EXAMPLE 16

Channel Modification

Purpose

This example demonstrates the use of HEC-RAS to perform a channel modification on an existing channel geometry using a series of trapezoidal cuts. Water surface profiles resulting from a channel modification can be compared to water surface profiles resulting from the existing channel geometry.

The user is referred to Chapter 12 of the **User's Manual** for discussion on modifying the existing geometric data, implementing the new channel geometry, and comparing existing and modified conditions.

To review the data files for this example, from the main program window select **File** and then **Open Project**. Select the project labeled "Channel Modification - Example 16." This will open the project and activate the following files:

Plan:	"Existing Conditions"
Geometry:	"Base Geometry Data"
Flow:	"100 Year Profile"

Geometric Data

To view the geometric data for the river system, from the main program window select **Edit** and then **Geometric Data**. This will activate the **Geometric Data Editor** and display the river system schematic as shown in Figure 16.1.

Channel Modification Data

To perform a modification on the channel, select **Channel Modification** from the **Tools** menu of the **Geometric Data Editor**. This will activate the window shown in Figure 16.2. The data displayed in Figure 16.2 is not present upon entering a new channel modification window. The data shown in the left hand column of Figure 16.2 is used to construct the cuts for each cross section.

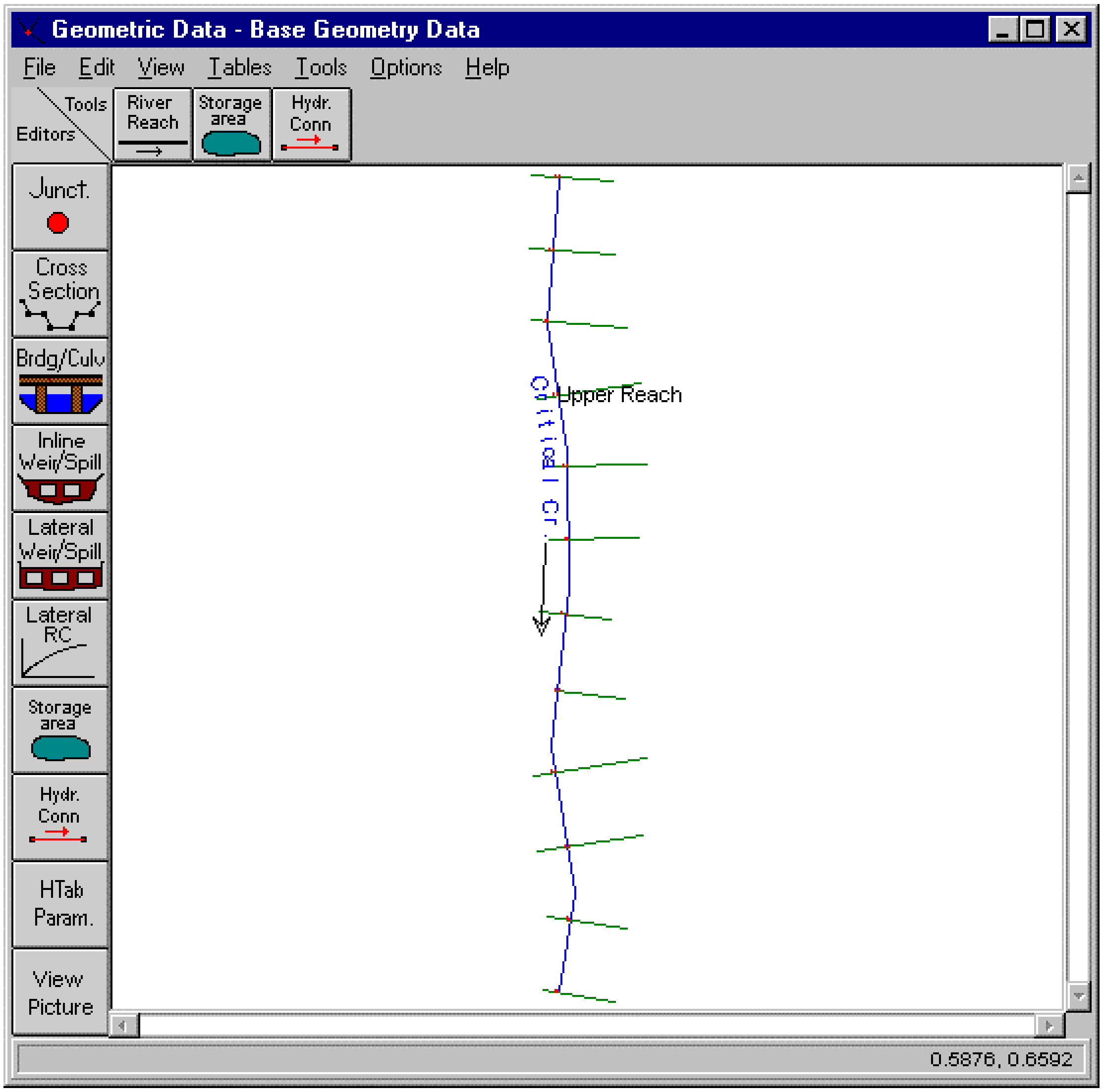


Figure 16.1 River System Schematic for Base Geometry Data

The channel modification began with the **River** set to "Critical Creek" and the **Reach** set to "Upper Reach." The **Starting River Station** was set by default to 12 and the **Ending River Station** was changed to a value of 1, the downstream end of this particular reach. The **Project cut from upper RS at slope** option was entered as 0.01. This option projects a cut using the specified slope from the invert elevation of the **Starting River Station**.

Once the correct river stations were set, the first cut was established. The **Center Cuts (y/n) column** in the **Set Range of Values** table was entered as "y." This set the centerline for the first cut at the centerline of the main channel. Next, "100" was entered in the **Bottom Width** column to set the width of the first cut to 100 feet along the centerline. The **Invert Elevation** column was left blank for the first cut, which defaults the program to the existing invert elevation of the **Starting River Station**. Both side slopes for the banks were entered as 2 (2 horizontal to 1 vertical). The **Cut n/K** column for the new Manning's n-value was entered as 0.025.

