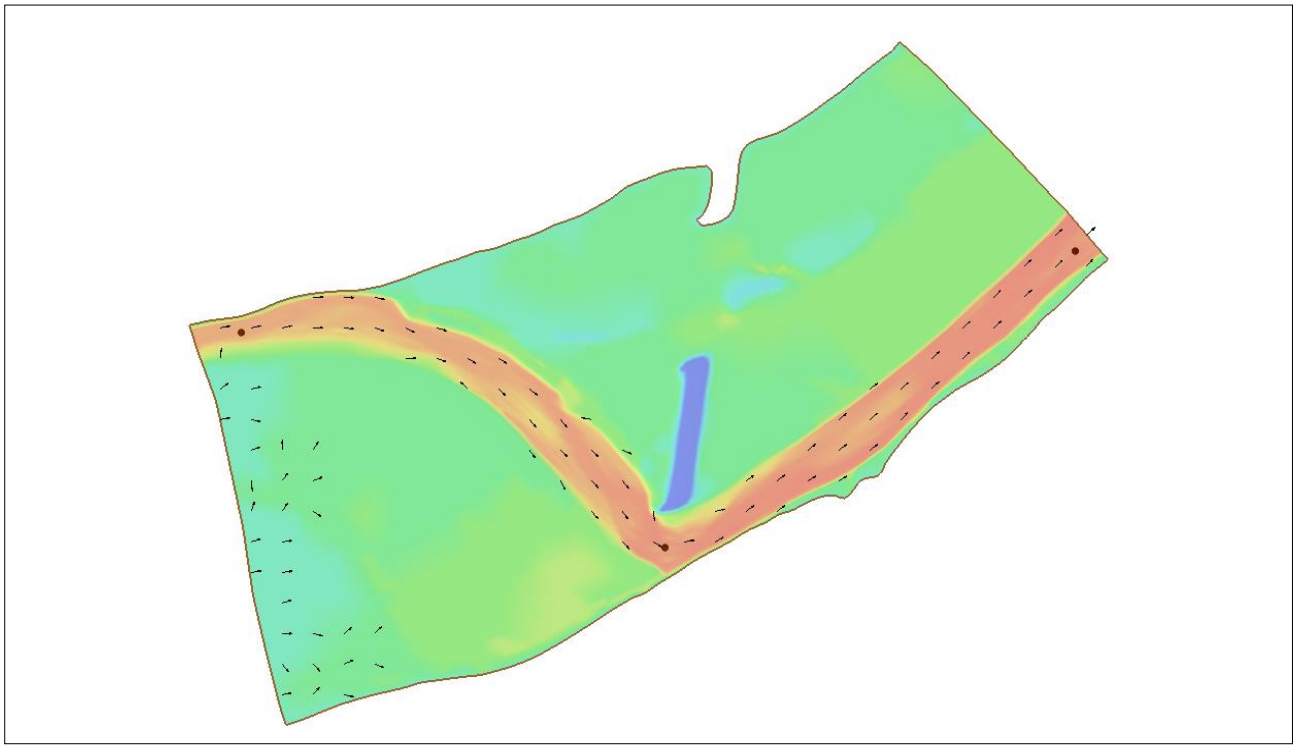
SMS

v. 12.2

SMS 12.2 Tutorial

SRH-2D – Additional Boundary Conditions



Objectives

Learn techniques for using various additional boundary conditions with the Sedimentation and River Hydraulics – Two-Dimensional (SRH-2D) engine.

Prerequisites

- SMS Overview tutorial
- SRH-2D
- SRH-2D Post-Processing

Requirements

- SRH-2D Model
- Map Module
- Mesh Module
- Data Files

Time

- 20–30 minutes

AQUAVEO™

1 Introduction

The Sedimentation and River Hydraulics – Two-Dimensional (SRH-2D) model is a two-dimensional (2D) hydraulic, sediment, temperature, and vegetation model for river systems developed at the United States Bureau of Reclamation (USBR) and sponsored by the United States Federal Highway Administration (FHWA).

This tutorial builds on previous SRH-2D tutorials and illustrates additional boundary conditions to represent transient conditions or ungaged outflow. Each major section of this tutorial can be completed independently and in any order.

2 Using a Hydrograph as the Inflow Boundary Condition

This section shows how to define the inflow, create monitor points, update the model control for proper output, and then run SRH-2D. The unsteady state model allows using a hydrograph inflow instead of a constant discharge.

