

Floodplain and Floodway Determination

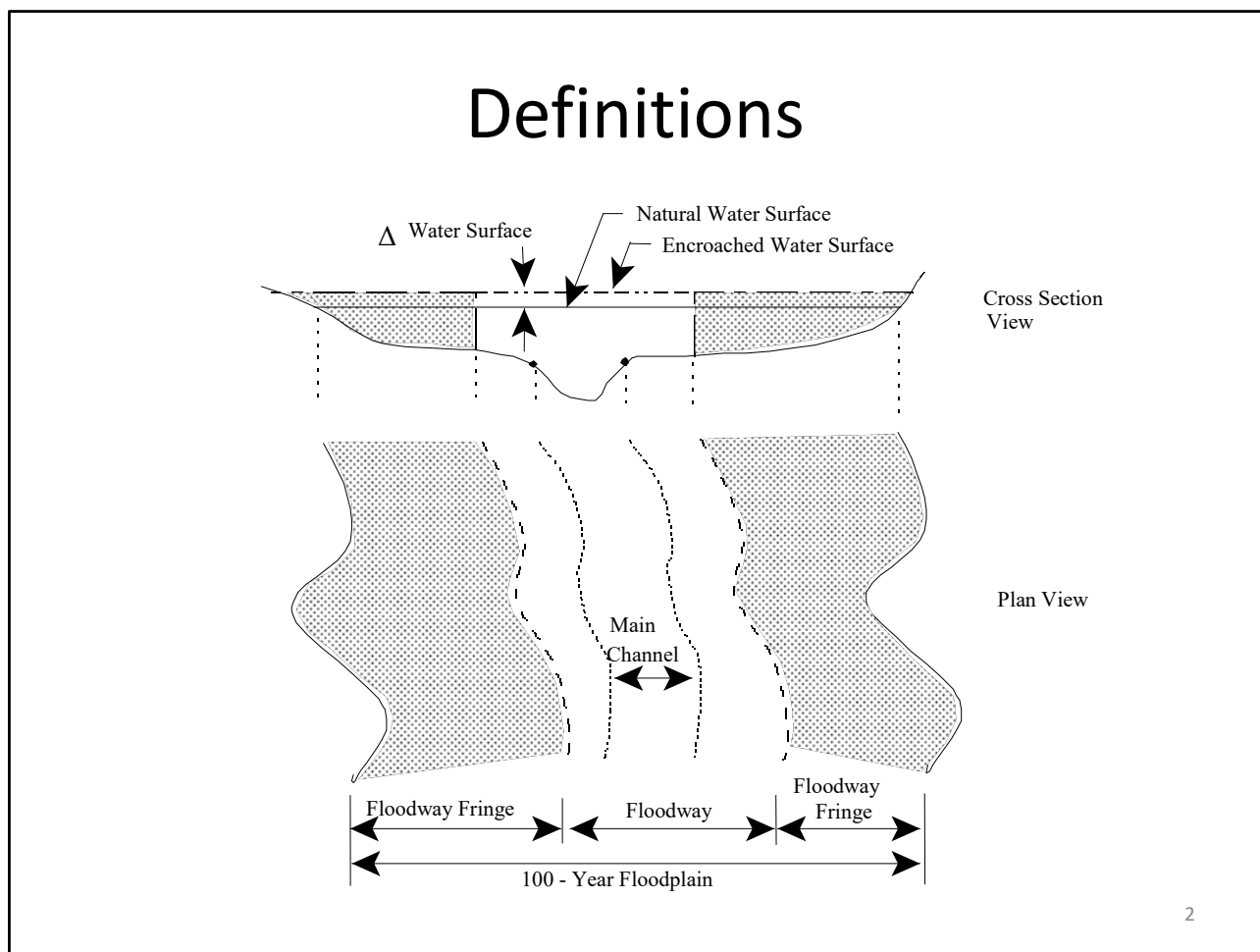
Objectives

To know the:

- Floodway Definitions and Approach
- RAS Encroachment Methods
- Bridge Modeling with Encroachments
- Floodway Input and Output

References:

1. HEC-RAS Hydraulic Reference Manual, Chapter 9, December 2000
2. HEC-RAS User's Manual, Chapter 10, December 2000.
3. Federal Emergency Management Agency, 1999. *Flood Insurance Study Guidelines and Specifications for Study Contractors*, FEMA 37, Washington D.C., April 1999.



FLOODPLAIN The channel of a water course and those portions of the adjoining land area which are required to carry a flood.

FLOODWAY The channel of a water course and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water-surface elevation more than a designated height. (FEMA 37)

FLOODWAY FRINGE That portion of the floodplain between the floodway and the natural outline of the floodplain of the base flood.

General Guidelines

- Hydrology and Hydraulics are based on existing conditions.
- Base flood is 1% chance event (100 yr flood)
- The floodplain is divided into floodway and fringe.
 - Floodway must pass the base flood without raising the water surface by more than 1 foot, unless states have agreed on a lesser value.
 - Floodway fringe is assumed to be filled solid.
- Floodway is normally determined with an equal loss of conveyance on both sides of the stream.

Hydraulic Calculations

- Develop a hydraulic model of the study reach.
- Calibrate the model to any historic flood information (gaged data & high water marks)
- Compute water surface profiles for a range of discharges (10, 50, 100, and 500).
- Compute water surface profiles for existing and proposed floodway conditions (100 yr event).

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HEC-RAS has several options for making initial estimates of the floodway based on change in water surface elevation and equal conveyance reduction criteria.

Hydraulic Calculations - Continued

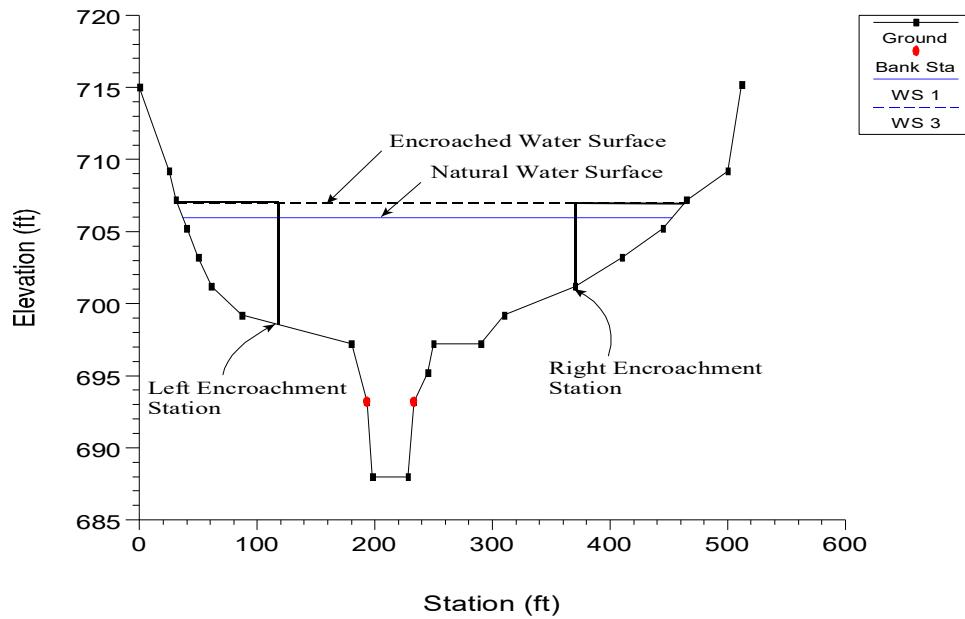
- Analyze the trial floodway computations and make necessary changes required by:
 - Excessive changes in water surface elevation
 - Significant increases in velocities
 - Undulating top widths (dumbbell shape top widths)
 - Results inconsistent with local needs
 - Hazardous conditions (*while the Guidelines do not mention this, the goal is to "guide the development of proposed construction away from locations which are threatened by flood hazards," Sec. 1361.(c1) of the National Flood Insurance Act of 1968*)

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Based on the review, a new floodway is defined and the water surface profile is computed. Several iterations may be required before the required conditions are all met.