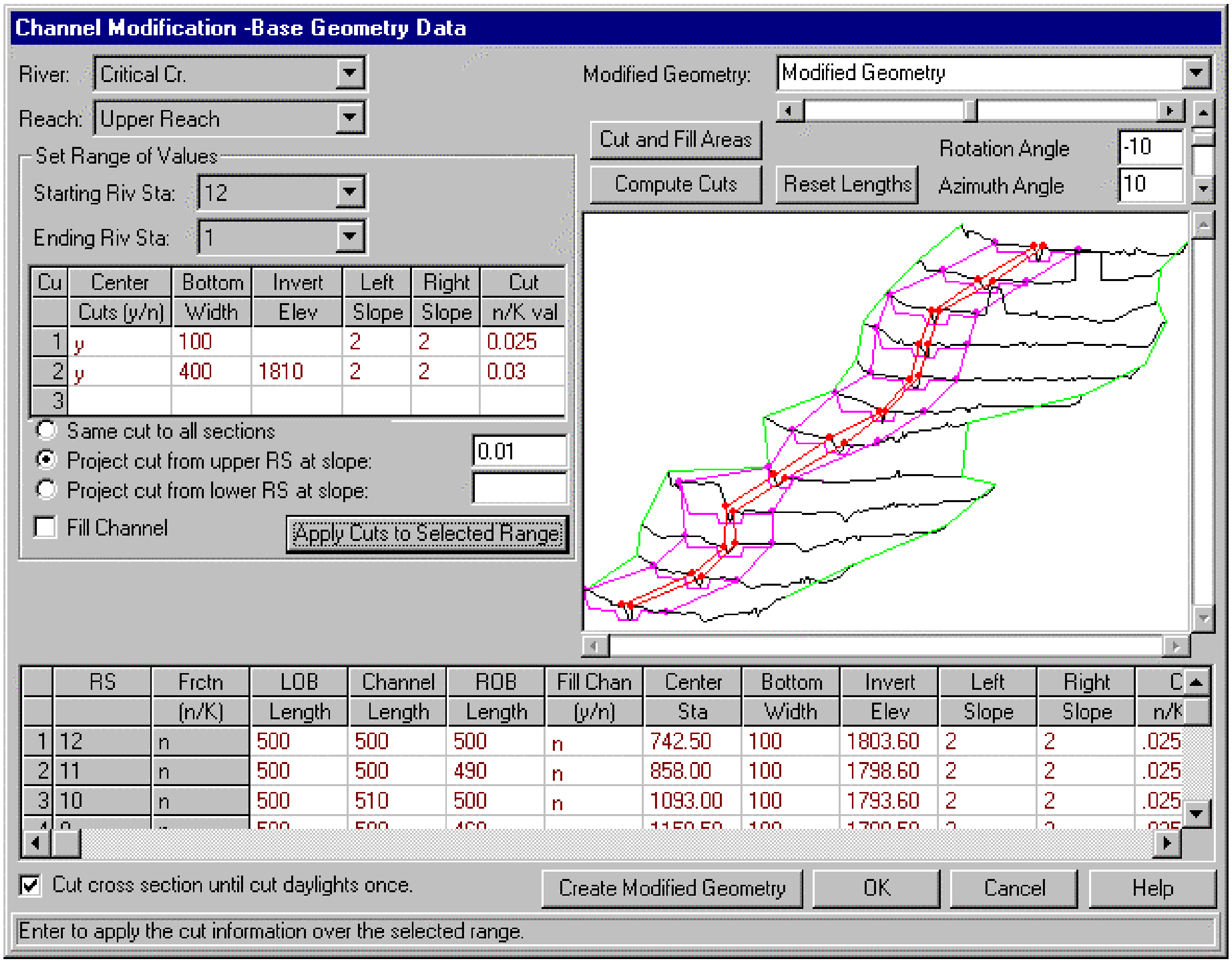


Figure 16.2 Channel Modification Window

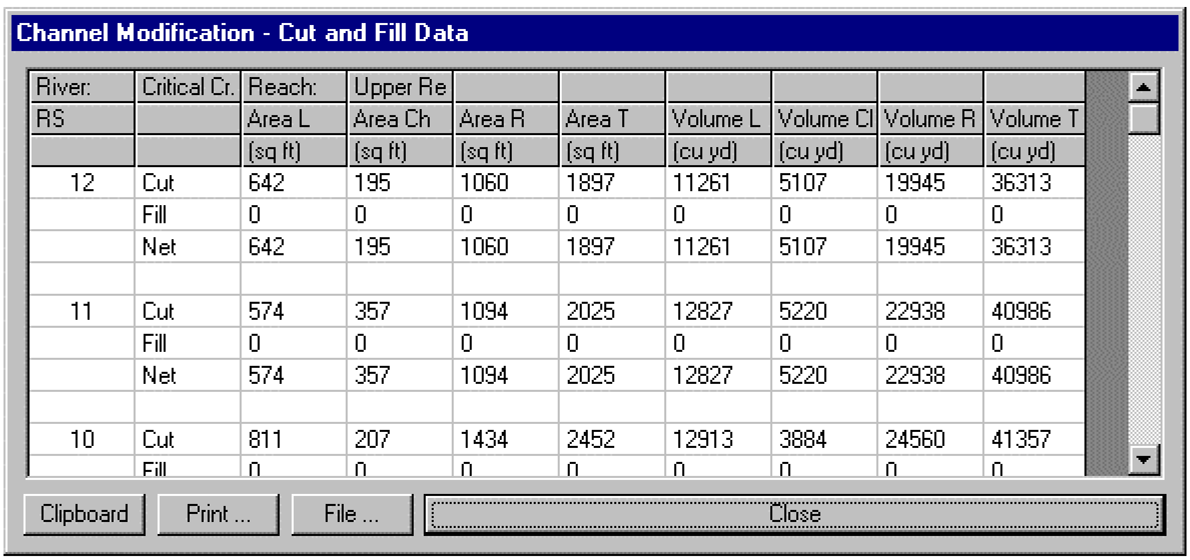
The second cut was also done on the existing centerline of the main channel. A **Bottom Width** of 400 feet and an **Invert Elevation** of 1810 feet were entered. The entry initiated the second cut at an elevation of 1810 feet, at the **Starting River Station**. The cut will then project with the specified slope from this elevation. The slopes were again entered with a value of 2 and Manning's n-value was entered as 0.03. After the data was entered, the **Apply Cuts to Selected Range** button was pressed to compute the data shown in the lower table of Figure 16.2.

An option available to the user is **Cut cross section until cut daylights**. For this particular example this option was selected. As the program performs the cutting of the trapezoidal channel, the left and right banks of the channel will initiate at the invert elevation and cut through the ground until they reach open air, then the cutting will stop. If this option is turned off, the left and right banks of the trapezoid will be projected to infinity, continually cutting any ground that lies above them.

Performing the Channel Modifications

After the **Apply Cuts to Selected Range** was selected, the **Compute Cuts** button was pressed. This applied all of the channel modification data from the lower table to the graphic, updating the information. Additionally, the **Cut and Fill Areas** button was pressed to display Figure 16.3

The Cut and Fill Data displays the area and volume of each individual cut for the left overbank, main channel, and right overbank. The table also displays the total area and volume for each individual cut as well as the total volume for the entire reach.



