

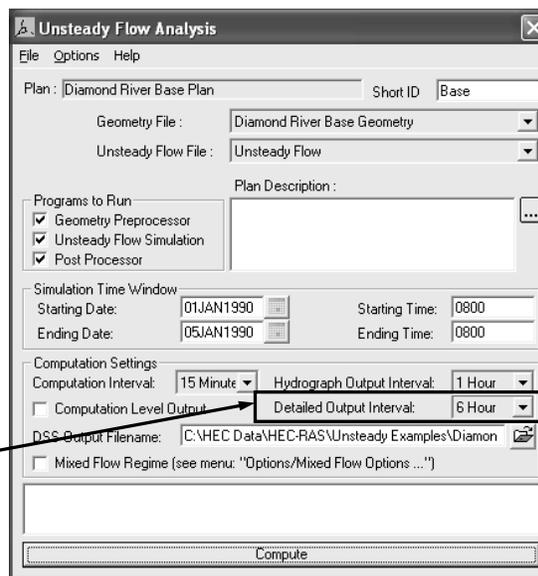
# Overview of Model Output for Unsteady Flow

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Mark Jensen

# Introduction

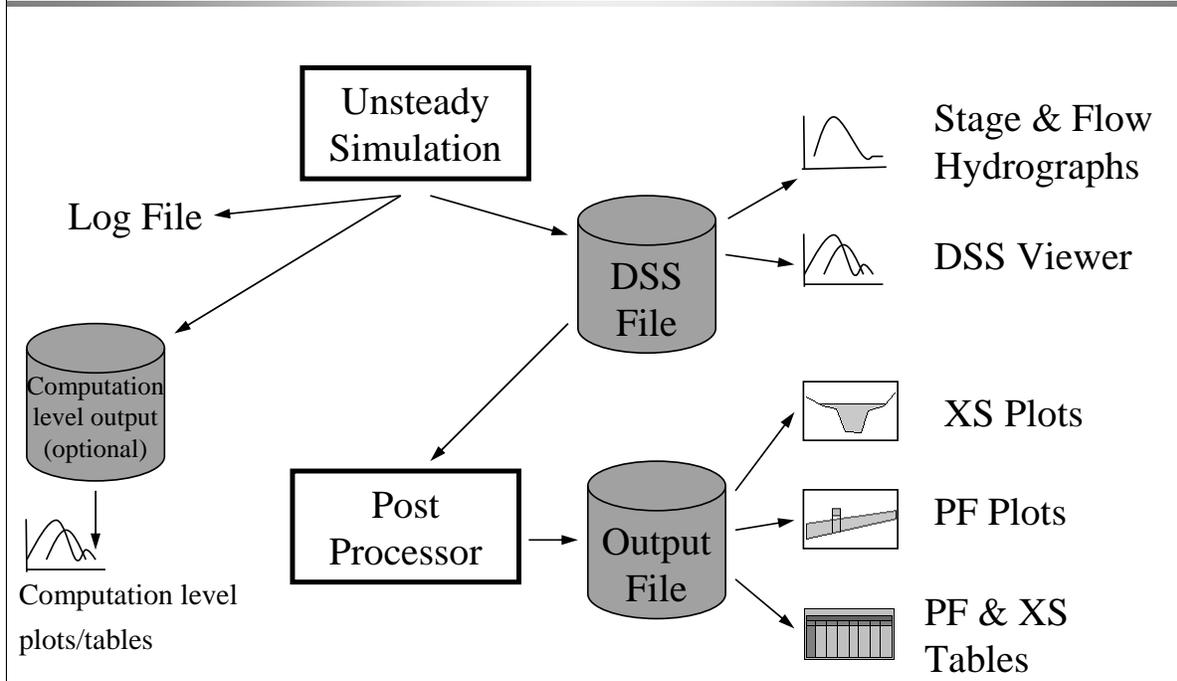
- Unsteady Flow Output
  - Stage and Flow Hydrographs
  - Log File Output
- Post Processor
  - Detailed output
    - Max Stage
    - Selected Time Intervals
- Computation Level Output



The output from an unsteady flow run are stage hydrographs, flow hydrographs, and basic stage profiles. These hydrographs and profiles are stored in DSS.

For more detailed output you must run the post processor. The post processor reads the hydrograph and profile information in the DSS file and creates detailed output data for the maximum stage computed and series of snap shots in time on a selected “Detailed Output Interval”.

## Program Output Flow Chart



The log file is a text file, and can be viewed with any text file viewer such as Notepad.

DSS files are a special binary format that requires a program specifically designed to work with it.

The output files from the post processor are in the same format as the output files from the steady flow computation engine. These files can only be accessed from the HEC-RAS interface.

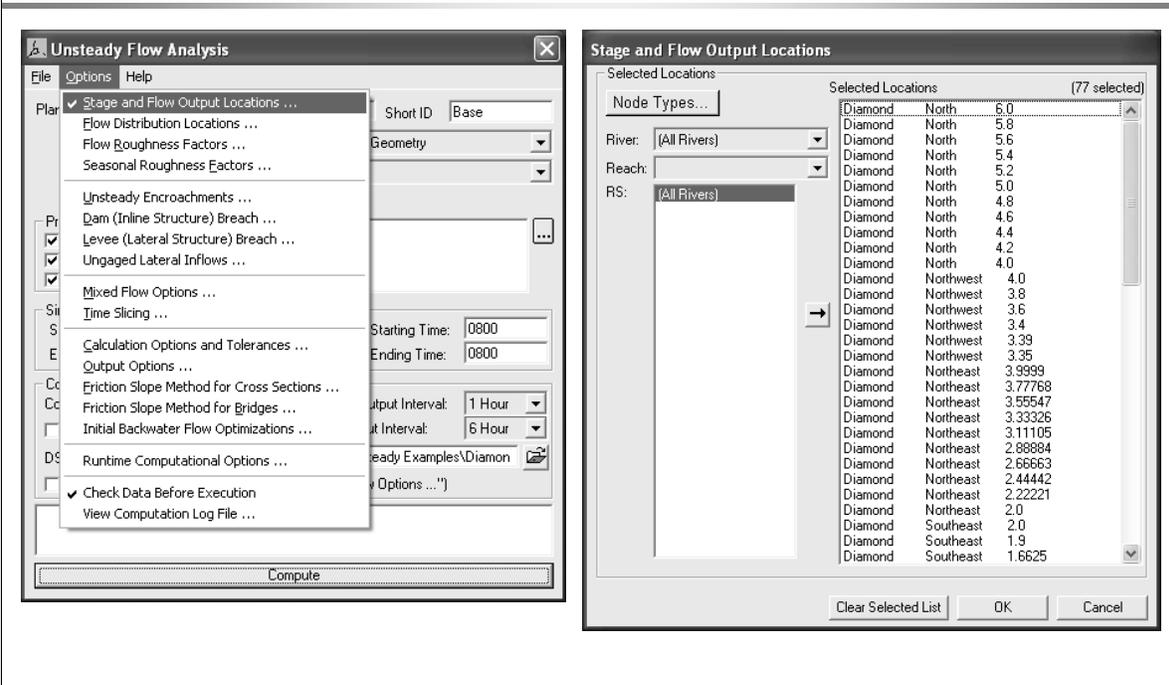
## Stage and Flow Hydrographs

- Only created at certain locations
  - Virtually no limit on how many locations – limited by computer memory
- Default Locations
  - Upper and Lower XS of all Reaches
  - Upstream and Downstream XS of internal boundaries
  - Observed DSS data connections
- User Selected Locations
  - Can be selected from the “Options” menu on the unsteady flow analysis window

