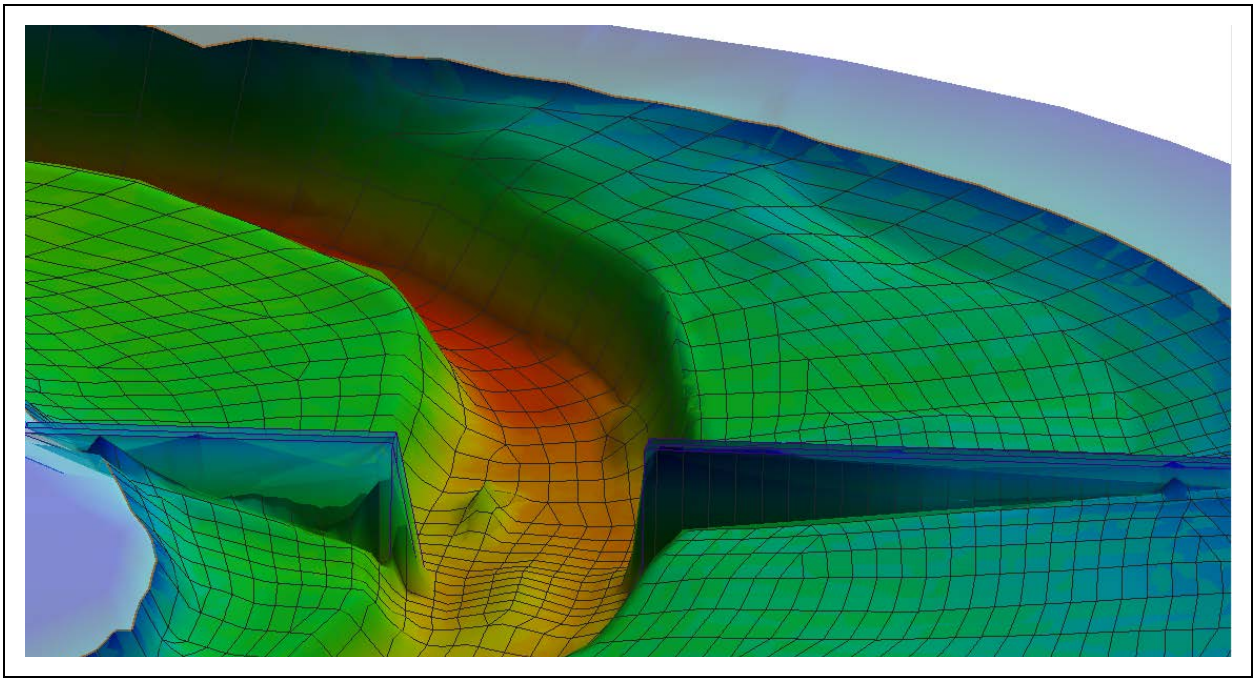
SMS

v. 11.1

SMS 11.1 Tutorial
Feature Stamping



Objectives

In this lesson you will learn how to use conceptual modeling techniques to create numerical models that incorporate flow control structures into existing bathymetry. The flow control structures you will be creating are abutments for a proposed bridge over Double Pipe Creek near Detour, Maryland. To do this you will be using feature stamping.

Prerequisites

- Overview Tutorial

Requirements

- TABS
- Map Module
- Mesh Module
- Scatter Module

Time

- 45-60 minutes

AQUAVEO™

Opening a Background Image

To provide a base map and to help you place the centerlines for the abutments of the proposed bridge you will open an aerial photograph of Double Pipe Creek near Detour, Maryland. To open the image:

Select *File* | *Open*.

Select "DoublePipeCreekPhoto.jpg" in the Data Files Folder for this tutorial and click the *Open* button.

Depending on your preference settings, SMS may ask if image pyramids are desired. It is advised that you select the toggle to not ask this question again and click *Yes*.

SMS displays the aerial photograph (Figure 1).

