field #2 of the A.B. Smith Farm in Hunterdon County, New Jersey.

The drainage area above the site of the proposed waterway (indicated by the black dot at the waterway outlet) is 90 acres. Figure A-1 shows the watershed boundary in blue and watershed time of concentration flow path in red.

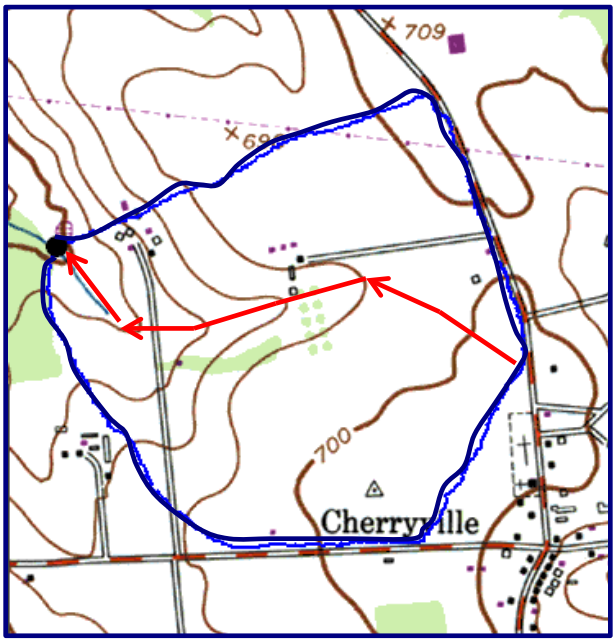


Figure A - 1. Watershed boundary map showing time of concentration flow path (Example A)

The average watershed slope determined by averaging the slopes of the mapped soils is 1 percent, and the time of concentration flow path length as measured from the United States Geological Survey (USGS) topographic map is 3,400 feet.

Soils data for this watershed was used in conjunction with land use information obtained in the field to determine the appropriate Hydrologic Soil Groups shown in Figure A-2 and summarized in Table A-1.

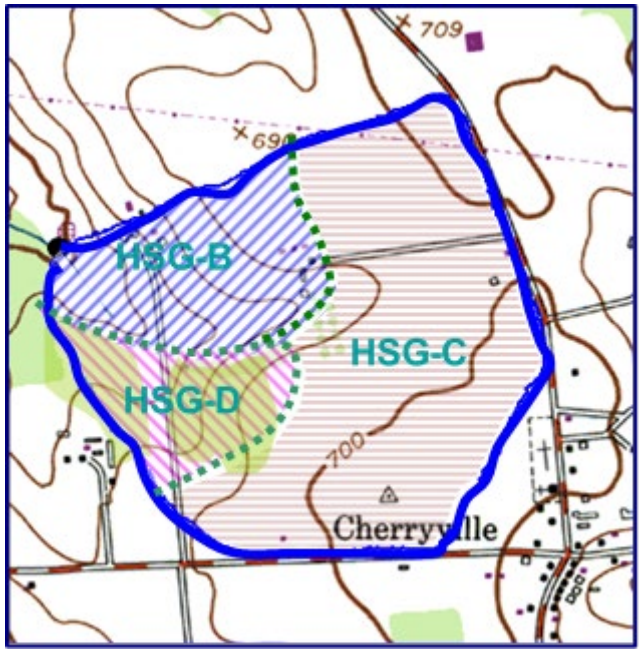


Figure A - 2. HSG boundaries within the project watershed (Example A)

Hydrologic Soil Group	Cover Description	Area acres
B	Pasture, Good Condition	25
C	Straight Row Crops, Good Condition	55
D	Woods, Poor Condition	10

Table A – 1. Drainage area soil-cover complexes (Example A)

Hunterdon county uses a Type NOAA_C rainfall distribution for hydrologic analyses.

Grassed waterway design is based on a 10-year peak discharge.

Determine the peak discharge for the 10-year storm event.

Solution

Step 1. Basic data tab

Enter the Client, State, County, Practice, and By information. The Date field will automatically populate with the current date.

Hunterdon County rainfall data is included in the rainfall database file and Hunterdon will appear in the County drop-down list.

Do not enter the Drainage Area. Instead, it will be calculated along with Runoff Curve Number on the **RCN** tab.

The **Basic data** tab should appear as shown in Figure A-3 upon completion of this portion of the data entry.

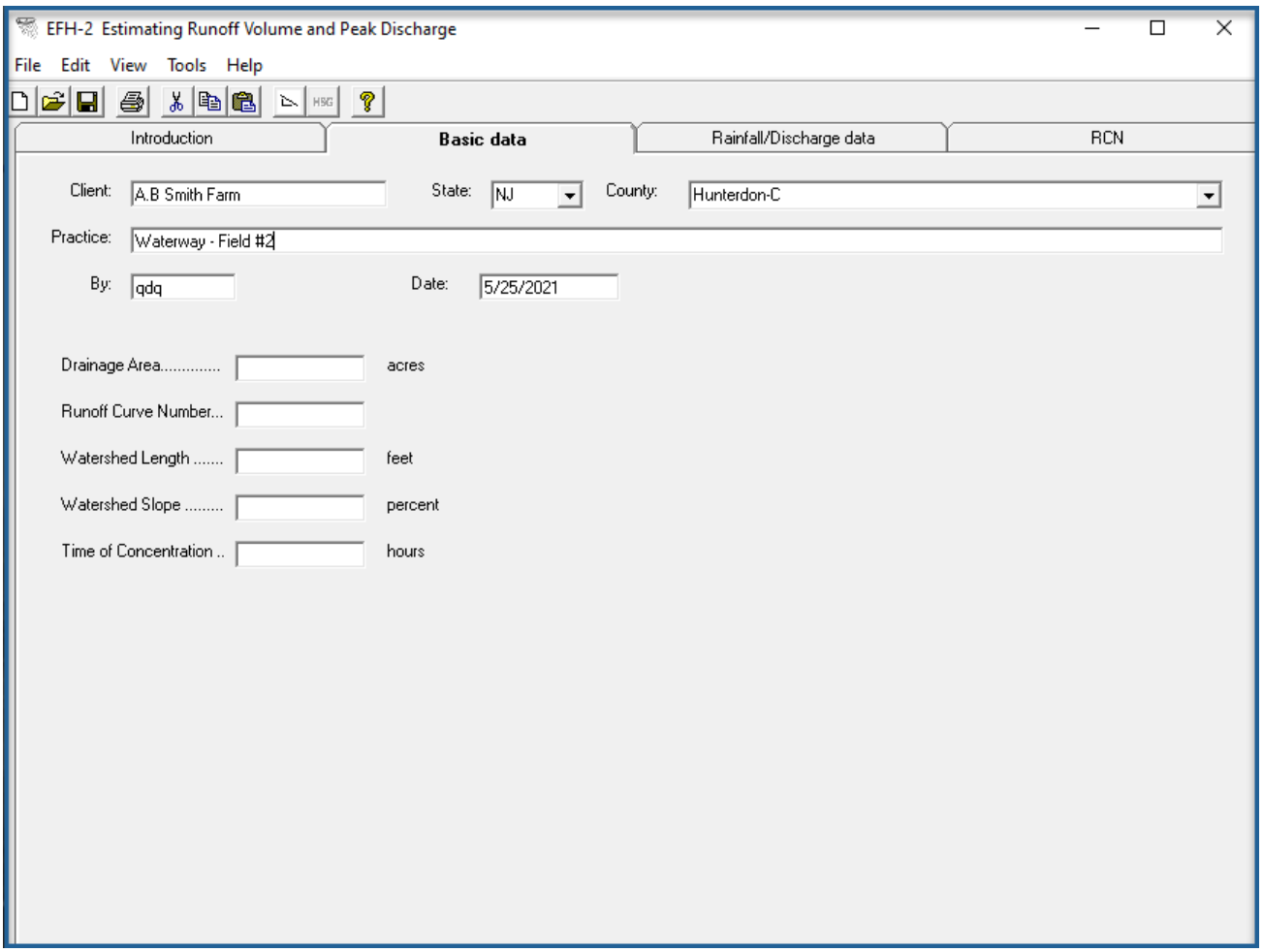


Figure A - 3. Basic Data tab (Example A)

Step 2. RCN tab

Click on the **RCN** tab and enter the appropriate soil-cover complex and area information in order to calculate the runoff curve number for the watershed. Upon completion of data entry, the **RCN** tab should appear as shown in Figure A-4.

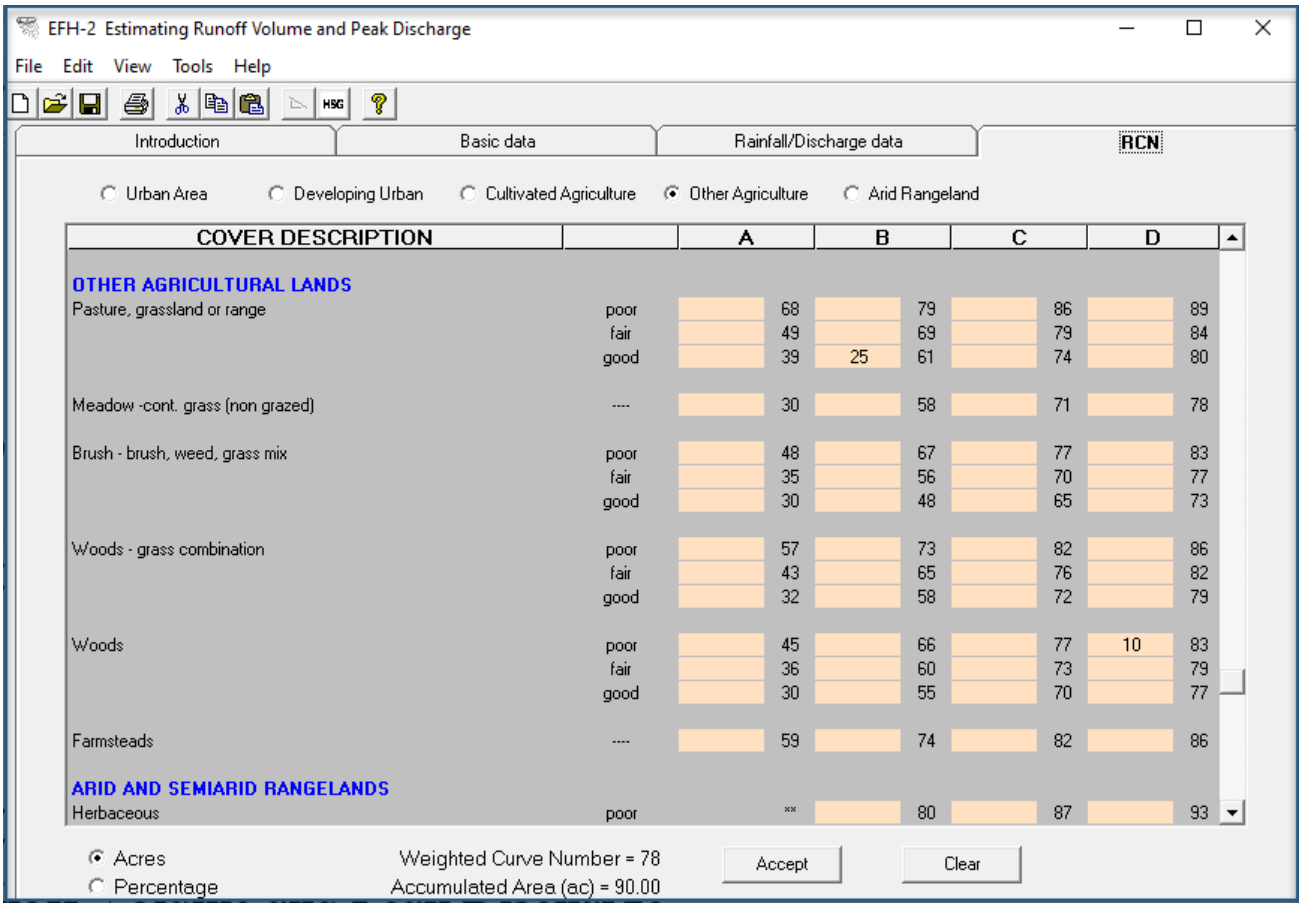


Figure A – 4. RCN tab (Example A)

When data entry is complete, click Accept to automatically return to the **Basic data** tab.