Encroachment Methods Method 1

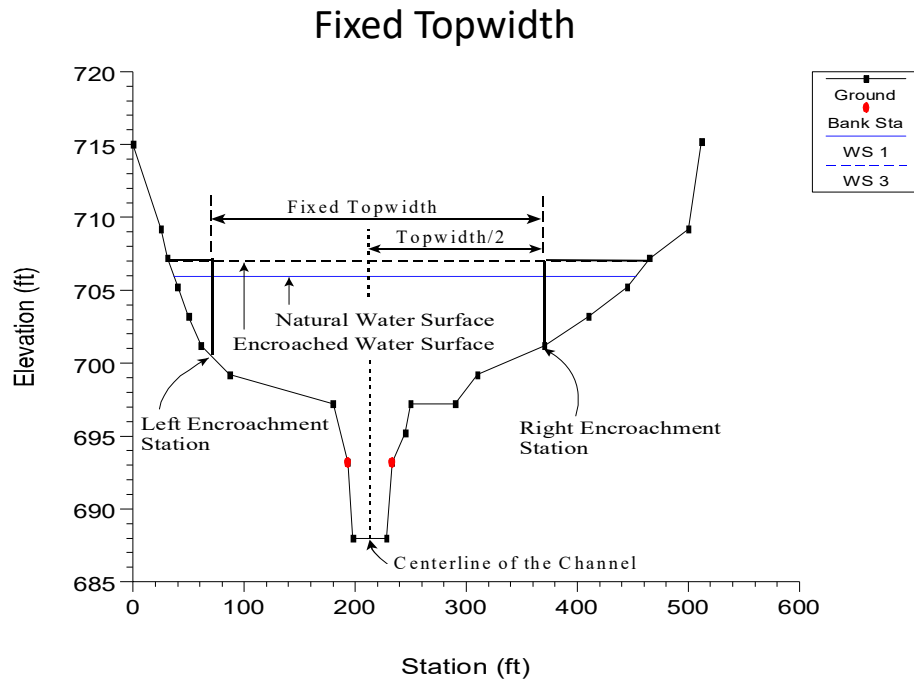
User Specified Locations



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With encroachment method 1 the user specifies the exact locations of the encroachment stations for each individual cross section. The encroachment stations can also be specified differently for each profile. An example of encroachment method 1 is shown in the Figure above.

Encroachment Method 2



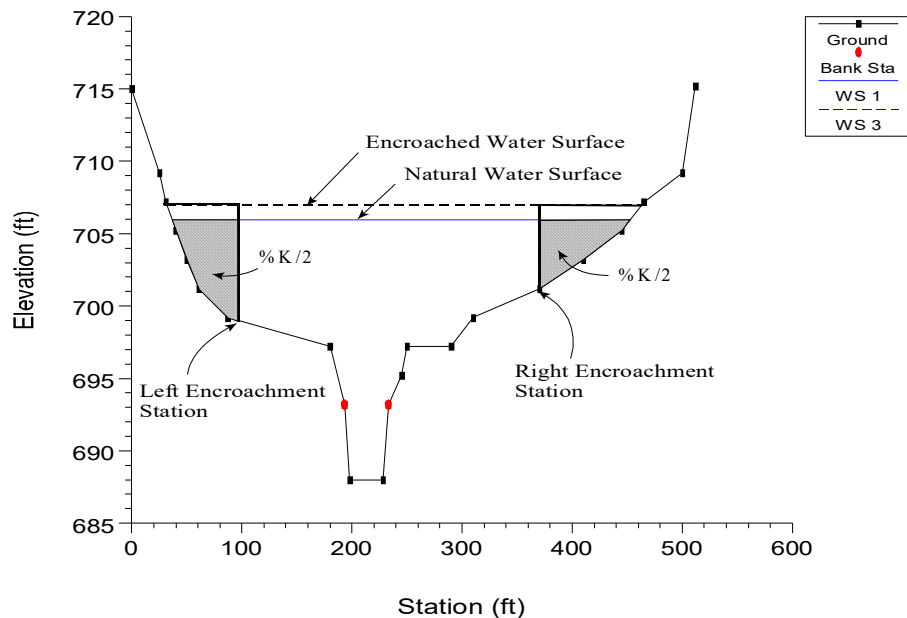
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Method 2 utilizes a fixed top width. The top width can be specified separately for each cross section. The left and right encroachment stations are made equal distance from the centerline of the channel, which is halfway between the left and right bank stations. If the user specified top width would end up with an encroachment inside the channel, the program sets that encroachment (left and/or right) to the channel bank station. An example of encroachment method 2 is shown in the Figure above.

HEC-RAS also allows the user to establish a left and right offset. The left and right offset is used to establish a buffer zone around the main channel for further limiting the amount of the encroachments. For example, if a user established a right offset of 5 feet and a left offset of 10 feet, the model will limit all encroachments to 5 feet from the right bank station and 10 feet from the left bank station. If a user entered top width would end up inside of an offset, the program will set the encroachment at the offset stationing.

Encroachment Method 3

Percent Reduction in Conveyance



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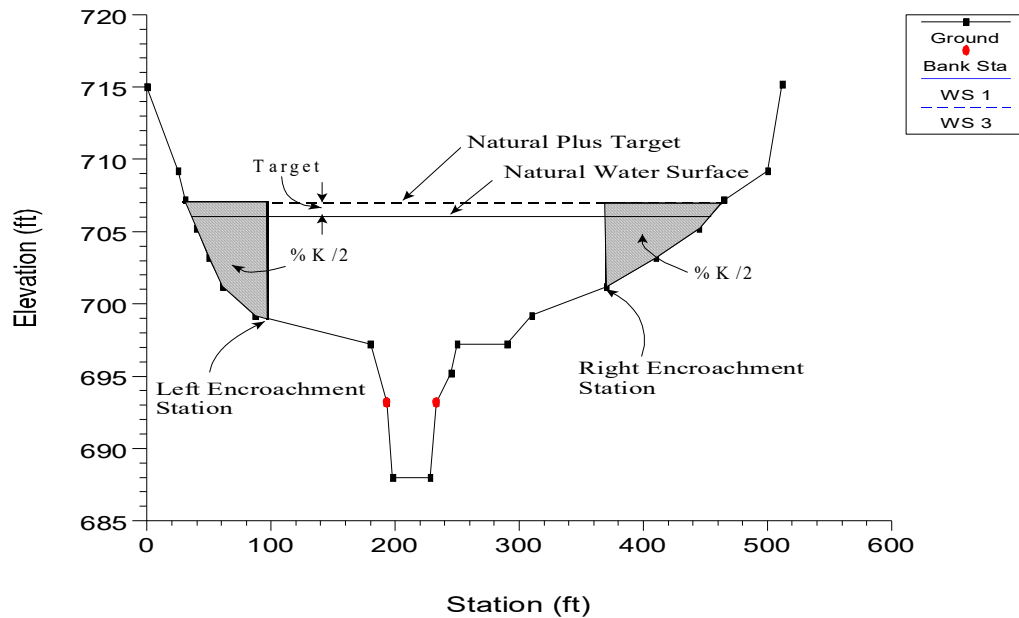
Method 3 calculates encroachment stations for a specified percent reduction in the conveyance (%K Reduction) of the natural profile for each cross section. One-half of the conveyance is eliminated on each side of the cross section (if possible). The computed encroachments cannot infringe on the main channel or any user specified encroachment offsets. If one-half of the conveyance exceeds either overbank conveyance, the program will attempt to make up the difference on the other side. If the percent reduction in cross section conveyance cannot be accommodated by both overbank areas combined, the encroachment stations are made equal to the stations of left and right channel banks (or the offset stations, if specified).