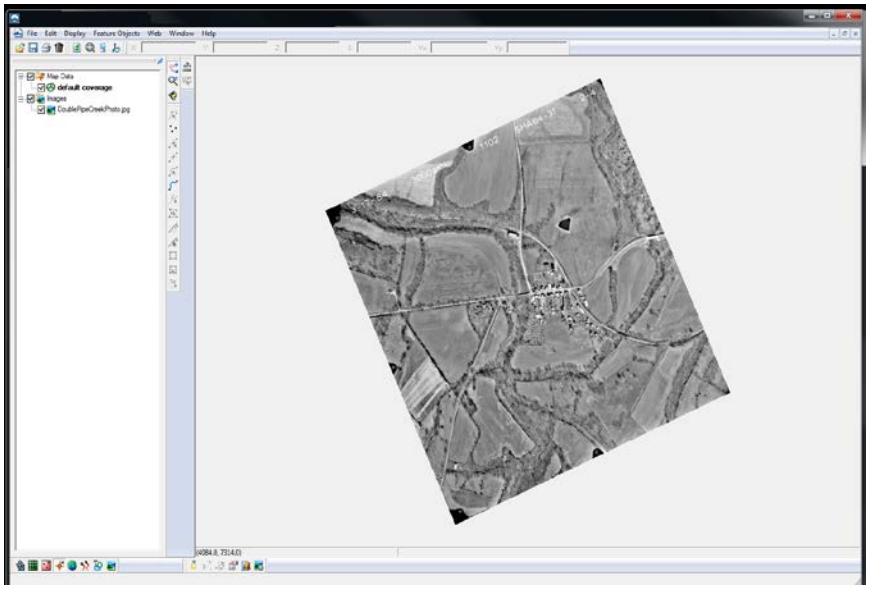


Figure 1 Aerial photograph of Double Pipe Creek near Detour, Maryland

Specifying the Coordinate System

The image has now been read into *SMS*, but *SMS* has not been told what coordinate system the data is referenced to. The coordinate system is dependent on the data source. To specify the coordinate system:

1. Select *Display* | *Projection*.

2. Make sure the *Horizontal System* is set as "Local Projection" and the *Horizontal* and *Vertical Units* are set to "U.S. Survey Feet."

Importing Bathymetric Data

For this lesson you will use bathymetry from a survey of the area around Double Pipe Creek near Detour, Maryland before construction of the elevated road and bridge. To bring the survey data into *SMS*:

1. Select *File* | *Open*.
2. Select *detour.xyz* and click the Open button.
3. The *File Import Wizard* dialog will appear. Click *Next* to proceed to step 2 of the File Import Wizard.
4. Click *Finish* to close the File Import Wizard and import the survey data.
5. Next go into the *Display* | *Display Options* Menu. Select the *Scatter* section and switch off the *points* and select *contours*. Click on the *Contour Options* tab and switch the *color method* to *Color Fill* and change the *transparency* to 50% and click *OK*.

This survey file contains elevation data for Double Pipe Creek and its floodplain which includes the town of Detour, Maryland. The survey data has already been adjusted to the same local coordinate system as the image. Transparent contours of the survey points displayed over the background image are shown in Figure 2.