Step 3. Basic data tab

Upon returning from the **RCN** tab, note the purple text indicating Drainage Area and Runoff Curve Number were developed using the 'RCN Calculator' (Figure A-5).

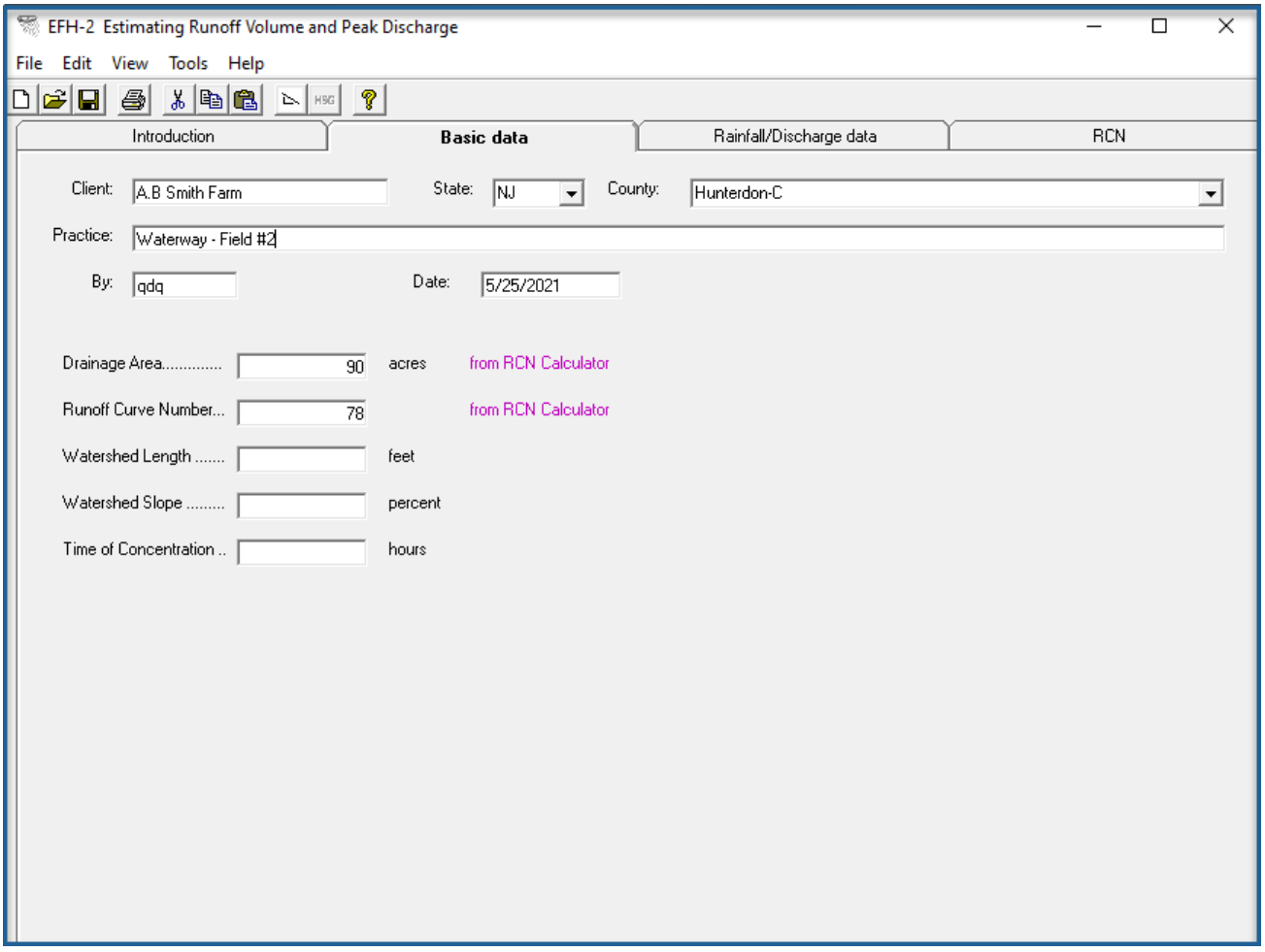


Figure A – 5. Basic Data tab showing drainage area and runoff curve number carried over from RCN tab (Example A).

Enter the Watershed Length (the length of the flow path) and the Watershed Slope. The program automatically calculates Time of Concentration utilizing the lag equation and displays the information with a note in purple text indicating that the time of concentration was 'calculated'. Alternatively, if time of concentration is already known, the user may enter it directly, upon which a note indicating that the value was user entered is displayed.

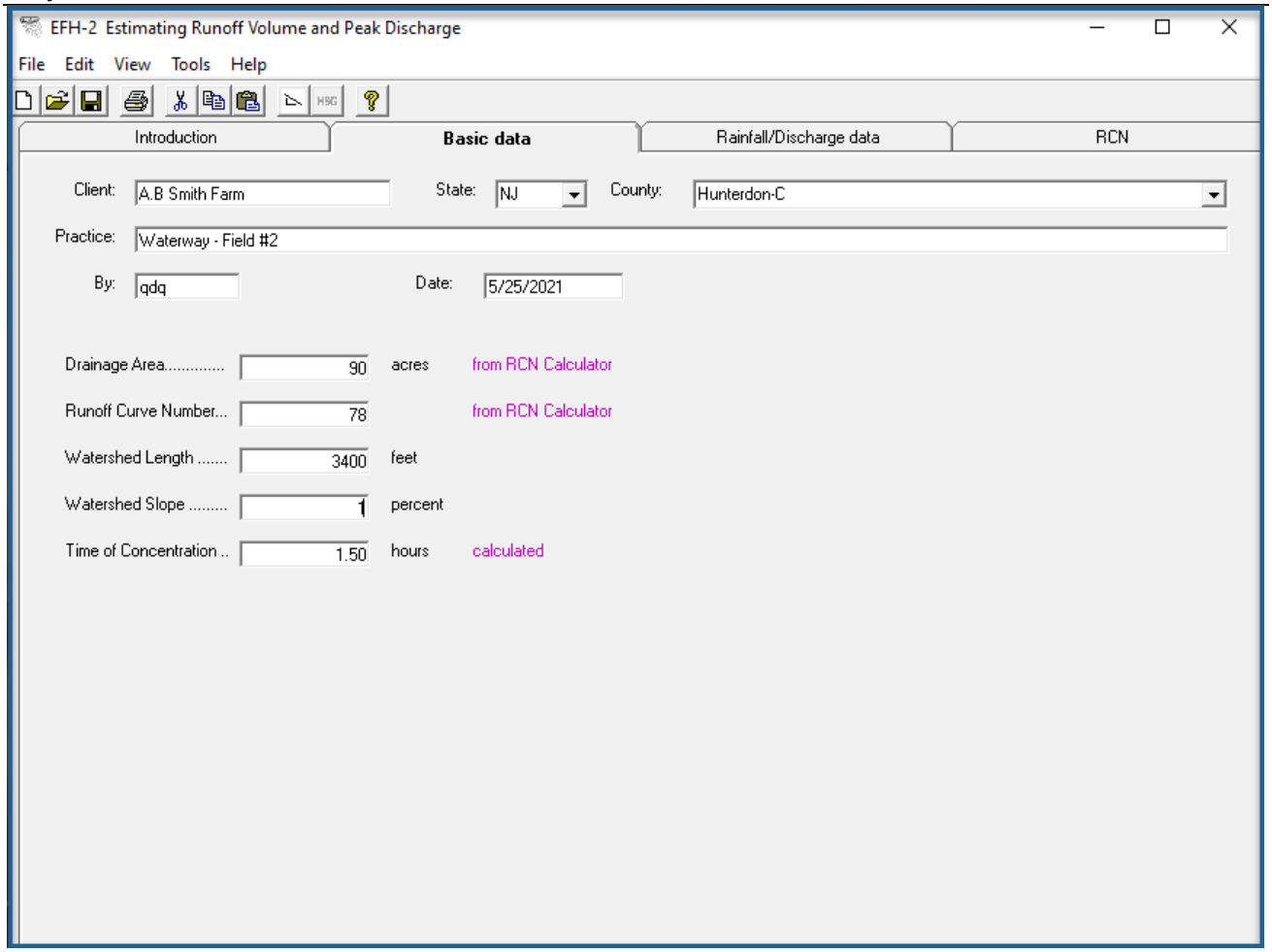


Figure A - 6. Basic Data tab showing time of concentration data calculated from user input watershed length and slope (Example A)

Step 4. Rainfall/Discharge data tab

Click on the **Rainfall/Discharge data** tab. The rainfall data, rainfall volumes (24-hour rainfall amounts by Frequency and Storm #) for seven (7) storms are displayed for the county/State combination entered on the **Basic data** tab.

Rainfall Distribution – Type: **NOAA_C** storm for New Jersey.
Dimensionless Unit Hydrograph: **<standard> default 484**

Provided that data on the **Basic data** tab is complete, the discharge data (Peak flow and Runoff volume) for each of the seven storms are calculated and displayed (Figure A-7). If the values are not displayed, return to the **Basic data** tab and ensure that data entry is complete.

