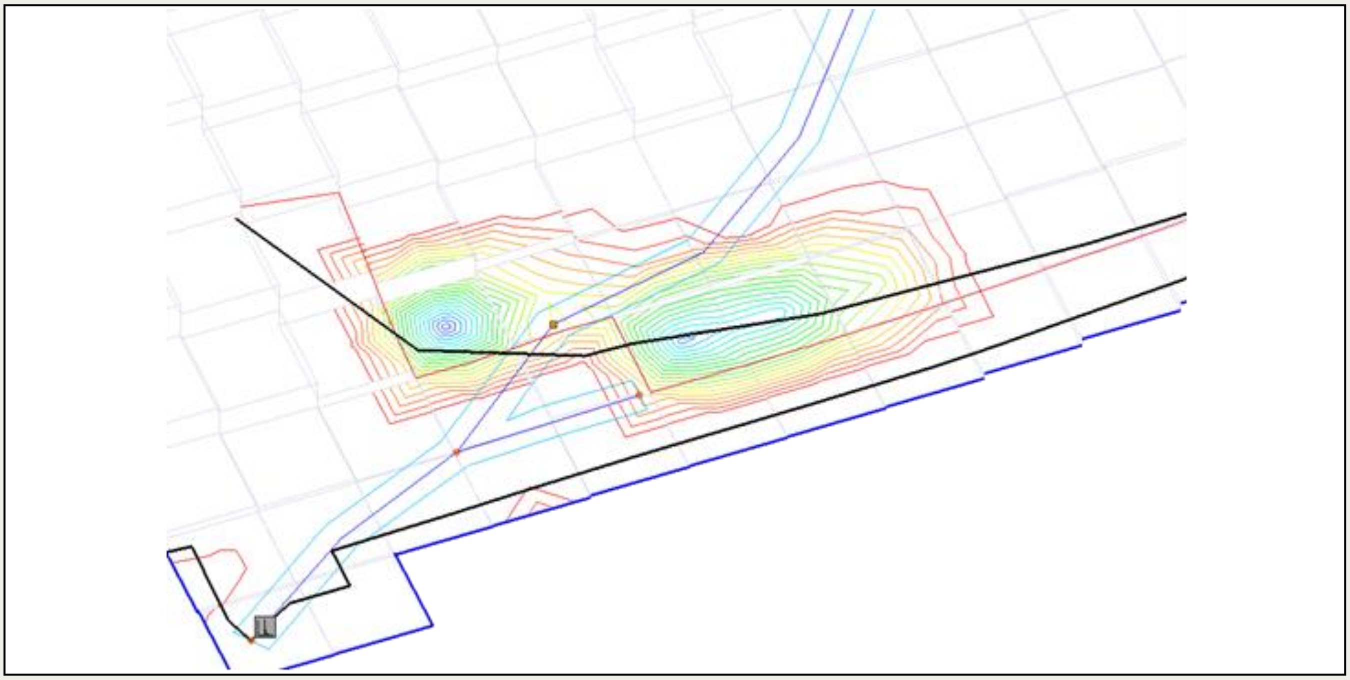
WMS 11.4 Tutorial

GSSHA Land Use Change – Detention Basins

Include the effects of detention basin runoff abatement measures in GSSHA models



Objectives

Learn to add the effects of detention basins as a runoff abatement measure in a GSSHA model.

Prerequisite Tutorials

- Developing a GSSHA Model Using the Hydrologic Modeling Wizard

Required Components

- WMS Core
- GSSHA Model

Time

- 10–20 minutes

1 Introduction

Changing the land use in a certain portion of the watershed can cause an increase in the peak flow at the watershed outlet. This situation is often undesirable as natural streams and various hydraulic structures—like culverts and channels downstream of the new development—become undersized.

This tutorial adds detention basin abatement measures to the project used in the "GSSHA Land Use Change – Industrial" tutorial.

1.1 Getting Started

Begin by opening an existing GSSHA model:

1. Open WMS, or click **New** to reset to the default settings and clear any existing data.
2. Switch to the **2-D Grid** module.
3. Select *GSSHA* | **Open Project File…** to bring up the *Open* dialog.
4. Browse to the *data files* folder for this tutorial and select "Industrial.prj".
5. Click **Open** to import the project and exit the *Open* dialog.
6. Select *GSSHA* | **Save Project File…** to bring up the *Save GSSHA Project File* dialog.
7. Select "GSSHA Project File (*.prj)" from the *Save as type* drop-down.
8. Enter "DetBasin.prj" as the *File name*.
9. Click **Save** to save the project under the new name and close the *Save GSSHA Project File* dialog.

