

2. Telescoping Grid Generation

The telescoping grid capability was introduced in SMS 11.0 for CMS-Flow Inline (Implicit) V4.0. Also referred to as a quadtree grid, the telescoping grid offers local grid refinement with low effort and very clear visualized boundaries of refinement. In a telescoping grid, local refinement is achieved by subdividing a rectangular cell into four cells. The grid can be arranged as block-structured or rectilinear block-structured. This improved user-defined refinement allows for small scale accuracy of the focus area in a very large, regional domain. Having more expansive domains allows the user to include more coastal environments that play a role in the hydrodynamics and morphodynamics of an area. As an example, a multi-inlet system can now include several inlets that serve one bay, but only truly refine the particular inlet of interest.

In the case of Shark River Inlet, the telescoping grid is used because of its flexibility in having very small computational cells for the narrow inlet throat that quickly coarsen in refinement to large cells, which allow for extending the lateral domain to capture more of the littoral zone that is dominated by structures. Because of the refinement within the inlet and the structured beaches, the computational efficiency is improved without reducing accuracy at these key coastal features.

The main inlet channel at Shark River is the primary area of focus for calculating the correct current velocity, and should have 8-12 cells across it. The general rule of thumb for any major channel carrying flow is for it to have at least 10 cells across to define the horizontal (2D) best. CMS-Flow Inline (Implicit) requires a passageway, river entrance, or channel to have a minimum width of 3 cells. The two main back channels splitting off of the entrance, the north and south channels, each carry half of the tidal prism and therefore also have large velocities. The north channel actually has the strongest current because it is narrower, yet is the closest route to the north portion of the bay. Both split of channels should be represented by at least five cells in width.

2.1 Set Project & Bathymetry Projection

- Choose *Edit | Projection* from the pull down menu. The resulting dialog is shown in Figure 2.1.
- Click “Set Projection” and choose Projection - State Plane Coordinate System, Zone - New Jersey, Planar Units – Meters, Datum NAD83.

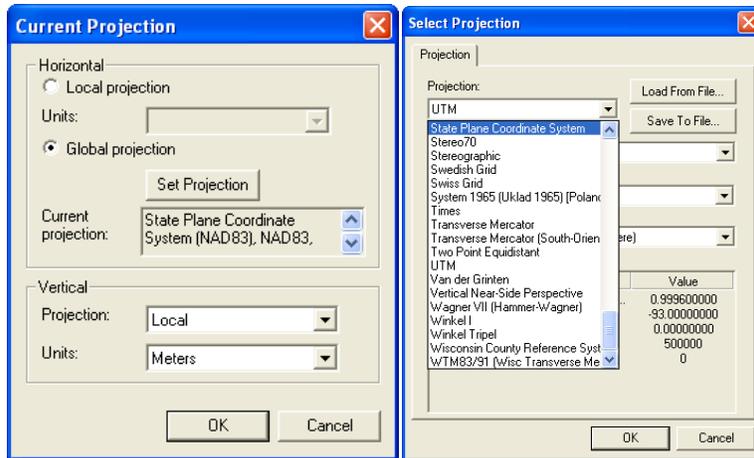


Figure 2.1. Current Projection dialogs.

2.2 Define Map Module Coverage & Create a Grid Frame

To create a new CMS-Flow Grid, you must first bring your final bathymetric dataset (merged) into the metric projection you will be working in.

- Click the *Map Module* button , or *Map Data*, . Rt-click on *default coverage*, and under *Type, Models*, select *CMS-Flow*. Now there is the option to create either a refined, rectilinear grid or a telescoping grid.
- Click the *Create 2-D Grid Frame* button, , draw two legs of the rectangular boundary for the model domain by clicking the lower ocean boundary corner point, then the lower landward boundary corner, and then the upper landward boundary corner to close the box.