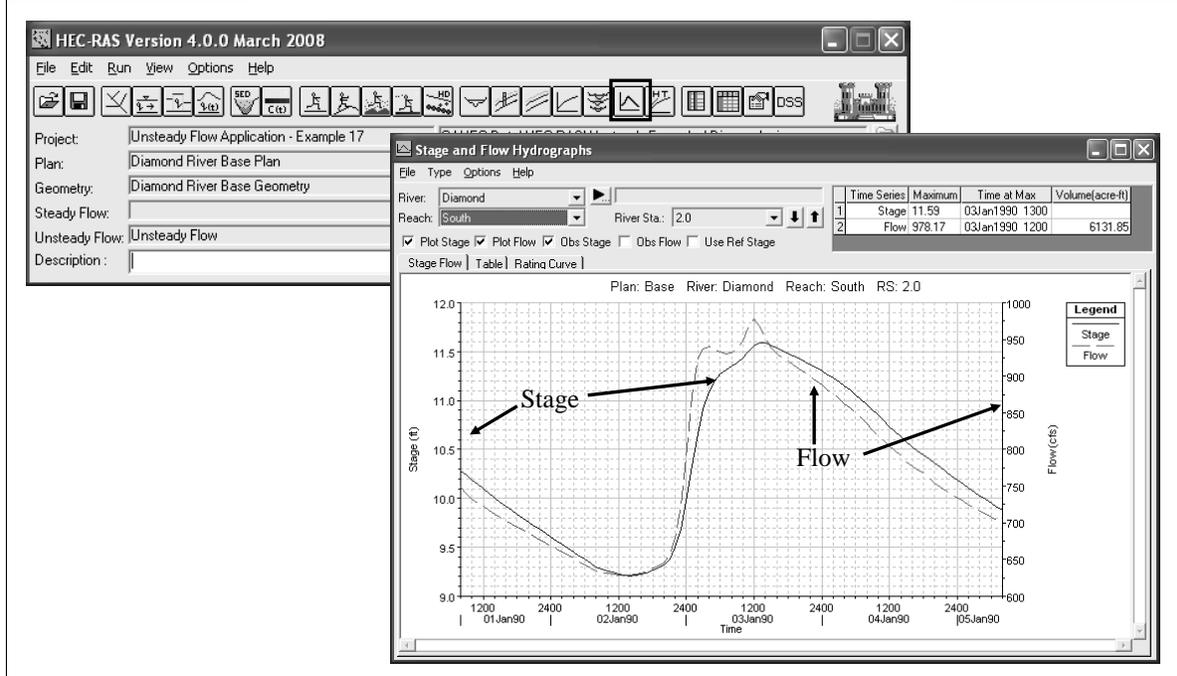
Stage and flow hydrographs are written by the unsteady computation engine at some default locations, but users have the option to request hydrographs at any cross sections desired.

# Stage and Flow Hydrographs

## User Selected Locations



# Stage and Flow Plot



The stage and flow plotter is opened from the main RAS window. “Stage and Flow Hydrographs” can be selected from under the “View” menu of the button highlighted above can be pressed to open the window.

Data can be viewed graphically or in table form by selecting the desired tab. By default, both stage and flow are plotted. When there are both stage and flow on the plot, a second Y axis is displayed.

## Stage and Flow Plot

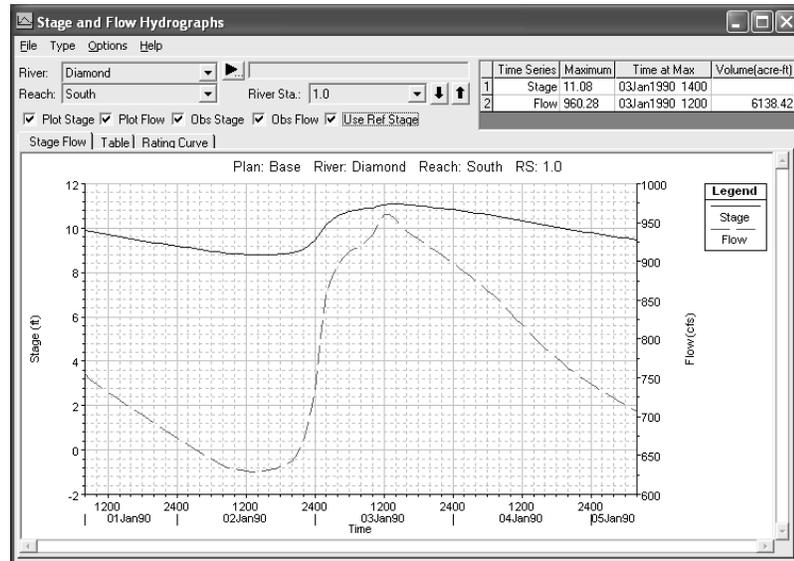
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- Cross Sections
- Bridge/Culverts
- Inline Structures
- Lateral Structures
- Storage Areas
- Storage Area Connections
- Pump Stations
- Ground Water Interaction

# Stage and Flow Plot - Cross Sections

## Stage and Flow versus Time

- Default Locations
- User Selected

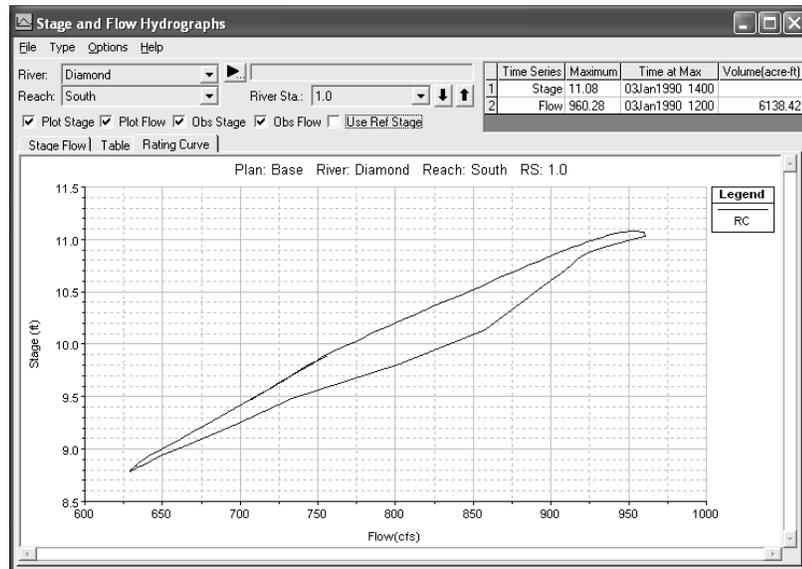


Cross sections hydrographs plots are available for the default locations and the user defined locations as discussed previously.

