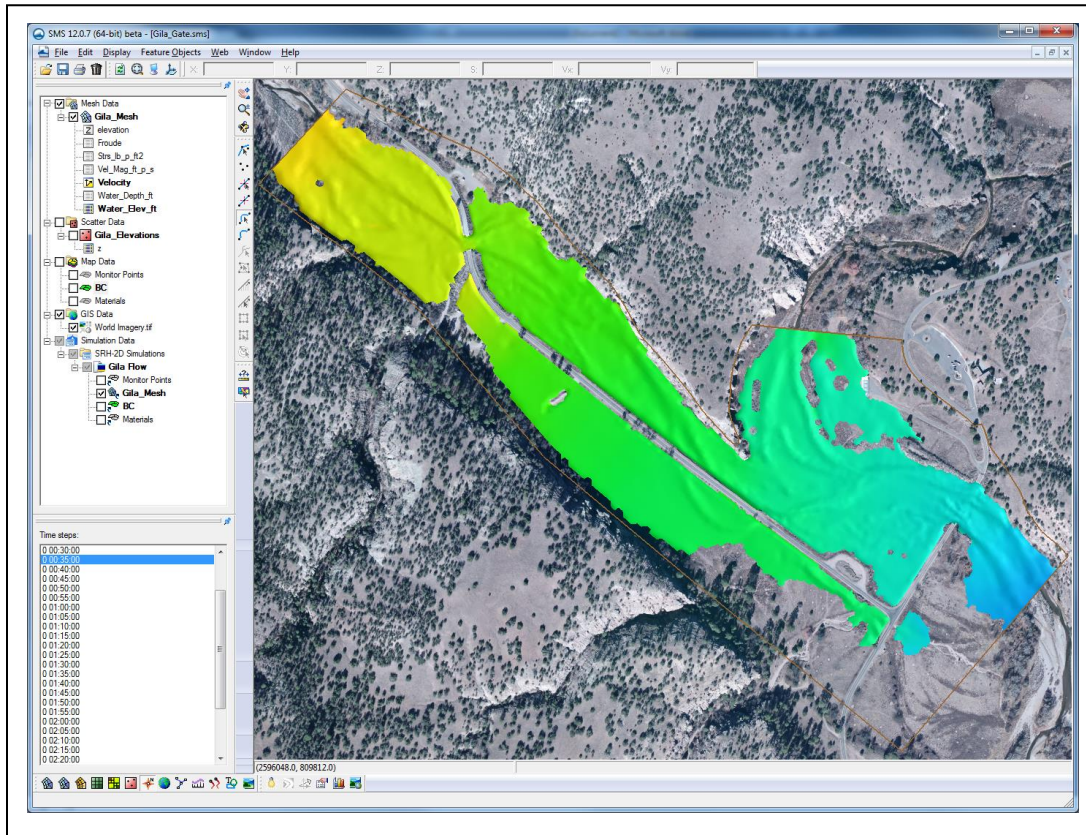*SRH-2D Tutorial*
Gates

Objectives

This tutorial demonstrates the process of modeling gates in SRH-2D. The "SRH-2D" tutorial should have been completed before attempting this one. All files for this tutorial are found in the "Data" folder within the "SMS_ SRH-2D_Gate" folder.

Prerequisites

- SRH-2D

Requirements

- SRH-2D
- Mesh Module
- Scatter Module
- Map Module

Time

- 15–20 minutes

1   Model Overview

An existing SRH-2D model will be used to facilitate the setup for this tutorial. The area being modeled is located at the confluence of the west and middle forks of the Gila River, located in New Mexico.

In this model simulation, excess flow passes through an overflow weir and into a relief basin. The water is then released further downstream through a vertical gate. This tutorial will demonstrate the creation of a gate boundary condition within SMS to simulate flow through a gate using SRH-2D.

The process of creating a simple model then duplicating the simulation, and adding structures or other model features to the duplicated simulation will be used in this tutorial. This can be a useful way of comparing changes in a model.

