Storage Areas and Storage Area Connections

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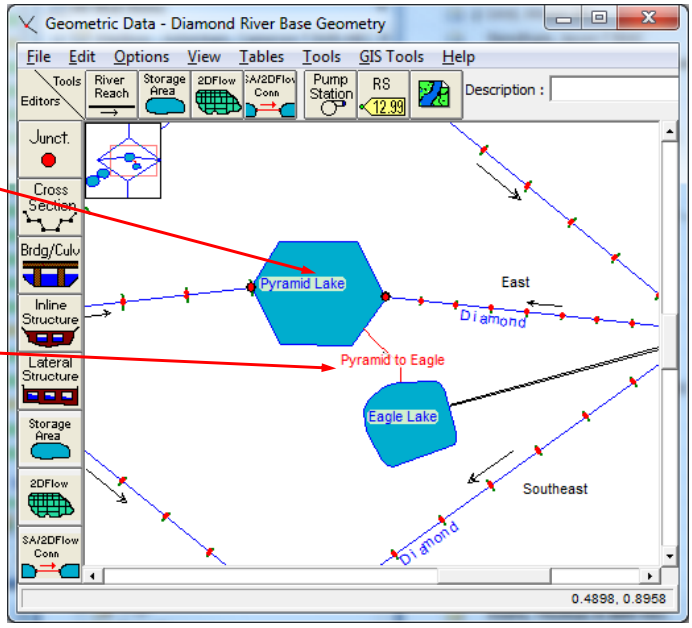
Introduction

- Storage Areas
  - Purpose
  - Data Entry
  - Output
- SA Connections
  - Purpose
  - Data Entry
  - Output



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- 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”.

Storage Areas - Purpose

- Good for areas that are either inline or off line storage areas where the water surface is horizontal
- Stabilizing influence on computations
- Continuity equation is used to account for volume of storage areas
- Momentum is not computed
- Can be connected to:
  - Lateral structures
  - Top or bottom of a reach
  - Another storage area (with a SA Connection)

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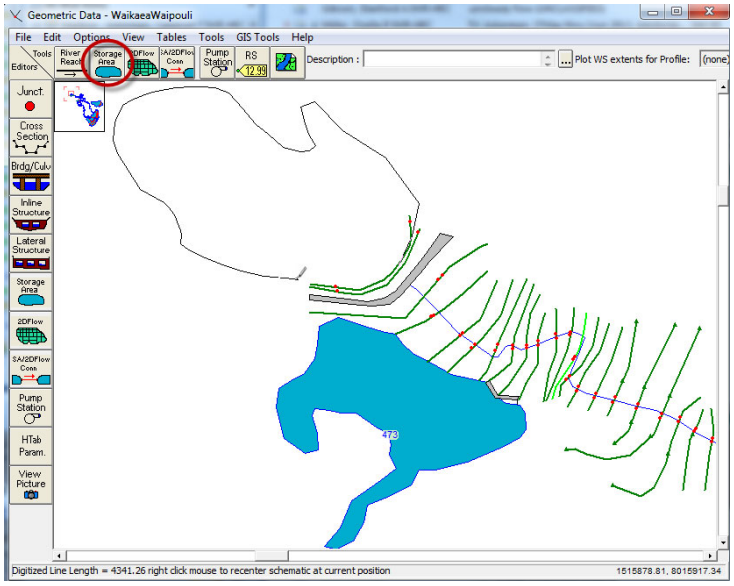
- Storage areas are more stable in computations (and faster) than representing a region with cross sections.

Storage Area - Creating

- Created on the geometry schematic using the Storage Area editor



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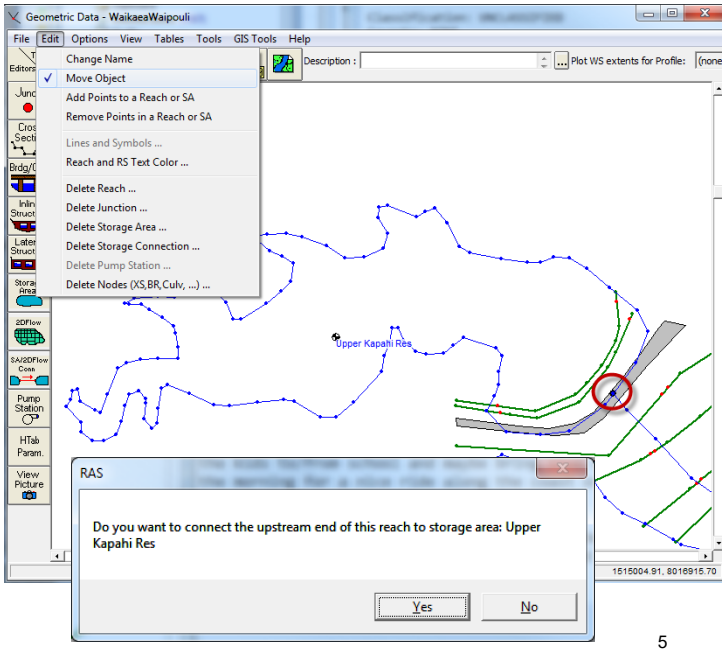
- Storage Areas are created on the geometry schematic with the “Storage Area” tool. Press the button and the mouse cursor changes to a pen, draw the storage area and double click to end drawing.

Storage Area - Connecting

- When you connect the river to the SA a “node” is formed
- Upstream
  - Inline Structure with 2 cross sections u/s of structure
- Downstream



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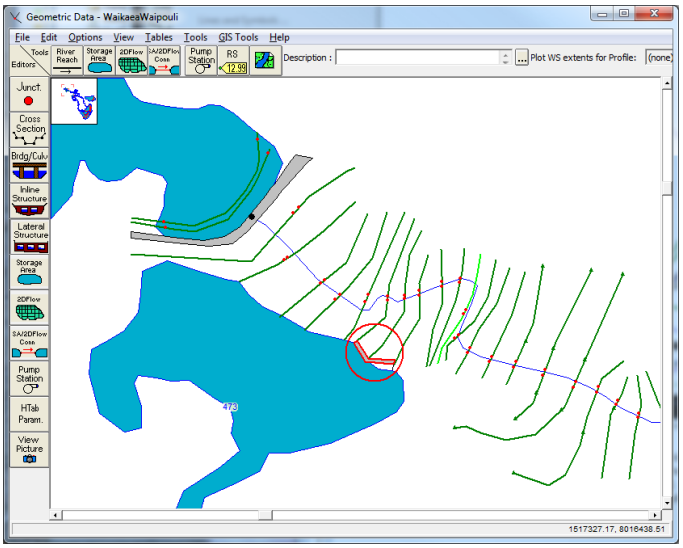
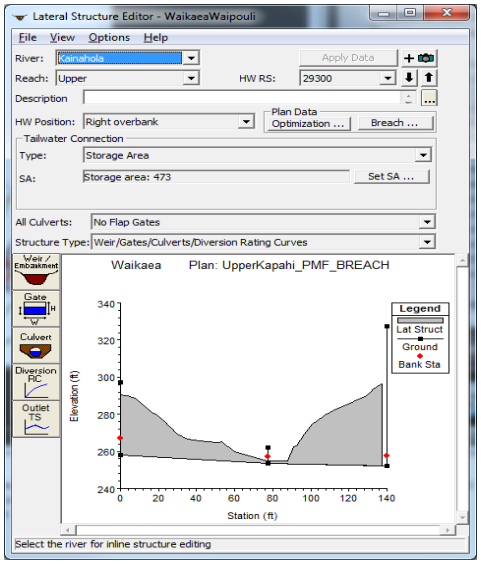
- In order to connect a storage area to the upstream or downstream end of a river reach, select the Edit | Move Object menu item. Then grab the end of the river reach and move it into the storage area. RAS will ask you if you want to connect the river reach and storage area. If you accept Yes, then a node will be formed at the boundary of the storage area and the river line.
- When using a storage area for an upstream boundary, there must be 2 cross sections placed upstream of an inline structure.

