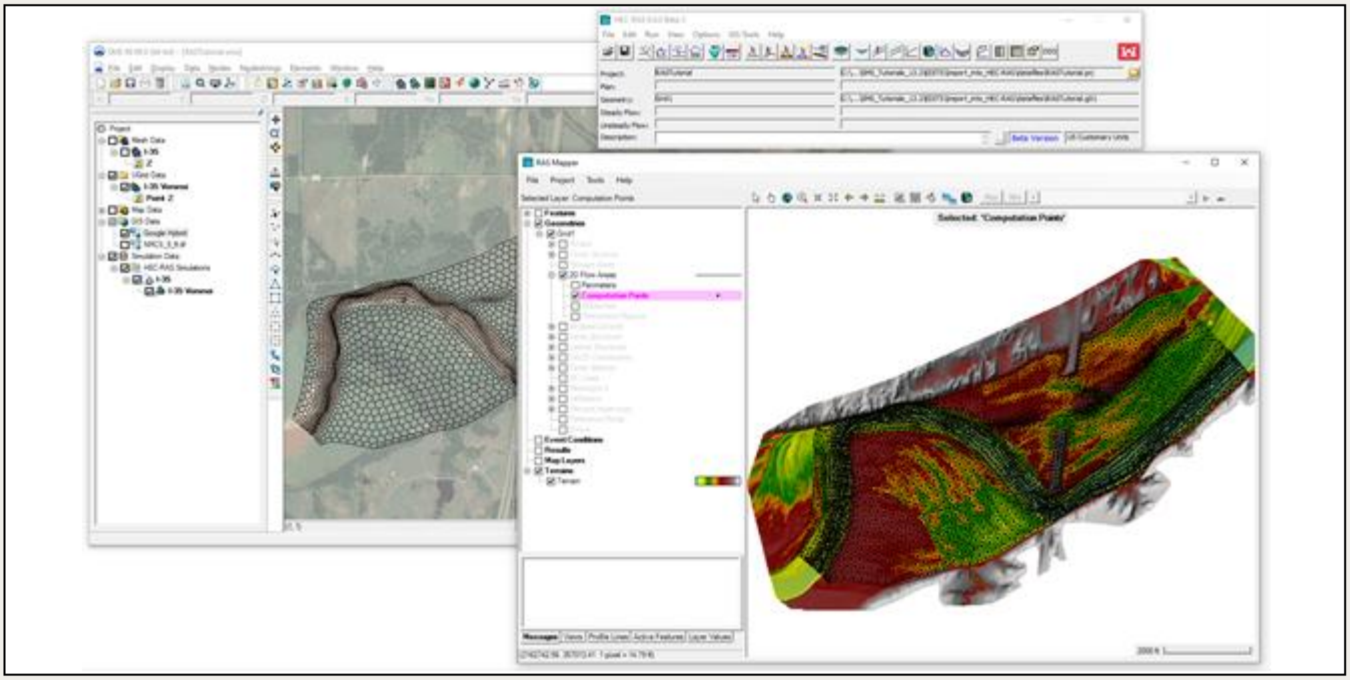
SMS 14.0 Tutorial

Importing into HEC-RAS

Import files from SMS into HEC-RAS



Objectives

This tutorial demonstrates importing files into HEC-RAS that were exported from SMS.

Prerequisite Tutorials

- HEC-RAS

Required Components

- SMS Core
- HEC-RAS 2D Geometry Import & Export

Time

- 20–35 minutes

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1 Introduction

The U.S. Army Corps of Engineers Institute for Water Resources Hydrologic Engineering Center's (CEIWR-HEC) River Analysis System (HEC-RAS) is a one- and two-dimensional model for computing water surface profiles for steady state or gradually varied flow. Two-dimensional capabilities were added to the program in version 5.0. This tutorial focuses on the 2D functionality of the model. Specifically this tutorial discusses importing files into HEC-RAS that were generated by SMS.

This tutorial uses a Voronoi grid generated by SMS (demonstrated in the HEC-RAS tutorial) from data gathered in a portion of the Cimarron River in Oklahoma. It also uses a shapefile from SMS to specify the spatially varied Manning's N values and a raster created by SMS.

The HEC-RAS software can be downloaded for free,[1] and version 6.0 is required to complete this tutorial. If this version of the software cannot be obtained or installed, this tutorial may not be completed.