Encroachment Method 3 requires that the first profile (of a multiple profile run) must be a natural (without encroachments) profile. Subsequent profiles (profiles 2-15) of a multiple profile run may be utilized for Method 3 encroachments. The percentage of reduction in conveyance can be changed for any cross section. A value of 10 percent for the second profile would indicate that 10 percent of the conveyance based on the natural profile (first profile) will be eliminated - 5 percent from each overbank. Equal conveyance reduction is the default.

An alternate scheme to **equal** conveyance reduction is conveyance reduction in **proportion** to the distribution of natural overbank conveyance. For instance, if the natural cross section had twice as much conveyance in the left overbank as in the right overbank, a 10 percent conveyance reduction value would reduce 6.7 percent from the left overbank and 3.3 percent from the right overbank.

Encroachment Method 4

Same Conveyance at Target Increase



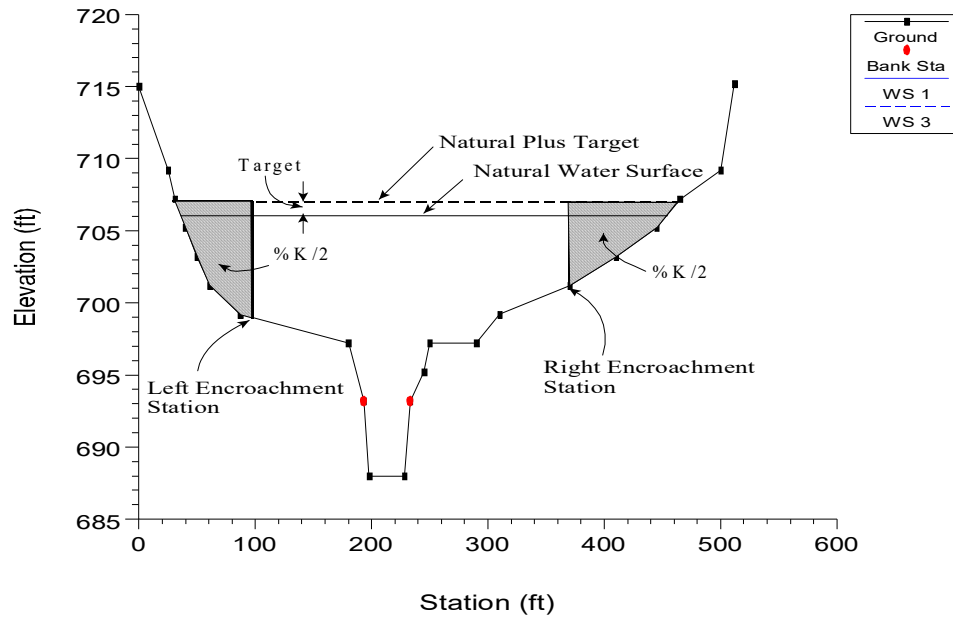
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Method 4 computes encroachment stations so that conveyance within the encroached cross section (at some higher elevation) is equal to the conveyance of the natural cross section at the natural water level. This higher elevation is specified as a fixed amount (target increase) above the natural (e.g., 100 year) profile. The encroachment stations are determined so that an equal loss of conveyance (at the higher elevation) occurs on each overbank, if possible. If half of the loss cannot be obtained in one overbank, the difference will be made up, if possible, in the other overbank, except that encroachments will not be allowed to fall within the main channel.

A target increase of 1.0 indicates that a 1 foot rise will be used to determine the encroachments based on equal conveyance. An alternate scheme to **equal** conveyance reduction is to reduce conveyance in **proportion** to the distribution of natural overbank conveyance. See Method 3 for an explanation of this. A key difference between Method 4 and Method 3 is that the reduction in conveyance is based on the higher water surface (target water surface) for Method 4, while Method 3 uses the lower water surface (natural water surface).

Encroachment Method 5

Method 4 + Optimization



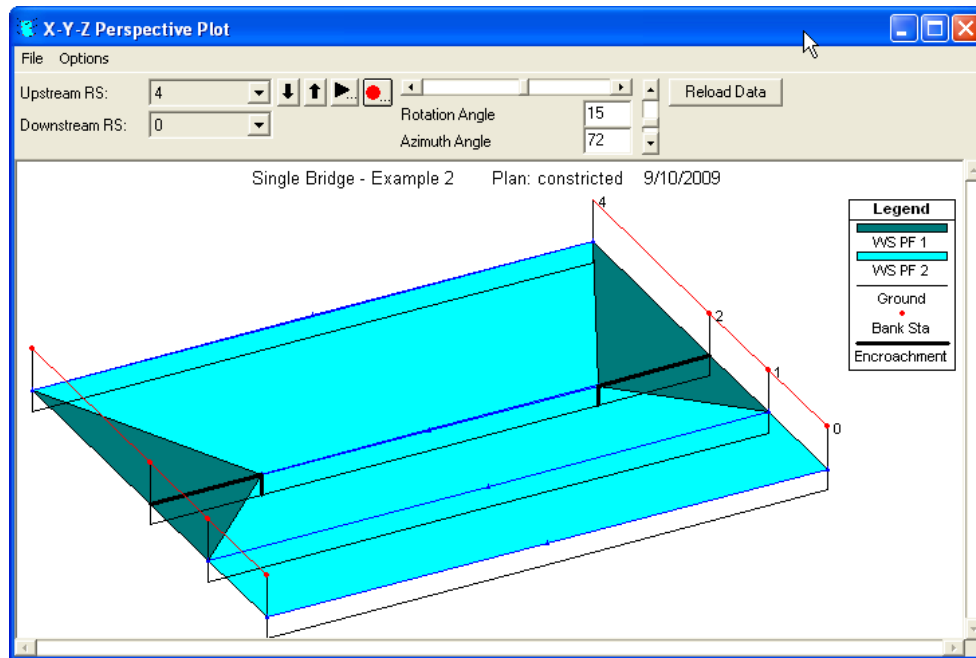
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Method 5 operates much like Method 4 except that an optimization scheme is used to obtain the target difference in water surface elevation between natural and encroached conditions. A maximum of 20 trials is allowed in attempting a solution. Equal conveyance reduction is attempted in each overbank, unless this is not possible (i.e., the encroachment goes all the way into the bank station before the target is met).

The input data for method 5 consists of a **target water surface** increase and a **target energy** increase.

The program objective is to match the target water surface without exceeding the target energy. If this is not possible, the program will then try to find the encroachments that match the target energy. If no target energy is entered, the program will keep encroaching until the water surface target is met. If only a target energy is entered, the program will keep encroaching until the target energy is met. If neither of the criteria is met after 20 trials, the program will take the best answer from all the trials and use it as the final result. The target water surface and energy can be changed at any cross section, like Methods 1 through 4.