Storage Area - Connecting



- Lateral Structure



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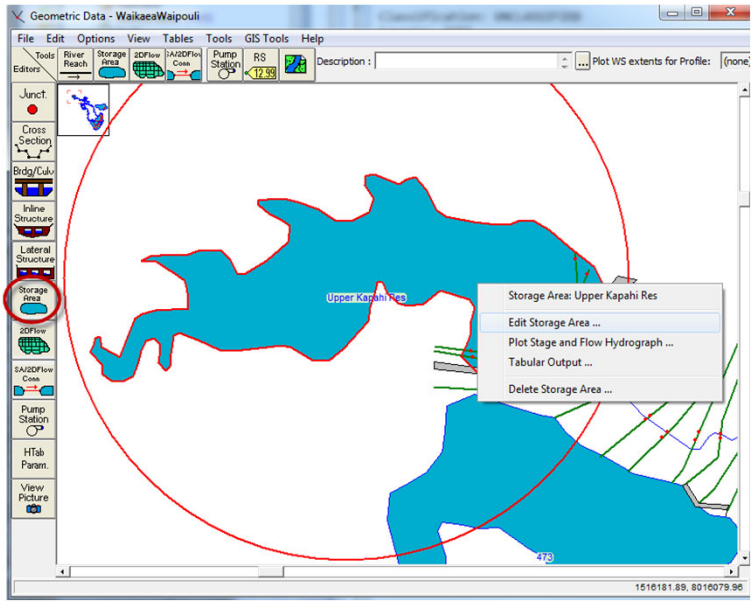
- To connect a storage are to a river, you do so using a lateral structure.
- A new lateral structure is added similar to adding a bridge, by selecting a river and reach and specifying a river station.
- The lateral structure has several options, but for a storage area you are connecting from the river (Headwater) on the right or left side to the storage area (Tailwater)!

Storage Area - Geometry Data

- Open editor
  - Floating menu from left mouse click
  - Button



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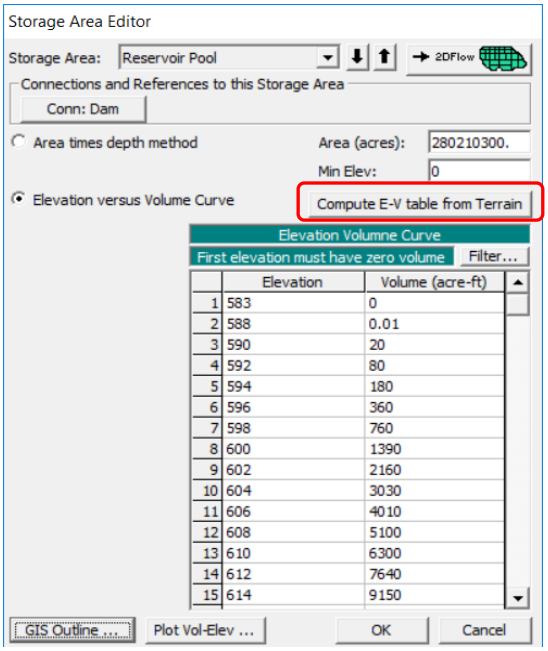
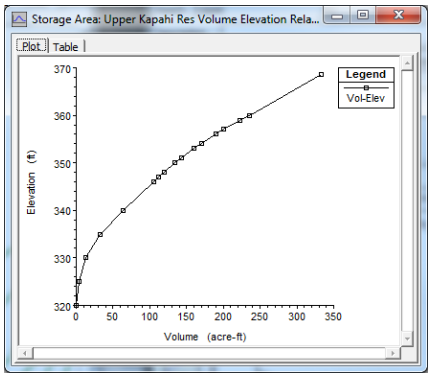
- The data editor for storage areas can be accessed by clicking on the “Storage Area” button on the schematic editor or clicking on the storage area with left mouse button, this will display an popup menu with the option to edit .

Storage Area - Geometry Data



- Volume Methods
  - Area times depth
  - Elevation - Volume Curve (cut from terrain)
- Edit outline
- Plot Curve



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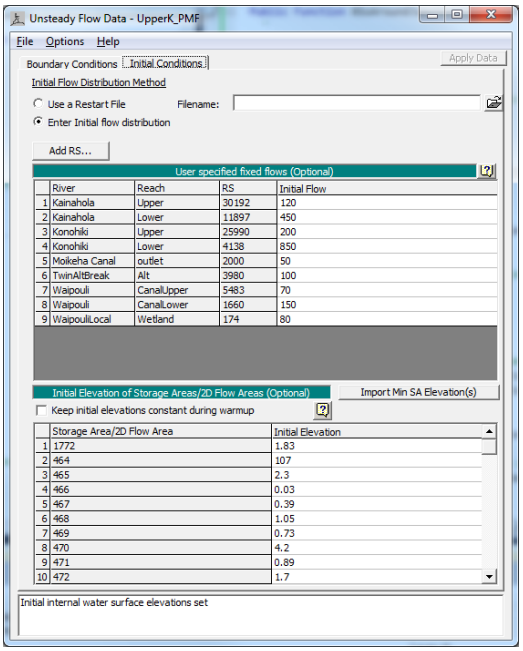
- The only data needed for storage areas is a method of computing storage verses elevation.
- Two methods are available, a surface area times a depth or interpolation from a rating curve.

Storage Area - Unsteady Flow Data

- Initial Conditions (Optional)
  - Starting WSE



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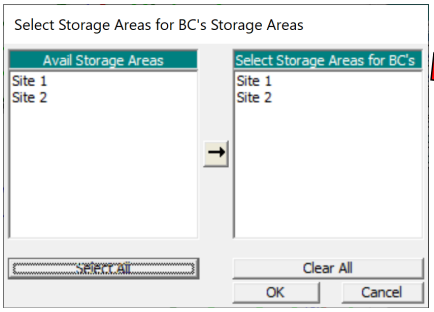
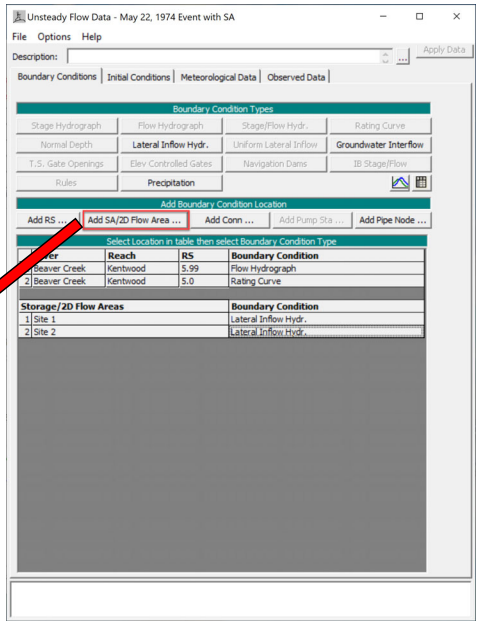
- The initial elevation of the storage area is required for simulation, this is specified on the unsteady flow data window on the “Initial Conditions” tab.