If working this section independently, open the project file by doing the following:

1. Select *File* | **Open…** to bring up the *Open* dialog.
2. Select "Project Files (*.sms)" from the *Files of type* drop-down.
3. Browse to the *data files* folder for this tutorial and select "CimarronTutorial.sms".

This file contains the SMS project.

4. Click **Open** to open the SMS project file and exit the *Open* dialog.

The project should appear similar to Figure 1.

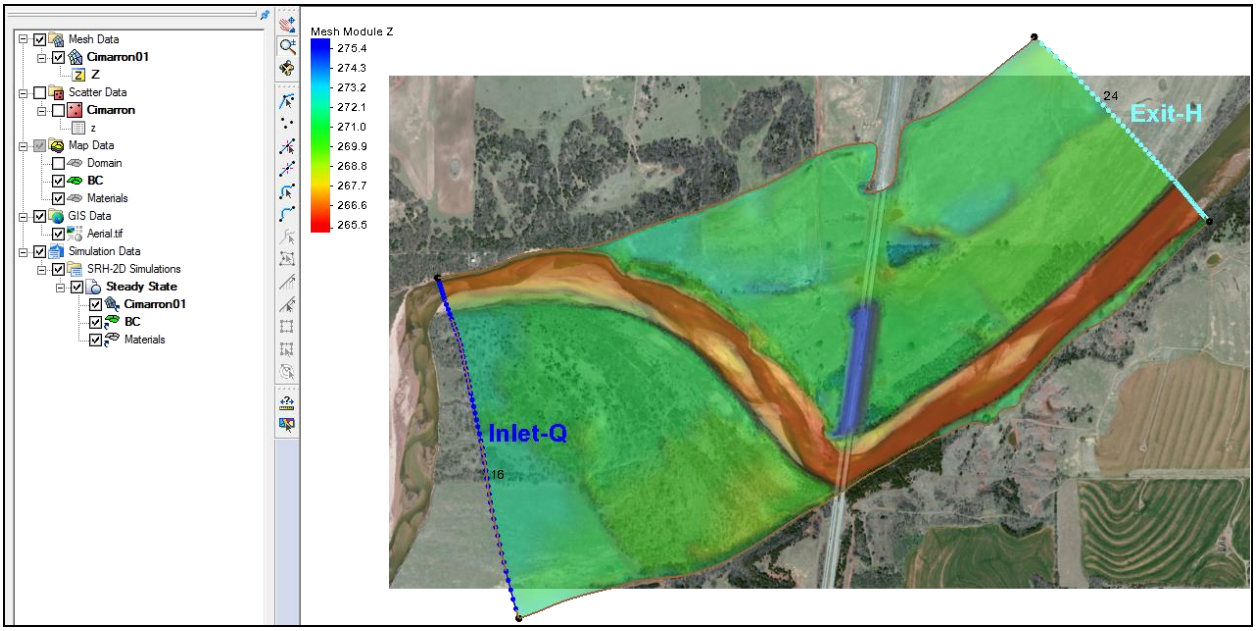


Figure 1 Initial project

2.1 Defining the Inflow Hydrograph

To define the inflow hydrograph:

1. **Zoom** in near the inflow (upstream) boundary on the left side of the model.
2. Select "BC" in the Project Explorer to make it active.
3. Using the **Select Feature Arc** tool, select the *Inlet-Q* arc.
4. Right-click and select **Assign Linear BC…** to bring up the *SRH-2D Linear BC* dialog.
5. In the *Discharge Options* section, select "Time Series" from the *Discharge (Q)* drop-down.
6. Select "hrs -vs- cms" from the drop-down to the right of the **Define curve…** button.
7. Click **Define curve…** to open the *XY Series Editor* dialog.
8. Outside of SMS, browse to the *data files* folder for this tutorial and open "InflowHydrograph.xls" in a spreadsheet program.
9. Copy the numerical values from the *Time (hrs)* column in the "InflowHydrograph.xls" file to the *hrs* column in the *XY Series Editor* dialog.
10. Copy the values from the *Flow (cms)* column in the "InflowHydrograph.xls" file to the *vol/sec* column in the *XY Series Editor* dialog. The graph should appear as in Figure 2.
11. Click **OK** to close the *XY Series Editor* dialog.
12. Click **OK** to close the *SRH-2D Linear BC* dialog.

