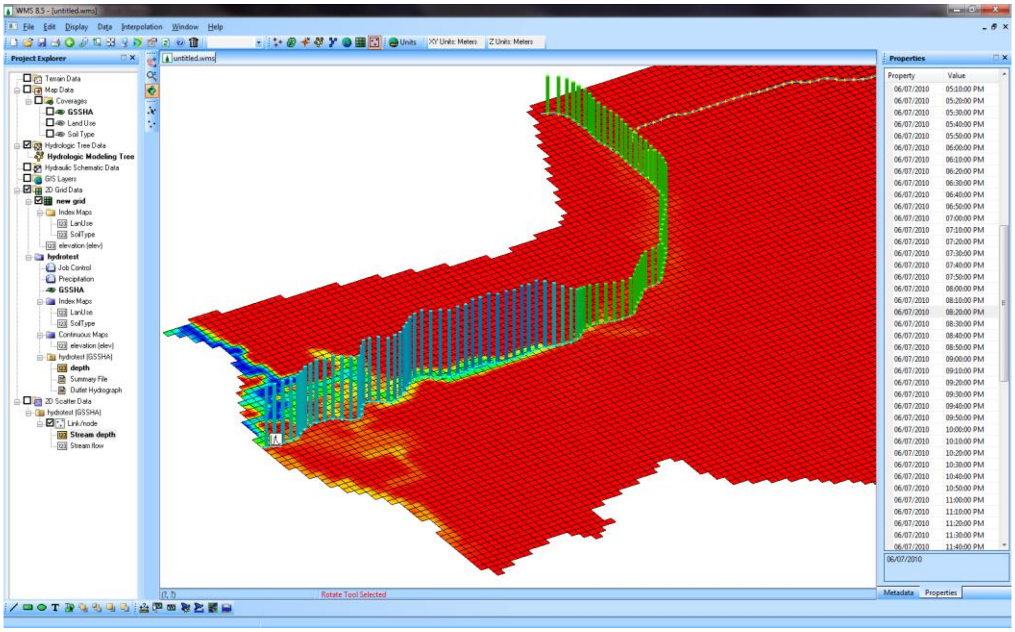
v. 10.1

WMS 10.1 Tutorial

GSSHA – Applications – Overland Flow Boundary Conditions in GSSHA

Define overland flow boundary conditions in a GSSHA model



Objectives

Learn how to use the GSSHA interface in WMS to define hydrograph boundary conditions from a separate watershed on stream nodes. Also learn how to define known head boundary conditions such as storm surge depths on overland flow cells.

Prerequisite Tutorials

- GSSHA – Modeling Basics – Developing a GSSHA Model Using the Hydrologic Modeling Wizard in WMS

Required Components

- Data
- Drainage
- Map
- Hydrology
- 2D Grid
- GSSHA

Time

- 30-60 minutes

1 Contents

2 Introduction

So far the only source of runoff in the GSSHA models has been precipitation. However, there is the possibility of defining sources separate from rainfall with other boundary conditions. Two such types of boundary conditions are hydrographs defined on stream nodes and head boundary conditions defined on overland flow cells.

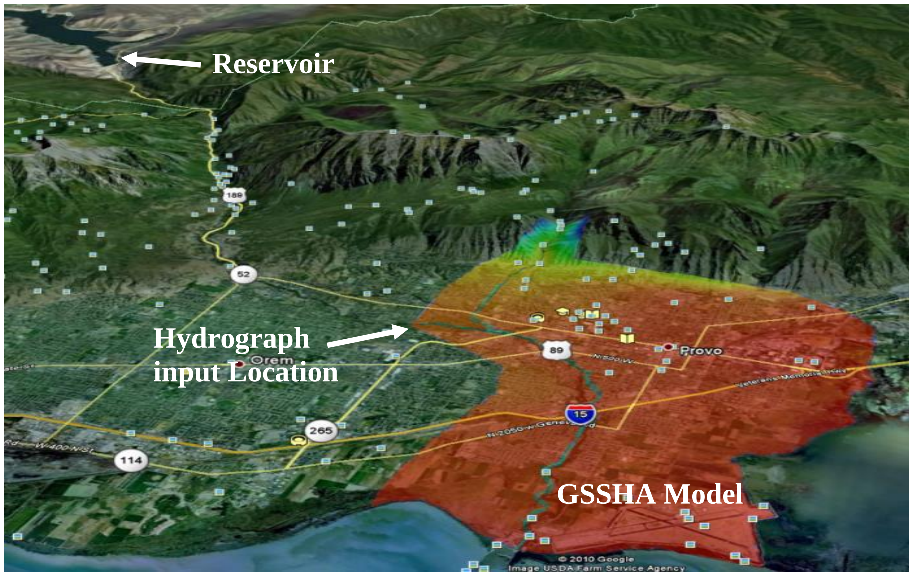
This workshop shows how to define a *hydrograph boundary* and a *variable stage (water surface elevation) boundary* condition using two separate models. Begin with an existing project file, modify the boundary conditions and evaluate the differences.