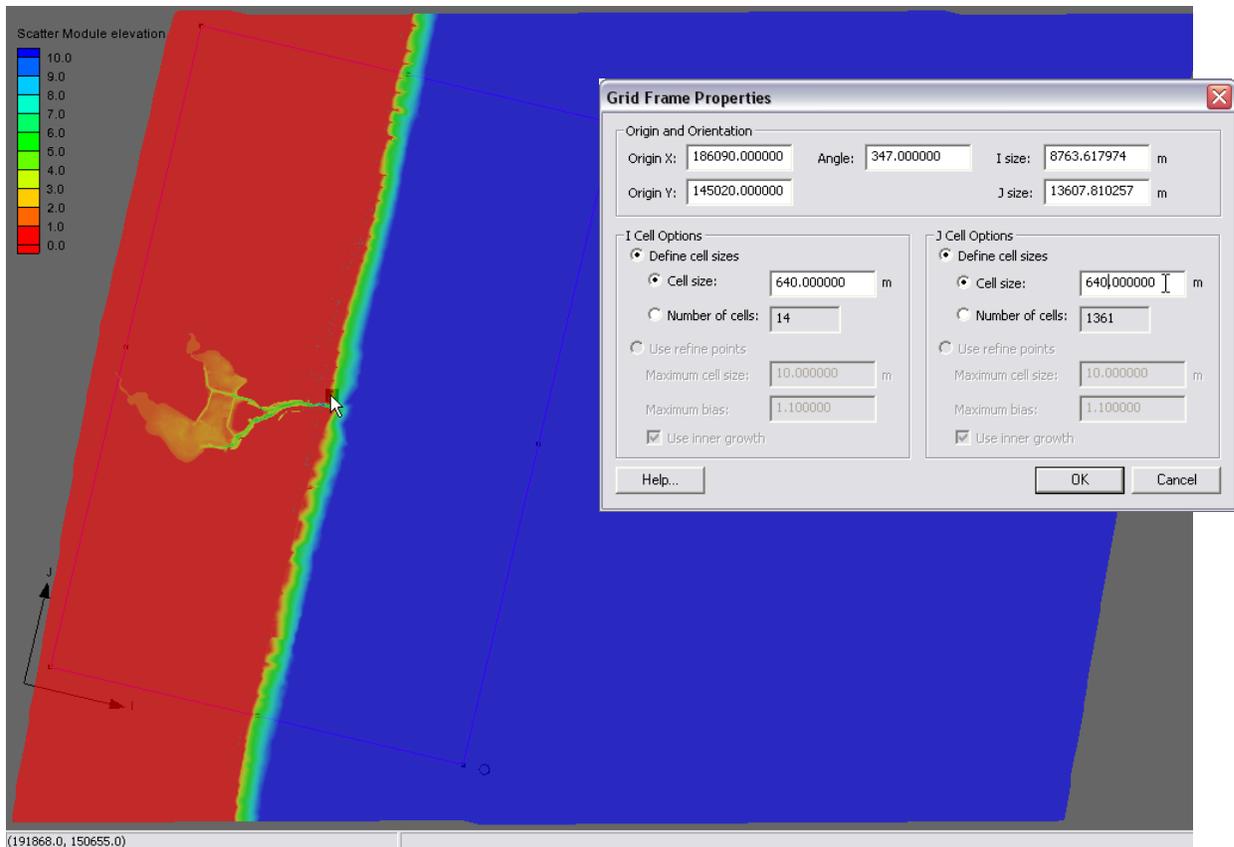


Figure 2.1. Current Projection dialogs.

- Use the Select 2-D Grid Frame button  to select the center point of the purple outlined grid domain, adjust the edges by dragging the center point of each edge, and change the orientation by selecting the circle  at the corner of the grid.
- Rt-click the highlighted center button and click Properties to further modify the dimensions of the grid boundary (Figure 2.1).

2.3 Define Refinements through Polygons

A telescoping grid is developed by using polygons to specify the local resolution to areas. Ideally, a Polyline is used or drawn to delineate the non-computational (land) area first, and then subsequent polygons that require finer resolution are added first. This section describes one methodology used to refine the channel inlet and littoral zone. Resolution can be added anywhere the user thinks there will be high flow or significant morphologic change.

- First, create an arc that delineates the non-computational land (anything higher than the tidal range or potential storm surge reach), and close this off along the landward or backside of the domain. Be sure to extend this polygon beyond the extent (purple line) of the future grid (Figure 2.3).

