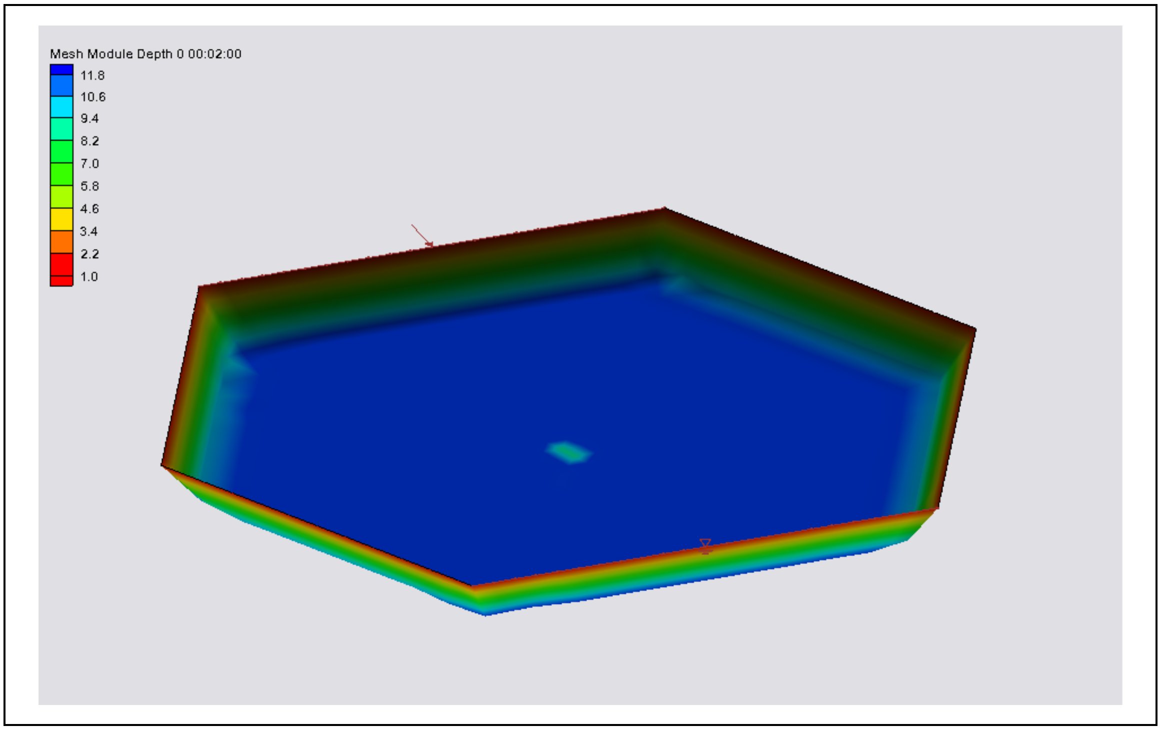
v. 11.1

SMS 11.1 Tutorial
AdH Vessels



Objectives
This tutorial will demonstrate the ability of AdH to model the effect of vessels on the hydrodynamics of a simulation. This tutorial gives a simple example of a small, shallow hexagon-shaped lake to demonstrate this feature.

Prerequisites
- Overview Tutorial
- AdH Intro Tutroral

Requirements
- ADH
- Mesh Module
- Map Module

Time
- 30-60 minutes

1 Introduction

One of the features of ADH is the ability to model the effect of vessels on the hydrodynamics of a simulation. The vessel's presence is incorporated into the model by applying a pressure field to the water column. Also the bed shear stresses due to the vessel can be output.

2 Creating Vessel

For this tutorial, you will first read in a mesh file, which has already been set up for you. This mesh represents the boundaries of a small shallow hexagonal shaped lake which will be used to simulate vessel movement.

2.1 Opening Mesh representing pond

To open the mesh:

1. Open "hexlake.2dm".
2. Select *Mesh Module*. Switch to the *ADH* model by choosing *Data* | *Switch current Model* and selecting ADH. Click OK. A warning will come up stating that switching models can result in a loss of data. Click OK and continue.
3. Select *Display* | *Display Options* and disable all mesh options except for *Contours*, *Nodestrings*, and *Mesh Boundary*.
4. Select the *Contours* tab and change the *Contour Method* to *Color Fill*. Click OK.
5. Go to *Display* | *Projection*. For both horizontal and vertical, select Local and Meters. Click Ok.