1.1 Disclaimer

HEC-RAS was created by the U.S. Army Corps of Engineers Hydrologic Engineering Center. Questions about how the HEC-RAS software operates cannot be answered by Aquaveo, and Aquaveo does not provide technical support for the software. The steps provided in this tutorial are for convenience only. Please refer to the HEC-RAS Support Policy[2] for assistance regarding use of the HEC-RAS software.

2 Opening the HEC-RAS Project

This tutorial illustrates how to import, set up, and run a simple 2D HEC-RAS simulation using files exported from SMS.

To use these files with HEC-RAS, do the following:

1. Launch the HEC-RAS software.

[1] Download the HEC-RAS software at https://www.hec.usace.army.mil/software/hec-ras/download.aspx

[2] HEC-RAS Support Policy: http://www.hec.usace.army.mil/software/support_policy.aspx

2. In HEC-RAS, select *File* | **Open Project…** to bring up the *Open Project* dialog.
3. Browse to the *Import_into_HEC-RAS\data files* directory.
4. Select “RASTutorial.prj” and click **OK** to import the file into HEC-RAS. This loads the project file and the geometry saved by *SMS*.

With the geometry from SMS loaded, the HEC-RAS simulation requires the following steps in order to run:

- Load/create a terrain model.
- Set up the boundary conditions.
- Load the material zones.
- Set up the plan.

3 Loading the Terrain

This section will show how to create a terrain model for RAS using the digital elevtion map from SMS. To do this:

1. Click on the icon to open the *RAS Mapper* dialog.
2. Select *Project* | **Set Projection…** to open the *RAS Mapper Options* dialog.
3. Click the *Projection file* browser icon to open the *Browse for the coordinate reference system file for this project* dialog.
4. Select the “I-35 Voronoi_projection.prj” file created by SMS and click **Open** to close the browser dialog.
5. Click **OK** to close the *RAS Mapper Options* dialog.
6. Right-click on the *Terrains* object and select **Create a new RAS Terrain** to open the *New Terrain Layer* dialog.
7. In the *Input Terrain Files* section, click to open the *Browse for Terrain raster files* dialog.
8. Browse *data files* directory for this project and select “NRCS_5_ft.tif”.
9. Click **Open** to exit the *Browse for Terrain raster files* dialog.
10. Click **Create** to exit the *New Terrain Layer* dialog and bring up the *Creating Terrain ‘Terrain’* dialog. This will create a new terrain named “Terrain.hdf” in a “Terrain” folder in the simulation folder. The filename could be changed if desired.
11. When it is complete, click **Close** to exit the *Creating Terrain ‘Terrain’* dialog.
12. Turn on *Terrains* in the *RAS Mapper* dialog to display the terrains and make the image appear.

Note: RAS Mapper created the file RASTutorial.rasmap” in the simulation folder and files “Terrain.hdf”. “Terrain.vrt”, and “Terrain.NRCS_5_ft.tif” in the terrain folder.

4 Reviewing the SMS Geometry in RAS-Mapper

The mesh created in SMS was loaded into RAS with the project. This geometry can be reviewed by using the *RAS Mapper* utility (the icon) or using the *Geometric Data* editor (the **View/Edit Geographic Data** icon). This can be entered in the *RAS Mapper* utility in the previous section so continue in that utility.

1. Expand the *Geometries* tree item (if needed) and turn on the *2D Flow Areas* item to see the computational domain.
2. Right-click on *2D Flow Areas* and select **Open Attributes Table** to bring up the *2D Flow Areas – Layer Properties (Grid1)* dialog.

This dialog shows one computation area with default roughness and other attributes.

3. Click to close the *2D Flow Areas – Layer Properties (Grid1)* dialog.
4. Under the *2D Flow Areas* item, turn on the *Computation Points* to see the display of the cell centroids.

These are the computation points for RAS.

5. Right-click on *Computation Points* and select **Edit Geometry** to enter edit mode for the computational points.
6. While in edit mode, right-click on *Computation Points* and select **Edit/View Computation Points** to open the *View/Edit Points* dialog.

This displays a list of all 3843 computation points.

7. Click **Cancel** to close the *View/Edit Points* dialog.
8. Right-click on *Computation Points* and select **Stop Editing**.

This exits the edit mode and brings up a prompt to save edits.

9. Click **No** because no changes were made.

More exploration could be done to review the mesh after it was loaded into RAS. There are changes to details because RAS constructs the elements/cells anew from the computation points in the Voronoi grid created by SMS.