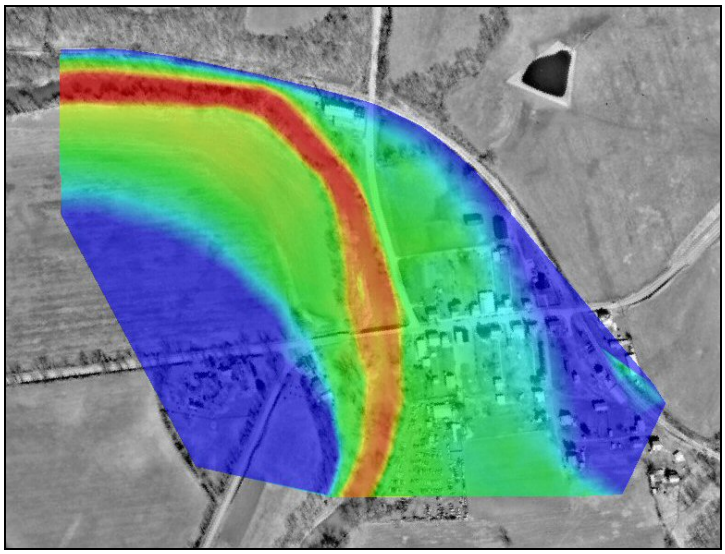


Figure 2 Bathymetry for Double Pipe Creek and its floodplain

Creating the Model Domain

Before creating a numerical model, a conceptual model will be created to define the extents of the model domain. By using a conceptual model, you can take advantage of automatic meshing algorithms. The two sides of the model domain running along the length of Double Pipe Creek will be formed by extracting the 330 foot contour from the survey data. The ends of these two boundaries will then be connected to create the upstream and downstream boundaries of the model domain. To define the model domain:

1. Right-click on the *Map Data* item in the *Project Explorer* and select the *New Coverage* menu item. The *New Coverage* dialog will appear. Name the coverage "Double Pipe Bridge" and select *TABS* as the coverage type.
2. Right-click on the "detour" scatter set in the Project Explorer and select the *Convert | Scatter Contours -> Map* menu item.
3. Enter an *Elevation* of 330 feet and a *Spacing* of 100 feet in the *Create Contour Arcs* dialog.
4. Click *OK* to close the *Create Contour Arcs* dialog and generate arcs along the 330 foot contour. The resulting arcs run along the length of Double Pipe Creek.
5. A single looped arc is created on the extreme east side of the scatter set. Delete this arc. To do this you will need to switch to map module if it isn't selected

already. Then click on the *Select Feature Arc* , click on the single looped arc and press *Delete* on the keyboard. Say "Yes" to the dialog.

6. With the *Create Feature Arc* tool create the upstream and downstream boundaries of the model domain as shown in Figure 3. You may want to zoom in and turn off the scatter set. Delete any dangling arcs that result when creating these two boundaries. Note the arcs are not to be placed on the ends of the existing arcs.

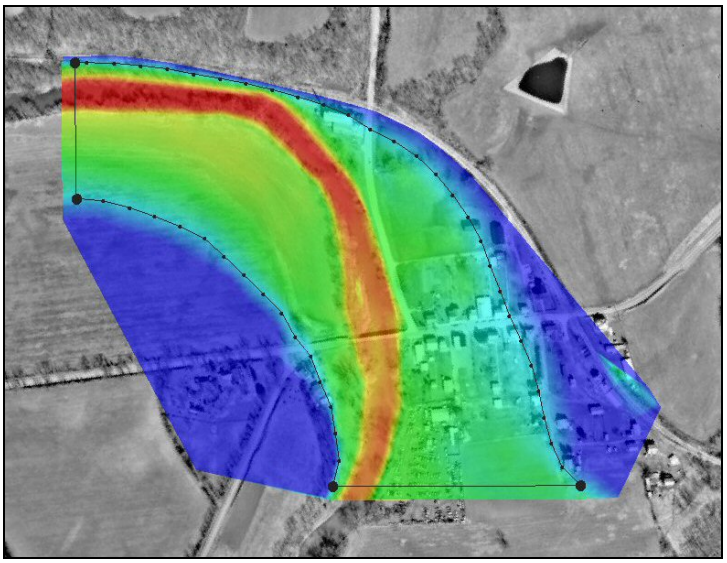


Figure 3 Model domain of Double Pipe Creek

The model domain extents are now defined in the "Double Pipe Bridge" coverage. It is important to note than when creating a finite element mesh from a conceptual model, the bathymetry is interpolated from the scatter set. Therefore, the conceptual model should be within the bounds of the scatter set to avoid difficulties that arise when extrapolating data.

Create a mesh without the abutments

We will first create a finite element mesh that does not include the abutments. This represents our existing conditions model and our abutments would represent a proposed condition.

1. A conceptual model using the merged scatter set has been prepared for you. To open it, open the file "NoAbutments.map". All of the polygons forming this conceptual model reference the detour scatter set.