River:	Critical Cr.	Reach:	Upper Re						
RS		Area L	Area Ch	Area R	Area T	Volume L	Volume Cl	Volume R	Volume T
		(sq ft)	(sq ft)	(sq ft)	(sq ft)	(cu yd)	(cu yd)	(cu yd)	(cu yd)
12	Cut	642	195	1060	1897	11261	5107	19945	36313
	Fill	0	0	0	0	0	0	0	0
	Net	642	195	1060	1897	11261	5107	19945	36313
11	Cut	574	357	1094	2025	12827	5220	22938	40986
	Fill	0	0	0	0	0	0	0	0
	Net	574	357	1094	2025	12827	5220	22938	40986
10	Cut	811	207	1434	2452	12913	3884	24560	41357
	Fill	0	0	0	0	0	0	0	0

Figure 16.3 Cut and Fill Areas

Saving the Channel Modifications

After the completion of all channel modifications a new geometry file was created. From the **Channel Modifications Data Window**, Figure 16.2, the title "Modified Geometry" was entered in the upper right hand window. Next, the button **Create Modified Geometry** was pressed and the file was saved. Finally, the original geometry file was saved to the hard disk by selecting **Save Geometry Data** from the **Geometric Data Editor**. This step was needed because the data entered in the **Channel Modification Data Window** is saved in the base geometry file and not the modified geometry file. Hence, when the modified geometry file was saved, the modifications which were used to create that file had not yet been saved.

Steady Flow Analysis

After saving all the geometric data, the steady flow data file was created. From the main program window, **Edit** and then **Steady Flow Data** were selected. This activated the **Steady Flow Data Window** shown in Figure 16.4. Profiles were selected with flows of 9000 cfs at river station 12 and 9500 cfs at river station 8. The upstream and downstream boundary conditions were established as “Normal Depth = 0.01.” This steady flow data file is identical to the file produced in Example 1. The user is referred to Example 1 for a further discussion on developing a steady flow data file.

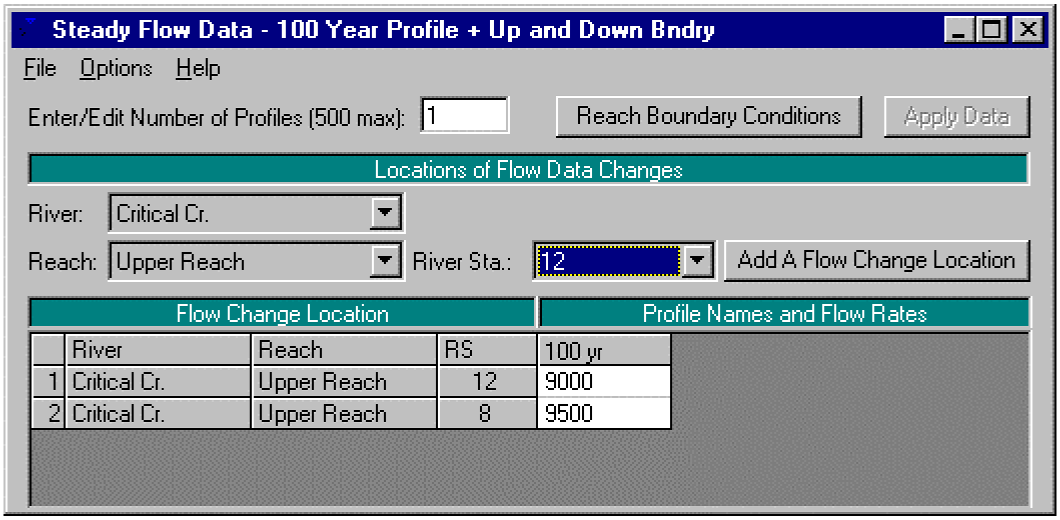


Figure 16.4 Steady Flow Data Window

Comparing Existing and Modified Conditions

Plans for the different geometry files must be manufactured before a comparison can be analyzed. Once the plans are created the user can view the graphical and tabular results.

Steady Flow Analysis

A new plan was created by selecting **Run** and then **Steady Flow Analysis** from the main program window. This activated the **Steady Flow Analysis Window** shown in Figure 16.5. The **Geometry File** was selected as “Base Geometry Data” and the **Steady Flow File** was selected as “100 Year Profile.” Next, a new plan was created by selecting **New Plan** from the **File** menu. The title was entered as “Existing Conditions,” and the **Short I.D.** was entered as “Exist Cond.” A mixed **Flow Regime** was selected and the file was saved by choosing **File** and then **Save Plan**. Finally, the **Compute** button was selected to perform the steady flow analysis.