The project should appear similar to Figure 1.

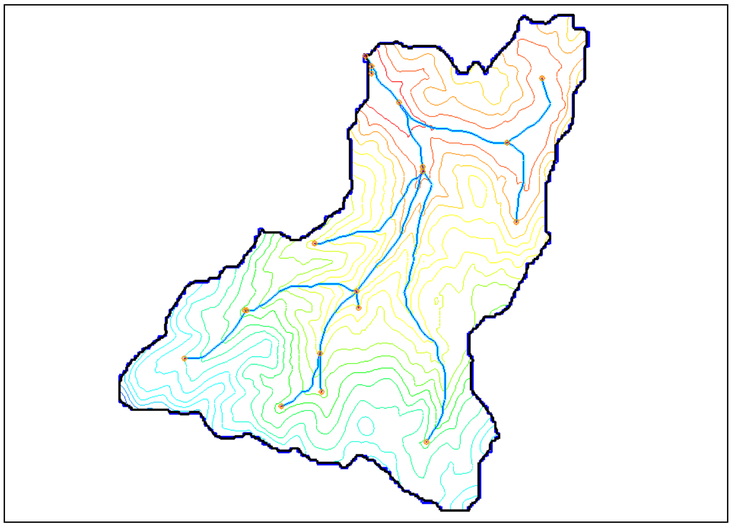


Figure 1 Initial project

2 Creating a Coverage for the Detention Basin

To mitigate the problems of flooding, introduce a detention basin in the watershed. Because the existing " GSSHAIndus" coverage already has most of the needed parameters set, duplicate it to create a new coverage to use for the detention basin.

1. Right-click on " GSSHAIndus" and select **Duplicate** to create a new " Copy of GSSHAIndus" coverage.
2. Right-click on " Copy of GSSHAIndus" and select **Rename**.
3. Enter "GSSHADB" and press *Enter* to set the new name.

Now assign the " DetBasin" project to use the new " GSSHADB" coverage by doing the following:

4. Right-click on the " GSSHAIndus" link under " DetBasin" and select *Assign Coverage* | **GSSHADB**.

3 Defining the Detention Basin Parameters

A detention basin is defined by an embankment arc at the downstream end of the detention basin. This arc represents the detention basin's downstream embankment. When the embankment arc is created, the grid edges defined by the embankment arc must be downstream from the detention basin's outlet point.

The detention basin outlet point is defined by adding a feature point along the stream at the downstream end of the detention basin. Define one or more outlet structures and a detention basin in the point attributes for this feature point.

3.1 Defining the Outlet Node

Begin by opening a background image to help with defining the detention basin embankment arc:

1. Click **Open** to bring up the *Open* dialog.
2. Browse to the *data files* folder for this tutorial and select “DetBasin_exported.tif”.
3. Click **Open** to exit the *Open* dialog.
4. **Zoom** in to the area shown in Figure 2.
5. Turn on “ 2D Grid Data” in the Project Explorer.

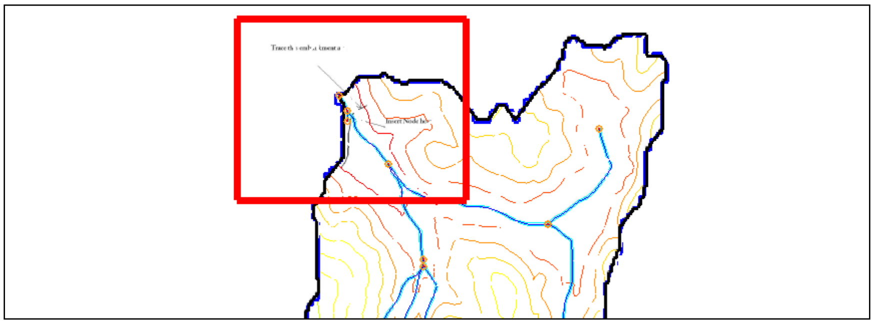


Figure 2 Zoom in to this area

6. Select “ elevation (elev)” and “ DetBasin” to make them active.
7. Turn off all coverages except “ GSSHADB” then select it to make it active.
8. Switch to the **Map** module.
9. Using the **Create Feature Point** tool and using the background image as a guide, create a node at the location indicated.
10. If asked to renumber links, select **Yes**.