2. To create the numerical model select *Feature Objects* | *Map -> 2D Mesh*.
3. Click *OK* in the *2D Mesh Options* dialog

Creating the Abutments

As mentioned above, the abutments of the proposed roadway will be created using feature stamping. This lesson presents stamping the abutments for the proposed bridge over Double Pipe Creek in five steps: (1) Set up a *Stamping* coverage, (2) Position the abutments, (3) Specify the geometry of the abutments, (4) Stamp the abutments into the existing bathymetry, and (5) Incorporate the stamped features to the conceptual model.

Setting Up a Stamping Coverage

SMS includes a coverage type called a *Stamping* coverage, for positioning and defining the geometry of features to be forced into existing bathymetry using feature stamping. To setup the *Stamping* coverage for this lesson:

1. Right click on Map Data in the *project explorer* and create a new coverage. Name it "Feature Stamp", and then set its Type to Stamping and activate it.

In the *Stamping Coverage Attributes* dialog, toggle on *Use cutoff*. Select the *elevation* (Z) item in the tree control and leave the *Bathymetry Type* as "Elevation." This sets the elevation (Z) dataset of the detour scatter set as the bathymetry the stamped features will be forced into. Furthermore, by leaving the *Bathymetry Type* as "Elevation," you tell SMS that the selected dataset contains elevation values rather than depth values.

Click *OK* to close the *Stamping Coverage Attributes* dialog.

Positioning the Abutments

You will position the abutments by creating feature arcs along their centerlines. The accuracy in how the abutments intersect the existing bathymetry depends on how many vertices are distributed along the centerline arcs. For this lesson you will distribute the vertices so they are closer together where the slope of the bathymetry changes rapidly near the banks of the creek and further apart where the slope is nearly flat in the floodplain. To create the centerline arcs for the abutments:

1. Using the *Create Feature* Arc tool create arcs representing the centerlines of the two abutments as shown in Figure 4. You can use the roadway in the aerial photograph to help you position the centerline arcs and line them up with each

other. Create the arcs starting outside the model domain in the floodplain and proceeding toward the "Double Pipe Creek". End the arcs at the edge of the creek. The length of the bridge will be roughly the distance between the two nodes. You may have to adjust your display options or zoom in to better see the model domain on the "Double Pipe Bridge" coverage.

With the *Select Feature Arc* tool, select the centerline arc for the west abutment and select *Feature Objects* | *Redistribute Vertices*. This brings up the *Redistribute Vertices* dialog.

In the *Redistribute Vertices* dialog set Specify to *Number of Segments*, the N*um Seg* to 20 and the *Bias* to 0.1. The Bias positions the vertices so that the distance between the last two vertices is 0.1 times the distance between the first two vertices. Click *OK* to close the *Redistribute Vertices* dialog. If your arcs don't distribute in the same manner as in Figure 4 then try to use a Bias of 10.

Redistribute the vertices along the centerline for the east abutment in a similar manner using 30 segments. Set a bias of 10.

Figure 4 Abutment centelines for the proposed bridge over Double Pipe Creek

Specifying the Geometry of the Abutments

Now that the abutments have been positioned with centerline arcs you can specify their geometry. To specify the geometry of the abutments:

1. With the *Select Feature Arc* tool double-click on the west abutment. This brings up the *Stamping Arc Attributes* dialog.
2. In the *Stamping Arcs Attributes* dialog specify the *Feature Name* as "West Abutment." Leave the *Stamping Type* as "Fill Feature" since this abutment will be increasing the elevation of the existing bathymetry.

3. Click the *Constant -> Elevation* button in the *Centerline (CL) Profile* area to bring up the *Constant -> Elevation* dialog. Enter a constant elevation of 332 feet and click *OK* to close the dialog. This sets the elevation at each of the points along the centerline arc to 332 feet. The elevations for the points along the centerline can be set one at a time in the *Centerline (CL) Profile Spreadsheet* or all at once using the macros found below this spreadsheet.

Note that the first point along the centerline is marked with an arrow ▶. This arrow identifies the current point. The *Cross-sections (CS)* area of the attributes dialog displays the cross-section for the current point for viewing and editing. When the current point is changed by clicking on it in the *Centerline (CL) Profile Spreadsheet*, the *Cross-sections (CS)* area updates to display the cross-section of the new current point. You will now specify the cross-sections at each point along the centerline.

