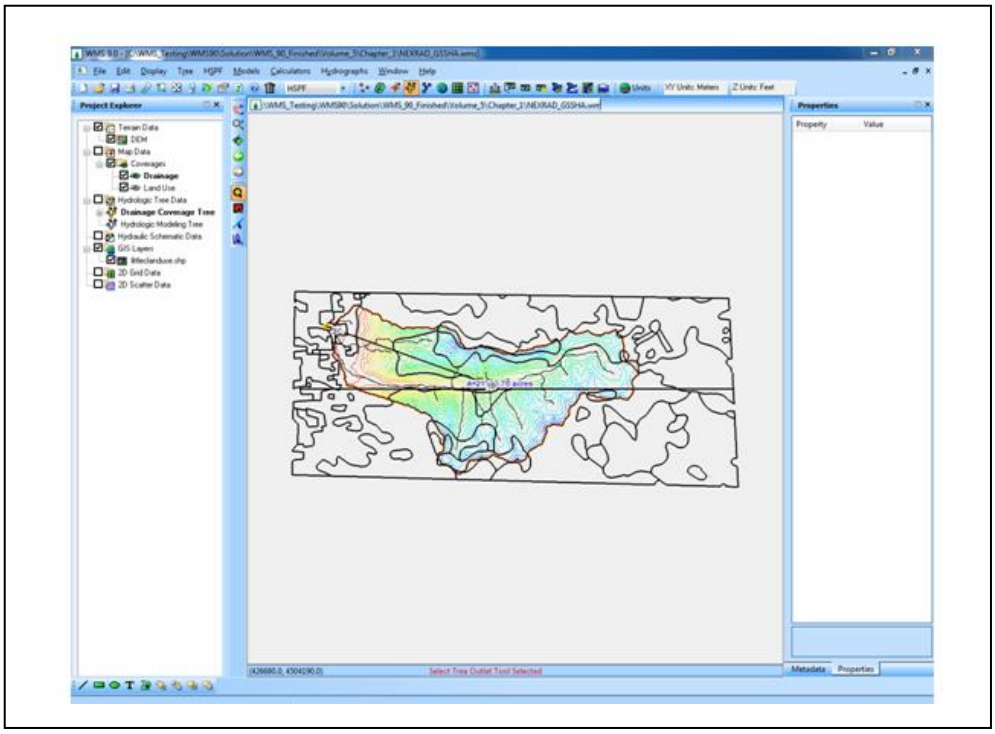
WMS

v. 10.1

WMS 10.1 Tutorial

Water Quality Modeling – HSPF Interface

Setup a basic HSPF model



Objectives

Read a delineated watershed and setup and run an HSPF model for the watershed.

Prerequisite Tutorials

- Watershed Modeling – DEM Delineation
- Watershed Modeling – Time of Concentration Calculations and Computing a Composite CN

Required Components

- Data
- Drainage
- Map
- Hydrology
- Hydrologic Models

Time

- 30-60 minutes

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1 Introduction

This chapter demonstrates how WMS can be used to process digital elevation and land use data to develop an HSPF input (.uci) file. The graphical user interface used to define input parameters is demonstrated for a basic hydrology simulation that includes doing the following:

- Delineating watershed segment boundaries from a digital terrain model and USGS land use file
- Defining segment parameters for a hydrologic analysis
- Developing reach segment parameters
- Defining precipitation time series data from standard WDM database files
- Entering mass links to define transformations from basin to reach

2 Opening the Watershed and Initializing the HSPF Model

Open a watershed that has been delineated from a USGS DEM in GridFloat format downloaded from USGS' seamless DEM web site at http://seamless.usgs.gov.

1. Open WMS. If WMS is already open select *File* | **New** then click **No** if asked to save changes.
2. Select *File* | **Open**  to access the *Open* dialog.
3. Locate the "hspf" folder in the files for this tutorial. If needed, download the tutorial files from www.aquaveo.com.
4. **Open** the file named "lc.wms".

The watershed will appear on the screen with the area displayed in the center of the basin. This indicates that the Basin Data has been computed and is ready to set up the HSPF model. To initialize the model:

5. Make sure that the projections are correct by right-clicking "DEM" under "Terrain Data" in the Project Explorer, then selecting *Projection* | **Projection**.
6. In the *Projection* dialog, ensure that the *Horizontal* and *Vertical Units* are both set to "Meters". After checking, click **OK**.

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7. Switch to the **Hydrologic Modeling** module.
8. Choose "HSPF" from the *Model* drop-down list at the top of the screen.
9. Select *HSPF* **|** **New Simulation**.
10. Select *HSPF* **|** **Global Options**. The *HSPF Global Options* dialog will appear.