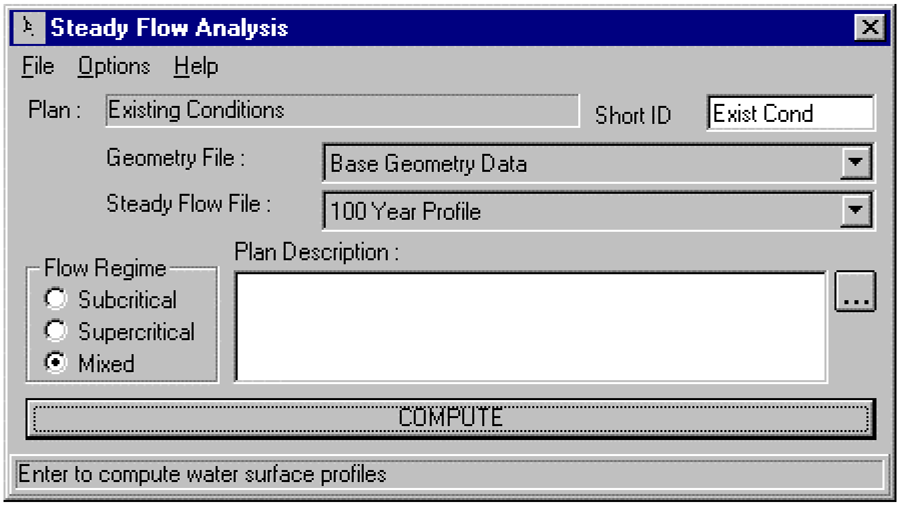


Figure 16.5 Steady Flow Analysis Window

This procedure was repeated for the modified channel geometry. On the **Steady Flow Analysis Window** the **Geometry File** was selected as "Modified Geometry" and the **Steady Flow File** remained "100 Year Profile." The **Flow Regime** was changed to "Supercritical." The title was entered as "Modified Conditions Run" and the **Short I.D.** was entered as "Modified." The file was saved and then the **Compute** button was selected.

Water Surface Profiles

After the simulation was completed, **Water Surface Profiles** was selected from the **View** menu on the main program window. To compare the different profiles for the existing and modified channel geometry, **Options** and then **Plans** was selected from the profile plot. This displayed the **Plan Selection Window.** From this window the radio button **Compare Plan Results and Geometry** was selected and the existing and modified geometry plans were selected for comparison, as shown on Figure 16.6.

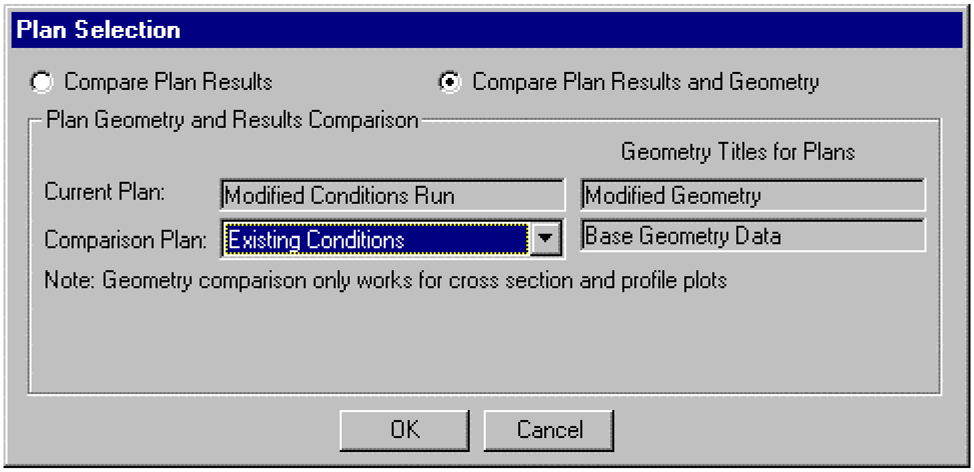


Figure 16.6 Plan Selection Window

After pressing the **OK** button on the **Plan Selection Window**, Figure 16.7 was displayed. The figure shows the two plans for the existing channel geometry and the modified channel geometry. It can be seen from the profile that the existing channel geometry had a flow that was mixed between the subcritical and supercritical regime. The modified channel geometry altered the flow to be exclusively supercritical for this reach.