Storage Area - Unsteady Flow Data

- Boundary Conditions (Optional)
  - Lateral Inflow Hydrograph





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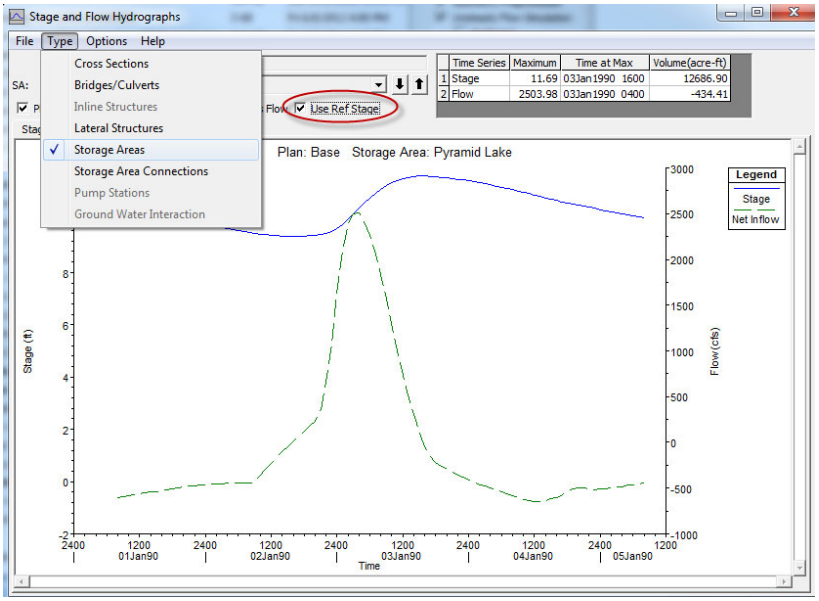
- A time series of lateral inflows can also be entered for a storage area, this would be entered on the same window, but on the “Boundary Conditions” tab.

Storage Area - Output

- Stage Flow Plot
  - Stage
  - Net Flow



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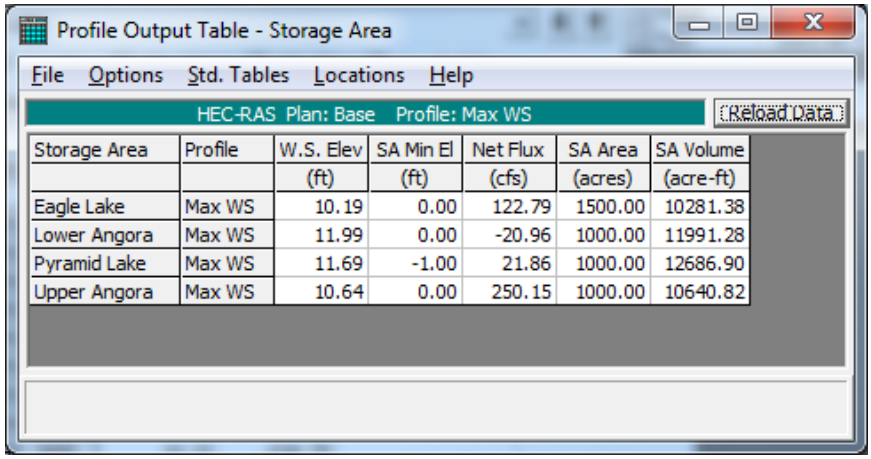
- Stage and flow hydrographs are available for storage areas if storage areas are selected as the node type in the hydrograph output window.
- From this window you have the option to view computed stage, computed flow, observed stage, and observed flow (or none of the above).
- There is also a checkbox that allows you to use a reference stage for the hydrograph.
- When this option is selected, it changes the scale along the y axis to include the entire range of values from the user input storage-elevation curve for that storage area. Otherwise, the y axis scale is set to the range of stages computed.

Storage Area - Output

- Profile Output Table



Storage Area	Profile	W.S. Elev (ft)	SA Min El (ft)	Net Flux (cfs)	SA Area (acres)	SA Volume (acre-ft)
Eagle Lake	Max WS	10.19	0.00	122.79	1500.00	10281.38
Lower Angora	Max WS	11.99	0.00	-20.96	1000.00	11991.28
Pyramid Lake	Max WS	11.69	-1.00	21.86	1000.00	12686.90
Upper Angora	Max WS	10.64	0.00	250.15	1000.00	10640.82

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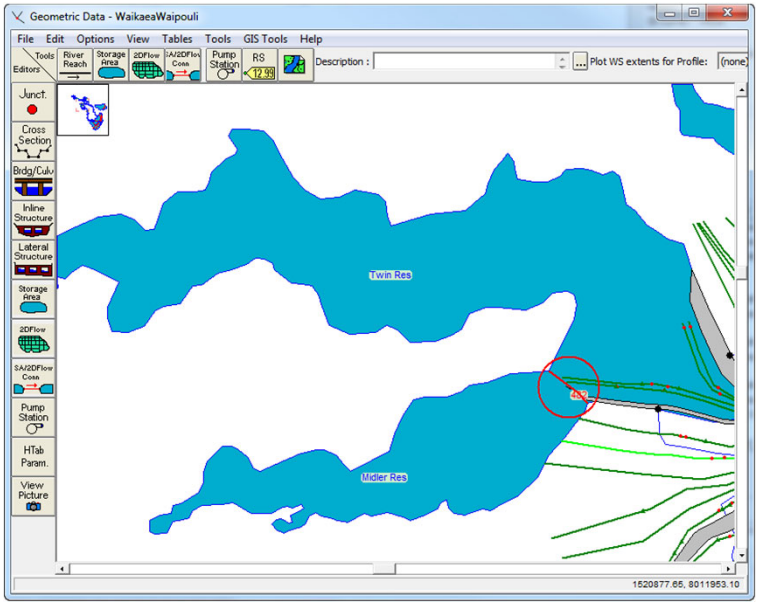
SA Connection - Purpose