# Stage and Flow Plot - Cross Sections

## Stage verses Flow

- Default Locations
- User Selected

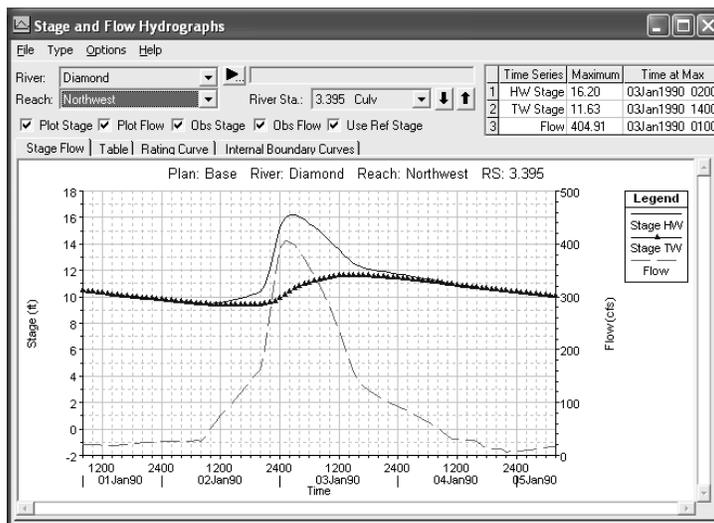
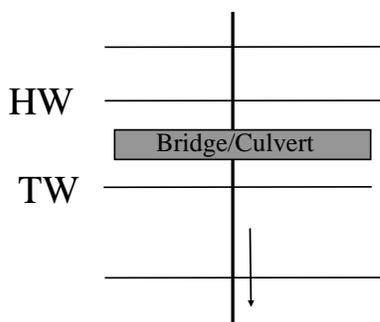


Cross sections hydrographs plots are available for the default locations and the user defined locations as discussed previously.

# Stage and Flow Plot - Bridge/Culverts

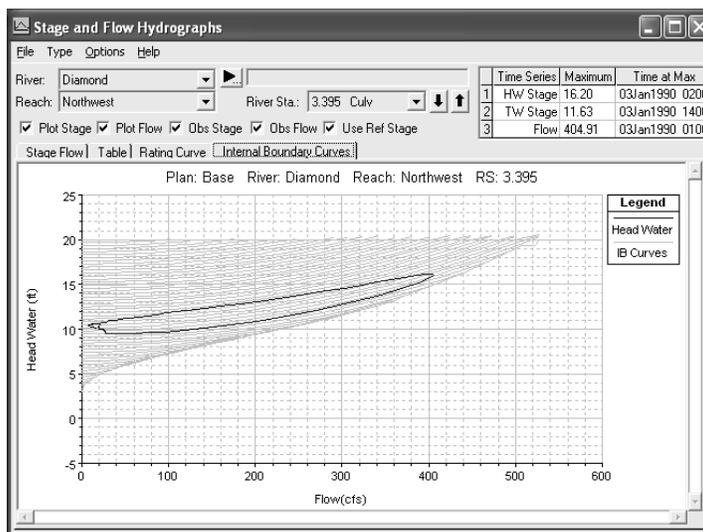
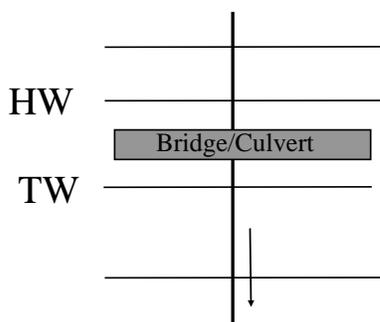
## Stage and Flow verses Time

- Stage Headwater
- Stage Tailwater
- Flow



# Stage and Flow Plot - Bridge/Culverts Internal Boundary Curves

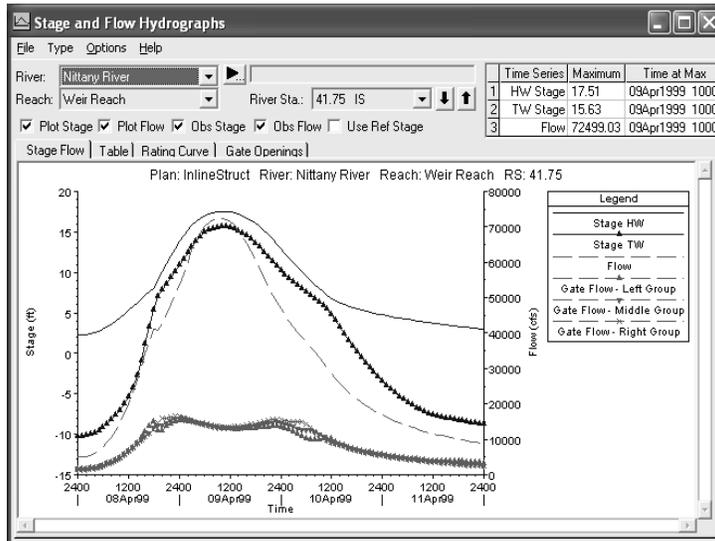
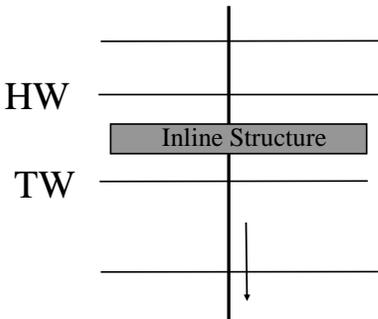
- Stage Headwater
- Stage Tailwater
- Flow



The internal boundary family of curves is shown with the headwater rating curve plotted on top. This shows the region of the curves that were used in the simulation.

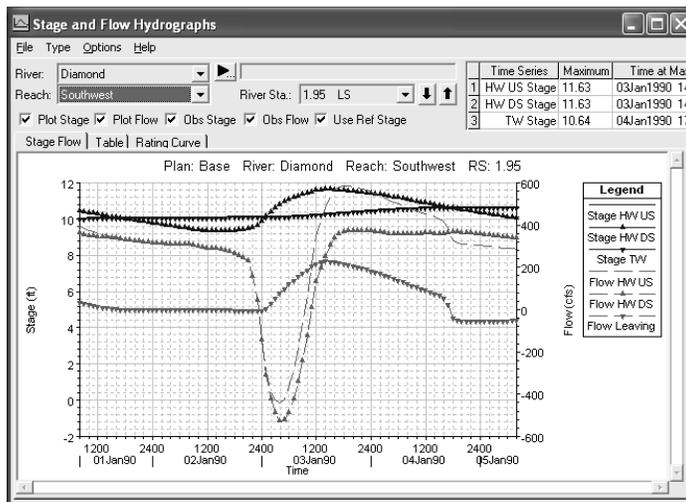
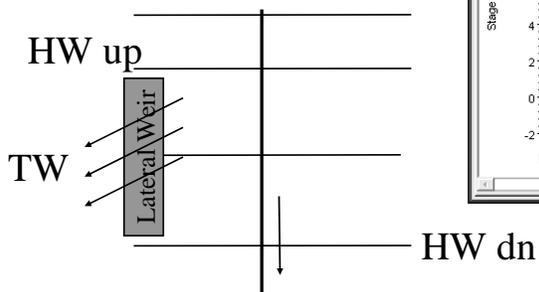
# Stage and Flow Plot - Inline Structures

