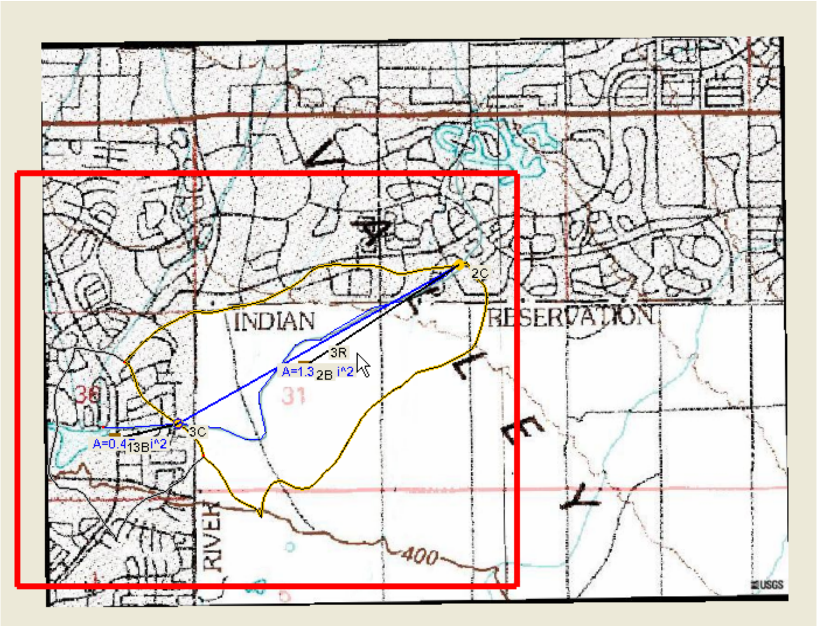
WMS

v. 8.4

WMS 8.4 Tutorial

Watershed Modeling – Maricopa County: Master Plan – Creating a Predictive HEC-1 Model

Build a watershed model to predict hydrologic reactions based on land use development in Maricopa County, Arizona, USA



Objectives

Define an urban watershed for an area of interest in Maricopa County. Build an HEC-1 simulation and run this simulation based on both existing and proposed land use conditions to determine the impact of land use changes on the watershed hydrograph.

Prerequisite Tutorials

- Watershed Modeling – HEC-1 Interface
- Watershed Modeling – Advanced DEM Delineation Techniques

Required Components

- Data
- Drainage
- Map
- Hydrology

Time

- 30-60 minutes

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1 Contents

2 Objectives

This exercise illustrates the use of a watershed model to predict possible hydrologic reactions based on planned land use developments. The following sections will show you how to use WMS to:

1. Define the watershed of interest
2. Build a Maricopa County HEC-1 simulation
3. Run HEC-1 based on existing land use and soil conditions
4. Run HEC-1 based on proposed conditions

3 Defining the Watershed

To create the basins to be used in our HEC-1 simulations, we will use a shapefile containing pre-delineated sub basins for the Maricopa County. Also, we will manually create drainage outlets and feature stream arcs for the basins of interest. Finally, we will use WMS to compute the hydrologic parameters for our watershed basins.

3.1 Converting the Shapefile to Feature Polygons

1. Close all instances of WMS
2. Open WMS
3. Switch to the *GIS* module 
4. Select ***Data | Add Shapefile Data***
5. Locate the folder ***C:\WMS80\tutorial\Maricopa\tut2***

6. Open *“basins.shp”*
7. Select ***File* | *Open***
8. Open *“zoom_here.wpr”*. This file identifies the basins used in this exercise.
9. Select the *Zoom* tool
10. Drag a box approximately around the rectangle shown in Figure 3-1

