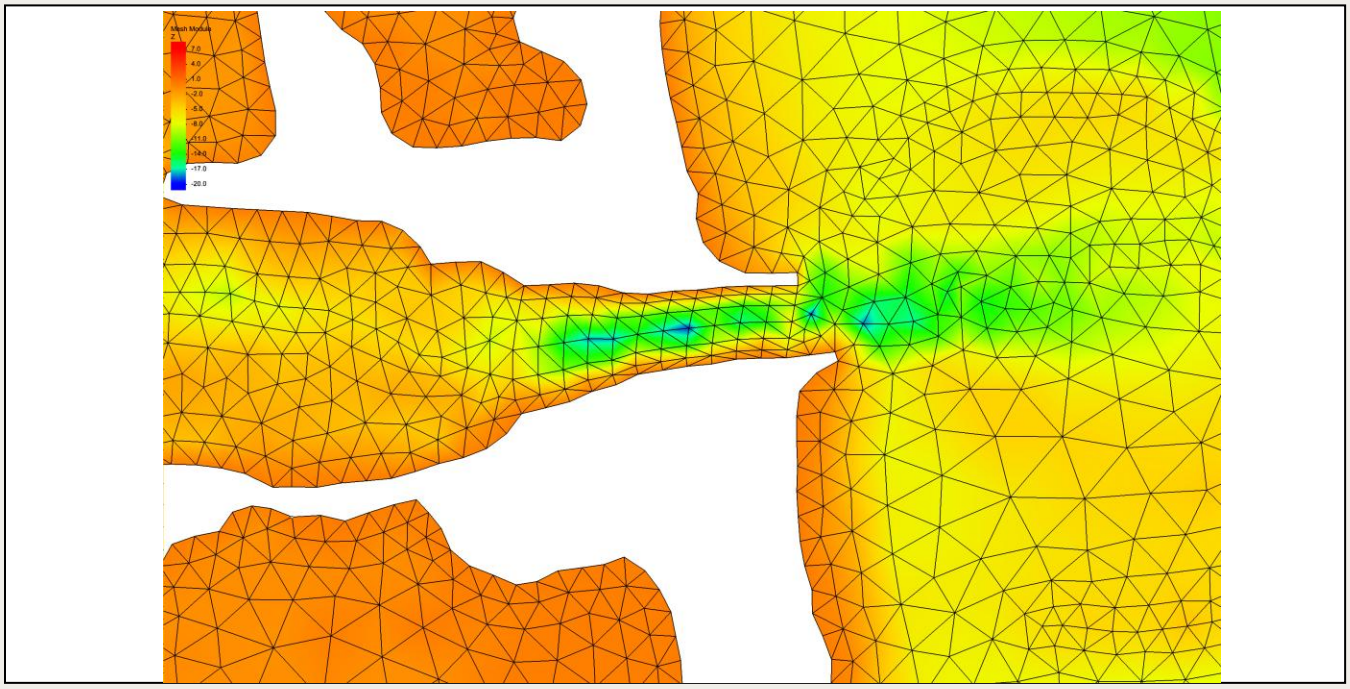
SMS 14.0 Training

ADCIRC Levee Mesh Generation



Objectives

This tutorial demonstrates additional options for generating a mesh for ADCIRC to include levees and a river in the simulation.

Prerequisite Tutorials

- Overview
- Map Module
- Raster
- Background Data
- Simulation Domain
- Mesh Generation
- Mesh Quality

Required Components

- SMS Core

Time

- 15–20 minutes

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1 Introduction

This exercise illustrates additional functionality for defining a mesh for use with a numeric model such as ADCIRC or SCHISM. Specifically, this exercise makes use of the patching approach, inserting levee, and setting up a boundary for a river inflow.

This exercise utilizes data from the region around Indian River Inlet located on Delmarva Peninsula along the Maryland coast between Delaware Bay and Chesapeake Bay. It commences with the results of the *ADCIRC Visualization* exercise.

2 Getting Started

Start by importing a project file containing a completed solution:

1. Launch the SMS application.
2. Select the *File* | **Open…** menu command to bring up the *Open* dialog.
3. Navigate to the *data_files* folder.
4. Select the “start.sms” file.
5. Click the **Open** button to import the project and exit the *Open* dialog. The initial project should appear similar to Figure 1.
6. From the *Menu* bar, select the *File* | **Save As…** menu command to open the *Save As* dialog.
7. Save the project as “IR_feature_pave.sms”.