2.2 Vessel

As you can see, this lake is a simple 10 meter deep pond in the shape of a hexagon. It is about 300-350 meters across. This does not exactly represent an actual lake but it is big enough to contain a moving boat for simulation purposes.
The vessel and path information will be stored as part of an SMS coverage. The vessel attributes will be stored as coverage attributes and the path as arcs within SMS.
The effect of the propeller for vessels can also be simulated. If vessels are turned on, ADH assumes two propellers equally spaced from the middle of the boat.
First we will make the vessel.

1. Right-click on *Map Data | New Coverage*. Choose *ADH | Vessel* as the coverage type. Name the coverage “boat”. Click OK.
2. The Vessel Attributes dialog will open.
3. Under *Vessel parameters*, set the boat’s *length* to 15, *width* to 8.0, and *draft* to 3.0. Leave everything else as defaulted.
4. Select the *Include propeller data* checkbox to check it.
5. Select “open wheel” as the *propeller type*, and set *diameter* to 0.15 and *distance between propellers* to 6. It’s a big boat for such a small lake particularly with a 3 meter draft. However, its large size and excessive draft will help us to see our boat moving around.
6. Click OK to exit dialog.

Now that the vessel attributes have been defined, we need to define the path that the boat will take within the domain. The paths are defined by feature arcs. Each feature node (endpoint) has an attribute that defines the speed of the boat at that point. The speed along the arc will be interpolated from the values at the endpoints. Intermediate vertices along the arc will change the boat direction but do not affect the vessel speed. If you wish to have a speed change at a vertex convert the vertex to a node.

1. With the boat coverage active and using the *Create Feature Arc* tool, create an arc from (-50, -80) to (75, 115). This is just a simple path that will be changed later.
2. With the *Select Feature Point* tool, double-click on the first node to enter its attributes. Set the *boat speed* to 0.5 and click Ok.
3. Double-click on the second node and change its *boat speed* to 1.5. Click Ok.
4. Drag the boat coverage onto the “hexlake” mesh. This will create a link to that boat coverage, indicating that we want it included in the simulation. Figure 1 shows the Project Explorer with the created link for the ADH simulation under the Mesh Module.

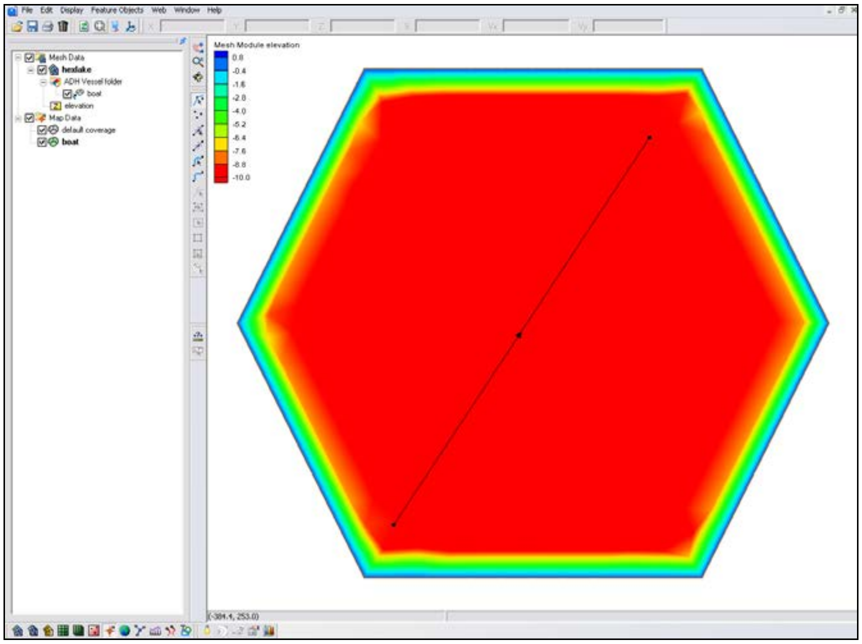


Figure 1. First Boat Path and simulation link under Mesh module.

3 Model Parameters

Next we need to set up the model parameters for the ADH simulation:

1. Click on the hexlake mesh item in the project explorer and go to *ADH* | *Model Control* in the menu. Click on the *Solver* tab.
2. Enter 40 in the text box under *Increment memory allocation block size.*
3. Next check *Include vessel stress effects*. This will make use of the propeller information we set.
4. Next select the *Time* tab.
5. We are running a dynamic simulation. Change the *start date* to 7/1/2009 1:00:00 PM. Then set the *duration* for 15 minutes.
6. Click on the *Time step size* graph. Our time steps won't change throughout the simulation. Set the *Time* column to range from day 0.0 to day 10.0. Change the *Time step size* column to 30 seconds in both rows. Click Ok.
7. Next go to the *Output* tab.