- Convey water from storage area to storage area



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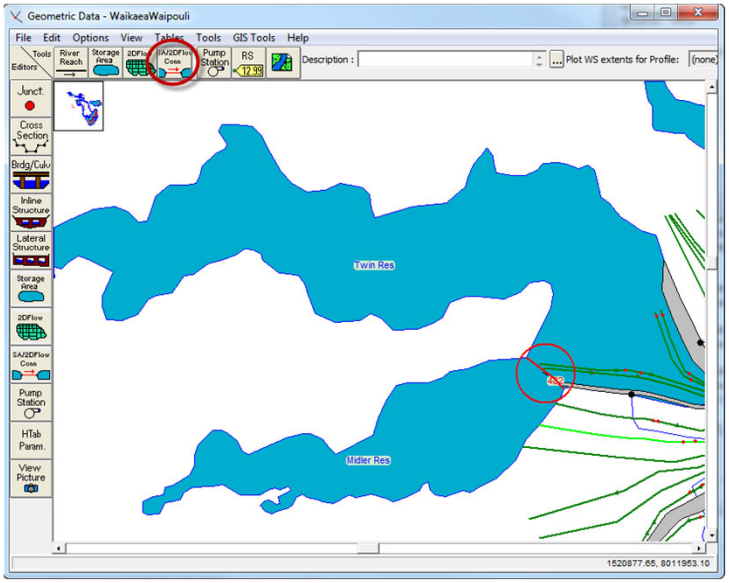
SA Connection - Geometry

- Created on the geometry schematic
- Ends snap to the nearest Storage Area



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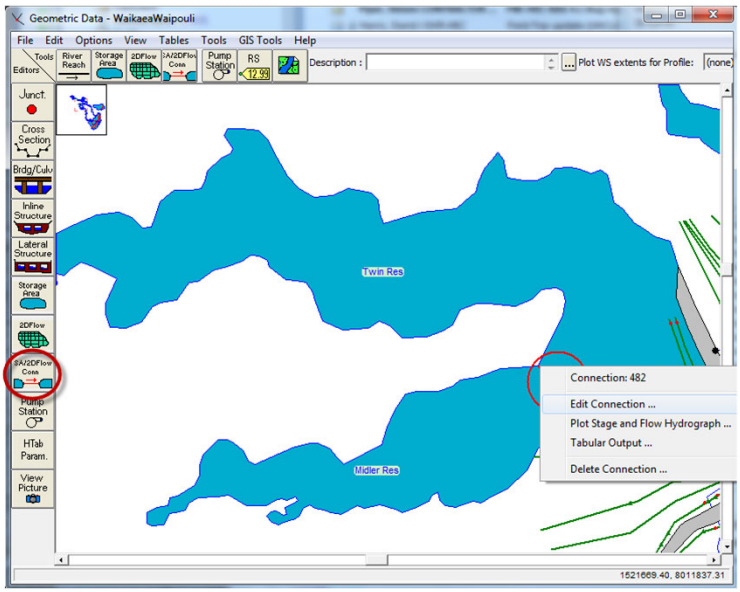
- Press the SA Conn tool button on the top row of the schematic editor, and the mouse pointer will change to a pen.
- Draw the connection and double click to finish the polyline.
- SA connections snap to the nearest possible end point so start and end the connection near the desired storage area.

SA Connection - Geometry

- Open editor
  - Floating menu from left mouse click
  - Button



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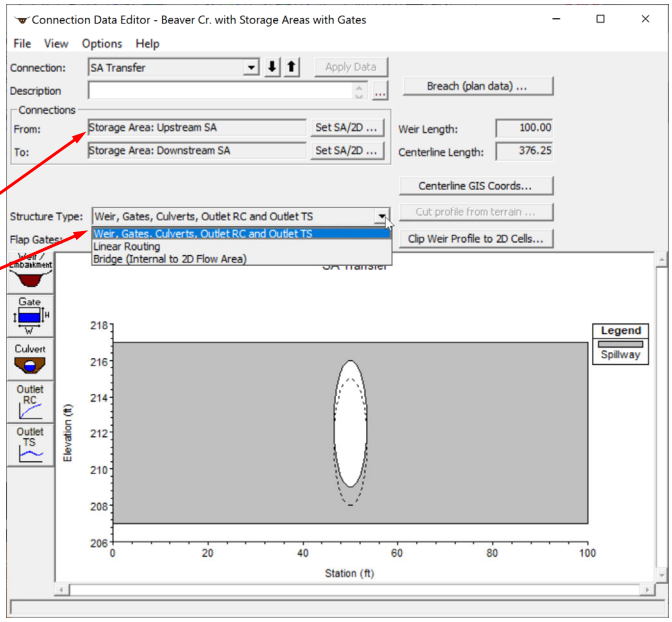
SA Connection - Geometry

- Connection Selection drop down list
- Description
- Editor Shows connections “From” and “To”
- Structure Types:
  1. Weir, Gates, & Culverts, etc
  2. Linear Routing Method
  3. Bridge (Internal to 2D Areas)



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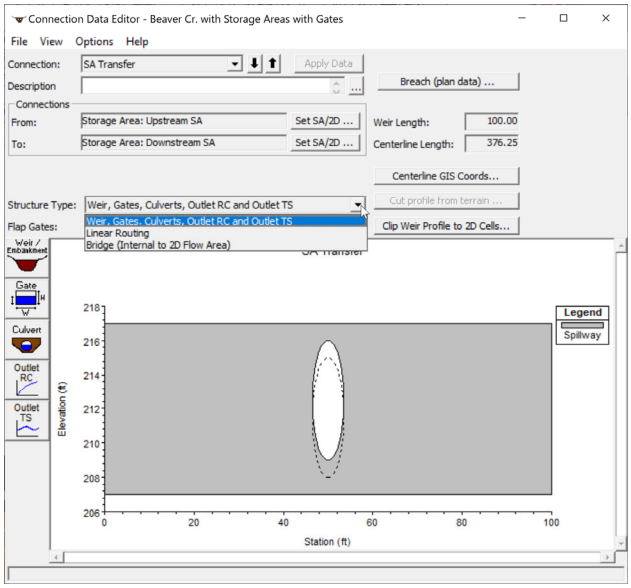
- When the SA Connection editor is opened the plot will initially be blank.
- The description can be entered and the “From” and “To” ends of the connection.
- The buttons on the left, load sub-editors for the components of the connection.

SA Connection - Computations

- Inline Weir Type
  - Can use the weir equation in computations
  - Can use a family of curves
- Inline Weir Type with Gates or Culverts
  - Uses the weir and gate equations in computations
  - Cannot use curves because the gates change the properties over time
  - Outlet Time Series
  - Outlet Rating Curve
  - Culverts need HTab Parameters



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- The data for storage area connections is a combination of things that are available elsewhere in the program.
- For example, the culvert data for a storage area connection is similar to the normal culvert data at a bridge/culvert crossing.