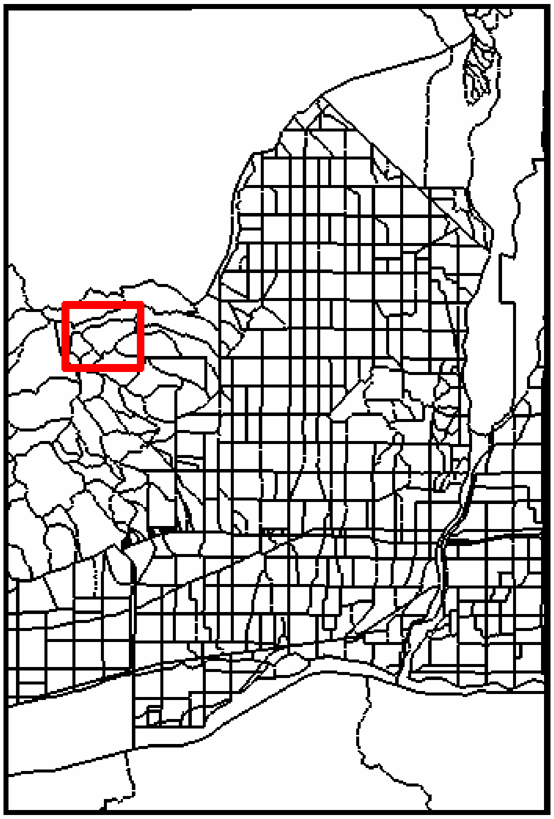

Figure 3-1: Zoom in on the area bounded by the rectangle

We will select two basins before converting the shapefile to feature polygons (when mapping shapefile data to feature objects, only the selected shapes are converted).

11. Choose the *Select Shapes* tool
12. Multi-select the two polygons shown in Figure 3-2 by holding the SHIFT key while selecting each polygon

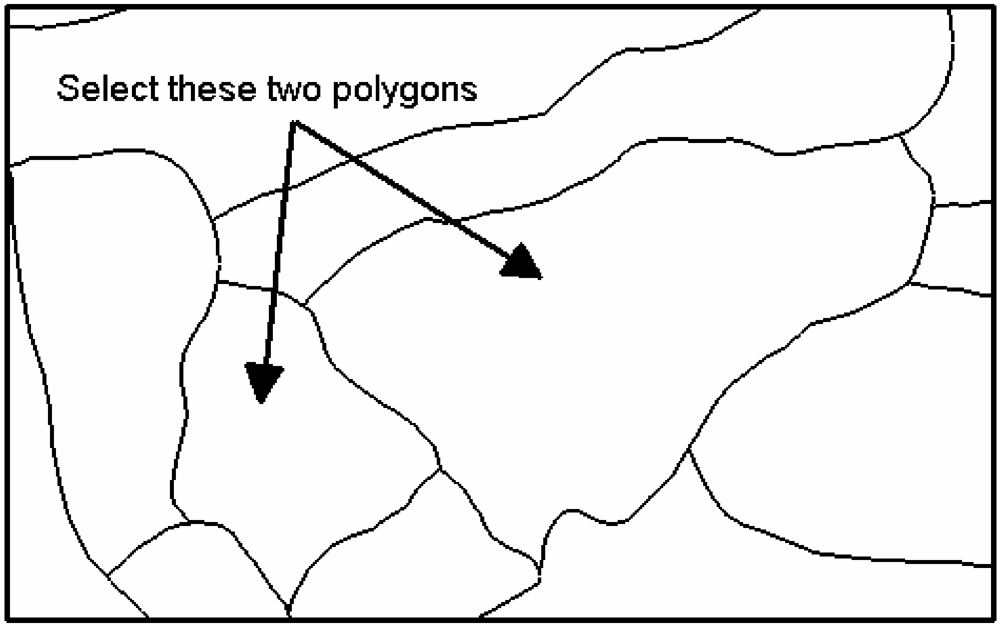

Figure 3-2: Select the two polygons highlighted in yellow

13. Select ***Mapping | Shapes -> Feature Objects***
14. Select *Next*
15. Select *Next*
16. Select *Finish*

The feature polygons have now been created and we are ready to create the stream arcs. Before continuing, we will remove the basins shapefile from the Project Explorer:

17. Right-click *"basins.shp"* in the Project Explorer and select ***Delete***

3.2 Getting a Background Image Using the TerraServer

To aid us in drawing the stream arcs, we will import a background map depicting some of the geographic features within the watershed.

1. Select ***File | Open***
2. Open *"maricopa.jpg"*
3. Switch to the Map module
4. Select the Create Feature Arc tool
5. Select ***Feature Objects | Attributes***
6. Change the Arc type to *Stream*
7. Select *OK*
8. Using Figure 3-3 as a guide, begin drawing an arc from the location labeled "Start Here." Click along the outline of the stream shown on the topo map so that the arc represents the stream's geometry. Double-click at the location labeled "End Here" to end the arc.