3 Hydrograph Boundary Condition

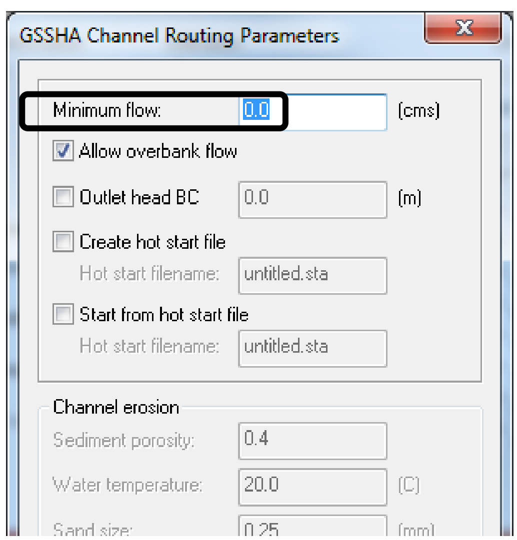
This boundary condition is used if a hydrograph is input from a source upstream of the model, for example using the results from HEC-HMS or some other “regional” model to drive a local model where GSSHA is employed. The hydrograph is defined in GSSHA at a node on a stream arc.

3.1 Open Existing Model

In the model, assume a hypothetical scenario where a reservoir breach occurs upstream the GSSHA model. This breach can be represented by a hydrograph input into the GSSHA model as shown in the following figure. Using the channel overbank option which allows flow from the stream to “spill” onto the overland grid, see how the dam breach hydrograph floods the area surrounding the stream.

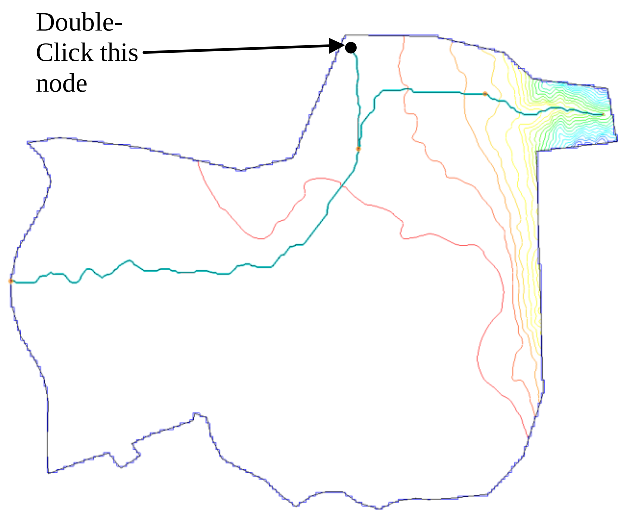


1. Locate the ***GSSHA Distributed Hydrologic modeling*** folder in the files for this tutorial. If needed, download the tutorial files from www.aquaveo.com.
2. Open the WMS project ***\GSSHA Distributed Hydrologic modeling\BoundaryCondition\ProvoBase.prj.*** This model has variable overland flow roughness and variable infiltration processes already defined. A negligible amount of precipitation is defined because GSSHA won't run when not performing a long term simulation if no precipitation is defined.
3. Save the project as ***\GSSHA Distributed Hydrologic modeling\Personal\Boundary\Hydrograph.prj*** so that the original project remains unchanged.
4. Turn off the display of all other coverages except the *GSSHA* coverage.
5. In the GSSHA *Job Control*, select *Diffusive wave* for the *channel routing method* and click the *Edit Parameters* button.
6. Toggle on *Allow overbank flow* option and click OK twice.