- **How to Close and Arc:** If the arc does not snap to close the polygon, confirm this by zooming close to the connection. The feature point, , at the end of the arc can be dragged to the line, and preferably overlain on another node or feature point. Select *Feature Object, Clean*, and check *Snap Nodes and Vertices*, select *OK*, and click on the two feature points to complete the connection. Now if you try to drag the feature point it should drag the arcs from both lines because they are connected.
- Vertices can be added manually, , between the feature points, and the arcs can be moved as the user specifies.
- Bring in the “SRI_LandOnly.map” file to skip this step.

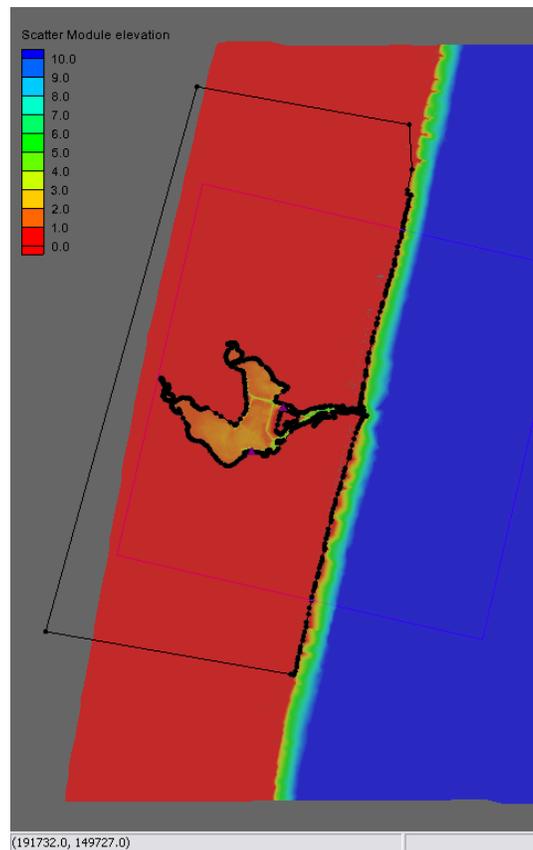


Figure 2.3. Land polygon generated around the bay and landward of the beach.

2.4 Build Polygons

The most important rule of thumb for designing the polygons is to make sure that the resultant cells in each resolution area will be at least 3-4 cells wide. When generating the arcs, keep the resolution size in mind when deciding how far apart to make each polygon.

- Create small refinement polygons around each of the groins or important features in the nearshore that may experience complicated hydrodynamics. Next, add feature arcs that cover the nearshore zone (Figure 2.4, left). Because the resolution is decreasing seaward, i.e. the cell sizes will be larger and larger, the distance between arcs should be increasing seaward to accommodate 3-4 cells in the transition.
 - It is important that all arcs create closed areas that can be used to later generate polygons.
- When drawing the polygons around the inlet, be sure to that expand much further offshore to accommodate the needed resolution to reproduce the ebb jet (Figure 2.4, right). Some arcs will need to close in the nearshore if they are much finer than the rest of your littoral zone.
- In Figure 2.5, the bay has been divided up to keep the finer resolution in the north and south channels, increasing in size (decreasing in resolution) towards the middle of the open bay.
 - Finer resolution is necessary along most estuary shorelines to properly model the wetting and drying due to the tidal range. This is done for Shark River Estuary for example, but is not necessary for much of the shoreline because it is structured (with seawalls).

