HECRAS Basis Input

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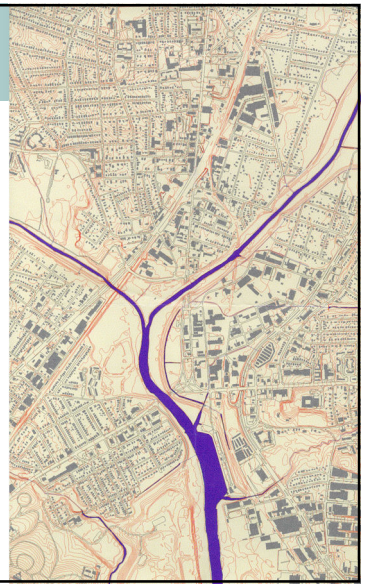
The Basics

- Geometry Data.
- Flow Data.
- Perform Hydraulic Computations
- Viewing the Output

Before you start… Layout the model

- Extent of study area
- Area of interest
- Boundary conditions
- Section locations and orientation



Geometry Data - the basics

- Cross-section information
- Roughness coefficients
- Distance between sections
- Bridge/culvert data

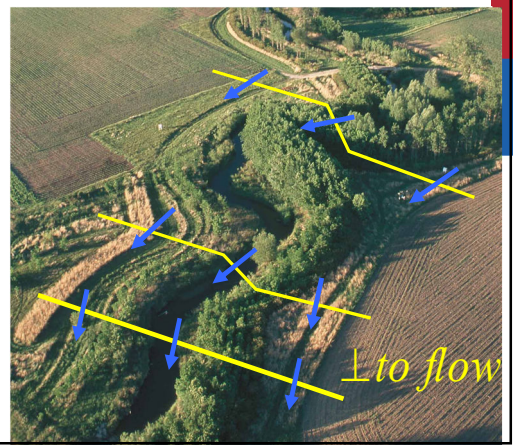
Cross Section Locations

Place and measure cross sections when there is a change in:

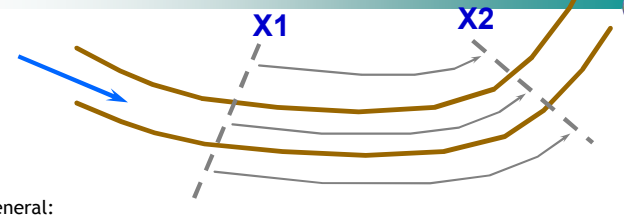
- Slope
- Discharge
- Roughness
- Channel shape
- Control (bridge, levee, weir, etc)

Cross section orientation

- Very important
- Survey perpendicular to flow
- May not be a straight line



Cross Section Spacing: Where to measure?

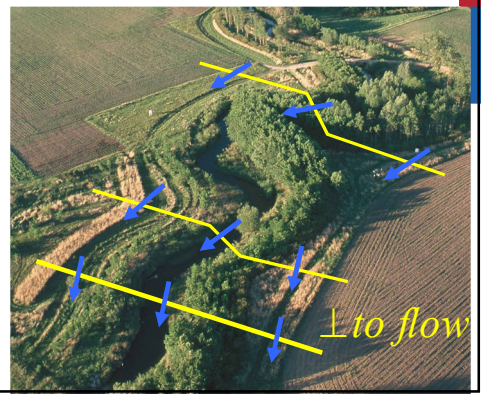


In general:

- Widely spaced for flat, very large rivers and closer for steep small streams
- Very large rivers (Mississippi) on the order of a mile (1600 m)
- For large rivers on the order of 1000 feet (300 m)
- For slower streams on the order of 200 feet (60 m)
- For small creeks on the order of 25 feet (8 m)
- For supercritical reaches, on the order of 10 to 50 feet (3 to 15 m)
- For drop structures, as low as 5 feet (1 m)
- Can interpolate if reasonable (check results)
- Not too close (1', may drop friction loses)

Reach Lengths - Are they constant?

High flow
Low flows

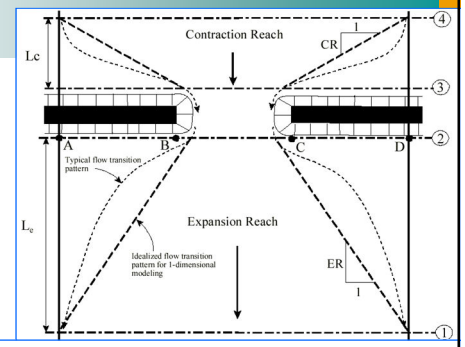


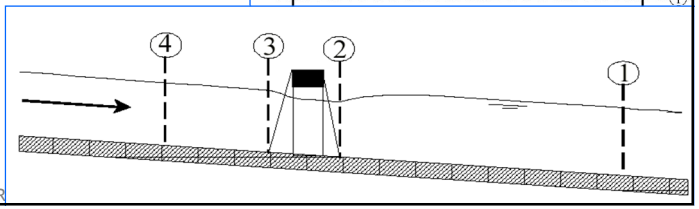
Survey

- Survey shots must describe the channel and overbank flow area
- Section should extend across the entire floodplain
- Plot cross-section data, especially electronic surveys
- Take photographs
- Assume modeler has never seen the stream
- Note vegetation changes in cross-section e.g. field, trees, grass buffer, etc.
- No 3-point cross-sections

Bridge Surveys

- Profile road and bridge deck centerline
- Pier width, location
- Low Chord Elevation
- Skew Angle (bridge - stream)
- Bridge opening



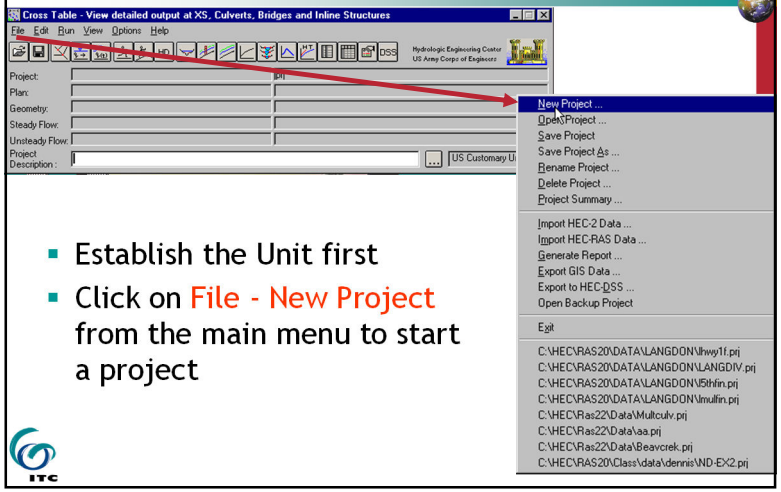


Basic Input - the model

Starting HEC-RAS

Double Click on HEC-RAS icon.