Constricted Cross Section



Change In Water Surface?

$$EG = WSE + V^2/2g$$

$$EG - V^2/2g = WSE$$

$$EG\uparrow - V^2/2g\uparrow = WSE?$$

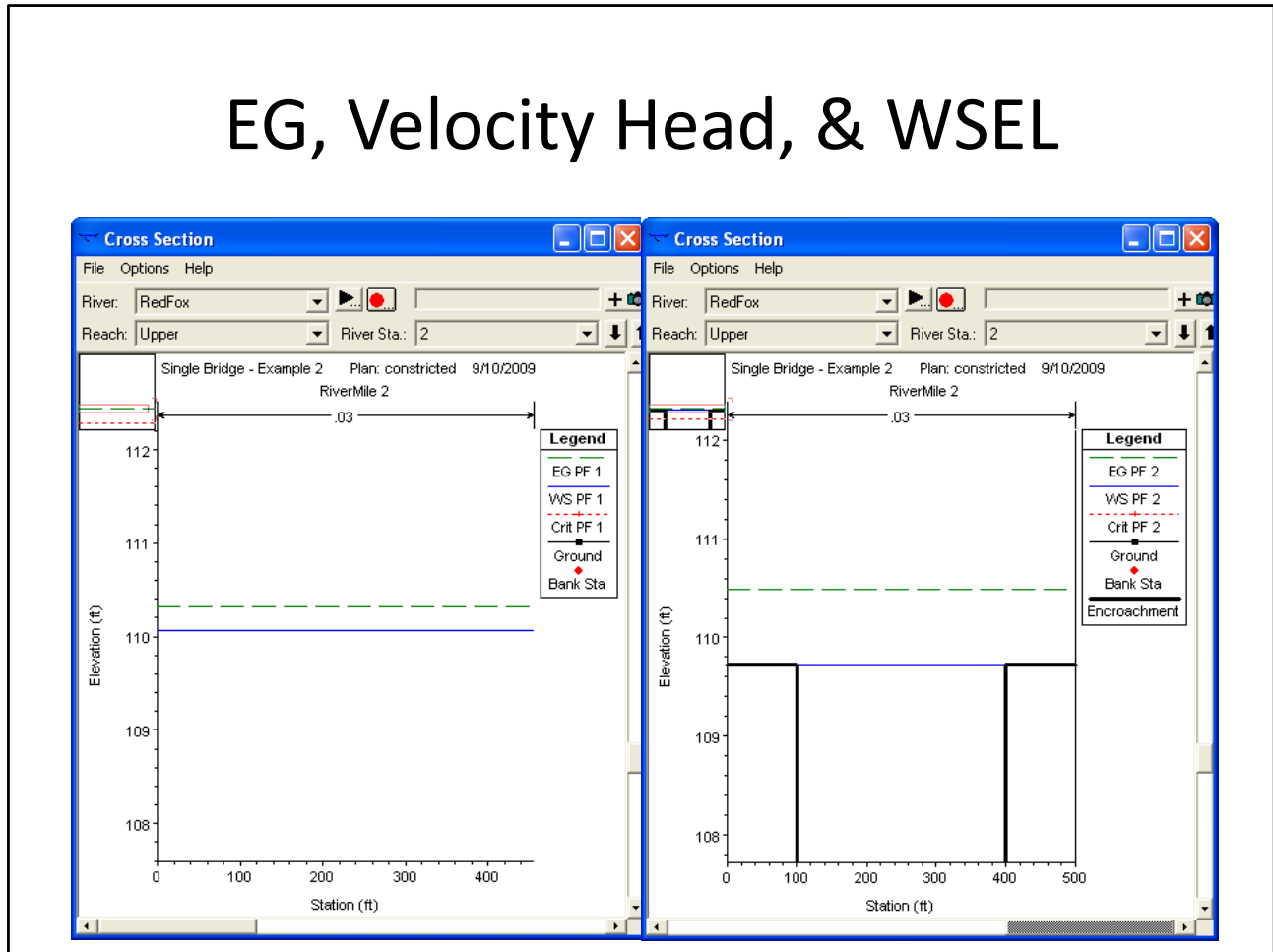
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Constricting a cross section will normally cause the energy grade to rise. (Although if a cross section, to begin with, is wider than the downstream cross section, constricting it could cause less constriction/expansion losses by creating a more uniform river shape). The change in water surface is less predictable.

The constricted shape combined with the higher energy grade often results in a higher velocity at the constriction. If the velocity head ($v^2/2g$) increases more than the energy grade, then the water surface will drop. This behavior can be counter-intuitive (and confusing) even to H&H engineers (and even more so for those without a technical H&H background).

Higher velocities will cause greater friction loss. If the encroachment takes place over a long enough distance, these higher friction losses will eventually cause a rise in water surface (as compared to the original, non-encroached condition).

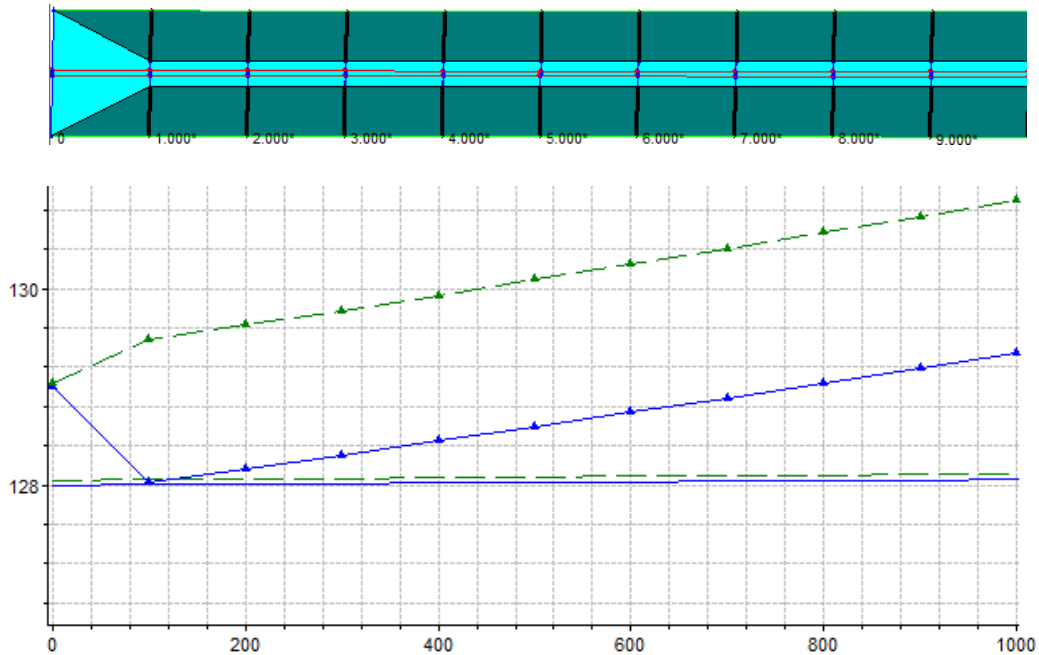
EG, Velocity Head, & WSEL



Even when the water surface does not drop, it may show only a minimal rise. At some locations, it may not be possible to get the target [one foot] rise. Or, alternately, getting a one foot rise would take much more than a one foot rise in energy. If the energy gets too high at one location, it may not be possible to meet the one foot water surface limit at locations further upstream. Sometimes, the high energy can cause the upstream cross sections to exceed the target water surface even if they have no encroachments.