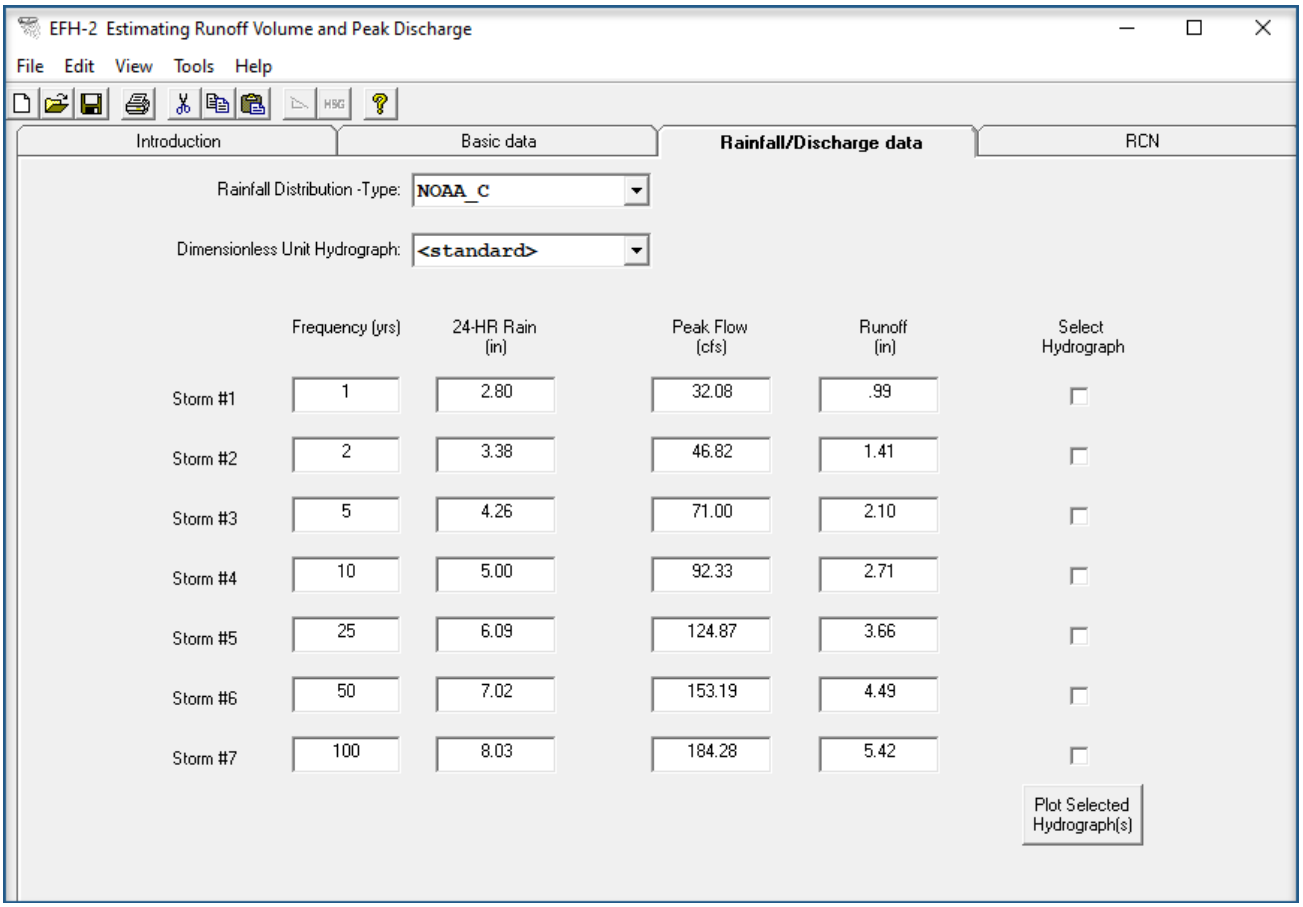


Figure A – 7. Rainfall/Discharge data tab (Example A)

Conclusion

The 10-year, 24-hour rainfall event of 5.00 inches results in a peak discharge of **92.33** cfs and a runoff volume of **2.71** inches as shown in Figure A-7 for Storm #4.

The design flow rate of **92 cfs** should be used in sizing the grassed waterway.

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Appendix B: Example Problem B

Problem Statement

A diversion is planned above a barnyard agricultural waste handling facility on the Kennedy farm in Lancaster County, Pennsylvania as shown on the Location map in Figure B-1. The diversion conservation practice standard (362) requires a minimum capacity of the 25-year peak discharge to protect against flows toward an animal waste management system.

Figure B - 1. Location map (Example B)

The watershed boundary (dashed red line), planned diversion location (heavy blue line), field boundaries (solid yellow lines), contours (dark gray lines), and soil boundaries (light gray lines) are shown on the aerial photo (Figure B-2). The soil-cover complexes are summarized in Table B-1 for each of the fields in the watershed drainage area.

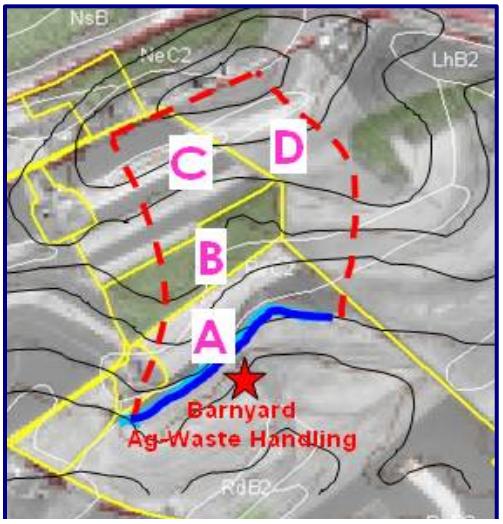

Figure B - 2. Aerial photo of project area (Example B)

Field	Cover Description	HSG	Area (ac.)
A	Close Seeded Legume, Straight Row/Good Cond.	B	2.3
A	Close Seeded Legume, Straight Row/Good Cond.	C	0.8
B	Woods, Good Condition	B	8.3
B	Woods, Good Condition	C	0.7
C	Close Seeded Legume, Straight Row/Good Cond.	B	4.0
C	Small Grain, Contoured & Terraced, Crop Residue/ Good Cond.	B	2.2
C	Small Grain, Contoured & Terraced, Crop Residue/ Good Cond.	C	2.2
C	Row Crop, Contoured & Terraced, Crop Residue/ Good Cond.	B	2.0
D	Row Crop, Contoured & Terraced, Crop Residue/ Good Cond.	B	12.1
D	Row Crop, Contoured & Terraced, Crop Residue/ Good Cond.	C	2.6

Table B – 1. Drainage area soil-cover complexes (Example B)

Figure B-3 shows the watershed boundary (red line) and the flow path (blue arrows) identified as the T_c flow measuring 3,300 ft.

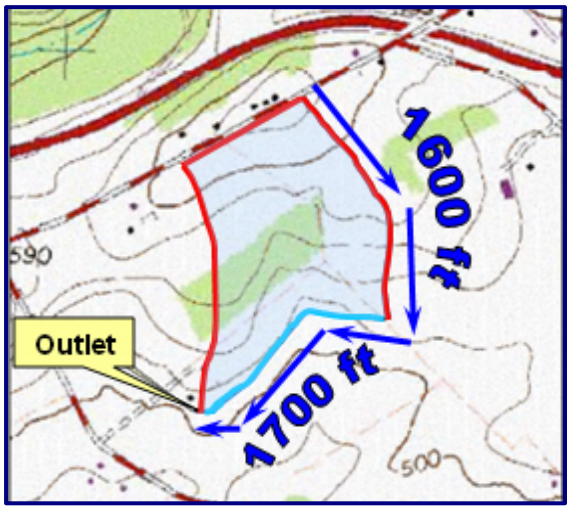

Figure B - 3. Topo map showing watershed boundary and Tc flow path (Example B)

Figure B-4 shows the watershed boundary (red line) and three lines identified for estimating the watershed average slope.

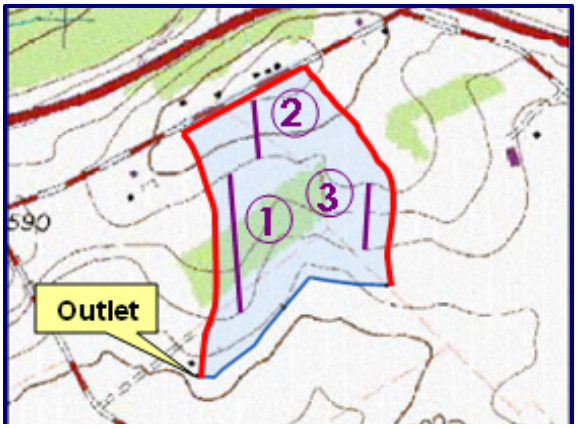

Figure B - 4. Topo map showing watershed drainage area (shaded blue) and three lines for determining average watershed slope (Example B)

The average watershed slope was calculated by determining the slopes of the individual lines (by determining the elevation drop along the line and dividing by the length of the line) and averaging the slopes of the three individual lines as shown in the following computation.

Slope of line #1: $\frac{40\text{ft}}{900\text{ft}} = 0.044\text{ft/ft}$

Slope of line #2: $\frac{40\text{ft}}{400\text{ft}} = 0.10\text{ft/ft}$

Slope of line #3: $\frac{40\text{ft}}{450\text{ft}} = 0.088\text{ft/ft}$

Average Slope: $\frac{0.044+0.10+0.088}{3} = 0.077\text{ft/ft} = 7.7\%$

Lancaster County, Pennsylvania uses the NOAA-C rainfall distribution developed by NOAA Atlas 14 data.

Solution

Step 1. **Basic data** *tab*

Enter the Client, State, Practice, and By information. The Date field will automatically populate with the current date.

Lancaster County rainfall data is included in the rainfall database file. Open the County drop-down list and start typing the city name: "Lancaster". The list will scroll down to the matching city. Press Enter to select.

Do not enter the Drainage Area. Instead, it will be calculated along with Runoff Curve Number on the **RCN** tab.

The **Basic data** tab should appear as shown in Figure B-5 upon completion of this portion of the data entry.

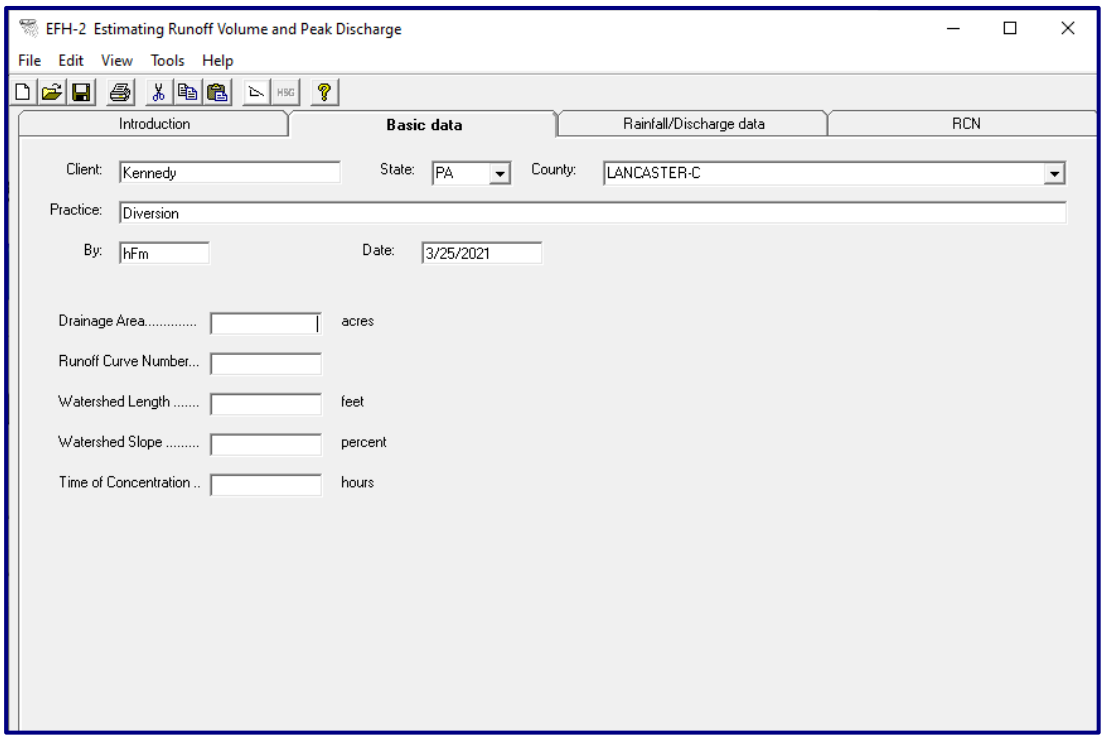

Figure B - 5. Basic Data tab (Example B)

Step 2. **RCN** *tab*

Click on the **RCN** tab and enter the appropriate soil-cover complex and area information in order to calculate the runoff curve number for the watershed. Note that farm fields A and C, and also C and D have the same land use soil-cover complexes for part of their total acreage. The acres for these similar cover descriptions will need to have their acreage combined and reported as one value in the table.

Upon completion of data entry, the **RCN** tab should appear as shown in Figure B-6. Notice that the entry of 14.1 acres for Row Crop, Contoured and Terraced, with Crop Residue in good condition includes 2 acres in field C and 12.1 acres in field C.