8. In the *Add by specifying a range* section, enter the following values. Start the simulation at 0.5 minutes and end it at 15.0 minutes. Change time increment to 30.0 seconds.
9. Click *Add*.
10. Since we are not changing materials or sediment data, so we can leave the other two tabs as they are. Click Ok to exit Model Control.

ADH requires you to enter initial conditions for the model. To do this:

1. Next go to *ADH | Hot Start Initial Conditions*. Select *Constant water surface* and enter 1.0 as the water *elevation*. Click Ok

4 Boundary Conditions

Now would be a good time to save your work.

1. Save your project as hexlake_001.sms. As you can continue to model, you can choose "Save Project" to save to last files saved or use "Save As" to start writing to a new set of files.

Now we should create an inlet and outlet to our lake. The water flowing past is another way we can see the effects of our boat. We will create two nodestrings one for flowrate and one for tailwater (water surface elevation) as shown in Figure 2. We will have a constant flowrate and water surface elevation throughout the simulation.

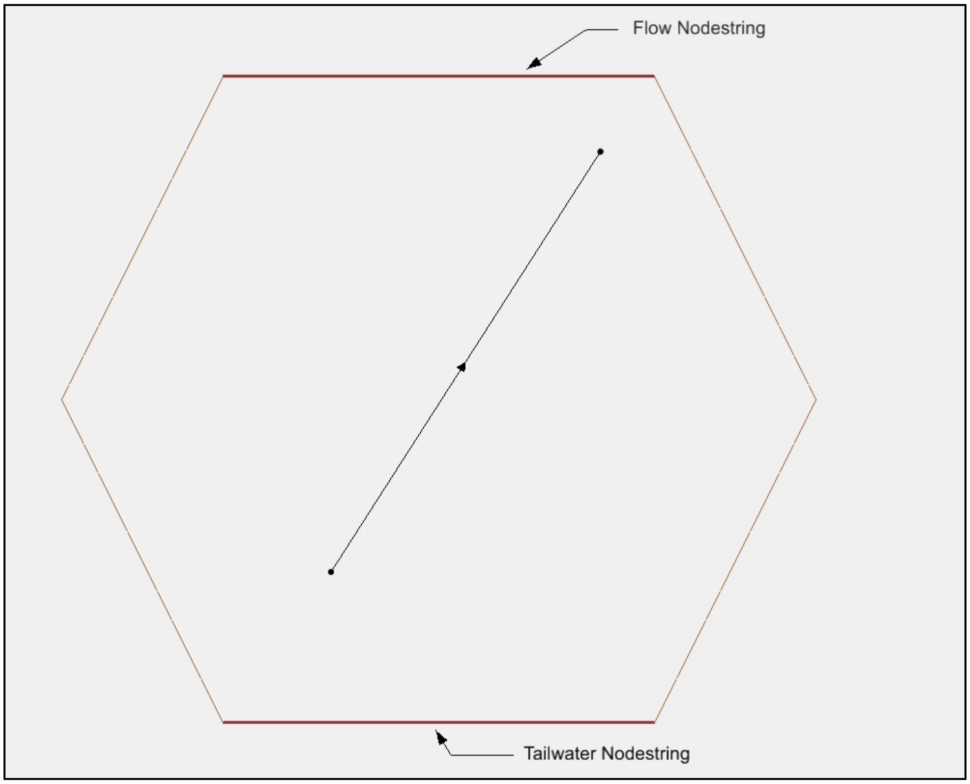


Figure 2 Boundary nodestring locations

1. With the mesh selected, choose the *Create Nodestring* tool. Click on the upper-left corner of the mesh

2. Hold shift and double-click on the upper-right corner of the mesh, creating a nodestring across the top edge of our hexagon.

   Note: Holding the shift key is very important in order for the nodestring to boundary conditions to be available so do not forget to hold the shift key when clicking in the nodestring.

3. With the *Select Nodestring* tool, select the nodestring and right-click it. Choose *Boundary Condition | Assign*.

4. In the *Flow* tab, select *Flow (per unit length)* as the type. For *Friction*, choose Manning's n and enter a *roughness* value of 0.03.