SA Connection - Computations

- Linear Routing Type

$Q = kS$: Flow

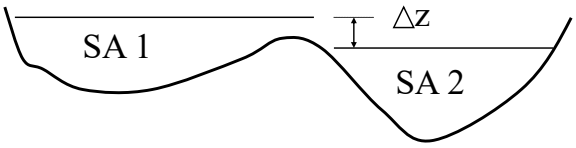
$S = A\Delta z$: Available storage

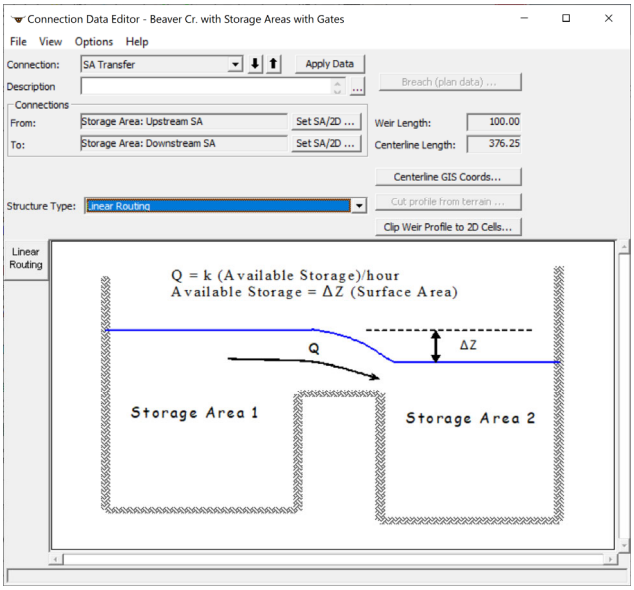
A : Surface area

k : Linear routing coefficient (1/hr)

Range of k : $0 - 1$

Typical k value: 0.05





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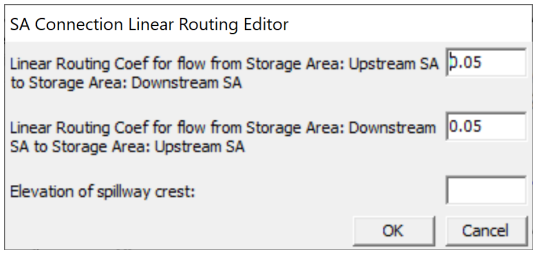
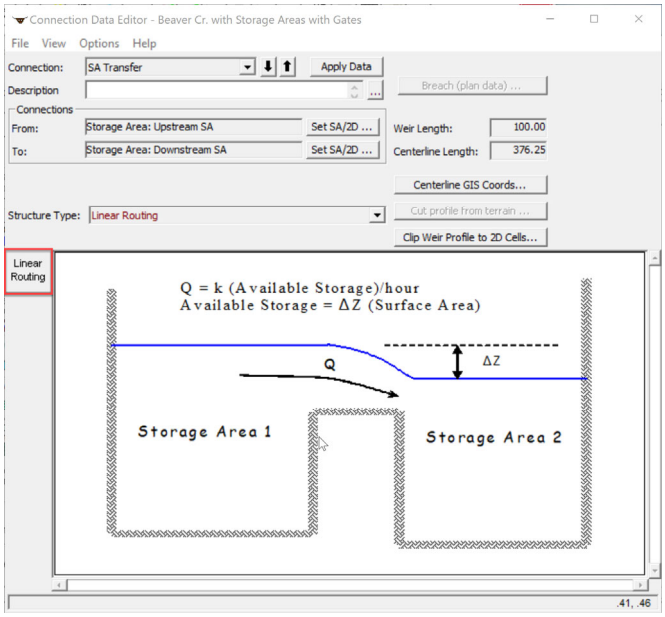
- Another method of computing flow between storage areas is with linear routing.
- Linear routing computes the flow between storage areas by a simple fraction of the available storage difference between each storage area for each time step.
- The coefficients k has units of 1/hours.

SA Connection - Geometry Data

- Linear routing
  - Separate linear routing coefficients selected for each flow direction
  - Optional Spillway Crest Elevation





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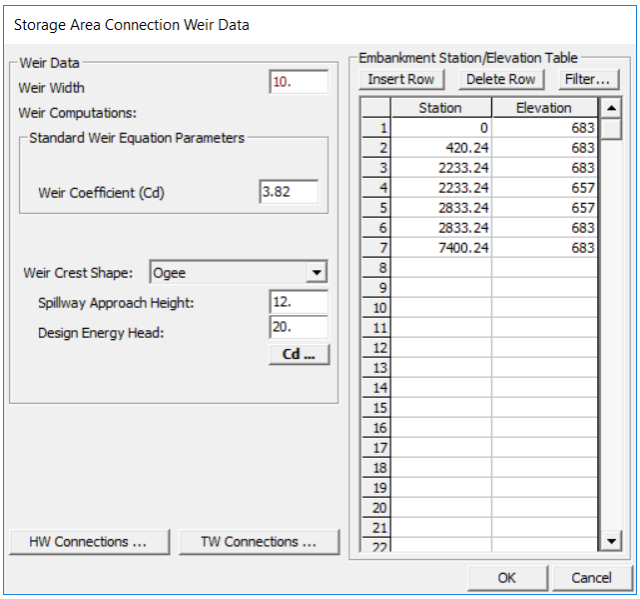
The linear routing coefficient is direction dependent, so one for each flow direction must be entered. The "elevation of crest" is a reference that determines when water will start flowing from one storage area to the next.

SA Connection - Geometry Data

- Weir/Embankment
  - Weir Width (Optional)
  - Flow Reference
  - Weir Coefficient
    Range 0 - 4
    Default = 3 (maybe 2.6 would be better)
  - Weir Crest Shape
    - Broad Crested
    - Ogee
  - Weir Profile



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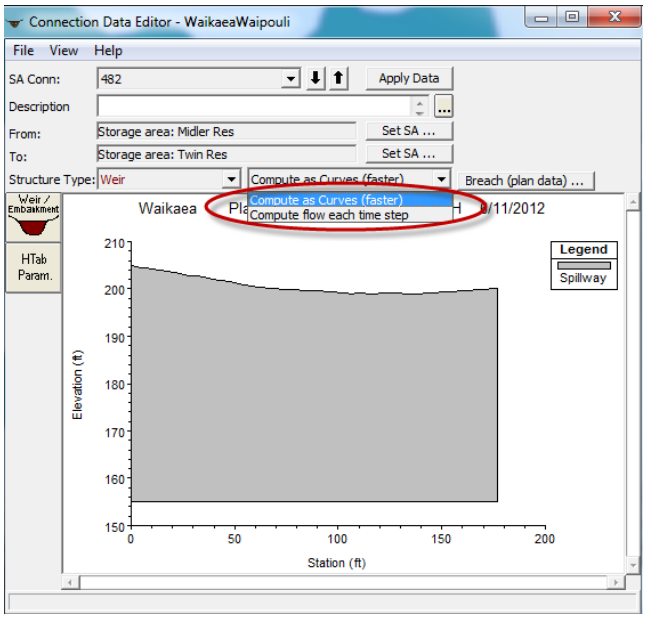
Weir Coefficients range from 0 to 4.