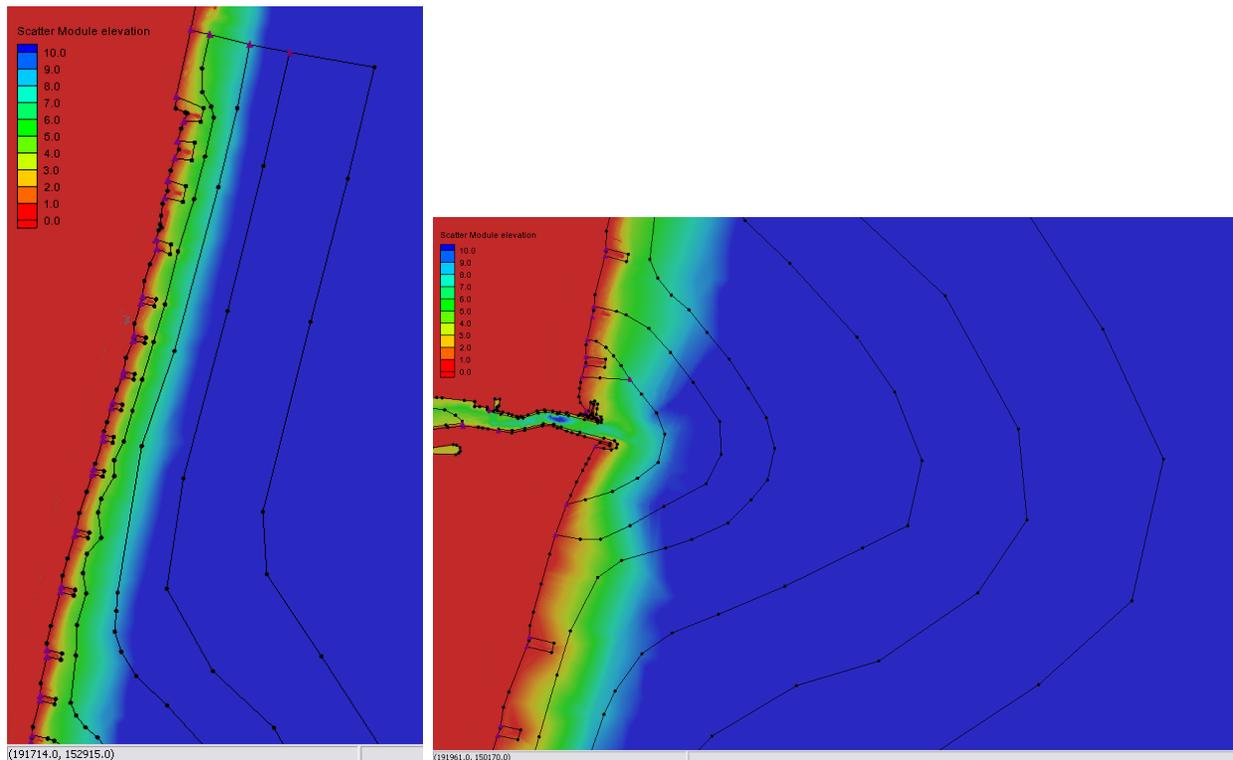


Figure 2.4. Left: resolution added to the nearshore with the finest resolution around the groins, with increasing distance moving seaward, from arc to arc. Right: continuation of the polygons around the inlet region that expand further offshore to accommodate the needed resolution to reproduce the ebb jet.