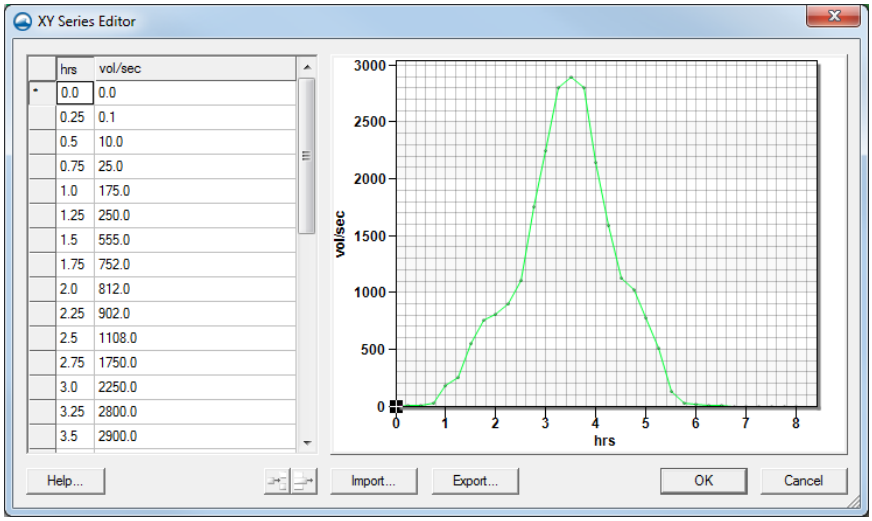


Figure 2 XY Series Editor dialog once values are entered

2.2 Creating Monitor Points

SRH-2D exports solution time series at every monitor point. Using monitor points is useful when the hydraulic parameters need to be determined at specific locations in the model domain. It is necessary to create three monitor points: one near each end of the model and one at the middle.

To do this:

1. Right-click "Map Data" in the Project Explorer and select **New Coverage** to bring up the *New Coverage* dialog.
2. In the *Coverage Type* section, select *Models* | *SRH-2D* | **Monitor Points**.
3. Accept the default "Monitor Points" as the *Coverage Name* and click **OK** to close the *New Coverage* dialog.
4. Select "Monitor Points" to make it active.
5. Using the **Create Feature Point** tool, create three monitor points as shown Figure 3.

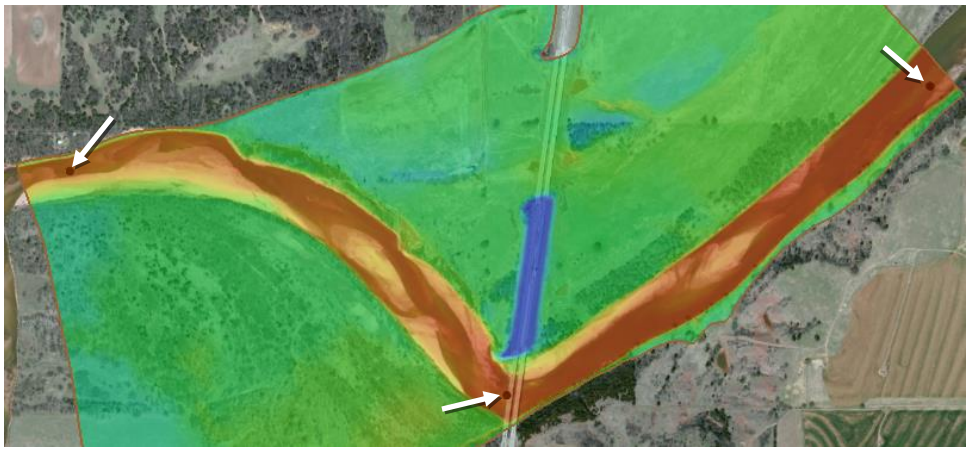


Figure 3 Monitor points at upstream, midway between, and downstream

There are no attributes necessary for these points. However, it is necessary to assign the Monitor Points coverage to the model so that SRH-2D knows where these points are located.

6. Right-click on "Monitor Points" and select *Link to* | **SRH-2D Simulations→Steady State**.

These monitor points are not required to run SRH-2D, but they can provide helpful information.

2.3 Updating the Model Control

Since the model attributes have changed, it is recommended to change the *Case Name* in the *Model Control* dialog so the previous input files are not overwritten.