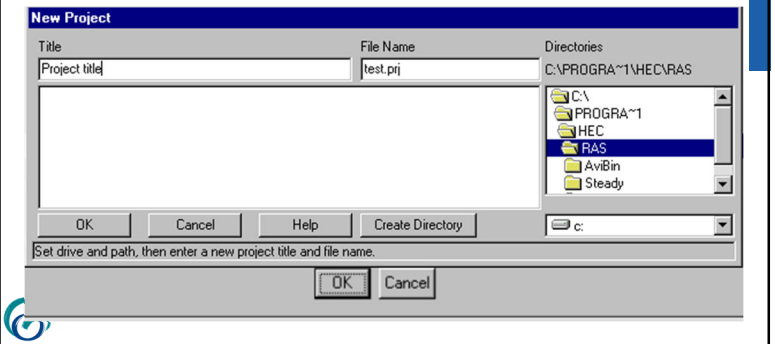
Starting a Project



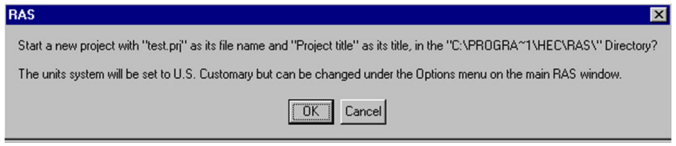
- Establish the Unit first
- Click on File - New Project from the main menu to start a project

Starting a Project

- Select a working directory
- Then enter project title and file name



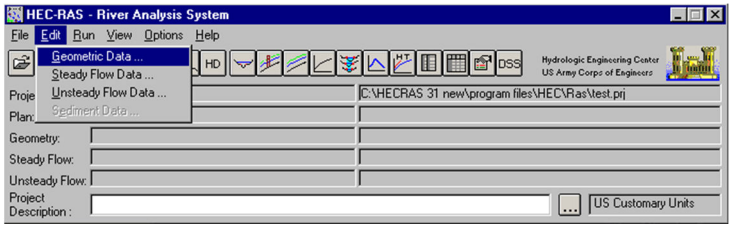
Starting a Project



- Check the unit system before accepting.
- Units can be change before or after the model is created.

Stream Geometry Data

- To add data, click on **Edit** and **Geometric Data**



Or, you can click on the Geometry Editor button:

Stream Geometry Data

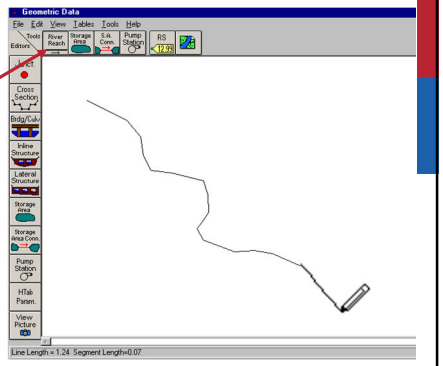
- **Suggested order of data entry:**
  - Add River Reach(es) along with any Junctions (actually, this **must** be first).
  - Add Cross-Section names, elevation-station data, 'n' values, bank stations, reach lengths, loss coefficients, etc.
  - Add Road/Bridge/Culvert and/or Weir/Spillway data.

River System Schematic

- Must be added before any other features.
- Draw and connect the reaches of the stream system.
- Draw from upstream to downstream, which will coincide with a flow direction arrow - generally from top of screen to bottom. Double click on last point to end.
- Connection of 3 reaches is a junction.
- Can model from single reach to complicated networks. The river can even split apart and then come back together.
- Can accentuate by adding background bitmap.

River System Schematic

- To add a River Reach, select the River Reach button from the Cross-Section Editor Window.
- Then add line(s) representing the schematic of the river(s) you are modeling. Single click between each segment of the line. After your last line segment, double click to end.

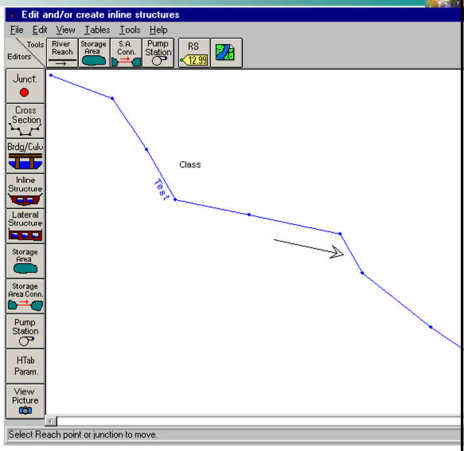


River System Schematic

- A window then pops up to allow you to enter the:
- River name
- Reach name

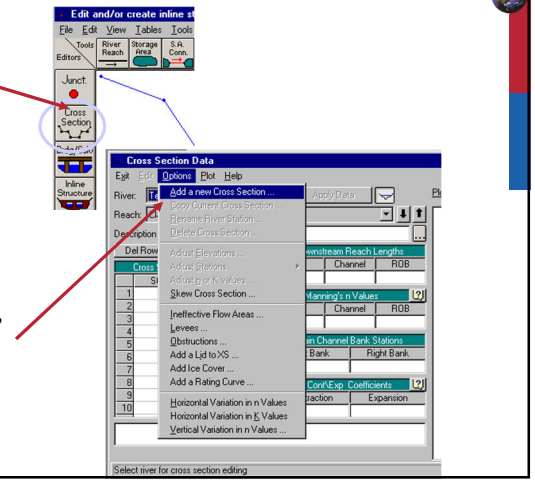
River System Schematic

- The program then displays the river and its name in blue. The reach name is in black.
- Tributaries and/or additional reaches can be added to the main reach using the same procedure.



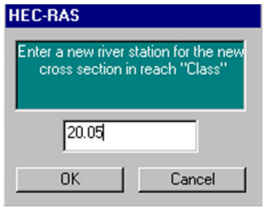
Adding Cross Sections to Reaches

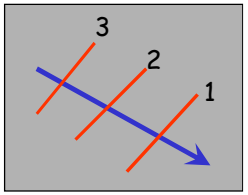
- To add cross-section data, click on the "Cross-Section" button from the Geometry Data Window.
- This brings up the Cross Section Data window from where you choose "Options" and then "Add a new Cross-Section…"



Adding Cross Sections to Reaches

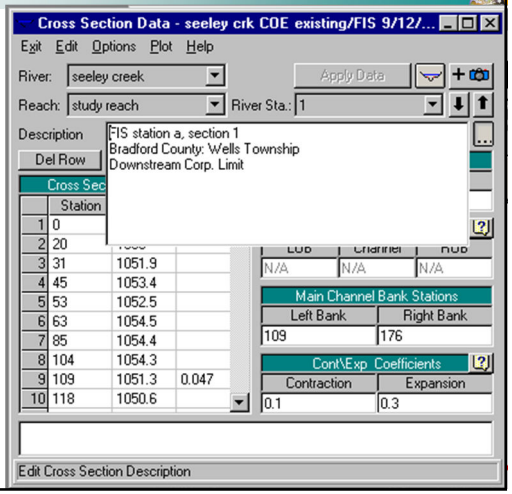
- Enter the cross-section name (it must be a number
- It must be in numerical order - upstream = highest number) and select OK.
- Numbering is not related to progressive.
- To add a cross section between two existing ones, add a number in between.
- Number can be real or integers.





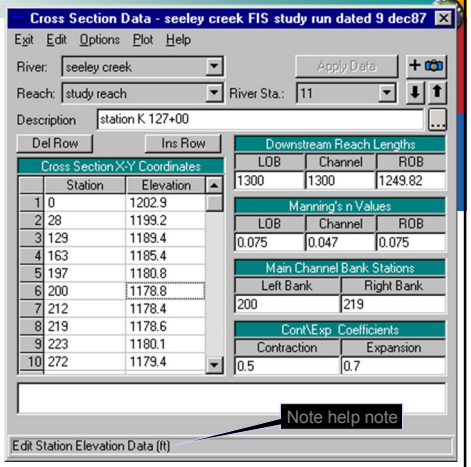
Entering Cross Section Data

- You can enter a lengthy description of the cross-section.



Entering Cross Section Data

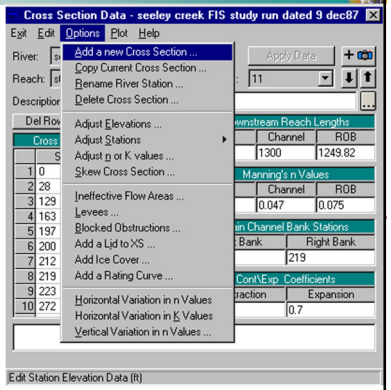
- This is the main Cross-Section Data window. Here you enter the basic cross-section data such as elevation-station data, reach lengths, 'n' values, bank stations, and contraction and expansion loss coefficients.