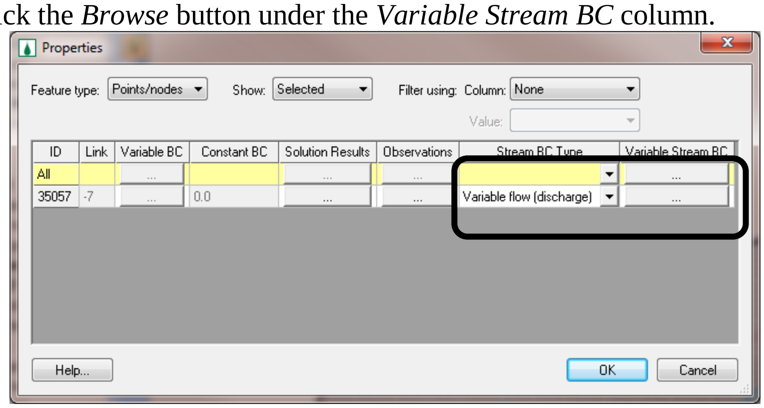


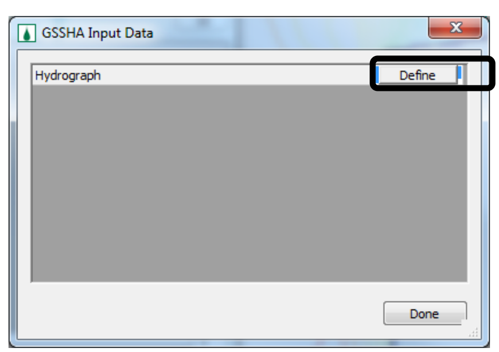
3.2 Defining an Input Hydrograph

1. Turn off the display of *2D Grid Data* by checking it off in the project explorer.
2. In the *Map Module*, click on *GSSHA* coverage and click the *Select Feature Point\Node* tool  and double-click on the stream node furthest upstream on the left branch. See the following figure

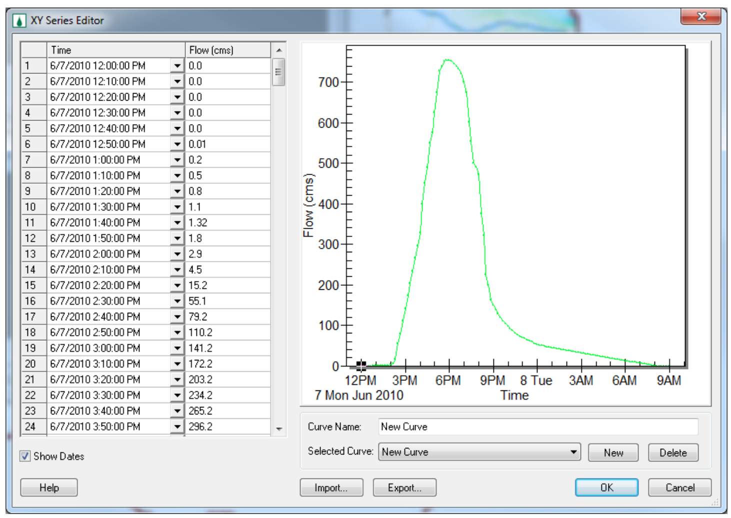


3. This will open the *Properties* dialog. In this dialog, scroll over to the right and change the *Stream BC Type* option to *Variable flow (discharge)*.
4. Click the *Browse* button under the *Variable Stream BC* column.





5. Click the *Define* button. This brings up an XY series editor where the input hydrograph can be defined.
6. Outside of WMS open the file ***\GSSHA Distributed Hydrologic modeling \BoundaryCondition\ hydroinput.txt*** and copy all the data from it.
7. Return to the WMS, XY Series Editor window and paste the hydrograph ordinates. This is a hydrograph that is being input at the node in the channel. This hydrograph represents a hypothetical scenario of the dam failure, but it can come from any source, such as an upstream regional model or an output from dam break simulation, etc.
8. When pasting the data in the XY series editor, the dates are not shown and a time increment of 10 mins is shown. Toggle on *Show dates* at the bottom of XY Series Editor.
9. In the *Reference Time* window, enter *6/7/2010* for data and *12:00:00 PM* for time. This is the time when precipitation begins (as does the GSSHA model).
10. Click *Select.* Now see the time column replaced with date/time, see the following figure.