Now enter the parameters to indicate that the model will simulate about 3 years of time with a time step of 1 day. Name the model, choose the units to use, specify output levels, and name the input/output files:

11. Enter "Little Cottonwood Canyon Model" in the *Title* field.
12. Set the *Start Time* to January 1, 1996 ("1/1/1996") with Hour: 0, Minute: 0, Second: 0.0 ("12:00:00 AM").
13. Set the *End Time* to July 31, 1999 ("7/31/1999") with Hour: 0, Minute: 0, Second: 0.0 ("12:00:00 AM").
14. Enter "24" in the *hours* field under the Time step heading (leave *minutes* at "0").
15. Ensure that the *Units flag* is set to "English".
16. Change the *Run Flag* to "1"; this indicates that HSPF will interpret the data and run the simulation (0 indicates that HSPF will only interpret – error check – the data).
17. Set the *OUTLEV* to "10" (under *Output Levels*); this indicates maximum output to the Error and Warning files. Leave the *SPOUT* flag at "0" (this is only for Special Actions).
18. In the *Files* section, enter "littleco" in the *Prefix* field, then click the **Update File Names** button. This names all the HSPF input/output files associated with this model to the same name.

Note that the file "littleco.wdm", to be used for time series input and output, must be created and named appropriately outside of WMS (this has been done already, in this case). Create a ".wdm" (watershed data management) file using the WDMUtil program installed when installing HSPF from the WMS installation.

19. Select **OK** to close the *HSPF Global Options* dialog.

The Global Options are now set for the model. Everything is now ready to proceed with segmenting the watershed and entering parameters for the segments.

3 Importing Land Use and Segmenting the Watershed

To divide this watershed into hydrologically similar segments, overlay a land-use data layer. Import this data from an ArcView Shapefile:

1. Select *File* **|** **Open** to access the *Open* dialog.
2. Open the file named "littleclanduse.shp".
3. Right-click on the "Coverages" folder in the Project Explorer and select **New Coverage**.
4. Change the *Coverage type* to "Land Use" and click **OK** in the *Properties* dialog.

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5. Switch to the **GIS** module.
6. Select *Mapping* **|** **Shapes → Feature Objects**.
7. Select **Yes** to use all available shapes.
8. Select **Next** in the *GIS to Feature Objects Wizard*.
9. Ensure that *LUCODE* is mapped to "Land Use".
10. Select **Next** and then **Finish**.
11. Turn off the display of "littleclanduse.shp" by deselecting it in the Project Explorer.

Notice the land use data polygons overlaid on the watershed. Everything is now ready to compute HSPF segments based on the land use polygons that fall inside the watershed.

12. Switch to the **Hydrologic Modeling** module.
13. Select *Calculators* **|** **Compute GIS Attributes**.
14. The *Compute GIS Attributes* dialog will open. Choose "HSPF Segments" from the *Computation* drop-down list.
15. In the central section of the dialog, ensure that "coverage" appears next to "Use a" text and that "Land Use" is the selected *Land use coverage name*.
16. A text file that correlates the land use ID to land use attributes (name, perviousness, etc.) must be read in. Click the **Import** button to browse for this file.
17. Select **OK** to overwrite existing land use table.
18. Open the file named "littleclanduse.txt".
19. Choose **OK** in the *Compute GIS Attributes* dialog to compute the HSPF segments.
20. Click **OK** if warned that "Continuing will delete all HSPF segment data".
21. Deselect the toggle box next to the "Land Use" coverage in the Project Explorer.
22. Select the "Drainage" coverage in the Project Explorer to make it the active coverage.

4 Aggregating Segments

Note from the display that there are several land segments in the watershed. Some are quite large, such as the Evergreen Forest Land segment, while others are rather insignificant, like Bare Exposed Rock. To make this simulation simpler, aggregate some of these segments.

1. Switch to the **Hydrologic Modeling** module.
2. Double-click on the basin icon (or select it and then select *HSPF* **|** **Edit Parameters**).

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3. Note in the *HSPF Segments* dialog the list of segments in the Basin Data window. There are 8 separate segments (or land use classifications) in this watershed.

To reduce the number of segments computed by WMS, first delete one segment, and then add the area of the deleted segment, manually, to another similar segment.