To do this:

1. Right-click "Steady State" and select **Model Control…** to bring up the *Model Control* dialog.
2. On the *General* tab, in the *Hydrodynamics* section, enter "Hydrograph" as the *Case Name*.
3. Leave all other settings at the default and click **OK** to close the *Model Control* dialog.

2.4 Running SRH-2D

The SMS project should be saved with a different name in a different folder so the results from any previous solution will not be overwritten.

To do this:

1. Select *File* | **Save As…** to bring up the *Save As* dialog.
2. Browse to the *data files* folder for this tutorial and click **New Folder**.
3. Enter "Hydrograph" and press *Enter* to set the new name.
4. Double-click on the "Hydrograph" folder to open it.
5. Select "Project Files (*.sms)" from the *Save as type* drop-down.
6. Enter "CimarronHydro.sms" in the *File name* field.
7. Click **Save** to save the project under the new name and close the *Save As* dialog.
8. Right-click "Steady State" and select **Save, Export and Launch SRH-2D** to bring up the *SRH-2D: Steady State* model wrapper dialog and the SRH-2D model run monitor window.
9. Click **OK** if advised that one or more coverages will be renumbered before exporting.
10. In the SRH-2D model run monitor window, there will be one or more sub-windows visible. Select *Window* | **Tile** to view all of them at the same time, or select each in turn. Use the scroll bars in each sub-window to view the charts and other information.

SRH-2D plots water surface elevation (WSE) versus time charts at the monitor points as the model run progresses (Figure 4). This provides an idea of how well the model is performing. Once the run completes, the results can be visualized as desired.

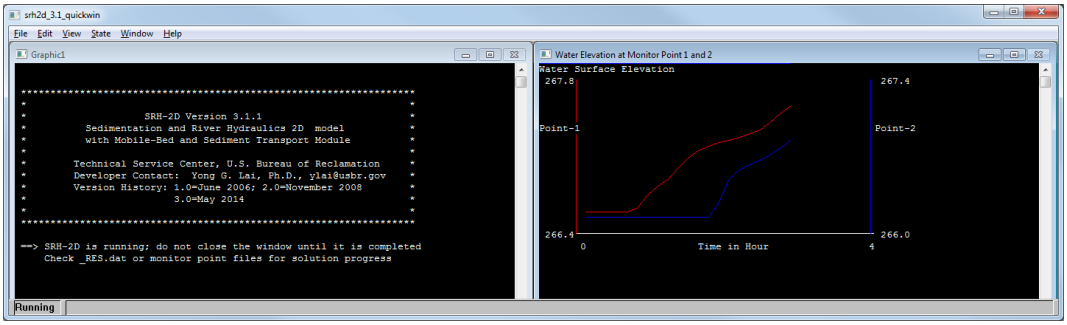


Figure 4 WSE at monitor points and residual monitor windows

11. When SRH-2D is finished, a dialog will appear asking to close the SRH-2D model run monitor window. Do one of the following:
    - Click **Yes** to close the SRH-2D model run monitor window.
    - Click **No** to review the plots in the SRH-2D model run monitor window. Once finished reviewing the plots, click the **Close** button at the top right of the SRH-2D model run monitor window to close it.
12. Turn on *Load Solution* and click **Exit** to close the *SRH-2D: Steady State* dialog.

SRH-2D creates a DAT file at each of the monitor points. These DAT files are located in the *data files\Hydrograph\CimarronHydro\SRH-2D\Steady State* folder and contain all the model output parameters exported for each monitor point. The values in these files can be used for hydraulic analysis and designs. A spreadsheet program can also be used to plot these values.

SMS also created several scalar and vector datasets under the "Cimarron01" mesh in the Project Explorer.

3 Using a Rating Curve on the Downstream Boundary

This section of the tutorial shows how to use a rating curve on the downstream boundary. It will first be defined, the model control will be updated, and SRH-2D will be run. To begin this section, do the following:

1. Press *Ctrl-N* or select *File* | **Delete All** to clear any existing projects.
2. Select *File* | **Open…** to bring up the *Open* dialog.
3. Browse to the *data files* folder for this tutorial and select "CimarronTutorial.sms".

This file contains the SMS project.

4. Click **Open** to open the SMS project and close the *Open* dialog.

The project should appear similar to Figure 1.