5 Setting up the Material Zones

This section illustrates how to load a material shapefile created in SMS for application in a RAS simulation. To do this, while still in *RAS Mapper*:

1. Right-click on *Map Layers* and select *Create a New RAS Layer* **| Land Cover Layer** to open the *Create a New Land Cover Layer* dialog.
2. Click to open the *Browse for Land Classification files* dialog.
3. Browse *data files* directory for this project and select “CimarronMats.shp”.

The procedure to create this shapefile was illustrated in the HEC-RAS tutorial.

4. Click **Open** to exit the *Browse for Land Classification files* dialog.

The polygons and their specifications have been mapped by *RAS Mapper*. However, the actual values for Manning’s n from the shapefile have not been mapped.

5. To add the Manning's n values, click **Add Field…** to open the *Select Data to Import* dialog.
6. Set the *Data Type* to "Manning's n" and set the *Field* to "MANNINGS" which is the attribute saved by SMS.
7. Click **Add** to add the values and close the *Select Data to Import* dialog.
8. Click **Create** to exit the *Create a New Land Cover Layer* dialog and bring up the *Compute Window – Creating Mannings n Layer 'LandCover.hdf'* dialog.

This will create a new layer named "LandCover.hdf" in a "Land Classification" folder in the simulation folder. The filename could be changed if desired.

9. When it is complete, click **Close** to exit the *Compute Window – Creating Mannings n Layer 'LandCover.hdf'* dialog.
10. Turn on *LandCover* layer in the *RAS Mapper* dialog to display the zones of each material type.

Note: RAS Mapper created the "Land Classification" folder along with the files "LandCover.hdf" and "LandCover.tif".

11. Make sure the land cover is associated with the terrain by right-clicking on *Terrains* and selecting **Manage Terrain Associations…** to open the *Manage Layer Associations* dialog.
12. Make sure the *Manning's n* field references the "LandCover" layer.
13. Click **Close** to exit the *Manage Layer Associations* dialog.

Multiple terrains and/or Manning's n layers can be loaded into a project. Each simulation references a terrain. Each terrain can reference a Manning's n layer.

6 Setting up Boundary Conditions

The boundary conditions for the 2D hydraulic regions are specified in two steps: defining the location of the lines, then setting the values.

6.1 Defining the Location

To define the location, do the following:

1. Right-click on the *Boundary Condition Lines* entry under *Geometries/Grid1* and select **Edit Geometry**. The item is dim by default because it has no data loaded as of yet.
2. Using the **Add New Feature** tool, digitize a line across the channel on the upstream side (left) of the domain. This line does not need to be precise, but it should be outside of the domain. It is recommended to just click two points near the two left corners.
3. Double-click on the last point in the line to end the line and bring up the *Name BC Line* dialog.
4. Enter "Upstream" in the provided text field.
5. Click **OK** to close the *Name BC Line* dialog.

HEC-RAS will snap the line to the edge of the domain when the simulation is run.

6. Repeat steps 2–5 to create a boundary condition line on the downstream (right) side of the domain named “Downstream”.
7. Right-click on the *Boundary Condition Lines* entry again and select **Stop Editing**.
8. In the prompt that appears, click **Yes** to save.
9. Select *File* | **Save** to update the geometry (“g01” and “g01.hdf” files).
10. Select *File* | **Exit** to close the *RAS Mapper* dialog.

6.2 Defining Boundary Condition Values

To define the boundary condition values, do the following:

1. Select *Edit* | **Unsteady Flow Data** or click to open the *Unsteady Flow Data* dialog.
2. On the *Boundary Conditions* tab, in the spreadsheet near the bottom, click on the “BCLine: Downstream” line. This makes that line active.
3. In the *Boundary Condition Types* section, click **Stage Hydrograph** to open the *Stage Hydrograph* dialog.
4. Select “4 Hour” from the *Data time interval* drop-down.
5. In the *Select/Enter the Data’s Starting Time Reference* section, leave the *Use Simulation Time* as the selected option.
6. In the *Hydrograph Data* section, enter “896” on both rows *1* and *2* in the *Stage* column.
7. Click **OK** to close the *Stage Hydrograph* dialog.
8. Select “BCLine: Upstream” in the *Boundary Condition* spreadsheet.
9. In the *Boundary Condition Types* section, click **Flow Hydrograph** to open the *Flow Hydrograph* dialog.
10. Select “4 Hour” from the *Data time interval* drop-down.
11. In the *Hydrograph Data* section, enter “178208” on both rows *1* and *2* in the *Flow* column.
12. At the bottom of the dialog, enter “0.001” as the *EG Slope for distributing flow along BC Line*.
13. Click **OK** to close the *Flow Hydrograph* dialog.
14. Select *File* | **Save Unsteady Flow Data** to bring up the *Save Unsteady Flow Data As* dialog.
15. Enter “Q50” as the *Title* and click **OK** to close the *Save Unsteady Flow Data As* dialog. HEC-RAS will save a file named “RASTutorial.u01” and “RASTutorial.u01.hdf” containing this unsteady flow data.
16. **Close** the *Unsteady Flow Data* dialog.