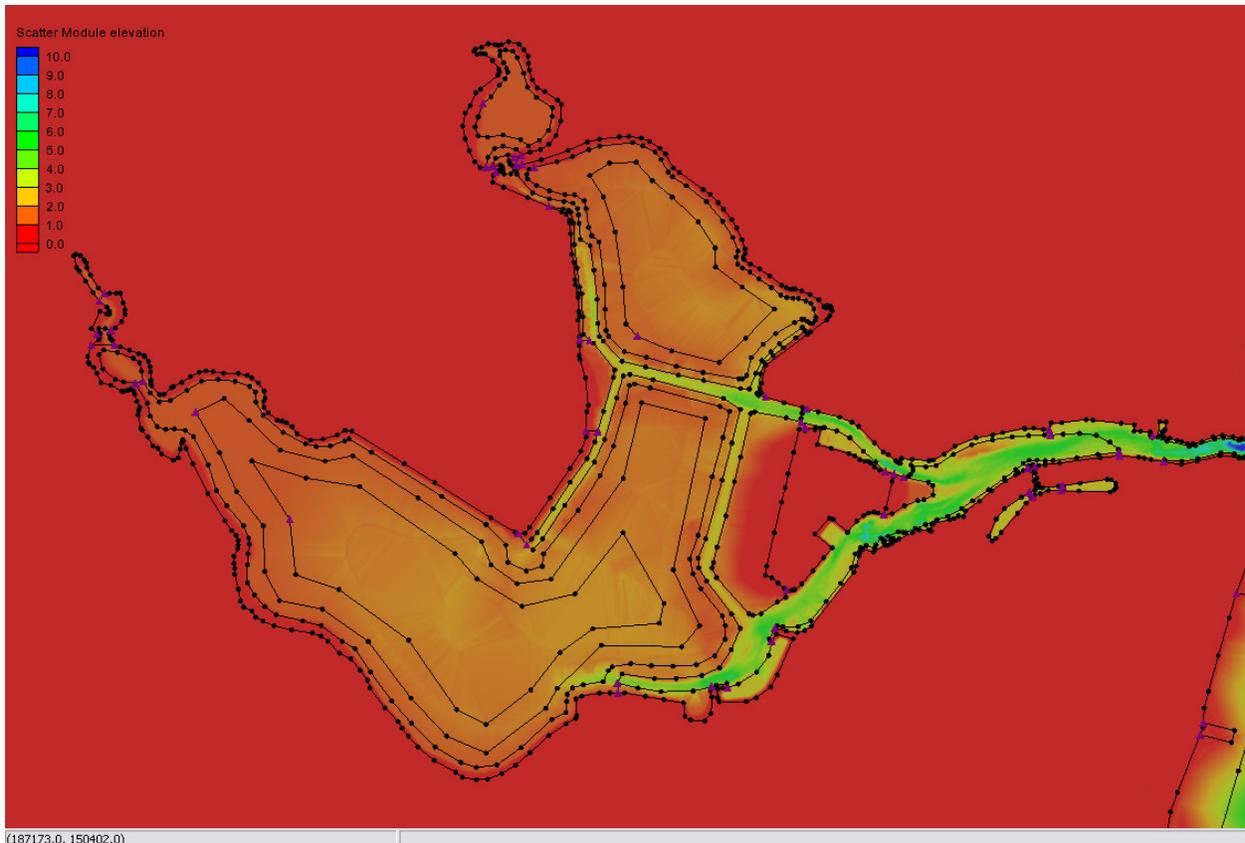
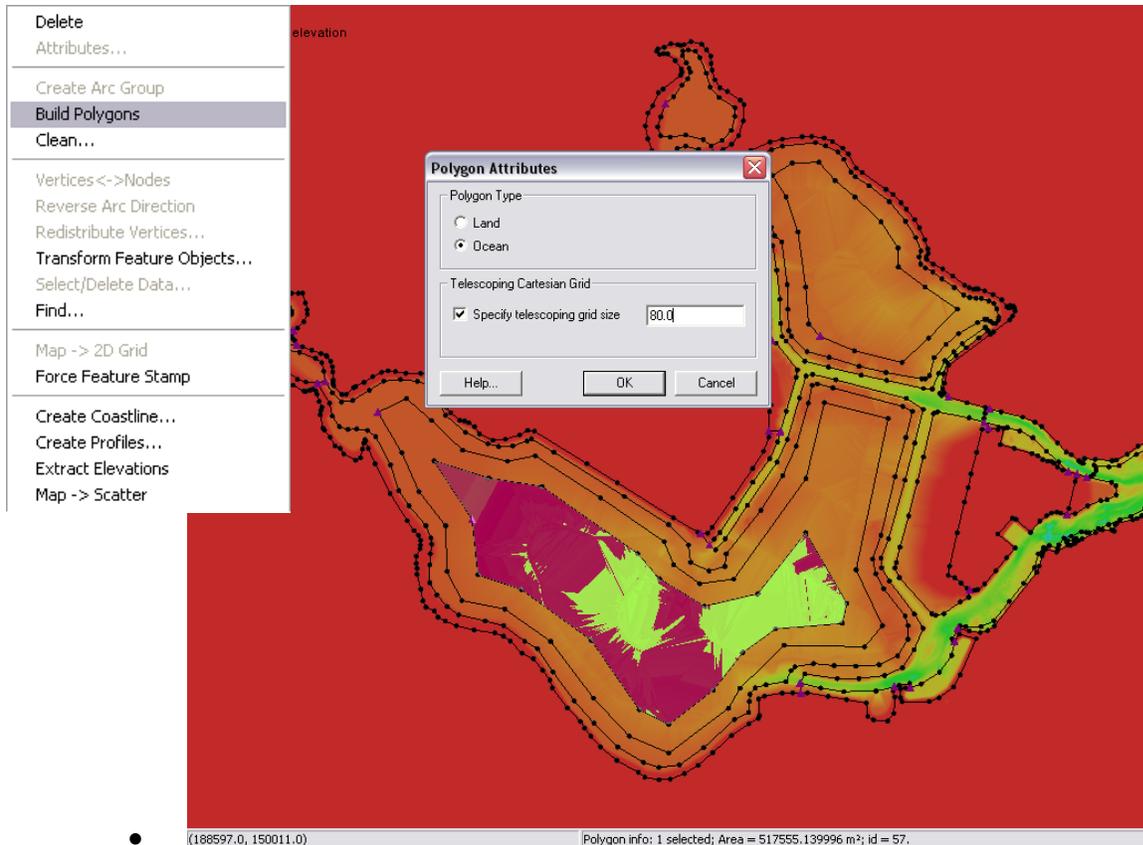