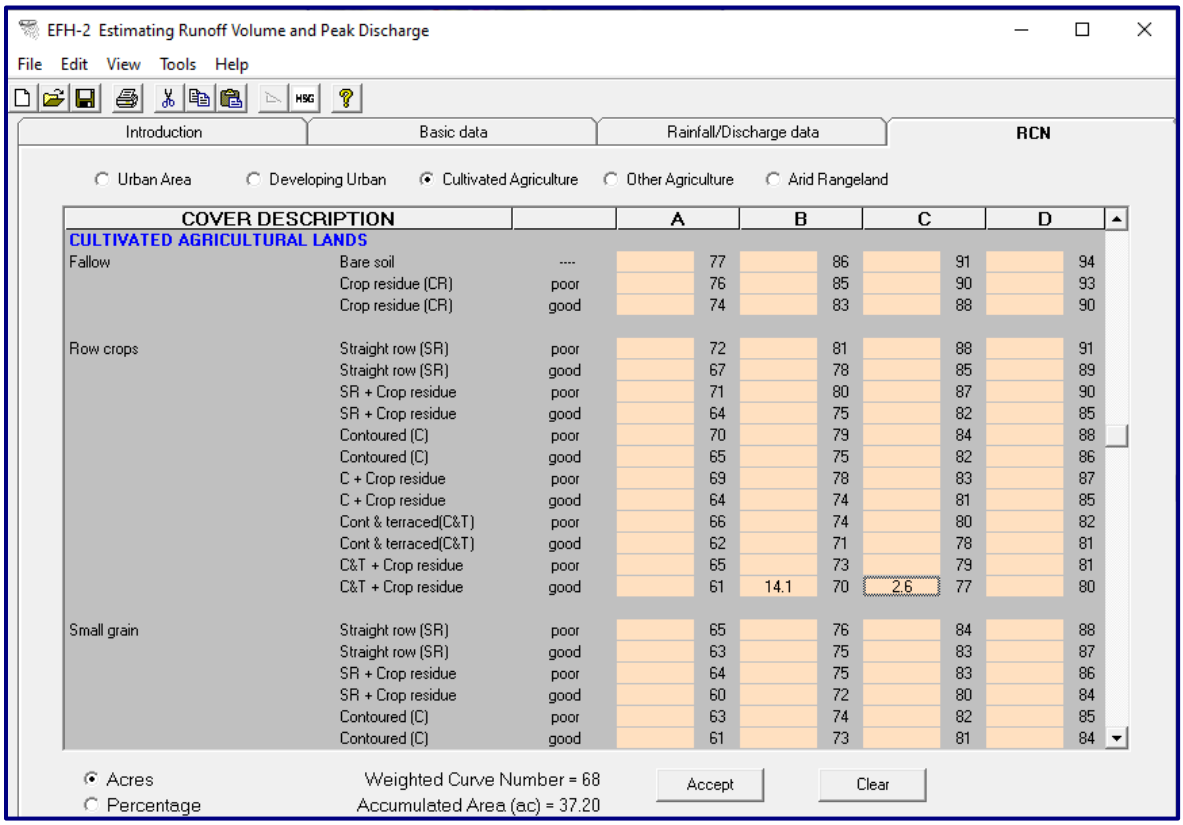

Figure B - 6. RCN tab (Example B)

As summarized at the bottom of the **RCN** tab and shown in Figure B-6, the Weighted Curve Number computed by **EFH-2** is 68; and the Accumulated Area is 37.20 acres.

When data entry is complete, click Accept to automatically return to the **Basic data** tab.

Step 3. Basic data *tab*

Upon returning from the **RCN** tab, note the purple text indicating Drainage Area and Runoff Curve Number were developed using the 'RCN Calculator' (Figure B-7).

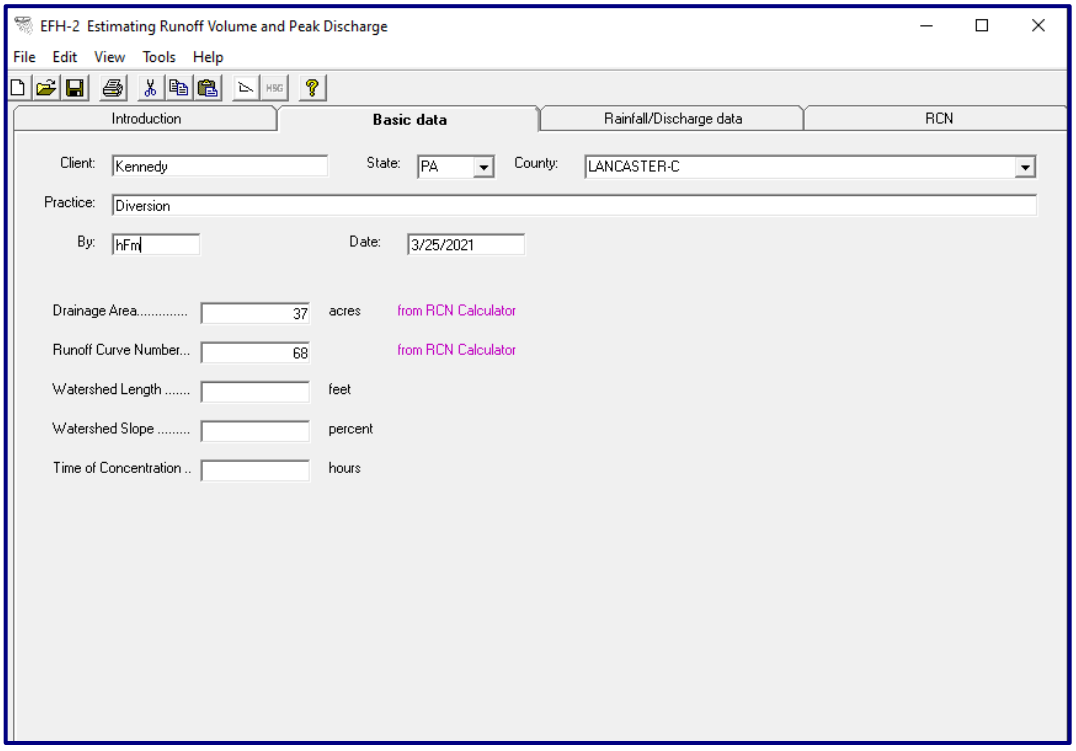

Figure B - 7. Basic Data tab showing drainage area and runoff curve number carried over from RCN tab (Example B)

Enter the Watershed Length (measured previously, as described in the problem introduction, to be 3,300 feet) and the average Watershed Slope (computed as described in the problem introduction) of 7.7 percent.

The program automatically calculates Time of Concentration, using the Lag Equation, to be 0.698 hours and displays it as 0.70 hours with a note in purple text to indicate that the Time of Concentration was 'calculated' as illustrated in Figure B-8.

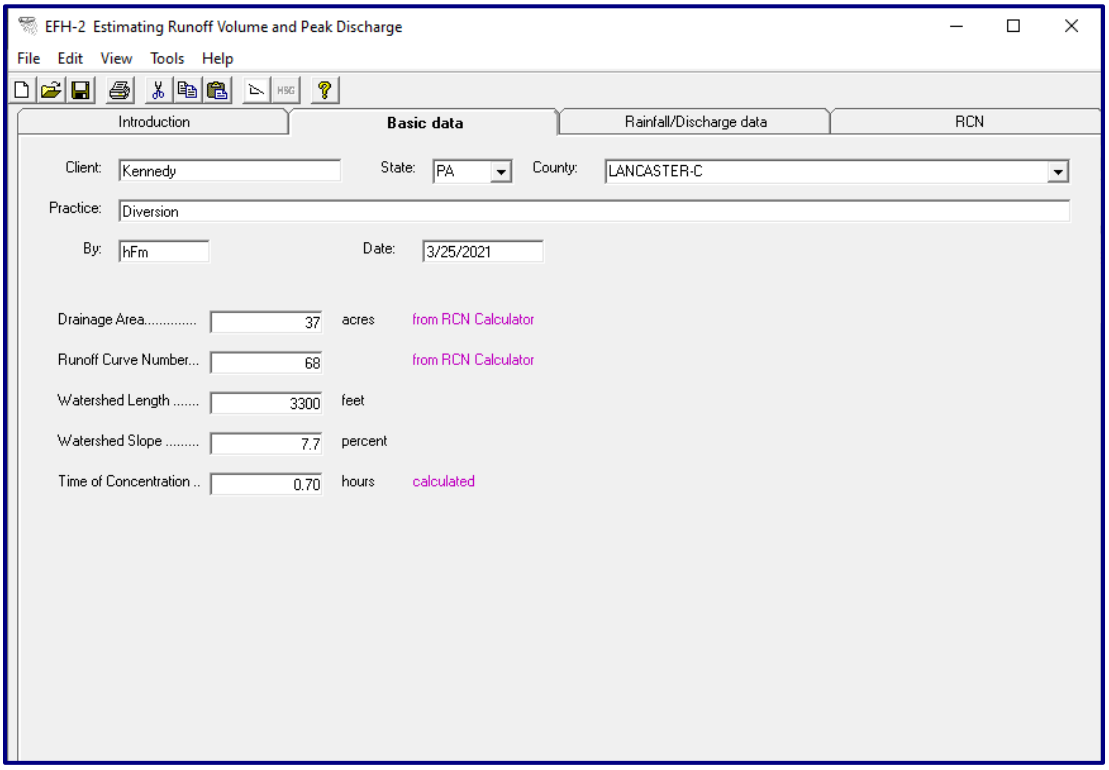

Figure B – 8. Basic Data tab showing time of concentration data calculated from user input watershed length and slope (Example B)

Step 4. Rainfall/Discharge data *tab*

Click on the **Rainfall/Discharge data** tab. Note that the Rainfall Database only contains the 1-YR through 25-YR frequency storms for Lancaster, PA. As a result, Storms #1 through #5 will be populated with data while Storm #6 and #7 will be empty (Figure B-9). Additional data can be entered manually if desired.