7 Setting up the Plan

The final step in setting up the simulation is to define a plan. To do this:

1. Click **Perform an unsteady flow simulation** to open the *Unsteady Flow Analysis* dialog.
2. In the *Programs to Run* section, turn on *Geometry Preprocessor*, *Unsteady Flow Simulation*, and *Post Processor*.
3. In the *Simulation Time Window* section, enter the current date as both the *Starting Date* and the *Ending Date* (RAS needs a date).
4. Enter "0000" as the *Starting Time* and "0400" as the *Ending Time*.
5. In the *Computation Settings* section, select "5 Second" from the *Computation Interval* drop-down.
6. Select "10 Minute" from the *Mapping Output Interval* drop-down.
7. Select "10 Minute" from the *Hydrograph Output Interval* drop-down.
8. Select "10 Minute" from the *Detailed Output Interval* drop-down.
9. Click on the button next to the *Computational Interval* edit field. This brings up the *HEC-RAS Unsteady Computation Options and Tolerances* dialog.
10. Switch to the *2D Flow Options* tab and set the *Equation Set* solver to "SWE-EM (Stricter Momentum)".
11. Click **OK** to close the *HEC-RAS Unsteady Computation Options and Tolerances* dialog.
12. Back in the *Unsteady Flow Analysis* dialog click *Options* **| Output Options…** to open the *HEC-RAS – Set Output Control Options* dialog.
13. Select the *HDF5 Write Parameters* tab and turn on *Cell Velocity*, *Cell Invert Depth (WSE – Cell Min Elev)* and *Cell Hydraulic Depth* options.
14. Click **OK** to close the *HEC-RAS Set Output Control Options* dialog.
15. Select *File* **| Save Plan** to bring up the *Save Plan Data As* dialog.
16. Enter "Q50" as the *Title* and click **OK** to close the *Save Plan Data As* dialog and bring up the *HEC-RAS* dialog.

This dialog asks for a short plan Identifier between 16 and 64 characters in length.

17. Enter "Q50" and click **OK** to close the *HEC-RAS* dialog.

8 Running the HEC-RAS Analysis

The simulation is now ready to run. To do this:

1. Click **Compute** to bring up the *HEC-RAS Computations* dialog.

At this point, HEC-RAS processes the geometry and runs the simulation. The *HEC-RAS Computations* dialog reports the analysis progress and other notifications. It should take only a few seconds to run the 4 hours simulation.

2. When the process is complete, click **Close** to exit the *HEC-RAS Computations* dialog.

3. **Close** the *Unsteady Flow Analysis* dialog.

9 Viewing the Results in RAS Mapper

To view the solution:

1. Click **Open RAS Mapper to view maps and data spatially** to open the *RAS Mapper* dialog.

There should now be items in the *Results* section.

2. Turn on the box next to *Velocity (Max)*.
3. In the scroll bar at the top of the graphics window, drag the bar to the farthest right position (4 hours into simulation). Note that the name in the results section changes to indicate the current time for this dataset.
4. Double-click on the *Velocity* dataset to bring up the *Velocity – Layer Properties* dialog.
5. Turn on the *Update Legend with View* option.

This option instructs *RAS Mapper* to set the contour range based on the current view. It simplifies the setting up of contour colors and should be used when generally reviewing the results.

6. **Close** the *Velocity – Layer Properties* dialog.

The velocity magnitudes will now be clearly visible in the graphic display (Figure 1).