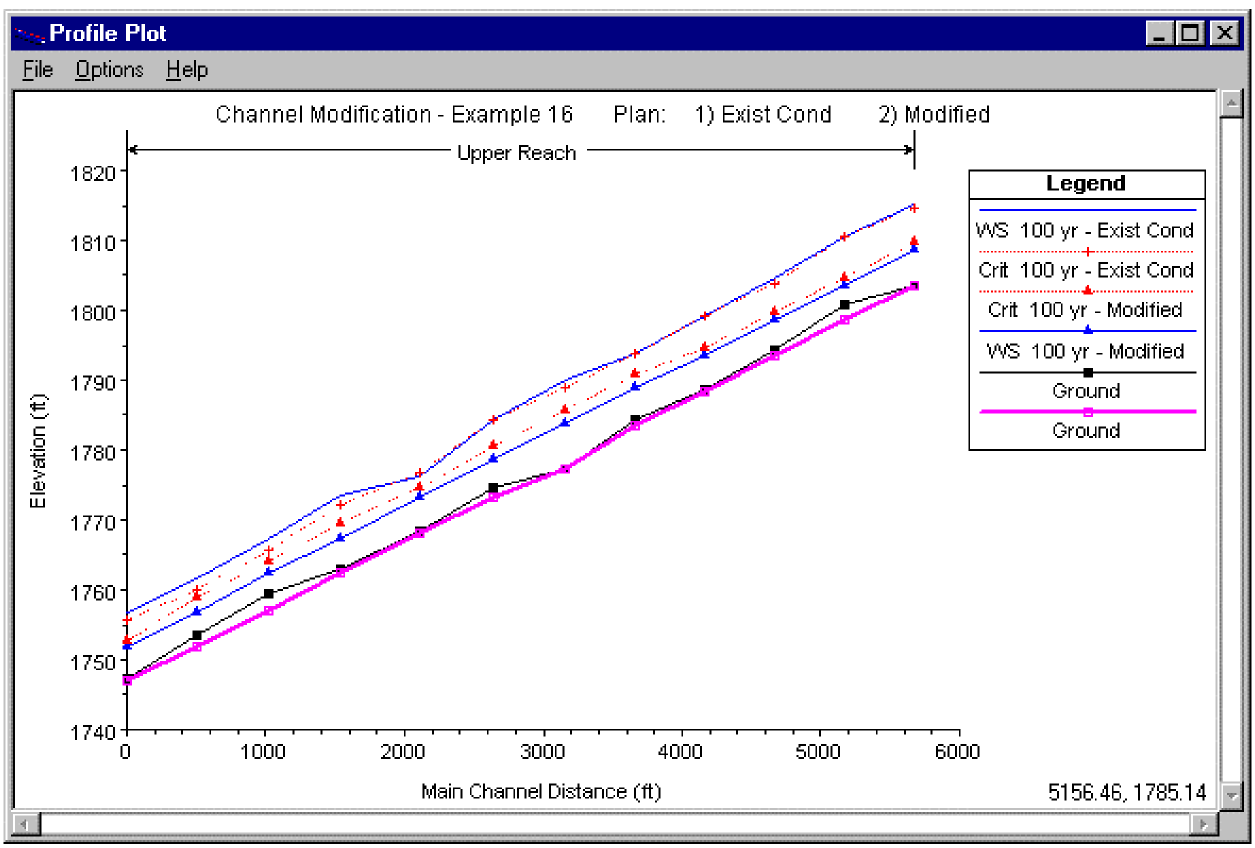


Figure 16.7 Water Surface Profiles showing existing and modified geometry

Cross Section Plots

From the main program window, select **View** and then **Cross Section**. The same method illustrated in the previous section was used for selecting the existing and modified plans. The cross section plot illustrated in Figure 16.8 displays the existing and modified channel geometry along with the water surface profiles for both plans. As seen from the figure, the channel modification lowered the water surface for the 100-year event. For the modified geometry the water surface level was lowered enough to contain the 100-year flow in the main channel. In addition, the channel modifications changed the type of flow from subcritical to supercritical at this particular cross section.