4. In the *Cross-sections (CS)* area click the *Specify Top Width and Single Side Slopes* macro button to bring up the *Top Width and Side Slopes* dialog. Enter a *Top Width* of 25 feet and *Left* and *Right Slopes* of -1. Click *OK* to close the dialog. A simple cross-section has now been specified. To ensure these cross-sections intersect the bathymetry when being stamped, specify a *Maximum Distance from CL* of 35 feet for both the left and right sides of the cross-section.

5. Copy this cross-section to the remaining centerline points by clicking the *Current CS -> All CS* macro button. Click *Yes* when prompted to adjust the cross-sections based on the centerline elevation.

6. To specify a slope on the end of the abutment click the *Last End Cap* button to bring up the *Last End Cap* dialog. Leave the *Type of end cap* as "Sloped Abutment" and the *Angle* as 0.0°. In the last row of the *Slope Spreadsheet* enter a *Distance from CS* of 1 foot and an *Elevation* of 331 feet. To ensure the sloped abutment intersects the bathymetry, specify a *Maximum Distance from CS* of 25 feet.

7. Click *OK* twice to exit the *Last End Cap* and *Stamping Arc Attributes* dialogs.

8. Repeat steps 1 through 7 for the east abutment except set the *Feature Name* to "East Abutment."

The geometry for both the abutments has now been specified. For this lesson you are creating fairly simple features to force into the existing bathymetry. The feature stamping interface inside *SMS* has been designed to create simple features quick but at the same time allow for the creation of more complex features. You are now ready to stamp the abutments and add them to the conceptual model.

Stamping the Abutments

To maintain the integrity of the conceptual model and the existing bathymetry, feature stamping creates a new coverage and a new scatter set for each stamped feature. If the conceptual model or the existing bathymetry becomes corrupted, it makes it difficult to test several scenarios for the placement and geometric design of features being stamped. To stamp the abutments into the existing bathymetry:

1. Select *Feature Objects* | *Stamp Features* to bring up the *Stamp Features* dialog.
2. In the *Stamp Features* dialog make sure the *Coverage Type* is set to "TABS" and click *Stamp*.

You will notice a coverage and scatter set are added to the *Project Explorer* for the west abutment and east abutment.

Incorporating the Abutments into a Numerical Model

There are several ways to incorporate a stamped feature into a numerical model. Two methods will be illustrated in this tutorial.

Method 1 will use the existing mesh elements and apply the stamped elevations to the nodes of the mesh. The second method will create a new mesh that will use the stamped elevations. The new mesh will have a different configuration of elements than the original mesh. Both methods require a new scatter set that includes the stamped elevations. The second method also requires a new conceptual model. In general, the second method is the preferred approach so you can setup your elements to match the updated bathymetry.

Creating Merged Scatter Set

In order to use the new scatter sets in our numeric model, we want to combine them with our original data. To create the merged scatter set:

1. Click on the *Scatter Data* item in the *Project Explorer* to activate the Scatter Module.
2. Select *Scatter* | *Merge Sets* to bring up the *Merge Scatter Sets* dialog.
3. Under *Overlapping region options,* Select *Merge all scatter points*.
4. In the *Merge Scatter Sets* dialog click the *Select All→ button* to specify that all available scatter sets are to be merged.
5. At this point you would normally click OK to close the Merge Scatter Sets dialog and create the merged scatter set. However, SMS triangulates the new set of merged points. This TIN does not always honor the stamped feature boundaries,

and therefore may need to be edited (swapping triangle edges) to accurately represent the combined surface. Click *OK* to merge the sets.