Figure 2.5. Note the decreasing resolution in the bay means wider polygons.

Once the arcs have been created, the enclosed areas are converted to polygons. These polygons can then be selected and their attributes changed to reflect the desired telescoped cell size. It's suggested to start with the smallest resolution and work outward. This will generally find any issues or constraints with how many polygons you have made in the bay, inlet, and nearshore.

- Convert Feature Arcs to Feature Polygons by selecting *Feature Objects, Build Polygons* (Figure 2.6). If a polygon isn't created for one of your arcs, it is likely that the arc doesn't completely close (see above section on 'How to Close and Arc').
- Assign resolution values to all ocean polygons, and designate appropriate polygons as land by double clicking the polygon, or, click on the select feature polygon tool, .
 - Right-click on a polygon to assign resolution, select Attributes, and specify the telescoping grid cell size desired for the polygon.
 - Repeat for all polygons in the domain.



• Figure 2.6. Note the decreasing resolution in the bay means wider polygons.

2.5 Generating the Telescoping Grid

- Generate Telescoping grid by right-clicking on *Default Coverage*, selecting *Convert, Map>2D Grid*, then defining I and J cell options for the telescoping grid (Figure 2.7)
 - Select the elevation from the merged bathymetry. There is no need to “mark cells above datum as land” because the polygons have already delineated the land areas.
- Generating the final telescoping grid typically takes some trial and error, testing to see how the grid looks, and refining the polygons. Be sure to modify the polygons to address areas of concern, particularly the number of cells across the entrance, north, and south channels, and groin cell width toward the lateral boundaries.

Figure 2.8 illustrates the grid with the bathymetry contours turned on, and a zoomed in look at the highly resolved bathymetry around the inlet. Note that there are at least 10 cells across the inlet entrance channel. Figure 2.9 illustrates what the final grid looks like with the Cartesian cells outlines in blue and brown.