Note: Orientation is looking downstream

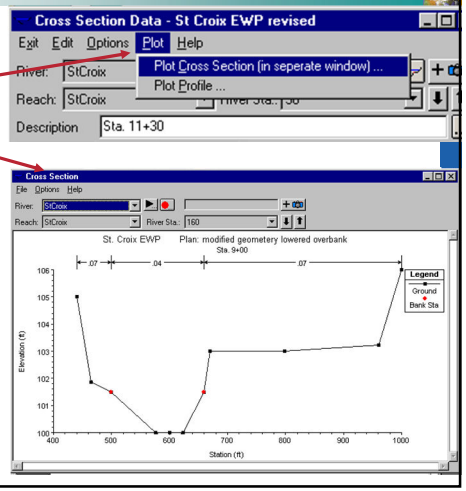
Entering Cross Section Data

- There are several options available to further refine the cross section data.
  - File editing tools
  - Geometric transformations and rescaling tools
  - Editor of blocking, no flow and disturbances
  - Editors and rescaling of roughness



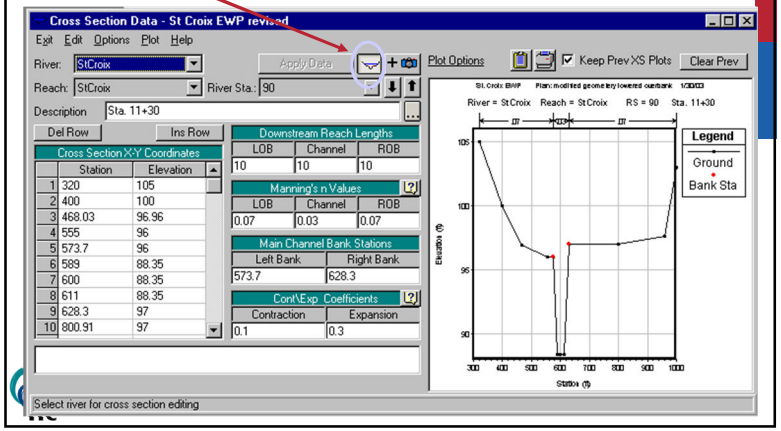
Entering Cross Section Data

- A quick visual check of the data is available through the "Plot Cross Section (in separate window)" option.
- In 'x' the progressive
- In 'y' the absolute elevation with respect to a datum
- Dots show stations
- Red dots separate channel from banks (left and right)
- 'n' values display on top
- Coordinates display as the mouse is moved around.
- ORIENTATION IS LOOKING DOWNSTREAM!!



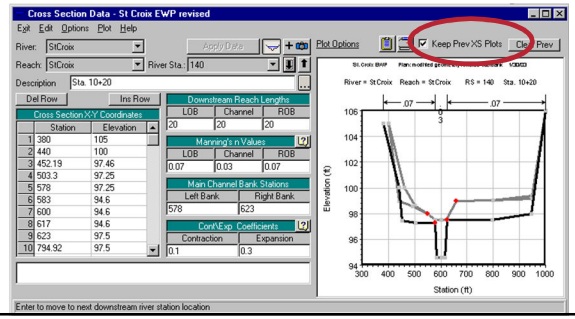
Entering Cross Section Data

XSections can be plotted from the editor.



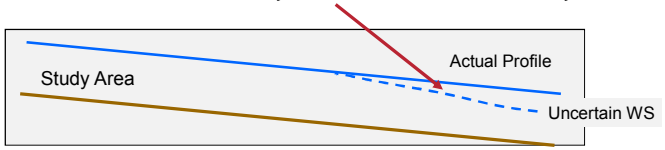
Entering Cross Section Data

- Other but present sections can be shown in the same plot.
- Ideal to check relative shape and elevation differences.



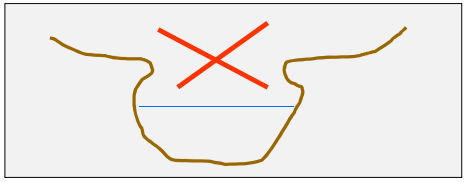
Notes on Cross-Section Data

- X-sections should extend across the entire floodplain and be perpendicular to anticipated flow lines (approximately perpendicular to ground contour lines).
- X-sections should accurately represent stream and floodplain geometry. Put in where changes occur in discharge, slope, shape, roughness, and bridges.
- Enter X-Section elevation-station data from left to right as seen when looking downstream.
- Cross-Sections should start far enough downstream to “zero out” any errors in boundary conditions assumptions (for sub-critical profile). Far from upstream for super-critical flow. The section of analysis should be farm from boundary errors.



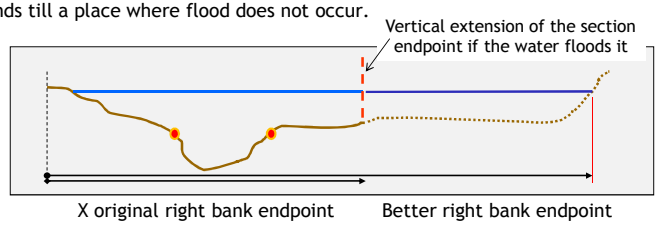
Notes on Cross-Section Data (cont)

- Location of X-sections within a reach varies with the intensity of the study and the conditions of the reach
- The choice of friction loss equations will also affect X-section spacing and predicted flood elevations
- Higher number X-section river stations are assumed to be upstream of lower number river stations. Slope areas require more X-sections.
- The left side of the X-section, looking downstream, is assumed to have the lower X values and progress right as the X values increase, (can not narrow the section)



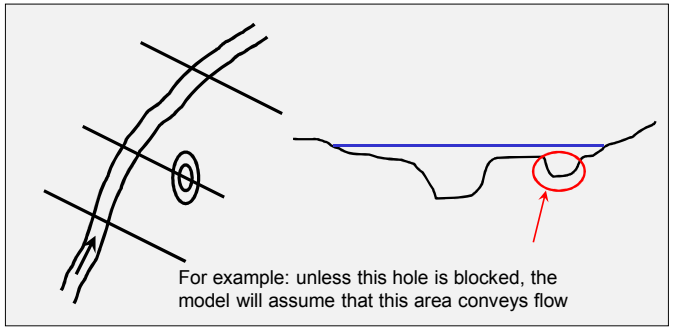
Notes on Cross-Section Data (cont.)

- The left and right channel banks, must be given at a station located in the X-section elevation-station data set. (Figure shows only right bank)
- Boundaries are fixed, can not reflect changes during a storm (scour deposition).
- X-section **endpoints** that are below the computed water surface profile will be extended vertically to contain the routed flows with area/wetted perimeter reflecting this boundary condition. To avoid this, be certain that the cross section extends till a place where flood does not occur.



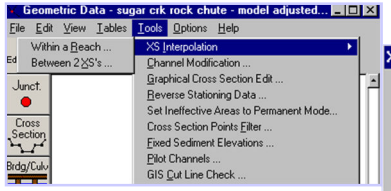
Notes on Cross-Section Data (cont.)

- Consider what is being modeled. The program can only reflect what is being entered.

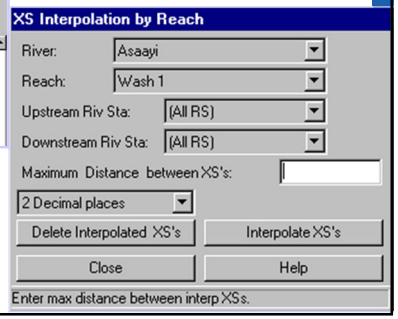


Notes on Cross-Section Data (cont.)

- HEC-RAS has an option to create interpolated cross sections. It can be used to create more "in between" sections as long as there are not section singularities.