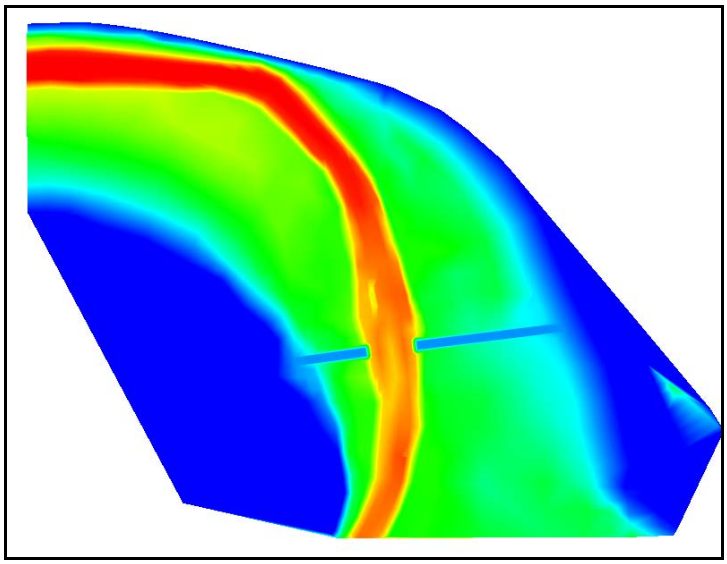


Figure 5 Merged scatter set.

The Merge Report dialog will a appear showing a summary of what was merged. Click *Close* to close the dialog.

To integrate the abutments into a numerical model using this method:

1. Click on the *Merged* item in the Project Explorer under Scatter Data to activate the Scatter Module.
2. In the menu, select *Scatter* | *Interpolate to Mesh* to bring up the Interpolation dialog.
3. Under *Scatter Set to Interpolate From*, Make sure the Elevation in the *Merge scatter set* is selected.
4. Under Other Options, Make sure that Map Z is selected. Click OK.

In the case where the difference in elevations are not noticeable, the z magnification might have to be modified. To change the z magnification:

1. Go into the *Display Options* Menu. This is done by selecting *Display* | *Display Options* from the menu.
2. Select the *General* section. Make sure that Auto z-mag is turned off, then change the *z magnification* to 5.

3. Click ok to exit the *Display Options* dialog.

A mesh incorporating the east and west abutments has now been created. Figure 6 shows a rotated view of the resulting mesh zoomed up to the abutments. Breaklines are automatically created when using feature stamping. Breaklines forces the contours to follow abutment when triangulation is done. Figure 7 shows the breaklines that are created during feature stamping.

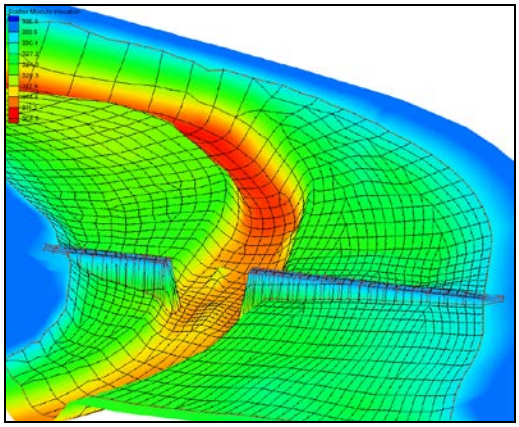


Figure 6 *Mesh incorporating the east and west abutments.*

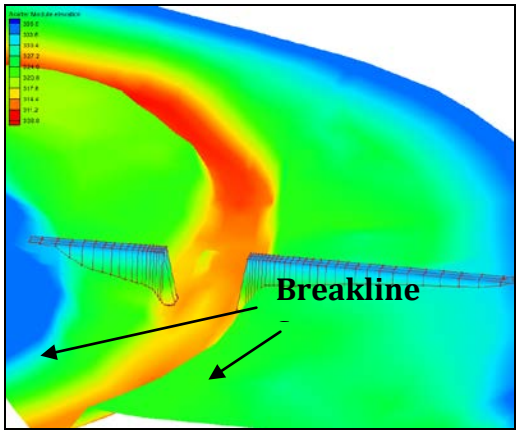


Figure 7 *Merged scatter set with Mesh off and breaklines showing.*

Conclusion

This tutorial demonstrates the creation of an embankment using the feature stamping utility. The same tools can be used to create channels, pits, or mounds. You may want to experiment with some of these other options.