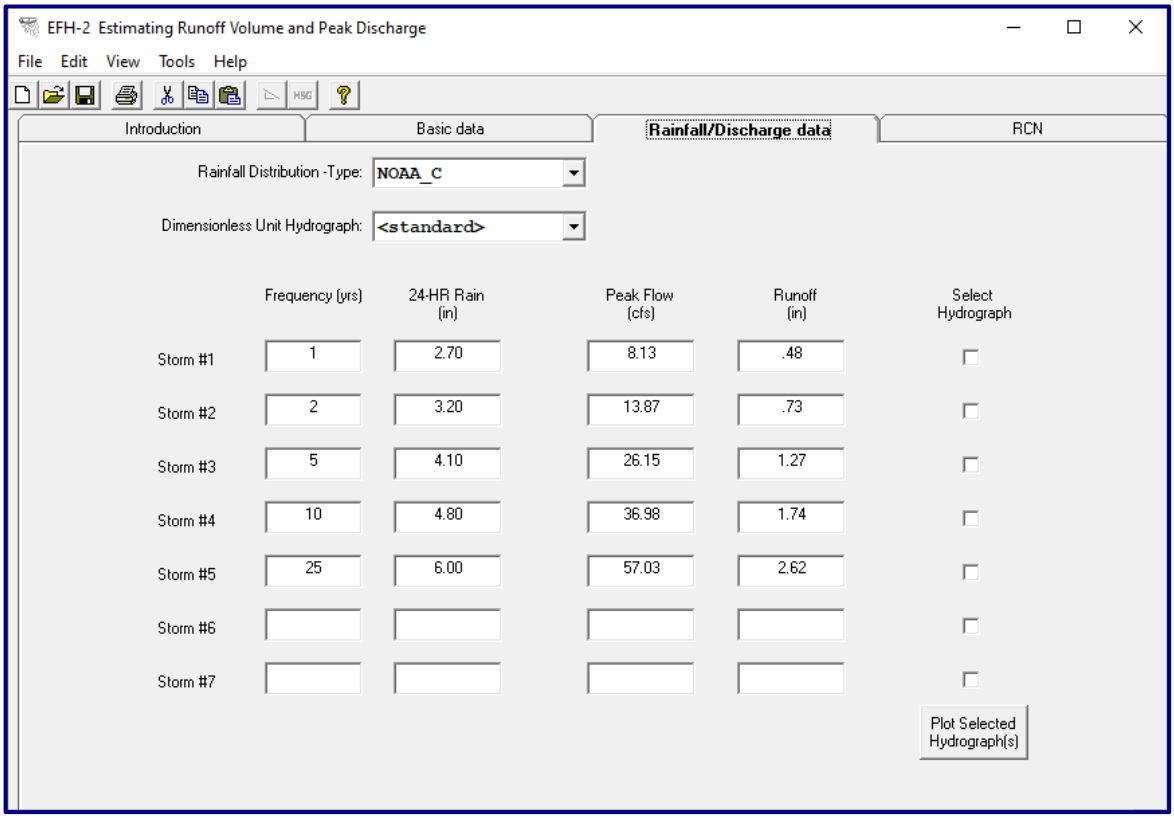

Figure B - 9. Blank Rainfall/Discharge data tab (Example B)

Based on the county selection, the Rainfall Distribution is assigned as NOAA_C while the Dimensionless Unit Hydrograph option assumes the NRCS standard PRF 484 hydrograph.

Conclusion

The 25-year, 24-hour rainfall of 6.0 inches results in a peak flow rate of **57.03 cfs** and a runoff volume of **2.62 inches**. The design capacity peak flow rate to use in sizing the diversion is **57 cfs**.

Appendix C: Example Problem C

Problem Statement

The site is the same as in Example B, except that the EFH-2 Average Slope Calculator will be used to calculate the Average Watershed Slope.

From the watershed map, measure the length of the contour lines and sum them.

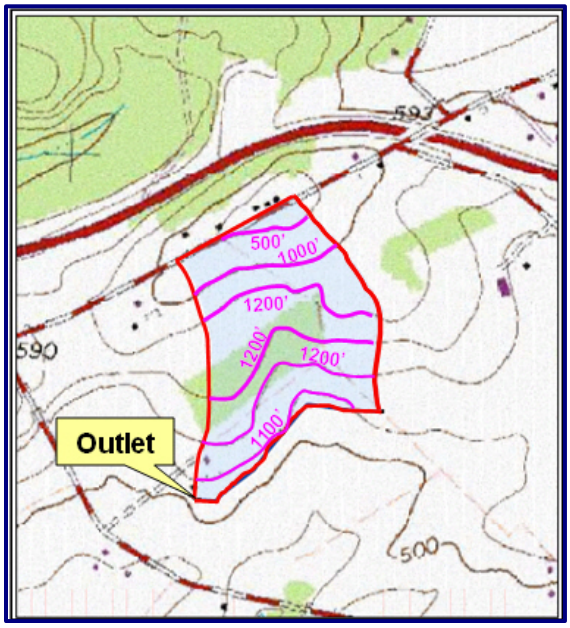

Figure C - 1. Lengths of contour lines within the watershed boundary (Example C)

The total length of all the contour lines in the watershed:

500'
1,000'
1,200'
1,200'
1,200'
+ 1,100'
6,200'

The contour line interval is 20 feet. The drainage area is 37 acres.

Click on the Average Slope Calculator Button:

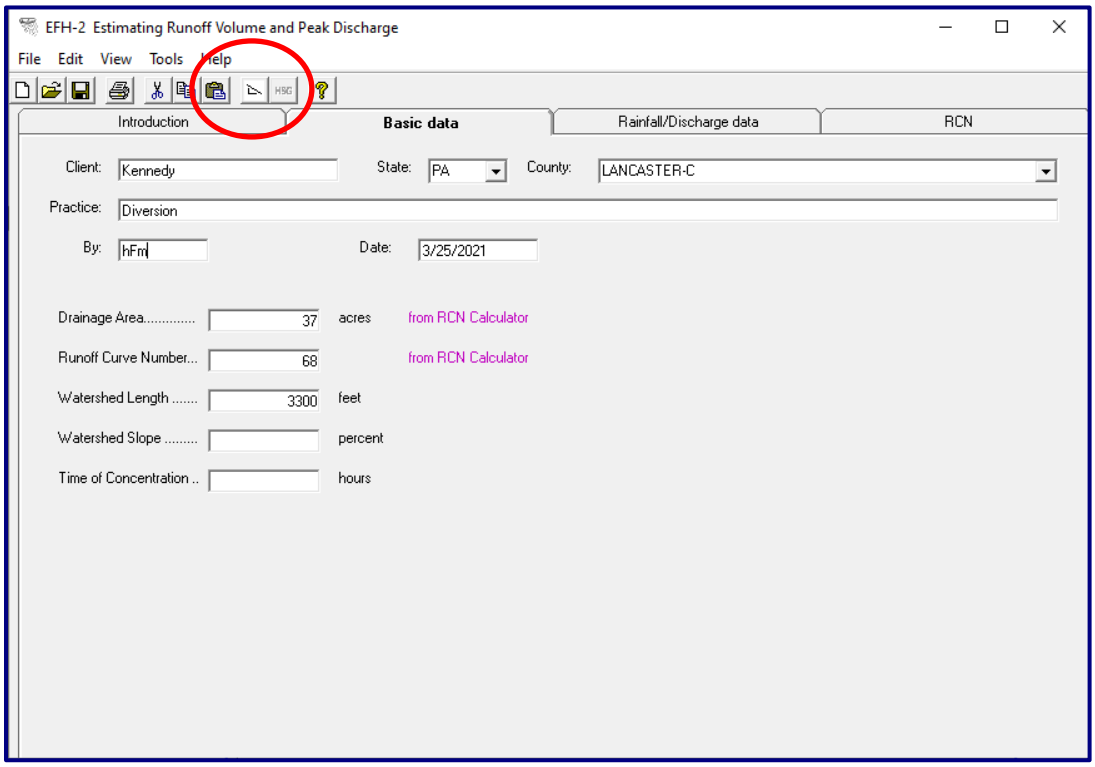

Figure C - 2. Average Slope Calculator button (Example C)

Enter 6,200 feet for the length of the contours, 20 feet for the contour interval, and 37 acres for the drainage area, as calculated from the RCN tab in Example B.

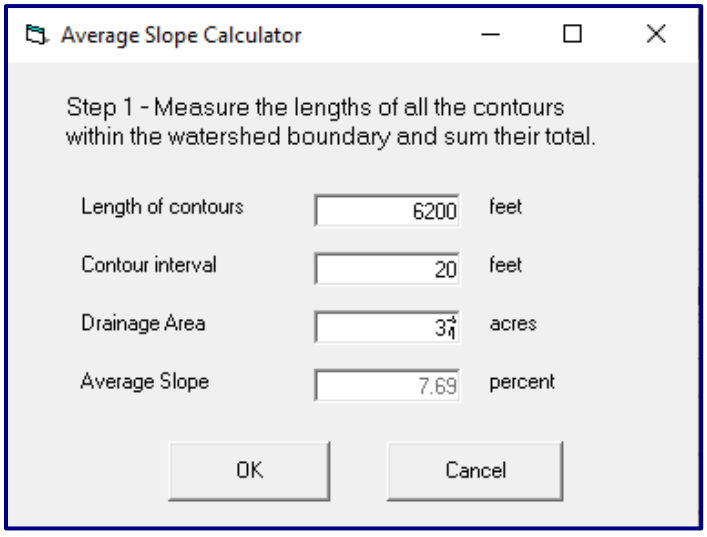

Figure C - 3. Average Slope Calculator window (Example C)

The calculated slope is 7.7 percent. Click OK to return to the Basic Data tab (Figure C-4). Notice that the Watershed Slope field is now populated with the associated note: 'from Average Slope Calculator'. Proceed with the problem solution following Steps 1 through 4 in ***Example Problem B***.

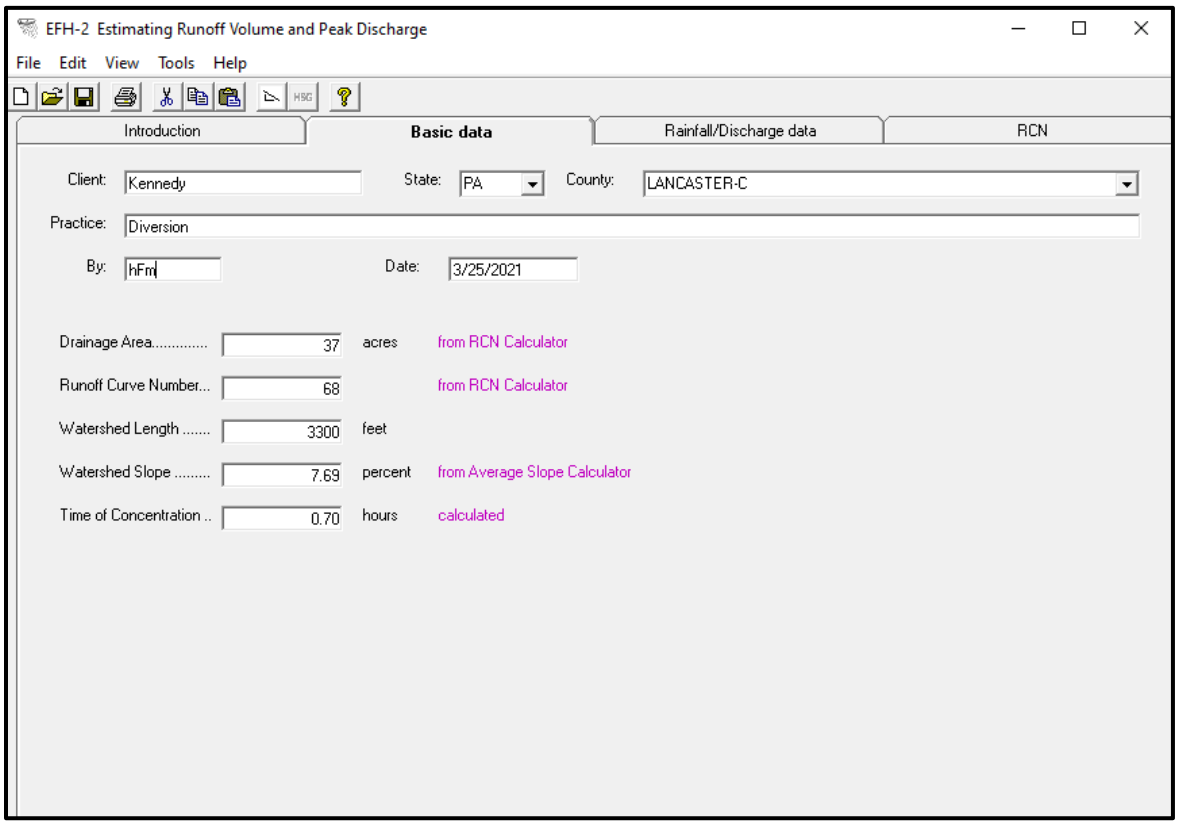

Figure C - 4. Basic Data tab with Average Slope

Note: If the user calculates the average slope by both the methods in example problems A and B and compares them, they will most likely have somewhat different values. These differences can result in differences in the final answer. The user must then decide which is more appropriate to use.