4. Choose the segment entitled *Other Urban* from the *Land segments* window. Note that the area is 57.89 acres – insignificant in this watershed. Delete this area and add it to the *Shrub & Brush Rangeland* segment to aggregate these segments.
5. Select the **Delete** button.
6. Click **Yes** for the message that asks if the segment is to be removed from further use.
7. Repeat these steps for the segment entitled *Bare Ground*. Note the area of 378.73 for the *Bare Ground* segment.
8. Enter a new area of "7999.06" to the *Shrub & Brush Rangeland* segment.
9. Delete the *Mixed Forest* segment and add its area to the *Evergreen Forest* segment. The new total area for the *Evergreen Forest* segment will be "12162.63" acres.
10. Delete the *Bare Exposed Rock* segment and add its area to the *Mixed Tundra* segment. The new total area for the *Mixed Tundra* segment will be "1189.25" acres.

There are now four remaining land segments. These are the segments for which input parameters must be entered in order to simulate with HSPF.

5 Defining Land Segment Parameters

It is now time to begin defining parameters for the land segments of the HSPF model. This model will be set up for purely hydrologic analysis, so parameters for only the SNOW and WATER modules of HSPF will be activated and have data entered. Further, to decrease the time needed to complete the exercise, fully set up one segment then copy those parameters to the other 3 in the model. Do the following to complete these tasks:

1. Choose the *Evergreen Forest* segment from the *HSPF Segments* dialog.
2. Click the **Define…** button for this segment to bring up the *HSPF* dialog.
3. Click the boxes next to *Snow (SNOW)* and *Water (PWAT)* to checkmark them.

The Snow and Water modules have just been activated for this land segment (*Evergreen Forest*). Now enter the parameters for each active module to allow HSPF to simulate the segment correctly.

4. Click on the *Snow (SNOW)* text to highlight it.
5. Toggle between the tabs to enter the following values in the appropriate fields (leave other fields as the default values; these values are either generally recommended values or HSPF defaults):

SNOW-INIT1	SNOW-INIT2	SNOW-PARM1	SNOW-PARM2
Pack-snow = 4.0 in	SKYCLR = 1.0	LAT = 40.5°	TSNOW = 35.0° F

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Pack-ice = 2.0 in Pack-watr = 2.0 in		MELEV = 8410.8 ft SHADE = 0.40	MWATER = 0.2

NOTE: These values were extracted from meteorological datasets.

6. Now that all values are entered for this segment, click the **Apply Parameters to Segments** button. This allows assigning these same parameters to other segments in the model.
7. The *Select Segments* dialog will appear. Choose "Shrub & Brush Rangeland" in the *Available Segments* window; move it to the *Selected Segments* window by clicking the → button.
8. Repeat for "Residential" and "Mixed Tundra".
9. Click **OK**. The selected segments will be assigned the same parameters input here.

The final step in entering parameters for a module in HSPF is to define time series input (External Sources) and time series output (External Targets). For the land segments in this model, define External Sources for input data, but no External Targets will be specified. Choose output to be given at the outlet of the watershed, not at each land segment.

10. Click on the **External Sources** button with the *Snow (SNOW)* module highlighted. The *Assign External Sources* dialog will appear with a list of the datasets available in the WDM file specified for this model ("littleco.wdm").
11. If the dialog is empty (there may be a warning message that the file is not there), open the "littleco.wdm" file and click **OK**.
12. Assign the following datasets as sources by setting the fields to the appropriate values, then clicking the **Assign** button for each line.
13. If a mistake is made, choose the incorrect line in the lower window and click **Delete**.

Member Name	Units	Missing Data	Transfor-mation	Quality Flag	Multiplication Factor	Dataset
PREC	ENGL	UNDF	SAME	0	0.25	3
PREC	ENGL	UNDF	SAME	0	0.75	7
DTMPG	ENGL	UNDF	AVER	0	1.0	14
WINMOV	ENGL	UNDF	AVER	0	1.0	15
SOLRAD	ENGL	UNDF	SAME	0	1.0	16
AIRTMP	ENGL	UNDF	AVER	0	0.4	17
AIRTMP	ENGL	UNDF	AVER	0	0.6	18

14. Since other External Sources will be added to this segment with the PWAT module input, the External Sources will not be assigned to other segments yet. Click **Done** to return to the *HSPF* dialog.

The set up of the *SNOW* module is complete. Now repeat the same basic steps to set up the PWAT module for the land segments of the model.