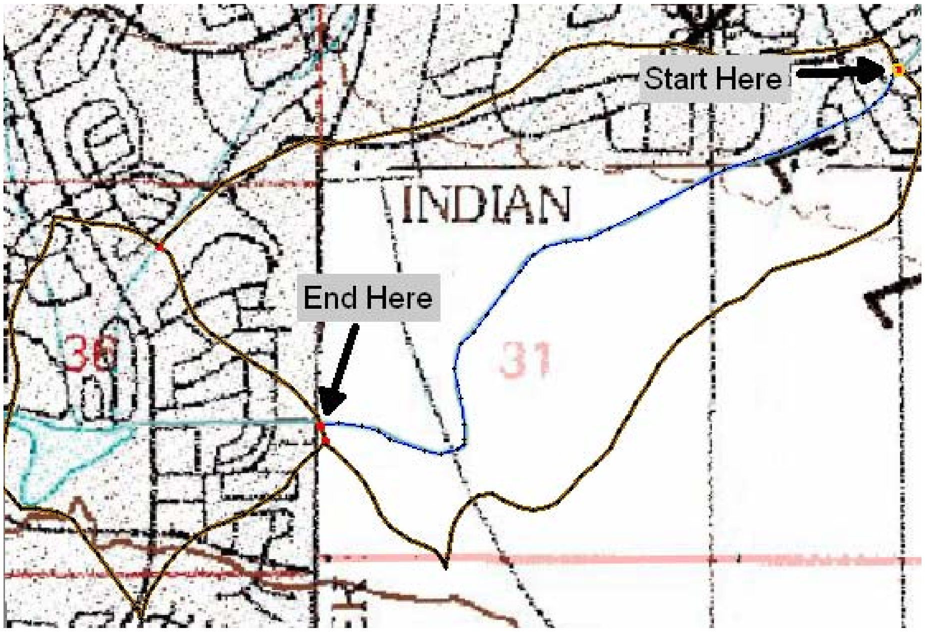

Figure 3-3: Guide for creating the first stream arc. Double-click to end the arc

9. Draw a second stream arc as indicated in Figure 3-4

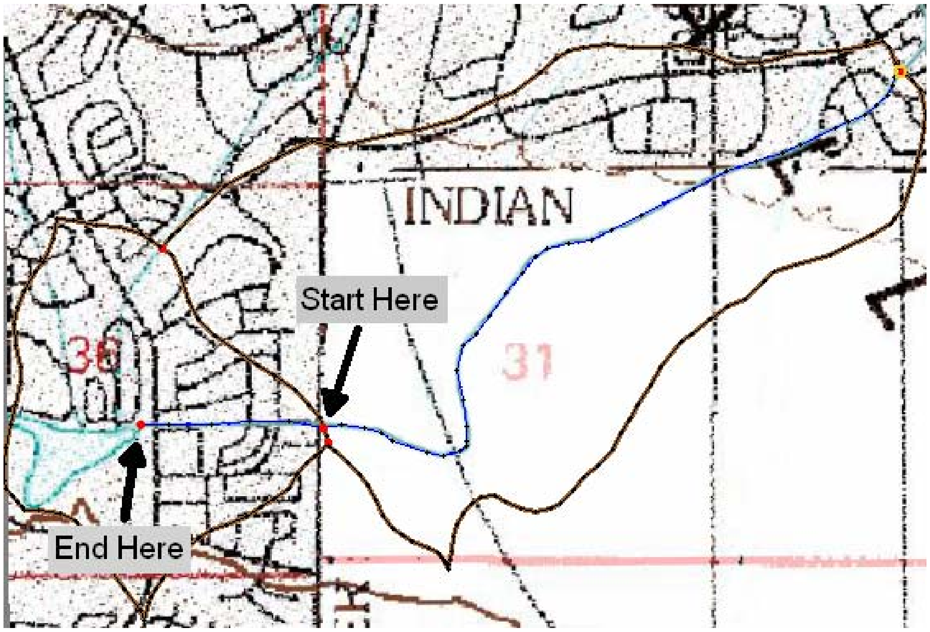

Figure 3-4: Location of the second stream arc

Having created the stream arcs, we will define their shared node as an Outlet point:

10. Select the *Select Feature Point* tool
11. Double-click on the node labeled "Start Here" in Figure 3-4
12. Change the Point type to *Drainage outlet*
13. Select *OK*

3.3 Compute the Basin Data

You have completed the watershed construction and are ready to compute the basin parameters that will be used by HEC-1

1. Select ***Feature Objects | Compute Basin Data***
2. Click the *Current Coordinates* button
3. Change both the Horizontal and Vertical Units to *U.S. Survey Feet*
4. Select *OK*
5. Verify that the Parameter Units are *Square miles* for Basin Areas and *Feet* for Distances
6. Select *OK*

4 Building the HEC-1 Model

Having computed parameters such as basin area, slope, and length, we will proceed to set up a HEC-1 simulation.