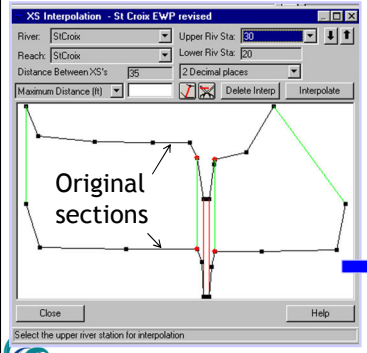


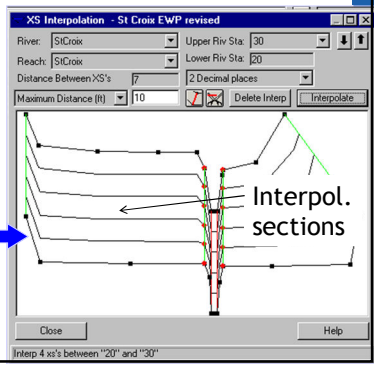
By reach



Notes on Cross-Section Data (cont.)

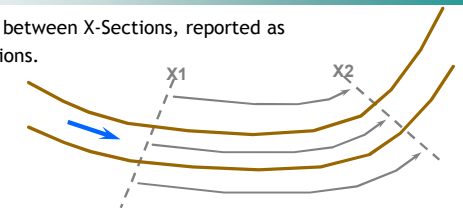
- HEC-RAS has an option to create interpolated cross sections in a reach or between two sections





Reach Lengths

- Measured distances between X-Sections, reported as distance to D.S. X-Sections.



- 3 distances!!: Left overbank, right overbank, and channel
- They can be very different for channels with large meander or in a bend of a river.
- A discharge weighted total reach length is determined by HECRAS based on the discharges in the main channel and left and right overbank segments.

$$L = \frac{L_{lob}\overline{Q}_{lob} + L_{ch}\overline{Q}_{ch} + L_{rob}\overline{Q}_{rob}}{\overline{Q}_{lob} + \overline{Q}_{ch} + \overline{Q}_{rob}}$$

Expansion & Contraction Coefficients

	Contraction	Expansion
No Transition	0.0	0.0
Gradual Transition (default)	0.1	0.3
Typical Bridge Transition	0.3	0.5

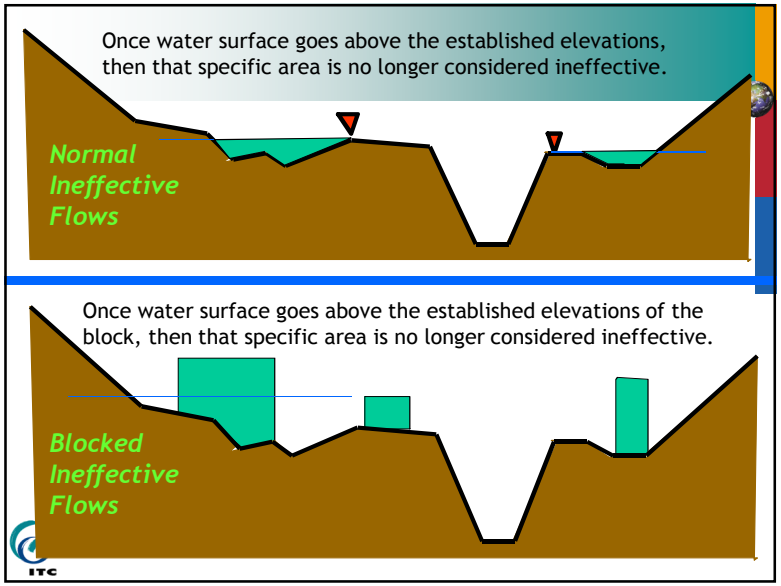
- Typical values for gradual transitions in supercritical flow are 0.05 for contraction and 0.10 for expansions.
- Constructed prismatic channels should have expansion and contraction coefficients of 0.0

Ineffective Flow Areas

- Ineffective flow areas are used to model portions of the cross-section in which water will pond, but the velocity of that water in the downstream direction is equal to zero.
- This water is included in the storage and wetted cross section parameters, but not in the active flow area.
- No additional wetted parameter is added to the active flow area (unlike encroachments).
- Once ineffective flow area is overtopped, then that specific area is no longer considered ineffective.
- Commonly used in culverts, near road crossings.

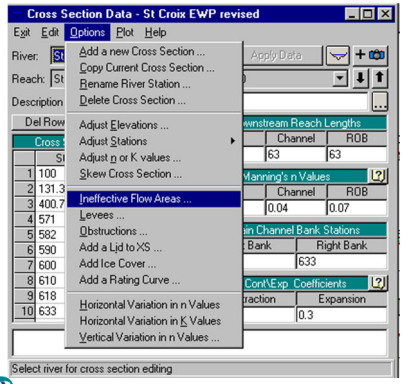
Ineffective Flow Areas

- Two types of Ineffective Flow Areas :
  - 1. Normal where you supply left and right stations with elevations which block flow to the left of the left station and to the right of the right station
  - 2. Blocked where you can have multiple (up to 10) blocked flow areas within the X-section

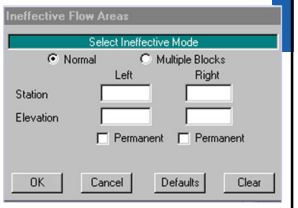


Ineffective Flow Areas

Option is from x-section window...

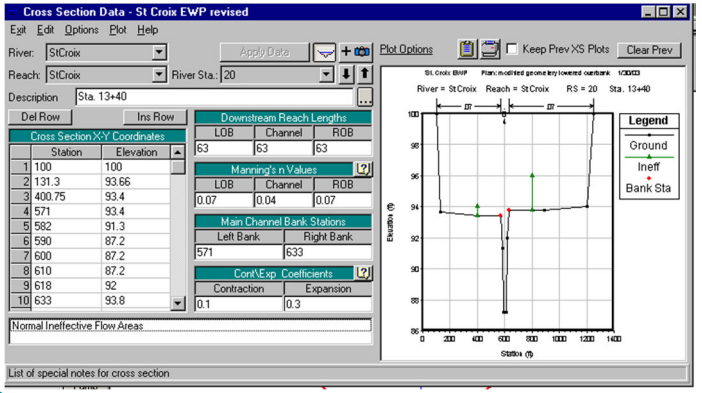


which brings up this window:

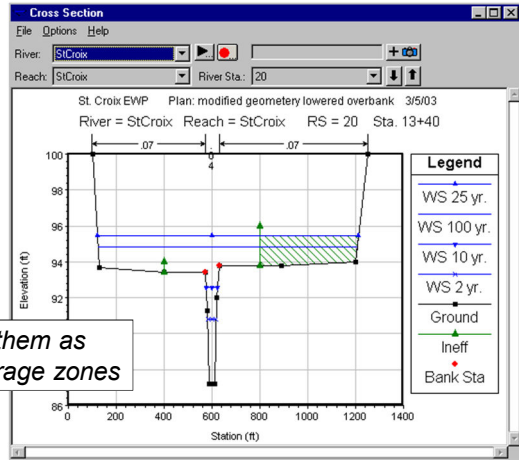


Ineffective Flow Areas

The plotted x-section looks like this:



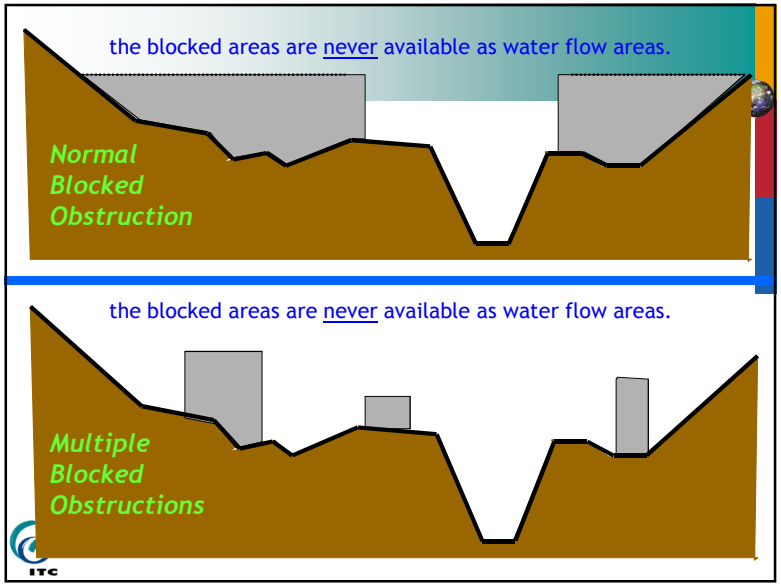
Ineffective Flow Areas



Think of them as dead storage zones

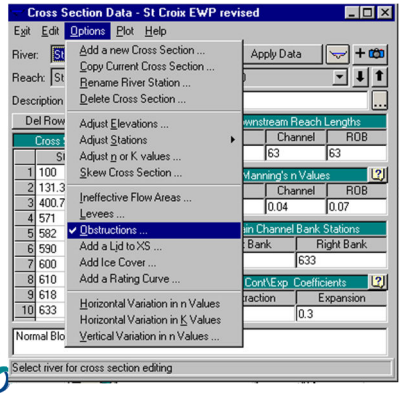
Blocked Obstructions

- Used to define areas that will be permanently blocked out.
- Decreases flow area and increases wetted perimeter when the water comes in contact with it.
- Two types of blocked obstructions are available - Normal and Multiple. They are very similar to the Ineffective Flow areas, except that the blocked areas are never available as water flow areas.
- Water can get to the off-sides of these obstructions.



Blocked Obstructions

Option is from x-section window...



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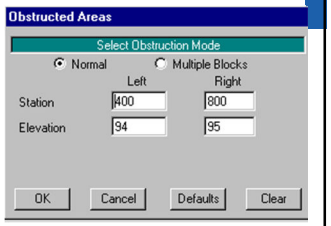
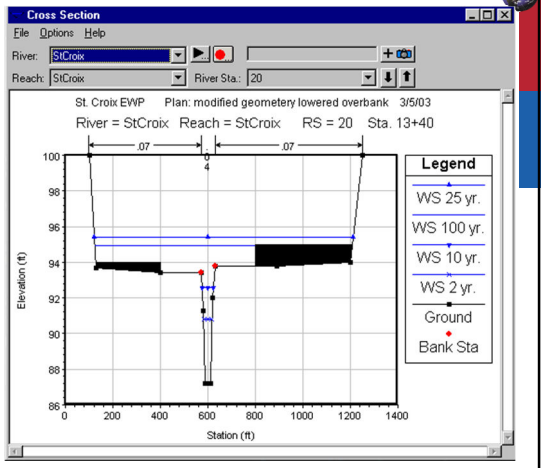


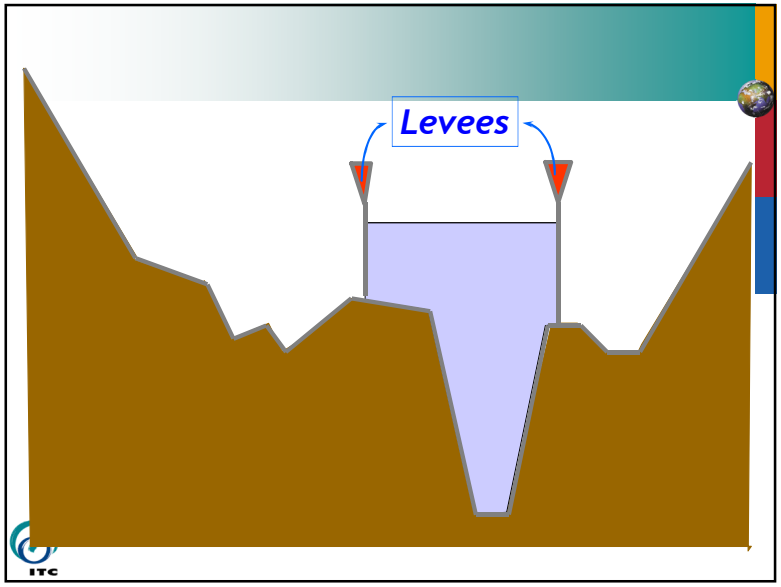
Blocked Obstructions

The plotted x-section looks like this:



Levees

- No water can get outside of a levee until it is overtopped.
- Simulated by a vertical wall.
- Additional wetted perimeter is included when water comes in contact with the levee wall.



Levees

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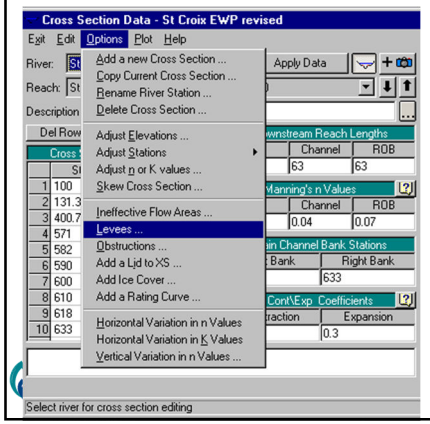

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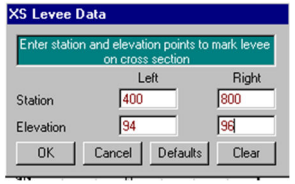
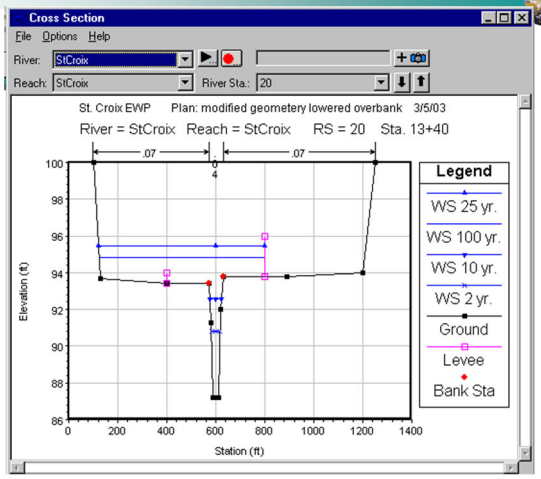


Levees

The plotted x-section looks like this:

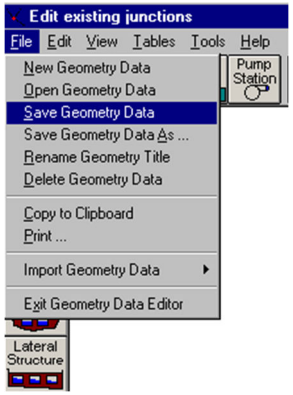


Levees vs. Ineffective Flow Areas

- Are conceptually similar but very different hydraulically
- Ineffective flow areas is used where water is present to the left/right of the ineffective station but the velocity is zero. Volume included in storage and wetted perimeter calculations but not in conveyance. (think: ponded area)
- A levee acts as a vertical wall. No water occupied the space to the left/right of the levee unless the levee elevation is exceeded. The distance that the levee is in contact with the water is included in the wetted perimeter calculations. (think: wall)

Entering Cross Section Data

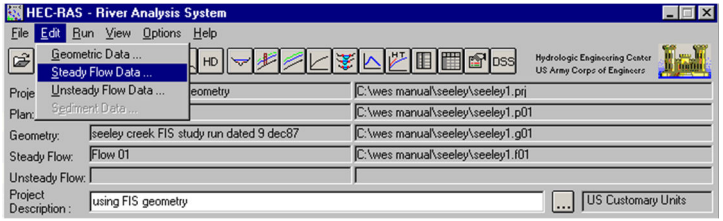
After entering geometry data, it is wise to save it. Recommend doing this often as you enter data.



