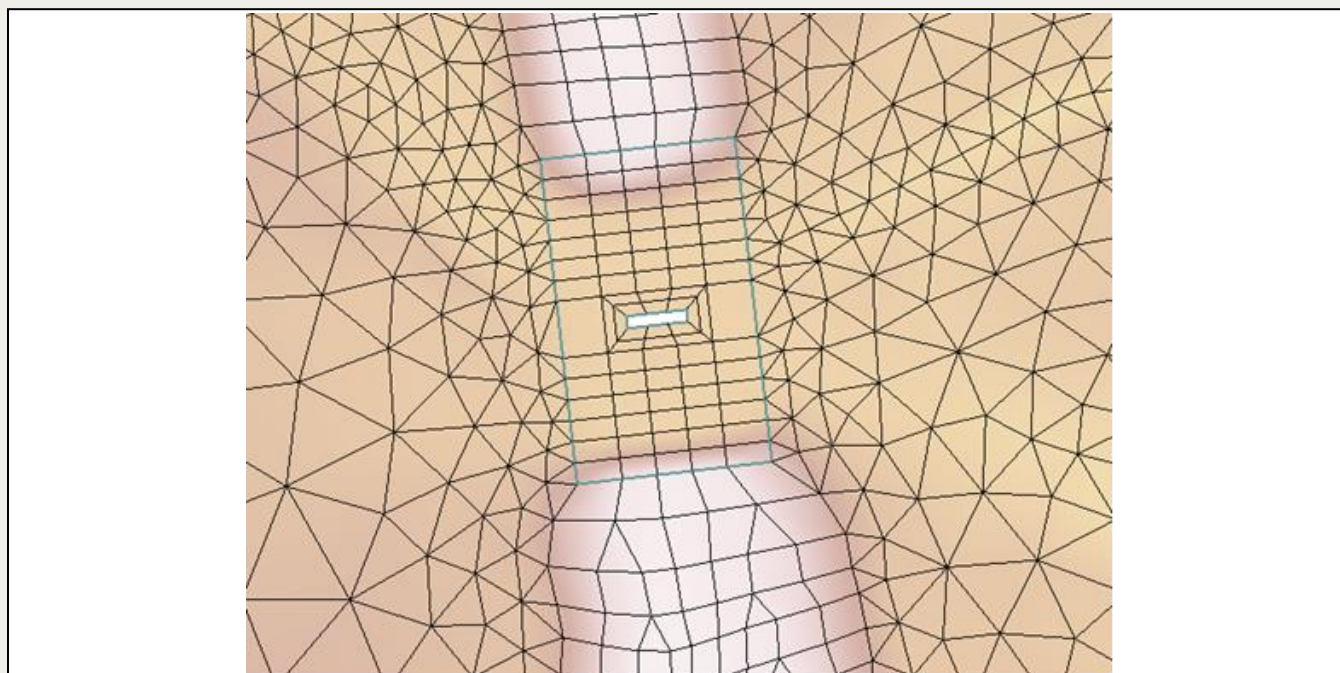




## SMS 13.3 Tutorial

### **Bridge Scour**

Use the Bridge Scour Tool



### Objectives

This tutorial demonstrates how to prepare to use the bridge scour tool by setting up a bridge scour coverage.

#### Prerequisite Tutorials

- Overview
- Map Module
- SRH-2D

#### Required Components

- SMS Core

#### Time

- 15–25 minutes

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## 1 Introduction

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This tutorial demonstrates creating a bridge scour coverage to use for exporting bridge scour values to the Hydraulic Toolbox to use in analyzing a bridge site. Bridge scour arcs will be created in a specific order. The coverage properties will then be defined. Computations will be completed, and the final scour values will be exported to the Hydraulic Toolbox. While some explanation is provided about various options and settings, please see the *SMS User Manual* for detailed explanations.

The data used in this tutorial is from the Gila River in the state of New Mexico in the United States. The projection for the project has been preset.

## 2 Getting Started

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Start by importing a project file containing the data for this simulation:

1. Launch the SMS application.
2. Select *File* | **Open...** to bring up the *Open* dialog.
3. Select "Project Files (\*.sms)" from the *Files of type* drop-down.
4. Browse to the *data files* folder for this tutorial and select "GilaRiver.sms".
5. Click **Open** to import the project and exit the *Open* dialog.

The project should appear similar to Figure 1. The contoured area near the center is the location of the pre-generated mesh.