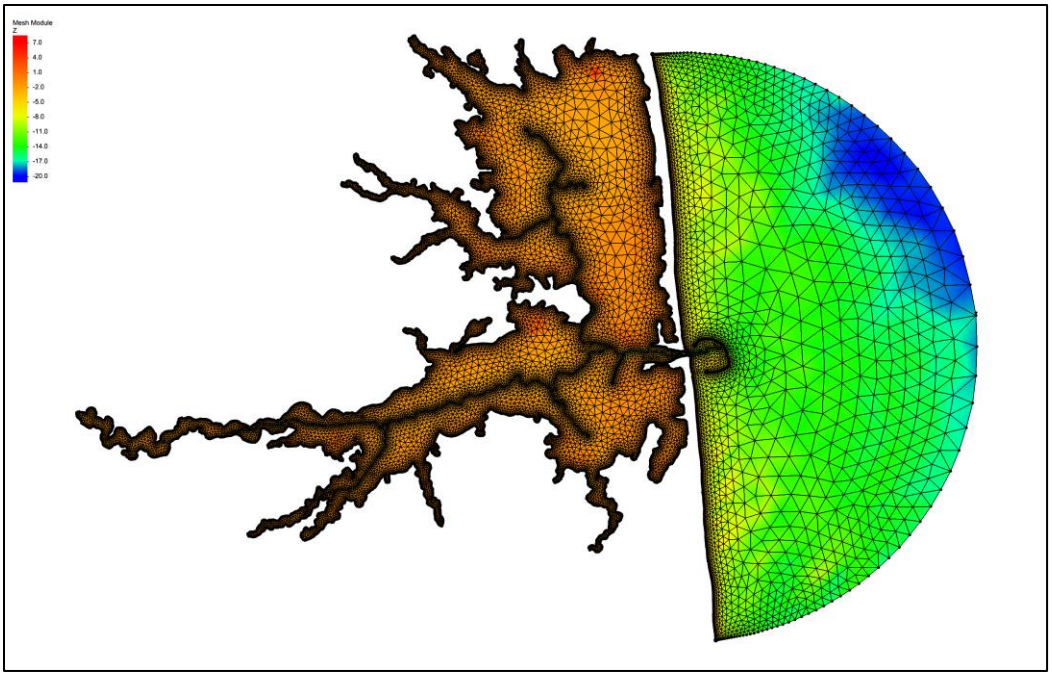

Figure 1 Initial project

In this tutorial, the mesh in three areas will need to be adjusted: inlet, levee and the river inflow as shown in Figure 2.

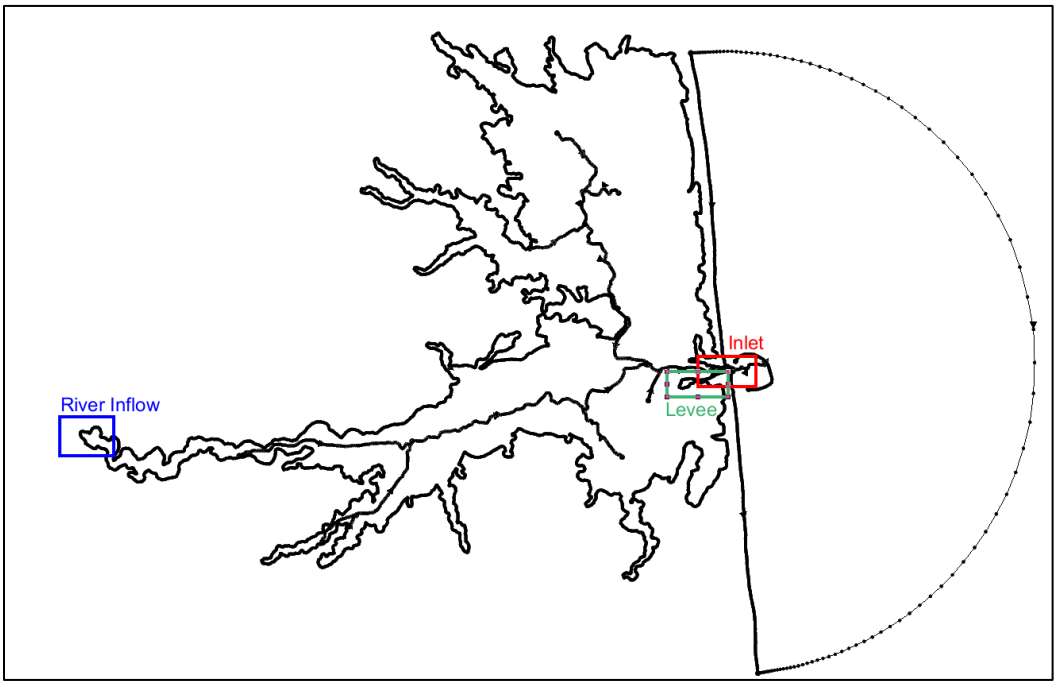

Figure 2 Mesh adjustment locations

3 Creating a New Mesh Generator Coverage

This tutorial includes the "*feature pave (2)"* coverage which was the basis for generating a mesh for this project. In this tutorial an additional mesh will be created, making use of an additional coverage.

To create a new coverage:

1. Right-click on the "*feature pave (2)*" map data coverage and select the **Duplicate** context menu command. This creates a new coverage that can be modified to create a new mesh.
2. Right-click on the "*feature pave (3)*" map data coverage and select the **Rename** context menu command.
3. Change the name of the new coverage to "patch inlet" and press the *Enter* key to set the new name.
4. Click on the "patch inlet" map data coverage to make it active.

4 Controlling Resolution in the Inlet

SMS will create elements/cells for each polygon in a *Mesh generator* coverage. This means the domain can be subdivided into multiple polygons to give greater control over mesh resolution and element shape.