Because of this behavior, it is recommended that Method 5 generally be used with an energy grade target (either with or without a water surface target). Additionally, when using Method 1, it is generally recommended that the energy grade not be allowed to get too high at any one location (even if the water surface is in range). As already discussed, the high energy can cause problems upstream. Furthermore, the actual height of the flood line may, in some cases, be closer to the energy grade line than it is to the displayed water surface (i.e., the hydraulic grade line).

Energy Grade Too High



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In the example above for the encroached profile, the user specified the downstream water surface boundary one foot higher than the original non-encroached boundary (this is typically recommended). However, the downstream cross section has no encroachments whereas the next cross immediately upstream has a large encroachment (this is *not* generally recommended). The first encroached cross section has an EG that is ~1.5 feet higher although the WSE is basically the same. The encroachments cause the velocity to be higher which causes more friction losses. For the XS at 800 feet, the encroached WSE is now a little more than 1.0 feet higher and the EG is more than 2.0 feet higher. At this cross section, it is no longer possible to limit the rise to 1.0 feet. Reducing the encroachment at this cross section would actually cause an even higher WSE because it would reduce the velocity head. The solution is to reduce the amount of encroachment for the downstream cross sections in order to prevent the EG from getting so high in the first place.

Bridge, Culvert, and Multiple Opening Encroachments

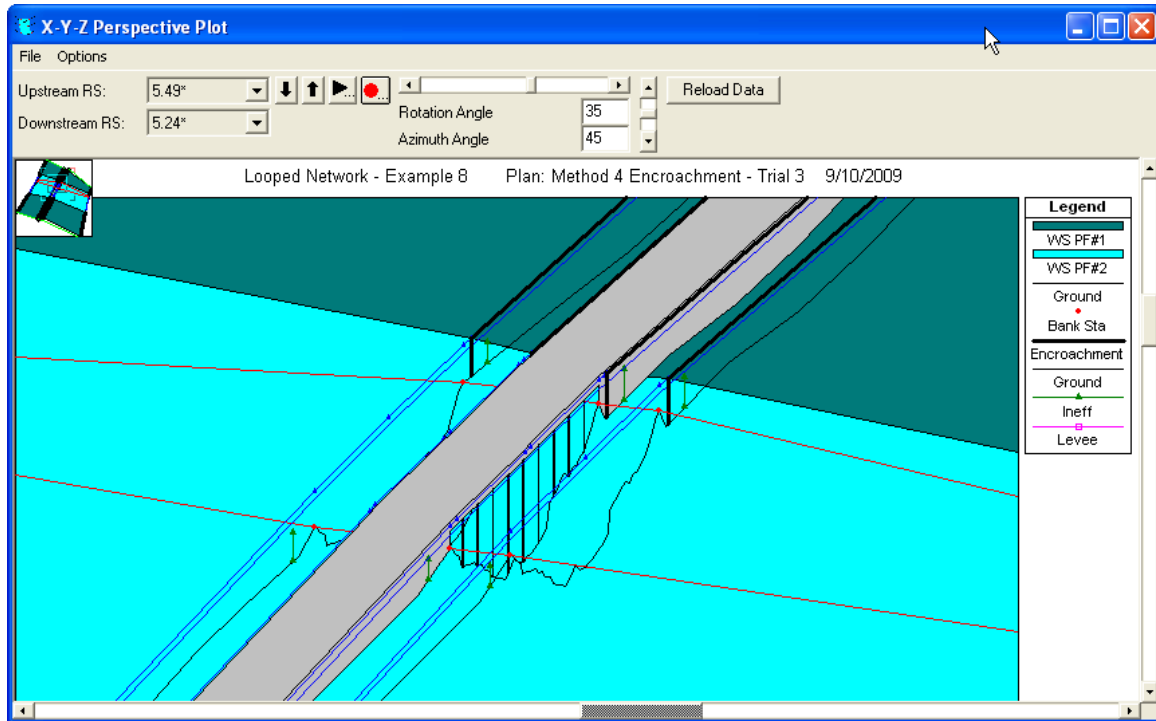
- The encroachment at the inside bridge cross section is the same as the immediately adjacent outside cross section.
- If Method 1 is used, the upstream and downstream side can have different encroachments. Otherwise they are the same.
 - Methods 2-5 apply the d/s encroachment u/s
 - The encroachment is based on channel location

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The encroachment at the inside bridge cross section is the same as the immediately adjacent outside cross section (downstream inside matches downstream outside—upstream inside matches upstream outside).

If Method 1 is used, the user can enter different encroachments for the upstream and the downstream side of the structure. Otherwise (for Methods 2-5), RAS will compute the encroachment at the downstream side (based on the user selected method) and will use this same encroachment at the upstream side. If the channel bank stations exactly match on the downstream and upstream end, then the encroachments are “projected” upstream. If the channel stations do not match (that is, they don’t have the same horizontal stationing), then the same offset from the channel is used. For instance, if the downstream side encroaches to within 15 feet of the [downstream] left bank station, then the upstream side will encroach to within 15 of the [upstream] left bank station.

Encroachment at a Bridge

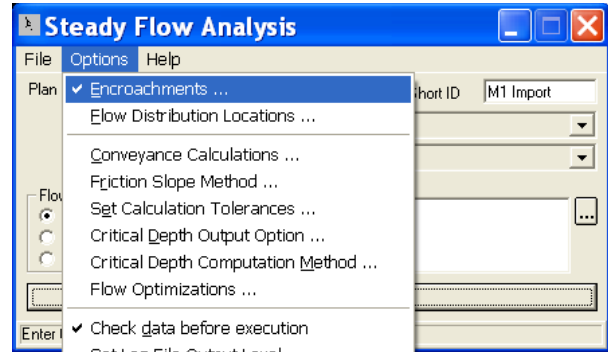


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The cross sections that define a bridge are usually close together and it wouldn't usually make "hydraulic sense" for the inside of the bridge to be less encroached than the outside. Similarly, it wouldn't normally make sense for the encroachments at the upstream side to be significantly different from the downstream side. However, the user is allowed to enter different encroachments at the upstream and downstream side, if desired, by using Method 1. If the internal bridge cross sections do need to have a different encroachment than the outside cross sections (for whatever reason), this can be modeled by adjusting the station/elevation data on the internal bridge cross sections.

Entering Encroachment Data

- Floodway encroachment data are entered in the **Steady Flow Analysis** window.
- Encroachment data are stored as part of the current **Plan Data**.
- Select **Encroachments** from the **Options** menu of the **Steady Flow Analysis** window.



Entering Encroachment Data - *Continued*

Global
Information

River Sta	Method	Value 1	Value 2
1 5.99	4	0.8	
2 5.875*	4	0.8	
3 5.76	4	0.8	
4 5.685*	4	0.8	
5 5.61	4	0.8	
6 5.49*	4	0.8	
7 5.41	4	0.8	
8 5.4 BR			
9 5.39	4	0.8	
10 5.24*	4	0.8	
11 5.13	4	0.8	
12 5.065*	4	0.8	
13 5.0	4	1	

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Global Information. Global information are data that will be applied at every cross section for every profile computed. The first piece of global information is the **Equal Conveyance Reduction** selection box at the top of the Encroachment data editor window. Equal conveyance reduction applies to encroachment methods 3, 4, and 5. When this is turned on, the program will attempt to encroach, such that an equal loss of conveyance is provided on both sides of the stream. If this option is turned off, the program will encroach by trying to maintain a loss in conveyance in proportion to the distribution of natural overbank conveyance. The default is to have equal conveyance reduction turned on.