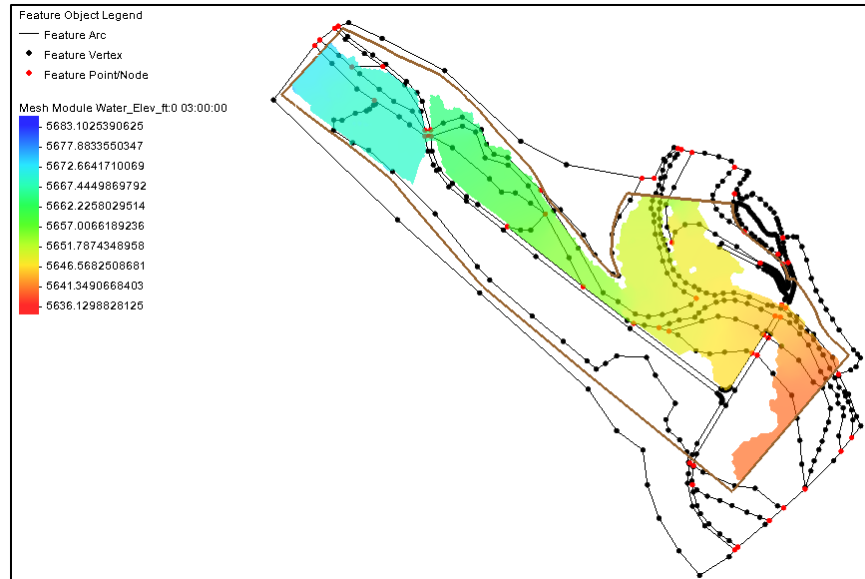


Figure 1 Initial project

### 3 Creating the Bridge Scour Coverage

A bridge scour coverage can be created by either duplicating an existing coverage or by creating a new coverage. This example will start with a new coverage. Create a new bridge scour coverage by doing the following:

1. Right-click "Map Data" and select **New Coverage** to bring up the *New Coverage* dialog.
2. Select *Generic | Bridge Scour* in the *Coverage Type* section.
3. Click **OK** to close the *New Coverage* dialog.
4. If a welcome dialog appears, click **OK** to close the welcome dialog and bring up the *Bridge Scour Coverage Properties* dialog.
5. Click **OK** to accept the defaults and exit the *Bridge Scour Coverage Properties* dialog.

The various parameters in the *Bridge Scour Coverage Properties* dialog will be discussed later in the tutorial.

### 4 Creating the Bridge Scour Arcs

There are six types of bridge scour arcs: contracted section, approach section, centerline, bank, abutment toe, and pier. These arcs should be defined in that order to take advantage of the automatic type assignment done by the bridge scour coverage. The arc type can be changed manually, if needed, in the *Bridge Scour Arc Attributes* dialog.

In order to facilitate quick completion of this tutorial, the Annotations module has been used to create a number of different arcs that can be used as templates for the bridge scour arcs. Simply follow along them when creating each arc in order to create the arcs in the correct locations (Figure 2).