3.1 Defining the Rating Curve

1. **Zoom** in near the downstream boundary on the right side of the model (labeled "Exit-H" in Figure 1).
2. Select the "BC" coverage in the Project Explorer to make it active.
3. Using the **Select Feature Arc** tool, click on the *Exit-H* arc to select it.
4. Right-click and select **Assign Linear BC…** to bring up the *SRH-2D Linear BC* dialog.
5. Select "Exit-H (subcritical outflow)" from the *Type* drop-down.
6. In the *Exit Water Surface Options* section, select "Rating Curve" from the *Water Elevation (WSE)* drop-down.
7. Select "cms-vs-meters" from the drop-down just to the right of the **Define curve…** button.
8. Click **Define curve…** button to open the *XY Series Editor* dialog.
9. Outside of SMS, browse to the *data files* folder for this tutorial and open "RatingCurve.xls" in a spreadsheet program.
10. Copy the values from the *Flow (cms)* column in the "RatingCurve.xls" file to the *vol/sec* column in the *XY Series Editor* dialog.
11. Copy the values from the *Elevation (m)* column in the "RatingCurve.xls" file to the *WSE* column in the *XY Series Editor* dialog. The graph should appear as in Figure 5.
12. Click **OK** to close the *XY Series Editor* dialog.
13. Click **OK** to close the *SRH-2D Linear BC* dialog.

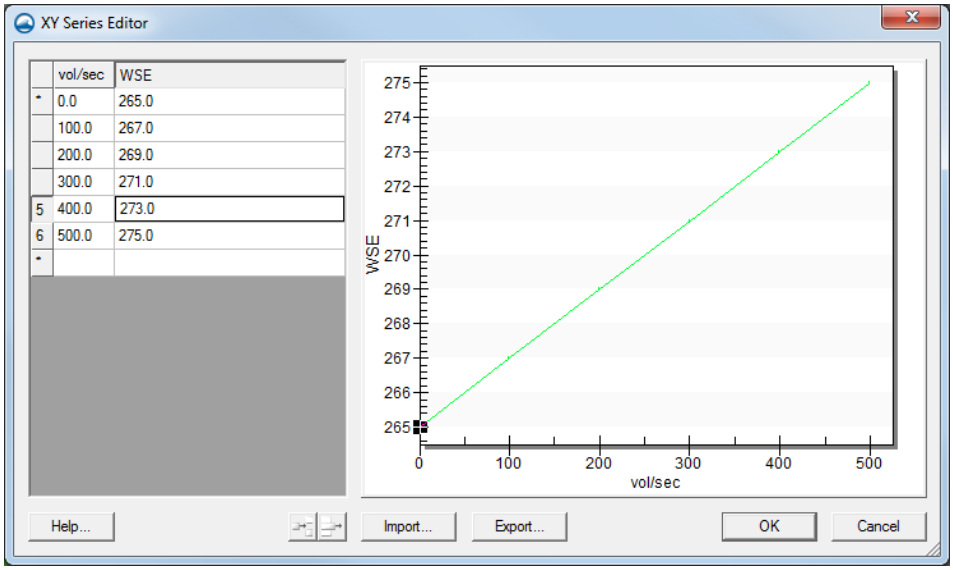


Figure 5 Rating curve in the XY Series Editor dialog

3.2 Creating Monitor Points

SRH-2D exports solution time series at every monitor point. Using monitor points is useful when the hydraulic parameters need to be determined at specific locations in the model domain. It is necessary to create three monitor points: one near each end of the model and one at the middle.

To do this:

1. Right-click "Map Data" in the Project Explorer and select **New Coverage** to bring up the *New Coverage* dialog.
2. In the *Coverage Type* section, select *Models* | *SRH-2D* | **Monitor Points**.
3. Accept the default "Monitor Points" as the *Coverage Name* and click **OK** to close the *New Coverage* dialog.
4. Select "Monitor Points" to make it active.
5. Using the **Create Feature Point** tool, create three monitor points as shown in Figure 6.