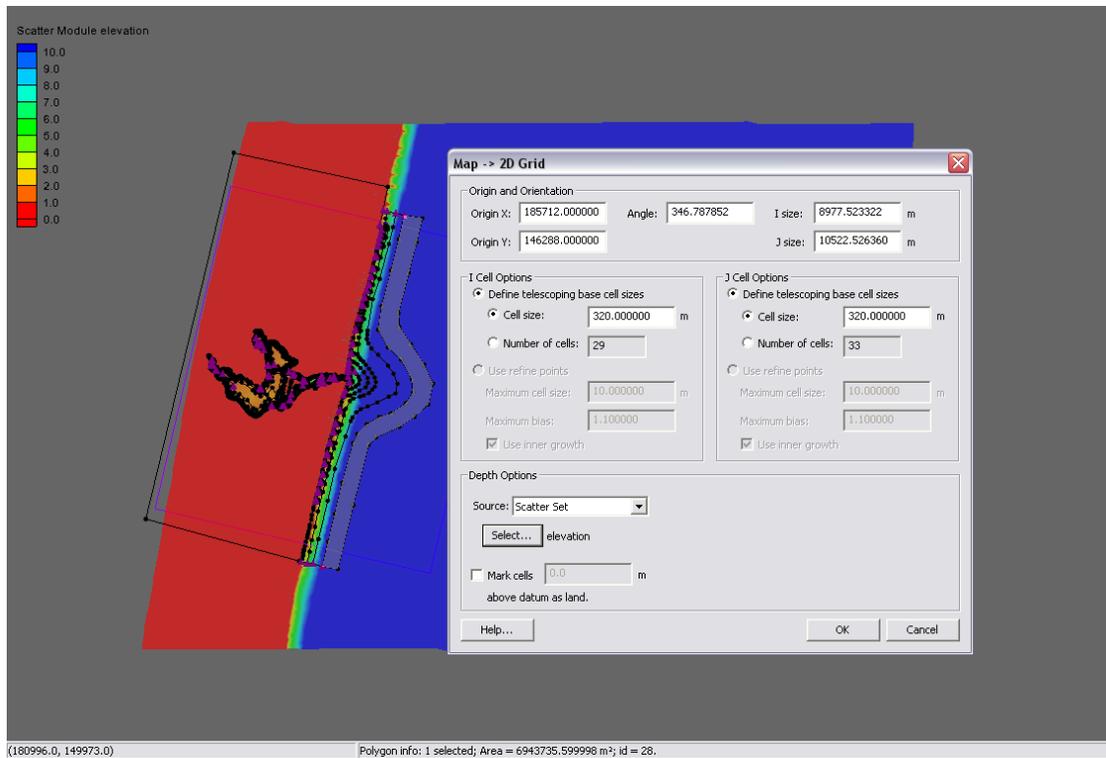


Figure 2.7. When Mapping → 2D Grid, be sure to set the telescoping base cell size to the maximum cell size the grid will automatically generate for non specified reaches.