Flow Data

Enter Flow Data

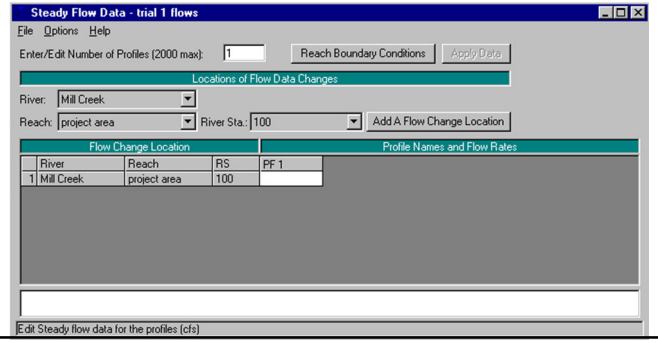
Enter the Steady Flow Data Editor from the main menu



Or, you can select the Steady Flow Data button:

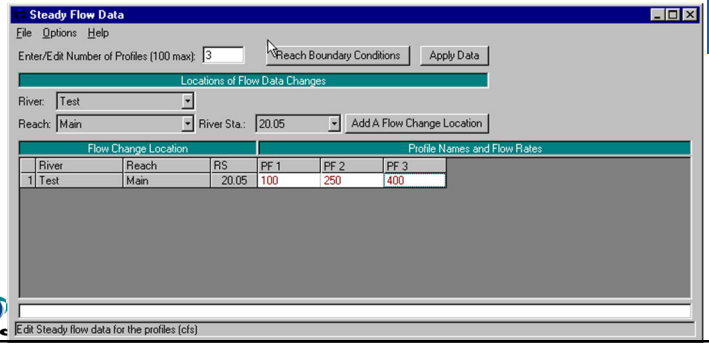
Enter Flow Data

- This brings up the Steady Flow Data Window.
- You can have up to 100 profiles.
  - One profile corresponds to one possible flow input configuration for the system. River geometry does not change for different profiles.
  - I.e it brought up 3 boxes when 3 profiles are specified.



Enter Flow Data

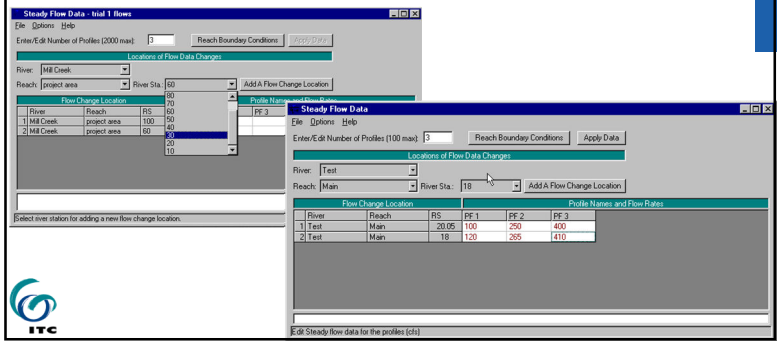
- Enter the input discharges for each profile in appropriate box.
- Each river and branch require one the same number of profiles.
- In the example, you enter 3 profiles, then 3 boxes appear. For the river "Test" in the Reach "Main" the 3 input discharges are entered in the profiles.



Enter Flow Data

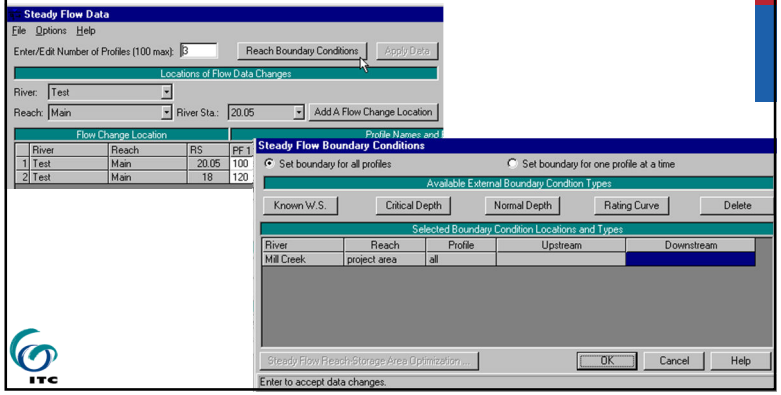
User can add flow changes at a certain station along one certain reach.

- Select River Station
- Click "Add a Flow Change Location", and select the station and enter the added flow to the reach.
- NOTE: Normally the flow input will be required at least in the most upstream section of each river branch (program default).



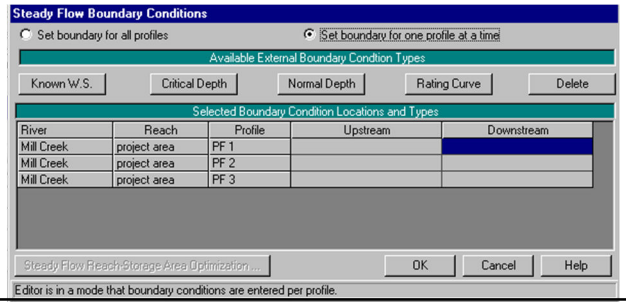
Enter Flow Data: Boundary Conditions

- Set the boundary conditions by selecting "Reach Boundary Conditions"
- This brings up Steady Flow Boundary Conditions window. You can set the boundary for all profiles at once, or separately.



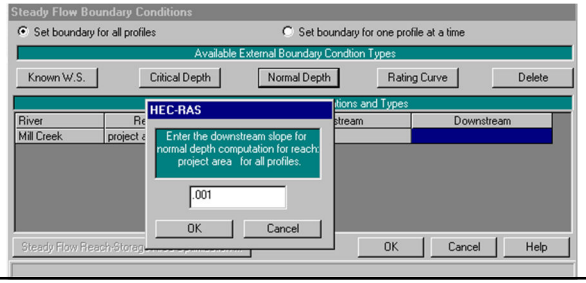
Enter Flow Data

- There are 4 different methods for specifying the starting water surface at the boundaries in steady flow:
  - known elevation: When the elevation of the water is fixed (big lakes or sea)
  - critical depth: up and downstream of a critical section, the river branch is hydraulically separated and independent,
  - normal depth: The slope of the water surface is known.
  - rating curve: The rating curve at the boundary is known,



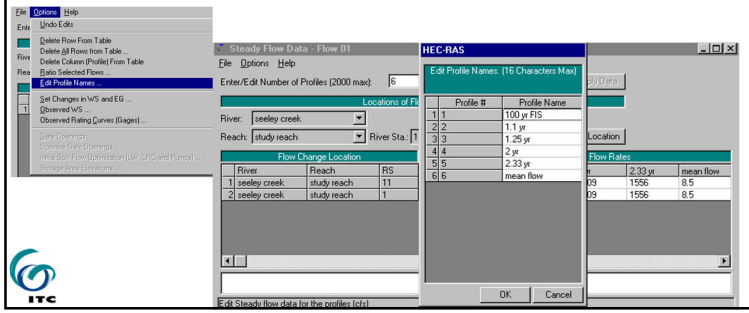
Enter Flow Data

- After selecting either the upstream or downstream data box and then selecting method for providing starting conditions, a window appears for entering your data.
- Boundary conditions are entered:
  - downstream end for sub-critical flow
  - upstream end for super-critical
  - both for mixed (when in the reach there are both sub- and super-critical sections)

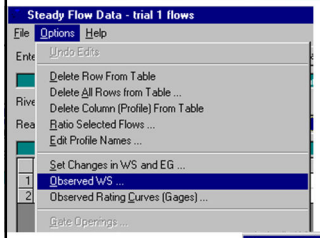


Enter Flow Data

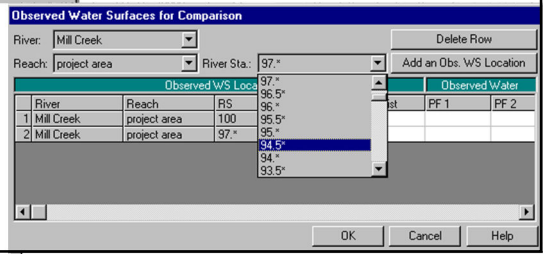
- There are several options available in the “Options” window of the Steady Flow Data window such as changing profile names, applying a ratio to all flows, etc.
- Make a consultation of the manual for details.