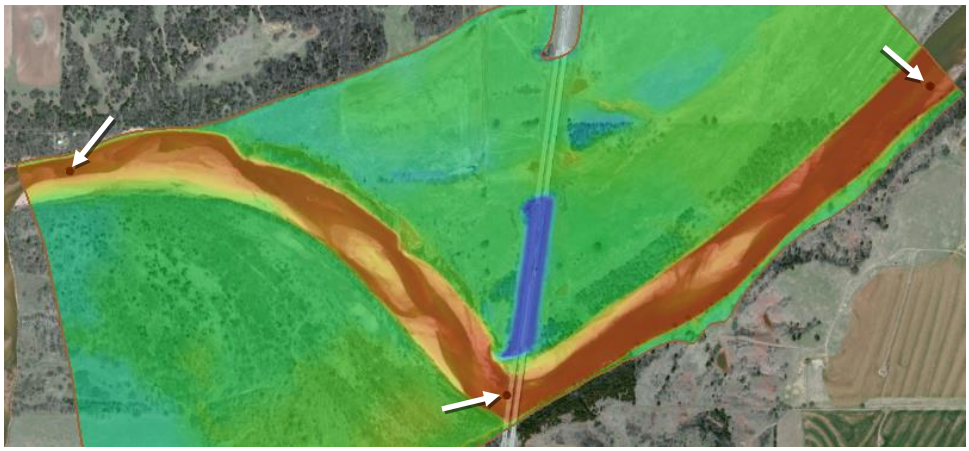


Figure 6 Monitor points at upstream, midway between, and downstream

There are no attributes necessary for these points. However, it is necessary to assign the Monitor Points coverage to the model so that SRH-2D knows where these points are located.

6. Right-click on the "Monitor Points" coverage and select *Link to* | **SRH-2D Simulations→Steady State**.

These monitor points are not required to run SRH-2D, but they can provide helpful information.

3.3 Updating the Model Control

Since the model attributes have changed, it is recommended to change the *Case Name* in the *Model Control* dialog so the previous input files are not overwritten.

To do this:

1. Right-click "Steady State" and select **Model Control…** to bring up the *Model Control* dialog.

2. On the *General* tab, in the *Hydrodynamics* section, change the *Case Name* to "RatingCurve".
3. Leave all other settings at the default and click **OK** to close the *Model Control* dialog.

3.4 Running SRH-2D

The SMS project should be saved with a different name in a different folder so the results from any previous solution will not be overwritten.

To do this:

1. Select *File* | **Save As…** to bring up the *Save As* dialog.
2. Browse to the *data files* folder for this tutorial and click **New Folder**.
3. Enter "RatingCurve" and press *Enter* to set the new name.
4. Double-click on the new "RatingCurve" folder to open it.
5. Select "Project Files (*.sms)" from the *Save as type* drop-down.
6. Enter "CimarronRC.sms" in the *File name* field.
7. Click **Save** to save the project under the new name and close the *Save As* dialog.
8. Right-click "Steady State" and select **Save, Export and Launch SRH-2D** to bring up the *SRH-2D: Steady State* model wrapper dialog and the SRH-2D model run monitor window.
9. Click **OK** if advised that one or more coverages will be renumbered before exporting.
10. In the SRH-2D model run monitor window, there will be one or more sub-windows visible. Select *Window* | **Tile** to view all of them at the same time, or select each in turn. Use the scroll bars in each sub-window to view the charts and other information.

SRH-2D will plot water surface elevation (WSE) versus time charts at the monitor points as the model run progresses. This provides an idea of how well the model is performing. Once the run completes, the results can be visualized as desired.

11. When SRH-2D is finished, a dialog will appear asking to close the SRH-2D model run monitor window. Do one of the following:
    - Click **Yes** to close the SRH-2D model run monitor window.
    - Click **No** to review the plots in the SRH-2D model run monitor window. Once finished reviewing the plots, click the **Close** button at the top right of the SRH-2D model run monitor window to close it.
12. Click **Exit** to close the *SRH-2D: Steady State* dialog.

SRH-2D creates a DAT file at each of the monitor points. These DAT files are located in the *data files\Hydrograph\CimarronHydro\SRH-2D\Steady State* folder and contain all the model output parameters exported for each monitor point. The values in these files can be used for hydraulic analysis and designs. A spreadsheet program can also be used to plot these values.

SMS also created several scalar and vector datasets under the "Cimarron01" mesh in the Project Explorer.

4 Using Variable WSE on the Downstream Boundary

In this section, change the downstream BC to use a time varying water surface elevation. It will first be defined, the model control will be updated, and SRH-2D will be run. To begin, do the following:

1. Press *Ctrl-N* or select *File* | **Delete All** to clear any existing projects.
2. Select *File* | **Open…** to bring up the *Open* dialog.
3. Browse to the *data files* folder for this tutorial and select "CimarronTutorial.sms".