In the area of the inlet, the flow aligns to the inlet. Therefore, elements that are also aligned to the inlet make sense. This can be accomplished by isolating the inlet in a polygon of its own.

4.1 Adding Arcs to Isolate the inlet

To create a polygon for the inlet:

1. Turn off the "feature pave (2) 50-1000m" mesh checkbox.
2. Turn on the "patch inlet" map data coverage checkbox.
3. Using the **Zoom** static tool, zoom into the inlet as shown in Figure 3.

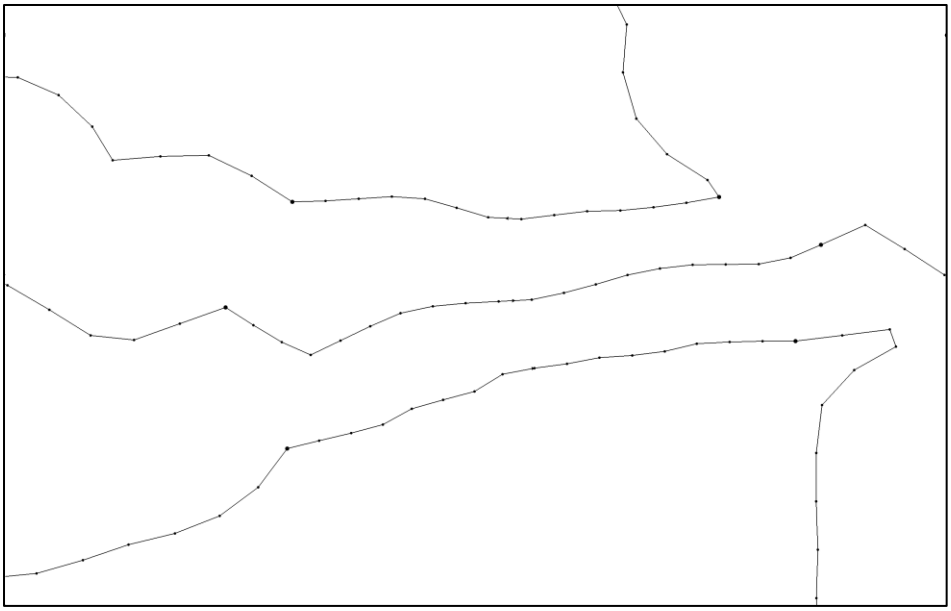

Figure 3 View zoomed into the inlet

4. Using the **Select Feature Arc** dynamic tool, select the stream arc through the center of the inlet.
5. Press the *Delete* key to delete the stream arc through the center of the inlet. It is not needed with the patch.

4.2 Defining Jetty Arcs

1. Using the **Create feature arc** dynamic tool, digitize arcs across the inlet as shown in Figure 4.

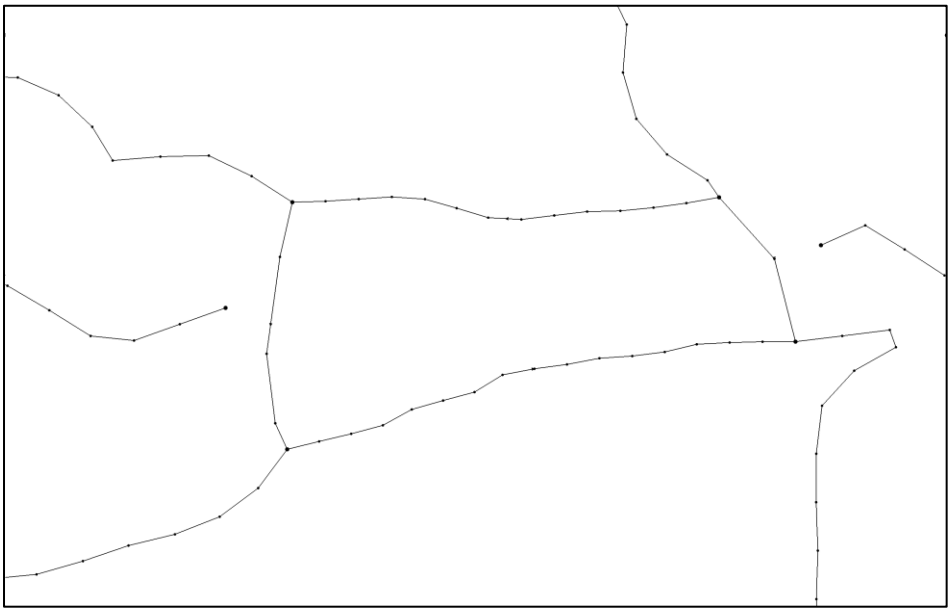

Figure 4 New arcs created to isolate the inlet

2. In the Project Explorer, turn on the *IR_Inlet_DEM_215.tif* GIS data image checkbox.

3. Using the **Select Objects** dynamic tool, drag the node defining the end of the north jetty out to the inside tip of the jetty and the vertex on the arc crossing the inlet to straighten out that arc as shown in Figure 5.

   Note: for the purpose of defining the levee, it is useful for this point to be near or below Mean Sea Level (MSL) so that the levee crest elevation will be higher than the associated mesh nodes.