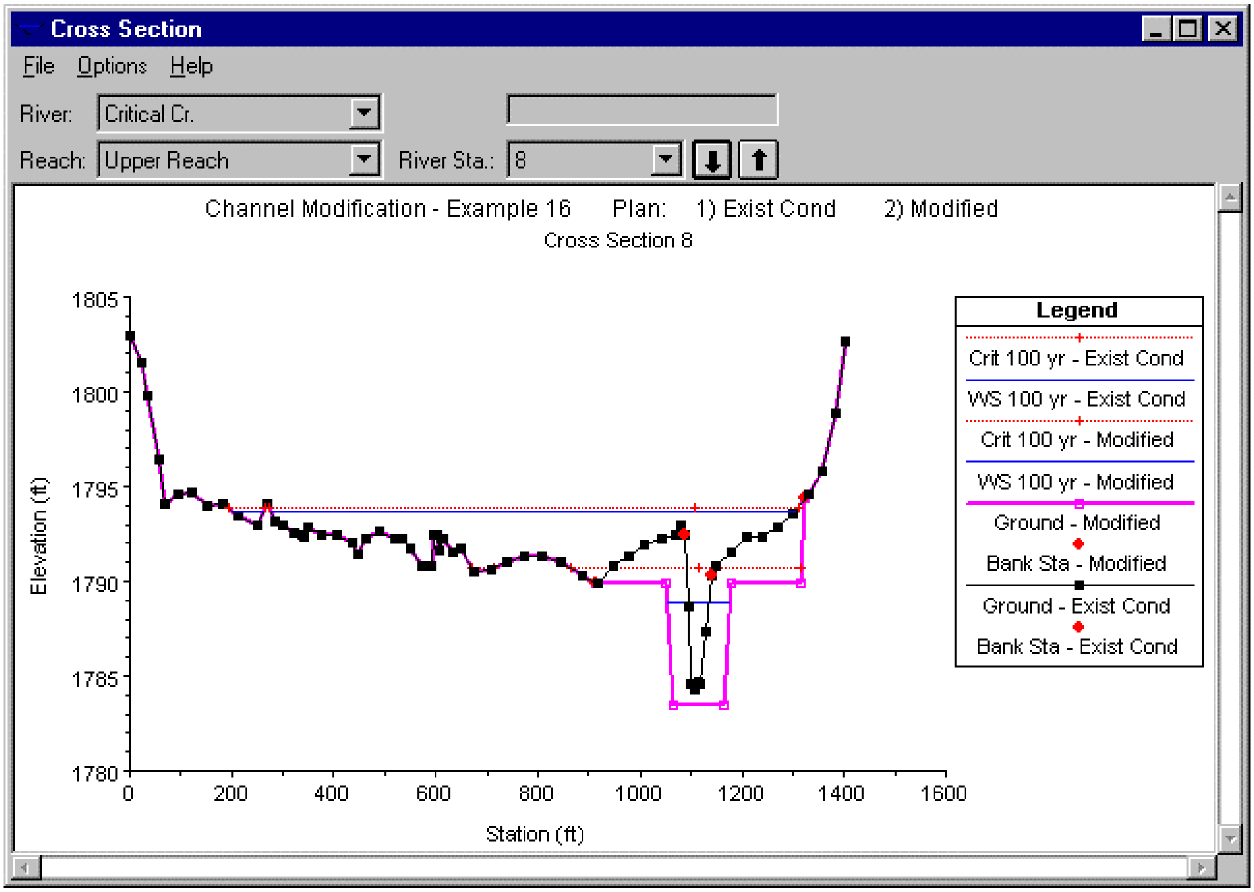


Figure 16.8 Cross Section showing existing and modified geometry

X-Y-Z Perspective Plot

From the main program menu select **View** and the **X-Y-Z Perspective Plots**. Figure 16.9 displays the 3D plot from river station 12 to river station 1. The user can select various azimuth and rotation angles to obtain differing views of the reach. The figure shows the difference in lateral distribution of the water surfaces for the existing and modified channel geometry for the given flow data.