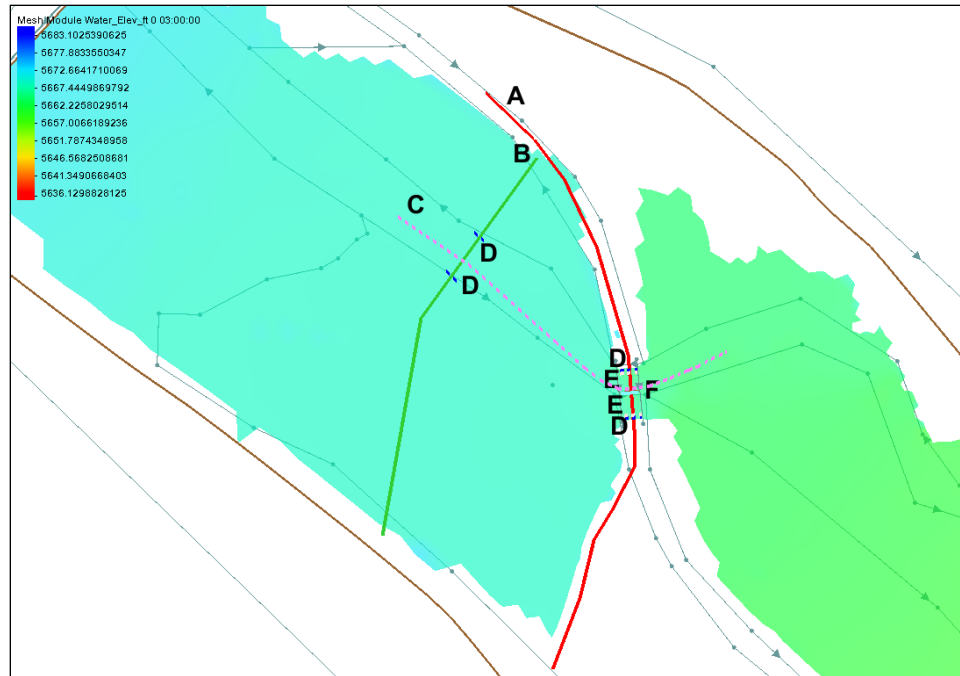


Figure 2 Bridge scour arcs labeled

There are six types of bridge scour arcs shown in Figure 2:



- **A** – Contracted section
- **B** – Approach
- **C** – Centerline
- **D** – Bank (there are four in this case)
- **E** – Abutment toe (there are two in this case)
- **F** – Pier




The creation of each of these arcs will be demonstrated below.

#### 4.1 Contracted Section Arc

The contracted section arc is created at the maximum contraction of flow through the bridge constriction within the bridge limits. The maximum contraction may occur downstream of the bridge. It begins on the left side of the stream (looking downstream), where the projected edge of the stream intersects with the roadway. It travels along the roadway until it reaches the same intersection on the right side. When viewing the feature attributes of this arc, it will provide the stations of the bank arcs and abutment arcs, if they are defined.

The contracted section arc must be created in the correct direction: from the left side of the river to the right side, as if looking downstream. The contracted section arc is created at the maximum contraction of flow through the bridge constriction within the bridge limits.

1. Turn on “ Annotation Data” in the Project Explorer.
2. Select “ Bridge Scour” to make it active.

3. **Zoom**  in to the area near the bridge, as shown in Figure 2.
4. Starting on the left side of the river (at the end with the “A” at the top of the screen in Figure 2) and using the Annotations arc as a template, use the **Create Feature Arc**  tool to create the contracted section arc as shown in Figure 2. Double-click to end the arc.
5. Turn off “ Annotation Data” in the Project Explorer.

When the arc is completed, it should appear similar to the one in Figure 3. Ignore the pier near the center of the arc. There is a hole in the mesh at that location since water cannot flow there.

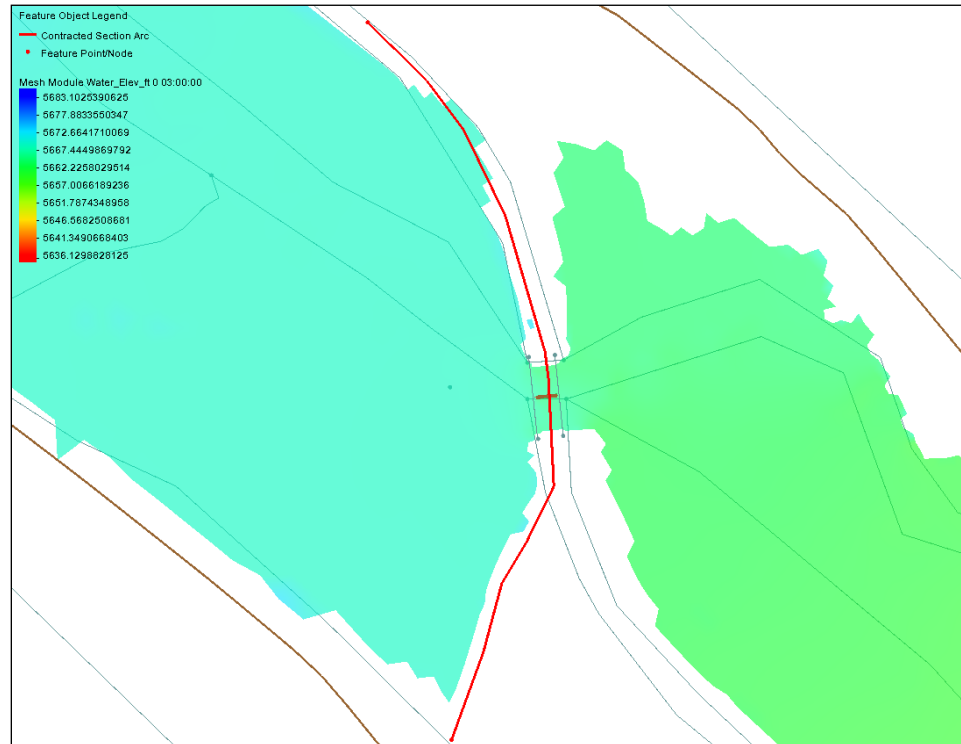




Figure 3 Contracted section arc

This can be verified by doing the following:



6. Using the **Select Feature Arc**  tool, double-click on the contracted section arc to bring up the *Bridge Scour Arc Attributes* dialog.
7. In the *Arc Type Options* section, verify that “Contracted Section Arc” is selected in the *Type* drop-down.
8. In the *Gradation Options* section, click **Define Soil Gradation...** to bring up the *Bridge Scour Soil Gradation* dialog.
9. Enter “5” as the *Number of Points*.
10. Enter the values from the *Sediment Particle Diameter* column below into the same column in the *Bridge Scour Soil Gradation* dialog:

	Sediment Particle Diameter (ft)	Percent Passing (0.0–1.0)
1	0.000771	0.05
2	0.00327	0.16
3	0.0393	0.5
4	0.258	0.84
5	0.360	0.95


11. Click **OK** to close the *Bridge Scour Gradation* dialog.
12. Click **Close** to exit the *Bridge Scour Arc Attributes* dialog.
13. Click anywhere other than on the contracted section arc to deselect it.
14. Turn on  "Annotation Data" in the Project Explorer.

## 4.2 Approach Arc

As with the contracted section arc, the approach arc must be created from the left side of the river to the right side as if looking downstream.

1. Using the **Create Feature Arc**  tool, create the approach arc (labelled "B" in Figure 2) from left to right as if looking downstream. Use the Annotations arc as a guide.
2. Using the **Select Feature Arc**  tool, double-click on the approach arc to bring up the *Bridge Scour Arc Attributes* dialog.
3. In the *Arc Type Options* section, verify that "Approach Arc" is selected in the *Type* drop-down.
4. In the *Gradation Options* section, click **Define Soil Gradation...** to bring up the *Bridge Scour Soil Gradation* dialog.
5. Enter "5" as the *Number of Points*.
6. Enter the values from the *Sediment Particle Diameter* column below into the same column in the *Bridge Scour Soil Gradation* dialog:

	Sediment Particle Diameter (ft)	Percent Passing (0.0–1.0)
1	0.000771	0.05
2	0.00327	0.16
3	0.0393	0.5
4	0.258	0.84
5	0.360	0.95

7. Click **OK** to close the *Bridge Scour Gradation* dialog.
8. Click **Close** to exit the *Bridge Scour Arc Attributes* dialog.
9. Click anywhere other than on the approach arc to deselect it.
10. Turn off  "Annotation Data" in the Project Explorer.

The project should appear similar to Figure 4. The approach arc is the arc on the left.

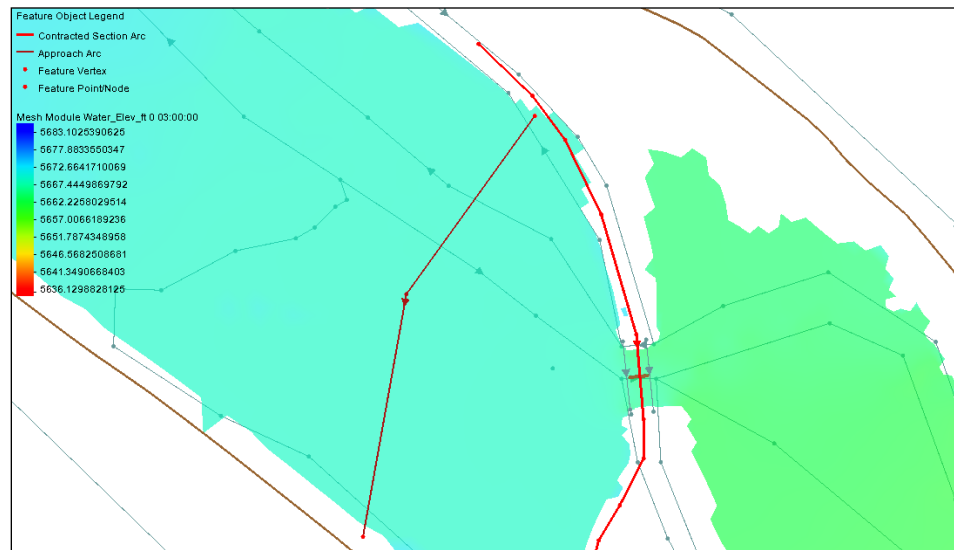


Figure 4 Approach arc is on the left

11. Turn on "Annotation Data" in the Project Explorer.

### 4.3 Centerline Arc

The centerline arc must be created from upstream downstream. Do this by:

1. Using the **Create Feature Arc** tool, create the centerline arc (labelled "C" in Figure 2) from left to right (upstream to downstream). Use the Annotations arc as a guide.
2. Using the **Select Feature Arc** tool, double-click on the centerline arc to bring up the *Bridge Scour Arc Attributes* dialog.
3. In the *Arc Type Options* section, verify that "Centerline Arc" is selected in the *Type* drop-down.
4. Click **Close** to exit the *Bridge Scour Arc Attributes* dialog.
5. Click anywhere other than on the centerline arc to deselect it.
6. Turn off "Annotation Data" in the Project Explorer.

The project should appear similar to Figure 5. The centerline arc is the dashed arc going diagonally, then mostly horizontally, to the right.

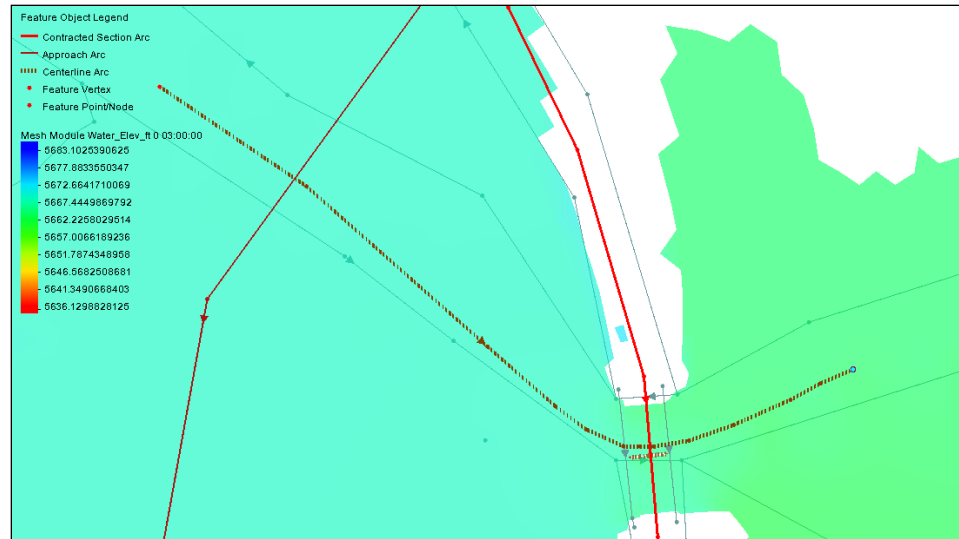


Figure 5 Centerline arc (dashed) crossing the approach and contracted section arcs

7. Turn on "Annotation Data" in the Project Explorer.

#### 4.4 Bank Arcs

Four bank arcs will be created by doing the following:

1. Using the **Create Feature Arc** tool, create the first bank arc (lower arc labelled "D" crossing the approach arc in Figure 2). Use the Annotations arc as a guide. The arc direction is not important.
2. Repeat step 1 for each of the other three bank arcs (labelled "D" in Figure 2). Use the Annotations arc as a guide.
3. Using the **Select Feature Arc** tool, double-click on one of the bank arcs to bring up the *Bridge Scour Arc Attributes* dialog.
4. In the *Arc Type Options* section, verify that "Bank Arcs" is selected in the *Type* drop-down.
5. Click **Close** to exit the *Bridge Scour Arc Attributes* dialog.
6. Repeat steps 3–5 for each of the other three bank arcs.
7. Turn off "Annotation Data" in the Project Explorer.

The project should appear similar to Figure 6. Two bank arcs should be crossing the approach arc and two more should be crossing the contracted section arc near the edges of the bridge.