5. Click on *Curve undefined*. Click New… and name the curve "Flow data". Figure 3 shows the Time Series dialog.

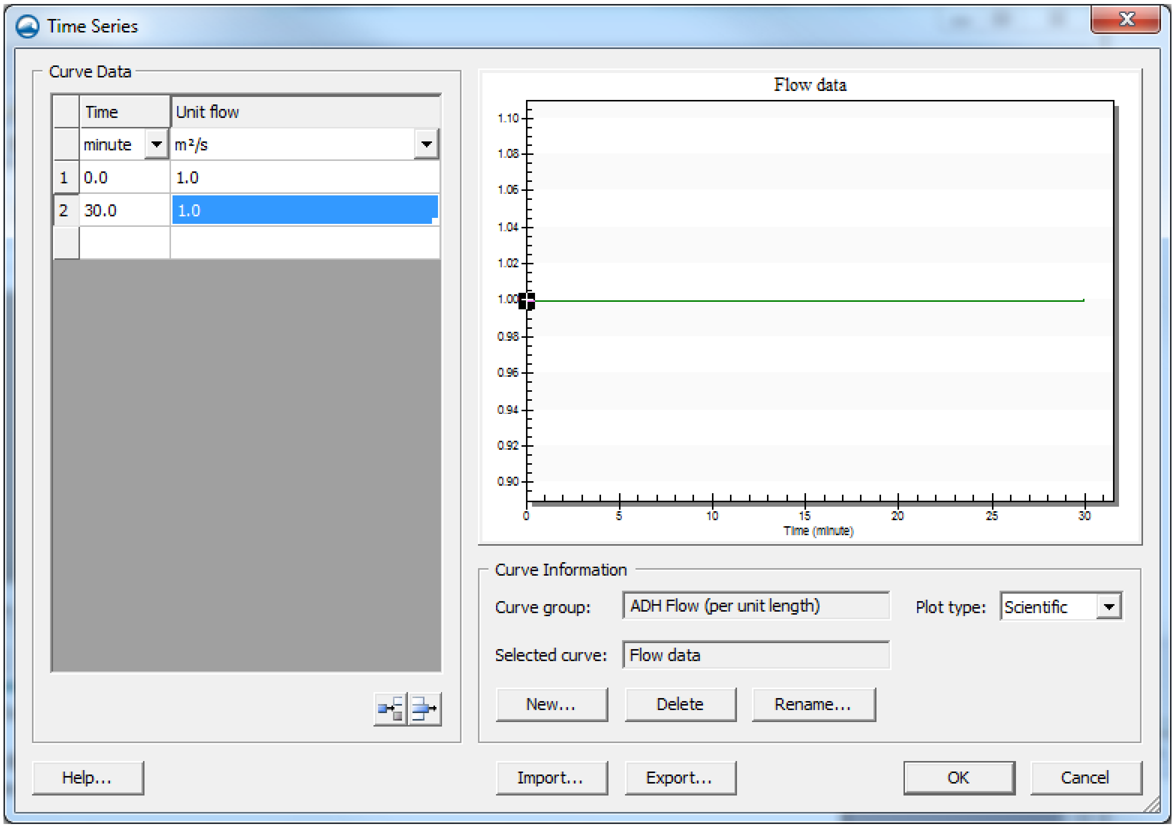


Figure 3. Time Series for Flow data.

6. In the *Time* column, choose minutes as the units and enter 0.0 and 30.0 in the rows.
7. In the *Unit flow* column, choose m^2/s as the units and enter 1.0 in both rows.
8. Click Ok twice to exit the dialogs.
9. With the *Create Nodestring* tool selected, make another nodestring across the bottom edge of the mesh starting at the lower-left corner and ending on the lower-right (remember to hold shift to make it select all nodes between the points).
10. Choose the *Select Nodestring* tool and select it. Right-click it and choose *Boundary Condition | Assign*.

11. Set this one as a *water surface elevation* type. Change Friction to Manning's n and *roughness* to 0.03.
12. Click on the Curve undefined. Click New… and name it "Water surface elevation data".
13. In the *Time column* select minute as the units, and enter 0.0 and 30.0 in the rows. In the WSE column select meters (m) as the units and enter 1.0 in both rows.
14. Click Ok twice to exit.

5 Defining Boat Path

So far our boat is kind of boring. It just goes forward from one corner of the lake to the other at about 1 meter per second on average, finishes in just under 4 minutes, and then stops there and floats in place for the remainder of the 15 minute simulation. That's not especially thrilling, so let's give it more to do.