4.1 Initialize Rainfall Data

1. Switch to the *Hydrologic Modeling* module
2. Select *HEC-1* from the model drop-down box
3. Select ***HEC-1 | Job Control***
4. Click the *Initialize Maricopa County Precipitation Data* button
5. Choose the *Basin Average* method and change the duration to *6 hour*
6. Click on the Browse button to select a rainfall grid to read in and use to compute precipitation
7. Open *"noaa50y6h"*
8. Select *OK* to close the Compute Rainfall dialog
9. Select *OK* twice more to return to the WMS window

4.2 Define Unit Hydrograph Method

1. Double-click on the left basin icon
2. Click the *Unit Hydrograph Method* button
3. Click the *Compute Parameters-Basin Data* button
4. Set the Computation type to *Compute Lag Time*
5. Select *Tulsa Rural Method* from the Method drop-down box
6. Highlight the line containing *S Maximum flow distance slope* from the Variable list by clicking on it
7. Enter 2000 in the *Variable value* field

8. Highlight the line containing the variable *S* once again to update its value
9. Select *OK*
10. Choose the *Given unit hydrograph (UI)* option
11. Select the *Maricopa County S-Graph* button
12. Choose *Phoenix Valley* as the S-Graph type and select *OK*
13. Select *OK* to exit the XY Series Editor
14. Select *OK* to exit the Unit Hydrograph Method dialog
15. Click the *Next Hydrograph Station* -> button twice to edit the basin on the right
16. Repeat steps 2 thru 14 above to define the unit hydrograph for this basin. In this case, however, enter 2400 for the variable *S Max flow distance slope*.

4.3 Define Routing Method

1. Click the <- *Previous Hydrograph Station* button to select the outlet located between the two basins
2. Click the *Routing Data* button
3. Choose the *Muskingum (RM)* option
4. Click the *Compute NSTPS* button
5. Choose the *From Channel Velocity Estimate* option
6. Enter 6 for the velocity estimate and select *OK*
7. Select *OK* to exit the HEC-1 Routing Data dialog
8. Select *Done* to exit the Edit HEC-1 Parameters dialog

4.4 Import the Soil Type and Land Use Coverages

The last parameter we need to define before running HEC-1 is the Green-Ampt losses. To have WMS compute losses, we will create one soil-type coverage and three land-use coverages (one representing existing land-use conditions and two representing future land-use scenarios).

1. Switch to the *Map* module 
2. Choose the *Select Drawing Objects* tool  at the bottom of screen
3. Select the rectangle surrounding our two basins and press DELETE
4. Right-click on the Coverages folder in the Project Explorer and select ***New Coverage***
5. Change the Coverage type to *Soil Type* (notice that the coverage name is automatically changed to “Soil Type”)
6. Select *OK*
7. Create another new coverage and change its type to *Land Use*

8. Set the coverage name as *“LU existing”*
9. Select *OK*
10. Create two more Land Use type coverages and name *them “LU future 1”* and *“LU future 2”*, respectively
11. Select the LU existing coverage in the Project Explorer to activate it
12. Switch to the *GIS* module
13. Select ***Data*** | ***Add Shapefile Data***
14. Open *“ExistingCondition.shp”*
15. Select ***Mapping | Shapes -> Feature Objects***
16. Select *Yes* when asked if you want to use all shapes
17. Select *Next*
18. Find the column labeled LDUSE_LID and change its Mapping field to *Land use*
19. Select *Next*
20. Select *Finish*
21. Select *LU future 1* in the Project Explorer to activate it
22. Hide *ExistingCondition.shp* by un-checking its box in the Project Explorer
23. Switch to the *GIS* module
24. Select ***Data | Add Shapefile Data***
25. Open *“LU_future1.shp”*
26. Choose the *Select Shapes* tool
27. Draw a selection box around the two basins (the extents of the watershed area)

By drawing a selection box around the extents of our watershed area, we select all land use polygons that overlap our watershed.