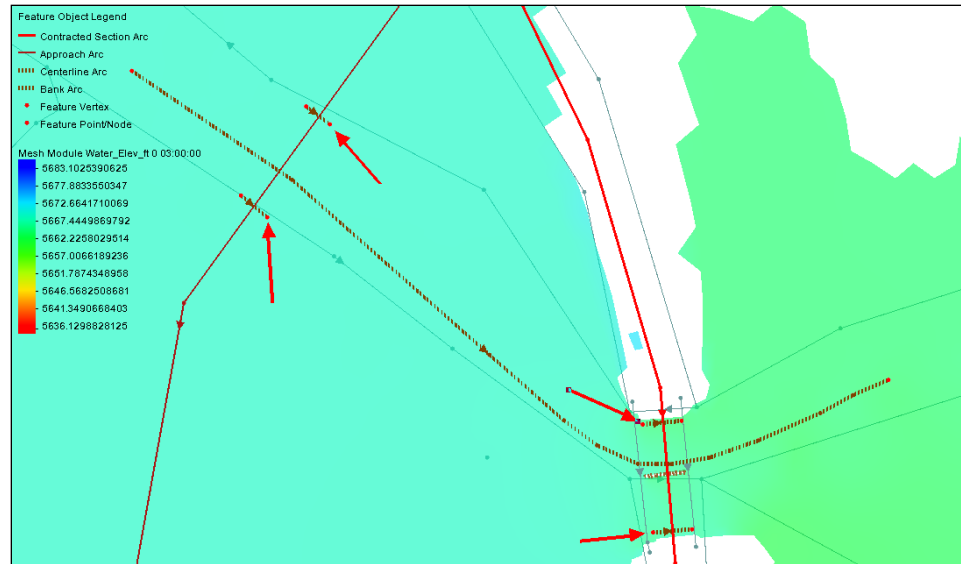





Figure 6 Four bank arcs (indicated with arrows)

8. Turn on "Annotation Data" in the Project Explorer.

## 4.5 Abutment Toe Arcs

Two abutment toe arcs should be created by doing the following:

1. **Zoom**  in to the bridge area (Figure 7).
2. Using the **Create Feature Arc**  tool, create the top abutment toe arc (upper arc labelled "E" in Figure 2). Use the Annotations arc as a guide. The arc direction is not important.
3. Repeat step 2 to create the lower abutment toe arc, using the Annotations arc as a guide.
4. Using the **Select Feature Arc**  tool, double-click on the upper abutment toe arc to bring up the *Bridge Scour Arc Attributes* dialog.
5. In the *Arc Type Options* section, verify that "Abutment Toe Arcs" is selected in the *Type* drop-down.
6. Click **Close** to exit the *Bridge Scour Arc Attributes* dialog.
7. Repeat steps 4–6 for the lower abutment toe arc.
8. Turn off "Annotation Data" in the Project Explorer.

The project should appear similar to Figure 7. Two abutment toe arcs should be crossing the contracted section arc near the bank arcs at the bridge.

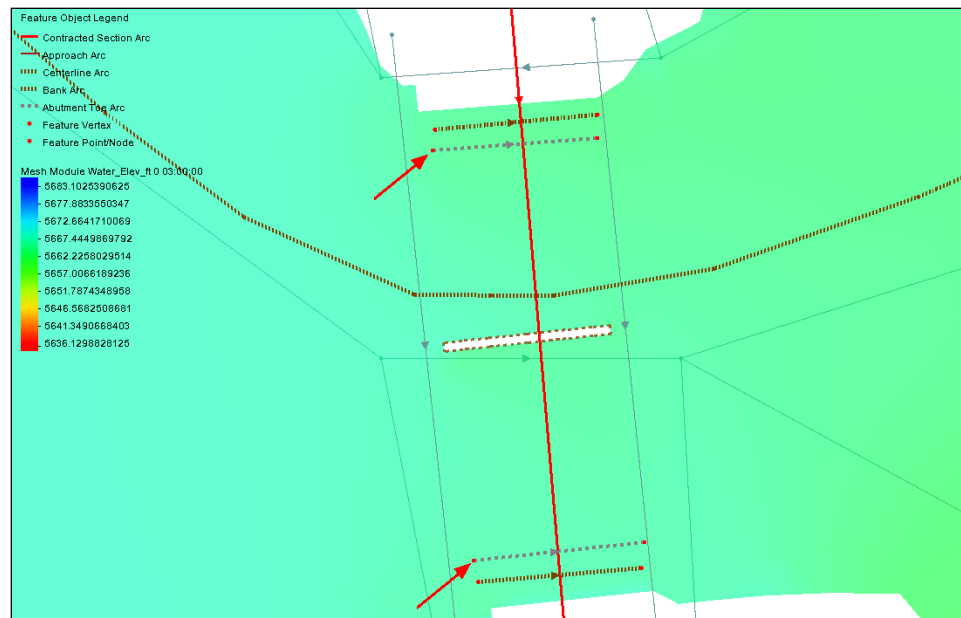


Figure 7 Two abutment toe arcs (indicated by arrows)