The second item under global information, is the **Left bank offset** and the **Right bank offset**. The left and right offsets are used to establish a buffer zone around the main channel for further limiting the amount of the encroachments. For example, if a user established a right offset of 5 feet and a left offset of 10 feet, the model will limit all encroachments to 5 feet from the right bank station and 10 feet from the left bank station. The default is to have no right or left offset, this will allow the encroachments to go up to the main channel bank stations, if necessary.

Entering Encroachment Data - *Continued*

River, Reach, and
Profile →

Encroachments

Equal Conveyance Reduction

Left bank offset: 10 Right bank offset: 10

River: Beaver Creek Profile: PF#2

Reach: Kentwood Import to Method 1

Set Range of Values

Upstream RS: 5.99 Method: none

Downstream RS: 5.0 Value 1: Value 2:

Set Selected Range

River Sta	Method	Value 1	Value 2
1 5.99	4	0.8	
2 5.875*	4	0.8	
3 5.76	4	0.8	
4 5.685*	4	0.8	
5 5.61	4	0.8	
6 5.49*	4	0.8	
7 5.41	4	0.8	
8 5.4 BR			
9 5.39	4	0.8	
10 5.24*	4	0.8	
11 5.13	4	0.8	
12 5.065*	4	0.8	
13 5.0	4	1	

OK Cancel Clear Profile Clear All Profiles

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River, Reach and River Station Selection Boxes. The next piece of data for the user to select, is the river and reach in which to enter encroachment data. The user is limited to seeing one reach at a time on the encroachment data editor. Once a reach is selected, the user can then enter a **Starting and Ending River Station** to work on. By default, the program selects all the sections in the reach. The user can change this to any range of cross sections within the reach.

Profile. Next, the user should select a profile number to work on. Profiles are limited to 2 through the maximum number set in the currently opened flow data (e.g., 2 through 4, if the user has set 4 profiles in the flow data editor). The user can not set encroachments for profile 1.

Entering Encroachment Data - *Continued*

Set Method and
Target over a range of
river stations →

Encroachments

Equal Conveyance Reduction

Left bank offset: 10 Right bank offset: 10

River: Beaver Creek Profile: PF#2

Reach: Kentwood Import to Method 1

Set Range of Values

Upstream RS: 5.99 Method: none

Downstream RS: 5.0 Value 1: Value 2:

Set Selected Range

	River Sta	Method	Value 1	Value 2
1	5.99	4	0.8	
2	5.875*	4	0.8	
3	5.76	4	0.8	
4	5.685*	4	0.8	
5	5.61	4	0.8	
6	5.49*	4	0.8	
7	5.41	4	0.8	
8	5.4 BR			
9	5.39	4	0.8	
10	5.24*	4	0.8	
11	5.13	4	0.8	
12	5.065*	4	0.8	
13	5.0	4	1	

OK Cancel Clear Profile Clear All Profiles

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Method and Target Values. The next step is to enter the desired encroachment method to be used for the currently selected profile. Once a method is selected, the data entry boxes that corresponds to that method will show up below the method selection box. Some of the methods require only one piece of data, while others require two. The user should then enter the required information that corresponds to the method that they have selected. For example, if the user selects encroachment method 4, only one piece of information is required, the target change in water surface elevation.

Set Selected Range. Once the encroachment method is selected, and its corresponding data are entered, the user should press the **Set Selected Range** button. Pressing this button will fill in the table below with the selected range of river stations; the selected method; and the corresponding data for the method. Note that, if the selected method only has one data item, that method's data will go under the **Value 1** column of the table. If the selected method has two data items, the first goes into the **Value 1** column and the second goes into the **Value 2** column. Once the data is put into the table, the user can change the method and corresponding data values directly from the table.

Entering Encroachment Data - *Continued*

Encroachments

Equal Conveyance Reduction

Left bank offset: Right bank offset:

River: Profile:

Reach:

Set Range of Values

Upstream RS: Method:

Downstream RS: Value 1:

Value 2:

	River Sta	Method	Value 1	Value 2
1	5.99	4	0.8	
2	5.875*	4	0.8	
3	5.76	4	0.8	
4	5.685*	4	0.8	
5	5.61	4	0.8	
6	5.49*	4	0.8	
7	5.41	4	0.8	
8	5.4 BR			
9	5.39	4	0.8	
10	5.24*	4	0.8	
11	5.13	4	0.8	
12	5.065*	4	0.8	
13	5.0	4	1	

Table of Encroachments →

At this point the user should repeat these tasks until all of the encroachment data are entered (i.e., for all the reaches and locations in the model, as well as all of the profiles for which the user wants to perform the encroachment analysis). Once all of the encroachment data are entered, the user presses the **OK** button and the data will be applied and the window will close. The user can return to the encroachment window and edit the data at any time. The encroachment data are not saved to the hard disk at this time, they are only saved in memory. To save the data to the hard disk, the user should either select **Save Project** from the File menu of the main HEC-RAS window, or select **Save Plan** from the File menu of the Steady Flow Analysis window.

Entering Encroachment Data - *Continued*

Encroachments

Equal Conveyance Reduction

Left bank offset: 10 Right bank offset: 10

River: Beaver Creek Profile: PF#2

Reach: Kentwood **Import to Method 1**

Set Range of Values:

Upstream RS: 5.99 Method: none

Downstream RS: 5.0 Value 1: Value 2:

Set Selected Range

	River Sta	Method	Value 1	Value 2
1	5.99	4	0.8	
2	5.875*	4	0.8	
3	5.76	4	0.8	
4	5.685*	4	0.8	
5	5.61	4	0.8	
6	5.49*	4	0.8	
7	5.41	4	0.8	
8	5.4 BR			
9	5.39	4	0.8	
10	5.24*	4	0.8	
11	5.13	4	0.8	
12	5.065*	4	0.8	
13	5.0	4	1	

OK Cancel Clear Profile Clear All Profiles

Import to Method 1

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The **Import Method 1** option, allows the user to transfer the computed encroachment stations from a previous run (output file) to the input data for a future run. For example, if the user performs a preliminary encroachment analysis using any of the methods 2 through 5, they may want to convert the results from one of the runs to a method 1 encroachment method. This will allow the user to further define the floodway, using method 1, without having to enter all of the encroachment stations. The import of encroachment stations, in this manner, is limited to the results of a single encroachment profile for each reach.

Computing Floodway Encroachments

- Profile 1 must always be a natural profile (i.e. no encroachments).
- Force target increase at downstream end.
- Generally, methods 4 and 5 are used first to get a reasonable floodway.
- The results should be analyzed for increases in water surface, changes in velocity, changes on top width, and other parameters.
- Fine adjustments can be made by changing the target values of method 4 and 5.

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The HEC-RAS floodway procedure is based on calculating a natural profile (no encroachments) as the first profile of a multiple profile run. Subsequent profiles are calculated with the various encroachment options available in the program. The downstream end [of the encroachment region] should include the target rise in the water surface (e.g. force the water surface to be 1 foot higher than profile 1). If the encroachment starts at the downstream end of the reach, a known water surface, one foot [or whatever the target is] higher, can be used. If the encroachment study starts in the middle of the reach, force the next cross section downstream to be one foot higher, using the Set Internal Change in WS option.