Enter Flow Data - Observed Water Surfaces

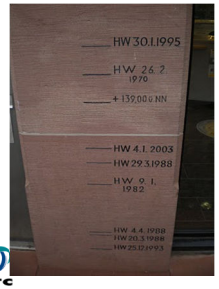


- Under “Options”, select “Observed WS”
- A menu appears. Select River Station
- Select “Add an Obs WS Location”
- Enter observed elevation.
- The observation of the water elevation must be in accordance with the profile



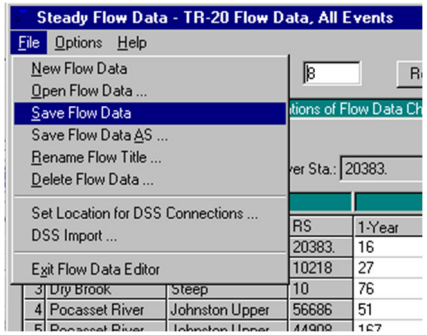
Enter Flow Data - Observed Water Surfaces

- Where do you get observed data?
- Use calibration data - survey debris lines, mud marks, gage data, etc



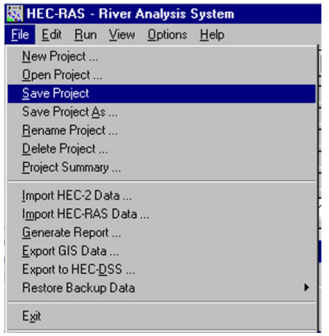
Enter Flow Data

- After entering your flow data, it is suggested you save it to a file.



Save Project

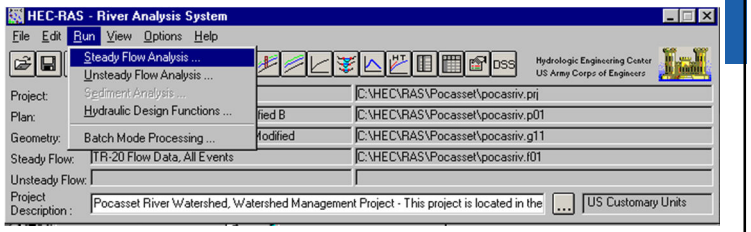
- After entering and saving the geometry and flow data, it is suggested that you save your project from the main HEC-RAS File Menu.
- Saving is not automatic in HECRAS.
- RED NUMBERS while entering data mean that the data is not saved yet!!



Perform the Hydraulic Computations

Perform the Hydraulic Computations

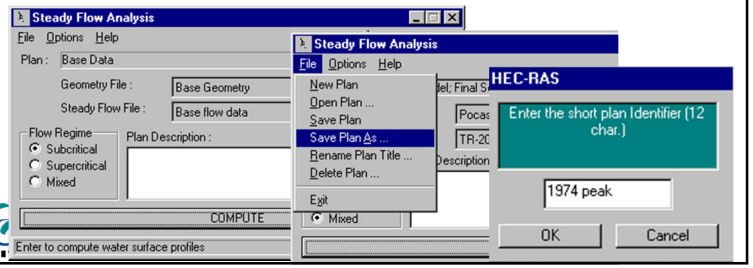
Enter the Steady Flow Analysis window from the main menu



or select the Steady Flow Analysis button:

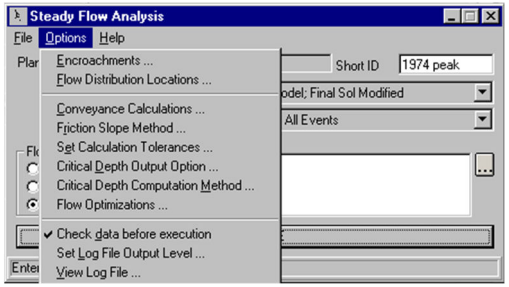
Perform the Hydraulic Computations

- In the window: you can set flow regime, select geometry and/or flow files, and start the computations.
- The user must select the adequate subcritical, supercritical or mixed options depending on the river regime.
- A mistake in the river regime selection can be corrected after understanding the warnings & graphical output
- ALWAYS SAVE: Under “File”, select “Save Plan As…”
- Create a project title.
  - it brings up a window allowing you to enter a short plan identifier, used in printouts and reports.



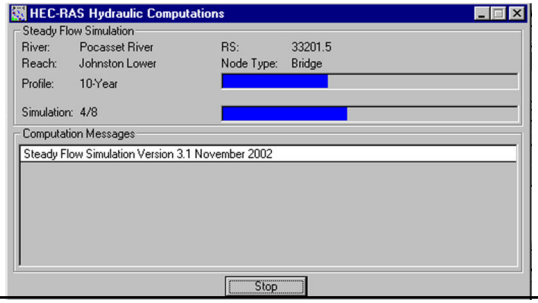
Perform the Hydraulic Computations

- There are several options available for the hydraulic computations
  - User must refer to the manual for details



Perform the Hydraulic Computations

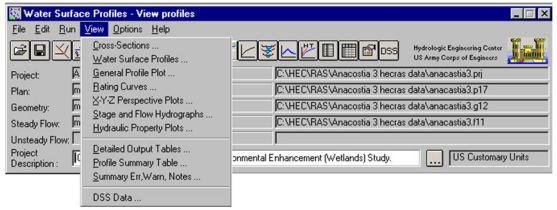
- After selecting the compute button, HECRAS does it’s magic.
- Simulation creates files of considerable size.



Viewing the Output

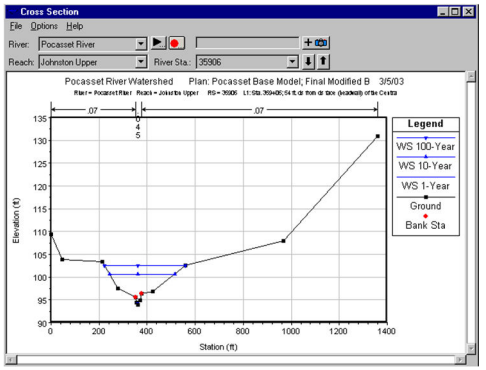
View the Output

- Many output formats to view within the view menu:
  - plotted cross-sections,
  - profiles,
  - rating curves
  - 3-D views
  - cross-section
  - profile tabular data
  - Others



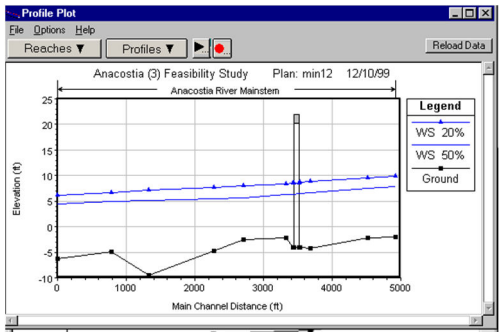
View the Output

- View Cross-Sections
- Or, you can select the appropriate button:



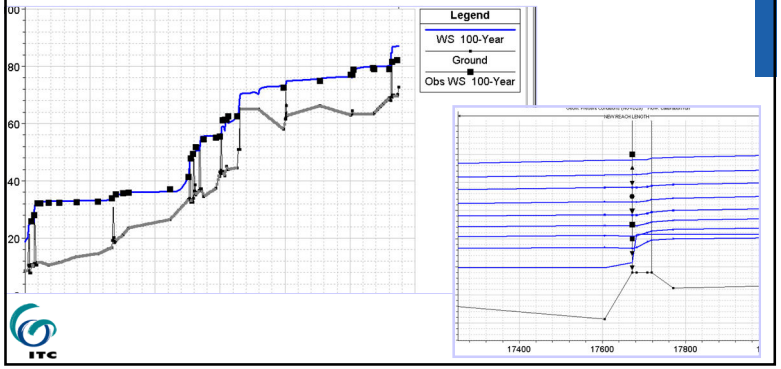
View the Output

- Plot Profiles



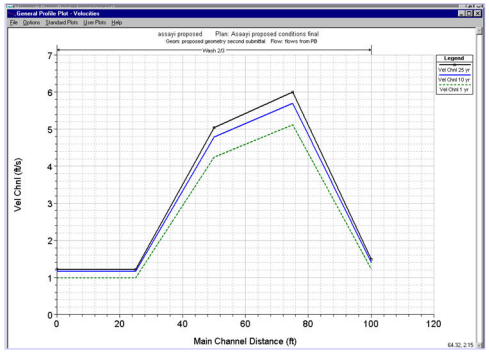
View the Output

- See observed water surface profiles when you plot the profile
- You can plot many profiles at the same time.
- Zoom and Pan possibilities for details.



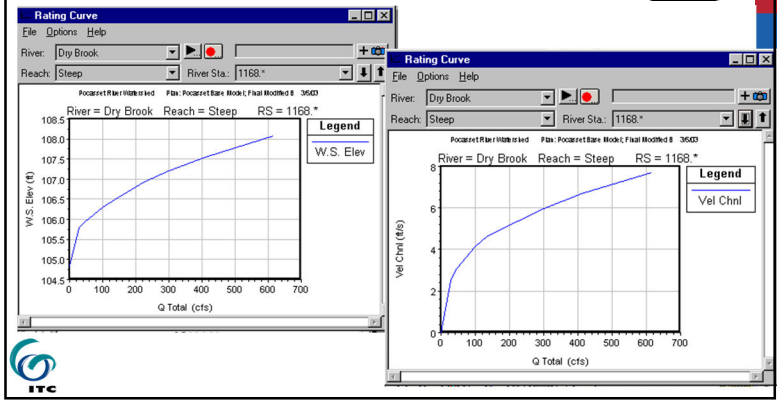
View the Output

- Plot profiles of different data



View the Output

- Plot Rating Curves for a specified station

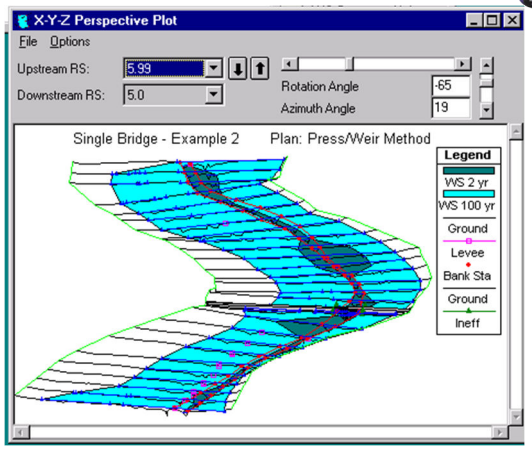


View the Output

- Plot 3-D View

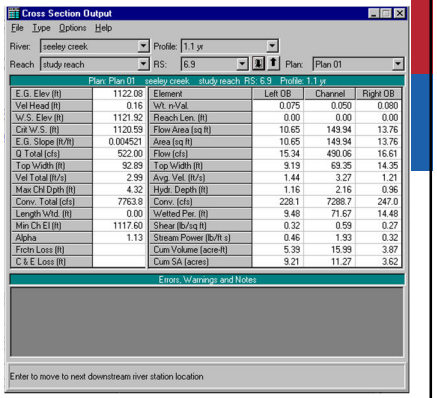
Note:

Cross-section widths should be consistent for better presentation.

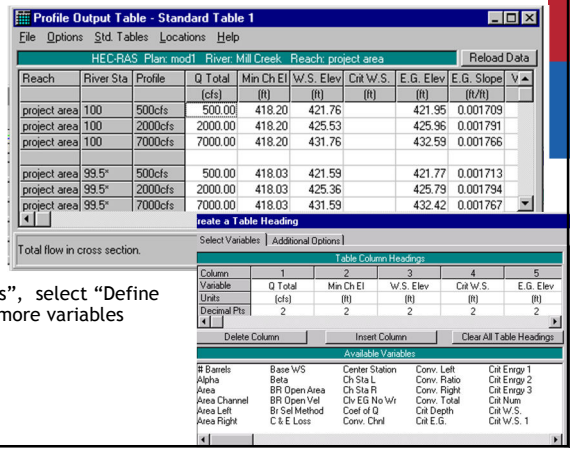


View the Output

- View Cross-Section Table
- Several geometric, energetic and hydraulic information is available per cross section.



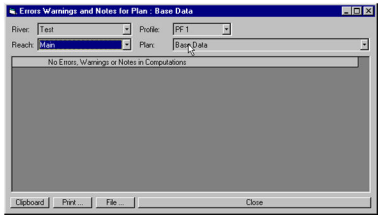
View the Output



- Under “Options”, select “Define Table” to see more variables

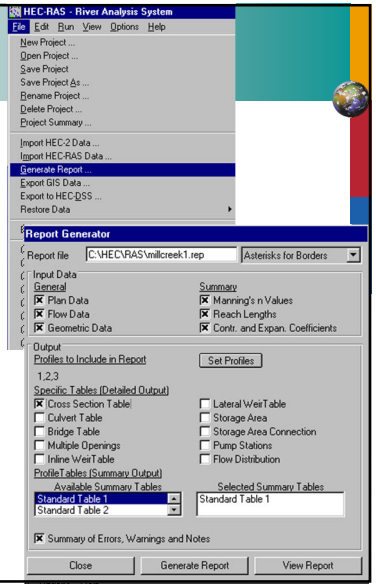
Output: Errors, Warnings, & Notes

- Errors: problems that prevents the program from running. The user must change something.
- Warnings: does not prevent the program from running but the user should examine and review. The user may want to change some input.
- Notes: provides information about how the program is performing the calculations, user should review.

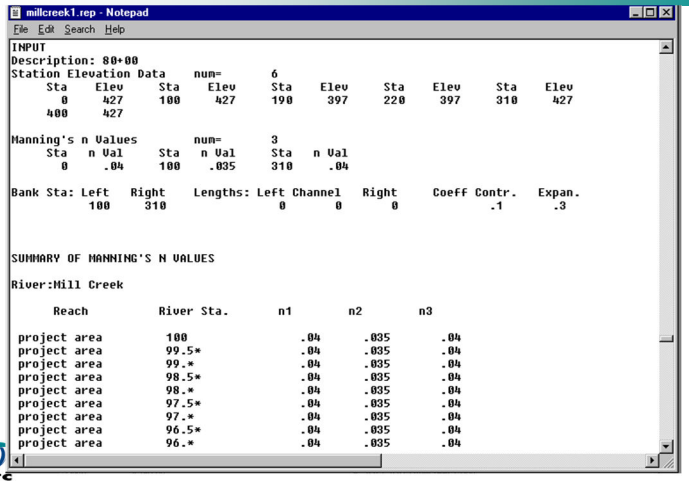


Generate Reports

- You can select “Generate Report …” from the HEC-RAS main menu.
- There are several options available for the report content. The report generated can be viewed or the resulting file printed.



Sample view of the report:



Hydraulic Model Accuracy

- Absolute accuracy: how good is your data? +/- 0.5 foot
- Relative accuracy: very good (compare one condition to another)

End of lecture