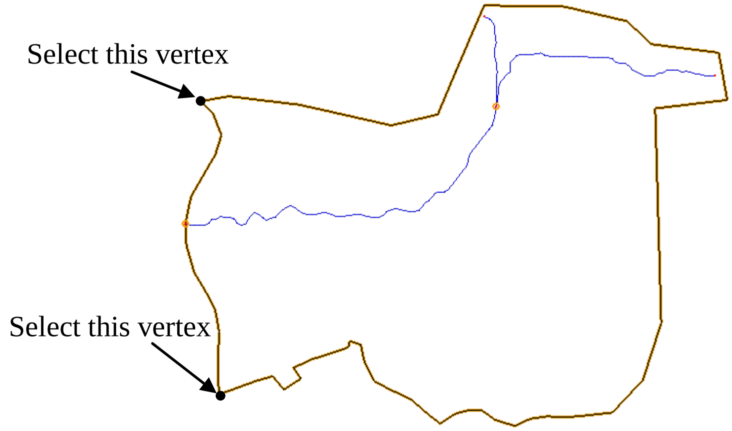


11. Click OK, Done and OK to close all the dialogs.

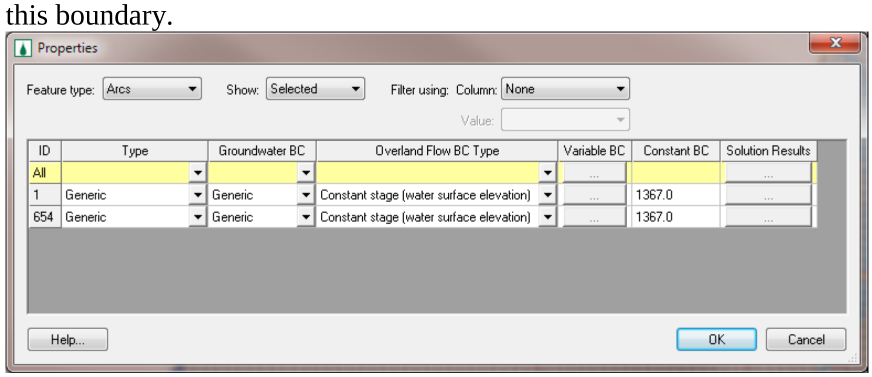
3.3 Changing overland boundary condition

Currently, all of the model boundary is defined as *No Flow Boundary*. But on the western side of the model, there is a lake and any flow that hits this boundary will get into the lake. To simulate this process, change the model boundary condition to a *Constant Stage.*

1. Click on GSSHA coverage to make it active.
2. Click on *Select Feature Vertex* tool .
3. Select a vertex at northwest corner of model, to select it. Then select ***Feature Objects | Vertex↔Node***.
4. Repeat the same process on the vertex at Southwest corner. See the following image.



5. Then click on *Select Feature Arc* tool  hold down shift key in the key board. Then click on both arcs on the western side of the model.
6. Select ***Feature Objects|Attributes***. Under *Overland Flow BC Type* column, select *Constant Stage (water surface elevation)* for both rows.
7. Under *Constant BC* column, enter *1367.0* for both rows which represents the water surface elevation at the lake which is adjacent to this boundary.



8. Click *OK*.

3.4 Save and Run the model

1. Save the project as ***\GSSHA Distributed Hydrologic modeling\ Personal|Boundary\Hydrograph.prj***
2. Click Yes if prompted to overwrite existing project
3. Select ***GSSHA| Run GSSHA***