15. Click on *Water (PWAT)* to highlight it.
16. Toggle between the tabs to enter the following values in the appropriate fields (leave other fields as the default values):

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PWAT-PARM1	PWAT-PARM2	PWAT-PARM3	PWAT-PARM4	PWAT-STATE1
CSNOFG = On RTOPFG = On UZFG = On	LZSN = 5.0 INFILT = 0.48 LSUR = 2258.0 SLSUR = 0.25 KVARY = 0.7 AGWRC = 0.997	DEEPFR = 0.1 PETMAX = 35.0 PETMIN = 30.0	CEPSC = 0.1 UZSN = 1.0 NSUR = 0.25 INTFW = 3.0 IRC = 0.7 LZETP = 0.8	CEPS = 0.2 UZS = 1.0 LZS = 6.0 AGWS = 1.6 GWVS = 1.9

17. Now that all values are entered for this segment, click the **Apply Parameters to Segments** button. This allows to assigning these same parameters to other segments in the model.
18. The *Select Segments* dialog will appear. Choose "Shrub & Brush Rangeland" in the *Available Segments* window; move it to the *Selected Segments* window by clicking the → button.
19. Repeat for "Residential" and "Mixed Tundra".
20. Click **OK**. The selected segments will be assigned the same parameters input here.

Now define the additional External Sources needed for the PWATER simulation. Most of the External Sources entered for the SNOW module are also used for the PWATER module, but there is one input series that is not yet entered.

21. Click on the **External Sources** button with the *Water (PWAT)* module highlighted. The *Assign External Sources* dialog will appear with the sources created for this segment in the SNOW module listed in the lower window.
22. Assign the following dataset (evapotranspiration) as a source by setting the fields to the appropriate values, then clicking the **Assign** button.
23. If a mistake is made, choose the incorrect line in the lower window and click **Delete**.

Member Name	Units	Missing Data	Transfor-mation	Quality Flag	Multiplication Factor	Dataset
PETINP	ENGL	UNDF	SAME	0	1.0	23

All the External Sources needed for the simulation are now assigned to this segment. Now copy these same External Sources to all other land segments in the model.

24. Click the **Apply Sources to Segments** button. This allows assigning these same External Sources to other segments in the model.
25. The *Select Segments* dialog will appear. Choose "Shrub & Brush Rangeland" in the *Available Segments* window; move it to the *Selected Segments* window by clicking the → button.
26. Repeat for "Residential" and "Mixed Tundra".
27. Click **OK**.
28. Select **Done** in the *Assign External Sources* dialog, then select **OK** in the *HSPF* dialog.

The *HSPF Segments* dialog should now be active. The SNOW and PWATER modules have been successfully set up for all land segments in the model (the modules were explicitly set up for the Evergreen Forest segment and then the parameters were copied to

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all other segments). Feel free to review the set up for the other segments by choosing the segment in the Basin Data window, then clicking the Define Activities button and reviewing the SNOW and PWATER input.

Now that the land segment data is complete, enter data for the reach (stream) segment of the model.

29. Click **Done** to close the dialog.

6 Defining Reach Segment Parameters

To simulate runoff in-stream, activate the HYDR module for the reach segment of the model. Also specify the output dataset needed (a hydrograph in this case) to view the results of the simulation.

1. Double-click on the watershed outlet in the Graphics Window (this can be done while the *HSPF Segments* dialog is still present by only single-clicking the outlet). The *HSPF Segments* section of the *HSPF Segments* dialog will become active and display the name of the outlet chosen (3C).
2. Click on the **Define…** button for this segment. The *HSPF* dialog will open.
3. Check the box to activate the *Hydraulics (HYDR)* module of HSPF for this reach.
4. Toggle between the tabs to enter the following values in the appropriate fields (leave other fields as the default values):

HYDR-PARM1	HYDR-PARM2
ODFVFG = 4	Length = 13.82 DeltaH = 2200.0

The next input to be entered is the FTABLE for the reach. The FTABLE is a spreadsheet-like table that contains the conveyance parameters of the reach (depth, area, volume, and outflow). This table may be calculated manually or with the help of the Channel Calculator in WMS.

5. Click on the **Define** button under the *FTABLE* row in the *HYDR-PARM1* tab.
6. In the *FTABLE* dialog that appears, enter the following values (it is possible to change the number of rows and columns in the FTABLE, but the default values will be sufficient in this case. These values are saved in a text file called "ftable.txt" in the hspf directory of the tutorials. Open this file, copy the data, and paste the data to the FTABLE dialog:

Depth (ft)	Area (ac)	Volume (ac-ft)	Outflow (cfs)
0.0	0.0	0.0	0.0
0.25	25.99	6.393	13.876
0.5	26.828	12.995	43.954
0.75	27.666	19.807	86.269
1.0	25.50	26.828	139.241
1.25	29.340	34.059	201.950
1.5	30.181	41.499	273.794
1.75	31.019	49.150	354.355
2.0	31.858	57.009	443.334
2.25	35.211	90.540	879.902

7. Click **OK** to save the FTABLE.

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The final task in defining the reach parameters is to specify the desired output from the reach and select where HSPF will write the output. This is done by defining an External Target. Specify that a hydrograph should be output to a dataset in the WDM (*littleco.wdm*) file for this reach.