3.2 Defining the Embankment Arc

Now define the embankment arc by doing the following:

1. Using the **Create Feature Arc** tool and using the background image as a guide, create an embankment arc starting at either end. Be careful to not click on the stream or boundary arcs while creating the embankment arc.
2. Turn off “ DetBasin_exported.tif” in the Project Explorer.
3. Using the **Select Feature Arc** tool, double-click on the embankment arc to bring up the *Properties* dialog.
4. In the spreadsheet, in the *Type* column, select “Embankment” from the drop-down on the *All* row.
5. In the *Embankment* column, click ... to bring up the *Embankment Arc Profile Editor* dialog.
6. In the *Vertical Curve Parameters* section, enter “2118.0” as the *PVI Elevation*.
7. Above the *Vertical Curve Parameters* section, click **Compute Vertical Curve**.

A plot should appear at the top of the dialog (Figure 3).

8. Click **OK** to close the *Embankment Arc Profile Editor* dialog.
9. Click **OK** to close the *Properties* dialog.

The arc created to define the embankment is not directly used by GSSHA. In GSSHA, the embankment is represented by grid cell edges. WMS uses the arc and finds the nearest cell edges to represent the embankment in GSSHA.

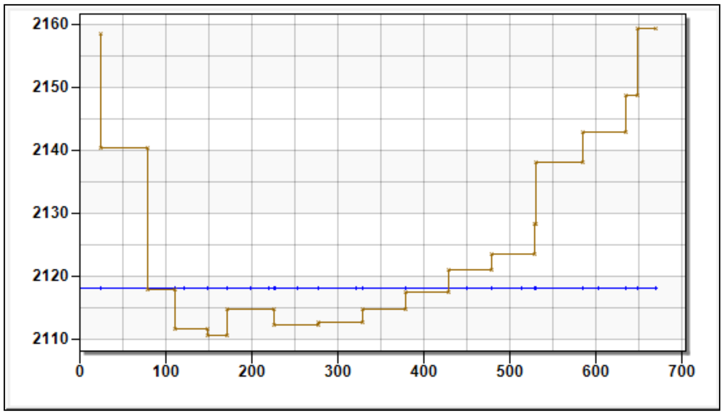


Figure 3 Vertical curve plot

To make the embankment edges visible, do the following:

10. Click **Display Options** to bring up the *Display Options* dialog.
11. Select “2D Grid Data” from the list on the left.
12. On the *2D Grid* tab, turn on *Cells* and *Embankment Edges*.
13. Select *Blocked* under *Cells*.
14. Click **OK** to close the *Display Options* dialog.

This displays the edges of grid cells designated as embankment edges in a different color than the regular grid cell edges (Figure 4).

NOTE: If the node inserted in the stream is downstream (left) of the cell edge representing the embankment edge (red line in Figure 4), the node should be moved. Simply convert the incorrect node to a vertex, then create the node on the upstream side of the cell edge (Figure 4).

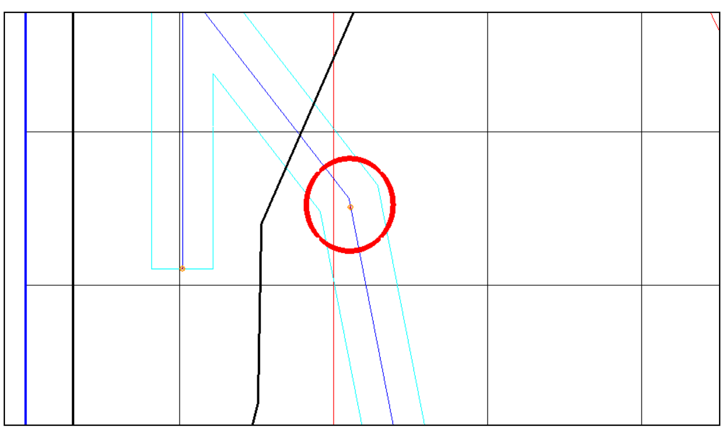


Figure 4 The node is at the center of the circle to the right of the red line marking embankment cell edge

3.3 Defining the Outlet Node

To adjust the elevation of the outlet node, do the following:

1. Switch to the **2-D Grid** module.
2. Using the **Select grid cell** tool, select the cell in which the node is located.
3. Verify that the elevation (S) shown in the Property section of the WMS window is about “2115.5303”.
4. Select “ GSSHADB” to make it active.
5. Using the **Select Feature Point/Node** tool, select the node that was just created.