3.5 Results Visualization

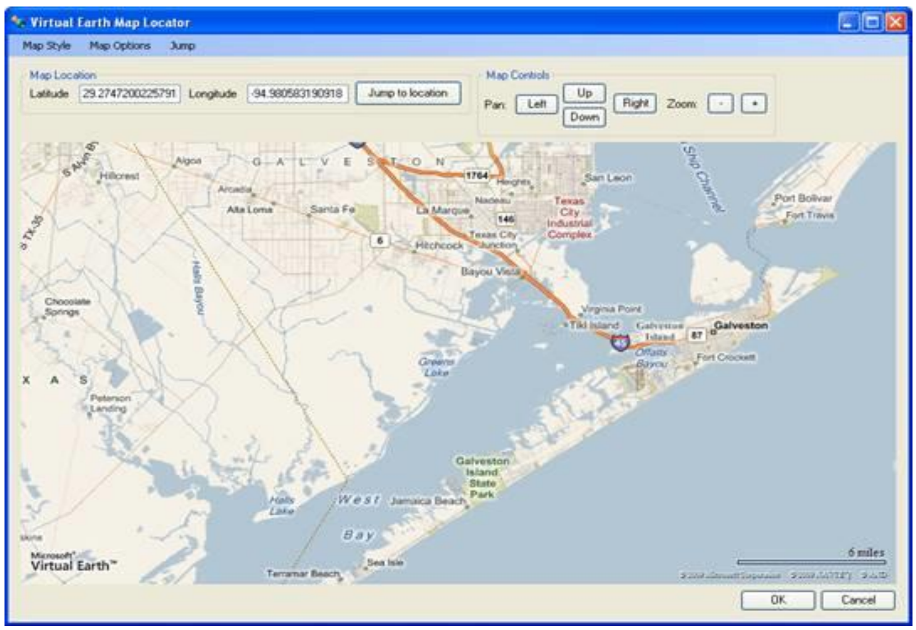
1. Select the overland depth datasets in the project explorer and toggle through the time steps in the properties window.
2. Turn the stream flow bar plots on from the display options and see how the flood wave propagates downstream.
3. Notice as the flood wave proceeds downstream along the stream, it overflows the bank and inundates the flood plain.
4. If desired, export the flood animation into Google Earth.

4 Variable Stage Boundary Condition

This workshop will create a variable stage overland flow boundary condition in a GSSHA model. For the hydrograph boundary condition, an inflow hydrograph was entered at a stream node which let the GSSHA flood the downstream grid cells. In this case put water directly onto the grid cell and let it flow overland on the grid. The condition being simulated here is a coastal tidal surge.

4.1 Open Existing Model

Simulate the effect of the storm surge from hurricane Ike on Galveston Island, Texas. The tidal surge data were obtained from the *NOAA tides and currents* website. Begin with a developed GSSHA model in which the boundary conditions will be updated and run.

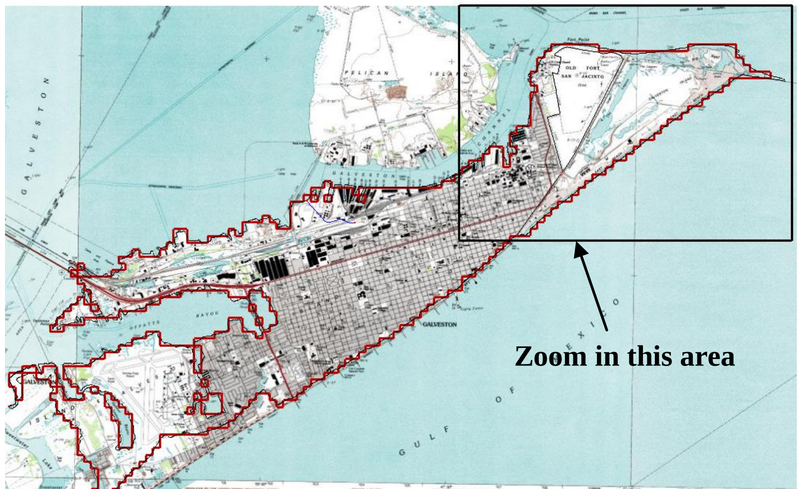


1. Open the GSSHA project ***\GSSHA Distributed Hydrologic modelin \BoundaryCondition\ GalvestonBase.prj.*** This model has variable overland flow roughness defined where as the infiltration is turned off. A precipitation of 10.5 mm\hr is defined for one day. Since simulating a large overland flow, the amount of water that infiltrates is negligible by comparison.
2. The model currently does not have a flow boundary condition.
3. Save the project as ***\GSSHA Distributed Hydrologic modeling\Personal \Boundary\Overland.prj*** so that the original project remains unchanged.
4. Turn off the display of all the coverages except the *GSSHA* coverage.