In general, when performing a floodway analysis, encroachment methods 4 and 5 are normally used to get a first cut at the encroachment stations. Recognizing that the initial floodway computations may provide changes in water surface elevations greater, or less, than the "target" increase, initial computer runs are usually made with several "target" values. The initial computer results should then be analyzed for increases in water surface elevations, changes in velocities, changes in top width, and other parameters. Also, plotting the results with the X-Y-Z perspective plot, or onto a topo map, is recommended. From these initial results, new estimates can be made and tested.

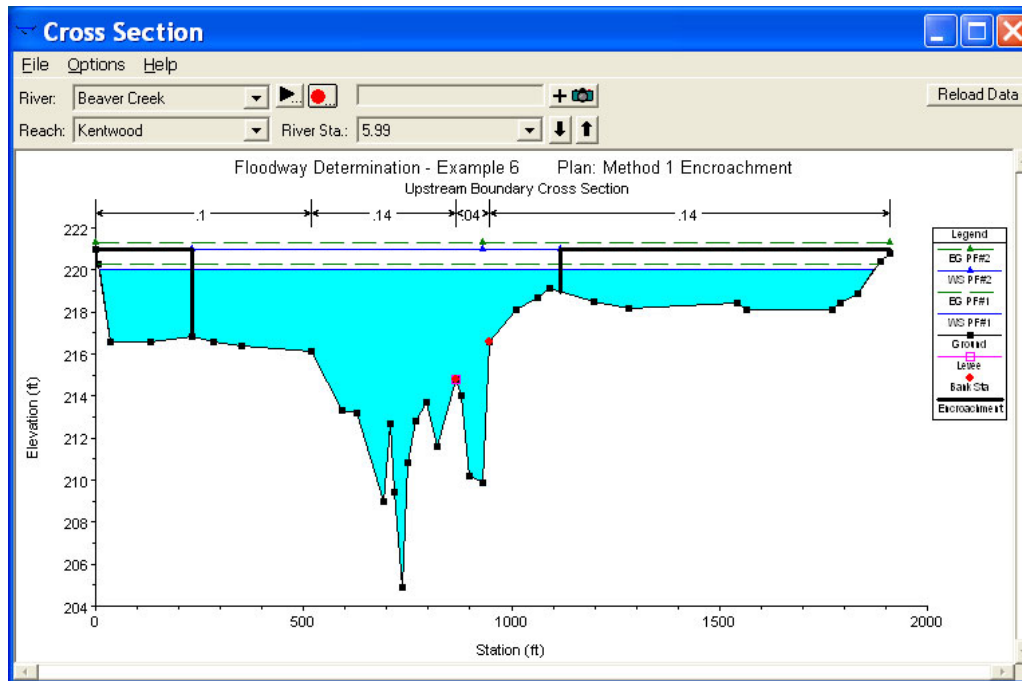
Computing Floodway Encroachments - *Continued*

- The user may want to convert to method 1 in order to perform some final adjustments
- Remember, the floodway must be consistent with local development plans
- The floodway should provide reasonable hydraulic transitions through the study reach
- Once the computed floodway is transferred to a map, further adjustment may be necessary.

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While the floodway analysis generally focuses on the change in water surface elevation, it is important to remember that the floodway must be consistent with local development plans and provide reasonable hydraulic transitions through the study reach. Sometimes the computed floodway solution, that provides computed water surfaces at or near the target maximum, may be unreasonable when transferred to the map of the actual study reach. If this occurs, the user may need to change some of the encroachment stations, based on the visual inspection of the topo map. The floodway computations should be re-run with the new encroachment stations to ensure that the target maximum is not exceeded.

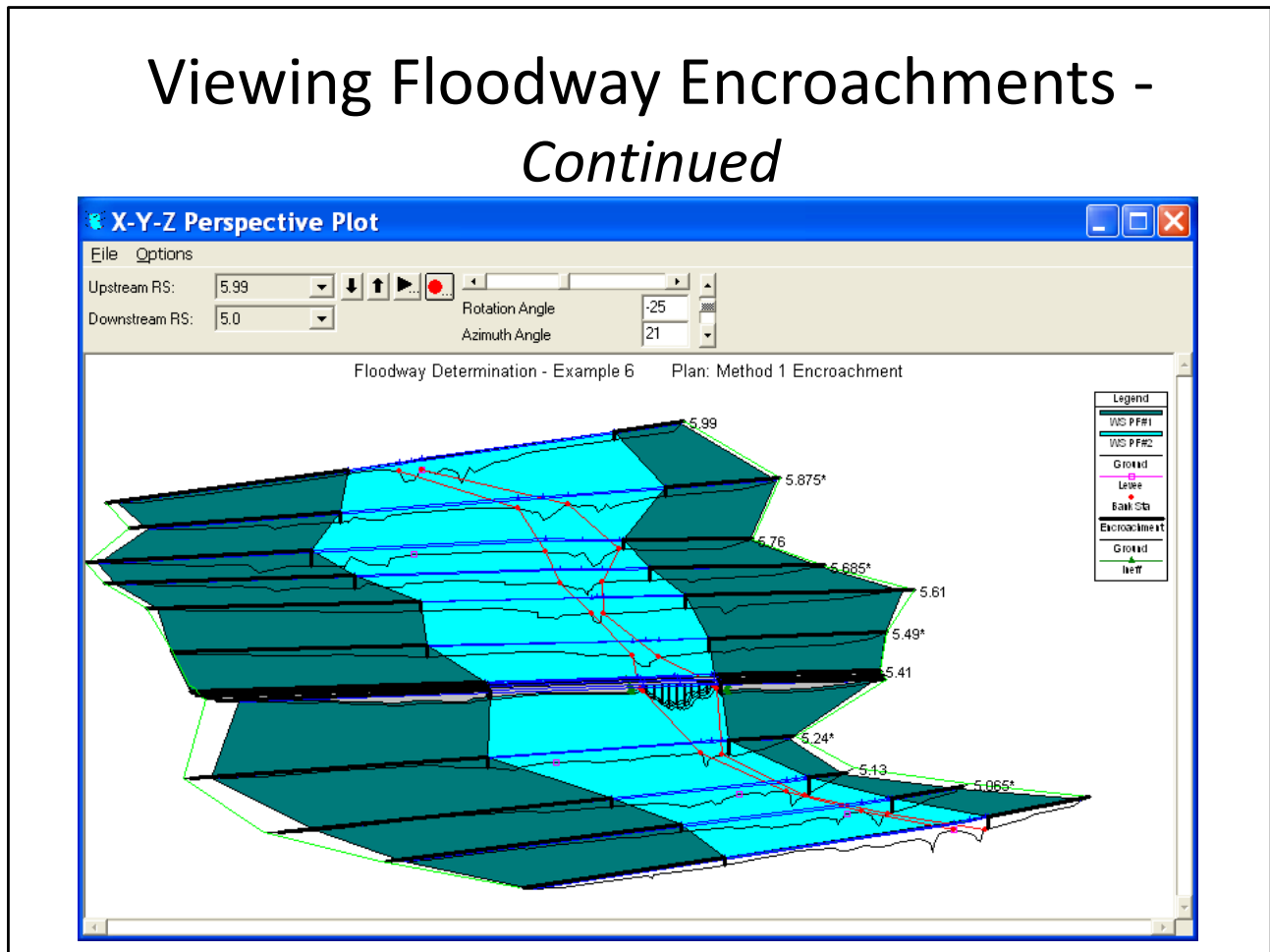
Viewing Floodway Encroachments



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Floodplain encroachment results can be viewed in both graphical and tabular modes. Graphically, the encroachment results show up on the cross section plots as well as the X-Y-Z Perspective plot. As shown in the Figure above, the encroachments are plotted as outlined blocks. In this example, the water surface profile for the base run (first profile) is plotted along with one of the encroached profiles. The user can plot as many profiles as they wish, but it may become a little confusing with several sets of encroachments plotted at the same time.