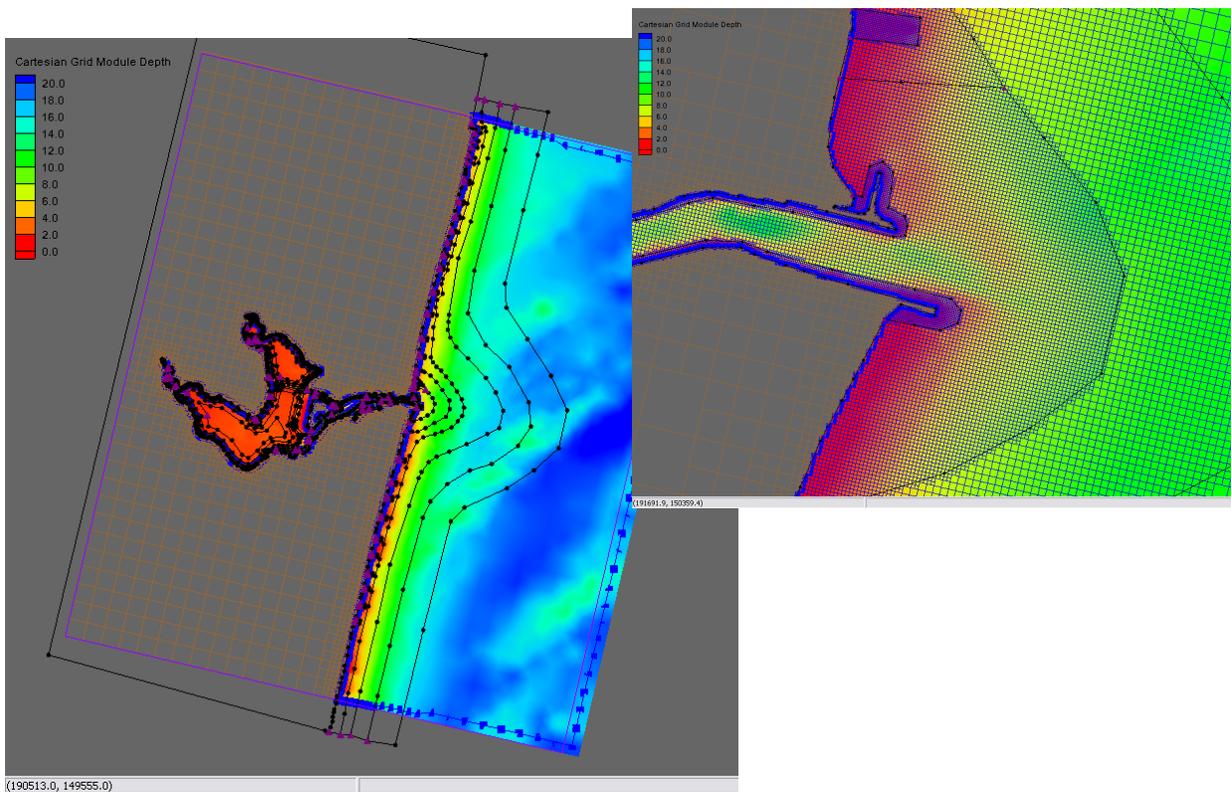


Figure 2.8. Grid showing bathymetry with arcs overlain (left). The blue-square line around the offshore boundary serves as the boundary condition “cellstring”. A close zoom to the inlet illustrates the fine resolution around the structures and across the inlet entrance channel.

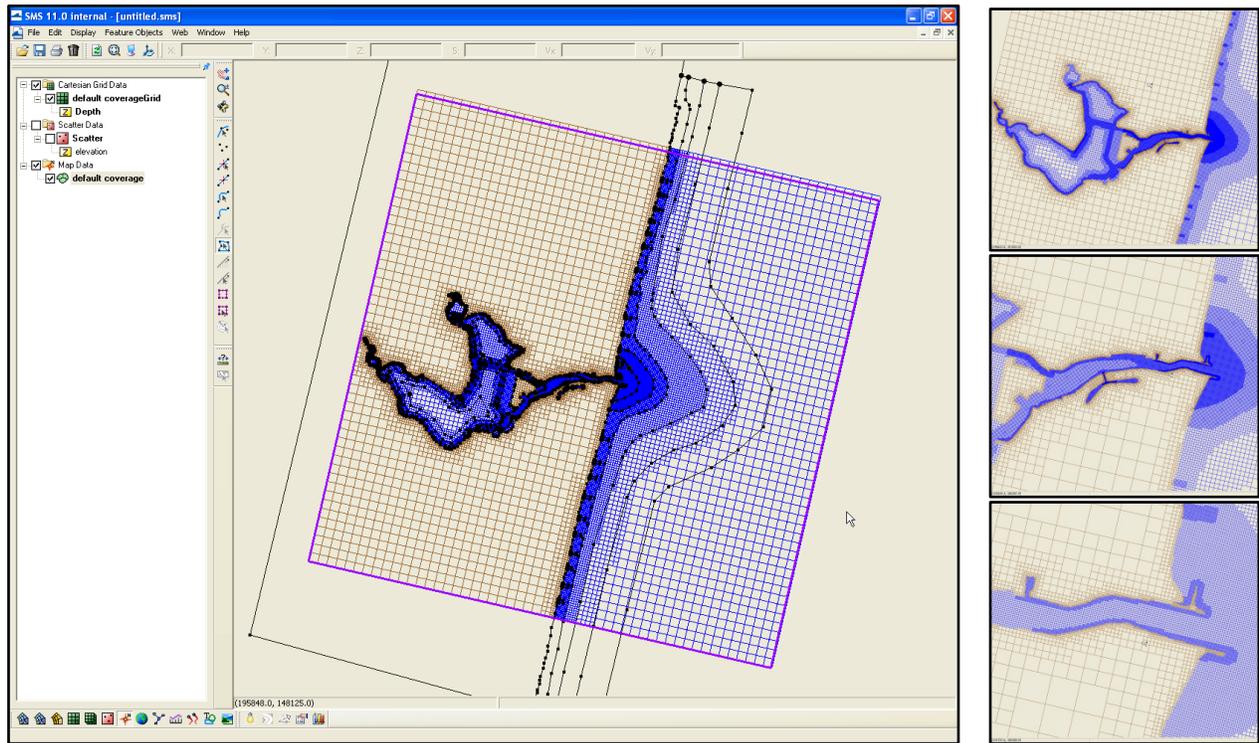


Figure 2.9. Final grid with inset figures showing resolution.