- Stage Headwater
- Stage Tailwater
- Flow Total
- Flow in Gates



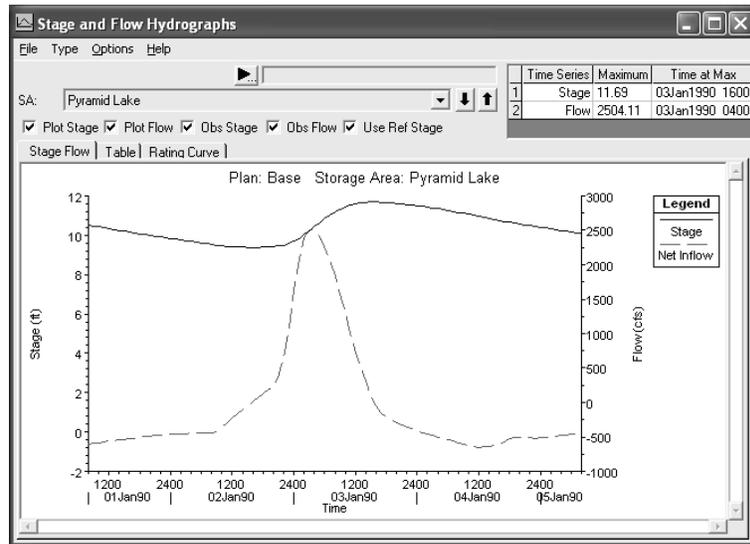
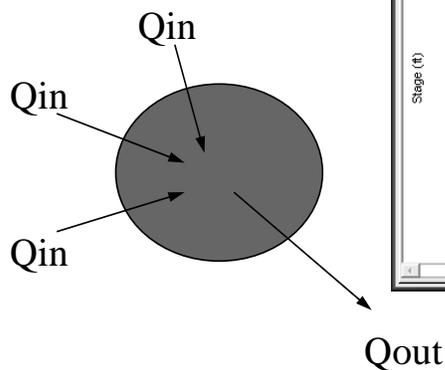
# Stage and Flow Plot - Lateral Structure

- Stage - HW (up & dn) TW
- Flow – HW (up, dn) & leaving



# Stage and Flow Plot - Storage Areas

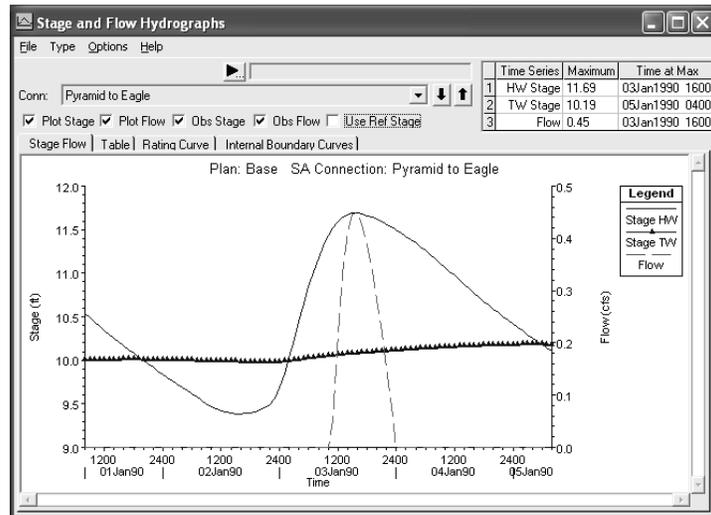
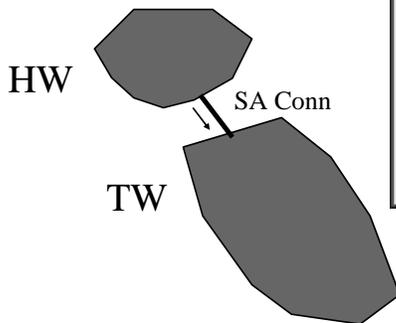
- Stage
- Net Inflow



The only flow information saved for a storage area is the net inflow. This is a sum of all flows into a storage area (flows leaving are considered negative). For information about the individual links to a storage area, go to the links specific output. For example if a lateral weir is connected to a storage area, go to the lateral weir output.

# Stage and Flow Plot - SA Connection

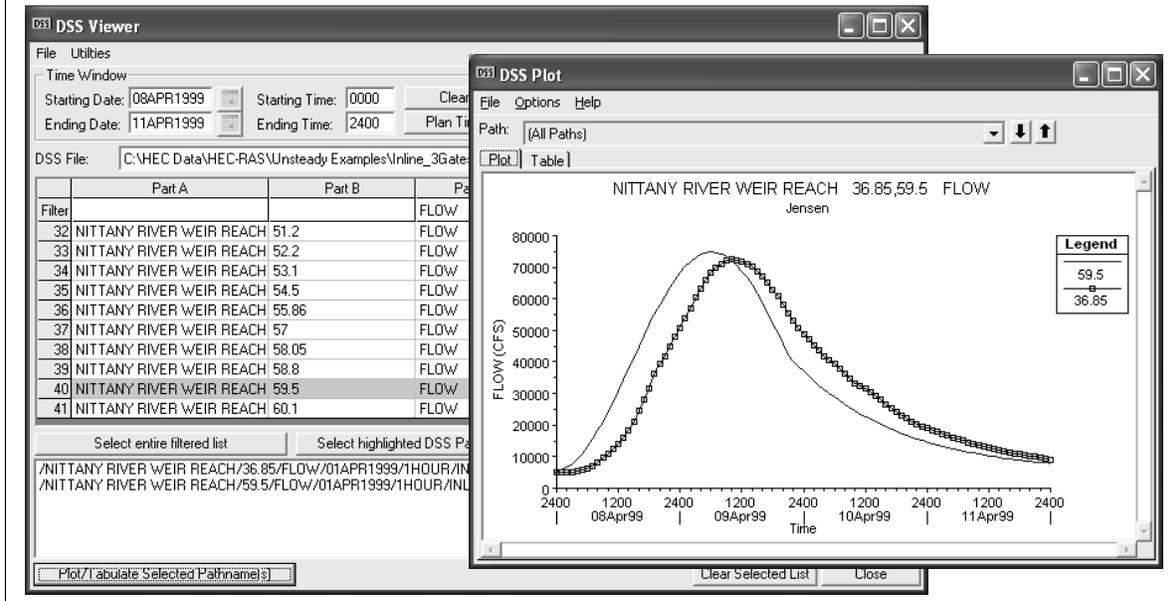
- Stage Headwater
- Stage Tailwater
- Flow



The output for a hydraulic connection is two stage hydrographs and a flow hydrograph.