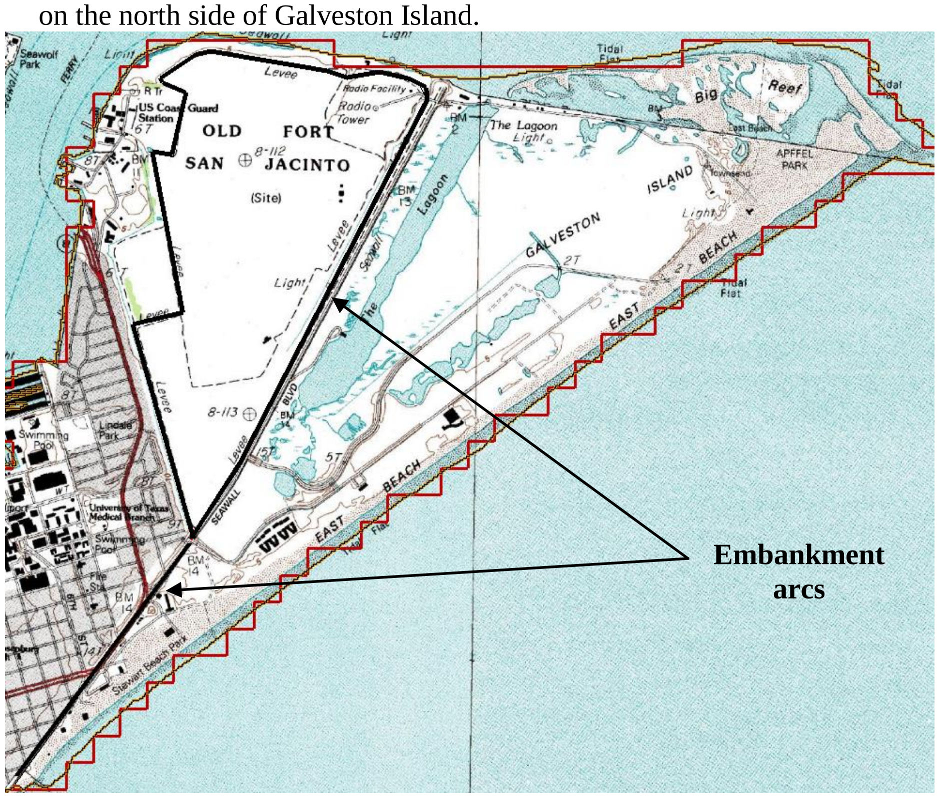
4.2 Creating an Embankment

1. Open the topographic map for Galveston located at ***\GSSHA Distributed Hydrologic modeling\BoundaryCondition\Galvestontopo.jpg.***

2. Zoom into the area as shown in the following figure:

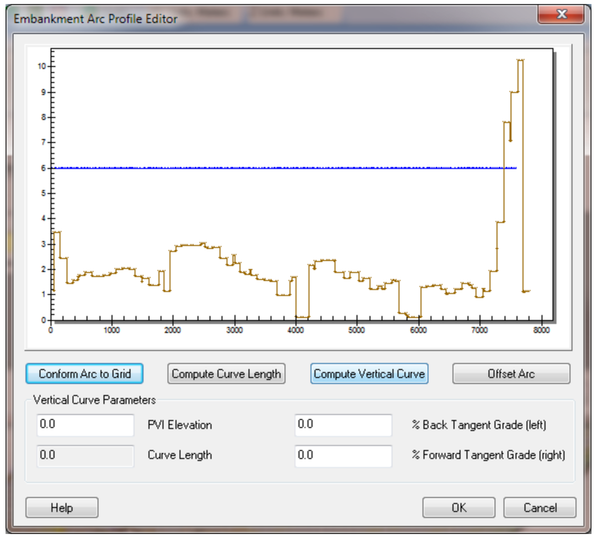


3. Switch to the *Map Module* and click on *Create Feature Arc* tool .
4. With the background image and the following picture as a reference, create an embankment arc for the levee surrounding Old Fort San Jacinto located on the north side of Galveston Island.