This file contains the SMS project.

4. Click **Open** to open the SMS project and close the *Open* dialog.

The project should appear similar to Figure 1.

4.1 Defining a Variable WSE Curve

1. **Zoom** in near the downstream boundary of the model.
2. Select "BC" in the Project Explorer to make it active.
3. Using the **Select Feature Arc** tool, click on the *Exit-H* arc to select it.
4. Right-click and select **Assign Linear BC…** to bring up the *SRH-2D Linear BC* dialog.
5. Select "Exit-H (subcritical outflow)" from the *Type* drop-down.
6. In the *Exit Water Surface Options* section, select "Time Series" from the *Water Elevation (WSE)* drop-down.
7. Select "hrs-vs-meters" from the drop-down just to the right of the **Define curve…** button.
8. Click **Define curve…** to open the *XY Series Editor* dialog.
9. Outside of SMS, browse to the *data files* folder for this tutorial and open "VariableWSE.xls" in a spreadsheet program.
10. Copy the values from the *Time (hrs)* column in the "VariableWSE.xls" file to the *hrs* column in the *XY Series Editor* dialog.
11. Copy the values from the *Elevation (m)* column in the "VariableWSE.xls" file to the *m or ft* column in the *XY Series Editor* dialog. The plot should appear as in Figure 7.
12. Click **OK** to close the *XY Series Editor* dialog.
13. Click **OK** to close the *SRH-2D Linear BC* dialog.

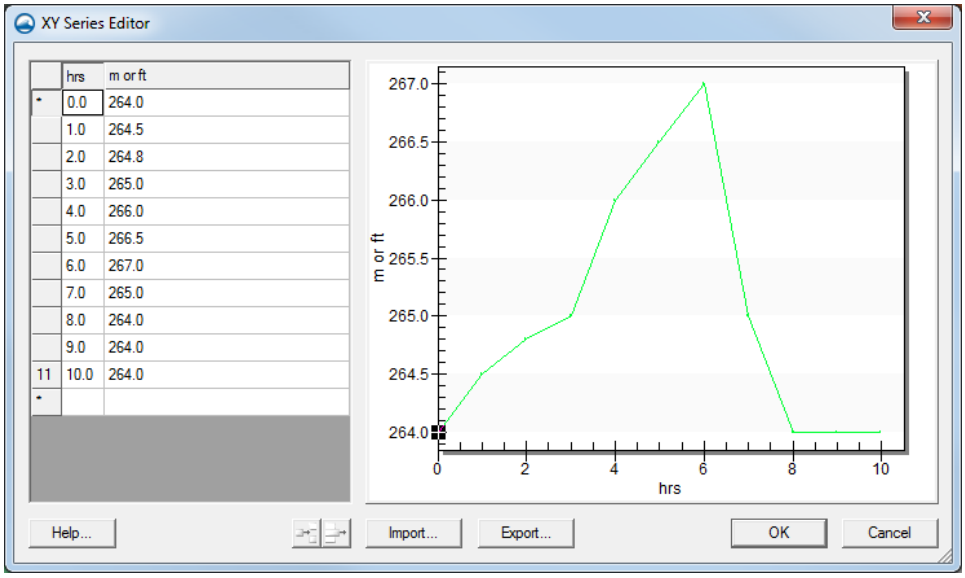


Figure 7 Variable WSE plot in the XY Series Editor dialog

4.2 Creating Monitor Points

SRH-2D exports solution time series at every monitor point. Using monitor points is useful when the hydraulic parameters need to be determined at specific locations in the model domain. It is necessary to create three monitor points: one near each end of the model and one at the middle.

To do this:

1. Right-click "Map Data" in the Project Explorer and select **New Coverage** to bring up the *New Coverage* dialog.
2. In the *Coverage Type* section, select *Models* | *SRH-2D* | **Monitor Points**.
3. Accept the default "Monitor Points" as the *Coverage Name* and click **OK** to close the *New Coverage* dialog.
4. Select the "Monitor Points" coverage to make it active.
5. Using the **Create Feature Point** tool, create three monitor points as shown in Figure 8.