# DSS View of Hydrographs

- DSS Viewer can be used for comparisons



The DSS Viewer in HEC-RAS can also be viewed to look at the same data in the Stage and Flow Plotter. It is a little more laborious to find the desired paths, but in the DSS View, users have more options for comparisons. In the plot above, the inflow and outflow hydrograph for a long reach are compared.

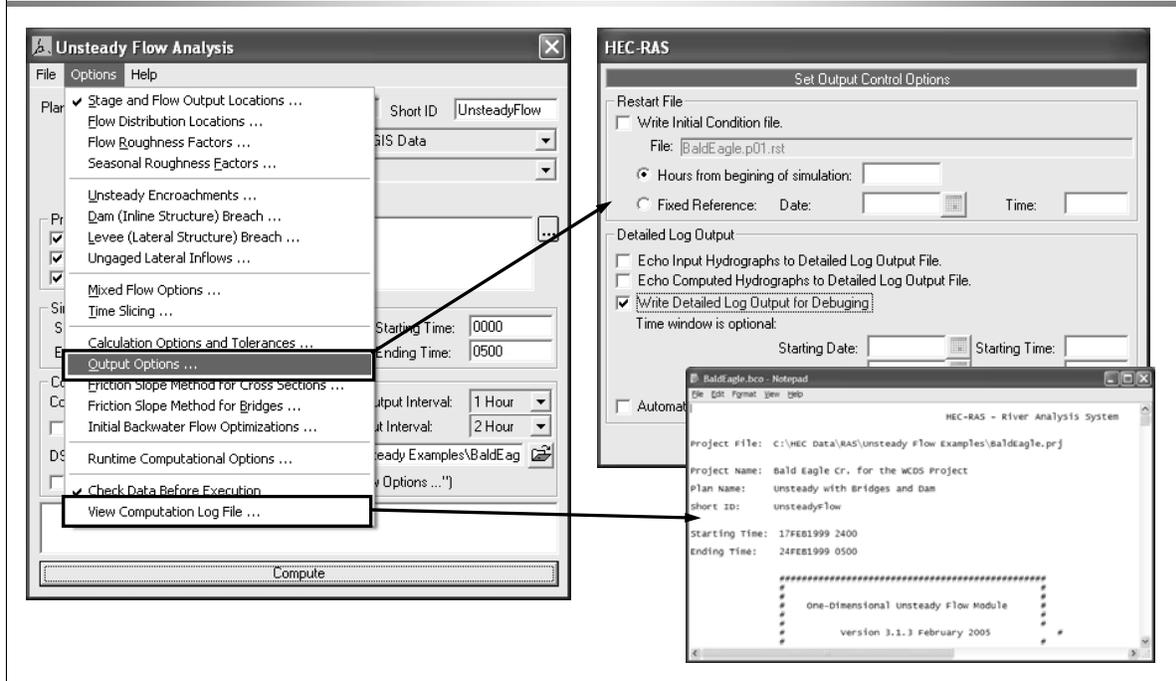
## Log File Output

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- Can be generated during computations
- Information about progression of simulation
- Can make a large, large file
  - Are you sure you want to open it?

The log file can easily get into the hundreds of megabytes. If your simulation is crashing a long way into it, consider creating a restart file before things go unstable. Then restart the simulation nearer the point where it crashes.

# Log File Output



In addition to the DSS output, the unsteady flow computation engine can write detailed output to a text log file. The log file contains a detailed information about the progression of computations and can be of assistance in finding errors that cause the unsteady flow program to crash.

This output option is turned on from the “options” menu on the Unsteady Flow Analysis window. Select “Output Options” and a dialog will appear (upper right) with the option to turn on the detailed output. When this option is on, the unsteady flow computation engine will write a text file that can be accessed from the options menu again with “View Computation Log File”.

The range of times can be specified or left blank for all.

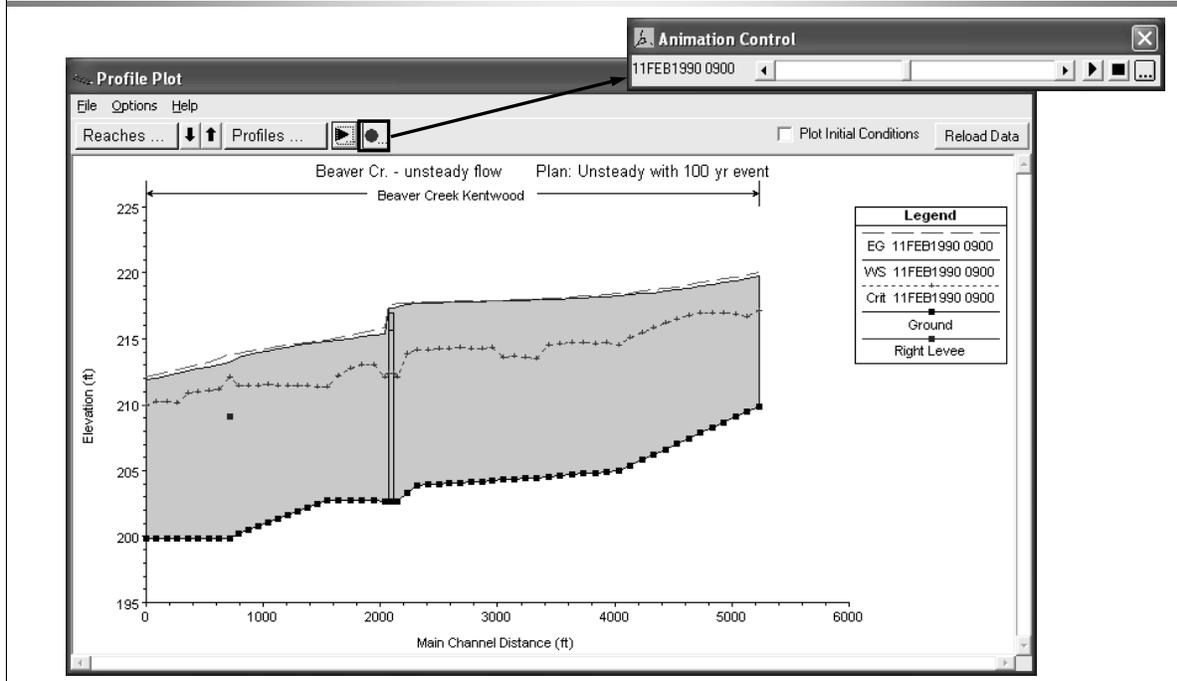
The input and output hydrographs can be echoed to the file if desired.