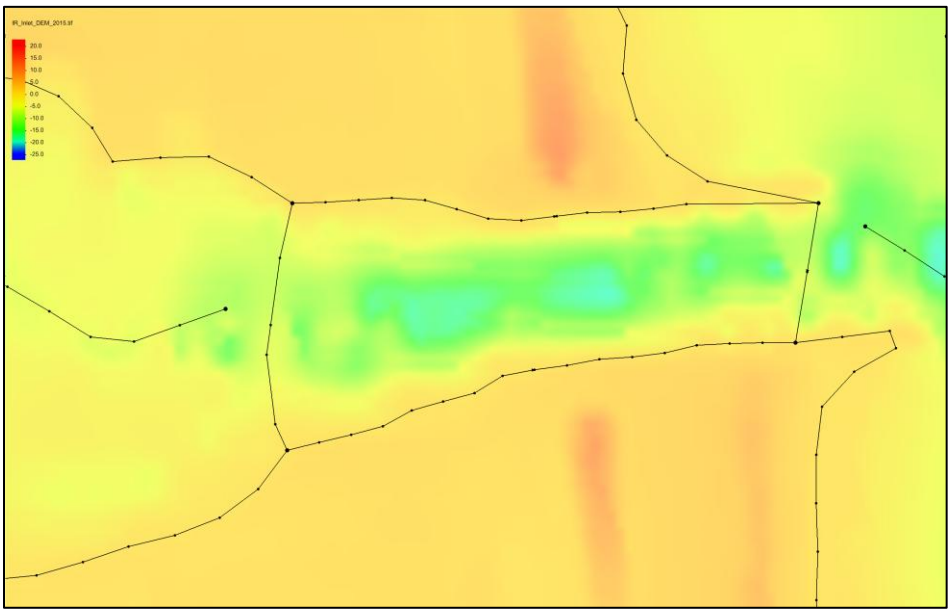

Figure 5 North jetty extended

4.3 Redistributing Vertices

1. Using the **Select Feature Arc** dynamic tool, select the two arcs along the sides of the inlet.
2. Right-click and select the **Redistribute Vertices…** context menu command to bring up the *Redistribute Vertices* dialog.
3. In the *Arc redistribution* section, from the *Specify* drop-down menu, select “Number of segments”.
4. For the *Number of segments,* enter “11”.
5. Click the **OK** button to close the *Redistribute Vertices* dialog.
6. Using the **Select Feature Arc** dynamic tool, select the two arcs across the ends of the inlet.
7. Right-click and select the **Redistribute Vertices…** context menu command to bring up the *Redistribute Vertices* dialog.
8. In the *Arc redistribution* section, from the *Specify* drop-down menu, select “Number of segments”.
9. For the *Number of segments,* enter “6”.
10. For the *Bias*, enter “2.0”.

11. Turn on the *2nd Bias* checkbox and enter "2.0".
12. Click the **OK** button to close the *Redistribute Vertices* dialog.

The results will be vertices spaced as shown in Figure 6.

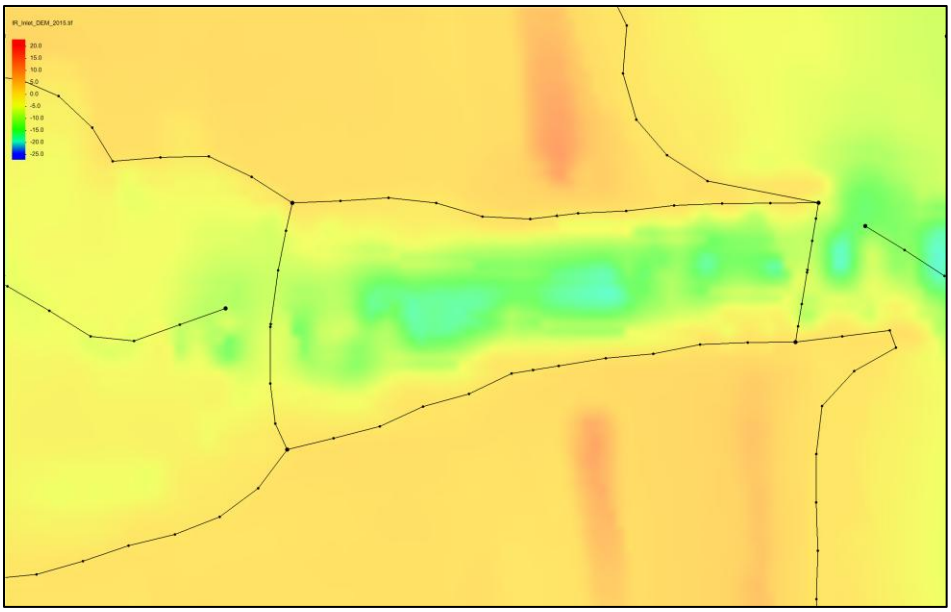

Figure 6 The inlet polygon

This includes six segments across the inlet, which will result in six mesh elements across the inlet to allow for better representation of the flow in the inlet.