Viewing Floodway Encroachments - *Continued*



Another type of graphic that can be used to view the encroachments is the X-Y-Z perspective plot, an example is shown in the slide above. In this example, the base profile (profile 1) as well as one of the encroached profiles is plotted at the same time over a range of cross sections. This type of plot allows the user to get a reach view of the floodplain encroachment. The user can quickly see if the encroachments transition smoothly or if they are erratic. In general, the final encroachments should have a consistent and smooth transition from one cross section to the next. With the assistance of this type of plot, the user may want to further refine the final encroachment stations and re-run the model.

Viewing Floodway Encroachments Encroachment Table 1

Reach	River Sta	W.S. Elev (ft)	Prof Delta W/S (ft)	E.G. Elev (ft)	Top Width Act (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Enc Sta L (ft)	Ch Sta L (ft)	Ch Sta R (ft)	Enc Sta R (ft)
Kentwood	5.61	218.09		218.14	1988.71	5107.05	1408.46	7484.49		830.00	860.00	
Kentwood	5.61	218.71	0.62	218.86	707.62	3372.75	2019.23	8608.02	609.60	830.00	860.00	1317.22
Kentwood	5.49*	217.90		217.98	1910.08	4180.82	3241.47	6577.70		611.30	682.70	
Kentwood	5.49*	218.34	0.43	218.54	752.77	1926.42	4737.75	7335.83	477.33	611.30	682.70	1230.10
Kentwood	5.41	217.43		217.67	1847.01	1227.45	9657.21	3115.34		450.00	647.00	
Kentwood	5.41	217.54	0.11	218.02	617.70	17.11	12202.99	1779.90	440.00	450.00	647.00	1057.70
Kentwood	5.4 BR U	217.43		217.67	1847.01	843.41	10817.74	2359.12		450.00	647.00	
Kentwood	5.4 BR U	217.54	0.11	218.02	617.70	32.15	11983.30	1981.99	440.00	450.00	647.00	1057.70
Kentwood	5.4 BR D	217.43		217.67	1824.00	852.71	10867.03	2300.54		450.00	647.00	
Kentwood	5.4 BR D	217.54	0.11	218.02	617.70	32.84	12003.20	1961.40	440.00	450.00	647.00	1057.70
Kentwood	5.39	215.62		216.04	1702.87	1073.66	10252.91	2673.44		450.00	647.00	
Kentwood	5.39	216.61	1.00	217.23	617.70	30.52	12569.51	1399.97	440.00	450.00	647.00	1057.70
Kentwood	5.24*	214.64		214.77	1633.33	2335.77	2506.42	9157.81		200.30	257.00	
Kentwood	5.24*	215.64	1.00	215.83	680.87	322.54	3058.78	10618.68	182.33	200.30	257.00	863.20

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Encroachment results can also be viewed in a tabular mode from the Profile Output Tables. Select **Profile Table** from the **View** menu of the main HEC-RAS window. When the table comes up, the user can select from three different pre-defined encroachment tables. To bring up one of the encroachment tables, select **Encroachment 1** from the **Std. Tables** menu on the Profile table window. An example of Encroachment 1 table is shown in the slide above. The table shows the basic encroachment results of : computed water surface elevation; change in water surface from the base profile; the computed energy; top width of the active flow area; the flow in the left overbank, main channel, and right overbank; the left encroachment station; the station of the left bank of the main channel; the station of the right bank of the main channel; and the right encroachment station.

Viewing Floodway Encroachments Encroachment Table 2

Reach	River Sta	Prof Delta WS (ft)	Top Width Act (ft)	K Perc L	Enc Sta L (ft)	Dist Center L (ft)	Center Station (ft)	Dist Center R (ft)	Enc Sta R (ft)	K Perc R	Enc W/D (ft)
Kentwood	5.49*		1910.08				647.00				
Kentwood	5.49*	0.43	752.77	20.64	477.33	169.67	647.00	583.10	1230.10	15.40	752.77
Kentwood	5.41		1847.01				548.50				
Kentwood	5.41	0.11	617.70		440.00	108.50	548.50	509.20	1057.70		617.70
Kentwood	5.4 BR U		1847.01				548.50				
Kentwood	5.4 BR U	0.11	617.70		440.00	108.50	548.50	509.20	1057.70		617.70
Kentwood	5.4 BR D		1824.00				548.50				
Kentwood	5.4 BR D	0.11	617.70		440.00	108.50	548.50	509.20	1057.70		617.70
Kentwood	5.39		1702.87				548.50				
Kentwood	5.39	1.00	617.70	8.68	440.00	108.50	548.50	509.20	1057.70	15.08	617.70
Kentwood	5.24*		1633.33				228.65				
Kentwood	5.24*	1.00	680.87	14.26	182.33	46.32	228.65	634.55	863.20	13.96	680.87
Kentwood	5.13		1430.09				184.00				
Kentwood	5.13	1.00	595.57	6.48	145.00	39.00	184.00	556.57	740.57	17.52	595.57

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Encroachment 2 table provides some additional information that is often used when plotting the encroachments onto a map. This table includes: the change in water surface elevations from the first profile; the top width of the active flow area; the percentage of conveyance reduction in the left overbank; the left encroachment station; the distance from the center of the main channel to the left encroachment station; the station of the center of the main channel; the distance from the center of the main channel to the right encroachment station; the right encroachment station; and the percentage of conveyance reduction in the right overbank.

Viewing Floodway Encroachments

Encroachment Table 3

The screenshot shows a software window titled "Profile Output Table - Encroachment 3". The window contains a menu bar (File, Options, Std. Tables, User Tables, Locations, Help) and a status bar (HEC-RAS Plan: Method 1 River: Beaver Creek Reach: Kentwood). The main content is a table with the following data:

Reach	River Sta	Top Width Act (ft)	Area (sq ft)	Vel Total (ft/s)	W.S. Elev (ft)	Base WS (ft)	Prof Delta WS (ft)
Kentwood	5.41	1847	8979	1.6	217.4	217.4	
Kentwood	5.41	618	4044	3.5	217.5	217.4	0.1
Kentwood	5.4 BR U	1847	2527	5.5	217.4	217.4	
Kentwood	5.4 BR U	618	1980	7.1	217.5	217.4	0.1
Kentwood	5.4 BR D	1824	2516	5.6	217.4	217.4	
Kentwood	5.4 BR D	618	1980	7.1	217.5	217.4	0.1
Kentwood	5.39	1703	6632	2.1	215.6	215.6	
Kentwood	5.39	618	3548	3.9	216.6	215.6	1.0
Kentwood	5.24*	1633	5817	2.4	214.6	214.6	
Kentwood	5.24*	681	4716	3.0	215.6	214.6	1.0
Kentwood	5.13	1430	5017	2.8	213.3	213.3	
Kentwood	5.13	596	4096	3.4	214.3	213.3	1.0
Kentwood	5.065*	1782	5753	2.4	212.5	212.5	
Kentwood	5.065*	674	4173	3.4	213.5	212.5	1.0

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The last encroachment table, Encroachment 3, provides the minimum floodway data for reporting. This table includes: the active flow top width; the flow area (including any ineffective flow area); the average velocity of the entire cross section; the computed water surface elevation; the base water surface elevation (profile 1); and the change in water surface from the first profile.