## Post Processor

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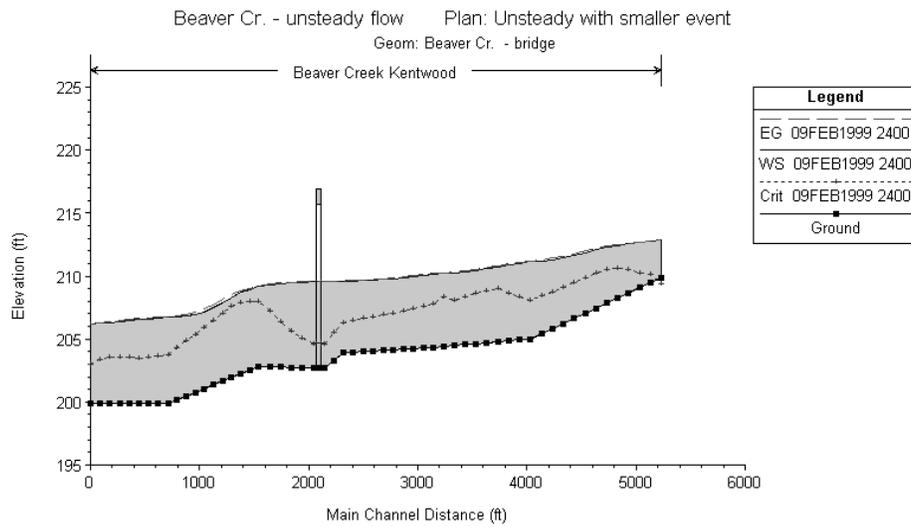
- Can be run after the unsteady simulation is completed
- Provides profiles for the maximum stage and at regular intervals
- All regular graphics and tables can be used to view the post process results
- Graphics can “animate” the simulation

# Profile Animation



The cross sections plot, profile and 3d plots can animate the simulation. Under the options menu of the profile plot, select animate, and the animation bar will be displayed. Select the button with an arrow to the right for an animation. The animation will affect all graphics loaded, so if a cross section and profile plot are opened, the water surface will be animated in both windows.

# Profile Animation (AVI)



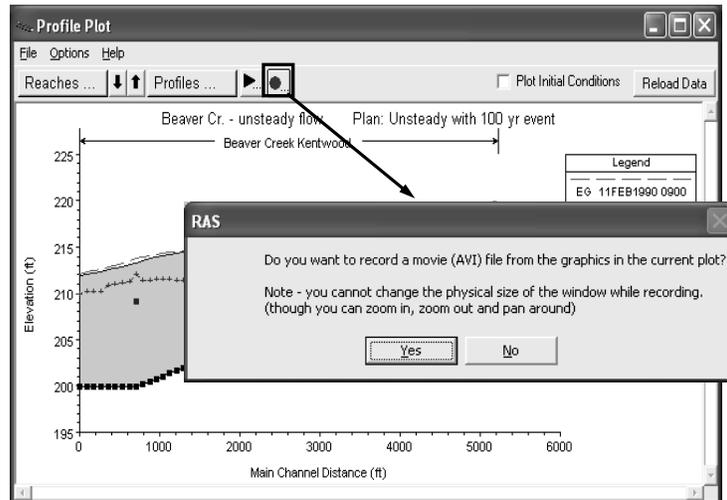
## Creating AVI's

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- Save a bunch of bitmap images
- Stitch them together and compress them into a standard format

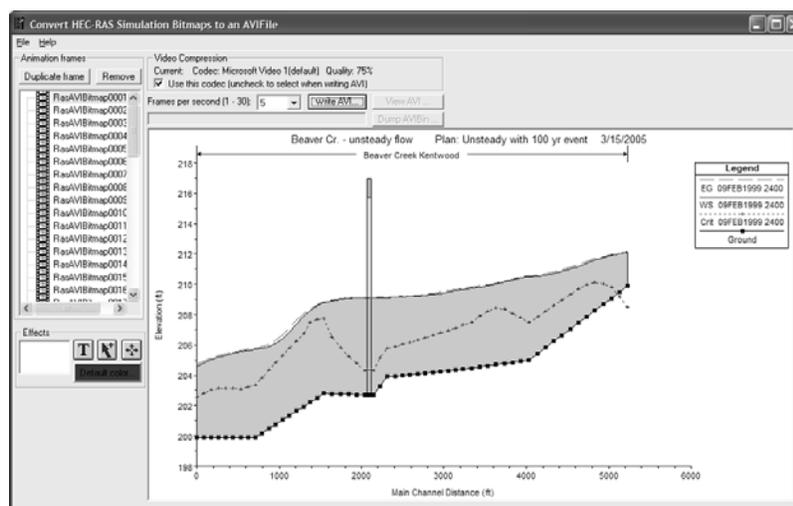
# Create an AVI – Make the images

- Click red dot button
- Dialog will ask if you want to do this
- Animate/Zoom/Pan
- Frame count shown in caption
- Click red dot again



# Create an AVI – Stitch bitmaps together with Bmp2avi

- Bmp2avi
- Write AVI ...
- Recommend using “Microsoft Video 1”
- Uncompressed file is 32 MB, Video 1 -> 2 MB



## BMP2AVI

Takes a buffer of bitmap files and compresses them into an AVI file. This file can be inserted into PowerPoint presentations or played with standard media players.

This will load with the files saved from the simulation in the list box. Select “Write AVI..” to generate the AVI file. A dialog will load that prompts for the target AVI filename. This dialog will be followed by the “Video Compression” window. It is recommended that users select the “Microsoft Video 1” option, as this has shown to have good compression and wide player support.

## Unsteady Profile Tables

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- Lateral Structures
- Junctions
- Storage Areas
- Pump Stations

# Unsteady Profile Tables Lateral Structures

Profile Output Table - Lateral Structures														
HEC-RAS Plan: Base River: Diamond Reach: Southwest														
Reach	River Sta	Profile	Q US (cfs)	Q Leaving Total (cfs)	Q DS (cfs)	Q Weir (cfs)	Q Gates (cfs)	W/ Top Width (ft)	Weir Max Depth (ft)	Weir Avg Depth (ft)	Min EI Weir Flow (ft)	E.G. US. (ft)	W.S. US. (ft)	
Southwest	1.95	Max WS	495.08	229.19	265.84	229.19		50.00	1.63	1.63	10.00	11.64	11.63	
Southwest	1.95	01JAN1990 0800	391.08	32.06	359.39	32.06		50.00	0.44	0.44	10.00	10.45	10.44	
Southwest	1.95	01JAN1990 1400	348.45	7.49	341.31	7.49		50.00	0.17	0.17	10.00	10.18	10.17	
Southwest	1.95	01JAN1990 2000	324.11	-1.09	325.50	-1.09		50.00	0.05	0.05	10.00	9.93	9.92	
Southwest	1.95	02JAN1990 0200	310.81	-1.44	312.53	-1.44		50.00	0.06	0.06	10.00	9.70	9.69	
Southwest	1.95	02JAN1990 0800	305.83	-1.81	307.77	-1.81		50.00	0.06	0.06	10.00	9.47	9.46	
Southwest	1.95	02JAN1990 1400	287.70	-2.20	289.92	-2.20		50.00	0.07	0.07	10.00	9.36	9.36	
Southwest	1.95	02JAN1990 2000	245.40	-2.60	247.93	-2.60		50.00	0.08	0.08	10.00	9.43	9.42	
Southwest	1.95	03JAN1990 0200	-386.21	29.36	-417.21	29.36		50.00	0.41	0.41	10.00	10.42	10.41	
Southwest	1.95	03JAN1990 0800	-179.90	156.83	-337.86	156.83		50.00	1.27	1.27	10.00	11.27	11.27	
Southwest	1.95	03JAN1990 1400	481.57	229.04	252.42	229.04		50.00	1.63	1.63	10.00	11.64	11.63	
Southwest	1.95	03JAN1990 2000	580.97	208.02	373.28	208.02		50.00	1.53	1.53	10.00	11.54	11.53	
Southwest	1.95	04JAN1990 0200	536.22	170.59	366.09	170.59		50.00	1.34	1.34	10.00	11.35	11.34	
Southwest	1.95	04JAN1990 0800	481.85	123.61	358.85	123.61		50.00	1.08	1.08	10.00	11.09	11.08	
Southwest	1.95	04JAN1990 1400	433.76	73.64	360.74	73.64		50.00	0.77	0.77	10.00	10.78	10.77	