2   Getting Started

To begin, open an existing SRH-2D model:

1. Open a new instance of SMS, or press *Ctrl-N* to reset it.

2. Select *File* | **Open…** to bring up the *Open* dialog.

3. Navigate to the *SMS_SRH-2D_Gate/Input* folder for this project and select "Gila_Flow.sms".

4. Click **Open** to import the project file and close the *Open* dialog. The Graphics Window will appear as in Figure 1.
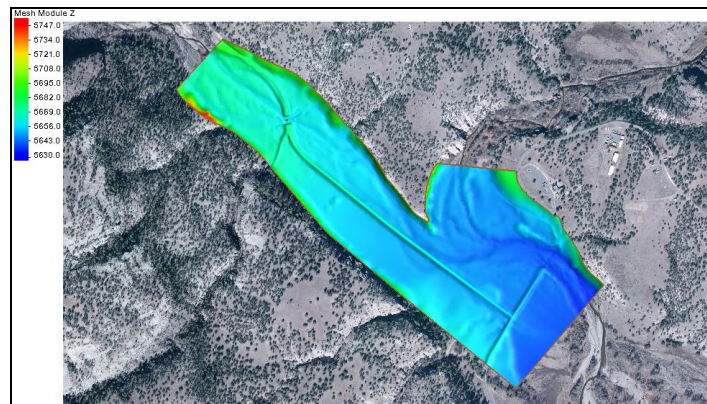

Figure 1   Gila_Flow.sms project

3   Creating the Gate Structure

Gate structures are defined by creating a pair of arcs in the boundary condition coverage, one on the upstream face and one on the downstream face of the gate structure. The arcs are then defined as gate arcs in SMS, and attributes of the gate are specified.

3.1   Creating the Gate Structure Arcs

The first step is to create two arcs within the boundary condition coverage that represent the gate structure faces. The gate in this exercise is located near the intersection of the two roads as displayed in Figure 2.
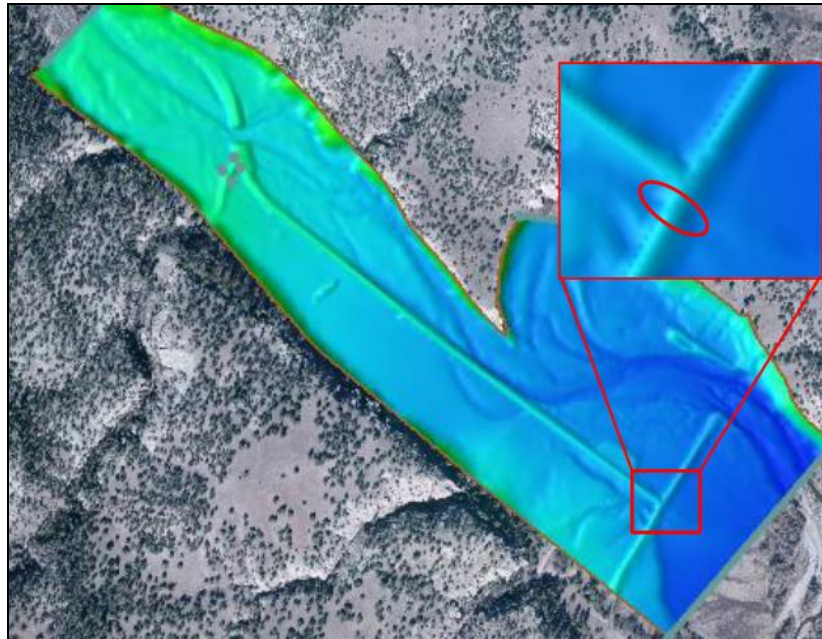

Figure 2   Zoomed in on the gate location

1. **Zoom** into the gate location shown in the Figure 2 inset image.

2. Select *Display* | **Display Options…** to open the *Display Options* dialog.

3. Select "2D Mesh" from the list on the left.

4. In the *2D Mesh* tab, check the box next to *Elements*.

5. Select **OK** to exit the *Display Options* dialog.

6. In the Project Explorer, check the box next to the " BC" coverage and select it to make it the active coverage.

7. Using the **Create Feature Arc** tool, create two arcs, one on each side of the road (Figure 3). These arcs will define the upstream and downstream faces of the gate structure.

In most cases, both a gate structure and a culvert would be included in a scenario such as this. For simplification purposes, this tutorial uses only a 1D gate with flow computed which implies the existence of a culvert sufficiently large as to not impede flow under the road.

It is recommended that the mesh be created to contain quadrilateral elements within the area between the two arcs which represent the gate structure and that the structure arcs are aligned with a clean row of element edges.