Application	Weir Coefficient
For a levee	2.6
Broad Crested Weir	2.6
Natural ground	<2

SA Connection - Geometry Data

- Inline Weir
  - "On the fly" computations
  - Family of Curves
    Cannot change curves
    Can produce errors if
    stage goes beyond curves



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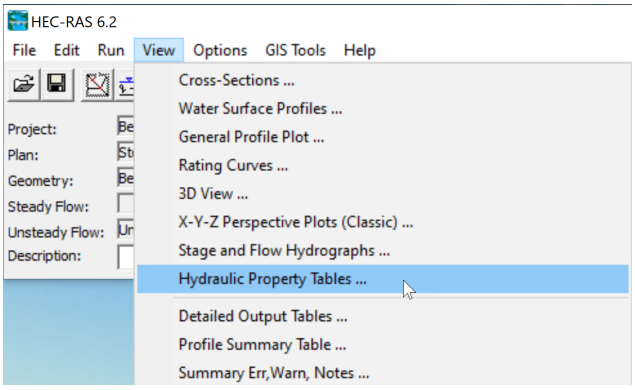
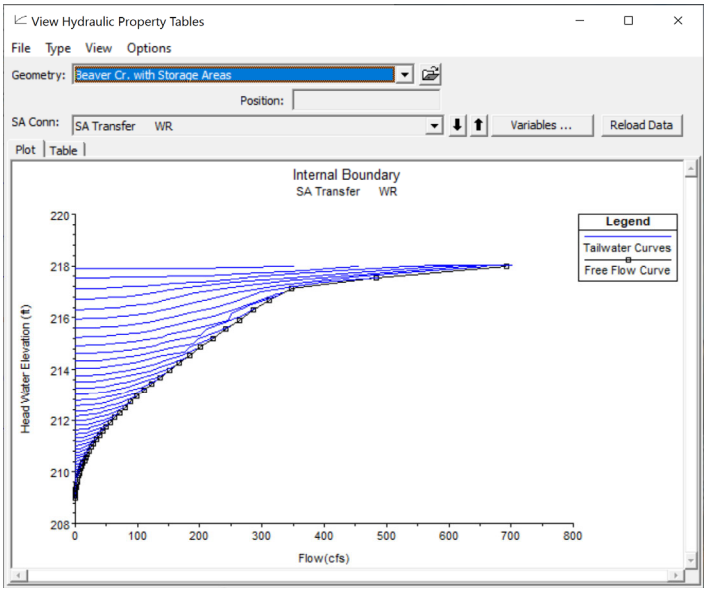
SA Connection - Computations





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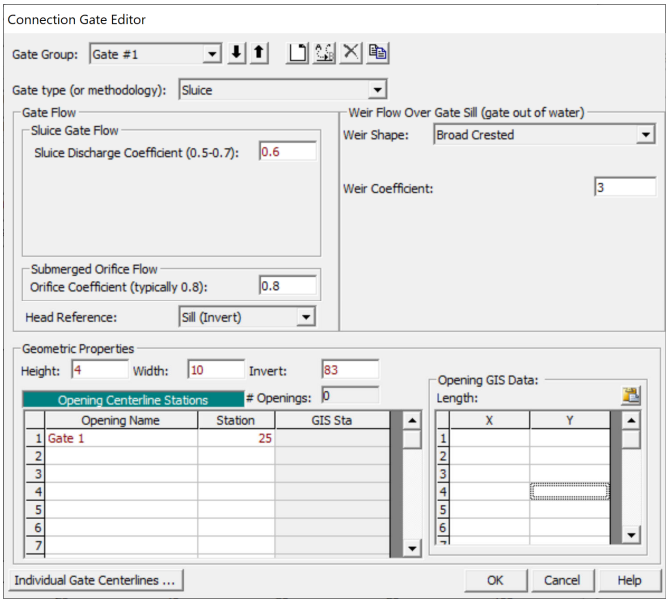
The family of rating curves can be viewed from the “View Hydraulic Properties” window. Select “SA Connections” under the “Type” menu option.

SA Connection - Geometry Data

- Gate Editor
  - Same editor for Inline and Lateral Structures



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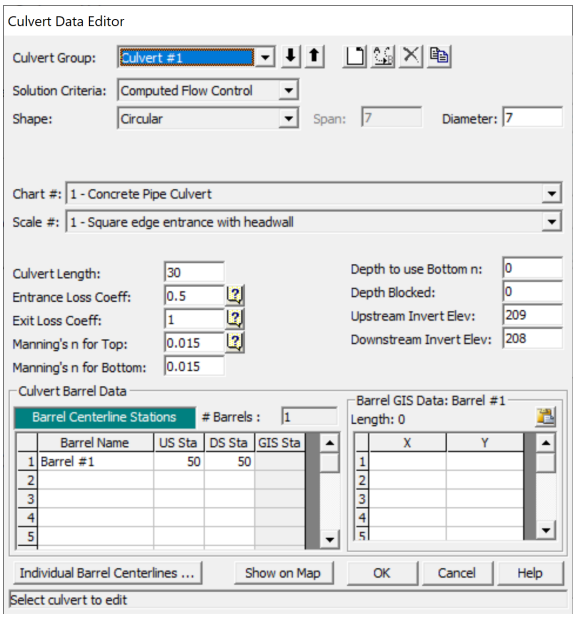
- The data for a gate editor is the same as for an inline weir.
- Refer to the inline weir section of the HEC-RAS Users Manual.

SA Connection - Geometry Data

- Culvert Editor
  - Same editor for Bridge/Culverts and Lateral Structures



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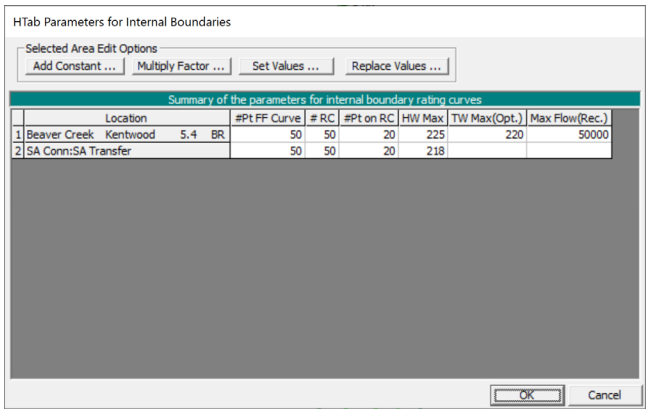
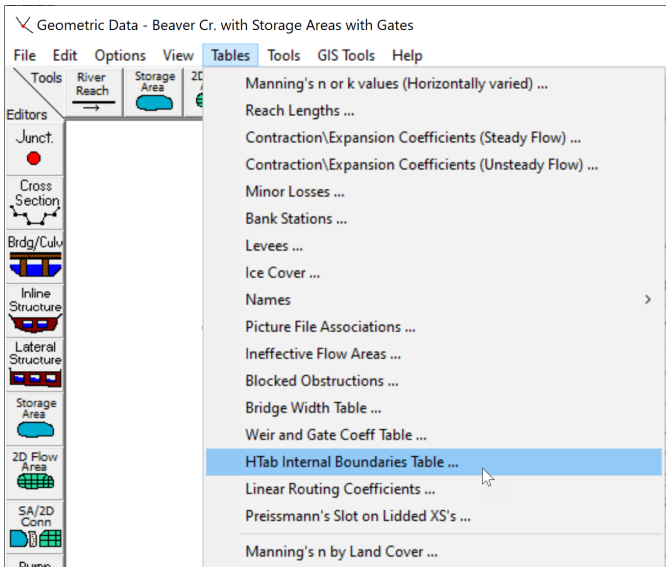
- The data for a gate editor is the same as for an inline weir.
- Refer to the inline weir section of the HEC-RAS Users Manual.