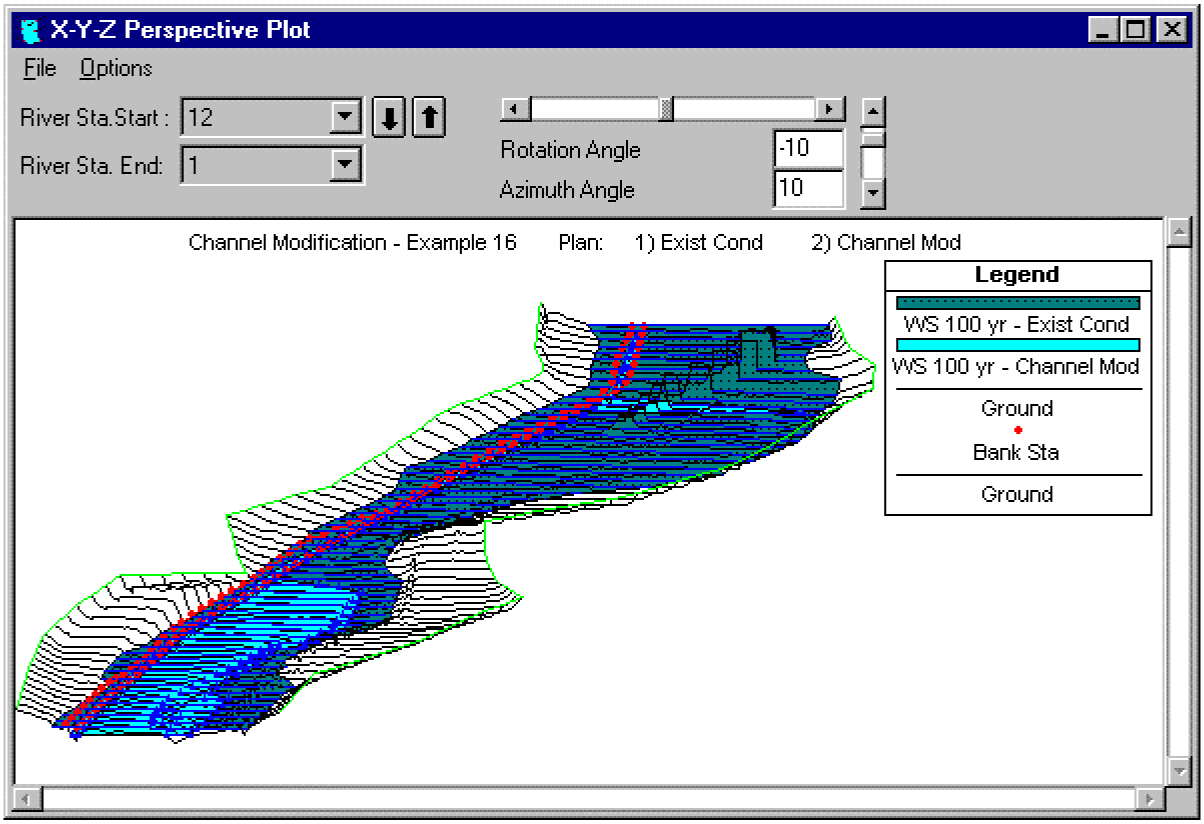


Figure 16.9 X-Y-Z Perspective Plot

Standard Table

In addition to graphical display, the user can compare the output in tabular form. From the main program window, select **View** and then **Profile Summary Table**. By selecting **Standard Table 1**, the table shown in Figure 16.10 is displayed. The first two columns of the table display the river reach and river station. The third column identifies which plan corresponds to the data. The identifiers in this column are obtained from the **Short ID** entered in the **Steady Flow Data Editor**. The remaining portion of the table displays information about total flow, energy grade line elevation, water surface elevation, etc.

As shown in the table the modifications lowered the water surface by approximately 5 feet. The table also shows the transformation of flow from the subcritical regime, for the existing conditions, to a supercritical regime for the modified conditions. This corresponds with the increase in velocity.

Profile Output Table - Standard Table 1

File Options Std. Tables Help

HEC-RAS River: Critical Cr. Reach: Upper Reach Profile: 100 yr

Reload Data

Reach	River Sta	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Upper Reach	12	Exist Cond	9000.00	1803.60	1815.06	1814.46	1815.76	0.006851	10.51	2558.45	878.61	0.69
Upper Reach	12	Modified	9000.00	1803.60	1810.68	1810.68	1811.95	0.002795	9.06	1000.08	465.44	1.02
Upper Reach	11	Exist Cond	9000.00	1800.70	1810.42	1810.42	1811.87	0.008552	12.03	1734.74	562.38	0.82
Upper Reach	11	Modified	9000.00	1798.60	1805.67	1805.67	1806.95	0.002799	9.07	992.61	402.70	1.02
Upper Reach	10	Exist Cond	9000.00	1794.40	1804.47	1803.69	1804.98	0.010246	10.47	2480.68	914.90	0.79
Upper Reach	10	Modified	9000.00	1793.60	1800.68	1800.68	1801.89	0.002698	8.90	1172.02	551.80	1.00
Upper Reach	9	Exist Cond	9000.00	1788.70	1799.31	1799.31	1800.16	0.008851	11.48	2719.81	1216.82	0.80
Upper Reach	9	Modified	9000.00	1788.50	1795.58	1795.58	1796.85	0.002792	9.05	994.18	402.71	1.02
Upper Reach	8	Exist Cond	9500.00	1784.30	1793.89	1793.89	1795.08	0.008613	12.38	2524.66	1110.69	0.81
Upper Reach	8	Modified	9500.00	1783.50	1790.68	1790.68	1791.99	0.002884	9.16	1061.38	496.13	1.01
Upper Reach	7	Exist Cond	9500.00	1777.20	1789.88	1788.87	1791.00	0.007407	13.16	2155.88	526.62	0.76
Upper Reach	7	Modified	9500.00	1777.20	1785.58	1785.58	1786.85	0.003238	9.08	1078.69	488.85	0.99
Upper Reach	6	Exist Cond	9500.00	1774.50	1784.29	1784.29	1786.35	0.011143	13.38	1266.30	332.38	0.93
Upper Reach	6	Modified	9500.00	1773.30	1780.43	1780.43	1781.75	0.003003	9.21	1031.39	402.91	1.01

Total flow in cross section.

Figure 16.10 Profile Output Table

Summary

The geometry of Example 1 was modified to prevent the flow from the 100-year event from overflowing the channel. This was accomplished by modifying the existing channel conditions to include two cuts down the centerline of the channel. By reviewing the water surface profiles and tables, the user can determine the benefits of a specific channel modification for a given flow.