Note: When drawing these arcs, they should be drawn in the same direction. After the first arc has been drawn, ensure that the second arc is drawn in the same direction (north to south or south to north). Drawing them in opposing directions may cause an error when running SRH-2D.
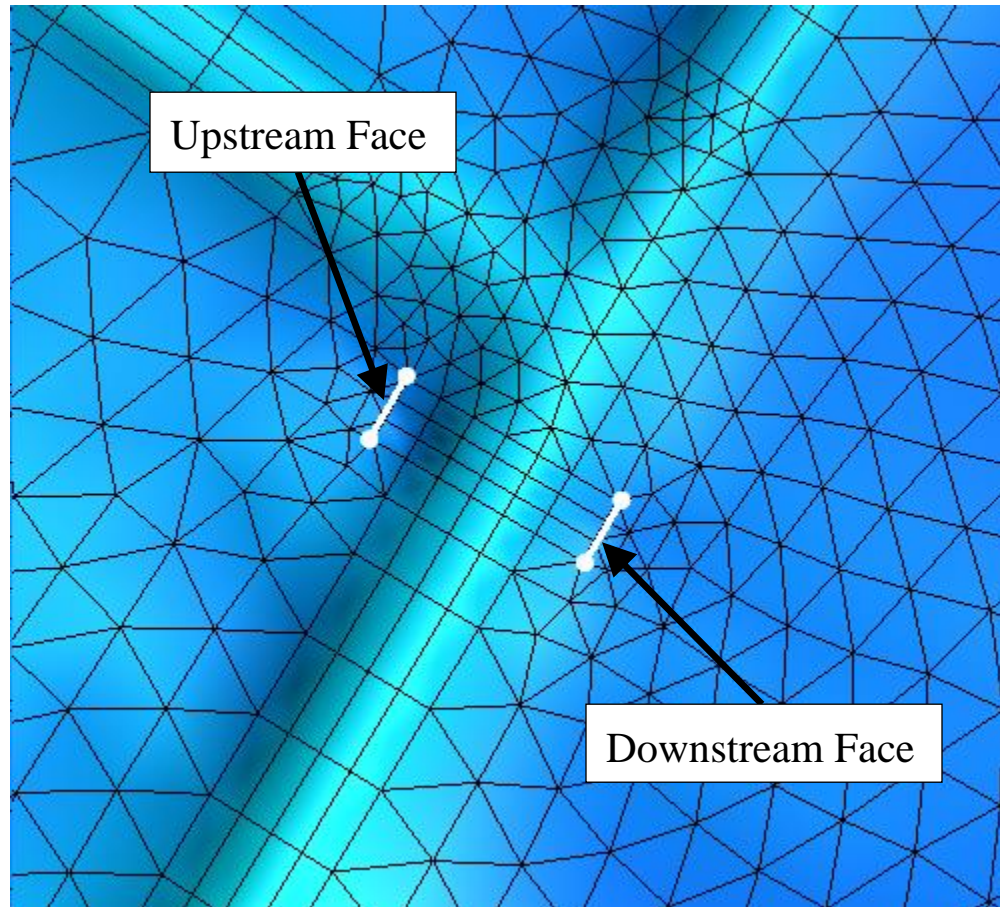

Figure 3   Upstream and downstream gate structure arcs

3.2   Assigning the Gate Structure Attributes

The next step in creating a gate structure is to specify the arc type and define the attributes of the gate. Within SRH-2D, 1D gates simulate the flow of an underflow gate such as a vertical lift gate or radial gate. These types of gates behave as an orifice when the water surface is above the top of the gate opening and as a weir when the water surface is below the top of the gate opening.

If the gate to be modeled is an overflow gate, such as a flap gate, sector gate, or roller gate, these can simply be modeled as a weir structure in SRH-2D. The gate in this tutorial will be defined as a vertical underflow gate.

To do this, do the following:

1. Using the **Select Feature Arc** tool, select the upstream (leftmost) arc and take note of the ID for this arc (displayed at the bottom of the Graphics Window).

2. Hold the *Shift* key and select the downstream arc so that both of the arcs are selected.

3. Right-click on either arc and select **Assign Linear BC...** to bring up the *SRH-2D Linear BC* dialog.

4. Select "Gate" from the *Type* drop-down menu.

Note the *Role* assignment of "gate upstream" and "gate downstream" to the two arcs, associated with the *Object ID* values. If the *Object ID* displayed for gate upstream is not the same as noted above in step 1, switch the associations using the drop-down in the *Role* column.

5. Select "ft" from the *Units* drop-down.

6. Scroll down and enter "5647" in the *Crest Elevation* field. This represents the elevation of the base upon which the gate closes, or channel bottom.