28. Select ***Mapping*** | ***Shapes -> Feature Objects***
29. Select *Next*
30. Notice that in this case, the LU_CODE field was automatically mapped to the Land use attribute
31. Select *Next*
32. Select *Finish*
33. Activate the LU future 2 coverage in the Project Explorer
34. Hide *LU_future1.shp* by un-checking its box in the Project Explorer
35. Switch to the *GIS* module
36. Select ***Data | Add Shapefile Data***
37. Open *“LU_future2.shp”*

38. Choose the *Select Shapes* tool
39. Draw a selection box around the two basins (the extents of the watershed area)
40. Select ***Mapping* | *Shapes -> Feature Objects***
41. Consecutively select *Next*, *Next*, and *Finish*
42. Activate the Soil Type coverage in the Project Explorer
43. Hide *LU_future2.shp* by un-checking its box in the Project Explorer
44. Switch to the *GIS* module
45. Select ***Data | Add Shapefile Data***
46. Open *"soilwhitetanks.shp"*
47. Choose the *Select Shapes* tool
48. Draw a selection box around the two basins (the extents of the watershed area)
49. Select ***Mapping | Shapes -> Feature Objects***
50. Select *Next*
51. Find the column labeled SLTYP_LID and change its Mapping field to *SCS soil type*
52. Select *Next*
53. Select *Finish*
54. Hide *soilwhitetanks.shp* by un-checking its box in the Project Explorer

4.5 Computing Losses

1. Switch to the *Hydrologic Modeling* module
2. Select ***Calculators | Compute GIS Attributes***
3. Change the Computation field to *Green-Ampt parameters*
4. Select the *Land use mapp*ing option at the bottom
5. Click the *Import* button
6. Open *"landusemagtable.tbl"*
7. Select the *Soil type mapping* option
8. Click the *Import* button
9. Select *OK* if you receive a warning that any previous tables will be replaced
10. Open *"soiltable.tbl"*
11. Set the land use coverage name field to *LU Existing*
12. Select *OK*

We have computed the losses for the existing land use conditions. Later, when we want to compute runoff values for the future scenarios, we will simply re-compute losses in the Compute GIS Attributes calculator.

5 Run HEC-1 for Existing Conditions

1. Select ***HEC-1 | Run Simulation***
2. Click the browse button next to the Input File
3. For the file name enter "*Mp_existing*" and click *Save* (this specifies the file name but does not actually save it)
4. Verify that the Save file before run is toggled on
5. Select *OK*
6. Select *Close* when the HEC-1 simulation finishes
7. Double-click on the most downstream hydrograph icon (farthest to the right)
8. The hydrograph shows that for the existing land use conditions, the peak runoff for a 50 year, 6 hour storm is approximately 1260 cfs.
9. Close the hydrograph plot window

6 Run HEC-1 for the Proposed Conditions

1. Select ***Calculators | Compute GIS Attributes***
2. Change the land use coverage name to *"LU future 1"*
3. Change the Computation field to *Green-Ampt parameters*
4. Select *OK*
5. Select ***HEC-1 | Run Simulation***
6. Click the browse button next to the Input File
7. For the file name enter "*MP_future1*" and click *Save* (this specifies the file name but does not actually save it)
8. Verify that the Save file before run is toggled on
9. Select *OK* to run HEC-1
10. Select *Close* when the HEC-1 simulation finishes
11. Double-click on the most downstream hydrograph icon
12. In the upper left-hand corner of the Plot Window, note that the peak runoff has increased to 1440 cfs. This new hydrograph is superimposed over the previous one. We can zoom in on a portion of the hydrographs and/or maximize the Plot Window to enlarge the graph(s).
13. Drag a box around the peaks of the hydrographs
14. Right-click anywhere within the Plot window and select ***Maximize Plot***

15. Press the ESC key to return the Plot window to its original size
16. To view the entire hydrographs once more, right-click anywhere within the Plot Window and select ***Frame Plot***
17. Close the plot window
18. Select ***Calculators | Compute GIS Attributes***
19. Change the land use coverage name to *“LU future 2”*
20. Select *OK*
21. Select ***HEC-1 | Run Simulation***
22. Click the browse button  next to the Input File
23. For the file name enter “*MP_future2*” and click *Save* (this specifies the file name but does not actually save it)
24. Verify that the *Save file before run* is toggled on
25. Select *OK* to run HEC-1
26. Select *Close* when the HEC-1 simulation finishes
27. Double-click on the most downstream hydrograph icon
28. Notice that the peak runoff for LU future 2 (1460cfs) is slightly higher than for LU future 1. The results we are viewing in the plot window can be exported as tabular data.
29. Right-click within the Plot window and select ***Export/Print***
30. Change the Export type to *Text / Data Only*
31. Change the Export destination to *File*
32. Click the *Browse* button
33. Specify a path and filename
34. Click the *Export* button
35. Leave the options at the default settings and click the *Export* button

The exported data can now be opened in a spreadsheet editor for further manipulation. Another effective way to view HEC-1 results is to browse the HEC-1 output file (*.out), which can be viewed with any text editor. Also, if HEC-1 had not terminated successfully, then checking the (*.out) file might reveal possible errors and/or warnings.