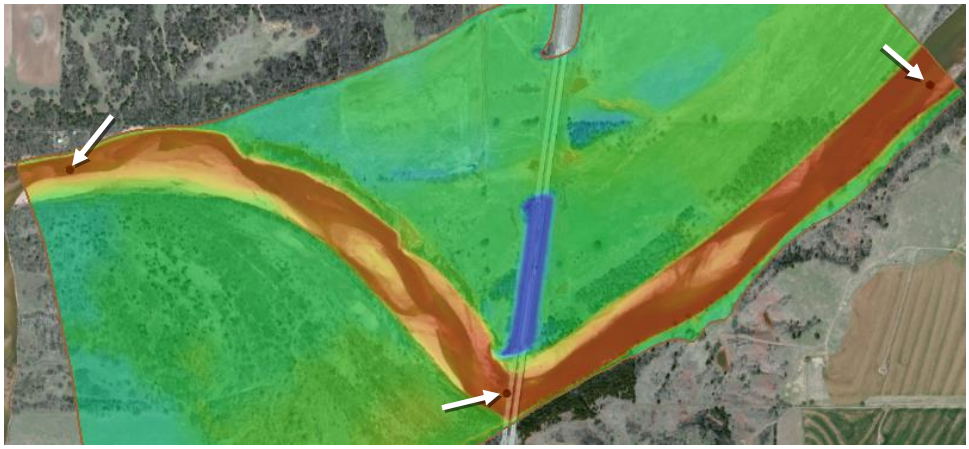


Figure 8 Monitor points at upstream, midway between, and downstream

There are no attributes necessary for these points. However, it is necessary to assign the Monitor Points coverage to the model so that SRH-2D knows where these points are located.

6. Right-click on the "Monitor Points" coverage and select *Link to* | **SRH-2D Simulations→Steady State**.

The monitor points in this section are not required to run SRH-2D, but they can provide helpful information.

4.3 Updating the Model Control

Since the model attributes have changed, it is recommended to change the *Case Name* in the *Model Control* dialog so the previous input files are not overwritten.

To do this:

1. Right-click on the "Steady State" simulation and select **Model Control…** to bring up the *Model Control* dialog.
2. On the *General* tab, in the *Hydrodynamics* section, change the *Case Name* to "VariableWSE".
3. Leave all other settings at the default and click **OK** to close the *Model Control* dialog.

4.4 Running SRH-2D

The SMS project should be saved with a different name in a different folder so the results from any previous solution will not be overwritten.

To do this:

1. Select *File* | **Save As…** to bring up the *Save As* dialog.
2. Browse to the *data files* folder for this tutorial and click **New Folder** .
3. Enter "VariableWSE" and press *Enter* to set the new name.
4. Double-click on the new "VariableWSE" folder to switch to it.

5. Select "Project Files (*.sms)" from the *Save as type* drop-down.
6. Enter "CimarronVWSE.sms" in the *File name* field.
7. Click **Save** to save the project under the new name and close the *Save As* dialog.
8. Right-click "Steady State" and select **Save, Export and Launch SRH-2D** to bring up the *SRH-2D: Steady State* model wrapper dialog and the SRH-2D model run monitor window.
9. Click **OK** if advised that one or more coverages will be renumbered before exporting.
10. In the SRH-2D model run monitor window, there will be one or more sub-windows visible. Select *Window* | **Tile** to view all of them at the same time, or select each in turn. Use the scroll bars in each sub-window to view the charts and other information.

SRH-2D will plot water surface elevation (WSE) versus time charts at the monitor points as the model run progresses. This provides an idea of how well the model is performing. Once the run completes, the results can be visualized as desired.

11. When SRH-2D is finished, a dialog will appear asking to close the SRH-2D model run monitor window. Do one of the following:
    - Click **Yes** to close the SRH-2D model run monitor window.
    - Click **No** to review the plots in the SRH-2D model run monitor window. Once finished reviewing the plots, click the **Close** button at the top right of the SRH-2D model run monitor window to close it.
12. Click **Exit** to close the *SRH-2D: Steady State* dialog.

SRH-2D creates a DAT file at each of the monitor points. These DAT files are located in the *data files\Hydrograph\CimarronHydro\SRH-2D\Steady State* folder and contain all the model output parameters exported for each monitor point. The values in these files can be used for hydraulic analysis and designs. A spreadsheet program can also be used to plot these values.

SMS also created several scalar and vector datasets under the "Cimarron01" mesh in the Project Explorer.

5 Conclusion

This concludes the "SRH-2D Additional Boundary Conditions" tutorial. If desired, further experiment with the model in SMS or continue on to other tutorials.