9. Turn on "Annotation Data" in the Project Explorer.

## 4.6 Pier Arcs

The final arc to be created is the pier arc (in this tutorial, there is only one) by doing the following:

1. Using the **Create Feature Arc** tool, create the pier arc ("F" in Figure 2). Use the Annotations arc as a guide. The arc direction is not important.
2. Using the **Select Feature Arc** tool, double-click on the pier arc to bring up the *Bridge Scour Arc Attributes* dialog.
3. In the *Arc Type Options* section, verify that "Pier Arcs" is selected in the *Type* drop-down.
4. In the *Pier Options* section, enter "1.5" as the *Pier width*.
5. Click **Close** to exit the *Bridge Scour Arc Attributes* dialog.
6. Turn off "Annotation Data" in the Project Explorer.

The project should appear similar to Figure 8. The pier arc should be within the hole in the mesh near the middle of the bridge.

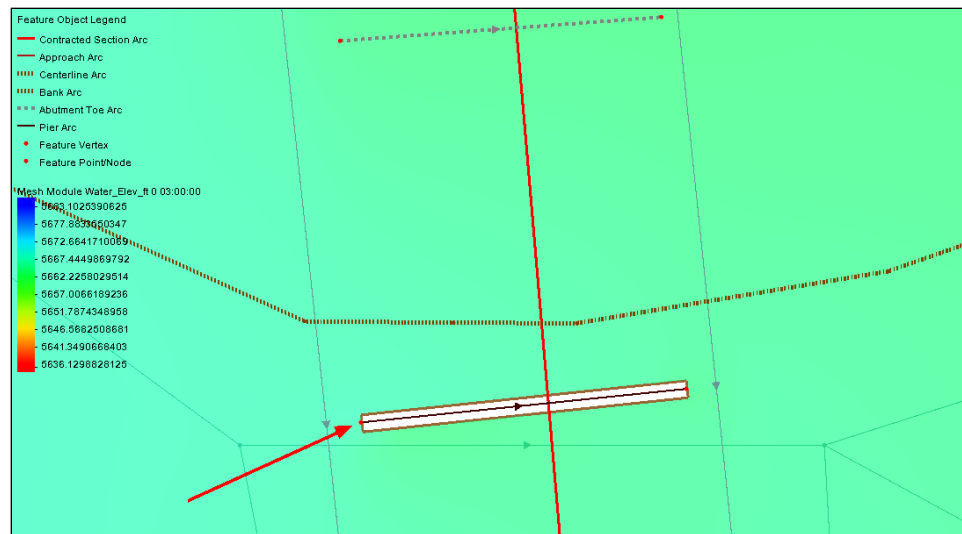




Figure 8 The single pier arc

To see all of the bridge scour arcs at once, do the following:

7. **Frame**  the project.
8. **Zoom**  in to the area shown in Figure 9.

The project should appear similar to Figure 9.