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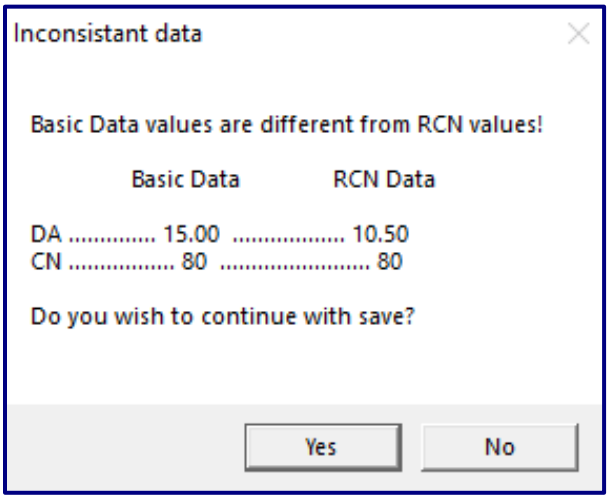
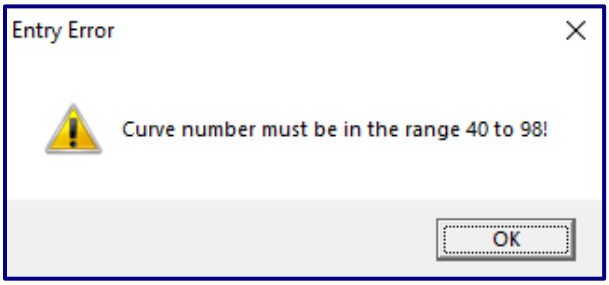
Appendix D: Errors & Messages

EFH-2 has a number of error messages and warnings to assist the user in developing an error free data file. The messages and warnings are listed below along with suggestions for correcting the data file.

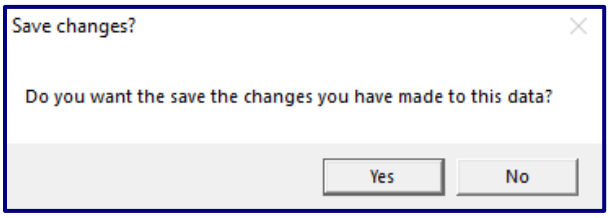
- **"Basic Data values are different from RCN values! Do you wish to continue with save?"** Values on the Basic Data tab are different from those in the RCN tab. This may be a user-entry or rounding error. Note that the drainage area listed on the Basic Data tab is automatically rounded up or down to the nearest integer value (e.g. 25.2 ac. = 25 ac., 26.7 ac = 27. ac.). The RCN tab rounds cumulative acreage to the nearest hundredth. Continue with saving to accept the difference or cancel and make the values match before saving. Continuing will accept the Basic Data entries.



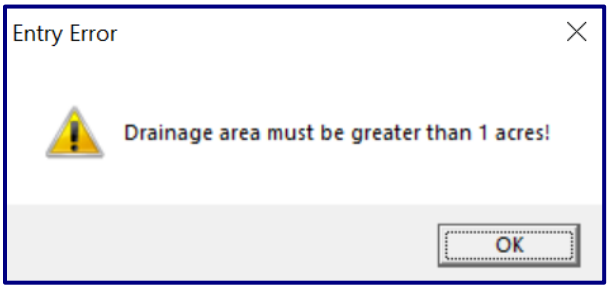
- **"Curve number must be in the range 40 to 98!"** Enter curve number within the given range.



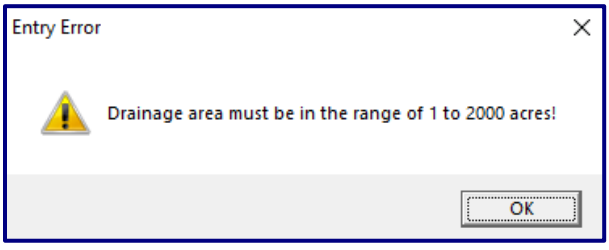
- **"Do you want the save the changes you have made to this data?"** To keep the changes, save the data; otherwise, exit the program, losing changes made since the last save.



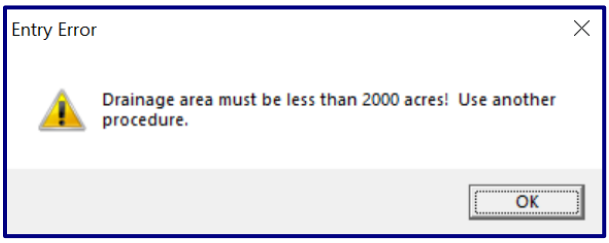
- **"Drainage area must be greater than 1 acre!"** Enter drainage area greater than 1 acre.



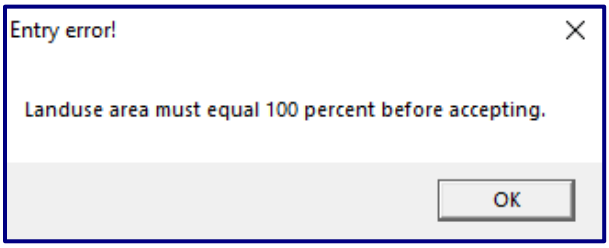
- "**Drainage area must be in the range of 1 to 2000 acres!"** Drainage area for the project must be within the limits given.



- **"Drainage area must be less than 2000 acres! Use another procedure."** Use WinTR-55 or WinTR-20 for the analysis.

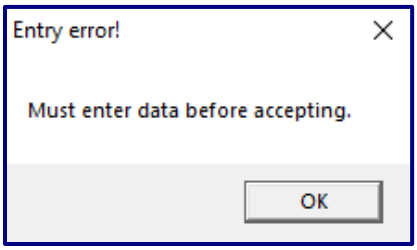


- **"Land use area must equal 100 percent before accepting."** While using the percentage option on the RCN tab, the user has made entries that, when added together, are less than 100 percent. Correct the entries to total 100 percent.

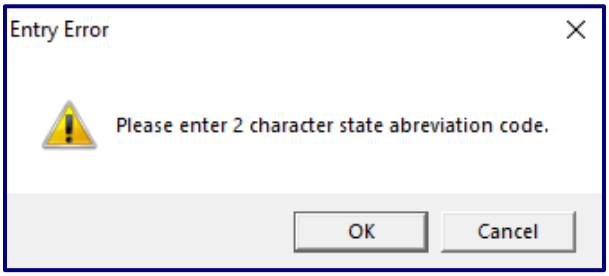


- **"More than 10% of watershed is urban land use. Recommend using WinTR-55. Press Retry to revise or Cancel to Exit."** EFH-2 is not recommended for use in watersheds with greater than 10 percent urban land use. Revise the data or use another program such as WinTR-55 or WinTR-20.

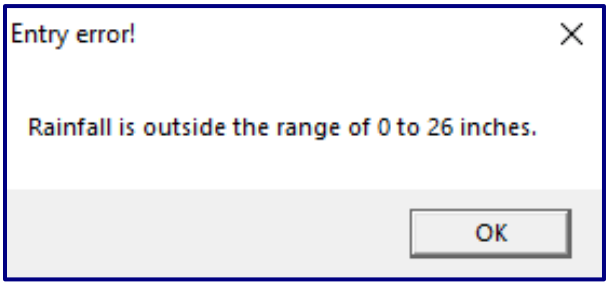
- **"Must enter data before accepting."** The user must enter some data on the RCN tab before clicking on the accept button. Enter data and continue.



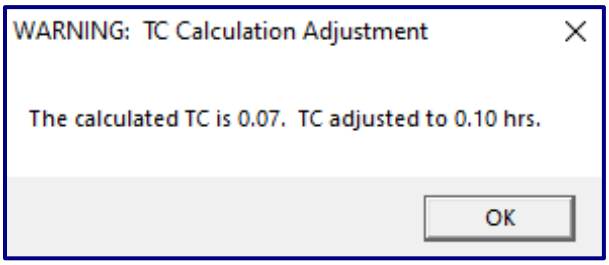
- **"Please enter/select 2 character State abbreviation code."** The user may click on the Cancel button and continue entering data with the State and County fields left empty. They must then enter the rainfall frequency and depth data on the Rainfall/Discharge Tab.



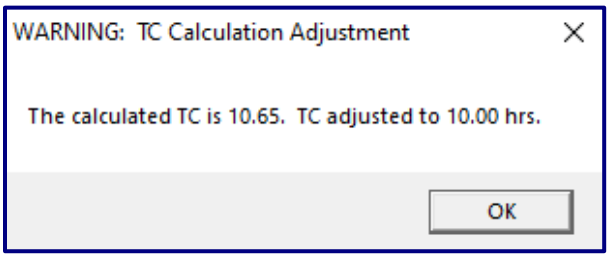
- **"Rainfall is outside the range of 0 to 26 inches."** Keep the rainfall depths within this range or use WinTR-55, which accepts rainfalls from 0 to 50 inches in depth.



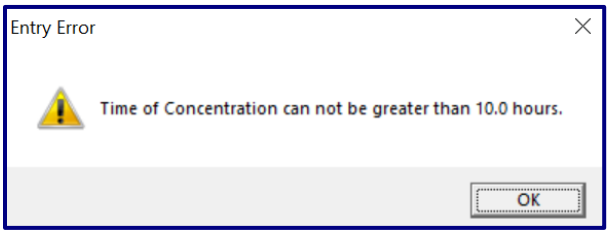
- **"The calculated TC is 0.##. TC adjusted to 0.10 hours."** The calculated Tc is less than the 0.10-hour threshold and therefore rounded up to 0.10 hours. Adjust input data as needed.



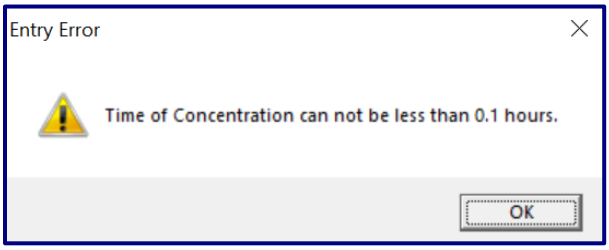
- **"The calculated TC is ##.##. TC adjusted to 10.00 hours."** The calculated Tc is greater than the 10-hour threshold and therefore rounded down to 10.0 hours. Adjust input data as needed.



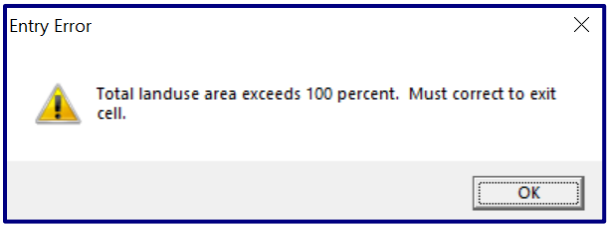
- **"Time of Concentration can not be greater than 10.0 hours."** Manual Time of Concentration entry must be greater than 10.0 hours. Revise and continue.



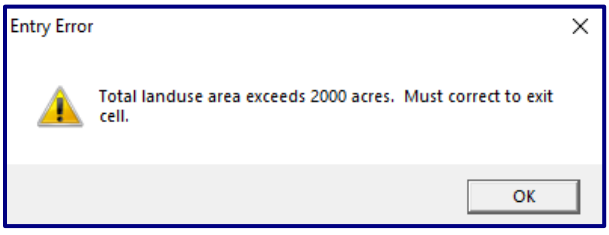
- **"Time of Concentration can not be less than 0.1 hours."** Manual Time of Concentration entry must be greater than 0.1 hours. Revise and continue.