4.4 Adding the Jetties to the Coast

Next, better represent the jetties in the coastline. This can be done by editing the arc to go around the jetty. The following steps illustrate how this could be done:

1. Using the **Create Feature Vertex** dynamic tool , click on the coastline arcs to add two new vertices on the north side of the north jetty as shown in Figure 7.

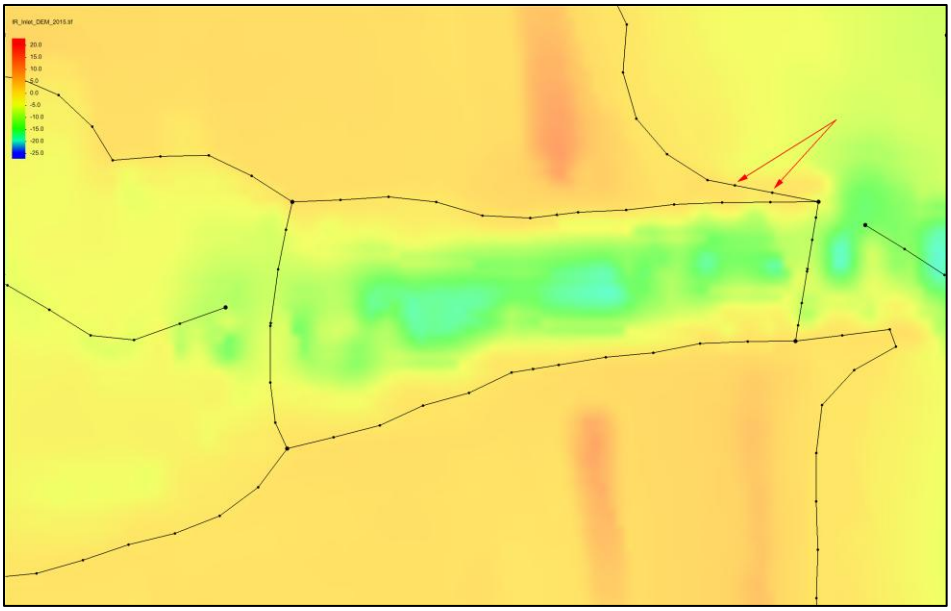

Figure 7 New jetty vertices

2. Now using the **Select Feature Vertex** dynamic tool, drag the jetty vertices as shown in Figure 8.

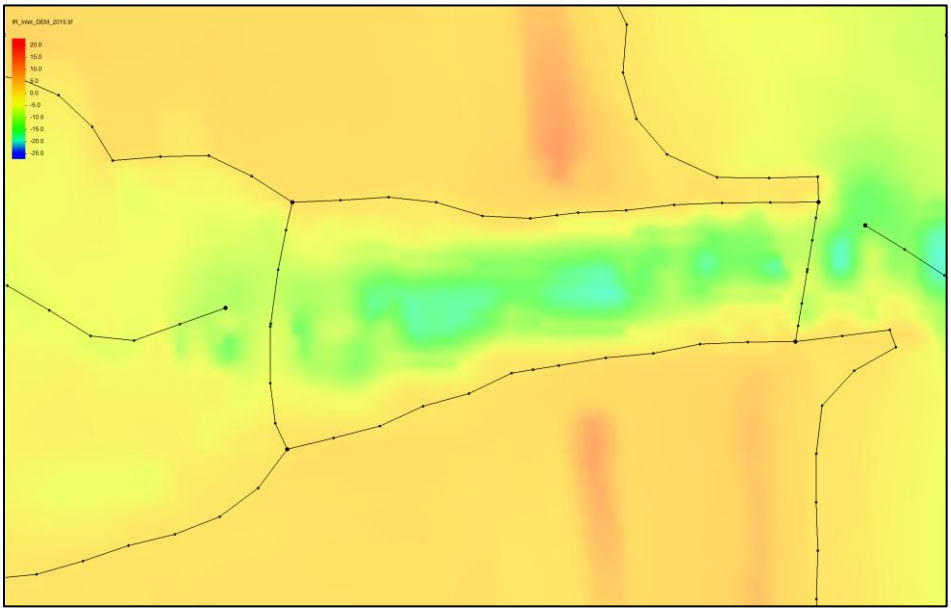

Figure 8 Corrected jetty representation in the coastline

This configuration of arcs will create geometry to represent levees for the two jetties.