SA Connection - Geometry Data

- HTab Parameters
  - Headwater maximum (required)
  - Tailwater maximum (optional)
  - Maximum Flow (Optional)





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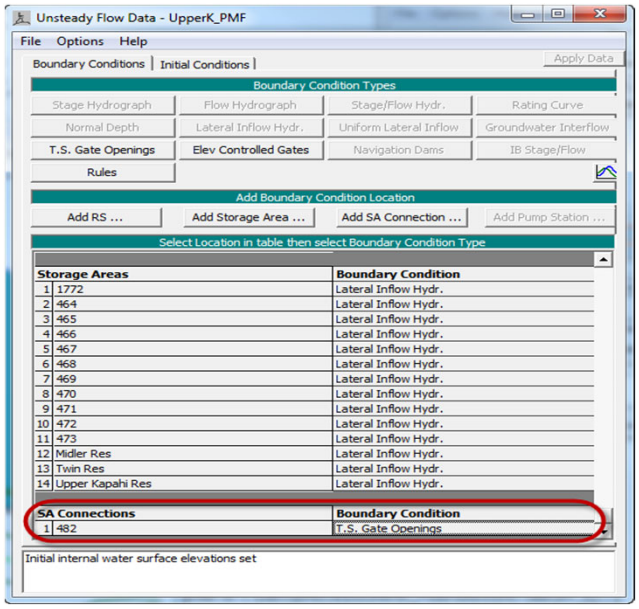
- The HTab data is only needed for the culvert type connections.
- The data required here is the same as covered for bridges and culverts, covered earlier in this course.
- The maximum swell head parameter is the largest difference between head water and tailwater.
- All four parameters maximum headwater, tailwater, and maximum flow are used to limit the range of the family of rating curves.
- It's important to keep the curves in the possible flow and stage ranges to minimize the errors in interpolation
- The only parameter required for connections is the headwater maximum, the program computes default values for the others.

SA Connection - Unsteady Flow Data

- Gated Connections
  - Time series of Gate Openings
  - Elevation Controlled Gates



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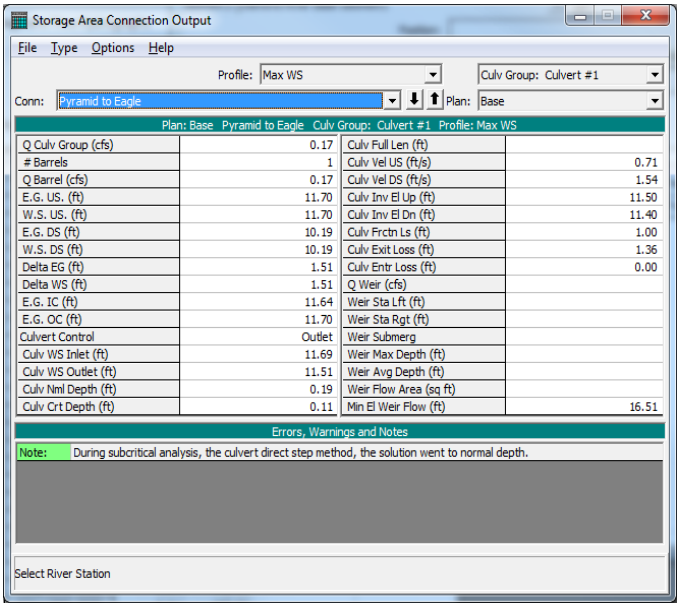
- If a SA Connection has gates, then boundary condition data will need to be entered on the unsteady flow data editor.
- The lower portion of the boundary condition editor is where the connection is added to the table.
- Two types are possible, a time-series of gate openings and elevation-controlled gates.
- The data for these boundary conditions are the same as for the gates on inline and lateral weirs.

SA Connection - Tabular Output

- Culvert Type



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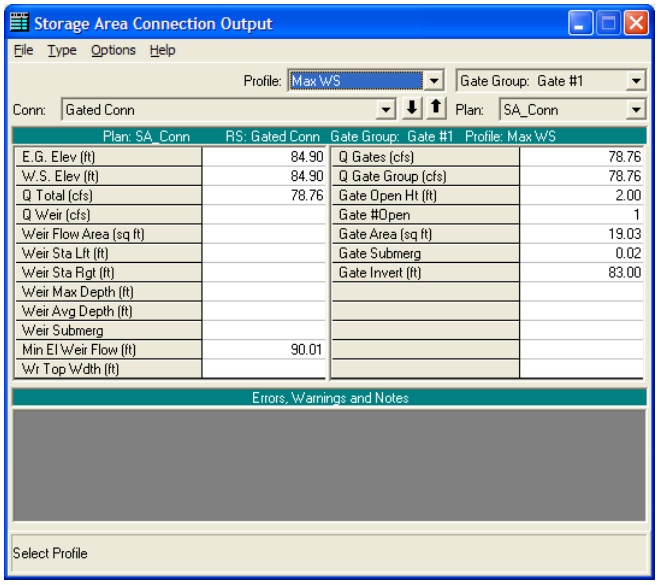
SA Connection - Tabular Output

- Inline Weir with Gates



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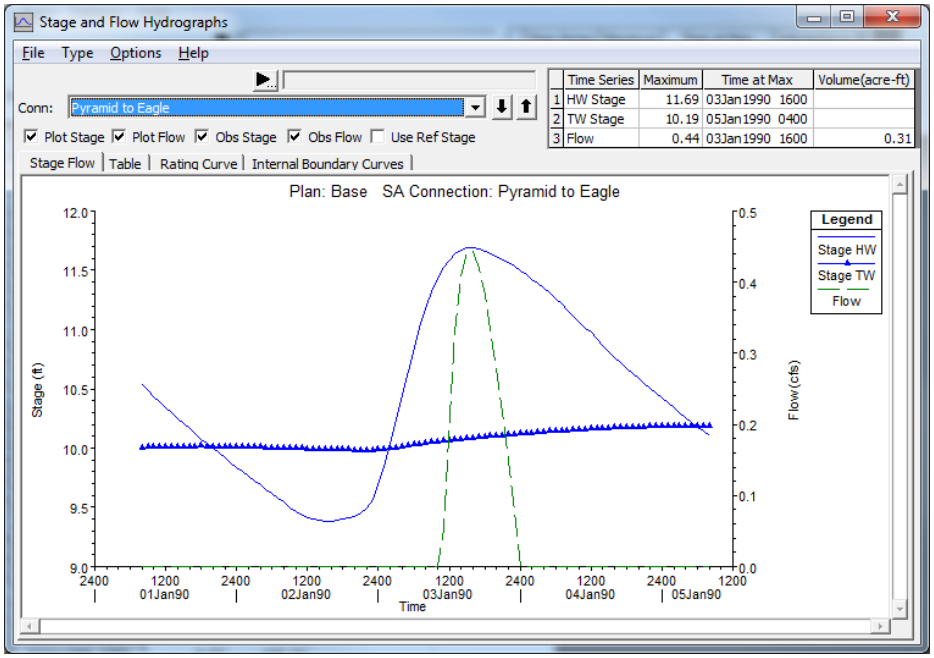
SA Connection - Stage Flow Plots