8. With the *HYDR* option selected, click on the **External Targets** button.
9. Set the following fields to the specified values:

Member Name	Units	Access	Aggreg-ation	Multiplication Factor	Quality Flag	Transformation Function
RO	ENGL	REPL	Aggregate	1.0	0	AVER

10. Select the *Use existing dataset* option.
11. Click on the **Select Dataset** button.
12. In the *Select WDM Time Series* dialog, scroll down and select dataset "20 (Flow)", then click the **OK** button
13. The *Dataset name*, *type*, and *number* should appear in the *Assign External Targets* dialog.
14. Click **Assign** to add the External Target line to the lower window.
15. Click **Done**.

The HYDR module in this reach has now been completed. This will be the only module active for this simulation, so exit the dialogs.

16. Click **OK** in the *HSPF* dialog, then click **Done** in the *HSPF Segments* dialog.

The input for all land and reach segments is now complete in the model. The last task before saving and running the HSPF model is to assign Mass Links.

7 Creating Mass Links

Mass Links control how materials (water, sediment, constituents) are transferred from land segments to reaches, and from one reach to the next. Conversions in units, such as inches/acre per day of runoff to cubic feet per second, are defined in the Mass Links also. Enter Mass Links to transfer water from land to reach and from reach to reach for this model.

1. Select *HSPF* **| Mass Link Editor**.
2. When entering the *Mass Link Editor* window, it is set to begin adding/deleting mass links for PERLND segments. Set the fields to the values below:

Volume Name	Volume Group	Volume Member Name	Multiplication Factor	Target Name	Target Group	Target Member Name
PERLND	PWATER	PERO	0.08333	RCHRES	INFLOW	IVOL

NOTE: 0.08333 is the conversion for inches/acre per day to cfs.

3. Click **Add Link** (if a mistake is made, select the link in the window and click the Delete Link button).
4. Change the *Segment Type* (upper left) to "IMPLND".
5. Set the fields to the values below:

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Volume Name	Volume Group	Volume Member Name	Multiplication Factor	Target Name	Target Group	Target Member Name
IMPLND	IWATER	SURO	0.08333	RCHRES	INFLOW	IVOL

6. Click **Add Link**.
7. Change the *Segment Type* (upper left) to "RCHRES".
8. Set the fields to the values below:

Volume Name	Volume Group	Volume Member Name	Multiplication Factor	Target Name	Target Group	Target Member Name
RCHRES	HYDR	ROVOL	1.00	RCHRES	INFLOW	IVOL

9. Click **Add Link**.

The Mass Links needed for PERLND, IMPLND, and RCHRES segments are set up. Now save and run the model

10. Click **OK** to exit the *Mass Link Editor*.

8 Saving and Running an HSPF Simulation

The last step is to save and run the HSPF UCI (User control input) file.

1. Select *HSPF* **| Save HSPF UCI File…**
2. Select **Save** in the *Select UCI filename* dialog.

WMS will save the HSPF UCI file. Save the project from WMS, close WMS, and try running the project in either WinHSPF or WinHSPFLt. WinHSPF and WinHSPFLt are installed when HSPF is installed during the WMS installation. If trying to run the UCI file from WinHSPF while WMS is open, an error will occur. Both WMS and WinHSPF are trying to access the WDM file associated with the UCI file, and only one program can access the WDM file at a time.

TIP: HSPF cannot read WDM files in folders with long path/file names (combined path/file names longer than 64 characters). If the WDM file is located in a folder with a long path name, move the .wdm file to another folder with a short path name (such as "c:\models\hspf") and save the .uci file from WMS here. Then save the WMS project file, close WMS, read the .uci file into WinHSPF or WinHSPFLT, and run the model.

9 Conclusion

This tutorial demonstrated how to use WMS to process digital elevation and land use data to develop an HSPF input (.uci) file. The following topics were discussed:

- Delineate watershed segment boundaries from a digital terrain model and USGS land use file
- Define segment parameters for a hydrologic analysis
- Develop reach segment parameters
- Define precipitation time series data from standard WDM database files
- Enter mass links to define transformations from basin to reach

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