5 Preparing for a Levee on the South Side of the Inlet

The south side of the inlet, between the inlet and the back bay, is another possible location for flow to overtop. Because a levee structure should consist of matching nodes on either side of the structure this will be set up for the south side of the inlet:

1. Zoom into the south side of the western end of the inlet as shown in Figure 9.

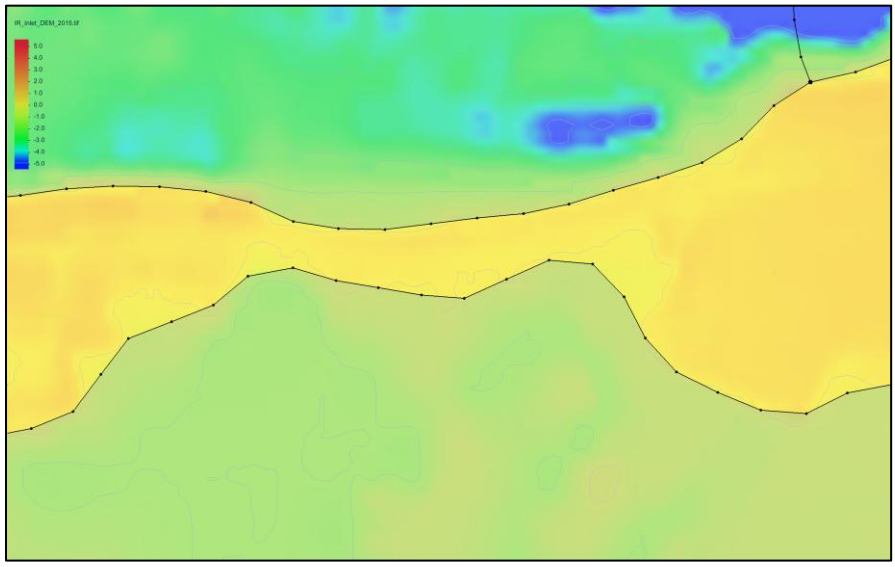

Figure 9 Narrow portion of the south wall of the inlet

2. Using the **Select Objects** dynamic tool, select each vertex shown in Figure 10, in turn, right-click and select the **Nodes <-> Vertices** context menu command.

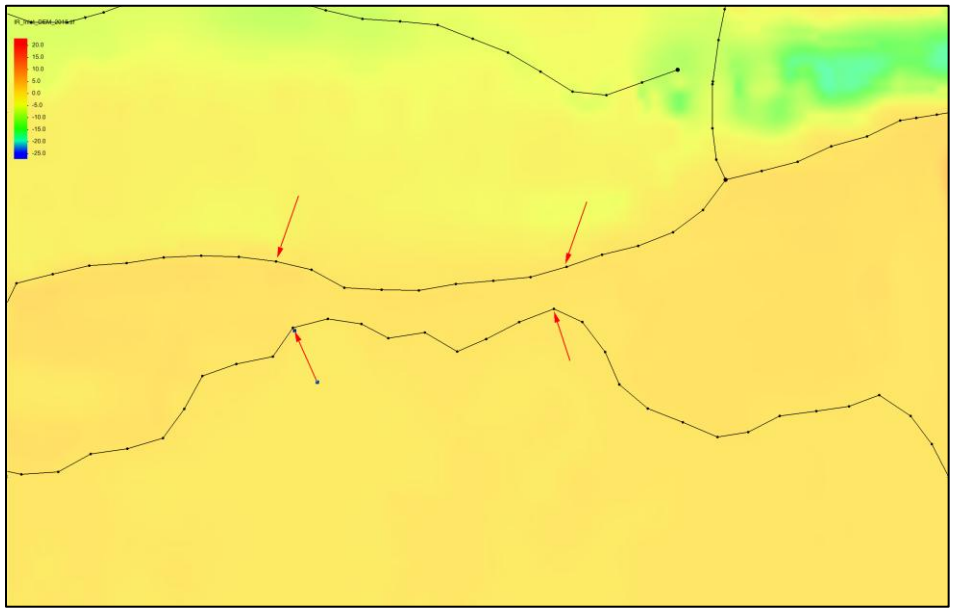

Figure 10 Vertices converted to nodes

3. Using the **Select Feature Vertex** dynamic tool, drag the new nodes and vertices to approximately align with each other across the levee as shown in Figure 11.

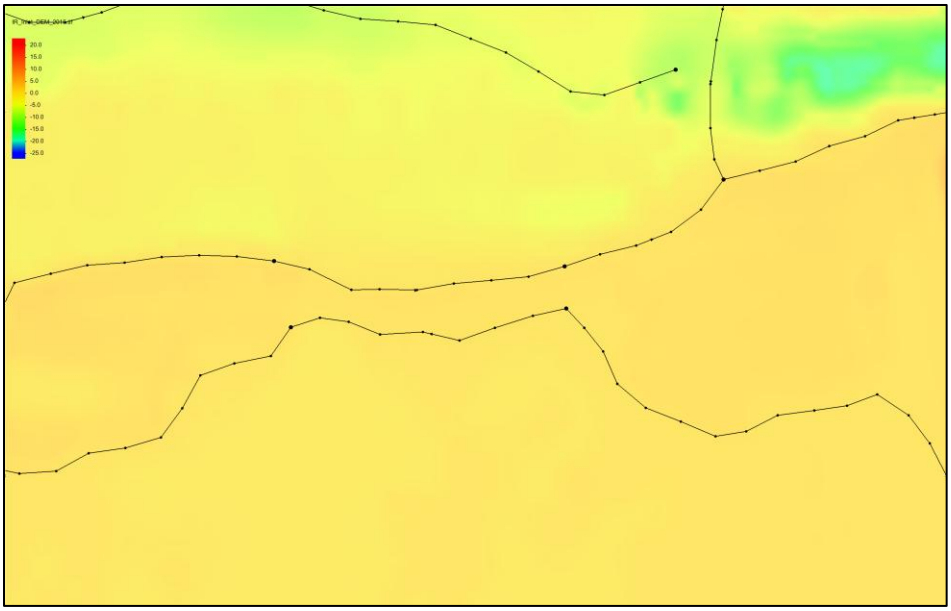

Figure 11 Repositioned nodes

Note: A levee in ADCIRC must consist of two node strings with the same number of segments. The nodes of the levee do not need to be directly across from each other, but they should be approximately aligned. The need for the same number of segments means that you may need to redistribute the vertices on the arcs, so that the two arcs have the same number of segments.