# Unsteady Profile Tables

## Junctions

Reach	River Sta	Profile	W.S. Elev (ft)	E.G. Elev (ft)	Q Total (cfs)
North	4.0	Max WS	16.22	16.42	4122.32
North	4.0	01JAN1990 0800	10.46	10.46	114.55
North	4.0	01JAN1990 1400	10.18	10.19	112.40
North	4.0	01JAN1990 2000	9.94	9.94	110.99
North	4.0	02JAN1990 0200	9.71	9.72	110.49
North	4.0	02JAN1990 0800	9.49	9.49	112.57
North	4.0	02JAN1990 1400	9.70	9.72	519.31
North	4.0	02JAN1990 2000	10.36	10.42	929.43
North	4.0	03JAN1990 0200	16.21	16.42	4197.23
North	4.0	03JAN1990 0800	14.95	15.09	2863.43
North	4.0	03JAN1990 1400	12.82	12.88	1296.81
North	4.0	03JAN1990 2000	11.98	12.00	788.66
North	4.0	04JAN1990 0200	11.59	11.61	524.71
North	4.0	04JAN1990 0800	11.18	11.19	265.52
North	4.0	04JAN1990 1400	10.80	10.80	122.44
North	4.0	04JAN1990 2000	10.53	10.54	118.32

# Unsteady Profile Tables

## Storage Areas

Profile Output Table - Storage Area

File Options Std. Tables Locations Help

HEC-RAS Plan: Base [Reload Data]

Storage Area	Profile	W.S. Elev (ft)	SA Min El (ft)	Net Flux (cfs)	SA Area (acres)	SA Volume (acre-ft)
Eagle Lake	Max W/S	10.19	0.00	122.83	1500.00	10281.43
Eagle Lake	01JAN1990 0800	10.00	0.00	33.01	1500.00	10006.69
Eagle Lake	01JAN1990 1400	10.01	0.00	19.73	1500.00	10019.86
Eagle Lake	01JAN1990 2000	10.01	0.00	-14.30	1500.00	10021.18
Eagle Lake	02JAN1990 0200	10.01	0.00	-22.06	1500.00	10011.52
Eagle Lake	02JAN1990 0800	10.00	0.00	-24.48	1500.00	9999.87
Eagle Lake	02JAN1990 1400	9.99	0.00	-24.62	1500.00	9987.67
Eagle Lake	02JAN1990 2000	9.98	0.00	-22.80	1500.00	9975.79
Eagle Lake	03JAN1990 0200	10.00	0.00	110.88	1500.00	9997.01
Eagle Lake	03JAN1990 0800	10.04	0.00	110.85	1500.00	10061.73
Eagle Lake	03JAN1990 1400	10.08	0.00	88.01	1500.00	10115.40
Eagle Lake	03JAN1990 2000	10.10	0.00	77.20	1500.00	10156.01
Eagle Lake	04JAN1990 0200	10.13	0.00	69.40	1500.00	10192.36
Eagle Lake	04JAN1990 0800	10.15	0.00	58.44	1500.00	10224.13
Eagle Lake	04JAN1990 1400	10.17	0.00	45.15	1500.00	10249.42
Eagle Lake	04JAN1990 2000	10.18	0.00	32.29	1500.00	10268.37

# Node Specific Tables

- Cross Section
- Culvert
- Bridge
- Conveyance
- Inline Structure
- Lateral Structure
- Storage Areas
- Storage Area Connections
- Pump Stations
- Flow Distribution

The screenshot shows the 'Cross Section Output' window with a menu open over 'Cross Sections'. The table below represents the data displayed in the window.

		North RS: 6.0 Profile: Max WS			
		Left OB	Channel	Right OB	
E.G	Inline Structures				
Vel	Lateral Structures	0.080	0.030	0.080	
W.L	Storage Areas	1056.00	1056.00	1056.00	
Crit	Storage Area Connections	436.82	661.40	460.87	
E.G	Pump Stations	436.82	3497.38	460.87	
Q.T	Flow Distribution in Cross Sections	471.34	3497.38	497.94	
Top		92.12	45.00	97.12	
Vel Total (ft/s)	2.86	Avg. Vel. (ft/s)	1.08	5.29	1.08
Max Chl Dpth (ft)	15.81	Hydr. Depth (ft)	4.74	14.70	4.75
Conv. Total (cfs)	213537.4	Conv. (cfs)	22533.4	167199.0	23805.0
Length/Wtd. (ft)	1056.00	Wetted Per. (ft)	94.38	57.36	99.38
Min Ch El (ft)	3.00	Shear (lb/sq ft)	0.13	0.31	0.13
Alpha	2.70	Stream Power (lb/ft s)	0.14	1.67	0.14
Frcn Loss (ft)	0.43	Cum Volume (acre-ft)	142.24	178.50	150.03
C & E Loss (ft)		Cum SA (acres)	22.55	10.91	23.76

Errors, Warnings and Notes

Select Profile

# Node Specific Table Storage Area

The screenshot shows a software window titled "Storage Area Output" with a menu bar (File, Type, Options, Help) and a toolbar. The window displays the following data:

Profile: Max W/S  
 SA: Pyramid Lake  
 Plan: Base

Plan: Base Storage Area: Pyramid Lake Profile: Max W/S			
W.S. Elev (ft)	11.69	Pyramid to Eagle	-0.17
SA Min El (ft)	-1.00	RS 0.0	419.81
SA Area (acres)	1000.00	RS 0.0	-398.02
SA Volume (acre-ft)	12686.89		
Inflow (cfs)	419.81		
Outflow (cfs)	398.19		
Net Flux (cfs)	21.62		

Below the table is a section titled "Errors, Warnings and Notes" which is currently empty.

The lateral weir table displays information for each gate in the lateral weir. The different gates are accessed with the Gate ID drop down box. In the above example, the lateral weir does not have any gates so the Gate ID box is empty and the gate variables are blanked out.