7. Enter "3" in the *Height of Gate Opening* (H_g). This represents the opening measured vertically from the base of the structure to the top of the gate opening as shown in Figure 4.

8. Enter "5" for *Width of Gate Opening*. This represents the horizontal width of the gate opening.

9. Enter "0.61" for *Contract Coefficient with Underflow Orifice*. This is used to calculate the discharge coefficient, which is then used to determine the flow under the gate.

10. Select "Gravel" from the *Type* drop-down.

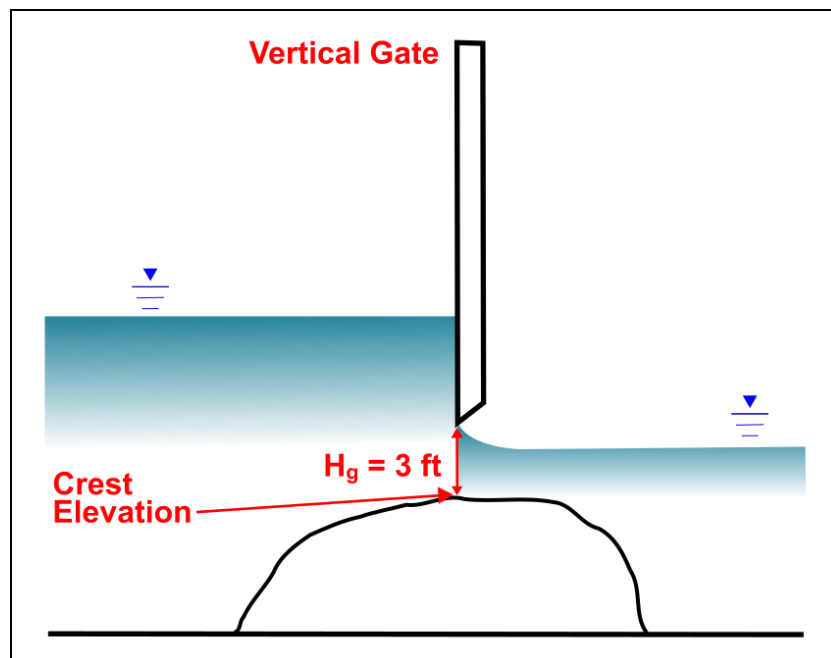11. Select **OK** to exit the *SRH-2D Linear BC* dialog.

Figure 4   Height of gate opening

4   Saving and Running the Simulation

Now that the gate structure has been created and defined, set up the simulation by doing the following:

1. Right-click on the "📄 Gila Flow" simulation in the Project Explorer and choose **Model Control…** to bring up the *Model Control* dialog.

2. Enter "Gate_Flow" as the *Case Name*.

3. Click **OK** to accept all other default settings and close the *Model Control* dialog.

To save the project, do the following:

4. Select *File | Save as…* to bring up the *Save As* dialog.

5. Enter "Gila_Gate.sms" in the *File name* field

6. Select "Project Files (*.sms)" from the *Save as type* drop-down.

7. Click on **Save** to save the project and close the *Save As* dialog.

4.1   Running the Simulation

Now to run the simulation:

1. Right-click on the "📄 Gila Flow" simulation and choose **Save, Export, and Launch SRH-2D**.

2. Click **OK** if a warning is displayed stating that the "Materials" coverage will be renumbered before exporting. This brings up the *SRH-2D: Gila Flow* model wrapper (Figure 5) and the SRH-2D run window (Figure 6).
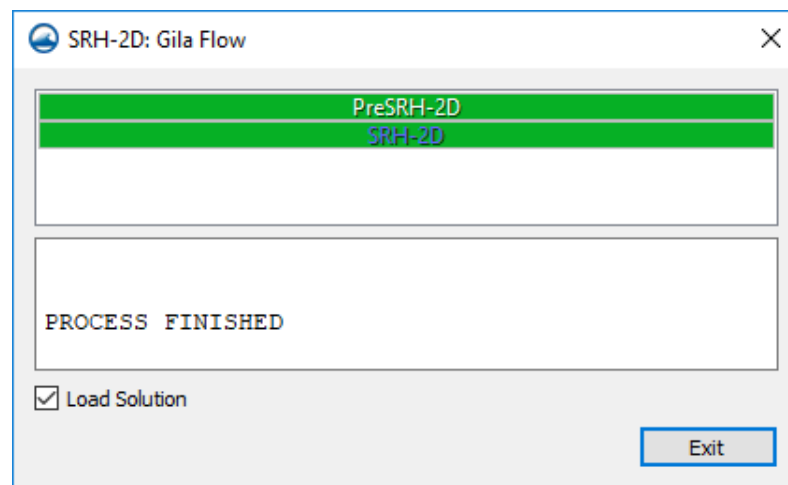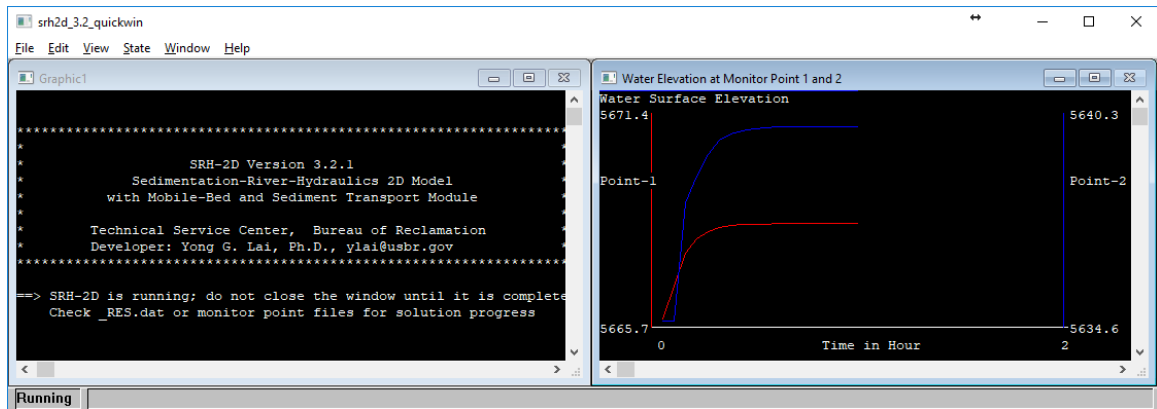

Figure 5   SMS Model Wrapper

Figure 6   SRH-2D run window showing SRH-2D run status

Once SRH-2D is finished running, a small dialog will appear stating "Program terminated with exit code 0 Exit Window?"

3. Click **Yes** to close the SRH-2D run window and return to the *SRH-2D: Gila Flow* dialog.

4. Check the box next to *Load Solution* (Figure 5) and click **Exit** to close the *SRH-2D: Gila Flow* dialog.

The solution datasets will now be listed in the Project Explorer under " Gila_Mesh".

5. **Frame**   the project.

6. Uncheck the box next to the " BC" coverage in the Project Explorer.

7. Select *Display* | **Display Options…** to bring up the *Display Options* dialog.

8. Select "2D Mesh" from the list on the left.

9. Uncheck the box next to *Elements*.

10. Check the box next to *Vectors* to turn on the display of velocity vectors.

11. Click **OK** to close the *Display Options* dialog.

5   Analyzing the Results

The results will now be viewed.

1. Select the " Water_Elev_ft" mesh dataset to make it active.

2. Select the first timestep, "00:00:02", and toggle through the rest of the time steps.

Notice that the water spills over the weir and into the relief basin. It runs through the relief basin and eventually reaches the gate, where it passes water downstream.

3. Outside of SMS, go to the file location where the SRH-2D output files are stored (*SMS_SRH-2D_Gate/Input/Gila_Gate/SRH-2D/Gila Flow*).

4. Open the "Gate_Flow_GATE1.dat" file in a text editor. This is the output summary file for the gate structure.

5. Review the data that was saved to this file, including the discharge through the gate, upstream and downstream water surface elevations, and the crest height.

Notice that, for the first several lines, zero discharge was computed as the water had not yet arrived at the gate. Also notice that, for the last few time intervals, the discharges and upstream water surface elevations are slowly rising. This indicates that the relief basin inflows are greater than the outflows, and that storage is still increasing. This simulation could be run for a longer period of time to determine if the flows would eventually equilibrate, or whether the basin would spill over at some other location before equilibrium is achieved.

6   Conclusion

This concludes the "SRH-2D – Gates"[1] tutorial. If desired, further analysis could be performed to evaluate other aspects of the model. Continue to experiment with the SMS interface or save the project and close the program.

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[1] This tutorial was developed by Aquaveo, LLC under contract with the Federal Highway Administration.