6 Preparing for a River Inflow

Flow will enter the domain perpendicular to the boundary, so it is a good idea to create a section of the domain that matches the cross section of the river.

To do this:

1. Using the **Frame** macro, zoom to the extents of the project.
2. Using the **Zoom** static tool, zoom into the west side of the domain where the river will enter the domain as shown with the red box in Figure 12.

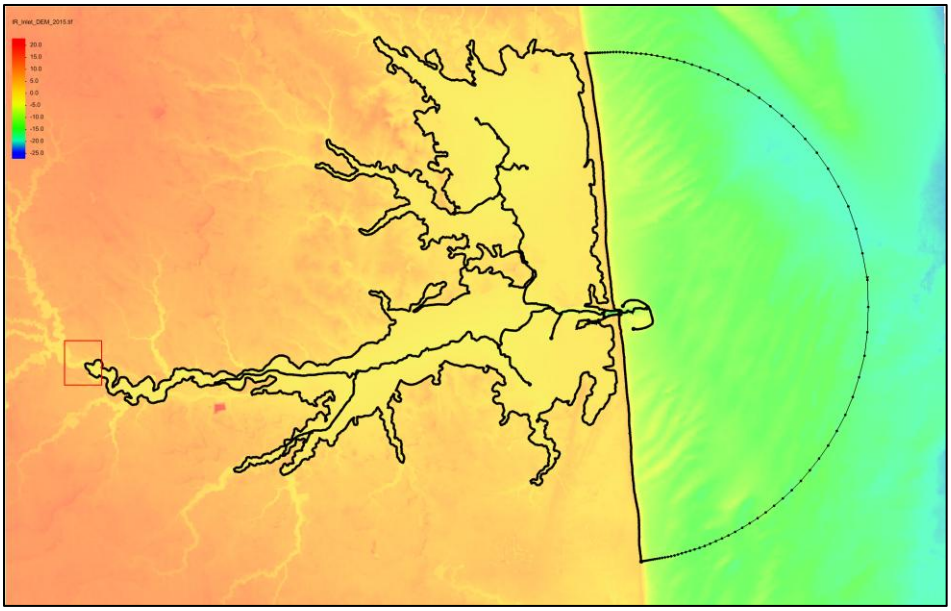

Figure 12 River inlet location

3. Using the **Select Objects** tool, select and drag the four vertices shown in Figure 13 to create a row across the channel of the river.

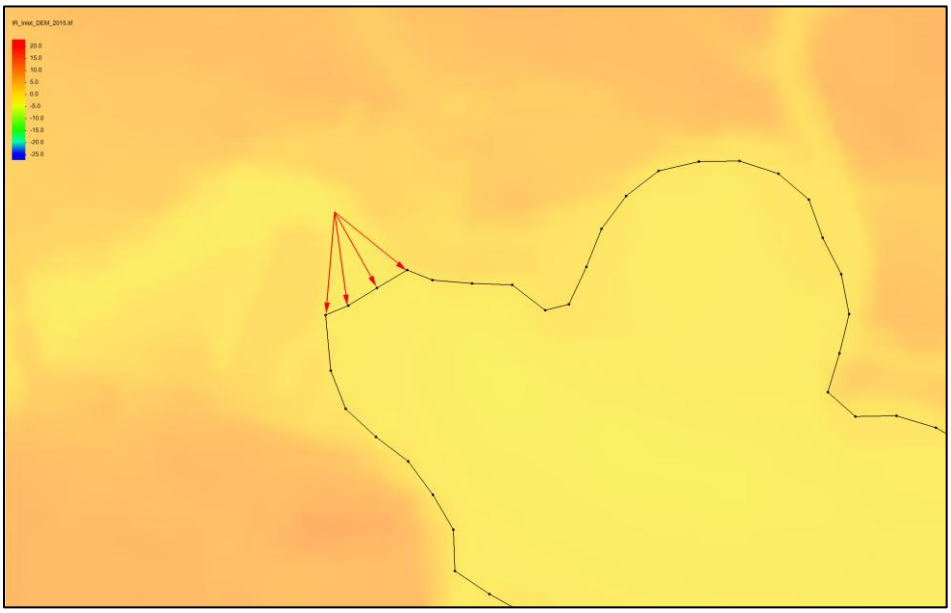

Figure 13 River vertices positioned across the channel

7 Generating the Levee Mesh

A mesh will now be generated following the same procedure used in the Mesh Generation exercise.