## Node Specific Table Storage Area Connections

The screenshot shows a software window titled "Storage Area Connection Output". The window has a menu bar with "File", "Type", "Options", and "Help". Below the menu bar, there are several dropdown menus: "Profile: Max WS", "Culv Group: Culvert #1", "Conn: Pyramid to Eagle", and "Plan: Base". Below these are two more dropdown menus: "Plan: Base" and "Profile: Max WS". The main area of the window contains a table with the following data:

Plan: Base Pyramid to Eagle Culv Group: Culvert #1 Profile: Max WS			
Q Culv Group (cfs)	0.17	Culv Full Len (ft)	
# Barrels	1	Culv Vel US (ft/s)	0.71
Q Barrel (cfs)	0.17	Culv Vel DS (ft/s)	1.54
E.G. US (ft)	11.70	Culv Inv El Up (ft)	11.50
W.S. US (ft)	11.70	Culv Inv El Dn (ft)	11.40
E.G. DS (ft)	10.19	Culv Frctn Ls (ft)	0.15
W.S. DS (ft)	10.19	Culv Exit Loss (ft)	1.36
Delta EG (ft)	1.51	Culv Entr Loss (ft)	0.00
Delta WS (ft)	1.51	Q Weir (cfs)	
E.G. IC (ft)	11.64	Weir Sta Lft (ft)	
E.G. OC (ft)	11.70	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	11.69	Weir Max Depth (ft)	
Culv WS Outlet (ft)	11.51	Weir Avg Depth (ft)	
Culv Nml Depth (ft)	0.19	Weir Flow Area (sq ft)	
Culv Crit Depth (ft)	0.11	Min El Weir Flow (ft)	16.51

Below the table is a section titled "Errors, Warnings and Notes". It contains a note: "During subcritical analysis, the culvert direct step method, the solution went to normal depth." Below this note is a large empty rectangular area. At the bottom of the window, there is a text label: "Elevation where weir flow begins."

The output data for a storage area connection depends on the connection type. The view above, the output is shown for a connection with a culvert, if it had gates, the table would look more like the inline structure table.

# Node Specific Table Pump Stations

The screenshot shows a software window titled "Pump Station Output" with a menu bar (File, Type, Options, Help) and several control elements. At the top, there are dropdown menus for "Profile: Max WS" and "Pump Group: Group #1". Below these are buttons for "Pump: Pumps" and "Plan: Pump". A table displays the following data:

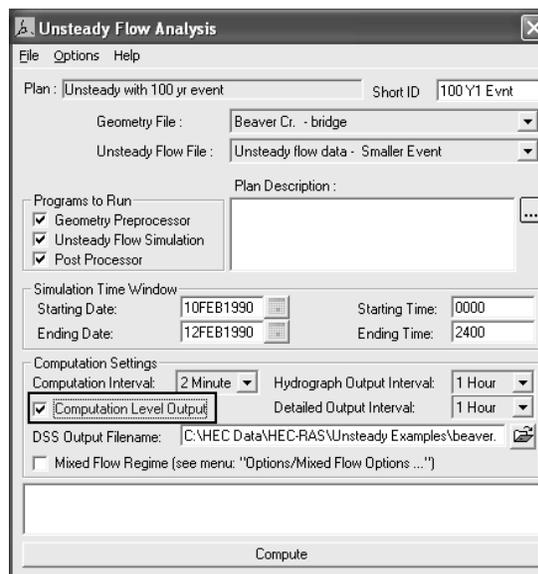
Plan: Pump	Pump Station: Pumps	Pump Group: Group #1	Profile: Max WS
Q Pump Station (cfs)	250.41	Q Pump Group (cfs)	250.41
WS Inlet (ft)	206.73		
WS Outlet (ft)	220.00		
Pumping Head (ft)	13.27		

Below the table is a section labeled "Errors, Warnings and Notes" which is currently empty.

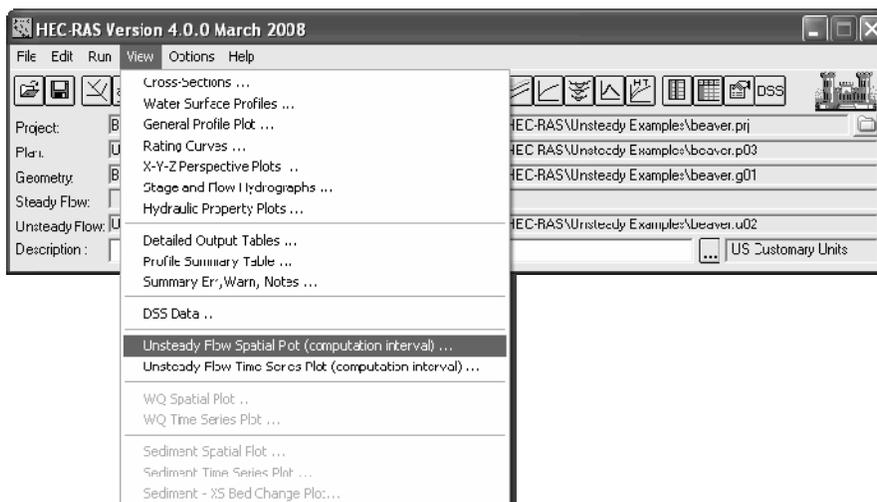
The lateral weir table displays information for each gate in the lateral weir. The different gates are accessed with the Gate ID drop down box. In the above example, the lateral weir does not have any gates so the Gate ID box is empty and the gate variables are blanked out.

## Computation Level Output

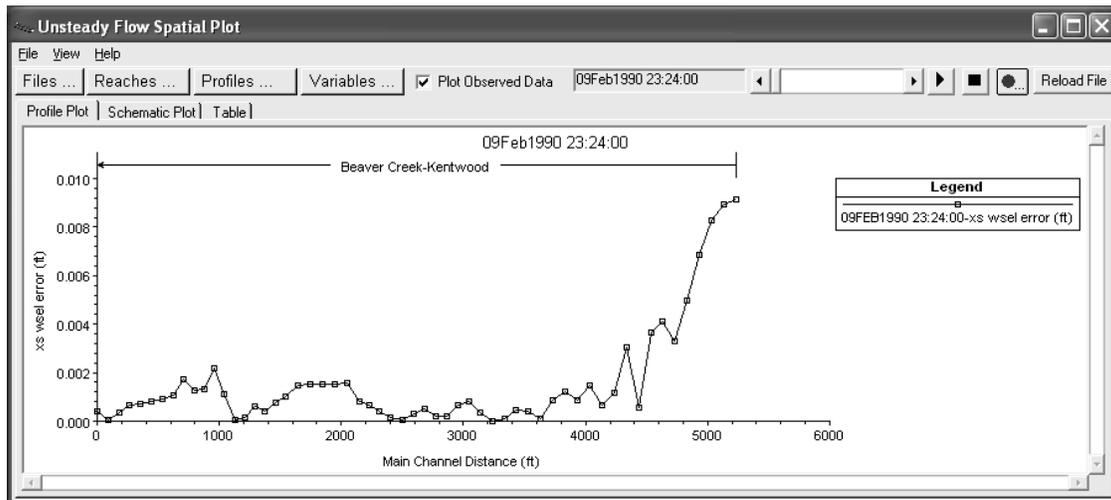
- Output at the User specified computation interval
  - WSEL
  - Flow
  - WSEL error
  - Flow error
  - Depth
  - Vel Channel & total
  - Courant # channel and total



# Viewing Computation Level Output



# Computation Level Spatial Plot



# Computation Level Time Series Plot