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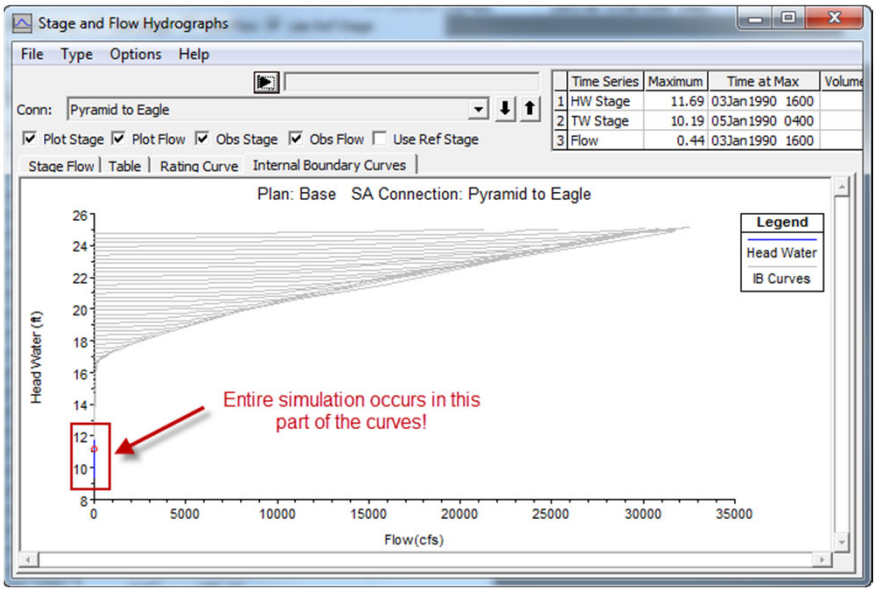
SA Connection - Stage Flow Plots

- Limit hydraulic properties



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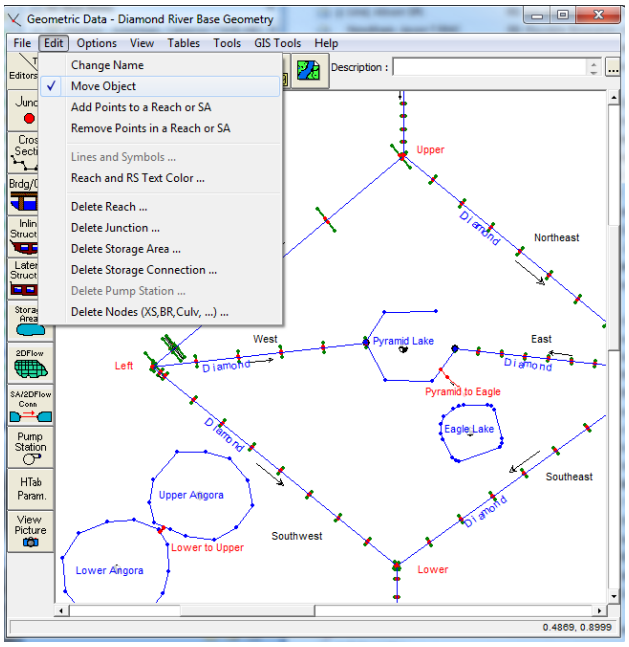
Schematic Editing

- Select “Move Object” under “Edit”
- Move individual points
- Move whole SA with centroid
- Move Text
- SA Conn snap to nearest point



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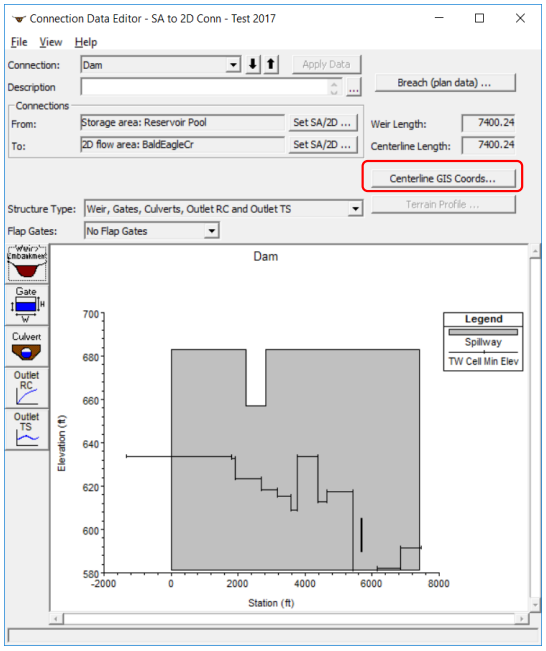
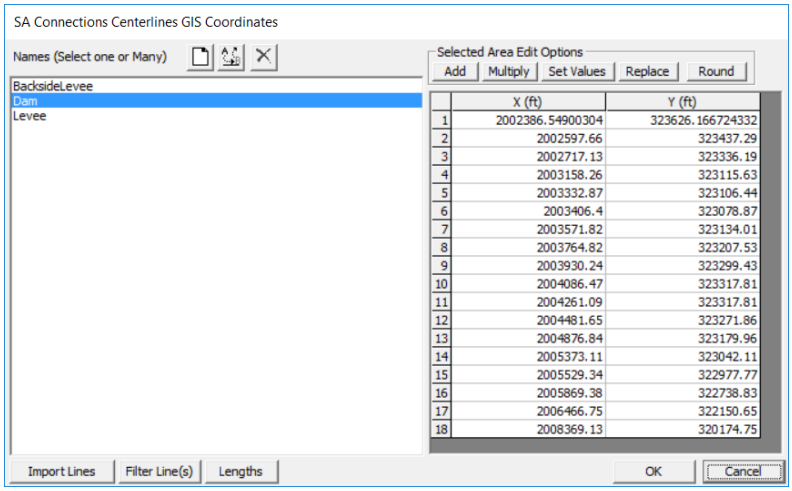
Once the outline is created, it can be edited by selecting the “Move Object” menu item under “Edit”. The schematic will change its appearance and allow features to be moved.

Editing GIS Data in Table





	X (ft)	Y (ft)
1	2002386.54900304	323626.166724332
2	2002597.66	323437.29
3	2002717.13	323336.19
4	2003158.26	323115.63
5	2003332.87	323106.44
6	2003406.4	323078.87
7	2003571.82	323134.01
8	2003764.82	323207.53
9	2003930.24	323299.43
10	2004086.47	323317.81
11	2004261.09	323317.81
12	2004481.65	323271.86
13	2004876.84	323179.96
14	2005373.11	323042.11
15	2005529.34	322977.77
16	2005869.38	322738.83
17	2006466.75	322150.65
18	2008369.13	320174.75

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