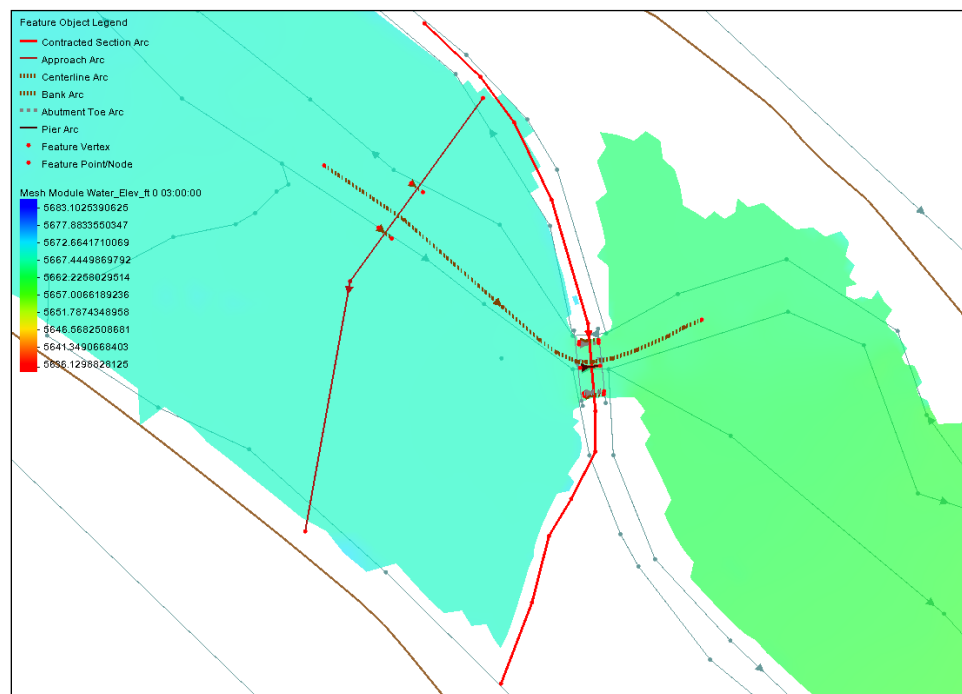


Figure 9 All of the bridge scour arcs visible

## 5 Bridge Scour Properties


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All of the required bridge scour arcs have now been created. Before exporting the file for the Hydraulic Toolbox, some additional properties should be set. These settings create defaults for a number of different settings within the Hydraulic Toolbox so that the same information does not have to be entered multiple times.


### 5.1 Input

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These are the basic inputs based on datasets within the project as well as soil gradation that must be entered manually.

1. Right-click on “ Bridge Scour” and select **Bridge Scour Properties...** to bring up the *Bridge Scour Coverage Properties* dialog.

Start with creating a scenario. Multiple scenarios can be created and ran at the same time. Using scenarios is covered in more detail in another tutorial.

1. Select “MeshEC” from the *Mesh* drop-down.
2. Click the **Add**  button to bring up the *Select Tree Item* dialog.
3. Select “Q25EC” folder item from the list and click **OK** to open the *Edit Bridge Scour Scenario* dialog.

Selecting the solution folder will auto-populate this dialog with the appropriate dataset when available.

4. Click **Close** to exit the *Edit Bridge Scour Scenario* dialog.

### 5.2 Model Specifications and Output

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These parameters tell the Bridge Scour tool how to complete the computations:

1. In the *Model Specifications* section, select “Bank Width Ratios” from the *Contraction Scour Variable Extraction Approach* drop-down.
2. Under *NCHRP Abutment Scour Condition*, select “Scour Condition a (Main Channel)” for both the *Left Abutment* and *Right Abutment*.

In order to use the Hydraulic Toolbox, an output file must be created. Do the following to set the name of the output file:

3. In the *Output filename* section, click **Browse...** to bring up the *Choose file* dialog.
4. Select “Hydraulic Toolbox Files (\*.hyd)” from the *Files of type* drop-down.
5. Enter “GilaRiver-output.hyd” as the *File name*.
6. Click **Save** to exit the *Choose file* dialog.

Notice that the entered filename now appears to the right of the **Browse...** button.

### 5.3 Compute and Export Scour Values

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Now that the basic input data has been set, the bridge scour calculations can be made:

1. In the *Scenarios* section, select the “Q25EC” scenario and click **View Values...** to compute the bridge scour values and bring up an *SMS* dialog.

2. If desired, copy the information in this dialog by clicking pressing *Ctrl-A* followed by *Ctrl-C*.
3. Open an external text editor and paste the information using *Ctrl-V*.

This allows saving the calculated information so it can be reviewed at any time.

4. Click **OK** to close the *SMS* dialog.

To export the Hydraulic Toolbox file, do the following:

5. Click **Export Hydraulic Toolbox File**.
6. Click **OK** when advised the export is complete.

The “GilaRiver-output.hyd” file will be saved to the location specified when entering the output filename. The default location is the same location as the project file (in this case, the *data files* folder).

## 5.4 Advanced

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There are two buttons in the *Advanced* section:

- **Edit Advanced Options...** – The advanced options will not be used in this tutorial. Please see the *SMS User Manual* for details on this button.
- **Delete Generated Arcs** – Removes the arcs generated when exporting the bridge scour file or viewing the bridge scour values. This button does not delete the manually-created arcs.

## 6 Viewing the Results

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The results file (in this case, “GilaRiver-output.hyd”) can be viewed in Hydraulic Toolbox 4.4.1 or later. This is available from the hydraulics software download page maintained by the Federal Highway Administration.<sup>1</sup>

Please see the documentation for the Hydraulic Toolbox for information on the various viewing and results assessment options available.

## 7 Conclusion

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This concludes the “Bridge Scour” tutorial. Feel free to continue to experiment with the SMS bridge scour tool, or exit the program.

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<sup>1</sup> See <https://www.fhwa.dot.gov/engineering/hydraulics/software.cfm> for more details.