7.1 Assigning Polygon Attributes

Polygon attributes must be assigned to all of the polygons. To do this:

1. Using the **Frame** macro, zoom to the extents of the project.
2. Click on the **Build Polygons** macro. There will be three polygons built, including: the ocean, the inlet, and the bay. All of these polygons will have attributes set to use constant paving because that is what the original polygon was set to.
3. Using the **Zoom** static tool, zoom into the inlet and double click on the inlet polygon as shown in Figure 8.
4. Using the **Select Feature Polygon** dynamic tool, right-click on the polygon and select the **Polygon Attributes…** context menu command. The *2D Mesh Polygon Properties* dialog appears.
5. In the *Mesh Type* section, from the drop-down menu, select “Patch (quadrilaterals)”.
6. Click the **Preview Mesh** button to generate a preview in the *Preview* window.
7. Click the **OK** button to close the *2D Mesh Polygon Properties* dialog.

   Note: the preview will show quadrilateral elements. ADCIRC requires triangular elements. This will be addressed later.

7.2 Generating the Mesh

To generate the mesh:

1. Click on the **Toolbox** macro.
2. In the *2D Mesh* folder, select the *2D Mesh from Coverage* tool.
3. Click the **Run Tool…** button to run the tool and open the *2D Mesh from Coverage* tool dialog.
4. For the *Coverage* select the “Map Data/patch inlet” coverage.
5. For the *Name of the output mesh,* enter “patch inlet 50-1000m”.
6. Click the **OK** button to close the *2D Mesh from Coverage* tool and open the *2D Mesh from Coverage* feedback dialog.
7. Click the **OK** button to close the *2D Mesh from Coverage* feedback dialog.

SMS generates a new mesh. Feel free to review it and note issues.

7.3 Clean Up the Mesh

The mesh generated by SMS includes quadrilateral elements in the channel. ADCIRC requires an all-triangular mesh. To resolve this:

1. In the Project Explorer, turn off the *IR_Inlet_DEM_2015.tif* GIS data image.
2. Select the new “patch inlet 50-1000m” mesh to make it active.
3. Click on the *Elements* | **Split Quadrilaterals** menu command. This will split all the quads in the inlet into triangles suitable for ADCIRC. If asked to split all quadrilaterals, click the **Yes** button.

4. Click the *Nodes* | **Renumber** menu command to optimize the mesh after editing.

The resulting mesh is shown in Figure 14.

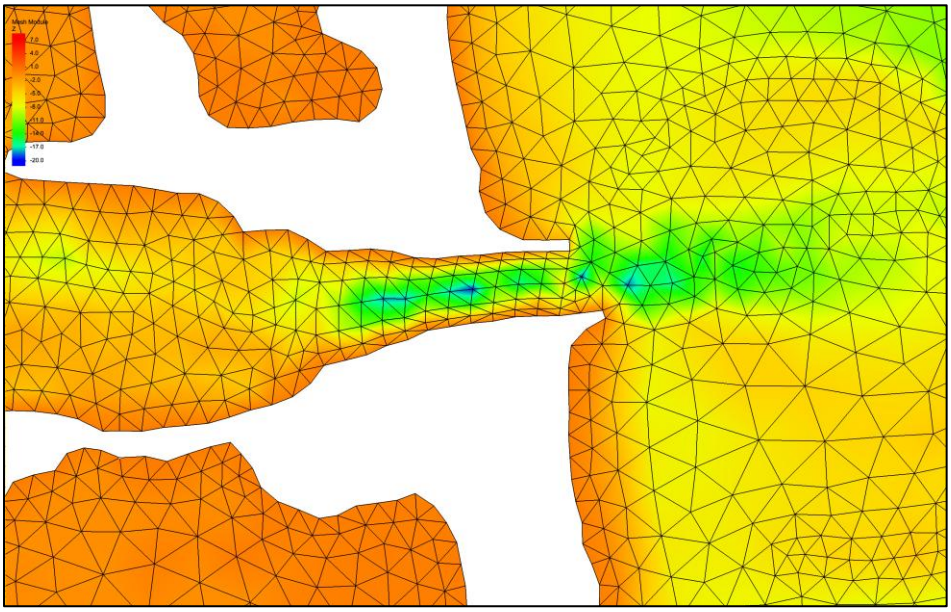

Figure 14 The levee mesh around the inlet polygon

Review the operations discussed in the *Mesh Quality Review* tutorial when reviewing this new mesh. This could include:

- Reviewing the ARR plot for the mesh and addressing concerns if they exist.
- Create a raster of the mesh and compare the bathymetry with the terrain.
- Reviewing the element quality display options.

8 Saving the Project

To save the project:

1. From the *Menu* bar, select the *File* | **Save As...** menu command.
2. Navigate to the *data_files* folder.
3. For the *File name*, enter the name "IR_levee_mesh".
4. Click the "Save" button, to save the project.

9 Conclusion

This concludes the “Levee Mesh Generation” exercise. Several features have been demonstrated including:

- “Patch” meshing.
- Aligning arcs for levees.
- Aligning vertices for river inflows.

This exercise is continued in the *Levee Simulation* exercise.