The elevation for the node (as indicated in the Properties section of the WMS window) should be about “2110”.

6. In the *Value* column, change the *Feature Point Z* (elevation) to “2115.3” and press *Enter* to set the value.

The elevation of this node should not be too far below that of the grid. After changing the elevation of the node, the stream arc profile needs to be re-interpolated so that there is no adverse gradient along the flow direction.

7. Select “GSSHA” from the model selection drop-down at the top of the WMS window.
8. Using the **Select Feature Arc** tool, select the upstream portion of the stream on which the node was created.
9. Select *GSSHA* | **Smooth Stream/Pipe Arcs…** to bring up the *Smooth GSSHA Streams* dialog.
10. Drag the vertices along the stream arc upward (toward the grid) so that there is no adverse gradient.

When finished, it should look similar to the blue line (the middle line) in Figure 5.

Note: Do not click on **Interpolate Stream Elevations** as that will change the elevation of the most downstream mode.

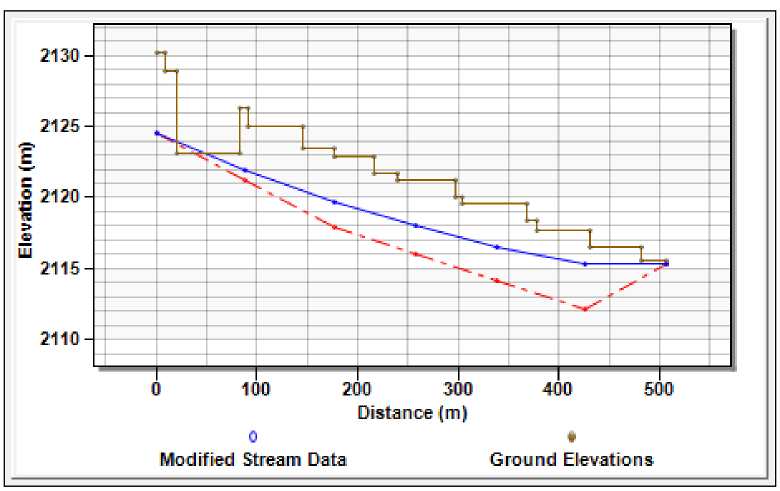


Figure 5 Profile arcs showing the original (bottom), adjusted (middle), and the grid (top)

11. Click **OK** to close the *Smooth GSSHA Streams* dialog.

3.4 Defining the Outlet Node Hydraulic Structures

Now adjust the properties of the outlet node by adding hydraulic structures to it.

1. Using the **Select Feature Point/Node** tool, double-click on the previously-created node to bring up the *Properties* dialog.

This is the outlet for the detention basin.

2. In the *Hydraulic* structures column of the spreadsheet, click ... on the row for the node to bring up *GSSHA Hydraulic Structures* dialog.
3. In the *Hydraulic Structures and Curves* section, click **Detention Basin** to add a new "Detention Basin" to the list on the left.
4. Enter "2115.5" as the *Min Water Surface Elevation (m)*.
5. Enter "2115.5" as the *Init Water Surface Elevation (m)*.
6. Enter "2117.0" as the *Max Water Surface Elevation (m)*.
7. Click **Culvert** to add a new "Culvert 2" to the list on the left.

"Culvert 2" will be automatically selected in the list on the left.

8. Enter "1.0" as the *Diameter (m)*.
9. Enter "2115.3" as the *Upstream invert (m)*.
10. Enter "2115.0" as the *Downstream invert (m)*.
11. Enter "0.5" as the *Inlet loss coeff*.
12. Enter "1.0" as the *Loss coeff (rev. flow)*.
13. Enter "30.0" as the *Length (m)*.
14. Enter "0.01" as the *Manning's roughness*.

The node elevations of the stream arc where the culvert is being inserted are used for the upstream elevation of the culvert. The length and diameter of the culvert are governed by the flow rate and site conditions.

15. Click **Weir** to add a new "Weir 3" to the list on the left.
16. Enter "13.0" as the *Crest length (m)*.
17. Enter "1.0" as the *Discharge coeff (for. flow).*
18. Enter "1.0" as the *Discharge coeff (rev. flow).*
19. Enter "2116.5" as the *Crest Low Point Elev (m)*.
20. Click **OK** to close the *GSSHA Hydraulic Structures* dialog.
21. Click **Yes** if asked to renumber the links and nodes.
22. Click **OK** to close the *Properties* dialog.
23. Click **Yes** if asked to renumber the links and nodes.