1. Using the *Create Feature Arc* tool, add additional segments to the arc. You can also select vertices and right-click on them and select "Convert to node". Nodes are able to change the speed of the boat at that location. Vertices simply interpolate their speed based on the nodes before and after them. The following Table 1 shows a list of points and their attributes. It might be easiest to create all of the points as stand alone points using the edit fields at the top of the dialog, connect them as arcs and then convert the appropriate nodes to vertices. When you are finished the boat path should look like Figure 4.

Table 1. List of Nodes and Vertices for Boat path.

X	Y	Type	Speed
130	10	Node	1
130	-15	Vertex	--
60	-115	Node	2
-75	-115	Node	10
-125	-15	Node	10
-125	10	Node	0.3
-55	120	Node	0.3

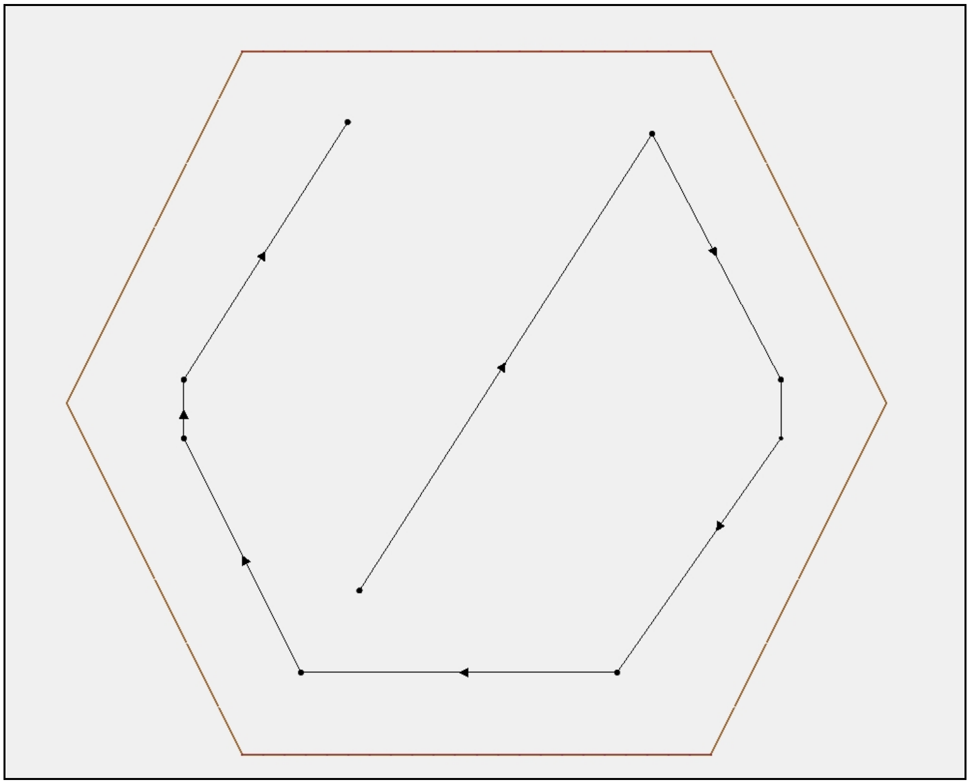


Figure 4 Full boat path

This path simply takes the boat around the edges of the lake. It starts out at a speed, of 1-2 m/s. Near the bottom it throttles up to 10 m/s (36 kph), then slows down quickly to almost a stop, and drifts the rest of the way at a very low speed.

6 Model Check and Simulation Run

1. Select the mesh and use *File* | *Save As* and save the project as hexlake_002.sms.
2. Switch to the mesh module by clicking on the mesh item “hexlake”
3. Then go to *ADH* | *Model Check*. There shouldn’t be any problems, but if there are, follow the steps in the dialog to solve them.
4. Click *ADH* | *Run ADH*. Pre-ADH runs first to set things up and check for problems.
5. When it finishes, click the Run ADH button to get ADH started. When the model finishes, click Exit and the solution will load automatically (if you left the checkbox checked). If it asks you to select time units, leave it in seconds.

6. Select the Depth dataset and step through the time steps. You can see the boat as it moves along the left edge, zips around the bottom right corner, and then slows down for the final segment.
7. You can also open hexlake_str.dat from the same location where you saved your ADH files. This is the vessel stress file.
8. We also have the Overland Velocity Dataset. Enter the display options and select Mesh. Turn on Vectors and click Ok. Now step through the time steps again, and you can see the direction of flow throughout the simulation.

7 Conclusion

This concludes the *ADH Vessel* tutorial.