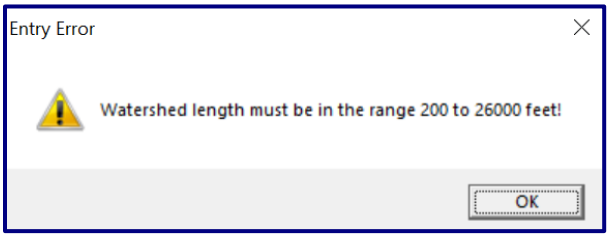
- **"Total landuse area exceeds 100 percent. Must correct to exit cell."** While using the percentage option on the RCN tab, the user has made entries that when added together exceed 100 percent. Correct the entries to total 100 percent.



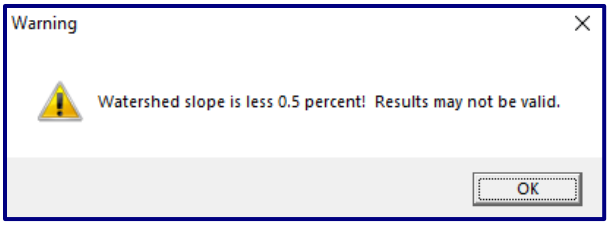
- **"Total landuse area exceeds 2000 acres. Must correct to exit cell."** Reduce the land use area to 2000 acres or less and continue.



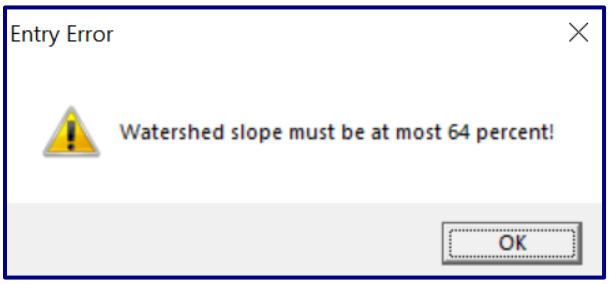
- **"Watershed length must be in the range 200 to 26000 feet!"** Correct the watershed length value to be within this range and continue.



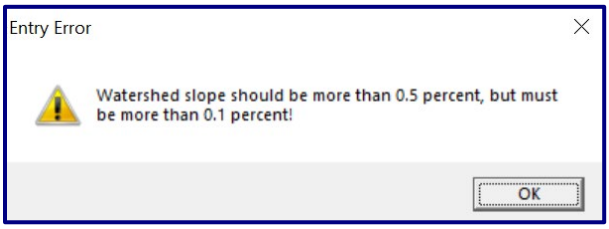
- **"Watershed slope is less than 0.5 percent! Results may not be valid."** Although the user may run the program with slopes less than 0.5 percent, the results should be thoroughly checked for validity.



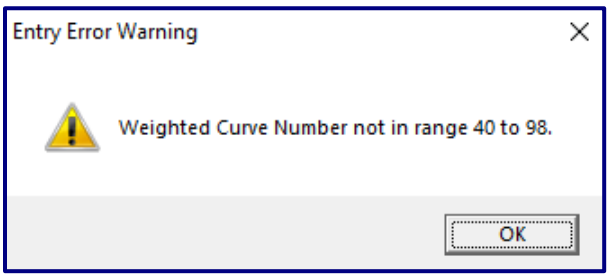
- **"Watershed slope must be at most 64 percent!"** Correct the slope to fall within the recommended limits or use a different program.



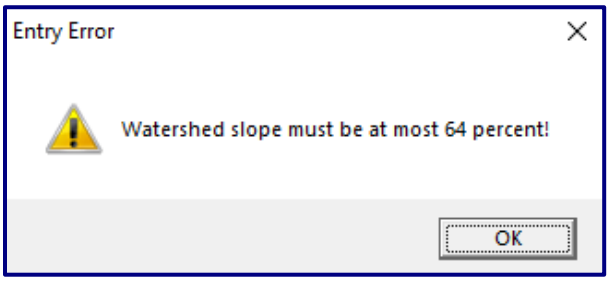
- **"Watershed slope should be more than 0.5 percent, but must be more than 0.1 percent!"** The program will run with slopes between 0.1 and 0.5, but the user should check the results carefully.



- **"Weighted Curve Number not in range 40 to 98."** Revise the RCN data so that the Weighted Curve Number is within the recommended limits.



- **"Watershed slope must be at most 64 percent!"** Correct the slope to fall within the recommended limits or use a different program.



Appendix E: Updating Soils Data

As stated in the main document, users can utilize the Hydrologic Soil Group (HSG) lookup tool to recall data from the *SOILS.HG* file and determine the hydrologic soil class associated with specific soils within their county or state. A sample *SOILS.HG* file is included with the EFH-2 installation package which may be edited by the user and updated with state specific soils data. If a separate soils data file is created from scratch, it must be saved with the filename *SOILS.HG* and replace the original file in the EFH-2 program folder. The file extension '.HG' must be maintained or EFH-2 will not be able to locate the file. IT can put these files (or replace) on your computer with administrator privileges or you can follow the instructions listed below.

The *SOILS.HG* file is a three-column text file which can be developed using a standard ASCII editor. Column breaks must be indicated by a comma, space, or tab. If the soils data file is created using an Excel spreadsheet, use separate columns for each of the fields and save the file as a '*comma delimited text file*'. The resulting text file should be checked carefully for any extra characters. Beyond the column requirements, the *SOILS.HG* file does not have a required format; the user is free to enter whatever information into the three columns that he or she might wish. Note, however, that information may be truncated when viewed in **EFH-2** if the values exceed the maximum character thresholds. A suggested format for the *SOILS.HG* file, denoted by column, is illustrated below.

Column	*Maximum Number of Characters*	*Data Description*
1	40	Soil map unit name
2	10	Textural class
3	10	Hydrologic soil group

NRCS does not maintain a national list of soils by hydrologic soil group in any engineering directives. The most up-to-date information on assigned hydrologic soil groups is available through the NRCS **Field Office Technical Guide**, published soil survey databases, and/or the Web Soil Survey website (*http://websoilsurvey.nrcs.usda.gov/*).

Step 1. Establish Area of Interest

Access Web Soil Survey via the URL listed above and click the START WSS button on the homepage (Figure E-1). Manually navigate to the approximate site location or use one of the two features:

- Area of Interest *import a shapefile representing their area of interest*
- Quick Navigation *manually navigate to a site by searching for an address, state/county, etc.*

With the view centered over the approximate extents of interest, click to activate the 'rectangle' or 'polygon' AOI tool. For the 'rectangle' tool, click and hold the left-mouse button to add a vertex and drag diagonally to cover the area or interest. Release the mouse to close the rectangle. For the 'polygon; tool, click to add vertices and double-click the final vertex to finish the shape (Figure E-3).

Figure E - 1. Web Soil Survey homepage

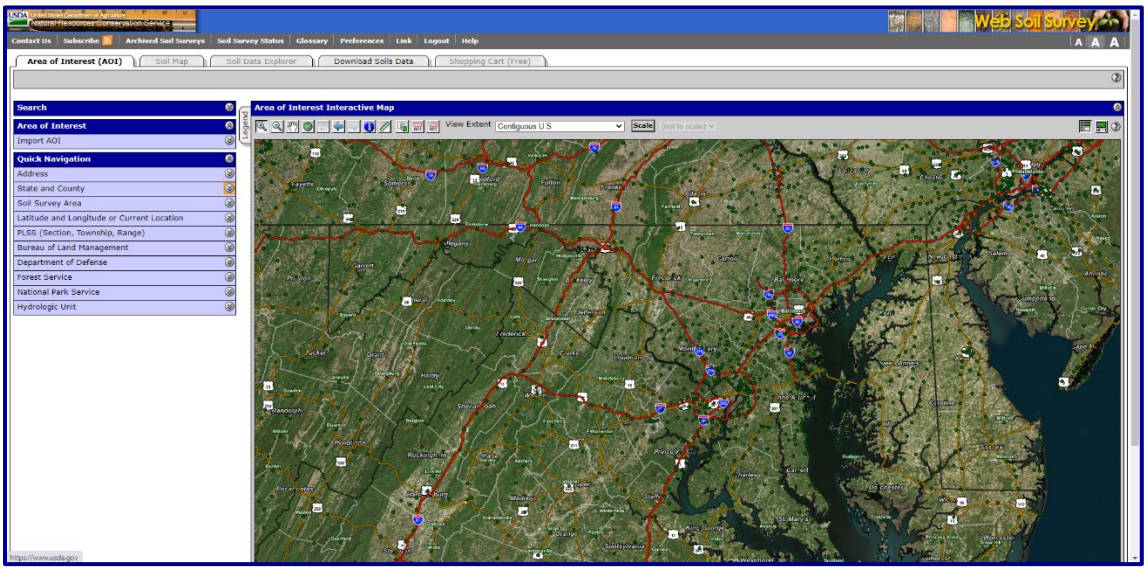


Figure E - 2. Web Soil Survey Main Menu

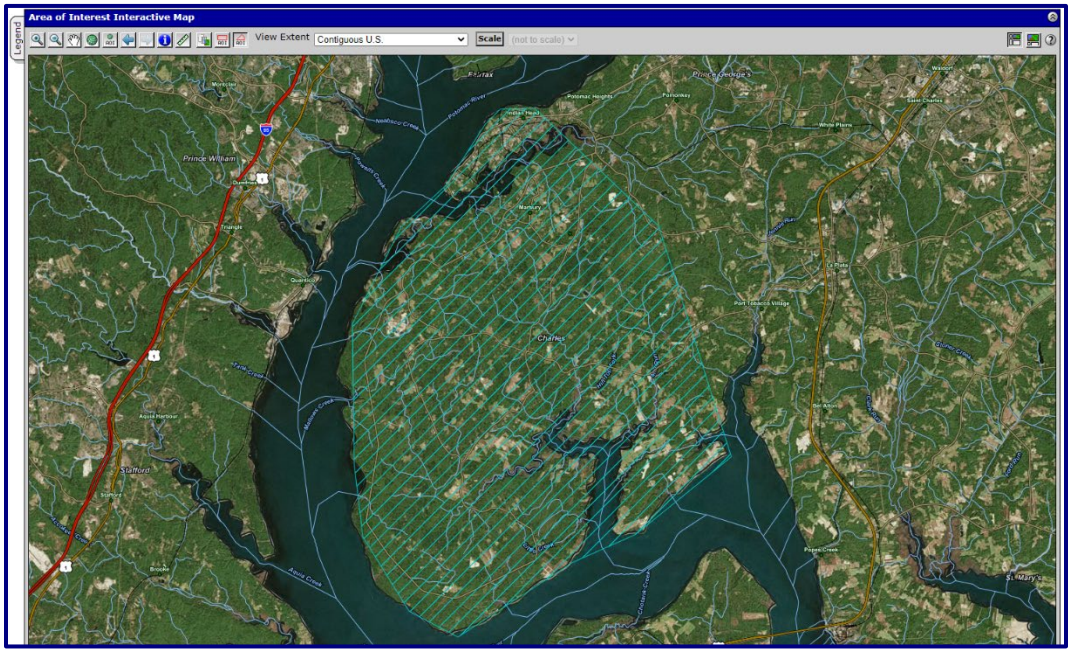


Figure E - 3. Establish Area of Interest Boundary (Polygon)

Step 2. View Hydrologic Soil Group

After setting the area of interest boundary, users will have access to the Soil Map and Soil Data Explorer tabs. To view the *Hydrologic Soil Groups* (HSG) for the soils found in the area of interest, click the Soil Data Explorer. Next find and click the Soil Properties and Qualities sub-page (Figure E-4).