3.5 Redistribute Stream Vertices

GSSHA pours water from the grid cells to the stream at specific locations. Since the spacing changed on some of the stream vertices, redistribute the vertices.

1. Using the **Select feature line branch** tool, select the most downstream stream arc (the one at the top left of the watershed, see Figure 6).

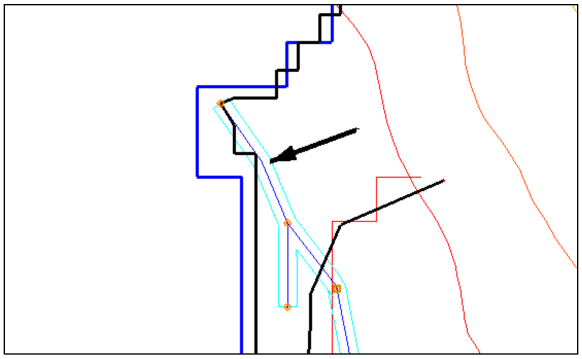


Figure 6 Most downstream stream arc indicated by arrow

This causes the entire stream network in the project to be selected (Figure 7).

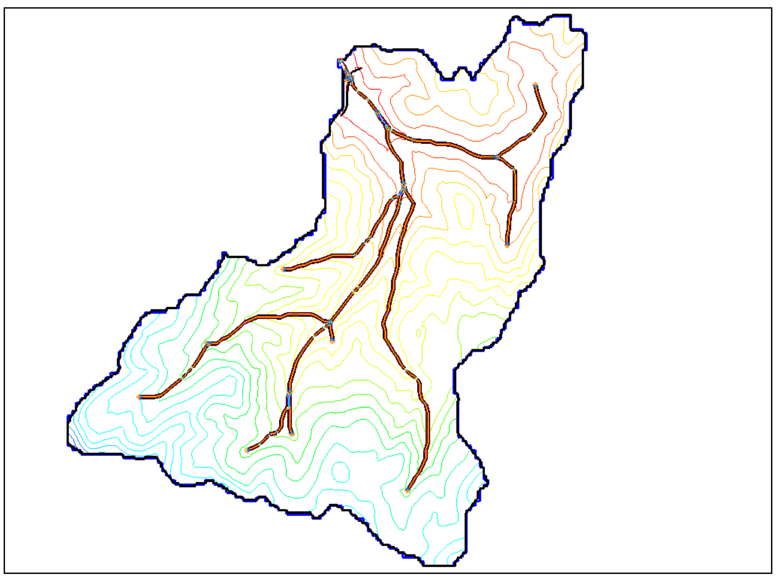


Figure 7 Entire stream network selected

2. Select *Feature Objects* | **Redistribute…** to bring up the *Redistribute Vertices* dialog.
3. In the *Arc Redistribution* section, enter "85.0" as the *Average spacing*.
4. Click **OK** to close the *Redistribute Vertices* dialog.

4 Saving and Running GSSHA

Before proceeding, it is recommended to save the project.

1. Right-click on " DetBasin" and select **Save Project File…** to bring up the *Save GSSHA Project File* dialog.
2. Select "GSSHA Project File (*.prj)" from the *Save as type* drop-down.
3. Enter "DetBasin_run.prj" as the *File name*.

4. Click **Save** to save the project under the new name and exit the *Save GSSHA Project File* dialog.
5. Right-click on " DetBasin_run" and select **Run GSSHA** to bring up the *GSSHA Run Options* dialog.
6. Click **OK** to exit the *GSSHA Run Options* dialog and open the *Model Wrapper* dialog.
7. When GSSHA finishes, turn on *Read solution on exit* and click **Close** to exit the *Model Wrapper* dialog.
8. If one or more warnings appear regarding the number of points on the arc, click **OK**.

5 Visualizing the Solution

There are a variety of methods for visualizing the solution datasets. The "Post - Processing and Visualization of GSSHA Model Results" tutorial discusses various methods of visualization. Feel free to experiment with them.

6 Conclusion

This concludes the "GSSHA Land Use Change – Detention Basins" tutorial for WMS. Feel free to continue to experiment, or exit the program.