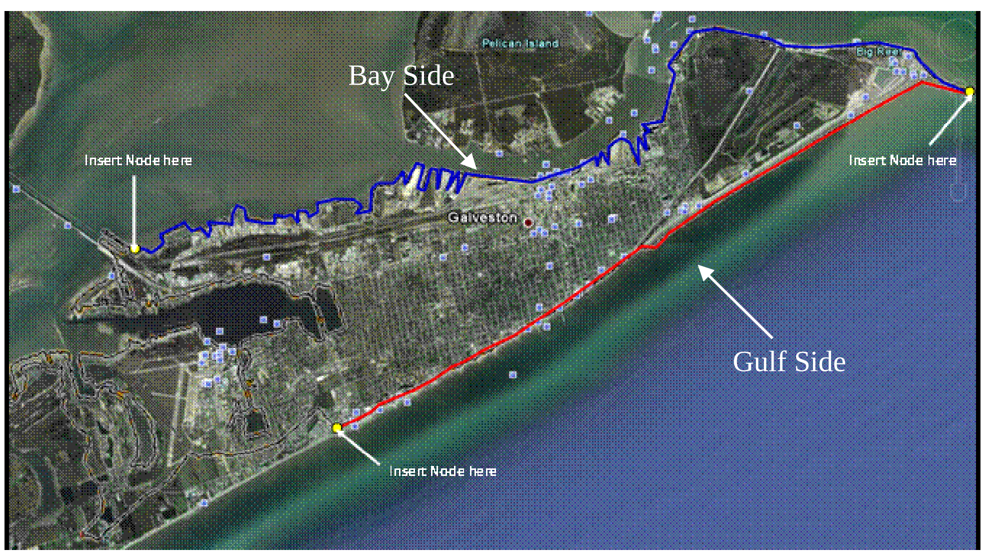
5. Note in the background map that there is a dotted line that represents a Levee. Just trace the embankment arc along that line to form a polygon around the protected area.
6. Make sure to not intersect the embankment arc with the watershed boundary.
7. The second embankment line that runs to lower left corner (representing a sea wall) should not intersect the embankment arc on the top.

8. For each of the embankment arcs double-click to change the type to *Embankment* and click on the *Browse* button under *Embankment*.
9. In the *Embankment Arc Profile Editor* dialog, enter 6 for *PVI elevation* and click *Compute Vertical Curve*. This will set embankment height to 6 meters. Do this for both arcs.



4.3 Creating Boundary Arcs

The boundary arcs are used to define the variable surge boundary condition that flows directly into the cells overlapping the arc. In this model, use the watershed boundary arc, so the arcs are already there but currently the arc representing the boundary is a single arc. Break the arc so that the variable head can be defined only on those locations where the storm surge occurred. Break an arc by inserting a node at the desired location.

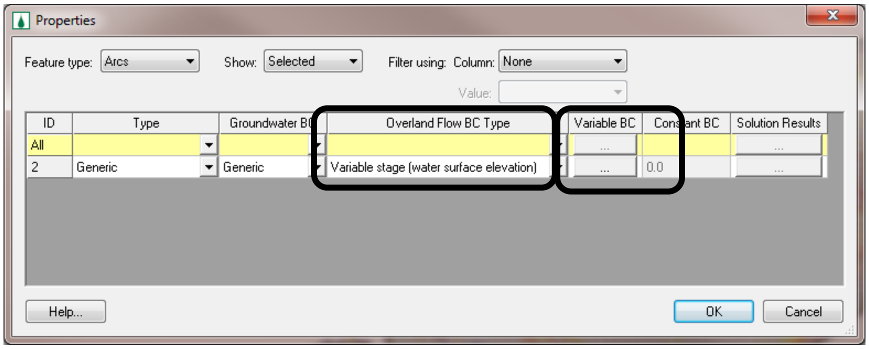


1. Create a node at the start point and end point of the Gulf Boundary arc as shown in above figure.
2. Similarly, insert a node in the start point and end point of the Bay Boundary arc as shown in the above figure. Include a node in the middle where the watershed outlet is located.

NOTE: it's not necessary to draw an arc, the arcs are already there. The arcs are shown in the above figure to show which arcs are used to define the boundary condition.

4.4 Entering Variable stage data

1. Select the arc(s) on the *Gulf Side* and set the arc attributes to *variable stage (water surface elevation)* under the Flow BC type field.



2. Click on the *Browse* button under the *Variable Stage BC* column and enter the Galveston Pleasure Pier storm surge time series into the XY series editor. The time series can be found in ***\GSSHA Distributed Hydrologic modeling\Boundary\PleasurePier.txt***. Rename the time series to *Pleasure Pier*.
3. Similarly, select the arc(s) on the *Bay Side* and set the arc attributes to *variable stage (water surface elevation)* and enter the Galveston Pier 21 storm surge time series into the XY series data editor. Get the time series data from ***\GSSHA Distributed Hydrologic modeling\Boundary\Pier21.txt***. Rename the time series to *Pier 21*.

4.5 Save and Run the model

1. Save the project as ***\GSSHA Distributed Hydrologic modeling\Personal\Boundary\Overland.prj***
2. Click Yes if prompted to overwrite existing project
3. Select ***GSSHA| Run GSSHA***

4.6 Result Visualization

1. Select the overland depth datasets in the data tree and toggle through the time steps in the properties window.

2. Export the flooding animation to Google Earth.