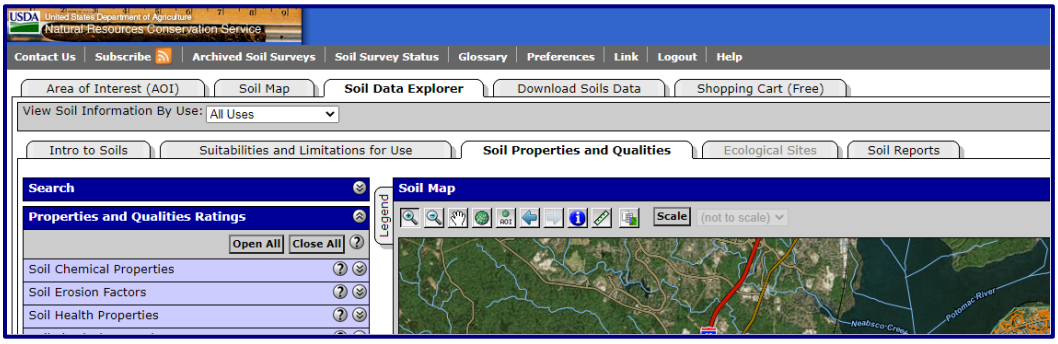


Figure E - 4. Soil Properties and Qualities tab

On the side menu, expand the Soil Qualities and Features and find the Hydrologic Soil Group option (Figure E-5). Select the custom options and click View Rating to open the HSG report for the area (Figure E-6).

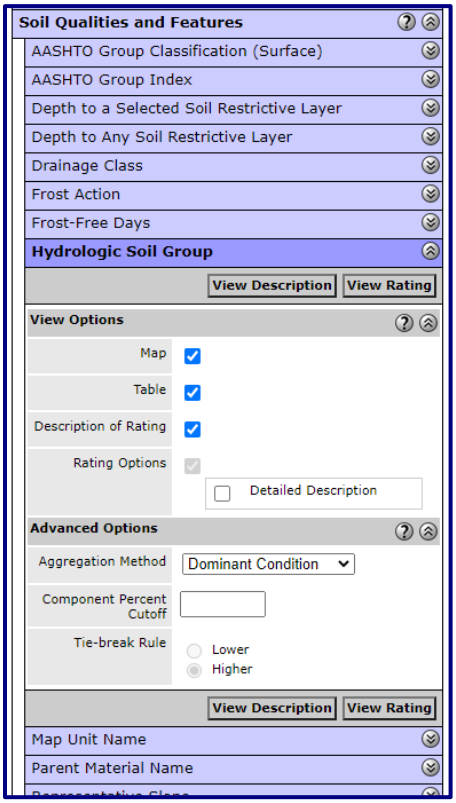


Figure E - 5. Hydrologic Soil Group report options

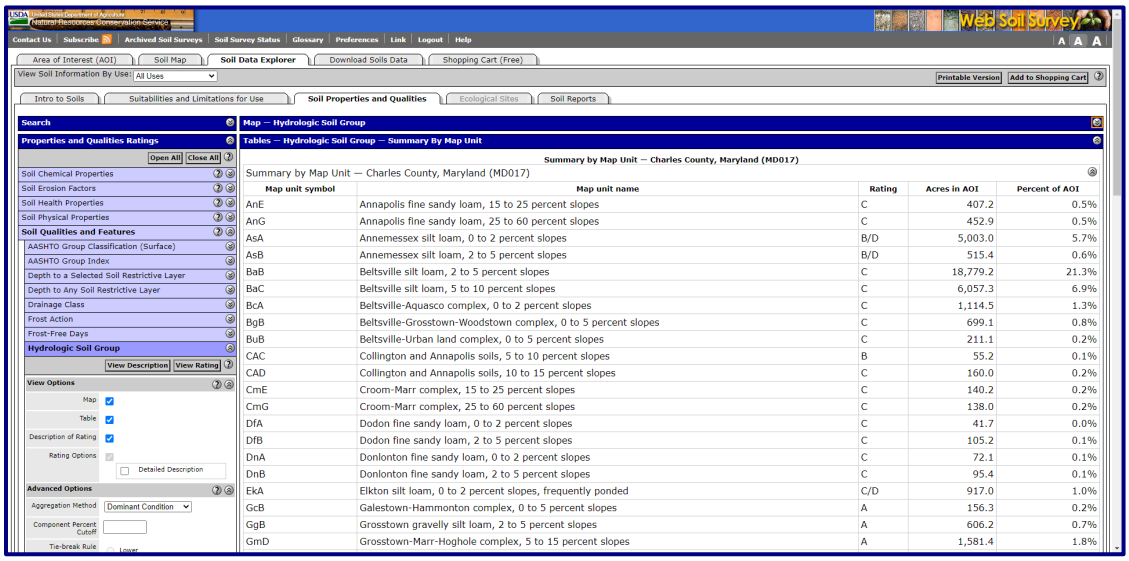


Figure E - 6. Hydrologic Soil Group report

Step 3. Edit the SOILS.HG file

With the local hydrologic soil group data collected, users can either revise the existing *SOILS.HG* file or create a new version to replace the default file. For this example, it is assumed that users will copy, paste, and edit the original HSG data file. Alternatively, users can contact your state specific EFH-2 soils file from your State Conservation Engineer/Hydraulic Engineer/Soil Scientist or contact Quan D. Quan and Jacob Dieguez (WNTSC-WQQT).

Before accessing the SOILS.HG file, ensure that your computer is set to display 'hidden' folders and items. Open any File Explorer window and click the View tab near the top. Find the Show/hide panel and verify that Hidden items is checked (Figure E-7).

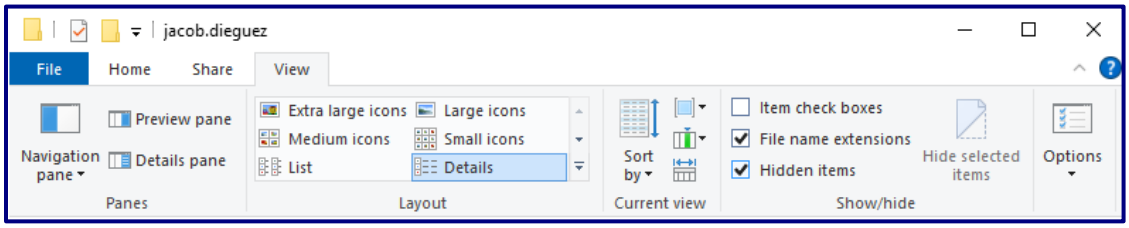


Figure E - 7. Show 'Hidden items' in File Explorer

Next, navigate to the default *SOILS.HG* file at the following path: **C:\Program Files (x86)\USDA\EFH2**

Copy and paste the file to the following path: **C:\Users\user.name\AppData\Roaming\EFH2**
Users will update and revise this file moving forward. Files stored at this location will take priority over the default program files. Open the file using the Windows® Notepad app (Figure E-8).

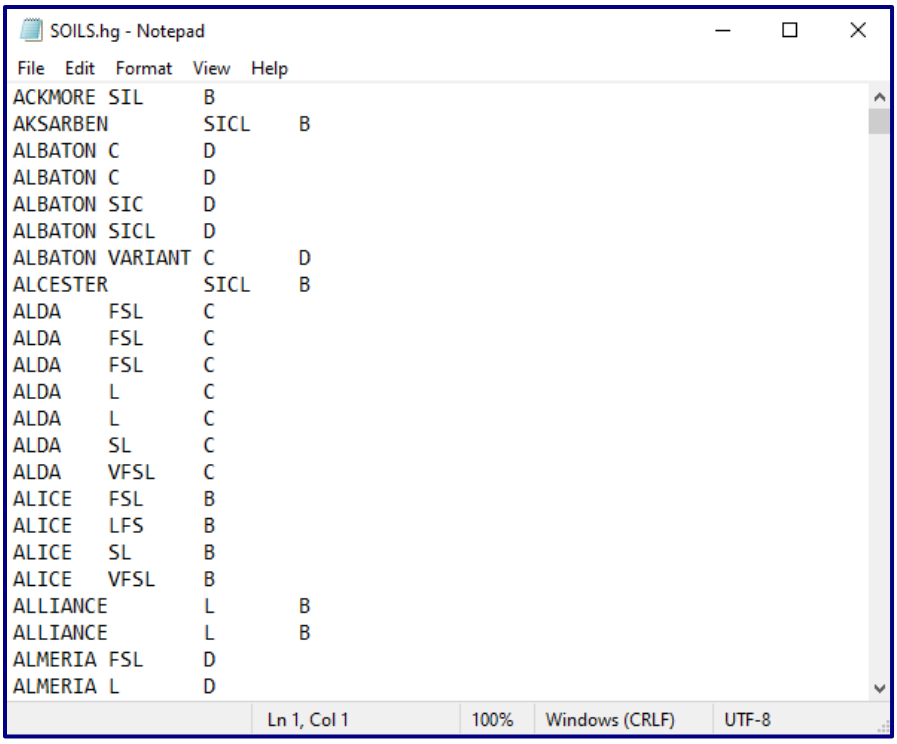


Figure E - 8. Open and edit the SOILS.hg file in Notepad

Users can now edit the HSG data file to reflect their local area, county, and/or state. Be careful to maintain the formatting – separating the columns by a comma, a space, or at least one tab. When finished, save, and close the file – making sure to maintain the original file name. The HSG data file within **EFH-2** will now be updated (Figure E-9).

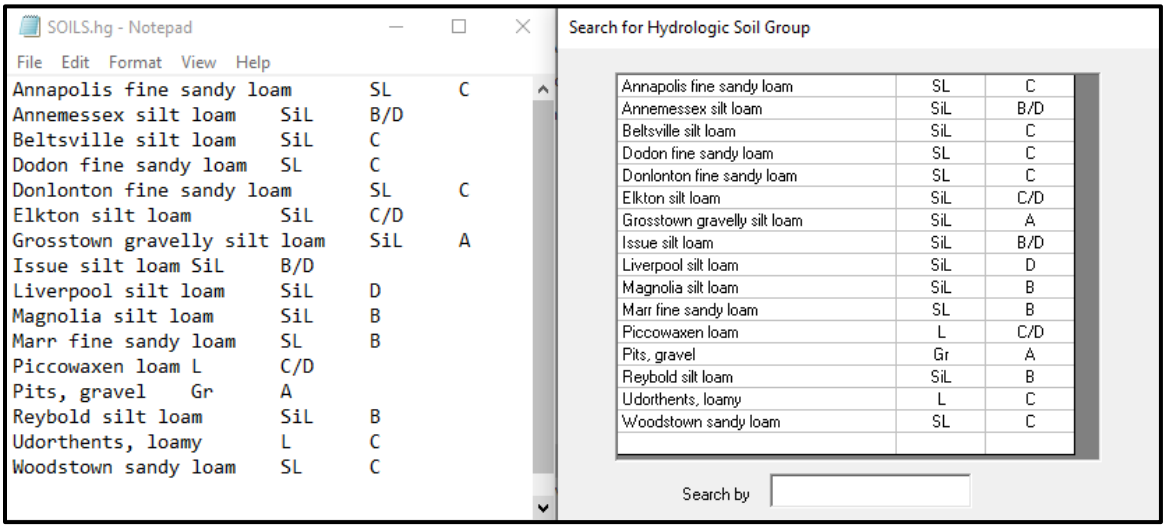


Figure E - 9. Side-by-side comparison of the updated SOILS.hg file and the HSG data in EFH-2