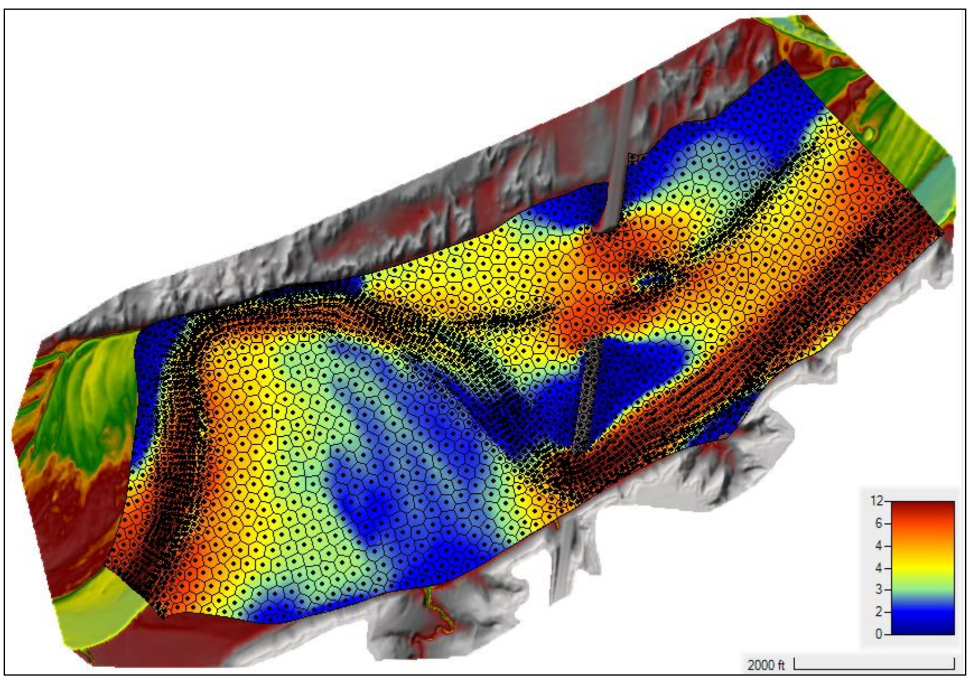

Figure 1 Velocity magnitude dataset

Explore the solution by changing which dataset is displayed and which time step is selected. The buttons at the top also allow for display of vectors.

7. **Close** the *RAS Mapper* dialog when done exploring.

8. **Close** HEC-RAS.

10 Viewing the Results in SMS

For comparison purposes, a feature has been added to SMS to allow visualization of HEC-RAS solutions in SMS. To do this:

1. Start SMS
2. Select *File* | **Open…** to bring up the *Open* dialog.
3. Select "Project Files (*.sms)" from the *Files of type* drop-down.
4. Browse to the *Import_into_HEC-RAS\data files* folder and select "RASTutorial.sms".
5. Click **Open** to import the project and exit the *Open* dialog.
6. Select *File* | **Open…** to bring up the *Open* dialog.
7. Browse to the *Import_into_HEC-RAS\data files* folder and select "RASTutorial.p01.hdf".
8. Click **Open** to do the following::
   - Loads a new unstructured grid. This is the grid as HEC-RAS modified it.
   - Loads datasets representing the water surface, hydraulic depth, invert depth (water surface – minimum cell elevation), and cell velocity. These are output by HEC-RAS because of the output options specified in section 7 above.
9. Turn off " I-35 Voronoi" UGrid to declutter the display.
10. Right-click on " UGrid Data" and select **Display Options…** to open the *Display Options* dialog.
11. Select the "Ugrid: I-35 Voronoi (2)" ugrid from the list on the left.
12. Turn on the *Face contours* and *Vectors* options.
13. Click on the **Options** button next to *Face contours* to open the *Dataset Contour Options – Point Z* dialog.

Note that the options are similar to the options for meshes. One difference is that cell centered data sets have the option to use a "Block Fill" contour which is a single color for the whole cell. This is the default option.

14. Set the *Transparency* to "20%".
15. Click **OK** to close the *Dataset Contour Options – Point Z* dialog.
16. Click on the **Options** button next to *Vectors* to open the *Vector Display Options* dialog.
17. Turn off *3D Arrows* as these are only useful on 3D UGrids.
18. Turn on the *Arrows follow flow path* option and set the *Origin* to "Relative to max elevation".
19. Click **OK** to close the *Vector Display Options* dialog.
20. Click **OK** to close the *Display Options* dialog.

Click on the different time steps and note that the arrows are displayed at each cell. This reflects the fact that the dataset is a cell based dataset. The display options can be set to use a grid as is demonstrated on other geometric objects in SMS.

Feel free to experiment with the display options and the datasets created on the HEC-RAS grid.

11 Conclusion

This concludes the “Importing into HEC-RAS” tutorial. The following key concepts were discussed and demonstrated:

- Importing files exported from SMS for use in HEC-RAS 2D.
- Using HEC-RAS 6.0 with the files prepared in SMS.
- Visualizing HEC-RAS results in SMS for comparison with other engines.
- If desired, experiment further with the HEC-RAS simulation. When done, exit the program.